



CHOC Children's Hospital
Best Evidence and Recommendations

Chest X-rays Only When Clinically Indicated after Chest Tube Removal

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PICO: In inpatient pediatric medical-surgical patients following chest tube removal, what is the impact of performing clinically indicated chest x-rays compared to routine chest x-rays (CXRs) on clinical outcomes, cost of care, and patient exposure to radiation?

P (Population/problem): In inpatient pediatric medical-surgical patients following chest tube removal
I (Intervention/issue): what is the impact of performing clinically indicated
C (Comparison): compared to routine CXRs
O (Outcome): on clinical outcomes, cost of care, and patient exposure to radiation?

Background:

Chest (thoracostomy) tube placement is a common surgical intervention for the management of trauma, primary lung disorders, and pleural space disease (Cunningham et al, 2014). Examples of indication for chest tubes are post-surgical drainage, pneumothorax, pleural effusion, hemothorax, chylothorax, and pyelothorax (empyema). Chest tubes can be placed in the operating room, in the emergency department, in the intensive care unit (ICU), or in interventional radiology. A chest tube is removed when the primary indication for placement has resolved or improved. This is evidenced by CXR interpretation, decreased chest tube drainage, and absence of an air leak. Routine CXRs after chest tube removal are often performed to evaluate for post-procedural development of new or worsening pre-existing trace pneumothorax, hemo/pyelo/chylo-thorax, or pleural effusion. When these findings are present and significant, chest tube reinsertion may be indicated. However, chest tube reinsertion is uncommon, and tube replacement is often completed secondary to symptoms rather than to CXR findings (Cunningham, et al, 2014). CXR after chest tube removal rarely changes patient management (Johnson et al, 2017), raising the question of whether routine imaging following chest tube removal is necessary.

The Image Gently Alliance is a coalition of health care organizations dedicated to providing safe, high quality pediatric imaging worldwide. Members include the American Academy of Pediatrics and the Society for Pediatric Radiology. The Alliance recommends x-rays when there is a clear medical benefit, and repeating images only when necessary (Image Gently Alliance, n.d., p. 2). The American College of Radiology's Appropriateness Criteria for ICU patients (2014) states, "A routine chest radiograph is not recommended following chest tube removal, unless indicated by clinical presentation" (p. 4).

The amount of radiation in a single-view CXR is fairly minimal, equivalent to 3 days of natural radiation exposure, and there is no known certainty of its associated long-term cancer risks

(World Health Organization, 2016). Because CXRs are relatively low in cost and radiation, they are often obtained without regard to its significance, and whether results will change clinical management. It is important to consider the cumulative effects of these repeated CXRs. In addition to the radiation



exposure, CXRs utilize radiology, medical, and nursing resources, and interrupt patient care (Woodward, 2013).

CHOC Children's Hospital does not currently have a standardized, evidence-based approach to post chest tube removal imaging. The organization's standardized procedure on chest tube removal states that a "CXR is obtained 3-24 hours after removal in the acute care setting and as clinically indicated in the intensive care units." The spontaneous pneumothorax care guideline specifically recommends performing a CXR four hours after chest tube removal in that patient population. Medical-Surgical patients with surgically placed chest tubes, chest tubes placed in the ICU, or ultrasound-guided pigtail chest tubes placed in Interventional Radiology, are primarily managed by the general surgery service. These chest tubes are removed by general surgery nurse practitioners, surgical residents, and attending surgeons, following the chest tube removal policy. It has been routine practice to obtain a CXR following all chest tube removals to rule out post-procedural complications such as the development of a new or worsening of a pre-existing trace pneumothorax, hemo/pyelo/chylo-thorax, or pleural effusion. This follow up film is ordered as early as 4 hours, to as late as the following morning. The follow up film is reviewed, and if there are no new significant findings, and the patient is asymptomatic, the patient can be surgically cleared for discharge home.

Over the last two calendar years (7/2015-7/2017), there were 144 patients with chest tubes, cared for in the medical-surgical units at CHOC Children's. These patients, on average, had 9 CXRs performed during their hospital stay, which does not include the CXRs that may have been performed prior to admission, either at an outside hospital, or in an emergency department. The estimated patient cost of a single-view CXR at CHOC is \$618. Eliminating one CXR following chest tube removal would result in a savings of approximately \$44,500 annually. This amount is negligible in the grand scheme of hospital expenses, but the cost-savings is not merely in dollars. Time and resources are required to transport a patient to radiology, or have a radiology technologist travel to the patient room, to have a radiologist interpret the film and dictate a report. The elimination of one CXR would also decrease patient exposure to the harmful effects of unnecessary radiation.

The purpose of this evidence-based practice project is to present comprehensive literature review findings that support the practice of limiting CXRs after CT removal to those that are clinically indicated. It is recognizing the importance of the pediatric surgery clinician's clinical assessment skills to help identify patients who are stable, versus patients who may possibly be developing post-procedural complications after CT removal. It is also identifying the associated reduction of radiation exposure for pediatric patients, and savings of financial cost, time, and resources for the hospital.

Search Strategies and Databases Reviewed:

- Databases searched for this review included CINAHL, Medline in EBSCO and Pub Med. Key search words: Pediatric, chest tube removal, chest drain removal, thoracostomy tube removal, chest x-ray, chest radiograph, and imaging. This search yielded 13 articles describing CXRs following chest tube removal.
- Websites reviewed included the World Health Organization, Image Gently Alliance, Joint Commission, American Association of Critical Care Nurses, and American Academy of Pediatrics.
- Patient sample data obtained from CHOC Cerner database.
- A listserv survey through NAPNAP and APSNA, and messages via LinkedIn were sent to pediatric surgical nurse practitioners from key children's hospitals across the nation regarding this topic. This survey yielded 14 responses.



Synthesis of the Evidence:

- Several studies from 2000-2017 provided evidence that routine CXR after chest tube removal are not necessary. Literature review was narrowed down to a critical appraisal of 13 studies.
- Studies vary in their sample population, including both adult participants and pediatric participants. Indication for chest tube varied in the studies as well, ranging from spontaneous pneumothorax, pleural effusion, hemothorax, empyema, thoracic trauma, cardiac surgery, and various types of thoracic surgery.
- Some of the studies targeted cardiac surgical patients, thoracic surgery patients, trauma patients, and some were a mixed sample, or non-specific.
- Cumulative findings of the 13 studies supported the practice of performing CXRs following chest tube removal based on good clinical judgment and discrimination of the surgeon, and used as an adjunct to suspected clinical conditions (Palesty et al, 2000).
- The most recent study (McGrath et al, 2017) was a 3-year, retrospective chart review of pediatric general surgery patients with chest tubes and post-removal CXRs. Only 0.7% of 281 patients required a significant intervention (chest tube replacement; re-intubation). Interventions were based on clinical changes, and both had benign post-removal CXRs. The re-intubation patient was unrelated to the chest tube removal. Boston Children's Hospital has since made a practice change to limit post-pull CXRs to patients with a change in respiratory status, any other clinical concern, or at the request of the provider/surgeon.
- Altering the practice of performing only clinically indicated CXRs may lead to a significant cost savings, and yield other benefits such as eliminating unnecessary interventions on asymptomatic patients (Pacharn et al, 2002) and reducing pain and discomfort associated with obtaining CXRs without adverse impact on outcomes (McGrath et al, 2017).
- Pediatric hospitals across the country were surveyed regarding their current practice related to post-pull CXRs. Of 14 responses from varying pediatric hospitals, only 7 continue to obtain routine post-pull CXRs. The remaining have adopted the practice of ordering CXRs only if patients exhibit clinical changes in respiratory status, or if removal of the chest tube did not go smoothly, eliciting concerns.

Practice Recommendations:

- CXRs following chest tube removal should be performed as an adjunct to clinical assessment, when clinical signs and symptoms, history, or difficulty of chest tube removal warrant concern for post-procedure complications, or at the surgeon's discretion (Eisenberg et al, 2011; Goodman et al, 2010; McGrath et al, 2017; Palesty et al, 2000).
- There are some patient groups that would be exempt from omitting post-pull CXRs, which include those who are mechanically ventilated, those who cannot adequately express clinical changes (Goodman et al, 2010), and cardiac surgery patients, whose chest tubes are managed by the Cardiothoracic Surgery team.
- Patients should be closely monitored for the development of clinical signs and symptoms of respiratory distress (respiratory rate higher than normal for age, oxygen saturation below 92% in room air, decreased breath sounds on auscultation, chest pain, increased work of breathing, or shortness of breath) for 4 hours post-pull prior to discharge home (Johnson, 2017).
- Make recommendations for the modification of CHOC's Chest Tube Policy, Chest Tube Removal policy, and Spontaneous Pneumothorax care guidelines, to reflect evidence-based practice changes.



Evidence-Based Practice Follow Up:

- Collect data on patients with chest tubes that are managed by the Surgery team.
 - Indication for chest tube
 - Type of chest tube placed: Pigtail chest drain versus surgically placed chest tube
 - CXR findings prior to chest tube removal
 - Was a post-pull CXR ordered? If so, why?
 - Any signs/symptoms of respiratory distress after chest tube removal
 - Any post-pull interventions performed
 - Disposition after chest tube removal
- Review data collected to determine whether eliminating routine CXRs after chest tube removal at our institution supports pre-existing evidence-based literature findings.
- Determine what barriers there are to eliminating routine post-pull CXRs.
- Compare number of CXRs ordered for patients with chest tubes after implementing the practice change of eliminating routine CXRs after chest tube removal.
- Will consider synthesizing data collected to compose an article for future journal submission.

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Bibliography:

- American College of Radiology. (2014). *American College of Radiology Appropriateness Criteria: Intensive Care Unit Patients*. Retrieved from <http://www.acr.org/ac>.
- Cunningham, J., Knott, E., Gasior, A., Juang, D., Snyder, C., St. Peter, S. & Ostlie, D. (2014). Is routine chest radiograph necessary after chest tube removal? *Journal of Pediatric Surgery*, 49, 1493-1495.
- Eisenberg, R. & Khabbaz, K. (2011). Are chest radiographs routinely indicated after chest tube removal following cardiac surgery? *American Journal of Radiology*, 197, 122-124.
- Goodman, M., Huber, M., Johannigman, J. & Pritts, T. (2010). Omission of routine chest x-ray after chest tube removal is safe in selected trauma patients. *The American Journal of Surgery*, 199, 199-203.
- Image Gently Alliance. (n.d.). *X-rays for children: What parents should know about radiation protection in medical imaging*. Retrieved from http://www.imagegently.org/Portals/6/Parents/Im_Gently_XRAY_2pg_English.pdf.
- Johnson, B., Rylander, M. & Beres, A. (2017). Do x-rays after chest tube removal change patient management? *Journal of Pediatric Surgery*, 52(5), 813-815.
- Khan, T., Chawla, G., Daniel, R., Swamy, M. & Dimitri, W. R. (2008). Is routine chest X-ray following mediastinal drain removal after cardiac surgery useful? *European Journal of Cardio-thoracic Surgery*, 34, 542-544.



- McGrath, E., Ranstrom, L., Lajoie, D., McGlynn, L. & Mooney, D. (2017). Is a chest radiograph required after removal of chest tubes in children? *Journal of Pediatric Health Care*, 31(5), 588-593.
- Pacanowski, J., Waack, M., Daley, B., Hunter, K., Clinton, R., Diamond, D. et al. (2000). Is routine roentgenography needed after closed tube thoracostomy removal? *The Journal of Trauma: Injury, Infection and Critical Care*, 48(4), 684-688.
- Pacharn, P., Heller, D., Kamman, B., Bryce, T., Reddy, M., Bailey, R., et al. (2002). Are chest radiographs routinely necessary following thoracostomy tube removal? *Pediatric Radiology*, 32, 138-142.
- Palesty, J., McKelvey, A. & Dudrick, S. (2000). The efficacy of x-rays after chest tube removal. *American Journal of Surgery*, 179, 13-16.
- Sepehrpour, A., Farid, S. & Shah, R. (2012). Is routine chest radiography indicated following chest drain removal after cardiothoracic surgery? *Interactive CardioVascular and Thoracic Surgery*, 14, 834-838.
- van den Boom, J. & Battin, M. (2007). Chest radiographs after removal of chest drains in neonates: Clinical benefit or common practice? *Archives of Disease in Childhood, Fetal & Neonatal Edition*, 92, F46-F48.
- Whitehouse, M., Patel, A. & Morgan, J. (2009). The necessity of routine post-thoracostomy tube chest radiographs in post-operative thoracic surgery patients. *Surgeon*, 7(2), 79-81.
- Woodward, C., Dowling, D., Taylor, R. & Savin, C. (2013). The routine use of chest radiographs after chest tube removal in children who have had cardiac surgery. *Journal of Pediatric Health Care*, 27, 189-194.
- World Health Organization (2016). Communicating radiation risks in paediatric imaging: Information to support healthcare discussion about benefits and risks. Retrieved from http://www.who.int/ionizing_radiation/pub_meet/radiation-risks-paediatric-imaging/en/.