

Is a Chest Radiograph Required After Removal of Chest Tubes in Children?

Ellen McGrath, PNP, Lee Ranstrom, PNP, Debra Lajoie, PhD, RN, Lauren McGlynn, PNP, & David Mooney, MD, MPH

ABSTRACT

Our objective was to determine the clinical value of obtaining a chest radiograph after removal of a chest tube. We conducted a retrospective chart review of pediatric general surgical patients with a chest tube in place after a thoracic procedure over a 3-year time period. Postremoval films were considered to be of value if they led to a change in clinical management. Of 468 patients who had a thoracic procedure, 281 patients had a chest tube and a postremoval film. In 263 patients (93.6%) there was no change in the postremoval film result compared with baseline. Only two patients (0.7%) required an intervention based on symptoms, not based on the postremoval film. Eliminating routine postremoval radiographs after chest tube removal in pediatric patients will lessen radiation exposure and provide cost savings with no adverse impact on outcome. *J Pediatr Health Care.* (2017) ■, ■-■.

Ellen McGrath, Pediatric Nurse Practitioner, Department of General Surgery, Boston Children's Hospital, Boston, MA.

Lee Ranstrom, Pediatric Nurse Practitioner, Department of General Surgery, Boston Children's Hospital, Boston, MA.

Debra Lajoie, Director of Nursing Research Surgical Programs, Boston Children's Hospital, Boston, MA.

Lauren McGlynn, Pediatric Nurse Practitioner, Department of General Surgery, Boston Children's Hospital, Boston, MA.

David Mooney, Associate Professor of Surgery, Harvard Medical School, and Staff Surgeon, Department of General Surgery, Boston Children's Hospital, Boston, MA.

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Correspondence: Ellen McGrath, PNP, Department of General Surgery, Boston Children's Hospital, 10 East, 300 Longwood Ave, Boston, MA 02115; e-mail: ellen.mcgrath@childrens.harvard.edu.

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KEY WORDS

Chest radiograph, chest tube removal, pediatrics, thoracostomy tube

BACKGROUND

Chest tubes are a routine part of postoperative care for children undergoing many types of thoracic procedures. There are various indications for chest tube placement after surgery, but they are often used for drainage of pleural fluid or evacuation of air or potential air leaks. During removal of the chest tube, it is possible for air to be entrained into the pleural space, for a new air leak to occur, or for fluid to collect in the pleural space. Each of these possible complications of chest tube removal can cause respiratory compromise and necessitate intervention.

At the Surgical Service at Boston Children's Hospital, chest tubes are most often removed at the bedside by the general surgery nurse practitioner or resident using a standard chest tube removal protocol unless otherwise specified. Historically, a postremoval film was obtained shortly after chest tube removal to rule out any complications.

With the current push for safety and cost containment in health care, practitioners rely on evidence-based medicine to help determine the need for laboratory and/or diagnostic studies in various clinical scenarios (Finkler & Ward, 2003). Working with pediatric patients increases concern regarding the long-term effects of radiation exposure, making it important to ensure the necessity of all radiographic studies performed. In our clinical practice, we noticed that many postremoval

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films showed no clinically significant findings. The purpose of this study was to determine if a postremoval film was clinically necessary.

LITERATURE REVIEW

There is growing evidence in the peer-reviewed literature that chest radiographs are not routinely indicated after removal of chest tubes in pediatric and adult patients (Goodman, Huber, Johannigman, & Pritts, 2010; McCormick, O'Mara, Papasavas, & Caushaj, 2002; Palesty, McKelvey, & Dudrick, 2000; Sepehripour, Farid, & Shah, 2012; Whitehouse, Patel, & Morgan, 2009). Several articles suggested that close monitoring of respiratory status and clinical symptoms would identify nearly all patients with significant pneumothoraces (Cunningham et al., 2014; van den Boom & Battin, 2007).

Although three studies suggested that selective chest radiography should be based on the provider's good clinical judgment in combination with the patient's respiratory symptoms (Anand et al. 2012; Pacharn et al, 2002; van den Boom & Battin, 2007), limited evidence was found specific to the pediatric population (Pacharn et al, 2002; Stather, Cheshire, Bogwandas, & Peek, 2011).

A study with Level 3 evidence in cardiothoracic surgery patients found that clinically significant changes were detected on 2% to 40% of routine postremoval films, versus 79% of clinically indicated chest films, and that clinical symptoms are a positive predictor of major reintervention (Sepehripour et al., 2012). A retrospective study of 374 pediatric cardiac surgery patients found that 13.6% of patients had a visible pneumothorax on postremoval chest films and that clinical signs or symptoms identified those patients with pneumothoraces that required major intervention (Anand et al., 2012; Pacharn et al, 2002). A large retrospective study of noncardiac pediatric patients ($N = 462$) compared patients with or without a postremoval film concluded that development of a pneumothorax after chest tube removal was rare and that routine chest radiography after chest tube removal does not provide clinically relevant information (Cunningham et al., 2014).

Chest wall thickness was found to be an independent risk factor for the development of a pneumothorax after chest tube removal. A study of 100 infants concluded that clinical observation was sufficient to identify recurrent pneumothoraces (van den Boom & Battin, 2007). Stather (2011) found an incidence of pneumothorax of 4.2% after chest tube removal in a cohort of 95 pediatric patients. Omitting a postremoval film in low-risk trauma patients was not associated with an increase in reinsertion rates and provided a 3-year savings of \$48,840 (Goodman et al., 2010).

In reviewing the existing literature, we did not believe that the pediatric data were compelling enough to warrant eliminating a chest radiograph (Table 1).

METHODS

After institutional review board approval was obtained, a retrospective chart review was conducted of all general surgical inpatients with a chest tube in place after a thoracic procedure using *International Classification of Diseases, 9th Edition* (Centers for Disease Control and Prevention, National Center for Health Statistics, 1979) codes between January 1, 2010 and December 31, 2012 (Box).

Patients who had cardiac surgery were excluded. Cardiac surgical patients were excluded because their chest tubes are most often mediastinal and it is not possible to tell from the medical record if the mediastinum communicated with the pleural spaces or not. Cardiac surgical patients were also excluded because they differ significantly from general surgical patients in postoperative complications. The electronic medical record was reviewed to acquire demographic data; location, size, date, and time of chest tube insertion and removal; vital signs including respiratory rate and pulse oximetry before chest tube removal and at 4 hours and 12 hours after removal; and chest radiographs before and after chest tube removal. We used the official radiology report in lieu of reviewing films.

The most recent chest film done before chest tube removal was compared with the postremoval film to identify any changes. In the circumstance that a patient had more than one thoracic procedure during this timeframe, we used data from the first chest tube placement. For patients with more than one chest tube in place simultaneously, the last chest tube removal was used for data analysis. Our standard was a chest radiograph immediately after chest tube removal, and most patients in this cohort had their film taken within 2 hours after chest tube removal. A clinically significant change in physiology or film findings was considered to be one that was either documented or led to a change in management. A clinically significant change was a change in vital signs or oxygen saturation that was recognized and noted by a clinician. In addition, new findings noted on the radiology report were also considered clinically significant if they would typically be associated with a change in clinical status. The data were then entered into a Red Cap database for analysis (Vanderbilt University, Nashville, TN).

RESULTS

We identified 468 potential patients who underwent a thoracic procedure that met the search criteria. Of these, 184 patients had no chest tube left in place, and three were excluded (one had a cardiac procedure, one was transferred to another hospital with a chest tube in place, and one did not have postremoval chest radiography). The remaining 281 patients who had a chest tube and a postremoval chest film made up the study group.

In 263 patients (93.6%), there was no change in the postremoval chest radiograph compared with

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