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Do X-rays after chest tube removal change patient management?☆

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ABSTRACT

Background: A link between childhood radiation and future cancer risks exists, and reduction of unnecessary radiation in childhood has been recommended. Pneumothoraces, pleural effusions, and many surgical procedures require placement of a chest tube/pigtail catheter. Traditional management is daily x-rays, with an x-ray after tube removal. Our hypothesis is the “post pull” x-ray rarely results in changing clinical management of the patient.

Methods: With IRB approval, a 5-year retrospective chart review was performed. Inclusion criteria were chest tube or pigtail placed for any reason with complete records. Data collected were demographics, reason for and duration of placement, number of x-rays done prior to and after removal. Primary outcome was whether the “post pull” x-ray changed clinical management.

Results: A total of 179 episodes were evaluated. Seventeen were excluded for incomplete data, or death/transfer of the patient with the tube in situ. Forty-nine tubes/pigtails were placed for pneumothorax, 48 for pleural effusion/empyema, 9 for hemothorax, and 51 during operative procedure. A median of 5 x-rays was done post insertion. 99% of the patients (160/162) had a “post pull” x-ray performed after tube removal. In 9 cases the x-ray changed patient management.

Conclusions: X-ray after chest tube/pigtail removal rarely changes patient management. We recommend considering imaging if there are clinical symptoms.

Level of evidence: Prognosis study, level II (retrospective cohort)

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The use of tube thoracostomy, whether in chest tube or pigtail catheter format, is a common practice in modern-day pediatric surgery. From earliest descriptions of thoracostomy with Hippocrates, diagnoses that often necessitate chest tube placement today include pleural effusion or empyema, pneumothorax, traumatic chest injury, or operative placement during procedures such as lung resections [1]. Practical daily management of the tubes of pigtails is often diagnosis and provider dependent, and there is currently no standard of care, specifically related to timing and frequency of x-rays [2,3].

We know that x-rays are invaluable tools in not only potentially diagnosing the need for chest tube placement, but also in supplementing clinical evaluation and determining readiness for tube discontinuation once the reason for placement has improved or resolved [2,4]. What continues to be debated, however, is the necessity of chest x-ray after discontinuation of the tube [2–6].

When questioning the timing and necessity of x-rays, particularly in the pediatric population, the ALARA (as low as reasonably achievable) principle must be considered [7]. This concept has helped to guide

clinical practice for decades, suggesting that the lowest doses of radiation possible be utilized for diagnostic testing [7,8]. The correlation between radiation exposure during childhood and the development of cancer later in life has been clearly documented in the literature [9–12]. From even the smallest amount of radiation that is that emitted during routine dental x-rays, to more comprehensive radiology studies that are required during times of illness, children are potentially exposed to radiation multiple times during their time of growth and rapid cell turnover [10–12]. Two main issues with this include the following: First, children are known to be more susceptible to the carcinogenic effects of ionizing radiation exposure than adults. Second, it is not only the exposure to the radiation that is concerning, but also the cumulative exposure over time. Consider these elements together and the child's risk of developing a radiation-induced cancer later in life is compounded exponentially [9–12].

Recent studies have proposed that omission of the post-pull chest x-ray after discontinuation of the chest tube or pigtail catheter in a patient that remains asymptomatic may be a reasonable change to implement into practice. Previous data have suggested that as little as 1%–4% of patients evaluated required intervention following chest tube discontinuation [3,4,6]. Given the varied practice patterns for even the timing and frequency of x-ray evaluations, our goal was to evaluate if the x-ray obtained after chest drain removal resulted in a significant amount of practice change. Our hypothesis is that in asymptomatic

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patients, the routine use of chest x-ray after chest tube or pigtail removal does not frequently result in a change in patient management.

1. Methods

After obtaining institutional IRB approval (IRB # STU 042015-072), a retrospective chart review was performed including all patients who underwent chest tube placement (traditional chest tube or pigtail catheter) during a 5-year period from January 1, 2010 to December 31, 2014 at our institution. Encounters were identified from our electronic medical record system using ICD-9 procedure codes for tube thoracostomy. Inclusion criteria for this study were patients who had placement of a chest tube for any cause, including: pneumothorax, pleural effusion or empyema, hemothorax, placement as part of an operative procedure, and chest tubes placed for additional reasons other than those defined. Only charts that included a complete record from time of placement to time of chest tube removal were included in the study. Charts were analyzed for patient demographics, reason for chest tube placement, and the number of chest x-rays performed prior to removal and following removal of the chest tube. Patients who had a separate admission that required another chest tube were treated as a separate encounter. The primary outcome of interest was a change in clinical management for the patient based upon the results of the chest x-ray performed following removal of the tube.

2. Results

A total of 179 patient encounters were identified from medical record codes that met inclusion criteria for the study. Seventeen encounters were then excluded from the study owing to duplicate patient encounters ($n = 2$), incomplete data ($n = 7$), death of the patient with the chest tube remaining in place ($n = 7$), or transfer to another institution prior to removal of the chest tube ($n = 1$). This left 162 encounters for evaluation. Demographics and underlying diagnoses are presented in Table 1, along with data on the provider placing the tube and type of tube placed. The distribution of type of tube placed based on reason for placement is shown in Table 2.

The tubes remained in place for a mean of 6.36 ± 8.51 days during which time a median of 5 (range 1–48) chest x-rays was obtained for ongoing evaluation of lung status. In the 162 patient encounters included in the study, post-pull chest x-rays were obtained on all but 2 of the patients (98.8%). Despite obtaining post-pull chest x-rays on all but 2 of the patients, management was only changed by the results of these films on 9 patients (9/160, 5.6%). Additionally, post-pull chest x-ray only changed management on a single patient following removal of a pigtail catheter (1/29, 3.4%) compared to the other 8 who had traditional chest tubes removed (8/133, 6%). The two patients who did not have post pull x-rays were discharged home after a short period of observation. Encounters where management changed based on the

Table 1
Demographics and data.

Age in years (mean \pm SD)	8.52 \pm 6.25	
Sex (M:F, %)	106 (65.4%):56 (34.6%)	
Diagnosis		
Pneumothorax	49	
Pleural effusion/empyema	48	
Hemothorax	9	
Part of an operative procedure	51	
Other	5	
Chest tube type and provider placement	Chest tube (N = 135)	Pigtail (N = 27)
Surgeon	134	8
Radiologist	1	15
ED Physician	3	4

Table 2
Indications for and type of chest drainage.

Indication for Chest Tube	Pigtail Chest Tube	Traditional Chest Tube	Total Chest Tubes
Pneumothorax	9	40	49
Pleural effusion or empyema	15	33	48
Hemothorax	0	9	9
Operative procedure	0	51	51
Other	3	2	5

post removal x-ray are described in Table 3. Many of these patients did not have clear symptoms requiring further imaging or intervention. Three patients had their tube replaced (or replaced with a pigtail) the day following the chest tube removal when their subsequent x-rays showed their pneumothoraces to be enlarging. Two patients went to the operation room for VATS and pleurodesis within 48 h of their initial tube removal for enlarging pneumothorax and pleuritic chest pain. No child had emergent replacement of a tube for symptoms. One child (patient 6) had her chest tube replaced 9 days later for an enlarging hydropneumothorax that was being observed.

3. Discussion

The clinical management of thoracostomy tubes is known to vary by practitioners and institutions: from indications, timing and type of tube placed [2,3,13–22]. The daily management, including timing and frequency of chest x-rays, as well as timing of removal and post removal practices is also variable. In our own institution, the procedure note written in the chart for the tube removal would have varying statements about the timing of the post procedure film—such as 1 h, 4 h or 6 h post removal. In addition, the removal of chest tube while on suction or on water seal is also variable by practitioner. Clamping of chest tubes is generally not performed at our institution. This variability in management leads to a completely unstandardized approach to clinical practice.

The data from this study span 2010 to 2014 during which time only 29 pigtail catheters were placed. We have noted an increasing utilization of imaged guided pigtail catheters placed by interventional radiology at our institution since that time. The benefits of pigtail catheter placement include: precise placement (when image guided), less invasiveness and improved patient pain given the smaller tube, lack of incision, and lack of spread of intercostal muscles at time of placement [23]. Pigtail catheters have been demonstrated to be effective, less invasive options to traditional chest tubes [24,25]. Although there have not been dedicated studies to compare the complication rate following removal of traditional chest tubes compared to pigtail catheters, there is theoretically less chance of air entry upon removal with these smaller tubes and smaller holes. In this study, only 1 of 29 (3.4%) pigtail catheters experienced a complication after removal necessitating replacement of the tube, compared to 8/133 (6.0%) of standard chest tubes. With the increasing usage of pigtail catheters, routine post-pull chest x-rays are unlikely to demonstrate significant abnormalities that aren't clinically evident by history and physical examination, thus further placing this standard of practice in question.

Limitations to this study include those inherent to a retrospective review. It is difficult to ascertain the exact reasoning behind each chest tube management order. It is also possible that we are missing some patient encounters from this review owing to coding inaccuracies or missing codes.

Clinical practice varied widely in the indications and timing for imaging; including daily chest x-rays for routine evaluation of chest tube and lung status, following a change in tube management (e.g. switching from suction to water seal), or following a change in clinical status. Although chest x-rays were obtained frequently for evaluation of lung status while the chest tubes were in place, as well as following their removal, the clinical evaluation of the patient often overruled these data with regards to treatment decisions. In our review,

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