

Decisions and Outcomes after Chest X-ray in Pediatric Intensive Care Unit

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Abstract

Background: Chest X-ray (CXR) is an important diagnostic and interventional imaging modality in critically sick children admitted in PICU. But the data on their association with clinical decisions and interventions are scant. **Methods:** It was a retrospective descriptive study conducted in PICU. A total of 60 consecutive children aged one month to 14 years were included and all CXR done on those during PICU stay constituted the sample size. We collected data on indication of CXR, diagnosis on CXR and matching of indication and diagnosis, decision and actions taken after CXR. **Results:** A total of 200 CXR were available. Mean number of CXR per patient were 3.67. At 1st day of admission CXR was done for almost all the patients. The interventions were done in 32 events based on CXR findings while in 40 events there were no interventions associated with CXR. Longer duration of PICU stay, ARDS and persistent pneumonia were associated with increased number of CXR. There was good matching of clinical diagnosis and CXR diagnosis as in a very few cases diagnosis was picked up on CXR when it was missed on clinical assesment. **Conclusion:** A good number of CXR can be avoided like post intubation for ET position, daily CXR in ARDS. Although pre-extubation CXR were associated with action but we opine these can be avoided and patients can be extubated on clinical judgement. Some baseline X ray for bronchiolitis and GBS could have been avoided.

Keywords: Chest X-ray; Pneumonia; PICU; Ventilator Associated Pneumonia; VAP; ARDS; Pediatric.

Introduction

Chest X-ray (CXR) use is a common but important diagnostic and interventional imaging modality in critically sick children for various reasons admitted in pediatric icu (PICU). These may be needed for diagnosis of hospital acquired pneumonia [HAP] [1]; ventilator associated pneumonia [VAP] [1]; acute respiratory distress syndrome [ARDS] [2] and cardiac diseases like congestive heart failure and pericardial effusion. It may be needed to drain pneumothorax,

empyema and pericardial tamponade. During the clinical course and stay in PICU; a patient may have any acute catastrophic events due to disease or any interventional procedure like pneumothorax with central subclavian line placement. Similarly patient may have deteriorating or fresh symptoms of respiratory distress and may require further CXRs. These are ordered very frequently in PICU but the literature of their effect on clinical decision and outcome is scant. In our PICU we however do not order routine CXR; still we feel some of the X-rays can be avoided especially when these do not help in reduced length of PICU stay or mortality [3]. The aim of this study was to document the events or clinical diagnosis when doing a CXR resulted in some kind of interventions. This will help identifying those situations when these are most beneficial to do CXR and will avoid unnecessary CXR. This may facilitate decreasing the health care costs involved and the radiation exposure both to the patients and to health care staff.

Method

It was a retrospective descriptive study conducted in PICU of a university affiliated hospital.

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All consecutive children admitted in PICU and undergone single or multiple CXR during study period constituted the study sample. We collected data on indication of CXR, diagnosis on CXR and matching of indication and diagnosis, decision and action taken after CXR. All analysis was done in r studio software for statistical computing.

Results

A total of 200 CXRs were available for 60 patients and all were taken in antero-posterior view. Mean age of patients were 6.9 years and included 46 males. Overall mean number of CXR done per patient were 3.67. Overall mean duration of stay in PICU was 13 days. Table 1 shows the mean number of CXR per patient and per PICU days according to different length of stay in PICU ranging from less than 3 days to more than 30 days.

Figure 1 shows number of CXR per patient increased from 0.83 to 8.0 in patients who stayed in PICU for more than 30 days.

All CXRs had some abnormal finding. At first day of admission CXR was done for most patients including bronchiolitis and GBS. For seven patients diagnostic first day CXR was not done. Their diagnosis was 1) Hypertensive encephalopathy [two patients]; 2) status epilepticus [two patients]; 3) severe malaria [one patient]; and 4) hepatic encephalopathy [two patients]. Figure 2 shows various indications for ordering a CXR. Figure 3 shows various interventions taken upon CXR findings. The intervention were done in 32 events based on CXR findings while in 40 events there were no interventions associated with

CXR done as shown in Figure 3.

Longer duration of PICU stay, mechanical ventilation; ARDS and persistent pneumonia, complex diagnosis, occurrence of VAP; severity of illness and severity of abnormal CXR (a five-point CXR scoring tool)* (4) were associated with increased number of CXR done. Figure 4. Shows comparison of CXR ordered in patients receiving mechanical ventilation and patients who did not receive it. Figure 5. Shows comparison of CXR ordered in patients with ARDS and patients without ARDS.

*Severity of abnormal CXR findings categorized as: 1 = normal; 2 = patchy atelectasis and/or hyperinflation and/or bronchial wall thickening; 3 = focal consolidation; 4 = multifocal consolidation; and 5 = diffuse alveolar changes.

Good matching between CXR and clinical diagnosis was observed. Details have been given in Table 2.

Discussion

Our study shows although the CXRs done in PICU whether routine or on demand are abnormal, yet few of them are associated with some kind of intervention. We noticed that many of the CXRs done post intubation to see the position of endotracheal tube (ET) was unnecessary as only in one case ET position could not be judged clinically. In rest of the patients, the ET position was correct as judged clinically. This is supported by other studies. A study by Lotano R et al showed that when

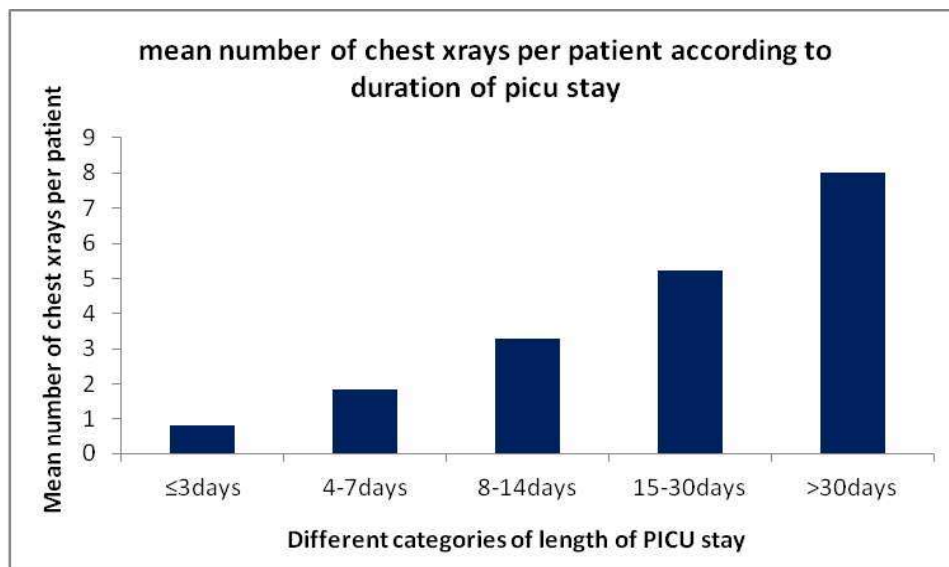


Fig. 1: Distribution of chest x-rays according to duration of stay.

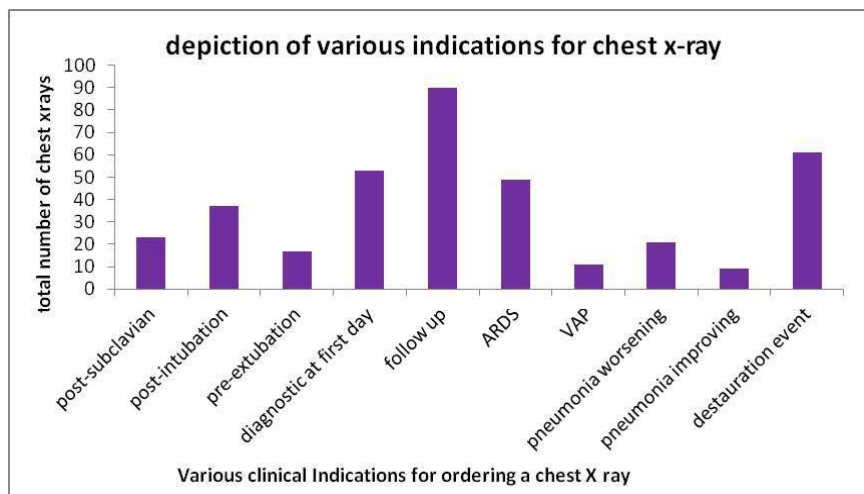


Fig. 2: Various clinical indications for ordering a chest X ray in picu (results are overlapping).

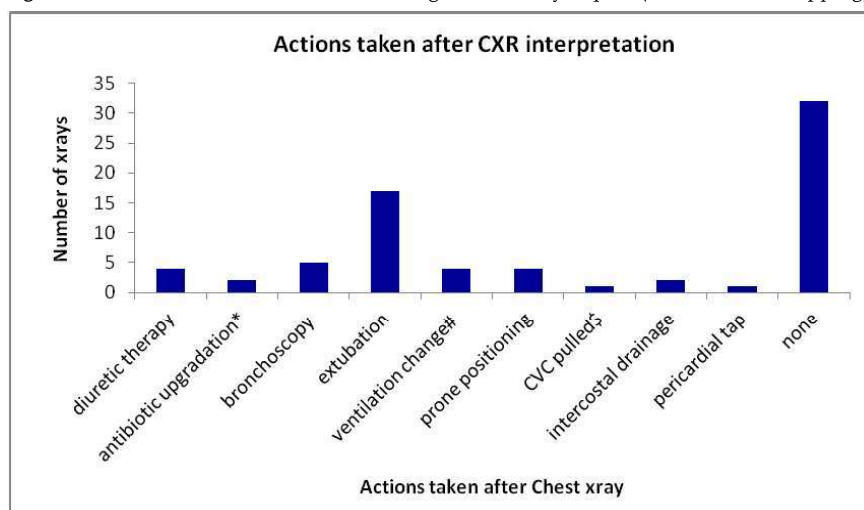


Fig. 3: Showing various interventions taken upon CXR findings.

*Antibiotics were upgraded on clinical diagnosis of VAP. Only in two it was done on CXR basis. #In most occasions ventilation changes were made on clinical assessment. ‡Subclavian vein catheter

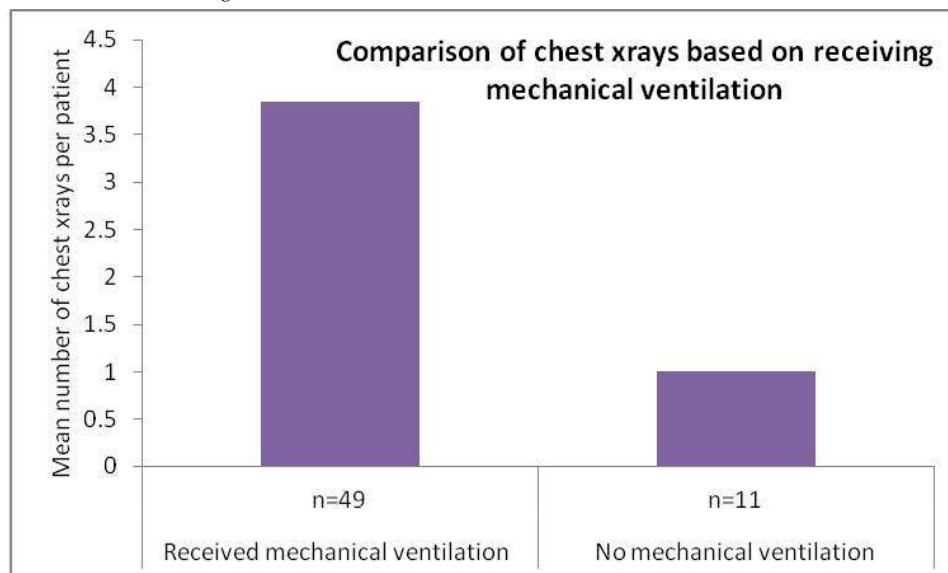


Fig. 4: Shows comparison of CXR ordered in patients receiving mechanical patients is more than those who did not receive it.

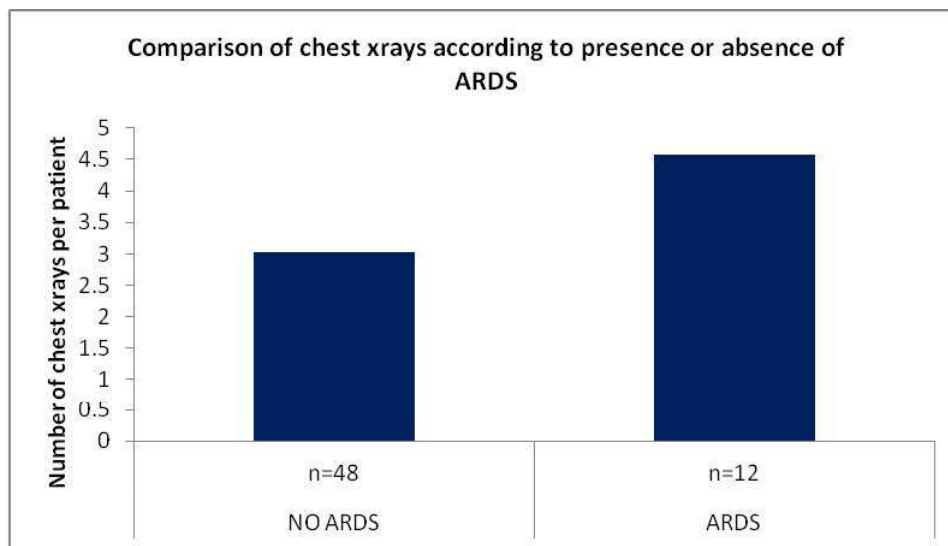


Fig. 5: Shows comparison of CXR ordered in patients with ARDS and patients without ARDS.

Table 1: Distribution of patients and chest X-rays according to duration of stay in PICU.

| Duration of stay in PICU | Total number of patients | Total duration of stay in PICU | Total CXR done | Mean days per patient | Mean CXR per patient | Mean CXR per day |
|--------------------------|--------------------------|--------------------------------|----------------|-----------------------|----------------------|------------------|
| ≤3d | 6 | 17 | 5 | 2.88 | 0.83 | 0.29 |
| 4-7d | 12 | 75 | 22 | 6.25 | 1.83 | 0.29 |
| 8-14d | 27 | 311 | 99 | 11.5 | 3.67 | 0.31 |
| 15-30d | 13 | 315 | 78 | 24.2 | 6.0 | 0.25 |
| >30d | 2 | 67 | 16 | 33.5 | 8.0 | 0.24 |

Table 2: shows comparison between the clinical diagnosis and CXR diagnosis.

| | | Clinical (number of events) | Chest X-ray (number of events) |
|-------------------------|-----------------------|-----------------------------|--------------------------------|
| Post intubation | At carina | 37 | 36 |
| | Right bronchus | 0 | 1 |
| Post subclavian | In subclavian vein | 23 | 22 |
| | In right atrium | 0 | 1 |
| Pre extubation | Fit for extubation | 17 | 14 |
| | Not fit | 0 | 3 |
| | Successful extubation | 17 | 17 |
| Diagnostic at first day | pneumonia | 41 | 35 |
| | bronchiolitis | 1 | 0 |
| | ARDS | 6 | 12 |
| | CHF with pneumonia | 5 | 5 |
| Follow up | ARDS | | |
| | ARDS Worsening | 49 | 49 |
| | ARDS improving | 20 | 18 |
| Pneumonia | Pneumonia worsening | 25 | 21 |
| | Pneumonia improving | 09 | 09 |
| | VAP | 13 | 11 |

performed by experienced critical care personnel, acutely significant malpositions were rare (one out of 101 intubations). The authors concluded that stat CXR are unnecessary if, ET intubations are performed by experienced clinicians and if there are no specific pulmonary complications. So intubation may be followed by routine CXR [5]. In our PICU, experienced residents perform intubations which have resulted in almost negligible misplacements. Some authors have found contradictory results. A study by McGillicuddy DC et al. showed that CXR was still able to identify some patients that may need immediate intervention based on their CXR findings and that were probably missed clinically. The authors concluded that post-intubation CXR should remain a routine practice for ED intubations [6]. Similarly a study by Hossein-Nejad H et al also concluded that post-intubation CXR remains a necessary step to minimize the misplacement of the ET tube [7]. In our study, only in one patient the subclavian vein catheter was found to be in the right atrium and it was pulled back on CXR examination. Rest all the CXR showed normal position of catheters. We also found that chances of misplacement are very rare if the procedure is performed by the experienced hands. Different studies give different result on the topic. A study by Abood GJ et al showed that "clinical judgment does not reliably predict mal-positioning after central venous catheter (CVC) or the presence of post-procedural complications". They concluded that "CXR done after CVC placement in the critically ill should remain the standard of care" [8]. While another two studies by different authors showed that post-procedural CXR is not necessary as subclavian placement is safe and without complication if done by an experienced person [9,10]. We observed that CXRs done before extubation to predict successful extubation were also unnecessary as when a patient is on pressure support mode or spontaneous breathing trial during weaning from mechanical ventilation; the chest condition can be assessed clinically very efficiently. Two patients showed abnormal CXRs but were successfully extubated on clinical judgment. A study by Alvarado-Socarrás JL showed that although it may help accelerate hospital discharge, the utility of routine CXR on prognosis is uncertain. Consequently, it is required to conduct studies of greater magnitude in order to assess the relevance of this procedure [11]. Further when pleural effusion was suspected clinically, the CXRs confirmed the same and it resulted in interventions like pleural tap. But as we have critical care ultrasound facility, the pleural taps were done under ultrasound examination and ultrasound

showed better assessment of pleural effusions. So CXR maybe a useful investigation in the PICU which do not have critical care ultrasound. Similarly in cases of pericardial effusion, CXR did not result in any intervention without doing bedside ultrasound examination. There are few studies in literature which have studied the utility of routine CXRs in ICU setting. A study by Marleen E. Graat et al done on thousands of patients showed that avoiding daily routine CXRs reduced the number of CXR and did not affect re-admission rate and mortality rates in hospital and ICU [12]. A study by Natalie Chahine-Malus et al showed that routine CXRs have some value in guiding management decisions in the ICU. This study showed that 15.4% of routine CXRs in patients with an ICU stay less than 48 hours and 26% of routine CXRs in patients with an ICU stay of 48 hours or more; changed management. However, the authors concluded that daily CXRs may not be necessary for all patients [13]. A study by Marleen E Graat et al showed that daily routine CXRs in ICU seldom reveal unexpected, clinically relevant abnormalities, and rarely prompt action. They proposed that this diagnostic examination be abandoned in ICU patients [14]. Krivopal et al concluded that "for mechanically ventilated patients, a strategy calling for daily routine CXRs compared to CXRs obtained based on clinical indications alone was not associated with reduced ICU or hospital length of stay or with reduced mortality" [15]. Similarly, a study by Hendrikse et al on a large sample showed that diagnostic and therapeutic value of the daily routine CXR was low and concluded that daily routine CXRs can be avoided in the ICU without compromising on clinical care and safety of the patients [16].

We observed that there were no daily routine CXR done in our patients. The strength of the study is that we studied a good number of CXRs. Our study has a few limitations; it was a retrospective collection of data and data was collected from a single center. So results cannot be generalized to other centers.

Conclusion

A good number of chest -rays can be avoided like post-intubation for ET position, daily CXR in ARDS and VAP. Although pre-extubation CXR were associated with action but these can be avoided and patients can be extubated on clinical judgment. Some baseline CXR for bronchiolitis and GBS could have been avoided.

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