Simple measures to improve correct chest and abdomen imaging in pediatric portable x-ray

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Aims and objectives

Correct chest and abdomen imaging in the neonatal intensive care unit (NICU) is of utmost and at times vital importance for the diagnosis and treatment of the pediatric intensive care patient. The results of a radiograph may in some cases alter patient management and mistakes should be kept at a minimum. Mistakes that may affect the diagnostic accuracy could for instance be, beam orientation i.e. horizontal beam, positioning of the infant, anteroposterior (AP) only/or both AP and lateral (LAT). It could be whether to do chest and abdomen views or only chest or abdomen views.

As an example, following placement of a central venous catheter (CVC) an AP chest radiograph is enough to evaluate positioning of the catheter and performing a lateral chest radiograph on this indication would mean unnecessary radiation to the infant. On the other hand, both AP and lateral radiographs of a neonate is necessary to demonstrate correct positioning of an umbilical venous catheter (UVC) where correct positioning of an umbilical artery catheter (UAC) may be verified with only a frontal chest and abdomen radiograph.1

At Department of Radiology, Odense University Hospital, the radiographers have access to large and very detailed protocol containing standard radiological practice for the NICU patient. The protocol includes guidelines, image criteria for all relevant pathology, images and in depth description on all pathology relevant for the infant in the NICU. The protocol is meant to be a databank, containing all information that the radiographers may need before visiting the NICU, helping them decide which images to obtain. ¹

There may however be multiple indications in a referral and in daily practice it is the responsibility of the radiographer to identify the appropriate clinical information, correlate this with department protocol and obtain the essential views needed to answer the clinical question.

There may of course be occasions where the appropriate views may not be obtained, for instance when the infant, for health reasons, cannot be placed on the left side or instances where the referring physician will only allow one view. In those cases with discrepancies from department protocol the radiographers are obliged to register the reason in the hospital Registration Information System (RIS).

Odense University Hospital (OUH) has a very large pediatric ward with several intensive care units. At department of Radiology, OUH approximately 900 radiographic bedside examinations are performed yearly on children between the ages of zero and three
years. There are more than 90 radiographers at department of radiology, OUH and of those approximately 50 could potentially perform bedside examinations. The amount of examinations, the numerous different pathologies and the number of radiographers performing portable radiographs in the NICU necessitate a readily available protocol with easy to understand guidelines.

The primary purpose of this study was to evaluate current practice by the number of incorrect images obtained in the NICU, secondly introducing a simplified one-page schematic protocol containing only absolutely essential information needed to decide which images to obtain and then thirdly to evaluate the number of incorrect images after introduction of the simplified schematic protocol.
Methods and materials

A three-step approach was adapted.

**Step 1.** To evaluate current practice, i.e. the radiographers correlating clinical information with already existing department protocol and consequently obtaining the essential images, a retrospective audit was performed. The audit included 80 consecutive NICU bedside examinations evaluating the correlation of clinical information to the views obtained. If an examination differs from department protocol and there is a valid explanatory registration from the radiographer in the RIS, the case is counted as correct in the audit. Only incorrect cases with no explanatory registration are counted as incorrect.

**Step 2.** A simplified one-page schematic protocol containing only absolute essential information needed to decide which images to obtain was then made based on the already existing department protocol. The protocol was constructed in collaboration with a pediatric senior radiologist. The table was derived directly from the department protocol, leaving out all explanatory information and images. Tabel 1.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Positioning</th>
<th>Alternative x-ray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>• AP</td>
<td></td>
</tr>
<tr>
<td>Respiratory Distress Syndrome (RDS)</td>
<td>• LAT</td>
<td></td>
</tr>
<tr>
<td>Wet Lungs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>• AP</td>
<td>If the infant cannot be positioned on the side, a LAT x-ray with the infant in the supine position and a horizontal beam orientation is to be performed.</td>
</tr>
<tr>
<td></td>
<td>• AP (decubitus x-ray): With the infant lying on the side, and the lung in question</td>
<td></td>
</tr>
</tbody>
</table>
Bei der Thoraxaufnahme: Indikation für AP und LAT-Bildgebung.

**Chest**
- Tracheal tube placement • AP
- LongLine catheter • AP, LAT
  - The elbow (on the side with the catheter) must be included in the AP image.

**Chest**
- CVC • AP
- Necrotizing EnteroColitis (NEC) • AP
- Ileus • AP (Decubitus x-ray): With the infants left side down and horizontal beam orientation.

**Abdomen**
- Necrotizing EnteroColitis (NEC) • AP
- Ileus • AP

**Chest & Abdomen**
- UVC • AP
  - LAT
- UAC • AP

**Tabel 1.** schematic protocol containing essential information needed to decide which images to obtain on the pediatric patient.

The guidelines were laminated and attached to all mobile x-ray units for the radiographers to consult prior to visiting the NICU, in the NICU or whenever in doubt. All radiographers were informed that the guidelines were now available at all mobile x-ray units and they were reminded of the importance of registering in the RIS whenever their practice differed from the guidelines.
**Step 3.** Approximately three months after the guidelines were made available on the mobile x-ray units, another retrospective audit was performed. The second audit also included 80 consecutive examinations.

**Images 1 & 2** show correct imaging of an infant in the NICU. The referring physician asked for an evaluation of placement of the Long Line catheter. An AP and LAT image was correctly obtained with the elbow, on the side with the catheter, included in the AP image.
**Fig. 1:** Correct imaging of an infant when evaluating placement of a Long Line catheter. An AP and LAT image with the elbow, on the side with the catheter, included in the AP image.

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**Fig. 2:** Correct imaging of an infant when evaluating placement of a Long Line catheter. An AP and LAT image with the elbow, on the side with the catheter, included in the AP image.

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Results

Step 1. The result of the first audit, i.e. evaluation of current practice (already existing department protocol), was that 36% of the included examinations differed from department protocol, but 6% had an explanatory valid reason registered in the RIS i.e. in 30% of the examinations, the views obtained differed from department protocol with no registered explanation.

Step 2. The simplified one-page schematic protocol containing only essential information needed to decide which images to obtain was attached to all mobile x-ray units.

Step 3. Approximately three months after the guidelines were made available on the mobile x-ray units, another retrospective audit was performed. The second audit also included 80 consecutive examinations. The number of inaccurate images fell from 24 to 11 (i.e. from 30% to 13%) and the number of explanatory comments logged by the radiographers rose from 6% to 12%.

Figure 3 show the decrease in number of incorrect images from audit one to audit two (blue columns) and the rise in number of logged explanatory comments (green columns).

Statistical analysis Fisher’s Exact Test was applied in the unpaired comparisons of the number of correct/incorrect examinations in between the two audits. The difference was statistically significant p<0.001

The most frequent mistake in the first audit was that in ten instances with images query pneumothorax there was only an AP image and no decubitus image, with no explanatory comment. The corresponding number in the second audit was one.
Fig. 3: Audit 1 and Audit 2. The blue columns represent the number of incorrect images and the green columns represent the number of explanatory comments logged by the radiographers.

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Conclusion

When auditing the number of correct examinations at the NICU at Department of Radiology, OUH, it was possible to alter the behavior of the radiographers and improve the amount of correct examination with minimal intervention by simplifying already existing guidelines and making them available at all mobile x-ray units.

The number of incorrect images with no explanatory reason logged in the RIS fell from 24 to 11 before and after introduction of the schematic guidelines. The difference was statistically significant with a p value of p<0.001 (Fisher’s Exact Test).
References

1. "Protocol for pediatric imaging". Department of Radiology, Odense University Hospital. Poulsen, R. M.