Lateral x-thorax for bedridden patients

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**Aims and objectives**

An x-ray of the chest (x-thorax) is an important diagnostic radiograph for respiratory-, heart- and other health symptoms [1,2].

Because the patient is three dimensional and the radiograph only two dimensional it is not possible to determine the exact location and nature of a foreign body with only one direction [3].

The standard international protocol of the x-thorax is therefore to make two projections, posterior-anterior (PA) and lateral [4]. Normally these lateral radiographs are made with the patient’s left side against the wall stand in stand position [3,5].

A lot of patients for whom an x-thorax is ordered from the radiology or emergency department cannot stand because they are in a wheelchair or in a bed. In that case the radiograph will be taken while the patient is in a sitting position. Instead of the PA using the wall stand, an AP radiograph will be taken using a wireless detector [3]. The lateral radiograph stays almost the same but now the patient stays in bed and has to move to the edge of the bed towards the wall stand.

Because of the condition of the patients, the second radiograph takes a lot of time, energy and effort for both the patient and the radiographer. This makes the positioning of bedridden patients harder. As a consequence that the lateral radiograph often is omitted, despite the fact that two-directions were ordered by the requesting physician.

As a result of this, information can be lost. For example metastases in the vertebral column, which are not visible on the AP radiograph because of the overprojection of the sternum [6]. Edema can be lost behind the heart shadow [2] and enlargement of the retrosternal space can be lost because of the overprojection of the sternum which could be caused by chronic obstructive pulmonary disease (COPD) (Fig. 1) [4,7]. Not only is visual information on pathology lost, but also the exact location of possible infiltrates is needed for that determination [4].

Because this information is not available with only the AP radiograph, new radiographs will often be taken in two directions, or a CT scan will be provided the next day. Additional radiographs and/or a CT scan causes more radiation exposure to the patient [8]. Furthermore it frequently happens that after the supplementary radiographs are taken that there is no need for the patient to stay in the hospital.
The purpose of this study was to determine the feasibility of obtaining a lateral exposure thorax radiograph for bedridden patients and to determine whether this second radiograph yields additional diagnostic value. Using the wireless detector for the lateral radiograph in stead of the wall stand.
Fig. 1: Lateral thorax radiograph. A: vertebral column; B: sternum, C: heart, D: lung, E: retrosternal space, F: aortic arch, G: retrocardiac space.

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Methods and materials

Study design

This was a quantitative prospective study conducted at the radiology department at the Atrium Medical Center Heerlen, the Netherlands. Approval was obtained from the institutional review board. The purpose and method was explained to the patient and an informed consent form was signed.

Inclusion criteria

- all clinical patients who came to the radiology department for the standard two direction x-thorax irrespective of indication, sex, age or department,
- patients with the indication "check status" underwent the standard two-direction x-thorax the first time only.

Exclusion criteria

- patients with the indication "check status" were excluded after the first time to minimize radiation exposure,
- patients who were not able to hold their breath. It is required that the patient can hold their breath for best radiograph quality.

Study protocol

The lateral radiograph was taken after the AP radiograph. Therefore the patient is already sitting upright in bed. Instead of the wall stand, the wireless detector and the mobile detector holder were used. Using the wireless detector, the detector can be placed as close as possible against the left side of the patient to prevent distortion due to the diverging x-ray bundle [9]. Another advantage of using the wireless detector is that the patient can stay in bed and does not have to put energy and effort to move to the edge of the bed. However, due to the weight of the body the back of the patient will be pushed into the matress which causes overprojection of the matress and the back of the patient. This was prevented by putting two expanded polystyrene plates between the back of the patient and the matress. Because the plates are relatively hard, the patient will automatically sit up more straight. This improves the quality of the radiograph [4].

Data collection

Two radiologists independently assessed the radiographs when given only the patient number and their indication. First they assessed only the AP radiograph. They assessed the AP plus the lateral views radiographs a couple of days later (to prevent recognition
of the AP radiograph). When evaluating both the AP and lateral views they were asked to write down if the lateral radiograph provided additional value or not and why (Table 1).

Because they also evaluated the AP radiograph separately both results could be compared and it was checked whether there was an agreement.

**Data analysis**

The results were established in SPSS (19.0 SV).

Cohen’s Kappa [10] was calculated to find out the agreement between the radiologists' scoring on whether the lateral view was of additional value. Likewise, the correlation between the two radiologists' diagnoses was calculated. This applies to the assessments of the AP view only as well the AP plus the lateral view.
Images for this section:

<table>
<thead>
<tr>
<th>No value</th>
<th>Value</th>
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<tbody>
<tr>
<td>A  Insufficient quality.</td>
<td>E  Determination of exact location.</td>
</tr>
<tr>
<td>B  Prospectively: the AP view only was sufficient given the indication.</td>
<td>F  Gave more certainty given the indication.</td>
</tr>
<tr>
<td>C  Retrospectively: the AP view only was sufficient (irrespective the indication).</td>
<td>G  A suspicious structure was spotted on the AP radiograph and the lateral gave more certainty.</td>
</tr>
<tr>
<td>D  Nonspecific.</td>
<td>H  New findings were showed on the lateral view.</td>
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<td></td>
<td>I  Nonspecific.</td>
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**Table 1:** The answers for (no) value that the radiologist could choose.

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Results

Fifty patients were included in this study.

Radiologist 1:

In 26 patients (52%) the lateral radiograph added no value (Fig. 2).

![Pie chart showing 52% Value and 48% No Value](image)

**Fig. 2:** Radiologist 1. Percentage of the lateral radiograph that added value or not according to radiologist 1. N=50.

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In 31% (8/26) of those cases the reason for no value was insufficient quality, in 12% (3/26) the AP view only was sufficient given the indication (prospectively), in 50% (13/26) the AP view only was sufficient, and in 8% (2/26) the reason "nonspecific" was given (Fig. 3).
Fig. 3: Radiologist 1: Percentage of the different reasons that radiologist 1 gave why the lateral radiograph had no value. A = insufficient quality, B = prospectively, the AP view only was sufficient given the indication, C = retrospectively, the AP view only was sufficient, D = non specific reasons. N=50.

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In the remaining 24 patients (48%) the lateral view did have an additional diagnostic value (Fig. 4). In 29% (7/24) of those cases additional value was due to determination of exact location, in 13% (3/24) the lateral view gave more certainty given the indication, in 4% (1/24) a suspicious structure was spotted on the AP radiograph and the lateral view gave more certainty, in 46% (11/24) there were new findings, leading to a change in diagnosis and in 8% (2/24) the reason "nonspecific" was given.
Fig. 4: Radiologist 1: Percentage of the different reasons that radiologist 1 gave why the lateral radiograph added value. E = determination of exact location, F = the lateral view gave more certainty given the indication, G = a suspicious structure was spotted on the AP radiograph and the lateral view gave more certainty, H = new findings were found, I = non specific reasons. N=50.

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In total, the diagnosis changed in 17 patients of which 82% (14/17) it was actually said that the lateral radiograph had a diagnostic value (Fig. 5).
**Fig. 5:** Radiologist 1: The radiographs with a change in diagnosis. Red = the radiologist said that the radiograph did not have a value. Blue = the radiologist said that the lateral view added additional diagnostic value.

**References:** Department of Radiology, Atrium Medical Center, Heerlen/NL 2013

**Radiologist 2:**

In 23 patients (54%) the lateral view had no value (*Fig. 6*).
Fig. 6: Radiologist 2. Percentage where the lateral radiograph added value or not. According radiologist 2. N=50.

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In 22% (5/23) of those cases the reason for no value was insufficient quality, in 22% (5/23) the AP view only was sufficient given the indication (prospectively), in 26% (6/23) the AP view only was sufficient (retrospectively), in 13% (2/23) it was a combination of insufficient quality and the AP view only was sufficient given the indication (prospectively), in 8.5% (2/23) it was a combination of insufficient quality and the AP view only was sufficient (retrospectively), and in another 8.5% (2/23) it was a combination of the AP view only was sufficient given the indication (prospectively) and the AP view only was sufficient (retrospectively) (Fig. 7).
Fig. 7: Radiologist 2: Percentage of the different reasons that radiologist 2 gave why the lateral view had no value. A = insufficient quality, B = prospectively, the AP view only was sufficient given the indication, C = retrospectively, the AP view only was sufficient, D = non specific reasons, A+B = combination of reasons A and B, A+C = combination of reasons A and C. B+C = combination of reasons B and C. N=50.

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In the remaining 27 patients the lateral view did have additional diagnostic value. In 59% (16/27) of those cases additional value was due to determination of exact location, in 4% (1/27) the radiograph gave more certainty given the indication, in another 4% (1/27) there were new findings leading to a change in diagnosis, in 19% (5/27) it was a combination of determination of exact location and the lateral view gave more certainty given the indication, in 11% (3/27) it was a combination of determination of exact location and there were new findings and in 4% (1/27) it was a combination of there were new findings and a suspicious structure was spotted on the AP view and the lateral view gave more certainty (Fig. 8).
Fig. 8: Radiologist 2: Percentage of the different reasons that radiologist 2 gave why the lateral radiograph added value. E = determination of exact location, F = the lateral view gave more certainty given the indication, G = a suspicious structure was spotted on the AP radiograph and the lateral view gave more certainty, H = new findings were found, I = non specific reasons, E+F = combination of reason E and F, E+H = combination of reasons E and H, G+H = combination of reasons G and H. N=50. 

References: Department of Radiology, Atrium Medical Center, Heerlen/NL 2013

In total the diagnosis changed in 16 patients of which in 63% (10/16) it was actually said that the lateral view had a diagnostic value (Fig. 9).
Fig. 9: Radiologist 2: The radiographs with a change in diagnosis. Red = the radiologist said that the radiograph did not have a value. Blue = the radiologist said that the lateral radiograph added additional diagnostic value.

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When looking at each radiograph separately the lateral radiograph had a diagnostic value in 34 (68%) patients for at least one of the two radiologists. On the other hand in 41% it had additional value for both radiologists. When looking only at the given conclusions for the AP radiograph, it was the same in 27 (54%) patients. In 23 patients a different diagnosis was determined, whereas in 10 of these patients the diagnosis was essentially unchanged. In 13 patients there was no agreement between the radiologists.

There was agreement for both AP and lateral radiograph in 31 (62%) patients. In 19 patients the diagnosis was essentially the same. One radiologist diagnosed pleural fluid in 12 of these patients whereas the other radiologist did not. There was no agreement between the radiologists in 10 patients.
Based on Cohen's Kappa there is no (statistical) agreement between the radiologists for the choice of diagnostic value (k=0.12), nor for the given reason (k=0.1). Based on Cohen's Kappa there is a moderate agreement between the assessment of both radiologists for the AP radiograph only (k=0.5) as well as for the AP plus the lateral radiograph (k=0.51).

When pleural fluid is left out, the kappa score for the AP radiograph increased to k=0.7 (substantial agreement) and for the AP plus the lateral radiograph to k=0.78 (substantial agreement).
Fig. 10: Percentage of value or no value given by both radiologists. N=50.
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Fig. 11: Percentage of the different reasons that both radiologists gave why the lateral radiograph had no value. A = Insufficient quality, B = prospectively, the AP view only
was sufficient given the indication, C = retrospectively, the AP view only was sufficient, D = non specific reasons, A+B = combination of reasons A and B, A+C = combination of reasons A and C, B+C = combination of reasons B and C. N=50.

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Fig. 12: The given reason for value by both radiologists. E = determination of exact location, F = the lateral view gave more certainty given the indication, G = a suspicious structured was spotted on the AP radiograph and the lateral view gave more certainty, H = new findings were found, I = non specific reasons, E+F = combination of reason E and F, E+H = combination of reason E and H, G+H = combination of reason G and H. N=50.

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Fig. 13: The radiographs with a change in diagnosis for both radiologists. Red = the radiologist said that the radiograph did not had a value. Blue = the radiologist said that the lateral view had additional diagnostic value.

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Table 2: The answers given by the radiologists. Brown stands for the reasons for no value and blue stands for the reasons for value. P. = Patient, R. 1 = radiologist 1, R. 2 = radiologist 2.

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Conclusion

This is the first study, so far known, which determines the value of the standard two directions x-thorax for bedridden patients as opposed to just an AP radiograph. Not only the diagnostic value was determined but also the reason for that value was examined. And a better result analysis will lead to a better and more concise diagnosis [11].

The aim of this study was to determine whether the standard two directions x-thorax for bedridden patients yields additional diagnostic value for determining the diagnosis as opposed to just the AP radiograph.

The difference in agreement for the given value or not could be explained by differences in specialisation of the radiologists, years of experience, and their participation in different courses. Radiologists will have their own unique training background and use a degree of judgement when assessing chest radiographs which will result in differences of opinions when reporting results.

Looking at the given reasons for radiographs with a diagnostic value, no agreement was found. This may be because that radiologist 2 chose more than one reason for the value a few times while radiologist 1 always chose one reason. For example, while they both filled in reason E, radiologist 2 also chose reason F which meant there was no statistical agreement.

Looking at the given diagnosis it stands out that one of the radiologists identified pleural fluid more often than the other. It’s a possibility that one radiologists tend to report a small amount of pleural fluid down while the other radiologist omits it.

Based on this study, it appears that the lateral radiograph for bedridden patients had additional diagnostic value in about 50% of the patients. When looking at the radiographs separately, the value increased up to 68% (34/50) for at least one of the radiologists. This value has additional benefit useful mostly for determining the position and for determining pathology with more certainly. Furthermore, it had a clearer and more specific diagnosis as a result. The conclusion changed for radiologist 1 for 17 patients and for radiologist 2 for 16 patients.
References

    Consulted 2013 March 22.