



**SAHLGRENKA ACADEMY**

## **Evaluation of Conventional Chest X-Ray in the Trauma Bay**

Degree Project in Medicine

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## ABSTRACT

**Title:** Evaluation of Conventional Chest X-Ray in the Trauma Bay

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**Introduction:** The Advanced Trauma Life Support (ATLS™) provides guidelines for the initial management of major trauma patients, which have become the golden standard at Sahlgrenska University Hospital (SU/S). These guidelines recommend conventional chest x-ray (CXR) to be used in the trauma bay. Extended Focused Assessment Sonography in Trauma (eFAST) has in recent years become more frequently used as an alternative to CXR. Since almost all trauma patients are subject to a trauma computed tomography (CT) scan, the value of CXR in the trauma bay has been questioned.

**Aim:** The aim of this study was to evaluate the usage of CXR to diagnose pneumo- and hemothoraces in the trauma bay at SU/S.

**Methods:** The study was partly retrospective, where an expert radiologist examined the quality of all CXRs taken at SU/S between 2016 and 2018. Also, findings on CXR as compared to CT were compared. Additionally, all tube thoracostomies placed during the same period were investigated. Finally, a survey, where surgeons and radiologists assessed CXR-images to assess their ability to diagnose pneumo- and/or hemothoraces, was performed.

**Results:** A total of 77 chest x-ray (CXR) images were obtained in the trauma bay at SU/S between 2016 to 2018. Of these, 74% had one or more remarks regarding quality. Comparison between findings on CXR and following trauma CT showed a sensitivity of 50% regarding pneumo- and/or hemothoraces of clinical relevance. Based on CXR findings a chest drain was placed in 10 patients. The survey showed that surgeons correctly assessed the presence of pneumothorax and/or pleural fluid in 66% of the cases.

**Conclusions:** The findings in this study suggest that the value of current routines as well as radiography equipment in the trauma bay is limited.

**Key words:** chest x-ray, trauma, pneumothorax, hemothorax.

## 1. Introduction

### 1.1 Background

Worldwide, more than nine individuals perish from injuries per minute, and approximately five million die every year due to trauma (1). Measuring in DALY (disability in life years), trauma accounts for 12% of the total loss, thus causing a significant burden of disease. Rapid diagnosis and treatment are usually the key elements in dealing with major trauma patients. When these patients arrive to the hospital, the initial management is a critical and demanding period, including assessment, resuscitation and diagnostic studies. This systematic approach is outlined in the Advanced Trauma Life Support (ATLS™) guidelines.

The ATLS course was introduced in 1978 by The American College of Surgeons (ACS). ATLS presented a model of structured care of persons injured by external violence. The concept of the course was spread across the world, and in 1996 it was introduced in Sweden. It is now mandatory for all Swedish residents in surgery, orthopaedics and anaesthesiology. Therefore, the principles that are given in ATLS have become a standard in the primary assessment and resuscitation of trauma patients. The content of the course is revised every four years.

An adjunct to the primary evaluation of trauma patients according to ATLS is the use of AP (anterior-posterior) plain-film radiography of the chest (CXR) and pelvis, as well as AP and lateral x-ray of the cervical spine in the trauma bay. The purpose is to early diagnose any major chest injuries, fractures of the pelvis and dislocations or fractures of the cervical spine. In case of penetrating injuries, it is also recommended to mark the entrance (and exit) wounds, with x-ray dense markers. This in order to obtain a perception of the trajectory (projectile path) in the body (1).

When the emergency department (ED) at Sahlgrenska University Hospital (SU/S) was renovated 20 years ago, radiology equipment was installed. It consists of an x-ray

tube hung on a rail attached to ceiling, able to slide over the three available beds. For technical reasons only AP exposures can be obtained on digital plates placed under the patient. The image is not immediately available since the plate must be removed and put in a scanner. The delay between exposure and presentation of the image on a monitor in the trauma bay is a few minutes. At this point in time, it can also be reviewed thru the internal network by the radiologist on call at the department of radiology.

Since the installation of x-ray equipment every member of the trauma team at SU/S is required to wear radiation protection gear. When a level 1 trauma alert is activated, two nurses from the department of radiology are summoned to the trauma bay. These are part of the trauma team and responsible for conducting any of the radiological examinations mentioned above requested by the trauma team leader.

## 1.2 Evolution

ATLS is revised every fourth year and the recommendations regarding x-ray examinations have changed over the years. Previously, the ATLS course recommended plain-film radiography of the chest, pelvis and cervical spine in all patients with blunt trauma (1). Nowadays, conventional radiography of the pelvis and cervical spine are only recommended to be performed in hemodynamically unstable patients or those with abnormal findings on physical examination. The reason for this is based on new evidence. Duane et al. (2) showed that clinical examination of the awake patient readily identified the need of pelvic x-ray. CCR (Canadian C-spine Rule) as well as NEXUS (National Emergency X-radiography Utilization Study) are two decision making rules that have been shown to have a high sensitivity and are recommended to be used in clinical practice by international guidelines (3). Nevertheless, in the latest edition (10th) of the ATLS course, CXR is still considered to be a valid adjunct to the primary survey, alongside and parallel to the introduction of physician operated ultrasound.

Besides the implementation of clinical protocols, much progress has been made in the field of radiology as well as other imaging modalities since the introduction of ATLS. Computed tomography (CT scanning) has replaced many of the radiological examinations previously used in various acute situations, including trauma. CT scanners are today readily available in all Swedish emergency hospitals and when emergency departments are renovated efforts are made to locate scanners within or near the ED.

An example of when conventional x-ray has been replaced by CT is in the care of haemodynamically stable patients injured through blunt trauma. These cases make up for most trauma patients at SU/S, and so called “trauma-CT” has become the golden standard for further diagnostic workup. Trauma-CT provides a detailed view of the head, (face), cervical spine, thorax, abdomen, pelvis and upper parts of the femur, and has a higher diagnostic accuracy than plain-film radiography (4). However, at SU/S, the examination requires transportation of the patient to the CT-scanner located approximately 200 meters from the ED. This, as well as the transfer of the patient from the stretcher to the scanner and reverse takes time and should only be done in patients assessed as circulatory stable (5).

In recent years, another type of examination that has become more frequently used in trauma patients is the Extended Focused Assessment Sonography in Trauma (eFAST) (6). eFAST can be used bedside to diagnose pneumothorax, haemothorax, cardiac tamponade as well as fluid (blood) in the abdomen.

Overall, the diagnostic accuracy and increased availability of CT scanning have made this examination the golden standard for trauma patients, and the delay between exposure and access to the x-ray image in combination with the introduction of eFAST in the trauma bay has made the use of plain x-ray examinations more and more rare at SU/S. Nevertheless, personnel from the department of radiology are summoned on every level 1 trauma alert. The present radiography equipment needs regular service as well as replacement

of this 20 years old equipment. This has led to questioning the value of radiography in the trauma bay at SU/S, and if investing in new hardware seems reasonable.

### 1.3 Chest Radiography

Plain-film chest radiography (CXR) is useful for detecting serious life-threatening conditions such as tension pneumothorax, hemothorax, gross pulmonary contusions, mediastinal hematoma, flail chest or malpositioned tubes (4). The availability of the CXR in the trauma bay gives the physician possibility to diagnose these conditions and immediately perform necessary interventions. The method includes a frontal (AP) and lateral projection. Although, at SU/S only a frontal supine projection is available, which impairs the ability to visualize ventral pneumothoraces or moderate dorsal hemothoraces. Another disadvantage at SU/S is that it takes a few minutes from exposure until the image can be viewed on the monitor in the trauma bay.

Based on the recommendations from ATLS, CXR has been considered as the mainstay in diagnosing thoracic injuries and recommended as a standard initial diagnostic test. However, Sears et al. (7) reported that mandatory CXR for all trauma patients yields little additional information as compared to the trauma surgeon's assessment, and that the negative predictive value (NPV) for the trauma surgeon's judgement was 98.2% regarding chest injuries. This suggest that a more selective policy is safe while costs and radiation exposure are reduced.

### 1.4 Computer Tomography

CT scanning of the chest (CCT) outperforms CXR in identifying chest injuries; Exadaktylos et al. (8) reported that CCT found significant injuries in patients with normal CXR in more than half of the group, and CCT revealed more extensive injuries as compared to abnormal initial radiographs, necessitating a change of management in 20% of the cases. Another study presented by Langdorf et al. (9) including 2048 patients whom underwent both CXR and chest CT showed that injuries were found only on CT in 71% of the cases, and one

third of these needed intervention. A third study presented by Kirkpatrick et al. (10) found that supine anterior posterior (AP) CXR had a sensitivity of only 20.9% in the detection of pneumothorax as compared to CT.

CT is superior to CXR from a diagnostic point of view, but carries higher radiation exposure and cost (9). Also, presently patients must be transported to the CT-scanner - a less monitored environment with limited possibilities to emergency interventions as compared to the trauma bay. Put together, it exposes a weakness for the use of CT as an effective screening tool.

### 1.5 Extended Focused Assessment Sonography in Trauma (eFAST)

In patients with major trauma, focused ultrasonography assessment for trauma (FAST) is a bed-side method performed by the surgeon or the emergency physician to diagnose intraperitoneal collections of free fluid (blood). The examination can be extended to the thorax, and thereby rule out any pneumo- and/or hemothoraces, and the examination is then referred to as extended-FAST (eFAST). The method is rapid and the use of eFAST has increased in recent years (6).

Several studies have been made on the diagnostic accuracy of eFAST for detection of pneumothorax in comparison with supine AP CXR. Wilkerson et al. (11) performed a meta-analysis in 2010 including four studies and 606 patients who suffered from blunt trauma. Thoracic ultrasonography (US) was compared with AP CXR for detection of pneumothorax. The sensitivity for US ranged from 86% to 98% compared to the sensitivity of CXR which ranged from 28% to 75%. The specificity of US ranged from 97% to 100%. The specificity of CXR was 100% in all included studies. Accordingly, the review suggest that thoracic US is a more sensitive diagnostic method for detecting pneumothorax than CXR in patients with blunt trauma.

In 2013, Ianniello et al. (12) performed a study to evaluate the accuracy of eFAST in the detection of pneumothorax as compared to CT. The retrospective case series



involved 368 adult patients admitted for major trauma. Thoracic CT scan detected 87 pneumothoraxes among these patients. eFAST detected 67 of 87, which gives a sensitivity of 77%. The specificity of US was 99.8%. Among the 20 missed pneumothoraxes with eFAST, 17 were small (thickness < 5 mm) and 3 were moderate.

However, the performance of eFAST is physician dependent and the accuracy varies with the skill of the operator. For example, in a study by Satori et al, as cited by Ding et al. (13), the sensitivity of thoracic ultrasonography for detection of pneumothorax was 100%, while another study showed a sensitivity of 59%.

### 1.6 Lodox/Statscan

The Lodox/Statscan device was originally developed as a very-low-dose X-ray unit for the diamond mining industry in South Africa to help in the detection of smuggled diamonds. However, Lodox has also proven useful in trauma centres. The x-ray scanner, approved for medical use both in the US as well as the EU, produces a whole-body AP scan in 13 seconds. If desired, the C-arm can be rotated and then provide a lateral scan. The unit includes a special docking resuscitation table which eliminates the need of transfer of the patient and enables ongoing resuscitation.

A study from Boffard et al. (14) showed that there were no difference in the amount of information obtained from conventional radiography compared with Lodox, but the use of Lodox allowed a substantial reduction in the time taken for resuscitation.

### 1.7 Aim

This study aimed to evaluate the usage of CXR in the trauma bay at SU/S to diagnose pneumo- and hemothoraces. Specific objectives were assessment of the quality of the CXR-images, calculation of sensitivity and specificity of CXR in relation to a following CT-scan, which interventions the CXRs led to as well a survey of the skills in assessing the images among surgeons and radiologist at SU/S.

## 2. Material and methods

### 2.1 Study design

The study consists of three different parts: 1) a retrospective observational study of patients at SU/S who underwent CXR in the trauma bay during the years 2016-2018, 2) a retrospective observational study of patients who received a tube thoracostomy during the same years, and 3) a survey to evaluate physicians' skills in assessing CXR-images.

### 2.2 Population and data collection

A total of 77 CXRs obtained in the trauma bay at SU/S between 2016 and 2018 were identified in the internal database at the Department of Radiology. These 77 images corresponded to 77 patients, for each of which corresponding medical records were reviewed in the digitized medical record system Melior. Since not all patients underwent a following CT scan including the chest (n=8), 69 patients were eligible for comparison between findings made on CXR as compared to CT. Data from the CT-scans were collected through WedAdapt.

A search was made in the Swedish Trauma Registry (SweTrau) for patients receiving a tube thoracotomy at SU/S in 2016-2018. The code that was searched for was GAA10.

Finally, 20 of the 77 CXR-images were copied and after removing patient-ID entered a PowerPoint-file. These 20 images were selected by an experienced radiologist accordingly: five with findings and good quality, five with findings and bad quality, five without findings and good quality, five without findings and bad quality. The PowerPoint-file was distributed to ten surgeons (occasionally taking trauma calls) as well as one radiologist doing on call service for the trauma service. The participants were asked to review and assess the images according to a questionnaire (presented in the appendices).

### 2.3 Variables

All 77 CXR-images were assessed by an experienced radiologist based on the following image quality (pruned, oblique positioned, movement artefacts, incorrect exposure),

and findings (pneumothorax, subcutaneous emphysema, pleural fluid, mediastinal widening, and parenchymal opacification). Together these nine variables make up the general examination of a CXR in the trauma setting.

The medical files of the patients who underwent a trauma-CT after resuscitation in the trauma bay were reviewed with focus on clinical parameters (respiratory frequency, blood oxygen saturation) and signs (breath sounds on thoracic auscultation, subcutaneous emphysemas, asymmetry, or instability of the chest). Further was the trauma surgeons' assessment of CXR and resulting interventions, as well as the radiologists' assessment of CXR, chest-CT (CCT) and any additional interventions following CT studied. The findings on chest-CT were categorized in three primary groups: "all findings", "clinically relevant findings" and "clinically non-relevant findings". All findings included pneumo- or haemothorax of any size. Clinically relevant (CR) findings (also referred to as "findings of significance") were pneumo- or hemothoraces measuring 20 mm or more on CCT, or pneumo- or hemothoraces of lesser size but treated with tube thoracotomy prior to CT. Clinically non-relevant (CNR) findings were pneumo- or hemothoraces measuring less than 20 mm, or no pneumo- or hemothoraces at all.

When searching in SweTrau, patients arriving as trauma alerts who received tube thoracostomy after a CT-scan without previous CXR were included. Their medical files were examined and clinical findings (blood pressure, pulse, POX, breathing frequency and sounds) prior and after receiving a chest tube were extracted.

The 20 images included in the survey were assessed accordingly to the variables presented in the beginning of this section. The survey formula is attached in the appendix.

#### 2.4 Statistical methods

When investigation of the clinical parameters and findings were made, the patients were divided into two groups: one with pneumo- and/or hemothoraces and one without. Mean respiratory frequency were calculated for the two groups. Clinical findings

(reduced breath sounds, subcutaneous emphysemas, asymmetry/instability of the chest wall) were considered as test methods and reliability was calculated thru binary classification. Also, the assessments of CXR by the surgeons and the radiologists were put in a binary classification system using CCT as a reference.

The responses to the survey were compared to the assessment by the expert radiologist. Answers were categorized as “correct” or “incorrect”. Individual results were then put together to calculate an overall result for surgeons and radiologist, respectively.

### 3. Ethics

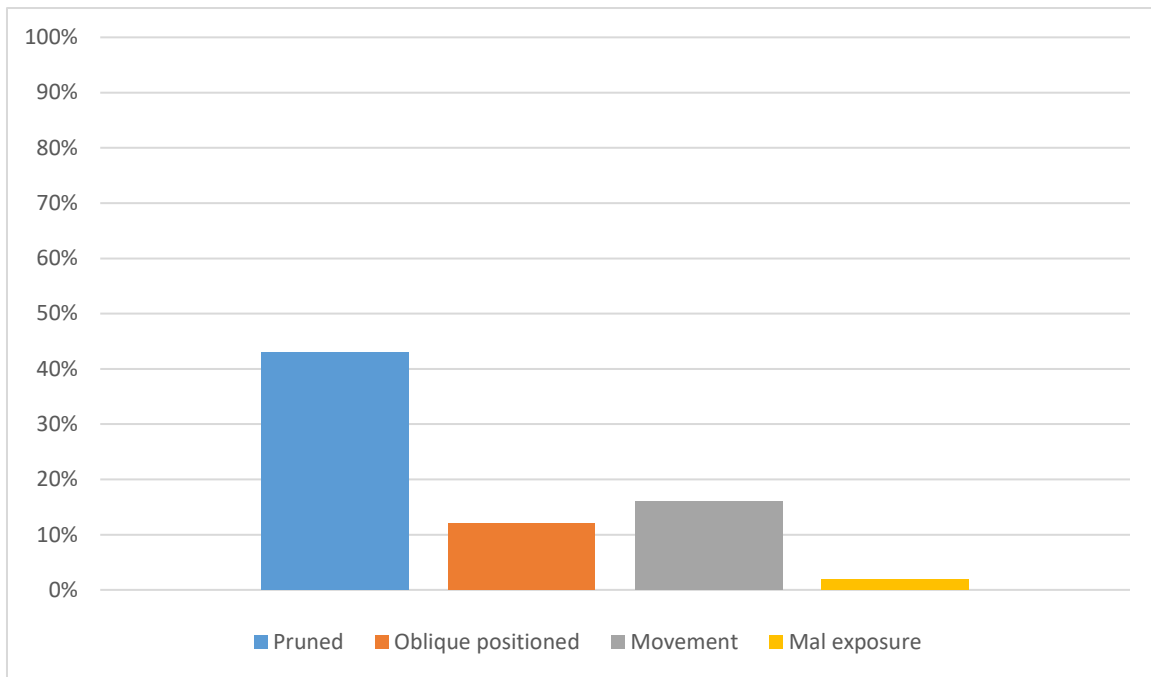
This study is a retrospective review and thus patients included were not exposed to any additional examinations or interventions. The only ethical consideration was the risk of infringement of integrity. Therefore, social security numbers were exchanged with codes in a data base, protected from unauthorized access.

This study was approved by the Swedish Ethical Review Authority (DNR 2020-04436).

## 4. Results

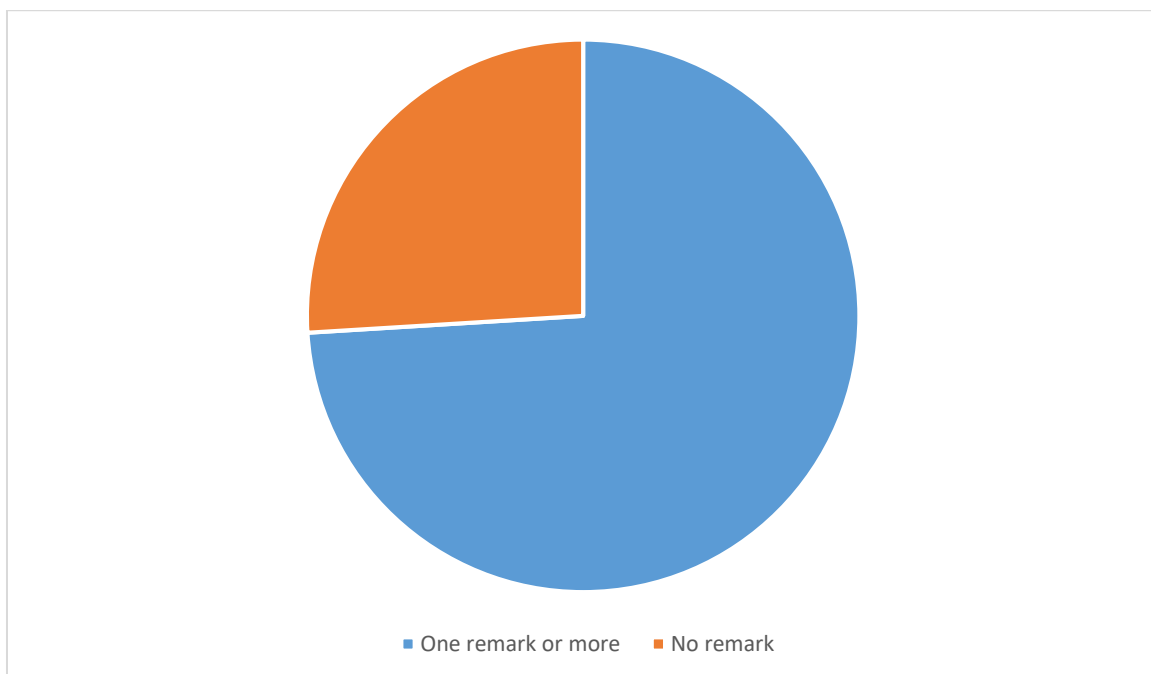
### 4.1.1 Quality of CXR

A total of 77 CXR-images were taken in the trauma bay at SU/S in the years 2016 to 2018. During the same period approximately 1100 level 1 trauma alerts were activated at SU/S. The assessment of the quality of the CXR-images are presented in Figure 1.



**Figure 1. Remarks on quality of the chest x-rays taken in the trauma bay at SU/S in 2016-2018.** An expert radiologist examined the 77 images based on 4 criteria; pruned, oblique positioned, movement, mal exposure.

As shown in Figure 1, a total of 43 images were pruned, 12 were oblique positioned, 16 had movement artefacts and 1 had mal exposure. Of the 77 images that were taken, 57 (74%) had one remark or more, and 20 images had no remark, as shown in Figure 2.



**Figure 2. Share of the 77 images that had at least one remark.** Based on the expert radiologist examination of all chest x-rays in the trauma bay at SU/S (2016-1018), it was calculated that 74% of the images had at least on remark in quality, and 26% were of perfect quality.

The 77 CXR-images done in 2016 to 2018 corresponded to 77 patients taken care of at SU/S. Nine pneumothoraces and six hemothoraces were identified by surgeons through CXR. On ten occasions, findings on CXR led to insertion of chest tubes in the trauma bay. Additionally, chest tubes were inserted before CXR on three occasions, and CXR was then used to control for tube positioning. Two out of the 77 images were so deficient that they could not be assessed whatsoever.

The radiologists' assessment of the 77 images were also investigated. They found pneumothorax on nine images and haemothorax on eight. On four occasions, the radiologists assessed that the quality of the images were too deficient to be examined.

#### 4.1.2 Reliability of CXR

Of the 77 patients having CXR performed in the trauma bay, 69 underwent a following trauma-CT (including chest-CT). In three patients the assessment of CXR by the surgeons were not documented in the medical files, and thus comparison between surgeons' findings on CXR and findings on following CCT was possible in 66 patients. Further, of the patients eligible for comparison, three had so deficient quality on their CXR that the radiologists did not review them, rendering 66 CXR-images eligible to compare the radiologists' findings to CCT. The surgeons' and radiologists' findings of CXR and CCT are shown in Table 1 and 2.

**Table 1. Surgeons' findings on CXR.** The surgeons' findings on CXR compared to following CCT. Put in a binary classification system, these are the results. In this table, pneumo- and hemothoraces of any size are used.

	N
Pneumo- and/or hemothorax detected on CXR by surgeons	14
- True positive	12
- False positive	2
No pneumo- and/or hemothorax detected on CXR by surgeons	52
- True negative	30
- False negative	22

All findings on CCT	35
Clinically relevant findings on CCT	22

**Tabell 2. Radiologists' findings on CXR.** The radiologist' findings on CXR compared to following CCT. Put in a binary classification system, these are the results. In this table, pneumo- and hemothoraces of any size are used.

	N
Pneumo- and/or hemothorax detected on CXR by radiologist	16
- True positive	13
- False positive	3
No pneumo- and/or hemothorax detected on CXR by radiologists	50
- True positive	39
- False negative	11
All findings on CCT	35
Clinically relevant findings on CCT	22

As presented above, surgeons diagnosed 14 pneumo- and/or haemothorax based on CXR. However, two of these findings were false positive, rendering 12 as true positive findings. Also, surgeons missed pneumo- and/or hemothoraces on 22 occasions, thus rendering in 11 false negatives. Radiologists, on the other hand, found 16 pneumo- and/or hemothoraces, of which 13 were true positive, and missed 11 pneumo- and/or hemothoraces. These results are calculated based on pneumo- and/or hemothoraces of any size.

When findings on CCT were categorized in CR and CNR, surgeons found 11 of the 22 CR findings on CXR and radiologist found 13 of the same. Surgeons missed 11 CR findings and radiologists missed 5. Through comparative statistics, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for surgeons' and radiologists' assessment of CXR. The results are presented in Table 3.

**Table 3. Reliability of CXR-assessments by surgeons and radiologist, respectively.** Surgeons and radiologists' findings on CXR were compared to following CCT. Results were categorized in true positives, true negatives, false positives, and false negatives. Sensitivity, specificity, PPV and NPV were then calculated for surgeons and radiologists on all findings and clinically relevant findings, respectively. Numbers are shown in percentage.

(%)	Sensitivity	Specificity	PPV	NPV
<b>Surgeons and all findings</b>	37	94	86	54
<b>Radiologists and all findings</b>	54	93	81	78
<b>Surgeons and CR findings</b>	50	95	85	81
<b>Radiologists and CR findings</b>	66	96	83	90

PPV (positive predictive value), NPV (negative predictive value), CR (clinically relevant; pneumo- and/or hemothoraces measuring 20 mm or more), CXR (chest x-ray), CCT (chest computed tomography, included in trauma-CT).

The assessments by surgeons of CXR-images had a sensitivity of 37% on all findings on CCT, and 50% of the CR. The radiologists had a higher sensitivity on all findings (54%) and on the CR (66%). Moreover, the NPV for surgeons was 54% on all findings but 81% on the CR. The radiologist had a NPV of 78% on all findings and 90% on the CR.

#### 4.1.3 Clinical findings

Results of comparison of clinical findings are presented in Table 4 and 5.

**Table 4. Clinical parameters.** Clinical findings in the trauma bay of those who had pneumo- and/or haemothorax of significance (e.g. CR) and those without were compared.

	CR findings	CNR findings
<b>Mean respiratory frequency (breaths per minute)</b>	21.1	20.9

"CR (clinically relevant), CNR (clinically non-relevant).

As presented in Table 4, the mean respiratory frequency differed 0.2 breaths per minute between the two groups.

**Table 5. Clinical signs.**

	Sensitivity	Specificity	PPV	NPV
<b>Decreased breath sounds (%)</b>	83	69	58	94



<b>Subcutaneous emphysemas (%)</b>	30	100	100	73
<b>Asymmetry or instability of the thorax (%)</b>	11	98	67	71

PPV (positive predictive value), NPV (negative predictive value).

As shown in Table 5, decreased breath sounds had a sensitivity of 83% but a PPV of only 58%. In contrary, the presence of subcutaneous emphysemas had a PPV and specificity of 100%.

#### 4.2 Tube thoracostomy

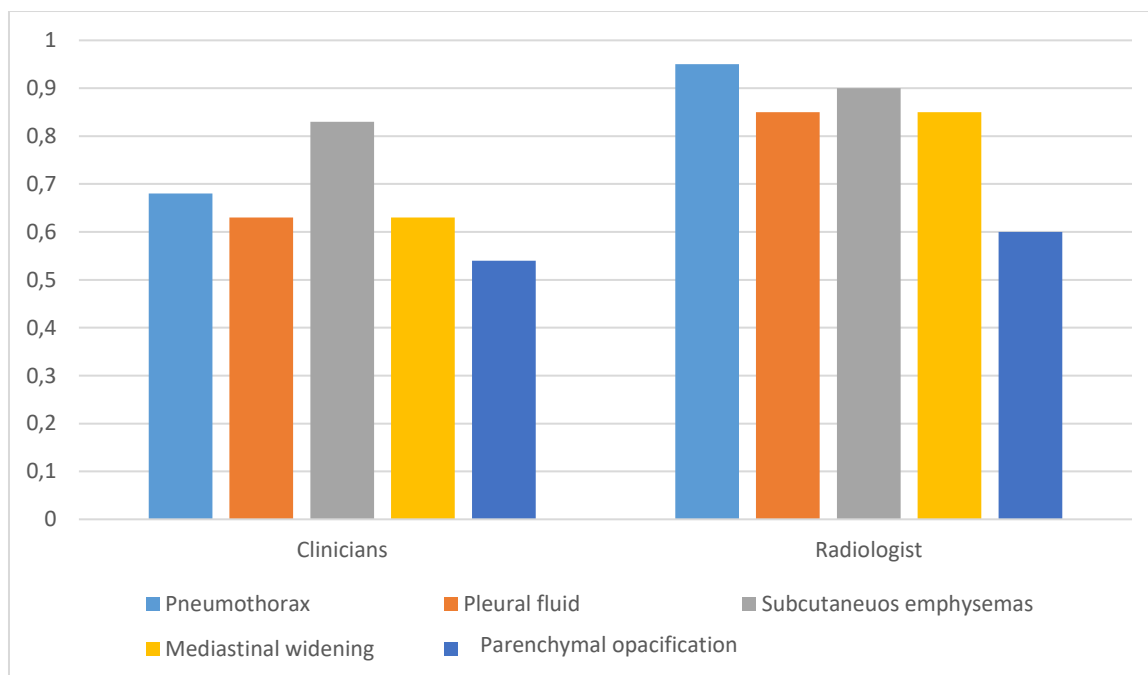
In a review of all patients receiving tube thoracostomies at the trauma ward at SU/S (n=275), 27 trauma calls were identified where chest tubes were inserted after the patients had underwent CCT, without previous CXR in the trauma bay. This suggest that in 27 cases, pneumo- and/or haemothorax could have been diagnosed and treated earlier if CXR would have been used in the trauma bay. Of these 27 patients, two were in pre-chock at the trauma bay, and would potentially benefit largely of a chest tube prior to CT. The other 25 patients were hemodynamically stable.

In 14 cases the patients received a chest tube in the trauma bay after a CXR. Four of these patients had CXR difficult to assess; two of these had complementary studies with eFAST. Two patients had chest tubes inserted based on clinical suspicion. Of the 14 patients, two were in physical distress. One of these two improved upon receiving a chest tube.

Further, there was a total of 26 trauma calls when the patients received tube thoracostomies based on clinical findings only, without previous diagnostic studies.

#### 4.3 Survey

A total of five surgeons and one radiologist participated in the survey. The surgeons' and radiologist's results are presented in Figure 3.



**Figure 3. Result of survey.** Five surgeons and one radiologist took the survey consisting of 20 chest x-ray images. Presence of pneumothorax, pleural fluid, subcutaneous emphysemas, mediastinal widening and parenchymal densification was asked. The answers were compared to the assessment by an expert radiologist. Shown is the percentage of correct answer by surgeons and radiologist separately.

Concerning the presence of pneumothorax, surgeons made the correct assessment in 68% of the answers, and in 63% of the answers concerning the presence of pleural fluid. Put together, surgeons had a correct assessment rate of 66% concerning pneumothorax and/or pleural fluid. The radiologist assessed correctly in 90% of the times regarding the presence of hemothorax and/or pleural fluid.

## 5. Discussion

### 5.1 Findings 1

This study attempted to evaluate the usage of CXR in the trauma bay at SU/S. A total of 77 CXR-images were taken during 2016 to 2018. Of these, 74% had one remark or more regarding quality. The high proportion of CXR-images of deficient quality, and especially being pruned, suggests that the current equipment is difficult to handle and that the personnel doing so needs more frequent practice. However, considering that 26% of the

images were of excellent quality, it is not the equipment that is deficient but rather the infrequent practice in handling it. That fact that only around 25 images are taken per year indicates that this examination is rare. However, the time delay between exposure and access to the images could be minimized with newer equipment. For example, Boffard et al. (14) presented a time delay of just 13 seconds when investigating the Lodox/Statscan. Such a rapid examination would probably increase the popularity of conventional x-ray in the trauma bay immensely.

Furthermore, the sensitivity of surgeons' interpretation of the CXR-images was only 50% regarding diagnosing pneumo- and hemothoraces of clinical relevance. This is in line with previous research (8), while other studies have presented an even lower sensitivity (9, 10). Radiologists had a slightly higher sensitivity in interpretation (66%). It could therefore be suggested that a radiologist should be included in the trauma team and present in the trauma bay. Yet, only 77 images were taken when around 1100 trauma alarms were issued, which advocates that the cost/benefit of this would be limited.

Moreover, the results of the survey showed that surgeons had a diagnostic accuracy of 66% concerning the presence of pneumothorax and pleural fluid. This suggests that a more frequent practise in interpretation of CXR-images is needed. The radiologist had an accuracy of 90%. Future studies could include more radiologist to investigate this further.

## 5.2 Findings 2

The study also revealed, somewhat surprisingly, that the difference in mean respiratory frequency between the two compared groups was small, and thus respiratory frequency cannot be used to rule in or out pneumo- and/or hemothorax. However, the presence of decreased breath sounds had a sensitivity of 83%, consequently being a useful tool. Also, the presence of subcutaneous emphysemas had a specificity of 100%, hence being

a valuable indicator. Research on larger number of patients is needed to investigate this further.

During the three years that the study included, there were two cases where patients in pre-chock with pneumo- and/or hemothorax underwent CCT and received a chest tube, without a previous CXR in the trauma bay. Although these cases being few, they point out the value of the possibility to perform radiographic diagnostic studies in the trauma bay. However, on ten occasions, findings on CXR were the reason the patient received a chest tube in the trauma bay. A future study could investigate the number of patients that receive chest tubes based on clinical findings but not having pneumo- and/or hemothoraces. These chest tubes are not indicated and could have been avoided if previous CXR would have been performed.

### 5.3 Limitations

A main weakness of the study is that there is a time lapse of around 20 minutes between exposure of CXR and CCT. During this period, any pneumo- or hemothorax can increase in size. Potentially, it could be smaller than 20 mm when CXR is performed, and then expand to be larger and thus be categorized as clinically relevant. This is especially relevant if the patient has been intubated and subjected to positive pressure ventilation during this time.

Other limitations of the study are the small sample size of only 77 CXR-images, most of them caused by blunt trauma. Thus, the value of CXR in penetrating chest injuries cannot be assessed. Moreover, only five surgeons and one radiologist participated in the survey.

## 6. Conclusions and Implications

This study set out to evaluate the usage of CXR in the trauma bay at SU/S. The most obvious findings were that the images often were of poor quality, that the sensitivity was

low and that surgeons at SU/S need training in interpretation of CXR-images. The findings suggest that in general the current radiography equipment and routines are of limited value. The question about what kind of equipment to replace the current remains.

## Populärvetenskaplig sammanfattning

Christoffer Örtenwall, examensarbete, läkarprogrammet, Göteborgs Universitet, 2021.

**Titel:** Utvärdering av konventionell lungröntgen på traumarummet.

**Bakgrund:** Personer som varit med om olyckor (trauma) omhändertas på Sahlgrenska Universitetssjukhus (SU/S) enligt internationella riktlinjer. Dessa riktlinjer rekommenderar att patienterna genomgår en ”vanlig” (konventionell) röntgen av lungorna på akuten (i traumarummet) för att utesluta förekomst av luft eller blod i lungsäcken. På senare tid har skiktröntgen och ultraljud fått en växande roll i omhändertagande av traumapatienter, och användbarheten av vanlig röntgen har blivit ifrågasatt.

**Syfte:** Den här studien syftar till att undersöka användbarheten av lungröntgen på traumarummet på SU/S.

**Metod:** Studien bestod av tre delar: en erfaren röntgenläkare bedömde kvalitén av alla röntgenbilder som togs på traumarummet under 2016 till 2018, och de fynd som gjordes med vanlig röntgen på traumarummet jämfördes med de fynd som gjordes med efterföljande skiktröntgen; en registergenomgång av alla thoraxdrän (slang i lungsäcken för att dränera luft eller blod) som sattes SU/S under samma treårs-period; en enkätundersökning bland kirurger på SU/S bestående av vanliga lungröntgenbilder.

**Resultat:** Studien visade att 74% av alla röntgenbilder som togs på traumarummet hade minst en anmärkning i kvalitén. Dessutom framgick att bara hälften av alla fall där patienterna hade luft eller blod i lungsäcken av betydande storlek upptäcktes på traumarummet med lungröntgen. Dock ledde röntgen på traumarummet till att patienter fick thoraxdrän vid tio

tillfällen. Slutligen visade enkätundersökningen att kirurger på SU/S behöver mer träning i att granska lungröntgenbilder.

**Slutsats:** Studiens resultat indikerar att befintlig utrustning och rutiner är av begränsat värde.

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# Appendices

## Survey form

### Assessment of chest x-ray from the trauma bay

#### Quality of image:

- Pruned
  - Right
  - Left
  - Cranial
  - Caudal
- Oblique positioning
  - Yes
  - No
- Movement artefacts
  - Yes
  - No
- Exposition OK
  - Yes
  - No

#### Fynd:

- Pneumothorax
  - Yes, right
  - Yes, left
  - No
- Subcutaneous emphysemas
  - Yes, right
  - Yes, left
  - No
- Pleural fluid
  - Yes, right
  - Yes, left
  - No
- Mediastinal widening
  - Yes
  - No
- Parenchymal densification
  - Yes, right
  - Yes, left
  - No





**BESLUT**

Sökande forskningshuvudman  
Västra Götalandsregionen

Forskare som genomför projektet  
Jenny Skytte Larsson

Projekttitel  
Har slätröntgen på akuten vid omhändertagande av traumapatienter spelat ut sin roll?

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Etikprövningsmyndigheten beslutar enligt nedan.

**BESLUT**

Etikprövningsmyndigheten godkänner den forskning som anges i ansökan.

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På Etikprövningsmyndighetens vägnar

Evelina Englund  
Ordförande

Beslutet har fattats efter föredragning av vetenskaplig sekreterare Britt Gustafsson.

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Beslutet sänds till  
Ansvarig forskare: Jenny Skytte Larsson  
Forskningshuvudmannens företrädare: Erik Johnsson

