

## SCIENTIFIC LETTER

## Use of chest radiography in the emergency diagnosis of acute congestive heart failure

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The objective of the present study was to evaluate the diagnostic accuracy of chest radiography in the diagnosis of congestive heart failure (CHF) in a contemporary cohort of consecutive patients presenting with acute dyspnoea to the emergency department.

## METHODS

Among 452 BASEL (B-type natriuretic peptide for acute shortness of breath evaluation) study patients,<sup>1</sup> 202 were eligible for the present analysis. We included only patients who had a chest radiograph recorded in the emergency department before or immediately after intravenous loop diuretics or vasodilators were given and when the film was read by the radiologist in charge of the emergency department. We excluded patients who presented to the emergency department with an external chest radiograph already recorded, patients who did not have chest radiography in the emergency department, and patients with no formal radiological reading available. Overall, baseline characteristics were similar in the 202 patients in the current study and the original BASEL study cohort.

The radiologist in charge of the emergency department evaluated chest radiographs obtained in the emergency department as part of the regular routine. At the time of the reading, the radiologist was unaware that this reading would be specifically analysed with regard to CHF. On the basis of the official reading of the radiograph, the presence of predefined findings was recorded. In addition, we determined whether the radiologist considered the radiograph to indicate CHF. For logistical reasons, the official reading of the radiograph was not available to the physician in the emergency department. The final discharge diagnosis of CHF was adjudicated by an internal medicine specialist applying current guidelines for CHF diagnosis on the basis of

all available medical records pertaining to the individual patient, including the response to treatment and necropsy data for patients who died in hospital. Transthoracic echocardiography was performed in 101 patients, B-type natriuretic peptide concentrations were measured in 190 patients, and these data were available for the final discharge diagnosis in 106 patients (measured in a blinded fashion in 84 patients). Comparisons were made by using the *t* test, Mann-Whitney U test, Fisher's exact test, and  $\chi^2$  test as appropriate. Sensitivity, specificity, positive and negative predictive values, and accuracy were calculated with standard formulas.

## RESULTS

In 107 of 202 patients CHF was found to be the cause of acute dyspnoea. Patients with CHF were older and more often had coronary artery disease and arterial hypertension. Most likely due to their significantly higher age, CHF patients more often required chest radiography to be performed in the supine position (36% *v* 22%, *p* = 0.066). Overall, radiographic CHF signs were specific but only moderately sensitive in the diagnosis of CHF (table 1). Cardiomegaly was the only radiographic finding with a sensitivity > 50%. However, specificity (71%) was lower than that for cephalisation (93%), hilar haziness (94%), Kerley B lines (96%), interstitial oedema (93%), and alveolar oedema (99%). Accuracy was modest overall and was highest for cardiomegaly (67%). The radiological interpretation regarding CHF was accurate in only 69% of patients. Patients with an incorrect radiological interpretation had a non-significantly higher rate of hospital admission (91% *v* 81%, *p* = 0.078) and longer time to discharge (median 14 *v* 9 days, *p* = 0.068) than did patients with a correct interpretation.

**Table 1** Diagnostic performance of radiographic findings and radiological interpretation in the diagnosis of congestive heart failure

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Cardiomegaly	63.6	70.5	70.8	63.2	66.8
Cephalisation	19.6	92.6	75.0	50.6	54.0
Vascular prominent hilum	16.8	71.6	40.0	43.3	42.6
Hilar haziness	22.4	93.7	80.0	51.7	55.9
Peribronchial cuffing	16.8	95.8	81.8	50.6	54.0
Kerley B lines	23.4	95.8	86.2	52.6	57.4
Haziness of pulmonary vessels	17.8	97.9	90.5	51.4	55.4
Peripheral extension of pulmonary vessels	10.3	95.8	73.3	48.7	50.5
Interstitial oedema	29.0	92.6	81.6	53.7	58.9
Alveolar oedema	12.1	98.9	92.9	50.0	53.0
Right sided pleural effusion	11.2	90.5	57.1	47.5	48.5
Left sides pleural effusion	11.2	92.6	63.2	48.1	49.5
Bilateral pleural effusion	19.6	94.7	80.8	51.1	55.0
Radiological interpretation	53.3	86.3	81.4	62.1	68.8

NPV, negative predictive value; PPV, positive predictive value.

## DISCUSSION

This study quantifies the diagnostic performance of radiographic findings in the diagnosis of acute CHF in consecutive patients presenting with acute dyspnoea to the emergency department. Acute CHF requires active treatment and therefore accurate diagnosis. Overall, radiographic CHF signs were specific but only moderately sensitive in the diagnosis of CHF. This finding has important implications for clinical practice. The presence of any of the signs of acute pulmonary congestion reliably indicates acute CHF. Their absence, however, in no way excludes acute CHF. Interestingly, radiographic interpretation regarding the presence or absence of CHF was accurate in only 69% of patients. Our results are supported by data from the breathing not properly study.<sup>2</sup> Knudsen and colleagues<sup>2</sup> showed that alveolar oedema, interstitial oedema, and cephalisation all had a specificity > 90% for CHF but that only cardiomegaly had a sensitivity > 50%.

Our study has three particular strengths. Firstly, it included a large contemporary cohort of consecutive patients presenting with acute dyspnoea. Changes in causes in recent years and specific limitations associated with respiratory distress resulting in suboptimal positioning and single plan supine imaging in many patients make our data particularly important.<sup>3</sup> Secondly, the study population was highly representative of the elderly population of patients with acute dyspnoea in clinical practice.<sup>1,2</sup> These patients have extensive co-morbidity. As early as 35 years ago, pulmonary co-morbidity was noted to influence the radiographic appearance of pulmonary venous hypertension. Thirdly, this was the first study in which B-type natriuretic peptide concentrations could be considered for a considerable number of patients in the standard definition of CHF.<sup>1,2</sup>

Our study has several limitations. Firstly, not all patients could be examined in the standing position and no standardised criteria for the radiographic signs of pulmonary venous hypertension were used. Moreover, the chest radiographs were not evaluated by core laboratory. Although this may have led to an underestimation of the diagnostic accuracy of the chest radiographs, the study very well reflects the "real world" diagnostic performance. Our approach may have significantly reduced the bias of previous studies in which the radiologist specifically evaluated the chest radiograph for the presence of CHF. Secondly, the chest radiograph beyond doubt did confound the final discharge diagnosis. This may have led to an overestimation of the diagnostic accuracy of the chest radiographs. This effect should have been smaller than in previous studies, however, because for logistical reasons the radiological report was not available to the physicians in the emergency department but became available only on the ward.<sup>2</sup> Thirdly, only 101 patients underwent echocardiography. Therefore, we cannot in all patients differentiate between systolic and diastolic CHF.

In conclusion, chest radiography is only moderately accurate in the diagnosis of CHF in contemporary patients presenting with acute dyspnoea to the emergency department. Radiographic findings of CHF are specific but only moderately sensitive.

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The study was carried out according to the principles of the Declaration of Helsinki and approved by our local ethical committee.

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