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WHAT IS THE VALUE OF CHEST X-RAY FOR PATIENTS WITH ACUTE CHEST PAIN?

ABSTRACT

Background: Chest pain is a frequent reason of consultation in emergency department (ED). Despite the lack of recommendations, chest X-ray (CXR) is often performed in this context.

Methods: This is a single-center retrospective study. From September to November 2012, adult patients admitted to ED with chest pain were included in the study. CXR and patients characteristics were analyzed. An expert committee was in charge to determine if the realization of the CXR was useful or not.

Results: Of the 300 patients who consulted in our Ed for chest pain, CXR were performed for 71% (N = 205) of them. Twenty percent (N = 40) of CXRs were interpreted as pathological. Radiological confirmation rate for the initial medical hypothesis was 12% (N = 24). Our expert committee judged 92% (N = 188) of the CXR was relevant. Discordances between experts were observed for 20 medical records (kappa test = 0.109). In multivariate analysis, variables associated with abnormal CXR were: presence of one or more cardio-vascular risk factor (p = 0.05), clinical exam abnormalities (dyspnea, caught, pulmonary exam abnormalities) (p = 0.006) and laboratory abnormalities (troponin, D-dimers, CRP, and white blood cells) (p = 0.016).

Conclusions: One CXR of five find abnormalities. Experts judged relevant for nine cases of ten with a low level of concordance. The absence of dyspnea, fever, cough, auscultatory abnormalities, and biological inflammatory reaction are independent criteria of normal CXR. Pulmonary ultrasound and guidelines could help to optimize practices.

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There is no conflict of interest to declare

BACKGROUND

Five percent of patients present to the emergency department (ED) with chest pain [1]. The etiologies of chest pain are numerous and heterogeneous in severity [2;3]. Imaging and biological tests are ordered to diagnose these life-threatening etiologies. Among these tests, chest radiography (CXR) is frequently prescribed and remains often the first radiological procedure performed in the ED, at a rate of 60 exams per 1,000 patients [4]. Indeed, CXR can be used to diagnose some diseases, such as pneumonia or pneumothorax, and can eliminate some other cardiac and pulmonary diseases [4-6]. However, it appears that a routine CXR provides little information of practical value in the management of patients with chest pain. Thus, CXR influences diagnosis for only 14%-23% of patients with chest pain in the ED [7]. In some countries, CXR for isolated non-acute chest pain is not indicated (grade C) [8]. Nevertheless, there is no national or international guideline for treating acute chest pain in emergency medicine.

Many studies found a relationship between the use of X-rays and radiation-induced cancers [9;10]; moreover, the ED length of stay increases by simply requesting a radiological examination [11;12]. CXRs represent a real expenditure, which is estimate at 135 million € annually in France [4]. With no guideline for acute chest pain, we ask whether all CXRs prescribed in the ED are useful and relevant.

The aims of our study were to describe the rate of CXR with pathological images and to assess the relevance and concordance of these exams.

METHODS

Study design

This was a monocentric retrospective observational study. The study took place in the ED of the University Hospital, Nîmes, with an annual census of 80,000 patients, in a major town in the south of France with 150,000 citizens. The study was submitted to and approved by the hospital's Institutional Review Board (IRB number: 13/11-02). We collected data on consecutive patients from September 1, 2012 to October 31, 2012.

Population

All adult patients (age > 18 years) with chest pain admitted to the ED were included. Exclusion criteria were pregnancy or breastfeeding, missing data in the medical record, or participation in another clinical trial.

Outcome measures

The primary endpoint, defined a priori, was the rate of CXR with pathological images. The radiologist's interpretation was considered the gold standard. The secondary endpoints were the rate of CXR ordering that was considered relevant by experts to the reading of each medical record, and the concordance between experts concerning the decision whether to do a CXR. The experts were two experienced emergency physicians (more than five years' experience each), they worked at the same site and were blinded for the physician that had prescribed the CXR. They first investigated the clinical and paraclinical data to determine whether the ordering of the CXR was useful or not. If their opinions were divided, then a third expert was consulted.

Measurement

Following enrollment, patient data were extracted from the ED's electronic clinical record system (Clinicom, InterSystems Corporation, Cambridge, MA, USA). Data on CXR were collected using the computerized physician order entry system (Centricity PACS, GE Healthcare, Little Chalfont, UK and Xplore, EDL, Marseille, France).

Data analysis

Categorical outcomes were characterized by sample size and percentages and compared using Chi2 or Fisher's exact test when appropriate. Continuous variables were characterized by their means and standard deviations and compared by t-test or Wilcoxon rank sum test when appropriate. The Cohen's kappa test was used to describe the agreement between the two expert opinions.

We gathered the following elements in this model to avoid a collinear bias: clinical examination gathered cough, dyspnea, and pulmonary auscultation and laboratory values gathered data on troponin, CRP, white blood cells, and D-dimers. We conducted logistic regression with backward stepwise selection for variables associated with abnormal CXR on univariate analysis with a p-value less than 0.2. For the different models, identification of each covariate was adjudicated by the empiric association with abnormal CXR using Akaike's information criterion. A p value less than 0.05 was considered significant for all analyses. Analyses were performed with the using R statistical software (R Core Team 2013, R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria). The authors had full access to and take full responsibility for the integrity of the data.

RESULTS

Baseline characteristics

Three hundred and forty-two (3.9%) patients consulted in the ED for chest pain from September 1, 2012 to October 31, 2012. After applying the exclusion criteria, we included 300 patients in the analysis. **Figure 1** shows the data flow diagram. **Table 1** shows the characteristics of the 300 patient visits. Non-lethal pathologies (idiopathic parietal pain, digestive pathology, and anxiety) represented 72% (216 patients) and lethal pathologies existed in 16% (48 patients). On this 300 patients, eighteen (6%) had already visited the ED for the same reason during the last past month.
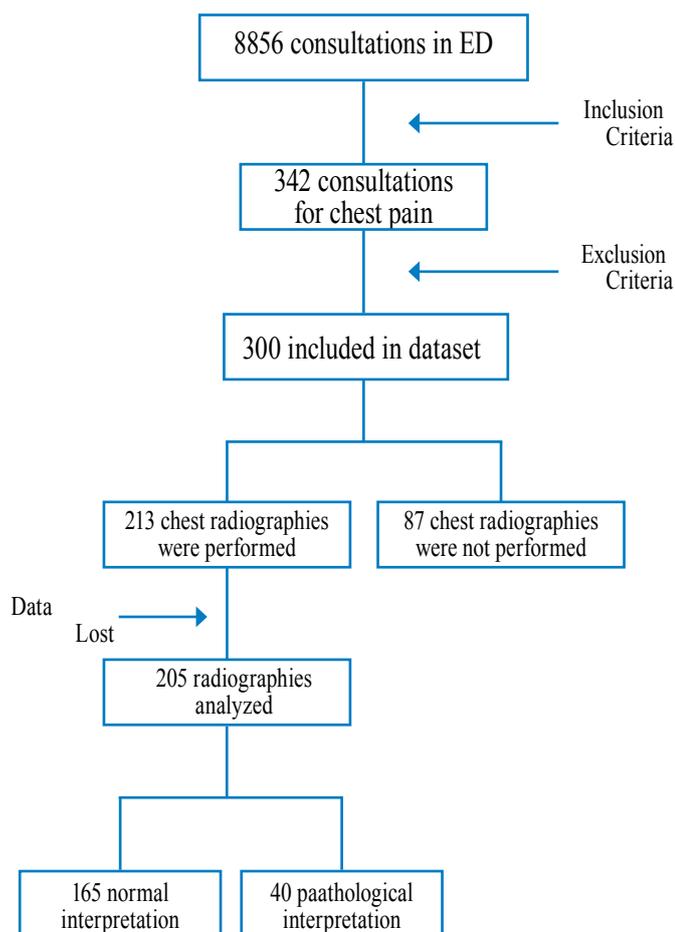
Figure 1: Data flow diagram

Male gender, no. (%)	168 (56)
Age, mean (+/- Standard deviation) - year	53 (15)
Past medical history, no. (%)	
One or more cardio-vascular risk factor	192 (64)
Chronic obstructive pulmonary disease	17 (6)
Heart Disease	38 (13)
Thrombo-embolic disease	8 (3)
Pain characteristics, no. (%)	
No pain (Analogic Visual Scale = 0)	57 (43)
Intense Pain (Analogic Visual Scale > 7)	19 (15)
Clinical data at admission, no. (%)	
Hyperthermia > 38°C	10 (3)
Bradycardia < 50 beats.min^{-1}	7 (2)
Tachycardia > 100 beats.min^{-1}	27 (9)
Saturation > 90%	231 (77)
Systolic blood pressure-mmHg	No data
Associated symptoms, no. (%)	
Brutal pain	142 (47)
Radiating pain	92 (31)
Anxiety	72 (24)
Dyspnea	48 (16)
Cough	20 (7)
Electrocardiogram interpretation, no. (%)	
Normal	215 (75)
ST-segment abnormalities	28 (10)
Rhythm abnormalities	14 (5)
Conduction abnormalities	19 (7)
Laboratory values, no. (%)	
Positive troponin (> 12ng.L^{-1})	29 (11)
White Blood cells (> 8000g.L^{-1})	76 (27)
C-Reactive Protein (> 3 mg.L^{-1})	98 (40)
D-Dimers (> 500ng.L^{-1})	27 (30)
Diagnosis, no. (%)	
Idiopathic parietal pain	120 (40)
Digestive pathology	54 (18)
Anxiety	42 (14)
Coronary disease	33 (11)
Pneumonitis	9 (3)
Pulmonary embolism	3 (1)
Pericarditis	3 (1)
Pneumothorax	0 (0)
Others etiologies	37 (12)

Table 1: Patient characteristics

Chest X-ray analysis

Two hundred and five patients (71%) had a CXR during their ED visit (**Figure 1**). Forty CXRs were interpreted as pathological (20%) and 165 were interpreted as normal (80%). The radiological confirmation rate for the initial medical hypothesis was 12%. From patient arrival in ED, CXRs were done after a median time of 133 minutes (range: 77-179 minutes) on weekdays and 109 minutes (range: 66-131 minutes) on weekends (i.e., Saturday and Sunday) (p = 0.03). **Figure 2** shows different radiological abnormalities, e.g., 60% (24) were pulmonary opacities.

Variables associated with abnormal chest radiography in univariate analysis are listed in **Table 2**.

In multivariate analysis, variables associated with abnormal CXR are: presence of one or more cardio-vascular risk factors, clinical exam abnormalities (dyspnea, cough, pulmonary exam abnormalities), and laboratory abnormalities (troponin, D-dimers, CRP, and white blood cells).

If laboratory values are normal, then CXRs are normal in 98% of cases, and if clinical examinations do not present abnormalities, then CXRs are normal in 93% of cases.

Figure 2: Radiological abnormalities

	Univariate Analysis		Multivariate Analysis	
	OR [95% CI]	P-Value	OR [95% CI]	P-Value
Gender	0.88 [0.4-1.8]	0.72		
Age > 65 years	10 [4.5-22]	<0.001	2.4 [0.81-7.14]	0.18
Past Medical History				
One or more cardio-vascular risk factor	5.5 [1.9-16]	<0.001	5.2 [1.44-25]	0.05
Chronic obstructive pulmonary disease	5.2 [1.44-25]	0.11	0.27 [0.06-1.12]	0.14
Heart disease	3.5 [1.5-8.4]	<0.001	2.44 [0.66-10]	0.27
Associated symptoms, no. (%)				
Brutal pain	0.4 [0.2-0.9]	0.02	0.62 [0.23-1.6]	0.39
Radiating pain	0.7 [0.3-1.7]	0.5		
Dyspnea	2.9 [1.3-6.2]	0.005		
Cough	3.5 [1.3-9.4]	0.01		
Anomalies in pulmonary auscultation	19.1 [8.1-45]	<0.001		
Anomalies in clinical examination	10 [4.6-23]	<0.001	5.2 [1.9-14.2]	0.006
ECG interpretation, no. (%)				
Normal	0.3 [0.1-0.5]	<0.001	0.45 [0.16-1.4]	0.25
Laboratory values, no. (%)				
Positive troponin (> 12 mg.L^{-1})	13 [4.6-38]	<0.001		
White blood cells (> 8000 G/L)	6.9 [3.1-15]	<0.001		
C-Reactive Protein (> 3 mg.L^{-1})	19.1 [6.4-57]	<0.001		
D-Dimers (> 500 mg.L^{-1})	33.3 [2-1000]	0.02		
Anomalies in laboratory values	30.2 [1.8-510]	<0.001	7.5 [2.1-37.3]	0.016

Table 2: Variables associated with abnormal chest radiography

Relevance of chest X-rays

Ninety-two percent of the CXRs were relevant and 8 % were not relevant to the patient's diagnosis. Discordance between experts was observed for 20 medical records (kappa test = 0.109). For medical records where CXRs were not ordered, experts judged this as relevant for 76% of the 87 patients. Discordance between experts was observed for 30 medical records (kappa test = 0.092).

DISCUSSION

Among the patients admitted in our ED for chest pain, 71% benefited from a CXR and only 20% of these CXRs found a pathological anomaly. However, experts judged, with a low level of concordance, that the CXR was relevant in 92% of cases.

In our hospital's ED, emergency physicians ordered CXRs for more than two-thirds of patients admitted for chest pain, making it the most requested radiological exam; however, most CXRs reveal no abnormalities. At first, relevance and, by consequence,

interest seems to be low for this expensive and irradiating investigation since four CXRs of five were interpreted as normal. However, our expert committee considered the prescriptions of CXR as relevant for nine patients out of ten. Therefore, the CXR was used to eliminate, not to diagnose, a serious pathology. Nevertheless, the concordance rate between experts was very low: there is no consensus regarding the management of acute chest pain and professional practices are very heterogeneous.

The CXR is a frequently ordered exam in EDs and is often ordered as an investigation of acute chest pain [4;13;14] despite the absence of guidelines or recent publications. The first study related to this issue was published in 1964 [15] and the topic was widely studied in the 1980s. The most important trial [16;17] showed an interest in the diagnostic uses of CXR; however, this preceded improvements in CT scanning. Indeed, a CT scan is more efficient than a CXR in detecting cardio-pulmonary abnormalities, although a CT scan is more irradiating than a CXR [18]. In the present state of knowledge, one technique is not considered superior to the other [19]; however, CXR is more frequently used due to its accessibility and faster results. Our ED uses the CXR for 71% of patients that present with chest pain.

Although the ED ordered many CXRs, only one in five showed pathological abnormalities. This rate is the same as in other studies [20;21]. To the best of our knowledge, no studies have demonstrated relevance; however, experts judged CXRs useful in 92% of the cases. One reason we observe a low level of concordance is probably because there are neither national nor international guidelines for the management of acute chest pain. Moreover, concordance probably would have been lower if experts were from different hospitals. Thus, medical practice is very heterogeneous in the way clinical examinations and investigations are conducted.

One way to harmonize practices and reduce the number of unnecessary CXRs would be to target certain predictive criteria for CXR referral.

In our multivariate analysis, we identified the following clinical predictive criteria of normal CXR: no cardio-vascular risk factors and no clinical exam abnormality (dyspnea, cough, pulmonary exam abnormalities).

Nevertheless, the use of physiological parameters alone in diagnosing chest pain does not eliminate serious etiologies [22] and the clinical impression is only relevant for discriminating severity [23]. These studies show that we cannot construct our judgment based only on these clinical parameters, but using focused investigations.

Other investigations readily available in EDs, such as laboratory analysis and ECGs, are also predictive for CXR.

Therefore, in the absence of dyspnea, cough, fever, pulmonary exam abnormalities, and biologic inflammatory reaction, would it be wise to forego a CXR? Rothrock et al. have shown that the use of related quantitative criteria can reduce the number of CXRs performed [21].

Subject to further prospective studies, we believe it is possible to reduce the number of CXRs performed on patients admitted with acute chest pain. For this, we need to reduce the number of normal CXR (currently 80%) using independent predictive criteria, i.e., if abnormalities appear on clinical examination, in the ECG result, or in key laboratory values, then a CXR should be done.

Indeed, CXR should be discussed and compared with pulmonary ultrasound, which shows excellent results in detecting pneumothorax [24;25], pleurisy, and pneumonitis [26]. Ultrasound techniques, however, are not well developed and many EDslack training with ultrasound devices [27].

LIMITATIONS

This study has limitations that should be considered when interpreting the results. The study was conducted at a single ED, which limits the generalization of our findings. The results may not be applicable to other patients' populations and will need to be confirmed in future prospective studies. Another limitation is the retrospective design, which increases selection bias and the possibility of missing data. Respiratory rate and saturation couldn't be analyzed because of this.

CONCLUSION

In our ED, one CXR in five found clinical abnormalities that were judged relevant for nine out of ten cases, with a low level of concordance between experts. The absence of dyspnea, fever, cough, auscultatory abnormalities, and biological inflammatory reaction are independent criteria of normal CXR. However, a prospective and multicenter trial must be conducted. Pulmonary ultrasound and guidelines could help optimize practices and reduce the large number of normal CXRs in the ED.

REFERENCES

1. Lee TH, Cook EF, Weisberg M, Sargent RK, Wilson C, Goldman L. Acute chest pain in the emergency room. Identification and examination of low-risk patients. Arch Intern Med 1985; 145:65-9.

2. Fruergaard P, Launbjerg J, Hesse B, Jørgensen F, Petri A, Eiken P, et al. The diagnoses of patients admitted with acute chest pain but without myocardial infarction. Eur Heart J 1996; 17:1028-34.

3. Erhardt L, Herlitz J, Bossaert L, Halinen M, Keltai M, Koster R, et al. Task force on the management of chest pain. Eur Heart J 2002; 23:1153-76.

4. Carbonneil C. Quelles indications aujourd'hui pour la radio du thorax? HAS 2009.

5. Raphaël M, Valéri M.L. Prise en charge d'une douleur thoracique aux urgences. EMC – Médecine Urgence 2007; 25:1-21.

6. Mayaud C, Saidi F, Parrot A. Place de la radiographie de thorax pour la prise en charge des pneumonies communautaires. Rev Pneumol Clin 1999; 55:373-91.

7. Russell NJ, Pantin CF, Emerson PA, Crichton NJ. The role of chest radiography in patients presenting with anterior chest pain to the Accident & Emergency Department. J R Soc Med 1988; 81:626-8.

8. Institut de veille sanitaire de radioprotection et de sûreté nucléaire (France). Exposition de la population française aux rayonnements ionisants liée aux actes de diagnostic médical en 2007. Institut de veille sanitaire 2010.

9. Mathews JD, Forsythe AV, Brady Z, Butler MW, Goergen SK, Byrnes GB, et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians. BMJ 2013; 346:f2360.

10. Rohner DJ, Bennett S, Samaratunga C, Jewell ES, Smith JP, Gaskill-Shipley M, et al. Cumulative total effective whole body radiation dose in critically-ill patients. Chest. 2013; 144:1481-6.

11. Claus EB, Calvocoressi L, Bondy ML, Schildkraut JM, Wiemels JL, Wrensch M. Dental x-rays and risk of meningioma. Cancer 2012; 118:4530-7.

12. Shah DJ, Sachs RK, Wilson DJ. Radiation-induced cancer: a modern view. Br J Radiol 2012; 85:e1166-73.

13. Jesse RL, Kontos MC. Evaluation of chest pain in the emergency department. Curr Probl Cardiol 1997; 22:149-236.

14. Lee TH, Goldman L. Evaluation of the patient with acute chest pain. N Engl J Med 2000; 342:1187-95.

15. Campione KM. Cardiovascular chest pain as an emergency situation. J Lancet 1964; 84:213-23.

16. Aronchick J, Epstein D, Gefter WB, Miller WT. Evaluation of the chest radiograph in the emergency department patient. Emerg Med Clin North Am 1985; 3:491-505.

17. Clinton JE, Yaron M, Tsai SH. Chest radiography in the emergency department. Ann Emerg Med 1986; 15:254-6.

18. Samad Z, Hakeem A, Mahmood SS, Pieper K, Patel MR, Simel DL, Douglas PS. A meta-analysis and systematic review of computed tomography angiography as a diagnostic triage tool for patients with chest pain presenting to the emergency department. J Nucl Cardiol 2012; 19:364-76.

19. Dedic A, Genders TS, Nieman K, Hunink MG. Imaging strategies for acute chest pain in the emergency department. Am J Roentgenol 2013; 200:W26-38.

20. Templeton P, McCallion W, McKinney L, Wilson H. Chest pain in the accident and emergency department: is chest radiography worthwhile? Arch Emerg Med 199; 8:97-101.

21. Rothrock SG, Green SM, Costanzo KA, Fanelli J-M, Cruzen ES, Pagane JR. High yield criteria for obtaining non-trauma chest radiography in the adult emergency department population. J Emerg Med 2002; 23:117-24.

22. Greenslade JH, Beamish D, Parsonage W, Hawkins T, Schluter J, Dalton E, et al. Relationship between physiological parameters and acute coronary syndrome in patients presenting to the emergency department with undifferentiated chest pain. J Cardiovasc Nurs 2015; 31:267-73.

23. Visser A, Wolthuis A, Breedveld R, TerAvest E. HEART score and clinical gestalt have similar diagnostic accuracy for diagnosing ACS in an unselected population of patients with chest pain presenting in the ED. Emerg Med J 2015; 32:595-600.

24. Targhetta R, Bourgeois JM, Balmes P. Echography of pneumothorax. Rev Mal Respir 1990; 7:575-9.

25. Alrajhi K, Woo MY, Vaillancourt C. Test characteristics of ultrasonography for the detection of pneumothorax: a systematic review and meta-analysis. Chest 2012; 141:703-8.

26. Bourcier JE, Paquet J, Seinger M, Gallard E, Redonnet JP, Cheddadi F, et al. Performance comparison of lung ultrasound and chest x-ray for the diagnosis of pneumonia in the ED. Am J Emerg Med 2014; 32:115-8.

27. Bobbia X, Hansel N, Muller L, Claret PG, Moreau A, Genre Grandpierre R, eta l. Availability and practice of bedside ultrasonography in emergency rooms and prehospital setting: a French survey. Ann Fr Anesth Reanim 2014; 33:e29-33.