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Accuracy of the chest radiograph to identify bilateral pulmonary infiltrates consistent with the diagnosis of acute respiratory distress syndrome using computed tomography as reference standard☆

Juan B. Figueroa-Casas MD[a,*], Noemi Brunner MD[b], Alok K. Dwivedi PhD[c], Anoop P. Ayyappan MD[b]

[a]*Division of Pulmonary and Critical Care Medicine, Paul L. Foster School of Medicine, Texas Tech University Health Sciences Center, El Paso, TX 79905, USA*
[b]*Department of Radiology, Paul L. Foster School of Medicine, Texas Tech University Health Sciences Center, El Paso, TX 79905, USA*
[c]*Division of Biostatistics and Epidemiology, Paul L. Foster School of Medicine, Texas Tech University Health Sciences Center, El Paso, TX 79905, USA*

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Abstract

Purpose: The purpose of the study is to evaluate the diagnostic accuracy of the anteroposterior chest radiograph to detect pulmonary abnormalities consistent with acute respiratory distress syndrome (ARDS).
Materials and methods: Ninety patients who met criteria for ARDS regardless of the radiographic one and had near simultaneous chest radiograph and computed tomography (CT) performed were identified. These radiologic studies were reviewed blindly and independently by 2 radiologists for the presence or absence of bilateral pulmonary abnormalities consistent with ARDS using defined radiologic criteria. Disagreements were resolved by consensus. Using the chest CT interpretation as reference standard, the chest radiograph diagnostic parameters were calculated.
Results: Sensitivity (Se) was 0.73; specificity, 0.70; positive and negative predictive values were 0.88 and 0.47, respectively. Female sex was associated with higher Se and lower specificity. When patients were divided according to disease distribution by CT, the Se was significantly lower for focal as compared with diffuse.
Conclusions: The accuracy of the portable chest radiograph to detect pulmonary abnormalities consistent with ARDS is significantly limited. These findings suggest that the use of the chest radiograph results mainly in underrecognition of the syndrome, particularly when disease is not diffusely distributed, but also in overdiagnosis.

☆ Institution where work was performed: University Medical Center of El Paso, El Paso, Texas.

* Corresponding author.
E-mail address: Juan.Figueroa@ttuhsc.edu (J.B. Figueroa-Casas).

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1. Introduction

The presence of bilateral infiltrates on an anteroposterior chest radiograph is a necessary criterion for the diagnosis of acute respiratory distress syndrome (ARDS) by recommendation of the American-European Consensus Conference (AECC) in ARDS [1]. This definition has been the most commonly used in clinical practice and in epidemiologic [2] and other research studies with important clinical implications [3–6]. However, this radiographic criterion is not precise and can result in significant interobserver variability [7–9] or equivocal interpretation [10]. The recent Berlin definition of ARDS, likely to be widely used in the future, recommends a similar radiographic criterion of bilateral opacities [11]. Those limitations to the radiographic criterion may have important implications in the correct selection of patients for research studies and in the appropriate diagnosis and consequent application of therapies in clinical practice.

This study aims to evaluate the accuracy of the anteroposterior chest radiograph to detect pulmonary abnormalities consistent with ARDS in patients who may have the syndrome, using chest computed tomography (CT) as reference standard. We conducted a comparison between chest radiograph and chest CT in patients meeting criteria for ARDS regardless of the radiographic one.

2. Materials and methods

2.1. Subjects

Subjects were retrospectively selected from patients admitted to a 30-bed adult medical-surgical-trauma intensive care unit (ICU) of a university hospital between March 2009 and October 2011. The selection was performed using initially the hospital radiology computerized database and further refined by review of the subjects' medical records by an intensivist. Informed consent was waived by the local institutional review board given the nature of the study and that data were collected without identifiers. Inclusion criteria were the following: (1) chest CT performed in the ICU (or emergency department before ICU admission) within 6 hours of an anteroposterior chest radiograph, (2)ordering indication of the chest CT referring to evaluation of acute respiratory distress or failure, (3) clinical diagnosis of acute respiratory failure while in the ICU, (4) presence of a risk factor for ARDS (sepsis, multiple trauma, pneumonia, bronchoaspiration, acute pancreatitis, recent blood product transfusion), (5) invasive or noninvasive mechanical ventilation with a positive end-expiratory pressure 5 cm H_2O or greater, and (6) a ratio of PaO_2 to fraction of inspired oxygen (PaO_2/FIO_2) of 264 mm Hg or less (corresponding to 300 mm Hg at sea level after correction for our barometric pressure—666 mm Hg—as recommended when altitude >1000 m [11]). Both criteria 5 and 6 had to be present on the day the selected chest images were performed. Exclusion criteria were the following: (1) ordering indication of the chest CT absent or referring to evaluation of other conditions (trauma, pleural disease, mediastinal evaluation, metastases evaluation, cavities, or "follow-up"), (2) procedures (endotracheal intubation, pleural or surgical procedures, or acute resuscitation interventions) performed in the interval between the chest radiograph and the chest CT were done, (3) history of chronic interstitial lung disease, and (4) congestive heart failure as main clinical diagnosis.

2.2. Data collection

Demographic and clinical information was extracted from review of the subjects' medical records by an intensivist. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Arterial blood gases performed on the same day of and closest to the chest CT were selected for calculation of PaO_2/FIO_2.The number of days from the day of intubation to the day of images was calculated using midnight as a limit for a new day. The number of days was zero if both intubation and images were performed on the same day.

2.3. Radiologic studies and interpretation

All chest radiographs were obtained in the anteroposterior projection with the patient in bed using a digital mobile radiography unit. Chest CT examinations were performed with patients in supine position on multidetector CT scanners ranging from 16- to 64-detector row configuration. Ventilated patients were sedated and kept at the same levels of positive end-expiratory pressure and tidal volume that were receiving in the ICU using a mechanical ventilator (840; Nellcor Puritan Bennett, Pleasanton, Calif). The chest CT protocol entailed the use of 120 kVp, and a reference tube current-time product of 60 to 180 mAs. The images were reconstructed at 1- to 3-mm slice thickness.

All radiologic studies were reviewed independently by 2 thoracic imaging fellowship trained radiologists (APA and NB) with 7 and 5 years of postfellowship experience. The radiologists were blinded to patient demographics, clinical information, prior or subsequent imaging studies, and prior interpretations, but they were aware of the purpose of the study and inclusion criteria. The chest CT studies were interpreted 4 to 6 weeks after interpreting chest radiographs to eliminate recall bias. Radiologists were allowed but not required to make measurements of CT attenuation to support their interpretation. Disagreements between the 2 radiologists were solved by a consensus session among them. Persistent disagreements were solved by interpretation by an intensivist with experience in chest imaging and blinded to subjects' clinical information and each radiologist interpretation.