

Could Chest Ultrasonography Replace Routine Chest X-rays in Mechanically Ventilated Patients?

Thesis

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Chest Diseases*

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هل يمكن استخدام الموجات فوق الصوتية بدلاً من أشعة الصدر السينية في المتابعة الروتينية للصدر في المرضى المتنفسين اصطناعياً؟

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٢٠١٣

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا

لسبب انك لا تعلم لنا
إلا ما علمتنا إنك أنت
العليم العظيم

صدقة الله العظيم

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List of Abbreviations

%	: Percentage sign
<	: Less than
>	: More than
2-D	: Two dimensional
ARDS	: Adult Respiratory Distress Syndrome
BLUE	: Bedside Lung Ultrasound in Emergency
Cm	: Centimeter
CT	: Computed tomography
CXR s	: Chest X-rays
DP	: Double probe
ED	: Emergency department
HS	: Highly significant
ICU s	: Intensive Care Units
m/s	: Meter per second
MHz	: Mega Hertz
ml	: milliliter
mm	: Millimeter
NS	: Non significant
P	: probability
RICU	: Respiratory intensive care unit
S	: Significant
SD	: Standard deviation
SPSS	: Statistical Package for Social Science
US	: Ultra sound
VS	: Versus
yrs	: years

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Introduction

Mechanical ventilation is an essential life support for patients in the intensive care unit, emergency department and operating room who cannot sustain adequate homeostasis through spontaneous ventilation. This life-saving modality is implemented in a wide spectrum of clinical situations that result in respiratory failure, whether it be hypoxic or hypercapnic, acute or chronic. The wide breadth of causes of respiratory failure encompasses many specialties in both adult and pediatric practices especially pulmonary medicine (*Truwit and Epstein, 2011*).

Mechanical ventilation is indicated when the patient's spontaneous ventilation is inadequate to maintain life. It is also indicated as prophylaxis for imminent collapse of other physiologic functions, or ineffective gas exchange in the lungs. Because mechanical ventilation only serves to provide assistance for breathing and does not cure a disease, the patient's underlying condition should be correctable and should resolve over time (*Cabrini et al., 2011*).

Chest x-rays (CXRs) are the main imaging tool in intensive care units (ICUs). CXRs also are associated with concerns inherent to their use, considering both healthcare organization and patient perspectives. In recent years, several studies have focussed on the feasibility of lowering the number of bedside CXRs performed in the ICU. Such a

decrease may result from two independent and complementary processes: a raw reduction of CXRs due to the elimination of unnecessary investigations, and replacement of the CXR by an alternative technique (*Clec'h et al., 2008*).

Routine CXRs theoretically have two main advantages. First, some potentially life-threatening situations that might otherwise be missed could be discovered and treated. Second, scheduling CXRs during morning rounds might be more efficient on a logistical point of view. In contrast, the on-demand strategy might avoid unnecessary radiation exposure and provides substantial cost savings (*Price et al., 1999*).

The radiological diagnostic approach of the thorax in the critically ill patient has traditionally been based on the anteroposterior chest X-ray. However, it is generally accepted that it has important limitations regarding its diagnostic accuracy of pleuro-pulmonary disease. The introduction of computed tomography largely solved this problem, but with the dual disadvantage of a larger radiation dose and the unavoidable transportation outside of the ICU. In this context, the lung ultrasound has become an alternative technique, with the advantage that due to its portability, it is done at the patient's bedside (*Colmenero et al., 2010*).

Ultrasonographic examination in pulmonology provides a revolutionary advance because it is very helpful

in the diagnosis and management of various pleural and peripheral pulmonary defects. Lung ultrasonography allows the clinicians to diagnose some pulmonary abnormalities more rapidly, including the diagnosis of pleural effusion. Ultrasound examination also provides great assistance for the clinicians to perform invasive techniques in the field of pulmonology, which may increase the success rate and reduce the likelihood of complications (*Moore and Copel, 2011*).

Chest ultrasonography has many Uses, both diagnostic and interventional. It is used in diagnosis of diseases of the pleural space such as pleural effusion, pleural thickening, pleural Masses and pneumothorax. It's used also in diagnosis of diseases of the lung parenchyma such as pneumonia and lung abscesses, neoplasms, pulmonary embolism and arteriovenous malformation. It can also be used in diagnosis of diseases of the chest wall such as enlarged lymph nodes, rib abnormalities and also diaphragmatic abnormalities like diaphragmatic paralysis. chest ultrasonography can also be used in interventional procedures of the pleural space such as thoracocentesis and pleural biopsy. In lung cancer, peripheral lung tumors that are in contact with or near the pleural surface can be safely biopsied under US guidance (*Havelock et al., 2010*).

Aim of the Work

Comparison between chest ultrasonography versus routine chest X-rays in diagnosis and follow up of diseases in mechanically ventilated patients admitted to *respiratory intensive care unit (RICU)* of Ain Shams University hospitals during the period between October 2012 and May 2013.

Imaging of mechanically ventilated patients

I- Chest x-ray

The radiological diagnostic approach of the thorax in the critically ill patient has traditionally been based on the anteroposterior chest X-ray. However, it is generally accepted that it has important limitations regarding its diagnostic accuracy of pleuro-pulmonary disease. The introduction of computed tomography largely solved this problem, but with the dual disadvantage of a larger radiation dose and the unavoidable transportation outside of the ICU.

The lung ultrasound has become an alternative technique, with the advantage that due to its portability, it is done at the patient's bedside. In the lung ultrasound, the ribs, spine and air in the thorax act as barriers to the ultrasounds, causing artifacts that must be recognized and interpreted for a correct diagnosis. However, intrathoracic diseases, existence of fluid in the pleural space and consolidation, or atelectasis in the lung provide a sufficient ultrasound window for the correct evaluation (*Lichtenstein et al., 2004*).

It is common for a patient in the intensive care unit (ICU) to undergo chest radiography on a daily basis, especially those who are mechanically ventilated. Daily

routine chest radiographs are obtained in an attempt to find a relevant abnormality that would otherwise not be detected. The American College of Radiology's Appropriateness Criteria (*Bushberg and Seibert, 2002*) recommend daily chest radiography for patients with acute cardiopulmonary problems and for patients on mechanical ventilation. However, this practice has been scrutinized and may have little benefit (*Lichtenstein et al., 2004*).

Obtaining a daily routine chest radiograph for every ICU patient remains a common practice despite the accumulating evidence suggesting that this may not be necessary. This practice, as well as the recommendations of the American College of Radiology are based on studies from the 1980s and early 1990s that reported the high incidence of new or unexpected findings seen on daily routine chest radiographs.

More recent studies reported a lower incidence of unexpected radiographic abnormalities that led to a change in treatment (*Bushberg and Seibert, 2002*).

One study reported that most of the radiographic abnormalities were clinically anticipated and only two (1%) substantial changes in radiographic findings were missed at clinical examination (*Lichtenstein et al., 2004*).

The difference in opinion on the utility of daily routine chest radiography and the discrepancy of efficacy data are probably a result of differences in patient population,
