Role of Lung Ultrasound in Weaning of Postoperative Mechanically Ventilated Patients

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا

إلا ما علمتنا إنك أنت

العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Foad Farouk Mohammed Gadouh

Contents

List of Abbreviations

ABGS	Arterial Blood Gases
ARDS	Acute respiratory distress syndrome
ARF	acute respiratory failure
ATC	Automatic Tube compensation
CHF	congestive heart failure
CI	Confidence interval
CO	cardiac output
COPD	chronic obstructive air way disease
CPAP	continuous positive airway pressure
CROP......................	compliance, rate, O2, pressure index
CT	computed topography
CXR	Chest X rays
DTF	diaphragmatic thickness factor
ECS	Echo Comet Score
EMG	electromyogram
FRC	functional residual capacity
GI............................	gastrointestinal

HCUs	Hand-carried ultrasounds
ICS	Inter Costal Space
ICU	Intensive Care Unit
IEQ	inspiratory effort quotient
MIP	maximal inspiratory pressure
MV...........................	Mechanical ventilation
MVV.......................	maximum voluntary ventilation
P 0.1	tracheal airway occlusion pressure 0.1 s
PCWP	pulmonary capillary wedge pressure
PE	pulmonary embolism
PEEP	positive end-expiratory pressure
pHi...........................	gastric intraluminal pH
PImax	maximum inspiratory pressure
PImax......................	maximum inspiratory pressure
PLAPS-profile…	Postero-Lateral Alveolar and/or Pleural Syndrome
PSV	Pressure support ventilation
RSBI	rapid shallow breathing index
RV	residual volume

SB	Spontanous breathing
SIMV	Synchronized Intermittent Mandatory Ventilation
SpO2	peripheral oxygen saturation
SvO2	venous mixed oxygen saturation
TLC	total lung capacity
ULC	Ultrasound Lung Comets
US	ultrasound
VC	vital capacity
Ve	minute ventilation
V_T	tidal volume

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List of Figures

List of Tables

Introduction

Difficulties in weaning from mechanical ventilation are encountered in approximately 20% of patients, and more than 40% of the time passed in the intensive care unit is spent to try to wean off from mechanical ventilation. **(Esteban et al., 1995)**

Several indices have been employed to assess the patient's ability to recover spontaneous breathing. Variables such as minute ventilation (Ve), maximum inspiratory pressure (PImax), breathing frequency, rapid shallow breathing index (RSBI, i.e., respiratory frequency/tidal volume), tracheal airway occlusion pressure 0.1 s (P 0.1), and a combined index named CROP (compliance, rate, O2, pressure index) have been used in common clinical practice. RSBI was found to be one of the most accurate predictors of failure of weaning. However, values of sensitivity and specificity and negative predictive values for the suggested threshold of rapid shallow breathing index <105 were highly variable in different studies. **(Krieger et al., 1997)**

The traditional physical examination is often significantly limited in the diagnosis of cardiopulmonary pathology. The tremendous potential of Hand-carried ultrasounds HCUs to immediately provide diagnostic information at the bedside not assessable by the physical examination alone has been increasingly demonstrated and recognized in the last few years. Equipping critical care physicians with HCUs and training them to perform point-of-care examinations will potentially translate into improved patient care. **(Mangione et al., 2006)**

Diagnostic ultrasonography is the only clinical imaging technology currently in use that does not depend on electromagnetic radiation. Therefore, it can be considered an attractive complementary diagnostic tool and one of the most promising techniques for the management of critically ill patient with acute respiratory failure (ARF).**(Daabis et al., 2014)**

Examination of the thorax is a rapidly developing application of ultrasound (US) and may be used to evaluate a wide range of peripheral parenchyma, pleural and chest wall diseases. The technique is particularly used to be a bedside test in the intensive care unit, where suboptimal radiography may mask or minimize clinically significant abnormalities and where differentiation of pleural from parenchymal changes can be confusing.(**Yu et al., 1992)**

It is usually not feasible to have a sonographer available on immediate call on a 24-h basis to perform bedside ultrasonographic examinations in the ICU. Appropriately trained intensive care specialists have been using ultrasound devices with great success. With expert back-up, “focused” bedside ultrasonography by intensivists is not only feasible but can be done safely and rapidly and yield information pertinent to the management of critically ill patients. **(Counselman et al., 2003)**

The incidence of lung consolidation and atelectasis in critically ill patients who received mechanical ventilation is high. Interstitial edema is a subclinical step that precedes alveolar edema. **(Wang et al., 2012)**

Among critically ill patients, opacification of a part or whole lung field on chest radiography may pose a challenge in the differential diagnosis of acute pulmonary pathologies and selection of treatment modalities. In cases in which clinical findings, history, and imaging studies are not conclusive, bedside ultrasonography may be invaluable in achieving a diagnosis. It could be an easily repeatable noninvasive tool for assessing lung recruitment. **(Burak, 2006)**

Aim of the Work

Our aim in this study was to evaluate transthoracic lung US as a clinical tool in weaning of postoperative mechanically ventilated patients.

Lug Ultrasound

For many years ultrasound has not been employed for the evaluation of the lung. **(McGraw, 2008)**

In 2004, Picano and Jambrik, brought LUS from the Intensive Care Unit to the Cardiology Department, describing the correlation between EVLW assessed by chest X-ray, and the number of B-lines detected by LUS.

Diagnostic Ultrasound Equipments: how the image is produced:

Regarding diagnostic ultrasound equipment, ceramic crystals in the transducer deform and vibrate when electronically stimulated to produce the sound pulses. Echoes that return to the transducer disrupt these crystal elements and produce an electric pulse, which is processed into an image.**(Koegelenberg et al., 2008)**

When a pulse of ultrasound energy is incident upon the body, it interacts with the tissue in a variety of ways. Some of the incident energy is directed back towards the source and is detected. The time delay between the energy going into the body and returning to the ultrasound probe determines the depth from which the signal arises, with longer times corresponding to greater depths. This information is used in the creation of an image. Other factors that make the tissues distinguishable on a screen are their slightly different acoustical properties; one is known as the acoustic impedance. **(Hedrick et al., 2004)**

Echogenicity:

Ultrasound images are displayed on a gray scale. The strongest echo appears white while it is black when no sound wave is reflected from the organs. Depending on the reflected wave amplitude, the following terms are used to define echogenicity. When no sound wave is reflected and the image appears black it is anechoic as in pleural effusion. It is isoechoic when the echoes are of comparable amplitude with the surrounding tissue as with kidneys or spleen. It is hyper echoic when echoes are stronger than the surrounding tissue as in diaphragm, and hypo echoic when it is weaker than that from the surrounding tissue. (**Bolliger et al., 2009)**

Ultrasonography of lung appears as homogenous amorphic grayness rather than a discreet structural entity. Because of the difference in acoustic impedance and velocity of ultrasound between tissues, certain artifacts arise at the air-tissue-fluid-bone interface. **(Rahul Khosla, 2012)**