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قسم

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صفحات بالرسالة

لم ترد بالأصل

Sonographic evaluation of the heart, lung and diaphragm during weaning from mechanically ventilated critically ill patients

Thesis

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Presented by

Fady Nader Abdelmessih Guirguis

M.B.B.CH; M.Sc. in Intensive Care medicine

Faculty of Medicine-Ain Shams University

Supervised by

Prof. Dr. Nahed Effat Youssef

Professor of Anesthesia and Intensive Care medicine

Faculty of Medicine-Ain Shams University

Ass. Prof. Dr. Adel Mohammad Alansary

Assistant Professor of Anesthesia and Intensive Care medicine

Faculty of Medicine-Ain Shams University

Dr. Adel Alaa elDin Habib

Lecturer of Anesthesia and Intensive Care medicine

Faculty of Medicine-Ain Shams University

Faculty of Medicine

Ain Shams University

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List of abbreviation

ARDS	: Acute respiratory distress syndrome
BMI	: Body mass index
CCE	: Critical care echocardiography
CCW	: Compliance of the chest wall
CL	: Compliance of the lung
COPD	: Chronic obstructive lung disease
CRS	: Total compliance of respiratory system
DTF	: Diaphragm thickening fraction
EF	: Ejection fraction
EMG	: Electromyography
Hb	: Hemoglobin
HR	: Heart rate
GCS	: Glasgow coma score
ICU	: Intensive care unit
LTAC	: Long-term acute care
LUS	: Lung ultrasound
LV	: Left ventricle
LVEF	: Left ventricular ejection fraction
MIP	: Maximal inspiratory pressure
MSFP	: Mean systemic filling pressure
MV	: Minute ventilation
NAVA	: Neutrally adjusted ventilatory assist
PAL	: Alveolar pressure

PAOP	: Pulmonary artery occlusion pressure
Pdi	: Transdiaphragmatic pressure
Pdi,tw	: Transdiaphragmatic pressure twitches
PLR	: Passive leg raising
PMV	: Prolonged mechanical ventilation
PPER	: Pericardial pressure
PPL	: Pleural pressure
PTP	: Transpulmonary pressure
PWD	: Pulsed wave Doppler
RAP	: Right atrial pressure
RR	: Respiratory rate
RSBI	: Rapid shallow breathing index
SBT	: Spontaneous breathing trial
SD	: Standard deviation
SPSS	: Statistical package for social sciences
TAPSE	: Tricuspid Annular Plane Systolic Excursion
TDI	: Tissue Doppler imaging
Tinsp	: Inspiratory time
TNFa	: Tumor necrosis factor alpha
TTot	: Total cycle time
TV	: Tidal volume
VIDD	: Ventilator induced diaphragm dysfunction

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Introduction

Failure of weaning is a commonly encountered problem that faces intensivists, unfortunately this is a multifactorial condition and includes multiple interplays between cardiac and pulmonary functions.
Timing is critical when determining if a patient can be successfully extubated. Premature discontinuation of mechanical ventilation may lead to increased cardiovascular and respiratory stress, CO2 retention and hypoxemia with up to 25% of patients requiring reinstitution of ventilator support.**(Esteban et al., 2002), (Funk et al., 2010)**.

Unnecessary delays in weaning from mechanical ventilation also can be deleterious. Complications such as ventilator associated pneumonia and ventilator induced diaphragm atrophy consequently can be seen.

Tools available for determining the optimal timing of extubation are limited. Subjective decisions are often wrong.**(Grosu et al., 2012)**. It was found that clinical prediction of extubation success or failure was often incorrect with the decision to extubate biased toward ventilator dependency. Measures such as breathing frequency, minute ventilation, and negative inspiratory force, have done little to improve the timing of successful extubation **(Nemer et al., 2009)**. Another parameter, the rapid shallow breathing index provides a guide for timing extubation with spontaneous breathing trials but its value is limited when used to predict successful extubation during pressure support trials **(Fadaii et al., 2012)**.
Also weaning may be considered an exercise requiring an elevation in cardiac index, oxygen demand and consumption **(De Backer et al., 2000)** a study has reported that patients who failed a spontaneous breathing trial (SBT) had significant reduction in mixed venous oxygen saturation (SvO2) compared to patients who pass the SBT where SvO2 remained constant**(Teboul et al., 2010)**. In the failure group, an uncoupling between the left ventricle and the systemic circulation and between the right ventricle and the pulmonary circulation occurred. While cardiac function is crucial to the weaning process, the incidence of cardiac-related weaning failure is not known. It is difficult to evaluate its incidence, as increases in respiratory load and cardiac load are strongly interrelated (Boles et al., 2007); so it is difficult to identify to what extent a cardiac problem is the cause for the failure. Cabello et al. reported that cardiac related weaning failure occurred in 42 % of cases among 76 patients who failed SBT **(Cabello et al., 2010)**.

Ultrasonography allows easy visualization of the two hemidiaphragms and their excursion during respiratory cycles. Two different ultrasonographic parameters have been described to evaluate diaphragmatic performance. The first parameter refers to the measurement of diaphragmatic excursion ***(E)*** during inspiration **(Lerolle et al., 2009)**. Thickening fraction (TF = [thickness at end-inspiration - thickness at end-expiration]/thickness at end- expiration) is reported in most studies. For both parameters, technical tips to improve reproducibility and accuracy of measurements have been published in detail allowing excellent operating characteristics**(Pasero et al., 2015)** Lung ultrasonography (LUS) for guiding the weaning process in the ICU was also found useful, derived from the observation that the initiation of spontaneous breathing after a period of mechanical ventilation is associated with some loss of lung aeration in the critically ill. LUS assessment before and at the end of the SBT is useful for detecting aeration loss, which is relevant for prediction of postextubation distress **(Soummer et al., 2012).**

Ultrasound is a well-established useful tool in the hand of the intensivists, it is a bedside machine and requires no transportation of the critical patients and furthermore it doesn’t harbor any radiation exposure at all.
In this study we will enroll prolonged mechanically ventilated patients during weaning trial and by ultrasound assessment of the heart, lung and diaphragm we will review the utility of it in predicting success or failure of weaning off mechanical ventilation.

Aim of the study

Evaluate the role of ultrasonography (Heart, lung and Diaphragm) as compared to clinical data during spontaneous breathing trial as a part of weaning of mechanical ventilation in critically ill patients.

Chapter 1

Causes of weaning failure

Weaning is the gradual withdrawal of mechanical ventilation and the continuation of spontaneous breathing. In 1987, Hall and Wood, proposed liberation from mechanical ventilation as the ultimate objective, and subsequently several studies investigated various methods and tools to assess readiness of ventilated patients for a successful weaning trial**(Esteban et al., 1999)**. Also, Penuelas et al. analyzed 2714 mechanically ventilated patients for more than 12 hours who were weaned and underwent scheduled extubation. They found that 1502 patients (55%) could be classified as simple weaning, 1058 patients (39%) as difficult weaning, and 154 (6%) as prolonged weaning (>7 days) **(Penuelas et al., 2011)**. Variables associated with prolonged weaning were: severity at admission (according to Simplified Acute Physiology Score II), duration of mechanical ventilation before first attempt of weaning, chronic pulmonary disease other than chronic obstructive pulmonary disease, pneumonia as the reason to start mechanical ventilation, and level of positive end-expiratory pressure applied before weaning. The prolonged weaning group had a non-significant trend toward a higher rate of re-intubation, tracheostomy, and significantly longer length of stay and higher mortality in the intensive care unit **(Esteban et al., 2002)**.

Bickenbach et al. found that prolonged weaning and mechanical ventilation are independent predictors of ICU discharge and 1-year mortality**(Bickenbach et al., 2011)**. Also Thille et al., found that, compared with successful extubation, failed extubation lead to a marked clinical deterioration**(Thille et al., 2011)**. Furthermore, unsuccessful weaning was associated with worse outcome**(Aboussouan et al., 2008)**, higher risk of myocardial ischaemia **(Pinsky, 2005)** and perhaps psychological trauma **(Jubran et al., 2010)**.

These studies re-emphasize the importance of successful liberation from mechanical ventilation, and its effect on acute and long-term prognosis. It is therefore, of utmost importance for clinicians to keep abreast of the latest developments in the field of liberation from mechanical ventilation.

About 20% to 30% of patients found to be difficult to wean from mechanical ventilation. The pathophysiology of difficult weaning is complex.

Accordingly, detecting the cause for difficult weaning and subsequently developing a management strategy require a dedicated clinician with indepth knowledge of the pathophysiology of weaning failure. In the majority of patients, mechanical ventilation can be discontinued as soon as the underlying pathology for acute respiratory failure has been ameliorated. Weaning failure is when a weaned patient fails to pass a spontaneous- breathing trial or the needs re-intubation within 48 hours after extubation**(Heunks and van der Hoeven, 2010)**. Identification of reliable predictors of weaning failure may represent potential avenues of treatment that could reduce the incidence of weaning failure and its associated morbidity. Known risk factors of weaning failure are considerably interconnected, especially those related to the heart, lungs and diaphragm. Known predictors of unsuccessful weaning include chronic obstructive airway disease **(Boles et al., 2007)**, cardiac failure **(Moschietto et al., 2012)**, lung de-recruitment **(Soummer et al., 2012)**, positive fluid balance, pneumonia **(Frutos-Vivar et al., 2006)** and diaphragmatic dysfunction **(Kim et al., 2011)**.

Several ventilatory parameters have been evolved for identifying the right time for starting a weaning trial, however, none of them have met the criteria required to provide satisfactory accurate success rates **(Savi et al., 2012)**.

Mechanisms of weaning failure:

The number of patients requiring mechanical ventilation has risen worldwide, and accordingly the proportion of patients requiring prolonged mechanical ventilation (PMV) has increased concomitantly **(Cox and Carson, 2012)**. The hospital mortality and overall 1 -year mortality rates for patients requiring PMV are also strikingly high **(Damuth et al., 2015)**. However, PMV has been variously defined as >24 hours, >2 days **(Clec'h et al., 2007)**, >3 days **(Cox et al., 2004)**, >14 days **(Hough et al., 2015)**, or >21 days **(Loss et al., 2015)** of MV in different studies. Nonetheless, PMV has been defined, by consensus, constituting >21 consecutive days of MV for >6 hours per day as most patients receiving MV who are transferred to a longterm acute care (LTAC) hospital have received MV for minimum of 21 days **(MacIntyre et al., 2005)**.

Weaning success is a significant prognostic factor in patients needing PMV **(Bigatello et al., 2007)**. However, the rate of weaning success in patients requiring PMV is low, ranging from 38% to 78% **(Mifsud Bonnici et al.,**