Ultrasound Measurement of Inferior Vena Cava Diameter Versus Central Venous Pressure As a Tool of Assessment of Intravascular Volume in Adult ICU Patients

Thesis

Submitted for the Partial Fulfillment of Master Degree in Intensive Care Medicine

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2018

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

Acknowledgments

First and forever, thanks to ***Allah,*** *Almighty for giving me the strength and faith to complete my thesis and for everything else.*

I would like to express my deepest gratitude and appreciation to ***Prof. Dr. Bassem Boulos Ghobrial,*** *Professor of Anesthesia and Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University, who initiated and designed the subject of this thesis, for his kindness, over available, fatherly attitude and untiring supervision, helpful criticism and support during the whole work.*

My extreme thanks and gratefulness to ***Dr. Adel Mohamad Alansary,*** *Assistant Professor of Anesthesia and Intensive Care and pain management, Faculty of Medicine, Ain Shams University, I'm much grateful for his patience and strict supervision and revision of this work.*

I would like also to thank ***Dr. Rania Mahrous Aly,*** *Lecturer of Anesthesia and Intensive Care and pain management, Faculty of Medicine, Ain Shams University, for the efforts and times she has devoted to accomplish this work. Her valuable advice helped me a lot to pass many difficulties.*

Last but not least, I would like to thank all members of my family, specially my ***Parents****, for their care and support.*

Ahmed Maged Alsayed

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List of Abbreviations

Abbr.	Full-term
AF	: Atrial fibrillation.
ANOVA	: A one-way analysis of variance**.**
ARDS	: Acute Respiratory Distress Syndrome.
CI	: Collapsibility index.
CKD	: Chronic kidney disease.
CO	: Cardiac output.
CO2	: Carbon dioxide.
COPD	: Chronic obstructive pulmonary disease.
CVA	: Cerebrovascular accident.
CVC	: Central venous catheter.
CVP	: Central venous pressure.
DI	: Distensibility index.
DM	: Diabetes mellitus.
DO2	: Oxygen delivery.
DVT	: Deep venous thrombosis.
ECG	: Electrocardiogram.
EDV	: End diastolic volume.
EF	: Ejection fraction.
ESV	: End systolic volume.
EVLW	: Extra vascular lung water.

FAST: Focused ultrasound assessment in trauma.

FS	: Frank Starling
GEDV	: Global end-diastolic volume.
HS	: Highly significant.
HTN	: Hypertension.
ICU	: Intensive care unit.
IPPV	: Intermittent positive pressure ventilation
IVC	: Inferior vena cava.
IVC-USM	: Inferior vena cava diameter ultrasound measurement.
LiDCO	: Lithium Dilution Cardiac Output.
LV	: Left ventricle.
LVEDV	: Left ventricular end diastolic volume.
MOF	**:** Multi organ failure.
NIRS	: Near infra-red spectroscopy.
OPS	: Orthogonal polarization spectral Output.
PAC	: Pulmonary artery catheter.
PAOP	: Pulmonary artery occlusion pressure.
PEEP	**:** Positive end expiratory pressure.
PiCCO	: Pulse Contour Continuous Cardiac Output
PLR	**:** Passive leg raising.
PPV	**:** Pulse pressure variation.
P-value	: Probability value
PVI	: Pleth variability index
RA	: Right atrium
SD	: Standard deviation

SA-AKI	: Sepsis associated Acute Kidney injury
SDF	: Side stream dark field
SpO2	: Arterial O2 saturation
SPSS	: Statistical package for social sciences
SPV	: Systolic pressure Variation
StO2	: Tissue oxygen saturation
SV	: Stroke Volume
SVC	: Superior vena cava
SvO2	: Mixed venous oxygen saturation
TEE	: Transesophageal echocardiography
TTE	: Transthoracicechocardiography
US	: Ultrasonography.

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Abstract

Background: Measurements of central venous pressure (CVP), pulmonary arterial catheterization, esophageal Doppler, ultrasound, and trans-esophageal echocardiography may be used to determine the volume status of critically ill patients. Appropriate interpretation of the information offered by hemodynamic monitoring requires the integration of several variables. Echocardiography is increasingly used as a first tool to identify a problem and help select initial treatment. To improve patient management and outcome, the clinician must understand the advantages and the limitations of the various tools and parameters used during ICU stay. **Aim of the Work:** to assess the intravascular volume by comparing between IVC diameter, IVC collapsibility index by ultrasound with central venous pressure (CVP) in critically ill patients. **Patients and Methods:** A clinical interventional study was carried out at department of intensive care at Ain Shams University hospitals – Cairo – Egypt., during a three months (from October 2017 till December 2017).This study was approved by Ethical Committee of Faculty of Medicine, Ain Shams University, including the informed consents which were obtained from either the patient or the closest family member. **Results:** In our study the IVC Collapsibility Index correlated well with the Central Venous Pressure. The sensitivity and specificity of IVC Collapsibility to Central Venous Pressure were also found to be highly statistically significant. The change in IVC diameters were also found to be statistically significant when compared to Central Venous Pressure.. **Conclusion:** The IVC CI% can provide a useful guide for noninvasive intravascular volume status and analternative to CVP measurement assessment in critically ill patients.

Key words: ultrasound, inferior vena cava diameter, central venous pressure, intravascular volume, ICU, Adults

Introduction

An accurate assessment of intravascular volume remains one of the most challenging and important tasks for clinicians. A significant number of patients are at risk of complications, which are associated with increased lengths of hospital and ICU stay, costs, and mortality. Reducing these risks is important for the individual patient but also for health-care planners and managers. Insufficient tissue perfusion and cellular oxygenation due to hypovolemia, heart dysfunction or both is one of the leading causes of complications. Adequate management guided by effective and timely hemodynamic monitoring can help reduce the risk of complications and thus potentially improve outcomes**(Boyd et al., 2011)**.

Bedside ultrasonography is readily available in intensive care setups. It is safe, cheap and non-invasive. Ultrasound of IVC is a tool that can provide a rapid and non-invasive means of gauging preload and the need for fluid resuscitation. Few studies in past have shown correlation between CVP and IVC measurements. This non invasive rapid measurement of CVP is especially important in critical care settings. It can help in differentiating hypovolemic, septic and cardiogenic shock.Recently, measuring IVC diameter by ultrasound was suggested as a novel outcome measure to guide this resuscitative approach**(Kastrup et al., 2007).**

Aim of the Work

The objective of our study is to assess the intravascular volume by comparingbetween IVC diameter, IVC collapsibility index by ultrasound with central venous pressure (CVP)in critically ill patients.

Chapter (1)
Hemodynamic Monitoring techniques

Cardiocirculatory dysfunction with subsequent hemodynamic instability is a frequent and crucial symptom found in many medical conditions requiring intensive care therapy. Hemodynamic instability diminishes oxygen supply to the end organs and is associated with an increased mortality rate.Thus; hemodynamic management represents a cornerstone of intensive care therapy and has therefore been addressed by an increasing number of guidelines and recommendations**(Vieillard-Baron A et al., 2014).**

The risk of complications is related to various factors, including patient status and comorbidities and laboratory findings. Insufficient tissue perfusion and cellular oxygenation due to hypovolemia, heart dysfunction or both is one of the leading causes of complications and poor outcomes.Thus, effective fluid management to prevent and treat hypo/hypervolemia and titration of vasoactive drugs for heart dysfunction are crucial to maintain adequate oxygen delivery (DO_2) and prevent fluid overload and its consequences (**Cecconi Met al., 2013).**Therefore, selecting the most appropriate hemodynamic monitoring device (for diagnosis and to guide therapies) may be an important first step in reducing the risk of complications (**Kulemann B et al., 2013**).