

COMPARISON BETWEEN HES 130/0.4 AND MODIFIED FLUID GELATIN DURING ABDOMINAL SURGERY GUIDED BY TRANSESOPHAGEAL DOPPLER

Thesis

**Submitted for Partial Fulfillment
of MD in Anesthesiology**

By

Mohamed Mahmoud Hussein
(M.B.B.Ch , M.Sc.)

Supervisors

Prof. Dr. Ayman Adel Eldesouky
Professor of Anesthesiology
Faculty of Medicine
Cairo University

Prof. Dr. Gehan Gamal-Eldin Elfandy
Professor of Anesthesia
President of Theodor Bilharz Research Institute

Ass. Prof. Maged Salah Abdallah
Assistant Professor of Anesthesiology
Faculty of Medicine
Cairo University

**Faculty of Medicine
Cairo University
2010**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(وَقُلْ رَبِّی زِدْنِی عِلْمًا)

صَدَقَ اللَّهُ الْعَظِيمُ

ACKNOWLEDGEMENT

First and foremost, I wish to express my sincerest thanks to ALLAH for his care and generosity throughout my life.

I am deeply grateful to Prof. Dr. Gehan Gamal-Eldin Elfandy, President of Theodor Bilharz Research Institute and Professor of Anesthesiology, for her continuous help, support and direct supervision of the work and for her fruitful thinking which was behind the progress of the work.

I wish to express my sincere appreciation and deepest gratitude to Prof. Dr. Ayman Adel Eldesouky, Professor of Anesthesiology, Faculty of Medicine, Cairo University, for his supervision, illuminating guidance, valuable instructions as well as his support throughout this work.

I am also deeply indebted to Dr. Maged Salah Abdallah, Ass. Professor of Anesthesiology, Faculty of Medicine, Cairo University, for his kind help, encouragement, precious advice and great support throughout the whole work.

My sincere thanks are due to Prof. Dr. Sohaila Omar, Professor of Anesthesiology, Theodor Bilharz Research Institute for planning the design of the work, devoting her intellectual energies and high sense of profession in the entire development of this thesis, offering all help, supervision, patience, guidance and all laboratory facilities throughout the entire work.

I am also greatly grateful to Prof. Dr. Ahmed Mohamed Mukhtar, Professor of Anesthesiology, Faculty of Medicine, Cairo University, for his advice, help and cooperation throughout this work.

I am truly grateful to Prof. Dr. Emad Seddik, Head and Professor of Anesthesiology, Theodor Bilharz Research Institute, for his valuable support.

Many Thanks to Prof. Dr. Hend Kamel, Professor of Anesthesia and Head of Surgical Clinical Board, Theodor Bilharz Research Institute for approving the registration of this thesis and valuable advice.

Many thanks to all staff members of Anesthesia at Theodor Bilharz Research Institute who bore with me the brunt of this work,

I would like to really thank all my family for their infinite support.

Finally, I cannot miss thanking the patients that were the mainstay of the study.

Mohamed Husssein

2010

LIST OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	3
Chapter I: Esophageal Doppler Monitor	3
Chapter II: Types of Fluids and Perioperative Fluid Management	27
PATIENTS AND METHODS	61
RESULTS	68
DISCUSSION	90
SUMMARY	101
REFERENCES	104
ARABIC SUMMARY	

LIST OF FIGURES

No.		Page
Fig. 1:	Esophageal Doppler probe in situ.	6
Fig. 2:	Velocity-time plot.	9
Fig. 3:	The descending aortic stroke volume can be determined by multiplying the stroke distance with the aortic cross-sectional area.	10
Fig. 4:	Velocity-time waveforms of aortic blood flow under various hemodynamic conditions.	18
Fig. 5:	Original recordings of waveforms and variables from patients with hypovolemia (A), increased afterload (B), and left ventricular failure (C) and the response to adequate treatment.	19
Fig. 6:	Algorithm to guide intraoperative fluid therapy with Doppler derived variables.	23 & 64
Fig. 7:	Model for volumes of distribution of isotonic colloid, saline, and glucose solutions.	29
Fig. 8:	Starch from maize is similar to glycogen from human cells.	38
Fig. 9:	Substitution of hydroxyethyl groups (-OCH ₂ CH ₂ OH) within the starch molecule.	39
Fig. 10:	C2:C6 ratio describing the amount of hydroxyethyl groups on position C2 within the glucose ring in relation to C6.	39
Fig. 11:	Schematic representation of the response of central venous pressure (CVP)/pulmonary artery occlusion pressure (PAOP) to an increase in intravascular volume.	57
Fig. 12:	Schematic representation of the response of stroke volume to an increase in intravascular volume.	59
Fig. 13:	Mean value of platelets in the two studied groups.	81
Fig. 14:	Mean value of INR in the two studied groups.	84
Fig. 15:	Mean value of serum creatinine (mg/dl) in the two studied groups.	86

LIST OF TABLES

No.		Page
Table 1:	Demographic features of the two studied groups.	68
Table 2:	Mean heart rate (beat/min.) in the two studied groups.	70
Table 3:	Systolic blood pressure (mmHg) in the two studied groups.	70
Table 4:	Diastolic blood pressure (mmHg) in the two studied groups.	71
Table 5:	Mean arterial blood pressure (mmHg) in the two studied groups.	71
Table 6:	Mean value CVP (mmHg) in the two studied groups.	72
Table 7:	Mean value of urine output (ml) in the two studied groups.	72
Table 8:	Mean cardiac index in the two studied groups.	73
Table 9:	Mean value of stroke volume (ml) in the two studied groups.	74
Table 10:	Mean value of stroke volume index in the two studied groups.	74
Table 11:	Mean value of peak velocity (cm/sec) in the two studied groups.	75
Table 12:	Mean value of systolic flow time in the two studied groups.	75
Table13:	Mean value of oxygen delivery index in the two studied groups.	76
Table 14:	Mean value of central venous saturation % in the two studied groups.	76
Table 15:	Mean blood loss and transfusion requirements in the two studied groups.	78
Table 16:	Mean value of hemoglobin (g/dl) in the two studied groups.	79
Table 17:	Mean value of hematocrite (%) in the two studied groups.	80
Table 18:	Mean value of platelets in the two studied groups.	81
Table 19:	Mean value of prothrombin time (seconds) in the two studied groups.	82

Table 20:	Mean value of prothrombin concentration (%) in the two studied groups.	83
Table 21:	Mean value of INR in the two studied groups.	83
Table 22:	Mean value of serum creatinine (mg/dl) in the two studied groups.	85
Table 23:	Mean value of serum AST (mg/dl) in the two studied groups.	88
Table 24:	Mean value of serum ALT (mg/dl) in the two studied groups.	89
Table 25:	Mean value of serum bilirubin (mg/dl) in the two studied groups.	89

LIST OF ABBREVIATIONS

ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
BSE	Bovine spongiform encephalitis
CO	Cardiac output
CI	Cardiac Index
CVP	Central venous pressure
Da	Dalton
EDM	Esophageal Doppler monitor
FTc	Flow time corrected
GEL	Gelatins
GST	Glutathione serum transferase
HES	Hydroxyethyl starch
INR	International normalized ratio
HR	Heart rate
MD	Minute distance
MW	Molecular weight
PAOP	Pulmonary artery occlusion pressure
PT	Prothrombin time
PV	Peak velocity
PVE	Plasma volume expansion
RCTs	Randomized controlled trials
SCVO ₂	Central venous oxygen saturation
SV	Stroke volume
TED	Transesophageal Doppler

TEG™

Thromboelastograph

vWF

von Willebrand factor

ABSTRACT

Intraoperative fluid management plays important role in anesthesia. Different types of fluids are used in plasma volume expansion. Modified fluid gelatin and Hydroxyethyl starches are commonly used in plasma volume expansion. The new Hydroxyethyl starch 130/0.4 is efficient plasma substitute with relatively safe profile on renal and platelet function.

Key Words: Modified fluid gelatin, Hydroxyethyl starch 130/0.4, plasma volume expansion

Plasma volume expansion is of substantial importance during major surgery. To achieve this goal, colloids may be preferred to crystalloids, as they more effectively increase blood volume and consequently, cardiac output (1). A number of studies have compared the different available colloids. In almost all these studies, the outcome was either not an endpoint or was not reported (2, 3). It is therefore not surprising that reasons for choosing specific products remain unclear. (4) Gelatins (GEL) have the advantage of their unlimited daily dose recommendation and minimal effect on hemostasis (5). However, they are associated with a more frequent incidence of allergic reaction (6). GEL are associated with more than twice the incidence as the modified fluid form (7).

Hydroxyethyl starches (HES) have the advantage of a higher plasma-expanding effect and an infrequent incidence of allergic reactions, but they have more pronounced effects on hemostasis (8). As the HES-related effects on hemostasis appear to be related to their specifications (9), a new HES with a lower *in vivo* molecular weight (HES 130/0.4) has been introduced. This new synthetic colloid appears to have fewer effects on hemostasis (10–12) while maintaining the same effectiveness as medium molecular weight HES (12–14).

Esophageal Doppler monitoring (EDM) measures blood flow velocity in the descending thoracic aorta. When combined with a nomogram-based estimate of aortic cross sectional area, which is derived from the patient's age, height, and weight, it allows hemodynamic variables, including stroke volume, cardiac output, and index to be calculated. The monitor, however, does not

provide direct measurement of pulmonary artery and pulmonary artery occlusion pressures, although changes in the corrected systolic flow time have been shown to reflect qualitative changes in pulmonary artery occlusion pressures, allowing optimization in left ventricular filling **(15)**. Several studies demonstrated the importance of the use of EDM to direct intraoperative fluid administration **(16, 17)**.

Hemodynamic optimization is one of the crucial goals of anesthesia management in ensuring adequate perioperative organ perfusion. Adequate perfusion, however, not only relies on sufficient perfusion pressure but also on systemic blood flow, i.e., cardiac output (CO), to deliver oxygen and substrates to the organs and to eliminate metabolic by-products. Although arterial blood pressure is measured perioperatively in most patients, CO is not routinely monitored.

Thermodilution techniques, requiring insertion of a pulmonary artery catheter, are considered to be the clinical standard of CO measurement **(18)**. However, major risks, high costs, and considerable additional time needed for pulmonary artery catheter insertion limit the routine assessment of CO. Intraoperative CO monitoring could, however, be useful in many patients to guide fluid administration and therapy with vasoactive and inotropic substances. Therefore, transesophageal Doppler (TED) ultrasonography of the descending aorta could be a useful monitoring device. TED allows a continuous estimation of CO and facilitates the assessment of preload, afterload, and myocardial contractility by calculating advanced hemodynamic variables **(19)**.

Various studies have demonstrated improved patient outcome and reduced length of hospital stay when hemodynamic management is guided by TED **(20, 21)**, suggesting that this technique may be a valuable supplement to

the current standard hemodynamic monitoring. Early TED devices were not user friendly and were difficult to operate, which prevented widespread clinical use. In recent years, new devices have been developed, which combine the benefits of safe and continuous CO monitoring with the advantages of simple operation and straightforward display of the measured data. We review the technical basis and clinical applications including limitations, risks, and contraindications.

TECHNICAL PRINCIPLES

Doppler Sonography

The Doppler Effect describes an apparent change in the frequency of a wave noticed by an observer moving relative to the source of the wave. The frequency shift, i.e., the discrepancy between actual and noted frequency, is directly proportional to the relative velocity between the emitter and receiver. By measuring this Doppler frequency shift (Δf), which is produced when moving red blood cells are interrogated by an ultrasound beam, blood flow velocity (v) can be determined by the standard Doppler equation (22)

$$v = \frac{\Delta f \times c}{2fT \times \cos\theta}$$