INTRAOPERATIVE ASSESSMENT OF CARDIAC OUTPUT

An essay submitted for partial fulfillment of Master Degree in anesthesiology

BY

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List of Abbreviations

CO	**Cardiac output**
CI	**Cardiac Index**
SV	**Stroke Volume**
HR	**Heart Rate**
EDPVR	**End-Diastolic Pressure Volume Relationship**
ESPVR	**End-Systolic Pressure Volume Relationship**
CVP	**Central Venous Pressure**
PCWP	**Pulmonary Capillary Wedge Pressure**
EDV	**End-Diastolic Volume**
SVR	**Systemic Vascular Resistance**
MAP	**Mean Arterial Pressure**
PVR	**Pulmonary Vascular Resistance**
EF	**Ejection Fraction**
AV	**Atrio-Ventricular**
SA node	**Sino-Atrial node**
ASA	**American Society of Anesthesiologists**
PAC	**Pulmonary Artery Catheter**
MI	**Myocardial Infarction**
VSR	**Ventricular Septal Rupture**
ARDS	**Acute Respiratory Distress Syndrome**
ARF	**Acute Renal Failure**
SIRS	**Systemic Inflammatory Response Syndrome**
PAP	**Pulmonary Artery Pressure**
IJV	**Internal Jugular Vein**

PVC	**Premature Ventricular Contraction**
VT	**Ventricular Tachycardia**
LBBB	**Left Bundle Branch Block**
RBBB	**Right Bundle Branch Block**
RV	**Right Ventricle**
IVC	**Inferior Vena Cava**
VSD	**Ventricular Septal Defect**
CV	**Central Venous**
CPB	**Cardio-Pulmonary Bypass**
CCO	**Continuous Cardiac Output by Thermo-Dilution**
VO_2	**Oxygen Consumption**
CaO_2	**Arterial Oxygen Content**
CvO_2	**Mixed Venous Oxygen Content**
SaO_2	**Arterial Oxygen Saturation**
SvO_2	**Mixed Venous Oxygen Saturation**
FiO_2	**Fraction of Inspired Oxygen**
PA	**Pulmonary Artery**
CABG	**Coronary Artery Bypass Graft**
TDCO	**Thermo-Dilution Cardiac Output**
RA	**Right Atrium**
TR	**Tricuspid Regurgitation**
SVV	**Stroke Volume Variation**
PPV	**Pulse Pressure Variation**
TCPTD	**Trans-Cardio-Pulmonary Thermo-Dilution**
LiDCO	**Lithium Dilution Cardiac Output**

f_{dop}	**Doppler Frequency Shift**
CW	**Continuous Wave**
PW	**Pulsed Wave**
TEE	**Trans-Esophageal Echocardiography**
VTI	**Velocity Time Integral**
CSA	**Cross-Sectional Area**
2D	**2 Dimensional**
LVOT	**Left Ventricular Outflow Tract**
LVET	**Left Ventricular Ejection Time**
VCO_2	**Elimination of** CO_2
C_aCO_2	**Arterial** CO_2 **Content**
C_vCO_2	**Venous** CO_2 **Content**
$etCO_2$	**End-Tidal** CO_2

INTRODUCTION

Hemodynamic monitoring is a cornerstone of care for the hemodynamically unstable patients, but it requires a manifold approach and its use is both context and disease specific. One of the primary goals of hemodynamic monitoring is to alert the health care team to impending cardiovascular crisis before organ injury ensues; it is routinely used in this manner in the operating room during high-risk surgery. ***(Pinsky et al., 2005)***

The effectiveness of hemodynamic monitoring depends both on available technology and on the ability to diagnose and effectively treat the disease processes for which it is used. The utility of hemodynamic monitoring has evolved as it has merged with information technology and as our understanding of disease pathophysiology has improved.***(Pinsky et al. ,2005)***

Cardiac output, expressed in liters/minute, is the amount of blood the heart pumps in one minute. Cardiac output is logically equal to the product of the stroke volume and the number of beats per minute (heart rate).***(Vincent , 2008)***

An accurate and reliable technique for measuring cardiac output would be of considerable value both in research and clinical medicine. Ideally, such a technique should be non-invasive, versatile, reliable, cost-effective, and easy-to-use. (***Spiering et al., 1998)***

Indicator dilution techniques using thermal, indocyanine green, and lithium can measure blood flow from both central venous and pulmonary artery catheter (PAC) .Left ventricular stroke volume can be estimated using a beat-to-beat based, algorithmic analysis of arterial pulse pressure. Several monitoring techniques use subtle variations in this concept to calculate stroke volume and cardiac output. The overall accuracy of these techniques varies. Esophageal Doppler techniques can be used to measure descending aortic flow and to estimate both stroke volume and cardiac output. ***(Pinsky et al., 2005)***

Cardiac output is routinely monitored in critically ill patients with the primary goal of maintaining adequate tissue perfusion. In most patients in the surgical settings,thermodilution using a pulmonary artery catheter is still the most frequently applied technique and has generally been accepted as the clinical gold standard. However, the value of the pulmonary artery catheter has been questioned in recent years, and its impact on outcome is controversial. More recently, several less-invasive techniques that avoid the risks associated with the pulmonary artery catheter have become available for routine cardiac output monitoring. These devices include continuous monitors that use arterial pressure waveform analysis to estimate cardiac output and other hemodynamic parameters. ***(Auler et al., 2010)***

The trans-esophageal Doppler echocardiography is based on measurement of blood flow velocity in the descending aorta by means of a Doppler transducer (4 MHz continuous or 5 MHz pulsed wave, according to the type of device) at the tip of a flexible probe. The probe may be introduced orally in anaesthetized, mechanically ventilated patients. ***(Berton et al., 2002)***