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Invasive Monitoring in Intensive care unit

An Essay

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بِسْمِ اللّهِ الرّحمَنِ الرّحيمِ

[...رَبِّ أَوزِعنِي أَن أَشكُرَ نِعمَتَكَ

الّتِي أَنْعَمْتَ عَلَيَّ وعَلى والِدَيَّ

وأَنْ أَعْمَلَ صَالِحاً تَرْضَاهُ

وأَدْخِلْنِي بِرَحْمَتِكَ

فِي عِبَادِكَ الصَّالِحِينَ]

صدق الله العظيم

النمل.. اية رقم ١٩

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Ahmed Abdallah Sayed

Contents

List of Abbreviations

Abbrev.	Full term
ABI	: Acquired brain injury
ABP	: Arterial blood pressure
ARDS	: Acute respiratory distress syndrome
ASA	: American society of anesthesiology
BNP	: Beta natriuretic peptide
BP	: Blood pressure
cICC	: Continuous intracranial compliance
CO	: Cardiac out put
CPP	: Cerebral perfusion pressure
CRBSIs	: Catheter related blood stream infections
CSF	: Cerebrospinal fluid
CT	: Computerized tomography
CVC	: Central venous catheter
CVL	: Central venous line
CVP	: Central venous pressure
CXR	: Chest X ray
DAI	: Diffuse axonal injury
EDV	: End diastolic volume
EKG	: Electrocardiogram
ETT	: Endotracheal tube
EVD	: External ventricular drainage
GCS	: Glasgow coma scale
GOS	: Glasgow outcome score scale
ICH	: Intra cranial hemorrhage
ICP	: Intracranial pressure
ICU	: Intensive care unit
IJ	: Internal jugular
IJV	: Internal jugular vein
IVC	: Inferior vena cava

List of Abbreviations *(Cont.)*

Abbrev.	Full term
LA	: Left atrium
LBBB	: Left bundle branch block
LIJ	: Left internal jugular
LV	: Left ventricle
MABP	: Mean arterial blood pressure
mL	: Milli litre
mm	: Millimeter
mmHg	: Millimeter mercury
MRI	: Magnetic resonance imaging
PA	: Pulmonary artery
PAC	: Pulmonary artery catheter
PAOP	: Pulmonary artery occlusion pressure
PCo2	: Carbon dioxide pressure
PCWP	: Pulmonary capillary wedge pressure
PEEP	: Positive end expiratory pressure
Ppa	: Pulmonary arterial pressure
Ppao	: Pulmonary artery occlusion pressure
PVCs	: Premature ventricular contractions
PVR	: Pulmonary vascular resistance
RA	: Right atrium
RHC	: Right heart catheterization
RIJ	: Right internal jugular
RV	: Right ventricle
SA	: Sinoatrial node
Sao2	: Arterial oxygen saturation
ScVO2	: Central venous oxygen saturation
SVC	: Superior vena cava
Svo2	: Mixed venous oxygen saturation
TBI	: traumatic brain injury
VT	: Ventricular tachycardia

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Introduction

In critical care, the monitoring is essential to the daily care of ICU patients, as the optimization of patient's hemodynamics, ventilation, temperature, nutrition, and metabolism is the key to improve patients' survival. Monitoring in The ICU is divided into invasive & noninvasive ***(Kipnis et al., 2012)***.

Invasive monitoring in ICU is composed of intracranial pressure monitoring, Central Venous pressure monitoring, pulmonary artery catheter, direct arterial Blood pressure monitoring & intra-abdominal pressure monitoring.

Intracranial pressure monitoring: is indicated in patients with severe head injury especially if he's hypotensive ***(Susan et al., 2007).*** But, it has the risk of increase increasing cerebral edema, intracranial hemorrhage, cortical damage and intracranial infection ***(Raboel et al., 2012).***

Central venous Catheter is helpful in monitoring fluid status, administration of irritant drugs or Vaso-active drugs, total parenteral nutrition, hemodialysis, temporary pacemaker and to monitor patients with cardiorespiratory failure (Organophosphorus poisoning, cerebrovascular accident, congestive cardiac failure, dilated cardiomyopathy, liver cirrhosis, GB syndrome, hypokalemic periodic paralysis, chronic cor-pulmonale, acute pulmonary embolism, myxedema coma with pericardial effusion).

But, it has the risk of causing pneumothorax, cardiac tamponade, arrhythmias and infection, air & catheter embolism ***(Gopal et al., 2009).***

A pulmonary Artery Catheter provides the Intensivist with critical hemo dynamic data that includes cardiac output mixed venous oxygen saturation, intrapulmonary and intra cardiac pressure.

It's used for pre-operative optimization of hemodynamics, intra operative monitoring and postoperative management of critically ill patients, and in cardiothoracic surgery patients Such as coronary artery bypass graft and valvular surgery to guide therapy and differentiate various types of Shock states.

But, it has The complication of balloon rupture, Knotting, pulmonary infarction, pulmonary artery perforation, thrombo-embolic complication, Rhythm disturbances, Intracardiac damage, Catheter related blood stream infection ***(Rajaram et al., 2013).***

Direct arterial blood pressure monitoring: indicated in hemodynamically unstable patients for beat to beat blood pressure monitoring & to assess the waveform & the effect of arrhythmia on perfusion & effect of large tidal volume of mechanically ventilated patient on his blood pressure. Also, it helps in case of frequent arterial Blood gas samples &

arterial administration of drugs like thrombolytics & intra-aortic balloon pump insertion ***(Ribezzo et al., 2014).***

But, it may be complicated by thrombosis that may need surgical intervention, cerebral embolization especially by air & infection ***(Bernd et al., 2002).***

Aim of the Study

To spot the light on Invasive monitoring in ICU & its indications, contraindications, advantages, disadvantages and complications.

Chapter (1):
Types of Invasive Monitoring in ICU

1-intracranial pressure monitoring:

In 1926, Harvey Cushing, American neurosurgeon, formulated the doctrine as we know it today, namely that with an intact skull, the volume of the brain, blood, and CSF is constant. An increase in one component will cause a decrease in one or both of the other components ***(Cushing, 1926).***

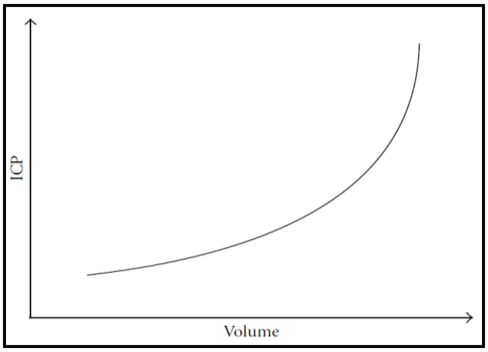

Figure (1): The volume / pressure curve

This relationship provides a compensatory reserve, also called spatial compensation. It is 60–80mL in young persons and 100–140mL in elderly, mainly due to cerebral atrophy. The volume/pressure curve is shown in Figure 1.

The first part of the curve is characterized by a very limited increase in pressure due to the compensatory reserve being large enough to accommodate the extra volume. With increasing volume, the compensatory reserve is eventually exceeded, causing a rapid increase in pressure ***(Gjerris et al., 2004).***

In cases of elevated ICP or circulatory hypotension, the cerebral perfusion pressure (CPP) is decreased. CPP is calculated by subtracting ICP from the mean artery pressure (MAP), defined as the sum of the diastolic pressure added to a third of the difference between systolic and diastolic pressure ***(Raboel et al., 2012).***

Under normal physiological conditions, the cerebral autoregulation maintains a constant flow of blood to the brain by dilating or constricting the arterioles. However,

This autoregulation is only effective with a MAP between 50 and 150mmHg. Pressure above the upper limit of autoregulation will cause hyperemia and cerebral edema. Pressures below the limit lead to insufficient blood flow and cerebral ischemia ***(Raboel et al., 2012).***

2-Hemodynamic monitoring:

Hemodynamics is the study of blood flow. Hemodynamic monitoring therefore refers to the monitoring of blood flow through the cardiovascular system. In the intensive care unit (ICU), hemodynamic monitoring is used to detect cardiovascular insufficiency, differentiate contributing factors and guide therapy.

In the hemodynamically unstable patient where volume status is not only difficult to determine, but excess fluid administration can lead to adverse consequences, utilizing markers that guide resuscitation can greatly affect outcomes ***(Kipnis et al., 2012)***.

Frank starling law of the heart:

The frank starling law of the heart states that the stroke volume of the heart increases in response to an increase in the volume of blood filling the heart (the end diastolic volume) when all other factors remain constant. The increased volume of blood stretches the ventricular wall, causing cardiac muscle to contract more forcefully. The stroke volume also increases due to an increase in cardiac muscle contractility, independent of the end diastolic volume ***(Costanzo et al., 2007).***

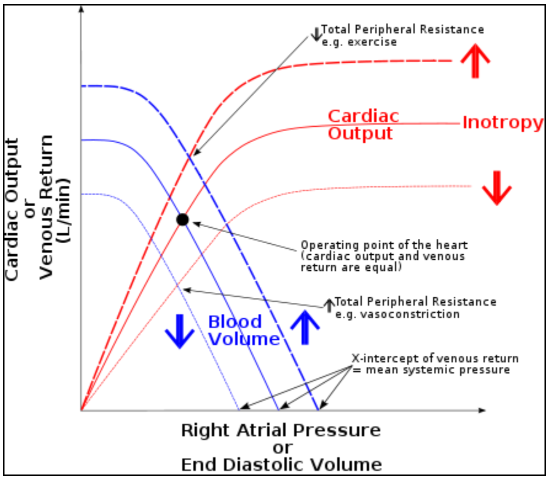

Figure (2): Cardiac output/right atrial pressure curve ***(Costanzo et al., 2007).***