Comparative Study of the Effect of Na Nitroprusside versus Sevoflurane on tissue perfusion in pediatric cardiac surgery

Thesis
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DEDICATION

I dedicate this work to my ***Wife***

And ***my Forecoming baby***

For their help and assistance.

ABSTRACT

Cardiopulmonary Bypass affects most of the body's physiologic processes. Some of these effects are controlled completely or at least partially during or after CPB, but some are out of direct control. An example of the latter group is the systemic inflammatory response induced by the contact of blood with non-endothelial foreign surfaces. Partially controllable parameters are systemic vascular resistance, total-body oxygen consumption, regional and organ blood circulation, metabolic rate, and lactic acidosis. The effects of completely controllable parameters, such as blood flow rate and pattern, perfusion temperature, perfusate characteristics, and systemic arterial, venous, and pulmonary pressures, have been widely investigated and clarified. Nevertheless, it is evident that ideal CPB management can only be obtained by investigating these uncontrollable or partially controllable effects. These effects are among the principal causes of increased morbidity, especially in infants and children undergoing cardiac surgery.

Patients undergoing cardiac surgery are often cooled to 25 to 28°C core temperatures during cardiopulmonary bypass (CPB) and rewarmed before termination of CPB. During the rewarming period, the aim of the anesthesiologist is to achieve a uniform rewarming of the whole body. Despite rewarming core temperatures to 37°C, decreases up to several degrees in core temperatures after discontinuation of CPB have been documented by many authors. This drop in core temperatures after termination of CPB is referred to as "afterdrop" and is said to be a sign of inadequate total body rewarming on CPB.

The surgeon’s decision about when to rewarm is critical; adequate rewarming requires time, but rewarming too soon removes the protective effects of hypothermia. Rapid rewarming often results in large temperature gradients between well-perfused organs and peripheral vasoconstricted tissues; subsequent equilibration following separation from CBP decreases core temperature again. Infusion of a vasodilator drug by allowing higher pump flows often speeds the rewarming process and decreases large temperature gradients.

The aim of this study is to investigate whether, the negative effects of CPB on pediatric patients' arterial tone and microcirculation can be overcome by pharmacologic vasodilation. Therefore, the effects of intravenous Na nitroprusside and inhaled sevoflurane on body heat distribution, oxygen consumption, and blood lactate values will be assessed during and after CPB.

Key Words:

Cardiopulmonary bypass (CPB).

Congenital Heart Diseases.

Sevoflurane.

Na Niroprusside infusion.

Serum lactate.

Hypothermia.

Hypoperfusion.

Afterdrop temperature.

Rewarming

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LIST OF ABBREVIATIONS

α:	alpha
A – a gradient:	alveolar – arterial gradient.
ACTH:	adreno-cortico-trophic hormone.
AMP:	adenosine mono-phosphate.
ANOVA:	analysis of variance.
ASD:	atrial septal defect.
ASA:	American society of anesthesiologists.
ATP:	adenosine tri-phosphate.
BIS:	bi-spectral index.
BSA:	body surface area.
Ca^{++} :	calcium.
C3a:	complement 3a.
CBF:	cerebral blood flow.
CHD:	congenital heart disease.
CI:	cardiac index.
CMR:	cerebral metabolic rate.
CMRO2:	cerebral metabolic rate of oxygen.
CN^{-}:	cyanide.
CNS:	central nervous system.
CO :	cardiac output.
CO2:	carbon dioxide.
CPB :	cardiopulmonary bypass
Cyanmet Hgb:	cyan-methemoglubin.
º C:	degree Celsius.
DHCA:	deep hypothermic circulatory arrest.
DNA:	deoxyribonucleic acid.
DNase:	deoxyribonuclease.
DO2:	oxygen delivery.
ECG:	electrocardiogram.
ED50:	effective dose 50.
ED95:	effective dose 95
EEG:	electroencephalogram.
Fa:	arterial gas concentration.
FA:	alveolar gas concentration.
Fe^{+++}:	ferric ion.
FI:	inspired gas concentration.
FRC:	functional residual capacity.
H_2 blockers:	histamine-2 receptor blockers.
Hct:	hematocrite.
HFIP:	hexa-fluoro-iso-propanol.

Hgb:	hemoglobin.
HLFB:	hypothermic low flow bypass.
HR :	heart rate.
ICP:	intra-cranial pressure.
ICU:	intensive care unit.
IL:	interleukin.
IVC:	inferior vena cava.
IQ:	intelligence quotient.
K^+:	potassium.
LD50:	lethal dose 50.
LV:	left ventricle.
MAC:	minimum alveolar concentration.
MAP :	mean arterial pressure.
Met Hgb:	methemoglubin.
MUF:	modified ultra-filtration.
Na^+ :	sodium.
Na^+/K^+ ATPase:	sodium potassium adenosine tri-phosphatase.
NMBAs:	neuro-muscular blocking agents.
NMDA:	N-methyl-D-aspartate.
NSR :	normal sinus rhythm.
NTG:	nitroglycerine.
O2:	oxygen.
OR:	operation room.
PACU:	post-anesthetic care unit.
PaCO2:	arterial carbon dioxide tension.
PaO2:	arterial oxygen tension.
PDA:	patent ductus arteriosus.
PPB:	plasma protein binding.
ppm :	parts per million.
PVR:	pulmonary vascular resistance.
Qp/Qs:	pulmonary-to-systemic blood flow ratio.
RBC:	red blood corpuscles.
SCN^-:	thiocyante.
SD:	standard deviation.
SNP:	sodium nitroprusside.
SpO2:	arterial oxygen saturation.
SR:	sarcoplasmic reticulum.
SVC:	superior vena cava.
SvO2:	mixed venous oxygen saturation.
SVI :	stroke volume index.
SVR:	systemic vascular resistance
SVRI :	systemic vascular resistance index.
T1/2:	half time.

TNF:	tumor necrosis factor.
TR:	therapeutic ratio.
TSH:	thyroid-stimulating hormone.
UK:	United Kingdom.
Vd:	the volume of distribution of a drug.
VO2:	oxygen consumption.
Vs:	versus.
VSD:	ventricular septal defect.
WBC:	white blood corpuscles.

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Chapter One

Pediatric Anesthesia Pharmacology

Introduction

During the first months of life, there is rapid physical growth and maturation, causing a rapid change in the factors involved in the uptake, distribution, redistribution, metabolism, and excretion of drugs (1).

Important differences in these processes between the infant and adult explain the young infant's altered quantitative response to many anesthetic drugs and adjuncts. Variations in drug penetration of the blood-brain barrier and in the sensitivity of the neuromuscular junction have been observed in infants in response to some anesthetics & neuromuscular blocking agents (2).

Although physical growth and physiologic maturation gradually take palace over childhood, pharmacological maturation takes place in the first 6 months (2).

In this chapter, only the pharmacodynamics of inhalation anesthetics with special regard to Sevoflurane and pharmacodynamics of vasodilators with special regard to Na Nitroprusside will be discussed in details.