Crystalloids Vs Colloids For Fluid Replacement In Pediatrics

Essay

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بسم الله الرحمن الرحيم

(قَالُوا سُبْحَانَكَ لاَ عِلْم
لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ
أَنْتَ العَلِيمُ الحَكِيمُ)

صدق الله العظيم

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ACS : American College of Surgeon.

ADH **:** Anti diuretic hormone.

ALT **:** Alanine amino transferase.

ARDS **:** Acute respiratory distress syndrome.

ARF : Acute renal faliure.

AST **:** Aspartate amino transferase.

ATLS **:** Advanced trauma life support.

BP **:** Blood pressure.

BSA **:** Body surface area.

BW : Body weight.

C : Celsus.

CCIS : Critical care information system.

CNS : Central nervous system.

CO : Cardiac output.

CO2 : Carbon dioxide.

ECF : Extracellular fluid.

ECG : Electro cardiogram.

ECV : Extracellular volume.

ESPA : European Society of Pediatric Anesethia.

FENa : Fractional excretion of sodium.

GFR : Glomerular filtration rate.

GI : Gastrointestinal.

HES : Hydroxyethyl starch.

HF **:** Heart failure.

ICF **:** Intracellular fluid.

ICP **:** Intracranial pressure.

IV **:** Intravenous.

IVF **:** Intravascular fluid.

LES **:** Lower oesophageal sphincter.

LR **:** Lactated ringer.

MW **:** Molecular weight.

NPO **:** Nothing per oral.

NS **:** Normal saline.

ORT **:** Oral rehydration therapy.

PICU **:** Postoperative intensive care unit.

Posm :Plasma osmolality.

PPF **:** Plasma protein fraction.

PS **:** Primary survey.

PVCs :Premature ventricular contractions.

PVR : Peripheral vascular resistance.

RBCs **:** Red blood cells.

RH **:** Rheusus factor.

SIADH : Syndrome of inapropriate antiduretic hormone release.

SICU **:** Surgical intensive care unit.

SID : Strong ion difference.

SS **:** Secondary survey.

SVC : Superior vena cava,

TBW **:** Total body water.

TKVO : To keep vein open.

VW **:** Von Willbrand factor.

WT **:** Weight.

YR **:** Year.

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Introduction

Hypovolemia is the most common cause of circulatory failure in children and can lead to critical tissue perfusion . Unlike crystalloids , colloids may be used to rapidly treat or prevent hypovolemia with the advantage of markedly reducing the total volume of the administered infusion. ***(James, 2008).***

Water is an essential carrier for nutrients and metabolites , and it comprises the major part of human body mass at any age . Water and electrolyte requirements per unit body mass are very high after birth and decrease with age until adulthood. ***(Espaghan ,2005).***

Children are particulary vulnerable to the effects of acute hyponatraemia and become symptomatic at higher plasma sodium concentrations than adults. More than 50% of children with serum sodium less than 125mmol/litre develop hyponatraemic encephalopathy . ***(Mortiz M. ,2005).***

Calculation of fluid and electrolyte requirements must account for maintenance requirements and ongoing losses, as well as replacement of deficits. Maintenance fluid requirements are those needed for neutral water balance after accounting for obligatory losses (e.g. urine and stool) and insensible losses (e.g. skin and lungs). Requirements will be influenced by factors that include the gestational and postnatal age , ambient temperature, humidity and renal function. ***(Mortiz, 2004).***

Crystalloids are solutions of small particles. They are composed of low molecular weight solutes less than 30,000 Dalton, either ionic (e.g. Na+ and Cl^-) or nonionic (e.g. mannitol) . They are groubed as balanced , hypertonic and hypotonic salt solutions . They are inexpensive compared to blood products and artificial colloids. These solutions do not contain larger , oncotic particles and

will therefore pass freely across the microvascular membrane. Their distribution will be determined by the amount of sodium in the solution .***(Brauer ,2002).***

Colloids are solutions that contain electrolytes as well as high molecular weight proteins. The large molecules are unable to diffuse through normal capillary membranes and therefore stay in the intravascular space . There are many proteins in use, but most of those manufactured are based on fractionated cellulose or gelatin. ***(Rochow et al., 2002).***

Physiological differences between pediatrics and adults.

The cardiovascular system:

Developmental changes in myocardial structure and function:

The changes in the proportion of muscle to connective tissue during development lead to an alteration in myocardial compliance**,** also the development of left ventricular dominance alters ventricular characteristics. Thus nearly every determinant of cardiac output (heart rate, contractility, afterload, and preload relationships) undergoes distinct developmental changes. ***(Tobin and Wetzel, 2005)*.**

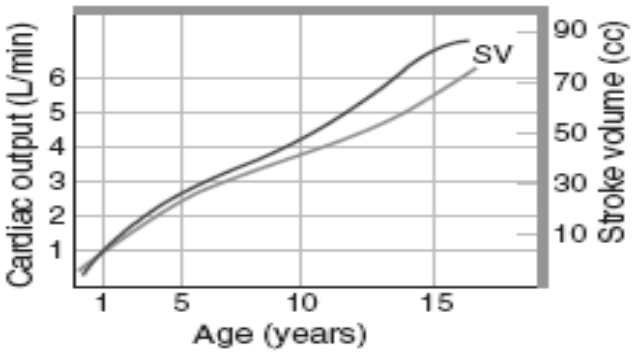

Figure (1): Stroke volume and cardiac output increase with age ***(Randall, 2007)***.

In neonates and infants, heart rate is the predominant determinant of cardiac output. The infant's heart is able to sustain greater rates than that of the adult while maintaining preload, contractility, and myocardial oxygenation before there is a decrease in cardiac output. ***(Tobin and Wetzel, 2005)***.

Bradycardia can seriously decrease the cardiac output in infants and children. Increasing cardiac output by increasing heart rate should be considered

early in responding to decreases in cardiac output as represented by hypotension. That children adapt to changes in cardiac output by changes in heart rate accounts for the wide ranges in heart rate seen in healthy children. ***(Randall, 2007).***

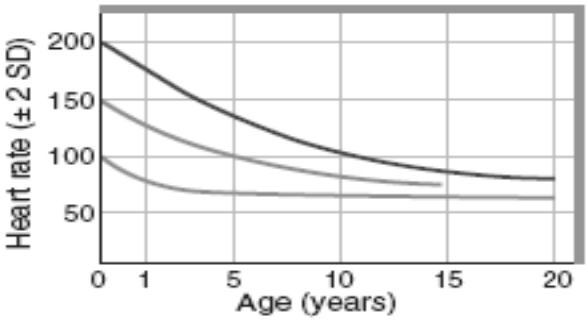

Figure (2): Normal heart rates shown in relation to age. ***(Randall, 2007)***.

The cardiovascular system undergoes dramatic physiologic changes during the first year of life. In utero, most of the cardiac out put (CO) is directed from the placenta across the foramen ovale into the ascending aorta (oxygenated blood). Superior vena cava (SVC) blood is directed to both the pulmonary artery and ductus arteriosus. Thus the pulmonary blood flow is minimal. ***(Charles, 2000).***

At birth, the fetal circulation becomes an adult type circulation. Specifically, the placenta is removed from the circulation and exposure of blood entering the ductus arteriosus to oxygen induces closure of the ducts. In fact true mechanical closure by fibrosis doesn't occur until 2 or 3 weeks of age. ***(Rudolph, 2001).***

As the result of the combined effect of the lung expansion and exposure of blood to oxygen, peripheral vascular resistance (PVR) rises rapidly while pulmonary vascular resistance decreases, the increase in (PVR) leads to an increase in the pressure of the left side of the heart which induces mechanical closure of the foramen ovale after interruption of the placental circulation ***(Friedman et al., 1996).***

The myocardial structure of the heart, particularly the volume of cellular mass devoted to contractility, is less in the neonate than in the adult. This differences and others (table 1) produce a less compliant ventricle.

Thus immature development of the heart accounts for tendency towards biventricular failure, sensitivity to volume loading, poor tolerance to increased after load, and relatively fixed stroke volume. The CO is there fore very dependant on heart rate ***(Charles, 2000).***

Although basal heart rate is higher than in the adult table (2), activation of the parasympathetic nervous system, anesthetic overdose, or hypoxia can cause bradycardia and reduction in (CO). Sick infants undergoing emergency or prolonged surgical procedures appear especially prone to episodes of bradycardia that can lead to hypotension, asystole, and intraoperative death ***(Morgan et al., 2002).***

The sympathetic nervous system and baroreceptor reflexes are not fully mature, the infant cardiovascular system maintains lower catecholamine stores and displays a blunted response to exogenous catecholamine. The vascular tree is less able to respond to hypovolemia with vasoconstriction. The hallmark of intravascular fluid depletion in neonates and infants is therefore hypotension without tachycardia ***(Perry et al, 1999).***

Table (1): Characteristics of infants that differentiate them from adult patients *(Morgan et al., 2002)*

phsiology
Higher heart rate dependent
Faster heart rate
Lower blood pressure
Faster respiratory rate
Lower lung compliance
Greater chest wall compliance
Lower functional residual capacity
Higher ratio of body surface area to body weight
Higher total body water content

Table (2): Age related changes in arterial blood pressure and heart rate *(Morgan et al., 2002)*

Age	**Heart rate (beat/min)**	**Arterial blood pressure (mmhg)**	
		Systolic	diastolic
12 months	120	95	65
3 years	100	100	70
12 years	80	110	60

The cardiac output at birth is 200ml/kg per min and this declines gradually to 100ml/kg per min by puberty. Resting stroke volume in all ages is about 1ml/kg. The cardiac output at younger ages is maintained by increases in heart rate so bradycardia reduce cardiac output and it is important to rectify any bradycardia that may occur during anesthesia ***(Hatch and Hunter, 1999).***