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ANESTHETIC CONSIDERATIONS IN NEONATAL SURGERIES

Essay submitted for partial fulfillment
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بسم الله الرحمن الرحيم
قالوا
سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم
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Mohamed Khamis Osman

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List of Abbreviations

Abbreviation	Full Text
ADH	Anti-diuretic hormone
AIDS	Acquired immunodeficiency syndrome
BBB	Blood-brain barrier
CDH	Congenital diaphragmatic hernia
CPAP	Continuous positive airway pressure
CVP	Central venous pressure
CXR	Chest X-ray
ECG	Electrocardiogram
ECMO	Extracorporeal membrane oxygenation
EMLA	Eutectic mixture of local anesthetics
Et-CO_2	End-tidal carbon dioxide
ETT	Endotracheal tube
GFR	Glomerular filtration rate
HCO_3	Sodium bicarbonate
HFOV	High frequency oscillatory ventilation
HPV	Hypoxemia-induced pulmonary vasoconstriction

IAC	Intra-arterial catheter
ICU	Intensive care unit
IHPS	Infantile hypertrophic pyloric stenosis
IM	Intramuscular
IRDS	Infantile respiratory distress syndrome
IV	Intravenous
NEC	Necrotizing enterocolitis
NICU	Neonatal intensive care unit
NST	Non-shivering thermogenesis
OA	Oesophageal atresia
OI	Oxygenation index
OR	Operating room
PAA	Post-anesthetic apnea
PACU	Post-anesthesia care unit
PCO_2	Carbon dioxide tension
PDA	Patent ductus arteriosus
PEEP	Positive end-expiratory pressure
PFO	Patent foramen ovale
pH	Hydrogen ion concentration

PICCs	Peripherally inserted central catheters
PO_2	Oxygen tension
PR	Per-rectum
PVR	Peripheral vascular resistance
RDS	Respiratory distress syndrome
RSI	Rapid sequence induction
RV	Reserve volume
SaO_2	Oxygen saturation
SNP	Single nucleotide polymorphism
SVR	Systemic venous resistance
TEE	Trans-esophageal echocardiography
TOF	Tracheo-oesophageal fistula
URTI	Upper respiratory tract infection
US	Ultrasound
Vd	Dead space volume
VO_2	Oxygen volume
Vt	Tidal volume

Introduction

By definition, a term infant is born between 37 and 42 weeks of gestation. The gestational age is calculated as the interval between the first day of the mother's last menstrual period and birth; this method's reliability is superseded by ultrasonographic measurement of in utero fetal crown-rump length during the first trimester.

The neonatal period is defined as the first 28 days of life whatever the gestational age. ***(Pittaway, 2011)***

Neonates undergoing surgical operations present several difficult challenges for the anesthesiologist. Many surgical emergencies in the neonate are life threatening and are frequently accompanied by multiple organ system failure.

Communication and cooperation between the entire health care team, including the surgeons, anesthesiologists and neonatologists, are of utmost importance to ensure the best possible care of the neonate. ***(Pani and Panda, 2012)***

Regardless of the type of surgery planned, safe neonatal anesthesia can only be performed with an insightful understanding of the physiological and anatomical changes taking place in the transition from fetal to neonatal life. ***(Cote, 2010)***

Airway and respiratory complications are the most common causes of morbidity during general anesthesia in children. The airway

changes in size, shape and position throughout its development from the neonate to the adult.

Knowledge of the functional anatomy of the airway in neonates forms the basis of understanding the pathological conditions that may occur. ***(Adewale, 2009)***

Obtaining vascular access in the neonate is a challenging and important aspect of their care. Some of the challenges are unique to the neonatal population.

New equipment such as ultrasound (US) and newer types of catheters, such as peripherally inserted central catheters (PICCs), have produced substantial changes and opportunities, and increasingly the choice of access and management of the lines is becoming evidence based. ***(Detaille et al., 2010)***

Three quarters of all critical incidents and one-third of all perioperative cardiac arrests in pediatric anesthesia are related to the respiratory system.

Preterm and term infants are at even higher risk of anesthesia-related critical incidents than older children, which can be explained by the differences in respiratory physiology in this vulnerable population. ***(Neumann and von Ungern-Sternberg, 2014)***

According to the World Health Organization, one in 33 infants born has one or more congenital anomaly.

Some of these children will require surgical treatment in the neonatal period for defects of the heart, neural tube, GI tract, etc., and other children may require intervention in their first month of life for acquired disorders including necrotizing enterocolitis (NEC), reflux, and feeding disorders. ***(Hines and Michael, 2013)***

Chapter (1)

Anatomy, physiology and pharmacology of the neonate

I - Neonatal respiratory system

In neonates, with a relatively hypoplastic mandible, the oropharynx and the entrance to the larynx at the level of the aryepiglottic folds are the areas being most easily collapsed. ***(Holzman, 1998)***

Several reflex mechanisms are present to maintain the balance between the dilating and collapsing forces in the pharynx. Chemoreceptor stimuli such as hypercapnia and hypoxemia stimulate the airway dilators preferentially over the stimulation of the diaphragm so as to maintain airway patency. ***(Ellis et al., 2003)***

Negative pressure in the nose, pharynx, or larynx activates the pharyngeal dilator muscles and simultaneously decreases the diaphragmatic activity. Such an airway pressure reflex is especially prominent in infants younger than 1 year of age. ***(Thach, 1992)***

Upper airway mechanoreceptors are located superficially in the airway mucosa and are easily blocked by topical anesthesia.

Sleep, sedatives, and anesthesia depress upper airway muscles more than they do the diaphragm. ***(Ochiai et al., 1992)***

The skull develops from a membranous and cartilaginous neurocranium. The membranous neurocranium gives rise to the flat bones of the skull (the cranial vault) and the cartilaginous neurocranium (chondrocranium) forms the skull base. The shaping of the skull base is a dynamic process involving reciprocal influences between the cranial base, the pharynx, the face and the palate. ***(Holzman, 1998)***

In the fetus, the rapid growth of the brain leads to a predominance of neural influences; whilst in the neonate and young child, nasal influences play a major role. Later, because of changing nutritional requirements and the development of speech, the pharynx also influences the development of the skull base. Children have a proportionally larger head and occiput relative to body size. This causes neck flexion, leading to potential airway obstruction when lying supine. ***(Wheeler et al., 2007)***

Nose

The nose originates in the cranial ectoderm and is composed of the external nose and the nasal cavity ***(Holzman, 1998)***. The external nose is made up of the nasal bones, the nasal part of the frontal bones and the frontal processes of the maxillae. The nasal cavity is subdivided by the nasal septum into two separate compartments that open to the exterior via the nares and