Anesthesia for In-situ Surgery in Neonatal Intensive Care

A comparative study of three Anesthetic protocols

Thesis

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AI= APNEA INDEX

CBF= CEREBRAL BLOOD FLOW

CDH= CONGENITAL DIAPHRAGMATIC HERNIA

CHD=CONGENITAL HEART DISEASE

CHF= CONGESTIVE HEART FAILURE

CNS= CENTRAL NERVOUS SYSTEM

CVL= CENTRAL VENOUS LINE

CVP= CENTRAL VENOUS PRESSURE

ECMO= EXTRACORPOREAL MEMBRANE OXYGENATION

ED_{95}= EFFECTIVE DOSE 95

$ETCO_2$= END TIDAL CARBON DIOXIDE

FIO_2= FRACTION OF INSPIRED OXYGEN SATURATION

GABA= GAMMA AMINO-BUYERIC ACID

HFOV= HIGH FREQUENCY OSCILLATORY VENTILATION

HVAC= HEATING, VENTILATION &AIR CONDITIONING

ICU= INTENSIVE CARE UNIT

ISS= IN-SITU SURGERY

IVH= INTRAVENTRICULAR HEMORRHAGE

MAC= MINIMUM ALVEOLAR CONCENTRATION

MRSA= METHICILIN RESISTANT STAFF. AUREUS

NEC= NECROTIZING ENTEROCOLITIS

NMDA= N-METHYL D-ASPARTATE

NO= NITRIC OXIDE

NSU= NEONATAL SURGICAL UNIT

OI= OXYGENATION IDEX

OR= OPERATION ROOM

PCA= POSTCONCEPTUAL AGE

PCV= PREESURE CONTROLLED VENTILATION

PDA= PATENT DUCTUS ARTERIOSUS

PIP= PEAK INSPIRATORY PREESURE

PVR= PULMONARY VASCULAR RESISTANCE

RDS= RESPIRATORY DISTRESS SYNDROM

ROP= RETINOPATHY OF PREMATURITY

RR= RESPIRATORY RATE

TIVA= TOTAL INTRAVENOUS ANESTHESIA

TOF= TRACHEOESOPHAGEAL FISTULA

UGI= UPPER GASTROINTESTINAL TRACT

VD= VOLUME OF DISTRIBUTION

VIMA= VOLATILE INDUCTION &MAINTENANCE OF ANSTHESIA

VSG= VENTRICULOSUBGALEAL SHUNT

Abstract

Surgery in the critically ill neonate was traditionally performed in the OR. In-situ surgery (ISS) in the NSU is relatively a new concept that is gaining popularity in the last decade. Many surgical procedures can be done as in-situ surgery without any difficulty including ligation of the PDA, insertion of ventriculo-subgaleal shunts, laparotomy for necrotizing enterocolitis, repair of congenital diaphragmatic hernia and repair of tracheoesophageal fistula.

ISS avoid transfer of the neonates with associated risk of hypothermia, disruption of vascular lines or chest tubes, dislodgement of endotracheal tube, discontinuation of medical treatment or ventilation.

The aim of the work is to compare 3 anesthetic techniques in neonates suffering from anterior abdominal wall defects scheduled for ISS who met the inclusion criteria as regard intraoperative HR, BP, temp, OI, PIP, Spo_2, time to extubation we also compared postoperative ABG, Spo2, apnea index, HR, RR, MAP, temp., postoperative infection and postoperative stay in the NSU. The study included 45 patients who are divided into 3 groups each containing 15 patients. The sevoflurane group received sevoflurane, fentanyl & rocuronium. The Ketamine group received Ketamine & rocuronium. The Midazolam group received Midazolam, remifentanil & rocuronium. There is statistically significant higher intraoperative MAP & HR in the Ketamine group. There is statistically significant lower postoperative RR & oxygen saturation and higher apnea index and Pco_2 in the midazolam group. There is no statistically significant difference between the 3 groups as regard incidence of infection and postoperative stay in the NSU.

KEYWORDS

Neonatal surgical unit, in-situ surgery, total intravenous techniques, Sevoflurane, fentanyl, Ketamine, rocuronium, remifentanil, oxygenation index and apnea index

In-situ surgery in the neonatal surgical unit

Neonatal surgical unit also known as NSU is the area of a hospital where sick babies, having surgical problem, go once they are born. Typically staffed by neonatologists and neonatal nurse practitioners, a NSU can offer the specialized surgical care that premature babies and sicker full term babies may need [(1)].

While high infant mortality rates were recognized by the British medical community at least as early as the 1860s, modern neonatal surgical unit is a relatively recent advance. In 1898 Dr. Joseph B. De Lee established the first premature infant incubator station in Chicago, Illinois. The first American textbook on prematurity was published in 1922. In 1952 Dr. Virginia Apgar described the APGAR score scoring system as a means of evaluating a newborn's condition. The modern practice of pediatric intensive care has started in Sweden in 1955 It was not until 1965 that the first American neonatal surgical unit was opened in Yale New Haven, Connecticut and in 1975 the American Board of Pediatrics established sub-board certification for neonatology [(1)].

The 1960s brought a rapid escalation in neonatal services with the advent of mechanical ventilation of the newborn. This allowed for survival of smaller and smaller newborns. In the 1980s, the development of pulmonary surfactant replacement therapy further improved survival of extremely premature infants and decreased chronic lung disease, one of the

complications of mechanical ventilation [2].

In-situ surgery (ISS) in the NSU means that neonates who require surgery can be operated upon in specially designed area within the NSU without the need to transfer these neonates to the classic operation room (OR) with its associated hazards.

Operating room standards inside NSU:

Operating rooms in health-care facilities where neonatal procedures may be performed shall be constructed to operating room specifications except for the following modifications:

Ambient lighting

Assuming infant's eyes are shielded (eye patches) while in the operating room, Ambient lighting levels in infant spaces shall be adjustable through a range of at least 10 to no more than 600 lux (approximately 1 to 60 foot candles), as measured at each bedside. Both natural and electric light sources shall have controls that allow immediate darkening of any bed position sufficient for transillumination when necessary. The sources shall avoid unnecessary ultraviolet or infrared radiation by the use of appropriate lamps, lens, or filters [3].

Ambient temperature and ventilation

Laminar flow diffusers over the surgical bed shall be set at the low end of the air velocity range (approximately 25 ft/min) and balanced with the surrounding slot diffuser air curtain to minimize convective and evaporative heat and water loss from higher air flow onto the neonate. In addition, ambient temperature and humidity shall be adjustable into the range of 72-78° F (22 to 26° C) with a relative humidity of at least 30-60% [(4)].

Acoustic environment

The acoustic environment is a function of both the facility (e.g. building mechanical systems and permanent equipment, the intrusion of exterior sounds, the sound containment afforded by doors and walls, and the sound absorption afforded by surface finishes) and operations (e.g. the activities of people and function of medical equipment and furnishings). The acoustic conditions of the NSU should favor speech intelligibility, normal or relaxed vocal effort, speech privacy for staff and parents, and physiologic stability, uninterrupted sleep, and freedom from acoustic distraction for infants and adults. Such favorable conditions encompass more than the absence of noise and require specific planning for their achievement. Speech Intelligibility ratings in infant areas, parent areas, and staff work areas should be "good" to "excellent" as defined by the International Organization for Standardization ISO 9921:2003 [(5)].

Vibration isolation pads are recommended under leveling feet of permanent equipment and appliances in noise-sensitive areas or areas in open or frequent communication with them. NSU rooms (including operation room), staff work areas, family areas, and staff lounge and sleeping areas and the spaces opening onto them shall be designed to produce minimal background noise and to contain and absorb much of the transient noise that arises within them. All other penetrations for conduits, inset boxes, pipes, ducts, and other elements in sound demising partitions shall be sealed airtight to prevent noise leakage through gaps and openings, **(Figure 1)** [6].

Figure 1: inside view of the neonatal surgical unit operation room.

Specialized procedure spaces (e.g OR) or rooms within the NSU shall be constructed to achieve all of the above, as well as all of the requirements for an infant bed space, except for the following additional modifications:

Figure 2: outside view of the neonatal surgical unit operation room.

Each procedure area must be physically separated from other areas, **(Figure 2)**, so that during surgery or procedures; patient and staff flow may be strictly controlled. Air flow must be designed so as to not disrupt the air curtain around the surgical field, and shall be adjustable so as to be able to increase to 15 changes /hr during procedures then returns to baseline values. A scavenging system to vent waste inhalation anesthesia and