NEONATAL CEREBRAL MONITORING IN THE POSTNATAL TRANSITION PERIOD

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Abstract

The transition to extrauterine life is a complex process. Currently initial assessment at birth is clinical and that is subjective. Current methods of objective assessment of the clinical status of the newborn immediately after birth detect cardiac activity and peripheral oxygen saturation. Although these monitors during the neonatal transition appear to have some benefits, they have not yet been revealed in the long or short term. There remains controversy over which SpO2 target should be used for resuscitation or oxygen therapy. However, these monitors do not include cerebral monitoring. The brain is the most vulnerable organ especially in the case of a hypoxic-ischemic event during labor or immediately postnatal. Thus, it is necessary to develop some non-invasive, real-time and feasible monitoring technologies in delivery room for the fetal brain status. These can significantly contribute to the optimization of neonatal resuscitation.

Keywords: newborn, cerebral status, cerebral blood flow, electric cerebral activity, cerebral oxygenation

Introduction

Monitoring this process of the Transition to extrauterine life is still a challenge in terms of early detection of disruptions. Initial assessment at birth currently includes clinical evaluation (visual inspection, palpation, ausculation, stimulus reactivity) quantified in the Apgar score including (skin coloration, muscle tone, breathing, heart rate and reflexes) [1]. But clinical evaluation of the newborn has increased variability among observers, causing similar variability of the Apgar score [2]. This variability is amplified in preterm or those requiring neonatal resuscitation [3]. Therefore, the need to monitor vital fetal or neonatal parameters to guide neonatal reanimation has increased. Currently, postnatal cardiac activity (heart rate-HR) and peripheral oxygen saturation (SpO2) are monitored by pulse oximetry [4]. This is a routine recommendation for preterm newborns by placing the pulse oximeter sensor on the right hand to measure SpO2 preductal [5]. But there are conflicting observations on heart rate when measured by pulsometry from ECG measurement [6]. These differences are significant in the first few minutes of life [7]. Thus, the current recommendation is to use concurrent pulse oximeter and ECG during neonatal reanimation and / or continuation of the respiratory support. With regard to oxygenation measured by pulse oximetry, the controversy over which the SpO2 target is to be used in case of resuscitation or oxygen therapy [8] persists. It is currently recommended to target the 25th reference value in the first 10 minutes of life [9].

Objectives

The brain is the most vulnerable organ especially in the case of a hypoxic-ischemic event during labor or immediately postnatal. Currently, cerebral status is assessed clinically only based on neurological behavior and examination of reflexes and muscle tone [8]. Current routine monitoring (SpO2 and FC) does not provide information about oxygenation, blood flow or brain activity. Monitoring these parameters can guide the perinatal management of the fetus or neonate with significant effects on the survival or progression of short or long term neurodevelopment. The current study systematically reviews what brain function parameters can be monitored in the newborn with current technologies and assessing their feasibility in the delivery room in the immediate postpartum period.

Material and method

Systematic analysis of randomized or meta-analysis of the studies in which the newborn's cerebral status is assessed. Three different brain neonatal monitoring technologies (transfontalian ultrasound, electroencephalogram and near infrared light spectroscopy) assess three different cerebral parameters (cerebral flows, cerebral electrical eccience, and cerebral oxygenation). Then, the current studies on the application of these brain monitoring techniques in the delivery room during the transition to extrauterine life were analyzed.

Results

In the last decade, cerebral monitoring was attempted in the human newborn in the delivery room or in the immediate postnatal transition period, that randomly defined as the first 10-15 minutes of life [8]. Cerebral status can be assessed by measuring three main parameters: cerebral blood flow (CBF), cerebral electrical activity, and cerebral regional saturation of oxigen. Each of these brain parameters requires a different technologyc method.

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Thus cerebral blood flow can be assessed by Doppler ultrasound, electrical brain by electroencephalography and cerebral oxygen saturation by measuring the oxygen and non-oxygenated hemoglobin proportions by in vivo spectroscopy with near infrared light (NIRS).

1. Doppler ultrasound.

Cerebral perfusion defined cerebral blood flow (CBF) was evaluated with transfontanelar Doppler ultrasound. It has the advantage of being non-invasive and can explore brain flow in multiple brain areas. The first studies in term newborns [10-11] show a decrease of approximately 20% in systolic, diastolic and medial cerebral blood flow in the first few minutes but without changes in blood pressure or heart rate. The pulsatility index (PI) in the fetal brain flow is constant during and between contractions (1.39 ± 0.36 and 1.4 ± 0.39 respectively) [11], decreases significantly to 4 minutes postnatally (1.06 ± 0.3), increases significantly in 1 hour of life (1.5 ± 0.25) and decreases on the first day to 0.95 ± 0.25 [12]. The mode of delivery influences transient fetal brain flow, observing initial increases in the first few minutes of life, but with the equalization of the CBF and PI velocity in neonates appropiate for gestational age by caesarean versus vaginal birth [13] . Recent studies on a lot of term vaginal newborns show that the mean cerebral artery velocity decreases from 34 cm / s to 7 minutes at 25 cm / s at 14 minutes and has a dynamic evolution inversely proportional to that of shunt by patent arterial duct (PDA) [14]. Reduction of postnatal CBF may be due to increased arterial O2 pressure and / or shunt reduction through PDA. However, the clinical implications of this postpartum decline of CBF remain questionable because comparative studies are difficult to achieve. Measurements are different due to differences in diameters of the mesured arteries, insensitivity angle, or different time of measurement. Other limitations of the ultrasound method in the postpartum period are determined by the artifacts produced by the newborn movement, the assessment can not be carried out continuously, the velocity of CBF is measured, but not the CBF, and the technical difficulty in the delivery room, especially during reanimation [8].

2. *Integrated Amplitude Electroencephalography (aEEG.)*

May record neonatal brain electrical activity. This technique has the advantage of being a non-invasive method of continuous monitoring. aEEG trace of early life-time correlated with clinical status have prognostic value in neonates with perinatal asphyxia [15]. Recent studies of neonates have been post-partum monitored brain electrical activity with aEEG combined with monitoring regional cerebral saturation through the NIRS method. These studies have shown feseabtility in this type of post-natal monitoring and increased brain activity in parallel with increased cerebral oxygenation in term newborns. The baseline aspect of the EEG is different in neonates requiring neonatal resuscitation [16]. The limitations of this method of monitoring electrical activity are the technical difficulties of application of neonatal scalp sensors and interpretation problems due to increased artifacts incidence.

3. *Near-Infrared Spectroscopy (NIRS).*

In the last years, the interest for brain monitoring through NIRS in the postparum period, has increased greatly. The first study was conducted by Peeble in 1992, a case study of a term newborn, observing the gradual increase of oxygenated hemoglobin after birth. Cerebral oxygen saturation in the immediate postnatal neonate is first reported by Isobe et al (2002) [17]. Recent studies highlight normal values in the first 10-15 minutes of term newborns born by vaginal or caesarean section and which do not require neonatal resuscitation [16]. An increase in rcSO2 is observed parallel to the SpO2 increase with the difference that rcSO2 reaches a plate at 7-8 minutes of life versus SpO2 which achieves a maximum of 10 minutes of life [18]. crSO2 is significantly higher in the first 4 minutes of life in vaginal birth versus extraction through C-section (Urlesberger et al 2010). Cerebral Fractional Tissue Oxygen Extraction (Cerebral FTOE) fraction defined as the ratio of difference SpO2-rcSO2 to SpO2 has a inversate dynamic, downward, versus saturation. FTOE increases after 8 minutes of life with a slight decrease in rcSO2 in vaginal births [19]. This may be due to the decrease in cerebral flow after 8 minutes by increasing the oxygen arterial concentration and the reduction of the flow through the PCA [14]. rcSO2 is with 7% higher in term newborns at 15 minutes of life with shunt through the PDA left-right visibly to those without a detectable shunt [20]. Cerebral FTOE compared to the somatic peripheral have a faster postnatal plateau immediately showing the favored oxygen supply of the brain [21] confirmed by the increase of CBF in this transition period confirmed by ultrasonography [11].

NIRS is a viable method during the postnatal transition period. NIRS limits are due to the differences between current devices that use different technologies and algorithms. Out of the transition period, brain oxygenation values in the newborn show approximately 10% differences between the different devices. In the case of postpartum measurements, there were differences between devices of lower rcSO2 values of 2-3% [22]. However, this method allows the optimization of oxygen therapy in the immediate postnatal period by preventing the complications of hypoxemia or hepiroxemia.

Discussions

The assessment of these three brain parameters and their combination can provide extremely useful information about intrapartum and postnatal fetal status during the transition period. There are some issues that may affect the measurements. As for NIRS sensors that are applied in the frontal cerebral area, excluding important brain areas that are more vulnerable to ischemic hypoxic fluctuations, and should be taken into account large brain fissures (eg. Sylvius sulcus), if sensors are applied in other areas. Maternal medication, especially analgesic or anesthetic, can

significantly affect brain parameters. We noticed a significant decrease in FTOE in neonates from mothers who received nitrous oxide analgesia (data currently under publication). aEEG is currently performed with 2 or 4 channels / sensors that may be insufficient in many cases. The optimal minimum number of aEEG sensors is 8-12 channels, but the difficulty of their application in the delivery room increases.

Conclusions

The assessment of brain status is extremely important from the delivery room. Currently, cerebral status is evaluated only by subjective clinical mode. Objective and noninvasive cerebral monitoring with appropriate devices is feasible in the delivery room. The development of these devices to assess cerebral blood flow, cerebral electrical activity, and brain oxygenation of newborn in early postpartum period provide vital information about intrapartum fetal and transitional neonatal evolution and optimize neonatal reanimation management.

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