ADVANCES IN EXPERIMENTAL AND COMPUTATIONAL ANALYSIS OF THE NEONATE'S BRAIN COOLING PROCESS

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ABSTRACT According to the World Health Organization, perinatal asphyxia (PA) represents the 3rd most common cause of neonatal death. This means that all over the world, almost 600,000 newborns die every year, and at least as many develop hypoxic-ischemic encephalopathy (HIE), which is one of the most common causes of severe neurological deficits in children, presently in approx. 15 out of 10,000 live births.

Among the various methods tested for efficacy in newborns with PA, therapeutic hypothermia (TH) has proved to be useful in clinical practice and to be effective in protecting the brain against the effects of ischaemia/hypoxia. Generally, there are two main types of TH: selective TH carried out using cooling cap and whole body TH in which cooling pad (or blanket) is used. They are schematically demonstrated in Fig.1.

Fig.1. The selective and whole body Therapeutic Hypothermia

Although, each specific TH has its own peculiarities, there are several actions/steps which are very similar and important from a heat transfer point of view. In both cases, the newborn is placed in an open incubator, and in both cases, the treatment lasts 72 hours. The essence of TH is to maintain the newborn's core temperature at a reduced level, which in the case of selective head hypothermia is 34-35^{o}C, and 33-34^{o}C in the case of whole body hypothermia. This can be achieved in different ways, depending on the type of cooling device.

In this presentation the heat transfer processes occurring during both, the selective TH as well as the whole body TH will be described and compared. The non-invasive thermal measurements of temperatures and heat fluxes occurring during cooling therapy will be presented and discussed. They will also be subject of the cumulative energy balance which seems to be a new method of assessing the thermogenesis of infants with HIE undergoing TH. Calculated in this way the metabolic heat flux can be used to improve the process of therapeutic hypothermia. Finally, based on those cumulative energy balances, so-called Thermal Index become a candidate for an indicator (predictor) that can help in the assessment of the degree of brain injury and in the prognosis of the patient's condition after treatment.

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