Thermomangement in Neonatology and Paediatrics: Clinical Problems and Challenges

Konrad Heimann, Mark Schoberer, Thorsten Orlikowsky
Department of Neonatology, University Children’s Hospital, RWTH Aachen University, Aachen, Germany
kheimann@ukaachen.de

Abstract: Maintenance of an adequate body temperature is an essential part in neonatology and paediatrics. Delivery room, transports, daily routine care, diseases like sepsis, operations etc. retrieve the danger of hypothermia in these patients. Consequences of an inadequate heat loss especially for preterm and term infants are: metabolic acidosis, increasing oxygen consumption, hypoglycaemia, the risk of brain damage and a higher mortality. Prevention through external heat supply, routine care in the “thermoneutral-zone” and continuous temperature monitoring are necessary to prevent the risks of a drop of body temperature. Further development of existing methods and application of other, e.g. non-invasive, techniques are needed to simplify, improve and reduce the physical stress of these patients.

Keywords: Hypothermia, thermoneutral-zone, temperature monitoring, non-invasive technology.

Introduction

Term and preterm infants are unable to produce body heat through shivering. Lipolysis of plurivacuolal (“brown”) adipose tissue is the only source of heat directly after birth. Its amount does not suffice to equalize the postnatal heat loss, increases energy-, oxygen- and glucose consumption, resulting in metabolic- and lactate-acidosis. Dangers for a postnatal heat loss are: convection, conduction, radiation, evaporation, respiration and perspiration. They can result in a hypothermia, which is defined as a body temperature <36°C, associated especially with a higher mortality. Clinical situations with a high risk of temperature loss are resuscitation in the delivery room, infections e.g. sepsis, transports, operations, x-ray and daily routine care like weighing and bathing. Consequences of a persistent hypothermia are metabolic acidosis, increasing oxygen consumption, hypoglycaemia, brain damage and increased mortality. The disastrous consequences of hypothermia causing a situation of critical oxygen transport, result in a reduction of oxygen diffusion into tissue.

Methods to prevent hypothermia after birth

Different methods to prevent hypothermia after birth are:

- Radiant warmers: Neonatal resuscitation units have radiant warmers on the top and a heatable area of support
- Covering, caps and plastic foils: Heated blankets and plastic foils prevent significantly hypothermia [1]
- Hydrosun®: electromagnetic radiation-A (bandwidth 760-1400nm) and visible light (bandwidth 380-760 nm)
- Transport incubators: with additional warmers
- Double walled incubators: beside warmers with adjustable humidity for preterm infants
- Kangaroo care: Originally developed to overcome a shortage of incubators in the developing world, kangaroo care was shown to improve bonding between mother and child and to decrease mortality and morbidity in premature infants [2]

Standard during daily routine is care in the “thermoneutral-zone” which depends on body weight, gestational age and body temperature [3].

Methods to guarantee normothermia after birth

The infant’s body temperature is continuously measured by cable bound temperature sensors on the skin or rectally [4]. Some NICU’s in Germany apply incubators that are able to regulate temperature depending on the measured temperature of the infant.

Methods to guarantee normothermia in infants and adolescents

Different methods are available to prevent hypothermia in infants and adolescents:

- Portable radiant warmers
- Heated blankets
- Air blowers

Methods to measure body temperature in infants and adolescents

Body temperature is continuously measured by urinary catheters with integrated temperature sensors.

Prevention of hypothermia as a challenge

Congenital malformations, daily routine care and special circumstances can be accompanied with hypothermia. Daily routine care (e.g. change of diaper) and sepsis are associated with disturbances in temperature regulation, causing a centralisation combined with less perfusion of distal body areas (hands, feet etc.). Consequence is a persistent hypothermia. A special adaption of temperature regulation e.g. in terms of
manual regulation from incubator temperature or humidity can be necessary.

**Application of non-invasive methods in neonatology**

To avoid and/or register changes in body temperature of premature infants, it is standard to continuously measure skin or rectal body temperature by cable-bound sensors. Colour infrared thermography (IRT) is a method to measure skin temperature distribution of mature and premature infants and seems to be an appropriate method to detect fluctuations in different body areas of these infants [4]. Another reliable non-invasive method to get information about the intravascular filling and flux is the measurement of the Pleth Variability Index (PVI) [5].

**Future aspects of thermoregulation**

An extension of temperature measurement into multiple target areas may give the opportunity to analyze temperature distribution patterns and correlate them with diseases that are known for changes in perfusion (e.g. sepsis, persistent ductus arteriosus, necrotizing enterocolitis). The requirements would be a flexible miniaturized camera, placed at the inner roof of the incubator in combination with software systems that are equipped with individualized long term patient data, algorithms to predict significant changes and flagging alarms. In addition, measuring the PVI possibly can give early information about shifts of intravascular filling as an early sign of centralisation (e.g. in sepsis).

**Bibliography**


