This is a pre-copyedited, author-produced PDF of an article accepted for publication in *Nursing Children & Young People* following peer review. The version of record [Nursing Children & Young People (March 2013) 25 (2): 18 - 22, published 1 March 2013] is available online at doi: http://dx.doi.org/10.7748/ncyp2013.03.25.2.18.e140

Understanding evidence-based thermal care in the low birth weight neonate: PART 1: An overview of principles and current practice

Article reference number: **NCYP140**

PART 1

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SUMMARY

This is the first of a two part paper focusing on the issue of neonatal thermoregulation using a specific case study of a low birth weight (LBW) neonate to capture important issues for discussion and learning. Optimum evidence based thermal care is paramount in the neonatal population and a fundamental component of good practice in this field globally. Care should aim at preventing heat loss and, in the worse case, hypothermia following birth and beyond. This applies to the delivery suite, hospital or home setting for newborns delivered at any gestation in any country across the world. The potential for heat loss is even more significant however in the LBW and / or premature neonate due to the physiological immaturity of thermoregulatory systems. In part 1, this discussion focuses on the areas of heat loss prevention and temperature regulation in the delivery suite and neonatal unit. Health professionals working with LBW neonates can learn from a case example as this which highlights important practice points within an evidence based and global perspective. Part two will focus on family centred thermal care.

INTRODUCTION

Globally, keeping neonates warm and preventing hypothermia is a fundamental aspect of early care. Any health professional caring for small and vulnerable neonates should be aware of the key practice issues and understand the evidence based rationale for interventions. This paper centres on the important area of neonatal thermoregulation in clinical practice. Through a case study presentation, the aim is to highlight and discuss key issues in the area of neonatal temperature control for nurses new to this specialist area in line with current literature. Comparison between thermal care within the UK and developing countries will also be made within an international perspective.

DESCRIPTION; CASE STUDY

Jack (pseudonym) was a 27+6 week gestation, male infant, born via spontaneous vaginal delivery. At birth Jack was placed into a plastic bag up to his neck and then placed on the resuscitaire under the pre-warmed radiant warmer. Jack was born in poor condition and required resuscitation interventions. His head was dried and as mask intermittent positive pressure ventilation was delivered, a knitted ventilator hat was applied. He was then intubated and began to be stabilised ready to be transferred to the neonatal unit. Throughout the stabilisation, Jack remained under the radiant warmer (Figure 1) with the plastic bag intact up to his neck. He was then transported on the resuscitaire to the neonatal unit, weighed and transferred immediately into a pre-warmed incubator, which was set at 33°C, with the plastic bag still intact.

Jack was connected to the ventilator and stabilised; first observations on the ventilator were taken, all of which were satisfactory. His admission axilla temperature was 36.7°C, and the skin probe read 36.1°C. The plastic bag that covered him was then removed after incubator humidity was commenced. He remained within a closed incubator for numerous weeks until ready to be transferred into an open cot.

Figure 1: Resuscitaire in delivery suite with radiant overhead heater
Image source; Julia Petty; with permission

HEAT LOSS IN THE LOW BIRTHWEIGHT NEONATE

It is well documented throughout current literature that temperature control can be affected in four ways: evaporation, conduction, convection, and radiation (MacKinnon & Waldron, 2007).

It is important to recognise that the body temperature of neonates can drop by 0.2-1.0°C every minute depending on gestation and environmental factors (Aylott, 2006 a and b) and as we cannot control gestation it is vital that we make the environment as safe and optimal as possible in order to prevent hypothermia.

The World Health Organisation (2006) defines mild hypothermia as a body temperature of 36-36.5°C, moderate hypothermia as 32-36°C and severe hypothermia as less than 32°C. It is important to recognise that neonates are at a high risk of temperature loss for various reasons, and that risk is increased in preterm neonates (Ellis, 2005). Reasons include; ineffective positioning ability, greater body water content, decreased subcutaneous and brown fat, immature skin, reduced ability to peripherally vasoconstrict and poorly developed metabolic mechanism (Lyon et al, 2004; Lyon and Stenson, 2004; Lunze and Hamer, 2012). In addition to this, it is important to acknowledge the role hypothermia can play in affecting other systems. Aylott (2006a and b) explored hypothermia and its relationship to hypoxia and hypoglycemia describing the neonatal ‘energy triangle’; i.e.; that a problem in one aspect of the triangle can cause deterioration in another.

In 2007 Laptook et al investigated over 5000 neonates to determine whether admission temperature was associated with morbidity and mortality concluding that admission temperature was inversely related to mortality and late-onset sepsis. This supported the earlier EPICure Study (Costeloe, 2000) who examined the outcomes of neonates born before 26 weeks in an extensive cohort study of over 4000 births. They concluded that hypothermia was independently associated with death. Findings such as this show the vital part temperature control plays within neonatal care.

THERMAL CARE IN THE DELIVERY SUITE

Literature outlines recommendations in the support of temperature maintenance by various means (McCall et al, 2010). One example is that the LBW group should not be managed in the same way as the traditional newborn care of drying and wrapping in warm towels under a radiant heater; neonates under 30 weeks gestation, such as Jack, should be placed into a plastic bag or wrap immediately at birth (Resuscitation Council, 2010; See Figure 2) along with drying the head and putting on a hat. Many authors concur with this practice (Laptook et al, 2007; Knobel &Holditch, 2007; Kent & Williams, 2008; Bissinger & Annibale, 2010). The rationale behind using plastic wraps or bags for premature neonates at delivery is the prevention of heat loss through immature skin via evaporation (Knobel & Holditch-Davis, 2007).

Figure 2:
Image source; UK Resuscitation Council, 2010 With permission

Research by Vohra et al (2004) aimed to determine if polyethylene occlusive skin wrapping of very preterm infants prevented heat loss after delivery in a group of 28 weeks gestation neonates. They found significant heat loss prevention compared with controls. Kent and Williams (2008) also undertook a review of admission temperatures with the aim of improving these in preterm neonates less than 31 weeks gestation by increasing the ambient temperature in the operating theatre and wrapping in polyethylene wrap at caesarean section. They found that increasing the ambient temperature in the operating theatre and wrapping premature infants in polyethylene wrap improves admission temperature. Similarly, Rohana et al (2010) concluded following a randomized controlled trial, that wrapping neonates with a gestational age of less than 34 weeks in polyethylene immediately after birth was associated with a lower incidence of hypothermia.

Trevisanuto et al (2010) actually compared *three* methods of heat loss prevention in another a randomized controlled trial of neonates under 29 weeks gestation; covering neonates with plastic caps, wrapping neonates in plastic and a control group. The study found mean axilla temperature on admission was comparable in the cap and wrapping groups but importantly, and significantly, showed that the control group had much lower admission temperatures.

A Cochrane review (McCall et al, 2010) examined seven studies investigating preventative measures in relation to temperature control used within the first ten minutes of life. The review concluded that using plastic bags/wraps, plastic caps and heated mattresses kept neonates warmer than care without such measures and reduced incidences of hypothermia. Also highlighted by McCall et al (2010) is the importance of the routine precautions, such as warming the delivery room, pre-warming surfaces and eliminating draughts. A delivery suite room temperature should ideally be at least 26 °C (Resuscitation Council, 2010) aiming for a neonatal unit admission central temperature of 36 °C (BAPM, 2010).

THERMAL CARE IN THE NEONATAL UNIT

Incubator care: After initial stabilisation, the need for an optimum neutral thermal environment is paramount which is described as the environmental temperature in which a neonate uses a minimum metabolic rate and oxygen consumption to maintain a normal body temperature (Lyon, 2004; Sherman et al, 2006).

It is well documented that there is improved survival of neonates maintained in the thermoneutral range (Laroia et al, 2007). Currently in the UK, incubator care is the optimum practice to achieve this environment for the LBW neonate less than 1.5kg and most up-to-date models are double walled with the facility to provide humidity (Figure 3). Flenady and Woodgate (2003) underwent a systematic review to compare radiant (overhead) warmers to incubator care and concluded that the former resulted in increased insensible water loss (and therefore heat loss) compared to incubators. Knobel & Holditch-Davis (2007) explain that humidity, air flow, and temperature of surrounding radiating surfaces of incubators will minimise heat loss or gain to keep the neonate in a stable metabolic state and keep oxygen consumption to a minimum. In terms of humidity, Bissinger & Annibale (2010) discuss that at least 50% humidity is required in preterm neonates.

Jack received 50% although often much higher levels of humidity are recommended as discussed by Bredemeyer et al (2005); humidity up to 85% may be required for extremely preterm neonates for up to 21 days. The optimum level of humidity is determined by gestational age, days of life, skin maturity and underlying pathology. As with plastic bag use, humidity is necessary under this gestation to prevent evaporative heat and water loss through the skin that is yet to develop it's waterproofing properties through in-utero keratin formation. Generally a neonate born at less than 28 -30 weeks, and less than 1kg in weight in the first seven to 14 days, should be nursed in 50 per cent humidity or greater (Knobel & Holditch-Davis, 2007; Great Ormond Street, 2011).

There are large variations across different neonatal units and countries regarding the use of humidity, including percentages, duration and weaning. Sinclair et al (2009) explored this topic and concluded that due to the paucity of research that it is not possible to make concrete evidence based recommendations.

Some neonatal units use weaning processes and others stop at a particular gestation or when they believe the neonate is capable of maintaining their temperature, fluid balance and the skin has keratinized. Currently a Cochrane protocol (Sinclair and Sinn, 2009) to determine whether higher or lower levels of humidity prevent morbidity or mortality in preterm neonates has been proposed but is yet to make conclusions or recommendations. Therefore it is advised that individual unit protocols are followed with clinical judgment until specific evidence based recommendations are made.

Figure 3: Double walled incubator
Image source; Julia Petty; with permission

Incubator settings: A systematic review by Sinclair (2002) compared the two types of incubator control mechanisms available; 'servo' and manual. Servo control refers to a system that continually adjusts the incubator temperature according to the neonates' abdominal skin temperature using a probe (Allen, 2011)while manual relies on the nurse / carer to set the incubator temperature in line with either , again a continuous skin probe or intermittent readings. The review concluded during at least the first week after birth in LBW neonates, the thermoneutral point is best achieved by adjusting incubator temperature using either control method, to maintain an anterior abdominal skin temperature of at least 36 °C.

Jack had continuous 'servo' skin monitoring in the first 2-3 weeks of life using this alongside 4-6 hourly axilla temperature measurements; however he had no peripheral temperature measurement.

Temperature monitoring: Lyon and Freer (2011) state that sick premature neonates *should* have continuous temperature monitoring of central and peripheral temperatures; as an individual (intermittent) temperature does not always accurately reflect the energy that has been used to achieve that temperature, meaning the environment provided may not be adequate. Central temperature is usually taken 4-6 hourly via the axilla site aiming for a temperature of 36.7 - 37.3°C (Merenstein and Gardner, 2006). Continuous monitoring can be undertaken by an abdominal skin probe in order to make incubator adjustments but can also be done by a probe placed on the foot.

The latter is a true *peripheral* temperature and can be used to measure the core-toe temperature difference which can be one of the signs indicating peripheral shutdown during compromise. A temperature difference of 0.5-1 °C is considered normal whereas a difference above 2 °C can be a sign of a neonate becoming compromised, poorly perfused or a sign of cold stress. Since such stress can be associated with hypoglycemia, increased oxygen demands and respiratory compromise (Bissinger and Annibale, 2010), it is therefore important to assess temperature, blood glucose and oxygenation in unison in line with the aforementioned metabolic 'triangle' described by Aylott (2006 a and b).

Knobel & Holditch-Davis (2007) discussed thermoregulation in relation to ways of improving practice; areas examined included the avoidance of temperature drops during procedures, monitoring for the effects of fluid boluses, ensuring items are pre-warmed (e.g. weighing scales, X-ray plates)when placed next to the neonate and ensuring optimum ventilator humidity temperatures. With Jack, during the procedure of umbilical line insertion when the incubator doors were open, his axilla temperature rapidly dropped by 0.5°C from 37.0°C to 36.5°C.

This illustrates how rapidly a LBW neonate loses heat and how easy this could be prevented. The Resuscitation Council (2010) succinctly states how neonates require "simple things, done well''. The areas stated above are certainly simple but very effective measures even in the developed world where resources enable the availability of the latest models of incubator and heating devices (mattresses). In the UK as in Jack's case, resources allow the most up-to date latest technologies to enhance thermal care. This is not however the case in resource limited countries and so such simple measures are paramount in a global context. One must acknowledge the alarming gaps in neonatal healthcare provision globally in relation to resources, available equipment, technological advances (Uxaa et al, 2006; Oulton, 2006; Lawn et al, 2009; Bhutta et al, 2009; Darmstadt et al, 2009) and the significant differences in neonatal mortality (Wall et al, 2009, 2010). However that said, a neonate born in any country has the same basic needs; to be kept warm and fed within a protective family centred setting and they deserve the same fundamental care whether equipment is available to assist this or not. Singhal and Bhutta (2008) support this claim and state the need for staff training in simple resuscitation techniques in resource limited settings which includes keeping newborns warm as a key area. For the prevention of hypothermia, Kumar et al (2009) stress the importance of fundamental and cost-effective interventions such as drying, wrapping and skin to skin contact. Skin-to-skin care will be discussed further in part two.

CONTINUING THERMAL CARE

Thermal care should continue to play an important role throughout a neonates care in hospital. Questions can continue to arise such as; when to stop humidity, when to reduce incubator temperature, when to transfer a neonate into a cot and when to bathe a premature neonate. It is imperative that local guidelines and polices are followed to guide decision making and to consider the evidence to such transitions in care. New et al (2008) in a small Cochrane review of only 2 studies including only 74 neonates, concluded that LBW neonates can be transferred from an incubator into an unheated bassinette / open cot at a weight of 1.6 kilogramme following being dressed, hat applied (Figure 4) and confirmation of a stable central temperature. This was the case with Jack who coped well with the transition into an open cot. Close assessment should of course continue but will move from a continuous nature to general observation of intermittent central temperature and the use of key observational nursing skills. Bathing in LBW neonates has been shown to be safe from a weight over 1.5 kg again when physiological and thermal stability has been ascertained (Behring et al, 2003; Medves and OBrien, 2004; Newton et al, 2005). Again, this was so in Jack's case.

Figure 4: Neonate following transfer to a bassinette
Image source © Micha Fleuren | Dreamstime.com

CONCLUSION Temperature control plays a vital in the care of neonates born anywhere in the world particularly those born small and / or preterm, and needs to be recognised as an essential component of good practice in the field of neonatal care. Any health professional new to or learning this speciality should be aware of its importance in line with recent evidence as discussed in this paper. Establishing the importance of sound thermal care allows steps to be taken to facilitate optimum long-term outcome for neonates which is ultimately our main aim. Having now provided an over view of the principles of clinical practice in this area, Part 2 will address the important topic of the parental and psycho-social needs in relation to how thermal care can be provided within the concept of family centred care.

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