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Comparison of tympanic and rectal thermometry:

Diagnosis of neonatal hypothermia in Uganda

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Although newborn body temperature monitoring is not a routine occurrence in labour wards in Uganda, postnatal hypothermia is a significant problem. This study was undertaken to find a convenient and accurate method of measuring body temperature in order to assess the prevalence of neonatal hypothermia in a low-income tropical setting. Tympanic thermometry was compared to rectal thermometry in three hundred newborns up to 90 minutes after birth.

Keywords: *tympanic thermometry; rectal thermometry; skin-to-skin contact; HIV; hepatitis; hypothermia.*

Introduction

For several decades it has been recognised that neonatal hypothermia is a major contributor to neonatal mortality, particularly in low-income countries (Chintu and Sikani, 1978; Daga et al, 1991). In addition, low body temperature soon after birth is hazardous among low birthweight newborns, a fact well-known in both high-income countries historically (Silverman et al, 1958) and in low-income countries (Tafari, 1985). Current management of newborns in countries affected by widespread HIV infection implies a new scenario for several reasons. Firstly, it is an increasingly common practice to bathe the newborn in water in order to decrease the amount of potentially HIV-contaminated vaginal secretion on the newborn's skin. Secondly, both labour staff and parturient women are increasingly observed not to practise skin-to-skin contact between mother and newborn for fear of HIV transmission. Thirdly, any rectal thermometry of newborns in busy labour wards may lead to lesions of the rectal mucosa (Fonkalsrud and Clatworthy, 1965; Schiffman 1982) with concomitant risk of rectal transmission of contagious infections, e.g. hepatitis B, in these infants.

In most labour wards in low-income countries there is no routine monitoring of body temperature. Still, it is a well known fact that neonatal hypothermia is a significant problem in tropical countries (Tafari, 1985; Omene et al, 1979) and there is reason to pay attention to this condition in any attempt to reduce prevailing high perinatal mortality figures, which are occurring partly due to the higher prevalence of low birthweight.

The advent of new alternatives for quick, appropriate and affordable techniques for body temperature measurement makes the diagnosis of hypothermia easier (Bailey and Rose, 2000; Davis, 1993). Accordingly the authors have tentatively

introduced tympanic thermometry in a labour ward in Uganda in order to perform parallel, repeated measurements of tympanic thermometry and rectal thermometry in a series of Ugandan newborns. The study was designed to test the feasibility of the tympanic route and to find out the degree of agreement/disagreement between these two different methods of estimating neonatal temperature soon after birth.

Subjects and methods

Nsambya Hospital in Kampala is a tertiary referral hospital in a periurban area of Kampala with 5,000-6,000 deliveries annually. The maternal mortality ratio is in the range of 600:100,000 liveborn babies and the perinatal mortality rate is around 70 per 1,000 newborns (Byaruhanga, 2000).

Women presenting in labour in the hospital at any time of the day or night were approached for interview and informed

Key points:

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1. Hypothermia is a common problem in tropical as well as temperate climates.
2. Tympanic thermometry in newborns in resource-poor labour wards constitutes a rapid and appropriate tool for the assessment of hypothermia.
3. Tympanic thermometry of newborns in labour wards with a high prevalence of contagious viral pathogens like HBV and HIV is preferable to rectal thermometry due to problems of hygiene and the risk of mucosal damage via the rectal route.

about the purpose of the study. Informed consent was obtained from each woman before enrolment in the trial. Three hundred newborns were enrolled in this study. All women and all newborns were monitored according to prevailing routines in the hospital. Skin-to-skin care was encouraged but seldom practised due to the widespread practice of having the newborns separated from mothers in a cot, wrapped in cloth provided in the labour ward. Resource scarcity did not allow for any other kind of thermal protection, like hats or clothing. Both midwives and individual parturient women tended not to favour direct skin-to-skin contact between mothers and newborns. After delivery the normal procedure was followed with assessment of the newborn, cleaning, drying and resuscitation if needed. Where necessary newborns were transferred to an incubator in a nursery. Breast feeding was encouraged early and primary bottle feeding was exceedingly rare.

Temperature registrations were made by both rectal and tympanic thermometry. The rectal temperature was measured by a digital thermometer with a plastic sheath for three minutes. The tympanic thermometry was carried out using a Braun Thermoscan®. The ear temperature measurements were carried out in the left ear of the baby. Both temperature measurements were carried out 10 minutes, 30 minutes, 60 minutes and 90 minutes after the birth of the baby. A data sheet was filled in with information regarding the clinical features in each case and also the location of the mother and her newborn at these time intervals. Note was also taken whether or not the baby was with the mother and to what extent the baby was wrapped or not. The temperatures taken, either by rectal or tympanic thermometry, were considered to indicate hypothermia if the newborn's body temperature was less than 36.5°C. In the interval 36.0-36.4°C the hypothermia was considered mild, whilst the interval between 32.0-35.9°C was considered to indicate moderate hypothermia and below 32°C severe hypothermia (WHO, 1997).

All compiled data was entered and analysed using the EpiInfo version 6.04 for epidemiology and disease surveillance (CDC Atlanta, Georgia, USA). Ethical clearance was obtained through the Ethical Research committee at Karolinska Institutet and the Nsambya Hospital Ethical and Research committee.

Results

Among the 300 newborns enrolled 6.4% were <2,500 g, of whom 0.4% had a weight between 1,000 and 1,499 g. Apgar score <7 at 5 minutes occurred in 2.2% of newborns enrolled. There were no neonatal deaths.

The mean ear and rectal temperatures are presented in Table 1 for the four observations postpartum that were performed. Neonatal hypothermia was much more common than anticipated reaching a maximum (83%) at 60 minutes

Item	Temperature (°C)
Mean temperature 10 minutes postpartum	
Rectal temperature	36.7
Ear temperature	36.5
Wall temperature	24.2
Mean temperature 30 minutes postpartum	
Rectal temperature	35.9
Ear temperature	36.2
Wall temperature	24.5
Mean temperature 60 minutes postpartum	
Rectal temperature	35.6
Ear temperature	36.1
Wall temperature	24.5
Mean temperature 90 minutes postpartum	
Rectal temperature	35.7
Ear temperature	36.1
Wall temperature	not registered

Table 1. Mean rectal and tympanic temperatures of newborns at 10-90 minutes postpartum.

post partum. At 10 minutes postpartum the average ear temperature was slightly below the rectal temperature, whereas the ear temperatures at 30, 60 and 90 minutes were somewhat above the average rectal temperature for each interval. A falling trend of average rectal temperature was noted from 10 minutes postpartum to 60-90 minutes postpartum. The same pattern, though less pronounced, was seen for the outer ear temperature. The prevalence of neonatal hypothermia recorded by rectal and tympanic thermometry can be seen at different intervals postpartum in Table 2.

The grade of hypothermia is detailed in Tables 3 and 4 for each of the two measurement techniques. The trend over time is the same for the two techniques. Apart from the first measurement at 10 minutes, when the majority of hypothermic newborns had mild hypothermia, the remaining three observations (at 30, 60 and 90 minutes) showed that the majority were suffering from moderate hypothermia. Only one newborn had severe hypothermia at 10 minutes (by rectal, but not by tympanic measurement) but no newborns had severe hypothermia, by either method, at 30, 60 or 90 minutes.

Discussion

In the tropical setting investigated more than 80% of newborns were unexpectedly found to suffer from hypothermia 60 minutes postpartum. Of the two approaches to determine body temperature of newborns the tympanic route was by far the most convenient, presumably the least traumatic and the quickest. To the author's knowledge this study reports, for the first time a comparative approach involving simultaneous rectal and tympanic thermometry of newborns in Africa to assess

Type of thermometry	10 min. n (%)	30 min. n (%)	60 min. n (%)	90 min. n (%)
Rectal thermometry	86 (29)	245 (82)	249 (83)	238 (79)
Tympanic thermometry	128 (43)	182 (61)	209 (70)	199 (66)

Table 2. Prevalence of neonatal hypothermia by tympanic and rectal thermometry at different intervals postpartum.

Characteristics	10min n=86 (%)	30min n=245 (%)	60min n=249 (%)	90min n=238 (%)
Mild hypothermia	53 (61)	89 (36)	64 (26)	76 (32)
Moderate hypothermia	32 (38)	156 (64)	185 (74)	162 (68)
Severe hypothermia	1 (1)	0	0	0

Table 3. Grades of neonatal hypothermia at different time intervals using rectal thermometry.

Characteristics	10min n=128 (%)	30min n=182 (%)	60min n=209 (%)	90min n=199 (%)
Mild hypothermia	75 (59)	73 (40)	99 (47)	89 (45)
Moderate hypothermia	53 (41)	109 (60)	110 (53)	110 (55)
Severe hypothermia	0	0	0	0

Table 4. Grades of neonatal hypothermia at different time intervals using tympanic thermometry.

prevalence of hypothermia. The correlation between the tympanic and rectal temperatures among the newborns is reasonably satisfactory. Thus, instead of using time-consuming rectal thermometry (2-3 minutes), a very quick (a few seconds) and appropriate body temperature reading can be obtained from the outer ear of the newborn. The instrument tested provided useful practical information to guide the management of the newborn as far as hypothermia is concerned.

It is often believed that rectal thermometry provides the gold standard for accurate measurement of core body temperature (Rutter, 1992; Robertson, 1996). Some studies have questioned this (Shinozaki et al, 1988; Edge and Morgan, 1993). Other routes, like the oral one, cannot be easily used for newborns (Duce, 2001). For the diagnosis of neonatal hypothermia, rectal temperature may not be the ideal approach, since the core (hypothalamic) temperature is rapidly reduced when the skin temperature drops (Dodman, 1987). An alternative to rectal thermometry might be axillary measurement (Bailey and Rose, 2001), though it is more time-consuming and less practical than tympanic thermometry.

It has been argued that the best thermometry would be an approach measuring core temperature close to the organ of interest – the hypothalamus – which represents the area of the central nervous system where receptors for temperature regulation are situated (Shinozaki et al, 1988; Edge and Morgan, 1993). From this perspective, tympanic thermometry would be a potentially better reference thermometry than rectal thermometry, since it shares the vascular supply of the hypothalamus (Shinozaki et al, 1988; Edge and Morgan, 1993). Nothing is, however, known about the correlation between hypothalamic and tympanic membrane temperature in newborns. Some authors have made experimental attempts to measure 'deep' rectal and tympanic membrane temperatures and significant correlations were obtained (Mayfield et al, 1984). Since such an approach represents a truly invasive procedure it does not seem to be practically useful for routine temperature monitoring in newborns. Also resource scarcity frequently necessitates the use of the same rectal thermometer for several newborns which increases the risk of cross infection.

The threat of HIV transmission from mother to newborn

requires temporary separation of the mother from her newborn for bathing of the newborn. This is a common practice in many countries unrelated to (Qumar and Aggarwal, 1998; Cheah and Boo, 2000) or related to the risk of HIV transmission (Manji et al, 1998). Such bathing of the infant is less detrimental when carried out by careful immersion than by using a wet towel (Henningsson et al, 1981). Even if bathing is directly correlated to the risk of hypothermia (Smales and Kime, 1978) it can be safely performed if the temperature of the water used is carefully controlled (WHO, 1997).

The documented risk of lesions in the rectal mucosa of the newborn after rectal thermometry (Fonkalsrud and Clatworthy, 1965; Schiffman 1982) implies a risk of transmission of contagious viral infections like hepatitis, which is widespread in low-income countries (Ayoola, 1988). Hospital-acquired viral infections of newborns have recently attracted attention (Gelber and Ratner, 2002) and blood contamination between newborns due to deficient hospital hygiene and substandard neonatal care is a risk in overcrowded labour wards in third world countries (Patil et al, 1998). In this perspective tympanic thermometry would appear to be less traumatic, less time-consuming and associated with less risk of such viral transmission than rectal thermometry.

Monitoring thermal control represents an important concern after introducing adequate thermal management of the newborn infant. It has been shown that abandoning incubator care for re-warming newborns and using skin-to-skin contact between mother and newborn instead, is advantageous to the newborn (Christensson et al, 1998). Several other studies have indicated the potential value of careful skin-to-skin policy. This policy is instrumental not only in keeping the newborn warm but also in improving gas exchange in preterm infants (Fohe et al, 2000). In addition, the skin-to-skin method has been shown to be useful for prevention of readmission to neonatal wards for hypothermia (Mondlane et al, 1989).

A particularly important aspect is the cost. It has been clearly shown that the skin-to-skin practice does not require use of technology compared to conventional neonatal care in incubators (Cattaneo et al, 1998). In several settings there is, however, a resistance from the staff in adopting the skin-to-skin method. Staff may underestimate the problem of neonatal

hypothermia and may not be aware of management to prevent this problem (Chudhary et al, 2000).

In conclusion, monitoring of measures taken to avoid neonatal hypothermia will be of increasing importance with the advent of new, simple and appropriate technology to monitor neonatal temperature via the tympanic route. The combination of skin-to-skin approach and appropriate monitoring of neonatal body temperature by tympanic thermometry indicates a promising way ahead to decrease the negative impact of neonatal hypothermia on perinatal mortality, particularly among low birthweight newborns in resource-poor settings with high prevalence of contagious viral pathogens in the neonatal ward.

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