

Role of Hypothermia Detecting Device during Transitional Adaptation of Healthy Full Term Infant: A Pilot Study

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ABSTRACT

Introduction: Maintenance of warm chain and prevention of hypothermia to ensure smooth transitional adaptation of a newborn during early postnatal period is an important component of essential newborn care. Early detection of hypothermia in term normal weight newborns, kept in busy postnatal wards is essential, but is a challenge for healthcare personnels. Empowering the mothers with a simple tool to recognise hypothermia can decrease the burden on the healthcare personnels and also increase awareness among the mother and family members.

Aim: The present study aimed at detecting hypothermia in healthy term newborns in the postnatal ward using a hypothermia alert (BEMPU TempWatch) device while simultaneously recording the abdominal skin temperature.

Materials and Methods: The pilot study conducted from June 2018 to September 2018, recruited 51 full-term

healthy infants in the postnatal ward and monitored them for hypothermia using BEMPU TempWatch on the wrist for 6 hours. Simultaneously, abdominal skin temperature was also recorded for these babies using a portable monitor. The number of hypothermia episodes detected using Bempu TempWatch and simultaneous abdominal skin temperature were recorded and analysed using R i386.3.5.1 and Microsoft Excel ver. 2010.

Results: The device beeped when the temperature was $<36.5^{\circ}\text{C}$; 68 episodes of hypothermia using TempWatch were recorded in 51 infants within 6 hours of transfer to the postnatal ward. The hypothermic incidence was significantly more (p -value 0.006) during the day shift (70%) than during the night shift (30%).

Conclusion: The hypothermia alert BEMPU TempWatch was useful to detect hypothermia in healthy term neonates.

Keywords: Kangaroo mother care, Newborn, TempWatch, Temperature monitor, Tertiary care centers

INTRODUCTION

Hypothermia in infants is defined as core body temperature less than 36.5°C . Hypothermia occurs in preterm and low-birth weight infants due to factors such as less brown fat, decreased subcutaneous fat, and immature temperature regulating mechanisms. It is also known that hypothermia in infants plays a role in aggravating the complications of prematurity and diseases [1]. Neonatal hypothermia is highly prevalent across the globe including the hot tropical places. The prevalence rate of neonatal hypothermia is in the range of 11%-95% [2-6]. However, it is generally not considered a major issue in full-term and normal weight infants (>2500 g) [7]. These infants are kept in the postnatal wards with their mothers and are expected to be cared by the mother and relatives to keep the infant warm, clean and breast-fed adequately.

Postnatal transitional adaptation in the infants is a challenging period especially in the first 24 hour of life. A smooth transition

during this period, by maintaining normal body temperature, leads to uncomplicated postnatal adaptation [8]. Considerable awareness has been created among healthcare workers about the need and ways of temperature maintenance in Low Birth Weight (LBW) infants. Most hospitals in India follow the policy of 6 hourly temperature recordings. However, almost 55% of low resource hospitals in India have inadequate nursing staff who often skip temperature readings due to competing priorities [9]. There are plenty of devices available in market such as digital thermometer, and tele-thermometer to measure temperature of infants. However, these devices are operated manually and take time to measure the temperature; their accuracy is also a question [10].

The BEMPU TempWatch is believed to be a first of its kind automatic continuous monitoring device which can monitor the temperature in infants and indicate a hypothermia episode

[Table/Fig-1]. The TempWatch is worn on the wrist and is built using a medical grade silicone band with a thermistor metal cup to detect the temperature of a newborn. It beeps with an orange light that sounds till the baby's body temperature becomes stable, as indicated by the orange light turning back to blue. This device is easy to use, affordable, infant friendly due to its weight and size and easily available across India and other Lower and Middle Income Countries (LMIC's). The sensitivity and specificity of the device is 98.6% and 95%, respectively [11]. The device has clinical evidence in improving weight gain and promoting Kangaroo Mother Care (KMC) hours in LBW babies [12]. In a community pilot study in Rajasthan, India the use of the BEMPU TempWatch has shown to reduce mortality in LBW babies who were followed-up for one month after discharge [13].



[Table/Fig-1]: The BEMPU Hypothermia Alert Device (TempWatch).

Studies till date also show that there is a need to address the widespread hypothermia and neonatal care in postpartum wards of hospitals, especially in full-term, healthy babies [8,14,15]. Considering this, the current pilot study was undertaken to detect hypothermia in healthy full-term infants during transition in the postnatal ward using the hypothermia alert device (BEMPU TempWatch). The TempWatch alerts during shifts (day and night) and shift transition in the recruited newborns were further confirmed using the abdominal skin temperature monitor.

MATERIALS AND METHODS

A pilot study was conducted in a tertiary care centre (KAHER's Dr. Prabhakar Kore Hospital and MRC, Belgaum) located in Northern Karnataka, India. The study was carried out from June 2018 to September 2018. The Tertiary Care Centre has 10-12 deliveries every day and the hospital follows the policy of delivery, onto mothers abdomen with deferred cord clamping [8]. The study was approved by Institutional Ethics Committee (KAHER/EC/2018-19D 3738) and a team comprising of resident and trained nurses obtained consent from the mothers to enroll their infants in the study.

Inclusion criteria: Infants weighing >2500 g born at full-term, delivered by normal vaginal route or C-section and did not need resuscitation at birth were enrolled in the study after taking informed consent from their mothers.

Exclusion criteria: The mothers with any antenatal and intra-natal risk factors, or those not willing to give consent, preterm and Low Birth Weight neonates, neonates with congenital anomalies and those who required resuscitation at birth, were excluded from the study.

The mother and infants in the hospital were observed in the labor ward for 1 hour or 4 hour post-delivery, depending on normal delivery or C-section respectively. Post-observation, the mother and infant were shifted to the postnatal ward where they were attended by trained nurses and resident on duty for counselling on newborn care. The infants were provided cap and cotton clothes immediately after delivery and every attempt was made to initiate breast feeding within one hour of birth. A hypothermia alert device- BEMPU TempWatch, provided by BEMPU Health Pvt., Ltd., Bangalore, India was attached to the infants' right wrist immediately after shifting them to the postnatal ward. Simultaneously, continuous skin temperature recording was initiated by attaching a temperature skin probe over the right hypochondrium connected to a portable multipara monitor (Star Plus multipara monitor, L&T, India). The probe recorded the temperature, blood pressure and heart rate of infant, the values of which were displayed on the monitor but could not be extracted in the form of continuous data. Temperature below 36.5 was considered as hypothermic as per the WHO definition [16].

The nurses explained the mode of operation of the device and asked mothers and caretaker(s) to monitor it. The nurses also instructed them that, if the alarm rings and the orange light is displayed on the alert device, this should be reported immediately. The room temperature and the abdominal skin temperature were simultaneously recorded by the nurse.

Necessary action was advised by the neonatal doctor or the nurse to improve the baby's temperature such as changing of the soiled nappy, wrapping the baby in extra warm cloth and keeping them close to the mother. If the alarm did not stop with these actions, then mother was asked to give KMC to the baby.

The temperature recording was done only on day 1 of life for the baby recruited in the study. The 'Day shift' for study purpose meant 8 am to 8 pm and 'Night shift' was 8 pm to 8 am. Each infant was monitored for six hours using both the abdominal probe and BEMPU TempWatch. The number and duration of alarms presenting the need for KMC during the first 6 hours of life were also recorded.

STATISTICAL ANALYSIS

Statistical analysis was done by R i386.3.5.1 and Microsoft Excel ver. 2010. Continuous data represented in the form of mean±SD and the categorical variable is represented by the frequency table. Chi-square test was used to study the association between categorical variable and p-value <0.05 was considered as significant.

RESULTS

All the mothers enrolled in the study had a minimum education level of Secondary Level School Certificate (SLSC) i.e., 10 years of schooling, and n=23 mothers (45%) were multipara. From the total of n=51 recruited infants, n=6 (12%) were born by C-section, while n=45 (88%) were delivered by the normal vaginal route. A total of n=12 (24%) infants were monitored during the night shift. During the monitoring period, the humidity was recorded at 73.9±10% and the average room temperature was 26.75±0.1°C.

The BEMPU TempWatch was attached to the infant's wrist at an average of 112.2±48.2 minutes after the birth. Accuracy rate of TempWatch in diagnosing hypothermia was 95.8%. Except for n=2 (4%) infants, the TempWatch beeped at least once during the monitoring period of 6 hours. About n=19 infants (37%) had alarms beeping twice during the 6 hour period. Hypothermia was detected a total of 68 times for 51 babies during 6 hour of monitoring i.e., the average of one alarm per baby. The incidence of hypothermia (at least once) for the recruited infant population was 96.07%. The time taken to normalise the infant's temperature was 5.64±2.3 minutes after the necessary action was taken [Table/Fig-2].

Parameters	Total	Hypothermia alarm		
		Once	Twice	No alarm
Number of newborns recruited	51	49	19	2
Total Hypothermia episodes during 6hrs of monitoring	68			
Mean temperature at the time of applying device (°C)	36.1±0.56			
Mean temperature at alarm (°C)	35.36±0.89			
Mean time to take an action (minutes)	5.64±2.3			
Mean time the watch was placed on the baby after birth (minutes)	112.19±48.21			
Mean room temperature during monitoring period (°C)	26.7±0.1			
Relative humidity during monitoring period (%)	73.9±10			

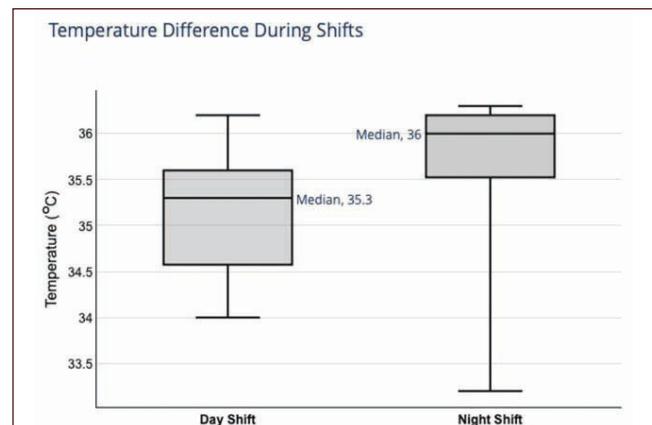
[Table/Fig-2]: Data on recruited newborns.

[Table/Fig-3] represents the difference in skin temperature at which the BEMPU TempWatch alarm beeped during the day

(34.98±0.7°C) and the night (35.68±0.8°C) shifts of the study period. Simultaneously, the abdominal skin temperature was also measured during this period. This temperature at start of monitoring was 36.1±0.56°C and average temperature at the time of alarms was 35.36±0.89°C. It was observed that the hypothermic condition was more during day shift (70%) than at night (30%) [Table/Fig-3]. Odds for being hypothermic in daytime was observed to be 2.33 [95% CI: 1.3-4.3] times higher than at night. It was recorded that hypothermic condition was observed more (p=0.006) during day shift than at night, however, no intensive care was required [Table/Fig-3,4].

Shift	Hypothermic			Odds ratio
	Number of babies monitored (n)	Number of alarms (n)	Average temperature (°C)	
Day	39	47	34.98±0.7	2.33 (95% CI: 1.3-4.3, p=0.006)
Night	12	21	35.68±0.8	

[Table/Fig-3]: Association (using Chi square test) between shift (day and night) temperature and hypothermia. p-value <0.05 was considered as significant



[Table/Fig-4]: Comparison of temperature between two shift timings.

It was observed that a wet soiled nappy was a common cause for hypothermia in all except two infants that received KMC care to stop the alarm and normalise their temperature. None of the infants from the study group needed advanced neonatal care for any complications.

DISCUSSION

A newborn is physiologically homeothermic and tachymetabolic [16]. The normal range of core body temperature for an infant baby is 36.5°C-37.4°C, regardless of weight and gestation [17]. Infant babies have large body surface area per unit body mass. Therefore, in an infant baby, heat loss is at least four times greater per unit of body mass compared to that of an adult [18]. Essential infant care by WHO therefore stresses on maintenance of the 'warm chain' throughout the neonatal period [16]. The

present study was conducted in a tertiary care centre to evaluate the temperature alert system of the BEMPU TempWatch and its need in the transitional period in healthy newborns.

In hospitals, normal healthy infants are not monitored by staff and are transferred to caretakers after regular check-ups as they are not presumed to be at risk of hypothermia. Studies have reported that the normal infants can also experience neonatal hypothermic conditions to some extent during postpartum period. Delavar MA et al., have found 46.4% and 37.2% incidence of significant hypothermia (axillary temperature below 36°C) 120 and 240 minutes after birth respectively among 522 term healthy infants cared in a baby friendly hospital. Recently a study from Karnataka, India has reported rectal temperature between 36°C-36.4°C in 50.4% and between 32°C-35.9°C in 22.4% of term infants weighing >2.5 kg in the postnatal wards [10,19]. These studies indicate that there is a risk of hypothermia even in normal weight babies, which was also observed in the present study (i.e., hypothermia episode, at least once in 6 hours, was seen in 96% of infants recruited). This emphasises that monitoring hypothermia in normal healthy infants is necessary in all the hospitals.

The study centre handles patient population from the lower socioeconomic strata lacking in awareness of newborn care. Therefore, every attempt is made to counsel the caregivers on newborn thermal control and appropriate warm clothing for the babies during the transition period. Previous studies at the tertiary hospital have shown higher incidence of hypothermia which reduced significantly after steps were taken to implement warm chain rigorously [14,15]. However, the mean temperature at the start of recording in the current study infant population was low, in spite of counselling the caregivers on thermal control. The drop in temperature may have been observed due to: 1) ignorance among caregivers regarding maintaining warm chain and 2) lack of personal attention by nurses or residents due to workload. This further highlighted the need to have a temperature monitoring device to alert the caretakers and parents of changes in temperature. BEMPU TempWatch, as demonstrated in the present study and in previously published studies, has the ability to alert the caretakers, thereby facilitating early intervention and prompt care [11].

In the present study, it was evident that the hypothermic condition was more during day shifts than at night [Table/Fig-4]. We found that the odds of being hypothermic in daytime is 2.33 times higher than at night. These low hypothermia incidences at night could possibly be due to: 1) the time of delivery of the recruited neonates; 2) warmth provided through bedding of the baby by the mother's side [6,20].

The methods used earlier for checking temperature in various studies were using axillary glass mercury thermometers, rectal

thermometers or skin probes with a portable multichannel monitor [6-8,10,19]. All these are time consuming and can cause anxiety among parents during measurement. Digital thermometer has been shown to be useful, but it also needs physical presence of nurse to measure the temperature at regular intervals. The difference in core body temperature and skin temperature also varies depending on site of measurement and the ideal site for skin temperature probe that could reflect the core body temperature is also not clear [14]. Considering these shortcomings, it is recommended to use BEMPU TempWatch to avoid the delay in recognising hypothermia episode and give proper care as soon as possible. The BEMPU hypothermia alert TempWatch is user friendly with no risk of infection or trauma and does not need constant monitoring by nursing staff. However, the results of this pilot study also need to be tested on a larger sample with a comparative arm to conclude the usefulness of the device in prevention of hypothermia in healthy term neonates and create awareness among parents (mothers) to take proper precautions after discharge from the hospital.

Limitation(s)

The recorded abdominal temperature could not be extracted in the form of continuous data, making it a limitation of the study. Another limitation of this study was the loss of continuous temperature recordings that would have detected exact time of drop in temperature when the abdominal skin temperature dropped below 36°C. The BEMPU TempWatch alarm only indicates the lower temperature, not the exact time of the temperature downfall. These limitations can however be worked on and implemented in updated versions of the device.

CONCLUSION(S)

Full term and normal weight babies are also at risk of developing mild-moderate hypothermia in postnatal wards. Therefore, the maintenance of a warm chain is essential, and the use of a BEMPU hypothermia alert bracelet (TempWatch) during transitional adaptation can assist in recognising hypothermia more efficiently. The continuous temperature monitoring may also help in preventing further complications. Hence, this device is useful to mothers in early recognition of hypothermia in full term, normal weight infants in busy postnatal wards.

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Author's contribution: MB conceptualised and designed the study. BP enrolled the subjects and collected the data. MB carried out the data analysis and wrote the paper.

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