Original Research Article

Comparison of rectal, infra red tympanic and infra red skin temperature in term neonates

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Abstract

Background: The measurement of body temperature is an important parameter in neonatal care as it is useful in the assessment of clinical state and necessary for the provision of appropriate nursing support. Hypothermia is one of the important risk factor in causing death in newborns of all weight and gestational age groups.

Aim and objectives: To compare rectal, infra red tympanic and infra red skin temperature in term neonates and to assess the accuracy and effectiveness of these non invasive thermometers in term neonates.

Materials and methods: It was a Hospital based prospective, non randomized study conducted at Department of Pediatrics in G.B Pant Hospital (neonatology section) an associated Hospital of GMC Srinagar. This study was conducted over a period of 1 year from April 2013 to march 2014.

Results: Total of 300 term neonates between the age of 1- 29 days were included in the study. Mean temperature recorded with rectal thermometer was 36.58 ^{0}C, with Infra red tympanic thermometer was 36.47 ^{0} C and with Infra red skin thermometer was 36.55 ^{0}C. Difference between means of rectal and Infra red tympanic thermometer was statistically significant (P=0.015) and difference between means of rectal and Infra red skin thermometer was statistically not significant (P = 0.18). Coefficient of correlation between rectal and tympanic was 0.772 and between rectal and skin was 0.955 which was statistically significant in both (P valve < 0.001).

Conclusion: Non contact Infra red skin thermometer is a very simple, safe and reliable method for measurement of body temperature in neonates. It can be used in peripheral settings as it is user friendly as well as patient friendly.

Key words

Hypothermia, Thermometer, Neonate, Temperature.

Introduction

The measurement of body temperature is an important parameter in neonatal care as it is useful in the assessment of clinical state and necessary for the provision of appropriate nursing support. Hypothermia is one of the important risk factor in causing death in newborns of all weight and gestational age groups [1]. It is estimated that 15% of newborn babies develop hypothermia at birth in developing world [2]. It is mandatory to identify hypothermia in order to reduce neonatal morbidity and mortality. Temperature is measured at the least as frequently as every three hours in a typical neonatal care unit. Thus, the importance of painless, accurate and rapid method of temperature measurement cannot be over-emphasized. Temperature measurement through the rectal route have been considered the gold standard method in children and neonates but there is evidence that it is associated with many risks and complications [1-16]. An appropriate instrument should be there, which could be convenient to use and applicable in all settings especially SNCUs where newborns are susceptible to temperature changes and vulnerable to hypothermia. Few studies have been carried out in country with infra red hand held devices.

Many routes have been used to record body temperature in the newborns; however a consensus on the best site has not been reached [3]. Different methods of temperature monitoring are:

Rectal thermometer: It is used as the 'gold standard' in most clinical settings [4, 5]. However, there are drawbacks to the use of the rectal route for temperature measurements in children. These include the risks of rectal perforation [15, 16], transmission of infection [3, 8, 9] and mercury poisoning when mercury-in-glass thermometers are used [8, 10, 11].

Axillary Thermometer: Axillary temperature is easy to measure (compared with oral or rectal measurements), it has been found to be an inaccurate estimate of core temperature in children [13-16].

Oral Thermometer: The sublingual site is easily accessible and reflects the temperature of the lingual arteries. However, oral temperature is easily influenced by the recent ingestion of food or drink and mouth breathing [17].

Tympanic thermometer: Tympanic thermometer however, has come as a newer and safer alternative to the traditional temperature measurements. Tympanic thermometers measure the thermal radiation emitted from the tympanic membrane and the ear canal, and have therefore been called infrared radiation emission detectors (IRED). Because the amount of thermal radiation emitted is in proportion to the membrane's temperature, IRED accurately estimates TM temperature [12].

Infrared skin Thermometers: Infrared skin thermometers (IRSTs) can be used to measure temperature rapidly and non-invasively, causing less distress to children than conventional methods. Like infrared tympanic thermometers, IRSTs can provide temperature readings within seconds. Most IRSTs measure temperature over the central forehead area, but temperature over other body surfaces may also be measured if the child's forehead is perspiring or if the child is moving. IRSTs can also measure child's temperature while sleeping. Since the use of IRSTs does not involve any body surface contact, the risk of cross-infection is negligible and neither disinfection nor disposable probe covers are needed.

Materials and methods

It was a Hospital based prospective study. The study was done over a period of one year from

April 2013 to March 2014. The study was conducted at Postgraduate Department of Pediatrics in G B Pant Hospital, an associated Hospital of Government Medical college Srinagar.

Inclusion criteria
- Term neonates whose weights were appropriate for age (37 and 42 weeks).

Exclusion criteria
- Preterm neonates
- Those in shock.
- Those who require assisted ventilation.
- Those who have congenital ear or anal malformation or pathology.
- Those with acute otitis media.

Devices used
- Mercury in glass thermometer was used for rectal temperature measurements.
- Infrared tympanic thermometer (BRAUN® Thermoscan Ear Thermometer) was used for tympanic temperature measurement. It measured the infrared heat generated by the eardrum and surrounding tissues.
- Non contact infra red skin thermometer for skin temperature monitoring was used. Temperature measurements were obtained by holding the thermometer approximately 0.5 cm from the body surface.

Rectal temperature was taken by a mercury-in glass thermometer. After informed consent from parents of neonates, for temperature monitoring, the anal openings of the babies were cleaned and mercury in glass thermometer was lubricated with xylocaine jelly and inserted within a depth of 2 cm from anal margin. The temperature was read 3 min after insertion. Only one reading of temperature was taken.

Skin temperature was recorded by same operator on the central part of forehead, abdomen and foot. The probe was positioned about 0.5 cm from the skin and reading was taken immediately

it displayed on the screen. The skin temperature was taken thrice from each site, and mean was taken followed by mean of three means from three different sites.

Tympanic temperature was taken with IR tympanic thermometer with a probe placed into the external auditory canal after an ear tug to straighten the canal and to a depth of 0.5 to 1 cm. The probe was held in the same position until a single beep was heard signifying the end of the temperature measurement which was then read from display screen. The same procedure repeated on other side.

Results

During the study period of one year from April 2013 to March 2014, 300 term neonates who fulfilled inclusion criteria were included in our study.

Out of 300 neonates, mean Age (SD) 8.34 (7.10) days (range 1-29 days), birth weight of 3.10 (0.51) kg (range 2.4-5.0 kg), male female ratio was 1.43.Out of 300 neonates 272 (90.7%) had gestational age 38-40 weeks and 28 (9.3%) had gestational age 40-42 weeks., postnatal age 9.22 $\pm$7.19 days range (1-29 days).

Mean temperature recorded with rectal thermometer was 36.58^0C, range (31.7-39.4) and with infra red tympanic thermometer was 36.47^0C, range (32.8-38.4) and difference was statistically significant (P value = 0.015).

Mean temperature recorded with rectal thermometer was 36.58^0 C, range (31.7-39.4) and that with infra red skin thermometer was 36.55^0 C, range (31.46-39.2) difference between two means was statistically not significant (P = 0.18). Coefficient of correlation between rectal and tympanic was 0.772 (**Figure - 1**) and between rectal and skin was 0.955 (**Figure - 2**) which was statistically significant in both (P valve < 0.001).

For calculating sensitivity, specificity, positive predictive value and negative predictive valveof

infra red tympanic and infra red skin thermometers we used cut off of <37.5 ^{0}C. For infra red tympanic thermometer sensitivity was 67.94% , 95% CI (59.53% to 75.32%), specificity was 82.25%, 95% CI (75.79% to 87.27%), positive predictive value was 74.79%, 95% CI (66.30% to 81.73%) and negative predictive value was 76.80%, 95% CI (70.13% to 82.35%).

Figure – 1: Scatter diagram showing correlation between rectal and Infra red tympanic thermometer.
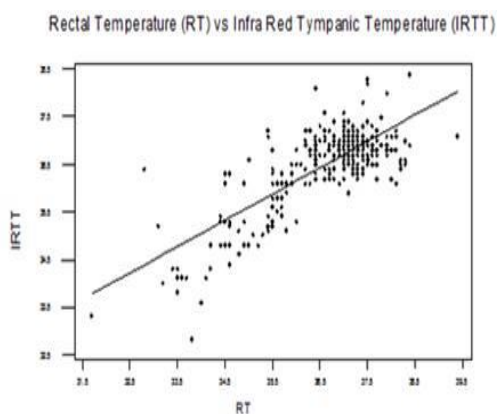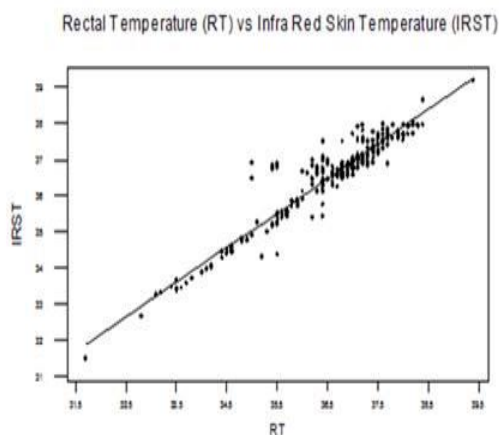

Rectal Temperature (RT) vs Infra Red Tympanic Temperature (IRTT)

Figure – 2: Scatter diagram showing correlation between rectal and infra red skin thermometer.

Rectal Temperature (RT) vs Infra Red Skin Temperature (IRST)

For infra red skin thermometer sensitivity was 93.46%, 95% CI (87.11% to 96.80%). Specificity was 88.08%, 95% CI (82.75% to 91.93%), positive predictive value was 81.30%, CI (73.50% to 87.20%) and negative predictive value was 96.05%, 95% CI (92.06% to 98.07%).

Discussion

The study was conducted over 300 term neonates to compare rectal , infra red tympanic and infra red skin temperature and to assess the effectiveness of infra red tympanic and infra red skin thermometer.

Rectal temperature measured with mercury thermometer was in range of 31.7 – 39.4, with mean 36.58 and SD 1.17. The temperature measured with IRT was in range of 32.8 – 38.4, with a mean of 36.47 and SD 0.84. The mean rectal temperature taken with mercury in glass thermometer was significantly higher than the mean tympanic temperature by 0.11°C (p < 0.015) which is in agreement with the findings reported by Chika O Duru, et al. [18] (mean rectal temperature 37.34+0.55, mean tympanic temperature 37.25+0.56 with a mean difference of 0.09^{0}C), Norman, et al. [19] reported a mean rectal temperature of 36.90 and mean tympanic temperature 36.80 with a mean difference of 0.10^{0}C (p < 0.015). The reason postulated for higher rectal temperature noted was that the rectum was better insulated than the tympanic membrane from external temperature changes [20]. Akinyika, et al. [21] reported a comparable mean difference between rectal and tympanic temperatures of 0.08^{0}C but the difference was not statistically significant. The lack of statistical significance in mean temperature difference in study by Akinyika, et al. [21] was attributed to the small sample size compared to our study. Weiss, et al. [22] got a difference of 0.4°C between rectal and tympanic measurements but the electronic thermometer was used to measure rectal temperatures instead of mercury-in-glass thermometer.

We found a strong positive correlation between rectal and tympanic temperatures (r=0.772, p < 0.001) as reported by Chika A Duru, et al. [18] (r=0.9, p value < 0.001).

We used a cut off temperature of < 37.5 to calculate sensitivity, specificity, positive predictive value and negative predictive value

for tympanic thermometer. It was noted that the sensitivity of tympanic thermometer in detecting rectal temperature at cut offs < 37.5 was low 67.94%. The specificity found in our study was 82.25%, the positive predictive value and negative predictive value was 74.79 % and 76.80%.

The low sensitivity at low temperature ranges was also found by Chika A Duru, et al. [18] (sensitivity ranging from 65-86% and specificity from 95-99% at rectal temperature cut-off of 37.5-38^{0}C. Norman M, et al. [19] found tympanic sensitivity of 80% and specificity of 87% for rectal temperature cut-off < 36.5. Difference in sensitivity, specificity was due to different cut-off values taken by different authors for calculation of these variables.

Non-contact infrared skin thermometer (IRST) can be used to measure temperature rapidly and non - invasively, causing less distress to children than conventional methods. IRST can provide temperature readings within seconds. Most IRST measure temperature over the central forehead area, but temperature over other body surfaces may also be measured if the child's forehead is perspiring or if the child is moving.

In the present study, rectal temperature was 31.7-39.4 (36.58±1.17) and infra-red skin temperature was ranged between 31.46 – 39.2 (36.55±1.18). The mean rectal temperature taken by mercury glass thermometer was higher than mean skin temperature taken by IRST, by 0.03°C, difference between two means was statistically not significant, with a p value of 0.18. The findings of the present study are in agreement with the study conducted by De Curtis, et al. [23] in which mean temperature measured with rectal mercury thermometer and infra-red skin device was 36.62 (0.66) and 36.66 (0.66), respectively with a p value of < 0.18.

A strong positive correlation (r=0.955, p value < 0.001) between rectal and IRST was found in our study which was in conformity with the findings of De Curtis, et al. [23].

In our study we used a cut off temperature of < 37.5 to calculate sensitivity, specificity, positive predictive value and negative predictive value for tympanic thermometer. The sensitivity of IRST found in our study was 93.46 % and specificity was 88.08% which is almost similar to that reported by Oscio CE, et al. [24] (sensitivity of 88.7% and specificity of 89.9%) and Teran CG, et al. [25] (sensitivity and specificity of 97%). We reported positive predictive value and negative predictive value were 81.30% and 96.05% respectively. Teran CG, et al. [25] observed negative predictive value of 99%.

A strong correlation between rectal and infra-red skin temperature (r = 0.955) as compared to that between rectal and infra-red tympanic temperature (r=0.772), makes IRST a valuable device for temperature monitoring in neonates.

Conclusion

Although Temperature measurements through the rectal route has been considered the gold standard method in children and neonates. Tympanic thermometry, however, has come as a newer and safer alternative to the traditional temperature measurements. The sensitivity of tympanic thermometer was relatively low in detecting rectal temperatures despite good correlation and agreement between them. Though using the tympanic route for measuring temperature in newborn is relatively safe, non invasive and hygienic, its low sensitivity limits its use.

Another very simple and easy method for measurement of body temperature in neonates which we used in our study was non contact infra red skin thermometer. We found the device was safe, without any potential risk, was well tolerated, measures temperature accurately and is easy to use. It does not involve any body surface contact, hence the risk of cross-infection is negligible and neither disinfection nor disposable probe covers are needed. All these features made infra red skin thermometer as a useful device for

measurement of temperature in neonates. The device can be used in special new born care units (SNCU) , peripheral settings as it is user friendly as well as patient friendly. As there are few studies in neonates especially for detection of hypothermia, using non contact infra red skin thermometer, more studies are recommended to support the evidence found in this study and compare its accuracy with more complex devices.

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