INTERNATIONAL JOURNAL OF MEDICAL SCIENCE RESEARCH AND PRACTICE

Comparative study of various techniques to measure neonatal hypothermia

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ORIGINAL RESEARCH

ABSTRACT

Aim

To compare different available modes (forehead infrared thermometer ,axillary temperature by thermister probe and digital thermometer, with axillary temperature by gold standard mercury thermometer) of temperature measurement in neonatal hypothermia in order to come out with most accurate one among them.

Background

Hypothermia is very important in essential newborn care as it can lead to mild to severe life threatening complication, so detecting hypothermia takes important role in its management.

Material Methods

Study Design: Setting was Neonatal Intensive Care Unit (Level 3), Kamla Raja Hospital ,Gajra Raja Medical College, Gwalior, India. A Prospective study of one year (July 2010 - June 2011) duration done with 1690 admissions of neonatal intensive care unit (full fill inclusion criterion) by applying Fisher test on 2×2 contingency table to get sensitivity , specificity , positive predictive value , negative predictive value and accuracy of above 4 methods by STATA 9.1 (STATA corporation, college station , TX, USA) .

Results

Digital thermometer is having highest sensitivity (99.1%), specificity (98.1%), positive predictive value (97.4%) and negative predictive value(99.3%).

Conclusion

Digital axillary thermometry is the best alternative to mercury thermometer for measuring neonatal temperature compared with axillary temperature by thermister probe and forehead temperature by infrared thermometer.

Key Words

Neonatal temperature recording, Digital thermometer, Forehead infrared thermometer, mercury thermometer, Thermister probe.

INTRODUCTION

Measurement of body temperature is one of the oldest known diagnostic methods and still remains an important indicator of health and disease, both in everyday life and in medical care.[1] Measuring body temperature is routinely performed in health care services, and can use different measuring instruments. The use of body temperature measurement and monitoring, in the oldest references in the first or second century BC and in 1592 Galileo manufactured a thermometer.[2]

Temperature regulation of neonate is of vital importance for their survival and well-being. It is important to assess the neonate at birth and maintain temperature within normal range because the neonates are prone to develop hypothermia after birth due to change in environmental temperature and various factors. These factors include following;

• Large surface area as compared to body weight. Their surface area of head is 25% vs 10% in adults

• Poor insulation for conservation of heat due to thin layer of subcutaneous fat

• Non-shivering thermo genesis which involves increased metabolism and oxygen consumption

• Reduced amount of brown fat[3]

Hypothermia is common in infant born at hospital (prevalence range 32%-85%) and home (prevalence range 11%-92%) even in tropical environment. Hypothermia contributed to substantial proportion of neonatal mortality globally, mostly as a co morbidity of severe neonatal infection, preterm birth and asphyxia. Addressing hypothermia might play a substantial role in reaching Millennium Development Goal 4, a reduction of child mortality.[4]

Hypothermia is very important in essential new born care as it can lead to mild to severe life threatening complications so detecting hypothermia takes important role in its management. But with advent of newer methods of temperature measurement like infrared and digital thermometer ,there is a need to find out most accurate one among them .As lot of studies going on regarding validation of these newer techniques,[5,6] we aimed to take three common methods and compared with gold standard axillary temperature by low reading mercury thermometer .

MATERIAL AND METHOD

Ethical Approval: Study protocol was reviewed and approved by Ethical committee of the Medical College.

Study design: cross-sectional, analytic in tertiary care Medical College Hospital

Subjects: 1690 Neonates admitted in NICU over a period of one year

Exclusion criteria:
1.Neonates with major congenital anomalies (e.g. gastroschisis, omphalocele)
2.Neonates with severe birth asphyxia (Levene Score).
Consent: Informed consent of parent or guardian was taken prior to enrolling the neonate.

Materials used:
1.Low reading Medical mercury thermometer (up to 32 ^{o}C)
2.Thermister probe (product of Zeal ,<40 ^{o}C)
3.Digital thermometer (product of Dr.Morepen ,up to 32 ^{o}C)
4.Infrared thermometer (HT-F03B Forehead temperature IR thermometer <100°C)

Methodology:
Temperature of each neonate was recorded by 4 different methods as described below
1.Low reading medical mercury thermometer: device cleaned with cotton swabs; shaken to get the mercury column at starting point. Axilla of neonate was dried with cotton and bulb of thermometer was kept at tip of axilla for 5 minutes, babies arm was held close to the body to keep thermometer in place and the reading was taken at eye level and recorded.

2.Digital thermometer: After switching the device on, and drying the axilla of neonate and the tip of digital thermometer was placed at apex of axilla and neonate's arm was held close to the body to keep thermometer in place until there was a beep from instrument indicating it had finished taking temperature and the reading was noted down. Less than 32 ^{o}C was shown as Low, for the rest we had reading displayed.

3.Thermister probe: Once the baby was kept on cot of radiant warmer, axilla was dried and thermister probe was placed at the apex of it, until the flashing temperature reading over monitor becomes static and that temperature was noted down.

4.Forehead Infrared Thermometer: It is specially designed with Heiman Infrared probe for measuring forehead temperature, with dynamic offset for the ambient temperature and forehead temperature. To measure the temperature ,window of instrument was aligned in the direction of forehead at distance of 50-100mm,and measure button pushed to get reading on LED screen , which was noted down (as per manufacturer instruction).

Statistical analysis:
Data was compiled in to on 2×2 contingency table and fisher test was applied to get sensitivity , specificity , positive predictive value , negative predictive value and accuracy of above 4 methods by STATA 9.1 (STATA corporation, college station , TX, USA)[7].

RESULT

Out of 1690 neonates 700 neonates were found hypothermic by low reading clinical thermometer. Thermister probe was in agreement for 681 neonates (True positive 681) but there was mismatch in 19 hypothermic neonates whom Thermister probe found normothermic (False negative 19). Out of 990 normothermic neonates as per low reading clinical thermometer Thermister probe was in agreement for 944 neonates (True negative 944) , and there was mismatch in 46 normothermic babies (False positive 46) whom Thermister probe found hypothermic. (Table I)

Table I: Diagnostic accuracy of Axillary temperature by Thermister probe (Standard: Low reading Mercury Thermometer)

Method		Hypothermia	Normal	Total
Thermister probe	Positive	681 (True)	46 (False)	727
	Negative	19 (False)	944 (True)	963
	Total	700	990	1690

Out of 700 hypothermic neonates , measured by low reading clinical thermometer Digital thermometer was in agreement for 694 neonates (True positive 694) but

there was mismatch in 6 hypothermic neonates whom Digital thermometer found normothermic (False negative 06). Out of 990 normothermic neonates as per low reading clinical thermometer Digital thermometer was in agreement for 972 neonates (True negative 972) , and there was mismatch in 18 normothermic neonates (False positive 18) whom Digital thermometer found hypothermic. (Table II)

Table II: Diagnostic accuracy of Axillary temperature by Digital thermometer (Standard: Low reading Mercury Thermometer)

Method		Hypothermia	Normal	Total
Digital thermometer	Positive	694 (True)	18 (False)	712
	Negative	06 (False)	972 (True)	978
	Total	700	990	1690

Out of 700 hypothermic neonates, measured by low reading clinical thermometer , Infra red thermometer was in agreement for 687 neonates (True positive 687) but there was mismatch in 13 hypothermic neonates whom Infra red thermometer found normothermic (False negative 13). Out of 990 normothermic neonates as per low reading clinical thermometer Infra red thermometer was in agreement for 922 neonates (True negative 922) ,and there was mismatch in 68 normothermic babies (False positive 68) whom Infra red thermometer found hypothermic.(Table III)

Table III: Diagnostic accuracy of Forehead temperature by Infrared thermometer (Standard: Low reading Mercury Thermometer)

Method		Hypothermia	Normal	Total
Infrared thermometer	Positive	687 (True)	68 (False)	755
	Negative	13 (False)	922 (True)	935
	Total	700	990	1690

Overall, Digital thermometer is having highest sensitivity (99.1%), specificity (98.1%), positive predictive value (97.4%), negative predictive value (99.3%) and overall Accuracy 0.98 (Table IV).

Table IV: Comparison of Accuracy of various modes of temperature measurements (Standard: Low reading Mercury Thermometer)

	Thermister Probe	Digital Thermometer	Infrared Thermometer
Sensitivity	97.2%	99.1%	98.1%
Specificity	95.3%	98.1%	93%
Positive Predictive Value	93.6%	97.4%	90.9%
Negative Predictive Value	98.0%	99.3%	98.6%
Likely hood ratio (+)	20.9	54	14.2
Likely hood ratio (-)	0.02	0.008	0.01
Kappa	0.92	0.97	0.90
Overall Accuracy	0.96	0.98	0.95

DISCUSSION

Padilla et al observed Digital axillary thermometry in children is having sensitivity of 88.46%, specificity of 98.65%, positive predictive value of 95.83% and negative predictive value of 96.05%.[2] Uslu S et al compared the accuracy of digital axillary thermometer , rectal glass mercury thermometer , infrared tympanic thermometer and infrared forehead skin thermometer measurements with traditional axillary glass mercury thermometer for intermittent temperature measurement in sick newborns and found good correlation between digital axillary thermometry and axillary glass thermometry in sick newborns.[5] Sganga A et al compared newborn temperature measurements obtained by digital disposable, electronic and tympanic thermometers with glass mercury thermometers and observed good correlation between digital axillary thermometry and axillary glass thermometry in healthy newborns.[8] Oncel MY et also observed that digital axillary thermometry in newborns by mother and physician showed a significant correlation which suggest that axillary digital thermometry is as good for taking temperature in community setting in newborns.[9]

CONCLUSION

Overall in the present study Digital thermometer has best likely hood ratio, kappa value (0.97) and overall accuracy (0.98), followed by thermister probe and Infrared thermometer. Digital axillary thermometry is the best alternative to mercury thermometer for measuring neonatal temperature compared with axillary temperature by thermister probe and forehead temperature by infrared thermometer. This is user and eco friendly without need of expertise, time saving and no inter observer difference. It can be recommended for both institutional and home use.

REFERENCES

1. Gasim GI, Musa IR, Abdien MT, Adam I. Accuracy of tympanic temperature measurement using an infrared tympanic membrane thermometer. BMC Research Notes 2013;6:194.
2. Padilla N, Raygoza, Diaz R, Garcia PA, Pantoja MA. Comparison Of Measurements Of Body Temperature With Four Thermometers In A Children Health Care Setting. Comparison of Thermometers. The Internet Journal of Pediatrics and Neonatology 2011; 13(2)
3. V Kumar, JC Shearer, A Kumar and GL Darmstad. Neonatal hypothermia in low resource settings: a review. Journal of Perinatology 2009;doi:10.1038/jp.2008.233
4. Lunze K, Bloom DE, Jamison DT, Hamer DH. The global burden of neonatal hypothermia: systematic review of a major challengefor newborn survival. BMC medicine 2013;11:24.
5. Uslu S, Ozdemir H, Bulbul A et al. A Comparison of Different Methods of Temperature Measurements in Sick Newborns; Journal of Tropical Pediatrics 2011 ; 57 (6): 418-2
6. Alexander D, Kelly B. Cost effectiveness of tympanic thermometry in the pediatric office setting.Clin Pediatr (Phila) 1991;30(4):57-9.
7. Landis RJ, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977; 33: 159-174.
8. Sganga A, Wallace R, Kiehl E, Irving T, Witter L. A comparison of four methods of normal newborn temperature measurement. MCN Am J Matern Child Nurs 2000;25(2):76-9.
9. Oncel MY, Tekgunduz AS,Ozdemir R et al. A comparision of different methods of temperature measurement by mothers and physicians in healthy newborns. Indian J Pediatr 2013;80(3):190-4.

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PEER REVIEW

Double Blinded externally peer reviewed.

CONFLICTS OF INTEREST

Nil