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Methods and Devices of Temperature Measurement in the Neonate: A Narrative Review and Practice Recommendations

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ABSTRACT

There are a number of measurement devices available for use. However agreement about the effectiveness of the various types of thermometers in the neonatal population remains unclear. The review indicates that the axilla method continues to be the site of choice for preterm and term infants. However, it has been noted in some studies that very little work has been done on the sensitivity and specificity of each method of temperature measurement, making it difficult to identify any negative or positive results in relation to measuring temperature at the axilla, rectal, skin, forehead and tympanic sites. Nurses need to be aware of the various temperature measurement methods, devices and factors influencing neonatal temperature recordings. New thermometers should be rigorously tested for suitability in the neonatal population. Evidence based practice remains important and studies need to continue into the accuracy and reliability of different temperature measurement devices and methods.

We as neonatal nurse specialists know that thermoregulation and therefore obtaining an accurate temperature measurement are an integral part of our work, almost innate. Accuracy of body temperature is essential to maximize quality of care in this susceptible population and temperature taking is usually one of the first things we as nurses do when the infant is admitted. What we are measuring, is simply, the measure of heat content of the infants body,[1] which plays an important role in any clinical decisions made. To ensure we have accurate, consistent, reliable methods and devices of temperature taking, studies need to continue and devices need to be investigated prior to use in this sensitive population. Therefore, papers relating to this topic are important and should be read and understood. However it is easy to be lost in the myriad of sometimes confusing discussions, conclusions and conflicting results published in journals around the globe.

Internal body temperature, also known, as core temperature (core temperature is where temperatures within the body are more steady and stable over time, when compared to skin temperature, which can fluctuate due to, for example the environment) is one of the clinical vital signs closely observed, along with other parameters such as heart rate, respirations and blood pressure. The main reason why temperature taking is significant is because a deviation from the normal range can give an indication that there is a pathological condition. The body has a temperature because combustion processes are constantly taking place in living organisms, releasing energy. Some of this energy will be conserved for later use, the rest evolves as heat, and can build up in the body, therefore causing an increase in body temperature, which is known as pyrexia. Heat, like fluids, runs down a gradient (Newton's law of cooling) and the heat generated in the body can readily be dissipated into the environment, so long as it is cooler than the body.

The most accurate and appropriate method of measuring core and skin temperature in newborns has been a topic of concern for many years (see Table 1). The use of the glass mercury thermometer has been phased out because of potential health problems associated with mercury. In addition to rectal, skin and axillary methods, there are newer modes of measuring temperature such as tympanic temporal artery and forehead methods.

For decades researchers have studied the most accurate, non-invasive and rapid method of temperature taking in preterm and term infants, comparing other methods of temperature measurement used with the 'gold standard' rectal thermometry. Many routes and devices have been used to obtain an accurate body temperature measurement in the neonates; however, a consensus on the best site and device to be used has not been reached.[2]

In general, any site near a major artery is suitable for assessing body temperature[3,4] known as the core temperature. A body's core temperature is best measured through the pulmonary artery or esophagus as they cover a large central vasculature area and are in close proximity to the heart.[4,5] Also, bladder temperature measurements have been found to closely correlate with pulmonary artery catheter temperature measurements.[6,7] After many centuries and still today, the rectal site still remains the most accurate when assessing core body temperature because of its close approximation to the neonates core temperature and it is not influenced by the environment.[8–10]

Many different types of thermometers are available. The type of thermometer used in the hospital environment is usually determined

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Table 1
Thermometer Studies.

Study	Site	Apparatus	Key Findings	Subjects
Torrance, J.T (1968)	Axilla Rectal	Thermistor probe GMT Telethermometer	Length of time – rectal and axilla were different, axilla >3 minutes and rectal <3 minutes Rectal stabilized faster	120 infants 24–42 weeks
Eoff, et al. (1974).	Axilla Rectal	Mercury in Glass Telethermometer	Significant difference between axillary and rectal temperatures with the mercury in glass ($P < .01$). Taking of axilla temperatures is recommended	Study conducted on healthy infants Sample size n = 30
Schiffman (1981)	Axilla Rectal	GMT	Significant positive correlation between axilla and rectal. Axilla method my be practical for neonatal temperature monitoring	46 full term infants
Mayfield, et al. (1984)	Rectal Axilla Skin	Glass mercury thermometer	There was close agreement with rectal and axillary temperatures	Wide gestational age an weight
Moen, et al. (1987)	Axilla Rectal	Glass mercury thermometer	Axillary measurement can be adequately substituted for rectal measurement temperature	Small sample size n = 25 Only preterm infants
Haddock, et al. (1988)	Axilla Rectal	Glass mercury thermometer	99% of preterm infants reached their optimum axillary temperature in 3 minutes. The difference between rectal and axilla showed a wider range than Mayfield, et al. (1984)	Small sample size n = 30 Only preterm infants
Bliss-Holtz (1989)	Rectal Axilla Inguinal	Glass mercury thermometer	At least 99% of the subjects reached temperature stabilisation by 5 and half minutes. It was found that the inguinal site temperatures are more reflective of rectal temperatures and may be less sensitive to the effects of BAT heat generation.	Only term infants
Johnson, et al. (1991)	Axilla Rectal Tympanic	FirsTemp Glass mercury	There was no difference in temperature in the protected and unprotected ear. No significant differences in axillary readings between tympanic and mercury in glass. Tympanic thermometer underestimated in 2 modes and overestimated in 1	Sample size n = 31 healthy infants
Weiss, et al. (1991)	Axilla Rectal Tympanic	Thermoscan IVAC electronic	Tympanic and axilla were similar. No significant difference found between tympanic and axilla. Correlations between left and right ear were moderate	Sample size n = 34
Hunter, et al. (1991)	Axilla	Glass mercury IVAC electronic	The study determined a 3 minute axillary temperature is a clinically appropriate length of time to measure newborn temperatures	Term infants Sample size n = 40
Akinbami and Sawunmi (1991)	Axilla Rectal	GMT	Strong positive correlation between axilla and rectal temperatures (r = 0.9) Axilla route can be used, good correlation with rectal readings	104 healthy full term infants
Yetman, et al. (1992)	Rectal Axilla Oral	Glass mercury Aural	Temperatures using the glass mercury in axilla and rectal site were similar. Tympanic thermometer in oral and rectal mode did not accurately reflect the infants rectal or axillary temperature	Study conducted on healthy infants
Rekha, et al. (1993)	Rectal Axilla	Not stated	The overall difference between rectal and axillary temperature was 0.3 F. Correlation was good. Axillary temperature can be used as an alternative to rectal temperatures	Sample size n = 55
Weiss, et al. (1994)	Axilla Rectal Tympanic	IVAC electronic	No significant differences between tympanic and axillary temperatures. The right ear (exposed ear) is best approximation of axillary measurement. The protected ear, (nearest the mattress) is best approximation of rectal temperature	Term infants sample size n = 34
Weiss, et al. (1994b)	Axilla	IVAC electronic in P and M mode	Results of this study support the use of the axilla temperature measurement via the P mode.	Sample size 34 full term newborns
Hicks, et al. (1996)	Axilla Tympanic	FirsTemp Glass mercury	No significant differences were noted between axillary and tympanic measurements for all subjects. There was a difference of 1.2 °C between axillary and tympanic for the overall sample	Sample size n = 40 20 preterm 20 term
Cusson, et al. (1997)	Tympanic Inguinal Axillary	IVAC electronic FirsTemp	No significant differences were found in the right and left ear. Correlations between tympanic and rectal were weak. Significant interaction was found between site and environment. Tympanic should be used with caution in newborns.	Study conducted on 63 healthy term infants
Leick-Rude & Bloom (1998)	Axilla Tympanic Tempa-dot Digital	IVAC electronic BD Digital Tempa-dot Glass Mercury	The BD thermometer has the highest correlation with the mercury in glass. Skin temperatures were influenced by swaddling. Tympanic was inappropriate for hospitalized neonates. Tympanic thermometer was awkward to handle and position. infants objected to the ear tug	Study conducted on 220 infants only <1500 g
Fallis (1999)	Axilla	IVAC Temp Plus in M and P modes	The P mode is sufficiently reliable for axillary temperature measurement	Study conducted on 72 healthy term infants
Seguin, et al. (1999)	Axilla Rectal	LighTouch Thermistor 400	Axillary temperatures via IR approximate rectal temperatures.	Study conducted on healthy term infants Sample size n = 28
Browne, et al. (2000)	Axilla Tympanic	Glass Mercury LighTouch Genius	Glass mercury axilla correlated well with standard rectal glass mercury. The use of IR axillary thermometer is recommended	Study conducted on healthy term infants
Jirapet, et al. (2000)	Tympanic Skin Axilla Rectal	FirsTemp Glass mercury Electronic	The mean axillary temperatures were the least different from the rectal. Tympanic temps in the rectal mode showed significantly higher mean temperatures than rectal temperatures. The protected ear has a significantly higher temperature than the exposed ear	52 preterm and 57 healthy term infants
Sganga, et al. (2000)	Axilla Tympanic	Digital disposable Electronic Glass Mercury	They encourage the use of digital and electronic thermometers. Tympanic were the most cost worthy but their lack of correlation with the glass mercury makes them a poor choice for newborns	Term newborns
Dollberg, et al. (2000)	Rectal Skin Axilla	Skin probe Rectal probe	No significant difference between abdominal and core temperatures or axilla and core temperatures. Transcutaneous thermometry is reliable for most core body temps in stable preterm	30 premature infants

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