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Comparison of tympanic infrared thermometer with glass-mercury thermometer in newborn infants

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Objective Our purpose was to determine the feasibility of tympanic infrared thermometer in newborn infants and compare it with the standart glass mercury thermometers.

Methods Term newborn infants without any apparent problems were evaluated within the first day of life. Infrared thermometer readings on both ears, forehead, axillary pit and over the liver were recorded and compared with the simultaneous rectal and axillary glass-mercury thermometer readings.

Results One hundred and ninety eight infants were enrolled. The mean tympanic "core" temperature was 36,10±0,94°C compared with the mean rectal temperature of 37,20±0, 71°C (p<0,001). The "surface" equivalent readings at the forehead, axillary pit and over the liver were also significantly lower than the "core" temperatures and also of the axillary and rectal glass-mercury thermometer readings.

Conclusion In the evaluation of normal term newborns, the infrared tympanic thermometer is unreliable, compared with the "gold standart" of thermometer, i. e. glass mercury rectal and axillary readings.

Keywords Newborn, glass-mercury thermometer, tympanic infrared thermometer

Introduction

Measuring the body temperature of the newborn infant is an invaluable part of the evaluation of the baby. The fragile nature of the newborn infant and his sensitivity to cold exposure stipulates that the method of temperature measurement should be rapid, safe and accurate with minimal disturbance to the baby.

The classical method of measuring the temperature of the infant is performed by using the glass mercury thermometer. The temperatures are read either at the axilla or at the rectum. The new aural infrared thermometer provides rapid and painless temperature measurements and has been found to correlate well with other measurements in pediatric patients (1,2). However, the accuracy and the reproducibility of this method have not been extensively investigated in newborn babies. The purpose of the current study was to compare the temperature readings of the glass mercury rectal and axillary thermometers along with the readings of the aural infrared thermometer in different settings.

Material and Methods

The FirstTemp Genius Model 3000A aural infrared thermometer (Intelligent Medical Systems, Carlsbad, California, USA) was used as a tympanic membrane thermometer and the readings were compared with the glass mercury thermometer readings. This device consists of two parts: A hand held probe with a disposable cover and a base unit for storage of the probe covers. The thermometer can be calibrated either to the "core" (tympanic) mode or to the "surface" mode by a push of a button. The probe with the cover over it is placed in the external auditory canal and the scan button is pushed. The probe gathers infrared energy emitted by the tympanic membrane and converts it to a digitally displayed reading within a few seconds.

Glass mercury thermometers were calibrated before the study to the accuracy of 0,1°C. The bulb of the thermometer was placed in the pit of the axilla or was inserted to the rectum and held in place for 5 minutes to achieve the maximum temperature.

The aural temperatures were taken on both ears and recorded as the dependent or non-dependent site temperatures. Skin temperatures were measured on the forehead, in the axillary pit and on the liver. The setting of the infrared thermometer was changed to the "surface" mode and the probe was held about 5 mm above the surface. Immediately ofter this measurement, a second investigator, unaware of the recordings of the first investigator, measured the axillary and rectal temperatures by the glass mercury thermometer simultaneously. The measurements were performed within the first 24 hours of life, after the initial stabilization of the baby. All temperatures in a baby were measured within 8 minutes.

Statistical analyses were performed with the SPSS for Windows package. Unpaired t test and box plots were used to compare the different modalities of temperature measurements. $p < 0,05$ was considered significant. All values are expressed as mean (standart deviation.

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Results

One hundred and ninety eight infants were enrolled in the study (100 boys and 98 girls). All of them were at least 36 weeks of gestational age (range: 36-42 weeks). Their mean birthweight was 3265±545 g (range: 2000-4930 g).

The mean glass mercury axillary temperature was 36,67±0,78°C and the mean glass mercury rectal temperature was 37,20±0,71°C. This 0,53°C difference was statistically significant ($p<0,001$) but was not considered clinically significant. There was no variation for gender.

The mean tympanic "core" temperature on the dependent ear was 36,10±0,94°C and 36,05±0,89°C on the non-dependent ear. The non-dependent ear temperature was compared to glass mercury axillary and rectal temperatures and the differences were found significant ($p<0,001$). Again, these differences were not considered clinically significant.

The mean "surface" equivalent readings were 32,38±1,00°C at the forehead, 33,68±1,05°C at the axillary pit and 33,52±1,25°C over the liver. All of these values were significantly lower than the readings of the "core" temperature and of the axillary and rectal glass mercury thermometer readings ($p<0,001$).

The results of different temperature readings are represented in the box-plot diagram (Figure)

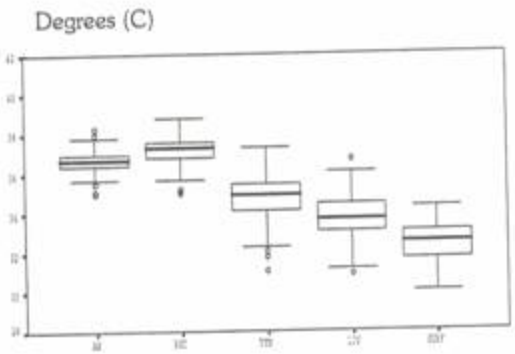

Figure. Box plot representation of different modes of temperature measurement. **Ax**: Glass-mercury axillary temperature, **Rec**: Glass-mercury rectal temperature, **Tym**: Infrared tympanic temperature on the non-dependent ear, **Liv**: Infrared surface temperature over the liver, **Surf**: Infrared surface temperature on the forehead. The differences between these modes are all significant ($p<0,001$).

Discussion

Previous studies in the newborns on the accuracy and reliability of tympanic thermometers have led to conflicting results (3, 4). Yetman et al. stated that tympanic membrane thermometer could not be substituted for glass mercury axillary or rectal thermometers (5).

In our study, there were significant differences between the aural infrared thermometer and glass mercury rectal or axillary thermometer readings. It might be argued that these differences might be due to a measurement error, but the number of the sample population is large enough to preclude this type of error. Although these differences were not considered as clinically significant, the study was done in normal, healthy term infants and should these differences occur in cases of fever also, they could gain clinical significance. The difference between the axillary and rectal glass mercury readings was 0,53°C and this was compatible with the other reports (6).

The tympanic membrane thermometer functioned very rapidly to obtain the temperature. However, in some babies, the ear had to be adjusted for optimal securing of the probe; this caused some discomfort to the baby. However, it was not more than the discomfort of the rectal glass mercury thermometer.

The tympanic thermometer readings were performed on both ears and classified as dependent (i. e. lying on it) and non-dependent (i. e. facing upward) ear. The readings in the ear facing the bed were expected to be higher but there were no significant differences between two ears. Interference by the cerumen does not appear to affect vaues, because ear wax is reported to be essentially transparent to infrared energy (7).

The three "surface" sites were chosen for the following reasons: The forehead was considered the place most exposed to ambient room temperature. The axilla was also the site for glass mercury readings and the liver surface was thought to represent the "trunk" temperature. As expected, all of the surface temperatures were lower than the glass mercury thermometers. Although the axillary reading was the highest among them, there were still significant differences between the infrared and glass mercury thermometer readings. However, these differences might not be considered as "real" differences, because as it is well known, heat loss by evaporation and convection is more rapid in the

skin areas more exposed to environmental changes, i.e. the forehead and over the liver. However, it is interesting that the infrared "surface mode" and glass mercury reading in the axillary pit were also significantly different from each other.

The results of this study suggest that the use of infrared tympanic thermometer either in the "core" mode or in the "surface" mode is not appropriate in the newborn period. Increased speed and minimal discomfort of infrared therometer are outweighed by the inaccurate measurements. However, investigations in the pathological states are also warranted to reach to a more definite conclusion.

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