THERMOREGULATORY ALTERATIONS AS A MARKER FOR SEPSIS IN NORMOTHERMIC PREMATURE NEONATES

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ABSTRACT

To evaluate the core-peripheral temperature alterations as a marker for sepsis in normothermic premature newborns, 50 normal term neonates and 11 preterms with sepsis and 11 normal preterms (controls) were studied. Axillary, rectal and sole temperatures were recorded in all babies using a single mercury-in-glass thermometer by a single observer. There was significant widening of the rectal-sole and axillary–sole temperatures in the preterms with sepsis ($p<0.001$). There was no significant difference ($p>0.05$) between the axillary and rectal temperatures in the term, normal preterms or those with sepsis. With an overall accuracy of 90.9%, a rectal-sole temperature difference of ≥2.3°C (100% sensitivity) or ≥3.2°C (100% specificity) is a useful marker to differentiate normothermic preterms with or without sepsis. Using the axillary-sole temperature difference, the respective values were ≥2.2°C and ≥3.0°C.

Key words: *Body temperature, Preterm, Sepsis.*

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Sepsis in the newborn period, especially in the preterms, is one of the prime contributors to the neonatal morbidity and mortality(1). Early diagnosis of neonatal sepsis is often difficult as early signs and symptoms are subtle and often nonspecific(2,3). Rapid diagnostic tests have been evaluated towards achieving this end(4). Inspite of them, the diagnosis of neonatal sepsis is often presumptive and managed zealously with a bewildering array of antibiotics.

Sepsis produces a metabolic stress and the neonate responds by trying to maintain the core temperature at the expense of the peripheries(5). Taking this hypothesis, it was planned to evaluate this thermoregulatory response in preterms as a clinical marker for definite and most probable sepsis.

Material and Methods

The study was conducted in the months of September and October, 1990 in the Neonatal Unit of the Department of Pediatrics. All these babies were well wrapped up, lying with their mothers. The term babies were in the general maternity wards while the preterm infants were kept in a separate area in the children ward in a thermo-neutral environment for clothed babies(6). All temperature measurements were made by using a standard single low reading mercury-in-glass thermometer by the same observer. This thermometer had a measurement capability range from 30°C to 43°C and the recordings were done between 1 p.m. and 5 p.m. The axillary and the rectal (insertion of the thermometer was to a distance of 2.5 cm) temperatures were measured by the standard technique(7,8). The sole temperature was measured by holding the foot above the ankle and placing the bulb of the

thermometer at the base of the toes which results in plantar flexion thereby covering most of the bulb of the thermometer. All temperature recordings were noted after keeping the thermometer in place for 2 minutes (for stabilisation) in all 3 mentioned sites.

Fifty term appropriate for date (Group A) babies with no neonatal problems were studied to generate the normal values and to standardize the technique, 11 preterm, gestation, birth weight matched normal babies (Group B) served as controls for the study of 11 sick preterm babies (Group C) with proven or most probable sepsis.

Proven sepsis was defined as the isolation of organisms from one or more tissue fluids (blood or CSF or urine). In the absence of culture positivity, any two or more of the following parameters found to be positive along with a strong clinical suspicion was deemed as evidence of probable sepsis. These parameters were (*a*) μESR $\geq$14 mm in the 1st hour(4), (*b*) an absolute neutrophil count suggestive of infection(9), (*c*) positive C-reactive protein(4). There were 3 babies with positive cultures, 6 with positive rapid diagnostic tests, two babies with pneumonia. All babies had their axillary, rectal and sole temperatures measured and recorded.

The results were analysed using the unpaired Student's t-test.

Results

There were 30 male and 20 female babies in group A (term neonates). *Table I* gives the birth weight, gestation and age at study and the temperature measurements of these babies. The mean (SD) temperatures from the rectal and axillary sites were 37.1°C (0.5) and 36.7° C(0.52) respectively. The sole temperature was 34.1 ± 1.34°C. There was very little difference between the rectal and axillary temperatures –0.39 ± 0.27°C. The values for rectal-sole (R-S) and axillary-sole (A-S) were 2.97 ± 2°C and 2.58 ± 1.28°C, respectively and the differences were not statistically different.

TABLE I—*Patient Characteristics: Normal Term (Group A), Preterms (Group B) and Preterms with Sepsis (Group C) (Mean ± SD)*

Parameter	Group A (n = 50)	Group B (n = 11)	Group C (n = 11)
Birth weight (kg)	2.83 ± 0.45	1.39 ± 0.3	1.48 ± 0.2
Gestation (wks)	38.66 ± 1.48	32.09 ± 2.78	32.27 ± 2.56
Age at study (days)	5.06 ± 2.33	17.64 ± 12.74	20.73 ± 13.46
Weight at study (kg)	–	1.47 ± 0.20	1.42 ± 0.15
Rectal temperature (°C)	37.10 ± 0.50	37.10 ± 0.38	37.00 ± 0.71
Axillary temperature (°C)	36.70 ± 0.52	36.80 ± 0.42	36.80 ± 0.82
Sole temperature (°C)	34.10 ± 1.34	35.30 ± 0.76**	33.20 ± 0.99**
Rectal-Axillary (R-A) (°C)	0.39 ± 0.27	0.31 ± 0.22	0.18 ± 0.13
Rectal-Sole (R-S) (°C)	2.97 ± 1.20	1.83 ± 0.60**	3.80 ± 0.73**
Axillary-Sole (A-S) (°C)	2.58 ± 1.28	1.54 ± 0.60**	3.62 ± 0.74**

The values were non-significant except marked ** where the values were significant ($p < 0.001$) on comparing Group B with Group C.

Table I also incorporates the patient characteristics of preterm babies in group B and Group C. Group B consisting of 11 preterms with 5 males and 6 females, had birth weights of 1.39±0.3 kg at a gestational age of 32.09±2.78 weeks. However, at the time of the temperature recordings (17.64±12.74 days), their weights were 1.47±0.2 kg. The mean temperatures (SD) from the various sites were rectal 37.1°C (0.38), axillary 36.8°C (0.42) and sole 35.3°C (0.76), respectively. In Group C, there were 7 males and 4 females with their birth weights (1.48±0.2 kg), gestational ages (32.27±2.56 weeks), age at the time of study (20.73±13.46 days) and weights at the time of study (1.42±0.15 kg). These differences were not statistically significant ($p>0.05$).

There was also no statistically significant difference ($p>0.05$) between the rectal and axillary temperatures of Group B *vs* Group C (*Table II*).

In fact, in all 3 groups, *i.e.,* Groups A, B and C there was hardly any difference ($p>0.05$) on comparing their rectal and axillary temperatures, rectal temperatures always being more or equal to the axillary. All babies were normothermic.

Comparing the sole temperatures (34.1±1.34°C) of Group A *vs* Group B (35.3±0.76°C), the difference was significant ($p<0.001$). Hence, rectal-sole and axillary-sole temperature differences were statistically significant.

The sole temperatures of the normal preterms (35.0±0.76°C) was significantly higher than those of the preterms with sepsis (33.2±0.99°C). This resulted in statistically highly significant values ($p<0.001$) when comparison of R-S and A-S was made between the two groups of preterms (*Table I*).

Figures 1 and 2 show the efficacy of using the R-S and the A-S temperature difference as a screening test for detection of sepsis. A value of ≥2.3°C had a sensitivity of 100% while ≥3.2°C had 100% specificity using the R-S difference. The respective values for A-S were ≥2.2°C and 3.0°C. The overall accuracy in each case was 90.9%.

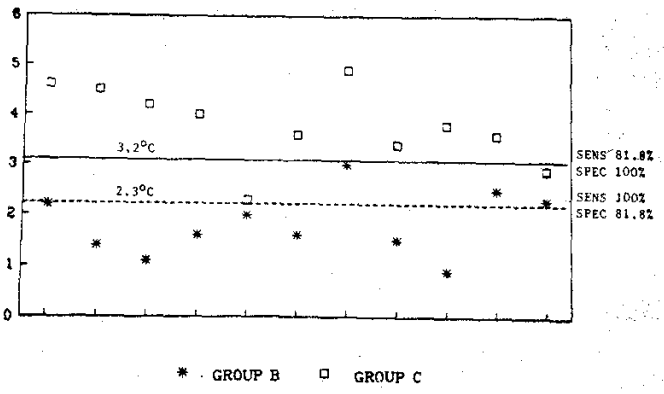

Fig. 1. Rectal-sole temperature difference in normal preterms versus preterms with sepsis.

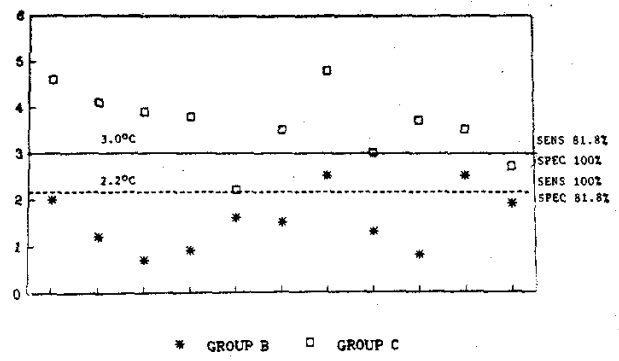

Fig. 2. Axillary-sole temperature difference in normal preterms versus preterms with sepsis.

Discussion

Since the early 1960's it has been demonstrated that a neonate has all the capabilities of a homeotherm, although the range of environmental temperature over which he can operate successfully is severely restricted as compared to an older child or adult and their thermo-regulatory responses may be jeopardized by disease(10). It has been stated that newborn

infants react to infection by widening the gap between the core and skin temperature. This situation is analogous to that seen in feverish children and adults, fever being a sign of infection. As is well recognized, neonates, especially prematures do not react with pyrexia in response to an infection(5) but they may become hypothermic.

Comparing preterm babies with or without sepsis, the R-S (1.83 ± 0.6; 3.8 ± 0.73°C) and the A-S (1.54 ± 0.74°C; 3.62 ± 0.74°C) showed a highly significant difference ($p < 0.001$). Babies stressed with sepsis had a widening of the core and peripheral (sole) temperature difference. In an earlier study(5), of 7 preterm babies, a mean R-S difference of 4.7°C was found in normothermic septicemic infants. They also found similar results in 21 additional infants in whom septicemia was suspected on clinical and laboratory criteria. All infants, in their study, were kept in incubators whose temperatures were maintained in the thermoneutral zone.

These results were presumably because of preterms efforts to maintain core temperature at the expense of peripheral vasoconstriction leading to colder peripheries.

This widening of the core-peripheral difference can be a useful marker for sepsis. Unlike, the previous study where infants were nursed in incubators(5), the babies in the present study were in the wards with their mothers. This is a fairly common situation in most of the hospitals in our country. The R-S and A-S values mentioned earlier would be useful as a pointer towards sepsis in normothermic preterm neonates. This would corroborate clinical and laboratory data, pending culture sensitivity reports, thus precluding the rampant misuse of antibiotics.

Sole temperatures of normal preterm babies were significantly more ($p < 0.001$) than those of the term babies. This has probably occurred because the term babies were in the general maternity wards, where the thermal environment was not adequately controlled, resulting in subclinical metabolic stress to these babies(11). The preterms being very low birth weight, were nursed in a thermoneutral environment compatible with their gestational and extrauterine age(6).

Rectal and axillary temperatures were similar both in term and preterm babies. There was no significant difference even in preterms with sepsis, who were all normothermic (*Table I*). This has been amply borne out by other workers also(5,6,7). Hence, axillary temperature does not require any addition for judging the actual (core) temperature in normal term, preterm and normothermic preterm with sepsis, as is the common belief.

We would, therefore, recommend that for routine use axillary temperature measurements would suffice. With a little experience, feeling of the temperature of the skin of the trunk/axilla or sole with the examiner's hand can be a reasonable indicator of the temperature at that site. In such a situation or when indicated on clinical grounds, measurement of rectal and sole temperatures is necessary for confirmation.

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