

neonatal sepsis and its associated factors are poorly researched in Africa is of concern.[19] The neonatal mortality rate - defined as the number of babies dying in the neonatal period (first 28 days of life) per 1000 live births was estimated at 44, four times the rate in Europe (11 per 1000 births) and the Americas (12 per 1000 births).[1] These figures further explain why the subject of pyrexia in the perinatal period is very important.

Although the commonly accepted definition of neonatal pyrexia is a rectal (core body) temperature of 38°C or more [20] there seems not to have been a consensus for the temperature at which action is warranted as this sometimes depends on local practice and customs. [5,21-23] While some say that neonatal pyrexia is a rectal (core body) temperature above 37.4°C and use a 37.5°C axillary temperature as an intervention point, others say there is no need to act until the temperature is above 37.8 °C. [23] The range of normal temperatures for new born babies should also be expanded to include lower temperature.[24] Relationships exist between temperature in the first few days of life and factors such as body weight, gestational age and route of delivery.[25]

Although it could be argued that the causative organisms responsible for neonatal pyrexia are more or less universal, other factors could be hospital dependent. For example a common cause of neonatal hyperthermia is inappropriate incubation [3]; however most of these studies were carried out in temperate climates where the ambient temperature is obviously different. In the harsh temperature environment of Namibia, could the number of babies with fever be higher? This is one of the knowledge gaps this research intended to address.

At the Intermediate Hospital Oshakati no study has yet been done on the pattern of temperature in neonates. It is hoped that with this work a baseline would have been set and more interest in future research would be stimulated.

AIM

To assess the prevalence and pattern of as well as factors associated with perinatal pyrexia amongst term babies delivered at Intermediate Hospital Oshakati (IHO).

OBJECTIVES

- 1) To determine the prevalence of neonatal pyrexia
- 2) To determine the temperature pattern of neonates within the first seven days of life
- 3) To assess the impact of maternal fever, urinary tract infection and premature rupture of membrane on perinatal pyrexia.

METHODS

Study design

The study design for this project was a descriptive cross-sectional survey of babies during their first 7 days of life. The outcome of interest was the frequency of pyrexia, where pyrexia was defined as at least one episode of temperature $\geq 37.2^{\circ}\text{C}$.

Three commonly encountered conditions known to be associated with pyrexia in neonates in this context were chosen to study their effects on the temperature pattern. These were maternal fever, premature rupture of membrane and maternal urinary tract infection.

Measurement of the babies' body temperature started at birth and then every 6 hours for the first 7 days. Temperature observations occurred partly in the hospital by the nursing staff and partly at home by the mothers. The armpit (axillary thermometry) route was used as recommended by the American Academy of Paediatrics.[26] Mothers were taught how to use the thermometers before discharge from the hospital. They returned on the 7th day for their first postnatal visit bringing the completed observation sheets with them.

Setting

The study took place at the Intermediate Hospital Oshakati, Namibia within the labour room, the neonatal intensive care unit and the postnatal ward. These three units are all situated in the same building, but have separate nursing staff. The hospital is a regional referral centre hence it receives patients into the above mentioned units from the various surrounding clinics and hospitals. Though there were three 'sites' for the study as mentioned above there was however only one

central register for these babies where records of events from delivery to discharge were kept and as such it was easy to get whatever information that was needed.

Study population

The study population consisted of all children born at IHO during the study period between 01 September 2014 to 28 February 2015. This 6 month period was necessary in order to recruit enough babies into the study to satisfy the sample size requirement.

Inclusion criteria

Term babies delivered at IHO, irrespective of the mode of delivery. Term delivery was considered as gestation of 37 completed weeks and above.[27]

Exclusion criteria

Babies were excluded from the study if they were born pre-term. Preterm delivery was any delivery at gestation less than 37 completed weeks. [27-28] No ill or congenitally deformed baby was excluded as long as such baby was delivered at term.

Sampling procedure

This was a prospective study involving a comparison of groups using a dichotomous variable (proportion of babies with temperature $\geq 37.2^{\circ}\text{C}$). Therefore to estimate the proportion (prevalence) with a 95% confidence interval of $\pm 5\%$ a total of 384 babies needed to be recruited into the study.

This is shown using the formula below:

$$\text{Sample size} = (Z \text{ score})^2 \times SD \times (1-SD) / (\text{Margin of error})^2$$

$$95\% \text{ confidence level} = Z \text{ score} = 1.96; SD = \text{standard deviation} = 0.5$$

$$\text{Margin of error} = \text{confidence interval of } \pm 5\% = 0.05$$

$$\text{Sample size} = 1.96^2 \times 0.5(1-0.5) / 0.05^2 = 384.16$$

No adjustment was made to this number because no drop out from the study was anticipated since the mothers were followed up telephonically and they were obliged to attend the mandatory 7th day post-natal checkup. Every consecutive 5th baby delivered during the study period and who met the inclusion criteria was systematically recruited into the study.

Data collection

Informed written consent was obtained from the mothers indicating their willingness to participate in the study and giving assent for their babies as subjects. Data collected at delivery was gender, weight and temperature. Temperature was then measured 6 hourly until discharge from the hospital. The usual length of stay in hospital was 2-3 days. Before discharge from the hospital, the mothers were educated on how to take the baby's temperature and how to record it on the sheet that was provided. Hence while at home the temperature recording continued every 6 hours until day 7 when the mother returned to the hospital for the final assessment. However if the temperature reached 37.2°C while at home before day 7, the mothers were instructed to bring the baby to the hospital at that point.

Temperature was measured using Mode KT-DT4B digital axillary thermometers which had a measuring range of 32°C-42°C and accuracy to the nearest tenth of degree. Digital thermometers were used since the accuracy is comparable to mercury in glass thermometers.[29] To ensure reliability and uniformity only thermometers from a single batch were used throughout the study. The readings were recorded on a specially designed data capturing sheet. The data capturing sheet was a modification of the commonly used temperature recording sheet designed by the Namibian Ministry of Health. A total of 28 readings were recorded per baby.

For babies identified as pyrexial, laboratory investigations such as full blood count, C-reactive protein, malaria parasite slide, urine culture and sensitivity, and where applicable Chest X-ray were performed and additional information was obtained such as gestational age at birth, mother's parity and number of days post-delivery before onset of fever. Additionally the clinical files of the mothers of these babies were retrospectively checked for documentation of at least one single episode of maternal fever, urinary tract infection or premature rupture of membrane prior to delivery. The birth register which was updated on a daily basis was the source for the total number of births during the study period (both term and preterm).

Data analysis

All data gathered were then captured into an Excel sheet for analysis. Descriptive statistics were used to analyze the data. Continuous variables were analyzed with means and standard deviations for normally distributed data and medians and interquartile ranges for non-normally distributed data. The mean and standard deviation of the temperature at equal points in time was computed

with the aim of observing the variability in the 6-hourly readings. The temperature readings were also grouped by the associated factors of maternal fever, premature rupture of membrane and urinary tract infection. A baby was considered pyrexial if the temperature reached 37.2°C at least once during the study period. The number of episodes where a baby had experienced pyrexia was computed. For each baby the count was summed up and used in a Poisson regression reporting the incidence rate ratio. For nominal and ordinal data absolute and relative frequencies were presented. The prevalence in this study was considered to be the proportion of all the babies (384) who had pyrexia at a given point in time. This was calculated as the number of babies who had a temperature of 37.2°C or higher as numerator and the total number of babies as denominator, expressed as a percentage. The data about the total number of babies born during the study period was obtained from the birth register.

ETHICAL CONSIDERATIONS

Ethics approval for the study was obtained from the Health Research Ethics Committee (HREC) of Stellenbosch University (Ethics Reference number: S14/01/023) and also from the Research Management Committee of the Namibian Ministry of Health (approval reference number: 17/3/3)

RESULTS

Total deliveries for the 6 month period of study were 2562 out of which 156 were preterm. Of the 384 babies that took part in the study, 205 were males and 179 were females. Birth weight ranged from 2.4kg to 9kg. The minimum recorded temperature was 32.0°C while maximum was 39.7°C. These characteristics are shown in Table 1.

Table 1. Demographic profile of study participants

Birth weight (Kg)	All (N=384)	Male (N=205) n (%)	Female (N=179) n (%)
< 2.5	1 (0.3)	1 (0.4)	0 (0)
2.5 to 3.0	18 (4.7)	9 (4)	9 (5)
3.1 to 3.5	72 (18.7)	26 (10.4)	46 (18.4)
3.6 to 4.0	293 (76.3)	169 (67.6)	124 (49.6)

Most of the babies were within normal birth weights. There was only one case of low birth weight (< 2.5kg). Each baby had 28 temperature recordings over the 7 days of monitoring. The mean, minimum and maximum values for temperature readings at each time point are presented in Table 2. Notably xx (68%) of babies had the first episode of raised temperature within the first 72 hours (3 days) after birth.

Table 2. The temperature profile at different time periods, showing the mean, standard deviation, minimum and maximum recorded temperatures plus point prevalence. (N=384)

Time of recording (hours)	Temperature values (°C)				Prevalence of pyrexia (%)
	Mean	Std Dev	Minimum	Maximum	
At birth	37.09	0.68	35.5	39.7	74
6hrs	37.01	0.73	35.2	39.2	68
12hrs	37.08	0.61	35.2	38.9	73
18hrs	37.11	0.72	32.0	38.9	76
24hrs	37.10	0.67	35.5	38.9	73
30hrs	37.12	0.64	35.2	38.9	77
36hrs	37.07	0.64	34.0	38.6	73
42hrs	37.07	0.60	35.5	38.5	74
48hrs	37.15	0.61	34.0	38.9	78
54hrs	37.13	0.66	35.2	38.8	75
60hrs	37.18	0.60	34.0	38.9	80
66hrs	37.12	0.65	35.4	39.5	74
72hrs	37.08	0.68	35.5	38.9	74
78hrs	37.18	0.58	35.2	38.8	81
84hrs	37.17	0.60	35.2	38.8	80
90hrs	37.08	0.64	35.5	38.5	75
96hrs	37.10	0.59	35.5	38.8	75
102hrs	37.14	0.61	35.5	38.9	78
108hrs	37.13	0.65	35.4	38.6	76
114hrs	37.16	0.69	35.0	39.5	78
120hrs	37.16	0.63	35.5	38.8	79
126hrs	37.13	0.61	35.5	38.8	78

132hrs	37.20	0.62	35.3	39.5	78
138hrs	37.17	0.60	35.5	38.9	78
144hrs	37.15	0.65	35.6	38.6	77
150hrs	37.21	0.63	35.5	39.5	80
156hrs	37.11	0.65	35.3	38.9	74
162hrs	37.12	0.60	35.6	38.9	76

What could be seen from this table is that the mean temperature for the whole period of study was close to the defined set value for pyrexia (37.2°C). Over the time period there was a mean of 3.06 (95% CI 2.99-3.13) observations of pyrexia per day per baby and all babies (100%) had pyrexia at some point in time. When the mean temperature was plotted over time it revealed the pattern as seen in Figure 1.

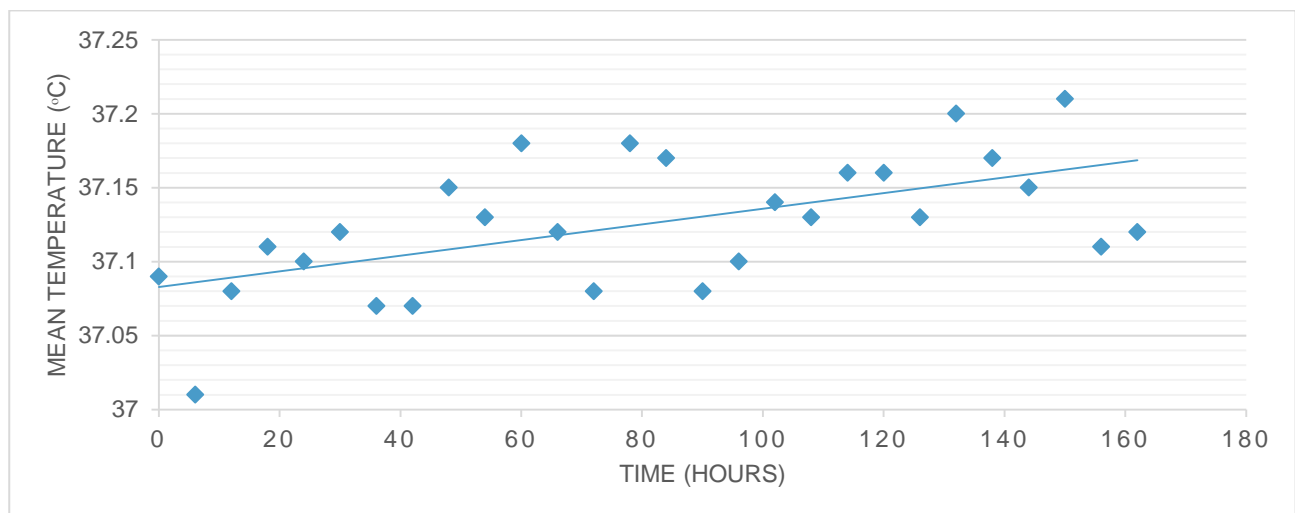


Figure 1. The mean temperature for all the babies over the period of 7 days (162 hours)

The graph shows that the lowest mean temperature was recorded at 6hrs (day 1) with a value of 37.01°C while the highest mean was at 150 hours (day 7) with a value of 37.2°C. This implies that for the period as a whole the prevalence of pyrexia was 100%. The prevalence of pyrexia in those with and without the selected risk factors is shown in Table 3.

Table 3. The relationship between the prevalence of pyrexia and the selected predictors.

Neonatal pyrexia	Maternal fever	UTI	PROM
Present	76.2	76.5	77.0
Absent	76.7	76.5	76.0

It is seen from the table that the presence or absence of these risk factors made no difference to the prevalence that was obtained.

DISCUSSION

Key findings

All the babies in the study group were pyrexial at one point or the other. The minimum recorded temperature was 32.0°C while the maximum was 39.7°C. The mean point prevalence at any given time period over the 28 points in time was 76.1% while the mean number of episodes of pyrexia per day per baby was 3. Maternal fever, UTI and PROM did not have an impact on the prevalence.

Discussion in relation to literature

The period during which this study was carried out was the summer months in Namibia and, especially in the northern parts of the country, temperatures usually reach excessive highs. It is likely therefore that the high prevalence of pyrexia is related to the high environmental temperature. This however is in contrast with a study conducted in the northern part of India during summer, where the prevalence of pyrexia was found to be only 36.8%. [30]

Data from this study though might have shown the temperature pattern in the babies but it might not have been sufficient to clearly show the associations between pyrexia and other risk factors apart from those mentioned here. This hospital environment may well be different in terms of persistently high temperatures and humidity in this region. However the fact that this study showed there was no serious impact on the temperature pattern goes to confirm that the relationship between pyrexia and its multiple associated/risk factors is complex.

This study showed a wider range of temperatures (32°C-39.7°C) when compared to similar studies under similar circumstances. [31]

The high prevalence of the first episode of pyrexia within the first 3-days (68%) is in contrast to much lower prevalence figures (15% [32] and 0.43% [33]) found elsewhere. This could finding could be explained by persistent high temperatures and humidity associated with our practice region.

Limitations of study

The thermometers used in this study were standard clinical digital thermometers and the nurses taking the temperatures used the techniques they use in clinical practice such that the errors from them are as minimal as possible. However the same cannot be said of the mothers taking the temperatures at home. Although all the mothers returned the data sheets fully completed, the authenticity and accuracy of the readings could not be verified.

The pattern of temperatures seen in Figure 1 suggests a gradual increase in mean temp over 7-days. This pattern reflects these 7-days as the environmental variation over 6-month would be a constant for the 7-days of any specific measurement. Furthermore, it is possible that one might have obtained different results if the study had been done in winter or across the whole year?

Not much significant inference can be made regarding the associations between the risk factors and pyrexia in this study. This is because for the selected predictors, the data were sourced retrospectively from the clinical files which were subject to either non-reporting or non-documentation. Another methodological limitation was the fact that the data were collected over a period of 6 months; during this period environmental variability could have also contributed to the pattern that was observed. Not making adjustments for this factor thus limit the degree to which the results could be generalized.

Ideally a study such as this requires that the participants be kept in the same environment (hospital) for the whole period of the study (7 days) as this would have eliminated environmentally biased sources of error. The pattern seen in Figure 1 could be explained by the transition from hospital to home over the 7-days. The financial implication of this on the part of the hospital management and the parents of the babies however made this impossible.

Recommendations

Studying the pattern of temperature of similar group of babies within a different seasonal period (winter) will enable a comparison with the result of this study and could further elucidate if environmental factors play a significant role in neonatal temperature patterns in the first few days of life. This study was not able to draw conclusion on the relationship between the months and prevalence.

A new research concentrating on more specific group of babies e.g. healthy term babies or pre term babies with emphasis on aetiologic factors of pyrexia will be beneficial in establishing the prevalent

risk factors for neonatal pyrexia in our hospital. This will also help in ensuring more rational antibiotics prescription and usage.

It is suggested that because of the high prevalence of pyrexia identified by this study, closer monitoring of new born babies should be the norm with a high index of suspicion for those babies whose mothers had antenatal risk factors for neonatal pyrexia.

CONCLUSION

All babies developed pyrexia at some point in the neonatal period and on average three-quarters had pyrexia at any given time point over the 7-days. Temperatures ranged from 32.0°C to 39.7°C and 68% developed the first episode of pyrexia within the first 3-days. There was no observed relationship with maternal fever, maternal UTI or PROM. Neonatal pyrexia during the summer months in Namibia is the norm and may be related to the high environmental temperatures in the absence of air conditioned hospitals and homes. The use of neonatal pyrexia alone as a sign of serious sepsis or underlying disease is therefore limited and further research should focus on developing clinical decision making pathways appropriate to the local context.

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