1990

Optimal axillary thermometer placement time for recording neonatal temperature

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OPTIMAL AXILLARY THERMOMETER PLACEMENT TIME FOR RECORDING NEONATAL TEMPERATURE

BY

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of

Bachelor of Health Science (Nursing) Honours

at the School of Nursing, Western Australian College of Advanced Education

Date of Submission: 22.10.90

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ABSTRACT

Since body temperature is a reflection of neonatal wellbeing, taking and recording an accurate temperature is an important nursing role. Research has shown that axillary temperature adequately reflects core body temperature and is the recommended site for neonates. However, researchers have been unable to agree on the length of thermometer placement time to record an accurate axillary temperature. The purpose of this study was to determine the optimal thermometer placement time to record the maximum axillary temperature in newborn infants using a descriptive, correlational design. Axillary temperatures were taken using a convenience sample of 100 healthy, term neonates between 38 and 42 weeks gestation, weighing greater than 2500 grams and who had been uncompromised during delivery. The same mercury in glass thermometer, which had been tested for accuracy, was held in the axilla of each neonate. Recordings were taken every minute until the mercury in the thermometer had been stable for 5 minutes. Data analysis revealed that in 90% of subjects the thermometer stabilised in 6 minutes. Other data recorded were gestational age, birthweight, type of delivery, age in hours, number of extra blankets, sex and time of data collection. These variables were analysed in conjunction with

the time for thermometer stabilisation to detect any significant relationship. Significance level was set at α=.05. No significant relationships were detected between thermometer stabilisation time and the extraneous variables. The results of this study indicate that the optimal thermometer placement time for recording an accurate axillary temperature in a healthy, term neonate is 6 minutes.

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

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ATHALIE JOHNSTON

22nd October 1990

DATE

I wish to thank the management and administration of Osborne Park Hospital for allowing me to use their facilities and records for this project. I would also like to acknowledge the Department of Biophysics at Sir Charles Gairdner Hospital for their assistance with testing the thermometers, Stan Suiter for his help with the graphs and Amanda Blackmore for her assistance with the computer analysis. Above all, I would like to thank David Shorten, Lecturer, Western Australian College of Advanced Education, School of Nursing for his patience, advice and supervision throughout this research and thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

As the neonate adjusts to extrauterine life, he/she is at risk of developing hypothermia or hyperthermia which may result in hypoglycaemia and hypoxia causing subsequent brain damage (Dodman, 1987). Therefore, accurate monitoring of the neonatal temperature is an important nursing role.

One site commonly used to assess infant temperature is the axilla. However, researchers have been unable to agree on the length of time the thermometer should be held in place to register the infant's maximum temperature. Placement times suggested range between 1 minute (Farrer, 1985) to greater than 11 minutes (Shiffman, 1982). This lack of consensus highlights the need to continue research in this area. The purpose of this study was to determine the optimal thermometer placement time to record the maximum axillary temperature in newborn infants.

LITERATURE REVIEW

Accurate monitoring of the neonatal temperature is an important nursing role. In fact, Perez (1981, p. 257) states that "assisting the newborn to maintain body temperature is the most significant aspect of neonatal care." The following literature review discusses relevant research relating to thermometer placement in adults and neonates and highlights

the recommended axillary thermometer placement times from noted text books.

Thermometer placement sites

The most common anatomical sites for temperature measurement are the mouth, axilla and the rectum (Eoff, Meier and Miller, 1974). Although oral temperature measurement is the most common method used for adults it is seldom used for children under 5 years of age. The sites most commonly used for younger children are the axilla and the rectum. Rectal temperature has been considered to reflect an accurate core temperature. However, as pointed out by Perez (1981), the core temperature is often normal in the presence of cold stress. She also maintains that by the time the rectal temperature becomes abnormal the infant's compensatory mechanisms have already failed. Lau and Ong (1981) investigated broken and retained rectal thermometers in infants and young children while Greenbaum, Carson, Kincannon and O'Loughlin (1969) found cases of pneumoperitoneum in the newborn induced by rectal thermometers. Consequently, the risk of perforation of the rectum and subsequent peritonitis has led researchers to recommend axillary, rather than rectal temperature measurement in neonates.

Eoff et al (1974), comparing rectal and axillary temperatures in 30 neonates, found that although rectal temperature was 0.5°F higher than the axillary temperature, they considered, for practical purposes, that this small difference would not be significant when assessing an

infant's health status. A more recent study by Guiffre, Heidenreich, Carney-Gersten, Dorsch and Heidenreich (1990), compared axillary temperature with core temperature in non post operative intensive care adults. They found a strong correlation between core and axillary temperature thus reflecting the accuracy of the axillary temperature.

Recently, researchers have compared alternative thermometer placement sites with rectal and axillary temperatures in the newborn. Kunnel, O'Brien, Munro and Medoff-Cooper (1988) and Bliss-Holtz (1989) explored the inguinal area and Kunnel et al (1988) included skin to mattress temperatures in their research. Although temperatures at these sites were similar, the researchers found no advantages over axillary or rectal thermometer placement.

Adults

Since opinions of how long a thermometer should be left in situ differed in the 1960's, Nichols, Ruskin, Glor and Kelly (1966) compared rectal, axillary and oral thermometer placement in 60 adults. They found that the majority of rectal thermometers stabilised in 4 minutes while oral and axillary thermometers took 10 to 11 minutes to stabilise. From this observation they suggested that 9 minutes was the optimum time for a mercury in glass thermometer to be placed in the axilla to record maximum temperature. As a result of this study, Kozier and Erb (1987, p. 778) advocate 9 minutes as the recommended time for axillary thermometer placement. Subsequent researchers such as Shiffman (1982), Haddock, Merrow and Vincent (1988) and Bliss-Holz

(1989), investigating thermometer placement time in neonates, have used definitions and references from this study.

Healthy, full term neonates

Although most research in neonatal temperature recording has been carried out on preterm and sick neonates some studies have examined full term neonates. Kunnel et al (1988) studied 99 full term neonates comparing rectal, femoral, axillary and skin to mattress temperatures. They found that it took 11 minutes for 90% of subjects to reach optimal axillary temperature. No recommendation for thermometer placement time was made from this study. These findings were not supported by Bliss-Holtz (1989) who compared rectal, axillary and inguinal temperatures in healthy full-term infants. She found that 95% of axillary thermometers reached maximum temperature by 5.5 minutes. She subsequently recommended 4 minutes for axillary placement time. This finding was supported by Mayfield, Bhatia, Nakamura, Rios and Bell (1984), who, comparing term and preterm neonates, found that 90% had stabilised axillary temperatures within 5 minutes with a mean time of 4.8 minutes for term infants and 3.8 minutes for preterm infants.

Pre term and ill full term neonates

Preterm and ill, term neonates are generally nursed in incubators or under radiant heaters. This warmed environment may influence the mercury in glass thermometer reading. Shiffman (1982), however, surveyed full term neonates in incubators and found that the axillary

temperature did not stabilise over a 10 minute period. This research was supported by Stephen and Sexton (1987) who recorded the axillary temperature of 60 healthy, term neonates and 40 neonates in incubators. They also found that axillary temperature continued to rise over an 11 minute period. However, both studies agreed that the difference in temperature rise past 3 minutes was small enough to be of no clinical significance. On the other hand, Haddock et al (1988), comparing axillary and rectal temperatures in pre-term infants, found that 90% of axillary thermometers reached optimum temperature in 3 minutes. Most of these infants were in isolettes or had radiant heaters. However, the researchers were surprised to find that this conflicted with a previous study they had conducted where the results indicated that it took 5 minutes for an axillary thermometer to reach optimal temperature in full term neonates. They concluded that thermometers in the axillae of pre term infants stabilise in a shorter time than full term infants. This conclusion may be supported by Fleming, Hakansson and Svenningsen (1983) who found that 2.5 minutes was adequate for preterm infants in intensive care while Bliss-Holtz (1989) recommended 4 minutes axillary placement time for full term neonates. However, the environmental factors of the isolettes and radiant heaters may have decreased the time required for axillary thermometers to reach optimum temperature rather than the fact that the infants were pre-term. Further comparison studies in this area are required to substantiate this conclusion.

Text books

As a result of the conflicting findings by researchers of optimum placement time for axillary, mercury in glass thermometers, text book recommendations also vary (see Appendix A). Farrer (1985, p. 172) suggests 1 minute, Olds, London and Ladewia (1988, p. 861) suggest 3 minutes while Kozier and Erb (1987, p. 778) advocate 9 minutes as the time required to record an axillary temperature. The consequence of this variation in recommended placement times is confusion among nurses. To support this, a survey was conducted by the author among 20 midwives working in a midwifery unit at a regional public hospital and 20 midwives who attended a College of Midwive's general meeting. The survey revealed that although 50% said the optimal time for thermometer placement was 3 minutes, the other 50% believed that either 1, 2, 4 or 5 minutes was the optimal time. The majority were in agreement that, should a subnormal temperature be discovered, the thermometer would be replaced in the axilla for an extended time period. This practice was also identified by Stephen et al (1987) who suggest that perhaps this serves as a safety valve. This practice should confirm hypothermia, but may not detect hyperthermia if the thermometer is removed too quickly.

Conclusion

The importance of temperature control in the neonate has been well documented. Rectal temperature was considered to be the most accurate as it closely reflected the core body temperature. However, research by Shiffman (1982), Kunnel et al (1988), Haddock et al (1988) and Bliss-

Holtz (1989), comparing rectal and axillary temperature, found that axillary temperature was, in fact, similar to rectal temperature. This has more recently been demonstrated by Giuffre et al (1990) who found a strong, positive correlation between core body temperature and axillary temperature taken with a mercury in glass thermometer. Since thermometer placement in the axilla is also safer than thermometer placement in the rectum, axillary temperature is recommended for monitoring the neonate. However, there is a lack of consensus concerning the length of time required to take an infant's axillary temperature. Therefore, further research is required to validate a universal, recommended time for axillary thermometer placement.

THEORETICAL FRAMEWORK

Since human beings are homeothermic, the neonates must attempt to maintain their temperature within a narrow range as they adapt to extrauterine life. Newborn thermoregulation is closely related to metabolic rate and oxygen consumption. Severe hypothermia or hyperthermia can result in hypoglycaemia and hypoxia causing subsequent brain damage or death (Dodman, 1987) (see Figure 1).

Factors which affect the neonate's ability to maintain body temperature are a larger body surface in relation to mass, decreased

NEUTRAL THERMAL ENVIRONMENT (NTE)→→→→→THERMOREGULATION
(ADJUSTED FOR WEIGHT AND GESTATION)

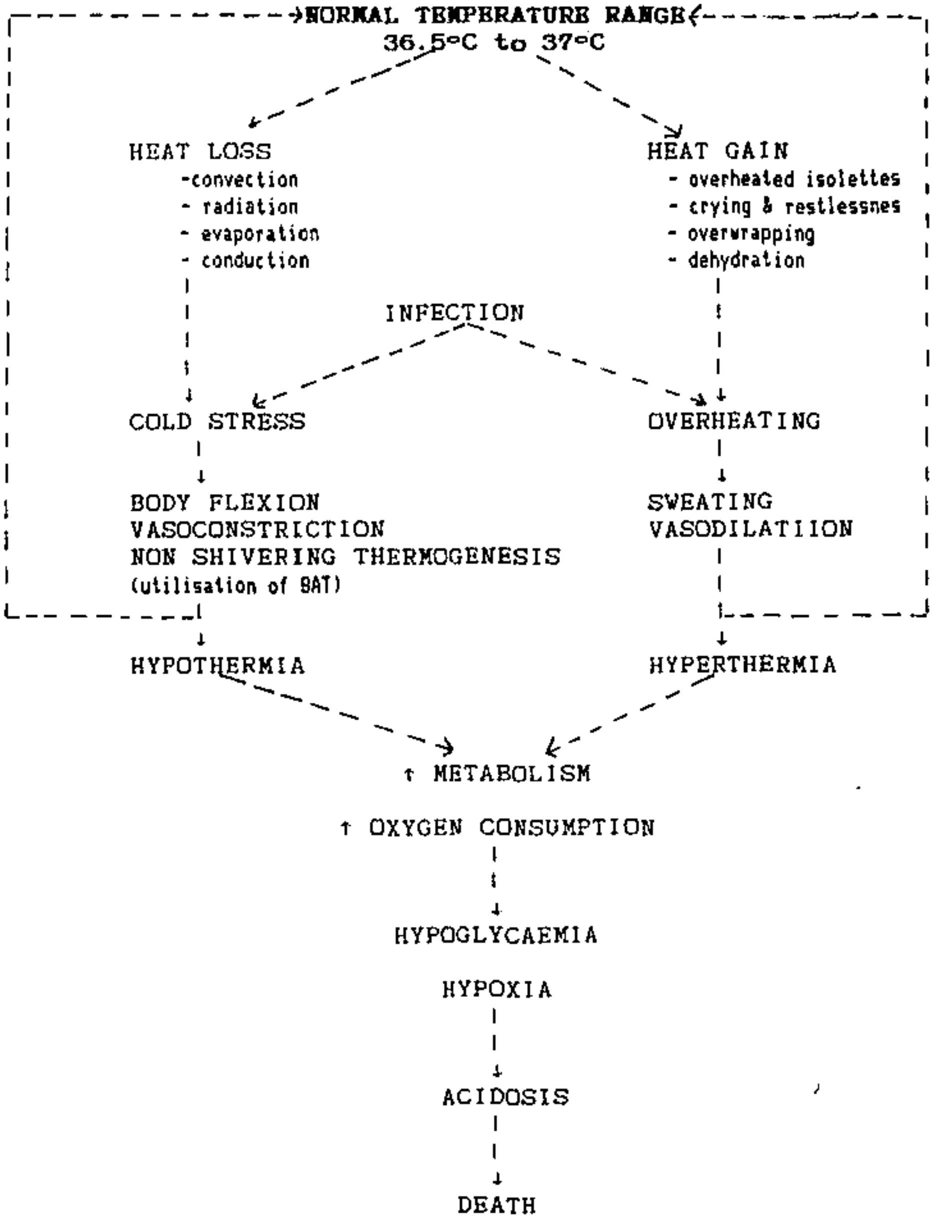

Figure 1: Neonatal Temperature Control.

subcutaneous fat, thin epidermis with blood vessels closer to the skin than adults and brown adipose tissue (BAT). BAT appears at approximately 28 weeks gestation and, in the normal term neonate, continues to increase until about 2 to 5 weeks of age. BAT is deposited around the neck, in the mid scapular area and axilla and around the trachea, oesophagus, abdominal aorta, kidneys and adrenal glands. When skin receptors perceive a drop in environmental temperature, sensations are sent to the central nervous system which stimulates the sympathetic nervous system. As a result, Norepinephrine is released by the adrenal gland and local nerve endings in the BAT causing the metabolism of triglycerides to fatty acids, thereby releasing heat. This is known as nonshivering thermogenesis (Olds et al 1988).

In the normal term neonate, the rate of heat loss per unit of body weight is four times that of an adult (Dodman 1987). Heat is lost from the base core to the surface and from the surface to the environment. There are four recognised routes of heat loss.

1. *Convection* is loss of heat from the warm body surface to the surrounding air currents.
2. *Radiation* is the transfer of heat from the body surface to the cooler surfaces and objects not in direct contact with the body.
3. *Evaporation* of water from the body surface results in heat loss as the water is vaporised.
4. *Conduction* is the loss of heat to the cooler surfaces which are in direct contact with the skin.

The term infant will attempt to prevent a fall in body temperature by adopting the flexed fetal position, peripheral vasoconstriction and non shivering thermogenesis.

It is essential to maintain a neutral thermal environment for neonates as they adapt to extra uterine life. Perez (1981, p. 260) defines Neutral Thermal Environment (NTE) as "the range of thermal environment in which an infant with a normal body temperature has minimal oxygen and caloric consumption and expends the least metabolic effort". It is essential to maintain this environment for the well being of the neonate as environmental changes influence the circulating blood which in turn influences the hypothalmic temperature control regulating centre (Olds, London and Ladewig, 1988). A room temperature of 24°C to 26.5°C is recommended in the labour ward and nursery to maintain the body temperature of 36.6°C to 37°C in the clothed full term neonate (Dodman 1987).

If the temperature of the neutral thermal environment falls, oxygen consumption and metabolism is increased as thermogenisis occurs. This results in hypoglycaemia and hypoxia. Prolonged exposure to cold stress depletes glycogen stores and eventually results in acidosis (Ladwig, London and Olds, 1986).

Hyperthermia, defined by Dodman (1987) as a temperature of more than 37.4°C is less common than hypothermia but can also become a problem. Pyrexia may be caused by increased environmental temperature such as overheated isolettes or simply overwrapping the

infant as well as by infection and dehydration. Neonates have six times as many sweat glands as adults but they have a limited function until after the fourth week of extrauterine life. However, sweating is the usual response of the newborn to hyperthermia. Heat is dissipated by vasodilation and evaporation of insensible water loss while metabolic rate and oxygen consumption are increased (Olds et al 1988).

The relationship between inadequate temperature regulation and neonatal morbidity has been well documented. Such conditions as impaired brain growth, spastic diplegia and reversible growth retardation have been demonstrated in infants maintained at slightly cooler skin temperatures (Perez, 1981). Therefore, the importance of careful maintainance of neonatal temperature is essential to the survival and quality of life of the neonate.

METHOD

Design

A descriptive, correlational design was used in this study to answer the research questions.

Questions for study

1. What is the optimal thermometer placement time to record the maximum axillary temperature of a healthy, term neonate?
2. Is there a relationship between the time taken for the axillary thermometer to reach maximum temperature and the variables age in hours, type of delivery, birthweight, gestation, number of extra blankets, time of day and sex?

Sample and setting

A convenience sample of 100 healthy neonates from a 32 bed low risk maternity unit in a peripheral public hospital were studied. Infants considered eligible for inclusion in the study were between 38 and 42 weeks gestation with a birthweight of greater than 2500 grams. They were all uncompromised during labour and delivery with an Apgar score of not less than 8 at 1 minute and 9 at 5 minutes. At the time of data collection each infant was at least 4 hours of age to allow time for thermoregulation to be established.

Infants were not considered for the study if they were receiving medical care, nursed in an isolette or receiving antibiotics since these variables may have influenced the results of the study. Assumptions were made that the infants in the study were healthy and not suffering from any underlying illness and they had been maintained in a neutral thermal environment. It was also assumed that these neonates were not dehydrated nor did they have undetected hypoglycaemia. The temperature was not taken while the infant was crying or restless as this physical activity may also have influenced the thermometer reading.

Instruments

Brazilian made 'Brite Sight' mercury in glass thermometers were used as these instruments were in clinical use in the hospital where this study was undertaken. A Tuta Temperature Control Water Bath, which gently moved the water while heating and a Filac electronic thermometer, which had been calibrated for accuracy, were used to test the mercury in glass thermometers for accuracy.

Six mercury in glass thermometers were placed in cold water in the water bath and the water heated. The water temperature was then tested with the Filac electronic thermometer and the mercury in glass themometers were immediately removed from the water and read. In all, 48 thermometers were tested in this way. Only 5 of these thermometers recorded the same temperature as the Filac while others

varied as much as 0.8°C. Using the same method, these 5 thermometers were once again checked and found to be accurate. To enhance internal validity, it was envisaged that all the temperatures would be taken with the same thermometer. However, the thermometers were numbered and recorded on the data collection sheet in case of breakage.

On completion of data collection, the thermometer, which had been used for 100 subjects, was retested in the same manner as the pretest using a similar Tuta Temperature Controlled Water Bath. The mercury in glass thermometer was held in the water until the mercury stabilised. The water temperature was taken with the same Filac electronic thermometer which, again, had been calibrated for accuracy and the mercury in glass thermometer was immediately removed from the water and read. This procedure was repeated six times. Three of these times the mercury in glass thermometer and the Filac electronic thermometer recorded the same temperature and three times there was a 0.1°C difference between the two thermometers.

A large pocket watch with a sweep second hand was used to time the recordings. Although a new battery was used and the watch appeared to maintain the correct time no test of reliability or validity was undertaken for this instrument.

Procedure

Prior to commencement of this study, approval was obtained from the ethics committee of the Western Australian College of Advanced Education, School of Nursing, the participating hospital and the consultant in charge of the obstetric unit. Prior to the collection of data, parental consent was obtained for those infants meeting the selection criteria. Parent/s were given an information sheet (Appendix B) and a written consent was obtained (Appendix C) prior to the collection of data.

Routine care of the well neonate in the obstetric unit requires the temperature to be taken hourly until three consecutive temperatures of between 36.5°C and 37°C are recorded. Following stabilisation the temperature is recorded at least once daily. Each participating infant was included once only in the study and, as much as possible, the data were collected during the normal daily observation period thus minimising duplication and subsequent double handling of the infant.

A pilot study consisting of five infants was conducted to test the data collection tools. No problems were encountered with the procedure or data collection tools. However, the thermometer was broken and another accurate thermometer was used for subsequent data collection. As the first thermometer could not be rechecked for accuracy the data from the pilot study have not been included in the data analysis and results.

Infants were taken to the same nursery with a temperature of between 25°C and 27°C. A large pocket watch with a sweep second hand was used for timing all thermometer placements. Each selected infant was wearing a singlet, jacket and nappy and was wrapped in a cuddle rug and covered with at least one blanket. Demographic information of time of day, sex, age, type of delivery, birthweight, gestation, and number of extra blankets was collected on the data collection tool (Appendix D). The thermometer was shaken down to below 35°C. The infant was gently unwrapped to expose the arm, taking care to keep the rest of the body well wrapped. The thermometer was positioned with the bulb in the middle of the axillary pocket and the graduations clearly visible for recording purposes. The arm was then held gently and firmly close to the body for a tight seal. This procedure left one of the researcher's hands free to record the data. Temperature readings were recorded every minute until the same temperature reading had been recorded six times. This ensured that the mercury had been stable for at least five minutes. To guard against cross infection the thermometer was carefully washed with soap and cold water between subjects.

OPERATIONAL DEFINITIONS

Maximum temperature - The temperature recorded when the mercury in the thermometer has been stable for five minutes.

Optimal placement time - Adapted from Kunnel et al (1988) - The time taken for the thermometer to reach maximum temperature in 90% of subjects.

RESULTS

Sample characteristics

A total of 112 mothers were approached for consent to include their infants in this study. Seven declined and 5 were discharged before data could be collected. Data were collected and analysed on 100 infants consisting of 55 males and 45 females. These demographic details are described in Table 1. Of these observations, 50 were recorded between 7 a.m. and 12 midday and 50 between 12 midday and 6 p.m. Gestational age ranged from 38 to 42 weeks (mean 39.8 weeks, SD 1.1 weeks) and birthweight ranged from 2660 grams to 4300 grams (mean 3401 grams, SD 373.6 grams). Seventy six of the infants had a normal vaginal delivery, 5 were delivered by forceps, 7 by vacuum extraction and 12 were delivered by elective lower uterine caesarian section. At the time of data collection, the age of the infants in hours ranged from 6 hours to 152 hours (mean 31.7 hours, SD 24.5 hours). All of the infants were dressed in a singlet, jacket and nappy, wrapped in a rug and covered with a blanket. The number of extra blankets on the infants at the time of data recording ranged from 0 to 5 (mean 1.4 SD 1.2).

Table 1.

Demographic Details of Infants.

Variable	Mean	SD	Minimum	Maximum
Gestational age (weeks)	39.8	1.1	38	42
Birthweight (grams)	3401	373.6	2660	4300
Study age (hours)	31.7	24.5	6.0	152.0
Extra blankets	1.4	1.2	0	5

Gender	
Male	55 (55%)
Female	45 (45%)
Type of delivery	
Normal vaginal	76 (76%)
Forceps	5 (5%)
Vacuum Extraction	7 (7%)
Elective caesarian	12 (12%)
Time of data collection	
7a.m. to 12 midday	50 (50%)
12 midday to 6p.m.	50 (50%)

Data analysis

The Statistical Analysis System computer package was used to calculate the minimum, maximum, mean and standard deviation of the variable, time for the thermometer to reach maximum temperature. Cumulative percentage was calculated to determine when thermometer readings had reached maximum temperature in 90% of subjects. Maximum temperature was considered to be reached when the mercury in the thermometer had been stable for si: consecutive recordings. Pearson Correlation Coefficients were used to detect any relationship between the time taken for the axillary thermometer to reach maximum temperature and the variables age in hours, birthweight, gestation and the number of extra blankets. T-tests were conducted to compare the difference in thermometer stabilisation time and sex and time of data collection. The data were categorised into type of delivery and similar tests were conducted to detect any relationships. A significance level of α=.05 was set for all analyses.

Optimal placement time

The time required for the thermometer to reach maximum temperature ranged from 2 minutes to 10 minutes (mean 4.05 minutes SD 1.29) (see Table 2). Cumulative frequency showed that 3% stabilised in 2 minutes, 40% in 3 minutes, 73% in 4 minutes, 87% in 5 minutes, 95% in 6 minutes, 99% in 7 minutes and 100% in 10 minutes. Table 3 and Figures 2 and 3 display these data. Therefore, the optimal

Table 2.

Analysis of Variable :

Time in Minutes for Thermometer to Reach Maximum Temperature.

	Number	Minimum	Maximum	Mean	S.D
Total Deliveries	100	2.0	10.0	4.05	1.29
Normal Vaginal Deliveries	76	2.0	10.0	4.05	1.27
Forcep Deliveries	5	3.0	5.0	3.80	1.09
Vacuum Extraction	7	2.0	7.0	4.42	1.90
Elective Caesarian	12	3.0	7.0	3.91	1.24

Table 3.

Axillary Thermometer Stabilisation Time : Cumulative Frequency.

Total deliveries N = 100

Time (Minutes)	Frequency	Percent	Cumulative Percent
2	3	3.0	3
3	37	37.0	40
4	33	33.0	73
5	14	14.0	87
6	8	8.0	95
7	4	4.0	99
10	1	1.0	100

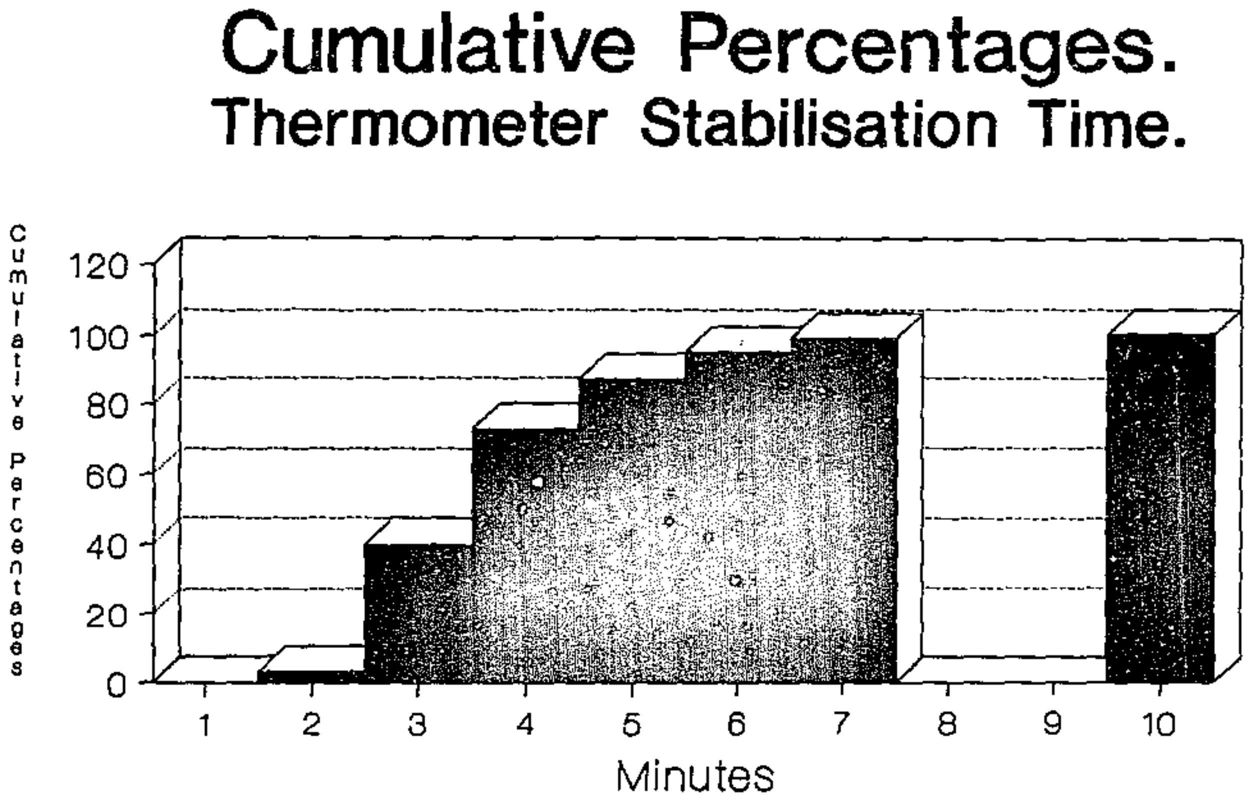

Figure 2. Cumulative Percent
For Total Deliveries.

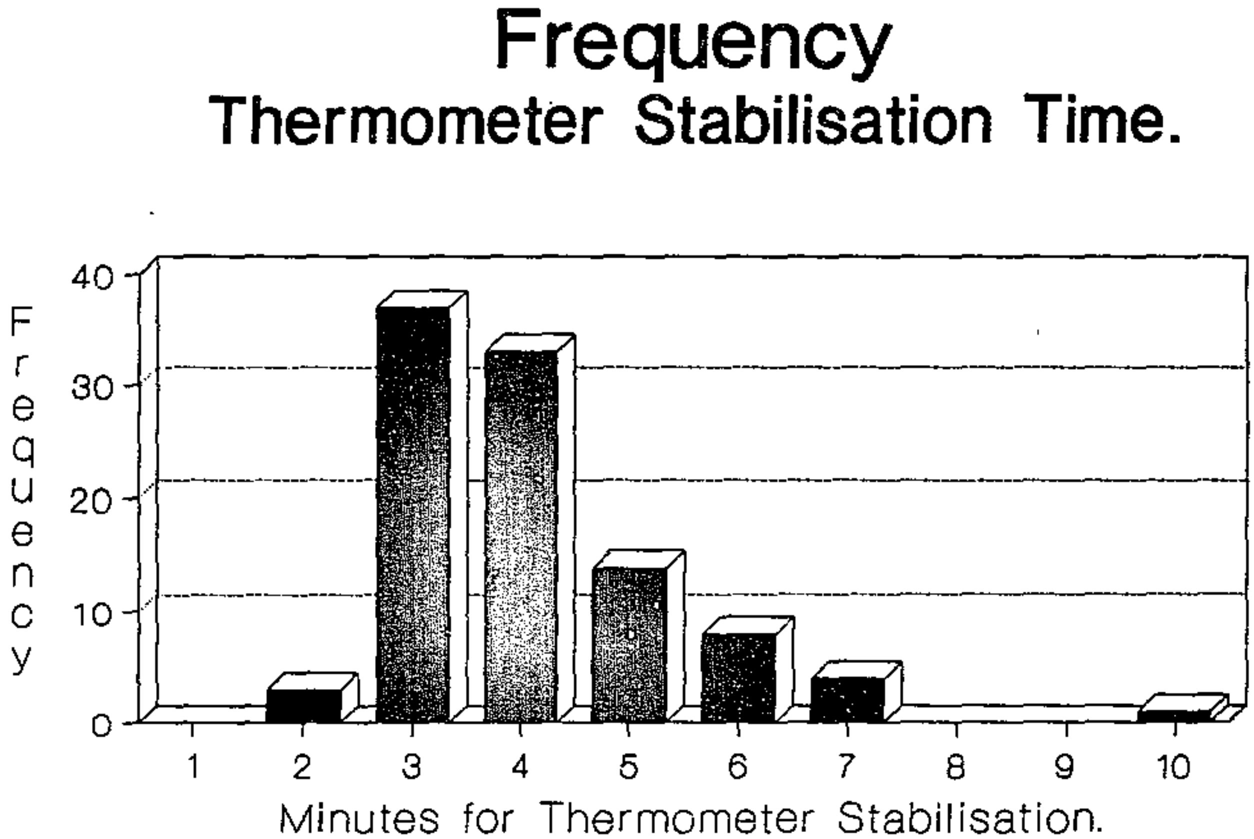

Figure 3. Frequency for Total Deliveries

placement time, defined as the time taken for the thermometer to reach maximum temperature in 90% of subjects, was 6 minutes. The data were further analysed in the categories of deliveries to determine whether the type of delivery influenced the time taken for the temperature to stabilise.

Normal vaginal deliveries

The time required for these 76 subjects' thermometer to reach maximum temperature ranged from 2 minutes to 10 minutes (mean 4.05 minutes, SD 1.27 minutes) (displayed in Table 2). Cumulative percentage showed that 2.6% stabilised in 2 minutes, 38.2% in 3 minutes, 73.7% in 4 minutes, 86.8% in 5 minutes, 97.4% in 6 minutes, 98.7% in 7 minutes and 100% in 10 minutes. Therefore, once again, 6 minutes was the time taken for the thermometer to reach maximum temperature in at least 90% of the subjects.

Forceps deliveries

Five subjects were delivered by forceps. The time required for the thermometer to reach maximum temperature ranged from 3 minutes to 5 minutes (mean 3.8 minutes, SD 1.09 minutes) (see Table 2). Cumulative frequency showed that 60% reached maximum temperature in 3 minutes and 100% in 5 minutes. It was noted that in 90% of subjects in this group the thermometer stabilised in 5 minutes.

Vacuum extraction

For 7 infants the time taken for the thermometer to reach maximum temperature ranged from 2 minutes to 7 minutes (mean 4.42 minutes, SD 1.90 minutes) (see Table 2). Cumulative frequency was 14.3% in 2 minutes, 28.6% in 3 minutes, 71.4% in 4 minutes and 100% in 7

minutes. In this group it took 7 minutes for the subjects' thermometer to record maximum temperature.

Elective caesarian section

Twelve infants were included in this category. The time taken for the thermometer to reach maximum temperature ranged from 3 minutes to 7 minutes (mean 3.91 minutes, SD 1.24 minutes) (see Table 2). Cumulative frequency showed that 50% reached maximum temperature in 3 minutes, 75% in 4 minutes, 91.7% in 5 minutes and 100% in 7 minutes. As with the forcep delivery group, it took 5 minutes for the thermometer to record maximum temperature in 90% of subjects.

Influence of other variables

Pearson Correlation Coefficients analysis detected no significant relationship between the variable, stabilisation time and gestation, age in hours, birthweight and the number of extra blankets (see Table 4). However, a significant, positive correlation between gestation and birthweight (p=.005) and a significant, negative correlation between age in hours and the number of extra blankets (p=.043) was noted.

T-Tests conducted to compare the difference between the time taken for the thermometer to stabilise and the variables sex and time of data collection were not significant ($\underline{t}$ (98) = -.2698, p=.7879).

Table 4.

Pearson Correlation Coefficients.

Total Deliveries N=100

	TIME	AGE	WEIGHT	GESTATION	BLANKETS
STABILIS'N	1.000	.040	.147	.064	-.085
TIME	p=.000	p=.686	p=.145	p=.527	p=.401
AGE	.041	1.000	-0.069	-.142	-.203
in HOURS	p=.686	p= .000	p=.490	p=.160	*p=.043
BIRTH	.147	-.069	1.000	.278	-.123
WEIGHT	p=.145	p=.493	p=.000	*p=.005	p=.223
GESTATION	.064	-.142	.287	1.000	-.129
	p=.527	p=.160	*p=.005	p=.000	p=.199
BLANKETS	-.085	-.203	-.123	-.129	1.000
	p=.401	*p=.043	p=.223	p=.199	p=.000

* Significant at p=.05

DISCUSSION

Thermometer stabilisation

The purpose of this study was to determine the optimal thermometer placement time to record the maximum axillary temperature in healthy, newborn infants. The results indicate that in 90% of the subjects the thermometer reached maximum temperature in 6 minutes. In fact, in this study, the thermometer of 95% of subjects stabilised in 6 minutes. Therefore, according to the operational definition, 6 minutes is considered the optimal axillary thermometer placement time. This conclusion is similar to Mayfield et al (1984) who found that 90% of axillary thermometers of 99 full term neonates stabilised in 5 minutes. Similarly, Bliss-Holtz (1989), who recorded the temperature of 120 full term neonates every 30 seconds, found that 95% of axillary thermometers reached maximum temperature by 5.5 minutes. Since temperatures in this study were only recorded every 60 seconds it is conceivable that this study is in agreement with Bliss-Holtz (1989). Further research may confirm this assumption.

Although this study found that 6 minutes was the optimal thermometer placement time to record maximum axillary temperature in a healthy neonate it is noted that the rise in temperature past the mean time of 4 minutes was 0.1°C in 26 of the remaining 27 subjects and 0.2°C for the other 1 subject. It is therefore worth considering whether 4 minutes is sufficient time for axillary thermometer placement as this

small rise in temperature would not affect the clinical care of the neonate.

While only one subject in this study took greater than 7 minutes for thermometer stabilisation, Kunnel et al (1988), who studied 99 healthy full term neonates with similar sample characteristics, found that it took 11 minutes for 90% of thermometers to reach maximum temperature. As in this study, thermometers were tested for accuracy both pre and post data collection. However, while this study concentrated on axillary temperature, Kunnel et al (1988) recorded rectal, femoral, axillary and skin-to-mattress temperature simultaneously over a 15 minute period. This necessitated greater handling of the infant. As a result, muscular activity may have increased with a possible rise in metabolic rate which may have influenced the thermometer recording. Another difference was that, in an attempt to ensure internal validity in this study, the same person collected all of the data while Kunnel et al (1988) used 16 nurses for data collection. However, it was documented by Kunnel et al (1988) that tests were conducted to ensure interrater reliability.

Again, Kunnel et al (1988) indicate that 45 of their subjects were quiet while 54 displayed behaviours from sleep to crying. However, crying can cause heat gain while movement of the arm of a restless subject could cause friction on the thermometer bulb and hence, a continued rise of the mercury within the thermometer. Therefore crying during data collection may have influenced the stabilisation time of the

mercury in the thermometer. For this very reason, crying and restless infants were excluded from this study.

In this study, the temperature of two males and one female stabilised in 2 minutes. These subjects were aged between 19 and 68 hours of age and weighed between 3170 grams and 3640 grams. One recording took place in the afternoon and two in the morning. Five subjects, four males and one female took 7 minutes or more for thermometer stabilisation. These infants weighed between 2970 grams and 4110 grams and were between 22 and 58 hours of age. One of these recordings took place in the afternoon and four in the morning. Since data collection was evenly distributed between morning and afternoon it is interesting to note that, of these eight extremes in stabilisation time, six took place in the morning. One possible explanation is that of circadian rhythm related to muscular activity and digestive processes. Another explanation could be that, as the data collection took place in the winter months and the infants are usually bathed in the mornings, they could have experienced a change in their neutral thermal environment with the subsequent activation of BAT relatively close to data collection. As the mean age of these infants was 30 hours, it is unlikely that primary thermoregulation had not been established.

Relationship of other variables

Although the purpose of this study was to determine the optimal axillary thermometer placement time to record the maximum temperature of a neonate, the data were also analysed for any relationship between

this optimal thermometer placement time and the extraneous variables age in hours, birthweight, gestation and number of extra blankets. No significant relationship was detected between these variables for the total number of infants. However, a significant, positive correlation was noted between birthweight and gestation (p=.005). This correlation is not unexpected as, in a healthy pregnancy, the weight of the fetus increases with gestation. As gestational age in this study was restricted to between 38 weeks and 42 weeks the difference in weight was not so evident and the correlation, although significant, was not as strong as one would expect if the gestational age range had been broader.

At the hospital where this study was conducted, healthy, full term infants are kept with their mother in the ward area where the environmental temperature may not be as warm as that in the nursery. As a result it is common practice to cover the infant with extra blankets to ensure warmth in the early hours of life. Therefore it was not unexpected in the analysis of the total deliveries to find a significant, negative correlation (p=.043) between the number of extra blankets and age in hours.

Hyperthermia

Hyperthermia is defined by Dodman (1987) as a neonatal temperature of more than 37.4°C. Seven infants in this study recorded temperatures of 37.5°C and above. Five of the infants recorded elevated temperatures in the morning and only two in the afternoon. The subjects were four

males and three females aged between 11 and 22 hours of age, between 40 and 42 weeks gestation and weighing between 3330 grams and 4050 grams. Two of the infants had no extra blankets while the other five had two extra blankets. Thermometer stabilisation took from three to seven minutes. It is possible that the infants with two extra blankets could have been overwrapped giving rise to the subsequent hyperthermia.

It is worth considering that if the thermometer is not left insitu for the recommended length of time the caregiver, finding a reading within normal temperature range, may accept this reading as the accurate recording. This may result in undetected hyperthermia.

Instrument

Since body temperature is a reflection of neonatal wellbeing, taking and recording an accurate temperature is an important nursing role. However, to be confident of a clinically accurate temperature, confidence is required in the accuracy of the thermometer used to take this temperature. Nichols et al (1966) tested 104 thermometers and found only 8 to be accurate. Conversely, Shiffman (1982) tested only six thermometers and found that all six met the U.S. National Bureau of Standards (1972) code for these type of thermometers. Giuffre et al (1990) used 31 mercury in glass thermometers in their study and, although they did not test them for accuracy, one failed to register during data collection. Guiffre et al (1990 are the only researchers who have identified the mercury in glass thermometers they used.

For this study, 48 thermometers were tested, but only 5 recorded the same temperature as the calibrated Filac electronic thermometer. The thermometers varied as much as 0.8°C. Since the therapeutic range for neonates is 36.5°C to 37.4°C this discrepancy could make a difference to patient care. It therefore seems reasonable to expect the thermometers used in clinical practice to be reliably accurate. A question to be considered then is, what is the criteria for purchasing thermometers used in hospitals? Is it accuracy and reliability or is it cost? The subsequent cost of under treatment or over treatment due to inaccurately recording body temperature could outweigh the cost of reliably accurate thermometers.

It is noted that the brand of mercury in glass thermometer used by Guiffre et al (1990) is different from the thermometer used in this study. Therefore, it is also likely that each research project has been conducted with a different brand of thermometer, made in a different country. This may have a bearing on the comparison of research result if the thermometers have not been checked for accuracy.

Skin to skin contact

Crying and restlessness results in increased muscular activity which can cause overheating and subsequent sweating and vasodilation. Therefore, for this study, data collection would have been abandoned should the infant have become restless or cried. However, although 100 infants were studied this occurred only once. During the data collection period, all but one of the infants remained either quiet or asleep. Most of the infants stirred or whimpered when the cold

thermometer was placed in the axilla but they soon settled when firm, gentle pressure was placed on the skin of the arm and lower face by the researcher's hand. Although no study was made into this phenomenon, perhaps this skin to skin, hand to face contact should be investigated as a method of pacifying unsettled infants.

Limitations of the study

Since the criteria for inclusion of infants in this study was restricted to healthy, full term neonates, it is not possible to state that six minutes is the optimal thermometer placement time to record maximum axillary temperature for all neonates. Data were collected from a convenience sample from a peripheral public hospital therefore the results of this study are restricted to this population. Results may have been influenced by the fact that a change in the neutral thermal environment at bath time and nappy change was not taken into account during data collection. Again, the time of the last feed and the type of feed was not noted. This may have influenced the results due to recent muscular activity, hydration and altered blood glucose levels.

IMPLICATIONS FOR NURSING PRACTICE

Nalepka (1976), Schmitt (1981), Perez (1981 and Dodman (1987) indicate that body temperature reflects neonatal well being. Therefore, taking and recording an accurate neonatal axillary temperature is an important part of nursing practice. To ensure an accurate temperature recording

the thermometer must be correctly placed and held in this position for a specific length of time. The results of this study indicate that 6 minutes is the optimal thermometer placement time to record maximum axillary temperature for a healthy, term neonate.

RECOMMENDATIONS FOR FURTHER RESEARCH.

Since temperature recording is such an important part of nursing care the instrument used for this recording should be accurate and reliable. Evidence from this study suggests that the current type of mercury in glass thermometer used at the hospital where this research took place may not be as accurate and reliable as one would expect. Further investigation into the procedure for purchasing thermometers is warranted.

This study examined only healthy, term infants and found that 6 minutes was the optimal axillary thermometer placement time. However, Haddock et al (1988) and Fleming et al (1983) who studied preterm neonates suggest 3 minutes and 2.5 minutes is the correct time for thermometer placement. Further study is required to determine if there is a difference in the time required for temperature stabilisation between preterm and full term, healthy infants.

All mothers know that nursing and holding a restless child has a soothing effect. It was noted during this study that skin to skin contact of hand to arm and face appeared to maintain the infants in a quiet, restful state. Further investigation into this concept may reveal a useful strategy for settling restless neonates.

Appendix A

Time documented for axillary thermometer placement in minutes.

	1	2.5	3	4	5	9	11
RESEARCH							
ADULTS					Nichols et al (1966)		
HEALTHY FULL TERM				Bliss-Holz (1989)	Haddock et al (1988)		Kunnel et al (1988)
ILL & PRETERM		Fleming et al (1983)	Haddock et al (1988)		Mayfield et al (1984)		Shiffman (1982) Stephen et al (1987)
TEXT BOOKS							
ADULTS						Kozier et al (1987)	
NEONATES	Farrer (1985)		Olds et al (1988)				

Appendix B

PARENT INFORMATION SHEET.

OPTIMAL THERMOMETER PLACEMENT TIME TO RECORD

MAXIMUM AXILLARY TEMPERATURE.

Athalie Johnston Registered Midwife (Researcher)

While still in the uterus, baby's temperature is controlled by his/her mother. After birth, however, he/she must adapt to the changed environment and control his/her own temperature accordingly. This is the reason that we wrap baby tightly in blankets. To monitor this transition, we take baby's temperature frequently.

At present, there are no set rules as to how long we should leave the thermometer under baby's arm to record an accurate temperature. As part of my degree in nursing I am undertaking research into this problem. It involves taking the temperature of a baby with the thermometer under the arm for a period of 12 minutes. As your baby will be having his/her temperature monitored, it will involve no extra treatment.

At all times, all information gathered will be kept in the strictest confidence and your name will not be used. Your decision to include your baby in the study will be entirely voluntary. You may refuse to consent or may withdraw your baby at any time without affecting any present or future treatment or care you may require.

Should you have any queries feel free to contact me at any time.

Athalie Johnston
Work - [redacted] page no. 309
Home - [redacted]

Appendix C

CONSENT FORM

OPTIMAL THERMOMETER PLACEMENT TIME TO RECORD

MAXIMUM AXILLARY TEMPERATURE.

I have read the accompanying information form and understand that my baby's temperature will be taken once, for a period of 12 minutes. I have had the opportunity to ask further questions about the study and they have been answered to my satisfaction.

I understand that I may withdraw my baby from the study without affecting any present or future care we may require.

I have been assured of complete confidentiality at all times.

______________________________ ________________
Signature of parent/s Date

______________________________ ________________
Signature of Witness Date

Appendix D

DATA COLLECTION SHEET

RESEARCH NUMBER................ [__ __ __]

TIME .... [__]

1. A.M.

2. P.M.

SEX

1. MALE .... [__]

2. FEMALE ....

AGE IN HOURS .... [__ __ __]

TYPE OF DELIVERY

1. S.V.D .... [__]

2. FORCEPS ....

3. VACUUM ....

4. L.U.S.C.S. ....

BIRTH WEIGHT .... [__ __ __ __]

GESTATION .... [__ __]

NUMBER OF BLANKETS .... [__]

THERMOMETER NUMBER .... [__]

MINUTES	1	2	3	4	5	6	7	8	9	10	11	12
TEMPERATURE												

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