FACTORS RELATED TO HYPOTHERMIA IN PREMATURE INFANTS ROOMING-IN WITH THEIR MOTHERS

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FACTORS RELATED TO HYPOTHERMIA IN PREMATURE INFANTS ROOMING-IN WITH THEIR MOTHERS.

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ABSTRACT

The purposes of this descriptive research were to describe the patterns of temperature and hypothermia in premature infants and to examine factors including gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention, and how they account for hypothermia in premature infants rooming-in with their mothers.

The biological model of thermoregulation and Orem's Self-Care Deficit Theory of Nursing (1995) provided the framework for this study. A purposive sample of 100 mother-premature infant dyads was recruited from a postpartum and gynecological ward, Nakornpathom Hospital, Nakornpathom Province, between June and December 2002. Premature infants' temperature, environmental temperature, and humidity were measured every two hours during the first 24 hours after birth. Data regarding maternal behaviors for hypothermia prevention were collected using a self-reported questionnaire. Data were analyzed using descriptive statistics and logistic regression.

Results indicate that 28% of premature infants rooming-in with their mothers had hypothermia. The highest occurrence of hypothermia was immediately after birth and six hours after birth. The mean temperature score during the 24 hours was not below 36.5°C. The lowest temperature was immediately after birth. The pattern of premature infants' temperatures was unstable during the first twelve hours after birth. The combination of gestational age, birth weight, environmental temperature and maternal behaviors for hypothermia prevention accounted for a 24.2% variance of hypothermia. After controlling for other factors, only variations in environmental temperature were statistically significant at the 0.05 level, infants rooming-in with their mothers in a low room temperature were 0.33 times more likely to have hypothermia than those who were not in a low room temperature (Odds ratio = 0.335, $p < .05$).

These results indicate that health care providers and the mothers should closely monitor for hypothermia and the factors related to hypothermia, especially environmental temperature. Also nurses could stress the importance of, and promote education about, thermoregulation to mothers, and how to practice more effective care. These steps can lead to an appropriate care for hypothermia prevention.

KEY WORDS : PREMATURE INFANT / HYPOTHERMIA / ROOMING-IN

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ปัจจัยที่มีความสัมพันธ์กับภาวะอุณหภูมิกายต่ำในทารกคลอดก่อนกำหนดที่อยู่กับมารดาในระยะ 24 ชั่วโมงหลังคลอด (FACTORS RELATED TO HYPOTHERMIA IN PREMATURE INFANTS ROOMING-IN WITH THEIR MOTHERS)

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บทคัดย่อ

การวิจัยเชิงบรรยายครั้งนี้มีวัตถุประสงค์เพื่อศึกษาแบบแผนอุณหภูมิกายและภาวะอุณหภูมิกายต่ำในทารกคลอดก่อนกำหนดที่อยู่กับมารดาในระยะ 24 ชั่วโมงหลังคลอด และหาอำนาจการอธิบายของปัจจัยที่มีความสัมพันธ์กับภาวะอุณหภูมิกายต่ำ ประกอบด้วย อายุครรภ์ น้ำหนักแรกเกิด อุณหภูมิสิ่งแวดล้อม ความชื้นสัมพัทธ์ และพฤติกรรมการป้องกันภาวะอุณหภูมิกายต่ำของมารดา

การวิจัยนี้ใช้กรอบแนวคิดการควบคุมอุณหภูมิกายและความพร่องในการดูแลตนเองของโอเร็ม (1995) เลือกกลุ่มตัวอย่างมารดาและทารกคลอดก่อนกำหนดตามเกณฑ์ที่กำหนด จำนวน 100 ราย จากหอผู้ป่วยสูติกรรมและนรีเวชกรรม โรงพยาบาลนครปฐม จังหวัดนครปฐม ในระหว่างเดือนมิถุนายนถึงเดือนธันวาคม พ.ศ. 2545 เก็บรวบรวมข้อมูล วัดอุณหภูมิกายทารก อุณหภูมิสิ่งแวดล้อมและความชื้นสัมพัทธ์ทุก 2 ชั่วโมงในระยะ 24 ชั่วโมงแรกหลังคลอด และให้มารดาตอบแบบสอบถามพฤติกรรมการป้องกันภาวะอุณหภูมิกายต่ำของมารดาด้วยตนเอง การวิเคราะห์ข้อมูลใช้สถิติบรรยายและสถิติการวิเคราะห์ถดถอยโลจิสติก

ผลการวิจัยพบว่า ทารกคลอดก่อนกำหนดที่อยู่กับมารดาในระยะ 24 ชั่วโมงหลังคลอด มีภาวะอุณหภูมิกายต่ำ 28 เปอร์เซ็นต์ จำนวนภาวะอุณหภูมิกายต่ำเกิดมากที่สุดเมื่อแรกเกิดทันทีและ 6 ชั่วโมงหลังคลอด ค่าเฉลี่ยอุณหภูมิกายทารกในระยะ 24 ชั่วโมงหลังคลอดไม่ต่ำกว่า 36.5 องศาเซลเซียส อุณหภูมิกายทารกต่ำที่สุดเมื่อแรกเกิดทันที แบบแผนอุณหภูมิกายทารกในระยะ 12 ชั่วโมงแรกหลังคลอดยังไม่คงที่ ปัจจัยด้านอายุครรภ์ น้ำหนักแรกเกิด อุณหภูมิสิ่งแวดล้อม และพฤติกรรมการป้องกันภาวะอุณหภูมิกายต่ำของมารดาร่วมกันอธิบายการเกิดภาวะอุณหภูมิกายต่ำได้ 24.2 เปอร์เซ็นต์ หลังจากควบคุมตัวแปรอื่นๆให้คงที่ อุณหภูมิสิ่งแวดล้อม เป็นปัจจัยเดียวที่มีความสัมพันธ์กับภาวะอุณหภูมิกายต่ำในทารกคลอดก่อนกำหนดที่อยู่กับมารดาในระยะ 24 ชั่วโมงหลังคลอดอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 โดยทารกที่อยู่กับมารดาในห้องที่มีอุณหภูมิต่ำมีโอกาสเกิดภาวะอุณหภูมิกายต่ำมากกว่าทารกที่อยู่กับมารดาในห้องที่มีอุณหภูมิไม่ต่ำ 0.33 เท่า (Odds ratio = 0.335)

การศึกษานี้แสดงให้เห็นว่า ทีมสุขภาพและมารดาต้องเอาใจใส่ต่อภาวะอุณหภูมิกายต่ำและปัจจัยที่มีความสัมพันธ์กับการเกิดภาวะอุณหภูมิกายต่ำโดยเฉพาะอุณหภูมิสิ่งแวดล้อม โดยเน้นให้มารดาเห็นความสำคัญให้ความรู้ความเข้าใจเกี่ยวกับการควบคุมอุณหภูมิกาย เพื่อให้เกิดการปฏิบัติอย่างมีประสิทธิภาพ อันจะส่งผลให้เกิดการป้องกันภาวะอุณหภูมิกายต่ำได้อย่างเหมาะสม

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CONTENTS

CONTENTS (continue)

LIST OF TABLES

LIST OF FIGURES

CHAPTER I
INTRODUCTION

Background and Significance of the Study

Hypothermia is an important problem of thermoregulation frequently found in newborn infants. It affects health status and survival of infants in early adaptation period after birth, especially premature infants who are considered as a high-risk neonate group. Hypothermia can be life threatening for infants if they receive inappropriate care for the prevention of heat loss or warming (Thongsouy Sitanon, 1998: 35). Therefore, premature infants require a careful neonatal surveillance for hypothermia from both health care providers and their mothers.

One study in USA found that 45% of hypothermia occur in premature infants (Loughead, Loughead, and Reinhart, 1997: 13). In Thailand, the study of Thongsouy Sitanon (1998) found that 86% of hypothermia occurred in premature infants born in the hospital and 91.7% occurred in premature infants referred from another hospital. Significantly, hypothermia is frequently found in a transitional period. Johanson, et al. (1992) found that 85% of hypothermia in premature infants occurs at two hours and nearly 50% at 24 hours after birth. However, Thongsouy Sitanon, (1998) found that hypothermia occurs within 30-510 minutes in infants weighing from 800 to 3,200 grams and from 28 to 36 weeks' gestation. According to these results, hypothermia is still an important problem occurring in the adaptation period.

Generally, all newborns have a period of irregular adjustment in the first six to eight hours for extrauterine life (Hammond, 2000: 671) before their body systems stabilize. The temperature of the newborn usually drops in the first phase of the transition period lasting up to 30 minutes after birth (Hammond, 2000: 672), especially in an air conditioned delivery room, but it returns to normal in about eight hours (Marlow, 1990: 158). The premature infants have a difficulty in thermoregulation because of the limitation of organ systems' maturation. The ability of them to maintain their internal body temperature is less than that of adults. Therefore, if the newborns have heat loss more than heat production, they develop hypothermia which can be detected by measuring body temperature with rectal and axillary methods below 36.5°C or skin mode below 36°C (Kriangsak Jirapaet, 1993: 261; Frigoletto and Little, 1988: 274).

The adverse effects of hypothermia, particularly in premature infants, occur in the functional of multiple organs (Engler & Rutton, 1996; Blake & Murray, 1993; Brink, 1990, cited in Thongsouy Sitanon, 1998: 33-35). The most common adverse effect is an increasing metabolic rate, which means more glucose and oxygen consumption. If these requirements of glucose and oxygen are not met, anaerobic metabolism continues, producing lactic acid as a by-product which then leads to metabolic acidosis and hypoglycemia (Merenstein and Gardner, 1989: 111-112). Finally, if hypothermia is prolonged without correction or prevention, it could cause respiratory distress, tachypnea, cyanosis, apnea, and even death.

Hypothermia in the premature infants depends on many factors. Johanson et al. (1992) studied the effect of post-delivery care on neonatal body temperature and found that the principal risk factors for hypothermia in premature infants weighing below 2,500 grams are preterm gestation, low birth weight, and cold air temperature. Also, according to Engler & Rushton (1996: 449), factors related to ineffective thermoregulation are environmental and maturational. Certainly, most infants born before term may have low birth weight and other physical characteristics, which are predisposed to excessive heat loss such as an even smaller muscle mass, fewer deposits of brown fat for producing heat, and lack of insulating subcutaneous fat (Whaley & Wong, 1999: 398). Moreover, their neurological maturity is less developed, that is, they have decreased muscle tone and less flexion of the extremities than in the term infants. Also, the conditions surrounding them that easily to contribute heat loss hypothermia such as cool air temperature and low humidity of delivery room. The infants may have high evaporative heat loss in the low humidity. Thus, these factors are related to the balancing of heat loss and heat production, especially the mechanisms of thermal exchange or the physical routes of heat loss, which are classified into four types: conduction, convection, radiation, and evaporation (Brueggemeyer, 1993: 247-262; Baumgart, 1991: 255; Korones and Lancaster, 1981: 85-87). The majority of heat loss in the neonate infant is through radiation and convection (Amlung, 1998: 208). Forty-three percent of heat loss after birth come from radiation and depend on environmental temperature (Fanaroff and Martin, 1983, cited in Wattana Kulnatsiri, 1993: 17). The highest evaporative heat loss occurs on the first day of life (Hammarlund, 1986: 1), especially with the premature infants who have evaporative heat loss excess 4 kcal/hr (Baumgart, 1991: 255). The neonate infants with wet skin who do not receive prevention of heat loss lose heat energy more than 200 cal/kg/min, and it taking one hour and 30 minutes to have compensating energy (Martin, 1991: 423).

Besides the above factors, mothers' behaviors in taking care of infants after birth including bathing, cleaning after bowel elimination and urination, feeding, and touching may have an effect on heat loss in infants. For example, bathing is one of the care-giving activities in daily living, which affects heat loss because evaporative heat loss from wet skin occurs during bathing. Orapin Chareonpol and Siriporn Intarakumhang (1991) studied the effect of tub-bath and sponge-bath on body temperature of newborn infants and found that neonatal temperature decreases rapidly after tub-bath and sponge-bath. The body temperature will increase to the level before the intervention in five hours after tub-bath and six hours after sponge-bath. The effects of sponge-bath on the changing of neonatal temperature are more than those of tub-bath. Kruawan Tinsulananda and Sirisopit Tipnak (1998) studied changing of body temperature after bath in premature infants found that the premature infants have 10.9 percent of hypothermia after bath. Thus, care-giving behavior is another important risk factor that should be taken into account.

Traditionally, the mothers are not allowed to care for their premature infants who weigh less than 2,500 grams as they are either seriously ill or they are infants with abnormal deliveries who are admitted to the neonatal unit immediately after birth. Although the admission of the premature infant to the neonatal unit is safer than to the postpartum ward, reduces neonatal mortality rate, and provides good management for the infant's health, bonding and attachment between the mother and her infant cannot be performed. Presently, the significance of keeping mothers and their newborn babies together is increasing, recognized changing the roles of mothers in the hospital (Klaus and Kennel, 1993: 189). The Baby-Friendly Hospital Initiative has been established to promote breast feeding, bonding, and attachment. The newborn infants who are healthy without complication are kept with their mothers after birth until discharge. Whitby, Cates & Roberton, (1982: 322) found that infants who weigh 1,800-2,500 grams can be kept safely with their mothers in the postpartum ward. Nakornpathom Hospital has been certified as a Baby-Friendly Hospital Initiative since 1993 by the Ministry of Public Health. The healthy newborn infants without complication weighing ≥ 1,800 grams are kept with their mothers after birth. The mothers are allowed to participate in daily care of the infants.

The reviewed data of Nakornpathom Hospital in the year 2001 indicated that there were 5,143 cases of newborn infants, 373 cases of premature infants, and 264 cases of low birth weight premature infants who weighed less than 2,500 grams (Nakornpathom Hospital Delivery's Statistics Year Book, 2001). The data regarding hypothermia from the postpartum ward showed that 24% of hypothermia in premature infants were rooming-in with their mothers at the postpartum ward (Nakornpathom Hospital Postpartum's Statistics Year Book, 2001), and 17% of hypothermic premature infants were transferred to the neonatal unit (Nakornpathom Hospital Neonatal Unit's Statistics Year Book, 2001). Although the incidence seemed rather low when compared to birth rate, it was still important to the quality of the infant's life because of the adverse effects of hypothermia.

From the clinical experience of the researcher as a neonatal nurse, inappropriate care of the baby is the most important factor related to the occurrence of hypothermia. Although staying with the mother makes it easy to keep the baby warm, inappropriate care of the mother may result in hypothermia. Most mothers who have premature infants are reluctant to take care of their infants because a baby may show signs of physiologic and anatomic immaturity. Moreover, the surveillance for hypothermia may not perform continuously. At present, most previous research focuses on the effect of heat loss prevention methods on the neonate term infants' temperature immediately after birth, but there is no study concerning factors related to hypothermia such as maternal behaviors for hypothermia prevention, gestational age, birth weight, environmental temperature, and humidity of premature infants rooming-in with their mothers. Therefore, the researcher was interested in studying the pattern of premature infants' temperature and hypothermia, as well as factors related to hypothermia in premature infants rooming-in with their mothers. The findings of this study may eventually help nurses in promoting practical ideas of maternal participation in caring for hypothermia prevention in premature infants if this research yielded positive results.

Conceptual Framework

The theoretical frameworks underlining this study were the biological model of thermoregulation and Orem's (1995) Self-Care Deficit Theory of Nursing.

Thermoregulation is a balancing between heat loss and heat production (Perlstein, 1997: 481; MacGillvray, 1996: 482; Blackburn & Loper, 1992: 677). That is, the body temperature will be maintained constantly depending on a balance between heat loss and heat production. Body temperature regulation is controlled by the nervous system feedback mechanisms located in the hypothalamus and temperature receptor of skin (Engler & Rutton, 1996: 450). Generally, hypothermia is frequently found in transitional period and occurs when the infants have heat loss more than heat production. Heat loss from the neonate infants' body after birth may come from the mechanism of thermal exchange, which are classified into four routes: conduction, convection, radiation, and evaporation. When the infants encounter a cold environment, they will attempt to conserve heat in their body by responding in peripheral vasoconstriction and flexed position to decrease surface area (Willett, et al., 1986, cited in MacGillvray, 1996: 482). Additionally, they produce extra heat from non-shivering thermogenesis of brown fat.

There are many major factors, which are predisposed to heat loss in neonate premature infant such as premature infant factors, environmental factors, and care-giving behaviors factor. First, premature infants factors include several physiologic and anatomic characteristics such as preterm gestation, low birth weight, large surface area and body mass ratio, small subcutaneous fat, less developed central nervous system, and less stores of brown fat. Secondly, environmental factors include environmental temperature and humidity. Premature infants may stay in various environmental temperatures and humidities, which contribute to heat loss easily such as cool air temperature and low humidity in the delivery room. Finally, premature infants are in the initial period of physical, mental and psychosocial development (Orem, 1985: 84-85). They have uncompleted and poorly functioning organ systems or they are limited in growth and development (Orem, 1995: 228), thus, leading them to become dependent persons. They need help from others for heat loss prevention. The care-giving behaviors for heat loss prevention may come from health care providers and/or their mothers. In this study, the researcher selected the factors related to hypothermia in premature infants rooming-in with their mothers as follows:

Gestational age determines the growth and functional maturity of the premature infant organ systems, especially the temperature control center in the brain of preterm infants is less mature (Murray, McKinney & Gorrie, 2002: 812). Thus, they may have heat production ineffectively. Moreover, the physical characteristics predisposed them to lose heat easily. For example, the premature infants have immature skin with an ineffective epidermal barrier for heat loss because the epidermal barrier function resides in the stratum corneum, which becomes functionally mature between 32-34 weeks estimate gestational age. Thus, infants with gestational age less than 32 weeks are susceptible to hypothermia. Basically speaking, the more premature the newborn is, the less it can tolerate cold and the more it will develop hypothermia.

Birth weight determined the growth and functional maturity of the premature infant organ systems just like gestational age. Birth weight means the whole body mass's weight, which comes from the deposited nutrients. Most of the nutrients are established in the last trimester of pregnancy. Therefore, increased birth weight is related to an increased gestational age. For example, the term infants have more birth weight than premature infants. The low birth weight premature infants will lack glycogen and brown fat storage, which are the important nutrients for heat production. Moreover, low birth weight premature infants may have larger surface area and mass ratio. Heat may be transferred from the warmer body surface area to the environment by radiation, convection and evaporation. Therefore, they will have imbalance between heat production and heat loss that leads to hypothermia easily. The smaller the newborn, the greater the risk of occurrence of hypothermia.

Environmental temperature is an environmental factor related to the occurrence of hypothermia. In this study, it means the room's temperature which is a risk for heat loss of premature infants through the environment by the mechanism of thermal exchange. Heat naturally moves from a warmer to a cooler area or surface (Novak & Broom, 1995: 591). Thus, the infants staying in the lower room's temperature, may have higher heat loss through the environment. The cold environmental temperature affects the high mortality of premature infants due to hypothermia. Therefore, the environmental temperature is related to the occurrence of hypothermia. The lower the environmental temperature, the greater the risk of the occurrence of hypothermia.

Humidity is an environmental factor related to the occurrence of hypothermia. In this study, it means the percentage of moisture in the air. For premature infants staying in low humidity, they will have high evaporative heat loss. Therefore, the lower the humidity, the more the occurrence of hypothermia.

Maternal behaviors for hypothermia prevention

In general, individuals have a responsibility for self-care requirements in each day to regulate their own functioning and development. However, premature infants need help with the activity of self-care from others because of the limitation in growth and development. The significant physiologic demands after birth of these infants are to maintain body temperature, normal respiration, waste excretion, and nutrient absorption (Munson, 1999: 25). But, these demands cannot be performed completely by infants. Therefore, they have self-care deficit to perform therapeutic self-care demands which mean the activity of total self-care to respond to self-care requisites exceed self-care agency (Orem, 1995: 12). Obviously, the caring in response to a newborn's body temperature maintenance is the responsibility of their mothers who are close to their infants and who should carry out this function because of the infants rooming-in with them, especially in the Baby-Friendly Hospital.

The purposes of such dependent-care practices are to meet needs categorized by Orem into three dimensions: universal, developmental, and health deviation self-care requisites (Orem, 1991: 125-136; Orem, 1995: 186-210). Universal self-care requisites is self-care in response to basic needs of humans which are found in every person's lifetime and can change according to age, development, environment, and other factors to promote and maintain the complete structure and mechanism of the body.

Prevention of hypothermia is related to universal dimension of the theory, specifically the requisites of preventing hazard to human life, human functioning, and human well-being. It is the hazard event because it has adverse effects on premature infants and it frequently occurs immediately after birth in the first 24 hours. The mothers should operate the prevention of hypothermia in premature infants at this time. For prevention of hypothermia, the mothers should know about infants' therapeutic self-care demands and the characteristics of premature infants which pose risks of hypothermia such as larger surface area and body mass ratio, lack of deposited subcutaneous brown fat, and poor reflex control of skin capillaries (Whaley & Wong, 1999: 398).

The mothers can prevent hypothermia and maintain stable temperature by wrapping, dressing the infant in a shirt and diaper, and providing head covering. Moreover, infants should be kept in a warm blanket or placed next to their mothers. The room's temperature should be maintained between 24 and 25°C and with humidity about 40-50%. Infants should be kept away from drafts, air conditioning vents, or fans. Additionally, the mothers give them initial bath according to hospital policy and prevent chilling of infants during bath. Bath should be postponed if there is any question regarding stabilization of body temperature. Finally, the mothers should cover the infants or expose only one area of the body for examination or others procedures, and be alert to signs of hypothermia (Whaley & Wong, 1995: 329).

However, the premature infants should have adequate food from breast feeding because 42% of total energy from the nutrient metabolism are used for their thermoregulation (Thomas, 1994: 15-22). Besides, the infants need holding or touching to promote sensory development. Holding has advantages to the premature infants because their body temperatures are maintained in the mother's arm (Mellien, 2001: 157). Additionally, the mother should seek information regarding problems in caring for premature infants, especially prevention of hypothermia, from medical professions such as physicians and nurses. The mothers should be attending in-service teaching sessions about hypothermia prevention methods. Finally, the mothers need to have knowledge related to pathophysiology of hypothermia in order to prevent hypothermia in infants, that is, the mechanism of thermal exchange such as conduction, convection, radiation, and evaporation. Thus, maternal behaviors for prevention of hypothermia affect the occurrence of hypothermia. That is, the more inappropriate maternal behaviors are, the more they cause hypothermia in infants.

In conclusion, gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention are negatively correlated with hypothermia, which is the health outcome of premature infants. The research framework of the relationships between the factors of gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention and hypothermia is shown in Figure1.

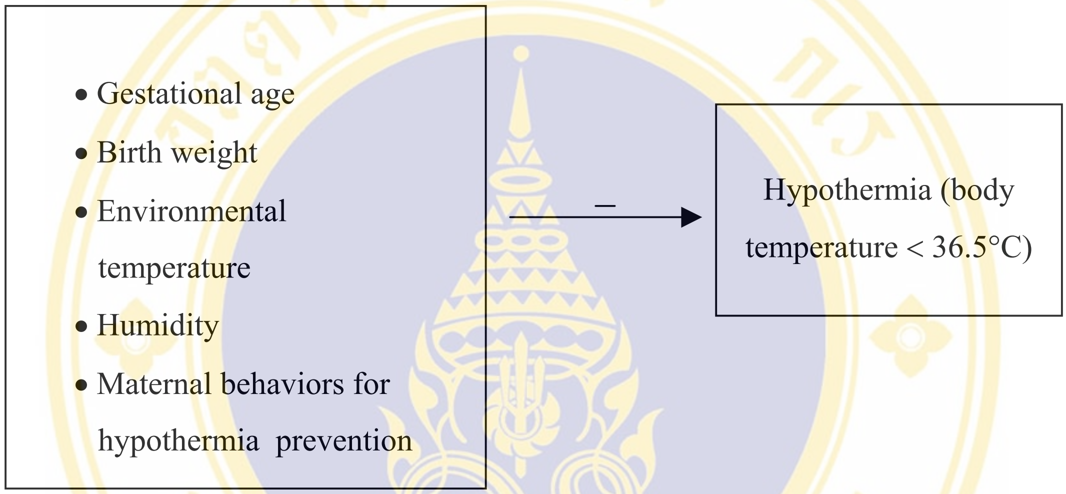


Figure 1. The research framework: The relationships between gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention and hypothermia in premature infants rooming-in with their mothers.

Research Questions

1. What are the patterns of premature infants' temperature and hypothermia in premature infants rooming-in with their mothers?

2. What are the factors of gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention in premature infants rooming-in with their mothers?

Objectives of the Study

1. To describe the pattern of premature infants' temperature and hypothermia in premature infants rooming-in with their mothers.

2. To examine the predictive value of gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention in premature infants rooming-in with their mothers.

Research Hypothesis

It is hypothesized that the factors of gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention will significantly account for hypothermia in premature infants rooming-in with their mothers.

Scope of the Study

This study was conducted on mother-premature infant dyads, who were hospitalized at the postpartum and gynecological ward, Nakornpathom Hospital, during June-December 2002.

Expected Outcomes and Benefits

1. The findings of this study would help nurses in promoting practical ideas or guidelines of maternal participation in preventing hypothermia in premature infants.

2. This study results would help promote awareness in health care teams about the importance of hypothermia prevention in premature infants.

3. This study could be used as a guideline for other research focusing on hypothermia prevention.

Definition of Terms

Hypothermia refers to the occurrence of a number of premature infants who had body temperatures below 36.5°C at least one time during the first 24 hours after birth. Body temperature was assessed by electronic digital thermometer-axillary measurement at every two hours, and before and after the first bath with a total of 15 times of surveillance.

Gestational age refers to the duration of pregnancy from the last menstruation period (LMP) through the day that the infant is born. In this study, it was assessed by the researcher and/or research assistant with the Ballard score.

Birth weight refers to the whole body mass of premature infants after birth weigh in grams by an infant scale.

Environmental temperature refers to the room's temperature where the mothers and their infants were staying during 24 hours after birth. In this study, it was measured using hygro-thermometer in the form of °C.

Humidity refers to the percentage of moisture in the air where the mothers and their infants were staying during 24 hours after birth. It was measured using the hygro-thermometer.

Maternal behaviors for hypothermia prevention refers to maternal behaviors in caring for premature infants to prevent hypothermia during the first 24 hours after birth. Maternal behaviors were measured by the questionnaires, which were developed by the researcher based on physiological and action demands for hypothermia prevention. The highest scores meant appropriate maternal behaviors for hypothermia prevention.

Rooming-in refers to the mothers and their premature infants stayed together in the room 24 hours a day after birth.

CHAPTER II
LITERATURE REVIEW

In this study, the literature related to the problem of thermoregulation, especially hypothermia, and factors related to hypothermia in premature infants was reviewed. The topics are presented in the sequence as follows:

- Thermoregulation and hypothermia in premature infants
- Factors related to hypothermia
- Maternal behaviors for hypothermia prevention
- Relationships between gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention and hypothermia

Thermoregulation and Hypothermia in Premature Infants

Thermoregulation is a goal to achieve thermal stability of human temperature (Perlstein, 1997: 481) and/or a vital body function reflective of physiological stability. In particular, it is a physiological demand in the newborn after birth. It is defined as the regulation of temperature, which is measured by rectal and axillary mode in normal range of 36.5 to 37.5°C (Blake & Murray, 1998: 100-115). Moreover, it is defined as a balancing between heat loss and heat production (Perlstein, 1997: 481; MacGillvray, 1996: 482; Blackburn & Loper, 1992: 677).

Generally, the human newborns are considered as homeotherm, who increase and decrease their heat production to maintain their internal body temperature, but the newborns' ability is less than that of adults. In utero, fetal temperature is linked to maternal temperature and the maternal-fetal thermal gradient. That is, the fetus cannot control its temperature independently. The temperature of the fetus is 0.5°C higher than the maternal temperature under a normal resting condition (Blackburn & Loper, 1992: 678; Sinclair, 1992, cited in MacGillivray, 1996: 482) because the environmental temperature is maintained constantly by the dissipation between the fetus and its mother.

After birth, all newborn infants seem to move through a period of irregular adjustment for extrauterine life before body systems stabilize. Hammond (2000: 671) called that the transition period of the infant, which should be during the first six to eight hours after birth. Otherwise, Hammond & Perry (2000: 723) have stated that the newborn's temperature should stabilize within the normal range by the twelfth hours. That is, all infants are at risk of cold stress particularly within the first twelve hours of life (Weber, 1997: 4). However, the temperature of the newborn usually drops lasting up to 30 minutes after birth in the first phase of the transition period (Hammond 2000: 672), especially in an air-conditioned delivery room, but it returns to normal in about eight hours (Marlow, 1990: 158). In conclusion, the pattern of premature infant's temperature is still unstable constantly in the first day of life, especially the first twelve hours after birth.

Heat production and heat loss

In general, thermoregulation is related to heat production and heat loss. The body will respond to increasing heat production and decreasing heat loss for to maintain body temperature when encountering the changing environment. That is, the body temperature will be maintained constantly depending on a balance between heat loss and heat production.

Heat production within the body is a by-product of metabolic processes and must equal to heat loss through the environment. Most of heat productions may come from nutrient, which is in the body storage. Thomas (1994: 15-22) has stated that 42% of total energy from the nutrient metabolism will be used for thermoregulation. However, one of the homeothermic characteristics is the ability to produce extra heat. In adults, additional heat production can come from voluntary muscle activity, involuntary tonic or rhythmic muscle activity (shivering thermogenesis), and non-shivering thermogenesis (Klaus, Martin & Fanaroff, 1993: 115). The premature infants who were born before term have minimal nutrient storage because most of the nutrients are established in the last trimester of pregnancy. Moreover, they are unable to increase activity and lacking a shivering response. Therefore, most of their heat productions may come from non-shivering thermogenesis, especially thermogenesis of brown fat. The metabolism of brown fat will occur when the sympathetic nerve endings, in response to chilling, are stimulated, and this leads to the release of norepinephrine, epinephrine, and thyroid hormone, which affect the induction of lipolysis in brown fat and glycogen storage.

Particularity, heat loss refers to the heat transfer within the body or heat lost to the environment, which can be divided into two types: internal gradient from within the body to the surface of the body and external gradient from the body surface to the environment. Most heat loss occurs in the external gradient from the body surface to the environment. That is, heat naturally moves from a warmer to a cooler area or surface (Novak & Broom, 1995: 591). The premature infants have more heat loss via the blood vessels, which are closer to the skin surface through environment because of the minimal thermal insulation. In general, heat loss involves the mechanism of thermal exchange (Klaus, Martin & Fanaroff, 1993: 116).

The mechanisms of thermal exchange between infants and their environments or physical routes of heat loss are classified into four types: convection, conduction, evaporation, and radiation (Amlung, 1998: 208; Engler & Rushton, 1996: 452; Klaus, Martin & Fanaroff, 1993: 116; Baumgart, 1991: 255). Besides, the mode of heat loss is via warming and humidifying of inspired air, urine, and stool (Engler & Rushton, 1996: 452). Four routes of heat loss are as follows:

1. Convection is simply the movement of air. Heat loss by convection refers to heat conducted to the air and then carried away by convection currents. In premature infants, it occur when ambient air temperature is less than the infant's skin temperature, so the infant's body heat is transferred to the cooler surrounding air in the environment (Mellien, 2001: 158). Incubators are used to prevent this heat loss.

2. Conduction is the heat lost to cooler surface by direct contact with an infant's skin depending on the material of the surface and its temperature such as the placement of an infant on a cold scale, wet towel, or cool hand contact to skin of the infant. Conductive heat loss can be reduced by assuring that cold surfaces are not in direct contact with the infant's skin and by using various types of thermal insulation such as blankets and head covering.

3. Evaporation is the passive transcutaneous heat loss of water, which is mostly defined in terms of insensible water loss. Generally, when water evaporates from the skin, 0.58 calories of heat are lost for every gram of water that evaporates.

Many factors influence evaporative heat losses including large surface area/mass ratio, lack of keratinized epidermal skin barrier, humidity, and environmental temperature. Evaporative heat losses can be minimized by keeping infants clothing (especially those on their heads), and bed linens dry (Engler & Ruaston, 1996: 452).

4. Radiation is the loss of heat that radiates from the body to surroundings that are cooler than the body itself (Engler & Rushton, 1996: 452) or the transfer of heat from an infant is warm skin via infrared electromagnetic waves to the cooler surrounding walls (Baumgart, 1991: 256). For example, radiative heat losses can occur even when nude infants are in warm, transparent, or single walled incubators, particularly when near a cool wall or window. Forty-three percent of heat loss after birth comes from radiation and depends on environmental temperature (Fanaroff and Martin, 1983, cited in Wattana Kulnatsiri, 1993: 17). Radiative heat losses can be minimized by increasing the room temperature, using external heating devices, and applying thermal insulators such as plastic or aluminized plastic sheeting (Engler & Rushton, 1996: 453).

In conclusion, thermoregulation in newborns will occur when they have a balance of heat production and heat loss. The critical modes of heat loss are via conduction, convection, radiation, and evaporation. The majority of heat loss in the neonate infant is through radiation and convection (Amlung, 1998: 208), especially radiation which depends on environmental temperature. Moreover, the highest evaporative losses occur on the first day of life (Hammarlund, 1986:1). The premature infant may incur evaporative loss in excess of 4 kcal/hour (Baumgart, 1991: 255). The neonate infants with wet skin who do not receive prevention of heat loss lose heat energy more than 200 cal/kg/min and need one hour and 30 minutes for compensating energy (Martin, 1991: 423). According to these results, hypothermia may occur easily if the infants have imbalance heat production and heat loss.

Hypothermia

Hypothermia is defined as the occurrence when the body temperature falls below 36.5°C as measured by the rectal or axillary route (Frigoletto and Little, 1988: 274; Kriangsak Jirapeat, 1993: 261). It is an important problem of thermoregulation which frequently occurs in newborn infants. World Health Organization (1993:3) has recommended the levels of body temperature of premature infants as follows:

Table 1 The levels of body temperature of the newborn

The levels of body temperature	Temperature (°C)
Normothermia	≥36.5
Mild hypothermia	36.0-36.4
Moderate hypothermia	32.0-35.9
Deep hypothermia	<32

From World Health Organization (1993). **Thermal control of the newborn: A practical guide**, 3.

A study in USA found that 45% of hypothermia occurs in premature infants (Loughead, Loughead, and Reinhart, 1997: 13). Moreover, all of premature infants in Turkey have the occurrence of hypothermia at first admission to the neonatal unit (Sarman, Can & Tunel, 1989, cited in Thongsouy Sitanon, 1998: 28). Besides, Johanson, et al. (1992) studied post-delivery care on neonatal body temperature. They observed 500 infants at Kathmandu Maternity Hospital, whose rectal temperatures were obtained routinely at birth, at 30 minutes and at two hours, and again at 24 hours. They found that 85% of these infants had temperatures <36°C at two hours and nearly 50% had temperatures <36°C at 24 hours. Eleven percent of the infants in this study were preterm.

Furthermore, Ellis, et al. (1996) studied postnatal hypothermia and cold stress among newborn infants in Nepal. It was found that 24 hours mean ambient temperatures were generally lower than the WHO recommended level of 25°C (median = 22.3°C; range 15.1-27.5°C). Postnatal hypothermia was prolonged, with axillary-core temperatures only reaching 36°C after a mean of 6.4 hours. There was persistent and increasing cold stress over the first 24 hours.

In Thailand, Thongsouy Sitanon (1998) studied hypothermia in preterm infants at Prapokklao Hospital Chantaburi and found that 86% of hypothermia occurred in premature infants born in the hospital and 91.7 % occurred in premature infants referred from another hospital. In addition, the rate tended to be increased in those who had low gestational age, birth weight, and Apgar score. Moreover, hypothermia occurred within 30-510 minutes in infants weighing from 800 to 3,200 grams and from 28 to 36 weeks' gestation. According to these results, hypothermia is still a significant problem of the newborn.

Hypothermia has many effects on system organs. Most adverse effects of hypothermia come from the increased metabolic rate. This leads to an increased need for oxygen and glucose consumption. Thus, they may have hypoglycemia, respiratory acidosis, and metabolic acidosis, if untreated, brain damage, respiratory distress, cyanosis, and death may eventually results (Marlow, 1990: 158) because of their limited compensation.

The National Association of Neonatal Nurses (1997: 3) has determined the symptoms of hypothermia, which reflect the systems involved. These symptoms include body cool to touch, central cyanosis, acrocyanosis, poor feeding, abdominal distention, increase gastric residuals, bradycardia, tachypnea, restlessness, shallow and irregular respirations, apnea, mottling or pallor, metabolic imbalances, decreased activity, lethargy, irritability, reflex diminished or absent, hypotonia, feeble cry, weak suck, CNS depression, hypoglycemia, and edema.

Conclusion, indication of inadequate thermoregulation included poor feeding or intolerance to feeding, lethargy, irritability, poor muscle tone, cool skin temperature, and mottled skin (Murray, McKinney & Gorrie, 2002: 812). However, the seriousness of hypothermia depends on the adaptation ability of the infants, environmental temperature, and duration of the occurrence of hypothermia (Wattana Kulnatsiri, 1993: 24).

Physiological response to hypothermia

The premature infants have many physiologic and anatomic characteristics, which are exposed to heat loss easily such as smaller muscle mass, few deposits of brown fat for producing heat, and lack of insulating subcutaneous fat. Moreover, their reflex and muscle tones have not yet fully developed. When they encounter a cold environment, they will attempt to conserve heat in their body by responding in peripheral vasoconstriction and flexed position to decrease surface area (Willett, et al., 1986, cited in MacGillvray, 1996: 482). These responses occur in temperature sensitive sites in hypothalamus and skin. The physiological responses to hypothermia are divided into three parts as follows:

Afferent: the responses to a cold environment begin with sensation of temperature which is identified in two temperature sensitive sites including hypothalamus and skin.

Central regulation: the responses to a cold environment occur in the hypothalamus. Integration of multiple skin and hypothalamic temperature inputs probably occur in the hypothalamus.

Effector: the limb of the neonatal thermal response is mediated primarily by the sympathetic nervous system.

Factors Related to Hypothermia

There are many factors related to hypothermia in premature infants. That is, the imbalance between heat production and heat loss caused by gestational age, birth weight, low room's temperature, asphyxia, and inadequate control of the thermal environment.

Johanson, et al. (1992: 859-863) studied effects of post-delivery care on neonatal body temperature in 500 infants under observation at Kathmandu Maternity Hospital and found that the effect of gestation on hypothermia was very clear at 24 hours where 73% of preterm infants had hypothermia compared with 46% of term infants (odds ratio = 3.2). Moreover, the effect of air temperature was significant at both two hours and 24 hours. The effect was more marked at 24 hours where 59% of infants in cold air were hypothermic compared with 35% of those in warm air (Odds ratio = 2.7).

In summary, the principal risk factors for hypothermia include low birth weight, preterm gestation, and cold air temperature (Johanson et al. 1992: 860). Engler & Rushton (1996: 449) have stated that factors related to ineffective thermoregulation are environmental and maturational that are presented in Table 2.

Table 2 Factors related to ineffective thermoregulation

Environmental	Maturational
Changing environmental temperature Insufficient heating or humidification Physical contact with or proximity to cold or warm objects Wet or exposed body surfaces Excessive or insufficient clothing or covering	Extreme of age Large ratio of body surface area to body mass Metabolic immaturity and decrease heat production Rapid metabolic rate Thin layer of subcutaneous fat

From Engler, A.J., & Rushton, C. H. (1996). Thermal regulation. In. M.A.Q. Curley, J.B. Smith, & P.A. Moloney-Hamon (Eds.), **Critical care nursing of infants and children**, 449.

Gestational age

Gestational age is the duration of pregnancy starting from the last menstruation period (LMP) through to the day that the infant was born. It is used to determine the maturity of the infant (Rothbarth & Pedigo, 1986: 557) in each organ and their characteristics. In particular, the temperature control center of the brain of preterm infants is less mature (Murray, McKinney & Gorrie, 2002: 812). The immature organs mean to poor functions. The premature infants are predisposed to excessive heat loss because they have large surface area, thin layer of subcutaneous fat, and immature heat production. The majority of premature infants are able to regulate their body temperature by a post-conceptional age of 34 weeks (Balaraman, 2002: 2).

Hammarlund, et al. (1986) studied the evaporation rate from the skin and ambience at an ambient humidity of 50% during the first four weeks after birth in 68 infants with 25-41 weeks' gestation. It was found that preterm infants had high evaporative heat loss on the first day of life. Moreover, the evaporative heat loss was decreasing when gestational and post-natal age increased.

Rutter & Hull (1979) studied water loss from the skin of term and preterm infant and found that term infants have water loss < 6g/sq.m per hour in the first four hours after birth. Particularly, preterm infants have high water loss, averaging 32g/sq.m per hour in the first four days of life.

According to this finding, water loss occurs more frequently in preterm infants than in term infants. Moreover, the premature infants are able to regulate their body temperature by a post conceptional age of 34 weeks (Balaraman, 2002: 2). Therefore, gestational age is a factor influencing the occurrence of hypothermia.

Birth weight

Birth weight refers to the whole body mass's weight, which comes from the established nutrients. Most of the premature infants born before 37 weeks' gestation have birth weight below 2,500 grams (Prawpan Nutpakdee, 1990: 66). That is, they may have less established nutrients. Moreover, low birth weight infants may have larger surface area and body mass ratio. The large surface area is a risk to loss of heat by evaporation, convection, and radiation.

Thomas (1994: 15-22) stated that 42% of total energy from the nutrient metabolism will be used in thermoregulation. Therefore, nutrients are an important resource for heat production, especially brown fat which is specific in newborn. Moreover, most nutrients are established in the last trimester of pregnancy, especially the deposit of brown fat which begins at 26-30 of gestational age through three-five weeks' postnatal age (Amlung, 1998: 210). Brown fat is only two to six percent of body weight in term infants. Thus, if the premature infants have low birth weight, they have less brown fat to produce heat.

Environmental temperature

Environmental temperature affects heat loss of the infant because of the external gradient between the infant's skin and environmental temperature. Heat from infants' body will lose through the cool environment by conduction, convection, radiation, and evaporation. Forty-three percent of heat loss after birth comes from radiation and depends on environmental temperature (Fanaroff and Martin, 1983, cited in Wattana Kulnatsiri, 1993: 17). Moreover, it may affect insensible water loss.

Bell, et al. (1980: 452-459) studied the effects of thermal environment on heat balance and insensible water loss in low birth weight infants. They found that increased ambient temperature produced a significant rise in insensible water loss. Moreover, decreased ambient temperature resulted in increased oxygen consumption. Besides, the maintenance of body temperature through control of the thermal environment significantly reduced mortality in LBW infant (Narendran & Hoath, 1999: 529).

The International Union of Physiological Societies has defined the neutral thermal environment as "the range of ambient temperature within which metabolic rate is at a minimum and within which temperature regulation is achieved by non-evaporative physical process alone, the individual being in thermal equilibrium with the environment" (Swyer, 1978 cited in Keeling, 1992: 126).

Blackburn & Loper (1992: 685) have noted that the appropriate temperature for thermoneutrality at environmental temperature for premature infants in the incubator is in the range of 32 to 34°C. A room temperature surrounding the incubator should be 25° to 26°C. Particularly, the room temperature for premature infants who are cared for in the crib should be between 27° and 28 °C (Veena Jirapaet 2000: 112). The delivery room's temperature for newborn should be higher than 25°C (Kriangsak Jirapaet, 1993: 51-67). Also, Whaley & Wong (1995: 329) have suggested that room temperature should be maintained between 24 and 25°C, while WHO has recommended the level of 25°C (WHO, cited in Ellis, 1996: F42). Also according to, the American Academy of Pediatrics recommends a nursery environmental temperature between 24° and 26.5°C when the neonate is dressed in a T-shirt and wrapped in a blanket (AAP cited in Keeling, 1992: 126).

In summary, the infant should be cared for in an appropriate environmental temperature; that is, the neutral environmental temperature with the ambient temperature with lowest oxygen consumption (Bell, et al., 1980: 454), metabolic rate, and heat production (Hey & Scopes, 1987; Kriangsak Jirapeat, 1993; Blake & Murray, 1993, cited in Thongsouy Sitanon, 1998: 37). The appropriate room temperature for the infant should be higher than 25°C (Schriener, 1981: 46), especially premature infants. Therefore, the environmental temperature is a factor that related to hypothermia.

Humidity

Humidity means the percentage of moisture in the air, which is an important factor that affects evaporative heat loss of the newborn. In the environment with high humidity, the newborn has low evaporative heat loss. The appropriate humidity for the newborn should be between 50-80% (Moore, 1981, cited in Wattana Kulnatsiri, 1993: 20). However, Amlung (1998: 210) has suggested that humidity of environment to protect premature infants from evaporative heat loss should be in the range of 40 to 60%. Similarly, Whaley & Wong (1995: 329) suggest that infants who have a high risk of altered body temperature should be maintained in a room with stable humidity about 40-50%. In conclusion, the appropriate humidity for the infant should not be lower than 40%.

Furthermore, there are other factors related to maternal behaviors that affect hypothermia such as physical contact with or proximity to cold or warm objects, wet or exposed body surfaces, and insufficient clothing or covering.

Maternal Behaviors for Hypothermia Prevention

Individuals have a responsibility to fulfill self-care requirements in each day to regulate their own functioning and development. The infants need help with the activity of self-care from others because they are in the initial period of physical, mental, and psychosocial development (Orem, 1985: 84-85). Therefore, infants become dependent persons because they have uncompleted and poorly functional organ systems or they have limitation in growth and development (Orem, 1995: 228).

The physiologic demands after birth of the infants are to maintain body temperature, normal respiration, waste excretion, and nutrient absorption (Munson, 1999: 25), especially prevention of hypothermia which is one important problem of thermoregulation frequently found in premature infants. Therefore, the need for hypothermia prevention in infants should be met. These self-care requisites of the infants cannot be met nor carried out completely by themselves. Therefore, the mothers who are a primary caregiver should carry out this function on their behalf.

The prevention of hypothermia is related to universal dimension of Orem's theory, specifically the requisites of preventing hazards to human life, human functioning, and human well-being. It is the hazard event because it has adverse effects on premature infants and frequently occurs immediately after birth during the first 24 hours. Orem (1995: 193) has specified the set of actions to prevent hazards as follows:

- Being alert to type of hazards that are likely to occur
- Taking action to prevent events that may lead to the development of hazardous situations
- Removing or protecting oneself from hazardous situations when a hazard cannot be eliminated
- Controlling hazardous situations to eliminate danger to life or well-being

In the Baby-Friendly Hospital Initiative, the infants will stay with their mothers all the time. It is called “Rooming-in”, which is the term used to designate a hospital arrangement whereby a mother and her newborn baby stay in the room or newborn baby in a crib by her bedside whenever she wishes (Phillips, 1996: 271). The mothers will participate in activities of daily living of their infants such as breast feeding, bathing, cleaning after bowel elimination and urination, and warming by swaddling and/or clothing. These activities may cause heat loss, if the mothers have an inappropriate care.

Bathing has multiple purposes including removal of waste materials, general aesthetics, and potentially reducing microbial colonization. It is one of the care-giving activities in daily living of the newborn. It affects heat loss because high evaporative heat loss from wet skin occurs during bathing.

Kruawan Tinsulananda and Sirisopit Tipnak (1998) studied changing of body temperature after bath in premature infants and found that the premature infants have 10.9 percent of hypothermia after bath.

Orapin Chareonpol and Siriporn Intarakumhang (1991) studied the effect of tub-bath and sponge-bath on body temperature of newborn infants and found that neonatal temperature decreases rapidly immediately after tub-bath and sponge-bath. The body temperature increased to the level before the intervention in five hours after tub-bath and six hours after sponge-bath. The effects of sponge-bath on the changing neonatal temperature are more than those of the tub-bath.

Furthermore, bathing can have deleterious effects on hypothermia during the newborn transition to extrauterine life, or in premature or ill newborn with physiologic instability. Therefore, bathing should be given after the newborn's temperature has stabilized in the normal range for two-four hours because hypothermia can result in increased oxygen consumption and respiratory distress (MacGillivray, 1996, cited in Lund, 1999: 245). The temperature of water should not lower than the infant's temperature (Porntip Siriboonpipatana, 2001: 235). According to Marlow (1990: 180), the temperature of the water should be 100-105°F (37.7-40.5°C) for newborns or 35°C for small infants. The mother should test the temperature with her elbow or a bath thermometer. Moreover, the infant should be bathed once a day.

Henningsson, et al. (1981: 1401-1403) have demonstrated that bathing in warm water followed by rapid drying leads to less heat loss than cleaning the baby with a wet towel. Therefore, when bathing the baby, the caregiver must ensure that it is done in a warm room and warm water is used. The infants should immediately be wrapped in a dry warm towel, dried immediately, dressed quickly, and placed near the mother after bath.

There are some research concerning newborn bathing, especially premature infants. For example, Peter (1998) studied bathing premature infants and found that physiological and behavioral disruptions occurred throughout the bath phase and in many cases beyond that phase. The disruption included significant increases in heart rate, cardiac oxygen demand, and frequency of behavioral motoric cues. Moreover, the decreased in oxygen saturation also accompanied the bath.

Cleaning after bowel elimination and urination

Infants who are fed with breast milk soil several times each day and frequently urinate. After the baby's evacuation, cleaning with absorbent cotton or soft cloth soaked with water should be done immediately because it might cause irritation to the baby's skin, hypothermia, and infection (Wangruangsatid, R., 2000: 26). Hypothermia may come from convection and conduction mechanisms.

Swaddling and clothing

The premature infant should be insulated and its skin should be covered with the material which can prevent heat loss such as clothing or swaddling with dry towel because the premature infants have immature skin with an ineffective epidermal barrier. The epidermal barrier function resides in the stratum corneum, which becomes functionally mature between 32-34 weeks estimate gestational age (Rutter, 1988, cited in Nopper, et al., 1996: 660).

Moreover, the prevention of heat loss is achieved by either warming the environment or covering the baby (Perlstein, 1997: 488). Whaley & Wong (1995: 329) have concluded that the infants who have a high risk for altered body temperature related to immature temperature control or change in environmental temperature should be maintained in stable temperature by:

1. Wrapping infants snugly in a warm blanket.

2. Placing infants in a preheated environment (under radiant warmer or next to their mother).

3. Placing infants on a padded and covered surface.

4. Taking infants' temperature on arrival at nursery or mother's room, proceeding according to hospital policy regarding method and frequency of monitoring.

5. Maintaining room temperature between 24 and 25°C and humidity about 40-50%

6. Giving initial bath according to hospital policy

- Preventing chilling of infants during bath
- Postponing bath if there is any question regarding stabilization of body temperature.
- Dressing infants in a shirt and diaper and swaddling infants in a blanket or cover with blanket.

7. Providing infants with head covering if heat loss is a problem (since large surface area of head favors heat loss).

8. Keeping infants away from drafts, air conditioning vents, or fans.

9. Placing infants in a recessed cubicle with high-enough walls to shield from cross-ventilation.

10. Warming all objects used to examine or cover infants (eg. placing them on radiant warmer).

11. Uncovering only one area of body for examination or procedures.

12. Postponing circumcision until after temperature has stabilized or using radiant warmer during procedures.

13. Being alert to signs of hypothermia.

Besides, the premature infants should have adequate and appropriate food from breast feeding. Nutrient is the significant energy resource for heat production, because 42% of the total energy from the nutrient metabolism is used for their thermoregulation (Thomas, 1994; 15-22). Therefore, premature infants have to have intake of breast feeding every three hours or eight times/day. If the mothers cannot feed breast milk, they should provide premature infants with formula in the same interval as breast feeding. However, the infants still need holding or touching to promote sensory development. The holding has advantage to the premature infants because their body temperatures are maintained in mothers' arm (Mellien, 2001: 157).

Furthermore, the mothers should seek information regarding problems in caring for premature infants, especially the prevention of hypothermia, from medical professionals such as physicians and nurses. The mothers should attend a health care teaching program about hypothermia prevention methods. Finally, the mothers need to have knowledge related to pathophysiology of hypothermia in order to prevent hypothermia in their infants, especially the mechanism of thermal exchanges which include conduction, convection, radiation, and evaporation.

Moreover, maternal behaviors should be assessed to identify mothers' practice level. From the literature reviewed, there are no studies of maternal behaviors of hypothermia prevention assessment tool. Thus, the researcher developed the maternal behaviors for hypothermia prevention questionnaire based on Orem's Self-Care Deficit Theory of Nursing and nursing guideline for body temperature maintenance in premature infants (Whaley & Wong, 1995: 329).

Relationships between Gestational Age, Birth Weight, Environmental Temperature, Humidity, and Maternal Behaviors for Hypothermia Prevention and Hypothermia

The researcher did not find studies whose findings confirmed the relationships between or prediction of factors included gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention, and hypothermia in premature infants. However, there were few similar studies related to those factors or maternal behaviors and health outcome as follows:

Wu & Hodgman (1974) studied insensible water loss (IWL) in 170 healthy preterm infants with birth weights ranging from 800 to 2,000 grams. They found that IWL increased with decreased birth weight. The correlation between IWL and birth weight was high ($r = -0.91; p<0.001$). Therefore, birth weight is a factor that related to hypothermia because insensible water loss may occur with heat loss.

Gelhar, et al. (1994) studied the effects of environmental temperature on neonatal temperature during the transitioning process from the incubator to open crib. The purpose was to examine the association of environmental temperature on the temperature of 151 premature infants weighing 1,500 to 1,800 grams. The nurses are responsible for maintaining the insulation prescribed by the protocol. It was found that there was no association between environmental temperature and infants' temperature ($r = .09$). Of concern in this study was the effect of the protocol to wrap the infant in layers.

Sumranchaiyadham, K. (1998) studied maternal caring behaviors and health outcomes of asthmatic children aged one to five years. The results showed that maternal caring behaviors were positively significantly correlated with health outcomes ($r = .37, p < .001$).

Ratanawan, W. (2001) studied the influence of maternal care-giving behaviors and basic conditioning factors on severity of asthma in children one to five years old. The results indicated that maternal care-giving behaviors were negatively significantly related to severity of asthma in children aged one to five years at a medium level ($r = -.542$ to $-.661$, $p < .01$). The basic conditioning factors were significantly related to severity of asthma at .01 level. Moreover, basic conditioning factors and maternal care-giving behaviors could account for 67.2% of variance of severity of asthma.

Although there are no studies of relationships among gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention and hypothermia in premature infants, existing studies have indicated that gestational age, birth weight, environmental temperature, humidity, and maternal behaviors in caring for persons are important for them to decrease the occurrence of health problems. However, the need to have more studies regarding these variables is apparent.

Summary

Thermoregulation is a goal set to achieve thermal stability of human temperature. It means the balance between heat production and heat loss. If heat production and heat loss are imbalance, it leads to hypothermia which is defined when the body temperature falls below 36.5°C as measured by rectal or axillary routes (Frigoletto and Little, 1988: 274). It is an important problem of thermoregulation, which frequently occurs in neonate infants who are the high-risk group, especially during the early adaptation period on the first day of life. Moreover, hypothermia has deleterious effects that can be life-threatening to the premature infants.

Although there are many factors related to hypothermia such as preterm gestation, low birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention, there are few studies of relationships between these factors, especially maternal behaviors for hypothermia prevention. Thus, the researcher believed that factors related to hypothermia should be further studied in detail, especially in premature infants who are kept with their mothers during the first 24 hours after birth. Certainly, if premature infants have appropriate caring including hypothermia prevention, they should be healthy enough for discharge from hospital with their mothers. The potential earlier discharge may decrease length of stay and reduce the costs of providing care to premature infants. Moreover, it can promote the mothers' function in caring for their premature infants as well.

CHAPTER III
RESEARCH METHODOLOGY

Research Design

The descriptive research design was used to describe the pattern of premature infants' temperature and hypothermia in premature infants. It also aimed to examine the predictive power of factors including gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention related to hypothermia in premature infants rooming-in with their mothers.

Population and Sampling

The population of this study was the mother-premature infant dyads hospitalized in the postpartum and gynecological ward at Nakornpathom Hospital during the first 24 hours after birth. Throndrike's method was used to calculate the number of subjects {10 x 5(Number of independent variables) + 50}(Throndike, 1987 cited by Prescott, 1987: 130-133). One hundred mother-premature infant dyads were selected by using a purposive sampling technique. The criteria of selecting the sample were as follows:

The mothers:

1. The mothers had normal delivery.
2. The mothers had good consciousness.
3. The mothers took care of their infants by themselves.
4. The mothers were willing to participate in the study.
5. The mothers could communicate in the Thai language.
6. The mothers had no evidence of complication before delivery such as fever.

The infants:

1. The premature infants weighed ≥1,800 grams.
2. The infants' gestational age was less than 37 weeks as assessed by Ballard score immediately at birth and 24 hours after birth.
3. The infants' Apgar score at five minutes was equal to or greater than 7.
4. The infants were healthy and had no congenital anomaly.
5. The infants' axillary temperature immediately at birth was not greater than 37.5°C.

Exclusion criteria

1. The infants were discharged from the setting before 24 hours.
2. The infants had serious complications and were transferred to the neonatal unit within 24 hours after birth.

Setting

The subjects in this study were recruited from the labor room and transferred to the postpartum or gynecological ward at Nakornpathom Hospital located in Nakornpathom Province. There were 36 beds in this setting. Nakornpathom Hospital was certified with Baby-Friendly Hospital Initiative in 1993 from the Ministry of Public Health. The healthy neonate infants without complications weighing ≥ 1,800 grams were rooming-in with their mothers. The mothers were allowed to participate in most daily care of the infants such as breast feeding, bathing, and cleaning after bowel elimination and urination. The infant's temperature was not checked routinely after two hours post-natal age, unless they had complication such as fever. Nurses were the consultant and took care of the infants such as temperature measurement and medical care treatment.

Instrumentation

Two types of instruments were used in this study: research tools and data collection tools.

Research tools

1. Electronic digital thermometer-axillary type named Terumo® model C202 was used to measure body temperature of premature infants. This thermometer could measure in the range from 32.0 to 42.0°C. It was calibrated by the manufacturer and deemed to be accurate with ± 0.1°C error. This thermometer had auto-reading when there was no fluctuation of the temperature. An electronic buzzer would go off about three times to indicate readiness to read the body temperature. The measurement was done by using the same thermometer throughout this study.

2. Hygro-thermometer named Union® model TFC 9202 was used to measure the special environmental temperature and humidity surrounding mothers and their infants by placing it in the room near area that mothers and their infants were staying. This Hygro-thermometer was calibrated by the manufacturer and deemed to be accurate.

3. Ballard score sheet was used to estimate gestational age of the premature infant by using the external physical and neuromuscular maturity mode, as developed in 1991 by Ballard and co-workers. The Ballard score was used to access the gestational age by the researcher and/or research assistant. The researcher had more than ten years of experience in neonatal care and had received certificate from the Neonatal Nurse Practitioner Program from the Department of Nursing, Faculty of Medicine, Ramathibodi Hospital, Mahidol University. One research assistant was trained to use Ballard score by the researcher.

4. Infant scale was used to weigh the premature infants in grams after birth at the delivery room. This scale was calibrated by the medical technician of Nakornpathom Hospital every six months and was calibrated with a piece of metal weighing 100 grams before each use. The same scale was used in every measurement.

Data collection tools

1. Demographic data recording form was used to obtain basic maternal and infant information. It was composed of two parts:

Part I: The maternal information included age, highest education level, number of gravidity and parity, experience in caring for a premature infant, and advice about hypothermia prevention received.

Part II: The infant information included sex, gestational age (calculated from Ballard score), birth weight, and Apgar score at one and five minutes.

2. Temperature recording form was used to record body temperature of premature infants, which began at birth immediately and then every two hours of postnatal age throughout the first 24 hours after the infants and their mothers were admitted to the postpartum or gynecological ward. The infants' temperature, environmental temperature, and humidity were recorded at the same time every two hours with a total of 13 times. Moreover, premature infants' temperature, environmental temperature, and humidity before and after bathing were recorded at the first bath. In total, temperature was measured 15 times.

3. Maternal behaviors for hypothermia prevention questionnaire

The maternal behaviors for hypothermia prevention questionnaire used in this study was developed by the researcher based on the biological model of thermoregulation and Orem's Self-Care Deficit Theory of Nursing. This questionnaire was composed of 17 questions (30 positive items) representing physiological and action demands in response to prevention of hypothermia, modified from the nursing guideline for body temperature maintenance in premature infants (Whaley & Wong, 1995: 329). The questionnaire used a three-point rating scale. The scoring of each item was **0 for never, 1 for sometimes, and 2 for everytime/always**. The highest total score was 60, and the lowest total score was 0. The highest scores mean appropriate maternal behaviors for hypothermia prevention.

Quality of the Instrument

Maternal behaviors for hypothermia prevention questionnaire

Validity

The content validity, language suitability, and scoring criteria for this instrument were evaluated by five experts including one neonatologist, three pediatric nursing educators, and one registered nurse in neonatal nursing. After the validation, the questionnaire was revised according to their recommendations and comments of the experts. (The list of the experts is in Appendix A)

Reliability

After the revision of the questionnaire, the internal consistency reliability produced by the researcher was tested with 30 qualified subjects. The calculation of the reliability was tested by Cronbach's alpha (Polit & Hangler, 1991: 372). The reliability was 0.85. When this tool was used with 100 subjects in the same setting, the Cronbach's alpha coefficient was 0.82.

Ballard score

Reliability

After the training on how to use the Ballard score was conducted by the researcher, a Neonatal Nurse Practitioner. The inter-rater reliability between the researcher and research assistant was tested based on the formula of Polit and Hungler (Polit & Hungler 1983, cited in Yuwadee Luecha, et al., 2000: 123). Inter-rater reliability was 0.83. The formula tested for inter-rater reliability was as follows:

$$\text{Inter-rater reliability} = \frac{\text{Number of same observations}}{\text{Number of same observations + number of different observations}}$$

Protection of Human Rights

The director of Nakornpathom Hospital gave permission to data collection. The human rights of the subjects were respected in this study (Appendix B). Eligible subjects were individually approached and asked to participate in this study. The study objective, data collection processes, expected research outcomes, subjects rights, the types of questionnaires, length of time required in completing the questionnaire, and the right to refuse to participate in this study were explained. The subjects who agreed to participate were assured that the data would be kept strictly confidential and reported only as group data. They were free to withdraw from the study at any time without jeopardizing the treatment of their infants. Informed consent was signed before data collection began.

Training of Research Assistant

Data collection was conducted by the researcher and/or the research assistant. The researcher was trained about gestational age assessment by using Ballard score from Neonatal Nurse Practitioner Program. Prior to data collection, the researcher, trained the research assistant about gestational age assessment by using Ballard score and informed about data collection procedure regarding infants' temperature, environmental temperature, and humidity measurement as follows:

Axillary temperature was measured by placing the thermometer bulb in the center of the axilla, holding the arm securely against the thorax, and then adjusting the thermometer for visibility. When electronic buzzer went off about three times, the infants' temperature were read.

Environmental temperature and humidity were measured by placing the Hygro-thermometer TFC 9202 in the room near the area that mothers and their infants were staying. When the infants' temperature measurement was completed, environmental temperature and humidity were recorded.

Data Collection Procedures

An introduction letter for the researcher was sent from Mahidol University to Nakornpathom Hospital in order to ask for permission to do research. Steps involved in data collection were as follows:

1. The researcher visited the head obstetrician, head of the nursing department, head of the postpartum and gynecological ward, and head of the delivery room in order to introduce herself, explain the objectives of the study, and ask for permission to collect data.
2. The researcher chose the sample from qualified mothers and their

infants at the delivery room from the medical record forms.

3. Immediately after birth, the researcher and/or research assistant did the following procedures:

3.1 Measuring body temperature of infants with electronic digital thermometer-axillary type model C202. At the same time, environmental temperature and humidity were measured with Hygro-thermometer TFC 9202.

3.2 Weighing the infants with an infant scale.

3.3 Assessing the actual infants' gestational age with Ballard score.

4. If the infants met the inclusion criteria, the researcher and/or research assistant approached the mothers to introduce herself and to inform them of the objectives of the research and data collection procedure.

5. At two hours after birth, the infants' temperature, environmental temperature and humidity were taken before a transfer of the infants and their mothers to the postpartum or gynecological ward.

6. After the infants and their mothers were admitted to the postpartum or gynecological settings, the infants' temperature, environmental temperature, and humidity were obtained via the same modes and instruments continuously every two hours throughout the first 24 hours after birth. Moreover, these measurements were conducted before and after the first bathing. In total, temperature was recorded in the temperature recording form 15 times.

7. At 24 hours after birth, the researcher and/or research assistant repeated the infants' gestational age assessment for actual gestation with the same Ballard score. The infants would not be excluded, if they had gestational age less than 37 weeks.

8. If the infants met the research inclusion criteria, the mothers completed the maternal behaviors for hypothermia prevention questionnaire. This procedure lasted about 15 minutes.

9. The researcher collected data between 8:00 a.m. and 4:00 p.m. Then the research assistant collected data between 4:00 p.m. and 8:00 a.m.

Data Analysis

Statistical Package for Social Science (SPSS) was used for data analysis. The procedures were carried out according to the objectives and the hypothesis of the study. The statistical methods for data analysis were as follows:

1. The descriptive statistics were used to describe the characteristics of premature infants and their mothers using number, percentage, mean, and standard deviation.

2. The Chi-square test was used to test the association between the gestational age and hypothermia.

3. The independent t-test was used to test the difference on birth weight, environmental temperature, humidity, and maternal behaviors for prevention of hypothermia between premature infants who had hypothermia and those who did not.

4. The logistic regression was used to determine the factors influencing the occurrence of hypothermia after controlling covariate variables. Afterward, the adjusted odds ratio (OR) of the important factors and 95% confidence interval of OR were estimated from the logistic regression.

5. Significance level alpha was set at 0.05.

Factors Selection in Multiple Logistic Regression Equation

The strategy in selecting a variable into the model was based on various important sources such as the theories, research reports, pathophysiology, and applications. Therefore, the researcher could choose each factor according to its importance sequence into an equation. In this study, there were relevant information based on biological model of thermoregulation and Orem's Self- Care Deficit Nursing Theory to confirm the hierarchical importance of each factor. So, the researcher chose the factors of gestational age, birth weight, environmental temperature, and humidity to enter first into the model, and maternal behaviors for prevention of hypothermia were selected next into the equation.

Each variable was tested independently for association with the dichotomous variable, hypothermia, using appropriate univariate analysis (Hosmer & lemeshow, 1989). Univariate analyses for continuous variables, such as birth weight, environmental temperature, humidity, and maternal behaviors for prevention of hypothermia, were performed by t-test analysis. Likewise, the chi-square test was used with the dichotomous variables. Since gestational age was not normally distributed when tested by Kolmogorov Smirnov test, the chi-square test was used to test the association between gestational age and hypothermia.

Variables for Analysis

The independent variables in this study were:

Gestational age

Birth weight

Environmental temperature

Humidity

Maternal behaviors for hypothermia prevention

The dependent variable in this study was:

Hypothermia

Dummy Variables for the Category Variables

Category variables dummy variables

Gestational age

32-34 weeks→ 1

35-36 weeks →0

Hypothermia

YES →1

NO → 0

CHAPTER IV
RESULTS

The descriptive research aimed to describe the pattern of premature infants' temperature and hypothermia in premature infants and to examine the predictive power of factors related to hypothermia in premature infants rooming-in with their mothers. A sample consisted of 100 mother-premature infant dyads who were hospitalized in the postpartum and gynecological ward at Nakornpathom Hospital, Nakornpathom Province.

In this chapter, the results of data analysis are presented in two parts: demographic characteristics of the subjects and the major variables, and the results of hypothesis testing.

Part I: Characteristics of the Subjects and the Major Variables

1. Demographic characteristics of the sample are presented in Tables 3-4.
2. The pattern of premature infants' temperature is presented in the linear graph in Figure 2, and hypothermia during 24 hours after birth is presented in Figure 3 and Table 5.
3. The description of environmental temperature, humidity, and maternal behaviors for hypothermia prevention is presented in Table 6.

Part II: The Results of Hypothesis Testing

The hypothesis stated that the factors including gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention would significantly account for hypothermia in premature infants rooming-in with their mothers. The result of hypothesis testing using logistic regression is presented in Tables 7-9.

Characteristics of the Subjects and the Major Variables

1. Demographic characteristics of the sample

The study findings indicated that the largest group of mothers (34%) were between 15-19 years old, and 50% of mothers finished primary school. Close to half of the mothers were primigravidarum (47%). The majority of the mothers, or 88%, had no experience on premature infant care, and 91% had not received any advice about hypothermia prevention. As for premature infants, the number of male infants was equal to the number of female infants (50%). The majority of the infants (66%) had 36 weeks' gestation, and 44% had birth weight between 2,200 and 2,599 grams as shown in Tables 3-4.

Table 3 Percentage, mean, minimum and maximum, and standard deviation of the mothers' characteristics (n = 100)

Characteristics	Percentage (%)
Age (years)	
15-19	34
20-24	28
25-29	22
30-34	16
35-41	8
(Mean = 24.71; SD = 6.13; Min-Max = 15-41)	
Highest education level	
No education	2
Primary school	50
Secondary school	41
Diploma	5
Bachelor's degree or higher	2

Table 3 Percentage, mean, minimum and maximum, and standard deviation of the mothers' characteristics (n = 100) (continued)

Characteristics	Percentage (%)
Number of pregnancy	
Gravidity	
1	47
2	31
3	18
4	2
5	2
Parity	
1	56
2	28
3	14
4	1
5	1
Experience in premature infant care	
Yes	12
No	88
Advice about hypothermia prevention received	
Yes	9
No	91

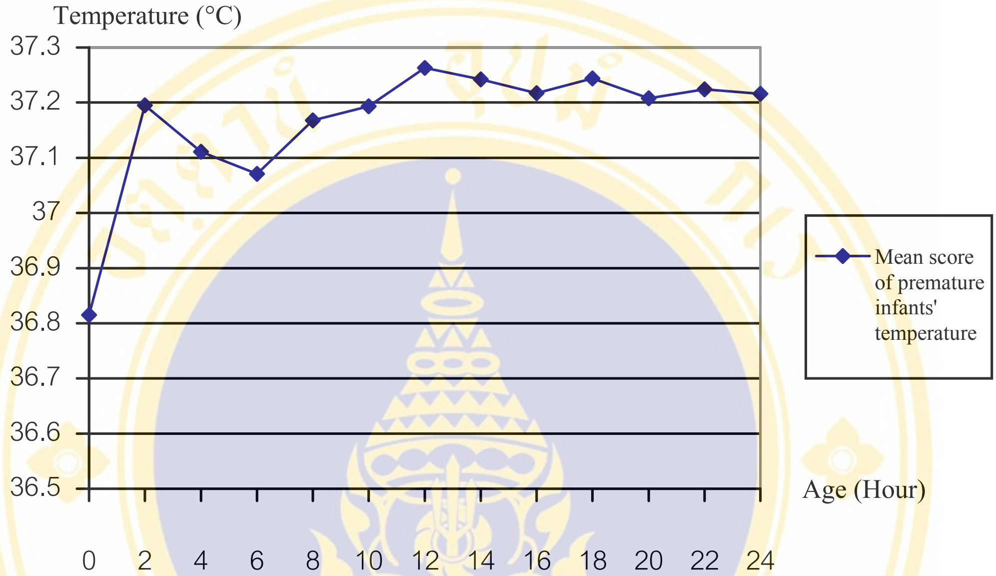
Table 4 Percentage, mean, minimum and maximum, and standard deviation of the premature infants' characteristics (n = 100)

Characteristics	Percentage (%)
Gestational age (weeks)	
32	1
33	1
34	13
35	19
36	66
(Mean = 35.48; SD = 0.83; Min-Max = 32-36)	
Birth weight (grams)	
1,800-2,199	14
2,200-2,599	44
2,600-2,999	36
3,000-3,399	6
(Mean = 2510.20; SD = 287.53; Min-Max = 1,800-3,210)	

2. The Pattern of Premature Infants' Temperature and Hypothermia during 24 Hours after Birth

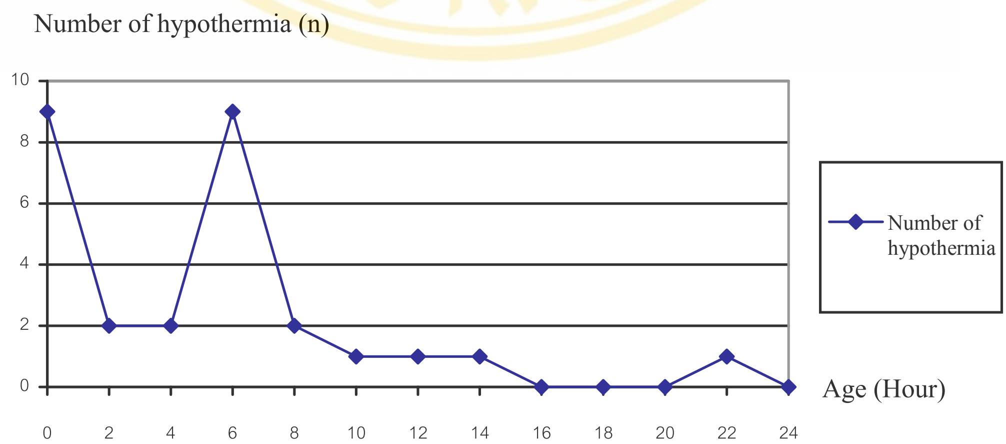
To illustrate the pattern of premature infants' temperature, the descriptive statistics were performed. Figure 2 showed that the lowest mean temperature score was immediately at birth (mean = 36.8). Also, there was no mean score of premature infants' temperature during 24 hours below 36.5°C. In addition, the pattern of premature infants' temperature rooming-in with their mothers was unstable within twelve hours after birth, but it tended to stabilize after twelve hours postnatal age. Furthermore, the majority of premature infants (72%) rooming-in with their mothers had no hypothermia (n = 72), whereas only 28% of premature infants had hypothermia (n = 28). The highest number of premature infants who had hypothermia was 9, both immediately after birth and at six hours after birth as shown in figure 3. When classifying temperature of hypothermic premature infants, it was found that of the 28 infants, 96.4% had mild hypothermia and only one infant had moderate hypothermia (35.9°C), and 46.4% had hypothermia after bath as shown in Table 5.

Figure 2 The linear graph showing the pattern of premature infants' temperature rooming-in with their mothers (n = 100)



Premature infants' temperature during 24 hours after birth

Figure 3 The linear graph showing number of hypothermia in premature infants rooming-in with their mothers (n = 28)



Number of hypothermia during 24 hours after birth

Table 5 Number and percentage of the sample classified by the level of temperature of premature infants rooming-in with their mothers (n = 100)

Temperature (°C)	Number	Percentage (%)
≥ 36.5	72	72
<36.5	28	28
36.0-36.4	27	96.4
35.9	1	3.6
<36.5 (after bath)	13	46.4

3. The Description of Environmental Temperature, Humidity, and Maternal Behaviors for Hypothermia Prevention

Table 6 Minimum and maximum, mean, and standard deviation of environmental temperature, humidity, and maternal behaviors for hypothermia prevention during 24 hours after birth (n = 100)

Characteristics	Min.-Max.	Mean	SD
1. Environmental temperature	27.2-29.5	28.305	.488
2. Humidity	56-84	70.64	5.91
3. Maternal behaviors for hypothermia prevention	26-59 (Possible range = 0-60)	44.33	7.45

According to Table 6, the environmental temperature during 24 hours was between 27.2 and 29.5°C (Mean = 28.305; SD = 0.488). Humidity was between 56 and 84% (Mean = 70.64; SD = 5.91). The scores of maternal behaviors for hypothermia prevention ranged from 26 to 59 with a mean score of 44.3 (SD = 7.45). It was rather high when compared a mean score with the possible range of 0 to 60.

Part II: The Results of Hypothesis Testing

The factors including gestational age, birth weight, environmental temperature, humidity and maternal behaviors for hypothermia prevention will significantly account for hypothermia in premature infants rooming-in with their mothers.

Since the sample size (n = 100) was not enough to begin the multivariate model with all independent variables, each variable was tested independently for association with the dichotomous dependent variable, hypothermia, using appropriate univariate analysis (Hosmer & Lemeshow, 1989). Univariate analyses for one dichotomous independent variable, gestational age, was performed by Chi-square test. The results of Chi-square test analysis are presented in Table 7. Likewise for continuous variables such as birth weight, environmental temperature, humidity, and maternal behaviors, t-test analysis was performed. The results of t-test analysis are presented in Table 8. Those variables whose univariate test had a p-value < 0.25 were selected for inclusion into the multivariate model (Hosmer & Lemeshow, 1989).

Based on the selected criterion, the variables included in the logistic regression model for the dichotomous dependent variable, hypothermia, were gestational age ($\chi^2 = 8.96$, $p < .003$), birth weight ($t = 3.04$, $p < .003$), environmental temperature ($t = 1.77$, $p < .08$), and maternal behaviors ($t = 1.79$, $p < .07$). This study results are shown in Tables 7-8.

Table 7 Chi-square test for gestational age and hypothermia in premature infants rooming-in with their mothers (n = 100)

Variable	Hypothermia	No hypothermia	χ^2	p-value
Gestational age (weeks)				
32-34	9	6	8.964	.003
35-36	19	66		

Table 8 Independent t-test for birth weight, environmental temperature, humidity, maternal behaviors for hypothermia prevention and hypothermia in premature infants rooming-in with their mothers (n = 100)

Variables	Hypothermia	N	Mean	SD	t	p-value
Birth weight	No	72	2526.50	261.290	3.04	.003
	Yes	28	2375.71	312.332		
Environmental temperature	No	72	28.358	0.4617	1.77	.080
	Yes	28	28.168	0.5346		
Humidity	No	72	70.50	6.228	-0.375	.709
	Yes	28	70.99	5.098		
Maternal behaviors for hypothermia prevention	No	72	45.15	7.342	1.79	.077
	Yes	28	42.21	7.455		

Furthermore, a hierarchical logistic regression was applied to determine whether gestational age, birth weight, environmental temperature, and maternal behaviors for hypothermia prevention could predict hypothermia in premature infants rooming-in with their mothers. In this equation, the factors of gestational age, birth weight, and environmental temperature were entered into the first step as independent variables and maternal behaviors for hypothermia prevention was entered into the second step. At step 1, the Chi-square model was significant (χ^2 =14.560, df = 3, p = .002). The accuracy of the model to predict hypothermia was 77%. Approximately 19% of variance in hypothermia was explained by the factors of gestational age, birth weight, and environmental temperature ($\underline{R}^2L$ = 0.195). No variables were significantly associated with hypothermia at the alpha of 0.05. The goodness of fit chi-square (χ^2 = 3.841, df = 8, p = .871) indicated that this model did provide a good fit for the data. Table 9 contains the results of the analysis.

At step 2, maternal behaviors for hypothermia prevention significantly was added to the prediction of hypothermia. The Chi-square model was significant (χ^2

=18.401, df = 4, p = .001). The accuracy of the model to predict hypothermia was increased to 79%. The variance of hypothermia explained by all factors in this step increased to 24% ($\underline{R}^2L$ = 0.242). The goodness of fit chi-square (χ^2 = 13.482, df = 8, p = .096) indicated that this model did provide a good fit for the data. After controlling for other factors, however, only environmental temperature was significantly related to hypothermia (OR = 0.335, 95% CI = 0.120-0.934, p < .05). The probability of hypothermia increased 0.3 times in premature infants with one unit decreased in the environmental temperature. Table 9 contains the results of the analysis.

Table 9 Summary of a hierarchical logistic regression for the factors affecting hypothermia

Variables	R^2L	β	S.E.	OR	95%CI for OR	P-value
Step 1	0.195					
Gestational age		-1.080	0.716	0.340	0.081, 1.381	.131
Birth weight		-0.002	0.001	0.998	0.996, 1.000	.090
Environmental temperature		-0.906	0.504	0.404	0.150, 1.086	.073
Step 2	0.242					
Gestational age		-1.046	0.724	0.351	-0.085, 1.451	.148
Birth weight		-0.002	0.001	0.998	0.996, 1.000	.087
Environmental temperature		-1.092	0.522	0.335	0.120, 0.934	.037
Maternal behaviors for hypothermia prevention		-0.066	0.034	0.936	0.875, 1.001	.055

Log Likelihood of step 1 = 104.030

Goodness of fit χ^2 = 3.841, df = 8, p = .871, correctly classified = 77%

Log Likelihood of step 2 = 100.190

Goodness of fit χ^2 = 13.482, df = 8, p = .096, correctly classified = 79%

CHAPTER V
DISCUSSION

The purpose of this descriptive research was to describe the pattern of premature infants' temperature and hypothermia in premature infants rooming-in with their mothers. The second purpose was to examine the predictive power of factors including gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention accounting for hypothermia.

In this chapter, the research findings are discussed in accordance with the study objectives and hypothesis testing.

The Pattern of Premature Infants' Temperature and Hypothermia during 24 Hours after Birth

The study results revealed that the highest number of premature infants had hypothermia immediately after birth and at six hours after birth (Figure 3). The lowest mean temperature score was immediately after birth (Figure 2). Moreover, in this study found that the mean temperature score of the sample during 24 hours after birth was not below 36.5°C. One possible explanation for the highest number of hypothermia and the lowest temperature immediately after birth was that all newborns have a period of physiologic adjustment for extrauterine life which is called the transition period in the first six to eight hours after birth (Hammond, 2000: 671) before their body systems stabilize. The temperature of the newborn usually drops lasting up to 30 minutes after birth in the first phase of the transition period (Hammond, 2000: 672), especially in air conditioned delivery room but it returns to normal in about eight hours (Marlow, 1990: 158). According to Hammond & Perry (2000: 723), the newborn's temperature should stabilize within the normal range by the twelfth hours.

Another reason for the lowest mean temperature score at birth might be that all premature infants have wet skin of amniotic fluid. The mechanism of thermal exchange between the premature infants and the environment may lead to the premature infants' temperature instability, especially evaporative heat loss.

Hammarlund, et al. (1986: 1-10) studied the evaporation rate from the skin and ambience at an ambient humidity of 50% during the first four weeks after birth in 68 infants with 25-41 weeks' gestation. It was found that preterm infants had high evaporative heat loss on the first day of life. The evaporative heat loss decreased when the infants' gestational and post-natal age increased. However, in this study it was found that the mean temperature score of the sample during the first 24 hours after birth was not below 36.5°C. It could be explained that there were some premature infants who had body temperature higher than 37.5°C (see Table11 in Appendix D).

In this study, when the linear graph was used to display the pattern of these premature infants' temperature during 24 hours with mean temperature score (Figure 2), it was found that the pattern of temperature was unstable within the first twelve hours after birth. It was revealed that their temperatures may fall below 36.5°C. In general, all infants are at risk of cold stress particularly within the first twelve hours of life (Weber, 1997: 4). This finding was incongruent with the study of Ellis, et al. (1996: F42-45) which studied postnatal hypothermia and cold stress among newborn infants in Nepal. It was found that postnatal hypothermia was prolonged over the first 24 hours. This may be because air temperature in Nepal was lower than the recommendation of WHO at 25°C. The premature infants who are considered as a high-risk neonate group may have more difficulty to have physiologic adjustment because of the limited system organs' maturation. Thus, the premature infants may still have difficulty of thermoregulation for extrauterine life within the first twelve hours after birth and/or in the first day of life.

Results indicated that 28% of the premature infants who were rooming-in with their mothers had hypothermia. It was also revealed that hypothermia was lower than that found in the studies of Loughead, Loughead, and Reinhart (1997) and Thongsouy Sitanon, (1998) which found 45% and 86% occurrence of hypothermia in premature infants, respectively. Besides, it seemed to be rather low when compared to 72% premature infants without hypothermia. One possible explanation might be because most of the premature infants in the present study were near term infants with 36 weeks' gestation. As Balaraman (2002: 2) has noted, the majority of premature infants are able to regulate their body temperature by a post conceptional age of 34 weeks. Another explanation might be these premature infants in this study received an appropriate method for prevention of heat loss immediately after birth by rapidly being removed of amniotic fluid, kept warmed on radiant warmer and then rooming-in with their mothers for initiation of bonding and attachment. Therefore, if newborns were dried immediately and placed under radiant warmer after birth, they had a smallest drop in body temperatures. Additionally, these premature infants were controlled the duration of special routine care for body cleaning, eye care, and wrapping after birth. That is, it was not longer than ten minutes. Patoommard Cheawcherngan, Chareerat Yangyuen and Suntharee Inthrapichet (1999: 17) have noted that it should not be longer than 15 minutes. Wattana Kulnatsiri (1993) studied the effect of heat loss prevention on body temperature of the neonate after birth and found that the newborn infants who received the heat loss prevention protocol had body temperature higher than the infants who did not. The incidence of hypothermia at two hours after birth and upon admission to the nursery was statistically lower than the infants who did not receive the heat loss prevention protocol. Moreover, Pennapa Pakdewong (1993) has suggested that heat loss can be prevented significantly by drying the newborns promptly, giving routine care under the radiant warmer, and placing the newborns in skin-to-skin contact with their mothers. According to the Baby-Friendly Hospital Initiative, the infants must have only breast-feeding and rooming-in with their mothers for bonding and attachment initiation. Thus, their body temperature is maintained in their mothers' arm (Mellien, 2001: 157) during breast-feeding. Therefore, the early breast-feeding should help reduce the risk of hypothermia (Van den Bosch & Bullough, 1990, cited in Ellis, et al., 1996: F43).

Finally, in the study result showed that the majority of hypothermic premature infants (96.4%) had mild hypothermia, which ranged from 36.0 to 36.4°C (WHO, 1993: 3) (Table 5). The finding is incongruent with the study of Thongsouy Sitanon (1998: 55) which found that most of the premature infants had moderate hypothermia (59.5%). Results indicated that the premature infants who were rooming-in with their mothers could regulate their body temperatures as evidenced by the low occurrence of hypothermia and mild hypothermia. Therefore, it helps confirm the advantage of premature infants' rooming-in with their mothers. However, the preventive heat loss methods are still important for hypothermia prevention in premature infants rooming-in with their mothers.

Although this study found that low incidence of hypothermia and the trend of premature infants' temperature to stabilize after twelve hours postnatal age, hypothermia may occur if the newborns receive an inappropriate care. Therefore, the health care providers and their mothers should be concerned about premature infants' temperature during 24 hours after birth because the temperature may still be unstable and fall below 36.5°C, especially within the first twelve hours after birth. However, if the premature infants have at least one time of hypothermia, they should receive a temperature monitoring until their temperature is stable. As noted by American Academy of Pediatrics & American College of Obstetricians and Gynecologists (1997, cited in Mckinney, et al, 2000: 539), the premature infants' temperature should be assessed at least once every 30 minutes until the infant's temperature has been stable for two hours after birth. Afterward, it should be often checked again at four hours and then once every eight hours as long as it remains stable (Mckinney, et al, 2000: 539). Thus, the temperature of premature infants who are kept with their mothers during the first 24 hours should be monitored every four hours routinely at least twelve hours after birth and/or until their temperatures are stable.

Moreover, this study found that among 28 premature infants, 46.4% had hypothermia after the first bath because these premature infants were bathed during the transition period. Thus, the premature infants' temperature after bath should be measured for hypothermia surveillance. However, other factors that were not studied in this research might influence the pattern of premature infants' temperature.

In summary, this study results supported the notion that the premature infants could be kept safely with their mothers in the postnatal ward in the Baby-Friendly Hospital Initiative because premature infants have the low occurrence of hypothermia and/or mild level of hypothermia. Moreover, the premature infants' temperature tends to be stable when premature infants have increased post-natal age.

Hypothesis Testing

Hypothesis: The factors including gestational age, birth weight, environmental temperature, humidity and maternal behaviors for hypothermia prevention will significantly account for hypothermia in premature infants rooming-in with their mothers.

The binary logistic regression method was performed. In the first step, the factors including gestational age, birth weight, and environmental temperature were analyzed. The combination of those factors accounted for 19.5% of the variance to hypothermia (Table 9). There was no statistically significant factor which could predict hypothermia separately. However, in the second step, when maternal behaviors for hypothermia prevention was included in the analysis, the combination of those factors, namely gestational age, birth weight, environmental temperature, and maternal behaviors for hypothermia prevention, accounted for 24.2% of the variance of hypothermia in premature infants rooming-in with their mothers. That is, maternal behaviors for hypothermia prevention were related to hypothermia because of increased power of prediction. However, after controlling other variables, only environmental temperature statistically significant accounted 0.335 times for the occurrence of hypothermia (Odds Ratio = 0.335, 95%CI = 0.120-0.934) ($p < .05$). The odds ratio of 0.33 was less than one, so it could be interpreted that the probability of hypothermia decreased 0.3 times in premature infants who were in low environmental temperature than those who were not in low environmental temperature. The results are discussed in the following parts.

Environmental temperature

The results of this study showed the significant contribution that environmental temperature could explain the risks of hypothermia. The premature infants have a limited thermal regulation. Their body temperature may depend on environmental temperature and usually be unstable after birth (Fanaroff and Martin, 1983, cited in Wattana Kulnatsiri, 1993: 17). Thus, the premature infants should be cared for in an appropriate environmental temperature to increase a high survival rate, that is, the ambient temperature with oxygen consumption (Bell, et al., 1980: 454), metabolic rate and heat production were lowest (Hey & Scopes, 1987; Kriangsak Jirapeat, 1993; Blake & Murray, 1993 cited in Thongsouy Sitanon, 1998: 37).

Generally, the appropriate environmental temperature for thermoneutrality, which is called the neutral environmental temperature, was in the range from 32 to 34°C (Blackburn, 1992: 685). This range of thermal conditions under which a newborn baby can maintain normal body temperature is also an appropriate environmental temperature for premature infants who are cared for in the incubator.

From this study, environmental temperature during 24 hours is between 27.2 and 29.5°C (mean = 28.305; SD = 0.488). It is higher than what the Word Health Organization has recommended. That is, environmental temperature should not be lower than 25°C. Also, it was higher than the American Academy of Pediatrics, recommends a nursery environmental temperature between 24° and 26.5°C when the neonate is dressed in a T-shirt and wrapped in a blanket (AAP cited in Keeling, 1992: 126). However, this study result was similar to an appropriate environmental temperature for premature infants who are cared for in a crib, that is, between 27 and 28 °C (Veena Jirapaet, 2000: 112).

Generally, environmental temperature may affect the infants' temperature by compassing the mechanism of thermal exchange, especially evaporative heat loss which occurs mostly on the first day in premature infants. Moreover, environmental temperature and heat loss has an inverse relation (Gelhar, et al. 1994: 341). That is, the lower environmental temperature, the more the occurrence of hypothermia. However, there was no statistically significant difference on environmental temperature between the hypothermic premature infants and those who did not.

Consequently, when analyzed with logistic regression, environmental temperature showed statistically significant association with the occurrence of hypothermia (OR = 0.335, 95%CI = 0.120-0.934) ($p < .05$). After controlling other factors, the infants who were in low environmental temperature would have 0.33 times increased risks for developing hypothermia as compared to those who were not in low environmental temperature. There might be other factor related to hypothermia such as maternal behaviors. That is, when the environmental temperature was low, the mothers may overwrap or overdress the premature infants' body. Thus, premature infants had no hypothermia. The findings from this study is in contrast to the findings of Johanson, et al. (1992: 861) which found that the effect of air temperature on hypothermia in preterm infant was marked 2.7 times in cold air over warm air (OR = 2.7).

However, in this study, there were some variables, namely gestational age, birth weight, humidity, and maternal behaviors for hypothermia prevention could not account for hypothermia. They might be indirectly related to hypothermia by compassing other variables or because of research limitation. The results are discussed in the following part.

Gestational age

As expected, in univariate analysis, gestational age was found to be significantly associated with hypothermia in premature infants rooming-in with their mothers after birth ($\chi^2 = 8.964$, $p < .01$). Thongsouy Sitanon (1998: 76) noted that the premature infants with lower gestational age had higher incidence of hypothermia. Significantly, maturation of the infants' functional organ was determined by gestational age. Moreover, hypothermia may occur in the premature infants with low gestational age because of the characteristics of the premature infants. However, when examined with other variables in a logistic regression, gestational age was not significantly related to hypothermia in premature infants at 95% level of confidence. One possible explanation for the findings may be that the majority of premature infants in this study had 36 weeks' gestation. They were near term infants, who were supposed to be able to regulate normal temperature. Balaraman (2002: 2) have stated that the majority of premature infants are able to regulate their body temperature by a post conceptional age of 34 weeks. Disappearance of association in this study might be due to the small number of the study subjects.

Birth weight

Comparing the body weight between low and high birth weight, there was significant difference concerning hypothermia. However, birth weight failed to be associated with hypothermia after controlling for confounding variables. This finding was consistent with the study of Thongsouy Sitanon (1998) which reported that premature infants with low birth weight had higher incidence of hypothermia.

In general, the infants were born before term have smaller muscle mass, lack insulating subcutaneous fat, and have little deposit of brown fat tissue. In fact, brown fat tissue is an important nutrient for heat production. It is only 2 to 6% of the total body weight. Thomas (1994: 15-22) has stated that 42% of total energy from the nutrient metabolism is used for thermoregulation. Therefore, if they have low birth weight, they will have less nutrient store for heat production, less insulating subcutaneous fat and larger surface area and body mass ratio. This study found that the majority of premature infants (44%) were 2,200 to 2,599 grams, and the mean of birth weight was greater than 2,500 grams. Thus, they had a low risk for hypothermia.

Humidity

In a univariate analysis, premature infants with and without hypothermia had no significant difference in humidity. From this study results revealed that humidity was between 56 and 84% (mean = 70.64). Amlung (1998: 210) has suggested that humidity of environment to protect premature infants from evaporative heat loss should be in the range of 40 to 60%. In fact, the humidity of the environment in this study was higher than normal. Hammarlund (1986: 4) has stated that the decease in ambient humidity results in a high evaporative heat loss. That is, in the environment with low humidity, the newborn may have high evaporative heat loss. Generally, evaporative heat losses may depend on large surface area/mass ratio, lack of keratinized epidermal skin barrier, humidity, and environmental temperature. The present research was performed in Thailand where the climate was rather hot with high humidity as the country is situated in a tropical zone. Thus, evaporative heat loss through the environment on the first day of life of the premature infants may be minimal.

Maternal behaviors for hypothermia prevention

In univariate analysis, premature infants with and without hypothermia had no significantly different in maternal behaviors for hypothermia prevention. It was apparent from this study that the total scores of overall maternal behaviors ranged from 26 to 59, with the possible range of 0 to 60 (mean = 44.34). That is, the mean score of overall maternal behaviors of the sample was rather high (see Table 6), indicating that the mothers may have appropriate behaviors for hypothermia prevention.

Maternal behaviors for hypothermia prevention was one of the care-giving behavior factors. Based on Orem's Self-Care Deficit Nursing Theory, premature infants are dependent care persons who need help with the activity of self-care from others such as their mothers and health care providers because of self-care deficit. In particular, in Baby-Friendly Hospital Initiative, the mothers should carry out this function because premature infants are kept with them all the time during the first 24 hours after birth. Thermoregulation is the physiological demand after birth of the premature infants, which is defined as the regulation of temperature in normal range 36.5-37.5°C or balancing between heat loss and heat production (Perlstein, 1997: 481; MacGillvray, 1996: 482; Blackburn & Loper, 1992: 677). Although the mothers in this study scored higher on hypothermia prevention, it might not indicate that the mothers had appropriate behaviors for balancing heat loss and heat production. If mothers had more hypothermia prevention behaviors, the infant may have hyperthermia. In this study, 73.4% of mothers whose infants had no hypothermia reported "everytime/always" in wrapping and covering infants all the times, while only 26.6% of mothers whose infants had hypothermia reported "everytime/always." Moreover, 100% of mothers whose infants had no hypothermia reported " everytime/always" in covering infants' head with a hat all the time, while no mothers whose infants had hypothermia reported "everytime/always" (see Table 10 in Appendix D). Therefore, these behaviors might be causes of overheating of babies, leading to decreased occurrence of hypothermia.

Research Limitations

1. This study was conducted by using purposive sampling which limited the generalization of the results to other groups of premature infants and their mothers.

2. In this study, the gestational age was a narrow range within 32-36 weeks and had no normal distribution because most of the premature infants had 36 weeks' gestation. Thus, it may have affected the outcomes of the data analysis.

3. The questionnaire of maternal behaviors for hypothermia prevention used in this study seemed to measure only maternal behaviors for hypothermia prevention, and it did not cover overall thermoregulation such as hyperthermia prevention.

CHAPTER VI
CONCLUSION

Conclusion of the Study

This descriptive research aimed to describe the pattern of premature infants' temperature and hypothermia in premature infants rooming-in with their mothers. The second purpose was to examine factors related to hypothermia, which were gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention. The biological model of thermoregulation and Orem's Self-Care Deficit Theory of Nursing were used as the conceptual framework.

The sample of the study was 100 mother-premature infant dyads hospitalized in the postpartum and gynecological ward, Nakornpathom Hospital during June to December 2002. The sample was chosen by means purposive sampling according to the inclusion criteria previously set.

The instruments for data collection consisted of scientific instruments, that is, electronic digital thermometer axillary type and hygro-thermometer, a demographic data form, and maternal behaviors for hypothermia prevention questionnaire. The maternal behaviors for hypothermia prevention questionnaire was developed by the researcher from the aspect of stable temperature maintenance (Whaley & Wong, 1995: 329) and based on physiological and action demands of hypothermia prevention in the newborn infant. The content was validated by five qualified experts who made improvements before it was tested with 30 mothers of premature infants with the same characteristics as the sample group. The internal consistency reliability of this questionnaire was tested with Cronbarch's alpha coefficient, and the value obtained was 0.85. And when the questionnaire was used with the real sample group consisting of 100 subjects, the value was 0.81.

The characteristics of the subjects and variables were analyzed by using descriptive statistics including number, percentage, mean, and standard deviation. The association among independent and dependent variables was tested by univariate statistics. That is, the association among gestational age and hypothermia was tested by Chi-square. And then, the difference on birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention with independent t-test was performed. Using p-value < 0.25 as a criterion, there were four factors of gestational age, birth weight, environmental temperature, and maternal behaviors for hypothermia prevention were selected for entry into the logistic regression model for the dichotomous variable, hypothermia. The results can be summarized as follows:

1. For characteristics of the sample group, close to half of the mothers (47%) were primigravidarum, and 34% aged 15-19 years old. Their highest level of education was primary school (50%). Most had no experience on premature infant care (88%), and 91% had not received any advice about hypothermia prevention. Regarding the characteristics of the premature infants, most of the infants (66%) had 36 weeks' gestation, and 47% infants' birth weight was between 2,200 and 2,599 grams.

2. The lowest mean temperature score was immediately after birth. The pattern of premature infants' temperature was unstable within twelve hours after birth, but it tended to be stabilized after twelve hours postnatal age. Also, 28% of the premature infants had hypothermia during 24 hours after birth (n=28). The highest number of hypothermia were nine immediately after birth and at six hours after birth (Figure 3). When classifying the temperature of hypothermic premature infants, it was found that of the 28 infants, 96.4% had mild hypothermia and only one infant had moderate hypothermia (35.9°C). Moreover, it was found that 46.4% of hypothermic premature infants had hypothermia after the first bath.

3. When univariate statistics were performed, it was found that there was a statistically significant association among gestational age and hypothermia at the .01 level ($\chi^2 = 8.964$, $p < .003$). Moreover, there was a statistically significant difference on birth weight among premature infants with and without hypothermia at the .01 level ($t = 3.035$, $p < .003$).

4. Finally, logistic regression analysis revealed that, in the first step, the combination of variables including gestational age, birth weight, and environmental temperature accounted for 19.5% of variance of hypothermia. In the second step of the analysis, maternal behaviors for hypothermia prevention, together with gestational age, birth weight, and environmental temperature, accounted for an increase of 24.2%

of variance of hypothermia. The independent variable which had a statistically significant prediction power of hypothermia in premature infants rooming-in with their mothers after birth was environmental temperature (Odds ratio = 0.335, $p < .05$).

It can be summarized that this research results partially supported the biological model of thermoregulation and Orem's Self-Care Deficit Theory of Nursing in the Baby-Friendly Hospital Initiative. The occurrence of hypothermia was low in premature infants rooming-in with their mothers. However, it was found that some factors were associated with hypothermia, that is, gestational age, birth weight, and environmental temperature. The combination of variables for gestational age, birth weight, and environmental temperature factors accounted for 19.5% of variance of hypothermia. Moreover, the maternal behaviors for hypothermia prevention was predicted together with gestational age, birth weight, and environmental temperature factors accounting for an increase of 24.2% of variance of hypothermia. After controlling for other factors, however, only environmental temperature was significantly related to hypothermia (OR = 0.335, 95%CI = 0.120-0.934, $p < .05$). Thus, there may be other factors that influenced those factors which were not studied in this research. However, the study results helped confirm that the premature infants could be kept safely with their mothers during 24 hours after birth, but health care providers should be concerned about hypothermia surveillance at least twelve hours after birth.

Recommendations

The findings of the study provide several important implications for the nursing profession including nursing practice, nursing research and nursing education.

Implications for nursing practice

1. The results of the study showed that 28% of premature infants rooming-in with their mothers had hypothermia, and the level of their temperature was between mild to moderate hypothermia. As such, it revealed the advantage of premature infants rooming-in with their mothers because they had low occurrence of hypothermia. Significantly, heat loss prevention method should be performed immediately after birth, and then premature infants should be kept with their mothers. Furthermore, the mothers should receive education and advice to perform an

appropriate hypothermia prevention. However, the premature infants' temperature was unstable within twelve hours after birth and had hypothermia after bath. Thus, health care providers should be concerned with hypothermia surveillance. That is, all health care providers in the postpartum unit need to be alert to the risk of hypothermia, which is a common condition, especially during twelve hours after birth so as to able to early detect hypothermia among premature infants. Thus, the body temperature of premature infants should be monitored every four hours routinely at least twelve hours after birth as recommended by WHO to ensure that the baby maintains a normal body temperature of 36.5-37.5°C and dose not become either too cold (hypothermia) or too hot (hyperthermia).

2. The mothers of newborn babies should receive in-service teaching from health care providers about the principles of thermal protection of the premature infant. From this study, most of the mothers (88%) had no experience on premature infants care, and 91% of them had not received any advice about hypothermia prevention. Moreover, it is worth noting that this study found that there were premature infants who had hyperthermia. That is, the mothers may have inappropriate behaviors in taking care of the infants such as overwrapping or overdressing the infants. Thus, the mothers should be given information on how to prevent and/or recognize both hypothermia and hyperthermia.

Implications for nursing research

The present study has provided some solutions as well as yielded some unsolved issues that need further investigation as follows:

1. This study had a limitation in the sample size; thus, this topic should be studied again in the same group of sample with a larger sample size. Further studies should also focus on the same factors related to hypothermia (gestational age, birth weight, environmental temperature, humidity, and maternal behaviors for hypothermia prevention) because some variables explored in this study showed no normal distribution.

2. Further research is required to define more precisely the other factors affecting hypothermia such as the maternal factors including age and education, as well as other care-giver's behaviors.

Implication for nursing education

Standards of care should be defined and thermal protection should be included in curricula to train nursing students and health care providers at all levels.

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APPENDIX A

APPENDIX A

LIST OF THE EXPERTS

In the study "Factors related to hypothermia in premature infants rooming-in with their mothers", the involved study tool was tested for validity. Following is the list of experts:

1. Asst. Prof. Kruawan Tinsulananda
   Department of Nursing
   Faculty of Medicine, Ramathibodi Hospital, Mahidol University
2. Asst. Prof. Poontaree Puangsuwan
   Department of Maternal and Child Nursing
   Faculty of Nursing, Khonkean University
3. Asst. Prof. Sarayuth Supapanachard
   Department of Pediatric
   Faculty of Medicine, Ramathibodi Hospital, Mahidol University
4. Prof. Veena Jirapaet, Ph.D
   Department of Nursing
   Faculty of Nursing, Chulalongkorn University
5. Miss Vimonvan Varolarn
   NICU, Department of Nursing
   Faculty of Medicine, Ramathibodi Hospital, Mahidol University

APPENDIX B

APPENDIX B

การพิทักษ์สิทธิผู้เข้าร่วมงานวิจัย

ข้าพเจ้านางสาว สุรีพร เกียรติวงศ์ครู นักศึกษาหลักสูตรพยาบาลศาสตรมหาบัณฑิต สาขาวิชาการพยาบาลเด็ก คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล กำลังศึกษาปัจจัยที่มีความสัมพันธ์กับภาวะอุณหภูมิกายต่ำในทารกคลอดก่อนกำหนดที่อยู่กับมารดาในระยะ 24 ชั่วโมงหลังคลอด ซึ่งคาดหวังว่าผลการศึกษานี้จะช่วยส่งเสริมการมีบทบาทของมารดาให้มีส่วนร่วมในการป้องกันภาวะอุณหภูมิกายต่ำในทารกคลอดก่อนกำหนด

การศึกษาครั้งนี้จำเป็นต้องขอเก็บข้อมูลของท่านและทารก ซึ่งประกอบด้วย ข้อมูลส่วนบุคคล และการวัดอุณหภูมิกายทารกทางรักแร้ หลังจากนั้นจะให้มารดาตอบแบบสอบถามเป็นเวลา 15 นาที ข้อมูลทั้งหมดจะถูกเก็บไว้เป็นความลับ ท่านสามารถถอนตัวจากการวิจัยได้ตลอดเวลาและจะไม่มีผลใดๆต่อการดูแลรักษาพยาบาลทารกของท่าน ถ้าท่านยินดีเข้าร่วมวิจัย กรุณาลงชื่อของท่านลงท้ายแบบฟอร์มนี้

ขอขอบคุณในความร่วมมือ

นางสาว สุรีพร เกียรติวงศ์ครู
ผู้วิจัย

ยินยอมเข้าร่วมวิจัย

ลงชื่อ……………………………

(…………………………..)

ผู้เข้าร่วมวิจัย

……./……../…….

บัณฑิตวิทยาลัยมหาวิทยาลัยมหิดล
25/25 ถ.พุทธมณฑลสาย 4 ต.ศาลายา
อ.พุทธมณฑล จ.นครปฐม 73170
โทร 441-0177 โทรสาร 441-0177

ที่ ทม 0802.01 (ศย)/2797

โรงพยาบาลนครปฐม
รับที่ 4013
วันที่ 10 มิ.ย. 45
เวลา 11.50 น.

31 พฤษภาคม 2545

เรื่อง ขอความอนุเคราะห์ให้นักศึกษาเก็บข้อมูล เพื่อประกอบการทำวิทยานิพนธ์

เรียน ผู้อำนวยการโรงพยาบาลนครปฐม

ด้วย นางสาวสุรีพร เกียรติวงศ์ครู นักศึกษาบัณฑิตวิทยาลัย มหาวิทยาลัยมหิดลหลักสูตรปริญญาโท สาขาวิชาการพยาบาลเด็ก คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี กำลังทำวิทยานิพนธ์ เรื่อง “FACTORS RELATED TO HYPOTHERMIA IN PREMATURE INFANTS ROOMING-IN WITH THEIR MOTHERS” อยู่ในความควบคุมของ อ.ดร.อัจฉรียา ปทุมวัน ในการศึกษาวิจัยครั้งนี้ นักศึกษามีความประสงค์เก็บข้อมูลจากมารดาและทารกคลอดก่อนกำหนดที่ห้องคลอด ตึกหลังคลอดและนรีเวช โรงพยาบาลนครปฐม โดยวิธีใช้แบบสอบถามและวัดอุณหภูมิกายทารกหลังคลอด เป็นเครื่องมือในการวิจัย ตั้งแต่วันที่ 10 มิถุนายน 2545 ถึงวันที่ 31 ธันวาคม 2545

บัณฑิตวิทยาลัย จึงใคร่ขอความกรุณาจากท่านโปรดอนุเคราะห์ให้นักศึกษาได้เก็บข้อมูลเพื่อประกอบการทำวิทยานิพนธ์ ตามที่เห็นสมควรด้วย จักเป็นพระคุณยิ่ง

เรียน ผู้อำนวยการฯ
- [ ] เพื่อโปรดทราบ
- [x] เพื่อโปรดพิจารณาสั่งการ
- [ ] เพื่อโปรดอนุมัติ
- [ ] เพื่อโปรดอนุญาต
- [x] มอบกลุ่มงาน/ฝ่าย
- [ ] อื่น ๆ

10 มิ.ย. 2545

ขอแสดงความนับถือ

ประกายรัตน์ สุขุมาลชาติ

(ผู้ช่วยศาสตราจารย์ประกายรัตน์ สุขุมาลชาติ)
รองคณบดีฝ่ายบัณฑิตศึกษาศาลายา
ปฏิบัติราชการแทน คณบดีบัณฑิตวิทยาลัย

ติดต่อประธานคณะกรรมการควบคุมวิทยานิพนธ์ อ.ดร. อัจฉรียา ปทุมวัน

โทร. 09-1250210

APPENDIX C

APPENDIX C
เครื่องมือวิจัย

เครื่องมือเก็บรวบรวมข้อมูล

กลุ่มตัวอย่างเลขที่.....................

หอผู้ป่วย.............................

ส่วนที่ 1 แบบบันทึกข้อมูลส่วนบุคคลของมารดาและทารก

คำชี้แจง โปรดทำเครื่องหมาย ✓ ในวงเล็บ ( ) หรือเติมคำลงในช่องว่าง

1.1 ข้อมูลของมารดา

1. อายุ ______ ปี
2. ระดับการศึกษาสูงสุด______________________________
3. จำนวนการตั้งครรภ์ _____ ครั้ง, การคลอด _____ ครั้ง
4. ประสบการณ์ในการดูแลทารกคลอดก่อนกำหนด
   ( ) มี ( ) ไม่มี
5. ท่านได้รับคำแนะนำเกี่ยวกับการป้องกันภาวะอุณหภูมิกายต่ำ
   ( ) ได้รับ ( ) ไม่ได้รับ
   ถ้าได้รับ จาก ( ) แพทย์
   ( ) พยาบาล
   ( ) บุคคลอื่นๆ ได้แก่ _______________

1.2 ข้อมูลของทารก

1. เพศ ( ) ชาย ( ) หญิง
2. อายุครรภ์ (คำนวณโดยใช้ Ballard score) _____ สัปดาห์
3. น้ำหนักแรกเกิด_______กรัม
4. คะแนนแอพการ์ ที่ 1 นาที เท่ากับ ____ , ที่ 5 นาที เท่ากับ_____

ส่วนที่ 2 ประเมินอายุครรภ์โดยวิธีของบาลลาร์ด

2.1 การตรวจทางระบบประสาท

2.2 การตรวจร่างกายภายนอก

ส่วนที่ 3 แบบบันทึกการวัดอุณหภูมิกายทารก อุณหภูมิสิ่งแวดล้อมและความชื้นสัมพัทธ์

คำชี้แจง

1. โปรดบันทึกการวัดอุณหภูมิกายของทารก อุณหภูมิสิ่งแวดล้อมและความชื้นสัมพัทธ์ลงในตาราง A ข้างล่างนี้ โดยเริ่มบันทึกตั้งแต่ทารกเกิดจนถึงอายุครบ 24 ชั่วโมงหลังคลอด แต่ละครั้งห่างกันทุก 2 ชั่วโมง

2. โปรดบันทึกการวัดอุณหภูมิกายของทารกก่อนและหลังอาบน้ำลงในตาราง B ข้างล่างนี้

ตาราง A บันทึกการวัดอุณหภูมิกายทารก อุณหภูมิสิ่งแวดล้อมและความชื้นสัมพัทธ์

วันที่	การวัดครั้งที่	เวลา	อายุ (ชม.)	ความชื้นสัมพัทธ์(RH) (%)	อุณหภูมิ ($^{\circ}$C)	
					ทารก (T_I)	สิ่งแวดล้อม (T_E)
	1.		แรกเกิด			
	2.		2			
	3.		4			
	4.		6			
	5.		8			
	6.		10			
	7.		12			
	8.		14			
	9.		16			
	10.		18			
	11.		20			
	12.		22			
	13.		24			

ตาราง B บันทึกการวัดอุณหภูมิกายทารกก่อนและหลังอาบน้ำ

วันที่	การวัดครั้งที่	เวลา	อายุ (ชม.)	ความชื้นสัมพัทธ์ (RH) (%)	อุณหภูมิสิ่งแวดล้อม (T_E) ($^{\circ}$C)	อุณหภูมิกายทารก($^{\circ}$C)	
						ก่อนอาบน้ำ (T_{Bb})	หลังอาบน้ำ (T_{Ab})
	1.						

ส่วนที่ 4 แบบสอบถามพฤติกรรมการป้องกันภาวะอุณหภูมิกายต่ำของมารดา

คำชี้แจง

ข้อคำถามต่อไปนี้เป็นข้อความที่ท่านจะใช้บอกการปฏิบัติของตนเองในการป้องกันภาวะอุณหภูมิกายต่ำที่ท่านได้กระทำต่อบุตรในระยะเวลา 24 ชั่วโมงที่ผ่านมา ขอให้ท่านตอบให้ตรงกับการปฏิบัติที่แท้จริงของท่านมากที่สุด คำตอบของท่านไม่มีถูกหรือผิดและไม่มีผลกระทบต่อการรักษาพยาบาลบุตรของท่าน

ขอให้ทำเครื่องหมาย ✓ ลงในช่องที่ท่านเห็นว่าตรงกับการปฏิบัติของท่านมากที่สุด แต่ละข้อคำถามมีคำตอบให้เลือกดังนี้ คือ

- ปฏิบัติบ่อย/ทุกครั้ง หมายถึง ท่านปฏิบัติหรือมีพฤติกรรมในข้อนั้นเป็นประจำทุกครั้งสม่ำเสมอ
- ปฏิบัติบางครั้ง หมายถึง ท่านปฏิบัติหรือมีพฤติกรรมในข้อนั้นโดยท่านทำบ้างไม่ทำบ้าง
- ไม่เคยปฏิบัติ หมายถึง ท่านไม่เคยปฏิบัติหรือไม่มีพฤติกรรมในข้อนั้นเลย

ตัวอย่าง

ข้อที่	ข้อความ	การปฏิบัติของมารดา		
		ปฏิบัติบ่อย/ทุกครั้ง	ปฏิบัติบางครั้ง	ไม่เคยปฏิบัติ
0.	ท่านดูแลวัดอุณหภูมิกายทารกทุก 4 ชั่วโมง	✓		

จากตัวอย่าง หมายความว่า ในระยะ 24 ชั่วโมงที่ผ่านมาท่านได้ป้องกันภาวะอุณหภูมิกายต่ำให้กับบุตรของท่านโดยการดูแลวัดอุณหภูมิกายบุตร ทุก 4 ชั่วโมงอย่างสม่ำเสมอ

ข้อที่	ข้อความ	การปฏิบัติของมารดา		
		ปฏิบัติบ่อย/ทุกครั้ง	ปฏิบัติบางครั้ง	ไม่เคยปฏิบัติ
1.	ท่านดูแลให้ทารกได้รับนมทุก 3 ชั่วโมง			
2.	ท่านหลีกเลี่ยงการอาบน้ำหรือเช็ดตัวให้ทารกในช่วงเวลาที่มีอากาศเย็น เช่น เวลาเช้าตรู่			
3.	เมื่อท่านอาบน้ำให้ทารก ท่านปฏิบัติสิ่งต่อไปนี้บ่อยเพียงใด 3.1 …………………………………….. 3.2 …………………………………….. 3.3 …………………………………….. 3.4 ……………………………………..			
4.	…………………………………………………			
5.	…………………………………………………..			
..	…………………………………………………..			
..	…………………………………………………..			
..	…………………………………………………..			
..	…………………………………………………..			
17.	ท่านสอบถามแพทย์ พยาบาลหรือเจ้าหน้าที่อื่นๆ เมื่อท่านมีปัญหาหรือไม่แน่ใจการดูแลทารกคลอดก่อนกำหนด เช่น การป้องกันภาวะอุณหภูมิกายต่ำ (ภาวะตัวเย็น)			

APPENDIX D

APPENDIX D

Table 10 Number and percentage of maternal behaviors for hypothermia prevention in premature infants rooming-in with their mothers (n=100)

Practices	Maternal behaviors for hypothermia prevention					
	No Hypothermia (n=72)			Hypothermia(n=28)		
	Never N(%)	Sometimes N(%)	Everytime/ Always N(%)	Never N(%)	Sometimes N(%)	Everytime/ Always N(%)
1. You provided feeding.	1(100)	43(81.13)	28(60.87)	0(0)	10(18.87)	18(39.13)
2. You postponed…	18(62.07)	34(77.27)	20(74.07)	11(37.93)	10(22.72)	7(25.93)
3.1. You frequent …	14(70)	24(66.67)	34(77.27)	6(30)	12(33.33)	10(22.72)
3.2 You frequent….	4(50)	8(80)	60(73.17)	4(50)	2(20)	22(26.83)
3.3 You frequent..	3(42.86)	20(83.33)	49(71.01)	4(57.14)	4(16.67)	20(28.99)
3.4 You frequent..	0(0)	5(83.33)	67(72.04)	1(100)	1(16.67)	26(27.96)
4. After hand cleaning..	1(100)	19(57.58)	52(78.79)	0(0)	14(42.42)	14(21.21)
5. You provided your…	8(44.44)	33(73.33)	31(83.38)	10(55.56)	12(26.67)	6(16.62)
6. You uncover as little	2(50)	14(60.87)	56(76.71)	2(50)	9(39.13)	17(23.29)
7. You provided…	3(60)	28(71.79)	41(73.21)	2(40)	11(28.21)	15(26.79)
8. You frequently…	0(50)	14(60.87)	58(75.32)	0(50)	9(39.13)	19(24.68)
9.1. After infant....	4(100)	8(72.73)	60(70.59)	0(0)	3(27.27)	25(29.41)
9.2. After infant ...	0(50)	4(80)	68(71.58)	0(50)	1(20)	27(28.42)
10. You dressed…	1(100)	1(25)	70(73.69)	0(0)	3(75)	25(26.31)
11. You wrapped..	1(100)	3(100)	68(70.83)	0(0)	0(0)	28(29.17)
12. You wrapped …	0(50)	14(66.7)	**58(73.4)**	0(50)	7(33.3)	**21(26.6)**
13. You put gloves...	1(50)	24(72.7)	47(72.3)	1(50)	9(27.3)	18(27.7)
14. You covered …	46(70.8)	25(73.5)	**1(100)**	19(29.2)	9(26.5)	**0(0)**
15.1. You noticed…	11(57.89)	26(74.29)	35(70.09)	8(42.11)	9(25.71)	11(23.91)
15.2. You noticed…	4(57.14)	12(63.16)	56(75.68)	3(42.86)	7(36.84)	18(24.32)
15.3.You noticed…	20(58.82)	21(77.78)	31(79.49)	14(41.18)	6(22.22)	8(20.51)
15.4.You noticed…	6(50)	29(74.36)	37(75.51)	6(50)	10(25.64)	12(24.49)

Table 10 Number and percentage of maternal behaviors for hypothermia prevention in premature infants rooming-in with their mothers (n=100) (continued)

Practices	Maternal behaviors for hypothermia prevention					
	No Hypothermia (n=72)			Hypothermia (n=28)		
	Never N(%)	Sometimes N(%)	Everytime/ Always N(%)	Never N(%)	Sometimes N(%)	Everytime/ Always N(%)
15.5. You noticed…	14(56)	28(87.5)	30(69.77)	11/(44)	4(12.5)	13(30.23)
15.6. You noticed…	16(64)	21(75)	35(74.47)	9/(36)	7(25)	14(25.53)
16.1. When you found ..	4(66.67)	20(68.97)	48(73.85)	2(33.33)	9(31.03)	17(26.15)
16.2. When you found..	3(60)	29(76.32)	40(70.18)	2(40)	9(23.68)	17(29.82)
16.3. When you found ..	5(55.56)	21(80.77)	46(70.77)	4(44.44)	5(19.23)	19(29.23)
16.4. When you found ..	18(75)	17(80.95)	37(67.27)	6(25)	4(19.05)	18(32.73)
16.5. When you found..	8(61.54)	25(75.76)	39(72.22)	5(38.46)	8(24.24)	15(27.78)
17. You kept asking…	25(61.10)	17(73.91)	30(78.95)	14(35.90)	6(26.09)	8(21.05)

Table 11 Min-max, mean, and standard deviation of premature infants' temperature during 24 hours after birth (n=100)

Age (hr)	Min-max	Mean	SD
0	36.0-37.5	36.815	.311
2	36.4-38.2	37.195	.399
4	36.1-38.3	37.111	.403
6	36.1-38.0	37.071	.402
8	36.4-38.2	37.168	.337
10	36.3-38.0	37.193	.360
12	35.9-38.1	37.263	.364
14	36.4-38.0	37.242	.343
16	36.6-38.2	37.217	.319
18	36.6-38.2	37.244	.352
20	36.6-38.2	37.208	.334
22	36.3-38.2	37.224	.346
24	36.6-38.2	37.216	.313
Before bath	36.5-38.0	37.242	.3137
After bath	36.2-37.9	36.800	.3244

Table 12 Min-max, mean, and standard deviation of environmental temperature during 24 hours (n=100)

Age (hr)	**Min-max**	**Mean**	**SD**
0	26.4-34.1	28.977	1.077
2	26.6-30.0	28.136	.673
4	26.3-30.0	28.279	.746
6	26.0-30.0	28.222	.803
8	25.1-31.0	28.256	.910
10	25.5-30.9	28.175	.929
12	25.1-30.0	28.193	.799
14	25.7-30.4	28.254	.811
16	25.8-31.0	28.178	.923
18	25.7-31.0	28.219	.871
20	25.4-31.9	28.346	.809
22	26.0-30.3	28.365	.748
24	26.0-30.5	28.361	.885

Table 13 Min-max, mean, and standard deviation of humidity during 24 hours (n=100)

Age (hr)	**Min-max**	**Mean**	**SD**
0	46-80	61.96	7.16
2	50-84	65.05	6.71
4	52-95	69.15	7.62
6	50-95	70.90	8.37
8	48-95	71.99	8.93
10	46-95	73.22	8.90
12	58-95	74.09	9.01
14	51-95	72.90	9.01
16	55-95	72.51	8.11
18	57-95	72.55	7.31
20	55-93	72.09	6.73
22	49-86	70.79	7.09
24	51-90	71.09	7.08

BIOGRAPHY

NAME	Miss Sureeporn Kearttiwongkru
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