EFFECT OF HEARTBEAT SOUND ON SLEEP DURATION OF PRETERM INFANTS

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ABSTRACT

This study employed a cross-over experimental design for exploring the effects of a heartbeat sound on the sleep duration of preterm infants with the objective of comparing the sleep time of preterm infants while both hearing heartbeat sounds and not hearing them. The study was conducted with only one sample group and every patient was in the self-control group. All twelve preterm infants were selected by purposive sampling from the Newborn Unit, Taksin Hospital during March – June of 2010. Each preterm infant was randomly assigned a stage to begin with: i.e. hearing a heartbeat sound (experimental stage) or not hearing a heartbeat sound (control stage) whereby equal amounts of tags (A or B) were made to choose at which stage each of the infants would start. The environments of both stages were arranged similarly to a womb environment, controlling light not to exceed 600 Lux and sound not to exceed 58 dB. The preterm infants' sleep-wake behaviors were evaluated by using the evaluation form from Chantima Charastong. General information was analyzed in terms of frequency, percentage, mean, and standard deviation. Sleep-wake information was analyzed by using the Wilcoxon Signed-Rank Test and Paired t-test.

The findings of the study revealed that the sleep duration and quiet sleep duration of preterm infants were longer while hearing heartbeat sounds than while not hearing heartbeat sounds with a .01 level of statistical significance, and their active sleep duration was shorter with a .05 level of non-statistical significance. The results can be utilized as nursing practice guidelines for promoting the sleep of preterm infants.

KEY WORDS: PRETERM INFANTS / SLEEP DURATION / HEARTBEAT SOUND

87 pages

ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด
EFFECT OF HEARTBEAT SOUND ON SLEEP DURATION OF PRETERM INFANTS

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คณะกรรมการที่ปรึกษาวิทยานิพนธ์: ทิพวัลย์ ดารามาศ, พย.ด., เรณู พุกบุญมี, พย.ด.

บทคัดย่อ

การศึกษาครั้งนี้เป็นการศึกษา ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด รูปแบบการวิจัยเป็นแบบ Cross-over experimental Design เพื่อเปรียบเทียบระยะเวลาการหลับในทารกเกิดก่อนกำหนดขณะได้รับฟังเสียงจังหวะการเต้นของหัวใจ และขณะไม่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ ศึกษาในตัวอย่างกลุ่มเดียวโดยผู้ป่วยทุกรายเป็นกลุ่มควบคุมในตนเอง กลุ่มตัวอย่างคัดเลือกแบบเฉพาะเจาะจง จากทารกที่รักษาตัวอยู่ในหอผู้ป่วยทารกแรกเกิดและคลอดก่อนกำหนด โรงพยาบาลตากสิน ระหว่างเดือนมีนาคม ถึง เดือนมิถุนายน พ.ศ. 2553 จำนวน 12 ราย ทารกแต่ละรายจะได้รับการทดลอง 2 ระยะ โดยได้รับการสุ่มว่าจะเริ่มระยะใดก่อนระหว่าง ได้รับฟังเสียงจังหวะการเต้นของหัวใจ (ระยะทดลอง) และ ไม่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ (ระยะควบคุม) โดยจัดทำฉลากขึ้นมาอย่างละเท่าๆ กัน (A หรือ B) ทั้ง 2 ระยะจะได้รับการจัดสิ่งแวดล้อมให้เหมือนอยู่ในครรภ์มารดา ควบคุมแสงไม่ให้เกิน 600 ลักซ์ ควบคุมเสียงไม่ให้เกิน 58 เดซิเบล ประเมินพฤติกรรมการหลับตื่นของทารก โดยใช้แบบประเมินของ จันทิมา จรัสทอง วิเคราะห์ข้อมูลทั่วไปโดยใช้ ความถี่ ร้อยละ ค่าเฉลี่ย และส่วนเบี่ยงเบนมาตรฐาน ส่วนข้อมูลการหลับตื่นวิเคราะห์โดยใช้สถิติ Wilcoxon Signed-rank test และ Paired t-test

ผลการวิจัยพบว่า ระยะเวลาการหลับทั้งหมด และระยะเวลาหลับลึกของทารกเกิดก่อนกำหนดขณะที่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ มากกว่า ขณะที่ไม่ได้รับฟังเสียงจังหวะการเต้นของหัวใจอย่างมีนัยสำคัญทางสถิติ ที่ระดับ .01 และมีระยะหลับตื้น น้อยกว่า อย่างไม่มีนัยสำคัญทางสถิติ ที่ระดับ .05 ผลการศึกษาครั้งนี้ สามารถนำไปใช้เป็นแนวทางในการปฏิบัติเพื่อส่งเสริมการนอนหลับในทารกเกิดก่อนกำหนดได้

87 หน้า

CONTENTS

CONTENTS (cont.)

LIST OF TABLES

LIST OF FIGURES

CHAPTER I
INTRODUCTION

Background and Significance

Preterm infants are a high-risk group because they are not ready to be exposed to external environments. According to current newborn statistics in the United State of America, preterm infants have reached 12.8% for an increase of 21% over the past 16 years (Neal & Lindeke, 2008). In Thailand, the preterm newborn statistics from 2005 to 2007 increased from 11.1% to 11.6%, respectively (Ministry of Public Health, 2007). According to the statistics of Taksin Hospital, preterm newborns rapidly increased in 2005, 2006, and 2007 by 10%, 12%, and 20.3%, respectively. Due to current medical and technological advancements, preterm newborns have an increasing survival rate. These infants need to stay in the hospital for weeks or months in order to ensure normal organ functions before going home, thus resulting in high expenses for treatment. In 2005, the United State of America had to pay 26.2 billion US dollars for the care of preterm infants. Unfortunately, very small infants are found to be at greater risk for complications. Low gestational age and birth weight further increase the risks for abnormality. Surveys following preterm infants from school age until adulthood have revealed the following percentages for abnormal infants: preterm infants weighing less than 1,500 grams (10%), preterm infants weighing less than 1,000 grams (10-20%), preterm infants weighing less than 750-800 grams (10-40%) and preterm infants weighing less than 600 grams (50%) or aged less than 23-24 weeks' gestational age were found to deviate from the norm most of all (Blackburn, 1995; MacDonald, 2002; Stephens & Vohr, 2009).

Preterm infants are exposed to external vivid light all of the time with the noises of staff and life saving appliances, touching by caregivers and several nursing activities which differ from the peaceful, warm, safe, properly heated, dimly lit environment of the womb which corresponded with mother's living where speech and maternal organ functions were the only sounds that could be heard (Glass, 2005).

Constantly disturbance by external environments affects the development of physical functions for preterm infants. Overly loud noises tend to disturb infants' sleep, causing them to become anxious and cry. Their heart rates, respiratory rates and blood pressure increase, resulting in increased intracranial pressure and intra-cerebral hemorrhage, reduced oxygen saturation and apnea (Brown, 2009; Holditch-Davis, Blackburn, & VandenBerg, 2003; Perlman, 2001). These conditions affect the brain development of preterm infants. According to a previous study on preterm infants treated in the Neonatal Intensive Care Unit and following the infants from birth until school age and adulthood, the infants were to found to have hearing impairment in addition to problems with speaking, reading and language proficiency with delayed development and learning, attention deficit hyperactivity disorders and low self-esteem (Stephens & Vohr, 2009; Stjernqvist & Svenningsen, 1999). Preterm infants provided with developmental care in environments arranged similar to the womb e.g. reduced light, reduced noise, day-night arrangement, heartbeat sounds, reduced touching and positioning were found to have slower and more stable heart and respiratory rates, higher oxygen saturation, longer sleep duration, more weight gain and reduced hospitalizations (Thanacharoenpipat, 2001; Makma, 2008; Nakklinkul, 2003; Feldman & Eidelman, 2003; Ferber & Makhoul, 2004; Kahn et al., 1993; Kurdrit, 2002; Messmer et al., 1997; Sudsaneha, 2005).

Sleep is extremely important for preterm infants. Infants generally require 16-17 hours of sleep per day (Hussakunachai, 2008) in order to accumulate energy, support growth and repair wear and tear for healthy conditions. However, preterm infants require more sleep and have been found to sleep nearly all day. During sleep, the body releases growth hormones, synthesizes protein, reduces the release of cortisol and adrenaline-causing stress and utilizes free fatty acids for energy (Glass, 1994). According to the study, infants with long sleep periods were found to gain more weight and have better immune systems contributing to faster recoveries (Hinds et al., 2007) and essential for future brain development (Bertelle, Sevestre, Laou-Hap, Nagahapitiye, & Sizun, 2007; Vandenberg, 2007). Therefore, environments similar to the womb should be arranged in order to ensure better sleep for preterm infants.

Heartbeat sounds are familiar to infants since the sounds in the womb are similar to musical sounds (Neal & Lindeke, 2008), so infants feel relaxed and calm

(Glass, 1994; Lowdermilk & Perry, 2006). According to the study of Salk (1973), infants who heard heartbeat sounds were found to cry less, have better sleep and gain more weight. Schmidt, Rose & Bridger (1980) studied the effects of heartbeat sounds on behavioral and cardiac responses. After sensory stimulation during the sleep of preterm infants, the preterm infants were found to have increased quiet sleep and decreased active sleep.

According to the literature review, no studies have been conducted on the effects of heartbeat sounds on the sleep duration of preterm infants in Thailand or foreign countries. Therefore, the researcher is interested in studying the effects of heartbeat sounds on the sleep duration of preterm infants in order to acquire a practice guideline for further promoting the sleep of preterm infants.

Conceptual framework

This study was based on Als's Synactive Theory of Development (Als, 1982) which asserts maintaining the balance of an infant's body and the interactions of infant with the environment through 5 subsystems: 1) The autonomic system which is the vital sign system indicating the state of being alive. This is a fundamental system controlling respiration, heart rate, complexion and internal signs such as gag reflex, coughing and bowel movement; 2) The motor system is the muscle tone for using the arms and legs, movement and activities of infants; 3) The state-organizational system proposes 6 stages of infant consciousness i.e. active sleep or rapid eye movement; quiet sleep or non-rapid eye movement, quiet awake or alert, active awake or alert, crying and drowsy. If infants are stressed, they tend to have spasms with wry facial expressions, staring, fright, feelings of discomfort and difficulty remaining calm; 4) The attention and interaction system – Infants who can adjust themselves and remained balanced pay attention to society and the environment with readiness to learn; 5) The self-regulation system – Infants who can remain balanced tend to suck on their hands, place their hands near the mouth or remain in positions similar to when they were in the womb.

These 5 subsystems are interrelated, beginning with the autonomic system. If the autonomic system is stable, the motor system, state-organizational system, attention and interaction system and self-regulation system will also remain stable. However, if an infant's the autonomic system is unstable, e.g. low oxygen saturation, the infant will not be able to completely develop to the stage of the motor system. Thus, environmental settings are important in promoting longer sleep in preterm infants and this study explores the subsystems related to the sleep-wake states of preterm infants.

Heartbeat sounds enable infants to feel relaxed and sleep longer. Heartbeat sounds enter the ear structures e.g. cochlea containing hair cells capable of perceiving frequency and noise level, changing into energy and electric currents transmitted along the auditory nerve (Braun & Anderson, 2007) to the thalamus and the limbic system in the hypothalamus. This results in reduced emotional responses, less eye movement and increased release of serotonin leading to better relaxation and sleep. In addition, the pituitary gland is stimulated to secrete the "happiness hormone", endorphin, which contributes to memory and happiness (Updike, 1990). As a result, infants feel relaxed and have better and longer sleep periods.

In this study, the researcher's interest focused on studying the sleep duration of preterm infants when hearing the sounds of a human heart. The conceptual framework of this study is presented as follows:

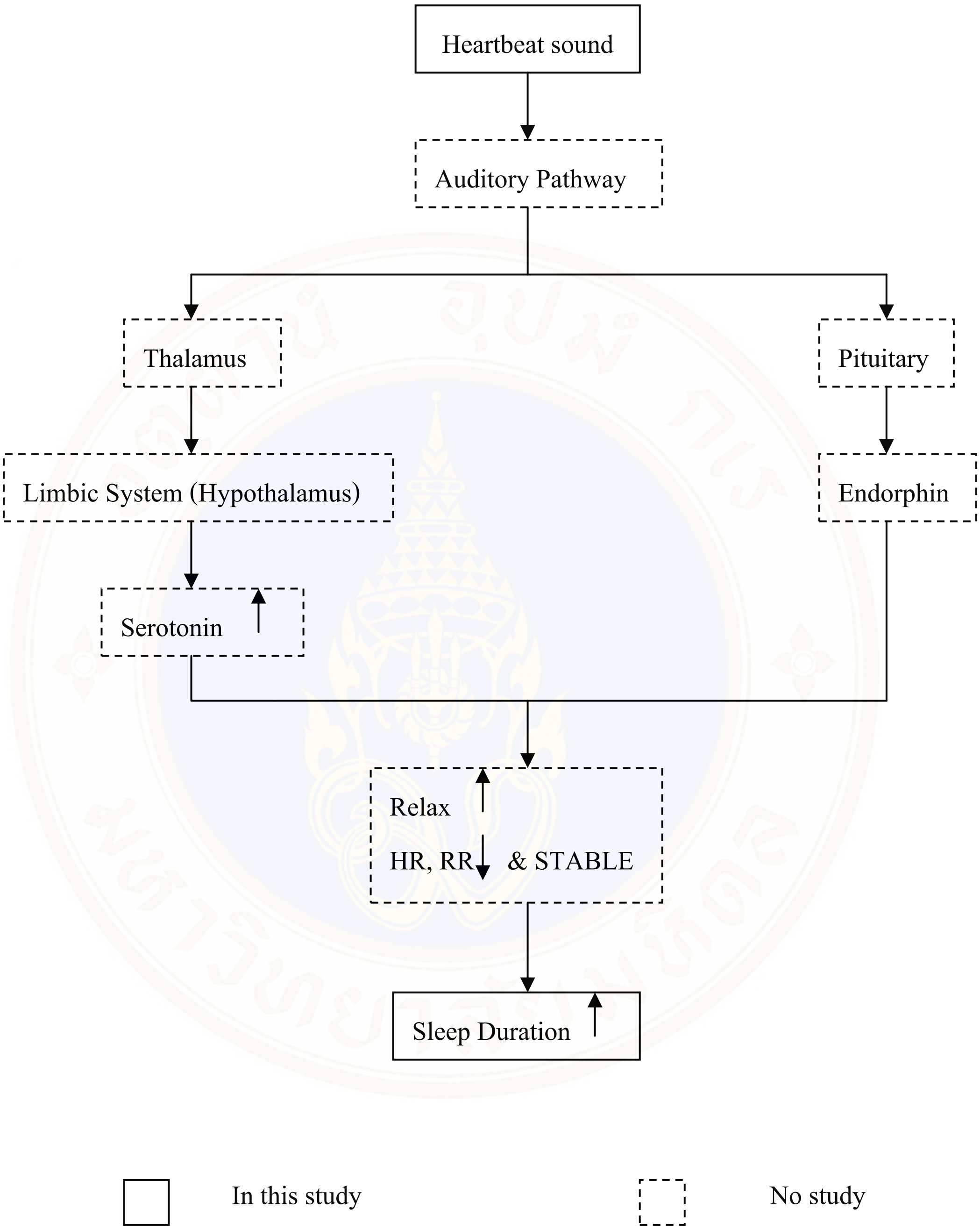

Figure 1 Conceptual Framework

Research question

What differences are present in the sleep duration of preterm infants hearing heartbeat sounds and not hearing heartbeat sounds?

Objectives

1. To study the sleep duration of preterm infants between hearing heartbeat sounds and not hearing heartbeat sounds.

2. To compare the sleep duration, of preterm infants while hearing heartbeat sounds and not hearing heartbeat sounds.

Research hypothesis

1. The sleep duration of preterm infants will be longer while hearing heartbeat sounds than while not hearing heartbeat sounds.

2. The quiet sleep of preterm infants will be longer while hearing heartbeats sound than while not hearing heartbeat sounds.

3. The active sleep of preterm infants will be shorter while hearing heartbeat sounds than while not hearing heartbeat sounds.

Variable definition

1. Sleep duration means the duration of infants' quiet sleep and active sleep. Sleep duration ends when infants show the stages of drowsy or active awake or alert as evaluated by the form of Charastong (2001) adapted from the form of Parmalee & Stern (1972: 200).

2. Heartbeat sound mean the sound made by the beating heart of a normal person with a heart rate of 72 beats per minute as recorded and turned on during the sleep of preterm infants at 58 dB (American Academy of Pediatrics, 1974) for 40 minutes.

CHAPTER II
LITERATURE REVIEW

This study aimed to compare the sleep duration of a single sample group of preterm infants during periods when heartbeat sounds were heard and periods when heartbeat sounds were not heard. The researcher reviewed papers, textbooks and research relevant to the following topics:

1. Preterm Infants
   - 1.1 Definition, classification of type and characteristics of preterm infants
   - 1.2 Development of the central nervous systems of preterm infants
   - 1.3 Auditory development of preterm infants
2. Sleep duration of preterm infants
   - 2.1 Development of preterm infants' sleep-wake states
   - 2.2 Sleep-wake states of preterm infants
   - 2.3 Assessment of infants' sleep-wake states
   - 2.4 Factors affecting the sleep-wake states of preterm infants
3. Effect of heartbeat sound on preterm infants' sleep duration

1. Preterm infants

1.1 Definition

Preterm infants means live births before 37-weeks' gestational age or aged 259 days from the first day of last menstrual period, regardless of birth weight (Siripoonya, 1993; Panburana, P. and Panburana, J., 2006; Taksapan, 2002; Behrman, Kliegman, & Jenson, 2000; Pilliteri, 2007; Santrock, 2007; Southgate & Pittard, 2001).

Classification of preterm infants

Preterm infants are not completely developed. These infants are born before the 37th week of gestational age. Fetal growth appears normal but some stimulus forces birth before complete development and most preterm infants are found to have low birth weights (Pilliteri, 2007) or, if weight is to be used as criteria, weight less than 2,500 grams (Siriboonpipattana, and Tunlert, 2001; Behrman, Kliegman, & Jenson, 2000; Pilliteri, 2007) comprising the following:

1. Low birth weight infants are preterm infants weighing less than 2,500 grams irrespective of gestational age. They are preterm infants who have either low gestational age or intrauterine growth retardation, or both.

2. Very low birth weight infants weighing less than 1,500 grams. Most of these infants are preterm infants.

3. Extremely low birth weight infants are infants weighing less than 1,000 grams. All of these infants are preterm infants.

Preterm infants with low birth weight and low gestational age have lower survival rates. In 1997, approximately 4.1% of all infants in the USA were very low birth weight infants. Among these infants, 85-90% weighed 1,250 – 1,500 grams, and 20% weighed 500 – 600 grams. Moreover, these very low birth weight infants can be predicted have mortality and disability rates of over 50%, respectively (Behrman, Kliegman, & Jenson, 2000).

Characteristics of preterm infants

The characteristics of preterm infants are subject to their gestational age. Infants with low gestational ages have specific characteristics as follows (Siripoonya, 1993; Siriboonpipattana, and Tunlert, 2001; Saengtaveesin, 2007; Supapannachart, 1997; Pilliteri, 2007)**:**

1. General characteristics – constant sleepiness, slow movement, soft crying, irregular respiration and unusually low body temperature.

2. Small bodies – Large heads compared with the body. Head circumference is usually less than 33 cms. and length is usually lower than 47 cms. while chest circumference is usually lower than 29 cms. and waist circumference is larger than chest circumference.

3. Short fleecy hair.

4. Eyes are usually closed with convex and swollen eyelids.

5. Skin is red, immature, shiny and sufficiently transparent to see veins under the skin. Hands and feet are swollen.

6. Minimal vernix covers the skin and skin is partially peeled away.

7. Lanugo covers the forehead, shoulder, arms and back.

8. The sex organs of neither males or females are completely developed. Small testicles remain around the groin or abdomen and not in the scrotum or upper scrotum. The scrotum does not hang down and has less indentation. As for females, the labia majora is small, long and unable to completely cover the labia minora. The clitoris is plainly visible.

9. Elastic cartilage is not completely developed. Ears are soft, flat and easily folded, even after holding.

10. Nails are short and soft, not germinating until the fingertips.

11. Nipples and areola are small, flat and unable to be felt at less than 33-weeks' gestational age, but able to be felt not to exceed 3 mms. at 36-weeks' gestational age.

12. Footprints are few and only 1-2 footprints can be easily seen at the anterior sole.

13. Preterm infants have few muscles. They usually sleep with straight arms and legs. Their low muscle tension causes them to slowly bend their arms and legs.

14. Muscle and muscle tension is not completely developed, so movement is not smooth and asymmetric. Infants with low gestational ages have slow movement.

15. The sternum is soft and easily moved along with the diaphragm when breathing.

16. Physical reactions to stimuli or reflexes are either incomplete or inefficient, e.g. swallowing, sneezing and coughing, with little or no neurological signs.

17. Lungs are not been completely developed in line with gestational age. Preterm infants use the diaphragm for breathing. Rhythm and depth of breathing are irregular while respiration is slow. Preterm infants usually have apnea because their respiratory muscle has not been completely developed.

18. Body temperature is generally low due to heat loss and low internal heat gain. Heat loss is caused by large body surface area and low subcutaneous fat, especially brown fat.

19. Limitations with renal excretions.

20. Little accumulated iron with a predisposition for paleness in the future.

21. Potential for more weight loss than full term infants, possibly by 25% of their body weight.

1.2 Development of the central nervous systems of preterm infants

The central nervous systems of preterm infants are not completely developed and require continued development while staying in the Neonatal Intensive Care Unit (NICU). NICU environments, however, might have negative effects on the development of infants' central nervous systems. The development of infants' central nervous systems can be divided into 6 stages. The first 3 stages are complete before the 4^{th} month of gestational age and comprise dorsal induction development, ventral induction development and neuronogenesis. The next 3 stages include neuron migration, synaptogenesis and arborization, and myelinization which continue developing after birth, especially in many infants in the NICU (Holditch-Davis et al., 2003; Volpe, 2001). This period is critical for developing behaviors in ill or preterm infants and affects how infants control the autonomic system e.g. sleep-wake states, movement and sensibility. If the development of infants in the NICU is interrupted, negative effects may be seen in the infants' behaviors.

The development of infants' central nervous systems is described below:

1. Development of dorsal induction occurs during the first 3-4 weeks' gestational age. The brain and spinal cord begin to form as the initial ectoderm of the embryo develops into a neural plate and becomes several parts of the brain.

2. The development of ventral induction occurs during 4-7 weeks' gestational age. Ventricles begin to form and the brain can be divided into 3 parts: forebrain/prosencephalon, midbrain/mesencephalon and hindbrain/rhombencephalon. During the 5^{th} week, the forebrain can be divided into 2 parts i.e. the telencephalon and the diencephalon whereas the hindbrain can be divided into the metencephalon and the myelencephalon.

3. Neuronogenesis occurs from 8-16 weeks' gestational age until full term (Polin & Fox, 1992). This stage occurs at germinal and is marked by proliferation, fission and the arrangement of neurons, as well as developing cells' interrelationship which is beneficial for further neuron migration.

4. Neuron migration occurs during 6-20 weeks' gestational age. Millions of neurons formed at germinal migrate to several parts of the central nervous system with support from specialized cells called radial glia cells and neurotransmitters. Early migration is at the deepest part and then moves to the top of sulcus. Migration is normally complete at 33-weeks' gestational age. During 32-34 weeks' gestational age, immature veins receive blood supply and veins are so fragile that periventricular and intraventricular hemorrhage can occur (Holditch-Davis et al., 2003).

5. Synaptogenesis and arborization, or organization, occurs during 25-30 weeks' gestational age until 1 year after birth (Blackburn, 2003). This stage represents the harmonious function of neurons comprising networking and proliferating in order to develop neurotransmissions sequentially, harmoniously and properly when stimulated by glutamate (Blackburn, 2003). Excessive or inefficient neurons are eliminated by apoptosis (Monk, Webb, & Nelson, 2001; Squier, 2001). The number of remaining neurons are appropriate for more efficient function. Such neuron ability is called brain plasticity (Holditch-Davis et al., 2003). This stage occurs when infants interact with environments. If infants are properly stimulated, the brain will become stronger and maintain repeatedly stimulated neurons while also removing unused parts leading to the development of gyrus resulting in more complicated behaviors of infants. In cases of improper stimulation, however, brain development is changed (Chatkup, 1999). Therefore, the environments of preterm infants in the NICU during the first month can affect infants' future brain development and perception.

6. Myelinization occurs from 20-weeks' gestational age until adulthood and involves coverage by layers of lipoprotein to help increase the efficiency and speed of neurotransmission.

The last stage of brain development during pregnancy is significant and critical for developing the behaviors of ill and preterm infants, especially with regard to autonomic homeostatic control. Preterm infants with 28-32 weeks' gestational age have balanced autonomic systems due to increased control of the sympathetic nervous system. Stable conditions of infants are evidenced by reduced bradycardia and apnea. When the brain is increasingly developed during the following month, infants start to be able to control their bodies for short periods, but not completely as shown by their sleep-wake patterns. Infants have changes in sleep duration, or active sleep, and their reactions are neither constant nor complete.

1.3 Auditory development of preterm infants

The main physical structure of infants' auditory systems starts to develop during 3-6 weeks' gestational age (Neal & Lindeke, 2008). Auditory organs are completely developed during 23-25 weeks' gestational age (Glass, 2005; Graven, 2000; Liu, Gujjula, Thanigai, & Kuo, 2008; Perlman, 2001). During this period, the auditory nerve connects to the brain, so infants can hear the heartbeat sounds and blood circulation of their mothers through the umbilical cord (Liu et al., 2008). Physical reactions to the sound include startling and blinking at 25-28 weeks' gestational age. At over 28-weeks' gestational age, infants have more complicated reactions to the sound, such as no movement, altered breathing patterns, opened mouth and widened eyes. These reactions can make infants feel fatigue (Glass, 2005; Perlman, 2001; Volpe, 2008). The highest reactions occur at 28-34 weeks' gestational age, including the reaction to soft sounds (Glass, 2005). At 30-35 weeks' gestational age, infants have similar auditory systems to adults (Neal & Lindeke, 2008). Infants can hear and respond to their mother's voice and begin to identify sounds, especially sounds with rhythm and volume (Neal & Lindeke, 2008). The sounds of the maternal heart beating significantly stimulate infants' growth and auditory development due to rather stable sound and movement (Chatkup, 1999).

Complete auditory abilities of infants depend on increased ability to receive both high and low frequency, but thresholds are reduced (Glass, 2005). Normal people can hear at frequencies of 20-20,000 hertz. As for the volume or intensity, infants have different hearing ability. Preterm infants with 25-weeks' gestational age can hear 65 dB, while those with 28-34 weeks' gestational age can hear 40 dB and those with 35-38 weeks' gestational age can hear 30 dB. Full term infants can hear 20-25 dB and those with 42-weeks' gestational age have similar hearing ability to adults at 13.5 dB (American Academy of Pediatrics, 1997; Glass, 2005; Perlman, 2001).

Regarding infants' hearing, sounds enter the ear structures e.g. cochlea containing hair cells capable of receiving frequency and volume, changing into energy and electric current transmitted along the auditory nerve (Braun & Anderson, 2007) to the temporal lobe located at both sides of the brain for further interpretation (Al-Mana, Ceranic, Djahanbakhch, & Luxon, 2008).

The sounds inside the womb have rhythm, structure, pattern and low frequency, mostly featuring the sounds of the mother's organs e.g. the sounds of the heart beating, blood circulating through the umbilical cord, breathing, air in the intestines and the mother's conversation (Glass, 2005; Neal & Lindeke, 2008; Philbin & Klaas, 2000).

Following birth, the familiar and monotonous sounds infants heard since they were inside the womb, e.g. heartbeat sounds, enable infants to feel calm and enter a sleep state. The sleep-wake states of infants are critical to evaluating reactions to sound stimulation. Infants tend to have active sleep when stimulated by the sounds and calm when hearing the rhythm (Gardner & Lubchenco, 1998).

The American Academy of Pediatrics (1974) has suggested that the highest volume for infants should not be over 58 dB. According to a study with guinea pigs in an incubator with 58 dB and receiving medicines affecting hearing, e.g. kanamycin for 5 weeks, the guinea pigs' cochlea was found to have been permanently changed. Another study conducted with guinea pigs provided with kanamycin and staying in the incubator with 90 dB of sound for 8 days found that 47% of the hair cells had been damaged. Therefore, safe volume should not be over 58 dB, particularly those provided with ototoxic aminoglycosidic antibiotics which might suffer permanent hearing loss (American Academy of Pediatrics, 1974) as volumes of over 60 dB have negative effects. Cortisol, the stress hormone, be increasingly released and damage the brain, especially in the cortex or brain surface related to thought and intelligence, and the hippocampus related to emotion and memory. Increasing function of the brain is also related to awakening resulting in infants' whole awakening (Chatkup, 1999), increasing blood pressure and respiratory rate resulting in feeling of discomfort and interrupted sleep for infants (Graven, 2000; Witt, 2008).

Therefore, infants can perceive and hear sound since 23-weeks' gestational age and have more development in line with their gestational age. Gestational age with similar auditory systems to adults develop at 30-35 weeks, so proper volume that is not harmful to infants in the incubator is 58 dB.

2. Sleep duration of preterm infants

Sleep is a behavior reacting and interacting with environments decreasingly and repeatedly. Sleep is a fundamental requirement of humans that appears from the womb until death. Sleep contributes to the protection of physical systems, energy accumulation, muscle repair, nerve cell formation and tissue restoration essential for infants' rehabilitation (Wong, 2005, Santrock, 2007). In addition, sleep enhances growth, development and metabolism with the central nervous system to control the sleep-wake states of infants (Wong & Whaley, 1999). The development of sleep-wake patterns for infants in each stage are subject to brain function. Because central nervous system of preterm infants had not been completely developed, the sleep-wake state control of preterm infants is not as good as that of full term infants. Preterm infants have sleep cycles of 30-40 minutes (Hack, 1992) whereas full term infants have sleep cycles of 50-60 minutes (Glass, 1994; Herman & Steinberg, 1997). Newborns mostly sleep for 16-20 hours per day and have the same nighttime sleep as daytime sleep. The sleep duration of infants can be divided into 6 stages i.e. active sleep or rapid eye movement; quiet sleep or non rapid eye movement; quiet awake or alert; active awake or alert; crying and drowsy. Preterm infants have more than 50% of active sleep or rapid eye movement that gradually reduces while having more quiet sleep or non rapid eye movement, including more growth and brain function in line with older age (Glass, 1994) until the age of 3 months when the infants have obvious quiet sleep or non rapid eye movement (Sheldon, 2002).

2.1 Development of preterm infants' sleep-wake states

The sleep-wake states of infants are visible in the womb. At 8-12 weeks' gestational age, infants exhibit slight movement stopping at intervals on the ultrasound monitor, and they can be monitored by electroencephalogram (EEG) at 21-weeks' gestational age (Peirano, Algarin, & Uauy, 2003). Some movements and activities that are cycled and rhythmic with unstable quietness can be recorded during 20-weeks' gestational age and EEG during sleep can be seen at 24-weeks' gestational age (Hack, 1992; Sheldon, 2002). At 24-26 weeks' gestational age, infants already have sleep states but cannot be clearly identified. At 28-30 weeks' gestational age, infants clearly show active sleep with rapid eye movement, physical movement and unstable heart and respiratory rates. EEG monitored during sleep at 28-31 weeks' gestational age (Hack, 1992; Peirano et al., 2003) is not continual (Hack, 1992; Peirano et al., 2003). At 32-weeks' gestational age, infants begin to have quiet sleep and EEG during this period can identify differences between quiet sleep and active sleep. As for infant behaviors, physical movement is found to disappear, showing 53% of quietness according to sleep records every 20 seconds for 2-3 hours. Quiet sleep is obvious and complete at 34-36 weeks' gestational age and increases to 60% at 40-weeks' gestational age (Sheldon, 2002). Active sleep is well developed at 34-36 weeks' gestational age whereas quiet sleep is well developed at 36-38 weeks' gestational age (Hack, 1992). Preterm infants have a small ratio of quiet sleep compared to all sleep duration and shorter periods of quiet sleep than full term infants.

Therefore, the duration of quiet sleep and active sleep can be seen from 32-weeks' gestational age and becomes more complete in line with older gestational age.

2.2 Sleep-wake states of preterm infants

Sleep states represent the consciousness of infants. The nervous systems of preterm infants are not completely developed. They have ineffective sleep duration or consciousness (Herman & Steinberg, 1997) and unstable sleep states. As previously mentioned, the sleep-wake states of infants can be divided into 6 stages (Brazelton, 1994; Feigelman, 2007; Lowdermilk & Perry, 2006) and infants respond to environments at each stage as follows:

1. Quiet sleep or deep sleep – Infants sleep deeply with their eyelids tightly closed and non rapid eye movement (NREM). They have no movement or little movement, except when frightened or intermittently sucking at their mouth. Breathing corresponds to abdominal movement periodically, deeply and slowly. The respiratory rate is equal to a mean of 36 times per minute.

Quiet sleep significantly indicates brain development. This stage requires more coordination among nerve cells than other stages (Peirano et al., 2003) and quiet sleep was very beneficial for infants. During quiet sleep, infants consume low amounts of oxygen (Kuptanon, and Preutipan, 2006), synthesize energy from food for helping cell division, release more serotonin to stimulate growth hormones, reduce secretions of glucocorticoid, glucagons and cathecolamine, thus resulting in less energy generation from tissue degradation leading to increased weight for the infants. In addition, cortisol and adrenaline are decreasingly secreted during quiet sleep (Glass, 1994) and result in reduced stress.

2. Active sleep or lighter sleep – This is not a deep sleep. Eyelids are closed with rapid eye movement (REM) for 10 seconds per time. The body might twitch, twist, bend or stretch. As for facial movement, infants frown, grimace, smile, spasm, move and suck at their mouths. During this stage, facial movement can be detected, but not frequently. Respiration mainly involves the chest muscles. Breathing rhythm is irregular and faster than in quiet sleep and respiratory rates equal up to 46 times per minute on average.

This stage is mostly found in over 50% of infants (Davis, Parker, & Montgomery, 2004; Glass, 1994), especially preterm infants who cannot respond to an external stimulus as normal infants do (Berk, 2006), thus indicating brain defects (Peirano, 2003). During this stage, cerebral blood flow is high, the body increasingly synthesizes protein and metabolizes free fatty acid (Glass, 1994) related to the learning process, memory, concentration, apnea and oxygen deficiency (Siripoonya, 1993; Long, Lucey, & Phillips, 1980 cited in Nakklinkul, 2003). This stage is also related to dreaming (Davis et al., 2004).

3. Drowsy – This is the stage before infants fall asleep or after becoming interrupted during sleep. Infants are half awake and half asleep at this stage. The eyelids can be closed and opened fully or partially. Eyes are still and confused. There may be slight movement. Breathing is rather stable but faster and shallower than with normal breathing.

4. Quiet awake or active alert – The infant body and face are calm and have no movement with bright eyes. They show interest in environments, stare at some objects or faces, or turn toward sounds (Feigelman, 2007). During this stage, infants' demands are fulfilled both physically and psychologically, so they are happy, delighted, smiling, attentive to environments with good ability to respond to stimuli and environments.

5. Active awake – Infants' behaviors at this stage are the same as the quiet awake stage, but the infants have more movement, make muffled sounds all the time, and might cry. During this stage, infants' demands are not fulfilled either physically or psychologically e.g. hungry, wet and painful states.

6. Crying – Infants have more movement and cry all the time. During this stage, infants' demands are not fulfilled or they are uncomfortable and painful which leads to crying.

Preterm infants have shorter sleep durations. Full term infants normally have sleep cycle of 50-60 minutes recurring every 3-4 hours (Glass, 1994, Herman & Steinberg, 1997, Wong, 2005) whereas preterm infants have sleep cycles of 30-40 minutes (Gardner & Lubchenco, 1998). Studies on the sleep patterns of preterm infants in Thailand at gestational ages of 34-36 and 37-39 weeks have revealed that infants had sleep cycles of 40-60 minutes comprising 57% of whole sleep duration, 21% of quiet sleep and 36% of active sleep (Charastong, 2001).

Therefore, this study chose preterm infants with 32-36 weeks' gestational age because this was the age that best responded to sound with the best auditory system where sleep behaviors are noticeable. Volume was set at 58 dB which was safe for the infants.

2.3 Assessment of infants' sleep-wake states

Sleep-wake states are infants' behaviors functioning under the central nervous system which indicates the wake level of each infant responding to external stimuli. The nervous systems of preterm infants are not mature. They cannot control sleep-wake states as well as adults, so it is difficult for them to maintain their sleep-wake states. Electroencephalogram (EEG) indicating the sleep-wake states of infants are not clear and differ from those of adults. Thus, the behaviors expressed by the infants indicate sleep-wake states.

The sleep-wake states of adults can be assessed by EEG. However, the nervous systems of infants are not mature, so EEG cannot be applied and further observation of significant behaviors at each stage is required to indicate sleep-wake states or responses to the environments of both preterm and full term infants. The following are 4 common assessment forms (Holditch-Davis et al., 2003):

1. Brazelton's State Scoring System

Brazelton, a pediatrician at Harvard University, Massachusettes, designed the assessment form in association with colleagues for infants' behaviors called the Neonatal Behavioral Assessment Scale (NBAS) in 1984 as a means of assessing the altered sleep-wake states of each infant. Each stage is divided based on the experiences of Brazelton with the maintained system of Prechtl, Beintema (1968) and Thoman. There is a total of 6 stages i.e. quiet sleep, active sleep, drowsy, alert, considerable motor activity and crying. This form is widely used with the advantages, of being simple, helpful for both researchers and respondents, easy to learn and clearly divided into only 6 stages. The disadvantages are that the small number of stages is insufficient for identifying the differences between full term infants and infants with complications. In addition, the form is appropriate for infants with gestational ages of 36-44 weeks only, so neither older nor younger infants cannot use this form (Holditch-Davis et al., 2003).

2. Thoman's State Scoring System

Thoman, a psychobiologist at the University of Connecticut, worked with guinea pigs, but focused on interactions between mothers and infants. He had a chance to study this matter when working with Dr. Anneliese Korner at Stamford University in 1969, and originally created the assessment form in 1975 based on the study of Wolff (1966) and Korner (1972) consisting of 10 stages i.e. alert, non-alert waking activity, fussy, cry, daze, drowse, sleep-wake transition, active sleep, active-quiet transitional sleep and quiet sleep. Dr. Thoman made a reliability test of this assessment form until the form was acceptable. The advantages included its reliability which is accepted by the researchers, sufficient difference at each stage to be applied to newborns with problems ranging from preterm infants and full term infants until the age of 1 month and the feasibility of integrating some stages in cases involving non-detailed requirements. The disadvantages were that several stages were difficult to learn, hard to understand, not widely used and the fact that the form is less frequently used than Brazelton’s assessment form due to its greater difficulty requiring some practice prior to implementation (Holditch-Davis et al., 2003).

3. Als’ State Scoring System

Als, a psychologist working with Dr. Brazelton at the Faculty of Medicine, Harvard University, spent several years developing Brazelton’s Assessment Form of infants’ sleep-wake states for application to preterm infants. Then he created his own form for assessing preterm infants’ behaviors called the Assessment of Preterm Infants’ Behavior (APIB) which is similar to Brazelton’s assessment form, but more elaborate. Not only does the form measure infants’ skills but also assesses their reactions and stress toward environments. The form is appropriate for infants with 36-44 weeks’ gestational age but can be applied to younger preterm infants. Als increased the sleep-wake states of the NBAS to 13 stages i.e. very still quiet sleep, quiet sleep, active sleep, noisy activet sleep, drowsy with more activity, drowsy, awake and quiet, hyper-alert, bright alert, active, considerable activity, crying and lusty crying. Each stage is different in both preterm and full term infants and relates to EEG. In addition, this assessment form is utilized as a guideline for the Neonatal Individualized Developmental Care and Assessment Program (NIDCAP). The advantages and disadvantages include too many stages, difficulty in using, but feasibility for reducing to 6 stages if required, because this assessment form was subdivided from Brazelton’s assessment form containing only 6 stages, is not widely used and has no report of infants’ behaviors at each stage (Holditch-Davis et al., 2003).

4. Anderson’s State Scoring System

Anderson, a nursing Ph.D. researcher working at Case Western Reserve University, Ohio, created the infants’ behaviors assessment form called the Anderson Behavioral State Scale (ABSS) for following observation of preterm infants’ with Parmalee and Stern and comprising 12 stages i.e. very quiet sleep, quiet sleep with irregular respiration, restless sleep, very restless sleep, drowsy, quiet awake, alert inactivity, restless awake, very restless sleep, fussing, crying and hard crying. Each stage was related to heart rate and metabolism. The advantages and disadvantages were that it the form is hardly used as it is a new form without any clear evidence of reliability; the form can be used with preterm infants; has not yet been used with full term infants and older infants; is difficult to use; has 12 complicated stages and is more difficult than any other forms, so it was not suitable for implementation in the present study (Holditch-Davis et al., 2003).

5. Parmalee & Stern's State Scoring System

This is an assessment form of sleep-wake states in newborns and preterm infants developed from a study of infants' sleep-wake states by observing and scoring on eyes and physical movement without EEG testing. Each criterion for the assessment comes from actual observation, so the form is feasible for wide application for infants in the womb and preterm infants (Pamalee & Stern, 1972: 200 cited in Charastong, 2001). The form contains 4 stages i.e. deep sleep (0-4), quiet awake (5-6), alert (7-8) and crying (9). The detailed scoring of Michaelis, Parmelee, Stern, & Haber (1973) are shown below:

0 Closed eyes; no body movement

1 Closed eyes; only facial movement

2 Closed eyes; arm and/or leg movement

3 Closed eyes; whole body movement

4 Opening and closing eyes with or without body movement

5 Opened eyes; no body movement

6 Opened eyes; only facial movement

7 Opened eyes; arm and/or leg movement

8 Opened eyes; whole body movement

9 Crying, opened or closed eyes

In this study, the researcher applied the assessment form of preterm infants' sleep-wake states of Charastong, (2001) which was adapted from the assessment form of Parmalee & Stern (1972:200) because it was translated into a Thai version, simple, uncomplicated, able to report the duration of each stage in minutes and did not have too many stages. The form is divided into only 6 stages i.e. quiet sleep, active sleep, drowsy sleep, quiet alert, active alert and crying. Infants express behaviors of each stage as follows:

1. Quiet sleep – Closed eyes, no eyelid movement; regular respiration with abdominal muscle movement; no body movement or slight movement; possible startling.

2. Active sleep – Closed eyes; eyelid movement; irregular respiration with intercostal muscle movement and arm/leg/hand/foot/head/body or whole body movement.

3. Drowsy sleep – Heavy eyes, closed eyes, or half-opened eyes; irregular respiration with or without body movement.

4. Quiet alert – Opened eyes; staring still; regular respiration; partial arm/leg/hand/foot/head movement or no movement.

5. Active alert – Fully opened eyes, irregular respiration, arms/legs/ facial/head/body or whole body movement.

6. Crying – Opened or closed eyes; irregular respiration; faster chest movement; whole body movement with muscle tension.

2.4 Factors affecting the sleep-wake states of preterm infants

1. Sound – Overly loud sounds disturbing the sleep-wake states of infants, making them cry easily with more body movement leading to negative effects, such as increased energy consumption, reduced blood oxygen (Tomas, 2007). Sudden loud sounds make infants cry. Some types of sound with continuous volume, such as heartbeat sounds, make infants relax, have less body movement, more receptive to sleep states and less prone to crying.

Sounds occurring from periodic and harmonious complicated vibrations contributing to comfortable feelings include music and human sounds.

Noises are periodic vibrations caused by abnormal and sporadic frequency without stable components resulting in listeners' fatigue and stress.

Environmental noise is an undesirable noise under environmental circumstances (Standley, 2002) comprising (Warolan, 2006):

1) Background sounds include sounds from air-conditioning and incubator monitors, etc. with the following volume levels (Brandon, Ryan, & Barnes, 2007; Bremmer, Byers, & Kiehl, 2003; Thomas & Uran, 2007):

Quiet room	58-62	dB
Incubator	50-60	dB
Ventilator	63-75	dB
High frequency ventilator	85-110	dB
Oxygen ventilation	55	dB
Heart rate monitor sound at 70% of volume	65.8	dB
Heart rate monitor sound at 30% of volume	55.4	dB

2) Peak sounds include telephone, suction, mobile phone alarms, incubator door opening and closing, etc. with the following volume levels (Brandon et al., 2007; Bremmer et al., 2003; Thomas & Uran, 2007):

Monitor alarm	55-92	dB
Radio and television	55-92	dB
Opening and closing incubator door	92-124	dB
Conversation	58-64	dB
Placing milk bottle on bedside table	75.3	dB
Placing milk bottle on top of incubator	96-117	dB
Opening drawer	69.8	dB
Opening nasogastric tube	71.3	dB
Placing syringe feed on plastic container	55.8	dB
Dragging chairs on the floor	62	dB
Turning faucet on and off	66-76	dB
Running water	54.2	dB
Closing drawer of treatment trolley	58.9	dB
Opening monitor	57.5	dB
Telephone	49.7	dB
Staff laughter	60-80	dB
Staff conversation	58-64	dB
Whispering	20-30	dB

The American Academy of Pediatrics (1997) collected information about the effects of volume on infants in the Neonatal Intensive Care Unit, excluding arranged quiet hours as follows:

Very quiet	20-30	dB	Appropriate for sleeping
Quiet	40-50	dB	Appropriate for sleeping and working
Moderate volume	60-70	dB	Noise
High volume	80-90	dB	Hearing loss in case of continuity
Very high volume	> 100	dB	Discomfort / negative effects on physical condition/ tension

The mean range for noise in the Neonatal Intensive Care Unit is 50-90 dB with the highest volume being 100-140 dB (Brandon et al., 2007; Bremmer et al., 2003; Brown, 2009; Neal & Lindeke, 2008; Witt, 2008). According to the literature review of Philbin et al. a volume of 55-75 dB was found to contribute to effective sleep and stable heart rate in full term infants (Philbin, Robertson, & Hall, 1999). However, preterm infants cannot control sleep-wake states as well as full term infants (Philbin & Klaas, 2000), and these infants mostly stay in the incubator with continuous background sounds at 50-60 dB (American Academy of Pediatrics, 1997). The American Academy of Pediatrics (1974) suggested that the highest volume in the incubator should not exceed 58 dB as a volume of over 60 dB can be harmful to physical conditions and disturb infants' sleep (Chatkup, 1999; Graven, 2000; Witt, 2008).

Long et al. (Long, Lucey, & Philip, 1980) studied infants' responses to environmental noises in the Neonatal Intensive Care Unit in the same population during the experimental and control stages. During the experimental stage, environmental noises were lower than 60 dB and the control stage had a normal volume of environmental noise. Next, behavioral responses were investigated through the observation of preterm infants' sleep-wake states and frequency of changes in state. The findings of the study revealed that preterm infants during the experimental stage had more sleep duration and fewer changes from sleep to wake states than the preterm infants in the control stage. However, there was no statistical difference because there were only 2 samples in the study.

Nakklinkul (2003) conducted a comparison study on the sleep duration of 20 preterm infants among quiet hours (experimental group) and normal environments (control group). The infants were arranged in a prone position with faces turned either to the left or right side, rolled cloths under the hip and around the infants for knee and hip flexion and feet placed against a cloth with a head elevation of 15-30 degrees and 2 quiet hours per day from 9.30 – 11.30 a.m. not touching the samples during quiet hours, and control volume to be not exceed 58 dB.

The sleep of the preterm infants was assessed by using Brazelton's Neonatal Assessment Behavioral Scale (NABS) whereby infants provided with quiet hours of less than 58 dB were found to have more quiet sleep than the other group without provision of quiet sleep at a .001 level of statistical significance.

Sudsaneha (2005) studied the effects of quiet hours on the sleep-wake states of 24 preterm infants in the Neonatal Intensive Care Unit. The samples were selected by purposive sampling based on the inclusion criteria and represented as the samples of the control period (normal time) and the experimental period (quiet hours). The samples received routine nursing care during the control period and routine nursing care along with quiet hours not exceeding 58 dB as suggested by the American Academy of Pediatrics during the experimental period. The findings of the study revealed that the average sleep-wake states of preterm infants during the quiet hours were lower than the normal hours with a .001 level of statistical significance. During the quiet hours, preterm infants had more quiet sleep than the normal hours by 23.3% and reduced crying by 10.9%.

According to the above study, it can be concluded that low volume environments contribute to better sleep for preterm infants and the sounds should not exceed 58 dB as suggested by the American Academy of Pediatrics.

2. Light – Newborns require very little light (White, Martin, & Graven, 1999). Light awakens infants, so too much or continuous light has negative effects on preterm infants' sleep-wake states, thus reducing the sleep duration of the infants. Dim light enables infants to enter active sleep and have longer quiet sleep (Glass, 2005). Light similar to daytime and nighttime encourages infants to have longer sleep duration, weight gain, less body movement and reduced heart rate (Lefrak & Lund, 2001).

Light is a wave radiation measured in lux or lumens/m^2 or foot candle (ftc). When lux is divided by 10, it equals ftc (Holditch-Davis et al., 2003) e.g. the light of 500 lux is equal to 50 ftc. The American Academy of Pediatrics and the American College of Obstetricians & Gynecologist suggest that light in neonatal intensive care units should be set at 60 ftc which is sufficient to observe infants' symptoms; light for treatment should be set at 100 ftc (cited in Gardner & Lubchenco, 1998). Sharp light is found in the neonatal intensive care units for 24 hours with an average of light intensity of 60-80 ftc (Blackburn & VandenBerg, 1993). Light of over 100 ftc reduces oxygen saturation which is likely to increase the retinopathy of prematurity, disturb infants' sleep and cause more body movement. In contrast, reduced light during the daytime reduces heart rate which results in more quiet infants (Warolan, 2006; Gardner & Lubchenco, 1998).

Therefore, this study controlled environmental light at less than 60 ftc or 600 lux so the light did not disturb infants' sleep and was sufficient for observing infants' symptoms.

3. Touch – The touch of caregivers or medical staff affects changes in infants' sleep-wake states, particularly in preterm infants who are touched by more than 10 staff members, e.g. nurses, doctors and x-ray staff. In addition, the holding and milk feeding by caregivers caused infants to be touched more than 150 times per day and infants have only 10-minute breaks. Too many touches often awaken infants which results in less sleep states (Glass, 2005; Holditch-Davis et al., 2003).

4. Nursing – Nursing as scheduled or as a treatment plan can occur constantly. Touch and painful nursing tasks disturb infants' sleep, so infants remain in their wake states for longer periods of time or change from quiet, drowsy stages to active awake or crying stages. Moreover, blood oxygen is reduced as energy consumption and body movement increase as a result of the negative effects on infants. Suction during sleep is particularly disturbing to the sleep-wake states of infants. Infants are awakened and cry, while their heart rate and blood oxygen are severely changed. One study in the Neonatal Intensive Care Unit found that nursing was provided for infants 5 times per hour. Preterm infants, however, change their sleep-wake 6 times per hour, and 78% of all changed sleep-wake states involve nursing as 48% of infants have been found to be in the crying stage (Zahr & Balian, 1995). Preterm infants and ill infants are unable to adjust themselves to each nursing task, so body wrapping and sucrose is provided for infants prior to painful treatments to help reduce altered sleep-wake states caused by pain (Holditch-Davis et al., 2003). Nursing and treatment should be done at the same time, so that infants have better and longer sleep durations (Holditch-Davis et al., 2003).

5. Positioning – The supine position makes infants easily startled, have more wake duration and less quiet sleep. The prone position on some soft surface makes infants feel warm and have higher oxygen saturation, but it can cause sudden infant death syndrome (SIDS). The lateral position reduces startled reactions, enables infants to console themselves as they can easily place their hands near their mouths and bend their arms and legs toward the center of the body. In addition, the kangaroo position has been found to make infants remain in a bending position similar to the womb, enable infants direct contact with mothers, hear the sound of the maternal heart beating and sleep well (Phatthanasiriwetin, 2005). According to a study on the effects of positioning on preterm infants' sleep duration (Thanacharoenpipat, 2001), no differences was found in the supine, lateral or prone positions regarding the whole sleep duration of preterm infants, but the mean quiet sleep duration was longer for the prone position than the supine and lateral positions with a .05 level of statistical significance. The mean active sleep duration for the prone position was shorter than the supine and lateral positions with .05 and .01 levels of statistical significance, respectively.

It has been found that the prone or lateral positions involved more bending of the arms and legs toward the center of the body than the bending position. Arms and legs are most bent toward the center of the body, which simulates the infants' position in the womb. Infants feel warm, safe, less startled and easily console themselves which further results in easier and better sleep.

This study required observation of infants' sleep behaviors, but the prone position does not allow the infants' behaviors to be observed as required. Furthermore, the prone position affects infants' hearing because infants have to turn their heads to either side, so one of the ears was close to the surface, thus resulting in different hearing on each side. For these reasons, this study arranged infants in the supine position with the arms and legs bending toward the center of the body, hands placed near the mouth and cloths wrapped around the preterm infants' bodies in order to facilitate observation without any effects on the infants' hearing.

3. Effect of heartbeat sound on preterm infants' sleep duration

The sounds in the womb are usually the mothers' heartbeat sounds, bowel sound, blood circulation sound and uterine sound, all of which are soft sounds with low frequency (Stanley et al, 1992). Among these sounds, the strongest rhythmic sounds are the sounds of the beating heart as blood is pumped through the arteries during the last trimester of pregnancy. Infant brains develop to remember the sounds of the maternal heartbeat and this memory remains until after birth. Newborns can become calm upon hearing heartbeat sounds, just as they were in the womb. This indicates that infants in the womb also sleep quietly when hearing mothers' heartbeat sounds (Kobayashi, 1981).

Porcaro et al. (2006) studied the reactions of infants in the womb to external sounds and mothers' heartbeat sounds by using Megnetoencephalography with 12 healthy pregnant mothers at 36-40 weeks' gestational age, finding that 8 infants were able to hear and respond to the low frequency sounds of the mothers' beating hearts.

Salk (1973) was the first person to study the effects of heartbeat sounds on infants after seeing a monkey in the zoo hold its baby on the left side of the chest for 40 times out of 42 observations with only two times of holding on the right side of the chest. Next, a study was conducted in 255 right-handed and 32 left-handed mothers with normal deliveries who stayed with their babies immediately after birth. The holding observation was done at 4 days' postpartum and the findings revealed that 83% of the right-handed mothers held babies on the left side of the chest or shoulder whereas 32 left-handed mothers held babies on the left side of the chest 78%. After the observation, the researcher asked about the mothers' reasons for holding their infants on the left side of the chest and found that most mothers held their babies instinctively, so this was a social behavior without any teaching. When the mothers held their babies on the left side, the infants were close to their hearts and heard their mothers' heartbeat sounds that had been familiar to them since the womb, so they stopped crying and slept quietly (Kobayashi, 1981).

In addition, Salk studied the effects of heartbeat sounds on newborns by allowing newborns to hear the recorded heartbeat sounds of normal people. The samples were newborns who had been separated from their mothers since birth in the Neonatal Intensive Care Units of hospitals in New York consisting of 102 persons in the experimental group and 112 persons in the control group. The experimental group heard recorded heartbeat sounds at 7-minute intervals for 30 minutes both daytime and nighttime whereas the control group did not hear the sound. Every infant was breastfed every 4 hours and their symptoms were observed for 4 days. As for the experimental group, heart rates of over 90 beats per minute were found to make infants feel uncomfortable and more anxious. Moreover, when heart rates were over 120 beats per minute along with unexpected loud noises in the environment, the infants showed tension e.g. little rest and more crying leading to negative behaviors in the future. Heart rates of 72 beats per minute, however, did not make the infants feel stressed. Thus, the researcher used a heart rate of 72 beats per minute at 85 dB, and observed weight change, milk feeding and number of crying bouts, finding that 70% of the infants hearing heartbeat sounds gained an average of 40 grams in weight. As for the control group without hearing heartbeat sound, 33% of the infants gained an average of 20 grams in weight. Milk feeding was no different in both groups with statistical significance. Crying was found in 38% of the experimental group and 60% of the control group. The results of the experiment indicated that heartbeat sounds can make infants quiet as evidenced by reduced crying. Although there was no difference in the milk feeding of both groups, the weight of the experimental group was found to have increased due to reduced crying which consumed less energy.

Additional findings show that infants in the womb create and remember relationships between heart rate and relaxation. Thus, when infants hear similar sounds after birth, they recreate the relationship they experienced in the womb. Some sounds such as music, especially the rhythm of songs by Beethoven and Mozart, strongly resemble heartbeat sounds (Kobayashi, 1981; Salk, 1973), and it is possible that humans create music from the soul of the heart and mind that was a part of infant memory. Therefore, the sounds of the maternal heartbeat in the womb have been selected as the origin of beautiful lullabies (Kobayashi, 1981).

Schmidt et al. (1980) studied the effects of heartbeat sounds on behavioral responses and the cardiovascular system from sensory stimulation during preterm infants' sleep. The samples were 30 randomized preterm infants consisting of 15 persons with sensory stimulation and 15 persons without sensory stimulation. Sensory stimulation, e.g. massage, environment arrangements, and conversation, began within 2 weeks after birth when the infants could be moved from the incubator and held in a rocking chair 3 times a day for 5 days a week at 20 minutes per time. Once the sensory stimulation was complete, the recorded heartbeat sounds was turned on the following day. The preterm infants of both groups were treated equally and separated in a room with 60-watt light. They were tested after milk feeding at lunchtime. The infants did not hear heartbeat sounds during the first day. During the second day, however, the infants the heard recorded heartbeat sounds of a normal person with a heart rate of 72 beats per minute with 42-78 dB and a low frequency of 63-1,000 hertz. The infants heard the sound only once. Environmental sounds were controlled at 60 dB and the sleep behaviors of the infants were observed during quiet sleep, active sleep, and transitional stage at 1-minute intervals for 1 hour by using the assessment form adapted from Dreyfus-Bisac's (1970a) form for observing the sleep of full term infants. The findings of the study revealed that during active sleep, only infants without sensory stimulation who heard heartbeat sounds responded to heart rate. The infants in both groups who heard heartbeat sounds had less body movement during active sleep. During quiet sleep, the sound did not affect the cardiovascular system or body movement. In addition, heartbeat sounds also contributed to increased sleep duration in both groups, while reducing active sleep and increasing quiet sleep with statistical significance. In conclusion, heartbeat sounds applied during the first hour of sleep strongly affect the sleep duration, body movement and heart rate response of preterm infants, thus resulting in behaviors or development more closely resembling that of full term infants.

From the above research findings, we can conclude that heartbeat sounds can make infants quiet, reduce crying and induce sleep, which contributes to brain growth and good development in the future. Moreover, according to the literature review, the researcher found a few studies on the effects of heartbeat sounds on the sleep duration of preterm infants, even though there had not been any studies in Thailand. Thusly, the researcher gained an interested in studying the effects of heartbeat sounds on the sleep duration of preterm infants as a guideline for further promoting sleep in preterm infants.

CHAPTER III
MATERIALS AND METHODS

This study employed a crossover-experimental design aimed at comparing the sleep duration of preterm infants while hearing heartbeat sounds and not hearing heartbeat sounds. The study was conducted with only one sample group and every patient was in the self-control group.

Population and sampling

The population of this study comprised preterm infants in the Newborn Unit at Taksin Hospital under the Department of Medical Services, Bangkok Metropolitan Administration.

The purposive sampling was based on following criteria:

1. Infants with 32-36 weeks' gestational age based on the doctor's Ballard score.
2. Normal hearing tested by professional nurses in the Child Development Unit, Taksin Hospital.
3. Stable condition without crisis based on a doctor's diagnosis e.g. normal respiration rate, heartbeat rate, body temperature and oxygen saturation without apnea.
4. No requirement to be on oxygen.
5. No congenital disabilities or severe complications e.g. infection, gastroenteritis, pulmonary complications and seizures diagnosed by a doctor.
6. No medications affecting sleep e.g. phenobarb, chloral hydrate, methadone, no maternal substance abuse or narcotic addictions.
7. Mothers or fathers who were willing to participate in the study and able to read and communicate in Thai.

Sample size

The sample size was based on Cohen Statistical Power Analysis (Cohen, 1988) determining the significance level = .05 and power of test = 80%. The effect size was of .83 was obtained from a literature review of 10 studies by Standley regarding the effects of music therapy on preterm infants (Standley, 2002). The present study was a one-tailed test resulting in a sample size of 12.

Research setting

The data collection took place at the Newborn Unit, Taksin Hospital under the Department of Medical Services, Bangkok Metropolitan Administration, with a total of 30 beds. The Newborn Unit admits ill newborns, non-critically ill and semi-critically ill preterm infants. The unit has a total of 7 rooms: the first and second rooms for ill newborns, a third room for infants with Phototherapy, a fourth room for preterm infants and infants requiring intensive care, a fifth room for preterm infants waiting for weight measurement and ill newborns waiting for injections and under observation before going back home with a sixth and seventh room for preterm infants and ill newborns whose mothers are allowed to provide nighttime care. Preterm infants stay in incubators covered with a cloth, are provided with nursing care on schedule and fed milk every 3 hours. There are no quiet hours provided in the Newborn Unit. Rather, the unit is lit at all the times, containing noisy medical equipment, air conditioners, telephones and the sounds of working staff. The staff members who care for infants consist of professional nurses, pediatricians, nursing assistants and patient assistants. Mothers and fathers are allowed to visit in line with schedules for milk feedings at every 3 hours. The infants in this study were selected from preterm infants in the fifth, sixth and seventh rooms.

Protection of human subjects

Once the research proposal and research instruments had been approved by the Human Research Ethics Committee of Ramathibodi Hospital and the Bangkok Metropolitan Administration, the researcher introduced herself, gave the parents of the samples some information about the research objectives and procedures, requested their cooperation with the research and informed the parents that the research was aimed at having preterm infants hear heartbeat sounds which tended to be beneficial for preterm infants and were not harmful. Responses or data were given as an overview presentation. Patient names were not disclosed. Infants were provided with close care during the study. In cases involving any complications, apnea, or less than 90% of oxygen saturation, the infants received immediate assistance from doctors or nurses and were not be included in the samples. Parents had the right to participate or withdraw from the study any time without being required to provide a reason and the parents were assured that such actions would not affect any treatment for the preterm infants. Once the parents had expressed willingness to participate in the study, they were required to grant written consent by signing informed consent forms.

Research instrumentation

The research instrumentation for the present study consisted of instruments for the experiment and instruments for the data collection as described below:

1. Instruments for the Experiment

1.1 An instrument for measuring oxygen saturation and heart rate called “masimo” which had passed quality assessment by a medical equipment testing company once a year and received maintenance twice a year or according to the life cycle. This instrument was used to assess the reliability of heart rate = ±5% and oxygen saturation = ±2%. The same equipment was used throughout the study.

1.2 A C450H-1C model Drager infant incubator that had passed quality assessment by a medical equipment testing company once a year and received maintenance twice a year or according to the life cycle. This instrument required a hood air temperature of ± 1 Celsius degrees and a patient probe temperature of ± 3 Celsius degrees. The same equipment was used throughout the study.

1.3 An instrument for measuring sound level called the “Sound Level Meter Digicon DS 40 (dB)” which had passed reliability testing by the manufacturing company as scheduled.

1.4 An instrument for measuring light intensity called "Digicon Lx 50 Lux Meter (Lux)" which had passed reliability testing by the manufacturing company as scheduled.

1.5 An MP3 player and Sony speaker for playing previously recorded heartbeat sounds for 40 minutes. The instruments were checked before use and the same equipment was used throughout the study.

1.6 The equipment for measuring hearing was an AccuScreen model TEOAE manufactured by GN Otometrics (Serial No. 33583) which had passed quality assessment by a medical equipment testing company once a year and received maintenance twice a year or according to the life cycle. Additional quality assessment was carried out by professional nurses in the Child Development Unit, Taksin Hospital, preceding every use with each infant.

1.7 A Sony VDO camera, Model DCR-DVD810, was checked before use. The same equipment was used throughout the study.

1.8 The heartbeat sounds of a normal person as recorded through a stethoscope from http://www.freesound.org/samplesViewSingle.php?id=21409 and modified for equivalence to a heart rate of 72 beats/minute, which was able keep infants calm according to the findings of the study.

2. Instruments for the data collection included the following:

2.1 Demographic data record comprising gender, gestational age, post-conceptual age, birth weight, delivery, treatment and current medications.

2.2 Record of the preterm infants' sleep-wake states and a manual on the evaluation of preterm infants' sleep-wake behavior by Charastong, (2001) adapted from the sleep-wake states evaluation form of Pamaelee & Stern (1972:200) recorded 6 sleep states of preterm infants under the observation of the researcher every 1 minute for 40 minutes as follows:

Quiet sleep: Behaviors in this state included closed eyes, no eyelid movement, constant breathing, abdominal muscle movement, no movement or slight movement of the body and sometimes being startled.

Recorded symbol: ●————●

Active sleep: Behaviors in this state include closed eyes, eyelid movement, no constant breathing, intercostal muscle movement, and arm/leg/head/torso or whole body movement.

Recorded symbol: ————————

Drowsy sleep: Behaviors in this state include heavy eyes, closed eyes or half opened eyes and no constant breathing with or without body movement.

Recorded symbol: 

Quiet alert: Behaviors in this state include opened and staring eyes, constant breathing, partial or no arm/leg/hand/foot movement.

Recorded symbol: ●- - - - - -●

Active alert: Behaviors in this state include fully-opened eyes, no constant breathing and arm/leg/face/torso or whole body movement.

Recorded symbol: ----------------

Crying: Behaviors in this state include opened or closed eyes, no constant breathing, faster chest movement, whole body movement and muscle tension.

Recorded symbol: 

The results were interpreted from VDO. After recording quiet sleep, active sleep, drowsy sleep, quiet alert, active alert and crying states with the symbols every 1 minute, the sleep duration of each state was available in minutes.

2.3 Light and sound intensity records were done at 5 minutes before the experiment and at the 20th minute of the experiment in order to control light not to exceed 600 Lux and sound not to exceed 58 dB.

2.4 Heart rate records were done every 1 minute for oxygen saturation and every 10 minutes for respiration rates.

Validation

Content validity and reliability were tested for preterm infants' sleep-wake states records and manual on the evaluation of preterm infants' sleep-wake behavior as follows:

1. Content Validity

The researcher used preterm infants' sleep-wake state records and the manual on evaluating preterm infants' sleep-wake behavior of Charastong (2001) which had been validated by a panel of 5 experts comprising 2 experienced nurses in the Neonatal Intensive Care Unit, 1 doctor specialized in neonatal care, 1 nurse experienced in preterm infants, and 1 nurse experienced in the NICU (Charastong, 2001).

2. Reliability

The researcher and expert cooperatively observed and evaluated the sleep behaviors of the preterm infants, recorded the details of each sleep state of the 10 preterm infants in the form every single minute, performing the reliability test before starting the research by using Polit and Hungler's formula (Polit & Hungler, 1999:233).

$$\text{Inter-rater reliability} = \frac{\text{Number of agreements}}{\text{Number of agreements + disagreement}}$$

In this study, the reliability calculated by the researcher and expert was equal to 0.90

Data collection

The researcher collected the data as follows:

1. The research proposal and research instruments were submitted for consideration by the Human Research Ethics Committees of Ramathibodi Hospital and the Bangkok Metropolitan Administration.

2. After receiving approval from the Committees, the researcher submitted the letter from the Faculty of Graduate Studies, Mahidol University, to the Director of Taksin Hospital to request permission for collecting data.

3. The researcher met with Head of the Newborn Unit to provide details on the data collection.

4. The researcher explored the patient roster, records of preterm infants and mothers from the labor records at the Newborn Unit, Taksin Hospital.

5. Next, the samples meeting the inclusive criteria were purposively selected.

6. Hearing tests were done by professional nurses in the Child Development Unit, Taksin Hospital. Cases involving hearing test failure were excluded from the samples.

7. The researcher met with the mothers of the samples in order to introduce herself, explain the research objectives and processes, ask for cooperation with data collection, and requesting the mothers to sign informed consent forms when they agreed to participate in the study.

8. The researcher filled in the demographic data record.

9. The sequence of experimental methods was randomly selected: hearing heartbeat sounds (Experimental stage), or not hearing heartbeat sounds (Control stage) by 2 equal lots for drawing, namely “A: Heartbeat/None” and “B: None/Heartbeat”. Then sampling without replacement was done by unconcerned persons.

10. Each infant participated in both stages. Those who finished one stage from 7:30-8:10 pm would enter the other stage during the same period of the next day, so they had some rest, received nursing care as scheduled to prevent the transfer of any effects from the first experiment to the next experiment.

Pre-experimental period

The researcher and expert conducted a pilot study prior to actual experimentation by studying a sample group of five preterm infants with characteristics and environments similar to the study. The researcher and expert encountered obstacles and problems in conducting the research, therefore, the researcher and expert jointly solved problems and created schedules for working, checking equipment and arranging the environment for implementation as principles or guidelines for the control of time and environment as specified prior to actual experimentation in order to prevent errors and facilitate the experiment.

Experimental method

The experimental method consisted of the following 2 stages:

Experimental stage (Hearing heartbeat sounds)

1. The researcher prepared equipment for the study, including oxygen saturation and heart rate measurement instruments, an MP3 player, a speaker, recorded heartbeat sounds, a VDO camera, a sound level meter and a light intensity meter.

2. The researcher prepared a room for the study with sound levels lower than 58 dB and light intensity not exceeding 600 Lux.

3. The preterm infants were placed in a separate room, or the door of the room was closed during the study, wearing diaper with special absorption to reduce interruption from excretion.

4. The oxygen saturation and heart rate measurement instruments were attached to one of the infants' feet for symptom observation. The sound level of the oxygen saturation measurement instrument was set to the minimum level. In cases of abnormal oxygen saturation or heart rate, the study was immediately stopped and the abnormality was reported the doctor. These infants were helped and excluded from the study.

5. According to the treatment plan, milk feeding was offered 1 hour and 30 minutes before the experiment to prevent vomiting and choking during the experiment. The infants were arranged in the supine position with a blanket rolled around them similar to the womb and so behaviors and hearing could be conveniently observed.

6. The operation of the MP3 player was checked for recording heartbeat sounds and set near the ear with a sound level not exceeding 58 dB; heartbeat sound level was controlled by the MP3 player at 58 dB whenever the study was conducted with each infant.

7. The VDO camera was installed to record the sleep-wake behaviors of the infants.

8. Light intensity and sound was measured at 5 minutes before the experiment and during the 20th minute of the experiment. The measured values were recorded in the form.

9. VDO began in order to observe the sleep behaviors and the heartbeat sounds from the MP3 player was turned on.

10. Data was recorded in the form during the study e.g. heart rate/oxygen saturation every minute, respiration rate for one minute every 10 minutes for a total period of 40 minutes. The sleep-wake behaviors of the preterm infants were recorded after finishing the VDO recording. The sleep-wake states from the VDO camera were interpreted minute-by-minute in the record of the preterm infants' sleep-wake states for the entire 40-minute period.

11. The record was continued if the infants were awake, moved or cried and able to stop by themselves. If, however, the infants were unable to stop crying, the record-taking was suspended in order to console the infants who were then evaluated the next day. In cases of less than 90% oxygen saturation, infants required assistance and were excluded from the study.

12. A poster saying "Please do not disturb during the study" was posted on the door. However, in cases of unintentional disturbance from the environment e.g. loud noises, lights turned on or door opening, the study was suspended and continued the next day.

Control Stage (Not hearing heartbeat sounds)

This stage contained the same practices as the experimental stage, but the MP3 player was eliminated from Step 9 and the preterm infants were not allowed to hear heartbeat sounds. The infants' sleep behaviors were recorded and observed.

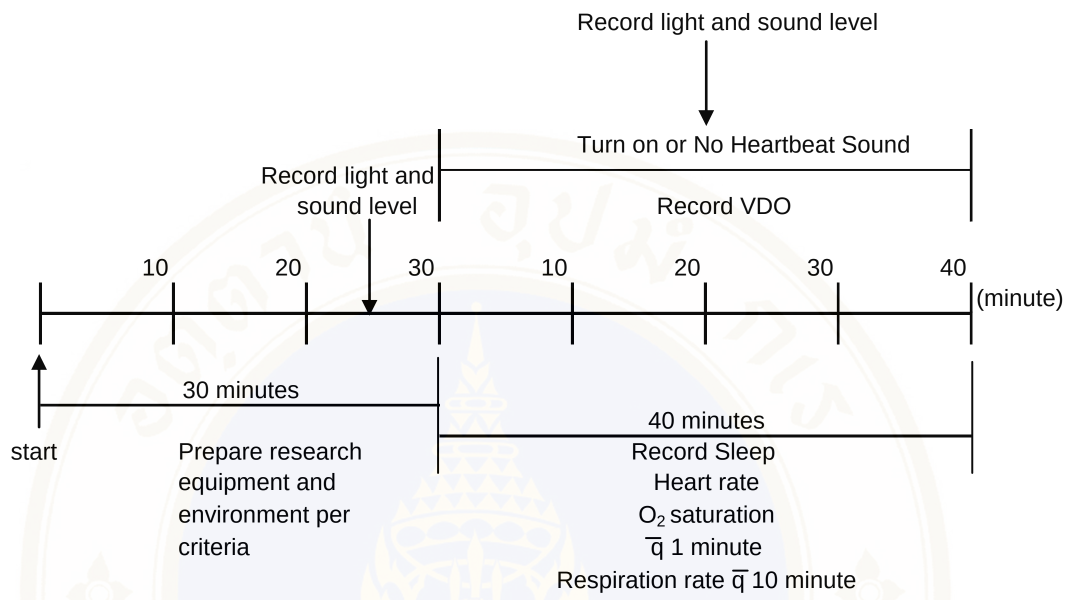

Figure 2 Study Process

Data analysis

The researcher analyzed the data with the a computer program used for statistical analysis:

1. The demographic data of the samples was analyzed by frequency distribution, percentage, mean and standard deviation.

2. Quiet sleep, active sleep and sleep duration were interpreted in terms of the minutes and percentage of each sleep state.

3. The mean sleep durations were compared while hearing heartbeat sounds and not hearing heartbeat sounds with the Wilcoxon Signed-rank test.

4. The mean quiet sleep times were compared while hearing heartbeat sounds and not hearing heartbeat sounds with Paired t-test.

5. The mean active sleep times were compared while hearing heartbeat sounds and not hearing heartbeat sounds with paired t-test.

CHAPTER IV
RESULTS

This study was to explore the effects of heartbeat sounds on sleep duration in preterm infants by employing a crossover-experimental design aimed at comparing the sleep duration of preterm infants between period of not hearing heartbeat sounds and periods of hearing heartbeat sounds. The study was conducted with only one sample group numbering 12 persons and every patient was in the self-control group. The research findings are presented in table form with descriptions consisting of the following three parts:

Part 1: Demographic data of the sample

Part 2: Sleep duration of preterm infants while not hearing heartbeat sounds and while hearing heartbeat sounds

Part 3: Hypothesis testing

Part 1: Demographic data of the samples

The demographic data for the sample in this study included gender, age, gestational age, post-conceptual age, birth weight and delivery method. The data is presented in terms of frequency, percentage, minimum-maximum, mean and standard deviation as shown in Table 1.

Table 1 Frequency, percentage, mean, standard deviation for the samples' Demographic Data (n = 12)

Demographic data	Number (persons)	Percentage
Gender		
Male	5	41.67
Female	7	58.33
Gestational Age (weeks)	(Min = 33, Max = 36, Mean = 35.33, S.D. = .89)	
32-34	1	8.33
>34-36	11	91.67
Post-conceptual Age (days)	(Min = .09, Max = 4, Mean = 1.62, S.D. = 1.40)	
< 1-2	9	75
3-4	3	25
Birth Weight (grams)	(Min = 1,960, Max = 2,480, Mean = 2,240.83, S.D. = 162)	
1,500-2,000	1	8.33
2,001-2,499	11	91.67
Delivery Method		
Normal labor	10	83.33
Caesarean Section	2	16.67

According to Table 1, the samples consisted of 12 infants. Most of these (7) were females (58.33%) whereas 5 of the infants were males (41.67%). Nearly all of the infants had more than 34-36 weeks' gestational age and 11 of the infants weighed between 2,001-2,499 grams (with the same numbers in both groups equivalent to 91.67%). The mean gestational age was equal to 35.33 weeks (S.D. = .89) with the youngest age at 33 weeks and the oldest age at 36 weeks. The preterm infants' mean weight was equal to 2,240.83 grams (S.D. = 162) with the lowest weight at 1,960 grams and the highest weight at 2,480 grams. A majority of 75% of the sample had less than 1-2 days' post-conceptual age with an mean post-conceptual age of 1.62 days (S.D. = 1.40) where the youngest age was 9 hours and the oldest age was 4 days. Most of the mothers (10) had delivered by vaginal birth with normal labor whereas 2 of the mothers had had Caesarean Sections.

Part 2: Sleep duration of preterm infants while not hearing heartbeat sounds and while hearing heartbeat sounds

The sleep durations of the preterm infants were compared in terms of NHB (No heartbeat sounds) and HB (Heartbeat sounds) during quiet sleep, active sleep, drowsy sleep, quiet alert, active alert and crying, while total sleep was determined by using descriptive statistics as shown in Tables 2 and 3.

Table 2 Minimum-maximum, mean, standard deviation and percentage of sleep duration between NHB (No heartbeat sounds) and HB (Heartbeat sounds) (n = 12)

Sleep-wake states (Minutes)	Min-Max		Mean		S.D.		Percentage	
	NHB	HB	NHB	HB	NHB	HB	NHB	HB
Sleep Duration	9-40	38.50-40	34.17	39.79	8.84	.45	85.42	99.48
Quiet Sleep	0-26	1-27	7.67	15.25	6.64	8.09	19.17	38.13
Active Sleep	9-39	13-39	26.50	24.54	8.79	8.18	66.25	61.35
Drowsy Sleep	0-10.50	0-1.50	3.58	.17	3.89	.44	8.95	.42
Quiet Alert	0-9.50	0-0	1.08	.00	2.74	.00	2.70	0
Active Alert	0-12.00	0-0	1.17	.00	3.46	.00	2.93	0
Crying	0-0	0-.50	.00	.04	.00	.14	0	0.1

HB = Heartbeat sounds

NHB = No heartbeat sounds

Table 2 reveals that the sleep duration during the HB period was longer than the sleep duration during the NHB period. The mean sleep duration was equal to 39.79 minutes (S.D. = .45) with the shortest time at 38.50 minutes and the longest time at 40 minutes for a total of 99.48% in total sleep-wake states. When sleep duration was categorized into quiet sleep and active sleep, the mean quiet sleep for the HB period was found to equal 15.25 minutes (S.D. = 8.09) which is equivalent to 38.13% longer than the mean quiet sleep during the NHB period equal to 7.67 minutes (S.D. = 6.64) or an equivalent of 19.17%. During the NHB period, the minimum sleep duration was no quiet sleep whereas the maximum quiet sleep duration was equal to 26 minutes. During the HB period, the minimum duration for quiet sleep was equal to 1 minute whereas the maximum was equal to 27 minutes. However, the mean active sleep duration for HB was equal to 24.54 minutes (S.D. = 8.18), an equivalent of 61.35%, which was shorter than the NHB period where the mean active sleep was equal to 26.50 minutes (S.D. = 8.79) or equivalent to 66.25%. While hearing heartbeat sounds, the minimum duration for active sleep was equal to 13 minutes whereas the maximum was equal to 39 minutes. While not hearing heartbeat sounds, the minimum duration of active sleep was equal to 9 minutes whereas the maximum was equal to 39 minutes. Additional findings on the means obtained during the NHB period were as follows: 3.58 minutes for drowsy sleep (S.D. = 3.89) equivalent to 8.95%, 1.08 minutes for quiet alert (S.D. = 2.74) equivalent to 2.7%, and 1.17 minutes for active alert (S.D. = 3.46) equivalent to 2.93, thus representing a higher value than during HB. Although there was no quiet alert or active alert sleep duration while hearing heartbeat sounds, crying was equal to 30 seconds (S.D. = .14) which is equivalent to 0.1%.

Table 3 Minimum-maximum, mean, and percentage of quiet Sleep, active sleep and sleep duration during NHB and HB (n = 12)

Sleep Duration (Minutes)	Min-Max		Percentage of Min-Max		Mean		Percentage of sleep	
	NHB	HB	NHB	HB	NHB	HB	NHB	HB
Quiet Sleep	0-26	1-27	0-65	2.50-67.50	7.67	15.25	22.45	38.33
Active sleep	9-39	13-39	22.50-97.50	32.50-97.50	26.50	24.54	77.55	61.67
Sleep duration	9-40	38-40	22.50-100	95-100	34.17	39.79	100	100

Table 3 reveals the mean sleep duration during HB to equal 39.79 minutes with the mean quiet sleep at 15.25 minutes which was equivalent to 38.33% of sleep duration (Min = 2.5%, Max = 67.5%), representing a higher value than during NHB. While not hearing heartbeat sounds, the mean sleep duration was equal to 34.17 minutes with a mean quiet sleep of 7.67 minutes which was equivalent to 22.45% of sleep duration (Min = 0%, Max = 65%). While hearing heartbeat sounds, the mean active sleep was equal to 24.54 minutes which was equivalent to 61.67% of sleep duration (Min = 32.5%, Max = 97.5%), representing a lower value while not hearing heartbeat sounds. During NHB, the mean active sleep was equal to 26.50 minutes which was equivalent to 77.55% of sleep duration (Min = 22.5%, Max = 97.5%).

Table 4 Minimum-maximum, mean, standard deviation, and difference testing of sound and light before and during the experiment (n=12)

Environment	Before (n=12)			During (n=12)			z	p
	Min-Max	Mean	S.D.	Min-Max	Mean	S.D.		
Sound (NHB)	41.50-46.50	45.57	1.31	41.60-46.10	45.39	1.25	-1.603	.109^{ns}
Sound (HB)	58-58	58	.00	57.30-58.40	57.84	.294	-1.827	.068^{ns}
Light	55-72	56.83	4.84	55-72	56.83	4.84	.000	1.00^{ns}

^{ns} p > .05

Table 4 reveals the mean environment sounds at 5 minutes before the experiment to equal 45.57 dB (S.D. = 1.31, Min = 41.5 dB, and Max = 46.5 dB). During the 20th minute of the experiment, the mean sound was equal to 45.39 dB (S.D. = 1.25, Min = 41.6 dB, Max = 46.1 dB). The mean for heartbeat sounds at 5 minutes before the experiment was equal to 58 dB (S.D. = .00, Min and Max = 58 dB). During the 20th minute of the experiment, the mean for heartbeat sounds was equal to 57.84 dB (S.D. = .294, Min = 57.3 dB, Max = 58.4 dB). Light during the NHB and HB period could be controlled at the same level before and after the experiment with a mean value of 56.83 Lux (S.D. = 4.84, Min = 55 Lux, Max = 72 Lux). When testing the difference between sound and light before and during the experiment by using the Wilcoxon Signed-rank test, sound and light levels before and during the experiment were found to not differ with statistical significance (z = -1.603, -1.827, .000, p > .05).

Part 3 - Hypothesis testing

The comparison between the sleep duration of preterm infants during the NHB and HB periods was made through the testing of sleep duration differences by using the Wilcoxon Signed-rank test. The data from the experiment came from a dependent population and acquired through two observations of sleep behaviors in the same infant. Every infant was in the self-control group. Each infant was an independent variable with a nominal level of measurement and two switching values. The dependent variable was sleep duration with an ordinal level of measurement and non-normal distribution (Appendix C) according to the assumption of Wilcoxon Signed-rank test (Rojplakorn-Guse, and Ruecha, 2006: 360) as shown in Table 5. The difference testing of the mean quiet sleep and active sleep met the assumption of the t-test, followed by the Paired t-test. The testing results are shown in Tables 6 and 7.

Hypothesis 1 - The sleep duration of preterm infants will be longer while hearing heartbeat sounds than while not hearing heartbeat sounds.

The difference testing of the sleep duration of preterm infants during NHB and HB was made by using the Wilcoxon Signed-rank test.

Table 5 Median test of sleep duration during NHB and HB (n = 12)

Sleep Duration (Minutes)	NHB			HB			z	p (one-tail)
	Min-max	Mean	S.D.	Min-Max	Mean	S.D.		
Sleep Duration	9-40	33.42	8.84	38.50-40	39.79	.45	-2.49	.007*

* p < .01

Table 5 reveals the data analysis for the 12 infants where the mean sleep duration during HB was equal to 39.79 minutes (S.D. = .45, Min = 38.50 minutes, Max = 40 minutes). This was longer than the mean sleep duration during NHB which was equal to 33.42 minutes (S.D. = 8.84, Min = 9 minutes, Max = 40 minutes). According to the difference testing of sleep duration during NHB and HB by the Wilcoxon Signed-rank test, the sleep duration of the preterm infants was longer during HB than NHB with statistical significance ($z = -2.49$, $p < .01$).

Hypothesis 2 – The quiet sleep of preterm infants will be longer while hearing heartbeats sound than while not hearing heartbeat sounds.

The comparison of the means for quiet sleep during NHB and HB was made by t-test.

Table 6 Comparison of the mean quiet sleep during NHB and HB (n = 12)

Quiet sleep	Mean	S.D.	$\overline{D}$	$S_{\overline{D}}$	t	p (one-tail)
No Heartbeat	7.67	6.64	-7.58	9.15	-2.87	.008*
Heartbeat	15.25	8.09				

* $p < .01$

Table 6 reveals the data analysis of the 12 infants where the mean quiet sleep duration during NHB was equal to 7.67 (S.D. = 6.64), the mean quiet sleep duration during HB was equal to 15.25 (S.D. = 8.09) and the mean quiet sleep difference during NHB and HB was equal to -7.58 (S.D. = 9.15). Comparison of the mean quiet sleep difference during NHB and HB showed that quiet sleep during HB was found to be longer than during NHB with statistical significance ($t = -2.87$, $p < .01$).

Hypothesis 3 – The active sleep of preterm infants will be shorter while hearing heartbeat sounds than while not hearing heartbeat sounds.

The comparison of the mean active sleep during NHB and HB was made by t-test.

Table 7 Comparison of the mean active sleep during NHB and HB (n=12)

Active Sleep	Mean	S.D.	$\overline{D}$	$S_{\overline{D}}$	t	p (one-tail)
No Heartbeat	26.50	8.79	1.96	7.91	.857	$.205^{ns}$
Heartbeat	24.54	8.18				

^{ns} $p > .05$

Table 7 reveals the data analysis of the 12 infants where the mean active sleep during NHB was equal to 26.50 (S.D. = 8.79), the mean active sleep during HB was equal to 24.54 (S.D. = 8.18) and the mean active sleep difference during NHB and HB was equal to 1.96 (S.D. = 7.91). Comparison of the mean active sleep difference during NHB and HB and active sleep during HB and NHB show no difference with statistical significance ($t =.857$, $p > .05$).

Heart Rate, Respiration Rate and Oxygen Saturation

According to the findings, the heart rate, respiration rate and oxygen saturation met the assumption of the t-test. Next, the difference testing of the mean heart rate, respiration rate and oxygen saturation was done by using paired t-test. The testing results are shown in Table 8.

Table 8 Comparison of the mean heart rate, respiration rate and oxygen saturation during NHB and HB (n = 12)

	Mean		S.D		$\bar{D}$	$S_{\bar{D}}$	t	p (one-tail)
	NHB	HB	NHB	HB				
HR	127.85	126.55	8.84	6.98	1.31	7.56	.598	$.281^{ns}$
RR	37.94	34.17	6.23	7.05	-3.77	7.42	-1.76	$.053^{ns}$
SO_2	96.58	97.62	1.92	1.29	-1.04	1.58	-2.276	.022*

^{ns} $p > .05$, * $p < .05$

Table 8 reveals the mean heart rate of the preterm infants during NHB to equal 127.85 beats/minute (S.D. = 8.84), while the mean heart rate of infants during HB was equal to 126.55 beats/minute (S.D. = 6.98) and the mean heart rate difference during NHB and HB was equal to 1.31 (S.D. = 7.56). Comparison of the mean heart rate difference during NHB and HB show no difference in the heart rate during HB and NHB with statistical significance (t = .598, p > .05).

The mean respiration rate of the infants during NHB was higher than during HB which was equal to 37.94 times/minute (S.D. = 6.23), and 34.17 times/minute (S.D. = 7.05) respectively. The mean respiration rate difference was equal to -3.77 (S.D. = 7.42). Comparison of the mean respiration rate difference and respiration rate during HB and NHB show no difference with statistical significance (t = -1.76, p > .05).

The mean oxygen saturation during NHB was equal to 96.58 % (S.D. = 1.92) and the mean oxygen saturation during HB was equal to 97.62 % (S.D. = 1.29). The mean oxygen saturation difference during NHB and HB was equal to -1.04 (S.D. = 1.58). Comparison of the mean oxygen saturation difference during NHB and HB show the oxygen saturation during HB to be higher than during NHB with statistical significance (t = -2.276, p < .05).

CHAPTER V
DISCUSSION

This study aimed to explore the sleep duration of preterm infants while not hearing heartbeat sounds and hearing heartbeat sounds. The study was conducted with only one sample group and every patient was in the self-control group. All of the samples were 12 preterm infants admitted to the Newborn Unit, Taksin Hospital under the Department of Medical Services, Bangkok Metropolitan Administration. The discussion is based on the research objectives and hypothesis as follows:

Demographic data of the samples

The samples comprised a total of 12 infants comprising females (58.3%) and males (41.7%). Most of the samples (91.7%) had gestational ages of more than 34-36 weeks where the mean gestational age was 35.33 weeks featuring obvious and complete quiet sleep (Sheldon, 2002) with a complete range of noticeable sleep states. The birth weights ranged from 2,001 to 2,499 grams with a mean weight of 2,240.83 grams. For the most part, conceptual age was less than 1-2 days with a mean conceptual age of 1.62 days equivalent to 75%. For the most part, (83.3%) the mothers had vaginal deliveries with normal labor.

Hypothesis testing

Hypothesis 1: The sleep duration of preterm infants will be longer while hearing heartbeat sound than while not hearing heartbeat sound.

Hypothesis 2: The quiet sleep of preterm infants will be longer while hearing heartbeat sound than while not hearing heartbeat sound.

In this study, the preterm infants heard the effective recorded heartbeat sounds of a normal person with a heart rate of 72 beats/minute (Liu et al., 2008; Salk, 1973) and a non-hazardous sound level not exceeding 58 dB (American Academy of Pediatrics, 1974) for 40 minutes in order to ensure the whole sleep states of infants (Gardner & Lubchenco, 1998) and protect infants from stress (Neal & Lindeke, 2008). The environment was arranged similarly to the womb. During the experimental stage, the preterm infants stayed in the incubator covered with a cloth in a separate room with dim lighting at a mean intensity of 56.83 Lux and a mean sound level of 57.92 dB (before the experiment = 58.0 dB; during the experiment = 57.84 dB). During the control stage, the preterm infants did not hear heartbeat sounds, but the environment was controlled the same as during the experimental stage: The mean light intensity was 56.83 Lux, the mean sound in the incubator was 45.48 dB (before the experiment = 45.57 dB; during the experiment = 45.39 dB) as shown in Table 4.

The experimental results showed that the mean sleep duration and quiet sleep while hearing heartbeat sounds was longer than while not hearing heartbeat sounds (Table 5 and 6). While hearing heartbeat sounds, the mean sleep duration was 39.79 minutes and the mean quiet sleep was 15.25 minutes. While not hearing heartbeat sounds, the mean sleep duration was 33.42 minutes, and the mean quiet sleep was 7.67 minutes. Furthermore, drowsy sleep was less while hearing heartbeat sounds with a mean duration of 0.17 minutes and a mean duration of 3.58 minutes while not hearing heartbeat sounds. No quiet/active alert was found while hearing heartbeat sounds, and only on crying case was found for a mean duration of .04 minutes as an immediate sound at the beginning made when the infant startled and changed from sleep to alert and crying states (Lund, 2003; Thomas & Uran, 2007; Zahr & Balian, 1995). While not hearing heartbeat sounds, there was no crying state, but an alert state was found at a mean duration of 1.08 minutes for quiet alert and a mean of 1.17 minutes for active alert. No alert state was found while hearing heartbeat sounds because heartbeat sounds had been a familiar maternal sound since in the womb. Accordingly, the study of Porcaro et al. (2006) about magnetoencephalographic assessment on infants' feedback to the sounds of their mothers's heart beating and conducted with 12 healthy mothers who had given birth to infants with gestational ages of 36-40 weeks revealed that 8 out of 12 infants were able to respond to the sounds of their mother’s heartbeat (Porcaro et al., 2006). This sound was embedded in their memories until after birth and was able to calm the infants during their alert or crying states (Liu et al., 2008; Lowdermilk & Perry, 2006).

Upon comparison of the differences, the sleep duration and mean quiet sleep of the preterm infants while hearing heartbeat sounds was found to be longer than while not hearing heartbeat sounds with statistical significance ($p < .01$) as shown in Tables 5 and 6. These findings support Hypotheses 1 and 2 which might be explained in that the heartbeat sound recording provided was able to comfort the preterm infants as the sound was rhythmic, structured, soft, repetitive, within a low frequency range, harmonious, within a limited dynamic range and familiar to the infants, thus leading to tranquility and earlier sleep states (Gardner & Lubchenco, 1998; Glass, 2005) while also sustaining long quiet sleep and reflecting more developed central nervous systems in the infants (Schmidt et al., 1980). The sounds of a beating heart are similar to music (Neal & Lindeke, 2008) and enter the ear structures through hair cells, changing into energy and electric currents transmitted along the auditory nerves to the limbic system and resulting in increased release of serotonin and stimulation of the pituitary gland to release endorphin, thus leading to better relaxation and longer sleep. In addition, these hormones affected the parasympathetic nervous system contributing to stable heart and respiration rates. Accordingly, the study of Salk (1973) stated that heartbeat sounds were able to make infants feel calm, reduce crying and gain weight as a result of better sleep. Moreover, the growth hormone released during quiet sleep helped increase infants’ weight. Similarly, the study of Schmidt et al. (1980) asserted that heartbeat sounds highly influenced sleep duration, increasing sleep duration, reducing active sleep and increasing quiet sleep with statistical significance.

Hypothesis 3: The active sleep of preterm infants will be shorter while hearing heartbeat sound than while not hearing heartbeat sound.

The findings of this study revealed that active sleep was slightly shorter than while hearing heartbeat sounds than while not hearing heartbeat sounds. The mean duration for active sleep while hearing heartbeat sounds was 24.54 minutes which was equivalent to 61.35% of the total sleep-wake states as shown in Table 2 and

61.67% of the sleep duration time as shown in Table 3. The mean duration for active sleep while not hearing heartbeat sounds was 26.50 minutes which was equivalent to 66.25% of the total sleep-wake states as shown in Table 2 and 77.55% of the sleep duration time as shown in Table 3. However, a comparison of the difference between the mean active sleep duration while hearing and not hearing heartbeat sounds showed the mean active sleep duration to be shorter while hearing heartbeat sounds than while not hearing heartbeat sounds without statistical significance ($p > .05$) as shown in Table 7. Normally, the active sleep of full term infants accounts for 50-55% of the total sleep-wake states (Gardner & Lubchenco, 1998; Hussakunachai, 2008), but preterm infants' brain function is not completely developed, so they have more active sleep accounting for 80% of sleep duration (Gardner & Lubchenco, 1998; Papalia, Olds, & Feldman, 1999; Peirano et al., 2003) which is an outstanding state of preterm infants' sleep cycles (Vandenberg, 2007). This is also an essential state of newborns as they are stimulated by the environment, develop their neural networks and circulate oxygen to their eyes through their rapid eye movement leading to vitreous flow (Berk, 2006). In this study, infants in both stages were arranged in environments similar to the womb or in a quiet hour where the infants' active sleep could be reduced at a .05 level of statistical significance according to the study of Nakklinkul, (2003) and Sudsaneha, (2005). Accordingly, the findings of this study revealed that the active sleep of preterm infants in both the experimental stage and control stage accounted for 61.35-66.25% which was less than the normal sleep patterns of the preterm infants having active sleep at 80%. In this study, there was no difference between the active sleep in the experimental group and the control group because the infants were arranged in similar environments leading to similar sleep patterns. The difference, however, was that the infants had more drowsy sleep, quiet alert and active alert states while not hearing heartbeat sounds than while hearing heartbeat sounds. No quiet alert or active alert was found while hearing heartbeat sounds. The findings of the study indicated that heartbeat sounds were able to calm the preterm infants. None of the preterm infants were found in the alert state while hearing heartbeat sounds which led to earlier and longer active sleep and quiet sleep.

Heart Rate, Respiration Rate and Oxygen Saturation

Heart rate was slightly different in the experimental and control stages. The mean heart rate while hearing heartbeat sounds was 126.55 beats/minute, which was lower than while not hearing heartbeat sounds which was equivalent to a mean of 127.85 beats/minute as shown in Table 8. Comparison of the mean heart rate of the preterm infants while hearing heartbeat sounds and not hearing heartbeat sounds revealed that the heart rate of infants was lower while hearing heartbeat sounds than while not hearing heartbeat sounds without statistical significance ($p > .05$) as shown in Table 8. The mean heart rate of the preterm infants at both the control and experimental stages was not much different because both stages provided the same quiet hour with controlled light and sound, so the infants curled up in the incubator covered with a cloth which contributed to better and longer quiet sleep according to the study of Nakklinkul and Sudsaneha (Nakklinkul, 2003; Sudsaneha, 2005). Therefore, the heart rates of the preterm infants were no different in the experimental and control stages as shown in Table 8. The quiet hour enhanced infants' quiet sleep. Although the mean heart rate of the preterm infants was not different, the heart rate while hearing heartbeat sounds was more stable, thus representing better quiet sleep (Holditch-Davis, 1993). During quiet sleep, the parasympathetic nervous system had greater function which led to the lowest heart rate and blood pressure within 24 hours with a low and stable metabolic state (Vasiknanon, 2003). Accordingly, the study of Schmidt et al. (1980) stated that heartbeat sounds did not affect the cardiovascular system or body movement of infants during quiet sleep.

Similarly, the respiration rate during the experimental and control stages of the present study were slightly different. The mean respiration rate while not hearing heartbeat sounds was equal to 37.94 times/minute whereas the mean respiration rate while hearing heartbeat sounds was equal to 34.17 times/minute. The study of Brazelton on infants' sleep behavior (Brazelton, 1994) found that infants had abdominal breathing that was deep, slow and constant during quiet sleep with a mean rate of 36 times/minute. Hence, the present study revealed the infants' mean respiration rate to be 34.17 times/minute which was less than 36 times/minute while hearing heartbeat sounds to represent their quiet sleep. During active sleep, most infants have diaphragmatic breathing, other respiratory muscles are more relaxed and breathing is shallow, fast and not constant which leads to reduction of alveolar ventilation, minute ventilation and tidal volume, as well as frequent central apnea. In addition, breathing responses to carbon dioxide concentrations send these values to the lowest level (Vasiknanon, 2003; Holditch-Davis, 1993). During quiet sleep, the infants bodies respond better to low blood oxygen and high levels of carbon dioxide in the blood by increasing minute ventilation than during active sleep, (Kuptanon and Preutipan, 2006) thus resulting in constant breathing. However, comparison of the mean respiration rate of infants while hearing and not hearing heartbeat sounds reveals their respiration rate while hearing heartbeat sounds to be lower than while not hearing heartbeat sounds without statistical significance ($p > .05$) as shown in Table 8, possibly because both the experimental and control stages were arranged in the same quiet hour leading to similar respiration rate. However, respiration rate while hearing heartbeat sounds were lower and more stable, thus representing better quiet sleep.

The mean oxygen saturation was 97.62% while hearing heartbeat sounds and 96.58% while not hearing heartbeat sounds. Comparison of the differences in the mean oxygen saturation revealed that infants' oxygen saturation while hearing heartbeat sounds was higher than while not hearing heartbeat sounds with statistical significance ($p < .05$) as shown in Table 8. The mean oxygen saturation while hearing heartbeat sounds was mostly higher and more stable, especially during quiet sleep because infants in this state hardly have body movement, require low energy and low oxygen consumption (Brown, 2009). In addition, oxygen saturation while hearing heartbeat sounds was more stable than while not hearing heartbeat sounds due to the relationships between active sleep and apnea. Preterm infants are predisposed to apnea during this state, so their oxygen saturation becomes decreased and unstable as a result of hypoventilation and lower end respiratory lung volume than during quiet sleep (Holditch-Davis, 1993; Lehtonen & Martin, 2004). The findings of this study revealed that oxygen saturation was found to be lower and less stable while not hearing heartbeat sounds, thus representing more active sleep while not hearing heartbeat sounds and better quiet sleep while hearing heartbeat sounds.

In conclusion, the findings of this study revealed that heartbeat sounds could enable preterm infants to increase sleep duration and quiet sleep, while reducing drowsy sleep without alert state, but with no difference in their active sleep.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

This study employed a crossover-experimental design in order to explore the effects of heartbeat sounds on the sleep duration of preterm infants. The study was conducted with only one sample group which served as both an experimental group and a control group. The purposive sampling was carried out based on the selection criteria set by selecting from 12 preterm infants in the Newborn Unit at Taksin Hospital during March – June of 2010. The selection criteria were as follows: 32-36 weeks' gestational age based on the Ballard score, normal hearing, stable condition, no requirement to be on oxygen, no congenital disabilities or severe complications, no medications affecting sleep, no serious conditions and parents who were willing to participate in the study. After the research proposal had been approved by the Human Research Ethics Committees of Ramathibodi Hospital and the Bangkok Metropolitan Administration, the researcher met with the Director and Head of the Newborn Unit at Taksin Hospital to provide details regarding the data collection and to explore infants' names and histories for further selection. Next, the researcher asked for cooperation from the parents in the data collection of the sample and requested written consent by obtaining signatures in informed consent forms.

The researcher filled in the demographic data record and the experiment was divided into 2 stages. All of the selected infants participated in both stages. The sampling was performed by non-related persons who determined the sequence of experimental/control stages, i.e. A: Heartbeat/None and B: None/Heartbeat. The period where heartbeat sounds were heard was the experimental stage and the period where heartbeat sounds were not heard was the control stage.The environments of both stages were arranged similarly to the womb i.e. being in an incubator located in a separate room, displaying a poster in front of the room which said, "Please do not disturb during the study", covering the incubator with a cloth, controlling light not to exceed 600 Lux, controlling sound not to exceed 58 dB, arranging infants in the supine position, attaching an oxygen saturation measuring instrument to one of infants' feet. During the experimental stage, the infants were allowed to hear recorded heartbeat sounds. VDO recordings during infants' sleep were carried out for 40 minutes in both stages. The researcher observed and recorded sleep behaviors, oxygen saturation and heart rate every 1 minute in addition to respiration rate every 10 minutes. If the infants were awake, moved or cried and could stop by themselves, or were unintentionally disturbed by the environment, the record was suspended and continued the next day. In cases involving less than 90% oxygen saturation, the infants were provided with assistance and excluded from the study. Research instrumentation consisted of 2 types i.e. instruments for the experiment and instruments for the data collection. Instruments for the experiment included instruments for measuring oxygen saturation and heart rate, instruments for measuring sound level, instruments for measuring light intensity, the MP3 player and speaker, equipment for measuring hearing, VDO camera and the heartbeat sounds of a normal person with a heart rate of 72 beats/minute. Instruments for the data collection included the demographic data record, preterm infants' sleep-wake states record and a manual on evaluation of preterm infants' sleep-wake behavior by Charastong (2001) as adapted from the sleep-wake states evaluation form of Pamaelee & Stern (1972) validated by 5 experts. In this study, the reliability calculated by the researcher and experts was equal to 0.90. In addition, the record of oxygen saturation, heart rate and respiration rate were also calculated. The data analysis carried out by using descriptive statistics, Paired t-test and Wilcoxon Signed-rank Test.

The research findings are as follows:

1. The sleep duration of the preterm infants while hearing heartbeat sounds was longer than while not hearing heartbeat sounds with statistical significance ($p < .01$).

2. The quiet sleep of the preterm infants while hearing heartbeat sounds was longer than while not hearing heartbeat sounds with statistical significance ($p < .01$).

3. The active sleep of the preterm infants while hearing and not hearing heartbeat sounds were no different with statistical significance ($p > .05$).

4. The heart rate of the preterm infants while hearing and not hearing heartbeat sounds were no different with statistical significance ($p > .05$).

5. The respiration rate of the preterm infants while hearing and not hearing heartbeat sounds were no different with statistical significance ($p > .05$).

6. The oxygen saturation of the preterm infants while hearing heartbeat sounds was higher than while not hearing heartbeat sounds with statistical significance ($p < .05$).

Research limitations

1. The researcher could not select infants with gestational ages of less than 32 weeks as some infants were unable to pass the hearing test, despite their developed auditory structure which was similar to adults' auditory processing but needed to wait for retesting.

2. The findings of this study can be applied only to Newborn Units that arrange the same environment as in this study.

Recommendations

Nursing practice

Nurses who provide care for preterm infants can implement the practice of providing heartbeat sounds for preterm infants during quiet hours in order to promote their sleep, thus leading to better growth and central nervous system development.

Nursing education

Knowledge on the promotion of preterm infants' sleep-wake development by heartbeat sounds for enhancing longer sleep duration should be included in nursing courses so nursing students will have knowledge and understanding along with nursing practice for properly promoting sleep in preterm infants'.

Nursing administration

The findings of this study can be submitted to the management of the Newborn Unit so it can be used for planning nursing practices and organizing the Newborn Unit's structure in terms of light and sound control with heartbeat sound application that would affect the preterm infants' growth and nervous system development, eventually resulting in their future quality of life.

The research findings suggest the following for nursing research:

1. Additional studies on various factors, such as infant weight and length of stay in the hospital when heartbeat sounds are turned on for the infants to hear.
2. Studies on other sounds affecting preterm infants' sleep, such as music, mothers' voice, percussion instruments, etc.
3. More of the same study with full term infants.
4. More of the same study in other Newborn Units for more extensive references.
5. Increased samples in the study for greater coverage of preterm infants.

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APPENDICES

APPENDIX A

เอกสารแนะนำโครงการวิจัย

ข้าพเจ้า นางสาว สมจิต วรรณขาว นักศึกษาปริญญาโท ภาควิชาพยาบาลศาสตร์ คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล มีความสนใจที่จะศึกษาวิจัยเรื่อง ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด การให้ทารกได้ฟังเสียงจังหวะการเต้นของหัวใจ มีแนวโน้มว่าจะเป็นผลดีต่อทารกเกิดก่อนกำหนด และไม่พบว่าจะมีอันตรายใดๆ ต่อทารก และบุตรของท่านได้รับเลือกเป็นกลุ่มตัวอย่างในการศึกษาวิจัย เนื่องจากมีอาการคงที่ และรักษาตัวอยู่ในโรงพยาบาลในช่วงเวลานี้ วัตถุประสงค์ของศึกษา เพื่อศึกษาระยะเวลาการหลับในทารกเกิดก่อนกำหนดที่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ และเพื่อเปรียบเทียบระยะเวลาการหลับในทารกเกิดก่อนกำหนดขณะที่ได้รับฟังเสียงจังหวะการเต้นของหัวใจและขณะที่ไม่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ ซึ่งการเก็บรวบรวมข้อมูลจะใช้กลุ่มตัวอย่างกลุ่มเดียว เป็นทั้งกลุ่มควบคุมและกลุ่มทดลอง จำนวน 12 ราย โดยจะบันทึกภาพวิดีทัศน์พฤติกรรมและระยะเวลาการนอนหลับ ขณะทารกได้รับฟังเสียงจังหวะการเต้นของหัวใจที่อัดจากเทป และขณะไม่ได้รับฟังเสียงจังหวะการเต้นของหัวใจ เป็นเวลา 40 นาทีในห้องแยก ที่ไม่มีแสงและเสียงรบกวน ช่วงเวลา 12.30-13.10 น. เป็นเวลา 2 วัน ทารกจะได้รับการสุ่มวิธีทดลองว่าทารกจะได้รับการฟังเสียงจังหวะการเต้นของหัวใจหรือไม่ได้รับฟังก่อน ข้อมูลที่ได้จากการวิจัยนี้จะนำไปวิเคราะห์และแปรผลในภาพรวม เพื่อเป็นแนวทางในการจัดการส่งเสริมการนอนหลับในทารกเกิดก่อนกำหนดต่อไป การรักษาและการบริการจากแพทย์และพยาบาลในด้านอื่นๆ ยังคงเป็นไปตามปกติ

จึงเรียนมาเพื่อขอความร่วมมือและอนุญาตให้บุตรของท่านเข้าร่วมการวิจัย ท่านสามารถยกเลิกการอนุญาตและให้บุตรของท่านออกจากการวิจัยครั้งนี้ โดยไม่มีผลต่อการรักษาพยาบาลที่ท่านได้รับแต่อย่างใด หากท่านอนุญาตให้บุตรเข้าร่วมการวิจัยครั้งนี้ กรุณาลงชื่อยินยอมเข้าร่วมการวิจัยด้วย

ขอขอบคุณในความร่วมมือ

นางสาว สมจิต วรรณขาว

นักศึกษาปริญญาโท

หนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ

(Informed Consent Form)

ชื่อโครงการ ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด

ชื่อผู้วิจัย นางสาวสมจิต วรรณขาว

*ชื่อผู้เข้าร่วมการวิจัย……………………………………………..

อายุ................เลขที่เวชระเบียน...........................

คำยินยอมของผู้มีอำนาจกระทำการแทนผู้เข้าร่วมการวิจัย

ข้าพเจ้านาย/นาง/นางสาว……………..……….…………..ซึ่งเป็นผู้มีอำนาจกระทำการแทน ด.ช/.ด.ญ . ...ในฐานะ.............................ได้ทราบรายละเอียดของโครงการวิจัย ตลอดจน ประโยชน์ และข้อเสี่ยงที่จะเกิดขึ้นต่อผู้เข้าร่วมการวิจัยจากผู้วิจัยแล้วอย่างชัดเจน ไม่มีสิ่งใดปิดบังซ่อนเร้นและยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้ารู้ว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้นข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถไม่ให้ผู้เข้าร่วมการวิจัยเข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อการรักษาที่ผู้เข้าร่วมการวิจัยได้รับ นอกจากนี้ ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวผู้เข้าร่วมการวิจัยเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวผู้เข้าร่วมการวิจัยต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผล ทางวิชาการเท่านั้น

ลงชื่อ……………………………………(บิดา/มารดาของผู้เข้าร่วมวิจัย)

...……………………………………..(พยาน)

………………………………………..(พยาน)

วันที่................/....................../...............

คำอธิบายของผู้วิจัย

ข้าพเจ้าได้อธิบายรายละเอียดของโครงการ ตลอดจนประโยชน์ของการวิจัย รวมทั้งข้อเสี่ยงที่อาจจะเกิดขึ้นแก่ผู้เข้าร่วมการวิจัยทราบแล้วอย่างชัดเจนโดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ลงชื่อ……………………………………(ผู้วิจัย)

(นางสาวสมจิต วรรณขาว)

วันที่ ..../..................../..........

หมายเหตุ: * ผู้เข้าร่วมการวิจัย หมายถึง ผู้ยินยอมตนให้ทำวิจัย

APPENDIX B

เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูล

ส่วนที่ 1 แบบบันทึกข้อมูลทั่วไป

ลำดับที่..............
วันที่...................

ชื่อ.......................................นามสกุล...เพศ.......................

อายุครรภ์..............................สัปดาห์ อายุหลังเกิด...........................วัน

น้ำหนักแรกเกิด.................................กรัม วิธีคลอด..

การวินิจฉัยโรค..

....

การรักษาที่ได้รับ...

....

....

....

....

ยาที่ได้รับ..

....

....

....

ลำดับที่...............................

วันที่...................................

ส่วนที่ 2 แบบบันทึกการหลับตื่นของทารกเกิดก่อนกำหนด

ชื่อ/นามสกุล..

= quiet sleep (QS) = active sleep (AS) = drowsy sleep (DS)

= quiet alert (QA) = active alert (AA) = crying (Cry)

เวลาที่เริ่ม ....

0 1 2 3 4 5 6 7 8 9 10

10 11 12 13 14 15 16 17 18 19 20

20 21 22 23 24 25 26 27 28 29 30

30 31 32 33 34 35 36 37 38 39 40

รวม quiet sleep ....นาที

active sleep ....นาที

drowsy sleep ....นาที

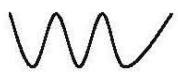
quiet alert ....นาที

active alert ....นาที

crying ....นาที

คู่มือการประเมินพฤติกรรมการหลับตื่นของทารกเกิดก่อนกำหนด

การประเมินสภาวะการหลับตื่นของทารกเกิดก่อนกำหนด สังเกตจากการปิดเปิดเปลือกตา การเคลื่อนไหวร่างกายและลักษณะการหายใจ

สภาวะการหลับตื่น (Sleep-wake state)	สัญลักษณ์	การเปิด-ปิดของตา	ลักษณะการหายใจ	การเคลื่อนไหวของร่างกาย
ระยะหลับลึก (Quiet sleep)		ตาปิด	หายใจสม่ำเสมอและใช้กล้ามเนื้อหน้าท้องเคลื่อนไหว	ไม่มีการเคลื่อนไหวหรือมีการเคลื่อนไหวเล็กน้อยอาจพบสะดุ้ง
ระยะหลับตื้น (Active sleep)		ตาปิด มี REM	หายใจไม่สม่ำเสมอและใช้กล้ามเนื้อซี่โครงเคลื่อนไหว	มีการเคลื่อนไหวของแขน ขา ,มือ , เท้า ,ศีรษะและลำตัว หรือทั้งร่างกาย
ระยะง่วงซึม (Drowsy sleep)		ตาหนัก ตาปิดหรือเปิดครึ่งตา	หายใจไม่สม่ำเสมอ	มีหรือไม่มีการเคลื่อนไหวร่างกาย
ระยะตื่นสงบ (Quiet alert)		ตาเปิด จ้องมองนิ่ง	หายใจสม่ำเสมอ	มีการเคลื่อนไหวเล็กน้อยของแขน , ขา ,มือ ,เท้า ,ศีรษะ เป็นบางส่วน หรือไม่มีการเคลื่อนไหว
ระยะตื่นเต็มที่ (Active alert)		ตาปิดเต็มที่	หายใจไม่สม่ำเสมอ	มีการเคลื่อนไหวทั้งแขน ขา ,หน้า , ศีรษะ ,ลำตัว หรือทั้งร่างกาย
ระยะร้อง (Crying)		ตาเปิดหรือปิด	หายใจไม่สม่ำเสมอ มีการเคลื่อนไหวทรวงอกเร็วขึ้น	มีการเคลื่อนไหวทั้งร่างกาย มีการดึงตัวของกล้ามเนื้อ

ลำดับที่...............

วันที่....................

ชื่อ.......................................นามสกุล...

แบบบันทึกค่าความเข้มแสงและเสียง

เวลา	ความเข้มแสง (Lux)	ความดังของเสียง (dB)
นาทีที่ 25 ก่อนการทดลอง		
นาทีที่ 20 ระหว่างการทดลอง		

ลำดับที่..............

วันที่...................

ชื่อ.......................................นามสกุล...**...........**

แบบบันทึกอัตราการเต้นของหัวใจ ค่าความอิ่มตัวของออกซิเจนและอัตราการหายใจ

	1	2	3	4	5	6	7	8	9	10
HR										
O_2										
RR										

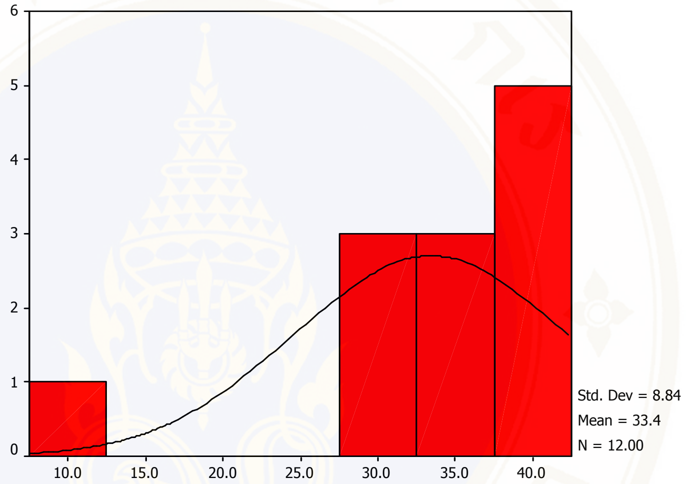
	11	12	13	14	15	16	17	18	19	20
HR										
O_2										
RR										

	21	22	23	24	25	26	27	28	29	30
HR										
O_2										
RR										

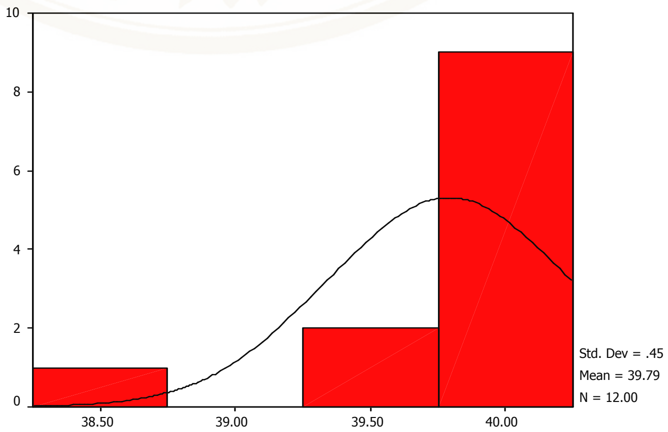
	31	32	33	34	35	36	37	38	39	40
HR										
O_2										
RR										

APPENDIX C

Histogram



ระยะเวลาหลับรวมขณะไม่ฟัง



ระยะเวลาหลับรวมขณะฟัง

APPENDIX D

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233

Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

เอกสารรับรองโดยคณะกรรมการจริยธรรมการวิจัยในคน
คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
มหาวิทยาลัยมหิดล

เลขที่ ๒๕๕๓/๑๒

ชื่อโครงการ	ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด
เลขที่โครงการ/รหัส	ID ๐๑ – ๕๓ – ๑๒ ว
ชื่อหัวหน้าโครงการ	นางสาวสมจิต วรรณขาว
สถานศึกษา	ภาควิชาพยาบาลศาสตร์ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับแนวปฏิญญาเฮลซิงกิ จากคณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

ลงนาม ....
กรรมการและเลขานุการจริยธรรมการวิจัยในคน (รองศาสตราจารย์ แพทย์หญิงดวงฤดี วัฒนศิริชัยกุล)

ลงนาม ....
ประธานกรรมการจริยธรรมการวิจัยในคน (ศาสตราจารย์ นายแพทย์บุญส่ง องค์พิพัฒนกุล)

วันที่รับรอง ๒๐ มกราคม ๒๕๕๓

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233

Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

เอกสารรับรองโดยคณะกรรมการจริยธรรมการวิจัยในคน

คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

มหาวิทยาลัยมหิดล

เลขที่ ๒๕๕๓/๑๒

ชื่อโครงการ ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด

เลขที่โครงการ/รหัส ID ๐๑ – ๕๓ – ๑๒ ว

ชื่อหัวหน้าโครงการ นางสาวสมจิต วรรณขาว

สถานศึกษา ภาควิชาพยาบาลศาสตร์
คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
มหาวิทยาลัยมหิดล

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับแนวปฏิญญาเฮลซิงกิ จากคณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

ลงนาม ....
กรรมการและเลขานุการจริยธรรมการวิจัยในคน (รองศาสตราจารย์ แพทย์หญิงดวงฤดี วัฒนศิริชัยกุล)

ลงนาม ....
ประธานกรรมการจริยธรรมการวิจัยในคน (ศาสตราจารย์ นายแพทย์บุญส่ง องค์พิพัฒนกุล)

วันที่รับรอง ๒๐ มกราคม ๒๕๕๓

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233

Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

Documentary Proof of Ethical Clearance Committee on Human Rights Related to Researches Involving Human Subjects Faculty of Medicine, Ramathibodi Hospital, Mahidol University

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No. MURA2010/12

Title of Project	Effect of Heartbeat Sound on Sleep Duration of Preterm Infants
Protocol Number	ID 01 – 53– 12
Principal Investigator	Miss Somjit Wannakhow
Education Address	Department of Nursing Faculty of Medicine, Ramathibodi Hospital Mahidol University

The aforementioned project has been reviewed and approved by Committee on Human Rights Related to Researches Involving Human Subjects, based on the Declaration of Helsinki.

Signature of Secretary **Committee on Human Rights Related to Researches Involving Human Subjects**	.... Assoc. Prof. Duangrurdee Wattanasirichaigoon, M.D.
Signature of Chairman **Committee on Human Rights Related to Researches Involving Human Subjects**	.... Prof. Boonsong Ongphiphadhanakul, M.D.
Date of Approval	January 20, 2010

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
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ที่ จวค ๒๗๐/๒๕๕๓ คณะกรรมการจริยธรรมการวิจัยในคน

วันที่ ๑ กุมภาพันธ์ ๒๕๕๓

เรื่อง แจ้งผลการพิจารณาของคณะกรรมการจริยธรรมการวิจัยในคน

เรียน นางสาวสมจิต วรรณขาว

อ้างถึงโครงการวิจัยเรื่อง ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด

หมายเลขโครงการวิจัย ID ๐๑ - ๕๓ – ๑๒ ว

ในนามของคณะกรรมการจริยธรรมการวิจัยในคน ผมขอแสดงความยินดีที่โครงการวิจัยดังกล่าวข้างต้นของท่านได้ผ่านความเห็นชอบ จากคณะกรรมการฯแล้ว

เพื่อให้สอดคล้องกับระเบียบปฏิบัติคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ว่าด้วยการศึกษาวิจัยและการทดลองในมนุษย์ พ.ศ. ๒๕๔๔ คณะกรรมการฯ ขอให้ท่านถือปฏิบัติโดยเป็นไปตามข้อแนะนำดังต่อไปนี้

๑. การดำเนินการวิจัยจะต้องเป็นไปตามโครงร่างวิจัยล่าสุดที่ผ่านการพิจารณาจากคณะกรรมการจริยธรรมการวิจัยในคนแล้ว
๒. การดำเนินการวิจัยจะต้องไม่เบี่ยงเบนไปจากโครงร่างวิจัยหรือมีการเปลี่ยนโครงร่างการวิจัยก่อนที่การ แก้ไขเพิ่มเติมโครงร่างวิจัยนั้นจะได้รับการอนุมัติและเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในคนก่อน ยกเว้นในกรณีจำเป็นที่จะต้องกระทำไปก่อนเพื่อขจัดอันตรายเฉพาะหน้าที่เกิดขึ้นกับผู้ยินยอมตนให้ทำวิจัย
๓. ในกรณีที่มีการเปลี่ยนแปลงชื่อโครงการไปจากชื่อเดิมที่เสนอไว้ ต่อคณะกรรมการฯ ต้องแจ้งชื่อมายังคณะกรรมการฯ เพื่อออกหนังสือรับรองให้เสมอ
๔. ผู้ยินยอมตนให้ทำวิจัยจะต้องได้รับเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมตนให้ทำวิจัย (Patient/Participant Information Sheet) และลงนามในหนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent Form) ก่อนเริ่มดำเนินการวิจัย
๕. ในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมตนให้ทำวิจัย (Patient's Information Sheet) จะต้องพิมพ์ข้อความดังต่อไปนี้ไว้ ด้วยทุกครั้ง

" ถ้าท่านมีข้อข้องใจหรือมีความกังวลใจเกี่ยวกับวิธีดำเนินการวิจัยของโครงการวิจัยนี้ ท่านสามารถติดต่อได้ที่ ประธานกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี หน่วยจริยธรรมการวิจัยในคน สำนักงานวิจัยคณะฯ อาคารวิจัยและสวัสดิการ ชั้น ๓ (ห้อง ๓) โทรศัพท์ ๐๒–๒๐๑ ๑๕๔๔ ในเวลาราชการ"

๖. ความลับของผู้ยินยอมตนให้ทำวิจัย จะต้องถูกปกปิดไว้ตลอดเวลา ยกเว้นถ้าเป็นคำสั่งตามกฎหมาย

สุดท้ายนี้ ขอให้โครงการวิจัยของท่านประสบผลสำเร็จตามความมุ่งหมายอันจะนำมาซึ่งความเจริญก้าวหน้าทางวิชาการ และเพื่อประโยชน์ของมนุษยชาติสืบต่อไป

ขอแสดงความนับถือ

(ศาสตราจารย์ บุญส่ง องค์พิพัฒนกุล)
ประธานกรรมการจริยธรรมการวิจัยในคน

ด่วนที่สุด

สำนักการแพทย์ รับเลขที่ 6260 วันที่ 9 มี.ค. 2553 เวลา 16.00 กรุงเทพมหานคร

บันทึกข้อความ

ส่วนราชการ กองวิชาการ (ฝ่ายพัฒนาบุคคล โทร. 0 2224 9710 โทรสาร 0 2221 6029)
ที่ กท 0602.4/วค.102 **วันที่** 8 มีนาคม 2553
เรื่อง อนุมัติโครงการวิจัย ของ นางสาวสมจิต วรรณขาว

กองวิชาการ สนพ. รับที่ 2200 วันที่ 10 มี.ค. 2553 เวลา 10.05น.

เรียน ผู้อำนวยการสำนักการแพทย์

ตามบันทึก กท.0602/1311 ลงวันที่ 12 กุมภาพันธ์ 2553 เรื่อง ขออนุมัติการทำวิจัยในคน ซึ่งท่านขอให้คณะกรรมการพิจารณาและควบคุมการวิจัยในคนของกรุงเทพมหานคร พิจารณาโครงการวิจัย ของ นางสาวสมจิต วรรณขาว เรื่อง "ผลของเสียงจังหวะการเต้นของหัวใจต่อระยะเวลาการหลับในทารกเกิดก่อนกำหนด" นั้น

บัดนี้คณะกรรมการพิจารณาและควบคุมการวิจัยในคนของกรุงเทพมหานคร ได้พิจารณาโครงการวิจัยที่นำเสนอแล้ว มีความเห็นว่าโครงการได้มาตรฐาน ไม่ขัดต่อสวัสดิภาพ และไม่ก่อให้เกิดภยันตรายแก่ผู้ถูกวิจัย เห็นควรให้ดำเนินการวิจัยในขอบข่ายของโครงการที่นำเสนอได้ และให้ผู้วิจัยรายงานผลการดำเนินงานต่อคณะกรรมการ ฯ ทุก 6 เดือน

จึงเรียนมาเพื่อโปรดทราบ และแจ้งผู้เกี่ยวข้องทราบต่อไป พร้อมนี้ได้แนบเอกสารรับรองโครงการวิจัยในคนมาด้วยแล้ว

ฝ่ายการพยาบาล โรงพยาบาลตากสิน รับที่ 217 วันที่ 16 มี.ค. 2553 เวลา 14.00 น.

โรงพยาบาลตากสิน เลขที่รับ 2582/53 วันที่ 12 มี.ค. 2553 เวลา 13.00 น.

(นางสาวเปรมวดี คฤหเดช)
กรรมการและเลขานุการ
คณะกรรมการพิจารณาและควบคุมการวิจัยในคน
ของกรุงเทพมหานคร

เรียน ผู้อำนวยการกองวิชาการ

(นางจอมใจ สำราญทรัพย์)
เลขานุการสำนักการแพทย์
10 มี.ค.-53

ที่ กท 0602.4/ 2.648
เรียน ผอ.รพต. [redacted]
เพื่อโปรดทราบและกรุณาแจ้งผู้เกี่ยวข้องทราบ
เพื่อโปรดทราบและแจ้งผู้เกี่ยวข้องทราบ

เรียน ผู้อำนวยการโรงพยาบาลตากสิน
เพื่อโปรดทราบและเห็นควร
มอบให้ ฝ่ายวิชาการ
ดำเนินการต่อไป

- เห็นชอบ
- ดำเนินการตามเสนอ

(นายอดิศักดิ์ จินดนาดิลก)
หัวหน้าฝ่ายวิชาการ
โรงพยาบาลตากสิน
15 มี.ค. 2553

(นางสมพร [illegible])
หัวหน้าฝ่าย[illegible]
กองวิชาการ สำนักการแพทย์
รักษาการในตำแหน่งผู้อำนวยการกองวิชาการ
11 มี.ค. 2553

(นางสาวชูรีรัตน์ ปาลกะวงศ์ ณ อยุธยา)
เจ้าหน้าที่วิเคราะห์นโยบายและแผน 7
หัวหน้าฝ่ายบริหารงานทั่วไป โรงพยาบาลตากสิน
12 มี.ค. 2553

(นางกิตติยา ศรีเลิศฟ้า)
ผู้อำนวยการโรงพยาบาลตากสิน
12 มี.ค. 2553

(นางนันทวัน ธาตุรันต์ณิชย์)

17 มี.ค. 2553

No. ท. 40

Ethics Committee
For
Researches Involving Human Subjects, the Bangkok Metropolitan Administration

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Title of Project	:	Effect of Heartbeat Sound on Sleep Duration of Preterm Infants
Registered Number	:	023.53
Principal Investigator	:	Miss Somjit Wannakhow
Name of Institution	:	Tak Sin Hospital

The aforementioned project has been reviewed and approved by Ethics Committee for Researches Involving Human Subjects, based on the Declaration of Helsinki.

P. Saicheua .... Chairman
(Mr. Pirapong Saicheua)
Deputy Permanent Secretary for BMA

DATE OF APPROVAL ... 5 MAR 2010

BIOGRAPHY

NAME	Miss Somjit Wannakhow
DATE OF BIRTH	8 April 1972
PLACE OF BIRTH	Roi-et, Thailand
INSTITUTIONS ATTENDED	Kuakarun College of Nursing; 1991-1995 Bachelor of Nursing Science Mahidol University; 2008-2010: Master of Nursing Science (Pediatric Nursing)
RESEARCH GRANTS	This thesis is partially supported by Graduate Styudies of Mahidol University Alumni Association
POSITION & OFFICE	543 Taksin Hospital, Bangkok, Thailand Position: Registered Nurse