

**THE EFFECT OF MUSIC ON SLEEP-WAKE STATES  
OF PREMATURE INFANTS  
IN NEONATAL INTENSIVE CARE UNIT**

The seal of Mahidol University is a large, circular emblem in the background. It features a central golden crown-like symbol (Chakrasana) surrounded by a blue ring. The outermost ring contains the university's name in Thai script: "มหาวิทยาลัยมหิดล" (Mahavithayalai Mahidol) at the top and "วิทยาการสุขภาพ" (Faculty of Graduate Studies) at the bottom.

**TIPPAWAN SRICHALERM**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF NURSING SCIENCE  
(PEDIATRIC NURSING)  
FACULTY OF GRADUATE STUDIES  
MAHIDOL UNIVERSITY  
2010**

**COPYRIGHT OF MAHIDOL UNIVERSITY**

Copyright by Mahidol University

Thesis  
entitled  
**THE EFFECT OF MUSIC ON SLEEP-WAKE STATES  
OF PREMATURE INFANTS  
IN NEONATAL INTENSIVE CARE UNIT**

Tippawan Srichalerm

Miss.Tippawan Srichalerm  
Candidate

Tipawon Daram

Lect.Tipawan Daramas,  
Ph.D.  
Major-advisor

Srisamorn Phumonsakul

Asst.Prof.Srisamorn Phumonsakul,  
D.N.S.  
Co-advisor

B. Mahaisavariya

Prof.Banchong Mahaisavariya,  
M.D.  
Dean  
Faculty of Graduate Studies  
Mahidol University

Orasa Panpakdee

Assoc.Prof.Orasa Panpakdee,  
D.N.S.  
Program Director  
Master of Nursing Science  
Faculty of Medicine  
Ramathibodi Hospital  
Mahidol University

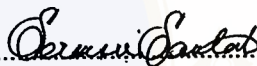
Thesis  
entitled  
**THE EFFECT OF MUSIC ON SLEEP-WAKE STATES  
OF PREMATURE INFANTS  
IN NEONATAL INTENSIVE CARE UNIT**

was submitted to the Faculty of Graduate Studies, Mahidol University  
for the degree of Master of Nursing Science (Pediatric Nursing)

on  
January 28, 2010



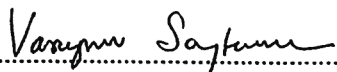
Miss.Tippawan Srichalerm  
Candidate



Lect.Sermsri Santati,  
Ph.D.  
Chair



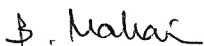
Lect.Tipawan Daramas,  
Ph.D.  
Member



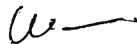
Lect.Varaporn Sangtawesin,  
M.D.  
Member



Asst.Prof.Srisamorn Phumonsakul,  
D.N.S.  
Member



Prof.Banchong Mahaisavariya,  
M.D.  
Dean  
Faculty of Graduate Studies  
Mahidol University



Prof.Winit Phuapradit,  
M.D.,Deputy Dean,  
Acting Dean  
Faculty of Medicine  
Ramathibodi Hospital  
Mahidol University

## ACKNOWLEDGEMENTS

This research could not have been successfully completed without the assistance of many persons. I would like to express sincere appreciation and gratitude to my major advisor, Dr. Tipawan Daramas and my co-advisor, Asst.Prof.Dr. Srisamorn Phumonsakul, for their kindness, encouragement, constructive guidance, and warmest support throughout this study. My gratitude is also extended to the thesis committee members, Dr. Sermsri Santati and Dr. Varaporn Sangtawesin for their valuable comments and supervision. In addition, I would like to thank Dr. Pharuhas Pongme, Dr. Prapaiporn Jongkongkiat, Miss Vimonwan Varolarn and Miss Sakultala Sudsaneha for their kindness in providing suggestions for improvement.

I would also like to thank all patients and parents who participated in my study. Additionally, I would like to express my sincerest thanks to the head nurse and all the staff members in Neonatal Intensive Care Unit (NICU) at Faculty of Medicine, Ramathibodi Hospital for their assistance and facilitation in data collection.

Finally, deepest thanks to Miss Sumoltip Sontimuang and Miss Ua-aree Wongsawat and my family for their warmth, encouragement, understanding, support, and assistance throughout the study.

Tippawan Srichalerm

# THE EFFECT OF MUSIC ON THE SLEEP-WAKE STATES OF PREMATURE INFANTS IN THE NEONATAL INTENSIVE CARE UNIT

TIPPAWAN SRICHALERM 4937035 RAPN/M

M.N.S (PEDIATRIC NURSING)

THESIS ADVISORY COMMITTEE: TIPAWAN DARAMAS, Ph.D., SRISAMORN PHUMONSAKUL, D.N.S.

## ABSTRACT

The present quasi-experimental research aimed at investigating the effects of music on the sleep-wake states of premature infants in the neonatal intensive care unit (NICU) based on Als' synactive theory of development. The study sample consisted of 20 premature infants with gestational age ranging from 28 to 36 months who were hospitalized in the NICU at Ramathibodi Hospital between August and October, 2009. The infants were selected using purposive sampling. Every premature infant was randomly selected to receive either the experimental condition - listening to music 30 minutes after vital signs were recorded, or the control condition - receiving routine nursing care conditions. Data were collected using the Anderson Behavioral State Scale (ABSS) which was translated into Thai and validated by Supreeda Kurdrit (2002). Demographic characteristics of the sample data were analyzed using descriptive statistics and sleep-wake states of premature infants data were analyzed by the Chi-square test, and the Wilcoxon signed rank test. The study findings showed that when premature infants listened to music at 5 and 30 minutes after vital signs were recorded, they slept longer and more deeply than when they did not listen to music with statistical significance at .01 and .001 levels, respectively. Based on these findings, it can be used as a guideline to promote sleep in premature infants in the NICU.

KEY WORDS: PREMATURE INFANTS/ SLEEP-WAKE STATES/ NICU/  
MUSIC

82 pages

ผลของดนตรีต่อภาวะหลับตื่นของทารกเกิดก่อนกำหนดในหอผู้ป่วยบำบัดวิกฤตทารกแรกเกิด  
THE EFFECT OF MUSIC ON SLEEP-WAKE STATES OF PREMATURE INFANTS IN  
NEONATAL INTENSIVE CARE UNIT

ทิพวัลย์ ศรีเฉลิม 4937035 RAPN/M

พย.ม. (การพยาบาลเด็ก)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: ทิพวัลย์ ดารามาศ, ประ.ด., ศรีสมร ภูมณสกุล, พย.ด.

บทคัดย่อ

การวิจัยนี้เป็นการวิจัยกึ่งทดลองเพื่อศึกษาผลของดนตรีต่อภาวะหลับตื่นของทารกเกิดก่อนกำหนดในหอผู้ป่วยบำบัดวิกฤตทารกแรกเกิด โดยใช้ Als's Synactive theory of development เป็นกรอบแนวคิด กลุ่มตัวอย่างเป็นทารกเกิดก่อนกำหนดที่มีอายุหลังปฏิสนธิ 28-36 สัปดาห์ และได้รับการรักษาในหอผู้ป่วยบำบัดวิกฤตทารกแรกเกิด โรงพยาบาลรามาธิบดี จังหวัดกรุงเทพมหานครฯ ระหว่างเดือนสิงหาคมถึงเดือนตุลาคม พ.ศ. 2552 เลือกกลุ่มตัวอย่างแบบเฉพาะเจาะจง จำนวน 20 ราย กลุ่มตัวอย่างถูกสุ่มทำการทดลอง 2 เหตุการณ์ คือ เหตุการณ์ทดลองทารกได้ฟังดนตรีหลังบันทึกสัญญาณชีพ 30 นาที และเหตุการณ์ควบคุม ทารกได้รับการพยาบาลตามปกติ รวบรวมข้อมูลโดยใช้แบบประเมิน The Anderson Behavioral State Scale (ABSS) ที่แปลเป็นภาษาไทยและทดสอบความตรงตามเนื้อหาโดย สุปรีดา เครือดิษฐ์ (2002) ประเมินการหลับตื่นโดยการถ่ายวิดีโอเพื่อให้ได้ภาพพฤติกรรมการหลับตื่นของทารก ข้อมูลทั่วไปวิเคราะห์โดยใช้ความถี่ ร้อยละ ค่าเฉลี่ย และค่าเบี่ยงเบนมาตรฐาน ส่วนข้อมูลการหลับตื่นของทารกวิเคราะห์ข้อมูลโดยใช้สถิติทดสอบ Chi-square และ สถิติ Wilcoxon Signed Ranks test ผลการศึกษา พบว่า ทารกเกิดก่อนกำหนดที่ได้ฟังดนตรีหลังบันทึกสัญญาณชีพที่นาที่ 5 และ นาที่ 30 มีระยะหลับมากกว่า และมีระดับการนอนหลับที่ลึกกว่าทารกเกิดก่อนกำหนดที่ไม่ได้ฟังดนตรีอย่างมีนัยสำคัญทางสถิติที่ระดับ .01 และ .001 ตามลำดับ ผลการศึกษานี้สามารถใช้เป็นแนวทางในการปฏิบัติการพยาบาลเพื่อส่งเสริมการนอนหลับในทารกเกิดก่อนกำหนดที่ได้รับการรักษาในหอผู้ป่วยบำบัดวิกฤตทารกแรกเกิด

## CONTENTS

|                                                                        | <b>Page</b> |
|------------------------------------------------------------------------|-------------|
| <b>ACKNOWLEDGEMENTS</b>                                                | <b>iii</b>  |
| <b>ABSTRACT (ENGLISH)</b>                                              | <b>iv</b>   |
| <b>ABSTRACT (THAI)</b>                                                 | <b>v</b>    |
| <b>LIST OF TABLES</b>                                                  | <b>viii</b> |
| <b>LIST OF FIGURE</b>                                                  | <b>ix</b>   |
| <b>CHAPTER I INTRODUCTION</b>                                          | <b>1</b>    |
| Background and Rationale                                               | 1           |
| Conceptual Framework                                                   | 4           |
| Research Question                                                      | 7           |
| Research Objective                                                     | 7           |
| Research Hypothesis                                                    | 7           |
| Scope of the Study                                                     | 7           |
| Definition of terms                                                    | 7           |
| <b>CHAPTER II LITERATURE REVIEW</b>                                    | <b>9</b>    |
| Premature infants                                                      | 9           |
| Assessment of behavioral sleep-wake states in premature infants        | 18          |
| Factors influencing sleep patterns of premature infants<br>in the NICU | 21          |
| Music for premature infants                                            | 25          |
| Effect of music in premature infants                                   | 28          |
| <b>CHAPTER III MATERIALS AND METHODS</b>                               | <b>31</b>   |
| Research Design                                                        | 31          |
| Populations and Sample                                                 | 31          |
| Research Setting                                                       | 32          |

## CONTENTS (cont.)

|                                                  | <b>Page</b> |
|--------------------------------------------------|-------------|
| <b>CHAPTER III MATERIALS AND METHODS (CONT.)</b> |             |
| Research Instruments                             | 32          |
| Protection of Human Subjects                     | 37          |
| Data collection                                  | 38          |
| Data analysis                                    | 42          |
| <b>CHAPTER IV RESULTS</b>                        | <b>43</b>   |
| <b>CHAPTER V DISCUSSION OF FINDINGS</b>          | <b>52</b>   |
| <b>CHAPTER VI CONCLUSION</b>                     | <b>58</b>   |
| <b>BIBLIOGRAPHY</b>                              | 62          |
| <b>APPENDIX</b>                                  | 69          |
| <b>BIOGRAPHY</b>                                 | 82          |

## LIST OF TABLES

| Table |                                                                                                                                                                     | Page |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1     | Demographic characteristic of the sample                                                                                                                            | 44   |
| 2     | Comparison of the mean scores of sound levels in the NICU between music administration and no music administration using t-test                                     | 45   |
| 3     | Comparison of the mean scores of light levels in the NICU between music administration and no music administration using t-test                                     | 46   |
| 4     | Comparison of sleep-wake states of the 20 infants between music administration and no music administration using Chi-square                                         | 47   |
| 5     | Comparison of median scores of sleep-wake states of the 20 preterm infants between music administration and no music administration using Wilcoxon Signed Rank Test | 50   |

## LIST OF FIGURES

| Table |                                                                                       | Page |
|-------|---------------------------------------------------------------------------------------|------|
| 1     | Conceptual Framework of the effect of music on sleep-wake states of premature Infants | 6    |
| 2     | Data collection procedures                                                            | 41   |
| 3     | The Observation record sheet                                                          | 75   |
| 4     | Anderson Behavioral State Scales: ABSS (Thai version)                                 | 76   |
| 5     | Assessment of premature infant handling (Thai version)                                | 77   |
| 6     | Histogram: Difference of sleep-wake score at immediately                              | 78   |
| 7     | Histogram: Difference of sleep-wake score at 5 minute                                 | 78   |
| 8     | Histogram: Difference of sleep-wake score at 30 minute                                | 79   |

## CHAPTER I

### INTRODUCTION

#### Background and Rationale

Current advances in medical and healthcare technology together with quality accreditation and high nursing standard for premature infants have increased the survival rates of premature infants. It was found in the United States of America that the birth rate of premature infants increased from 12.5% (525,000 cases/year) to 12.8% (543,000 cases/year) between 2004 and 2006 (Plains, 2007). There was no such report in Thailand, but the birth rate of infants weighing less than 2,500 grams increased from 8.53% to 8.99% during the years 2001-2003 (Ministry of Public Health, B.E. 2547). According to the survey of premature infants in Ramathibodi Hospital, it was found that the birth rate of premature infants increased from 10.92% in the year 2005 to 12.25% in 2007 (Medical Informatics, Ramathibodi Hospital, B.E. 2551).

Premature infants have high risks of having organ malfunction and developmental disorder because organ functions have not completely developed by the time they were born, particularly the central nervous system. In addition, premature infants need to stay in the Neonatal Intensive Care Unit (NICU) that is totally different from the womb environment. Fetuses in the womb float in the amniotic fluid, stay in a dark and quite environment, touch the uterine wall which is soft and bounded, and hear the sound of maternal heart beating and the intestine movement with no disturbing glare. Fetuses in the womb will be appropriately stimulated their senses resulting in their systematic and well-connected nerve cells (Bowden et al., 2000). On the other hand, the environment of NICU is brightened all day long without day and night recognition and filled with a lot of noises caused by the ventilator, pulse oximeter, and conversation between healthcare professionals. There are also provision of painful care such as suction, blood collection, and intravenous injection. A previous study has found that too much noise, glare, and touch would cause premature infants

to increase their heart rate, respiratory rate, and blood pressure. If such conditions are not treated immediately, apnea would be possible (Bremmer, Byers, & Kiehl, 2003), thus adversely affecting premature infants including brain abnormality, lack of intelligence, and lack of skills in using language, speaking, and learning in the long run (Symington & Pinelli, 2007).

As such, it is therefore important to enhance sleep of premature infants because they spend most of the time sleeping (80%) which will lead to their better growth and development. While they are sleeping, growth hormone will be released in order to enhance growth, increase protein level, and preserve energy. Furthermore, release of stress hormones such as cortisol and adrenaline will be stopped during the sleep state (Glass, 1994). According to a previous study, infants would decrease their facial expression and heart rate during sleep-rest states (Holsti, Grunau, Whifield, Oberlander, & Lindh, 2006) resulting in their proper weight increase, faster recovery, and satisfied development (Sizun & Westrup, 2004). Consequently, there have been some attempts to set up the environment for premature infants to make it similar to the womb environment as much as possible in order to enhance growth and development, reduce stress conditions, and encourage longer and more efficient sleep of premature infants as mentioned below.

Previous studies on the sleep enhancement of premature infants in NICU by means of setting up a quiet time had been conducted (Sakultala Sudsanaeha, B.E. 2548; Panita Nakklingul, B.E. 2546; Kurdrid, 2002; Strauch, Brandt, & Edwards-Beckett, 1993) based on the assumption that the quiet time could contribute to more efficient sleep-rest states of infants. It was found that the average scores of sleep-wake states of premature infants during the quiet time were lower than those of normal time with statistical significance ( $p < .001$ ). This meant that the premature infants had more deep sleep during the quiet time. Regarding a study of the effects of the sleep position on the sleep period of premature infants (Penjit Thanacharoenpipat, B.E. 2544), it was found that the average score of the deep sleep duration during the prone position was higher than those of the supine and lateral positions with statistical significance ( $p < .05$ ). In addition, Monterosso, Kristjanson, & Cole (2002) conducted a comprehensive literature review of neuromotor development and related physiologic effects of positioning in very low birth weight infants. One hundred and eighty theoretical

writings, research studies, and clinical papers related to neuromotor development, the physiologic effects of positioning, and interventions to minimize or prevent short-term and long-term effects of positioning in very low birth weight infants were reviewed. The findings have revealed that the development of posture and mobility in newborn infants requires an optimal balance between active and passive muscle tone, that the prone position is physiologically more beneficial for the premature infants than the supine and lateral positions, and that the prone position can lead to short-term and long-term postural and associated developmental problems. However, the current NICU dilemma is that the prone sleep position is contrary to the recommendation given by the American Academy of Pediatrics (AAP), which now supports supine positioning due to the fact that epidemiologic data have associated supine positioning with a lower rate of sudden infant death syndrome (SIDS). Corff and colleagues (1995) have documented that generalized motoric containment of an infant's arms and legs close to the infant's body while in a side-lying or supine position results in significantly lower mean heart rates, shorter mean crying and sleep disruption times, and fewer sleep-state changes after a painful heel stick procedure than without motoric containment (Lotas & Walden, 1996). Moreover, feeding times and hunger are known to have a great influence on the patterns of sleep and wakefulness in newborn infants. Quiet wakefulness is most often found after feeding (Karch et al., 1982) and skin-to-skin holding as a means of increasing stable infant sleep and rest is implemented (Smith, 2007).

In addition to the above studies, music is another approach that has been used to create relaxation, reduce anxiety, reduce pain, and enhance sleep (Sasitorn Phumdoung, B.E. 2548). When infants hear music similar to the womb effect, they are likely to feel safe and convenient as if they were in the womb. They tend to stop wriggling and crying as well. Thus, their muscles would be less tightened, and skeletal muscles would be relieved, leading to more efficient sleep-rest states. According to a study on the use of music with premature infants, infants are less painful (Bo & Callaghan, 2000; Butt & Kisilevsky, 2000), have a stable oxygen saturation (Collins & Kuck, 1991; Chou, Wang, Chen, & Pai, 2003), can be sufficiently breastfed, gain weight (Caine, 1991; Standley, 2003), have less tension, and have longer sleep duration (Lai et al., 2006).

The above studies on how to enhance efficient sleep of infants are still arguable in terms of practices. For example, the prone position could better contribute to sleep but it has caused more infant deaths for unknown reasons, so it is not recommended. Besides this, a peaceful environment is hard to set up in the NICU which involves complicated treatment and nursing activities. At Ramathibodi Hospital, there has already been an attempt to set up a quiet hour for infants in the NICU. Therefore, changing unpleasant noises into relaxing sound should be an alternative for environmental setup for premature infants. In this study, the researcher was interested in studying the effects of music on sleep-wake states of premature infants. It was anticipated that this approach could enhance the efficient sleep-rest states of premature infants leading to better growth and faster recovery.

### **Conceptual Framework of the Study**

In the present study, the Als's synactive theory of development (1982) was employed as the conceptual framework of the study. This theory indicates that premature infants need to adjust themselves to the environment outside the womb as their growth, physiology, and central nervous system have not yet completely developed. When infants are externally stimulated by noise, light, and medical treatment, they would respond to those stimuli by expressing behaviors or signals representing stress conditions. According to the synactive theory of development (1982), premature infants would react to the environment through their five subsystems namely (1) autonomic or physiologic subsystem—consisting of breathing pattern, heart rate, oxygen saturation, complexion change, and organ functions, such as darker complexion, decreased oxygen saturation, and increased or decreased heart rate; (2) motor subsystem—consisting of gesture, muscle tone, and body movement, such as flexed arms/legs/body, wrinkled face or forehead, stretched arms/legs/fingers, sticking tongue out, and clenched fist; (3) state-organization subsystem—consisting of sleep-wake patterns, including crying, vacant eyes, being nervous, being worried or scared, and having a frowned face; (4) attention-interaction subsystem—consisting of alertness, interest, or neglect of infants toward the environment, including scared face, yawning, hiccoughing, lack of eye contact, crying, and being nervous; and (5) self-regulatory subsystem—referring to infants' response to the stimulus through the autonomic or

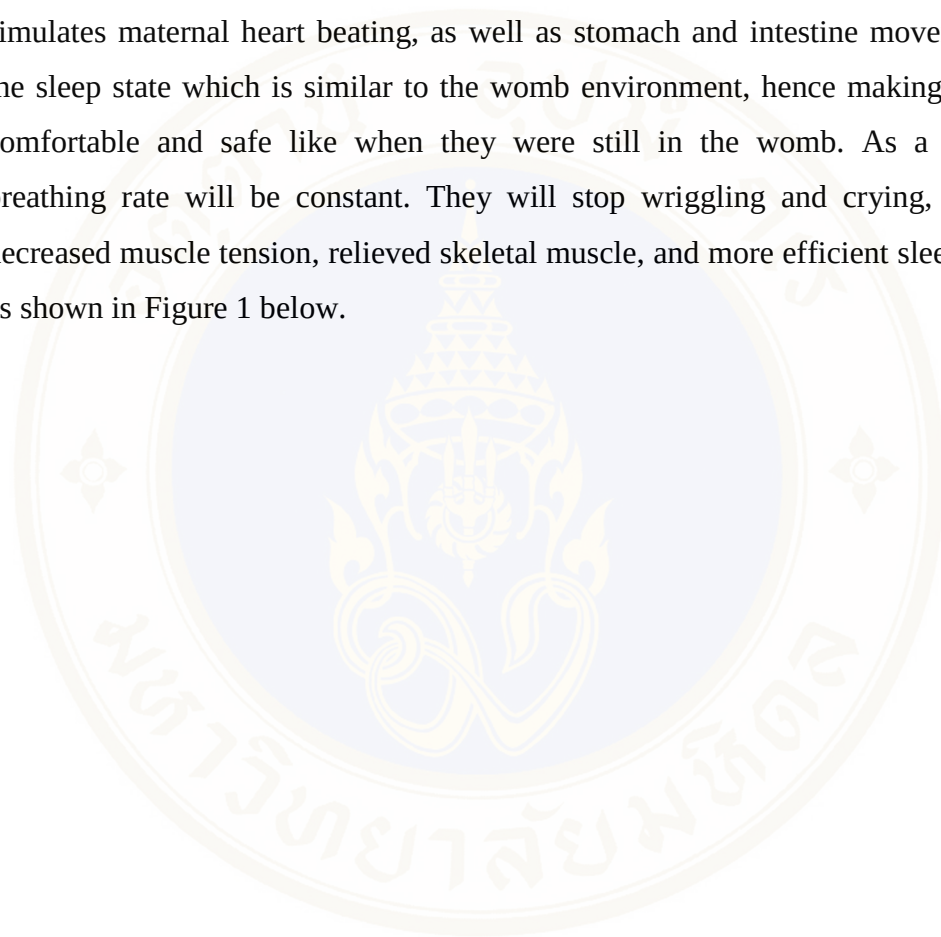
physiologic subsystem, motor subsystem, and state-organization subsystem as mentioned above. However, in general, infants are able to control or comfort themselves. They would suck their fingers, fold their arms/legs over the middle part of their body, lean their feet or back to the walls of the incubator, and place their hands near their mouth, thus leading to their balanced condition, namely normal heart rate, normal complexion, and relaxed feeling.

According to Als's synactive theory of development (Als, 1982), premature infants are delicate and presented changeable symptoms easily. Therefore, if the aforementioned subsystems change rapidly, these premature infants might have an all or nothing response. Each subsystem has intra-system and inter-system with continuous step by step development, relying on complete development of the previous system. Thus, each subsystem needs to be relevant. For example, when infants have good development of their autonomic or physiologic subsystem, they would be able to control their motor subsystem. Then, when infants have better development of their sleep-wake states, they would be able to be more responsive to caregivers or the environment. Subsystems of full-term infants would normally be able to work smoothly in harmony. As full-term infants have more complete development of their central nervous system than premature infants, they could control their balance more effectively. On the contrary, the subsystems of premature infants hardly work in harmony. In case of deficit of one subsystem, other subsystems' function would be affected. Therefore, the arrangement of the environment of the NICU for the least effects on subsystems of premature infants is necessary and important in order to contribute to better sleep-wake states of premature infants.

Relaxation music is seen as an alternative to create a desirable environment for premature infants in the NICU. This is because music affects the physical and psychological states of a person. It induces psychological and physiological relaxation responses by integrating function of the limbic-hypothalamic system that leads to a generalized decrease in central nervous system arousals. Musical sound takes place in the auditory cortex and is transmitted through the limbic system to the psychoneuro endocrine system of the hypothalamic-pituitary-adrenal axis, which stimulates secretion of endorphin, which functions like morphine and is important in pain reduction and relaxation (Well-Federman et al., 1995). Sound waves

of music are passed through the ear, a complicated structure to the auditory nerve to the thalamus which is linked to the cortex and limbic system and the auditory cortex which is a part of the cerebral cortex where perception occurs (Well-Federman et al., 1995).

A special kind of music is generally used for relaxation purposes. Music simulates maternal heart beating, as well as stomach and intestine movement during the sleep state which is similar to the womb environment, hence making infants feel comfortable and safe like when they were still in the womb. As a result, their breathing rate will be constant. They will stop wriggling and crying, resulting in decreased muscle tension, relieved skeletal muscle, and more efficient sleep-rest states as shown in Figure 1 below.



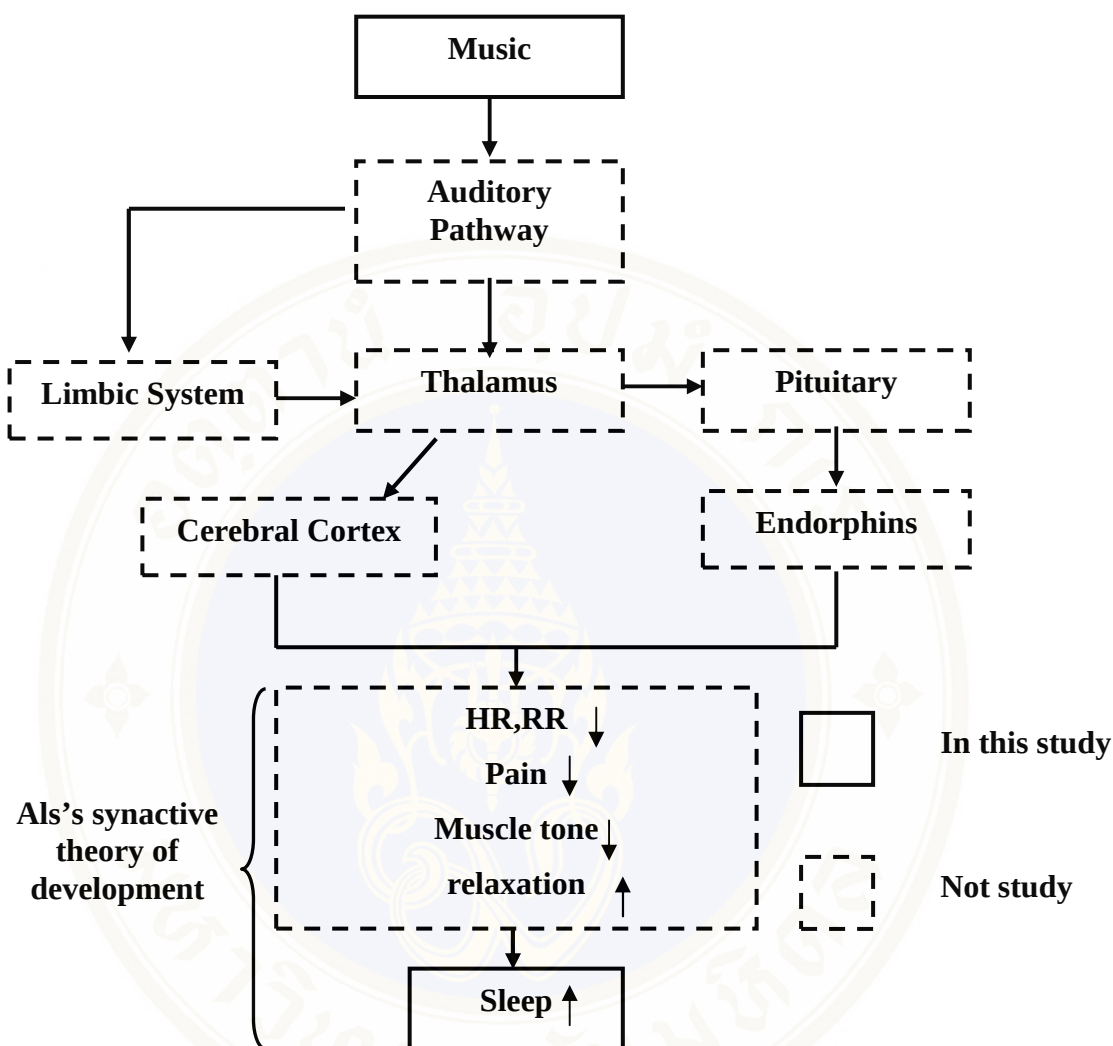


**Figure 1: Conceptual framework of the effects of music on sleep-wake states of Premature Infants**

## Research Question

Is the sleep-wake states of premature infants during music time different from their sleep-wake states during routine nursing care?

## Research Objective

To compare the effects of music on the sleep-wake states of premature infants during music time and during routine nursing care.

## Research Hypothesis

Premature infants receiving music would have more deep sleep state than premature infants receiving routine nursing care.

## Scope of the Study

This study was quasi-experimental research which aimed at investigating the effects of music on the sleep-wake states of premature infants between music administration and no music administration. The study sample was premature infants with their gestational age between 28 and 36 weeks who were admitted in the Neonatal Intensive Care Unit (NICU) of Ramathibodi Hospital.

## Expected Outcome

The findings of the present study can be used to develop a clinical nursing practice guideline on how to enhance sleep of premature infants in the NICU.

## Definition of Terms

**Music** means relaxing sound used for nursing practices in order to enhance the sleep state of premature infants by simulating the womb environment which is similar to the sound of maternal heart beating and stomach and intestine movement during the sleep state. This music created by William Lenihan (international composer/musician and Director of Music Studies at Washington University in St. Louis, Missouri, U.S.A.) and Jay Oliver (world-renowned pianist and composer/producer). The frequency of the music is low at a 58 dB sound level (AAP: Committee on Environmental Hazard, 1974) as measured by the sound level meter DS-40 model.

**Sleep-wake states of premature infants** refer to the level of alertness of premature infants which could be evaluated by facial expression and behaviors of premature infants. In this study, the sleep-wake states of premature infants were measured by Anderson Behavioral State Scale with sleep-wake states scores ranging from 1 point (regular quiet sleep) to 12 points (hard crying). As for scoring, the scores of 1 to 4 points represented behaviors of premature infants during the sleep state, the

score of 5 points represented behaviors of premature infants during the sleepy state, the scores of 6 to 9 points represented behaviors of premature infants during the awake state, and the scores of 10 to 12 points represented behaviors of premature infants during the crying state. Premature infants who fell into low state levels showed that they had a deeper sleep state.



## **CHAPTER II**

### **LITERATURE REVIEW**

The present research aimed at studying the effects of music on sleep-wake states of premature infants in the Neonatal Intensive Care Unit (NICU). The review of related literature covered the following topics: premature infants, sleep-wake states of premature infants, factors affecting sleep-wake states of premature infants, music for premature infants, and effects of music on sleep-wake states of premature infants.

#### **Premature infants**

Premature infants refer to infants who were born before 37 weeks or 259 days from the first day of the last menstruation period (American Academy of Pediatrics, 2000). Age estimation of premature infants consists of three components: gestational age counting weeks from conception to birth, chronological age counting weeks from birth to present, and post-conceptual age counting weeks from conception to present.

There are three groups of premature infants categorized by gestational age (Ballard et al., 1991) as described below:

1. Extremely premature infants mean infants aged between 24 and 30 weeks weighing 500-1,500 grams. Premature infants in this group have the most incomplete physical function and nervous system. In survival cases, their cerebral and neural pathology always remain problematic, especially for infants with less than 28 weeks of gestational age.

2. Moderately premature infants mean infants aged between 31 and 36 weeks weighing 1,500-2,000 grams or to a maximum of 2,500 grams. The infants in this group have incomplete physiology. Effective nursing care especially during the first few months can reduce the rate of mortality.

3. Slightly or borderline premature infants mean infants aged between 36 and 37 weeks weighing nearly 2,500 grams or above. The infants in this group have similar characteristics to full-term infants, so their survival rate is high.

Characteristics of premature infants depend on their gestational age. Low gestational age results in clearer characteristics of premature infants. General characteristics include a small, weak, and delicate body due to incomplete human system especially the central nervous system. Bad muscle flex and tension cause extremities to stretch out, weaken, bend slowly, or lack resistance when forcing to move. Sometimes they appear weary or twitch while moving. Breathing and heart rhythm is unstable. The head looks huge when compared to the chest. The skin is quite red and looks thin due to lack of subcutaneous fat, and veins can be clearly seen especially around the abdominal wall and head. Infants aged between 24 and 36 weeks are covered with white grease, whereas infants aged less than 25 weeks have no grease because it has not been produced yet. Soft hairs are widely spread around the back, forearms, forehead, and face side. In addition, anterior fontanel and posterior fontanel are small. Nipples and areolae are flat. Palm prints and footprints are not clear. Ears are flat, and no folds appear at the helix when folding them down. The helix is soft and remains folded or will gradually return to normal because ears do not have cartilage or only a little of it. As for female infants, large clitoris and labia minora cause labia majora to be unable to cover clitoris and labia minora wholly. As for male infants, testicle and scrotum are small, and the skin is smooth with little wrinkle (Pillitteri, 1999).

Due to incomplete organs as mentioned above, there are several problems with physical functions of premature infants which can possibly lead to a number of complications (Thrathip Kolatat, B.E. 2542; Blackburn & Loper, 1992) as follows:

1. Pulmonary system – Structure and function of the pulmonary system have not been completely developed. Alveolar ducts per lung are small. There is a lack of surfactant on the alveolar surface area. Surfactant is helpful for reducing surface tension and maintaining alveolar volume while exhaling without causing atelectasis. As for infants inside the womb, type II alveolar cells produce surfactant at the age of about 20 weeks, and gradually increase the production to the full extent at the age of 35 weeks. Therefore, when premature infants exhale, no air remains in

alveolar cells leading to atelectasis. Pulmonary ventilation and perfusion of alveolar cells lose balance leading to hypoxemia and insufficient oxygen in the body tissues. As a result, it is necessary to rescue breathing by using a breathing apparatus (Pimolrat Thaithumyanon, B.E. 2544).

2. Cardiovascular system – As blood volume per body weight of premature infants is quite high, compared to full-term infants (Premature infants have 100-110 cc./kg. body weight, whereas full-term infants have 85-100 cc./kg. body weight), they are unable to tolerate excessive blood volume, for example, late ligation of the umbilical cord after delivery would possibly cause infants to receive more cord blood by 10-25%. Meanwhile, cardiac muscle of premature infants do not completely function possibly leading to heart failure. Besides, premature infants have low blood pressure and low diffusion of blood and oxygen in tissue. Therefore, asphyxia increasingly causes insufficient blood and oxygen.

3. Thermoregulatory control – Premature infants have a rather high body surface area. Their thin skin and low subcutaneous fat cause the body to lose the heat easily. In addition, thermal energy inside the body could hardly be generated, so their body temperature easily becomes low (Veena Jirapaet, B.E. 2543).

4. Central nervous system – The following problems are generally found:

4.1. Low calcification of skull tissue and fragile capillaries increase the risk of cerebral hemorrhage.

4.2. Intraventricular hemorrhage (IVH) is often found in low-weight infants. Low gestational age increases the incidence of IVH. This incidence is mostly found on the fourth day after delivery. In case of vague symptoms, physical examination would not detect abnormality. In case of severe symptoms, premature infants would show paleness, shock, and seizure, and they may stop breathing and die within a short time.

4.3. Periodic breathing and apnea – The respiratory system of infants starts the operation at the age of 12-14 weeks. Contraction of the diaphragm begins at the age of 22 weeks, but effective respiration begins at the age of 27 weeks. Therefore, infants aged less than 28-30 weeks cannot control their respiratory system completely. As a consequence, periodic breathing and apnea are found. Such symptoms will improve when premature infants grow older.

4.4. Coordination of sucking and swallowing – Infants aged less than 34 weeks have ineffective coordination of sucking and swallowing, leading to low ability of sucking and high possibility of choking.

5. Gastrointestinal system – Gastrointestinal and digestive systems of premature infants have not been completely developed, so their digestion and metabolism are still ineffective. It is possible to have necrotizing enterocolitis caused by intestinal ischemia. Furthermore, intestinal mucosa of premature infants has not been developed completely. Lack of IgA secretion as well as several growing bacteria is mostly found after oral feeding (Sarayut Supapannachart, B.E. 2538).

6. Renal system – As renal arteries and renal function have not been developed completely, mineral absorption capacity is low. In case of excess water, water drainage capacity is also low leading to swollen body. Moreover, hydrogen atom emission is not good, resulting in metabolic acidosis (Prasin Chanvitan, B.E. 2548).

7. Hematology – As red blood cells have high fetal hemoglobin with high oxygen uptake but low tissue oxygen distribution, this results in insufficient oxygen in the tissues. Besides, the age of red blood cells is shorter. Hemolysis is found more than erythropoiesis leading to paleness and jaundice, and fragile capillaries. Clotting factors have not been completely developed resulting in bleeding disorders.

8. Metabolism – Low glycogen storage and insufficient nutrient intake but high demand of energy results in low blood sugar. Incomplete liver function might cause an elevated bilirubin level as well.

#### 9. Oxygen toxicity

Oxygen therapy might be toxic to premature infants as follows:

9.1. Retinopathy of prematurity (ROP) – ROP could occur from incomplete retina as well as hyperoxia. Patent ductus arteriosus and recurrent apnea also increasingly contribute to such incidence.

9.2. Bronchopulmonary dysplasia (BPD) – Pulmonary treatment for infants consisting of oxygen therapy and positive pressure of breathing apparatus, and complications of infectious pulmonary system result in chronic lung diseases (Sukanya Taksaphan, B.E. 2548).

10. Immunology – Immunology of premature infants are not completely developed, so they are more susceptible to infections.

11. Morbidity – Currently premature infants have a higher survival rate. However, some of survival infants have slow growth and development or became disabled due to their birth defects or complications of illness and treatment.

12. Psychological problems – Premature infants who are treated in the hospital for a long time would lack attachment to their parents, and both infants and their parents can become stressed. Infants are also likely to become abnormal and disabled. As a result, their parents might no longer need such infants or worry about their long-term care (Thrathip Kolatat, B.E. 2542).

### **Central nervous system development of premature infants**

Physical systems and growth of premature infants have not been fully developed. Their organ functions are not complete especially their central nervous system which is one of the most complicated systems and which takes quite a long time to develop. Central nervous system development is important to organ functions. The system controls muscle function and motility, sleep-wake states, and responses to the environmental stimuli, as well as self-adjustment. Central nervous system disorders are found in the womb, during delivery, or after delivery. Premature infants also have to change their environment from inside the womb to outside the womb. They need to stay in the incubator or in the NICU which is different from inside the womb of their mother (Blackburn, 1998). Such disorders would later affect survival, development, and intelligence of infants. Therefore, understanding of the central nervous system structure and function, starting from fetus to newborn infants, would help prevent risk of nervous system disorders in premature infants (Blackburn, 1993).

Central nervous system development from fetus to newborn infants could be divided into six stages. The first three stages are complete at the gestational age of 16 weeks. The last three stages would continue to develop until delivery and keep developing in adulthood. They are as follows (Nittaya Kotchabhakdi, B.E. 2543; Blackburn, 1993; Blackburn & Loper, 1992):

Stage 1 Dorsal induction – This stage starts when the fetus is 18-32 days old after conception. Development of bone structure of the nervous system includes the skull and backbone.

Stage 2 Ventral induction – The brain and ventricle are developed during the age of eight weeks. The highest development is found during the age of five to six weeks.

Stage 3 Neuronal proliferation – This stage is found during the age of eight to 16 weeks starting from proliferation of neuron and glial cells. Neuron and glial cells are generated around and below the ventricle called germinal. Several veins around the ventricle would enhance development of the neuron, and the blood flows most into this area. Thus, in this stage, premature infants can suffer from cerebral and intraventricular hemorrhage easily when they become stressed.

Stage 4 Migration – This stage is found during the age of 12-32 weeks. Millions of neuron and glial cells migrate from the germinal to the cerebral cortex and cerebellum. The migration starts during the age of 12-16 weeks, and develops quickly during the age of 20-24 weeks. The migration is complete during the age of 34-36 weeks.

Stage 5 Organization – This stage starts developing from the gestational age of 24 weeks to one year after delivery. This is a critical period which continues for several years until adulthood. There are five processes in this stage as follows (Als, 1982; Blackburn, 1998; Blackburn & Loper, 1992):

1. Architecture of layer
2. Sprouting of axon and dendrite
3. Synapse and synapse between neurons – Neuron and glial cells with nerve impulse transmission continuously develop. Protein and synapse are increasingly generated while learning. This process is the fundamental of learning and memory.
4. Excessive dendrite and synapse will be reduced. Unnecessary amount will be removed. About half of neurons are discarded. Excessive neuron removal contributes to suitable amount of neurons leading to effective neuron connection. This process is called brain plasticity.
5. Development of astrocytes – Astrocytes helps support central nervous system and provides nutrients for neurons. Oligodengogial cells generate myelin sheath at the age of about 30 weeks, and this continues until the age of two years.

Stage 6 Myelinization – Glial cells generate myelin sheath surrounding nerve bundles. This stage starts in the second quarter of pregnancy at the age of 20

weeks and continuously develops into adulthood. The highest development is found during the age of 32 weeks until one year.

### **Hearing development of infants**

During the age of 24 weeks, the auditory portion of the inner ear called cochlea is completely developed. Infants would start to hear the sound at the age of 25 weeks, and their hearing is stable from 28 weeks onward (Bilich, 2007). Suitable sound intensity level for infants is 58 dB (AAP: Committee on Environmental Hazard, 1974).

In the present research, the study subjects were premature infants aged between 28 and 36 weeks whose hearing system and auditory nerves have completely been developed.

### **Sleep-wake states in premature infants**

Sleep is a physical state of less movement and less perception on external environment. However, it is possible to awaken and recover consciousness within only a few minutes after being stimulated. Sleep is important to premature infants because their body will rebuild and repair damaged cells, preserve energy, and release growth hormone while they are sleeping (Spath-Schwalbe, Hundenborn, Kern, Fehm, & Born, 1995). According to the study of Ardura, Andress, Aldana, & Revilla (1995), it was found that premature infants would sleep longer than full-term infants during the first month after birth. Their average duration of sleep was 17.15 hours per day. Daytime sleep was 8.96 hours, and nighttime sleep was 8.19 hours. Moreover, full-term infants' sleep was 11.94-14.78 hours per day, and premature infants had more daytime sleep than full-term infants by 15%. Finally, the findings showed that sleep-wake states had relationships with maturity of cerebral cortex.

After birth, an infant exhibits alternating periods of sleeping and wakefulness. Sleep in neonates and infants is different from that of adults. As a result, sleep in infants is not well defined and definitions of sleep of infants are less precise than in adults. Consequently, neonatal and infant sleep is described in terms of state, which is a group of physiologic and behavioral characteristics that regularly recur together (Blackburn, 1982 cited in Blackburn & Loper, 1992). In other words, sleeping and waking states are clusters of behaviors that tend to occur together and represent

the level of arousal of the individual, the individual's responsiveness to external stimulation, and the underlying activation of the CNS (Holditch-Davis, 1998).

Three states have been identified in adults: awake, non-REM (rapid eye movement) sleep, and REM sleep. In infants, it is also possible to identify states during wakefulness and states that are transitional between waking and sleeping, because infants are less able to make rapid changes between states than are adults. Because the electrophysiological patterns associated with sleeping and waking states in infants are somewhat different from those in adults (Anders et al., 1971 cited in Holditch-Davis, 1998), the sleep states are usually designated as active and quiet sleep, rather than REM or non-REM sleep.

The major difference between conventional definitions of sleep-wake states of infants is the number of types of states and therefore the specificity and precision of the various states. Generally, the more immature neonate according to gestational and postconceptional age, the grosser or less precise the definitions of state and consistency among indicators. Six categories of behavioral states have been described, which include non-REM or quiet or deep sleep, REM or active or light sleep, drowsy, awake or quiet alert, active alert or considerable motor activity, and crying. They are explained as follows:

1. Quiet (non-REM) sleep is deep, restful sleep with the eyes closed, little body or facial movement, except for an occasional startle or twitch, regular respiration and heart rate, and no movement of the eyes. Quiet sleep is restorative and anabolic. An increase in cell mitosis and replication occurs during this stage. Oxygen consumption reaches the lowest levels during quiet sleep; that is, oxygenation is higher during this sleep state. Thus, quiet sleep may be beneficial for infants with respiratory problems.

2. Active (REM) sleep is a stage during which the eyes are closed, but there are movements of the extremities and face, mouthing, grimacing, and sucking movements. Respiration and heart rate are irregular. Active bouts of REM occur in association with dreaming; the fine, rapid movement of the eyes can be observed beneath the lid. Information is processed during active sleep and entered to memory; thus, active sleep has been linked to learning and restructuring of synapses and changes in protein synthesis which increase during active sleep. However, respiratory

patterns are relatively unstable in active sleep, and transcutaneous oxygen values are lower and more variable.

3. Drowsy state is the stage during which the neonate or infant seems partially awake and partially asleep. Drowsiness usually indicates a state transition between awake and sleep states.

4. Quiet alert is a stage during which the neonate or infant is awake, the eyes are open, and there is little motor movement. The neonate or infant is alert and shows interest or attention by focusing on visual stimulation. The quiet alert state is sometimes referred to as awake alert, emphasizing the limited motion and activity associated with the infant attending to sensory information.

5. Active alert is a stage during which the neonate or infant's motor activity escalates in the active awake state. The eyes may have a hyper alert appearance. There may be spitting up or hiccoughing. Respiration often becomes increased and irregular, and skin color changes may occur. The active alert state often precedes crying.

6. Crying. In healthy infants crying is easily recognizable. Crying behaviors include closed eyes with facial characteristics and the vocalization of cry sounds. In premature infants the motor actions associated with cry sounds are evident, but because of the infants' immaturity and weakness, the sounds may not be produced.

The ability to clearly differentiate these states is dependent on the premature infants' postconceptional age. The proportion of time spent in each of these states also varies with postconceptional age. The mean duration and frequency of episodes of each state also changes over the premature period: quiet waking, active waking, and sleep-wake transition episodes occur more frequently, and active waking and quiet sleep bout length increases over age (Brazelton, 1999; Holditch-Davis, 1998; Reid & Freer, 2000; Wolff, 1996 cited in Blackburn & Loper, 1992)

As premature infants really need to have sleep-rest states and are sensitive to environmental stimuli, they are unable to have long and efficient sleep-rest states. That badly affects premature infants. Therefore, the researcher was interested in studying how to enhance sleep-rest states of premature infants in the NICU in order to encourage premature infants to have sleep-rest states more efficiently, resulting in more efficient energy preservation for their growth and faster recovery.

## **Assessment of behavioral sleep-wake states in premature infants**

In adults, sleeping and waking states are usually scored by electroencephalography (EEG). However, because of the neurological immaturity of infants, EEG is less reliable and needs to be combined with observation. When EEG and behavioral scoring of states in premature infants are compared, there is a high degree of agreement (Sahni et al., 1995 cited in Holditch-Davis, 1998). Thus, sleeping and waking states in a newborn infant, whether full-term or premature, can be validly scored by directly observing the infant and identifying global categories that are made up of a number of specific behaviors that tend to occur together and reflect a similar level of arousal and responsiveness to the environment (Holditch-Davis, 1998). Variables observed when studying the sleep patterns of infants include facial and body movement, respiratory patterns, heart rate, and electro-oculogram (EOG) (Kick, 1996).

Currently, there are five standardized systems for scoring behavioral observations of neonatal sleep-wake states. These systems define states in very similar ways and are probably equally useful for clinical purposes with eye openness, rapid eye movement, face movement, body movement, muscle tension, regularity of respiration, and vocalization being the criteria used. These systems were developed by Brazelton (1984), Als (1982), Anderson (Gill, Behnke, Conlon, McNeely, & Anderson, 1988), Thoman (1990), and Reid (2000). Measurement of sleep-wake states in the newborn can be described as follows (Blackburn & Vandenberg, 1998; Brazelton, 1999; Chang, Anderson, & Lin, 2002; Creger, 1993; Holditch-Davis, 1998; Reid & Freer, 2000):

### **The revised Neonatal Behavioral Assessment Scale**

T. Berry Brazelton revised the Neonatal Behavioral Assessment Scale (NBAS) in 1984. He developed his first state scoring system in 1973. The NBAS is used to measure the coping capacities and the adaptive strategies of full-term healthy infants with gestational age ranging from 36 to 44 week that emerge during recovery from the stresses of labor and delivery and adjustment to demands of the extra-uterine environment. This scale consists of six states: quiet sleep, active sleep with rapid eye movement, drowsy, alert inactivity, fussing, and crying. One advantage of the scale is that it is easy to learn because the differences between the states are fairly obvious and there are only six states; therefore, it has been widely used in research and clinical

practice. However, owing to the small number of states described, it is not always sensitive enough to identify indeterminate and transitory qualities of premature infants' behavioral states.

### **The Assessment of Premature Infants' Behavior**

The Assessment of Premature Infants' Behavior (APIB) was developed by Heidelise Als in 1982. The APIB was a modification of the original NBAS (Brazelton, 1973) that was based on the synactive theory of development. Recently, it has become a component of the neonatal individualized developmental care and assessment program (NIDCAP). It is used to determine organization of the CNS and how infants cope with the intense environment of the NICU. It is particularly useful for the premature and full-term high risk infants from birth to 44 weeks' postconceptual age. The state scale from the NBAS has been expanded into a 13-state system by subdividing each of the six states so that the immature and unclear sleeping and waking states of premature infants can be more adequately described. This scale consists of 13 states: very still deep sleep, deep sleep, light sleep, noisy light sleep, drowsy with more activity, drowsy, awake and quiet, hyper alert, bright alert, active, considerable activity, crying, and lusty crying. The advantage of this system is that it also assesses autonomic and motor function as part of a holistic assessment and care-planning program, where state functioning is an important consideration. However, a 13-state system is difficult to assess because of the subtle definitions described; consequently, training and supervision in its use are essential.

### **The Anderson Behavioral State Scale**

The Anderson Behavioral State Scale (ABSS) was developed by Gene Cranston Anderson. She developed a 12 categorical states scale from Parmelee and Stern (1972) to be used with premature infants based on her own observations of these infants and on the work of Parmelee and Stern. The ABSS used to determine the behavioral state of an infant by noting his/her respiratory regularity, eye movement, degree of limb and trunk involvement, activity, and intensity of crying. This scale consists of 12 states: regular quiet sleep, irregular quiet sleep, active sleep, very active sleep, drowsy, quiet alert awake, quiet awake, active awake, very active awake, fussing, crying, and hard crying, which can also be collapsed when an investigator does not need such fine discrimination. It is worth noting that the ABSS is difficult to

learn because of the complexity of 12 states and it emphasizes quantitative differences among the states which is a different theoretical basis from the other state scoring systems that differentiate among states based on qualitatively different aspects of the infants' behavior. However, Anderson has recently emphasized qualitative differences between states and its inter-rater reliability has increased. Also, the scale was originally designed for use with premature infants and can be used in the infants with postconceptual age of at least 26 weeks.

### **The Thoman's Revised State Scoring System**

The Thoman's Revised State Scoring System was developed by Evelyn B. Thoman in 1990. She developed her first state scoring system in 1975 based on the work of Woff (1966) and Korner (1972). This state scoring system consists of ten states: quiet sleep, active-quiet transitional sleep, active sleep, sleep-wake transition, drowsy, daze, alert, non-alert waking, fuss, and crying. These states can be combined when an investigator does not need such fine discriminations. The sleeping and waking states are differentiated enough that they can be used with premature infants to infants older than one month after term who have perinatal complications. The scale has been shown to have predictive validity with later developmental outcome. Also, it is more sensitive and has inter-rater and test-retest reliability when used with premature infants. However, this system is more difficult to learn, and training is not always readily available.

### **The Modified Sleep-Wake Assessment**

The Modified Sleep-Wake Assessment was developed by Tilly Reid (formerly Padden) in 2000. This modified sleep-wake assessment consists of nine states: very quiet sleep, quiet sleep, restless sleep, drowsy, quiet awake, restless awake, hyper alert, fussing, and crying. This scale can be readily utilized in general practice with minimal training and supervision. It has practical validity and 85% inter-rater reliability with experienced nurses in three units. Furthermore, it has been shown to be a useful instrument in supporting the change process and promoting developmentally focused care in seconding units. However, it is less sensitive than other sleep-wake assessments of premature infants. In addition, as this scale is the newest tool, no research report on the use of this scale has been published.

For this research, the researcher used the Anderson Behavioral State Scale (ABSS) to assess sleep-wake states in premature infants because the study sample consisted of premature infants aged between 28 and 36 weeks. Moreover, the ABSS is rather up-to-date, and it easy to use to assess sleep-wake states in premature infants. It has been used as a research tool in a previous research study that investigated the effects of peaceful hours on sleep-wake states in premature infants in the Neonatal Intensive Care Unit (Sudsaneha, 2005), a study on relationships between behavioral patterns and responsiveness to pain in premature infants during treatment in the Neonatal Intensive Care Unit (Ahn, 2006), and a study on sucking behaviors in premature infants with different gestational age (Medoff-Cooper, Bilker, & Kaplan, 2001). It has been proven that the Anderson Behavioral State Scale has content and construct validity with interrater reliability ranging from 0.85 to 0.95 (Chang, Anderson, & Lin, 2002; Kurdrit, 2002; Zahr, 1998).

Therefore, the researcher decided to use the Anderson Behavioral State Scale to assess sleep-wake states in premature infants in this research.

### **Factors affecting sleep-wake states in premature infants**

Premature infants' neurological and sensory systems are likely to be stimulated from the environmental lights, noises, and touches in the NICU. When premature infants receive too much or unsuitable stimulation, they will become awoken and may develop stress as they still have very low tolerance to stimuli. Their physiological conditions will change, and it will be expressed through their behaviors which can be divided into five subsystems according to the synactive theory of development proposed by Als (1982) as follows:

**1. The autonomic system** refers to physiological function and is related to the care of infant function. This subsystem is observable in the infants' color, respiratory function, and visceral functions, such as vomiting, gagging and hiccups (Peter, 2001).

Premature infants respond to environment stress with a wide variation in physiologic changes; for instance, the infants' heart rate and respiratory rate change, oxygen saturation drops, and their color changes from pink to gray. If premature

infants are able to maintain autonomic stability in response to stimuli, their heart rate and respiratory rate remain stable and pink color stays over the infants' entire body.

**2. The motor system** includes posture, tone and activity of the trunk, extremities, and face. The infants' active movements can contribute to instability in the autonomic system.

The younger the infants' gestational age, the less control they exert over purposeless movement. When environment changes are perceived by the infants, overreaction of gross motor movements may occur, with arm flailing, leg extension, chest heaving, and the turning of the head from side-to-side.

**3. The state organization system** includes the range of states available to the infants, the transitions from one state to another, and the clearness and differentiation of states.

The concept of state organization is vital to the understanding of stress responses in premature infants and to correct interpretation of their behavior cues, as infants who are disorganized exhibit frequent and rapid changes in their state (Modrcin-McCarthy, McCue & Walker, 1997).

**4. The attention and Interaction system** includes the infants' ability to assume and maintain an alert state, and take in and respond appropriately to environmental input, including social cognitive and emotional input.

Interactional organized infants will respond to maternal input and presence in such a way as to encourage additional interaction without giving distress cues. However, these organized interactions are rare in infants younger than 40 weeks post-conceptional age (Ludington-Hoc & Swinth, 1996).

**5. The self-regulatory system** is the last system associated with the infants' ability to achieve and maintain a balance of all subsystems through self-consoling behavior, such as sucking or hand-to-mouth maneuvers. If the infants lack a self-regulatory capacity, they are not able to return to integrated subsystem functioning. Thus, if they are confronted with environmental demands, maladaptive behavior may result.

Premature infants (babies born before 37 weeks) can develop a range of problems because their organs are not mature. There is concern that an unfavorable

environment in the NICU can add to these problems and negatively affect the infants' growth, with the brain being particularly vulnerable (Symington & Pinelli, 2007).

Sources of stress in the NICU include medical and surgical procedures, pain, pathologic processes, caregiver interventions, and the physical environment, especially sound and light. Both medical/surgical interventions and pathologic processes can result in pain and place additional burdens on the infants' fragile resources and available energy. Neonatal stress leads to energy expenditure.

The environment is a potent source of stress for infants in the NICU. The rationale underlying neonatal intensive care is modification of the extra-uterine environment to meet infants' needs. Ideally the NICU environment should meet the infants' physiologic or neurobehavioral needs, provide a supportive milieu in which the infant can respond without undue stress, support the infants' emerging organization, and foster growth and development (Blackburn & VandenBerg, 1993 cited by Blackburn, 1998). This can be accomplished via modification of both the physical environment (light, noise) and caregiving interventions (handling, positioning, and organization of care).

### **Sounds in the NICU**

According to the study on sound level in the NICU, it was found that the average sound level in the NICU ranged from 50 to 80 dB (in the incubator). It was a low frequency sound remaining constant throughout day and night. The sound level became higher during crises when infants who were in a coma required cardiopulmonary resuscitation (Klaus & Fanaroff, 2001). According to AAP: Committee on Environmental Hazard (1974), the suitable intensity level for infants (in the incubator) should not exceed 58 dB.

Kenner and Lott (2003) studied sound level of several activities in the NICU and revealed some activities which caused sound level to exceed 58 dB as follows:

| <b>Activities in NICU</b> | <b>dB</b>       |
|---------------------------|-----------------|
| Phone ring                | 80              |
| Pulse oximeter alarm      | 70 (within 1 m) |
| Incubator door closure    | 100-135         |

| <b>Activities in NICU</b>               | <b>dB</b> |
|-----------------------------------------|-----------|
| Water in breathing apparatus            | 62-87     |
| Tapping fingers on the incubator        | 80        |
| Conversation of officers (normal level) | 60        |

According to the above study, it was found that most activities in the NICU produced excessive sound. In general, excessive sound could destroy hearing structure of infants causing them to change their physiology such as increased heart rate, increased respiratory rate, and increased blood pressure. Besides, it also leads to increased intracranial pressure and decreased oxygen saturation (Bremmer, Byers, & Kiehl, 2003). As for behavioral changes, infants would become anxious, cry, and feel uncomfortable. Their interaction with other people decreases. Moreover, the sound would disturb infants' sleep and possibly affect infants' growth, recovery, hearing, and further development.

#### **Light in the NICU**

Light in the NICU might be harmful to premature infants. It is not clear how intense light is harmful to infants in the long term, but it is assumed that light regularly entering the eye might destroy developing eye structure leading to retinopathy of prematurity. Some studies have reported evidence of the effect of light in the NICU on infants. For example, Mann et al. (1986) studied 41 premature infants for 19 days. The sample were divided into 21 subjects in the control group staying in the normal NICU, and 20 subjects in the experimental group staying in the NICU with dimmed lights from 7:00 p.m. until 7:00 a.m. the next day. After discharging them from the hospital to home, the researcher assessed infants aged six and 12 weeks and found that those in the experimental group gained weight and had better sleep/milk drinking period than those in the control group with statistical significance ( $p < .02$ ). Similarly, Brandon, Holditch-Davis, and Belyea (2002) studied the effects of cycled lighting on premature infants aged from 32 weeks to 36 weeks and found that those in the experimental group gained more weight than those in the control group with statistical significance ( $p < .05$ ).

According to the past studies and the assumption of experts, it can be concluded that intense light might be harmful to premature infants. Reduced light in

the NICU is beneficial to infants, including increased sleep period, increased body weight, growth contribution, and faster recovery.

### **Tactile stimulation**

Infants would mostly sleep inside the womb, so premature infants outside the womb are not ready for regular touch. Therefore, even tactile stimulation for social interaction would not be helpful for low-weight infants. Conversely, it causes infants to become stressed.

In one study on infant touch in the NICU, 44 times/day of infant touch were found (Jariya Intapun, B.E. 2544), and they were mostly related to medical treatment. Too frequent touch or inappropriate touch causes infants to become stressed, and changes their physiology and behaviors such as increased heart rate and respiratory rate, decreased oxygen saturation, apnea, increased blood pressure and intracranial pressure, crying, increased anxiety, reduced sleep time, and reduced body weight or stable body weight, hence affecting their growth and further development.

Previous studies have shown that infants in the NICU have the risk of being excessively stimulated because the NICU environment consists of light, sound, and painful stimulation. As a result, infants become stressful, change sleep-wake states rapidly, and lack an efficient sleep leading to slow growth and development. Therefore, the researcher was interested in studying how to set up an appropriate environment for premature infants similar to the womb environment in order to enhance more efficient sleep-wake states in premature infants.

### **Music for premature infants**

Music is the organized compositions of sound with clear pattern and structure. It can be utilized for three main purposes, namely recreation, therapy, and education (Thaweesak Siriratrakha, B.E. 2550).

Music affects physical and psychological changes, as well as several aspects of brain functions, as described below:

Music causes changes of respiratory rate, pulse rate, blood pressure, reaction of the iris, muscle tone, and blood circulation (Guzzetta, 1989).

Regarding the effects of music on psychological and brain functions, it could cause changes of emotion, consciousness, imagination, awareness, and nonverbal communication (Kemper, 2005).

**Compositions of music** include the following:

1. Rhythm means the relative duration of sounds measured in beats per minute. Rhythm is the crucial and the first composition of music (White, 2000). Rhythm contributes to concentration and relaxation (Chlan, 1998).

2. Pitch means the frequency of a sound measured in cycles per second (Hertz) (Chlan & Tracy, 1999). High frequency sound is high-pitched sound; low frequency sound is low-pitched sound. Pitch causes the same feelings as rhythm. Low and medium-pitched sounds lead to tranquility (White, 2000).

3. Volume/Intensity means intensity levels of sound measured in decibels (dB). It has been found that soft volume causes happiness and relaxation, whereas loud volume would cause tight and twitched muscles. Appropriate volume would contribute to self-control, tranquility, and concentration (Thaweesak Siriratrakha, B.E. 2550).

4. Melody of music is due to the sequence of musical pitch and interval between musical tones (Politoski, 1999). Melody helps release deep emotions, motivate creativity, and reduce anxiety.

5. Harmony means the harmonization of various sounds accompanied with rhythm and melody that add special dimension to deeper music. Harmony helps measure emotion through observing reactions after listening to harmonized songs (Kemper, 2005).

**Style of music**

1. Baroque music extended from 1600-1750 (Isaacs & Martin cited in Sasitorn Phumdoung, B.E. 2548). Main musical instruments include the organ and harpsichord. The pattern is not specific. It sounds natural. The rhythm is slower than the normal heart rate. It presents tonal balance of dissonance (unstable tone) and consonance (stable tone combination) as well as a variety of tone endings, timbres or tone colors, and intensity (Mornhinweg, 1992).

2. Classical music extended from 1770-1830 in Vienna Musical School. Besides, classical music includes music composed by Hayden, Mozart, and Beethoven

at the early stage. The pattern is specific with tonal balance. Classical music has no interval and it is a popular musical style (Mornhinweg, 1992).

3. New Age music was originally designed to promote health. It is believed that music influences individual emotion. This musical style was developed in 1960 in order to support surgery and reduce tension in daily life. It sounds plain and beautiful, and it could create a relaxing atmosphere and concentration (Mornhinweg, 1992).

#### **Types of music** (Sasitorn Phumdoung, B.E. 2548)

Live music means live music performance before an audience.

Tape recording means music recorded on mechanical devices.

An international research on the effects of music therapy on premature infants conducted by Arnon et al. (2006) studied and made a comparison among live music, tape or CD recording, and non-music therapy for newborn infants in the NICU. It has revealed that after listening to music for 30 minutes, live music could reduce heart rate of infants more than tape or CD recording and non-music therapy with statistical significance at 0.001. However, another study has shown that tape or CD recording contributed to increased oxygen saturation (Chou, Wang, Chen, & Pai, 2003), leading to decreased responses to environment (Collins & Kuck, 1991).

According to the above studies, it can be concluded that live music and tape or CD recording would reduce infants' responses to the environment. Nevertheless, live music is difficult, complicated, and its intensity level is hard to control. It is not convenient to use this type of music in limited space of the NICU of Ramathibodi Hospital. Therefore, the researcher chose to use tape or CD recording with intensity level of 58 dB which was suitable for premature infants as recommended by AAP: Committee on Environmental Hazard (1974) to enhance sleep of premature infants in the NICU in this study.

#### **Style of music for premature infants**

Research on style of music therapy for premature infants by Flowers, McCain, & Hilker (1999) aimed at comparing music therapy for premature infants between soft-rock ballads and music combined with uterine sounds (classical & new age). Infants would listen to each style of music for 20 minutes. The findings revealed that infants who listened to music combined with uterine sounds had decreased

respiratory rate, stable blood oxygen, and longer sleep time than those who listened to soft-rock ballads with statistical significance.

For this research, the researcher used music therapy called SoundSleep for Babies which was classical & new age style composed by William Lenihan (international composer/musician and Director of Music Studies at Washington University in St. Louis) and Jay Oliver (world-renowned pianist and composer/producer). This music was specially designed to enhance sleep of newborn infants based on Womb Effect. The music simulates the environment inside the womb while sleeping which is the appropriate environment for premature infants. Therefore, the researcher was interested in using SoundSleep for Babies to enhance sleep of premature infants (aged between 28 and 36 weeks) in the NICU. While listening to the music, infants had to stay in a peaceful room or during a peaceful hour. Infants would be allowed to listen to the music for about 20-30 minutes (Standley, 2002). The intensity level had to comply with the recommendation of AAP: Committee on Environmental Hazard.

For this research, the researcher would let premature infants (aged between 28 and 36 weeks) listen to the music after monitoring their vital signs because least medical and nursing activities were done at that time, and it was considered a peaceful time. Infants would be able to fully listen to the music for 30 minutes in order to achieve most effective outcomes.

## **Effects of music on premature infants**

There are some studies that have been carried out on music therapy for premature infants with different results as described below:

### **Effects of music on pain reduction**

Bo & Callaghan (2000) studied the effects of music therapy, dummy, and music therapy and dummy on responses to pain during heel prick in 27 premature and full-term infants aged between 30 and 41 weeks. The findings revealed that music therapy, dummy, and music therapy and dummy during heel prick could reduce infants' responses to pain with statistical significance at 0.001. Music could most reduce heart rate, and music therapy and dummy could most increase oxygen saturation. Similarly, Butt & Kisilevsky (2000) studied the effects of music therapy on

discomfort in 14 premature infants aged 28-34 weeks after heel prick for ten minutes. It was found that infants who listened to music after heel prick for ten minutes would have decreased heart rate, increased oxygen saturation, and reduced painful facial expression with statistical significance at 0.01.

### **Effects of music on blood oxygen**

Collins and Kuck (1991) studied the effects of music on 17 premature infants in the NICU. During the experimental event, infants would listen to music which was similar to the sound inside the womb mixed with lullaby songs. The findings revealed that infants who listened to music had higher blood oxygen and less behavioral expressions than those who did not listen to music with statistical significance. Similarly, Chou, Wang, Chen, & Pai (2003) studied the effects of music on blood oxygen in 30 premature infants aged between 28 and 36 weeks during tracheal suction. Each infant was randomly chosen to be in the experimental event and the control event. During treatment in the experimental event, infants listened to music called Transition continuously for 30 minutes. The findings revealed that infants in the experimental event had higher blood oxygen than those in the control event with statistical significance at  $p < .01$ .

### **Effects of music on sucking and swallowing and body weight gain**

Caine (1991) studied the effects of music on nutrient intake, body weight gain, and hospital stay period of 52 premature infants. There were the experimental group and the control group, with 26 infants assigned to each group. Infants in the experimental group would listen to music three times per day and 30 minutes per time throughout their stay in the hospital. The findings indicated that infants in the experimental group had better nutrient intake, gained more body weight, and had shorter hospital stay period than those in the control group with statistical significance. In addition, Standley (2003) studied the effects of music on sucking and swallowing skills of premature infants. The samples were 32 premature infants aged less than 34 weeks who had been fed by tube and had sucking and swallowing difficulties. There were the experimental group and the control group with 16 infants in each group. Infants in the experimental group listened to music for 15 minutes before and after feeding. The findings revealed that infants who listened to music had better sucking skill and behavior than those in the control group with statistical significance.

### **Effects of music on stress reduction and sleep enhancement**

Lai et al. (2006) studied the effects of music during kangaroo care on mothers' stress and premature infants' responses. The samples were 30 pairs of mothers of premature infants aged less than 37 weeks. There were the experimental group and the control group with 15 pairs of mothers and premature infants in each group. During kangaroo care, the experimental group listened to music therapy namely lullaby songs chosen by mothers for 60 minutes. The findings revealed that mothers and infants who listened to music would have lower stress level than those in the control with statistical significance at  $p < .01$ . Furthermore, infants in the experimental group had less behavioral responses and deeper sleep states than those in the control group with statistical significance at  $p < .05$ .

Based on findings of previous studies, it can be concluded that music is very useful for various utilizations. It can enhance physical, psychological, emotional, and social well-being as well as contribute to good quality of life when it is integrated into other treatments in order to achieve most effective results. As sleep is one of the fundamental human factors, infants' effective sleep would enable their body to increasingly preserve energy for their growth and faster recovery. It has been found that music therapy could help premature infants relax and make them sleep longer and more effectively. Therefore, the researcher was interested in studying the effects of music on sleep-wake states in premature infants in the NICU by using SoundSleep for Babies which was classical & new age style composed by William Lenihan and Jay Oliver. This music was specially designed to enhance sleep of newborn infants based on Womb Effect. The music simulated the environment inside the womb while sleeping which was an appropriate environment for premature infants. In 2003, Dr. Noboru Kobayashi (the Director of Child Research Net citing a study conducted 30 years ago in the United States) applied such music to newborn infants. It was found that infants could have longer and more efficient sleep. The longitudinal study revealed that these infants gained more weight than those who did not listen to music.

Due to the aforementioned reasons, the researcher was interested in using music called SoundSleep for Babies to enhance sleep of premature infants (aged between 28 and 36 weeks) in the NICU.

## **CHAPTER III**

### **MATERIALS AND METHODS**

The present study was quasi-experimental research which aimed at investigating the effects of music on the sleep-wake states of premature infants in the Neonatal Intensive Care Unit (NICU).

#### **Population and Sample**

The population of this study consisted of premature infants with the gestational age between 28 and 36 weeks in the Neonatal Intensive Care Unit (NICU). The calculation of their age was made by pediatricians based on the gestational age evaluation of Ballard et al. (1991). The study sample consisted of 20 premature infants with the gestational age between 28 and 36 weeks in the NICU of Ramathibodi Hospital in Bangkok. Data were collected during August - October 2009. The sample was chosen by means of purposive sampling based on the selection criteria as follows:

1. They were premature infants with the gestational age between 28 and 36 weeks who had a steady state condition, with their respiratory rate of 40-60 breaths/min, heart rate not lower than 100 beats/min, oxygen saturation not lower than 92%, and body temperature between 36.5 and 37.5 degrees Celsius.
2. They were premature infants who did not take tranquilizers before the experiment.
3. They were premature infants who did not use a high frequency ventilator.
4. They were premature infants who were not treated with phototherapy.
5. They were premature infants who did not have congenital nervous system malformations or heart diseases (except PDA).
6. Their parents gave permission for them to participate in the study.

The sample size of this study was determined by using the power analysis method with the statistical significance level set at .05 and power of the test set at

80%. According to ten previous studies on music therapy for premature infants, it was found that the effect size ( $w$ ) was .79 (Standley, 2002). When making a comparison using the repeated measures with the number of repeated measures equal to 3, the result revealed that there should be at least nine subjects (Setvens, 2002: 511). When making a comparison using the Chi-Square method with  $df = 1$  ( $u$ ), it was found that at least 19 subjects were needed (Cohen, 1988: 252-253). Since this study used both statistical methods, the sample size of premature infants to participate in both the control situation and the experimental situation should be 20.

### **Research Setting**

In this study, data were collected at the Neonatal Intensive Care Unit of Ramathibodi Hospital. It is worth noting that the research setting had a rectangle shape divided into four zones. The first zone was for infectious patients, the second and third zones were for general patients (On ETT, On CPAP, and On Oxygen and room air), and the last zone was for medical equipment and laboratory equipment. The researcher collected the data from patients in the second and third zones. The place was always brightly lit. Sometimes during the break of medical and nursing activities, the lights were turned off, but the unit was not totally dark. There was some medical equipment nearby patients' beds such as a ventilator, pulse oximeter, infusion pump, and syringe pump. Alarm of the equipment would go off and could be heard from time to time. Other noises included telephone, broadcasting, and conversation of doctors and nurses. During the afternoon and night shifts, some lights could be turned off for a longer period of time due to fewer medical and nursing activities. However, but the sound of alarms from medical equipment could still be heard.

A quiet time was set up for two hours per shift in the NICU during which medical and nursing activities were reduced as much as possible. However, a quiet time could not be available regularly due to possible critical situations, such as patient transfers and patients' respiratory failure which needed to be immediately rescued.

## Research Instruments

Three types of research instruments were used in this study including experimental instruments, assessment instruments, and data collection instrument as described below:

### 1. Experimental instruments

**1.1 Sony MP3 player:** A MP3 player with earphones of approximately 20 cms. in length, with set volume to 58 decibels (dB) measured by the DS-40 sound level meter was used.

**1.2 Music:** SoundSleep for Babies (music sample was modified original 5 minute to 30 minute) created by William Lenihan (international composer/musician and Director of Music Studies at Washington University in St. Louis, Missouri, U.S.A.) and Jay Oliver (world-renowned pianist and composer/producer) was a kind of music aiming at enhancing sleep of infants based on the Womb Effect. Such music was similar to the environment in the womb which was suitable for premature infants

**1.3 Equipment for recording infants' facial expressions:** A Kodak video camera were used.

### 2. Assessment instruments

**2.1 Sound level meter model: DS-40:** The sound level meter was a small, battery operated, electric condenser microphone, which could be used as a meter for measuring sound ranging between 35 and 130 dB-A. The sound measuring procedure was to place this instrument near the noise source and point the microphone to it. Then, the intensity value of noise would be displayed on the screen of the equipment in digital numbers in the unit of decibels-A weighting (dB-A).

The sound level meter was calibrated by an officer of the Industrial Metrology and Testing Service Center (a division of the Thailand Institute of Scientific and Technological Research, TISTR, which is a nonprofit state enterprise under the Ministry of Science and Technology, MOSTE). This center is recognized as the first accredited calibration laboratory of Thailand conforming to ISO/IEC 17025 accreditation.

**2.2 Digital lux meter model: LX-50:** The lux meter is small and battery operated equipment, which used to measure the intensity of light. It was used by

placing the instrument at the required point. The illuminant value would be displayed on the monitor of the equipment in digital numbers in unit of lux.

The lux meter was also calibrated by the officer of the Industrial Metrology and Testing Service Center.

**2.3 Assessment of premature infant handling.** The assessment tool was used in evaluating handling given to premature infants in NICU during non-music and music administrations. The evaluation process determined the five levels of handling received by infants: no handling, comfort handling (which must be received only during sleep states), disturb handling, discomfort handling, and painful handling, with the scores ranging from 0 (no handling) to 4 (painful handling), respectively. Increasing scores indicated the higher level of disturbing during the sleep period of the premature infants. Following is the definition of handling scores:

**Score 0:** No handling

**Score 1:** Comfort handling such as gently touching the infant after receiving painful medical procedures, or placing hands to his/her mouth.

**Score 2:** Disturb handling such as checking body temperature via axillary, changing diaper, or doing physical examination by using a stethoscope.

**Score 3:** Discomfort handling such as changing bed sheet, weighing, or checking body temperature via rectum.

**Score 4:** Painful handling such as direct subcutaneous medication injection, suctioning via an endotracheal tube, or lumbar puncture.

The content validity of assessment of premature infant handling was made by three pediatric experts who were a pediatrician, a pediatrics-nursing professor, and a nurse working in the NICU. The content validity index (CVI) was 1. The inter-observer reliability was made between the researcher and a pediatric expert by evaluating five types of touching premature infants recorded in the video camera. The inter-observer reliability was equal to 1. The intrarater reliability would be checked by the researcher who subsequently evaluated several types of touching in the same premature infants again from the video camera after finishing the first evaluation within one week, and the intrarater reliability was equal to 1.

### 3. Data collection instruments

**3.1 Demographic data form.** It was a data form used to collect demographic data which gender, post-natal age, date and time of birth, gestational age, birth weight, type of delivery and indication, current weight, postconceptual age, diagnosis, and health problems and treatments of premature infants.

**3.2 The Anderson Behavioral State Scale (ABSS).** This instrument was developed by Gene Cranston Anderson and translated into the Thai language by Supreea Kurdrat (B.E. 2545). The ABSS process, which adopted the study of Parmalee and Stern (1972), consisted of 12 categories for measuring the behavioral state of premature infants. Eye openness, regularity of respiration, body movement, muscle tension, and vocalization were used as the major criteria in determining the behavior state of the infant, which was defined with values ranging from 1 (regular quiet sleep) to 12 (hard crying). The researcher closely observed the infants' behavior for 30 seconds before making any conclusion. Following is the definition of behavioral state:

**State 1:** Regular quiet sleep-closed eyes, regular respiration, faint or no mouthing (movement of fingers and toes)

**State 2:** Irregular quiet sleep-closed eyes; irregular respiration; no movement or slight slow movement of face, hands, feet, head, forearm, or lower leg (brief apnea)

**State 3:** Active sleep-closed eye; irregular respiration; whole limb movement (rapid eye movement; facial grimaces)

**State 4:** Very active sleep-closed eyes; total body movement; twisting trunk

**State 5:** Drowsy-opening and closing eyes; quiet or some movement; dull glazed appearance to eyes.

**State 6:** Quiet alert awake-opened eyes, luminous, fixated, and/or following; no movement or slight slow movement of face, hands, feet, head, forearm, or lower leg (eye contact)

**State 7:** Quiet awake-opened eyes; not fixated and/or following; no movement or slight slow movement of face, hands, feet, head, forearm, or lower leg

**State 8:** Active awake-opened eyes; whole limb movement

**State 9:** Very active awake-opened eyes; total body movement; twisting or lifting trunk

**State 10:** Fussing-opened or closed eyes; normal color; slightly prolonged exhalation; whimpers; (pre-cry grimace; snorts)

**State 11:** Crying-opened or closed eyes; red face; prolonged exhalation; audible or silent cry; general body tension

**State 12:** Hard crying-opened or closed eyes; very red face; clenched fist; very prolonged exhalation; audible or silent cry; entire body very tense

*Scoring Rules:*

1. The highest number that occurred during a 30-second observation interval was scored.
2. If infant had eye patches on, it was assumed that eyes were closed unless they were seen to be open.
3. If someone was working with the infant, the scoring would be done one minute after the intervention, with the score arousal for 30 seconds.
4. If one eye was open and one was closed, this was scored as state 5.
5. Items in parentheses needed not be present.

Scores were measured by the Rating Scale ranging from State 1 to State 12. There were four main state levels. States 1-4 represented behaviors of infants during the sleep state, State 5 represented behaviors of infants during the sleepy state, States 6-9 represented behaviors of infants during the wake state, and States 10-12 represented behaviors of infants during the crying state. Premature infants who fell into low state levels showed that they had a deeper sleep state.

The Thai version of ABSS was translated by Supreeda Kurdrut (2002). The content validity of the Thai version was tested by seven experts in this field: four pediatrics-nursing educator, a physiologist, and two registered nurses having 21 years and ten years of work experience in the NICU. As for reliability, this tool demonstrated moderate to high interrater reliability (0.85-0.95) (Chang et al., 2002; Kurdrut, 2002; Zahr, 1998).

In this study, the content validity of ABSS was made done by three pediatric experts, which was a pediatrician, a pediatrics-nursing professor, and a nurse

working in the NICU. The content validity index: CVI was equal to 1. The interobserver reliability was made between the researcher and a pediatric expert by evaluating facial expressions of five premature infants recorded in the video camera, and the interobserver reliability ranged from 0.94. The intrarater reliability was examined by the researcher who evaluated facial expressions of the same premature infants again from the video camera within one week after finishing the first evaluation. The intrarater reliability was equal to 0.97.

**3.3 The observation record sheets.** These sheets were created with five columns for documenting the collected data, which included period, sound levels, light levels, handling, and sleep-wake states.

### **Protection of the Right of Human Subjects**

Before the data collection commenced, the researcher asked for permission from Human Research Ethics Committee, Faculty of Medicine, Ramathibodi Hospital, Mahidol University. The researcher also met the parents of the sample group before the data collection date in order to ask for permission to involve their infants in the research and explain the research objectives and research methodology to them. The researcher clarified that the data would be reported only as group data with no revelation of who each individual subject was, that they would not cause any damage to their premature infants, and that they would be kept strictly confidential. In addition, the researcher confirmed that the study findings would be utilized for research purposes only and reassured that they had the right to withdraw their participation in the study at any time if they wished without any negative effects on the treatment and services they would receive from the hospital. Only the premature infants whose parents allowed them to participate in the study would be included after the parents had sign the informed consent form.

During the experiment, if the premature infants had the oxygen saturation value lower than 88% ( $O_2 \text{ sat} < 88\%$ ), the data collection would be terminated and the infants would be treated from medical experts immediately.

## **Data collection**

### **1. Preparation Phase**

1.1. The researcher practiced how to use The Anderson Behavioral State Scale (ABSS) and the observation record sheets to ensure the ability to use these instruments skillfully and effectively.

1.2. A research assistant was recruited and practice how to use a video camera and find a suitable camera angle to record facial expressions of infants while receiving music administration and not receiving music administration. The videotape would be displayed for the evaluation. In case of some recording problem, it needed to be solved before the actual experiment took place.

### **2. Operation Phase**

2.1 After the proposal was approved by the Human Research Ethics Committee, the researcher sent a letter to ask for permission to collect data from the Dean of the Faculty of Medicine, Ramathibodi Hospital. After the permission was granted, the researcher met responsible doctors of the Department of Pediatrics, nurse director, and head nurse of the NICU in order to explain to them essential details and data collection methods as well as to ask for cooperation in conducting the research.

2.2 The researcher surveyed data of premature infants and chose those who met the inclusion criteria as the sample group. Then, the researcher met parents to give an introductory message, explain the research objectives and research methodology, and to ask for cooperation in conducting the research.

2.3 After gaining the permission from the parents, the researcher recorded infant data in the demographic data form based on the infants' medical records.

2.4 The researcher had a meeting with the research assistant to ensure mutual understanding of the research procedures. The researcher selected the location for placement of the sound level meter model: DS-40 and digital lux meter model: LX-50 to ensure accurate results. Then, the research assistant prepared the video camera to be ready for recording facial expressions of premature infants clearly and switched it on throughout the experiment.

2.5 The researcher chose the situation at random. Each infant would be involved in both the control situation and the experimental situation (interval time between two situations was 4 hour). The study would be conducted after measuring

vital signs because the least medical and nursing treatments occurred at that time. There were a label of the control situation (routine nursing care = no music administration) and a label of the experimental situation (music administration) for the draw. If the first draw was the control situation, it meant that premature infants would not receive music administration during the first time, but they would during the second time. If the first draw was the experimental situation, it meant that premature infants would receive music administration during the first time, but they would not during the second time (the first time and the second time each lasted four hours). In brief, the experiment would be conducted with the sample groups in the following manners:

#### **Experimental situation**

1. The research assistant recorded premature infants' facial expressions for five minutes for baseline data and continued recording during the experiment.
2. The researcher gave infants music administration for 30 minutes (used earphones case by case, protect from contaminate). The sound intensity level was adjusted to 58 dB as measured by the sound level meter model: DS-40.



#### **Control situation**

The procedures were the same as those in the experimental situation, but the premature infants would not receive music administration.

The premature infants would be placed in the same positions in both situations (with music administration and without music administration).

2.6 During the experiment, the researcher would measure the intensity level of sound, light, and touching every five minutes (to be set at zero every time it

needed to start a new record) by using the observation record sheets. The research assistant would record the premature infants' facial expressions, both while they were receiving music administration and no music administration, for 30 minutes.

During the experiment, if the premature infants had the oxygen saturation value lower than 88% ( $O_2 \text{ sat} < 88\%$ ), the data collection would be terminated and the infants would be treated from medical experts immediately.

To control the bias, the researcher displayed the video 3 days after recording.

2.7 The researcher displayed the video on a computer screen in order to evaluate sleep-wake states of premature infants in the slow motion mode, and then the researcher gave scores of facial expressions every five minutes starting from the five-minute baseline record.

2.8 The researcher checked completeness and accuracy of the data from the experiment.

Data collection procedures are shown in Figure 2 below.

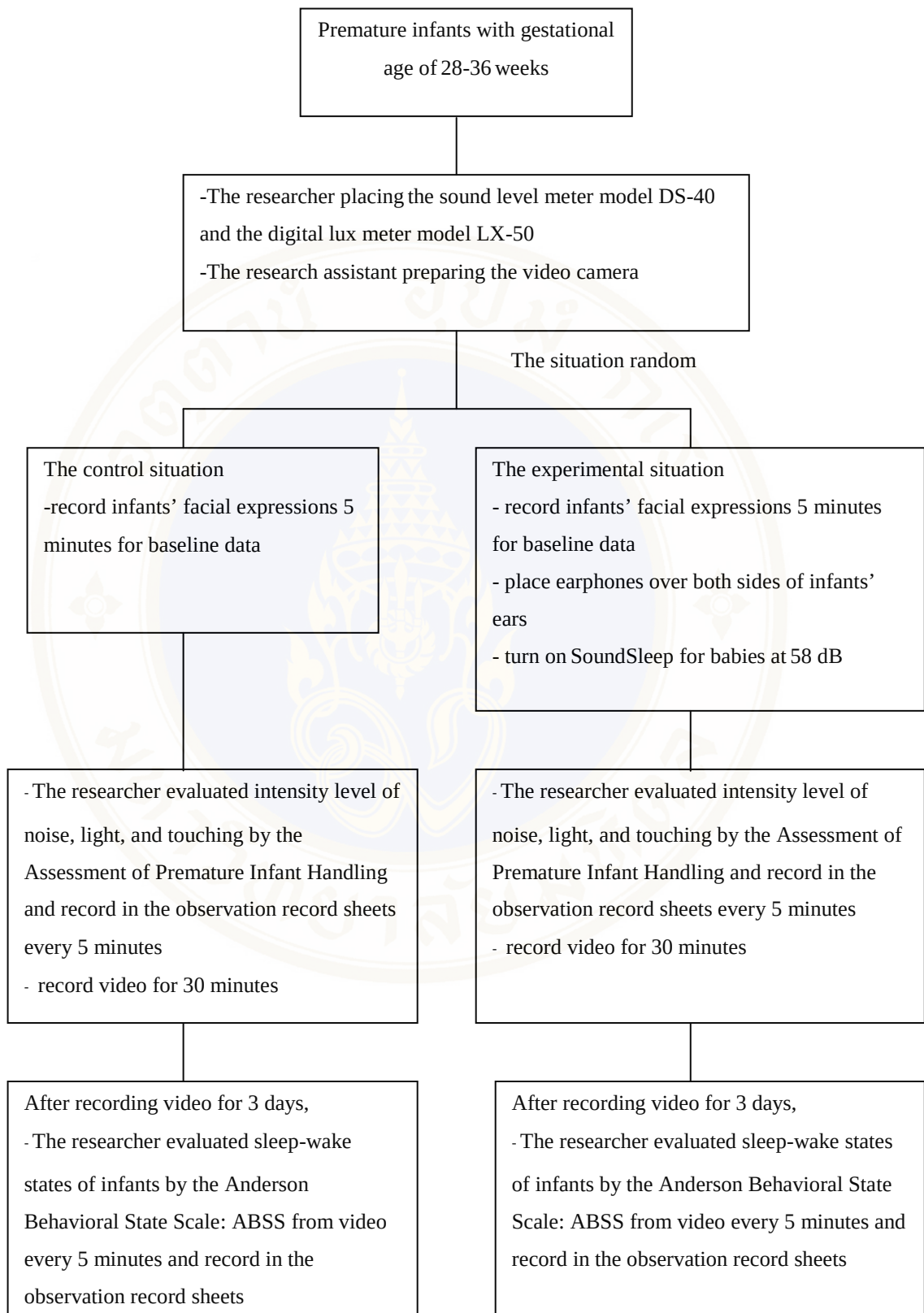


**Figure 2: Data collection procedures**

## **Data Analysis**

The SPSS for Windows version 11.5 computer program was used to analyze data as follows:

1. To analyze data regarding demographic characteristics of the subjects, descriptive statistics of frequency distribution, percentage, mean, and standard deviation were used.
2. To compare sleep-wake states of the same premature infants while receiving music administration and routine nursing care, the Chi-square test was used.
3. To compare scores of sleep-wake states of the same premature infants immediately, and five minutes and 30 minutes after vital signs were recorded, the Wilcoxon signed ranks test was used.

## **CHAPTER IV**

### **RESULTS**

This study was quasi-experimental research which aimed at investigating the effects of music on sleep-wake states of premature infants in the Neonatal Intensive Care Unit (NICU), Ramathibodi Hospital, Bangkok. In this chapter, the study findings are presented in tables together with description.

#### **Demographic Characteristics of the Study Sample**

The data regarding general demographic characteristic of premature infants who participated in this study included gender, age, gestational age (GA), birth weight, and current weight, which are presented in terms of frequency, percentage, mean, and standard deviation in Table 1.

**Table 1: Demographic characteristics of the sample (n = 20)**

| Characteristics                                                                      | Frequency | Percentage |
|--------------------------------------------------------------------------------------|-----------|------------|
| <b>Gender</b>                                                                        |           |            |
| Girl                                                                                 | 11        | 55         |
| Boy                                                                                  | 9         | 45         |
| <b>Age (days)</b>                                                                    |           |            |
| < 7                                                                                  | 11        | 55         |
| 7-28                                                                                 | 9         | 45         |
| (min-max = 1-28, $\bar{X}$ = 9.30, SD = 8.97, Mode = 4, Median = 5)                  |           |            |
| <b>GA (weeks)</b>                                                                    |           |            |
| <31                                                                                  | 9         | 45         |
| 31-36                                                                                | 11        | 55         |
| (min-max = 28-35, $\bar{X}$ = 31.35, SD = 2.54, Mode = 29, Median = 31.50)           |           |            |
| <b>Birth weight (grams)</b>                                                          |           |            |
| < 1,000                                                                              | 5         | 25         |
| 1,000-1,499                                                                          | 6         | 30         |
| 1,500-2,499                                                                          | 9         | 45         |
| (min-max = 760-2,495, $\bar{X}$ = 1,521.25, SD = 556.70, Mode = 960, Median = 1,290) |           |            |
| <b>Current weight (grams)</b>                                                        |           |            |
| < 1,000                                                                              | 1         | 5          |
| 1,000-1,499                                                                          | 10        | 50         |
| 1,500-2,499                                                                          | 9         | 45         |
| (min-max = 960-2,480, $\bar{X}$ = 1,580, SD = 544.59, Mode = 1145, Median = 1,340)   |           |            |

There were altogether 20 premature infants who participated in the study. The findings showed that 55% of them were female, were younger than seven days old, and had the gestational age between 31 and 36 weeks. In addition, the largest

group of subjects, or 45%, had the birth weight between 1,500 and 2,499 grams, followed by those who had the birth weight ranging from 1,000 to 1,499 grams, accounting for another 30%. Moreover, half of these infants, or 50%, had gained weight since their birth, having the current weight between 1,000 and 1,499 grams. However, the same number of the subjects, or 45%, still had their current weight between 1,500 and 2,499 grams (see Table1).

During the experiment, it was found that there was no touching of premature infants in both episodes (during music administration and no music administration).

A comparison of the mean scores of sound levels in the NICU between music administration and no music administration using t-test is shown in Table 2 below.

**Table 2 Comparison of the mean scores of sound levels in the NICU between music administration and no music administration using t-test**

| Shift     | Music administration<br>(n = 20) |           |      | No music administration<br>(n = 20) |           |      | t     | p    |
|-----------|----------------------------------|-----------|------|-------------------------------------|-----------|------|-------|------|
|           | Min-max                          | $\bar{X}$ | SD   | Min-max                             | $\bar{X}$ | SD   |       |      |
| Day       | 67.10-73.70                      | 72.06     | 2.63 | 64.50-76.80                         | 70.66     | 4.48 | -0.41 | 0.71 |
| Afternoon | 67.00-74.20                      | 71.20     | 2.70 | 67.40-76.90                         | 71.55     | 4.13 | 0.36  | 0.73 |
| Night     | 66.40-72.40                      | 69.68     | 1.94 | 65.90-74.50                         | 69.76     | 2.78 | 0.17  | 0.87 |

As for the sound levels in the NICU, the mean sound levels in the morning shift and the afternoon shift when there was music administration were equal to 72.06 dB ( $\bar{X} = 72.06$ ; SD = 2.63) and 71.20 dB ( $\bar{X} = 71.20$ ; SD = 2.70), respectively. Also, the mean sound levels in the morning shift and the afternoon shift when there was no music administration were equal to 70.66 dB ( $\bar{X} = 70.66$ ; SD = 4.48) and 71.55 dB ( $\bar{X} = 71.20$ ; SD = 4.13), respectively. Finally, during the night shift, the mean sound level during music administration was equal to 69.98 dB ( $\bar{X} = 69.98$ ; SD = 1.94), and when there was no music administration, the mean sound level was equal to 69.76 dB

( $\bar{X} = 69.76$ ;  $SD = 2.78$ ). When comparing the means of sound levels in each shift in the NICU, it was found that they were different with no statistical significance ( $p > .05$ ) (see Table 2).

A comparison of the mean scores of light levels in the NICU between music administration and no music administration using is depicted in Table 3.

**Table 3 Comparison of the mean scores of light levels in the NICU between music administration and no music administration using t-test**

| Shift     | Music administration<br>(n = 20) |           |       | No music administration<br>(n = 20) |           |       | t    | p    |
|-----------|----------------------------------|-----------|-------|-------------------------------------|-----------|-------|------|------|
|           | Min-max                          | $\bar{X}$ | SD    | Min-max                             | $\bar{X}$ | SD    |      |      |
| Day       | 8.10-52.70                       | 26.52     | 16.58 | 9.00-52.40                          | 26.96     | 15.97 | 0.95 | 0.38 |
| Afternoon | 5.00-35.30                       | 19.27     | 12.25 | 5.40-35.40                          | 19.68     | 12.17 | 1.08 | 0.33 |
| Night     | 5.10-21.40                       | 12.29     | 6.49  | 5.10-21.10                          | 12.49     | 6.24  | 1.04 | 0.33 |

As regards the light levels in the NICU, during the morning shift, the mean score of light levels when there was music administration was 26.52 lux ( $\bar{X} = 26.52$ ;  $SD = 16.58$ ). When there was no music administration, the mean score of light levels was 26.96 lux ( $\bar{X} = 26.96$ ;  $SD = 15.97$ ). During the afternoon shift, the mean scores of light levels when there was music administration and when there was no music administration were equal to 19.27 lux ( $\bar{X} = 19.27$ ;  $SD = 12.25$ ) and 19.68 lux ( $\bar{X} = 19.68$ ;  $SD = 12.17$ ), respectively. Finally, during the night shift, the mean score of light level during music administration was equal to 12.29 lux ( $\bar{X} = 12.29$ ;  $SD = 6.49$ ), and when there was no music administration, the mean light level was equal to 12.49 lux ( $\bar{X} = 12.49$ ;  $SD = 6.24$ ). When comparing the mean scores of light levels in each shift in the NICU, it was discovered that they were different with no statistical significance ( $p > .05$ ) (see Table 3).

## Hypothesis Testing

A Chi-square test was employed to compare the sleep-wake states of the 20 premature infants when there was music administration and when there was no music administration, as illustrated in Table 4 below.

**Table 4 Comparison of sleep-wake states of the 20 infants between music administration and no music administration using Chi-square**

| Sleep-wake states                               | Music administration<br>(n = 20) |            | No music administration<br>(n = 20) |            | $\chi^2$ | p     |
|-------------------------------------------------|----------------------------------|------------|-------------------------------------|------------|----------|-------|
|                                                 | Frequency                        | Percentage | Frequency                           | Percentage |          |       |
| <b>Immediately</b>                              |                                  |            |                                     |            | 0.40     | 0.53  |
| Sleep                                           | 12                               | 60         | 9                                   | 45         |          |       |
| Sleepy (Drowsy)                                 | 2                                | 10         | 3                                   | 15         |          |       |
| Awake                                           | 4                                | 20         | 6                                   | 30         |          |       |
| Crying                                          | 2                                | 10         | 2                                   | 10         |          |       |
| <b>Five minutes after recording vital signs</b> |                                  |            |                                     |            | 6.42     | 0.01* |
| Sleep                                           | 14                               | 70         | 5                                   | 25         |          |       |
| Sleepy (Drowsy)                                 | 2                                | 10         | 2                                   | 10         |          |       |
| Awake                                           | 4                                | 20         | 12                                  | 60         |          |       |
| Crying                                          | 0                                | 0          | 1                                   | 5          |          |       |
| <b>30 minutes after recording vital signs</b>   |                                  |            |                                     |            | 20.05    | 0.00* |
| Sleep                                           | 19                               | 95         | 4                                   | 20         |          |       |
| Sleepy (Drowsy)                                 | 1                                | 5          | 2                                   | 10         |          |       |
| Awake                                           | 0                                | 0          | 7                                   | 35         |          |       |
| Crying                                          | 0                                | 0          | 7                                   | 35         |          |       |

\* p < .05, \*\* p < .01

As shown in Table 4, the Chi-square test showed that when analyzing the differences in the sleep-wake states of premature infants when there was music administration and when there was no music administration, there were 12 premature infants who were in the sleep state when listening to the music immediately after their vital signs were recorded, accounting for 60%. Also, there were two premature infants

who were in the sleepy (drowsy) state, making up another 10%, four premature infants who were in the awake state (20%), and two premature infants who were in the crying state (10%). On the other hand, when these premature infants did not listen to the music immediately after their vital signs were recorded, it was found that nine premature infants were in the sleep state, making up 45%, three (15%), were in the sleepy (drowsy) state, six premature infants (30%), were in the awake state, and two premature infants (10%), were in the crying state. Statistical analysis showed that the sleep-wake states of premature infant when listening to the music and when not listening to the music immediately after their vital signs were recorded were not statistically different ( $\chi^2 = 0.4$ ,  $p > .05$ ).

In addition, when music was administered five minutes after the premature infants' vital signs were recorded, the findings revealed that 14 premature infants (70%), were in the sleep state, two premature infants (10%), were in the sleepy (drowsy) state, and four premature infants (20%), were in the awake state. On the other hand, when music was not administered five minutes after the premature infants' vital signs were recorded, it was found that five premature infants (25%), were in the sleep state, two premature infants (10%), were in the sleepy (drowsy) state, 12 premature infants (60%), were in the awake state, and one premature infant (5%), was in the crying state. Statistical analysis indicated that the sleep-wake states of premature infant when listening to the music and when not listening to the music five minutes after their vital signs were recorded were different with no statistical significance ( $\chi^2 = 6.42$ ,  $p < .05$ ).

Furthermore, when music was administered 30 minutes after the premature infants' vital signs were recorded, the findings indicated that 19 premature infants (95%), were in the sleep state, and only one premature infant (5%), was in the sleepy (drowsy) state. However, when music was not administered 30 minutes after the premature infants' vital signs were recorded, the findings showed that four premature infants (20%), were in the sleep state, two premature infants (10%), were in the sleepy (drowsy) state, seven premature infants (35%), were in the awake state, and another seven premature infant (35%), was in the crying state. Statistical analysis revealed that the sleep-wake states of premature infant when listening to the music and when not

listening to the music 30 minutes after their vital signs were recorded were statistically significantly different ( $\chi^2 = 20.05$ ,  $p < .01$ ).

Before the hypothesis testing was performed, the critical assumptions of the Wilcoxon Signed Ranks test were considered (Pett, 1997: 115-117). First, the data were paired observations from a single randomly selected sample through utilizing subjects as their own controls. Second, the data employed by the Anderson Behavioral State Scale (ABSS) were ordinal in level of measurement. Third, the distribution of the difference scores would be symmetric (not necessarily normal) about the population median (see Appendix C). It could be then concluded that this study approach met these assumptions. A comparison of median scores of sleep-wake states of the 20 premature infants between music administration and no music administration is depicted in Table 5 below.

**Table 5 Comparison of median scores of sleep-wake states of the 20 premature infants between music administration and no music administration using Wilcoxon Signed Rank Test**

| Sleep-wake states                            | Music administration<br>(n = 20) |        |      | No music administration<br>(n = 20) |        |      | Z     | P<br>(one-tailed)  |
|----------------------------------------------|----------------------------------|--------|------|-------------------------------------|--------|------|-------|--------------------|
|                                              | $\bar{X}$                        | Median | SD   | $\bar{X}$                           | Median | SD   |       |                    |
|                                              |                                  |        |      |                                     |        |      |       |                    |
| Immediately                                  | 4.30                             | 3      | 2.66 | 5.45                                | 5      | 2.67 | -1.29 | 0.10 <sup>ns</sup> |
| Five minutes after vital signs were recorded | 3.90                             | 3      | 0.59 | 6.25                                | 6      | 2.20 | -2.89 | 0.00*              |
| 30 minutes after vital signs were recorded   | 2.85                             | 3      | 0.59 | 7.55                                | 7      | 2.76 | -3.93 | 0.00**             |

ns  $p > .05$ , \*  $p < .01$ , \*\*  $p < .001$

When considering the findings regarding the sleep-wake states of 20 premature infants when there was music administration and when there was no

administration, it was found that the median score of the sleep-wake states of premature infants who listened to the music immediately after their vital signs were recorded was equal to 3 ( $\bar{X} = 4.30$ ,  $SD = 2.66$ ). When there was no music administration immediately after the vital signs were recorded, the median was 5 ( $\bar{X} = 5.45$ ,  $SD = 2.67$ ). When testing the difference in the median scores of the sleep-wake states of premature infants when listening and when not listening to music immediately after their vital signs were recorded using Wilcoxon Signed Rank Test, it was found that there was no difference ( $Z = -1.29$ ,  $p > .05$ ).

When music was administered five minutes after the vital signs of premature infants were recorded, the findings showed that the median score of the sleep-wake states of premature infants was equal to 3 ( $\bar{X} = 3.90$ ,  $SD = 1.55$ ). When there was no music administration five minutes after the vital signs were recorded, the median was 6 ( $\bar{X} = 6.25$ ,  $SD = 2.20$ ). When testing the difference in the median scores of the sleep-wake states of premature infants when listening and when not listening to music five minutes after their vital signs were recorded using Wilcoxon Signed Rank Test, it was found that when listening to the music the premature infants had a deeper sleep state than when not listening to the music with statistical significance ( $Z = -2.89$ ,  $p < .01$ ).

Finally, when music was administered 30 minutes after the vital signs of premature infants were recorded, the findings revealed that the median score of the sleep-wake states of premature infants was equal to 3 ( $\bar{X} = 2.85$ ,  $SD = 0.59$ ). When there was no music administration 30 minutes after the vital signs were recorded, the median was equal to 7 ( $\bar{X} = 7.55$ ,  $SD = 2.76$ ). When testing the difference in the median scores of the sleep-wake states of premature infants when listening and when not listening to music 30 minutes after their vital signs were recorded using Wilcoxon Signed Rank Test, it was discovered that when listening to the music the premature infants had a deeper sleep state than when not listening to the music with statistical significance ( $Z = -3.93$ ,  $p < .001$ ).

## **CHAPTER V**

### **DISCUSSION OF FINDINGS**

The present study aimed to investigate the effects of music on the sleep-wake states of 20 premature infants in the Neonatal Intensive Care Unit (NICU). The premature infants who were the subjects of the study received both the control episode (no music administration) and the experimental episode (music administration). In this chapter, the study findings are discussed in accordance with the research objectives and the research hypotheses as follows:

#### **Demographic Characteristics of the Sample**

There were 20 premature infants who participated in the study. Of these, 55% and 45% were female and male, respectively. However, a survey of birthrates in 202 countries in the world in the past ten years has shown that there were more male newborn infants than female new born infants, accounting for 51.3% and 48.7%, respectively. In Thailand, in 2008, 51.5% of newborn infants were male, while 48.5% of newborn infants were female (Population Information Center, College of Population Studies, Chulalongkorn University, B.E. 2551).

As regards age, more than half of the subjects, or 55%, were younger than seven days old. The youngest subjects were one day old, and the oldest subjects were 28 days old. The mean age of the subjects was 9.3 days old. The study findings showed that more than half of the subjects were in the early neonate period (younger than seven days old), so they were more familiar with the environment in their mother's womb than the environment in the outside world when compared to those who were in the late neonate period (seven to 28 days).

In addition, when considering the gestational age of the newborn infants, it was found that close to half of them, or 45%, were considered extremely premature infants, with the gestational age less than 31 weeks. On the other hand, the rest of the subjects, or 55%, were moderate premature infants, with the gestational age between

31 and 36 weeks. The mean gestational age was 31.35 weeks. In general, such gestational ages mean the premature infants still lack certain physiological developments. That is, when the infants were born with the gestational age less than 35 weeks, the structure and functioning of the respiratory tract have not been fully developed, there are fewer air sacs in the lungs, the production of pulmonary surfactants is incomplete, and their breathing is not yet fully controlled. Therefore, they may breathe intermittently and may stop breathing. However, these symptoms will improve when they are older. Moreover, these premature infants will have more body surface areas per body weight, and their skin is rather thin with less subcutaneous fat deposits, so they can easily lose body heat. This, coupled with the fact that they are not fully able to generate body heat by themselves, makes them more susceptible to lower body temperature (Veena Jiraphat, B.E. 2543). Besides this, in premature infants, the digestive tract is not fully developed, hence incomplete functioning of the digestion and absorption of nutrients, which can lead to necrotizing enterocolitis caused by ischemia in the digestive tract. Their incomplete immune system makes them susceptible to infections as well. For these reasons, premature infants are unable to fully adjust themselves to the life outside their mother's womb.

In this study, the largest group of the subjects, or 45%, had body weight between 1,500 and 2,499 grams, and 30% of them had their body weight between 1,000 and 1,499 grams. After that, there was an increase in their body weight, and half of these premature infants, or 50%, had their current weight ranging from 1,000 to 1,499 grams. However, the same number of premature infants, or 45%, had their body weight between 1,500 and 2,499 grams. It can be seen that there were some changes in these premature infants' body weight as they gained or lost weight. This can be explained that when the fetuses are in their mother's womb, their total body water will be high as the body has to prepare itself for postnatal stress. For instance, when they are about to be full-term, their level of cortisol will be higher. However, after birth, the total body water of newborn infants will be decreased through extracellular fluid which may be lost through insensible loss through the skin due to high environmental temperature. Also, fluid intake of newborn infants may be low, especially during the very initial period of life. For these reasons, newborn infants tend to lose body weight after birth. However, they will begin to gain weight after about two weeks after birth

(Crosse, 1975). In this study, most of the subjects in this study were premature infants who were considered moderate premature, with their gestational age ranging from 31 to 36 weeks. However, their body weight was lower than 1,500 grams, which was considered very low birth weight. Their neurological and physiological developments were not yet complete. Therefore, these premature infants required very efficient care, especially during the first two months of life, to reduce the mortality rate among them.

### **NICU Environment during the Control and Experimental Periods**

In the present study, the factors affecting the sleep-wake states of premature infants were investigated including sound, light, and touch. There were both control and experimental periods in the study. However, it is worth noting that during the data collection, there was no touching of the infants in both the experimental and control episodes (with and without music administration). This is because each of the experimental and control episodes lasted approximately 30 minutes, during which different instruments were installed and used for recording purposes. If the premature infants did not show any sign of abnormality during those periods, the staff would not touch or hold the infants as it might interfere with the experimental condition.

#### **Sound**

According to the study findings, the sound levels in the neonatal intensive care unit during the experimental condition (with music administration) and the control condition (without music administration) were not different. The mean scores of sound levels in the NICU during the morning, afternoon, and night shifts when there was music administration were 72.06 dB, 71.20 dB, and 69.68 dB, respectively, and the mean scores of sound levels in the NICU during the morning, afternoon, and night shifts when there was no music administration were 70.66 dB, 71.55 dB, and 69.76 dB, respectively. However, it is noteworthy that the sound levels during each shift, with or without music administration, were still too high for newborn infants. The level of sound that was appropriate for newborn infants was equal to 58 dB (AAP: Committee on Environmental Hazard, 1974). This is because there are constantly disturbing sounds in the NICU from other sources such as the ventilator and the water in the ventilator (62-87 dB), the warning sign of the pulse oximeter (70 dB), and the talking sounds of the healthcare team members ( $\geq 60$  dB) (Kenner & Lott, 2003).

When the noise level is too high, it can destroy the hearing structure of newborn infants and affect their physiological conditions including faster heart rate, faster breathing, higher blood pressure levels, increased intracranial pressure, and decreased oxygen saturation (Bremmer, Byers, & Kiehl, 2003). As for behavioral changes, newborn infants will become restless and listless, they will cry more, they will show signs of discomfort, and they will have less interpersonal interactions. In addition, loud noises disrupt newborn infants' sleep, and this may affect their growth and resuscitation, and may have adverse effects on their subsequent hearing and growth.

### **Light**

A review of existing research has shown that lowering light in the NICU has a positive effect on infants as it increases the duration of their sleep and their body weight, hence a more satisfactory growth rate and recovery rate (Mann et al., 1986; Brandon, Holditch-Davis, & Belyea, 2002). Thus, in the present study, the level of light was controlled and reduced as much as possible without affecting the medical and nursing care activities. During the morning, afternoon, and night shifts, when there was music administration, the mean scores of light levels in the NICU were 26.52 lux, 19.27 lux, and 12.29 lux, respectively, and when there was no music administration, the mean scores of light levels in the NICU were 26.96 lux, 19.68 lux, and 12.49 lux, respectively. When comparing the mean scores of light levels in the NICU during the experimental and control periods, it was found that there was no statistical difference ( $p > .05$ ).

### **Sleep-wake states of Premature Infants between the Control and Experimental Periods**

With regard to the differences in the sleep-wake states of premature infants when there was music administration and when there was no music administration, it was found that the sleep-wake states of premature infants when listening to the music immediately after their vital signs were recorded and when not listening to the music immediately after their vital signs were recorded were not different ( $\chi^2 = 0.4$ ,  $p > .05$ ). However, when the premature infants listened to the music five and 30 minutes after their vital signs were recorded, their sleep-wake states were statistically significantly

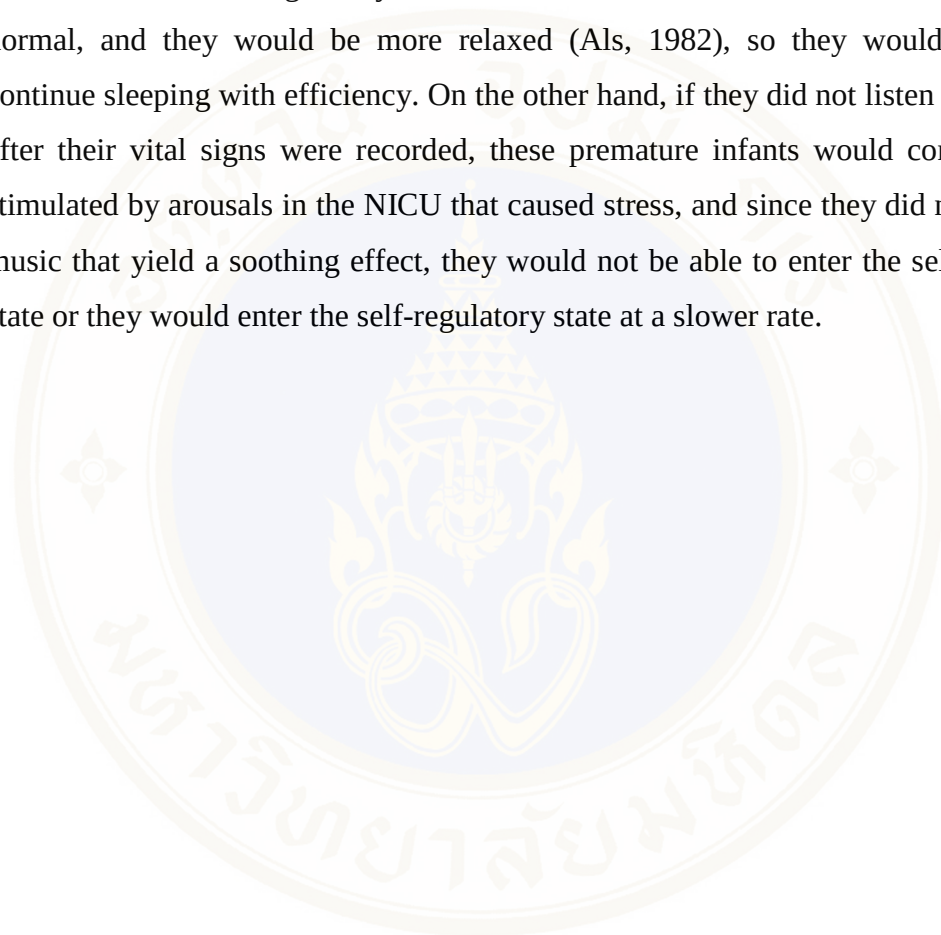
different from their sleep-wake states when they did not listen to the music five and 30 minutes after their vital signs were recorded at the  $p = .05$  and  $p < .01$  levels, respectively.

When testing the differences in the sleep-wake states of premature infants when they listened to the music and when they did not listen to the music, the findings revealed that the mean scores of the sleep-wake states of premature infants when listening to the music immediately after their vital signs were recorded and when not listening to the music immediately after their vital signs were recorded were not different ( $Z = -1.29$ ,  $p > .05$ ). However, when the premature infants listened to the music five and 30 minutes after their vital signs were recorded, their sleep-wake states were deeper than when they did not listen to the music five and 30 minutes after their vital signs were recorded with statistical significance at the  $p < .01$  and  $p < .001$  levels, respectively.

One plausible explanation for such findings is that, in general, when the vital signs of infants are recorded, the infants will be touched. There are also loud noises caused by the blood pressure monitor, and the light in the room will be increased to facilitate the nursing care activities. Such changes in the environment will stimulate the functioning of the five subsystems as specified by Als (1982) including the autonomous nervous subsystem, the muscular and motor subsystem, the sleep-wake subsystem, the interest and interaction subsystem, and the self-regulatory subsystem. Therefore, the infants who are in the sleep state will change into the wake state (Zahr & Balian, 1995). There will also be more movements of the limbs. When premature infants are stimulated by arousals that cause stress, they will respond by expressing a behavior or showing a sign that indicates that the body is under stress (Als, 1982). For example, their skin will be darkened, the oxygen saturation will be reduced, and their heart rate will be changed. However, in this study, when premature infants listened to the music which was soothing as it resembled the sounds in the mother's womb when the mother was sleeping, the music would reduce the functioning of the five subsystems.

To further explain, the music would go through the cochlear neurons in the ears to the thalamus and the cortex, which worked collaboratively. The thalamus would then stimulate the pituitary gland to secrete endorphins which was a morphine-

like substance (Well-Federman et al., 1995). Thus, the infants would feel comfortable and safe as if they were in the mother's womb. They would stop fidgeting and crying, so their muscles would become more relaxed, hence more efficient sleep. And when these premature infants had been listening to the music for five to 30 minutes, they would enter the self-regulatory state. Their heart rate and skin color would return to normal, and they would be more relaxed (Als, 1982), so they would be able to continue sleeping with efficiency. On the other hand, if they did not listen to the music after their vital signs were recorded, these premature infants would continue to be stimulated by arousals in the NICU that caused stress, and since they did not have any music that yield a soothing effect, they would not be able to enter the self-regulatory state or they would enter the self-regulatory state at a slower rate.



## CHAPTER VI

### CONCLUSION

The present study was quasi-experimental research with a one-group design with both control and experimental episodes to investigate the effects of music on the sleep-wake states of premature infants in the Neonatal Intensive Care Unit (NICU).

The study sample consisted of 20 premature infants who were born after the gestational age of 28 to 36 weeks and were treated at the NICU of Ramathibodi Hospital, Bangkok, between August and October 2009. The subjects were selected by mean of purposive sampling. The inclusion criteria were as follows: 1) the subjects' rate of breathing was 40 to 60 times per minute, 2) their heart rate was not lower than 100 beats per minute, 3) the oxygen saturation rate was no less than 92 %, 4) their body temperature was between 36.5 and 37.5 degrees Celsius, 5) they did not receive any suppressant medication before the experiment, 6) they were not put on a high frequency ventilator, 7) they were not treated with phototherapy, 8) they did not have neurological or chromosomal birth defects, 9) they were not born with congenial heart disease (except PDA), 10) there were no medical restrictions that prevented them from participating in the study, and 11) their parents were willing to let them participate in the study.

The experiment was divided into two episodes. In the experimental episode, the premature infants listened to the music 30 minutes after their vital signs were recorded; in the control episode, the premature infants did not listen to the music after their vital signs were recorded. Random sampling was used to assign the experimental and control episodes to the premature infants.

The instruments used in this study could be divided into two categories. First, the research instruments consisted of the mp3 player with a headphone with the noise intensity level of 58 decibels (dB) and the SoundSleep for Babies music. Second, the data collection instruments were composed of the demographic data form,

the sound level meter model: DS-40, the Digital lux meter model: LX-50, the observation record sheets, the instrument to record the facial expressions of the premature infants, and the Anderson Behavioral State Scale (ABSS). The Anderson Behavioral State Scale was translated into the Thai language and validated by Supreeda Kurdrit (2002). Its content validity index (CVI) was equal to 1, and the reliability was determined by the researcher with the interobserver reliability equal to 0.94 and intra-rater reliability equal to 0.97.

Before data collection commenced, the research proposal was submitted to the Ethical Committees on Research Involving Human Subjects of the Faculty of Medicine, Ramathibodi Hospital, for approval. The researcher also asked for permission from the parents of the selected premature infants. Data were collected only from the premature infants whose parents agreed to let them participate in the study and signed the informed consent form.

The researcher and one research assistant carried out data collection in this study. Data collection could be divided into two phases: 1) the preparation phase and 2) the operation phase. In the operation phase, the research used random sampling to assign the premature infants to the control and experiment episodes. Each premature infant would receive both the control episode and the experiment episode, which were conducted after their vital signs had been recorded. In the experimental episode, the researcher played the music called SoundSleep for Babies and let the premature infants listen to the music for 30 minutes, using the sound intensity level of 58 decibels (dB). During the experiment, the researcher recorded the intensity levels of the sound, light, and touches every five minutes using the observation record sheets, while the research assistant used a video-recorder to record the premature infants' facial expressions while they were and were not listening to the music for 30 minutes. Three days later, the researcher assessed the sleep-wake states of the premature infants every five minutes for the total period of 30 minutes.

Data were analyzed using the statistical packaged computer program. Descriptive statistics, t-test, Chi-square test, and Wilcoxon Signed Ranks test were used in the analysis.

## Findings

The study findings revealed that music had the following effects on the sleep-wake states of premature infants in the NICU:

1. The means of noise level and intensity of light in the NICU when the premature infants were listening and were not listening to the music were different with no statistical significance ( $p > .05$ ).

2. The levels of sleep of premature infants who listened to the music immediately after their vital signs were recorded and who did not listen to the music immediately after their vital signs were recorded were different with no statistical significance ( $p > .05$ ). In addition, the scores of the sleep-wake states of premature infants who listened to the music and who did not listen to the music after their vital signs were recorded were different with no statistical significance ( $p > .05$ ).

3. The levels of sleep of premature infants who listened to the music five minutes after their vital signs were recorded and who did not listen to the music five minutes after their vital signs were recorded were different with statistical significance ( $p < .05$ ). Moreover, the premature infants who listened to the music five minutes after their vital signs were recorded slept deeper than the premature infants who did not listen to the music five minutes after their vital signs were recorded with statistical significance ( $Z = -2.89, p < .01$ ).

4. The levels of sleep of premature infants who listened to the music 30 minutes after their vital signs were recorded and who did not listen to the music 30 minutes after their vital signs were recorded were different with statistical significance ( $p < .05$ ). Furthermore, the premature infants who listened to the music 30 minutes after their vital signs were recorded slept deeper than the premature infants who did not listen to the music 30 minutes after their vital signs were recorded with statistical significance ( $Z = -2.89, p < .01$ ).

## Limitation of the Study

The use of sound in premature infants can be done only with the infants who were born after the gestational age of at least 28 weeks. This is because the hearing structure has been fully developed, and their hearing is stable (Bilich, 2007).

## **Recommendations and Implications of the Findings**

### **For nursing practice**

The nurse practitioners who are in charge of caring for premature infants can implement the use of music to promote sleep in premature infants. Including with it should be control the sound level in NICU lower than 58 dB for promote premature infant's growth and development.

### **For nursing education**

The findings of the present study could be included in a nursing curriculum for nursing students or nursing staff to equip them with knowledge about how to assess the sleep-wake states of premature infants as well as to promote sleep of premature infants in the NICU.

### **For nursing research**

1. Further studies should be conducted to explore other methods or techniques that can be used to promote sleep in premature infants in the NICU.
2. Studies should also be carried out to investigate the use of sounds for relaxation purposes such as the sound of the mother's heartbeats to promote sleep in premature infants in the NICU.

## BIBLIOGRAPHY

- Als, H. (1982). Toward a synactive theory of development: Promise for the assessment and support of infant individuality. *Infant Mental Health Journal*, 3(4), 229-243.
- Ahn, Y. (2006). The Relationship between Behavioral States and Pain Responses to Various NICU Procedures in Premature Infants. *Journal of Tropical Pediatrics*, 52(3), 201-205.
- American Academy of Pediatrics [AAP]. (2000). Premature babies: Growth and development. *Medical library*. Retrived April 15, 2008, from <http://www.madem.com>
- American Academy of Pediatrics: Committee on Environmental Hazard. (1974). Noise Pollution: Neonatal Aspects. *Pediatrics*, 54(4), 476-479.
- Ardura, J., Andres, J., Aldana, J., & Revilla, M. A. (1995). Development of sleep-wakefulness rhythm in premature babies. *Acta Paediatrica*, 84, 484-489.
- Arnon, S., Shapsa, A., Forman, L., Regev, R., Bauer, S., Litmanovitz, I., & Dolfen, T. (2006). Live music is beneficial to preterm infants in the neonatal intensive care unit environment. *Birth*, 33(2), 131-136.
- Ballard, J. L., Khoury, J. C., Wedig, K., Wang, L., Eilers-Walsman, B. L. & Lipp, R. (1991). New ballard score: Expand to include extremely premature infant. *The Journal of Pediatrics*, 119, 417-423.
- Bilich, K. (2007). *Baby's Development of Senses*. Retrived May 20, 2008, from <http://health.discovery.com>
- Blackburn, S. T. (1993). Assessment and management of neurologic dysfunction. In C. Kenner, A. Brueggemeyer, & L. P. Gunderson (Eds.), *Comprehensive neonatal nursing* (pp. 637-644). Philadelphia: W. B. Saunders.
- Blackburn, S. T. (1998). Environment impact of the NICU on development outcomes. *Journal of Pediatric Nursing*, 13(5), 279-289.

- Blackburn, S. T., & Loper, D. L. (1992). *Maternal, fetal, and neonatal physiology: A clinical perspective* (pp. 788-792). Philadelphia: W. B. Saunders.
- Blackburn, S. T., & Vanderberg, K. A. (1998). *Assessment and Management of Neonatal Neurobehavioral Development*. In C. Kenner, J. W. Lott, & A. A. Fladermeyer (Eds.), *Comprehensive Neonatal Nursing: A Physiologic Perspective* (2<sup>nd</sup> ed., pp. 939-968). Philadelphia: W.B. Saunders.
- Bo, L. K., & Callaghan, P. (2000). Soothing pain-elicited distress in Chinese neonate. *Pediatrics*, 105, 49.
- Bowden, V., Greenberg, C., & Donaldson, N. (2000). Developmental care of the newborn. *Online Journal of Clinical Innovations*, 15(7), 1-77.
- Brandon, D. H., Holditch-Davis., & Belyea, M. (2002). Preterm infants born at less than 31 weeks' gestation have improved growth in cycled light compared with continuous near darkness. *Journal of Pediatrics*, 140(2), 192-199.
- Brazelton, T. B. (1999). *Behavioral competence*. In G. B. Avery, M. A. Fletcher, & M.G. MacDonald (Eds.), *Neonatology: Pathophysiology and Management of the Newborn* (5<sup>th</sup> ed., pp. 321-327). Philadelphia: Lippincott Williams & Wilkins.
- Bremmer, P., Byers, J. F., & Kiehl, E. (2003). Noise and the Premature Infant: Physiological Effects and Practice Implication. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 32, 447-454.
- Butt, M. L., & Kisilevsky, BS. (2000). Music modulates behaviour of premature infants following Heel lance. *Canadian Journal of Nursing Research*, 31(4), 17-39.
- Caine, J. (1991). The effects of music on the selected stress behaviors, weight, calorie and formula intake, and length of hospital stay of premature and low birth weight neonates in a newborn intensive care unit. *Journal of Music Therapy*, 28(4), 180-192.
- Chang, Y., Anderson, G. C. & Lin, C. (2002). Effects of prone and supine positions on sleep state and stress responses in mechanically ventilated preterm infants during the first postnatal week. *Journal of Advanced Nursing*, 40(2), 161-169.

- Chlan, L. (1998). Effectiveness of a music therapy intervention on relaxation and anxiety for patients receiving ventilatory assistance. *Heart & Lung*, 27(3), 169-176.
- Chlan, L., & Tracy, M. F. (1999). Music therapy in critical care : Indications and guidelines for intervention. *Critical Care Nurse*, 19, 35-41.
- Chou, L. L., Wang, R. H., Chen, S. J., & Pai, L. (2003). Effects of music therapy on oxygen Saturation in premature infant receiving endotracheal suctioning. *Journal of Nursing Research*, 11(3), 209-216.
- Collins, S., & Kuck, K. (1991). Music Therapy in the Neonatal Intensive Care Unit. *Neonatal network*, 9(6), 23-26.
- Creger, P. (1993). *Developmental support in the NICU*. In B. Patricia & J. Deacon (Eds.), *Core curriculum for neonatal intensive care nursing* (pp. 426-442). Philadelphia: W. B. Saunders.
- Crosse, V. M., & Hill, E. E. (1975). *The Preterm Baby and other Babies with Low Birth Weight* (pp. 249-260). London: Churchill Livingstone.
- Flowers, A. L., McCain, A. P., & Hilker, K. A. (1999). *The effects of music listening on premature infants* (pp. 211-216). Paper presented at the Biennial Meeting, Society for Research in Child Development, Albuquerque, NM.
- Gill, N. E., Behnke, M., Conlon, M., McNeely, J. B., & Anderson, G. C. (1988). Effect of Nonnutritive Sucking On Behavioral State In Preterm Infants Before Feeding. *Nursing Research*, 37(6), 347-350.
- Glass, P. (1994). *The Vulnerable Neonate and the Neonatal Intensive Care Environment*. In G. B. Avery, M. A. Fletcher, & M. G. MacDonald (Eds.), *Neonatology: Pathophysiology and Management of the Newborn* (5<sup>th</sup> ed., pp.77-94). Philadelphia: J.B. Lippincott Company.
- Guzzetta, C. E. (1989). Effects of relaxation and music therapy on patients in a coronary care unit with presumptive acute myocardial infarction. *Heart & Lung*, 18, 609-616.
- Holditch-Davis, D. (1998). *Neonatal Sleep-Wake States*. In C. Kenner, J. W. Lott, & A. A. Flandermeyer (Eds.), *Comprehensive Neonatal Nursing: A Physiologic Perspective* (pp. 921-938). Philadelphia: W.B. Saunders.

- Holsti, L., Grunau, R. E., Whifield, M., Oberlander., & Lindh, V. (2006). Behavioral Responses to Pain Are Heightened After Clustered Care in Preterm infants Born Between 30 & 32 weeks Gestational Age. *Clinical Journal of Pain*, 22(9), 757-764.
- Kenner, C., & Wright Lott, J. (2003). *Comprehensive Neonatal Nursing* (3<sup>rd</sup> ed., pp. 724-740). Philadelphia: Saunders.
- Kemper, K. J. (2005). Music Therapy. *Southern Medical Association*, 98(3), 282-288.
- Kick, E. (1996). *Sleep and the Family*. In P. J. Bomar (Eds.), *Nurses and Family Health Promotion: Concepts, Assessment, and Intervention* (2<sup>nd</sup> ed., pp. 245-263). Philadelphia: W.B. Saunders.
- Klaus, M. H., & Fanaroff, A. A. (2001). *Care of the high-risk neonate*. (5<sup>th</sup> ed., pp. 223-228) W.B. Philadelphia: Saunders Company.
- Kurdrit, S. (2002). *The Physiological and Sleep-wake Behavioral Responses of Premature Infants to the Neonatal Intensive Care Unit Environment*. The Degree of Master of Science. Mahidol University.
- Lai, H. L., Chen, C. J., Peng, T. C., Chang, F. M., Hsieh, M. L., Huang, H. Y., & Chang, S. C. (2006). Randomized controlled trial of music during kangaroo care on maternal state anxiety and preterm infant' responses. *International Journal of Nursing Studies*, 43(2), 139-146.
- Mann, N. P., Haddow, R., Stokes, L., Goodley, S., & Rutter, N. (1986). Effect of night and day on preterm infants in a newborn nursery. *British Medical Journal*, 293, 1265-1267.
- Medoff-Cooper, B., Bilker, W., & Kaplan, J. (2001). Sucking behavior as a function of gestational age: A cross-sectional study. *Infant Behavior & Development*, 24, 83-94.
- Modrcin-McCarthy, M. A., McCue, S., & Walker, J. (1997). Preterm infants and Stress: a tool for the neonatal nurse. *Journal of Perinatal and Neonatal Nursing*, 10(4), 62-71.
- Mornhinweg, G. C. (1992). Effects of music preference and selection on stress reduction. *Journal of Holistic Nursing*, 10, 101-109.
- Pett, M. A. (1997). *Nonparametric statistics for health care research*. London: SAGE.

- Plains, W. (2007). More *Babies Born Prematurely: New Report Shows* Retrieved August 17, 2008, from <http://www.marchofdimess.com>
- Pillitteri, A. (1999). *Child health nursing: care of the child and family* (pp. 442-446). Philadelphia: Lippincott.
- Ramsay, D., & Lewis, M. (2003). Reactivity and regulation in cortisol and behavioral to stress. *Child Development*, 74(2), 456-464.
- Reid, T. L., & Freer, Y. (2000). *Developmentally Focused Nursing Care*. In G. Boxwell (Eds.), *Neonatal Intensive Care Nursing* (pp. 14-42). London: Routledge.
- Setven, J. P. (2002). *Applied multivariate statistics for the social sciences* (4<sup>th</sup> ed). Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Sizun, J., & Westrup, B. (2004). Early developmental care for preterm neonates: a call for more research. *Archives of Disease in Childhood Fetal & Neonatal Edition*, 89(5), 384-388.
- Spath-Schwalbe, E., Hundenborn, C., Kern, W., Fehm, H. L., & Born, J. (1995). Nocturnal wakefulness inhibits growth hormone (GH)-releasing hormone-induced GH secretion. *Journal of Clinical Endocrinology & Metabolism*, 80, 214-219.
- Standley, J. M. (2002). A Meta-Analysis of the Efficacy of Music Therapy for Premature Infants. *Journal of Pediatric Nursing*, 17(2), 107-113.
- Standley, J. M. (2003). The effect of music-reinforced nonnutritive sucking on feeding rate of Premature infants. *Journal of Pediatric Nursing*, 18(3), 169-173.
- Symington, A., & Pinelli, J. (2007). *Developmental care for promoting development and preventing morbidity in preterm infants*. In the Cochrane Library (version 4): Update Software, Oxford, UK, 2.
- Well-Federman, C. L., Stuart, E. M., Deckro, J. P., Mandle, C. L., Baim, M., & Medich, C. (1995). The Mind-Body Connection: The Psychophysiology of Many Traditional Nursing Interventions. *Clinical Nurse Specialist*, 9(1), 59-66.
- White, J. M. (2000). State of the Science of Music Interventions. *Critical Care Nursing Clinics of North America*, 12(2), 219-225.
- Zahr, L. K. (1998). Two Contrasting: NICU Environment. *The American Journal of Maternal/ Child Nursing*, 23, 28-36.

Zahr, L. K., & Balian, S. (1995). Responses of premature infants to routine nursing interventions and noise in the NICU. *Nursing Research*, 44, 179-185.

กรมอนามัย กระทรวงสาธารณสุข. (2547). *ร้อยละของภาวะน้ำหนักทารกแรกเกิดน้อยกว่า 2,500 กรัม*  
Retrieved April 10, 2008, from <http://www.anamai.moph.go.th>

งานเวชสารสนเทศ. (2548). *ข้อมูลทารกแรกเกิดปี 2548-2550*. กรุงเทพฯ: หน่วยบริการข้อมูล งาน  
เวชสารสนเทศ โรงพยาบาลรามธิบดี.

จริยา อินทะพันธุ์. (2544). *การถูกจับต้องของทารกแรกเกิดก่อนกำหนดในหออภิบาลทารกแรกเกิด*.  
วิทยานิพนธ์พยาบาลศาสตรมหาบัณฑิต สาขากุมารเวชศาสตร์, บัณฑิตวิทยาลัย  
มหาวิทยาลัยเชียงใหม่.

ทวีศักดิ์ สิริรัตน์เรขา. (2550). *Music Therapy*. Retrieved April 21, 2008, from  
<http://www.happyhomeclinic.com/a06-musictherapy.htm>

ธราธิป โคละทัต. (2542). Anticipation and recognition of the high risk neonate. ใน ธราธิป  
โคละทัต และสุนทร ฮ่อเผ่าพันธ์ (บรรณาธิการ). *Neonatology for Pediatricians*.  
(หน้า 44-59). กรุงเทพฯ: พีเอลิฟวิ่ง.

นันทพร เสตกรณกุล. (2550). (Nantaporn Settakonnukoon, B.E. 2550). *ผลของคนตรีต่อความ  
เจ็บปวดและการตอบสนองทางสรีรวิทยาในเด็กวัยเรียนภายหลังผ่าตัดหัวใจแบบเปิด*.  
วิทยานิพนธ์ปริญญาพยาบาลศาสตรมหาบัณฑิต สาขาวิชาการพยาบาลเด็ก, บัณฑิต  
วิทยาลัย, มหาวิทยาลัยมหิดล.

นิตยา กษภักดี. (2543). *ขั้นตอนการพัฒนาของเด็กปฐมวัยตั้งแต่ปฏิสนธิ – 5 ปี*. กรุงเทพฯ: โรงพิมพ์  
คุรุสภาลาดพร้าว.

ประสิน จันทรวีทัน. (2548). Principles of fluid and electrolyte management in neonate. ใน สราวุธ  
สุภาพรรณาติ (บรรณาธิการ), *Best practice in neonatal care* (หน้า 155-168).  
กรุงเทพฯ: ธนาเพรส จำกัด.

พิมลรัตน์ ไทยธรรมยานนท์. (2544). *การดูแลทารกแรกเกิด*. กรุงเทพฯ: ชัยเจริญ.

เพ็ญจิตร ธนเจริญพิพัฒน์. (2544). *ผลของการจัดทำนอนต่อระยะเวลาการหลับของทารกแรกเกิดก่อน  
กำหนด*. วิทยานิพนธ์พยาบาลศาสตรมหาบัณฑิต สาขาวิชาการพยาบาลกุมารเวช  
ศาสตร์, บัณฑิตวิทยาลัย มหาวิทยาลัยเชียงใหม่.

วิณา จิระแพทย์. (2543). การควบคุมอุณหภูมิกายของทารกแรกเกิด. ใน สราวุธ สุภาพรรณาติ  
(บรรณาธิการ), *Advanced Neonatal Mechanical Ventilation and Neonatal Respiratory  
Intensive Care* (หน้า 99-113). กรุงเทพฯ: ธนาเพรส แอนด์ กราฟฟิค จำกัด.

ศศิธร พุ่มดวง. (2548). คนตรีบำบัด. *สงขลานครินทร์เวชสาร*, 23(3), 185-191.

สกุลตลา สูดเสนาหา. (2548). (Sakuntala Sudsaneha, B.E. 2548). *ผลของการจัดช่วงเวลาสงบต่อภาวะการหลับตื่นของทารกเกิดก่อนกำหนดในหออภิบาลทารกแรกเกิด*. วิทยานิพนธ์ปริญญาพยาบาลศาสตรมหาบัณฑิต สาขาวิชาการพยาบาลเด็ก, บัณฑิตวิทยาลัย, มหาวิทยาลัยมหิดล.

สรายุทธ สุภาพรรณชาติ. (2540). ทารกแรกเกิดน้ำหนักตัวน้อย. ใน วันดี วราวิทย์ ประพุทธศิริพันธุ์ และสุรางค์ เขียมจรรยา (บรรณาธิการ), *ตำรากุมารเวชศาสตร์* (ฉบับเรียบเรียงใหม่) (หน้า 18-32). กรุงเทพฯ: โฮลิสติกลิซซิ่ง.

สุกัญญา ทักขพันธุ์. (2548). Prevevion of bronchopulmonary dysplasia. ใน สรายุทธ สุภาพรรณชาติ (บรรณาธิการ), *Best practice in neonatal care* (หน้า 90-105). กรุงเทพฯ: ธนาเพรส จำกัด.

เอื้ออารี วงษ์สวัสดิ์. (2551). (Ua-aree wongsawat, B.E. 2551). *ผลของการดูแลเพื่อส่งเสริมความสุขสบายแบบองค์รวมต่อการตอบสนองด้านสรีรวิทยาและพฤติกรรมในทารกคลอดก่อนกำหนดที่ได้รับการใส่ท่อหายใจทางจมูก*. วิทยานิพนธ์ปริญญาพยาบาลศาสตรมหาบัณฑิต สาขาวิชาการพยาบาลเด็ก, บัณฑิตวิทยาลัย, มหาวิทยาลัยมหิดล.



## APPENDIX A



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 ๒๕๕๒/๑๕๐๕

|                    |                                                                               |
|--------------------|-------------------------------------------------------------------------------|
| ชื่อโครงการ        | ผลของคนตรีต่อภาวะหลับใต้นของทารกเกิดก่อนกำหนดในหอผู้ป่วยบำบัดวิกฤตทารกแรกเกิด |
| เลขที่โครงการ/รหัส | ID ๐๖ - ๕๒ - ๒๖ ๖                                                             |
| ชื่อหัวหน้าโครงการ | นางสาวทิพย์ ศรีเฉลิม                                                          |
| ที่ทำงาน           | ภาควิชาพยาบาลศาสตร์<br>คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี<br>มหาวิทยาลัยมหิดล    |

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับแนวปฏิบัติ  
เฮลซิงกิ จากคณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

ลงนาม .....  
กรรมการและเลขานุการจริยธรรมการวิจัยในคน (รองศาสตราจารย์ แพทย์หญิงดวงฤดี วัฒนศิริชัยกุล)

ลงนาม .....  
ประธานกรรมการจริยธรรมการวิจัยในคน (ศาสตราจารย์ นายแพทย์บุญส่ง องค์พิพัฒนกุล)

วันที่รับรอง ๑๗ มิถุนายน ๒๕๕๒



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**

No. MURA2009/1505

|                               |                                                                                              |
|-------------------------------|----------------------------------------------------------------------------------------------|
| <b>Title of Project</b>       | The Effect of Music on Sleep-Wake State of Premature Infants in Neonatal Intensive Care Unit |
| <b>Protocol Number</b>        | ID 06 – 52 – 26                                                                              |
| <b>Principal Investigator</b> | Miss Tippawan Srichalerm                                                                     |
| <b>Official Address</b>       | Department of Nursing<br>Faculty of Medicine, Ramathibodi Hospital<br>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 ..... *Dueng W.*  
Committee on Human Rights Related to Assoc. Prof. Duangrurdee Wattanasirichaigoon, M.D.  
Researches Involving Human Subjects

Signature of Chairman ..... *Boonsong*  
Committee on Human Rights Related to Prof. Boonsong Ongphiphadhanakul, M.D.  
Researches Involving Human Subjects

Date of Approval June 17, 2009



# 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

ที่ จวก ๑๑๙/๒๕๕๒

คณะกรรมการจริยธรรมการวิจัยในคน

วันที่ ๒ มิถุนายน ๒๕๕๒

เรื่อง แจ้งผลการพิจารณาของคณะกรรมการจริยธรรมการวิจัยในคน

เรียน นางสาวทิพย์ ศรีเฉลิม

อ้างถึงโครงการวิจัยเรื่อง ผลของคนตีต่อภาวะหลังต้นของทารกเกิดก่อนกำหนดในผู้ป่วยเบาหวานชนิดที่ 2

หมายเลขโครงการวิจัย ID ๐๖ - ๕๒ - ๒๖๔ ๖

ในนามของคณะกรรมการจริยธรรมการวิจัยในคน ผมขอแสดงความยินดีที่โครงการวิจัยดังกล่าวข้างต้นของท่านได้ผ่านความเห็นชอบจากคณะกรรมการฯ แล้ว

เพื่อให้สอดคล้องกับระเบียบปฏิบัติคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ว่าด้วยการศึกษาวิจัยและการทดลองในมนุษย์ พ.ศ. ๒๕๕๔ คณะกรรมการฯ ขอให้ท่านถือปฏิบัติโดยเป็นไปตามข้อแนะนำดังต่อไปนี้

๑. การดำเนินการวิจัยจะต้องเป็นไปตามโครงการวิจัยล่าสุดที่ผ่านการพิจารณาจากคณะกรรมการจริยธรรมการวิจัยในคนแล้ว
๒. การดำเนินการวิจัยจะต้องไม่เบี่ยงเบนไปจากโครงการวิจัยหรือมีการเปลี่ยนแปลงโครงการวิจัยก่อนที่การแก้ไขเพิ่มเติมโครงการวิจัยนั้นจะได้รับการอนุมัติและเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในคนก่อน ยกเว้นในกรณีจำเป็นที่จะต้องกระทำไปก่อนเพื่อจัดอันตรายเฉพาะหน้าที่เกิดขึ้นกับผู้ยินยอมคนให้ทำวิจัย
๓. ในกรณีที่มีการเปลี่ยนแปลงชื่อโครงการไปจากชื่อเดิมที่เสนอไว้ ต่อคณะกรรมการฯ ต้องแจ้งข้อมูลยังคณะกรรมการฯ เพื่อออกหนังสือรับรองให้เสมอ
๔. ผู้ยินยอมคนให้ทำวิจัยจะต้องได้รับเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมคนให้ทำวิจัย (Patient/Participant Information Sheet) และลงนามในหนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent Form) ก่อนเริ่มดำเนินการวิจัย
๕. ในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมคนให้ทำวิจัย (Patient's Information Sheet) จะต้องพิมพ์ข้อความดังต่อไปนี้ไว้ด้วยทุกครั้ง

" ถ้าท่านมีข้อสงสัยหรือมีความกังวลเกี่ยวกับวิธีดำเนินการวิจัยของโครงการวิจัยนี้ ท่านสามารถติดต่อได้ที่ ประธานกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี หน่วยจริยธรรมการวิจัยในคน สำนักงานวิจัยคณะฯ อาคารวิจัยและสวัสดิการ ชั้น ๓ (ห้อง ๓) โทรศัพท์ ๐๒-๒๐๑ ๕๕๔๔ ในเวลาราชการ"

๖. ความลับของผู้ยินยอมคนให้ทำวิจัย จะต้องถูกปกปิดไว้ตลอดเวลา ยกเว้นถ้าเป็นคำสั่งตามกฎหมาย

สุดท้ายนี้ ขอให้โครงการวิจัยของท่านประสบผลสำเร็จตามความมุ่งหมายอันจะนำมาซึ่งความเจริญก้าวหน้าทางวิชาการ และเพื่อประโยชน์ของมนุษยชาติสืบต่อไป

ขอแสดงความนับถือ

(ศาสตราจารย์ บุญส่ง องค์กรพัฒนกุล)  
ประธานกรรมการจริยธรรมการวิจัยในคน



## หนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent Form)

ชื่อโครงการ ผลของดนตรีต่อภาวะหลับตื้นของทารกเกิดก่อนกำหนดในหอผู้ป่วยวิกฤตทารกแรกเกิด

ชื่อผู้วิจัย นางสาวทิพย์ ศรีเฉลิม

\*ชื่อผู้เข้าร่วมการวิจัย .....

อายุ ..... เลขที่เวชระเบียน .....

### คำยินยอมของผู้เข้าร่วมการวิจัย

ข้าพเจ้า นาย/นาง/นางสาว ..... ได้ทราบรายละเอียดของโครงการวิจัยตลอดจนประโยชน์ และข้อเสี่ยงที่จะเกิดขึ้นต่อข้าพเจ้าจากผู้วิจัยแล้วอย่างชัดเจน ไม่มีสิ่งใดปิดบังซ่อนเร้นและยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้ารู้ว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้นข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถไม่เข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อการรักษาที่ข้าพเจ้าพึงได้รับ นอกจากนี้ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆที่เกี่ยวข้องกระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้น

ลงชื่อ.....(ผู้เข้าร่วมการวิจัย)

.....(พยาน)

.....(พยาน)

วันที่ .....

### คำอธิบายของแพทย์หรือผู้วิจัย

ข้าพเจ้าได้อธิบายรายละเอียดของโครงการ ตลอดจนประโยชน์ของการวิจัย รวมทั้งข้อเสี่ยงที่อาจจะเกิดขึ้นแก่ผู้เข้าร่วมการวิจัยทราบแล้วอย่างชัดเจนโดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ลงชื่อ.....(แพทย์หรือผู้วิจัย)

วันที่.....

หมายเหตุ: กรณีผู้เข้าร่วมการวิจัยไม่สามารถอ่านหนังสือได้ ให้ผู้วิจัยอ่านข้อความในหนังสือยินยอมฯ นี้ให้แก่ผู้เข้าร่วมการวิจัยฟังจนเข้าใจแล้ว และให้ผู้เข้าร่วมการวิจัยลงนามหรือพิมพ์ลายนิ้วหัวแม่มือรับทราบในการให้ความยินยอมดังกล่าวข้างต้นไว้ด้วย

\*ผู้เข้าร่วมการวิจัย หมายถึง ผู้ยินยอมตนให้ทำวิจัย

## APPENDIX B

## แบบบันทึกข้อมูลทั่วไป

H.N. .... เกิดวันที่ ..... เวลา ..... เพศ .....

อายุ ..... วัน วิธีเกิด .....

สาเหตุ.....

อายุครรภ์แรกเกิด ..... สัปดาห์      น้ำหนักแรกเกิด ..... กรัม

อายุครรภ์ปัจจุบัน ..... สัปดาห์      น้ำหนักปัจจุบัน ..... กรัม

การวินิจฉัยโรค.....

## ภาวะสุขภาพและการรักษาในปัจจุบัน

---

.....

---

---

---

.....

.....

.....

.....

.....

.....

**OBSERVATION RECORD SHEET**

| <b>Time</b>      | <b>Sound level<br/>(dB)</b> | <b>Light level<br/>(Lux)</b> | <b>Handling<br/>score</b> | <b>Sleep-Wake<br/>State</b> | <b>Remark</b> |
|------------------|-----------------------------|------------------------------|---------------------------|-----------------------------|---------------|
| <b>Non-music</b> |                             |                              |                           |                             |               |
| Baseline         |                             |                              |                           |                             |               |
| Immediately      |                             |                              |                           |                             |               |
| 5 minute         |                             |                              |                           |                             |               |
| 10 minute        |                             |                              |                           |                             |               |
| 15 minute        |                             |                              |                           |                             |               |
| 20 minute        |                             |                              |                           |                             |               |
| 25 minute        |                             |                              |                           |                             |               |
| 30 minute        |                             |                              |                           |                             |               |
| <b>Music</b>     |                             |                              |                           |                             |               |
| Baseline         |                             |                              |                           |                             |               |
| Immediately      |                             |                              |                           |                             |               |
| 5 minute         |                             |                              |                           |                             |               |
| 10 minute        |                             |                              |                           |                             |               |
| 15 minute        |                             |                              |                           |                             |               |
| 20 minute        |                             |                              |                           |                             |               |
| 25 minute        |                             |                              |                           |                             |               |
| 30 minute        |                             |                              |                           |                             |               |

☐ **Day shift (10.00-10.35 AM, 2.00-2.35 AM)**

☐ **Evening shift (6.00-6.35 PM, 10.00-10.35 PM)**

☐ **Night shift (2.00-2.35 PM, 6.00-6.35 AM)**

**Date.....No.....**

## ANDERSON BEHAVIORAL STATE SCALES: ABSS (THAI VERSION)

### แบบประเมินพฤติกรรมระยะหลับตื่นของทารกเกิดก่อนกำหนด

| คะแนน 1 – 4 เป็นพฤติกรรมระยะ หลับ ของทารก (Sleep State)                                                                                                                                                                                   |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. หลับลึกมาก<br>(regular quiet sleep)                                                                                                                                                                                                    | 2. หลับลึก<br>(irregular quiet sleep)                                                                                                                                                                                                              | 3. หลับตื่น<br>(active sleep)                                                                                                                                                                                                             | 4. หลับตื่นมาก<br>(very active sleep)                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>หลับตา</li> <li>ไม่มีการเคลื่อนไหวของเปลือกตา</li> <li>หายใจสม่ำเสมอ</li> <li>ไม่มีการเคลื่อนไหวของร่างกาย</li> </ul>                                                                              | <ul style="list-style-type: none"> <li>หลับตา</li> <li>ไม่มีการเคลื่อนไหวของเปลือกตา</li> <li>หายใจไม่สม่ำเสมอ</li> <li>มีการเคลื่อนไหวเพียงเล็กน้อยของ ศีรษะ, มือ, เท้า, แขนส่วนข้อศอกถึงข้อมือ และขาส่วนหัวเข่าถึงข้อเท้า</li> </ul>             | <ul style="list-style-type: none"> <li>หลับตา</li> <li>มีการเคลื่อนไหวของเปลือกตา</li> <li>หายใจไม่สม่ำเสมอ</li> <li>มีการเคลื่อนไหวเป็นระยะ แต่ไม่ตลอดเวลาของแขนและขาทุกส่วน</li> </ul>                                                  | <ul style="list-style-type: none"> <li>หลับตา</li> <li>มีการเคลื่อนไหวของเปลือกตา</li> <li>หายใจไม่สม่ำเสมอ</li> <li>มีการเคลื่อนไหวของร่างกายทุกส่วนตลอดเวลา มีการบิดตัวหรือยกลำตัว</li> </ul> |
| คะแนน 5 เป็นพฤติกรรมระยะ ง่วงซึม ของทารก (Drowsy State)                                                                                                                                                                                   |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>ทารกกำลังจะหลับตาหรือกำลังจะลืมตา หรือทารกหลับตาแบบสละสลือ หรือทารกเปิดตาข้างเดียวส่วนอีกข้างปิด</li> <li>ไม่มีการเคลื่อนไหวของร่างกายหรือมีการเคลื่อนไหวเพียงเล็กน้อย (หาว)</li> </ul>            |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |                                                                                                                                                                                                 |
| คะแนน 6 – 9 เป็นพฤติกรรมระยะ ตื่น ของทารก (Awake State)                                                                                                                                                                                   |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |                                                                                                                                                                                                 |
| 6. ตื่นไม่มีการเคลื่อนไหว<br>(quiet alert awake)                                                                                                                                                                                          | 7. ตื่นเงียบ<br>(quiet awake)                                                                                                                                                                                                                      | 8. ตื่นมีการเคลื่อนไหว<br>(active awake)                                                                                                                                                                                                  | 9. ตื่นมีการเคลื่อนไหวมาก<br>(very active awake)                                                                                                                                                |
| <ul style="list-style-type: none"> <li>ลืมตา</li> <li>ไม่มีการกลอกตาและไม่มองตาม</li> <li>ไม่มีการเคลื่อนไหวหรือมีการเคลื่อนไหวช้าๆ เพียงเล็กน้อยของ ศีรษะ, มือ, เท้า, แขนส่วนข้อศอกถึงข้อมือ และขาส่วนหัวเข่าถึงส้นเท้า</li> </ul>       | <ul style="list-style-type: none"> <li>ลืมตา</li> <li>มีการกลอกตาและมองตาม</li> <li>มีการเคลื่อนไหวเป็นระยะ แต่ไม่ตลอดเวลาของ ศีรษะ, มือ, เท้า, แขนส่วนข้อศอกถึงข้อมือ และขาส่วนหัวเข่าถึงส้นเท้า</li> </ul>                                       | <ul style="list-style-type: none"> <li>ลืมตา</li> <li>มีการกลอกตาและมองตาม</li> <li>มีการเคลื่อนไหวของ ศีรษะ และแขนขาทุกส่วน</li> </ul>                                                                                                   | <ul style="list-style-type: none"> <li>ลืมตา</li> <li>มีการกลอกตาและมองตาม</li> <li>มีการเคลื่อนไหวของร่างกายทุกส่วน บิดตัวหรือยกลำตัว</li> </ul>                                               |
| คะแนน 10 – 12 เป็นพฤติกรรมระยะ ร้องไห้ ของทารก (Crying State)                                                                                                                                                                             |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |                                                                                                                                                                                                 |
| 10. หงุดหงิด (fussing)                                                                                                                                                                                                                    | 11. ร้องไห้ (crying)                                                                                                                                                                                                                               | 12. ร้องไห้หนัก (hard crying)                                                                                                                                                                                                             |                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>หลับตาหรือลืมตา</li> <li>สีผิวปกติ</li> <li>หายใจออกยาวนานเล็กน้อย(หายใจออกนานกว่าหายใจเข้า &lt; 2 sec)</li> <li>ร้องครางมีเสียงหรือไม่มีเสียง</li> <li>มีการเคลื่อนไหวของอวัยวะทุกส่วน</li> </ul> | <ul style="list-style-type: none"> <li>หลับตาหรือลืมตา</li> <li>หน้าแดง</li> <li>หายใจออกยาวนาน (หายใจออกนานกว่าหายใจเข้า &gt; 2 sec แต่ &lt; 5 sec)</li> <li>ร้องมีเสียงหรือไม่มีเสียง</li> <li>มีการเหยียดตัวของลำตัวและอวัยวะทุกส่วน</li> </ul> | <ul style="list-style-type: none"> <li>หลับตาหรือลืมตา</li> <li>หน้าแดงมาก</li> <li>หายใจออกยาวนานมาก (หายใจออกนานกว่าหายใจเข้า &gt; 5 sec)</li> <li>ร้องมีเสียงหรือไม่มีเสียง</li> <li>มีการเหยียดตัวของลำตัวและอวัยวะทุกส่วน</li> </ul> |                                                                                                                                                                                                 |

\*\*\* ให้สังเกตพฤติกรรมทารกก่อนเป็นเวลา 30 วินาที จึงทำการสรุประยะการหลับตื่นของทารกลงในแบบบันทึก (1 – 12) \*\*\*

## ASSESSMENT OF PREMATURE INFANT HANDING (THAI VERSION)

### แบบประเมินประเภทการถูกจับต้องของทารกเกิดก่อนกำหนด

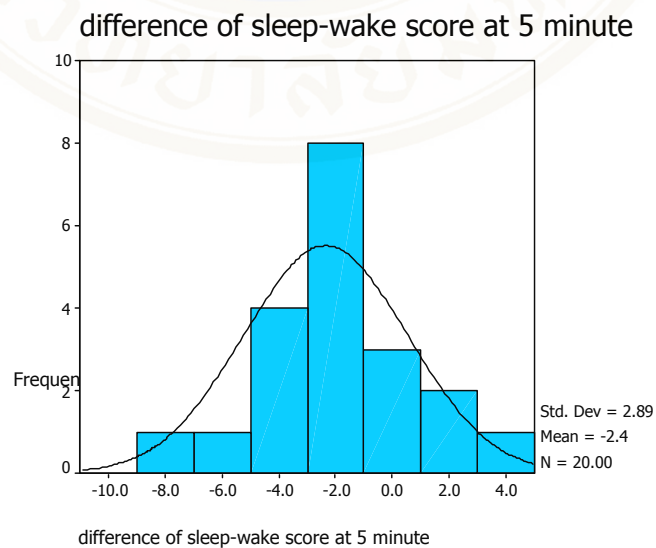
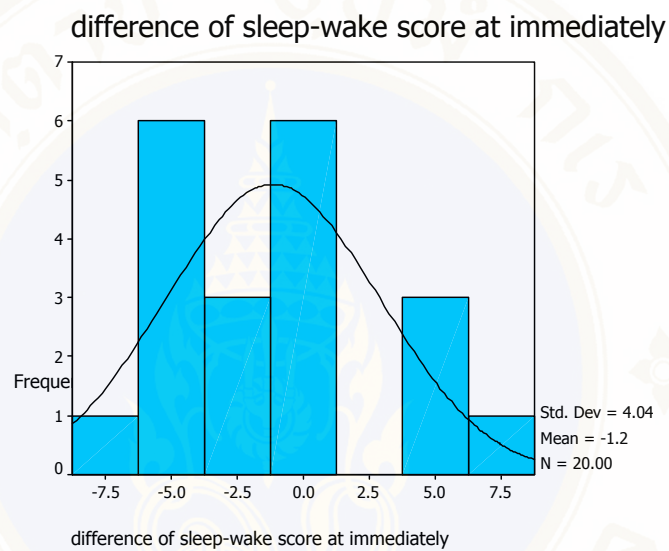
| 1. การถูกจับต้องเพื่อการปล่อยประโลม                                                                                                                                                                                                                                                                                                                                                                           | 2. การถูกจับต้องที่ไม่ให้เกิดความรำคาญ                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3. การถูกจับต้องที่ไม่เกิดความไม่สุขสบาย                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 4. การถูกจับต้องที่ไม่เกิดความเจ็บปวด                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• การอุ้มหรือสัมผัสเบาๆ</li> <li>• การสัมผัสและสบตากับทารก</li> <li>• การอุ้มทารก</li> <li>• การอุ้มทารกเพื่ออุ้มนมมารดา</li> <li>• การห่อตัวทารกเพื่อปล่อย โยน</li> <li>• การจับต้องทารกเพื่อใส่ห่มบนเปล</li> <li>• การจัดทำทารกโดยมือทารกอยู่ใกล้ปาก เช่น ขาทารกงอเข้าไปถึงกลางลำตัว</li> <li>• การอุ้มสัมผัสเพื่อการปล่อยประโลมหลังทารกได้รับความเจ็บปวด</li> </ul> | <ul style="list-style-type: none"> <li>• การเช็ดทำความสะอาดร่างกาย</li> <li>• การทำความสะอาดหลังการจับ</li> <li>• การเปลี่ยนเสื้อผ้า</li> <li>• การเปลี่ยนผ้าอ้อม</li> <li>• การเปลี่ยนท่านอน</li> <li>• การวัดอุณหภูมิทางรักแร้</li> <li>• การเปลี่ยนตำแหน่งสายสะดือต่างๆ</li> <li>• การติดพลาสติก</li> <li>• การฟังเสียงหัวใจ</li> <li>• การฟังเสียงหายใจ</li> <li>• การฟังเสียงการเคลื่อนไหวของลำไส้</li> <li>• การให้ยารหรืออมทางปากผ่านสายให้อาหาร</li> <li>• การ draw blood gas ทางสายสะดือ</li> </ul> | <ul style="list-style-type: none"> <li>• การทำกายภาพบำบัดทรวงอก</li> <li>• การดูดเสมหะทางจมูกหรือปากโดยตรง</li> <li>• การเกาะเพื่อตรวจร่างกาย</li> <li>• การมัดคางหรือการห่อตัวเพื่อมัดคาง</li> <li>• การวัดความดันโลหิต</li> <li>• การวัดอุณหภูมิทางทวารหนัก</li> <li>• การติดหรือคล้องกับปีศาจ</li> <li>• การชั่งน้ำหนัก</li> <li>• การอาบน้ำ</li> <li>• การเปลี่ยนผ้าปูที่นอน</li> <li>• การอุ้มหรือการเคลื่อนย้ายทารกเพื่อทำการสะอืดหรือเปลี่ยนเสื้อผ้าเพื่อลดเลือดผ่าน</li> <li>• การให้หยดหรือฉีดเข้าหลอดเลือดผ่าน</li> <li>• การสายให้น้ำเกลือ</li> <li>• การเอ็กซเรย์</li> <li>• การฉีดสารขาว</li> </ul> <p>การตรวจคลื่นไฟฟ้าหัวใจ</p> | <ul style="list-style-type: none"> <li>• การดูดเสมหะทางท่อช่วยหายใจ</li> <li>• การใส่หรือสอดสายให้อาหารทางปาก</li> <li>• การใส่หรือสอดสายสวนสะดือ</li> <li>• การใส่หรือสอดท่อหายใจ</li> <li>• การใส่หรือสอดสายสวนปีศาจ</li> <li>• การใส่หรือสอดท่อระบายของเหลวหรือลมออกจาทรวงอก (chest drain)</li> <li>• การฉีดเข้าทวาร</li> <li>• การฉีดเข้าหลอดเลือดโดยตรง</li> <li>• การแทงเข็มเพื่อใส่สารน้ำหรือสารอาหารทางหลอดเลือด</li> <li>• การเจาะเลือด</li> <li>• การเจาะหลัง</li> <li>• การทำ cut down</li> <li>• การกะพลาตหรือใส่แผ่นแผล</li> <li>• การตัดไหมหรือทำแผล</li> </ul> |

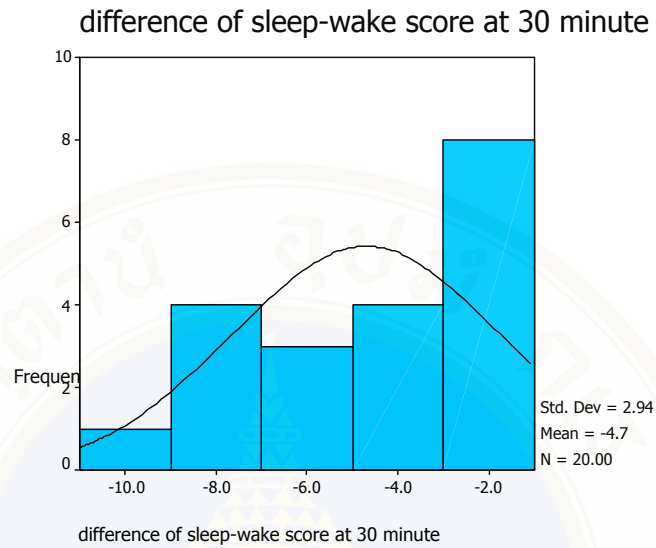
#### หมายเหตุ

1. ขณะสังเกต หากทารกไม่ถูกจับต้อง ให้ 0 คะแนน
2. ขณะสังเกต หากทารกถูกจับต้องมากกว่า 1 ประเภท ให้ใส่คะแนนประเภทที่มากที่สุด พร้อมทั้งใส่รายละเอียดของการถูกจับต้องในช่องหมายเหตุด้วย
3. ขณะสังเกต หากพบการจับต้องทารกที่นอกเหนือจากแบบประเมินนี้ ให้ใส่รายละเอียดของการถูกจับต้องนั้นๆ ลงในช่องหมายเหตุ โดยไม่ต้องใส่คะแนนในช่องการถูกจับต้อง

## APPENDIX C

### Histogram





## APPENDIX D



Request No. EE. 585/50

MTC No. EEL. BP. 64/0950

## CALIBRATION CERTIFICATE

Submitted by : Mahidol University

Address : Department of Nursing Faculty of Medicine, Ramathibodi Hospital

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Center

## Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Digicon

Model : DS-40

Serial No. : M114235

Microphone No. : -

Preamplifier No. : -

## Standards used :

Multifunction Acoustic Calibrator Brüel&Kjær 4226 S/N 2295571  
with Coupler UA0915 S/N 2295571

## Ambient Environment

Temperature :  $(23 \pm 3) ^\circ\text{C}$ Relative Humidity :  $(55 \pm 15) \%$ Ambient Pressure :  $(1\,008 \pm 5) \text{ hPa}$ 

Calibration Procedure : This procedure is developed by Electrical and Electronic Standards Laboratory based on ;

1. IEC 651(1979) Standard for Sound Level Meters
2. International Recommendation OIML R 58(1998) for Sound Level Meters

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to ;

- National Institute of Metrology (Thailand)

Date of Receipt : 24 Sep. 2007

Date of Calibration : 27 Sep. 2007

1 / 3

The above results are valid exclusively for the tested / analysed sample(s) calibrated item(s) as mentioned in this report/certificate.  
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)  
INDUSTRIAL METROLOGY AND TESTING SERVICE CENTRE

FM.DL.MTC.002 Rev.2

196 Phahonyothin Road, Chatuchak, Bangkok 10900  
Tel. (66) 0 2579 1121-30, 0 2579 5515 ext. 5225, 5226  
Fax. (66) 0 2561 4771, 0 2579 8592  
URL : <http://www.tistr.or.th>

Sri 1, Bangpoo Industrial Estate, Sukhumvit Road,  
Amphoe Mueng, Samutprakan 10280  
Tel. (66) 0 2323 1672 - 80, 0 2709 4147 ext. 115, 116  
Fax. (66) 0 2323 9165



Request No. BP-P 553 / 50

MTC No. PSL-P 389 / 50

## CALIBRATION CERTIFICATE

Nomenclature : **Digital Lux Meter**

Serial No. : L552583

Maker : DIGICON

Model : LX-50

Customer : **MAHIDOL UNIVERSITY**

Address : Department of Nursing Faculty of Medicine, Ramathibodi Hospital

Date of request : 24 September 2007

Date of calibration : 9 October 2007

Place of calibration : Photometry Standards Laboratory, MTC. (Bangpoo)

Basis of calibration : Calibrated at 0 ~ 5000 lux.

Condition of calibration :- Ambient temperature :  $25 \pm 2^{\circ}\text{C}$ .

- Relative humidity :  $60 \pm 20\%$

Reference Standard : Working Standard Luminous Intensity Lamp, Serial No.: SB50142C, which was calibrated on 5 July 2007, can be traceable to International System of Units (SI) through the National Measurement Institute (NMI), Australia calibration certificate No. RN45677, RN050210 and RN05211.

Support Equipment : 1. Photometric bench , 3.0 meter long  
2. DC power supply, Serial No.: BC - 341006035007/2  
3. Digital Multimeter , Model : R 6551 , S/N : 42040037 and 42040048

Calibration Procedure : The measurement was done in accordance with W1.CP.10.

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$  , providing a level of confidence of approximately 95 %.

page 1 of 2

The above results are valid exclusively for the tested / analysed sample(s) calibrated item(s) as mentioned in this report/certificate.  
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)  
INDUSTRIAL METROLOGY AND TESTING SERVICE CENTRE

FM.BL.MTC.002 Rev.2

196 Phahonyothin Road, Chatuchak, Bangkok 10900  
Tel. (66) 0 2579 1121-30, 0 2579 5515 ext. 5225, 5226  
Fax. (66) 0 2561 4771, 0 2579 8592  
URL : <http://www.tistr.or.th>

Soi 1, Bangpoo Industrial Estate, Sukhumvit Road,  
Amphoe Muang, Samutprakan 10280  
Tel. (66) 0 2323 1672 - 80, 0 2709 4147 ext. 115, 116  
Fax. (66) 0 2323 9165

## BIOGRAPHY

The background of the biography section features a large, faint, circular seal of Mahidol University. The seal contains the university's name in Thai script and English, along with a central emblem depicting a crown and other traditional symbols.

|                              |                                                                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NAME</b>                  | Miss Tippawan Srichalerm                                                                                                                            |
| <b>DATE OF BIRTH</b>         | 10 December 1980                                                                                                                                    |
| <b>PLACE OF BIRTH</b>        | Lopburi, Thailand                                                                                                                                   |
| <b>INSTITUTIONS ATTENDED</b> | Mahidol University, 1998-2002:<br>Bachelor of Nursing Science<br>Mahidol University, 2006-2010:<br>Master of Nursing Science<br>(Pediatric Nursing) |
| <b>POSITION &amp; OFFICE</b> | 270 Ramathibodi Hospital,<br>Bangkok, Thailand<br>Position: Registered Nurse                                                                        |