THE UNIVERSITY OF ALBERTA

A DESCRIPTION OF THE PAIN EXPERIENCE OF THE POSTOPERATIVE NEWBORN

by

Judith J. Coté

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF NURSING

FACULTY OF NURSING

EDMONTON, ALBERTA

SPRING 1987

ISBN 0-315-37841-7

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: JUDITH J. COTE

TITLE OF THESIS: A DESCRIPTION OF THE PAIN EXPERIENCE OF THE POSTOPERATIVE NEWBORN

DEGREE FOR WHICH THESIS WAS PRESENTED: MASTER OF NURSING

YEAR THIS DEGREE GRANTED: 1987

Signed: Judith J. Cote

PERMANENT ADDRESS:

10637 - 25A Avenue
Edmonton, Alberta
T6J 4K4

Dated: March 19, 1987

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A DESCRIPTION OF THE PAIN EXPERIENCE OF THE POSTOPERATIVE NEWBORN submitted by JUDITH J. COTE in partial fulfillment of the requirements for the degree of Master of Nursing.

Janice M. Morse
Supervisor

Peggy Anne Field

David E. Young

Date: March 19, 1987

DEDICATION

To all those nurses who wanted me to find them some information on the pain experience of the newborn and who encouraged me in the search.

ABSTRACT

Currently there are no methods available to evaluate the pain experience of newborns and no information available on newborns' responses to subacute or long term pain. In this exploratory study, ethological methods were used to examine the postoperative behavior of three male fullterm newborns requiring chest surgery. The infants were videotaped for 12 hours as well as a continuous recording taken of the infants' heart rates, respiratory rates, and blood pressures.

The infants' behaviors were coded for the first 20 seconds of each minute. Behavioral and physiological data were entered into a computer for analysis. Data were analyzed using descriptive statistics, observation analysis and factor analysis. Six factors accounted for 63.9 percent of the variance for Infant I, 65.5 percent of the variance for Infant II, and 70.3 percent of the variance for Infant III. Data combined for all three infants accounted for 61.6 percent of the variance when six factors were extracted.

Behavioral data indicated that infants exhibited behaviors of distress as a result of subacute pain (i.e., a slight frown, eyes closed and legs extended), and behaviors of distress as a result of acute pain (i.e., a frown, crying, eyes closed, and leg movements). Behaviors indicating acute distress were generally related to care given but some sudden acute distress episodes were apparently unrelated to external stimuli. Individual differences in behavior were also observed. The results of the physiological data were inconclusive.

This study demonstrates that ethological methods are appropriate for examining this problem. For future research, the coding system

must be revised and, perhaps, a larger number of infants examined. Infant behavioral and physiological responses may then be studied to determine responses to different types and locations of pain, effects of analgesics, and effects of comfort measures.

ACKNOWLEDGEMENTS

In the past four years there have been so many people who have given me support and encouragement. Top of the list is my husband Barry. I could not have accomplished this task without him and I know that he is happier than I am that this thesis is finally finished. My daughter Corinne's hugs and kisses also kept me going. A special thanks goes to the rest of my family especially my mother and father who have always encouraged us to further our education and my sister who cared for Corinne so lovingly so I could concentrate on my studies.

A big thank you also goes to my thesis committee particularly Dr. Janice Morse, my thesis chairman. Dr. Morse believed in my idea when few others did and was so encouraging at each step of the research process. Without her belief in this project and assistance, the project may not have been completed. Dr. Peggy-Anne Field was not only a great help with my thesis but was also so supportive of my efforts throughout my whole program. Her door was always open when I needed help. Dr. David Young provided rare expertise and helped me accomplish this task.

The nurses I worked with in NICU were very encouraging and their interest in this project helped keep me on track. I also wish to thank Dr. David Schiff and Mrs. Bettianne Hayward for their support and interest.

I also wish to thank the many people who were responsible for the final project: Delores Katzanzidou for typing my proposal, Donna Nicol of Donnic Word Processing for typing the final report, Judy Norris for entering the data, Suzanne Tylko for her expertise and assistance with computer files, Philip Clark of Avicom for the pictures of my babies, and Murray Pearson for the lovely graph.

Funding for this project was gratefully received from the Canadian Nurses Foundation and the Alberta Foundation of Nursing Research. This project does not reflect the policy of either organization.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

Figure | Page

LIST OF FIGURE

Figure

about the discomfort that the newborn may experience. There is still a need for constant observation of sick infants by skilled, experienced nurses (Korones, 1981). Nurses caring for infants sometimes recognize behavioral cues of infants in distress such as crying or frowning and verify these observations with physical indices of pain such as an increased heart rate. However, these behavioral cues have not been systematically examined and are recognized by nurses only after extensive experience or by "nursing intuition" (Pyles & Sterns, 1983, p. 54). In order to make these "intuitive" assessments explicit, there is a need to examine and document the behavioral responses of the postoperative newborn that may be attributed to pain.

In this study, a descriptive exploratory approach was used to investigate the behavioral indicators of distress in newborns. Ethological methods were used to code the behaviors of three male newborn infants for 12 hours, 24 hours following chest surgery. The infants' heart rate, respiratory rate and blood pressure were also recorded in an attempt to identify physiological indices of distress. This pilot project provides beginning information that may improve care of the postoperative newborn.

Statement of the Problem

Currently there are no methods available to evaluate the pain experience of newborns. Nurses assess newborns by carefully observing for behavioral cues and physiological indices of distress but information about these responses is inadequate and is frequently intuitive. Therefore, there is a need to investigate behavioral indices of distress in the postoperative newborn.

This exploratory study will address the following questions:

1. What are the newborn's behavioral indices of distress after chest surgery?
2. What is the response of the newborn's pulse, respirations and blood pressure after chest surgery?
3. What is the association between the behavioral response and the response of the newborn's pulse, respirations and blood pressure after chest surgery?

CHAPTER II

Review of Literature

Little information is available on the pain experience of the newborn or the newborn's behaviors of distress which could be an expression of pain. In order to begin to understand the postoperative newborn's pain experience, the literature was first reviewed for a definition of "pain". A discussion of "pain" is followed by what is known about the pain experience of the newborn as well as the difficulties in assessment of a newborn's pain which must be based on behavioral cues and physiological indices. Ethology is then presented as a method of gaining information about the newborn's behavioral response to pain.

What is Pain?

In the last few decades great strides have been taken to further our understanding of the phenomena of pain (Wall, 1984). Even with all the information gained however, no one has been able to adequately define pain (Melzack & Wall, 1983). A review of the pain literature reveals several types of definitions of "pain".

One type of definition discusses pain as strictly a physical phenomena. For example, pain is "an unpleasant sensation caused by noxious stimulation of the sensory nerve endings" (Urdang, 1983). Other definitions of pain discuss socio-cultural and psychological influences as well as the physical components of pain (Benoliel, 1977). Melzack and Wall (1983) include more information in their definition by discussing factors about pain which as yet are not completely understood such as phantom limb pain. McCaffery (1972) simply states that "pain is whatever the experiencing person says it is, existing whenever he says it does" (p. 8).

Schmidt (1981) adds that pain serves a "specific protective function" and is "indispensable for a normal life" (p. 111). Individuals with a congenital absence of pain, for example, wear out their joints because they do not feel pain and do not protect their joints. These people generally die of severe infection (Melzack & Wall, 1983).

The neuroanatomy of pain is not yet completely identified so that the pain experience must still be explained by theories, such as the Specificity Theory and the Gate Control Theory (Melzack & Wall, 1983). Perl (1984) states however that "pain is a complex function prowling a complex nervous system, and no simplistic model can cage it" (p. 958). None of the present theories discuss pain sensations in infants.

Pain of the Newborn

The tactile sensitivity of the newborn is one of the most difficult senses to test and is the sense on which little systematic investigation has been carried out (Lamb & Campos, 1982). "Newborns can clearly feel" (p. 88) but the extent to which they feel and if they can localize a sensation is not known. In order to come to some understanding about the pain experience of the newborn one must examine the role of peripheral sensory nerves, the role of the spinal cord and the brain and measures that appear to comfort the infant.

The Role of Peripheral Sensory Nerves

It is reported that at 28 weeks gestation the infant can already distinguish touch from pain (Saint-Anne Dargassies, 1966). In Volpe's (1981) sensory exam of the newborn he has observed responses such as "latency, limb movement, facial movement (i.e., grimace), vocalization (i.e., cry), and habituation" (p. 73) to five to ten pricks over the medical aspects of the limbs. "Withdrawal" is often the general term used to describe the infant's reaction to pain (Volpe, 1981).

Owens and Todt (1984) observed 20 newborns to determine their responses to heel lance and to non-invasive tactile stimulation. They concluded that infants experienced pain to a tissue damaging stimulus based on increase in heart rate and crying. Franck (1986) also observed 10 newborns' responses to a heelstick and found their reactions to be "immediate withdrawal of both the affected and unaffected leg, followed by facial grimacing and crying" (p. 28).

Studies of male newborns' reactions to circumcision also support that infants have functioning peripheral sensory nerves. Wiliamson and Williamson (1983) studied 30 infants and concluded that "the physiologic pain-stress response of well, normal, full-term male newborns to unanesthetized circumcision is significantly different from the response of infants circumcized under the influence of a local anesthetic" (p. 40). Marshall et al. (1980) found that in 90 percent of cases newborns had a change in behavior after circumcision.

Lack of complete myelination in the newborn has led researchers to believe that newborns experience pain to a lessor extent than adults or do not experience pain. This relationship is questionable however, when it is noted that approximately 60 to 70 percent of all sensory nerves are unmyelinated even in the adult (Melzack & Wall, 1983). Anecdotal information and research studies support that newborns' peripheral sensory nerves are functioning and that newborns experience pain as evidenced by behaviors of distress and accompanying physiological changes.

The Role of the Spinal Cord and the Brain

In the central nervous system, pain is processed predominantly subcortically, in the spinal cord, brain stem and the thalamus (Melzack & Wall, 1983). This information is important since reactions to painful stimuli need to be reflexive. If something hot is touched, withdrawal must be immediate. As any animal, regardless of level of cognitive development, needs information about dangerous stimuli at its body surface, lack of cognitive development in the infant does not necessarily mean a lack of the perception of pain (Brown & Deffenbacher, 1979).

At birth the infant's brain has a full complement of nerve cells; however, the brain does not have the connections between the cells (Dobbing, 1974). The growth spurt of the brain continues to, and perhaps beyond the infant's second year (Dobbing, 1974). The lack of connections in the infant's brain is evident in that the newborn does not have the "cortical organization to propagate and sustain a generalized seizure" (Volpe & Koenigsberger, 1981, p. 923). Lack of connections in the brain could mean that the infant's perception of pain is not influenced by memory of past experiences, emotions or previous knowledge.

Brazelton (1977) states that the cortex can have a powerful effect on the "autonomic and physiological systems in the neonatal period" (p. 38). He feels that the newborn is not neurologically insufficient but has predictable, directed responses when interacting with an adult or when responding to auditory or visual stimuli.

Newman's (1981) observations support Brazelton's. Newman suggests that premature infants respond to a painful stimuli with "self consoling, a closing out activity and ultimately receptor shut-down" for example, a sleep-like state (p. 10). This response suggests a complex ordering process to focus activity (Newman, 1981).

Responses to Comfort Measures

When infants are distressed they try to reduce or alleviate the distress using spontaneous hand to mouth efforts and sucking. As the infants are soothed their faces soften and they alert to "concentrate on maintaining this kind of self-regulation" (Brazelton, 1977, p. 45).

Distraction has also been effective in soothing infants. (Whaley & Wong, 1983) Methods of distraction commonly used are soothers, swaddling, rocking, placing a hand on the infant's abdomen, restraining an infant's arms and a patting motion of three times per minute (Brazelton, 1977). Field and Goldson (1984) studied 144 term and preterm neonates and found that infants who were given a soother "spent significantly less time fussing and crying during and following the heelstick procedures" (p. 1012).

Intra-uterine sounds (Callis, 1984) and music may also have a calming effect on the infant as well as providing sensory stimulation

(Livingston, 1979). Pharmacological agents, including analgesics such as morphine and meperidine and sedatives such as phenobarbital and chloral hydrate have also been used to soothe a distressed infant (Franke & Lund, 1986).

Assessment of Pain in the Newborn

Assessment of the newborn's pain experience is difficult in that one cannot rely on the most common method of pain assessment--self-report (Poznanski, 1976). Rather it is necessary to observe behaviors such as crying, grimacing, alteration in respiratory pattern, change in level of consciousness, or possibly change in color as manifestations of pain in the infant (Hack, 1973).

One method researchers have used to assess infants for pain as well as other emotions is measurement of facial expression. Two commonly used systems are the Facial Action Coding System (FACS), (Ekman & Friesen, 1978) and the Maximally Discriminative Facial Movement (MAX), (Izard, 1983). Observer reliability can be obtained with both systems. Campos et al. (1983) identifies a major disadvantage of these systems as being very time consuming. Live coding is very difficult and even a videotape requires several viewings. The pain experience used is an injection and not the subacute pain following surgery. Another critique of facial coding has been the neglect of studying other ways infants express emotion (Campos et al., 1983).

McCaffery (1979) suggests that adults in acute pain may have increased sympathoadrenal activity leading to increased heart rate, respirations, and blood pressure, pallor, excessive perspiration, nausea and vomiting. However, these physiological changes cannot be sustained and usually return to normal at least for short periods of time if pain is prolonged, suggesting that physiological adaptation occurs (McCaffery, 1979). Changes in physiological parameters particularly heart rate may be of some use in assessing pain in the newborn (Owen, 1984).

Cry analysis with a sound spectrograph may also be helpful in the future for assessing whether or not an infant is in pain (Levine & Gordon, 1982). Michelsson and Wasz-Höckert (1980) report that from existing research, differences are found in the cries of healthy infants and "differences occur in the crying of sick infants when compared to healthy ones" (p. 154). For example, various researchers have analyzed the cry after a pain stimulus such as the snap of a rubber band between small for gestational age and premature infants (Michelsson, 1971), full term, small for gestational age and normal birth weight infants (Lester & Zeskind, 1978), infants with chromosomal abnormalities (Lind et al., 1970) and asphyxiated infants (Michelsson & Wasz-Höckert, 1980). These studies however, all analyze the cry response to an acute pain stimulus rather than the subacute pain following surgery. Also following surgery infants are often intubated and therefore unable to make a sound when crying.

The assessment of pain in the newborn is further confounded by the values and beliefs of the care-giver. Abu-saad (1981) suggests nurses have to examine their cultural biases towards pain and note how these biases affect their assessment of pain. For example, it has been reported that nurses acknowledge pain in infants with some procedures but not others, and some nurses more consistently provide pain relief than other nurses. Until a reliable and valid method is developed to measure an infant's pain, nurses have to rely on their own clinical observations which could be affected by their cultural background and their own experience with pain.

Observation of Neonatal Behavioral Responses

Brazelton (1977) states that the neonate is able to respond to the environment with very predictable behaviors. For example, the neonate "has the capacity to attend to stimuli and to habituate or shut out stimuli" (p. 45). In order to attend to positive stimuli (such as the human voice), the neonate can actually suppress interfering reflexive responses. When neonates are confronted with disturbing repetitive stimuli such as a bright light, they 'shut down' by going into a deep sleep. Extremities appear tightened and flexed, there is little movement except "jerky startles", eyeblinks are absent, respirations regular and the heart rate is rapid and regular (p. 41). Newman (1981) found these same responses to stimuli in premature infants.

Behavioral responses of the newborn can provide caretakers with valuable information but one must also be aware of factors that influence an infant's behavior. These include: 1) the infant's state of arousal, 2) environmental factors that influence the arousal state (such as temperature, lighting and sound levels), 3) chemical imbalance (such as hypoglycemia or hypercalcemia), 4) state of hydration, 5) state of well-being (such as illness or other stress), and 6) the degree of recovery from perinatal or other stresses (Brazelton, 1977).

Ethology

In order to understand a complex behavior, a detailed description of that behavior is required. A descriptive study describes what occurs in real life and suggests new hypotheses as the study progresses. These inductively derived hypotheses are more likely to be correct than those derived by deduction (Jones, 1972). Sackett et al. (1978) states that direct observation is necessary when techniques for measurement are not available and standard tests and questionnaires are not appropriate.

Most simply, ethology is the study of behavior (Lorenz, 1981). Gould (1982) defines ethology as "the study of what animals do and how and why they do it. Ethologists, then, are interested in accurate observation and description of an animal's behavior, in the mechanisms and programming which underlie it, and most important, in the reasons an animal must behave as it does. Ethology is often defined as the study of an animal's behavior in its natural environment" (pp. 4-5).

Ethology has been useful in the study of human subjects as well as animals (Jones, 1972). Newman (1981) for example, used ethological methods to answer the question "What is the impact of the constructed environment of the isolette and the Neonatal Intensive Care Unit on the preterm infant?" (p. 1) One observation Newman made was that the infants responded consistently to "painful human interaction" with "eyes closed and upper body tense" (p. 4). Newman concluded that the sensory and social environment of the premature infant must receive attention.

Bowlby (1969) also learned a great deal about maternal deprivation by observing the behavior of young children in their natural environment, and stated that ethology can be useful for studying infants.

> Since the capacity to restrict associated behavior increases with age, it is evident that the younger the subject the more likely are his behavior and his mental state to be the two sides of a single coin. Provided observations are skilled and detailed, therefore, a record of the behavior of very young children can be regarded as a useful index of their concurrent mental state (Bowlby, 1969, p. 6).

Gould (1982) agrees with Bowlby and states that by studying infants one can determine "the inborn rules by which they structure their perceptual worlds, the innate behaviors which ensure their survival, and the prewired orchestration which guides their development" (p. 511). Ethology could be a useful method for nurses to use in studying the postoperative pain experience of newborns.

In 1983, Skerret, Hardin and Puskar wrote that "the most urgent requirement for any infant is for a caregiver who is able to respond to the infant's need for comfort, tension release, stimulation and social interaction" (p. 55). As the postoperative newborn is exposed to multiple internal and external stimuli that may contribute to comfort or distress but cannot make a sound if crying when intubated, the need to assess behaviors of these infants is critical. Furthermore, since the neonatal nurse uses behavioral cues to assess infants' conditions, it is important that these behaviors be systematically examined.

Summary

For the purposes of this study "pain" is defined as "a subjective experience that is unpleasant when there is evidence of tissue damage" (Owen, 1984, p. 225). As pain serves a protective function, if newborns could not experience pain they would not be stimulated to signal their caregivers that they have tissue damage. Surgery causes tissue damage and leads to the experience of pain. When newborns experience pain they express this pain with behavioral responses of distress and physiological changes. Pain cannot be measured in newborns because they cannot give a self-report. Health care professionals must assess pain in the newborn by observing behavioral responses of distress and measuring physiological indices.

CHAPTER III

Methods

Ethological methods were used to examine the response of full term newborns after chest surgery. This chapter includes a description of the subjects and how they were selected and the methods used to collect and analyze the data. Reliability and validity of the study and ethical considerations are also discussed.

The Subjects

Infants were chosen for the study as they arrived at a NICU in a large tertiary care hospital. Criteria for selection of infants included in the study were that they be greater than 36 weeks gestational age (as evidenced by Dubowitz exam), appropriate weight for gestational age, have no evidence of neurological deficit or defect, have abdominal or chest surgery and be stable after surgery. The first infant was selected for a pilot study. Subsequently, three more infants were chosen. It was considered that three subjects provided enough data in order to do some comparisons between infants and not an overwhelming amount of data for analysis. All infants were male and all had undergone chest surgery.

The infant for the pilot study was videotaped for four hours and the other infants were videotaped for approximately 12 hours starting 24 hours after surgery. The decision to delay taping for 24 hours was made to allow time for a reduction in the effects of the anesthetic, the infants to stabilize, and to explain the study and obtain informed consent from the infants' parents.

All infants were considered to be stable during the videotaping sessions and they remained stable. The infants' blood volumes were normal, they had no chemical imbalances and urine output was normal. The characteristics of the infants are summarized in Table 1.

<u>Pilot Study Infant</u>

The infant in the pilot study was 15 days old at the time data collection commenced. Birth weight was 3200 grams, Apgar score was seven at one minute and eight at five minutes and gestational age, 43 weeks. A laparotomy was performed a few hours after birth for repair of a left diaphragmatic hernia. At fourteen days a left thoracotomy was performed for a secondary repair of the diaphragmatic hernia.

The infant was intubated nasally and on a respirator with a rate of 12 breaths per minute, pressures of 20/4 and receiving room air. A chest tube was inserted in the left side. An oral-gastric tube was in place connected to suction. An intravenous infusion was inserted in the right hand which was taped to an armboard. A transcutaneous oxygen monitor and a skin temperature probe were taped to the abdomen. A urine catcher was attached to the groin. A blood pressure cuff was on the upper left arm. The infant was receiving nothing by mouth.

The infant received two doses of meperidine four milligrams intramuscularly at 22 and 28.5 hours postoperatively. His parents and grandmother were at the bedside frequently. His mother commented that he seemed to have more pain after this surgery than the first surgery.

<u>Infant I</u>

Infant I was 44.5 hours old at the time data collection commenced.

Table 1: Characteristics of the Infants

Characteristic	Pilot Infant[a]	Infant I[b]	Infant II[c]	Infant III[d]
Age at filming	15 days	44.5 hours	42.5 hours	9 days
Birth weight	3200 grams	2850 grams	2830 grams	4100 grams
Apgar Score	7^1 8^5	8^1 9^5	5^1 9^5	8^1 9^5
Gestation	43 weeks	40 weeks	37 weeks	40 weeks
Sex	Male	Male	Male	Male

Diagnoses:

a Left Diaphragmatic Hernia
b Tracheosophageal Fistula, Tetralogy of Fallot
c Tracheosophogeal Fistula
d Coarctation of Aorta

Birth weight was 2850 grams, Apgar score was eight at one minute and nine at five minutes and gestational age, 40 weeks. A right thoracotomy was required to repair a tracheosophageal fistula. A laparotomy was also done for insertion of a gastrostomy tube.

The infant was intubated nasally and on a respirator receiving a continuous positive airway pressure of +4 and 25 percent oxygen concentration. A chest tube was inserted in the right side connected to suction. An intravenous infusion was in the right hand. The infant was receiving nothing by mouth or gastrostomy tube.

Infant I received one dose of morphine 0.3 milligrams intramuscularly 4.5 hours postoperatively. He had no family visiting. This infant was also diagnosed as having Tetralogy of Fallot, but was in no distress from his heart condition.

Infant II

Infant II was 42.5 hours old at the time data collection commenced. Birth weight was 2830 grams, Apgar score was five at one minute and nine at five minutes and gestational age, 37 weeks. A right thoracotomy was required to repair a tracheosophageal fistula. A laparotomy was also done for insertion of a gastrostomy tube.

The infant was intubated nasally and on a respirator with a rate of six breaths per minute, pressure of 16/2, and receiving 30 percent oxygen concentration. A chest tube was inserted in the right side and connected to suction. An intravenous infusion was inserted in the left leg which was taped to an armboard. A urine catcher was taped to the groin and a blood pressure cuff was on the upper right arm. A skin temperature probe was taped to the abdomen. The infant received nothing by mouth or gastrostomy tube.

Infant II received two doses of meperidine 2.5 milligrams intramuscularly four and eight hours postoperatively. His father visited in the evening at the beginning of the videotaping session.

Infant III

Infant III was nine-days-old at the time data collection commenced. Birth weight was 4100 grams, Apgar score was eight at one minute and nine at five minutes and gestational age, 40 weeks. A left thoracotomy was required for a repair of a coarctation of the aorta.

The infant was intubated nasally and on a respirator receiving a continuous positive airway pressure of +4 and receiving room air. A chest tube had been removed one hour before videotaping began. An oral-gastric tube was connected to suction and a radial arterial line was inserted in the right wrist which was taped to an armboard. An intravenous infusion was inserted in the left leg and inserted in the right hand beside the arterial line. Both infusions were removed during the videotaping session. Intravenous infusions were started twice in scalp veins. A transcutaneous oxygen monitor and a skin temperature probe were taped to the abdomen. An oxygen saturation monitor was taped to the right foot and a urine catheter was inserted in order to monitor urinary output. He received nothing by mouth.

Infant III received six doses of morphine, one dose of 0.4 milligrams intravenously at 6.5 hours postoperatively and five doses of 0.6 milligrams intravenously at 10.5, 14.5, 22.5, 29.5, and 34 hours postoperatively. His parents visited frequently in the evening of the videotaping session. They patted and stroked him, and sang and talked to him. The parents observed that when the mother patted Infant III's forehead, he opened his eyes, saw his mother and started to cry.

Data Collection

A pilot study was first conducted by videotaping one infant for four hours starting 24 hours postoperatively. The pilot study was used to determine appropriate camera angles and to develop a coding system to analyze infant behavior.

The investigator sat at the bedside operating the video camera and recording events that occurred such as loud noises, nursing care and activity levels in the unit. As the VCR did not have a time/data generator, a digital clock was placed on the bedside in order to record the timing of events. All infants remained under overhead radiant warmers to provide an unobstructed view for the camera. Nurses in the unit relieved the investigator for short breaks when the infants were quiet and no nursing care was planned.

The investigator also operated the portable computerized unit which recorded the infants' pulse, respirations, and in the case of Infant III, blood pressure, once per second. The portable computerized data collection unit interfaces with the neonatal monitors that are regularly used in NICU to monitor infants' vital signs. Data are then uploaded to a host computer for analysis.

Data Analysis

The steps in the analysis of the infants' behaviors are outlined starting with the development of a coding system followed by the observation and recording of behaviors and various methods used to analyze the data.

Coding System

The first step in data analysis was to devise a coding system that divided the infants' behaviors into manageable and meaningful categories (Sackett, 1978). Using the videotapes from the pilot project and pertinent literature, a coding system was developed. This system was expanded as necessary when coding the behavior of the other infants. Adding codes to the system was necessary since each infant occasionally behaved differently. Codes were developed for all movements of the forehead, eyes, mouth, hands, arms, toes, feet, legs and general body movements. Behavioral states were also coded as well as any contact with the infants and background noises.

The face was divided into three areas: the forehead, eyes and mouth as suggested by Izard (1983). Four behaviors were noted in the forehead region: "smooth" forehead, "slight frown" (eyebrows pulled together slightly causing a thickening between the brows), "frown" (eyebrows pulled down tightly with furrows appearing on the forehead) and "eyebrows raised".

The right and left eye were coded separately as either "wide-eyed", "open", "slightly open", "shut" or "tightly shut". Coding the eyes separately was necessary since one eye was at times blocked from view and occasionally one eye would be open wider than the other eye.

Codes for the mouth included "relaxed shut", "relaxed open", "soother in mouth", "pursed lips" (i.e., corners of mouth pulled together), "grimace" (i.e., mouth closed or slightly open and corners of mouth pulled straight back), "corners down" (i.e., mouth open and corners down, as occurs prior to or following a cry), "squarish, open, crying", "rooting" (i.e., mouth open and searching) and "yawn". A separate variable was developed for mouth movements. Codes in this category were "no movement", "active sucking" (i.e., infant sucking the tongue only), "sucking soother", "swallow", "mouthing" (i.e., opening and closing mouth without sucking or searching as in rooting), and "gagging" (which occurred occasionally in the infants with oral-gastric tubes in place).

The left and right hand were coded separately as either "fist" (i.e., fingers flexed into palm with thumb either contained in or resting on the fingers), "curled fingers" (i.e., fingers slightly to moderately flexed), or "fingers extended" (i.e., fingers straight and spread apart).

Codes for the right and left arm were "flexed tight" (i.e., hand touching or almost touching the shoulder, elbow not necessarily touching the chest), "flexed" (i.e., elbow at approximately a 20° to 160° angle), "extended" (i.e., elbow at approximately a 160° to 180° angle), "stretch" (i.e., arm extended but movement or tension in the arm), and "hand to mouth" (i.e., movement when the infant brings up the hand and it touches the mouth).

The right and left toes were coded as either "flexed tight" (i.e., toes flexed down towards sole of foot), "flexed" (i.e., toes in a relaxed position), or "extended" (i.e., toes extended up and straightened space seen between toes). The same codes were used for the right and left foot: "flexed tight" (i.e., foot at less than a 90° angle), "flexed" (i.e., foot at approximately a 90° to 110° angle), and "extended" (i.e., foot at approximately a greater than 110° angle with tension as in a stretch).

Codes for the right and left leg were "flexed tight" (i.e., heel of foot close to buttocks), "flexed" (i.e., knee at approximately a 30° to 160° angle), "extended" (i.e., knee at approximately a 160° to 180° angle and relaxed), "pulls knee up" (i.e., a movement when the knee is pulled to the chest), "kick" (i.e., leg is extended suddenly), "pulls knee up and kicks" (i.e., a very sudden movement), and "stretch" (i.e., leg is extended with tension sometimes holding leg up off of the bed but not a quick movement like a kick). The angle at the hip was not coded.

As well as movement in the limbs, the infants were found to have body movements. These movements were coded as "no movement" (i.e., not including movement in the limbs), "slight squirm" (i.e., slight movement in head and shoulders), "squirm" (i.e., larger movement including head, shoulders and hips), "generalized movements" (i.e., head, shoulders, hips and limbs all moving), "startle", "myoclonic jerk" (i.e., total body jerks), "hiccough", "twinge" (i.e., sudden body movement or spasm followed by behaviors of distress), and "sneeze". Behavioral states such as "deep sleep", "active REM sleep", "drowsy", "wide awake" and "crying" were also coded. Brazelton (1977) stated instrumentation is not necessary to determine behavioral states but that states can be determined reliably by observation.

General codes were developed for times the infants were contacted. These codes were "repositioned" (i.e., total body or a limb), "diaper changed", "care given" (e.g., sponge bath, endotracheal tube instillation and suction, chest physiotherapy and heelstick), "touched to comfort", "touched to examine" and "touching equipment" (i.e., touching equipment attached to infant). A second variable was labelled "Infant Contacted" when it was found that occasionally two persons contacted the infant at the same time. This situation generally occurred when one person gave care and one person restrained and comforted the infant.

Four variables were developed for noise in order to code noises that occurred simultaneously. Noises were coded as "talking at bedside", "loud laughter", "IV alarm", "neonatal monitor alarm", "another infant crying", "bang" (e.g., garbage can lid closing), "quiet activity" (e.g., faint monitor alarms, talking, people moving), "quiet" (i.e., no sound heard), and "other" (e.g., tended to be the arterial oxygen monitor alarm).

The final variable coded was the camera view being either "Adequate View" or "Inadequate View". The percentage of time the camera's view was adequate was determined to assess sample size and the feasibility of videotaping infant behavior in NICU.

Numbers were assigned to each code and entered on data punching forms along with the infant's identification number, number of hours since surgery and the hours, minutes and seconds taken from a digital clock placed on the bedside. The information was entered into a computer for analysis. The coding system is presented in Table 2.

Observation and Recording of Behaviors

Once the coding system was developed, behaviors from the videotapes could be recorded. Lehner (1979) suggested instantaneous sampling as useful in estimating the percentage of time spent in various activities. In this method of sampling, predetermined "points" in time are chosen in which to score behavior.

The first 20 seconds of each minute were sampled in two second intervals. A 20 second interval was chosen because a set of behaviors seemed to be completed in this time period.

Using the time on the digital clock beside the infant the first 20 seconds of each minute were viewed in total if the infant was still. The videocassette recorder (VCR) was then put on "pause" and the behaviors coded. There were 10 lines of codes for each 20 second interval. One data punching form held three 20 second intervals giving each infant up to 240 coding sheets.

If the infant showed any activity or was contacted, the videotapes were viewed in two to 10 second intervals depending on the amount of activity. The baby's upper body was first viewed and coded. The tape was then rewound and the lower body viewed and coded. The tape was rewound again and noises and infant contact coded. The time period prior to the 20 second interval was also observed to see if a noise or contact had disturbed the infant. Approximately three to six hours were spent coding one hour of videotape depending on activity levels. When more detail was required (such as type of care given) or

Table 2: Coding System

Body Position
- 1-right side
- 2-left side

Forehead
- 1-smooth
- 2-slight frown
- 3-frown
- 4-eyebrows raised

Right Eye
- 1-wide-eyed
- 2-open
- 3-slightly open
- 4-shut
- 5-tightly shut

Left Eye
- 1-wide-eyed
- 2-open
- 3-slightly open
- 4-shut
- 5-tightly shut

Mouth Position
- 1-relaxed shut
- 2-relaxed open
- 3-soother in mouth
- 4-pursed lips
- 5-grimace (mouth closed or slightly open, corners pulled back)
- 5-hand to mouth
- 6-open, corners down
- 7-open, squarish, crying
- 8-rooting
- 9-yawm

Mouth Movement
- 0-no movement
- 1-active sucking
- 2-sucking soother
- 3-swallow
- 4-mouthing
- 5-gagging
- 6-missing data

Right Hand
- 1-fist
- 2-curled fingers
- 3-fingers extended

Left Hand
- 1-fist
- 2-curled fingers
- 3-fingers extended

Right Arm
- 1-tightly flexed
- 2-flexed
- 3-extended
- 4-stretch
- 5-hand to mouth

Left Arm
- 1-tightly flexed
- 2-flexed
- 3-extended
- 4-STRETCH

Right Toes
- 1-tightly flexed
- 2-flexed
- 3-extended

Left Toes
- 1-tightly flexed
- 2-flexed
- 3-extended

Table 2: Coding System (continued)

Right Foot
- 1-tightly flexed
- 2-flexed
- 3-extended

Left Foot
- 1-tightly flexed
- 2-flexed
- 3-extended

Right Leg
- 1-tightly flexed
- 2-flexed
- 3-extended
- 4-pulls knee up
- 5-kicks
- 6-pulls up & kicks
- 7-stretch

Left Leg
- 1-tightly flexed
- 2-flexed
- 3-extended
- 4-pulls knee up
- 5-kicks
- 6-pulls up & kicks
- 7-stretch

Body Movements
- 0-no movement
- 1-slight squirm
- 2-squirm
- 3-generalized movements
- 4-start
- 5-myoclonic jerk
- 6-hiccough
- 7-twinge (acute pain?)
- 8-sneeze
- 9-missing data

Behavioral States
- 1-deep sleep
- 2-active REM sleep
- 3-drowsy
- 4-wide awake
- 5-active awake
- 6-crying (Brazelton, 1984).

Infant Contacted (by second person)
- 0-no contact
- 1-repositioned
- 2-diaper changed
- 3-care given
- 4-touched to comfort
- 5-touched to examine
- 6-touching equipment

Infant Contacted (by first person)
- 0-no contact
- 1-repositioned
- 2-diaper changed
- 3-care given
- 4-touched to comfort
- 5-touched to examine
- 6-touching equipment

Noise 1
- 1-talking at bedside
- 2-loud laughter
- 3-IV alarm
- 4-neonatal monitor alarm
- 5-another infant crying
- 6-bang
- 7-quiet activity
- 8-quiet
- 9-other

Noise 2
- -second concurrent sound

Noise 3
- -third concurrent sound

Noise 4
- -fourth concurrent sound

Camera View
- 0-adequate view
- 1-inadequate view

an interesting behavior occurred, notes were made in the margin of the data punching forms.

Methods Used for Analysis

Three methods were used to analyze postoperative infant behaviors: descriptive statistics, observation analysis and factor analysis. The first method used was to examine frequencies of each variable for each infant as well as frequencies of variables under certain conditions (i.e., when the infants were slightly frowning or before and after analgesic). This initial analysis provided a general overview of the infants' behaviors.

Observational analysis was also used to describe the infants' responses. During initial coding of the three infants' behaviors, it was observed that the infants appeared to be having short periods of distress characterized by sudden jerking limb movements and crying. These behaviors were not initiated by any apparent external stimuli. Sequence sampling was used to determine the order of behaviors, when these behaviors occurred and how often. Sequence sampling focuses on a chain of behaviors and these behaviors are recorded every time they occur (Lehner, 1979).

The VCR was put on 'fast forward' to view the videotapes. When a sequence of behaviors of acute distress was observed, 'frame-by-frame advance' on the VCR was used and the behaviors were recorded in order of occurrence. The behaviorial sequences were then analyzed for patterns of behaviors as well as timing of the sequences.

Factor analysis was also utilized on the initial data to determine commonalities among the variables and how many groups of variables there were that had measures in common (Kerlinger, 1973). Since the variables were nominal, dummy variables were created. Factor analysis was performed using dummy variables only for each infant (See Appendix B for a list of the dummy variables).

Physiological data (heart rate for Infant I and Infant II and heart rate and blood pressure for Infant III) were plotted and ranges determined. When increases in heart rate were observed, simultaneous behavioral response was noted. Heart rate was also examined for changes before and after the administration of analgesics.

Each infant was treated as a case study serving as their own control. However, when appropriate some comparisons were made between infants.

Reliability and Validity

Before interpreting the results of the data analysis the reliability of the coding system was examined. Interrater reliability and intrarater reliability were determined as an index of agreement using the following formula: number of agreements/number of agreements + disagreements (Polit & Hungler, 1979).

Interrater Reliability

The investigator trained an observer to use the coding system. Randomly selected portions of videotapes were then coded by both the observer and the investigator. A reliability index of .85 was obtained.

Intrarater Reliability

Using a table of random numbers, one percent of the 20 second segments of all three infants were selected and the behaviors in these segments recoded. An overall reliability index of .84 was obtained. Reliability indexes for individual variables are presented in Table 3.

Validity of the study was determined by comparing results with results of other studies.

Ethical Considerations

Prior to the commencement of data collection, the study was approved by the appropriate ethical review committees. Permission to conduct the study was also obtained from the Medical Director of NICU and the Nursing Unit Supervisor.

The infants' parents were informed that the infant's care would not be affected by the study, that they would still be able to visit their infant, and that there were no additional risks for the infant while participating in the study. Rather, the infants would be observed more closely during data collection than under normal circumstances. Parents were assured that they could withdraw their consent at any time or refuse consent and care of their infant would not be affected. Parents were also assured that the name of their infant would not be disclosed but that the videotapes may be used to present the results of this study and for educational purposes. The investigator was available for any questions.

Consent for videotaping was also obtained from the nurse or nurses caring for the infants. The identity of the nurses will not be

Table 3: Intrarater Reliability Indexes

Variable	Number of Disagreements	Number of Agreements	Reliability Index
Forehead	35	175	.83
Eyes	23	397	.95
Mouth Position	50	160	.76
Mouth Movements	8	202	.96
Hands	60	360	.86
Arms	70	350	.83
Toes	91	329	.78
Feet	84	336	.80
Legs	84	336	.80
Body Movement	21	189	.90
Behavioral State	23	187	.89
Noise	87	543	.86

revealed. However, the nurses were informed that they may be identified from the videotapes since the tapes may be used to present the results of this project and for educational purposes.

Medical staff in NICU and the Nursing Unit Supervisor were given copies of the research proposal and an inservice session was held with the nursing charge group prior to data collection. Nurses caring for the infants were given information on the research project on an individual basis and were assured that they could change assignments if they did not wish to participate (see Appendix A: Informed Consent Forms).

CHAPTER IV

Results

In order to answer the research questions stated earlier, the data were analyzed to determine the behavioral responses and physiological responses of the three postoperative newborns.

Behavioral Responses

Behavioral responses of the postoperative newborns were first examined with analysis of general frequencies of the variables followed by frequencies during specific behaviors such as when the infants had a slight frown on their foreheads and before and after analgesic. Behaviors of sudden acute distress were recoded and analyzed in more detail.

General Frequencies

Camera View

The first variable to be examined was the "camera view" to determine how often the camera view was inadequate and the amount of videotape available for coding on each infant. The number of hours of videotape available for coding is presented in Table 4.

Facial Behaviors

The percentage of time the infants' foreheads were smooth, slightly frowning, frowning and eyebrows raised is presented in Table 5. Infant I spent a greater percentage of time with a slight frown than Infant III. Infant II spent the least amount of time with a slight frown. The three infants spent a small percentage of time with

Table 4: Number of Hours Infant Behavior Coded

Infant	Coding Points n	Adequate View n	Adequate View %	Inadequate View n	Inadequate View %	Number of Hours Coded
I	6280	6382	93.6	438	6.4	10.6
II	6831	5283	85.2	1008	14.8	9.7
III	7211	6011	83.4	1200	16.6	10.0

Table 5: Behaviors of the Forehead

Infant	Smooth n	Smooth %	Slight Frown n	Slight Frown %	Frown n	Frown %	Eyebrows Raised n	Eyebrows Raised %
I	271	4.3	5506	88.0	302	4.8	175	2.8
II	4988	85.4	570	9.8	248	4.2	32	0.5
III	3378	46.8	2317	32.1	189	2.6	4	0.1

a frown on their foreheads. The amount of missing data on the forehead was 8.3 percent for Infant I, 14.5 percent for Infant II and 18.3 percent for Infant III.

Positions of the eyes are summarized in Table 6. Only positions of the right eye are presented since there was little difference between the right eye and the left eye. The eyes of Infant II were shut for a greater percentage of time than the eyes of Infant I or Infant III. The amount of missing data on the right eye was 8.2 percent for Infant I, 14.5 percent for Infant II and 17.7 percent for Infant III.

Positions of the mouth are summarized in Table 7. The infants spent little time with their mouths in a grimace, corners down, crying or rooting. The amount of missing data on positions of the mouth was 8.6 percent for Infant I, 14.7 percent for Infant II and 26.5 percent for Infant III.

Mouth movements are summarized in Table 8. Infant I and Infant III spent more time sucking than Infant II. The amount of missing data for mouth movements was 6.4 percent for Infant I, 14.8 percent for Infant II and 26.3 percent for Infant III.

<u>Limb Positions</u>

The infants' limb positions had a greater percentage of missing data than the infants' facial behaviors. Reasons for missing data included limbs being taped to armboards, out of sight behind the infant, covered with a diaper, or in the case of the feet, being slightly out of camera range.

Positions of the hands are presented in Table 9 and Table 10.

Table 6: Positions of the Eyes

	Open		Slightly Open		Shut	
Infant	n	%	n	%	n	%
I	573	9.2	539	8.6	5145	82.2
II	315	5.4	98	1.7	5424	92.9
III	237	4.0	422	7.1	5279	88.9

Table 7: Positions of the Mouth

	Relaxed Shut		Relaxed Open		Soother In		Pursed Lips		Grimace		Corners Down		Crying		Rooting	
Infant	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
I	3176	50.9	2012	32.3	561	9.0	6	0.1	240	3.8	79	1.3	121	1.9	41	0.7
II	2054	35.3	3335	57.2	-	-	15	0.3	82	1.4	117	2.0	221	3.8	-	0
III	1596	30.1	3253	61.4	-	-	32	0.6	74	1.4	203	2.8	126	2.4	15	0.3

Table 8: Mouth Movements

	Sucking		Sucking Soother		Swallow		Mouthing		Gagging	
Infant	n	%	n	%	n	%	n	%	n	%
I	286	4.5	142	2.2	107	1.7	67	1.0	1	0.0
II	127	2.2	3	0.1	93	1.6	56	1.0	3	0.1
III	672	12.6	6	0.1	15	0.3	27	0.5	9	0.2

Table 9: Positions of the Right Hand

	Fist		Curled Fingers		Extended	
Infant	n	%	n	%	n	%
I	(taped to armboard)					
II	1933	43.2	2361	52.7	182	4.1
III	(taped to armboard)					

Table 10: Positions of the Left Hand

Infant	Fist		Curled Fingers		Extended	
	n	%	n	%	n	%
I	1604	27.0	3939	66.3	402	6.8
II	1934	37.2	2926	56.3	339	6.5
III	4431	90.0	484	9.8	6	0.1

Infant III spent a greater percentage of time with the left hand in a fist than Infant I and Infant II. Infant I and Infant III had their right hands taped to an armboard so that the fingers were not visible. Infant II had 34.5 percent of the data on the right hand as missing. The amount of missing data on the left hand was 12.8 percent for Infant I, 23.9 percent for Infant II and 31.8 percent for Infant III.

Positions of the arms are presented in Table 11 and Table 12. Infant III had his right arm extended a smaller percentage of time than Infant I or Infant II. Infant II had the left arm more tightly flexed than Infant I or Infant III. Infant I was the only infant to make a few hand to mouth movements. The amount of missing data for the right arm was 6.6 percent for Infant I, 16.2 percent for Infant II, and 18.0 percent for Infant III. The amount of missing data for the left arm was 7.8 percent for Infant I, 17.3 percent for Infant II, and 19.3 percent for Infant III.

Positions of the toes and feet are summarized in Tables 13, 14, 15 and 16. The positions of the toes and feet were the variables with the most missing data. The amount of missing data for the right toes was 40.0 percent for Infant I, 52.5 percent for Infant II, and 98.3 percent for Infant III; for the left toes was 19.0 percent for Infant I, 100.0 percent for Infant II and 73.4 percent for Infant III; for the right foot was 29.8 percent for Infant I, 39.5 percent for Infant II, and 44.6 percent for Infant III; and for the left foot was 11.1 percent for Infant I, 99.6 percent for Infant II and 39.3 percent for Infant III.

Table 11: Positions of the Right Arm

Infant	Tightly Flexed		Flexed		Extended	
	n	%	n	%	n	%
I		0.0	133	2.1	6236	97.9
II	313	5.5	304	5.3	5106	89.2
III	948	16.0	1213	20.5	3737	63.2

Table 12: Positions of the Left Arm

Infant	Tightly Flexed		Flexed		Extended	
	n	%	n	%	n	%
I	1817	28.9	3731	59.3	701	11.1
II	2871	50.8	2303	40.8	476	8.4
III	667	11.5	4029	69.2	1121	19.3

Table 13: Positions of the Right Toes

	Tightly Flexed		Flexed		Extended	
Infant	n	%	n	%	n	%
I	551	13.6	3065	75.4	448	11.0
II	455	14.0	2204	67.9	586	18.1
III	(O_2 saturation monitor taped to foot)					

Table 14: Positions of the Left Toes

	Tightly Flexed		Flexed		Extended	
Infant	n	%	n	%	n	%
I	336	6.1	4253	77.0	937	17.0
II	(IV in left ankle)					
III	75	3.9	1348	70.4	493	25.9

Table 15: Positions of the Right Foot

	Tightly Flexed		Flexed		Extended	
Infant	n	%	n	%	n	%
I	705	14.7	4049	85.2	1	0
II	211	5.1	3787	91.7	124	3.2
III	1245	31.2	2750	68.8	[illegible]	0

Table 16: Positions of the Left Foot

	Tightly Flexed		Flexed		Extended	
Infant	n	%	n	%	n	%
I	744	12.3	5317	87.7	3	0
II			(IV in left ankle)			
III	742	16.9	3638	83.1	0	0

Positions of the legs are summarized in Table 17 and Table 18. Infant III had the right leg more tightly flexed than Infant I and Infant II. Infant II had the left leg flexed a greater percentage of time than Infant I and Infant III. Infant I and Infant III pulled the knees up a greater percentage of the time than Infant II. The amount of missing data for the right leg was 8.0 percent for Infant I, 17.9 percent for Infant II, and 21.0 percent for Infant III. The amount of missing data for the left leg was 7.7 percent for Infant I, 18.3 percent for Infant II, and 21.2 percent for Infant III.

Behavioral States

The amount of time each infant spent in each behavioral state is summarized in Table 19. Infant II was asleep for a greater percentage of time than Infant I and Infant III. Infant I was wide awake for a greater percentage of time than Infant II and Infant III. The three infants spent little time crying. The amount of missing data for behavioral states was 7.3 percent for Infant I, 12.1 percent for Infant II, and 16.8 percent for Infant III.

Infants Contacted

During the videotaping sessions, the infants were contacted in order to provide care, to provide comfort or to adjust equipment attached to the infants. The three types of contact are summarized in Table 20.

Of the total amount of time behavior was coded, Infant I was contacted 11.1 percent of the time, Infant II was contacted 17.2 percent of the time and Infant III was contacted 30.6 percent of the time. Infant III was contacted to provide care and to provide comfort

Table 17: Positions of the Right Leg

Infant	Tightly Flexed		Flexed		Extended		Pulls Knee Up		Kicks		Stretch	
	n	%	n	%	n	%	n	%	n	%	n	%
I	1171	18.7	3223	51.4	1673	26.9	94	1.5	8	0.1	96	1.5
II	1098	19.6	2503	44.6	1926	34.3	38	0.7	6	0.1	36	0.6
III	1562	27.5	2092	36.9	1901	33.5	91	1.6	1	0	30	0.5

Table 18: Positions of the Left Leg

Infant	Tightly Flexed		Flexed		Extended		Pulls Knee Up		Kicks		Stretch	
	n	%	n	%	n	%	n	%	n	%	n	%
I	703	11.2	3152	50.1	2217	33.6	137	2.2	20	0.3	146	2.3
II	14	0.3	5150	92.3	376	6.7	16	0.3	5	0.1	20	0.4
III	697	11.9	2681	47.2	2155	37.9	137	2.4	0	0	32	0.6

Table 19: Behavioral States

Infant	Active REM Sleep n	Active REM Sleep %	Drowsy n	Drowsy %	Wide Awake n	Wide Awake %	Active Awake n	Active Awake %	Crying n	Crying %
I	4278	67.7	1214	19.2	677	10.7	4	0.1	145	2.3
II	4998	83.3	420	7.0	260	4.3	0	0	325	5.4
III	4383	73.2	1197	19.9	264	4.4	0	0	148	2.5

Table 20: Amount of Time Infants Contacted

Infant	Infant Contacted to Provide Care		Infant Contacted to Provide Comfort		Infant Contacted to Adjust Equipment	
	n	%	n	%	n	%
I	537	8.4	48	0.8	185	2.9
II	660	10.9	169	2.9	197	3.4
III	1225	20.4	451	7.5	164	2.7

more often that Infant I and Infant II.

Infant III had more care given than Infant I and Infant II because of intravenous infusions going interstitial and having to be restarted. Nurses provided the comfort to Infant I and Infant II while the parents provided most of the "comfort" to Infant III. Of the comfort provided Infant III, the nurses provided 24 percent, the mother provided 57 percent, the father provided 5 percent and both parents at the same time provided 11 percent of the comfort given. The amount of time nurses spent adjusting equipment was about the same for each infant.

Frequencies When Infants Slightly Frowning and Forehead Smooth

Frequencies of behaviors when the infants were frowning slightly and when the forehead was smooth were examined to determine behaviors that might be associated with a subacute pain experience. In the following tables, the frequencies of each variable are divided into two categories: when the infants were slightly frowning and when the infants' foreheads were smooth. Only behaviors with differences are presented.

Facial Behaviors

Positions of the right eye are presented in Table 21. Only the right eye positions are presented because there was little difference between positions of the eyes. Infant I spent a greater percentage of time with eyes open and slightly open when his forehead was smooth than when he had a slight frown. Infant III spent a greater percentage of time with eyes open and slightly open when he had a slight frown than

Table 21: Positions of the Right Eye

Infant	Forehead Position	Total n	Open n	Open %	Slightly Open n	Slightly Open %	Shut n	Shut %
I	Smooth	(271)	78	28.8	43	15.9	150	55.4
	Slight Frown	(5502)	397	7.2	446	8.1	4658	84.7
II	Smooth	(4988)	298	6.0	73	1.5	4616	92.5
	Slight Frown	(570)	16	2.8	21	3.7	533	93.5
III	Smooth	(3368)	45	1.3	97	2.9	3226	95.8
	Slight Frown	(2317)	126	5.4	317	13.7	1874	80.9

when his forehead was smooth.

The positions of the mouth are summarized in Table 22. When the infants were slightly frowning, the mouth was in a grimace, corners down or crying a greater percentage of time than when the infants' foreheads were smooth.

Mouth movements are summarized in Table 23. Infant I sucked a slightly greater percentage of time when he had a slight frown. Infant III sucked a greater percentage of time when his forehead was smooth.

<u>Limb Positions</u>

The positions of the left hand are summarized in Table 24. The right hand is omitted because data is missing on Infant I and Infant III. The data on the right hand of Infant II is almost the same as the left hand. The infants spent a greater percentage of time with their hands in a fist when their foreheads were smooth.

<u>Behavioral States</u>

The percentage of time in each behavioral state is presented in Table 25. Infant I spent a greater percentage of time wide awake when his forehead was smooth. Infant II and Infant III spent a greater percentage of time in active REM sleep when their foreheads were smooth.

<u>Behavioral Response Before and After Administration of Analgesic</u>

Infant III was the only infant to receive analgesic during ~~the~~ videotaping session. He received two doses of morphine intravenously. The behavioral response of Infant III was examined one hour before and one hour after morphine was administered. Frequencies were determined for each variable.

Table 22: Positions of the Mouth

Infant	Forehead Position	Total	Shut		Open		Grimace		Corners Down		Crying	
		n	n	%	n	%	n	%	n	%	n	%
I	Smooth	(271)	109	40.2	141	52.0	-	-	-	-	-	-
	Slight Frown	(5485)	2922	53.3	1774	32.0	176	3.2	32	0.6	1	0
II	Smooth	(4976)	1888	37.9	3033	61.0	38	0.8	5	0.1	-	-
	Slight Frown	(570)	155	27.2	278	48.8	36	6.3	67	11.8	34	6.0
III	Smooth	(3128)	1363	43.6	1733	55.4	6	0.7	-	-	-	-
	Slight Frown	(1970)	221	11.2	1494	75.8	49	2.5	152	7.7	35	1.8

Table 23: Mouth Movements

Infant	Forehead Position	Total n	Sucking n	Sucking %	Sucking Soother n	Sucking Soother %	Swallow n	Swallow %	Mouthing n	Mouthing %
I	Smooth	(271)	14	5.2	2	0.7	3	1.1	1	0.4
	Slight Frown	(5506)	265	4.8	140	2.5	93	1.7	58	1.1
II	Smooth	(4981)	121	2.4	1	0	80	1.6	52	1.0
	Slight Frown	(570)	5	0.9	2	0.4	13	2.3	3	0.5
III	Smooth	(3134)	552	17.6	6	0.2	9	0.3	7	0.2
	Slight Frown	(1690)	114	5.8	-	-	6	0.3	20	1.0

Table 24: Positions of the Left Hand

Infant	Forehead Position	Total	Fist		Curled Fingers		Extended Fingers	
		n	n	%	n	%	n	%
I	Smooth	(248)	96	38.7	146	58.9	6	2.4
	Slight Frown	(5194)	1375	26.5	3479	67.0	340	6.5
II	Smooth	(4531)	1800	39.7	2486	54.9	245	5.4
	Slight Frown	(464)	61	13.1	332	71.6	71	15.3
III	Smooth	(3310)	3021	91.3	289	8.7	-	-
	Slight Frown	(1420)	1240	87.3	179	12.6	1	0.1

Table 25: Behavioral States

Infant	Forehead Position	Total	Active REM Sleep		Drowsy		Wide Awake		Crying	
		n	n	%	n	%	n	%	n	%
I	Smooth	(271)	117	43.2	78	28.8	28	28.0	-	-
	Slight Frown	(5430)	3888	71.6	1041	19.2	490	9.0	11	0.2
II	Smooth	(4958)	4471	90.2	224	4.5	259	5.2	4	0.1
	Slight Frown	(570)	427	74.9	130	22.8	1	0.2	12	2.1
III	Smooth	(3348)	2885	86.2	443	13.2	20	0.6	-	-
	Slight Frown	(2296)	1418	61.8	649	28.3	182	7.9	47	2.0

Facial Behavior

The behaviors of the [illegible] are summarized in Table 26. Infant III spent less time with a frown and slight frown on his forehead after the analgesic was administered.

The positions of the right eye are presented in Table 27. Only the right eye is presented since data were the same for each eye. Infant III spent a greater percentage of time with his eyes open or slightly open after the analgesic was administered.

Positions of the mouth are summarized in Table 28. Infant III spent a greater percentage of time with his mouth shut after analgesic was administered. He also spent a smaller percentage of time with the corners of his mouth down and crying after analgesic was given.

Mouth movements are presented in Table 29. Infant III spent a greater percentage of time sucking after analgesic was administered.

Limb Positions

Positions of the left hand are presented in Table 30. The right hand was taped to an armboard and not visible. Infant III spent a great percentage of time with his left hand in a fist both before and after analgesic was administered. Positions of the left arm are not presented since little difference was noted.

Positions of the toes and feet are not presented because too much data were missing. Positions of the legs are presented in Tables 31 and 32. After analgesic was given Infant III held his legs tightly flexed a greater percentage of the time and held his legs extended a smaller percentage of time.

Table 26: Behaviors of the Forehead Before and After Analgesic

	Total	Smooth		Slight Frown		Frown	
	n	n	%	n	%	n	%
First Dose							
Before	(506)	1	0.2	486	96.0	19	3.8
After	(558)	452	75.6	102	18.3	4	0.7
Second Dose							
Before	(538)	234	43.5	264	49.1	40	7.4
After	(366)	236	64.5	111	30.3	19	5.2

Table 27: Positions of the Right Eye Before and After Analgesic

	Total	Open		Slightly Open		Shut	
	n	n	%	n	%	n	%
First Dose							
Before	(506)	-	-	2	0.4	504	99.6
After	(558)	-	-	47	8.4	511	91.6
Second Dose							
Before	(538)	-	-	4	0.7	534	99.3
After	(356)	28	7.9	17	4.8	311	87.4

Table 28: Positions of the Mouth Before and After Analgesic

	Total	Relaxed Shut		Relaxed Open		Grimace		Corners Down		Crying	
	n	n	%	n	%	n	%	n	%	n	%
First Dose											
Before	(391)	13	3.3	333	85.2	2	0.5	16	4.1	26	6.6
After	(558)	181	32.4	349	62.5	10	1.8	4	0.7	9	1.6
Second Dose											
Before	(538)	62	11.5	392	72.9	14	2.6	44	8.2	24	4.5
After	(367)	84	22.9	253	68.9	5	1.4	19	5.2	4	1.1

Table 29: Mouth Movements Before and After Analgesic

	Total	Sucking		Swallow		Mouthing	
	n	n	%	n	%	n	%
First Dose							
Before	(391)	9	2.3	-	-	9	2.3
After	(558)	128	22.9	3	0.5	2	0.4
Second Dose							
Before	(538)	23	4.3	-	-	-	-
After	(369)	84	22.8	2	0.5	-	-

Table 30: Positions of the Left Hand Before and After Analgesic

	Total	Fist		Curled Fingers		Fingers Extended	
	n	n	%	n	%	n	%
First Dose							
Before	(106)	106	100.0	-	-	-	-
After	(518)	518	100.0	-	-	-	-
Second Dose							
Before	(478)	419	87.7	59	12.3	-	-
After	(372)	359	96.5	13	3.5	-	-

Table 31: Positions of the Right Leg Before and After Analgesic

	Total	Tightly Flexed		Flexed		Extended	
	n	n	%	n	%	n	%
First Dose							
Before	(461)	5	1.1	116	25.2	310	67.2
After	(558)	292	52.3	224	40.1	35	6.3
Second Dose							
Before	(467)	144	30.8	99	21.2	216	46.3
After	(340)	320	94.1	10	2.9	-	-

Table 32: Positions of the Left Leg Before and After Analgesic

	Total	Tightly Flexed		Flexed		Extended	
	n	n	%	n	%	n	%
First Dose							
Before	(463)	13	2.8	120	25.9	319	68.9
After	(558)	430	77.1	-	-	126	22.6
Second Dose							
Before	(450)	[illegible]	8.4	66	14.7	331	73.6
After	(332)	[illegible]	[illegible]	20	6.0	5	1.5

Behavioral States

The behavioral states of Infant III are presented in Table 33. Infant III spent a smaller percentage of time sleeping and crying after analgesic was given.

Infant Contacted

The percentage of time Infant III was contacted is presented in Table 34. Infant III received less care and more comfort after the analgesic was given.

Observational Analysis

It was observed during the initial coding of the infants' behaviors that Infant I had several sudden brief episodes of behaviors that exhibited acute distress. These behaviors did not appear to be in response to external stimuli such as nursing care or noise and were not reflexive startle responses or myoclonic jerks. Every episode was coded for each infant and analyzed for sequences in behaviors and timing of episodes.

The episodes of behaviors exhibiting acute distress had a sudden onset, were for four to 20 seconds in length, and included crying. Other behaviors included in acute distress episodes were frowning, squirming, arm movements and leg movements. Episodes of acute distress associated with nursing care, loud noises or other external stimuli were excluded from analysis. The number of episodes of acute distress not related to external stimuli in the 12 hour rec[illegible] periods were 28 for Infant I, four for Infant II, and 13 for In[illegible]ee Figure 1).

Table 33: Behavioral States Before and After Analgesic

	Total	Active REM Sleep		Drowsy		Wide Awake		Crying	
	n	n	%	n	%	n	%	n	%
First Dose									
Before	(506)	473	93.5	7	1.4	-	-	26	5.1
After	(558)	376	67.4	169	30.4	-	-	13	2.3
Second Dose									
Before	(538)	466	86.6	39	7.2	-	-	33	6.1
After	(361)	220	60.9	118	32.7	20	5.5	3	0.8

Table 34: Percentage of Time Infant Contacted Before and After Analgesic

	Total	Care Given		Touched to Comfort		Touched to Examine		Equipment Adjusted	
	n	n	%	n	%	n	%	n	%
First Dose									
Before	(609)	100	16.4	4	0.7	10	1.6	2	0.3
After	(598)	-	-	45	7.5	12	2.0	2	0.3
Second Dose									
Before	(601)	278	46.3	12	2.0	26	4.3	24	4.0
After	(608)	43	7.1	85	14.0	24	3.9	57	9.4

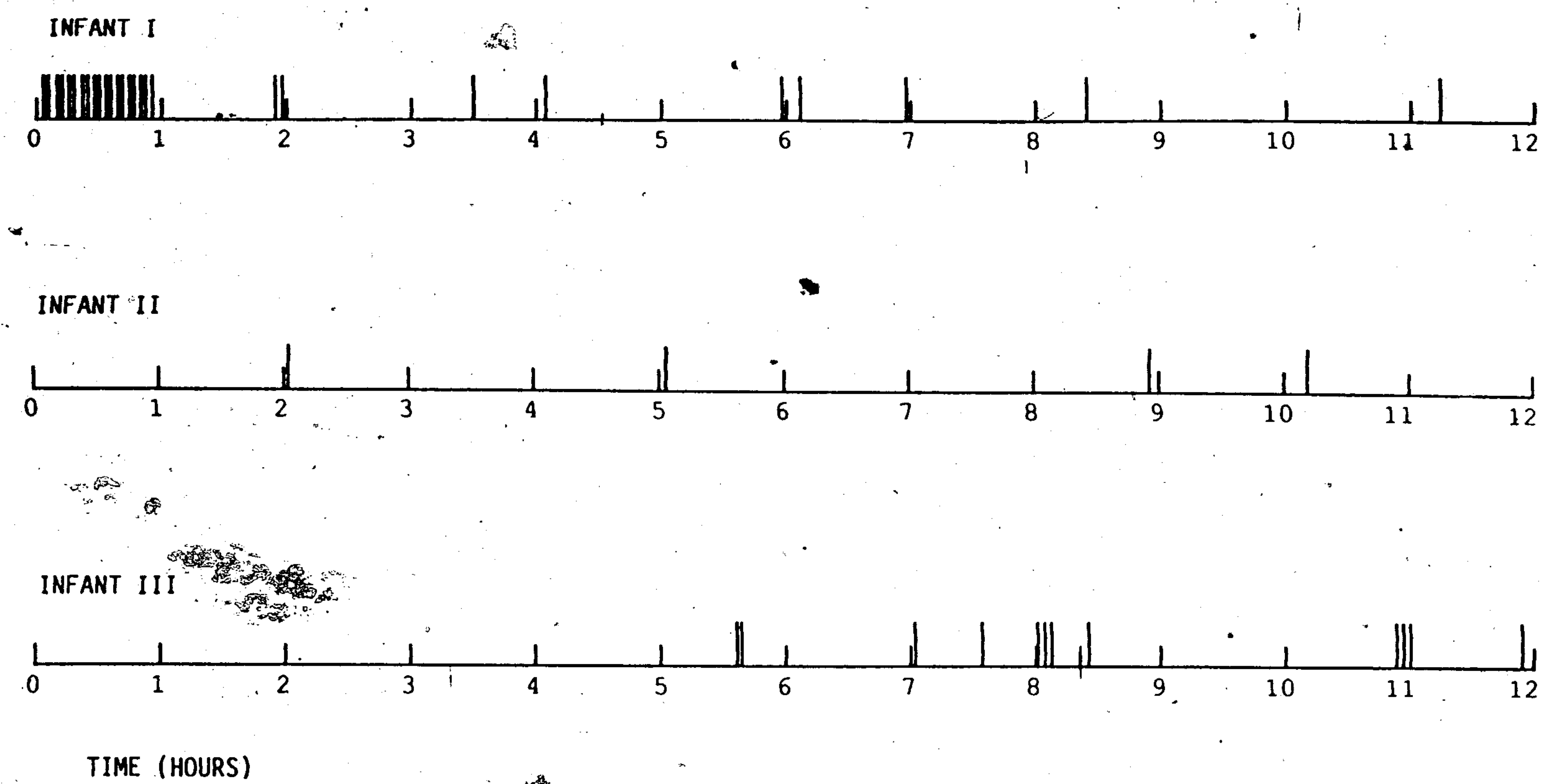


Figure 1: The number of episodes of behaviors of acute distress.

These behavioral sequences followed three basic patterns. The first pattern began with the infants frowning, then their knees were drawn up, and then the infants cried. The second pattern began with the infants' knees drawn up or other leg movements, followed by a frown and then the cry. The third pattern also began with a frown but was followed by a cry and then the infants drew their knees up or made other body movements. The frequency of these patterns is shown in Table 35.

Factor Analysis

The first method utilized was a principal-components factor analysis with an orthogonal varimax rotation of the factor axes using the SPSSx computer program. Analysis was conducted using data from each infant separately, as well as data combined from all three infants.

Behaviors of the infants were sampled once per minute rather than using the total number of 10 cases per minute. This decision was made because of the dependence of behaviors in the 20 second interval that was originally coded. The total number of cases for Infant I were 682, for Infant II were 685, for Infant III were 724 and for all infants were 2,091. The number of cases more than exceeds the recommended number of ten times the number of variables, reducing sampling error (Nunnally, 1978).

Factors with eigen values greater than 1.0 and variables with correlations greater than 0.30 were retained in the initial analysis. Variables with low loadings, that loaded on several factors, that did not load on any factors or were single and doublet factors were removed

Table 35: Sequential Patterns of Behaviors Exhibiting Acute Distress

Pattern	Infant I	Infant II (no. of episodes)	Infant III
1. Frown-knees-cry	7	-	8
2. Knees-frown-cry	14	-	-
3. Frown-cry-knees	7	4	5

from further analysis (i.e. hand and arm positions). These variables either had alot of missing data or very low numbers (i.e. sucking).

Significant loadings for the orthogonally rotated loading matrix are displayed in Tables 36 to 39. A total of eight factors were extracted for Infant I, nine factors for Infant II, nine factors for Infant III, and nine factors for all infants.

Analysis of the items that loaded on each factor revealed that approximately six factors accounted for 63.9 percent of the variance for Infant I, 76.7 percent for Infant II, 81.2 percent for Infant II and 61.6 percent for all infants while the remaining factors were unnamed single or doublet factors and each one added little variance. The factor analysis program was rerun forcing only six factors to be extracted. This left each infant with two unnamed factors without changing the named factors significantly. Further forcing the analysis to extract only five factors changed the named factors and left one unnamed factor. The extraction of six factors was then chosen for final analysis.

The six factors extracted for each infant and for all infants are listed in Table 40. Six factors accounted for 63.9 percent of the variance for Infant I, 65.5 percent of the variance for Infant II, 70.3 percent of the variance for Infant III, and 61.6 percent of the variance for all infants.

Results of the descriptive and observational data revealed that the infants exhibited behaviors of acute distress as well as behaviors of subacute distress. Results of the factor analysis confirmed these observations. Factors were labelled as either a behavioral state,

Table 36: Infant I: Factor-Loading Matrix for Principal Components Solution Using Varimax Rotation (Eight factor solution)

Variable	Factor I	II	III	IV	V	VI	VII	VIII
V32. Slight frown					.81			
V33. Frown			.77					
V34. Rt. eye open	.89							
V35. Rt. eye sl. open		.89						
V37. Lt. eye open	.93							
V38. Rt. eye sl. open		.90						
V41. Mouth relaxed & open				.90				
V47. Rt. leg tightly flexed						.78		
V49. Rt. leg extended	.31				.39			
V50. Rt. leg movement							.82	
V51. Lt. leg tightly flexed						.80		
V53. Lt. leg extended				.42	.41			
V54. Lt. leg movement							.78	
V56. Drowsy		.69						.36
V57. Wide awake	.82							
V58. Crying			.79					
V59. Care given			.67					

Table 37: Infant II: Factor-Loading Matrix for Principal Components Solution Using Varimax Rotation (Nine factor solution)

Variable	Factor I	II	III	IV	V	VI	VII	VIII	IX
V31. Smooth forehead	.73								
V32. Slight frown							.94		
V33. Frown				.81					
V34. Rt. eye open		.97							
V35. Rt. eye sl. open		.95							
V36. Rt. eye shut	.93								
V37. Lt. eye open		.97							
V39. Lt. eye sl. open			.95						
V40. Mouth relaxed & shut					.92				
V41. Mouth relaxed & open	.40								
V47. Rt. leg tightly flexed					.43				
V49. Rt. leg extended						.80			
V50. Rt. leg movement								.79	
V53. Lt. leg extended						.75			
V54. Lt. leg movement								.80	
V55. REM sleep	.81								
V56. Drowsy			.63				.33		
V57. Wide awake		.89							
V59. Care Given				.60			.30		
V60. Comforted									.89

Table 38: Infant III: Factor-Loading Matrix for Principal Components Solution Using Varimax Rotation (Nine factor solution)

Variable	Factor I	II	III	IV	V	VI	VII	VIII	IX
V31. Smooth forehead	.48								
V32. Slight frown						.91			
V33. Frown					.91				
V34. Rt. eye open		.96							
V35. Rt. eye sl. open			.96						
V36. Rt. eye shut	.89								
V37. Lt. eye open		.96							
V39. Lt. eye sl. open			.96						
V40. Lt. eye shut	.89								
V41. Mouth open	.32							.81	
V47. Rt. leg tightly flexed				.75					
V49. Rt. leg extended	.54								
V50. Rt. leg movement							.79		
V51. Lt. leg tightly flexed				.79					
V53. Lt. leg extended	.56								
V54. Lt. leg movement							.83		
V55. REM sleep	.74								
V56. Drowsy									.93
V57. Wide awake		.80							
V58. Crying					.89				

Table 39: All Infants: Factor-Loading Matrix for Principal Components Solution Using Varimax Rotation (Nine factor solution)

Variable	Factor I	II	III	IV	V	VI	VII	VIII	IX
V31. Smooth forehead					.93				
V33. Frown				.79					
V34. Rt. eye open	.93								
V35. Rt. eye sl. open		.92							
V36. Rt. eye shut			.43						
V37. Lt. eye open	.95								
V39. Lt. eye sl. open		.93							
V40. Lt. eye shut			.42			.39			
V41. Mouth open							.86		
V47. Rt. leg tightly flexed						.75			
V49. Rt. leg extended			.78						
V50. Rt. leg movement								.80	
V51. Lt. leg tightly flexed						.67			
V53. Lt. leg extended			.76						
V55. REM sleep			.35						
V56. Drowsy		.[illegible]6							
V57. Wide awake	.84								
V58. Crying				.82					
V59. Care given				.54					
V60. Comforted									.92

Table 40: Six Factor Solution: All Infants

Infant I (n = 682)		Infant II (n = 685)		Infant III (n = 724)		All Infants (n = 2091)	
Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading
Factor I: Wide Awake		Factor II: Wide Awake, No Distress		Factor II: Wide Awake		Factor I: Wide Awake	
Lt. eye open	0.93	Lt. eye open	0.96	Rt. eye open	0.96	Lt. eye open	0.94
Rt. eye open	0.89	Rt. eye open	0.96	Lt. eye open	0.96	Rt. eye open	0.92
Wide awake	0.82	Wide awake	0.88	Wide awake	0.81	Wide awake	0.83
Rt. leg extended	0.32	Smooth forehead	0.32				
Factor II: Drowsy		Factor III: Drowsy, No Distress		Factor III: Drowsy			
Rt. eye sl. open	0.90	Rt. eye sl. open	0.95	Rt. eye sl. open	0.96		
Lt. eye sl. open	0.88	Lt. eye sl. open	0.95	Lt. eye sl. open	0.96		
Drowsy	0.71	Drowsy	0.63	Drowsy	0.47		
		Smooth forehead	0.32				
Factor III: Acute Distress		Factor IV: Acute Distress		Factor V: Acute Distress		Factor III: Acute Distress	
Crying	0.81	Frown	0.78	Crying	0.81	Frown	0.75
Frown	0.79	Crying	0.64	Frown	0.79	Crying	0.74
Rt. leg movement	0.60	Care given	0.59	Rt. leg movement	0.58	Rt. leg movement	0.48
Lt. leg movement	0.55	Comforted	0.32	Lt. leg movement	0.57	Lt. leg movement	0.47
Care given	0.47	Drowsy	0.30			Care given	0.42

Table 40: continued

Infant I (n = 682)		Infant II (n = 685)		Infant III (n = [illegible]4)		All Infants (n = 2091)	
Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading
Factor V: Subacute Distress				**Factor VI:** Subacute Distress		**Factor IV:** Subacute Distress	
Slight frown	0.81			Slight frown	0.78	Slight frown	0.88
Lt. leg extended	0.41			Mouth open	0.44	Lt. leg extended	0.53
Rt. leg extended	0.39					Rt. eye shut	0.32
Rt. eye shut	0.35					Rt. leg extended	0.32
Lt. eye shut	0.32					Lt. eye shut	0.30
		Factor I: Sleeping, No Distress		**Factor I:** Sleeping, No Distress		**Factor II:** Sleeping, No Distress	
		Lt. eye shut	0.92	Lt. eye shut	0.88	Lt. eye shut	0.63
		Rt. eye shut	0.92	Rt. eye shut	0.88	Rt. eye shut	0.62
		REM Sleep	0.82	REM Sleep	0.77	REM Sleep	0.62
		Smooth forehead	0.74	Lt. leg extended	0.57	Smooth forehead	0.33
		Mouth open	0.40	Rt. leg extended	0.44	Mouth shut	0.30
				Mouth open	0.41		
				Smooth forehead	0.49		

Table 40: continued

Infant I (n = 682)		Infant II (n = 685)		Infant III (n = 724)		All Infants (n = 2091)	
Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading	Variable	Factor Loading
Factor VI: Unnamed Factor		**Factor V:** Unnamed Factor				**Factor V:** Unnamed Factor	
Rt. leg tightly flexed	0.80	Mouth open	0.78			Mouth open	0.90
Lt. leg tightly flexed	0.79					Smooth forehead	0.50
Factor IV: Unnamed Factor		**Factor VI:** Unnamed Factor		**Factor IV:** Unnamed Factor		**Factor VI:** Unnamed Factor	
Mouth open	0.88	Rt. leg extended	0.70	Rt. leg tightly flexed	0.77	Rt. leg tightly flexed	0.73
Lt. leg extended	0.46	Lt. leg extended	0.60	Lt. leg tightly flexed	0.60	Lt. leg tightly flexed	0.66
				Mouth open	0.46		
				Drowsy	0.43		

behaviors of acute or subacute distress or unnamed single or doublet factors.

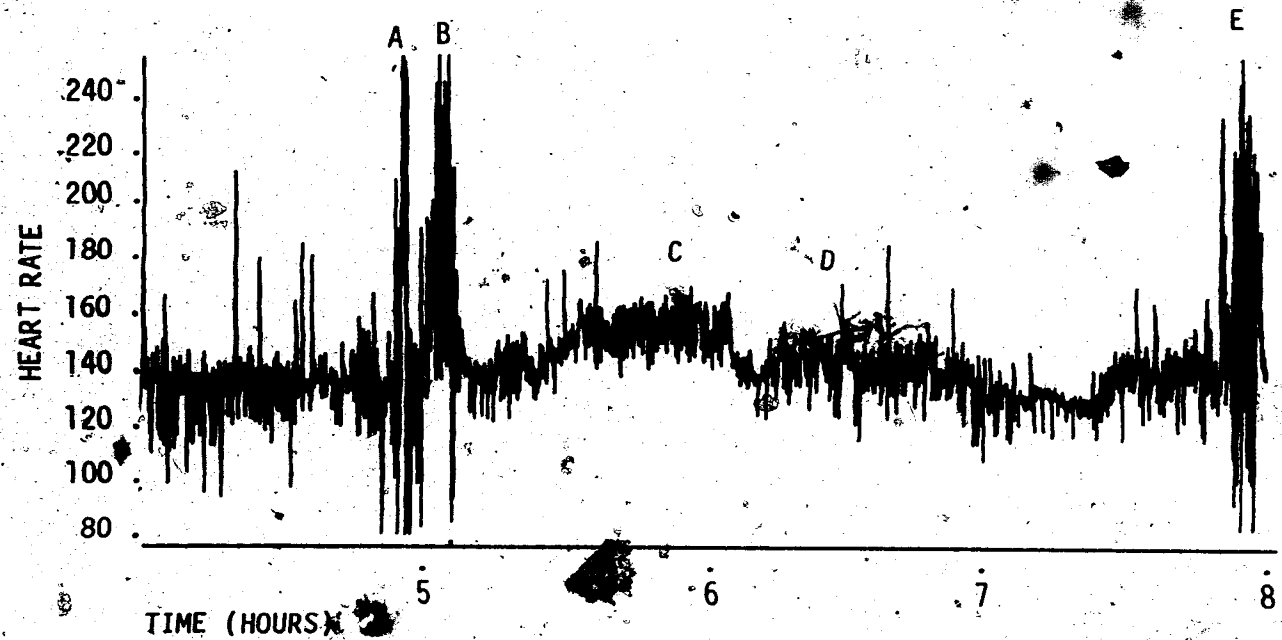
One limitation of factor analysis is that it does not examine the data serially but only at one point in time. Behaviors group together in sequences as well as occurring at the same time. An example is the variable "Comforting" only correlated with one factor. This could have occurred because the effects of comforting are probably seen after the comforting episode rather than during comforting measures.

Physiological Responses

Heart rate and respiratory rate were recorded once every second on the three infants as well as blood pressure on Infant III. Blood pressure was taken hourly on Infant III using the right arm. The blood pressure of Infant I was not recorded. Tracings of the respiratory rates were not examined. It was difficult to place the EKG leads in the appropriate places on the chest in order to pick up respiratory rates because of the infants' incisions and dressings. The blood pressure of Infant III was not examined because he had been on dopamine to increase his blood pressure until 30 minutes prior to videotaping.

The heart rate of Infant I varied between 125 and 160 beats per minute. While sleeping, his heart rate decreased to 125 and when awake increased towards 160 beats per minute. Brief episodes of a heart rate between 180 and 200 beats per minute were recorded when Infant I was disturbed (see Figure 2).

The heart rate of Infant II varied between 90 and 125 beats per minute. Brief episodes of a heart rate between 150 and 200 beats per



A. Checking IV, flushing gastrostomy tube
B. Awake
C. Awake
D. Sleeping
E. Sponge bath

Figure 2: An example of the variability of the heart rate of Infant I.

minute were recorded when Infant II was disturbed (see Figure 3). The hour blood pressure of Infant II is given in Table 41.

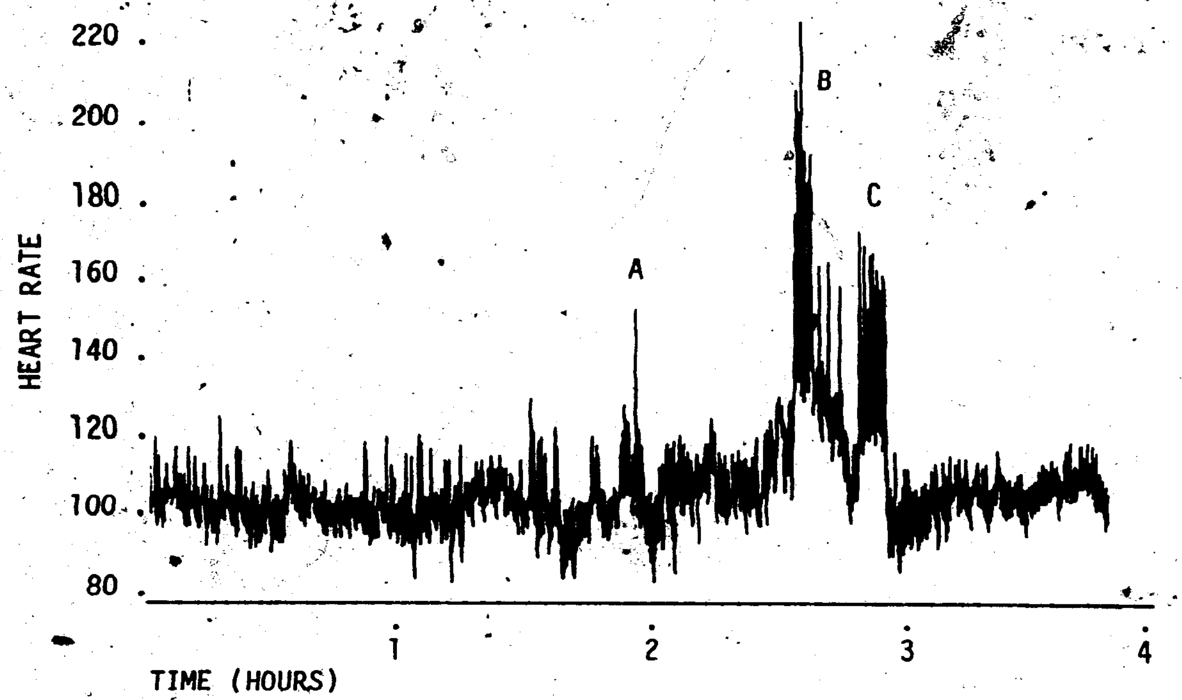
The heart rate of Infant III varied between 120 and 155 beats per minute. Brief episodes of a heart rate between 150 and 200 beats per minute were recorded when Infant III was disturbed (see Figure 4). No change in heart rate was noted after analgesics were given (see Figure 5). Infant I and Infant III had a heart rate noticeably higher than Infant II.

Summary of Behavorial Responses of the Infants

Behavioral Response of Infant I

Infant I exhibited behaviors of distress that indicated he was experiencing subacute pain during most of the videotaping session, acute pain episodes related to care given as well as acute pain episodes unrelated to external stimuli. The most noticeable behavior indicating subacute pain was a slight frown on his forehead 88.0 percent of the time coded. Behaviors that appeared to occur more often when the infant was slightly frowning than when his forehead was smooth were right eye shut, mouth shut, in a grimace or corners down, fingers curled or extended, and Active REM sleep.

As well as exhibiting behaviors of acute distress during care given, Infant I was observed to have 28 episodes of acute distress that were unrelated to external stimuli, 19 episodes occurring in the first hour of filming. It was not clear what event precipitated these acute pain episodes or when the episodes had started. The episodes of acute distress followed three basic patterns: frown, knees up, cry; knees

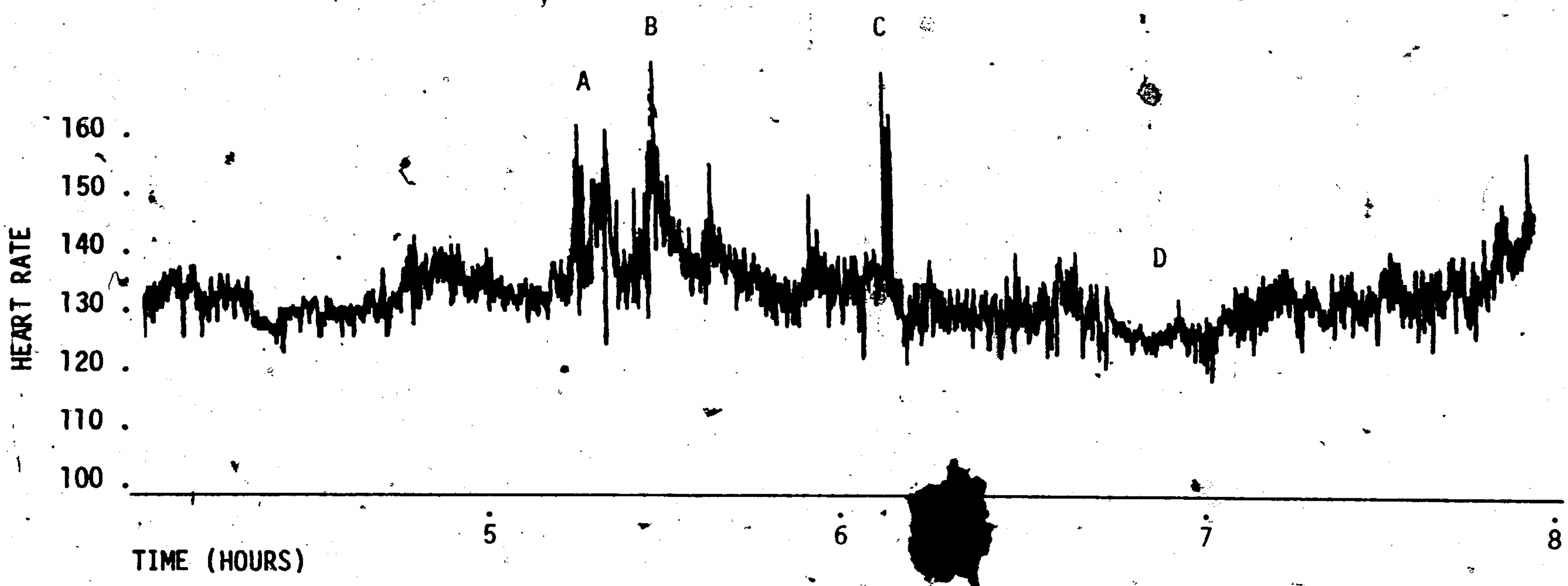


A. *Infant turned*
B. Chest physio and instillation and suction of endotracheal tube
C. Infant turned

Figure 3: An example of the variability of the heart rate of Infant II.

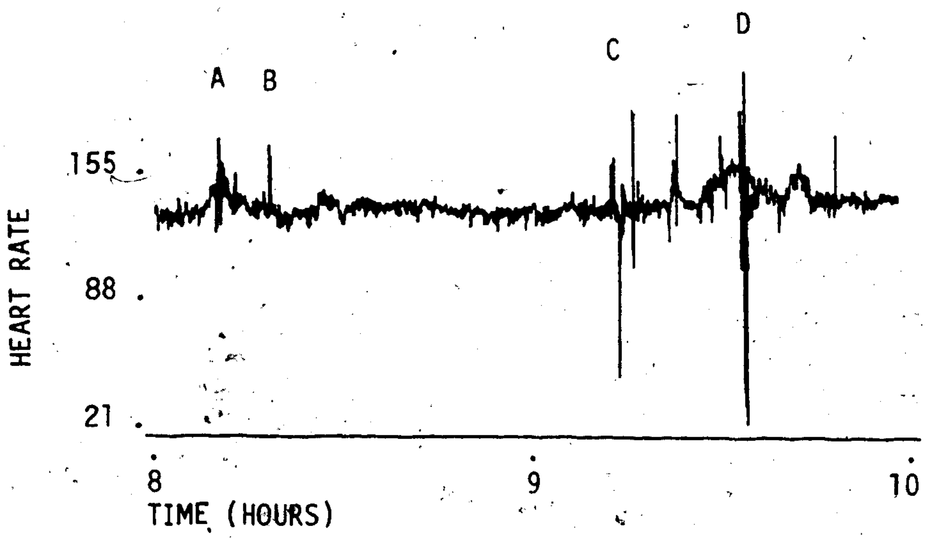
Table 41: Hourly Blood Pressure of Infant II

Time	Diastolic	Systolic	Mean
1700	61	40	51
1800	56	43	51
1900	61	40	46
2000	72	45	53
2100	67	42	46
2200	76	46	56
2400	61	33	41
0100	62	33	44
0200	60	37	48
0300	70	47	50
0400	66	42	50
0500	72	46	55



A. Chest physiotherapy
B. Instillation and suction of endotracheal tube
C. Intravenous restarted
D. Sleeping

Figure 4: An example of the variability of the heart rate of Infant III.



A. Endotracheal tube suctioned
B. Morphine given
C. IV restarted
D. IV restarted

Figure 5: The heart rate of Infant III before and after analgesic.

up, frown, cry; and frown, cry, knees up or other leg movements. Some of the episodes appeared to follow a deep breath or sudden abdominal movement however, no pattern was evident. For the following 11 hours, Infant I had seven acute episodes of distress.

The results of the factor analysis validated the observations made from the descriptive data and observation analysis. The first two factors were labelled 'awake' and 'drowsy'. Behaviors of subacute or acute distress did not load on these factors. Variables loading on the third factor, 'acute distress', were 'crying', 'frowning', 'right and left leg movements', and 'care given'. Variables loading on the fifth factor labelled 'subacute distress' were 'slight frown', 'right and left leg extended', and 'right and left eye shut'. The fourth and sixth factors were unnamed doublet factors consisting of the variables 'mouth open' and 'left leg extended' and 'right and left leg tightly flexed.' Infant I did not have a factor labelled 'Sleep' or a factor labelled 'No distress'.

Behavioral Response of Infant II

Infant II exhibited few behaviors of distress and appeared to sleep comfortably during most of the videotaping session. A physician commented on rounds "He doesn't seem to need anything (analgesic)" and the nurses agreed.

The descriptive data supported this observation. Infant II spent 85.4 percent of the time coded with a smooth forehead and 9.8 percent of the time with a slight frown on his forehead. During the time Infant II had a slight frown on his forehead, he had an increase in the percentage of time spent with his mouth in a grimace, corners down, crying, fingers curled or extended and an increase in the percentage of time spent in a drowsy state.

Infant II had four episodes of acute distress all following the basic pattern of frown, cry, knees up. Three episodes were preceded by a deep breath or abdominal movement. Acute distress appeared to be mostly associated with care given.

The factor analysis supported the observations made from the descriptive data and observation analysis. The first two factors 'sleeping, no distress' and 'wide awake, no distress' support that the infant had few behaviors of distress while sleeping or awake. The third factor 'drowsy' was also not associated with behaviors of distress. Variables indicating acute distress such as 'frown' and 'crying' loaded on Factor IV which was also associated with 'care given' and 'comfort'. Factor V and Factor VI, unnamed single and doublet factors, indicated the variables 'mouth open' and 'right and left leg extended'.

Infant II did not have a factor labelled 'subacute distress'. However it was reported to the investigator that the infant was very irritable and impossible to settle in the 24 hours following the videotaping session.

Behavioral Response of Infant III

Infant III exhibited behaviors that indicated he was experiencing episodes of subacute distress, acute distress associated with the frequent care given and periods of no distress. His forehead was smooth 46.8 percent of the time coded and a slight frown 32.1 percent of the time.

Variables that appeared to be associated with a slight frown rather than a smooth forehead were right eye slightly open, mouth open, in a grimace, or corners down, fingers curled and the behavioral states 'drowsy' and 'wide awake'.

Infant III was the only infant to receive analgesic during the videotaping session. The most notable difference in behavior before and after analgesic was given was a decrease in the amount of time the infant had a slight frown on his forehead: 90.6 percent to 18.3 percent after the first dose and 49.1 percent and 30.3 percent after the second dose.

The amount of time the infant spent with eyes open or slightly open increased slightly after analgesic was given. A decrease in the amount of time spent with mouth corners down or crying was noted along with an increase in the amount of time spent with the mouth shut. The infant spent more time sucking after analgesic was given and more time with legs tightly flexed rather than extended. After analgesic, he also spent more time in a 'drowsy' state and less time in 'active REM sleep'. The amount of care given decreased and the amount of comfort given increased after administration of the analgesic.

Infant III experienced 13 episodes of acute distress unrelated to external stimuli all occurring in the last six hours of the videotaping session. Six of these episodes were preceded by an abdominal movement. The episodes followed two basic patterns: frown, knees up, cry and frown, cry, knees up.

The factor analysis validated the observations made that Infant III experienced subacute and acute pain episodes as well as periods of no distress. Factor I was labelled 'sleeping, no distress' because one of the variables that loaded was 'smooth forehead'. Factor II, 'wide awake' and Factor III, 'drowsy' did not correlate with behaviors of distress or no distress. The variable 'drowsy' also loaded on the unnamed Factor IV with 'right and left leg tightly flexed' and 'mouth open'. Since the infant had an increase in the amount of time spent with legs tightly flexed after analgesic was given, Factor IV may be a factor indicating no distress. Infant III also had a factor labelled 'acute distress' as well as a factor labelled 'subacute distress'.

Behavioral Response of All Infants

Several observations were made of all three infants. One observation was that all infants spent relatively little time with behaviors associated with acute distress such as frowning (2.6 to 4.8 percent) and crying (1.9 to 3.8 percent). The infants also spent little time with 'rooting' behavior (0 to 0.7 percent) indicating that distress they did exhibit was not necessarily related to hunger.

Infant II, the infant who manifested the least amount of distress behavior, spent the smallest percentage of time sucking (2.3 percent) while Infant III spent the greatest percentage of time sucking (12.7 percent). Infant III was also the only infant with a tube for gastric suction inserted orally which may be a reason for increased sucking behavior. He had an increase in sucking behavior after analgesic was given. Most sucking behavior occurred when the infants did not have a soother.

The positions of the left hand of Infant I and Infant II were very similar while Infant III spent 90.0 percent of the time coded with his left hand in a fist. All three infants kept their right arm extended most of the time coded (63.2 to 97.9 percent). Infant I and Infant III had intravenous infusions and armboards on their right arms while Infant II had a blood pressure cuff on his right arm. Infant II kept his left arm more tightly flexed and less extended than Infant I and Infant III.

Positions of the toes were similar for all three infants while Infant II kept his right foot less tightly flexed than Infant I and Infant III. Infant II also had less leg movement than Infant I and III and kept his left leg with the intravenous infusion flexed 92.3 percent of the time. Otherwise the positions of the legs were similar for all three infants. The investigator noted that the infants' feet were very expressive. However, so much data were missing on the feet that no conclusions could be made.

Infant II spent more time in the state of 'acute REM sleep' and less time in the 'Drowsy' state than Infant I and Infant III. He also spent more time crying than Infant I or Infant II. Infant I was awake a greater percentage of time than Infant II and Infant III. None of the infants exhibited behaviors indicating that they were in a deep sleep.

Infant III was contacted to provide care approximately twice as often as Infant I and Infant II were contacted. Infant III was also contacted to provide comfort more often than the other infants. Infant

I with no parents visiting, received the least amount of comfort (0.8 percent) while Infant III with both parents visiting received the most comfort (7.5 percent).

The factor analysis of data on all the infants combined confirmed that the infants experienced periods of subacute distress, acute distress, mostly related to care given, and periods of no distress.

Summary of the Physiological Response of the Infants

Infant I and Infant III, the infants with the most behaviors of distress, also had a noticeably higher heart rate than Infant II. However, Infant I and Infant III also had heart defects while Infant II was considered to have a normal heart. The heart rates of all three infants and blood pressure of Infant II remained within normal limits as suggested by Scanlon et al. (1979). Although the behaviors of distress of Infant III decreased after analgesic was given there was no noticable decrease in his heart rate.

CHAPTER V

Discussion

An examination of the behaviors of three fullterm infants postoperatively revealed behaviors of distress that indicated that the infants, particularly Infant I and Infant III, experienced subacute pain and acute pain episodes resulting from the tissue damage caused by surgery. Although this study is only an exploratory one, it presents the most detailed study to date of the newborn's response to surgery.

Previous studies have concentrated on acute pain episodes only and have not examined the response of the infant to subacute or long term pain. This study contributes new information to the literature on the pain experience of the newborn by describing the infants' behaviors of distress and physiological response to subacute pain. Episodes of acute distress unrelated to external stimuli have also been described and have not been mentioned in the literature previously.

Behavioral Response of the Postoperative Newborns

Although authors such as Hack (1973) have suggested observing infant behavior in order to assess the pain of newborns, no one has described how the infant responds to long term pain such as that resulting from surgery. Behaviors commonly associated with the experience of pain such as frowning, crying, general body movements, kicking and pulling up the knees occurred infrequently with all three infants (see pp. 37-44) and often in association with care given. Therefore, these behaviors gave little indication of the pain the infants experienced following surgery. With so little crying behavior, the study of pain-induced vocalization that Levine and Gordon (1982) suggested would be of little use for the assessment of pain after surgery even if the infants were not intubated. The discomfort of the endotracheal tube may have reduced the amount of time spent crying.

Facial coding systems such as the one Izard (1983) has developed also would not be of use in assessing infants postoperatively because Izard has only developed a facial configuration for the acute pain response from a heelstick. This study supports that a newborn's behavioral response to pain involves more than just crying and frowning. The infant may have different total body responses to different kinds of pain. Observing only the face in order to assess pain is a simplistic approach. As Perl (1984) stated, the experience of pain is very complex. Observing the infants' whole body gave a more complete description of the infants' behavioral responses to pain and indicated that the infants experienced different types of pain.

Behaviors of Acute Distress

Behaviors of acute distress indicating the experience of sudden acute pain unrelated to care-given were found in all three infants, most often in Infant I. Three basic patterns of behaviors were noted. One pattern, knees up, frown, cry, was the same pattern that Franck (1986) found in the response to a heelprick procedure in fullterm newborns. The three different patterns could indicate that the infants were experiencing three different kinds of pain or pain from different locations. Some of the acute pain episodes were preceded by abdominal movements or deep breaths indicating that the infants could be experiencing spasms of pain. Spasms of pain from an abdominal incision may lead to a different behavioral response than spasms caused by a chest incision or chest tube. Infant II and Infant III may have had the same number of spasms as Infant I but may have had less of a behavioral response because of the effects of the analgesics administered.

In this study, little comfort was given to the infants. Methods of distraction that Whaley and Wong (1983) and Brazelton (1977) suggested work well in providing comfort to the newborn were used mostly by the parents of Infant III. The data were insufficient however to determine if stroking, talking and singing to the infant were effective methods of pain relief. It was noted however, when the father of Infant III stroked his leg, a startled reaction often resulted. Stroking the leg of Infant III appeared to cause more distress than comfort.

Self-consoling activities of the newborn such as hand to mouth movements (Brazelton, 1977) only occurred a few times in Infant I. However, all infants had one hand restrained which may have limited this activity. Sucking, another activity Brazelton (1977) labelled as self-consoling, was only seen for a small percentage of time in each infant.

Soothers were only given to these infants briefly and then they spent a small percentage of time sucking the soothers. In fact, more sucking occurred when the infants did not have a soother. Field et al. (1984) found that infants with soothers spent less time fussing and crying during a heelstick procedure. Soothers may be more effective as a distraction or comfort measure with the lesser pain of a heelstick than with the more acute and subacute pain following surgery. The fact that Infant III had more sucking behavior after analgesic was given tends to support that sucking is used as a comfort measure by infants for less acute pain. Nurses need to examine when infants are most receptive to soothers. These infants may have had little sucking behavior because soothers were not offered at appropriate times.

Analgesic appeared to comfort Infant III as noted by the decrease in behaviors of distress after both doses of morphine were given. Volpe (1981) and Brazelton (1962) noted that infants often withdraw as a result of painful procedures. The behavior of Infant III before and after analgesic confirms this observation in that after analgesic was given, he spent less time in active REM sleep and more time in the drowsy state. However this type of behavioral response only appears to be in the short term. Infant I and Infant III appeared to have more pain than Infant II and yet were awake and drowsy more often than Infant II. Infants may be unable to control state as Brazelton (1977) suggests when exposed to severe stimuli.

Infant III may have had so few behaviors of distress because of the long half-life of meperidine in infants. Infant II received two doses of meperidine postoperatively and his mother received one dose before being delivered by caesarian section. Hodgkinson et al. (1982) found effects of meperidine on infant behavior up to three days after delivery when mothers received meperidine prior to delivery. Infant II became irritable and difficult to settle approximately 60 hours after delivery which could indicate that the effects of meperidine may have worn off.

Marshal et al. (1980) noted a change in behavior of infants experiencing circumcision and that individual differences were observed. The three infants studied required the same chest incision and received the same anesthetic yet behaved differently. Effects of analgesics may have accounted for some of the differences in behavior but the infants may also have had individual responses to pain. The fact that Infant III was approximately seven days older than Infant I and Infant II, may have contributed to individual differences in behaviors of distress. Infants have been found to experience a period of disorganization and depression for up to 48 hours after birth and longer with complications (Brazelton, 1977).

Physiological Response of the Postoperative Newborn

Increases in heart rate were noted with stressful procedures such as chest physiotherapy and endotracheal instillation and suction confirming Owen's (1984) suggestion that heart rate increases in relation to strong stimuli and is "a sensitive measure of attention and emotion in neonates" (p. 224). However a prolonged increase in heart rate that McCaffery (1979) suggested may occur in response to pain was inconclusive. Attributing the noticeable increase in heart rate of Infant I and Infant II to subacute pain cannot be done since the two infants also had heart defects. More infants' physiological responses to pain need to be studied to determine the relationship between heart rate and the experience of pain over a prolonged period of time.

The Usefulness of Ethology in Studying Infant Behavior

In this study, ethological methods were useful in gaining knowledge about infants' behavioral responses to pain and other stimuli such as nursing care or comfort measures. Videotaping newborns postoperatively in order to obtain a permanent record of infant behavior was accomplished in NICU without interfering with the infants' care. Nurses caring for the infants appeared a little nervous at the beginning of filming but relaxed when they realized that only their arms appeared on the videotape.

Parents were able to visit their infants during the videotaping sessions and the camera did not appear to interfere with interactions with their infants. Parental visiting patterns did not appear to change during the videotaping sessions.

The video equipment blended so well with the other equipment in NICU that often staff did not notice the equipment even when standing right beside the camera. The equipment was relatively simple to operate and a good quality picture was obtained on each infant. The best camera angle was obtained by placing the camera at the side of the bed towards the head of the bed and aiming down on the infants. During the pilot study, the camera was placed towards the foot of the bed and a good picture of the face was not obtained. Two cameras may be necessary in order to obtain an adequate picture of the face as well as the feet.

Occasionally, the camera view was inadequate and the investigator was unable to code infant behavior for several reasons. Firstly, a nurse, physician or respiratory technician stood in front of the camera in order to provide care to the infants. This accounted for 39.6% of the time the camera view was obstructed. Secondly, when the infants were turned from one side to the other, it was necessary to change the camera angle. Moving the camera from one side of the bed to the other accounted for 16.5% of the missing data. Changing the videotapes every two hours accounted for 16.2% of the time the camera view was inadequate.

It was necesary to use a digital clock on the bedside to record time points on the videotapes because a time-date generator was not available on the VCR. Difficulties in reading the clock occurred due to glare, the view of the clock being blocked, the clock being knocked over or the overhead lights being turned off for a procedure on another infant. Problems with reading the clock accounted for 27.7% of the time the view was inadequate. In the future, a VCR with a time-date generator should be used rather than a clock at the bedside.

Continuous data collection for a 12 hour time interval was tiring for the investigator. In addition, two hours were required prior to filming to organize the equipment, and one hour after filming was needed to disassemble equipment for a total time period of 15 hours. In future research of this kind, research assistants should be hired to assist with operating the camera and recording events. Coding the videotapes was a time consuming but interesting task. A VCR with 'pause' and 'frame-by-frame' advance functions was essential.

Videotaping infant behavior in NICU was a relatively simple and inexpensive method of obtaining a permanent record of infant behavior.

It is recommended that infants be videotaped when studying behavior in order that a permanent record be obtained. A permanent record of behavior has advantages over single observation in that videotape can be viewed several times so that no behaviors are missed (Lehner, 1979). In this study, the episodes of sudden acute distress may have been missed by the investigator if single observation techniques were used rather than videotaping.

Conclusion

Regardless of the lack of information on the physiology of the pain experience or even lack of a definition of the word 'pain', examination of the three infants' behaviors postoperatively left no doubt that the newborns exhibited behaviors of distress indicating that they experienced pain as a result of the tissue damage of surgery. Infants exhibited behaviors such as a slight frown, eyes shut and legs extended indicating subacute pain as well as behaviors such as a frown, crying, grimace, eyes shut and leg movements indicating acute pain episodes. Individual differences in behaviors of distress were also noted. The investigator tends to agree with Owen (1984) that "the burden of proof should be shifted to those who maintain that infants do not feel pain (p. 215)".

Implications for Nursing

The study of the pain experience of the newborn is necessary in order to improve care for the infant. Nurses are the health care professionals who should be undertaking the study of pain management in the newborn since nurses are responsible for administering analgesics and providing non-pharmaceutical comfort measures to the infant.

For instance, nurses need to determine what comfort measures work best with each infant and appropriate times to give comfort. Parents then need to be taught comfort measures and to observe for behaviors that indicate effects of comfort measures. Infants, for instance, may be more receptive to soothers at certain times. They may also have individual preferences for the part of the body on which they prefer to be stroked. Nurses must also examine the effects of noise levels in NICU and the timing of care given, all of which may affect an infant's comfort.

An infant in NICU may experience many painful procedures and it is the responsibility of the nurse to search for methods to decrease the distress of the newborn. Ethological methods are feasible in the NICU environment and improved the assessment skills of the investigator. Many types of behaviors could be videotaped to use as teaching aids. As nurses learn more about infants' behavioral and physiological responses, assessment of newborns will improve.

Limitations

Lack of information on the physiology of the pain experience is a limitation of any research project on pain. Ethically, pain cannot be inflicted on an infant in order to observe cause and effect. Since infants are prelingual, one can only assume that the behaviors of distress observed are associated with the infants' actual sensations of pain. In this context, pain may be viewed as a hypothetical construct used to explain the cause of the behaviors of distress observed in the infants.

The primary limitation of this study is the small number of subjects examined. A large sample of behaviors was obtained from each infant over a prolonged period of time to provide an accurate description of each infant's behaviors. However, with only three subjects, results cannot be generalized to the total population of newborn infants undergoing surgery. More individual differences in response to pain may be found if more infants are studied after surgery. An infant's response to pain may also depend on the type of surgery, position of incision and so forth. For this exploratory study, however, three infants provided a sufficient amount of data.

Problems With the Coding System and Recommendations

Several of the variables in the coding system would have provided more information if the number of categories in the variables was increased. For example, the infant's body positions were coded as either 1-'right side' or 2-'left side'. In most instances the infants' heads were positioned on the right side or left side but the infants' bodies were actually flat on the bed. The categories for body positions should have included 'slightly on the right side', 'slightly on the left side' and 'lying on the back' (i.e., five categories instead of two).

To more accurately assess arm movements, categories should be developed for the wrist and the shoulder rather than simply the fingers and the elbows. Whether the arms were on the bed or held in the air should also be coded. Categories for hip and knee angles should also be added.

Sleep states were difficult to code. The infants did not exhibit behaviors of 'deep sleep' as described by Brazelton (1984). However, it was difficult at times to decide if they were exhibiting behaviors of 'active REM sleep'. The Anderson Behavioral State Scale [adapted from Parmellee and Stern (1972) and Burroughs, Asonye, Anderson, & Vidyasagar (1978)] with four categories for sleep may provide more information in future research.

The variable 'infant contacted' should be expanded and made more specific. In particular, a separate variable for comfort measures should be developed with a category for each comfort measure used.

The 'noise' variables were difficult to analyze using the present method of coding. Three variables for noises occurring at the same time was sufficient in number but the categories were not specific enough. A more useful method for analyzing noise levels might be to use a sound spectrograph on a continuous basis that could be attached to the portable computerized data collection unit. Physiological data and behaviors could then be analyzed in relation to noise levels. It was difficult to judge noise levels from the videotapes alone since the microphone on the camera only picked up noises from one direction. Noises from behind the camera were muted.

Another problem with the coding system was that it did not measure the degree of tension in the infants' limbs. For instance, the researcher could not determine whether the infants had their hands in a fist but relaxed or in a fist that was tightly clenched. In further research, the investigator may be able to observe and code tension in the limbs while at the bedside.

As much coding as possible should be done at the bedside as a reliability check with coding done from the videotapes. Behavioral states for instance, may be easier to code at the bedside rather than from the videotapes. The investigator found, as did Sackett et al. (1978) that the infants' behaviors on the two-dimensional picture of the videotape were not as clear as observing behaviors at the bedside using three-dimensional cues.

Problems With Collecting Physiological Data

As mentioned previously, respiratory rate was not used in analysis since it was difficult to place the electrodes in the correct place on the abdomen and chest in order to pick up respiratory rate accurately. A carbon dioxide spectophotometry breath detection monitor (Tri Med 511) has been used by Thomas et al. (1986) to more successfully determine respiratory rate continuously for up to eight hours. All signals from the monitor were conveyed to a portable computer.

Areas for Further Research

Ethological methods are useful for nurses to learn more about the pain experience of the newborn as well as other aspects of infant behavior and a multivariate approach appears to give the most information (Owens, 1984). The first step in further research however, must be adjusting the coding system as previously discussed and reliability and validity testing of the coding system. Also, a different method such as the one described by Thomas (1986) must be found for measuring respiratory rate. The next step in further research would be to use the coding system on a larger sample of normal fullterm newborns requiring surgery and developing the taxonomy further if necessary. Sequential analyses (Bakeman, 1978) should also be added in order to examine sequences in behaviors as well as behaviors that occur at the same time.

Using data from a larger sample of infants then, the following areas of research could be explored.

1. Examine infant behavioral and physiological responses after various types of surgery to determine responses to different kinds of pain or locations of pain.

2. Examine infant behavioral and physiological responses before and after analgesics to determine effects of analgesic and how long these effects last. Pharmacological studies of analgesics could be conducted in conjunction with behavioral and physiological studies.

3. Examine infant behavioral and physiological responses before and after comfort measures given by nurses or family members such as soothers, stroking, patting, talking and singing to the infant, music therapy, therapeutic touch and transcutaneous electrical nerve stimulation (TENS).

Other questions that may be asked when a larger sample is obtained are:

1. Does every newborn undergoing surgery have acute pain episodes postoperatively that are unrelated to external stimuli? What

events or behaviors precipitate episodes of sudden acute pain?

2. Do infants who have been born by caesarian section or whose mothers received meperidine prior to delivery consistently exhibit less behaviors of distress if undergoing surgery in the first three days after birth?

3. Are the infants' toes, feet, and legs better indicators of distress than the fingers, hands, and arms?

4. Will the amount of time parents spend comforting their infants increase if they are taught comfort methods and what behaviors to watch for to determine the effects of the comfort?

Summary

There is a controversy over the extent to which newborns experience pain and if newborns require analgesic. Thus far research has focused on the examination of the newborn's behavioral response to acute pain episodes such as heelsticks and circumcision. No information is available however on the newborn's response to subacute or long term pain such as that resulting from surgery.

Nurses caring for infants sometimes recognize behavioral cues of infants in distress and verify these observations with physical indices of pain. However, these behavioral cues have not been systematically examined and documented. Currently no methods are available to evaluate the pain experience of newborns. The purpose of this exploratory study was to begin to describe the newborn's behavioral and physiological responses following chest surgery using ethological methods.

Three normal fullterm male infants were videotaped for 12 hours beginning 24 hours after chest surgery. Heart rate and blood pressure were also recorded by a portable computerized data collection unit. Care of the infants was not affected by the study.

Using a coding system developed for this project, the first 20 seconds of each minute were coded in two second intervals. An interrater reliability index of 0.85 was obtained as well as an intrarater reliability index of 0.84.

Data on infant behavior were entered into a computer for analysis. Three methods were used to analyze the behaviors: descriptive statistics, observation analysis and factor analysis. Six factors accounted for 63.9 percent of the variance for Infant I, 65.5 percent of the variance for Infant II, 70.3 percent of the variance for Infant III and 61.6 percent of the variance for the combined data of all infants. Results of the analyses revealed that the infants exhibited behaviors of distress such as a slight frown, eyes shut and legs extended indicating a subacute pain experience as well as behaviors of distress such as frowning, crying, eyes shut and leg movements indicating an acute pain experience. Individual differences in behavior were also identified. The results of the physiological data were inconclusive.

The contribution this study makes to the literature on the pain experience of the newborn is the description of the subacute pain experience as well as the acute pain episodes which were unrelated to external stimuli. This study has also shown that videotaping infant behavior can be accomplished in NICU without interfering with infant care.

The study of the pain experience of the newborn is essential in order to improve care for the infant. Nurses are the health care professionals who should be undertaking the study of pain management in the newborn since nurses are responsible for administering analgesics and providing non-pharmaceutical comfort measures to the infant. Many types of behavior could be videotaped to use as teaching aids to improve assessment of the newborn.

Lack of information on the pain experience is a limitation of any study on pain. The major limitation of this study is the small number of subjects. More individual differences may be found if more infants are examined postoperatively as well as different responses to different kinds and locations of incisions. Problems with the coding system are outlined and recommendations made for future use of the coding system.

The next step in further research is revising the coding system, finding a different method for measuring respiratory rate and then examining a larger sample of normal fullterm newborns requiring surgery. Sequential analyses should also be added to data analysis methods. With data on more subjects, areas such as responses to different kinds and locations of pain, responses to analgesics, and responses to comfort measures may be examined.

REFERENCES

REFERENCES

Abu-saad, H. (1981). The Assessment of Pain in Children. Issues in Comprehensive Pediatric Nursing, 5, 327-355.

Anderson, G.C. (1986). Anderson Behavioral State Scale. Unpublished Manuscript, University of Florida, The J. Hills Miller Health Center, College of Nursing, Gainesville.

Bakeman, R. (1978). Untangling Steams of Behavior: Sequential Analyses of Observation Data. In G.P. Sackett (Ed.), Observing Behavior: Vol. 2. Data Collection and Analysis Methods. (pp. 64-78). Baltimore: University Park Press.

Benoliel, J.Q. (1977). Forward. In A.K. Jacox (Ed.). Pain: A Source Book for Nurses and Other Health Professionals (pp. ix-xi). Boston: Little, Brown & Company.

Bowlby, J. (1969). Attachment and Loss: Vol. 1. Attachment. New York: Basic Books, Inc.

Brazelton, T.B. (1962). Observation of the Neonate. Journal of the American Academy of Child Psychiatry, 1, 38-58.

Brazelton, T.B. (1977). Neonatal Behavior and its Significance. In A.J. Schaffer & M.E. Avery (Eds.), Diseases of the Newborn (4th ed.), (pp. 37-56.) Philadelphia: W.B. Saunders Company.

Brazelton, T.B. (1984). Neonatal Behavioral Assessment Scale (2nd ed.). Philadelphia: J.B. Lippincott Company.

Brown, E.L., & Deffenbacher, K. (1979). Perceptions and the Senses. New York: Oxford University Press.

Burroughs, A.K., Asonye, V.O., Anderson-Shanklin, G.C., & Vidyasagar

(1978). The effects of nonnutritive sucking on transcutanous oxygen tension in [illegible]ing, preterm neonates. Research on Nursing and Health, 1, [illegible]-76.

Callis, P.M. (1984). The Testing and Comparison of the Intra-uterine Sound Against Other Methods for Calming Babies. Midwives Chronicle & Nursing Notes, 97, 336-338.

Campos, J.J., Caplovitz Barrett, K., Lamb, M.E., Hill Goldsmith, H., & Stenberg, C. Socioemotional Development. In P.H. Mussen (Ed.), Handbook of Child Psychology: Vol. 2. Infancy and Developmental Psychobiology (pp. 783-915). New York: John Wiley & Sons.

Dobbing, J. (1974). Human Brain Development and Its Vulnerability. In Biological and Clinical Aspects of Brain Development. Mead Johnson Symposium on Perinatal and Development Medicine, No. 6, Dec. 8-11, 1974.

Ekman, P., & Friesen, W. (1978). Facial Action Coding System. Palo Alto, California: Consulting Psychologists Press.

Field, T., & Goldson, E. (1984). Pacifying Effects of Nonnutritive Sucking on Term and Preterm Neonates During Heelstick Procedures. Pediatrics, 74, 1012-1015.

Franck, L.S. (1986). A New Method to Quantitatively Describe Pain Behavior in Infants. Nursing Research, 35, 28-31.

Franke, L., & Lund, C. (1986). A National Survey of the Assessment and Treatment of Pain in the Neonatal Intensive Care Unit (NICU) [Abstract]. Pediatric Research, 20, 347A.

Gould, J.L. (1982). Ethology. London: W.W. Norton & Company.

Hack, M. (1983). The Sensorimotor Development of the Preterm Infant.

In A.A. Fanaroff & R.J. Martin (Eds.), Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant (3rd ed.), (pp. 333-335). Toronto: The C.V. Mosby Company.

Hodgkinson, R., & Husain, F.J. (1982). The Duration of Effect of Maternally Administered Meperidine on Neonatal Neurobehavior. Anesthesiology, 56, 51-52.

Izard, C.E. (1983). The Maximally Discriminative Facial Movement Coding System. Newark, Delaware: Instructional Resources Center, University of Delaware.

Jones, N.B. (Ed.). (1972). Ethological Studies of Child Behavior. New York, New York: Cambridge University Press.

Kerlinger, F.N. (1973). Foundations of Behavioral Research (2nd ed.). New York: Holt, Rinehart and Winston, Inc.

Korones, S.B. (1981). High-risk Newborn Infants: The Basis for Intensive Nursing Care. Toronto: The C.V. Mosby Company.

Lamb, M.E., & Campos, J.J. (1982). Development in Infancy. New York: Random Hosue, Inc.

Lehner, P.N. (1979). Handbook of Ethological Methods. New York & London: Garland STPM Press.

Lester, B.M., & Zeskind, P. (1978). Brazelton Scale and Physical Size Correlates of Neonatal Cry Features. Infant Behavior and Development, 1, 393-402.

Levine, J.D., & Gordon, N.C. (1982). Pain in Prelingual Children and its Evaluation by Pain-induced Vocalization. Pain, 14, 85-93.

Lind, J., Vuorenkoski, V., Rosberg, B., Partanen, T.J., and Wasz-Höckert, O. (1970). Spectographic Analysis of Vocal

Response to Pain Stimuli in Infants With Down's Syndrome. Developmental Medicine and Child Neurology, 12, 478-86.

Livingston, J.C. (1979). Music for the Childbearing Family. Journal of Obstetric, Gynecologic and Neonatal Nursing, 8, 363-367.

Lorenz, K.Z. (1981). The Foundations of Ethology. New York: Springer-Verlag, Inc.

Marshall, R.E., Stratton, W.C., Moore, J., & Boxerman, S.B. (1980). Circumcision I: Effects on Newborn Behavior. Infant Behavior and Development, 3, 1-14.

McCaffery, M. (1972). Nursing Management of the Patient With Pain. Philadelphia: J.B. Lippincott.

McCaffery, M. (1979). Nursing Management of the Patient with Pain (2nd ed.). Toronto: J.B. Lippincott Company.

Melzack, R., & Wall, P.D. (1983). The Challenge of Pain. New York: Basic Books, Inc.

Merenstein, G.B., & Gardner, S.L. (1985). Handbook of Neonatal Intensive Care. St. Louis: The C.V. Mosby Company.

Michelsson, K. (1971). Cry Analysis of Symptomless Low Birth Weight Neonates and of Asphyxiated Newborn Infants. Acta Pediatrica Scandinavia, Suppl. 216, 10-45.

Michelsson, K., & Wasz-Höckert, O. (1980). The Value of Cry Analysis in Neonatology and Early Infancy. In T. Murry & J. Murry (Eds.), Infant Communication: Cry and Early Speech, (pp. 152-182). Houston, Texas: College-Hill Press.

Newman, L.F. (1981, April). Anthropology and Ethology in the Special Care Nursery: Communicative Functions in Low Birthweight

Infants. Paper presented at the meeting of the Society for Applied Anthropology, Edinburgh, Scotland.

Nunnally, J.C. (1978). Psychometric Theory (2nd ed.). New York: McGraw-Hill Book Company.

Oehler, J.M. (1981). Family-Centered Neonatal Nursing Care. Toronto: J.B. Lippincott Company.

Owens, M.E. (1984). Pain in Infancy: Conceptual and Methodological Problems. Pain, 20, 213-230.

Owens, M.E., & Todt, E.H. (1984). Pain in Infancy: Neonatal Reaction to a Heel Lance. Pain, 20, 77-86.

Parmalee, A.H., & Stern, E. (1972). Development of States in Infants. In C.D. Clemente, D.P. Purpura, F.E. Mayor (Eds.), Sleep and the Maturing Nervous System (pp. 200-228). New York: Academic Press.

Perl, E.R. (1984). Pain and Nociception. In I. Darian-Smith (Ed.). Handbook of Physiology, Section 1: The Nervous System, Vol. 3, Sensory Processes, Part 2 (pp. 915-975). Bethsada, Maryland: American Physiological Society.

Polit, D.F., & Hungler, B.P. (1978). Nursing Research. Philadephia: J.B. Lippincott Company.

Poznanski, E.O. (1976). Children's Reactions to Pain: A Psychiatrist's Perspective. Clinical Pediatrics, 15, 1114-1119.

Pratt, H., Amlie, R.N., & Starr, A. (1981). Short Latency Mechanically Evoked Peripheral Nerve and Somatosensory Potentials in Newborn Infants. Pediatric Research, 15, 295-298.

Pyles, S.H., & Stern, P.N. (1983). Discovery of Nursing Gestalt in

Critical Care Nursing: The Importance of the Gray Gorilla Syndrome. Image, 15, 51-57.

Sackett, G.P., Ruppenthal, G.C., & Giuck, J. (1978). An Overview of Methodological and Statistical Problems in Observational Research. In G.P. Sackett, (Ed.) Observing Behavior: Vol. 2. Data Collection and Analysis Methods (pp. 1-14). Baltimore: University Park Press.

Saint-Anne Dargassies, S. (1966). Neurological Maturation of the Premature Infant of 28-41 Weeks Gestational Age. In F. Zaulkner (Ed.) Human Development (pp. 306-325). Philadelphia: W.B. Saunders Company.

Scanlon, J.W., Nelson, T., Grylack, L.J., & Smith, Y.F. (1979). A System of Newborn Physical Examination. Baltimore: University Park Press.

Schmidt, R.F. (1981). Somatovisceral Sensibility. In R.F. Schmidt (Ed.), Fundamentals of Sensory Physiology (M.A. Biederman-Thorson, Trans.), 2nd ed. (pp. 81-125). New York: Springer-Verlag.

Skerret, K., Hardin, S.B., & Puskar, K.R. (1983). Infant Anxiety. Maternal-Child Nursing Journal, 12, 51-59.

Stahler-Miller, K. (Ed.). (1983). Neonatal and Pediatric Critical Care Nursing. New York: Churchill Livingstone.

Thomas, K., & Brengelmann, G. (1986). Computerized Data Acquisition Systems: An Innovation in the Study of Human Response Patterns [Summary]. In S.M. Stinson, J.C. Kerr, P. Giovannetti, P.A. Field, & J. MacPhail (Eds.), Proceedings of the International

Nursing Research Conference, 358.

Urdang, L. (Ed.). (1983). Mosby's Medical and Nursing Dictionary. St. Louis: The C.V. Mosby Company.

Volpe, J.J. (1981). Neurology of the Newborn. Toronto: W.B. Saunders Company.

Volpe, J.J., & Koenigsberger, R. (1981). Neurologic Disorders. In G.B. Avery (Ed.), Neonatology (2nd ed.), (pp. 910-963). Toronto: J.B. Lippincott Company.

Wall, P.D. (1984). Introduction. In P.D. Wall & R. Melzack (Eds.), Textbook of Pain (pp. 1-16). Edinburgh: Churchill Livingstone.

Whaley, L.F., & Wong, D.L. (1983). Nursing Care of Infants and Children (2nd ed.). Toronto: The C.V. Mosby Company.

Wiliamson, P.S., & Williamson, M.L. (1983). Physiologic Stress Reduction by a Local Anesthetic During Newborn Circumcision. Pediatrics, 71, 36-40.

APPENDIX A

INFORMED CONSENT FORMS

INFORMED CONSENT FORM

PROJECT TITLE: A Description of the Postoperative Response of Newborns.

INVESTIGATOR: Judith J. Côté, R.N., B.Sc.N.
Graduate Student, University of Alberta
Staff Nurse, University Hospitals.
Phone: 436-4392

ADVISOR: Dr. J. Morse, R.N., Ph.D., Ph.D.
Associate Professor, University of Alberta,
Clinical Nurse Researcher, University Hospitals.
Phone: 432-6250

Little is known of the postoperative experience of infants. Infants cannot communicate their needs and, if the infant is receiving respiratory assistance, he/she cannot express discomfort by crying. The purpose of this research is to describe the responses of the infant after surgery. Behavioral responses and responses of the infant's pulse, respirations and blood pressure will be analyzed. The information will increase nursing and medical understanding of the infant's behavior postoperatively.

Routine care of the infant will not be interrupted by participating in this research. Medications for the postoperative relief of discomfort and other medical or nursing care will continue to be provided. However, to permit an unobstructed view of the infant, the infant will be cared for under an overhead warmer, rather than in an isolette during videotaping.

Each infant will be videotaped for 12 hours, beginning 24 hours after surgery, to allow for effects of the anaesthetic to wear off and the infant's condition to stabilize. A recording of the infants' pulse, respirations and blood pressure will also be taken for 12 hours.

There will be no apparent risk to the infants and all information will be coded so the information gathered cannot be identified with the infants. The infants' names will not appear in any documents or reports.

The infants may not directly benefit from involvement in this project, but information gained through their involvement may contribute to a greater understanding of care of the infant after surgery.

I/WE HEREBY AUTHORIZE Judith J. Côté to videotape my/our infant _________________________ (Name), and record his/her pulse, respirations and blood pressure for the above stated purpose.

I/WE UNDERSTAND that I/we are free to withdraw consent and terminate my/our infant's participation at any time without penalty.

I/WE HEREBY waive all rights that we or our infant have to any claims for payment in connection with any presentation of these recordings. This release is made with the understanding that these recordings may be used and reused for educational, research/scientific and other institutional purposes including publication.

I/WE HAVE BEEN GIVEN THE OPPORTUNITY TO ASK WHATEVER QUESTIONS I/WE DESIRE AND ALL SUCH QUESTIONS HAVE BEEN ANSWERED TO MY/OUR SATISFACTION

DATE: _________________________ PLACE: _________________________

SIGNATURE: _________________________

SIGNATURE: _________________________

WITNESS: _________________________

INFORMED CONSENT FORM FOR NURSING STAFF

AUTHORIZATION, CONSENT AND RELEASE FOR RECORDING

PROJECT TITLE: A Description of the Postoperative Response of Newborns.

INVESTIGATOR: Judith J. Côté, R.N., B.Sc.N.
Graduate Student, University of Alberta
Staff Nurse, University Hospitals.
Phone: 436-4392

ADVISOR: Dr. J. Morse, R.N., Ph.D., Ph.D.
Associate Professor, University of Alberta,
Clinical Nurse Researcher, University Hospitals.
Phone: 432-6250

AUTHORIZATION

I hereby authorize Judith J. Côté to take videotape recordings

______________________________ (participant)

CONSENT

I hereby consent to allow my first or given name and do not consent to allow my surname to be associated with any of these recordings.

RELEASE

I hereby waive all rights that I may have to any claims for payment in connection with any presentation of these recordings. This release is made with the understanding that these recordings may be used and reused for educational, research, scientific and other institutional purposes including publication.

DATE: ____________________ PLACE: ____________________

SIGNATURE: ____________________

WITNESS: ____________________

APPENDIX B

DUMMY VARIABLES USED IN FACTOR ANALYSIS

DUMMY VARIABLES USED IN FACTOR ANALYSIS

1. Smooth Forehead
2. Slight Frown
3. Frown
4. Right Eye Open
5. Right Eye Slightly Open
6. Right Eye Shut
7. Left Eye Open
8. Left Eye Slightly Open
9. Left Eye Shut
10. Mouth Relaxed Shut
11. Mouth Relaxed Open
12. Soother in Mouth
13. Mouth Distressed (Included 'Grimace', 'Corners Down', and 'Crying')
14. Sucking (Included 'Sucking' and 'Sucking Soother')
15. Left Fingers in a Fist
16. Left Fingers Extended
17. Left Arm Tightly Flexed
18. Left Arm Extended
19. Right Leg Tightly Flexed
20. Right Leg Extended
21. Movements in Right Leg (Included 'Pulls Knee Up', 'Kicks', 'Pulls Up and Kicks' and 'Stretch')
22. Left leg Tightly Flexed
23. Left Leg Extended
24. Movements in Left Leg
25. Active REM Sleep
26. Drowsy
27. Wide Awake
28. Crying
29. Care Given (Included 'Repositioned', 'Diaper Changed', 'Care Given' and 'Touching Equipment')
30. Comforted

APPENDIX C

EXAMPLES OF SEQUENCES OF BEHAVIORS OF ACUTE DISTRESS

EXAMPLES OF SEQUENCES OF BEHAVIORS OF ACUTE DISTRESS

INFANT I

Time	Behaviors
19:59:16	Sleeping
	Frown
	Cry
	Knees up, toes extended, feet flexed
	Legs down
19:59:25	Relaxed
20:00:25	Sleeping
	Lt. toes extended, moves Lt. leg slightly
	Frown
	Cry
	Toes extended
	Legs stretched
	Lt. arm up, fingers curled
	Rt. knee up
	Lt. knee up
	Two fingers extended
	Lt. leg stretch
	Rt. leg stretch
	Rt. knee up
	Legs stretch
	Legs relaxed
20:00:34	Toes extended, mouth corners down, fingers in a fist
20:01:16	Sleeping
	Frown, mouth corners down, fist
	Toes extended, Lt. knee up, arm down, cry
	Rt. knee up
	Lt. toes curled, Lt. foot flexed
20:01:20	Legs relaxed, frown, mouth corners down
20:03:06	Awake
	Extends fingers
	Frown
	Cry
	Arm pulled in
	Toes extended
	Lt. foot tightly flexed
	Lt. knee up
	Rt. knee up
	Fist
	Lt. knee down
	Legs relaxed, mouth corners down; frown, toes relaxed
20:03:12	Two fingers remain extended

20:16:00 Awake
Squirm
Frown
Slight cry
Eyes shut

APPENDIX D

ILLUSTRATIONS OF INFANT BEHAVIORS

INFANT I

Behaviors of Subacute Distress

Behaviors of Acute Distress

INFANT II

Behaviors of No Distress (Sleeping)

Behaviors of No Distress (Awake)

INFANT III

Behaviors of Subacute Distress

Behaviors of Acute Distress