NURSING PATTERNS OF KNOWING IN ASSESSMENT OF NEWBORN SEPSIS

by

Lorraine Baas Rubarth

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A Dissertation Submitted to the Faculty of the
COLLEGE OF NURSING
In Partial Fulfillment of the Requirements
For the Degree of
DOCTOR OF PHILOSOPHY
In the Graduate College
THE UNIVERSITY OF ARIZONA

2005
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ACKNOWLEDGEMENTS

The completion of this project required the support and assistance of many individuals. I would like to thank some of those whose efforts allowed me to move forward with this work. I am very grateful to the nurses and NNPs in the NICU who volunteered their time to work with me and help me with completing my research.

There are no words to describe my appreciation for the support and guidance I have received from my dissertation chair, Dr. Pamela Reed. Thank you for your unwavering belief in my abilities and the importance of this work. Your expertise as a theorist and researcher along with your superb skills as an academic advisor have been invaluable to me.

To Dr. Donna Christensen, a friend, mentor, and minor committee member, I especially thank you for your friendship over the years, and your willingness to assist me when I struggled. You’ve been there to support me since our meeting in your research methodology class. To Dr. Wendy Gamble, who encouraged my interest in the family and family studies, I am very grateful for your patience and encouragement over the past six years.

To Dr. Elaine Jones, you’ve been with me since the beginning and your thoughtful insights and suggestions have kept me focused. To Dr. Linda Chapman, I am grateful to you for stepping in when needed this last semester and being a support and encouragement to me during these final months.

Finally, I must thank my sons, Chris and Nick, for being such wonderful, loving human beings. Your spirit and humor have helped me maintain perspective on what is really important in my life. I also want to thank my husband, Tom, for supporting this endeavor and hanging in there when the going was tough. Chris, Nick and Tom – I love you so much and thanks for your confidence in me. Lastly, I thank God for giving me the abilities and courage to continue my education and live in service to Him.
DEDICATION

I dedicate this to my parents, Ralph and Harriet Bloem Baas, who sacrificed so that I would have a strong, Christian education and Christian values. They made me who I am today. My nursing career was a dream for my mother and I know that she would have been very proud of my continuing impact on nursing, nursing education, and the infants and families in the Neonatal Intensive Care Unit.
# TABLE OF CONTENTS

LIST OF ILLUSTRATIONS .......................................................................................................................... 11

LIST OF TABLES ........................................................................................................................................... 12

ABSTRACT ...................................................................................................................................................... 13

1 STATEMENT OF THE PROBLEM ............................................................................................................... 15
   Purpose .................................................................................................................................................. 15
   Background and Significance .................................................................................................................. 16
   Neonatal Sepsis ...................................................................................................................................... 17
      Prevalence ......................................................................................................................................... 18
      Signs of Sepsis ................................................................................................................................... 20
      Subtle Signs of Sepsis .......................................................................................................................... 20
   Novice or Inexperienced Nurses .............................................................................................................. 21

   Conceptual Framework: A Nursing Perspective of Human Development and Assessment of Potential Sepsis ................................................................................................................. 25
      Roger’s System of Unitary Human Beings ......................................................................................... 26
      Lifespan Developmental Perspective ................................................................................................. 26
      Conceptual Model of Assessment of Neonatal Sepsis ..................................................................... 29
      Nursing Assessment and Patterns of Knowing ..................................................................................... 32
   Patterns of Knowing .............................................................................................................................. 33
      Empirical Knowing ............................................................................................................................... 33
      Aesthetic Knowing ............................................................................................................................... 34
      Personal Knowing ................................................................................................................................ 34
      Ethical Knowing ................................................................................................................................. 35
      Sociopolitical Knowing ....................................................................................................................... 35
      Authority-based Knowing ................................................................................................................. 36

      Pattern Recognition as an Integrated Pattern of Knowing ............................................................... 36
      Factors that Influence Patterns of Knowing ....................................................................................... 38

   Definition of Key Terms ........................................................................................................................... 39
   Research Questions .................................................................................................................................. 40
   Summary ................................................................................................................................................... 41

2. REVIEW OF THE LITERATURE .................................................................................................................. 42
   Nurses Role in Evaluating Sepsis and Use of Patterns of Knowing ........................................................... 42

      Patterns of Knowing in Clinical Research ........................................................................................... 43
   Instrumentation and Assessment ............................................................................................................. 51
   Validity .................................................................................................................................................... 51
      Content Validity .................................................................................................................................. 51
      Construct Validity ............................................................................................................................... 52
      Discriminate Validity ............................................................................................................................. 53
      Sensitivity ............................................................................................................................................. 53
TABLE OF CONTENTS – Continued

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>53</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>55</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>55</td>
</tr>
<tr>
<td>Reliability</td>
<td>56</td>
</tr>
<tr>
<td>Internal Consistency</td>
<td>56</td>
</tr>
<tr>
<td>Interrater Reliability</td>
<td>56</td>
</tr>
<tr>
<td>Newborn Sepsis</td>
<td>57</td>
</tr>
<tr>
<td>Maternal/Perinatal Risk Factors</td>
<td>57</td>
</tr>
<tr>
<td>Markers of Sepsis in Newborns</td>
<td>59</td>
</tr>
<tr>
<td>Laboratory Markers</td>
<td>59</td>
</tr>
<tr>
<td>Clinical Indicators</td>
<td>65</td>
</tr>
<tr>
<td>Neonatal Screening Tools for Sepsis</td>
<td>65</td>
</tr>
<tr>
<td>New Laboratory Markers for Sepsis</td>
<td>74</td>
</tr>
<tr>
<td>Other Indicators for Neonatal Sepsis</td>
<td>77</td>
</tr>
<tr>
<td>Observation Scales in Pediatrics and Adults</td>
<td>79</td>
</tr>
<tr>
<td>Yale Observation Scale in Young Children</td>
<td>79</td>
</tr>
<tr>
<td>Sepsis Grading Scales in Adults</td>
<td>82</td>
</tr>
<tr>
<td>Summary</td>
<td>85</td>
</tr>
</tbody>
</table>

3. METHODOLOGY ................................................................................................ 87
Design ........................................................................................................... 87
Sample........................................................................................................... 88
  Nurses ........................................................................................................ 88
  Infants ...................................................................................................... 88
Setting .......................................................................................................... 89
Human Subjects .............................................................................................. 89
Description of Instruments .......................................................................... 90
  Nursing POK Scale .................................................................................... 90
  Demographic Questionnaire ....................................................................... 92
  Newborn Scale of Sepsis (SOS) ................................................................ 92
  Laboratory Markers .................................................................................. 93
  Clinical Indicators .................................................................................. 94
  Face Validity ............................................................................................ 98
  Content Validity ...................................................................................... 98
  Training of Data Collectors for the Newborn SOS Instrument ............... 99
Data Collection Procedure .......................................................................... 99
  Nursing POK Scale .................................................................................... 99
  Newborn SOS Instrument ..........................................................................100
Summary ........................................................................................................ 100

4. RESULTS .....................................................................................................102
Description of Sample.................................................................................. 102
TABLE OF CONTENTS – Continued

NICU Nurses Taking the POK ................................................................. 102
NICU Nurses Sub-Sample Completing SOS Scales on Infants ........... 104
Research Question #1: ...................................................................... 106
  Nursing Patterns of Knowing Scale (POK) ....................................... 106
    Psychometric Properties .............................................................. 106
    Reliability assessment ............................................................... 106
    Validity assessment ................................................................... 107
    Assessing for normalcy ............................................................. 108
  Nursing POK Data .......................................................................... 108
Research Question #2: ...................................................................... 110
Research Question #3: ...................................................................... 112
  Nurses Overall Years of Experience ............................................. 114
  Nurses Years of NICU Experience .............................................. 115
  Number of Different NICUs Worked In ....................................... 116
  Self Rated Clinical Expertise ......................................................... 117
  Neonatal Nurse Practitioner Correlations .................................... 117
Research Question #4: ...................................................................... 118
  Reliability of the SOS ................................................................. 118
    Internal Consistency .................................................................. 118
    Interrater Reliability .................................................................. 119
  Validity of the SOS ...................................................................... 119
    Face Validity ........................................................................... 119
    Content Validity ....................................................................... 119
    Predictive Validity ..................................................................... 120
Additional Analysis ........................................................................ 122
  Qualitative Analysis of the Comments on the POK ....................... 122
  Approaches to Assessment of Newborns .................................... 122
  Empirical Knowing ...................................................................... 124
    Use of Physiologic orScientific Data .......................................... 124
    Use of Research-Based Information ....................................... 124
  Aesthetic Knowing ...................................................................... 124
    Use of Habits or Routines ......................................................... 124
    Use of Intuition or “Gut Feelings” ............................................. 125
    Use of Previous Clinical Experiences ..................................... 125
    Doing What is Expedient or Necessary .................................... 126
  Personal Knowing ....................................................................... 126
    Use of Your Personal Knowledge of Self .................................. 126
    Use of Empathy ....................................................................... 126
    Use of Input from Parents ......................................................... 127
    Use of Your Own Personal Experiences .................................... 127
  Ethical Knowing ........................................................................... 128
    Use of Ethical Judgment .......................................................... 128
### TABLE OF CONTENTS – Continued

- **Evaluation of Consequences of Actions** .......................................................... 128
- **Sociopolitical Knowing** .................................................................................. 129
  - Use of Social Atmosphere of the Unit .............................................................. 129
  - Use of Political Climate of the Unit ................................................................. 129
- **Authority-Based Knowing** ............................................................................ 130
  - Use of Data from Those in Authority (NNPs, MD) ......................................... 130
  - Use of Nursing Policies and Procedures ......................................................... 131
- **Rating of Clinical Expertise** .......................................................................... 131
  - Self-Rating of Clinical Expertise .................................................................. 131
  - Ratings of the Newborn Scale of Sepsis (SOS) .............................................. 131
- **Summary** ........................................................................................................ 132

5. **DISCUSSION** .................................................................................................. 133

Research Question #1 .......................................................................................... 133
- **Nursing Pattern of Knowing Scale (POK)** .................................................. 133
  - Reliability ........................................................................................................ 134
  - Validity ............................................................................................................ 134
  - Uses of Different Patterns of Knowing ............................................................ 134

Research Question #2 .......................................................................................... 138
- **Age** ................................................................................................................ 138
- **Education** ....................................................................................................... 139

Research Question #3 .......................................................................................... 140
- **Nursing and NICU Experience** .................................................................... 140
- **Experience with Different NICUs** ................................................................. 142
- **Clinical Expertise Self-Rating** .................................................................... 143
- **Neonatal Nurse Practitioners** ...................................................................... 144
  - **Summary of POK Findings** ....................................................................... 144

Research Question #4 .......................................................................................... 145
- **Reliability of the SOS** .................................................................................. 145
- **Validity of the SOS** ...................................................................................... 145

- **Qualitative Data** ............................................................................................. 146
- **Limitations of the Study** ............................................................................... 147

- **Implications for Nursing Education, Practice and Research** ......................... 148
- **Nursing Research** ........................................................................................ 148
  - **Nursing POK** ............................................................................................ 148
    - **Combined Newborn SOS and Nursing POK** ......................................... 151
    - **Newborn SOS** ......................................................................................... 151
  - **Nursing Practice and the Newborn Scale of Sepsis** .................................. 152
    - **Preterm Signs of Infection** .................................................................... 152
    - **Diagnostic Tool vs. Assessment Tool** .................................................... 152
  - **Nursing Education** .................................................................................... 153

**Summary** ........................................................................................................ 154
TABLE OF CONTENTS -  *Continued*

APPENDIX A: HUMAN SUBJECTS APPROVAL LETTERS ..........................................156

- UNIVERSITY OF ARIZONA IRB APPROVAL  6/30/03 ..................................157
- UNIVERSITY OF ARIZONA IRB APPROVAL  7/21/03 ..................................158
- UNIVERSITY OF ARIZONA IRB APPROVAL  5/28/04 ..................................159
- UNIVERSITY OF ARIZONA IRB APPROVAL  10/28/04 .................................160
- BANNER HEALTH SYSTEMS IRB APPROVAL 10/7/03 .................................161
- BANNER HEALTH SYSTEMS IRB APPROVAL 10/7/04 .................................162

APPENDIX B: HUMAN SUBJECTS CONSENT FORMS .............................................164

- PARENTAL CONSENT FORM .................................................................165
- SUBJECT'S CONSENT FORM ..............................................................167
- SUBJECT DISCLAIMER ........................................................................170
- PARENTAL CONSENT FORM (PHI AUTHORIZATION FORM) ..................171

APPENDIX C: INSTRUMENTS AND QUESTIONNAIRES .......................................173

- NEWBORN SCALE OF SEPSIS (SOS) ......................................................174
- INFANT DEMOGRAPHIC DATA COLLECTION FORM ..........................175
- NURSING DEMOGRAPHIC QUESTIONNAIRE ......................................176
- NURSING PATTERNS OF KNOWING (POK) SCALE ............................177

APPENDIX D: CONTENT VALIDITY INDEX (CVI) ...............................................181

- CONTENT VALIDITY INDEX FORM .....................................................182
- DEFINITIONS OF SEPSIS SCALE ITEMS ...........................................183

REFERENCES .........................................................................................185
LIST OF ILLUSTRATIONS

FIGURE 1: Conceptual Model of Assessment of Newborn Sepsis........................................31
LIST OF TABLES

TABLE 1: A Decision Matrix for Screening Tests ................................................................ 54
TABLE 2: Markers of Sepsis Seen in the Literature ................................................................. 62
TABLE 3: Patterns of Knowing (POK) and Related Assessment Questions ......................... 91
TABLE 4: Laboratory Markers of Sepsis from the Newborn SOS ........................................... 93
TABLE 5: Rationale for Instrument Scoring Levels of Laboratory Markers of Newborn SOS ........................................................................................................................................ 94
TABLE 6: Clinical Indicators of Sepsis from the Newborn SOS ............................................. 95
TABLE 7: Rationale for Instrument Scoring Levels of Laboratory Markers of Newborn SOS ........................................................................................................................................ 97
TABLE 8: Participants by Age ............................................................................................... 102
TABLE 9: Highest Educational Level Achieved by Nurse Participants .................................. 103
TABLE 10: Nursing, Newborn Nursery and NICU Experience .............................................. 104
TABLE 11: Clinical Expertise Self-Rating of Respondents .................................................... 104
TABLE 12: Infant Demographic Data .................................................................................... 105
TABLE 13: Percentage of Infants with Maternal Risk Factor ............................................... 105
TABLE 14: Item-to-Scale Correlations of Each POK Item ..................................................... 107
TABLE 15: Summary of Patterns of Knowing (POK) Scores for Individual Questions ......... 109
TABLE 16: Mean Score of Each Patterns of Knowing (POK) in NICU Nurses ..................... 110
TABLE 17: Correlations of Types of Patterns of Knowing with Age and Educational Level of Nurses ................................................................................................................................ 111
TABLE 18: Correlation Coefficients of Dimensions of Experience and Total POK Scores 113
TABLE 19: Correlations of Types of Patterns of Knowing and Nurses’ Years of Experience ............................................................................................................................................. 114
TABLE 20: Correlation of Types of Patterns of Knowing with Different NICU Experiences and Nurses’ Clinical Expertise ..................................................................................... 116
TABLE 21: Total SOS Scores .................................................................................................. 121
TABLE 22: Sensitivity, Specificity, Positive and Negative Predictive Values for SOS Scale ........................................................................................................................................... 122
ABSTRACT

Sepsis is a devastating, life-threatening disease and a major problem for many newborns; it develops rapidly and requires expertise to identify the early, subtle signs to prevent death or disability. Evidence from nursing practice and philosophic inquiry indicates that nurses use diverse ways of knowing in their assessments. The purpose of this research was to address research questions concerning two areas: 1) Neonatal Intensive Care Unit (NICU) nurses’ patterns of knowing in the assessment of infants with sepsis as related to dimensions of nursing practice; and 2) Test the psychometric properties of the Newborn Scale of Sepsis (SOS) as a diagnostic or assessment tool. The theoretical framework incorporated the epistemological theories of nurses Carper and Benner and philosopher of science Nagel.

This study employed a prospective, correlational design with a convenience sample of 119 NICU nurses. Twenty-eight of these nurses also completed the Newborn SOS to document their assessments of 62 newborns for sepsis. Two instruments were used: 1) The 16-item norm-referenced Nursing Patterns of Knowing (POK) scale ($\alpha = .82$ and item-scale correlations $\geq 0.33$), and 2) The 13-item Newborn Scale of Sepsis (SOS), developed to assist the novice nurse to assess for signs of sepsis ($\alpha = .65$ and interrater reliability of 96.3%). Descriptive, psychometric, and correlational analyses were applied to the research questions.

Results indicated that the more clinically experienced NICU nurses used a more integrated pattern of knowing when assessing newborns for signs of sepsis. The more experienced and competent nurses incorporated empirical, aesthetic and personal
knowing in their assessments. More experienced nurses also used less authority-based knowing. More diversity in work experiences was negatively correlated with the sociopolitical pattern of knowing. Psychometric properties of the Newborn SOS indicated that, while its sensitivity was very good, its low specificity limited its usefulness as a diagnostic tool.

It was concluded that the Newborn SOS can be used to assist novice nurses in developing pattern recognition of newborn sepsis. The Nursing POK has strong potential for use in a wide variety of studies examining nursing patterns of knowing in assessment of critical health conditions.
CHAPTER 1

STATEMENT OF THE PROBLEM

Sepsis is a devastating, life-threatening disease and a major problem for many newborns. Early-onset sepsis appears in the first week of life and generally develops rapidly. Expertise is required to identify subtle signs at an early stage in order to prevent newborn death or disability. Many newborns with early-onset sepsis can look healthy at birth, then within two to three hours be on a ventilator, unable to oxygenate, and in septic shock. There have been numerous technologic advances in the care of sick newborns in the past decade; however, science has not eradicated the deadly disease of sepsis. Treatment with antibiotics is the cure; however, early diagnosis is key to preventing the devastating effects of the disease including septic shock and/or death.

Nurses use many different ways of knowing in the assessment of infants for sepsis. When an infant begins to exhibit signs of sepsis, the nurse at the bedside uses her/his clinical expertise to evaluate the seriousness of the infant’s condition. The approaches nurses use to discern an infant’s condition can be diverse.

Purpose

The purpose of this research was to examine Neonatal Intensive Care Unit (NICU) nurses’ patterns of knowing in the assessment of infants with sepsis, and to test the psychometric properties (reliability, validity, including predictive validity) of the Newborn Scale of Sepsis (SOS) as a diagnostic or assessment tool. With pretreatment of mothers and longer hospital stays for their newborns, there has been a decline in early-onset neonatal Group B streptococcus (GBS) infections, yet the incidence of sepsis
continues to be high and the clinical spectrum of the disease has not changed
(Bromberger et al., 2000; Jeffery & Lahra, 1998; McKenney, 2001; Truong, Yancey &
Lentz, 2000; Volumenie, Fernandez, Vial, Lebrun, & Frydman, 2001). With prophylactic
treatment of mothers for GBS, there is some evidence of the emergence of non-GBS
types of sepsis in newborns. In addition, 10-20% of obstetricians do not follow the
guidelines set up by the CDC and treatment of mothers does not reliably prevent late-
onset GBS infections (Hager, 2001). Nurses are the frontline assessors in identifying this
potential problem. Therefore, research into the process of nursing assessment for neonatal
sepsis is needed.

Background and Significance

Typically, nursing assessment approaches are described in terms of the nurses’
experiences, intuition, judgments, relationships and facts in the daily assessment of
newborns. Carper’s (1978) nursing epistemology informed the discipline with distinct
patterns of knowing that provide a framework for systematically studying nurses’
approaches to assessing infants; her framework outlined four patterns of knowing:
empirical knowledge, aesthetic knowledge, personal knowledge and ethical knowledge.
White (1995) suggested an additional pattern of knowing, the sociopolitical. Cohen and
Nagel (1934) had also described an authority-based pattern of knowing that is still used
today. Each way of knowing potentially may play a role in the nurse’s approach to
assessing infants for signs of infection.

The Newborn Scale of Sepsis (SOS) was developed to aid nurses with the
interpretation of clinical signs and intuition about newborn sepsis. This instrument is an
empirical instrument based on specific physiologic data that with continued use develops aesthetic knowing skills. Empirical ways of knowing are used to build upon a nurse’s previous experiences so that a nurse will be able to “see” sepsis through the integration of clinical patterns of knowing. Assessment of newborn sepsis requires particular expertise and experience. Nurses experienced in the assessment and diagnosis of neonatal sepsis are able to discern the early signs of sepsis intuitively because of pattern recognition. The sepsis tool was developed to assist novice nurses with assessing infants in the early stages of neonatal sepsis. The SOS can be used to rapidly assess for changes in newborns.

Nurses have the professional responsibility to assess newborns for signs of sepsis. Nurses in the nursery or in couplet care must become proficient at assessment and clinical decision making to effectively decide if a newborn is showing signs of infection. The nurse’s assessment skills can be supplemented with a systematic measurement tool to identify early signs of sepsis in the newborn period. The well baby nurses or couplet care nurses assess newborns during the first 24 to 72 hours of life prior to discharge. These nurses have the first few days of life to assess for signs of infection. The nurses in the NICU must observe for signs of infection during the infant’s extended hospital stay. The NICU nurses must have proficient assessment skills to predict early-onset or late-onset sepsis in the newborns.

**Neonatal Sepsis**

Sepsis is an invasive infection of the body that is spread by the bloodstream. Newborns who develop sepsis become clinically ill. Many bacteria and viruses produce sepsis in newborns. Early-onset sepsis is a blood infection that occurs before the seventh
day of life. Late-onset sepsis occurs at or after the seventh day of life. The most prevalent type of early-onset neonatal sepsis is with Group B beta-hemolytic streptococcus (GBS) or Streptococcus agalactiae. GBS bacteria enter the circulation, causing septicemia and hemolysis of the red blood cells (James, 2001; Mullaney, 2001). About 10-30% of pregnant women are colonized with group B streptococcus bacteria in the genital tract or rectum (Zaichkin, 2003). The fetus contracts GBS sepsis when the bacteria ascends into the uterus during pregnancy, when the fetus aspirates infected amniotic fluid, when the bacteria crosses the placenta from the mother, or when the fetus passes through the birth canal at delivery. Of the women who are colonized with GBS, approximately 50-70% colonize their infants prior to or at delivery and, consequently the newborn infant has a 2-5% risk of developing GBS sepsis (Askin, 1995; Garland & Kelly, 1995; Witek-Janusek & Cusack, 1994).

**Prevalence**

Early-onset GBS sepsis has been the most common cause of bacterial sepsis in newborns in the United States and the leading cause of death attributable to infection in newborn infants for more than 30 years (Benitz, Gould & Druzin, 1999; Hager et al., 2000; Jones, Knoll, & Rubens, 2000; McKenney, 2001). In the 1970’s the mortality rate from neonatal sepsis was approximately 50%, but decreased to 4-10% in the 1990’s due to improved neonatal care, advanced technology, and maternal antibiotic treatment (McCoy, 2001; Zaichkin, 2003). Neonatal infection with GBS has decreased significantly in the past 10 years, partly due to prophylaxis guidelines issued in 1996 by the Centers for Disease Control (Estrada, 2002). These guidelines, endorsed by the American Academy of
Pediatrics, recommend administration of intrapartum antibiotics to women at risk for infection with GBS or those who were colonized with GBS (Mohle-Boetani, Lieu, Ray & Escobar, 1999; Revised Guidelines, 1997). The introduction of these guidelines has decreased the incidence of GBS from about 1.5 to 0.5 cases per 1000 live births (Cole & Bernstein, 2002). Yet, GBS disease remains a leading infectious cause of morbidity and mortality among newborns in the United States. Current estimates are 1600 newborns contracting early onset GBS sepsis every year, resulting in 80 deaths (Zaichkin, 2003).

Although GBS sepsis in newborns has decreased with intrapartum antibiotics, the overall incidence of newborn sepsis and the mortality rate from sepsis are unchanged (Wolf, Schaap, Smit, Spanjaard, & Adriaanse, 2000). The overall frequency of sepsis has remained relatively constant at 1 to 5 infants per 1000 live births (Escobar, 1999). Early-onset infections with other bacteria including *Escherichia coli* (*E. coli*), *Haemophilus influenza* (*H. flu*), *Listeria monocytogenes* and *Streptococcus pneumoniae* as well as GBS contribute to a 20-50% mortality rate in newborns with sepsis (McKenney, 2001). These five bacteria account for most early-onset newborn sepsis. The bacteria responsible for late-onset infections in a NICU are coagulase-negative *staphylococcus*, *pseudomonas areuginosa*, *Klebsiella*, and methicillin-resistant *staphylococcus aureus* (Leibovitz et al., 1997; Stoll et al., 1998; Berger, Salzer, Weninger, Sageder & Aspock, 1998; Lopez, Coto, Fernandez, 2000). Other pathogens, including ampicillin-resistant *E. coli* and *Streptococcus pneumoniae*, are now emerging as causes of newborn sepsis while GBS rates are decreasing (Nallusamy, 1998; Levine, Ghai, Barton & Strom, 1999; Schuchat et al., 2000).
Signs of Sepsis

Early-onset infection appears in the first week of life. Most infants display signs of infection within the first 24 to 48 hours, and about half are symptomatic at birth (Cowles & Gonik, 1997). Initial signs of sepsis in newborns can be fulminant or subtle. The fulminant form of neonatal sepsis presents with poor perfusion, shock, respiratory distress and increased bleeding times, and often leads to death (Cowles & Gonik, 1997). This form of sepsis is easier to diagnose due to the overwhelming array of signs indicative of sepsis.

Subtle signs of sepsis. Neonatal nurses and physicians frequently have difficulty assessing and diagnosing sepsis from the initial, subtle signs of infection. The infant with sepsis may first present with “just not doing well” (Sater, 1998, p. 278). Infants with subtle signs may appear well initially, with a slow progression of respiratory signs including mild tachypnea, soft grunting, mild retractions and progressive cyanosis. These are also initial signs of many respiratory disorders in the newborn, like transient tachypnea or pneumonia. Other subtle signs of sepsis are a decrease in temperature, decreased responsiveness, vomiting, or pale color (Sater, 1998; Dear, 1999; Escobar, 1999). Sater stated that “almost all infants with bacterial infection within the first few hours after birth will have one of the following symptoms: lethargy, apnea, seizures, hypothermia, hyperthermia, hypoglycemia, impaired cardiac output, respiratory distress, or poor feeding” (p. 278). She states that the most common finding is a lethargic infant with a poor suck and unstable temperature. These signs are common in many normal newborns and in newborns with the common problems of hypothermia, hypoglycemia or
respiratory distress, and are not limited to infants with sepsis. Yet a nurse is expected to
distinguish signs of sepsis in newborns whether he/she is highly experienced or a novice.

**Novice or Inexperienced Nurses**

All nurses begin their practice as novices. Through years of experience, nurses
develop expertise in specific areas of practice. Five stages describe the nurse’s clinical
development: novice, advanced beginner, competent, proficient, and expert. These stages

Novice nurses require care plans and must follow procedures to accomplish goals.
As nurses progress from novice to competent, they begin to gain insight into types of care
strategies to incorporate or not incorporate into their practice. The expert nurse does not
rely on methodical principles or book knowledge, but connects an understanding of a
specific situation to an appropriate action based in what Benner (1984) refers to as
“intuitive” knowledge or intuition.

Expert nurses are highly experienced, and express a certain intuition or sense that
the infant is ill. According to Benner (1984), nurses who become experts in clinical
practice have developed a high level of expertise where they no longer “think through” a
problem, but more often the solution just presents itself to them as intuitive knowledge.
In clinical situations, intuition is the act of deciding what to do in an ambiguous or
uncertain situation (Rew, 2000). With this “intuition”, nurses have “the perceptual ability
to recognize relationships without prespecifying the components of the situation” (Benner
& Tanner, 1987, p. 24). The mind recognizes something, prior to the brain realizing that
the mind was contemplating the situation. Intuition is feeling right about something,
without knowing why you feel that way. It is “the decision to act on a sudden awareness of knowledge that is related to previous experience, perceived as a whole, and difficult to articulate” (Rew, 2000, p. 95). While Benner and Tanner (1987) recognized intuition as a legitimate and essential aspect of clinical nursing judgment, this investigator prefers to describe this aspect of expert nurse knowing as ‘pattern recognition’ (Newman, 2002;2005), which incorporates various patterns of knowing and sensing or intuiting a problem. Pattern recognition, like intuition, requires the expert nurse to act with persistence, courage, and confidence even without objective data (Gruber & Benner, 1989; DeCoste & Benner, 1990).

Pattern recognition is the necessary component of clinical nursing judgment that the expert nurse has when confronted with a sick infant. The nurse makes a quick assessment of the infant and decides on a route of intervention or non-intervention. The novice, or inexperienced nurse may not see the same infant as sick. Novice nurses may not have the ability to see a situation, recognize a pattern, and intervene; therefore they require a list of features in order to identify the pattern (Benner & Tanner, 1987).

The novice nurse was described as focusing on the objective, concrete variables, without awareness of the context of the situation. “The novice attends to physicians’ orders and places importance on blind obedience to medical authority” (Kidd & Morrison, 1988). The novice nurse does not understand or use nursing theory or concepts and the authority of the physician or nurse practitioners are rarely questioned. Advanced beginner nurses learn by listening to other nurses discuss clinical situations, but continue to be influenced by medical authorities. Competent nurses start to look inward to the self
personal knowing) for solutions to problems with a need for less reliance on medical authority. Proficient nurses have developed a deep sense of understanding of clinical situation, incorporating the whole patient. The expert nurse can incorporate all areas of knowing and interpret simultaneously many aspects of the clinical situation to make correct assessments and treatment decisions (Benner, 1984; Kidd & Morrison, 1988).

The expert nurse in the NICU can recognize the pattern of the infant with sepsis. Many years of experience are needed to become adept at recognizing and responding to this pattern. The expert NICU nurse describes a specific “look” that has been identified as a subtle, non-specific sense of knowing the infant is infected (Lumb, 1994). Benner and Wrubel (1982) state that “the perception that something is wrong often begins with a feeling” (p. 13). The NICU nurse reports that a baby “just didn’t look right” and just knowing that he was getting sicker (Rubarth, 2003, p. 353). Escobar, a newborn intensive care physician, describes the process of implementing care guidelines in the intensive care nursery. He states that:

Implementing evidence-based guidelines cannot ignore the role of what we conveniently relegated to the category of items consider “irrational.” No guideline effort on “rule out sepsis” can succeed if it does not consider that feeling of fear in the pits of our stomachs, …that vague sense of unease we feel when we sign our names after the phrase, “Discharge to mother.” (Escobar, 1999, p. 371).

He also states that this “phenomenologic orientation values a clinician’s personal experience, not just methodologic rigor” (Escobar, 1999, p. 360).
Given the integrated patterns of knowing employed by expert nurses, novice nurses may need the additional assistance from standard instruments to assess patients. The Newborn Scale of Sepsis (SOS) can be the method for putting intuitive knowledge into an analytical decision-making tool for use by the novice or inexperienced nurse. The Newborn SOS can assist the nurse in putting clinical observational data into numerical form, to assess newborns at risk for sepsis, and to ascertain the degree of risk for developing sepsis.

Nurses at the bedside are in a unique position to use their expertise to quickly detect the subtle signs of sepsis prior to discharge. The bedside nurse is the only health professional who is likely to have continuous contact with the infant for the initial 24 to 48 hours of life. The initial 48 hours of life is the best time to detect early-onset sepsis. The nurse in the NICU must be on the alert for signs of sepsis during the infant’s entire hospital stay, which could be as long as 2-3 months. The nurse is critical to early recognition of the signs of sepsis in any setting (Crandall & Getchell-Reiter, 1993; Polinski, 1996).

The experienced nurse identifies the signs of sepsis faster than the novice or inexperienced nurse due to years of clinical experience and other patterns of knowing (Ruth-Sahd, 2003). There are many clues that the experienced nurse becomes aware of during the assessment process. Without experienced caretakers during the initial transition to extra-uterine life, in the well baby nursery, on a couplet care floor, or in the Neonatal Intensive Care Unit, the infant with sepsis could be diagnosed too late to stop the devastating effects of the disease. Knowledge of the patterns of knowing used by the
experienced nurse when an infant is becoming ill can help novice nurses build their assessment abilities by paying attention to the subtle clues of newborn sepsis.

A reliable and valid tool for early detection of neonatal sepsis would improve the chance of survival of our smallest citizens. The Newborn SOS will give novice nurses a tool to assist them in their assessment of sepsis. A tool that can assist nurses in assessing infants at risk for sepsis would be an asset to nursing, to health care institutions as well as the health care community. A way to recognize the patterns of knowing used by expert nurses to assess for sepsis can assist educators and managers in assisting novice nurses to become more proficient in their assessment skills and decrease the overwhelming manifestations of neonatal sepsis.

Conceptual Framework: A Nursing Perspective of Human Development and Assessment of Potential Sepsis

The conceptual framework for assessment of newborn sepsis is based on Rogers’ Science of Unitary Human Beings (1980, 1992) conceptual system and the Lifespan Developmental (LSD) perspective. A nursing conceptual framework is essential to the study of nursing phenomena and the lifespan developmental perspective assists in explaining the concepts brought together by Rogers’ theory and the conceptual model of newborn sepsis. Both newborn sepsis and the nurse’s approach to assessing sepsis depend upon the Rogerian concept of human patterns. The theoretical framework consists of two basic parts, one that focuses on manifestations of the pattern of newborn sepsis, and the second, which focuses on nursing patterns of knowing used in assessing infants. The
framework overall is based on a Rogerian and developmental perspective of human-environment patterning.

Rogers’ System of Unitary Human Beings

The central focus of Rogers’ conceptual model is unitary human beings and their environments (1980, 1992). The human and environmental energy fields are defined as irreducible, pandimensional energy fields identified by pattern and integral to each other (Rogers, 1992). According to Rogers (1992), energy field patterns change continuously, and this change is relative, innovative, increasingly diverse and unpredictable. Field patterns are not directly observable, but reveal themselves through their manifestations. These manifestations are the observable events in the real world, and emerge out of the human/environment field mutual process (Rogers, 1992).

The human field is thought to become increasingly diverse over time, as it incorporates past patterns and develops new ones (Rogers, 1992). This view of increasing diversity is similar to that found in the lifespan development perspective. Within this developmental perspective, change is a function of human and environmental factors.

Lifespan Developmental Perspective

The lifespan developmental framework is congruent with Rogers’ view of human beings. The key propositions of this theoretical perspective are: 1) embeddedness, 2) dynamic interaction, and 3) growth and development (Lerner, 2002). Embeddedness is the idea that human life exists at multiple levels of analysis with dynamic interaction among the levels. Multiple levels of analysis include the inner-biological (cellular), individual (newborn), dyadic (mother and child), social network, community, societal,
cultural, outer physical-ecological (environmental factors), and historical (Lerner, 2002). The variables and processes at one level influence the variables at another level. There is a dynamic interaction between the various levels. There is continual change and each variable has an effect on the other and is affected by it (reciprocal or dynamic process).

The variables that are assessed in the model of newborn sepsis are the markers seen in the newborn as an individual and the indicators of infection at the cellular level. The cellular changes when infection occurs, results in changes in the infant that can be assessed as signs of sepsis. The dyadic relationship with the mother, both prenatally and postnatally via breast milk and protection, alter and affect the newborn’s health and well-being.

The lifespan developmental perspective combines the concepts of growth and development. Growth is a change in size or quantity. Development is a change in form or quality. Growth can be seen as an additive process of the accumulation of cells. Development is the process of increasing differentiation and increasing capacity for specialized interactions with the environment.

Development is not a state of being. Development continues throughout life, and never ends. The immune system may become less efficient in later life, but changes have been seen with aging systems throughout life and are still considered development (Reed, 1983). Development is a process with the immune system. The development of the newborn’s immune system is a combination of growth and development, influenced by both heredity and environment.
The lifespan developmental framework also combines the concepts of quantitative and qualitative change in the process of development as well as an interaction of heredity and environment in development (Lerner, 2002). The orthogenetic principle of development in the lifespan developmental perspective is that all organisms become increasingly complex and specialized, as well as increasing in hierarchical integration or organization. The development of the immune system can be seen as a process of increasing complexity and organization. All blood cells of the body develop from the same stem cell through a process of cell differentiation (McKenney, 2001). The white blood cells that develop into neutrophils become more organized and specialized as they develop during the fetal and neonatal periods. The newborn’s immune system is deficient at birth and the process of differentiation and development fits the life-span development perspective. The cells continue to increase in number (quantity) and the cells themselves change or differentiate (quality) into the cells to fight infection. Their functioning improves over time. The T-cells and B-cells respond to antigens they come in contact with in the environment, have memory of the antigen and mount a response when further interaction occurs. This organization of the immune system that continues to differentiate and organize over time is the essence of the development of the immune system.

The newborn’s system is relatively immature and inexperienced at birth. The newborn immune deficiencies include anatomic barrier destruction via the birth process, invasive procedures done in the nursery, a decrease in the ability of the phagocytosis process of killing foreign organisms, and decreased levels of complement, immunoglobulins, fibronectin and cytokines that help the immune system to function
The newborn immune system is more deficient with decreasing gestational age (Crockett, 1995; McKenney, 2001).

**Conceptual Model of Assessment of Newborn Sepsis**

Newborn sepsis can be seen as the result of exposure to a hostile environment and/or the negative outcome of a poorly developed neonatal immune system. Newborns who are exposed to bacteria from the vaginal tract of the mother are often those who develop sepsis, but not all infants who traverse the vaginal tract develop sepsis. The deficiencies in the development of the infant’s immune system would also contribute to sepsis.

Therefore, the two influential factors in newborn sepsis are the environment that the fetus is exposed to in utero and the deficient immune system of the newborn. The maternal uterine environment could harbor bacteria and upon rupture of the fetal membranes, could allow bacteria to invade the uterine/fetal unit. The newborn’s ability to fight off an infection depends on the strength of the immune system. The intrauterine environment usually protects the fetus from harmful microorganisms. The process of labor and birth suddenly exposes the newborn to hostile environmental organisms including GBS. How the newborn responds to this exposure has vast implications for the newborn’s life and development.

Sepsis may be viewed as the immune system in chaos, completely undifferentiated and inefficient. Without a complete reorganization and continuing
differentiation of the neutrophils, the infant with sepsis will die. The organism struggles to achieve a functioning system in the midst of disorganization within.

Prenatal antibiotics are prophylactic antibiotics given to mothers in labor. Neonatal antibiotics are anti-bacterial medications given to newborns after birth. Antibiotics are moderators for newborns who are exposed to bacteria in utero. Antibiotics can stop a developing infection from becoming pneumonia and/or septicemia. Newborns with pneumonia (bacteria in the lungs) may not develop sepsis (bacteria in the bloodstream). Newborns with septicemia (bacteria in the blood) may not have pneumonia. Newborns that develop septicemia are at risk for the bacteria to spread to the meninges or spinal fluid (meningitis). Newborns with pneumonia, septicemia or meningitis can have signs that are distinct to each entity (see Figure 1).

The patterns that are inherent in the process of change are unique to each human system. Knowledge about patterns and their manifestations are acquired through research and assessment of human indicators (Shearer & Reed, 2004). The human indicators are those seen as the signs or markers of sepsis in the newborn. The environmental indicators are those that affect the newborn, whether prenatal environmental factors (exposure to bacteria, drugs, smoke, or poor maternal health) or post-natal environmental factors (traumatic delivery, exposure to bacteria, viruses, lack of feeding). These manifestations are included in the model of newborn sepsis. This model also depicts that the role of the nurse in assessing sepsis through patterns of knowing and subsequent interventions, along with the infant’s own life process, influence the outcome of sepsis.
Figure 1. Conceptual Model of Assessment of Newborn Sepsis

The newborn with sepsis may exhibit measurable markers (Agnoli, 1994; Crandall & Getchell-Reiter, 1993; Heimler, Nelin, Billman, & Sasidharan, 1995; Lumb, 1994; Philip, 1994; Snapp, 1999; Tollner, 1982; Witek-Janseke & Cusack, 1994). These markers of sepsis are seen in Figure 1. Other references state that the signs of sepsis are non-specific (Da Silva, Ohlsson, & Kenyon, 1995; Gerdes, 1991; Polinski, 1996).

Kreuz et al. (1999) states that “sepsis is a classical example of a disease greater than the sum of its parts; it is a complex process in which intervention in one area might have only a modest effect on the final outcome (p. 531).” The lifespan developmental
perspective and Rogers’ conceptual system of Unitary Human Beings provide a framework for conceptualizing the complexity of factors that nurses assess in infants, including environmental and physiological factors in the complex physiological process of sepsis and septic shock.

Physiologic and environmental factors play a role in sepsis. The newborn is exposed to bacteria in utero or during delivery. Prenatal environmental factors may influence the developing fetus or postnatal environmental factors may influence the infant’s ability to fight infection. The newborn has a deficient immune system at birth. The newborn may be exposed to antibiotics either prophylactic treatment of the mother or treated after birth in the nursery. Antibiotics are moderators of sepsis because they can alleviate or decrease the effects of the deadly bacteria. The newborn with sepsis exhibits markers of infection. These markers of infection can be used to assess for the presence of infection in newborn infants on the Newborn SOS.

*Nursing Assessment and Patterns of Knowing*

This model outlines pattern manifestations (markers) of newborn sepsis. Expert nurses view these manifestations and immediately perceive the newborn to have sepsis through a process of pattern recognition (Newman, 2005). Novice nurses may rely solely on systematic patterns, such as that offered by assessment tools. The Newborn SOS may be used to enhance their ability to recognize the newborn patterns and facilitate potential treatment regimens. In addition, other patterns of knowing may be used by nurses and the experienced nurses may integrate all or some of the patterns of knowing into their assessment process (Benner, 1984; Carper, 1978; Newman, 2005).
Nurses, like the infants they assess, possess patterns that are measurable. Nurses’ patterns in this case are related to their life process of nursing and providing health care for infants. These interrelated patterns of knowing facilitate nursing assessment of their patients, such as newborn infants and potential sepsis.

**Patterns of Knowing**

Epistemology is the study of knowledge; what people know. Nursing epistemology is the study of nursing knowledge, what nurses know and how nurses come to know what they think they know (Schultz & Meleis, 1988). In 1978, Barbara Carper identified four patterns of knowing in nursing. Her paper has become a widely read and discussed discourse on the epistemology of nursing. The patterns of knowing include: empirical knowing, aesthetic knowing, ethical knowing and personal knowing.

**Empirical Knowing**

Empirical knowing in nursing provides information that is factual, objective, descriptive and research-based; therefore, verifiable. This form of knowing is referred to as the “science of nursing” and is knowledge gained through systematic investigation (Carper, 1978). The empirical pattern of knowing “is based on the assumption that what is known is accessible through the senses: seeing, touching, hearing, and so forth” (Chinn & Kramer, 1999, p. 4). The critical question for the empirical pattern of knowing is “What is it and how does it work?” (Chinn & Kramer, 1999, p. 9). The infant is assessed based on physical signs and symptoms, including information obtained from the monitors and laboratory values. The nurses’ knowledge of evidence-based practice and research outcomes influences the assessment of the newborn in the NICU.
Aesthetic Knowing

Aesthetic knowing in nursing is a subjective form of knowing. The “art of nursing” or the aesthetics focuses on intuition, interpretation, and understanding. In aesthetic knowing, the nurse “comes to know” and find meaning in what she sees. Aesthetic knowledge is gained from experience rather than systematic investigation (Carper, 1978). The critical question for the aesthetic way of knowing is “What does this mean?” (Chinn & Kramer, 1999, p. 9). In assessing infants for signs of sepsis, the nurse “comes to know” that the infant has sepsis. She incorporates the patterns or manifestations of sepsis into her knowledge base after years of experience, both seeing infants with the disease and caring for infants who have died from the disease. The Newborn SOS was developed to assist the nurse who cannot “see” the infant with sepsis, without an objective tool to assist her. Aesthetic knowledge can also mean “to envision what is possible but not yet real”, or imagining what could happen if something is not done (Chinn & Kramer, 1999, p. 10).

Personal Knowing

Personal knowing refers to knowing the self, and the development of an interpersonal relationship between the nurse and patient (Carper, 1978). The critical question for the personal way of knowing is “Do I know what I do?” and “Do I do what I know?” (Chinn & Kramer, 1999, p. 9). This way of knowing can be seen as a method of looking at what the nurse knows about the infant and the disease process of sepsis. The more comfortable the nurse is with her own knowledge and abilities, the more comfortable the nurse will be with her assessment skills and evaluation. Personal
knowing requires maturity, self-confidence and trust in oneself and emerges more completely throughout life (Carper, 1978). Therefore, it would be presumed that personal knowing would increase with age and experience. Personal knowledge also comes from the interaction of the nurse with the infant’s family. Understanding of the family dynamics and communication skills can assist the nurse at the bedside in making an informed assessment of the infant, the changes going on and the interactions experienced.

*Ethical Knowing*

Ethical knowing focuses on the moral or ethical component of nursing practice. The nurse makes decisions based on what is right or good for the patient. Ethics in nursing practice involves making the right decision at the right moment, focusing on what “ought to be done” in a situation, offering alternatives and being responsible for the safety and best interest of the patient (Clements & Averill, 2004). This way of knowing involves nursing care based on perceptions of what the family or patient wants and often their perceived values. The critical question for the ethical way of knowing is “Is this right? Is this responsible?” (Chinn & Kramer, 1999, p. 9).

*Sociopolitical Knowing*

White (1995) critiqued Carper’s patterns of knowing and added sociopolitical knowing as an additional way of knowing for nurses. The sociopolitical way of knowing includes the context of nursing care. This can involve the society, community, culture, economics, and politics, all of which can impact nursing and healthcare. Within the context of newborn sepsis, there is the cost of treating or not-treating mothers with antibiotics and the cost of keeping infants hospitalized additional days for treatment.
There is the “community” of the NICU and the various effects on the nurses in the work environment. There is the influence of the family’s culture on the care the infant receives and the culture of the nurse can influence her/his assessment of the infant.

**Authority-Based Knowing**

Cohen and Nagel (1934) described ways people believe in things or come to believe something. This accumulation of knowledge is derived from scientific inquiry (empirical), intuition (aesthetic), tenacity (a habit or something you’ve always known) and authorities. Polit, Beck, and Hungler (2001) discussed sources of clinical nursing knowledge. They included tradition, authorities, personal experience, trial and error, intuition, logical reasoning, and disciplined research. They described authorities as “a person with specialized expertise and recognition for that expertise” (Polit, Beck & Hungler, 2001, p. 10). These authorities are seen as infallible but much of their knowledge is based on personal experience, not research-based knowledge. The use of authority-based knowing in nursing can be seen in nurses relying on physician, nurse practitioners, and other experienced nurses (e.g. mentors or preceptors) in obtaining knowledge on newborn assessment.

**Pattern Recognition as an Integrated Pattern of Knowing**

Another way of understanding expert nurse’s pattern of knowing is in terms of Newman’s (2002) idea of “pattern recognition.” Newman’s (2005) idea of pattern recognition refers to the ability to identify meaning or obtain knowledge through human characteristics, past experiences, present perceptions, and the relationships with the
patient. Through pattern recognition, nurses gain insight into a phenomenon through aesthetic or practice knowledge, but can describe their assessment empirically through its manifestations. Cowling (2001) noted that practitioners need practice-based knowledge (aesthetic) to provide nursing care but also need normative-based knowledge (empirical) to guide clinical decisions.

Pattern recognition is further conceptualized in this study as the integration of various patterns of knowing into a total understanding of the patient as a whole, seeing the person’s evolving pattern and understanding the meaning of the pattern for the individual. “As meaning is discovered, the pattern becomes apparent (and vice versa)” (Newman, 2002, p. 588). Pattern recognition represents a way of integrating various patterns of knowing into a coherent process of recognizing or assessing patient patterns. Thus, it is theorized that expert nurses use more patterns of knowing, and indeed, use an integrated pattern of knowing to a greater extent than do less experienced nurses. Specific nursing characteristics may influence the extent to which integrated pattern of knowing is used in assessment.

In contrast to the novice, the expert nurse is more willing to rely on patterns in addition to empirical knowledge, such the aesthetic pattern of knowing and react based upon that knowledge. In addition, the expert nurse is more likely to perceive the moral or ethical aspects of a clinical situation and be able to respond appropriately to it (Benner, 1984; Kidd & Morrison, 1988). The nurse’s age, educational level, clinical expertise and experiences (both personal and professional) may have an impact on how that knowledge is incorporated and used in the clinical setting.
Factors that Influence Patterns of Knowing

Age, experience and education level are all factors that can influence a nurses’ use of various patterns of knowing. Adult cognitive psychologists’ research has shown that reasoning and ways of knowing change across adult development and aging. Each phase of adult life poses different epistemological approaches to truth and knowledge not unlike the process identified by Piaget and child psychologists regarding social and cognitive changes in childhood and adolescence (Lerner, 2002).

Besides changes in learning with age, experienced nurses may use more types of patterns of knowing than inexperienced nurses. “The study of nursing knowledge must range from the seemingly intuitive ‘knowing’ of the experienced and expert nurses to the systematically verified knowledge of empirical researchers” (Schultz & Meleis, 1988, p. 217). There are many clues that the experienced nurse becomes aware of during the assessment process to recognize when a newborn infant has a serious, dangerous or deadly disease. The experienced nurse identifies the signs of sepsis faster than the novice or inexperienced nurse due to years of clinical experience and use of pattern recognition (Ruth-Sahd, 2003). The more ways a nurse uses to “come to the knowledge” that an infant is sick, the better the care is for the infant. The use of an assessment tool to help nurses identify the signs of infection and incorporate that knowledge into their repertoire of experiences (aesthetic knowing) may ultimately enhance the nursing care, of both experienced and novice nurses, regarding the health care of newborn infants at risk for sepsis.
There has been a recent exploration into patterns of knowing and teaching nurses at the baccalaureate and master’s degree level (Ruth-Sahd, 2003; Rancourt, Guimond-Papai, & Prud’homme-Brisson, 2000). Nursing faculty have been encouraged to look at various approaches to knowledge acquisition as seen in Ruth-Sahd’s (2003) guidelines for implementing an intuitive approach in the nursing classroom. She described self-awareness, valuing a culturally-sensitive perspective along with cultural ways of knowing, sharing intuitive experiences with students, creating a climate of curiosity and creativity, and encouraging students to have a holistic perspective in assessing their patients. She acknowledged that nurses use knowledge from a variety of sources and that the goal of education is to help students learn how intuitive ways of knowing can enhance the scientific approaches. Higher level education and training as an advanced practice nurse may provide a mechanism for increasing the nurses’ use of various ways of knowing.

Using a variety of patterns of knowing in an integrated manner can assist the nurse in providing holistic care to patients. The Newborn SOS can be a tool to assist inexperienced nurses in the assessment process.

Definition of Key Terms

**Sepsis:** A positive blood culture with bacteria or bacteremia.

**Neonate:** A newborn infant who is one month of age or less.

**Newborn:** An infant who is newly born, usually less than one month of age, and used interchangeably in this study with the term infant.
**Neonatal Sepsis**: A disease of infants who are clinically ill, with a positive blood culture during the first month of life.

**Early-Onset Sepsis**: A type of infection with bacteria during the first week of life.

**Late-Onset Sepsis**: A type of infection with bacteria that present after the first week of life.

**Group B Streptococcus (GBS)**: A bacteremia with beta-hemolytic Group B streptococcus.

**Positive Blood Culture**: A blood sample that grows bacteria upon incubation. This is the “gold standard” for diagnosis of sepsis in newborns.

**Novice or Inexperienced Nurse**: A nurse with less than 2 years of clinical experience.

**Experienced Nurse**: A nurse with 5 years or more of clinical experience.

**Research Questions**

Several research questions were identified to guide the research:

1) What patterns of knowing do NICU nurses use when assessing infants for signs of infection?

2) Do the demographic factors of age and educational level relate to the type of patterns of knowing used by nurses in the NICU?

3) Do four dimensions of nursing experience (total years of nursing experience, years of NICU experience, number of intensive care units the nurse has worked in, and the nurses’ self-rated clinical expertise rating score) relate to the type of patterns of knowing used by nurses in the NICU?
4) What are the psychometric properties of the Newborn Scale of Sepsis (SOS)?

Summary

Since subtle clinical symptoms of sepsis are often difficult to assess, nurses must develop an expertise to accurately and efficiently diagnose an infant at risk for sepsis. Lumb (1994) stated that “a nurse’s intuitive feeling that the infant ‘just does not look right’ may be the one factor that begins the cascade of events that may result in diagnosis and treatment” (p. 579). The nurse’s expert assessment of the newborn is often the driving force for initiating treatment. Experienced nurses have the unique knowledge, intuition and training to pick up subtle signs of early-onset infection. The nurse can then intervene to stop the deadly progression of the disease during the infant’s hospitalization.

The Newborn Scale of Sepsis (SOS) is a clinical evaluation tool that was developed to bridge the gap between the novice’s lack of experience and the need for early diagnosis of sepsis. This instrument will assist the novice and the expert nurse in assessing sepsis using both physical and laboratory data. The use of an instrument to assess for sepsis may enhance the practitioner’s patterns of knowing in assessing for the subtle signs of sepsis.

There is also a need to better understand various patterns of knowing used by experienced and novice nurses alike, in addition to the applicability to a formal scale such as the Newborn SOS. Knowledge of the patterns of knowing used by the experienced nurse when an infant is becoming ill can assist novice nurses in building their assessment abilities by being aware of the ways to recognize the subtle clues of newborn sepsis.
CHAPTER 2

REVIEW OF THE LITERATURE

Research on the nurses’ assessment for sepsis primarily describes the signs of sepsis and the diagnosis of sepsis from a medical perspective. Some articles describe the use of sepsis screening tools. This chapter addresses the research related to nurses’ patterns of knowing, and then the process of instrumentation research, including testing the validity and reliability of an instrument. There is also an overview of maternal and perinatal risk factors for sepsis, markers of sepsis in newborns, sepsis scales for newborns, neonatal scoring systems for other physiologic and clinical indicators, observational scales used with children, and sepsis grading scales used with adults. Many recent medical articles describe new indicators that may have promise for helping to diagnose sepsis in the future. Instrumentation approaches coupled with the nurses’ purposeful use of various patterns of knowing may increase the effectiveness of nursing assessment and interventions in infants with sepsis.

Nurses Role in Evaluating Sepsis and Use of Patterns of Knowing

The nursing literature describes assessment issues for newborns with sepsis, but no specific instrument has been developed to assist the nurse in doing her assessment. Most of the nursing literature describes the signs of sepsis, risk factors, and treatment methods.

Polinski (1996) describes screening tools that are used to assist in the assessment and diagnosis of newborn sepsis. These tools include an assessment of maternal and
neonatal risk factors, changes in the physical exam and vital signs of the infant, and laboratory studies, like a complete blood count (CBC) and blood culture. Yet infants with sepsis may present with acidosis, hypoglycemia, hyperglycemia, anemia or hyperbilirubinemia. The difficulty of early diagnosis of GBS sepsis was a motivator for the development of this study. “The evaluation of suspected sepsis is one of the most common and important diagnostic activities of the neonatal nurse, NNP and neonatologist” (Horns, 2000, p. 51).

Crandall and Getchell-Reiter (1993) and Lumb (1994) discuss nurses’ intuition and its importance in clinical decision-making, diagnosis and treatment of sepsis. Intuition is defined as experience-based knowledge that forms the basis for nurses’ clinical judgments. The basis for the nurses’ clinical judgment is difficult to characterize or to communicate to others, and “involves skills so well learned and familiar that the expert may not be consciously aware of using them in the course of performing a task” (Crandall & Getchell-Reiter, 1993, p. 43).

*Patterns of Knowing in Clinical Research*

Newborn assessment is an important part of clinical decision making in the NICU. Making the correct assessment and decision requires the nurse to use multiple patterns of knowing. Nurses learn to integrate the science and art of nursing along with the ethical obligations as an advocate for the patient and family and the personal knowledge of themselves. The nurse who uses all of the ways of knowing – empirical, aesthetic, ethical and personal – becomes an expert nurse. “Each nurse-patient interaction
is a holistic expression of different patterns of knowledge in nursing (Sherman, 1997, p. 4).

Carper’s (1978) fundamental patterns of knowing have not been the focus on much research as reported in the published literature. However, there are many articles discussing, critiquing and criticizing Carper’s patterns of knowing (Schultz & Meleis, 1988; Silva, Sorrell, & Sorrell, 1995; White, 1995; Fawcett, Watson, Neuman, Walker & Fitzpatrick, 2001). There are some articles that discussed how to incorporate women’s ways knowing into nursing theory (Banks-Wallace, 2000; Nelms & Lane, 1999), and elaborating on personal knowing (Schultz & Meleis, 1988), clinical knowing (Kidd & Morrison, 1988), unknowing (Munhall, 1993), and sociopolitical knowing (White, 1995). The following few articles are patterns of knowing applied to a clinical situation.

Sherman (1997) experienced using all four patterns of knowing with a patient encounter in her paper on the death of a newborn. She discusses healing the pain of the parents after a newborn death by: 1) empirical knowledge - her knowledge of the grief process and research on helping parents cope, 2) aesthetical knowledge - comforting and supporting the parents, holding them, crying with them (empathy), feeling their pain and anguish, 3) ethical knowledge – confronting the norms of the unit and making it possible for the parents to hold their dead infant, and 4) personal knowledge – understanding and ability to deal with the patient’s experiences of death based on her own personal life experiences.

Jenks (1993) described the pattern of personal knowing in a qualitative study of 23 nurses in a hospital setting. She described three areas of personal knowing:
1) knowing the patient, 2) knowing fellow nursing staff or peers, and 3) knowing the physicians. These interpersonal relationships of the nurses in the study were seen to facilitate the clinical decision making of the bedside nurse. Nurses described how “knowing” the physicians and having “positive relationships with physicians supported their decision making, particularly when their perceptions and observations were respected” (Jenks, 1993, p. 403). This study emphasized that the knowledge gained from getting to know your patients facilitate both ethical and responsible patient care.

McDonnell (1997) also used patterns of knowing in her reflection of caring for a patient and family in the intensive care unit (ICU). Empirical knowing involved research-based knowledge, vital signs, neurological assessment, blood results, fluid balance and drug therapies. She also discusses the treatment alternatives, complications, mortality rates, and success rates. Aesthetic knowing involved getting to know the patient and his family, being aware of non-verbal communication methods, and perceptions of various situations in the ICU. She describes becoming skilled at titrating and weaning the drugs based on direct observation of her patient’s responses. Personal knowing was described as developing an authentic, personal relationship with the patient and family. It included recognizing her own cognitive and emotional responses, and an awareness of her thoughts, feelings, values and behaviors. Ethical knowing was described as the obligation to “diminish the patient’s pain and suffering and to promote a peaceful death” (p. 41). Ethical knowing involved the decision to not prolong the patient’s life with artificial or aggressive means.
Ingram (1994) discussed the way a nurse assesses a patient’s level of consciousness using Carper’s patterns of knowing. Assessing level of consciousness in an ICU is done with an instrument called the Glasgow Coma Scale (GCS) (Teasdale & Jennett, 1974). This instrument uses empirical data to assess level of consciousness. Ingram discussed how experienced nurses were more consistent and reliable when using the GCS. Inexperienced nurses tended to make errors and failed to distinguish subtle changes. This is consistent with aesthetic knowledge, which is based upon practice experience. Intuition is described as ‘understanding without a rationale’ and includes pattern recognition, similarity recognition, common-sense understanding, skilled know-how, sense of salience and deliberative rationality (p. 883). In the current study, this is regarded as aesthetic, not intuitive, knowing. Ingram concludes that it is difficult to distinguish between empiric and aesthetic forms of knowledge. Empiric knowledge is research-based data that is objective, visible, and measureable. Aesthetic is experienced-based knowledge that is also objective, but incorporated into the knowledge-base of the nurse, and therefore, more intuitive or aesthetic.

The nurse who asks another nurse, “What do you think?” recognizes the individual contribution that each nurse brings to a clinical situation. This is part of personal knowing. A nurse who analyzes past experiences in order to learn from them is acquiring personal knowledge (Ingram, 1994).

Ethical knowledge was described by Ingram (1994) as a nurse who carries out safe and competent practice, for example, making a decision when to increase the pain
medication safely without compromising the treatment of the patient. This article encourages the use of all the patterns of knowing when assessing your patients.

Lee (2002) examined the use of Carper’s patterns of knowing in children’s nursing. She discussed the implementation of family-centered care and partnership with parents. She discussed the preparation for admission that focuses on teaching theories and the ethical decisions that include visiting policies and parents in the surgical suite. She also discussed the education of student nurses through imitative apprenticeships. This paper was written by an English nurse and published in an Australian journal so some language is difficult to understand, but the underlying premises are clear. Lee considered that pediatric nurses use primarily the empirical and ethical patterns of knowing. She speculated that the aesthetic and personal patterns of knowing in nursing take years to fully master, and may not even need to be practiced or utilized to the same extent as empirical and ethical knowledge. This supports the hypothesis that the nurses’ years of experience may be related to the patterns of knowing used in the assessment process.

Schultz & Meleis (1988) described the expert nurse as an “experienced knower” (p. 219). Munhall (1993) stated that the nurse must be open to “unknowing” in order to be able to obtain a deeper knowledge. A nurse must be able to say, “I never thought about it that way.” White (1995) adds the social (society), political and historical perspectives to the knowing necessary for nurses.

Clements and Averill (2004) applied the six patterns of knowing: empirical, aesthetics, ethics, personal, sociopolitical and unknowing to the comprehensive assessment and intervention needed for children exposed to family-member homicide.
They described the holistic approach using the patterns in nursing practice. They stated that using the patterns of knowing “represents a conscious choice to honor the values of caring, holism, and therapeutic communication at the heart of nursing” (p. 145). They used the critical questions developed by Chinn and Kramer (1999) to enhance the care of children during this very difficult time. “What is it and how does it work? Is this right? Is this responsible? What does this mean? Do I know what I do? Do I do what I know? Whose voice is heard? Whose voice is silences?” (Chinn & Kramer, 1999). They clearly discussed how the various patterns can be used in this setting with examples from forensic nursing. The goal using the various patterns in the assessment is to promote adaptive mourning and bereavement in the children.

Franzen (1998) found that nursing students used life experiences, ethical, aesthetic and personal ways of knowing predominantly. Used much less were empirical, factual patient data, and use of technical skills. The findings were congruent with feminist pedagogy and ways of knowing that emphasize the value of relationship building and personal experiences in assessment. The ethical knowing in their work with older adults related to their moral sense of obligation to care for, respect and accept older adults, and to promote their value of the patients’ autonomy and independence. The aesthetic involved use of empathy and relationship building with the family. They also found that personal reflection and sharing knowledge were important practices in developing sound ways of knowing.

Rockett (2001) found that nurses followed the rules only when it made sense in the context of the clinical environment. Often, because the rules lagged behind the daily
needs of nurses, nurses did not adhere to them as part of their pattern of coming to know their patients. Also, they used social interactions with patient, family, and other nurses and health care professionals in their assessment process.

Ruth-Sahd (2003) discussed ways to incorporate intuition into the nursing school curriculum. She discussed how intuition has been considered problematic because the source of knowledge could not be expressed. She acknowledged Benner’s work and listed 12 ways to incorporate intuitive ways of knowing into the nursing classroom. One method is to “encourage students to assess patients with a holistic perspective, using their senses and intuitive hunches, as well as objective scientific data” (p. 7). While performing assessments, she stated that one needs to encourage students to pay attention to the subtle clues of the patients. Ruth-Sahd challenged nurse educators to enhance scientific knowledge with intuition, embrace cultural diversity and acknowledge the many diverse ways of knowing used in nursing today. For purposes of this study, Ruth-Sahd’s work relates to both the empirical and aesthetic patterns of knowing.

Rancourt, Guimond-Papai, and Prud’homme Brisson (2000) studied three ways faculty used different ways of knowing. They described how knowledge is acquired through intuition (insight), reason (thought), and through the senses (perception). They described intuitive knowledge as “noetic”, reasoning knowledge as “rational”, and perceptive knowledge as “empirical”. They developed a model of these three ways of knowing and then described the ways they are each used in a teaching/learning philosophy with curriculum development done by faculty.
Heath (1998) discussed the use of Carper’s work in guiding students to reflect on their clinical experiences and learn from them. She discussed the concept of habitual practice when working under external pressure to get the work done. Carper’s (1978) four patterns of knowing, Munhall’s (1993) unknowing, and White’s (1995) socio-political knowing are evaluated in relation to reflection on nursing practice. Sharing reflections with other nurses was recommended in the education of nurses and in both critical incidents and positive experiences of practicing nurses.

Nagel, an American philosopher of science, discussed ways of knowing and believing in things. In his writings, Nagel (1934; 1965) described tenacity, authority, intuition and scientific inquiry. Tenacity was described as believing things always believed to be true; the use of habits. Authority was obtaining knowledge from a respected source. Intuition was described as self-evident knowledge, and scientific inquiry was reflective, systematic knowledge.

There was no published research relating educational level or type of education to the use of various patterns of knowing by nurses in the clinical setting. There were the hypotheses by Lee (2002) that aesthetic and personal knowing are not used extensively by new nurses, but that empirical knowledge and ethical knowledge are used by all nurses, regardless of their years of experience. The current study extends existing research by examining to what extent nurses used specific patterns as well as an integrated pattern of knowing in their assessment, and how the use of these patterns related to nursing characteristics.
Instrumentation and Assessment

Research instruments need to be valid and reliable. For screening tools, there are methods of testing for validity and reliability. Validity is the extent to which a measurement instrument correctly represents the characteristics of interest or measures what it is supposed to measure (Carmines & Zeller, 1979; Greenberg, 1993). Reliability is the consistency with which a measuring device assesses a content domain or characteristic of interest (Waltz, Strickland, & Lenz, 1991; Greenberg, 1993). Criterion-referenced measures are instruments that are used “to classify attributes related to client conditions that may be assessed through direct clinical observation or by laboratory tests” (Waltz, Strickland, & Lenz, 1991, p. 198). The Newborn SOS is an example of a criterion-referenced screening tool for sepsis. Norm-referenced measures are instruments that are used “when the interest is in evaluating the performance of a subject relative to the performance of other subjects in some well-defined comparison or norm group” (Waltz, Strickland, & Lenz, 1991, p. 4). The Nursing Pattern of Knowing Scale (POK), developed for this study, is an example of a norm-referenced instrument that examines a nurses’ use of various patterns of knowing in clinical practice.

Validity

Content Validity

Berk (1980) describes item validity as a prerequisite to content validity. Item-objective congruence or CVI measures how well each individual item or groups of items identify or measures the characteristic of interest. Either test determines content validity at the item level. Each item on a scale can be validated with a Content Validity Index
(CVI) or Index of Item-Objective Congruence (Lynn, 1985; Martuza, 1977; Hambleton, 1978). With any scale construction, content validation must measure: 1) the full domain of content that is relevant to each specific measurement situation, 2) the individual items that were selected, and 3) the way the instrument was constructed (Carmines & Zeller, 1979). Content validity is done to analyze whether there is a good range of items on the test, and that the items are representative of the concept of sepsis or patterns of knowing from experts in the field (Lynn, 1985). For items on a criterion-referenced instrument, the researcher does not rely on item statistics to select items. This would weaken the theoretical basis of the instrument and therefore, the interpretability of the domain score (Beck, 1980). For norm-referenced instruments, the content validity is mainly a function of how the instrument is developed and whether its domain is adequately addressed by the instrument (Waltz, Strickland, & Lenz, 1991).

Construct Validity

Construct validity supports the instrument’s ability to function in accordance with the purpose for which it is being used (Waltz, Strickland, & Lenz, 1991). Construct validity measures the accuracy of an instrument. For norm-referenced instruments, “construct validity is usually determined by using: 1) the contrasted groups approach, 2) hypothesis testing approach, 3) the multitrait-multimethod approach, and/or 4) factor analysis” (Waltz, Strickland, & Lenz, 1991, p. 174). For the SOS, construct validity is a way to measure the ability of the instrument to predict those infants with sepsis or without sepsis. For criterion-referenced measures, construct validity is referred to as predictive or decision validity (Nunnely, 1994; Waltz, Strickland, & Lenz, 1991).
Generally, predictive validity “refers to functional relations between a predictor and criterion events occurring before, during, and after the predictor is applied” (Nunnelly, 1994, p. 94).

**Discriminate Validity**

Sensitivity and specificity are two ways to measure the ability of a screening test to discriminate between individuals with or without disease, and therefore, measures a screening test’s validity. Sensitivity and specificity are determined by comparing the results of the screening test with results of a definitive test known as the “gold standard” (Mortan, Hebel & McCarter, 2001).

*Sensitivity.* Sensitivity is “the ability of the screening test to give a positive finding in those developing the disease” (Mortan, Hebel & McCarter, 2001, p. 58). Sensitivity is the number of positive tests in those who have the disease or the percentage of persons with the disease who have positive test results. The sensitivity of the test is its capacity to make a correct diagnosis in confirmed positive cases of the disease (Greenburg, 1993).

*Specificity.* Specificity is the ability of the test to give a negative finding when the subjects tested are not developing the disease (Mortan, Hebel & McCarter, 2001). Specificity is the number of negative tests in those who do not have the disease or the percentage of persons without the disease who have negative test results. Specificity indicates the capacity for making a correct diagnosis in confirmed negative cases (Greenburg, 1993).
Table 1. A Decision Matrix for Screening Tests (Greenburg, 1993; Morton, 2001)

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Disease</th>
<th>No Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Test</td>
<td>a “true positives”</td>
<td>b “false positives”</td>
</tr>
<tr>
<td>Negative Test</td>
<td>c “false negatives”</td>
<td>d “true negatives”</td>
</tr>
</tbody>
</table>

Using a decision matrix for screening tests (Table 1), the sensitivity of the test is described in the following formula:

\[
\frac{a}{a + c} \times 100 = \frac{\text{number of true positives}}{\text{sum of true positives + false negatives}} \times 100
\]

The greater the sensitivity of the test, the more likely the test will detect persons with the disease.

Using this decision matrix for screening tests (Table 1), the specificity of the test is described by the following formula:

\[
\frac{d}{b + d} \times 100 = \frac{\text{number of true negatives}}{\text{sum of false positives + true negatives}} \times 100
\]

The greater the specificity of the test, the more likely the test will detect persons without the disease. Sensitivity and specificity are both descriptors of the efficacy of a diagnostic or screening test (Feinstein, 1974).

Sensitivity is very important with newborn sepsis, due to the serious consequences of missing a diagnosis of sepsis. An instrument that is more sensitive to the diagnosis of sepsis will not be as specific. Sensitivity of the instrument will have priority over the specificity of the instrument. Over treatment of infants occurs by not being as specific in our diagnosis. Overtreatment is preferred over allowing infants with sepsis to
go untreated. Therefore, a sepsis score that gives high sensitivity will be key with a sepsis scale. A decreased specificity will be allowed in order to increase the sensitivity of the instrument.

Positive predictive value. Measures of predictive validity are the positive predictive value (PPV) and the negative predictive value (NPV). The PPV directly estimates the probability of disease. The PPV is the percentage or proportion of individuals with a positive test who actually have the disease (Mortan, Hebel & McCarter, 2001). The PPV can be described by the following formula using the decision matrix (Table 1):

\[
\frac{a}{a + b} \times 100 = \frac{\text{number of true positives}}{\text{sum of true positives + false positives}}
\]

The PPV measures how likely that the disease is present if the test is positive.

Negative predictive value. The negative predictive value (NPV) estimates the probability of no disease. The NPV is the percentage or proportion of individuals with a negative test who actually do not have the disease (Mortan, Hebel & McCarter, 2001). The NPV can be described by the following formula using the decision matrix (Table 1):

\[
\frac{d}{c + d} \times 100 = \frac{\text{number of true negatives}}{\text{sum of false negatives + true negatives}}
\]

The NPV is not often used, since the main objective of a screening test is to identify a disease. Therefore, the NPV is not of interest to most researchers (Mortan, Hebel & McCarter, 2001).
Reliability

Internal Consistency

Coefficient alpha is a measure of internal consistency. Coefficient alpha is a reliability index that estimates the homogeneity of a measure composed of several items or parts (Knapp, 1985). Reliability deals mostly with the degree of measurement error. Coefficient alpha is not a useful tool for the criterion-referenced instruments, since the instrument items have a theoretical basis, and items would not be dropped even with a low coefficient alpha.

Interrater Reliability

The reliability of a criterion-referenced instrument is tested using interrater agreement procedures. Interrater reliability is “the degree to which two raters or observers, operating independently, assign the same ratings or values for an attribute being measured” (Polit & Hungler, 1995). It is estimated by having two or more different observers watching an event and independently and recording the relevant variables according to a predetermined plan. The percent agreement and Kappa K (adjusted K) are two methods to estimate interrater agreement (Waltz, Strickland, & Lenz, 1991). Percent agreement is the proportion of test results that are consistently classified as agreeing or disagreeing (Waltz, Strickland, & Lenz, 1991).

\[
\text{Percent agreement} = \frac{\text{Total number of agreements}}{\text{Number of agreements} + \text{Number of disagreements}}
\]

Kappa K is the proportion of test results that are in agreement beyond that expected by chance (Cohen, 1960). Percent agreement overestimates the interrater agreement, and the Kappa K underestimates the interrater agreement. A percent agreement > 0.8 would be a
test of reliability of the screeners and the use of the scale among raters (Waltz, Strickland, & Lenz, 1991, p. 231). The closer the ratio is to 1.00, the higher the degree of consistency of classifications for the instrument.

Validity, reliability, sensitivity, specificity, and predictive values are terms used frequently with instrument development and testing. These terms are seen in the literature review in the following sections.

Newborn Sepsis

*Maternal/Perinatal Risk Factors*

In predicting which newborns will develop sepsis, various methods are used. One major area is maternal and perinatal predisposing factors. These factors include premature labor, maternal fever greater than 100.4° F., perinatal infection or chorioamnionitis, urinary tract infection, premature rupture of membranes more than 18-24 hours, little or no prenatal care, substance abuse, low socioeconomic status and high GBS colonization (Cole, 1998; Dear, 1999; Snapp, 1999; Oddie & Embleton, 2002; McCoy, 2001). Himmelberger (2002) described prenatal screening as critical to diagnosing and curing this deadly infection. Chorioamnionitis, premature delivery, GBS colonization, and a prolonged duration of internal monitoring were found to be risk factors for neonatal sepsis (Regan, el al, 1996; Yancey, Duff, Kubilis, Clark and Frentzen, 1996). Other factors associated with a higher incidence of neonatal infection are multiple gestation, galactosemia, immune system defects, congenital defects causing skin disruptions, and male gender (Snapp, 1999). Environmental risk factors for sepsis
include a prolonged or difficult delivery requiring instrumentation, resuscitation, or invasive procedures (Snapp, 1999; McCoy, 2001).

Escobar et al. (2000) described decreased risk for sepsis in infants who are asymptomatic at birth, while an increased risk was found among mothers with chorioamnionitis, endometritis and fever, babies with low absolute neutrophil count, and babies delivered with meconium-stained amniotic fluid. He also stated that there were many missed opportunities for treating mothers and babies that could have prevented infection.

Vermillion, Soper, and Newman (2000) found that maternal treatment with multiple courses of steroids (betamethasone) was associated with early-onset sepsis (odds ratio, 1.25; 95% confidence interval, 1.1-1.9) and neonatal death (odds ratio, 1.7; 95% confidence interval, 1.1-1.9).

Many newborn infants are subjected to sepsis work-ups involving a complete blood count (CBC) and blood culture due to maternal fever at delivery. Over-treatment of newborns in the United States has an estimated cost of approximately $800 million with only 6% of the treated infants having a blood culture-proven infection (McKenney, 2001; Mohle-Boetani, Lieu, Ray, & Escobar, 1999; Platt et al., 1999). New information in the literature reveals that maternal intrapartum fever is strongly associated with epidural anesthesia and therefore, with increased neonatal evaluations for sepsis (Lieberman et al., 1997; Viscomi & Manullang, 2000). These costly sepsis work-ups may not be necessary if the infant is asymptomatic. An assessment scale would assist the nurse in evaluating the clinical indicators for infection.
Markers of Sepsis in Newborns

Laboratory Markers

The traditional sepsis work-up of newborns with clinical signs or at risk due to perinatal history includes a complete blood count (CBC), differential, platelet count and blood culture. The CBC with differential has been a standard test of sepsis for both newborns and adults. The interpretation of the CBC in newborns can be more difficult than in adults due to the wide variations in normal values and variations based on gestation age, weight, and postconceptual age (Polinski, 1996). The presence of a low white blood cell count (leukopenia) or low neutrophil count (neutropenia) is predictive of bacteremia in newborns (Johnson, Whitwell, Pethe, Saxena, & Super, 1997). Manroe (1979) found that neutropenia and abnormal immature neutrophil to total neutrophil (I:T) ratios were most predictive of infection. In a NICU in India, signs associated with fatal neonatal sepsis included hypothermia, neutropenia, metabolic acidosis and elevated prothrombin time (Mathur, Singh, Sharma, & Satyanarayana, 1996). Early onset sepsis presents with a different clinical course and usually involves pathogens that are different than sepsis later in life (Berner et al., 1998).

Yet infants, both term and preterm, may present with neutropenia due to a variety of causes. Koenig and Christensen (1991) and Mouzinho et al. (1992) found that pregnancy-induced hypertension contribute to neutropenia in the newborns. Forty to fifty percent of term infants and thirty percent of preterm infants have neutropenia. Infants born with low Apgar scores due to hypoxia or asphyxia, have a higher (67%) incidence of neutropenia (Engle et al., 1997). Physiologic stress in newborns may also affect
neutrophil counts and may cause neutrophil dysfunction (Drossou et al., 1997; Frazier et al., 1982).

The urine latex agglutination test for newborn sepsis has been a quick, early test for many of the more common bacteria present in newborns. Williamson, Fraser and Tilse (1995) studied the accuracy of the latex agglutination test for GBS sepsis on 236 infants. The sensitivity was 90%, specificity 70%, a positive predictive value of 12%, a false positive rate of 31%, with an overall accuracy of 71%. The study showed the other tests have higher sensitivity as a screening tool for sepsis, and the false positive rate of 31% is quite high. Latex agglutination tests are rarely used today in clinical practice due to the high false positive rate and overtreatment cost.

Heimler, Nelin, Billman, and Sasidharan (1995) examined the value of the current diagnostic tests for neonatal sepsis including WBC, urine latex agglutination test and blood culture. They reviewed 219 mother-infant charts, of which 139 mother received intrapartum antibiotics and 80 mothers received no treatment. Infants in the no treatment group had a significantly higher number of positive blood cultures (20%, p < 0.003), higher numbers of positive urine GBS latex agglutinations (p < 0.001), and higher incidence of clinical symptoms. The interesting finding of this study was usefulness of neonatal blood tests for sepsis. The sensitivity of an abnormal white blood cell (WBC) count, with either an I:T ratio elevation, a low total neutrophil count (TNC) or high immature neutrophil count was 81%. The specificity of an abnormal WBC count was 51%, with a positive predictive value of 19% and a negative predictive value of 95%. The latex agglutination test for GBS was 94% sensitive, 92% specific, 52% positive
predictive value and 99% negative predictive value. This study showed less sensitivity of
the WBC than other studies, and improved values for the latex agglutination (LA) test.
One reason the LA test was a better predictor of sepsis in this study is that the skin was
cleaned well with betadine prior to obtaining the specimen. The extra cleaning could
decrease the skin contamination of the specimen. The authors also used repeated testing
to ensure accurate results. This study found that infants continue to be at risk for sepsis
due to other organisms even after mothers are treated for GBS prophylactically.

Clinically, there is no laboratory test with 100% sensitivity and specificity for
newborn sepsis (Laforgia et al., 1997). The blood culture is the “gold standard” for
detection of bacteremia (Schelonka et al., 1996) and therefore, the only known definitive
marker of newborn sepsis. The positive predictive value of a blood culture for diagnosing
sepsis is only about 36-38% (Bozzetti, Terno, Bonfanti & Gallus, 1984). The increasing
use of intrapartum antibiotics can interfere with neonatal blood culture growth.
Therefore, it is difficult to rely only on a positive blood culture for confirmation of
newborn sepsis. Since blood cultures are not always positive in neonatal septicemia, a
combination of clinical and laboratory evidence can be used to diagnose neonatal sepsis
(Sanghvi & Tudehope, 1996). Clinicians have not yet been able to find a set of clinical
signs or laboratory tests to be reliable for very early diagnosis of neonatal sepsis and up
to 20 infants are treated for each individual infant with a positive blood culture (Griffin &
Moorman, 2001). This results in the over-treatment of many infants who do not have
sepsis.
Besides the CBC, differential, and blood culture, many other predictors or markers for sepsis have been noted in the nursing and medical literature. They include laboratory markers, clinical indicators, and maternal risk factors. The markers for sepsis are delineated in Table 2.

Table 2. Markers of Sepsis Seen in the Literature

<table>
<thead>
<tr>
<th>Source</th>
<th>Markers of Sepsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agnoli, F. L. (1994)</strong></td>
<td><strong>Clinical Indicators:</strong></td>
</tr>
<tr>
<td></td>
<td>Temperature Instability (<em>fever or hypothermia</em>)</td>
</tr>
<tr>
<td></td>
<td>Loss of glucose homeostasis</td>
</tr>
<tr>
<td></td>
<td>Respiratory Distress (<em>grunting, retractions, apnea, cyanosis</em>)</td>
</tr>
<tr>
<td></td>
<td>CV Instability or Shock (<em>tachycardia, hypotension, poor perfusion, acidosis</em>)</td>
</tr>
<tr>
<td></td>
<td>Neurologic Findings (<em>hypotonia, seizures, lethargy, irritability, LOC changes</em>)</td>
</tr>
<tr>
<td></td>
<td>Feeding Intolerance (<em>vomiting, abdominal distension</em>)</td>
</tr>
<tr>
<td></td>
<td>Petechiae, Purpura</td>
</tr>
<tr>
<td></td>
<td>Jaundice (<em>direct hyperbilirubinemia</em>)</td>
</tr>
<tr>
<td><strong>Boyle, R. J., Chandler, B. D., Stonestreet, B. S. &amp; Oh, W. (1978)</strong></td>
<td><strong>Perinatal Factors:</strong></td>
</tr>
<tr>
<td></td>
<td>History of Prolonged Rupture of Membranes</td>
</tr>
<tr>
<td></td>
<td><strong>Clinical Indicators:</strong></td>
</tr>
<tr>
<td></td>
<td>Respiratory Distress (<em>low pressures to ventilate</em>)</td>
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<tr>
<td></td>
<td>Increasing Hypoxia</td>
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<tr>
<td></td>
<td>Shock</td>
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<tr>
<td></td>
<td>Apnea</td>
</tr>
<tr>
<td></td>
<td>Acidosis</td>
</tr>
<tr>
<td><strong>Chandna, A., Rao, M. N., Srinivas, M. &amp; Shyamala, S. (1988)</strong></td>
<td><strong>Clinical Indicators:</strong></td>
</tr>
<tr>
<td></td>
<td>Lethargy</td>
</tr>
<tr>
<td></td>
<td>Sluggish neonatal reflexes</td>
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<tr>
<td></td>
<td>Jaundice</td>
</tr>
<tr>
<td></td>
<td>Diarrhea</td>
</tr>
<tr>
<td></td>
<td>Poor feeding</td>
</tr>
<tr>
<td><strong>Crandall, B. &amp; Getchell -Reiter, K. (1993)</strong></td>
<td><strong>Clinical Indicators:</strong></td>
</tr>
<tr>
<td></td>
<td>Color Changes/Cyanosis</td>
</tr>
<tr>
<td></td>
<td>Lethargy</td>
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<tr>
<td></td>
<td>Bradycardia</td>
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<tr>
<td></td>
<td>Apnea</td>
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<td></td>
<td>Abdominal Distention</td>
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<tr>
<td></td>
<td>Unresponsiveness</td>
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<td></td>
<td>Poor muscle tone</td>
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<tr>
<td></td>
<td>Feeding Abnormality</td>
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<tr>
<td></td>
<td>Respiratory Distress</td>
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<tr>
<td></td>
<td>Unstable Temperature</td>
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<tr>
<td></td>
<td>Hypothermia</td>
</tr>
<tr>
<td></td>
<td>Residuals of feedings</td>
</tr>
<tr>
<td>Study Authors</td>
<td>Clinical Indicators</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Nyhan, W. L. &amp; Fousek, M. D. (1958)</td>
<td></td>
</tr>
</tbody>
</table>
| Rodwell, Leslie & Tudehope (1988) | Perinatal Factors:  
Chorioamnionitis  
Maternal fever  
Clinical Indicators:  
Lethargy  
Apnea  
Respiratory Distress  
Hypoperfusion  
Shock |
|---|---|
| Rodwell, Taylor, Tudehope & Gray (1993) | Lab Markers:  
Low neutrophils count (< 5000/mm³) |
| Snapp, B. (1999) | Clinical Indicators:  
Poor color  
Temperature instability  
Purpura  
Bleeding  
Tachycardia  
Hypotension  
Decreased Perfusion  
Feeding Intolerance or Poor feeding  
Loose stools  
Vomiting  
Abdominal Distension  
Grunting, flaring, retractions  
Tachypnea  
Hypoglycemia or Hyperglycemia  
Lethargy  
Irritability  
Change in behavior |
| Tollner, U. (1982) | Clinical Indicators:  
Skin coloration - marbling/grey-green  
Microcirculation  
Metabolic acidosis  
Muscular hypotonia  
Bradycardia  
Apnea  
Liver enlargement  
GI symptoms (vomiting, diarrhea, distention, reflux, ↑ residuals)  
Lab Markers:  
Leukocytosis  
Leukopenia  
Shift to the Left  
Thrombocytopenia |
Neutropenia  
Clinical Indicators:  
Often Subtle signs  
Respiratory distress |
“Individual markers of early-onset sepsis have yet to be identified, and no one predictive variable may exist” (Horns, 2000, p. 61-62). Therefore, the need to combine various indices of bacteremia with clinical markers of sepsis must be examined.

Clinical Indicators

In a pilot study of this research, the author conducted a phenomenology study to obtain descriptions of the infant with sepsis (Rubarth, 2003). Eight nurses with more than 10 years of experience described the infant with sepsis as being “gray”, “pale”, “shitty-looking”, “pasty”, “the color of putty”, or “greenish-gray”. Some nurses remarked that the infant “just doesn’t look right” or the baby has that “septic look” when assessing a baby prior to the diagnosis of sepsis. Nurses who work in the intensive care nursery also described signs of sepsis as changes in color, respiratory distress, and poor circulation (Rubarth, 2003). Most initial subtle signs are nonspecific and can be seen in sepsis as well as many other diseases (Snapp, 1999). The subtle and non-specific signs of sepsis can make the early diagnosis difficult for new as well as experienced practitioners.

Neonatal Screening Tools for Sepsis

Philip and Hewitt (1980) described the diagnosis of neonatal septicemia as “one of the most difficult tasks in clinical medicine” (p. 1036). They assessed the usefulness of
a group of tests to predict neonatal sepsis rapidly and reliably, in order to define the need for antibiotic therapy. The sample was 376 infants who exhibited signs or had a history indicating the need for a sepsis work-up in the first week of life. The infants included 58% premature infants and 42% term infants. The tests were the following: gastric aspirate for WBC smear, white blood cell count and differential, platelet count, blood culture, urine culture, cerebrospinal fluid culture, immunoglobulin M (IgM), C-reactive protein (CRP), alpha-1-acid glycoprotein (α-AGP), haptoglobin, and “mini” erythrocyte sedimentation rate (ESR). The designation of infection status as proven, not infected, or uncertain was made retrospectively. In 30 cases of proven sepsis, the authors found that an elevated band/neutrophil ratio, a low WBC count, a positive CRP, positive haptoglobin, and an elevated mini-ESR were fast and useful as tests for neonatal sepsis. If two or more were positive, the results showed a 93% sensitivity, 88% specificity, and 39% positive predictive accuracy for sepsis. The authors suggest these five tests for early detection of the presence or absence of infection. The high sensitivity is appropriate to assure no infants with sepsis are missed or left untreated. To strengthen the findings, the items could have been incorporated into a multiple regression analysis to look at which items added variance to the outcome of sepsis. The study also includes both term and premature infants without any attempt to separate the two distinct populations.

Philip (1981) used the sepsis screen of I:T ratio, WBC count, CRP, haptoglobin and ESR on infants in a study of the use of antibiotics when a sepsis screen is available as compared to when a sepsis screen was not available. The 284 infants in the original group and 240 infants in the second group were selected based on the following risk
factors: prolonged rupture of membranes (PROM) > 24 hours, evidence of maternal infection (e.g. fever), and premature labor without adequate explanation. The clinical factors indicating a sepsis screen were lethargy, temperature instability, abdominal distension, unexplained apnea or cyanotic spells, and irritability or convulsions. The infants included 60% premature infants and 40% term infants. The infants were designated as having “proven sepsis”, “very probable”, or “not infected”. The physicians used the sepsis scale scores to start or withhold antibiotic treatment in the second group. By using the sepsis scale scores, either retroactively in the first group or prospectively in the second group, the author evaluated the use of antibiotics using Chi square analysis. Results demonstrated that having a negative sepsis screen (less than two items positive) resulted in a marked decrease in antibiotic use ($p < 0.0001$). This study again shows the results of decreasing hospital and insurance costs by the use of a rapid and reliable sepsis scale for newborns. The study includes many premature and term infants that can have very different physiologic signs of sepsis, as well as premature infants having a more deficient immune system.

Philip (1982) continued the use of his sepsis screen with 56 infants evaluated between eight and 60 days of life in the nursery ICU. A positive sepsis screen was found in 23 of these infants with proven sepsis. With the addition of a high WBC count to the screen, all 25 proven positive sepsis infants would have been detected with a positive sepsis screen. With the addition of the high WBC count to the sepsis screen, the positive predictive accuracy was 46%, the sensitivity was 100% and the specificity 69%. Sensitivity, specificity, and confidence intervals were calculated only. This study was
done on premature infants, and because of the evaluation at between eight and 60 days of age, is a classification of late-onset sepsis, rather than early-onset sepsis that occurs within the first 24-48 hours. On the basis of the findings, the author recommends the use of the modified sepsis screen for all infants in the nursery ICU with suggestive clinical features of sepsis.

Faden (1976) examined the microscopic blood smears of 84 ill infants to assess their usefulness in the diagnosis of neonatal sepsis. No demographic data whether premature or term were given. No statistical analyses were done. Seven of the 15 infants (47%) were diagnosed by peripheral smear, whereas eight of the 15 infants (53%) with positive cultures were not diagnosed by this method. The author stated that five of the positive cultures were likely to have been contaminants, which then increases his positive results to 70% (7 out of 10). But this high number of contaminations of the specimens (33%) by bacteria seems quite high for most laboratories and cannot be assumed. Although in comparison to adults, who have about a 30% detection rate for bacteria on peripheral smears, the 47% to 70% positive peripheral smear result may be a significant amount. The author states that younger children have higher concentrations of bacteria in their blood during septicemia and therefore suggests the routine use of microscopic evaluation of a peripheral blood sample.

Boyle, Chandler, Stonestreet and Oh (1978) state a mortality rate of 40-80% with early-onset GBS sepsis. Because respiratory distress is a common sign of early onset sepsis, their study evaluated 116 infants with respiratory distress during the first 24 hours of life. Nine infants were later diagnosed as having sepsis and 105 were classified as non-
septic. The authors compared differences between the two groups of infants to determine the most specific laboratory test for early identification of early neonatal sepsis. Results indicated that leukopenia as a major indicator of newborn sepsis. The authors recommend a WBC count looking at leukopenia (< 10,000/cu mm) or neutropenia (< 4500/cu mm) as the criterion for diagnosis of sepsis. These criteria would have identified 91% of the infants with sepsis, but would have also identified 14% of infants without sepsis. According to the authors, this would be acceptable due to the high mortality of sepsis and would be worth the risk of unnecessary treatment of those falsely identified infants in whom antibiotic therapy would have been started. This study does not identify the type of analysis done. Since it is an older study, it may have been done prior to computer data analysis, though the significance levels were determined and graphics were used to look at the data. This study also had a very small number of participants in the sepsis group of which six of the nine infants died (high mortality rate). No discussion of human subjects or consents was made in any of the above-mentioned medical articles.

Gerdes and Polin (1987) evaluated a sepsis screen on 220 neonates less than a week of age with suspected early onset sepsis. These author’s sepsis screen included the following five items: WBC count (< 5000/mm$^3$ or absolute neutrophil count less than 1750/mm$^3$), Immature/Total neutrophil (I:T) ratio (> or = 0.2), C-reactive protein (positive), mico-erythrocyte sedimentation rate (≥ 10 mm/hour), and plasma fibronectin (< 120 μg/ml if < 34 weeks or < 145 μg/ml if ≥ 34 weeks). C-reactive protein is an acute phase reactant that is elevated in any acute inflammatory condition. Fibronectin is a positive acute phase reactant that is thought to be used up during sepsis, therefore low
levels may be an indicator for sepsis. The I:T ratio was the only test alone to give 100% sensitivity, but the specificity was only 50%, with an 11% positive predictive value and a 100% negative predictive value. With the addition of the WBC count, I:T ratio, CRP, and mini-ESR, there was still 100% sensitivity, and 100% negative predictive value, but there was an increase in the specificity to 83%, and the positive predictive value was 27%. The authors suggested that this sepsis screen was helpful in predicting infection, but that the addition of plasma fibronectin levels was not of diagnostic value. This study also used only laboratory values in its sepsis screen.

Kite, Millar, Gorham and Congdon (1988) used a different set of five items for their sepsis screen. They used the total neutrophil count, I:T neutrophil ratio, C-reactive protein assay, nitroblue tetrazolium test and an acridine orange leucocyte cytospin test. Of the 188 blood samples tested on 100 infants, 34 samples were associated with positive blood cultures. The authors recommend a combination of tests for the diagnosis of neonatal sepsis. The C-reactive protein, nitroblue tetrazolium and the acridine orange leucocyte cytospin test together gave the highest positive predictive value (56.8%), with a sensitivity of 92.3% and a specificity of 90.3%. In this study, the majority of infants were very low birthweight. When compared to other study results, there are significant differences with the results of the I:T ratio and WBC/neutrophil counts, but the prematurity of the infants could contribute to these differences.

Chandna, Rao, Srinivas and Shyamala (1988) studied the clinical presentation features of septicemia in neonates and evaluated the best possibility of diagnostic tests for sepsis. The 50 study infants were 36% premature and 64% term. The clinical features
most seen in the infants presenting with sepsis were lethargy, sluggish reflexes, jaundice, diarrhea and poor feeding. The screening tests used by these authors were the following: C-reactive protein, I:T ratio (≥ 0.2), buffy coat (peripheral blood) smear to look for organisms, gastric aspirate cytology (≥ 75%), and WBC count (< 5000/mm³). The CRP was found to be the best individual test for diagnosing neonatal sepsis with a sensitivity of 83%, specificity of 42%, and a positive predictive accuracy of 57%. With a combination of any two or more of the screening tests, the results were a sensitivity of 88%, specificity of 23%, and a positive predictive accuracy of 51%. The authors found that a combination of CRP with gastric aspirate cytology showed the highest degree of sensitivity (83%) and specificity (76%), with a positive predictive accuracy of 47.6%.

This study was well done but again uses only laboratory data in its sepsis screen.

Rodwell, Leslie & Tudehope (1988) utilized a hematologic scoring system for newborn sepsis. The scoring system was developed after an evaluation by the authors of many clinical criteria and laboratory tests. This study was done in Australia on 287 infants (243 infants < 24 hours of age, 55 infants between 2-30 days of age) and included 298 evaluations. Of the day old infants, 113 were premature and 130 were term. The infant’s infection status was designated as “sepsis” (n= 27), “probably infection” (n=23), and “non-infected” (n=248). Sepsis was classified as a positive blood culture. “Probably infection” was a negative blood culture, but strong clinical history for infection including maternal chorioamnionitis with maternal fever and clinical signs in the infant. The clinical signs of sepsis included lethargy, apnea, respiratory distress without obvious cause, hypoperfusion, and shock. Infants with a negative blood culture and no clinical
signs of infections were considered non-infected. Data were analyzed using the chi-square or Fisher exact test. The Hematologic Scoring System (HSS) assigns a score of one for each of seven findings: 1) abnormal leukocyte count, 2) abnormal total neutrophil count, 3) elevated immature neutrophil count, 4) abnormal immature to total neutrophil ratio (I:T ratio), 5) immature to mature neutrophils = 0.3, 6) platelet count = 150,000/mm$^3$, and 7) degenerative changes in the neutrophils like vacuolization, severity of toxic granulation or the presence of Döhle bodies. A score = 3 was chosen as the cut-point for this study because it provided a high sensitivity and acceptable levels of specificity and positive predictive values. No parental consents were obtained for this study.

The HSS scoring system deals only with hematological findings in attempting to predict sepsis. The scoring system was quite sensitive (96%) and relatively specific (78%), but had very high negative predictive accuracy (99%). Yet the entire score is based on only different variations of the values found on a CBC, which allows for some question as to its usefulness.

Rodwell, Taylor, Tudehope and Gray (1993) as a screening test for sepsis evaluated the Hematologic Scoring System (HSS) prospectively. The subjects included 455 preterm infants and 545 term infants with a total 1000 newborns being evaluated. Perinatal data and clinical assessments were also recorded on a data sheet. Neutropenic and non-neutropenic infants were compared using chi-square with a significantly higher proportion (35%) of preterm infants being neutropenic (= 5000/mm$^3$). Twenty-eight of the infants met criteria for sepsis (n=18) or probable infection (n=10). The sensitivity of
the HSS was 93%, specificity of 82%, positive predictive values of 50% and a negative predictive value of 98%. Again it was noted that premature infants have lower neutrophils counts than term infants, and that the neutropenia was more commonly due to non-infectious origins (83%). It was noted in this study that though not statistically significant, the HSS score was less sensitive but more predictive of infection than an elevated I:T ratio. Parental consents were once again not obtained for this study. The authors recommend the HSS or I:T ratio in conjunction with clinical findings for the early identification of sepsis and also recommend repeated testing.

Tollner (1982) developed a scoring system for newborns with sepsis based on both hematological and clinical symptoms. He studied the signs of sepsis in 83 sick newborns in the NICU retrospectively, developed the screening tool called “Sepsis Score”, and then studied 39 neonates with proven sepsis. The symptoms that were described were temperature instability, respiratory distress, hypotension, lethargy, feeding problems, skin discoloration, decreased capillary refill, metabolic acidosis, hypotonia, bradycardia, apnea, liver enlargement, and abdominal distention. The significance of each finding was tested with Chi Square analysis. Only those findings with significance (p<0.01) were included in the sepsis score. This study is the only sepsis scale in the literature to combine both clinical and laboratory markers for sepsis. One limitation of the study is that many infants were premature, and the markers of sepsis in premature infants differ from the signs exhibited by full-term infants.
New Laboratory Markers for Sepsis

New markers of sepsis have been discussed recently in the literature. These include C-reactive protein (CRP), interleukins (ILs), platelet activating factor (PAF), granulocyte colony-stimulating factor (G-CSF), tumor necrosis factor-alpha (TNF), superoxide dismutase (SOD), glutathione peroxidase (GPX), nitric oxide (NO), carbon monoxide (CO), procalcitonin, and thromboelastogram (TEG). Early diagnosis of sepsis or sepsis-like illnesses may be detected by cytokines prior to the clinical findings being apparent. These cytokines, like tumor necrosis factor or interleukins, play a major role in initiating and maintaining the inflammatory response associated with sepsis (Griffin & Moorman, 2001). Improved early diagnosis is the goal, and new approaches are needed.

Both CRP and Interleukin-6 are considered indicators of sepsis in newborns, but may not be adequate predictors of sepsis. The use of CRP has shown both positive and negative results in the literature. Some studies have shown that CRP levels are a valuable screening tool for the diagnosis of neonatal sepsis (Chan & Ho, 1997; Benitz, Han, Madan, & Ramachandra, 1998; Philip & Mills, 2000) whereas other studies do not support the use of CRP as a diagnostic tool due to its low sensitivity and positive predictive values (Jaye & Waites, 1997; Berner et al., 1998; Clyne & Olshaker, 1999; Kallman, Ekholm, Eriksson, Malmstrom, & Schollin, 1999). Da Silva et al. (1995) concluded that CRP was no better than WBC results, yet may be the best available single diagnostic test for evaluating newborn sepsis. They also remarked that serial CRP levels are helpful in determining the newborns’ response to antibiotics and the duration of treatment (Philip & Hewitt, 1980).
Other studies found interleukin-6 levels were significantly elevated in neonatal early-onset sepsis (Harris et al., 1994; Panero et al., 1997; Kuster et al., 1998; Kallman, Ekholm, Eriksson, Malmstrom, & Schollin, 1999; Silveira & Procianoy, 1999). Perenyi, Johann-Liang, and Stavola (1999) found IL-6 levels were not a reliable predictor to rule out early newborn sepsis. Magudumana et al. (2000) found that an IL-6 level obtained at the time of clinical symptoms was useful in the early diagnosis of neonatal sepsis, but serial levels were of no benefit.

Doellner, Arntzen, Haereid, Aag and Austgulen (1998) found a combination of CRP level > 10 mg/L and Interleukin-6 level of > 50 pg/ml drawn on admission to have a 96% sensitivity, 74% specificity, 49% positive predictive value and a 99% negative predictive value for neonatal infections. Silveira & Procianoy (1999) found the combination markers of IL-6 and TNF-alpha were highly sensitive markers for sepsis in the newborn period (at 98.5%). Spear et al. (1995) found interleukin-2 receptor levels significantly elevated in premature infants with sepsis. Kuster et al. (1998) found IL-6 and IL-1 receptor antagonist to be better predictors of sepsis than CRP. With very low birth weight infants, they found sensitivities of 18% for CRP, 57% for IL-6, and 64% for IL-1ra the day prior to becoming clinically ill with sepsis. The early inflammatory mediators like interleukins may be better predictors of sepsis than CRP, yet this study also excluded early-onset sepsis in newborns, who are often clinically symptomatic within the first 12-24 hours after birth.

Premature infants with Klebsiella pneumonia were found to have elevated levels of platelet-activating factor (PAF), and may be a predictor or marker of neonatal sepsis.
Neonates with positive blood cultures indicating septicemia had significantly increased levels of CD14, IL-6, CRP, and decreased fibronectin levels compared to healthy infants, though there was not a significant increase in TNF-alpha (Blanco et al., 1996). TNF-alpha was shown to be significantly elevated in infants with sepsis, and even higher levels were found in infants with septic shock (Atici, Satar, Cetiner & Yaman, 1997). Other studies have indicated TNF-alpha, SOD, GPX, NO, and CO as being significant markers for neonatal septicemia, yet their usefulness as a predictor for sepsis must also be questioned since they are late markers for sepsis (Seema et al., 1999; Ergenekon et al., 2000; Shi et al., 2000).

Serum procalcitonin was also found to be elevated in neonates with bacterial sepsis with both early-onset and late-onset infections (Gendrel et al., 1996; Monneret et al., 1997). The clinical usefulness of procalcitonin was also questioned in these studies. Yet in a study in Italy with a group of 203 infants, Chiesa et al. (1998) found a sensitivity and specificity of 92.6% and 97.5% respectively for procalcitonin levels in early-onset sepsis within the first 48 hours of life. This marker may prove to be one of the better indicators/predictors for newborn sepsis.

One last indicator or marker in the literature is the thromboelastogram (TEG). This test measures defects in the coagulation process. TEG abnormalities were detected in only those patients with early and established sepsis with a sensitivity of 96% and a specificity of 96% (Grant & Hadley, 1997).
These new laboratory markers of infection are not yet widely used in clinical practice. There are questions about their applicability as early markers for infection in newborns. Also, most hospital laboratories are not equipped for these tests. Therefore, the Newborn SOS will not include any of the newest laboratory markers but only the most widely used laboratory markers of WBC count, I/E ratio, immature neutrophils count, pH, and platelet count.

*Other Indicators for Neonatal Sepsis*

Griffin and Moorman (2001) described the use of heart rate analysis in the early identification of sepsis in newborns. This study was done in a NICU in the United States from 1995-1999. The study evaluated 40 infants with sepsis, 23 infants with sepsis-like illness, and 29 control infants without sepsis. A Score for Neonatal Acute Physiology (SNAP) and the Neonatal Therapeutic Intervention Scoring System (NTISS) measures of the severity of illness were also done on these infants. The analysis of heart rate characteristics involved differences from the means and increased skewness of the heart rate histograms showing reduced beat-to-beat variability and episodes of bradycardia (differences from the normal heart rate patterns). Infants’ heart rates were evaluated 5 days prior and 3 days after the incidents of cultures and antibiotics started (except on the control infants where a random day and time were chosen). The authors found that infants with sepsis or sepsis-like illness had abnormal heart rate characteristics for up to 24 hours preceding their abrupt deterioration. Multivariate logistic regression analysis found that both the SNAP and NTISS scores contributed to the final model, but that the SNAP score contributed significantly more (p < .003), and that both the heart rate
characteristics and clinical scores contributed independently to the final model (p = .02).
This study suggests that monitoring of heart rate characteristics may be helpful in the early diagnosis of sepsis. Understanding the physiologic functioning of the heart rates’ responses to the cytokines, to sepsis, and to the inflammatory response itself will need to be further studied.

Kempley and Murdoch (2000) studied the effect of bacterial infection on the splanchnic circulation in 76 premature infants in the intensive care unit during the first 24 hours of life. Using ANOVA and regression analyses, results indicated that infants with a positive blood culture or positive cutaneous culture had reduced celiac and superior mesenteric artery pulsatility index (p < 0.0001) and a higher celiac artery blood flow velocity (p < 0.05) as seen by Doppler ultrasound evaluations. This study involved high cost and clinical expertise to obtain the results, and would not be rationally possible in most neonatal intensive care nurseries. The study was also done on only premature infants.

Messaritakis et al. (1990) describe the differences in rectal and skin temperatures as being indicative of sepsis in newborn infants. They looked at temperature differences in 55 healthy and 26 septic newborns. They compared hyperthermic (>37.8° C) full-term infants, premature infants without fever, and dying premature, septic infants. Each of these groups of infants would have quite varying temperature differences due to their gestational age and their peripheral perfusion. The main finding of this article is to closely observe infants with temperature differences > 3.5 ° C.
Peripheral perfusion is also considered a clinical feature of early-onset sepsis. Poschl et al. (1994) found decreased blood flow or capillary filling (p < .05) in both premature and term infants with sepsis.

Horns (2000) described thermography as a potential method of early recognition of neonatal sepsis. Thermography is a non-invasive bioinstrument that measures vasoactive peripheral perfusion using an infrared thermographic camera. Only two studies in the literature (Clark et al., 1978; Anderson, Wailoo, & Petersen, 1990) described using thermography on neonates, but neither described its use in sepsis or as a diagnostic indicator for sepsis.

Observation Scales in Pediatrics and Adults

**Yale Observation Scale in Young Children**

McCarthy et al. (1982) tested an observation scale for identifying serious illness in febrile children 24 months of age or younger. Of the 312 febrile children, 37 had serious illness, many of which included infectious processes. The observation scale included 14 items scored on a five-point scale. Three items of the 14-item scale were highly correlated during the analysis (r = .81, .67 and .61) and subsequently removed from the scale. Multiple regression analysis revealed six items were predictors of serious illness. The multiple $R^2$ (42.2%) with the six-item scale was similar to that obtained with the 11-item scale. Therefore, the scale was reduced to six items. The item with the highest correlation to outcome was “quality of cry” (r = .494). The six-item predictive model had a specificity of 88%, sensitivity of 77%, and a positive predictive value of 56%. Infants, who tested negative on the scale with a total score less than or equal to 10,
had only a 2.7% probability of serious illness. This study shows that usefulness of an observation instrument for assessing young children for serious illnesses. One problem methodologically was the researcher’s use of 557 observers to implement the instrument in the primary care center-emergency room. Many of the infants were seen by more than one observer. Scoring of the observations of the two attending physicians tested interrater reliability using weighted kappa and the majority of the patients were seen by at least one attending pediatrician. Yet the total number of observers (557) included pediatric house officers and registered nurses. This gives a significant amount of variability in the training and possibly, the assessment skills of the clinical observers and would affect the reliability of the instrument.

McCarthy, Lembo, Baron, Fink and Cicchetti (1985) continued their work on the Yale Observation Scale (YOS). For this study, the researchers evaluated the interaction between the child’s clinical appearance and the history or physical examination findings. The sample included 103 febrile children who were seen by one or both attending physicians. The number of observers for the scale was significantly reduced for this study from the previous one, which improves the reliability. Children who appeared ill (YOS >10) had a significantly greater occurrence of abnormal physical findings on examination (64%). The positive predictive value of an abnormal physical examination finding for a serious illness in an ill-appearing child was 79%; whereas, the positive predictive value of an abnormal physical examination finding in a well-appearing child (YOS < 10) was 25%. The combination of physical examination and observation is shown to be important for predicting the risk of serious illness.
McCarthy, Lembo, Fink, Baron and Cicchetti (1987) added to their study by continuing the work on the YOS, which is now called the Acute Illness Observation Scale (AIOS). They looked at the child who appears “toxic” in an attempt to define the basis for the judgment of “toxicity”, much like the nurses who assess an infant as “septic” on very subtle symptoms. The assessment of toxicity by these authors was based on observational assessment, especially the child’s response to stimuli. The AIOS includes the following six items: Quality of Cry, Reaction of Crying to Parent Stimulation, State Variation, Color, Hydration, and Response to Social Overtures. The items are on a 3-point scale, with 1 = normal, 3 = moderate impairment, and 5 = severe impairment. The well child would have a score of 6. The use of 1 for normal rather than zero was of concern to me.

McCarthy, Lembo, Fink, Baron and Cicchetti (1987) have now combined the AIOS, history and physical examination findings to compare this data with the history and physical examination findings alone. Examples of the history and physical examination findings were listed in this study as compared to the last study. Of the 350 febrile children seen, 36 had serious illnesses (28 of which were detected on history and physical exam alone, while 31 were detected with the addition data from the AIOS as ill-appearing). The sensitivity of the scale when used with the history and physical findings was significantly improved (86-89%, 86-93%, and 50-75% in each of the three groups evaluated. These authors stated that “These data give substance to what is intuitively appreciated by pediatricians: a clinical evaluation that takes into account the febrile child’s appearance as well as symptoms and signs is a powerful diagnostic tool for
detecting serious illnesses in a variety of clinical settings” (McCarthy, Lembo, Fink, Baron, & Cicchetti, 1987, p. 30). The same can be said for the observation of newborns in the transition or intensive care nursery.

**Sepsis Grading Scales in Adults**

Elebute & Stoner (1983) developed a sepsis scoring system to evaluate the severity of sepsis by the type of infection and group of symptoms. They applied their sepsis scale to a sample of 15 adult patients aged 21 to 82. Individual items were drawn from a comprehensive list of known clinical features of sepsis in adults. The scores values were arbitrarily assigned and no maximum score was given. Items identical to those on the SOS are the following: temperature, metabolic acidosis, blood culture, WBC count and platelet count. Like the SOS, this scale was used over time to assess for change in a patient’s condition. Unlike the SOS, this scale predicts severity of disease, not whether the disease is present or absent. Scores over 20 were found to be associated with increased mortality (80%). There was no validity or reliability testing reported in the literature, therefore, one would question the usefulness of the instrument until the statistical tests can be done.

The Apache II (acute physiology and chronic health evaluation) scoring system is a variation of a severity of illness classification system developed by Knaus, Draper, Wagner and Zimmerman (1985). The Apache II is used to assess objective physiologic measurements in adult patients in the intensive care unit (ICU). Knaus, Draper, Wagner and Zimmerman (1985) have reduced the physiologic parameters from 34 to 12 in this study. The parameters used are the following: temperature, mean arterial pressure, heart
rate, respiratory rate, oxygenation, arterial pH, serum sodium, serum potassium, serum creatinine, hematocrit, white blood cell count, and the Glasgow coma score. These twelve items used together for the total acute physiology score (APS). Interobserver reliability testing revealed 96% agreement. The sample size was 5030 ICU admissions in 13 different hospitals. The scale has been tested and shown to be reliable for classifying ICU patients at increased risk of subsequent hospital death and the score provides a measure of severity of disease. Many of these same parameters on the Apache II are present on the neonatal SOS, so the combination of observational measures and laboratory data on the SOS are likely to be useful for newborns, even though the Apache II scale was developed and tested on an adult population.

Ponting, Sim and Dudley (1987) used the sepsis scoring system of Elebute and Stoner (1983) compared to the Apache II score. This study was done on 45 adult patients with sepsis. Their definition of sepsis was “the presence of pus in the chest or abdomen for more than three days” (p. 750). The Apache II score was more effective for predicting survival than the sepsis score. Besides the use of a significantly different population, this study used a definition of sepsis that is quite different than the definition used with neonatal septicemia. The study also looked at predicting survival, rather than predicting sepsis. The one interesting concept that these researchers looked at was that the Apache II score was more predictive of the severity of the disease because it relied on systemic factors more than local factors, which is similar to the newborn SOS.

Dominioni et al. (1987) developed a sepsis index of survival (SIS) based on a stepwise regression analysis to identify predictors of sepsis. The linear equation used the
sepsis score of Elebute and Stoner (1983), measured levels of complement factor B, and plasma levels of alpha-1-acid glycoprotein (both of which are acute-phase proteins). The authors studied 135 adults with sepsis in a surgical ICU in Italy. Mortality was positively correlated to the sepsis score. Using the sepsis score and factor B levels, the prediction of survival was highly specific (100%), but low in sensitivity (59%). With the addition of the alpha-1-acid glycoprotein level, the linear model was found to be highly sensitive (88%) and highly specific (86%). The predictive power was shown to be 100% and 0% for positive and negative predictive values respectively. This is an excellent study looking at sepsis scores (systemic factors and observations), and combining it with laboratory values. Though this study was done on adult patients who are experiencing either trauma or surgery, the use of a combination clinical and laboratory scale is similar to the newborn SOS.

Dominioni et al. (1991) continued to work with sepsis scores on adult surgical patients in this study of 62 patients. Using both the sepsis score of Elebute and Stoner (1983) and the Apache II scores of Knaus, Draper, Wagner and Zimmerman (1985), Dominioni et al. began a treatment regimen of high-dose immunoglobulin G (IgG) to evaluate the survival rates of severely septic patients. Results showed a significantly lower mortality rate in the IgG treated patients (38%) than in the control patients who were untreated (67%; p< 0.05). This study shows how the use of a sepsis score can assist the practitioner to treat based on the severity of the disease process, and therefore, change the outcome or mortality rate for that group of patients.
In response to the sepsis scale of Elebute and Stoner (1983) used extensively in Europe on adults and the Sepsis Severity Score of Stevens (1983) on surgical patients, Meek, Munster, Winchurch, and Dickerson (1991) developed the Baltimore Sepsis Scale to measure the severity of sepsis on burn patients. They studied 41 burn patients prospectively using a control group and a group of patients treated with Polymyxin B prophylactically. The sepsis scale was constructed retrospectively, applied to the records of the patients, and correlated with plasma levels of interleukin-6 (IL-6) and endotoxin measurements. The 13 items on the scale were heart rate, blood pressure, temperature, pH, platelets, white cell count, creatinine, systemic vascular resistance, urine output, peak end-expiratory pressure, oxygenation, modified Glasgow scale of coma, and use of antibiotics. Each item was measured daily on a variable point scale with no maximum number. Results showed a high correlation between the sepsis score and the IL-6 levels (p < 0.004), and between the sepsis score and a positive blood culture (p < 0.01). The peaking of the sepsis score occurred almost four days prior to the appearance of the positive blood culture; therefore, in theory, an accurate sepsis score could assist the practitioner to look or predict sepsis. On the basis of these results, the authors recommended using the sepsis score on a patient population without burn injuries.

Summary

The assessment and diagnosis of early-onset sepsis remains a difficult task for neonatal nurses and nurse practitioners. Differentiating those infants with sepsis from infants with other problems is complex. The infants with sepsis must be identified as early as possible, yet many laboratory indicators of actual neonatal sepsis are inadequate
positive predictors (Horns, 2000). Using multiple methods of knowing can facilitate early identification of newborn sepsis.

There is little research into nursing patterns of knowing, particularly in reference to the assessment of infants. The existing studies focused on the populations of pediatrics, nursing students and adults. In addition, no instrument that measured patterns of knowing could be found in the published literature. The nursing pattern of knowing (POK) scale was developed to evaluate the dominant patterns of knowing used by NICU nurses to achieve knowledge that an infant is deteriorating. A better understanding of the patterns of knowing in the NICU can be helpful in promoting and teaching effective assessment approaches. Researchers need to explore the many patterns that can influence a nurse’s knowledge and interpretation of signs and symptoms of infants’ health conditions.

Items for the Newborn Scale of Sepsis were developed from Tollner’s (1982) sepsis scale, Philip (1981), Rodwell’s Hematologic Scoring System (1987), and other previous qualitative studies describing the course of newborn sepsis in infants. The newer laboratory markers for sepsis were not used in the SOS due to the lack of widespread use in clinical practice, high cost of measuring the markers, and their inability to be used as in early diagnosis. This researcher is mostly concerned with finding clinical indicators to be used in the clinical setting, but knowing that laboratory data can influence treatment regimens, a combination tool was developed. The goal of instrument development and testing was to have a tool that is both reliable and valid, and one that will assist the novice or inexperienced nurse in the assessment of newborns for infection.
CHAPTER 3
METHODOLOGY

The purpose of this research was to examine the NICU nurses’ patterns of knowing in the assessment of infants with sepsis, and to test the psychometric properties of the Newborn Scale of Sepsis, a tool for early detection of neonatal sepsis. This chapter describes the methods used to answer the following research questions:

1) What patterns of knowing do NICU nurses use when assessing infants for signs of infection?

2) Do the demographic factors of age and educational level relate to the type of patterns of knowing used by nurses in the NICU?

3) Do four dimensions of nursing experience (total years of nursing experience, years of NICU experience, number of intensive care units the nurse has worked in, and the nurses’ self-rated clinical expertise rating score) relate to the type of patterns of knowing used by nurses in the NICU?

4) What are the psychometric properties of the Newborn Scale of Sepsis (SOS)?

Design

This study was a prospective, descriptive correlational design. Six patterns of knowing used by nurses who work in a Neonatal Intensive Care Unit were examined. The nurses’ experience, age and educational background were correlated with the type of patterns used. The validity and reliability of the SOS as a diagnostic tool for newborn sepsis was also examined in this study.
Sample

Nurses

The sample was a non-probability, convenience sample of nurses working in a NICU or a transition/observation nursery during the study period. The nurses were recruited at a regional neonatal conference and at the nurseries where the Newborn SOS documentation form was used. The sample of 119 nurses completed the Nursing Patterns of Knowing scale (POK). Of the 119 nurses who participated in completing the POK scale, a subsample of 28 of these nurses also participated in the documentation of their assessment utilizing the Newborn SOS.

The nurses completing the newborn SOS scale were experienced nurses with a minimum of two years of NICU experience, and able to complete a thorough assessment of a newborn infant. They also had completed a training class with the principal investigator and were reliable with a percent agreement of 0.96 in the use of the Newborn SOS instrument. All nurses could read and write English.

Infants

The subsample of nurses assessed a total of 62 infants. The infants comprised a non-probability, convenience sample who were admitted to the transition nursery or NICU. The transition nursery is an observation nursery for infants from birth through transition to extrauterine life. This time of transition is usually the first 4-6 hours of life. A subject was any infant who exhibited a sign that could be indicative of infection or had at least one perinatal risk factor for sepsis. The signs of infection are tachypnea, grunting, increased respiratory effort, low temperature, high temperature, change in color, or no
longer interested in nipple feedings. Perinatal risk factors for neonatal sepsis were chorioamnionitis, maternal fever, premature rupture of membranes greater than 18 hours, and cervical culture positive for GBS but untreated. Infants of any gestational age, from extreme prematurity to term, were admitted to the study. Infants were excluded from the study if they had a known intracranial hemorrhage or seizure activity which could have caused some of the signs of infection.

Setting

The nurse subjects were recruited from those nurses who were working in the NICU or transition nursery of a large metropolitan hospital and two smaller community hospitals in southwestern United States. Additional nurse subjects were recruited to take the POK questionnaire from a regional NICU nurses conference. The infant sample was drawn from infants born at the same three hospitals. The three hospitals were in the same hospital system, and had the same population base of 75% Caucasian, 20% Hispanic and 5% Black middle-class Americans. The three hospitals had similar treatment regimens for their newborns. The same physician and neonatal nurse practitioner groups covered the three hospitals.

Human Subjects

The study was reviewed by the University of Arizona Human Subjects Committee and each hospital’s Institutional Review Boards for approval. For nurses participating in the POK scale only, the nurses read a disclaimer prior to filling out the questionnaire (see Appendix B – Subject Disclaimer). Nurses who also agreed to participate in collection of data from newborn observations and recording of the data on the Newborn SOS form
were consented using the Subject consent form (see Appendix B – Subject Consent Form). The consent form for the NICU nurses was obtained during the education sessions during the training period. The consent form for the infant (see Appendix B – Parental Consent Form) was either delivered to the mother’s room after their newborn infant was admitted to the intensive care or transition nurseries or given to the parents upon change in the infant’s condition while a patient in the NICU. The researcher went to the mother’s room, explained the study to the mother and/or father including an explanation of the baby’s need for observation, answered any questions about the study, and obtained written consent. Consent included the use of the tool for assessment of the infant and obtaining information from the medical record of mother and infant.

Description of Instruments

*Nursing POK Scale*

The Nursing POK Scale (see Appendix C) is a new, untested, 16-item norm-referenced instrument developed by the investigator and advisor to facilitate an evaluation of the various ways of knowing nurses use in the NICU setting. The POK is based on patterns of knowing primarily from Carper’s (1978) work; questions on authority (Cohen & Nagel, 1934; Nagel & Brandt, 1965) and White’s (1995) sociopolitical knowing were added to extend Carper’s theory of knowledge development and include ways of knowing that nurse’s may use in assessing patients.

The POK uses a scaled response format instrument that rates the answers to the questions presented from “1 = Not at all” to “5 = All the time”. The scaled response format was selected for its ease of administration. The use of the numerical anchors was
used to facilitate analysis of the data (Waltz, Strickland, & Lenz, 1991). The respondent circles the number that best corresponds to the use of various patterns of knowing used by the nurse in her/his practice as it relates to assessment of infants for serious illness.

The instrument consists of 16 questions relating to the six patterns of knowing in the nursing literature; empirical, aesthetic, personal, ethical, sociopolitical, and authority, and one open-ended question concerning other approaches that may be used in assessing infants. Each of the 16 items can be answered from a score of one to five. The total maximum summed score on the scale is 80. A higher summed score on the scale indicates greater use of a variety of patterns of knowing in nursing practice – in other words a more integrated approach to knowing.

Table 3. Patterns of Knowing (POK) and Related Assessment Question

<table>
<thead>
<tr>
<th>Variable</th>
<th>POK Area</th>
<th>Question No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of physiologic or scientific data</td>
<td>Empirical</td>
<td>1</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>Empirical</td>
<td>8</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>Aesthetic</td>
<td>2</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>Aesthetic</td>
<td>3</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>Aesthetic</td>
<td>4</td>
</tr>
<tr>
<td>Doing what is expedient or necessary</td>
<td>Aesthetic</td>
<td>13</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>Personal</td>
<td>5</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>Personal</td>
<td>6</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>Personal</td>
<td>9</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>Personal</td>
<td>14</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>Ethical</td>
<td>11</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>Ethical</td>
<td>12</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>Sociopolitical</td>
<td>15</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>Sociopolitical</td>
<td>16</td>
</tr>
<tr>
<td>Use of data from those in authority (NNP, MD)</td>
<td>Authority-based</td>
<td>7</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>Authority-based</td>
<td>10</td>
</tr>
</tbody>
</table>
On the POK, there are 2 empirical knowing questions, 4 aesthetic knowing questions, 4 personal knowing questions, 2 ethical knowing questions, 2 sociopolitical knowing questions, and 2 authority-based knowing questions. The six areas of knowing and the questions related to the areas are listed in Table 3. The types and numbers of questions on each topic area provided the researcher with a broad base of knowledge development questions to explore.

**Demographic Questionnaire**

A demographic questionnaire was used to obtain information on age, gender, educational background, years of experience with newborns and years in the NICU. The experience included the number of different NICUs where the nurse had work experience and any newborn nursery experience. The nurse was also asked to rate their expertise with newborn infants on a 5-point scale of Benner’s (1984) novice to expert skill acquisition criteria. The scale was set up so the more experienced nurses had the higher scores. The scale rated the novice = 1, advanced beginner = 2, competent = 3, proficient = 4, and expert = 5.

**Newborn Scale of Sepsis (SOS)**

The Newborn SOS is a new, untested, criterion-referenced instrument based on predetermined criteria or standards seen in the nursing and medical literature. The SOS was developed by the investigator after a qualitative study to examine the early signs of sepsis that the experienced nurses “saw” or experienced during the assessment of infants in the NICU or transition nursery (Rubarth, 2003).
Laboratory Markers

The SOS consists of five laboratory tests and eight clinical indicators for newborn sepsis. A definition of each item on the SOS along with the rating scale and score for each marker are listed in Table 4 and Table 6. The five laboratory tests are: 1) white blood cell count (WBC), 2) Immature-to-Total (I:T) ratio, the ratio of immature neutrophils to the total number of neutrophils as seen on a peripheral smear, 3) platelet count, 4) blood acidity or pH, and 5) absolute neutrophil count (ANC).

Table 4. Laboratory Markers of Sepsis from the Newborn SOS

<table>
<thead>
<tr>
<th></th>
<th>Definitions of Criteria</th>
<th>Rating Scale of Markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WBC</strong></td>
<td>The total number of white blood cells reported on a complete blood count (CBC) as counted by a Coulter counter after the nucleated red blood cells are removed.</td>
<td>&lt; 5,000 = 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5,000 - 30,000 = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 30,000 = 2</td>
</tr>
<tr>
<td><strong>I:T Ratio</strong></td>
<td>The number calculated by taking the reported number (%) of immature neutrophils (bands, metamyelocytes, myelocytes, promyelocytes, blast cells) on a CBC and divide it by the total number (%) of neutrophils reported.</td>
<td>≥ 0.3 = 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 0.2 but &lt; 0.3 = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 0.2 = 0</td>
</tr>
<tr>
<td><strong>Platelet Count</strong></td>
<td>The total number of platelets counted by a Coulter counter.</td>
<td>&lt; 100,000 = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 100,000 = 0</td>
</tr>
<tr>
<td><strong>Blood pH</strong></td>
<td>The acidity of the blood on evaluation of an arterial blood sample.</td>
<td>pH &lt; 7.25 = 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH 7.25-7.34 = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH normal 7.35-7.45 = 0</td>
</tr>
<tr>
<td><strong>ANC</strong></td>
<td>The number of neutrophils reported on a CBC as a percentage of the total number of white blood cells.</td>
<td>&lt;1000 = 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000-2000 = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 2000 = 0</td>
</tr>
</tbody>
</table>
The laboratory markers are obtained from a complete blood count (CBC) and arterial blood gas (ABG). These lab tests, along with a blood culture, are routine laboratory tests obtained on infants with respiratory distress or a prenatal risk for sepsis. The scoring was developed from the literature review and from clinical experience. The three markers of WBC, I:T ratio, and ANC are well-documented signs of newborn sepsis obtained from the CBC. The pH and platelets are less specific for sepsis and also prevalent in other diseases. Therefore, the pH and platelet scores are lower than the CBC markers. The rationale for scoring of the laboratory markers on the Newborn SOS is listed in Table 5.

Table 5. Rationale for Instrument Scoring Levels of Laboratory Markers of Newborn SOS

<table>
<thead>
<tr>
<th>Laboratory Markers</th>
<th>Score</th>
<th>Rationale</th>
</tr>
</thead>
</table>
| WBC                | < 5,000 = 5<br> > 30,000 = 2<br> 5,000-30,000 = 0 | The literature shows that this item is relatively common indicator of sepsis, though not as good at high levels.
| I:T Ratio          | ≥ 0.3 = 5<br> 0.2-0.3 = 3<br> < 0.2 = 0 | The I:T ratio has been used in most studies as an indicator of sepsis, for any level above 0.2, therefore the higher scores for > 0.2.
| Platelet Count     | < 100,000 = 3<br> ≥ 100,000 = 0 | This item is not as common as the CBC indicators for infection.
| Blood pH           | pH < 7.25 = 2<br> pH 7.25-7.34 = 1<br> pH normal 7.35-7.45 = 0 | This item was added during CVI testing, but is more indicative of other diseases than sepsis, therefore not highly rated.
| ANC                | < 1000 = 5<br> 1000-2000 = 3<br> > 2000 = 0 | An excellent indicator in the literature and in this investigator’s clinical experience.

Clinical Indicators

The eight clinical indicators on the Newborn SOS are: 1) skin color, 2) perfusion, 3) muscle tone, 4) response to painful stimuli, 5) respiratory distress, 6) respiratory rate,
7) temperature, and 8) apnea. The clinical indicators are measurable observations obtained during routine nursing care and assessment of an infant (see Table 6).

Table 6. Clinical Indicators of Sepsis from the Newborn SOS

<table>
<thead>
<tr>
<th>Definition of Criteria</th>
<th>Rating Scale of Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin Color</strong></td>
<td>Ashen/Grey = 5</td>
</tr>
<tr>
<td></td>
<td>Dusky = 3</td>
</tr>
<tr>
<td></td>
<td>Mottled = 2</td>
</tr>
<tr>
<td></td>
<td>Acrocyanosis = 1</td>
</tr>
<tr>
<td></td>
<td>Pink = 0</td>
</tr>
<tr>
<td><strong>Perfusion</strong></td>
<td>Poor &gt;7 seconds = 5</td>
</tr>
<tr>
<td></td>
<td>Moderate 6-7 second = 3</td>
</tr>
<tr>
<td></td>
<td>Fair 4-5 seconds = 1</td>
</tr>
<tr>
<td></td>
<td>Good &lt; 4 seconds = 0</td>
</tr>
<tr>
<td><strong>Muscle Tone</strong></td>
<td>Flaccid = 5</td>
</tr>
<tr>
<td></td>
<td>Low tone = 3</td>
</tr>
<tr>
<td></td>
<td>Good tone = 0</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>No response =5</td>
</tr>
<tr>
<td></td>
<td>Mild withdrawal = 2</td>
</tr>
<tr>
<td></td>
<td>Active withdrawal or crying = 0</td>
</tr>
<tr>
<td><strong>Respiratory Distress</strong></td>
<td>Present with grunting = 5</td>
</tr>
<tr>
<td></td>
<td>Present no grunting = 3</td>
</tr>
<tr>
<td></td>
<td>None = 0</td>
</tr>
</tbody>
</table>
Respiratory Rate | The number of times an infant completes a respiratory cycle of inspiration and expiration within one minute. | Respiratory rate ≥ 100 = 5  
RR 60-99 = 3  
RR < 60 = 0
---|---|---
Temperature | An axillary temperature less than 97°F is low in a newborn. An axillary temperature greater than 99°F is high in a newborn. Temperature between these two extremes can be considered within the normal limits. The temperature will be taken by either electronic or mercury thermometers. | Low temp (< 97°F.) = 3  
High temp (> 99°F.) = 2  
Normal (97°-99°F.) = 0
---|---|---
Apnea | The cessation of breathing for greater than 20 seconds. | Present = 2  
Absent = 0
---|---|---

The clinical indicators for newborn sepsis were also assigned by the researcher based on the literature review and clinical experience. The babies with sepsis have a distinct “look” to them, which includes both their color and perfusion. Most infants with sepsis have some respiratory distress with or without apnea. Infants may have high temperatures or low temperatures. Premature infants exhibit apnea to a greater extent than term infants. The rationale for the scoring of the clinical indicators on the Newborn SOS is listed in Table 7.
Table 7. Rationale for Instrument Scoring Levels of Laboratory Markers of Newborn SOS

<table>
<thead>
<tr>
<th>Skin Color</th>
<th>Ashen/Grey = 5</th>
<th>Dusky = 3</th>
<th>Mottled = 2</th>
<th>Acrocyanosis = 1</th>
<th>Pink = 0</th>
<th>Infant are commonly acrocyanotic, sometimes mottled if cold, dusky indicates lack of oxygen (from many causes), but ashen/grey highly indicative.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfusion</td>
<td>Poor &gt;7 seconds = 5</td>
<td>Moderate 6-7 seconds= 3</td>
<td>Fair 4-5 seconds = 1</td>
<td>Good &lt; 4 seconds = 0</td>
<td>Poor perf usion noted in sepsis, so therefore the highest score for the worst perfusion. Mild perfusion problems not a sign of sepsis.</td>
<td></td>
</tr>
<tr>
<td>Muscle Tone</td>
<td>Flaccid = 5</td>
<td>Low tone = 3</td>
<td>Good tone = 0</td>
<td>Poor tone is a good indicator of sepsis from clinical experience, therefore the 5 and 3 scores.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsiveness</td>
<td>No response = 5</td>
<td>Mild withdrawal = 2</td>
<td>Active withdrawal or crying = 0</td>
<td>Responsiveness is a lesser indicator of infection, yet no response could mean sepsis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory Distress</td>
<td>Present with grunting = 5</td>
<td>Present no grunting = 3</td>
<td>None = 0</td>
<td>Significant respiratory distress is an early sign of sepsis in newborns, therefore 5 &amp; 3 scores.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>Respiratory rate ≥ 100 = 5</td>
<td>RR 60-99 = 3</td>
<td>RR &lt; 60 = 0</td>
<td>Respiratory rate again is a common indicator of sepsis or other newborn diseases.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Low temp (&lt; 97° F.) = 3</td>
<td>High temp (&gt; 99° F.) = 2</td>
<td>Normal (97°-99° F.) = 0</td>
<td>High or low temperature can be a normal finding in newborns, so a lesser score was used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apnea</td>
<td>Present = 2</td>
<td>Absent = 0</td>
<td>Apnea is not a common finding in sepsis, but can occur with premature infants. There are many causes of apnea in premature infants.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A numerical rating scale was used to obtain a score for each item. Each item was individually scored between 0 and 5. The items were weighted with the more severe signs of sepsis having the higher scores to reflect the higher predictive ability for sepsis. The 13 item scores are added together to obtain a total score. The maximum score for the
instrument is 55 with 20 for the laboratory markers and 35 for the clinical indicators. A score of zero was given if no markers or indicators were found.

**Face Validity**

The face validity of the instrument was assessed by content experts in the early development of the SOS. The experts were a group of four neonatal nurse practitioners and one physician who specialized in the care of neonates. The content experts assessed the SOS for readability and understanding of the content. They determined that the SOS was easy to read, understandable, and easy to use.

**Content Validity**

Content validity was assessed using a content validity index (CVI) (Hambelton, 1978; Berk, 1980) (see Appendix D). The neonatal experts used the content validity index to evaluate whether the items adequately described the concept of sepsis, and whether any markers or indicators were missing. The five experts evaluated each marker or indicator with one of four options: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, or 4 = very relevant. All five experts scored each item from 1 through 4. From the forms, a CVI was calculated, which includes the number of perceived relevant items to the total number of items as a percentage (Lynn, 1985). Items scored as a 3 or 4 were perceived as relevant to the concept of sepsis. Items scored as a 1 or 2 were perceived as not being relevant to the experts. The total relevant items for each expert were divided by the total number of items on the scale. Content validity for the entire scale was 0.77; the item scores ranged from 0.50-1.00. One expert suggested the addition of blood pH as an indicator of sepsis. This marker was added to the scale prior to CVI testing. The experts
also suggested separating muscle tone and responsiveness to pain, as two separate indicators. This was done prior to human subjects review and testing of the instrument.

Training of Data Collectors for the Newborn SOS Instrument

The investigator trained 28 registered nurses at three facilities. The investigator explained the purpose of the study to the registered nurses (RNs) who worked in the nurseries, trained them on the use of the SOS and conducted reliability testing with each nurse prior to the start of data collection. The training of the nursing staff in the nurseries included a review of the signs of sepsis and the definitions used for each clinical indicator on the Newborn SOS. Each RN who participated in data collection observed the investigator performing an assessment on two infants. Then, the RN participated in reliability testing by having the investigator complete the SOS on an infant at the same time as the RN completed the assessment. The percent agreement or interrater reliability between the two observers was measured at 96.3%. The time needed to complete the training and interrater reliability with the researcher was approximately 20-30 minutes.

Data Collection Procedure

Nursing POK Scale

The data collection process for the Nursing Patterns of Knowing scale was two-fold. A large number of the scales with demographic questionnaires were distributed at a regional NICU nurses conference held in October, 2004. The scales and questionnaires were distributed to all attendees at the conference upon registration with the subject disclaimer form. Nurses who worked in an NICU were asked to fill out the forms and
return them to the researcher at the end of the conference. Nurses who had participated in the SOS data collection training at the three local facilities were also asked to complete the POK scale and demographic questionnaire.

*Newborn SOS Instrument*

Data for the Newborn SOS scale were collected at three facilities. Infant data were gathered using the Newborn SOS and the Infant Demographic Data Form which included demographic data obtained from the infant’s medical record (see Appendix C). Demographic data included information about the pregnancy, labor, delivery, and specific prenatal risk factors associated with neonatal sepsis.

The nurse in the transition nursery evaluated each infant using the Newborn SOS as part of admission process. In the NICU, the nurse completed a Newborn SOS as part of the assessment process when an infant’s condition changed. All infants were undressed and assessed in a warm environment. The assessment was done under a radiant warmer or in an incubator with overhead lighting. Adequate lighting is essential for color assessment.

Nurses used the scale on each infant for up to three assessments following the initial assessment. Each infant in the transition nursery was evaluated on the scale hourly until the infant: 1) worsened and was transferred into the Neonatal Intensive Care Unit for hood oxygen or ventilation, 2) started on antibiotics, or 3) transferred back to the couplet care or postpartum units. Infants in the NICU had one or more scales completed if their condition continued to deteriorate. Only one SOS was completed if the condition remained stable. The laboratory results (CBC, differential, blood gas pH and blood
culture) were recorded on the scale by the researcher or nursing staff when the values became available.

There were 28 nurses who completed both the Nursing POK Scale and the Newborn SOS. These 28 nurses also completed additional information on the demographic questionnaire where they were asked to rate the Newborn SOS on ease of use, clinical use in picking up signs of sepsis, and to comment on any other issues with using the instrument.

Summary

The two instruments used in this study were the Nursing Patterns of Knowing Scale (POK) and the Newborn Scale of Sepsis (SOS). Demographic information was collected on both the nurses and the infants in the study. The methods used to collect data for this study were based on the nursing assessment of newborn infants in the nursery and NICU. The knowledge the nurses incorporate into their clinical practice is used to continually evaluate their patients in the NICU. It’s important to examine how the nurses ascertain the knowledge and how it becomes part of their clinical and experiential knowledge base. It is the clinical experience and knowledge base which continues the progress of making the novice nurse into an expert nurse.
CHAPTER 4

RESULTS

The purpose of this research study was to examine Neonatal Intensive Care Unit (NICU) nurses’ patterns of knowing in the assessment of infants with sepsis, and to test the psychometric properties of the Newborn Scale of Sepsis (SOS) as a diagnostic or assessment tool.

Description of Sample

NICU Nurses Taking the POK

One hundred and nineteen nurses participated in filling out the questionnaire called the Nursing Patterns of Knowing Scale (POK). Of the 119 nurses, 28 of them also participated in the documentation of their infant assessments on the Newborn Scale of Sepsis (SOS). All subjects were NICU nurses, but ten (8.4%) were also neonatal nurse practitioners (NNPs) and four (3.4%) were NNP students. One hundred and eighteen nurses were female and one was male. The nurses in this study ranged in age between from 22 years to 64 years with a mean age of 41.5 years (see Table 8 for distribution by age group). Three nurses did not report their age.

Table 8. Participants by Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-29 years</td>
<td>22</td>
<td>18.5</td>
</tr>
<tr>
<td>30-39 years</td>
<td>27</td>
<td>23.3</td>
</tr>
<tr>
<td>40-49 years</td>
<td>36</td>
<td>31</td>
</tr>
<tr>
<td>50-59 years</td>
<td>26</td>
<td>22.4</td>
</tr>
<tr>
<td>60-64 years</td>
<td>5</td>
<td>4.3</td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The nurses had various levels of education, from licensed practical nurse to registered nurse with a master’s degree (see Table 9). The nurses’ years of education ranged from 1 year to 16.5 years post high school with a mean of 4.7 years.

Table 9. Highest Educational Level Achieved by Nurse Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensed Practical Nurse (LPN)</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Associates Degree Nurse (AND)</td>
<td>35</td>
<td>29.4</td>
</tr>
<tr>
<td>Diploma</td>
<td>15</td>
<td>12.6</td>
</tr>
<tr>
<td>Bachelor of Science in Nursing (BSN)</td>
<td>52</td>
<td>43.7</td>
</tr>
<tr>
<td>Bachelor of Science (other)</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Master of Science in Nursing (MS/MSN)</td>
<td>12</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>119</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The nurses had varying levels of nursing experience both in the NICU and other nursing experience. Years of nursing experience ranged from 3 months to 42 years with a mean of 16.6 years. Years of NICU nursing experience ranged from 3 months to 42 years with a mean of 11 years. Experience in a regular newborn nursery gives the nurse experience with well newborns. Years of newborn nursery experience (not NICU) ranged from none to 37 years with a mean of 3 years. The nurses also were asked the number of different NICUs that they had worked in to get another idea of their experiences. The number of NICUs ranged from one to 16, with a mean of 3 (see Table 10).
Table 10. Nursing, Newborn Nursery and NICU Experience

<table>
<thead>
<tr>
<th>Variable</th>
<th>N = 119</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>Years of Nursing Experience</td>
<td>16.6</td>
<td>11.6</td>
<td>0.3-42</td>
</tr>
<tr>
<td>Years of NICU Experience</td>
<td>11.0</td>
<td>10.2</td>
<td>0-42</td>
</tr>
<tr>
<td>Years of Newborn Nursery Experience</td>
<td>3.0</td>
<td>7.7</td>
<td>0-37</td>
</tr>
<tr>
<td>Number of Different NICUs Worked In</td>
<td>3.0</td>
<td>2.7</td>
<td>1-16</td>
</tr>
</tbody>
</table>

The nurses rated themselves on their clinical expertise with newborn infants based on Benner’s (1984) novice to expert clinical skills acquisition criteria. Nine respondents rated themselves as novices (7.6%), nineteen rated themselves as competent (16%), 61 rated themselves as proficient (51.3%), and 25 rated themselves as expert (21%) (see Table 11). The mean rating was 3.8 placing it in the competent to proficient range.

Table 11. Clinical Expertise Self-Rating of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novice</td>
<td>9</td>
<td>7.6</td>
</tr>
<tr>
<td>Advanced Beginner</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Competent</td>
<td>19</td>
<td>16.0</td>
</tr>
<tr>
<td>Between Competent &amp; Proficient</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Proficient</td>
<td>61</td>
<td>51.3</td>
</tr>
<tr>
<td>Between Proficient &amp; Expert</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
<td>Expert</td>
<td>25</td>
<td>21.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>119</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Mean = 3.8           SD = 1.0

NICU Nurses Sub-Sample Completing SOS Scales on Infants

Twenty eight nurses completed the Newborn SOS on 62 infants. The infants were enrolled in the study to test the new instrument Newborn Scale of Sepsis (SOS) from
November, 2003-December, 2004. The infant’s gestational age ranged from 23 to 41 weeks with birth weight from 610 grams to 4250 grams (see Table 12). Of the 62 infants, 15 were preterm infants (24.2%), 12 were near term infants (19.4%), and 34 were term infants (54.8%). About half of the infants in the study were born by Cesarean section (41.9%), half by vaginal delivery (43.5%), with 14.6% missing data. Maternal risk factors for the infants enrolled in the study are listed in Table 13.

Table 12. Infant Demographic Data

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational Age (weeks)</td>
<td>35.2</td>
<td>5.2</td>
<td>23 - 41.3</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>2475</td>
<td>1071</td>
<td>610 – 4250</td>
</tr>
<tr>
<td>Initial Apgar</td>
<td>7.8</td>
<td>1.4</td>
<td>3 – 9</td>
</tr>
<tr>
<td>Five Minute Apgar</td>
<td>8.6</td>
<td>0.7</td>
<td>6 – 10</td>
</tr>
<tr>
<td>Ruptured Membranes (hours)</td>
<td>5.1</td>
<td>9.9</td>
<td>0 – 60</td>
</tr>
</tbody>
</table>

Table 13. Percentage of Infants with Maternal Risk Factors

<table>
<thead>
<tr>
<th>Maternal Risk Factors</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesarean Section Delivery</td>
<td>41.9</td>
</tr>
<tr>
<td>Vaginal Delivery</td>
<td>43.5</td>
</tr>
<tr>
<td>Signs of Chorioamnionitis</td>
<td>4.8</td>
</tr>
<tr>
<td>Foul-smelling amniotic fluid</td>
<td>1.6</td>
</tr>
<tr>
<td>Maternal Fever at Delivery</td>
<td>16.1</td>
</tr>
<tr>
<td>Maternal Antibiotics Given prior to Delivery</td>
<td>38.7</td>
</tr>
<tr>
<td>Presence of a Urinary Tract Infection</td>
<td>1.6</td>
</tr>
<tr>
<td>Positive GBS Status</td>
<td>16.1</td>
</tr>
<tr>
<td>Use of Internal Monitor</td>
<td>0.0</td>
</tr>
<tr>
<td>Meconium Stained Amniotic Fluid</td>
<td>4.8</td>
</tr>
<tr>
<td>Meconium Aspiration</td>
<td>1.6</td>
</tr>
<tr>
<td>Epidural Anesthesia</td>
<td>43.5</td>
</tr>
</tbody>
</table>
Research Question #1:

What patterns of knowing do NICU nurses use when assessing infants for signs of infection?

*Nursing Patterns of Knowing Scale (POK)*

The psychometric properties of the scale were examined in tandem with analysis of the research question. The total POK scores ranged from 41 to 80 with a mean of 58.09 and a standard deviation of 7.8. The possible range on the scale was 16 to 80.

*Psychometric Properties*

*Reliability assessment.* The assessment of reliability focused on internal consistency, which refers to the average correlation among test items (Nunnelly, 1994). Cronbach’s alpha was used to determine the internal consistency of the nursing POK scale. The reliability coefficient of the 16 item POK scale was 0.82. Inter-item correlations for the individual items on the scale were between -0.03 and 0.62, with a standard acceptable range of 0.30-0.70. Some of the items were not in the acceptable range. However, the item-to-scale correlations are all well above the recommended level of > 0.30 and are listed in Table 14 (Zeller & Carmines, 1980). There is reduced variability of the individual items due to skewed scores, but optimal variance on the total scale. There is good stability of the individual items and the total scale.
Table 14. Item-to-Scale Correlations of Each POK Item

<table>
<thead>
<tr>
<th>Variables</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of physiologic or scientific data</td>
<td>.33</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>.42</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>.36</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>.58</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>.63</td>
</tr>
<tr>
<td>Doing what is expedient or necessary</td>
<td>.63</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>.70</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>.56</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>.58</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>.60</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>.55</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>.64</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>.50</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>.44</td>
</tr>
<tr>
<td>Use of data from those in authority (NNP, MD)</td>
<td>.39</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>.35</td>
</tr>
</tbody>
</table>

**Validity assessment.** Validity is a crucial factor in the use of instruments because it concerns the extent to which the instrument measures what it is intended to measure (Lynn, 1985). The Nursing POK scale was developed from the theoretical literature on knowledge development. The scale includes six areas of knowledge development, therefore has face validity in that there is a full-range of items being used to test ways of knowing. The nursing POK was examined by the advisor who is an expert in the field of epistemology and nursing. Construct validity can be determined using factor analysis (Walsh, Strickland & Lenz, 1991). The validity of the POK was assessed based on the theoretical framework of knowledge development and factor analysis. All factors loaded together on the factor analysis of the instrument, thereby agreeing with the hypothesized theory that the instrument measures only one concept – that of nursing patterns of
knowing. The patterns of knowing are interrelated as theorized. Construct validity was supported in part by the significant positive correlation between POK scores and years of NICU experience and clinical expertise rating, indicating that a higher level of integrated patterns of knowing is associated with years of clinical experience as theorized based upon Carper (1978) and Benner’s (1984) theories.

Assessing for normalcy. As expected, the demographic variables are not normally distributed when looking at skewness, kurtosis, Q-Q scatterplots and histogram evaluations. The individual question scores are mostly skewed to the left (higher scores) as would be indicated by the negative skewness on all questions except “use of research-based information” which has a normal distribution, and “use of social atmosphere of unit” and “use of political climate of unit”, both of which are positively skewed (indicating lower scores). The total POK scores show normal distribution based on skewness of 0.06, kurtosis of -0.04 and histogram evaluation.

Nursing POK Data

The mean, standard deviation (SD) and range of each individual question on the Nursing POK is listed in Table 15.
Table 15. Summary of Patterns of Knowing (POK) Scores for Individual Questions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of physiologic or scientific data</td>
<td>4.8</td>
<td>.38</td>
<td>4-5</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>3.3</td>
<td>.95</td>
<td>2-5</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>4.4</td>
<td>.68</td>
<td>2-5</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>3.7</td>
<td>.95</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>4.3</td>
<td>.90</td>
<td>1-5</td>
</tr>
<tr>
<td>Doing what is expedient or necessary</td>
<td>3.7</td>
<td>1.08</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>3.6</td>
<td>1.02</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>3.9</td>
<td>.97</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>3.4</td>
<td>.95</td>
<td>2-5</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>3.0</td>
<td>1.25</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>3.9</td>
<td>.94</td>
<td>1-5</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>4.0</td>
<td>1.03</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>1.8</td>
<td>.97</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>2.0</td>
<td>1.03</td>
<td>1-5</td>
</tr>
<tr>
<td>Use of data from those in authority</td>
<td>4.2</td>
<td>.71</td>
<td>2-5</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>4.2</td>
<td>.90</td>
<td>1-5</td>
</tr>
<tr>
<td><strong>Total Patterns of Knowing Scores</strong></td>
<td><strong>58.09</strong></td>
<td><strong>7.81</strong></td>
<td><strong>41-80</strong></td>
</tr>
</tbody>
</table>

There were questions with missing data. The questions left unanswered by participants were “use of personal knowledge of self” (5%), “use of empathy” (2.5%), “use of previous clinical experience” (<1%), “use of input from parents” (<1%), and “evaluation of consequences of actions” (<1%).

On evaluating the data from the POK scale, the NICU nurses used authority, empirical and aesthetic ways of knowing most often in their assessment of sick infants. Ethical and personal knowledge was used to a lesser extent and sociopolitical knowing was used least often (see Table 16).
Table 16. Mean Score of Each Patterns of Knowing (POK) in NICU Nurses

<table>
<thead>
<tr>
<th>Grouped Variables by Pattern</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical</td>
<td>4.07</td>
<td>0.54</td>
<td>2-5</td>
</tr>
<tr>
<td>Aesthetic</td>
<td>4.04</td>
<td>0.64</td>
<td>1-5</td>
</tr>
<tr>
<td>Personal</td>
<td>3.49</td>
<td>0.75</td>
<td>1-5</td>
</tr>
<tr>
<td>Ethical</td>
<td>3.90</td>
<td>0.86</td>
<td>1-5</td>
</tr>
<tr>
<td>Sociopolitical</td>
<td>1.86</td>
<td>0.90</td>
<td>1-5</td>
</tr>
<tr>
<td>Authority</td>
<td>4.15</td>
<td>0.65</td>
<td>1-5</td>
</tr>
</tbody>
</table>

Research Question #2:

Do the demographic factors of age and educational level relate to the type of patterns of knowing used by nurses in the NICU?

The relationship between the NICU nurses’ age and educational level and the type of patterns of knowing used in assessment of newborns was investigated using Pearson product-moment correlation coefficient for the nurses’ age and Spearman’s rank order correlation for the educational level data. The patterns of knowing were examined individually and grouped together into the six types of patterns of knowing.

The correlation between the nurses’ age and empirical knowing was .23 (p < .05), and between age and aesthetic knowing was .24 (p < .05). This indicates that the older the nurses were, the more they used empirical and aesthetic knowing. The correlation between nurses’ age and the use of personal experiences was .22 (p < .02) and between age and previous clinical experiences was .38 (p < .01) indicating that older nurses used more personal and clinical experiences in their assessments of newborns for signs of serious/illness/infection. The correlation between nurses’ age and use of research-based information was .20 (p < .03), indicating nurses use of research increases with age. The
total POK score was not significantly correlated with the age of the nurse (see Table 17).

With removal of the authority-based and socio-political items, there was a significant correlation between age and the POK scale \((r = .23, p < .05)\).

The correlation between the nurses’ educational level and use of research-based information was \(.18\) \((p < .05)\). There were no other significant correlations with any of the patterns of knowing, individual items/questions, total POK score and the nurses’ educational level (see Table 17).

Table 17. Correlations of Types of Patterns of Knowing with Age & Educational Level of Nurses

<table>
<thead>
<tr>
<th>Type of Knowing</th>
<th>Age</th>
<th>Educational Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical Knowing (Mean)</td>
<td>.23*</td>
<td>.12</td>
</tr>
<tr>
<td>Use of physiologic or scientific data</td>
<td>.14</td>
<td>-.09</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>.20*</td>
<td>.18*</td>
</tr>
<tr>
<td>Aesthetic Knowing (Mean)</td>
<td>.24*</td>
<td>.06</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>.15</td>
<td>.07</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>.11</td>
<td>.06</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>.38**</td>
<td>.06</td>
</tr>
<tr>
<td>Doing what is expedient or necessary</td>
<td>.05</td>
<td>.00</td>
</tr>
<tr>
<td>Personal Knowing (Mean)</td>
<td>.18</td>
<td>.03</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>.14</td>
<td>.01</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>.09</td>
<td>.01</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>.02</td>
<td>.00</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>.22*</td>
<td>.12</td>
</tr>
<tr>
<td>Ethical Knowing (Mean)</td>
<td>.08</td>
<td>.10</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>.07</td>
<td>.15</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>.07</td>
<td>.02</td>
</tr>
<tr>
<td>Sociopolitical Knowing (Mean)</td>
<td>- .06</td>
<td>.14</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>-.06</td>
<td>.16</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>-.06</td>
<td>.11</td>
</tr>
<tr>
<td>Authority-based Knowing (Mean)</td>
<td>-.07</td>
<td>-.09</td>
</tr>
<tr>
<td>Use of data from those in authority (NNP, MD)</td>
<td>-.01</td>
<td>-.07</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>-.10</td>
<td>-.10</td>
</tr>
<tr>
<td><strong>Total POK Scale</strong></td>
<td>.17</td>
<td>-.01</td>
</tr>
</tbody>
</table>

* \( p < 0.05 \); ** \( p < 0.01 \)
Research Question #3:

Do four dimensions of nursing experience (total years of nursing experience, years of NICU experience, number of intensive care units the nurse has worked in, and the nurses’ self-rated clinical expertise rating score) relate to the type of patterns of knowing used by nurses in the NICU?

The relationship between nurses’ years of experience and their use of patterns of knowing was investigated using Pearson product-moment correlation coefficient. This correlation procedure was chosen due to the fact that the variables were normally distributed, there was no violation of the assumptions of linearity and homoscedasticity. There was no correlation noted between these two variables although the relationship was in the expected direction \( r = .14, n = 119, p = .12 \), noting that there is no significant correlation between the nurses’ total years of experience and whether they use more patterns of knowing in their assessment of infants (see Table 18). With the scale reduced to Carper’s (1978) subscale, there was a significant correlation between overall years of experience and the Total POK scores \( r = .23, p < .05 \).

Besides the nurses’ overall years of nursing experience, three other variables were noted by the researcher as relating to the nurses’ experience level. These were the nurses’ years of experience in the NICU, the number of different NICUs the nurse had worked in, and the nurses’ own rating of her/his clinical expertise. The relationship between these four dimensions of experience (the nurses’ overall years of nursing experience, the nurses’ years of experience in the NICU, the number of different NICUs worked in, and
the clinical expertise self-rating) and the use of types of patterns of knowing was investigated using Pearson product-moment correlation coefficient. There was a significant positive correlation between the total POK scale scores and the nurses’ NICU experience, experience in different NICUs, and their self-rating of clinical expertise (see Table 18). All four aspects of nursing experience were shown to be related to the use of multiple patterns of knowing when only Carper’s subscale was used.

Table 18. Correlation Coefficients of Dimensions of Experience & Total POK Scores

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of Nursing Experience</td>
<td>.14</td>
<td>.12</td>
</tr>
<tr>
<td>Years of NICU Experience</td>
<td>.20*</td>
<td>.03</td>
</tr>
<tr>
<td>Different NICUs Experienced</td>
<td>.19*</td>
<td>.04</td>
</tr>
<tr>
<td>Clinical Expertise Self-rating</td>
<td>.26**</td>
<td>.00</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01

The relationship of the nurses’ experience (total nursing, NICU experience, different NICUs experienced and clinical expertise self-rating) to the different types of knowing (empirical, aesthetic, personal, ethical, sociopolitical and authority-based) was also investigated. Each bivariate correlation was completed using Pearson product-moment correlation coefficient. The correlation coefficients for each of the variables are listed in Table 19 and Table 20.
Table 19. Correlations of Types of Patterns of Knowing and Nurses’ Years of Experience

<table>
<thead>
<tr>
<th></th>
<th>Years Nursing Experience</th>
<th>Years NICU Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Empirical Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>.20*</td>
<td>.21*</td>
</tr>
<tr>
<td>Use of physiologic or scientific data</td>
<td>.06</td>
<td>.12</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>.20*</td>
<td>.19*</td>
</tr>
<tr>
<td><strong>Aesthetic Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>.24*</td>
<td>.31**</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>.13</td>
<td>.17</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>.11</td>
<td>.26**</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>.39**</td>
<td>.39**</td>
</tr>
<tr>
<td>Doing what is expedient or necessary</td>
<td>.05</td>
<td>.07</td>
</tr>
<tr>
<td><strong>Personal Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>.17</td>
<td>.23*</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>.15</td>
<td>.16</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>.08</td>
<td>.10</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>.02</td>
<td>.08</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>.22*</td>
<td>.27**</td>
</tr>
<tr>
<td><strong>Ethical Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>.08</td>
<td>.09</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>.06</td>
<td>.05</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>.09</td>
<td>.11</td>
</tr>
<tr>
<td><strong>Sociopolitical Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>-.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>-.06</td>
<td>-.00</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>-.06</td>
<td>-.06</td>
</tr>
<tr>
<td><strong>Authority-based Knowing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mean)</td>
<td>-.18*</td>
<td>-.15</td>
</tr>
<tr>
<td>Use of data from those in authority (NNP, MD)</td>
<td>-.08</td>
<td>-.02</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>-.21*</td>
<td>-.20*</td>
</tr>
<tr>
<td>Total POK Scale</td>
<td>.14</td>
<td>.20*</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01

*Nurses Overall Years of Experience*

The correlation between years of nursing experience and empirical knowing was \( r = .20 \) (\( p = .03 \)), between years of experience and aesthetic knowing was \( r = .24 \) (\( p = .01 \)), and between years of experience and authority-based knowing was \( r = -.18 \) (\( p < .05 \)). This indicates that nurses with greater number of years of total nursing experience use more empirical, aesthetic and authority-based knowing. On the individual items of the POK scale, there was a correlation between years of total nursing experience and “use of
research-based information’’ (r = .20, p < .05), “use of previous clinical experiences” (r = .39, p < .01), “use of own personal experiences” (r = .22, p < .05), and a negative correlation with “use of nursing policies and procedures” (r = -.21, p < .05) (see Table 19).

**Nurses Years of NICU Experience**

The correlation between years of NICU experience and empirical knowing was r = .21 (p < .05), between years of NICU experience and aesthetic knowing was r = .31 (p < .01), between years of NICU experience and personal knowing was r = .23 (p < .05), and between years of NICU experience and authority-based knowing was r = -.18 (p < .05). This indicates that nurses with a greater number of years experience in the NICU use more empirical, aesthetic, and personal knowing and less authority-based knowing than nurses with less years of experience in the NICU. Both authority-based knowing and sociopolitical knowing had negative correlations, though the questions on sociopolitical knowing were not correlated at a significant level. There was a significant correlation between years of experience and the total POK scale with a correlation coefficient of r = .20 (p < .05), indicating nurses with more years of NICU nursing experience use more integrated patterns of knowing (see Table 19).

The highest significant correlations on individual items with years of NICU experience were “use of intuition or ‘gut’ feelings”, “use of previous clinical experiences”, “use of own personal experiences”, and “use of research-based information”. There was a negative correlation of “use of nursing policies and procedures” with years of NICU experience (see Table 19).
Table 20. Correlations of Types of Patterns of Knowing with Different NICU Experiences & Nurses’ Clinical Expertise

<table>
<thead>
<tr>
<th></th>
<th>No. of Different NICUs</th>
<th>Clinical Expertise Self-Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Empirical Knowing (Mean)</strong></td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Use of physiologic or scientific data</td>
<td>.06</td>
<td>.16</td>
</tr>
<tr>
<td>Use of research-based information</td>
<td>.02</td>
<td>.19*</td>
</tr>
<tr>
<td><strong>Aesthetic Knowing (Mean)</strong></td>
<td></td>
<td>.24**</td>
</tr>
<tr>
<td>Use of habits or routines</td>
<td>.05</td>
<td>.18</td>
</tr>
<tr>
<td>Use of intuition or “gut feelings”</td>
<td>.16</td>
<td>.34**</td>
</tr>
<tr>
<td>Use of previous clinical experiences</td>
<td>.28**</td>
<td>.48**</td>
</tr>
<tr>
<td>Do what is expedient or necessary</td>
<td>.20*</td>
<td>.09</td>
</tr>
<tr>
<td><strong>Personal Knowing (Mean)</strong></td>
<td></td>
<td>.10</td>
</tr>
<tr>
<td>Use of your personal knowledge of self</td>
<td>.16</td>
<td>.21*</td>
</tr>
<tr>
<td>Use of empathy</td>
<td>-.13</td>
<td>.03</td>
</tr>
<tr>
<td>Use of input from parents</td>
<td>.09</td>
<td>.11</td>
</tr>
<tr>
<td>Use of your own personal experiences</td>
<td>.15</td>
<td>.26**</td>
</tr>
<tr>
<td><strong>Ethical Knowing (Mean)</strong></td>
<td></td>
<td>.07</td>
</tr>
<tr>
<td>Use of ethical judgment</td>
<td>.03</td>
<td>.18</td>
</tr>
<tr>
<td>Evaluation of consequences of actions</td>
<td>.10</td>
<td>.12</td>
</tr>
<tr>
<td><strong>Sociopolitical Knowing (Mean)</strong></td>
<td>.22*</td>
<td>-.03</td>
</tr>
<tr>
<td>Use of social atmosphere of unit</td>
<td>.18*</td>
<td>-.01</td>
</tr>
<tr>
<td>Use of political climate of unit</td>
<td>.22*</td>
<td>-.04</td>
</tr>
<tr>
<td>Authority-based Knowing (Mean)</td>
<td>-.03</td>
<td>-.06</td>
</tr>
<tr>
<td>Use of data from those in authority (NNP, MD)</td>
<td>-.04</td>
<td>.01</td>
</tr>
<tr>
<td>Use of nursing policies &amp; procedures</td>
<td>-.02</td>
<td>-.10</td>
</tr>
<tr>
<td>Total POK Scale</td>
<td></td>
<td>.17</td>
</tr>
</tbody>
</table>

* p < 0.05;  ** p < 0.01

**Number of Different NICUs Worked In**

The correlation between the number of different NICUs the nurse worked in during her career and aesthetic knowing was .24 (p < .01) and between the number of different NICUs and sociopolitical knowing was .22 (p < .05). This indicates that greater the number of NICUs a nurse works in, the more they use aesthetic and sociopolitical
knowing. There was no correlation between number of NICUs worked in and the Total POK score (see Table 20).

Of the individual items, there was a significant correlation between number of different NICUs and “use of previous clinical experiences”, “doing what is expedient or necessary”, “use of social atmosphere of unit” and “use of political climate of unit” (see Table 20).

Self-Rated Clinical Expertise

The correlation between the nurses’ self-rated clinical expertise and empirical knowing was .22 (p < .05), between nurses’ self-rated clinical expertise and aesthetic knowing was .38 (p < .01), and between nurses’ self-rated clinical expertise and personal knowing was .22 (p < .05). This indicates that the higher the nurses’ clinical expertise rating, the more they use empirical, aesthetic, and personal knowing. There was no correlation between nurses’ clinical expertise rating and the Total POK score (see Table 20).

Of the individual items, there was a significant correlation between clinical expertise rating and “use of research-based information”, “use of previous clinical experiences”, “use of previous clinical experiences”, “use of personal knowledge of self”, and “use of own personal experiences” (see Table 20).

Neonatal Nurse Practitioner Correlations

One other demographic item of interest to this investigator was the variable of whether the nurse was also a neonatal nurse practitioner (NNP). Being an NNP was negatively correlated with the use of authority-based knowing (r = -.38, p < .01), based
on correlation with both factors under authority-based knowing. The two items were the use of nursing policies and procedures (r = - .37, p < .01) and use of data from those in authority like MDs, NNPS (r = - .22, p < .05). Also, being an NNP was positively correlated with clinical expertise rating (r = .27, p < .01), with the “use of research-based information” (r = .23, p < .05), and the “use of personal experiences” influencing their assessments (r = .31, p < .01).

Research Question #4:

What are the psychometric properties of the Newborn Scale of Sepsis (SOS)?

The total Newborn SOS scores ranged from zero to 37. There were 81 scorings done on the 62 infants in the study.

Reliability of the SOS

Internal Consistency

Internal consistency was determined using Cronbach’s formula for coefficient alpha for the Newborn SOS. Cronbach’s alpha is based on the consistency of responses to all items; therefore the more homogeneous the domain of newborn sepsis, the higher the consistency. Internal consistency, though not essential for a criterion-referenced instrument, due to the theoretical assumptions of the instrument as a complete tool for the concept of sepsis, was tested to assure consistency. The criterion for internal consistency of new instruments is 0.70 or higher. In the current study on the Newborn SOS, the Cronbach alpha coefficient was 0.65.
**Interrater Reliability**

Interrater reliability or the stability of the Newborn SOS was determined during the initial phase of the study using interrater agreement or percent agreement. Percent agreement overestimates the interrater agreement, therefore, a percent agreement > 0.9 was the goal of this test of reliability of the screeners. The nurses who completed the Newborn SOS were trained by the principal investigator. Interrater reliability testing was done between the investigator and the nurses using the assessment tool in the nurseries to assure reliable data collection by the nurses. The closer the ratio is to 1.00, the higher the degree of consistency of classifications for the instrument. The percent agreement on the Newborn SOS between the researcher and the nurse subjects was 96.3%, well above the goal for the study.

**Validity of the SOS**

**Face Validity**

The face validity of the instrument was assessed by content experts in the early development of the SOS. The experts were a group of four neonatal nurse practitioners and one physician who specialized in the care of neonates. The content experts assessed the SOS for readability and understanding of the content. They determined that the SOS was easy to read, understandable, and easy to use.

**Content Validity**

Content validity was assessed using a content validity index (CVI) (Hambelton, 1978; Berk, 1980) (see Appendix D). The neonatal experts used the content validity index to evaluate whether the items adequately described the concept of sepsis, and
whether any markers or indicators were missing. The five experts evaluated each marker or indicator with one of four options: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, or 4 = very relevant. All five experts scored each item from 1 through 4. From the forms, a CVI was calculated, which includes the number of perceived relevant items to the total number of items as a percentage (Lynn, 1985). Items scored as a 3 or 4 were perceived as relevant to the concept of sepsis. Items scored as a 1 or 2 were perceived as not being relevant to the experts. The total relevant items for each expert were divided by the total number of items on the scale. Content validity for the entire scale was 0.77; the item scores ranged from 0.50-1.00. One expert suggested the addition of blood pH as an indicator of sepsis. This marker was added to the scale prior to CVI testing. The experts also suggested separating muscle tone and responsiveness to pain, as two separate indicators. This was done prior to human subjects review and testing of the instrument.

Predictive Validity

Predictive validity of the SOS focused on the sensitivity and specificity of the instrument for newborn sepsis. Sensitivity is the ability to make the correct diagnosis of neonatal sepsis by the SOS score in confirmed positive cases of the disease (with a positive blood culture). Specificity is the ability to make a correct diagnosis of not having sepsis by the SOS score when the baby’s blood culture is negative.

Fifteen infants (24.2%) of the infants had positive blood cultures and 47 (75.8%) had negative blood cultures (or no growth). Eighty percent (12/15) of the preterm infants with symptoms had a positive blood culture, 8.3% (1/12) of the near term infants had a
positive blood culture, and 5.8% (2/34) of the term infants had a positive blood culture (Table 21).

Table 21. Total SOS Scores

<table>
<thead>
<tr>
<th>Blood Culture Result</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Growth (n = 47)</td>
<td>10.11</td>
<td>6.25</td>
<td>0 - 25</td>
</tr>
<tr>
<td>Positive Culture (n = 15)</td>
<td>19.07</td>
<td>8.82</td>
<td>7 - 37</td>
</tr>
</tbody>
</table>

Various cut-off points were used during the process of data analysis to determine the sensitivity and specificity of the data collected. The investigator experimented with different cut points to assess the best sensitivity and specificity for this instrument. The final cut point was selected based on its relative high sensitivity and specificity (see Table 22). A high sensitivity provides the clinician with almost all the true positives without missing cases of true sepsis. Initially, the cut point was selected to achieve 95% sensitivity, but this was determined to be too high due to the very low specificity achieved. The cut point was thought to be the point at which a clinician would begin treatment based on the baby’s risk of sepsis from the scores the infant received on the tool. The higher the score on the neonatal SOS, the higher would be the infants’ risk of sepsis, and therefore, treatment with antibiotics could be initiated for scores above a certain level in order to prevent neonatal morbidity and mortality.
Table 22. Sensitivity, Specificity, Positive and Negative Predictive Values for SOS Scale

<table>
<thead>
<tr>
<th>Cut-Point ≥ 10</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>93%</td>
<td>47%</td>
<td>29%</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>Cut-Point ≥ 14</td>
<td>73%</td>
<td>70%</td>
<td>35%</td>
<td>92%</td>
</tr>
<tr>
<td>Cut-Point ≥ 15</td>
<td>67%</td>
<td>73%</td>
<td>36%</td>
<td>90.5%</td>
</tr>
</tbody>
</table>

PPV = Positive Predictive Value; NPV = Negative Predictive Value

Predictive validity was also assessed by positive and negative predictive values. A positive predictive value (PPV) was the proportion of newborns with a positive SOS score (above the cut point) who actually had sepsis. A negative predictive value (NPV) was the proportion of newborns with a negative SOS score (below the cut point) who actually did not have sepsis. Along with sensitivity and specificity, the PPV and NPV tested the validity of the SOS. The positive blood culture is the “gold standard” for sepsis, and was used as the positive marker of disease.

Additional Analysis

Qualitative Analysis of the Comments on the POK

Qualitative evaluation using content analysis of the comments the nurses made on the questionnaires was also done. The evaluation looked at patterns and specific comments about individual patterns of knowing.

Approaches to Assessment of Newborns

Nurses described other approaches to assessment than those listed in the POK that could be used to gain knowledge. The comments were: “Infant’s response to assessment,
whether the infant is vigorous/distraught or lethargic or calm”, “personal feelings about
parent’s lifestyle (young, drug use, alcohol, smoking, etc) – pre and post delivery”,
“using a developmental approach”, “‘eyeball’ approach – a quick head to toe scan for
color/activity body (abdomen) shape, head shape. Also always assess with gestational age
appropriateness – at birth and corrected”, and “looking at all aspects”.

Another nurse’s description started with a more traditional approach to
assessment. “One of the biggest influences on how I assess infants was my training at
my first NICU job. Although I find/see different ways of doing things at different
facilities, I still will do things how I was taught unless I see a study or better outcome
somewhere else. If there are five ways of doing things that all bring about the same result
– I’ll still choose to intervene/assess the way I was first taught….My point is that for me,
the way I was trained influences me the most in the way I assess my patients. The
influence of new studies, learning from the medical team, knowing who you are as a
person only comes from experience (time and quantity of different patients) as a bedside
nurse. It’s an interesting question…How do you assess an infant because all of us can tell
you how you do it physically, but there are so many psychological influences that take
into consideration personality, education and emotional stability….” This nurse took on
the traditional way of providing care to her patient and then talked about her clinical
experiences and research evidence that influenced her assessments. She also looked at the
personal aspects and physiological aspects of knowing about her patient. She actually
looked at all the patterns of knowing in her comments. This was a good overview of
using multiple, integrated patterns of knowing.
Empirical Knowing

Use of Physiologic or Scientific Data

There were no comments under the section describing the use of physiologic or scientific data. Heart rate, respiratory rate, and saturations were adequate descriptors for the bedside NICU nurse for her understanding of the concept.

Use of Research-Based Information

On the use of research-based information, some nurses expect the hospital to provide it for the staff - “when supplied for me” - and others blamed themselves for not keeping up with the current literature. “Regrettably I have not kept myself up to date with ‘best practices’ by doing my own journal reviews.” Most nurses use information from co-workers, administration or education to keep updated. It was mentioned that a teaching hospital keeps nurses more up to date on research and evidence-based practice (EBP). “But you need the support of the management and neonatologist and NNP to push positive new ideas which can be difficult”. An NNP stated that “I feel that education refines the practitioner at all levels of care” and a nurse with 17 years of NICU experience as an ADN graduate says: “I use experience more than research based info”. Most of the nurses dealt with the difficulties of keeping up with the empirical knowledge, questioned the need but requested support for doing it at the hospital.

Aesthetic Knowing

Use of Habits or Routines

On the use of habit and routines, the nurses stated that they “have to use routine to not miss anything…[to] minimize handling time” and that they get “sometimes side-
tracked from routine with focused issues”. One nurse stated that “sometimes you need to alter your approach as some cases are unique”. This describes the nurses’ understanding of using habits and routines as part of her expertise (so as not to miss anything), but understanding that it may have to be altered if the infant’s condition changes.

**Use of Intuition or “Gut Feelings”**

On the use of intuition, the nurses stated that “the more experience I gain, the more I use my gut” and “use gut feeling frequently in conjunction with exam and vital signs”. Another nurse stated that she uses intuition “as much as possible”. A nurse with 17 years of experience in the NICU stated that “report is of great importance too (receiving it). It may cue me in as well. Sometimes that is where I may get alarmed or suspicious of something wrong “gut” bothering me about info I received.” One novice nurse stated that “[I] also use experience of pod partners to back-up my gut feelings”. An NNP with 20 years of experience wrote: “I feel that the use of ‘intuition’ is really that the nurse is unable to describe the physical finding that exists”. She felt she could not answer that she uses “intuition”, since it is probably so unscientific to her practical NNP consciousness. She scored her “use of intuition” as “1-does not use”. Yet she understands the concept of pattern recognition very well and how it is used with aesthetic knowing as a combination of many patterns of knowing.

**Use of Previous Clinical Experiences**

On the question of previous clinical experiences, one nurse stated that it “combines well with ‘gut feelings’”. She understood that previous clinical experiences and intuition are similar manifestations of the aesthetic way of knowing. Another nurse
stated that she uses previous clinical experience, and “especially things I did wrong previously, or better said – when things seemed to go wrong like a patient not getting better and you’re running all day and doing this and that and at the end of your day realize you learned so much”.

**Doing What is Expedient or Necessary**

On doing what is necessary or expedient, one nurse wrote: “necessary being the key work – if I am concerned about a finding, I feel strong need to follow up”. Acquiring clinical information, incorporating it into your psyche, being able to recognize the patterns during our routine care, and taking action when it is necessary - that is what aesthetic knowing is all about.

**Personal Knowing**

**Use of Your Personal Knowledge of Self**

On the personal knowledge of self, the majority of the comments were that they did not understand the question. “This question doesn’t make much sense.” This involved knowing about your own personality and relating with others. It also involved how you dealt with or acted in a certain situation with others and what you know about yourself. This question needs some explanatory descriptors to help the nurse understand the question.

**Use of Empathy**

On empathy, one nurse stated that …”[I] especially fear infants who have had surgery, -neuro issues”. This question may need to be reformulated also, due to the
comment that “this also does not make much sense”. This question involved having an empathetic understanding with the infant and family.

Use of Input from Parents

Concerning the use of parent input, the nurse stated they use it “especially if parents are frequently at the bedside, participating in care/learning about their child and it’s my first time caring for the infant” or “especially when parents are frequent visitors who have an active role in their infant’s care”. Another nurse stated she uses parent input “especially [in] babies who have been in the NICU for a long time. Parents know their baby is acting differently”. It “depends on parent competency” and if there are no language barriers. “Sometimes parents tend to think what is beneficial to them rather than what is best for the infant” stated a NICU nurse with 27 years of experience. “I listen to them when they note a difference and always consider it in the assessment”. “I think it’s hard for nursing to relinquish control to parents who may be less ‘medically’ knowledgeable.” Most nurses realized the importance parent interaction and the important knowledge that a relationship with the parents give the nurse in the assessment.

Use of Your Own Personal Experiences

On use of personal experiences in life, one nurse interpreted personal to mean “personal experiences IN [the] NICU”. Another nurse wrote that “life experiences do help with speaking with families”. Most nurses seemed to understand the item, and a few did not. Personal experiences are more than how you feel right now, but about your past, your interactions, and your relationship with the family.
Ethical Knowing

Use of Ethical Judgment

On the use of ethical judgment, one nurse stated: “I am willing to consider ‘other’ sources but if I feel strongly about a ‘right vs. wrong’. I want to be convinced by data before the ‘other’ source prevails.” A nurse with five years of experience stated: “I keep my personal feelings on ethics out of assessment. I do what I was trained to do and give full and complete assessments regardless”. An NNP with 20 years of experience stated: “I feel there is a constant challenge in the NICU to do what is right for the patient and the family”. Another nurse with 17 years of NICU experience wrote: “I would rather act (let authority know what I find amiss) and not be right than not act and be wrong if I suspect something is wrong”. Nurses have many ideas about ethics. One nurse said: “This walks the line between thinking ‘I know what is best’ vs. ‘we, as a team, do it this way because it is best’.

Evaluation of Consequences of Actions

On the influences of the consequences of your actions, one nurse wrote: “focus on ‘doing no harm’”. Another stated: “will do what is best for that baby” and another, “although sometimes we say ‘what we don’t know we can’t fix’…” Another nurse interpreted the question as relating to the use of “critical thinking skills”. Ethics to the nurse in the NICU means you’re going to always do what is right and best for the infant.


Sociopolitical Knowing

Use of Social Atmosphere of the Unit

On the social atmosphere of the NICU, one nurse stated that “having fun at work should be part of every day life, otherwise why would one want to go to work every day? If this means negative issues – there should be none but, it happens indirectly if you want it to or not”. Another nurse looked at the positive aspects: “it is more helpful to have a helpful pod mate or co-workers”, while others looked at the negative aspects: “sometimes I wish people would chat less so I’d have more time to spend focusing on reading and researching [the baby’s] history and learning; but physical assessment [is] not affected”. Another nurse stated: “as a traveler I’m not usually at a place long enough to worry about the social issues of a unit”. Another nurse felt that it had more to do with communication skills. She stated: “I feel comfortable asking ‘What do you think about this?’ Rapport allows me to open up about what may sound like a little thing.”

Use of Political Climate of the Unit

On the use of the political climate of the NICU, the responses were from “I do not” to “much because if we are in a hurry constantly, probably don’t assess as well as we should”. Another nurse stated that it was “very dependent on individual NNPs, MDs working – some listen, others do not. When ones who don’t listen are on, usually will let a gut assessment slide because no action will be taken anyway”. They also mentioned the similar issue of “different day, different doc, which nurse”, “different doctor’s group practice differently”, “I work with neos that are very controlling and we must do it the way they do it”, and “sometimes work with Neo or NNP who you feel are not working
well with others or they have poor judgment. You have to work harder.” The NICU travel nurse wrote that “one reason I decided to travel was to stay out of the unit’s politics as much as possible”. Then, another nurse wrote: “If I think something is off and a baby is getting seriously ill, the baby is #1. The politics at that time don’t matter with seeking further assessment or intervention.”

In the sociopolitical knowing area, there were many aspects of knowing used. There were interpersonal relations with others, physician, pod mates, NNPs, and other nurses (personal knowing). They discussed doing what is right (ethical knowing). They discussed “habits and not being able to work well” (aesthetic and ethical knowing). The travel nurse described the positive aspects of the social and political environments. These two items (sociopolitical knowing) seem to have both positive and negative aspects incorporated into this area of knowing for the NICU nurse. This could be why the items scored so much lower than the other items on the scale.

Authority-Based Knowing

*Use of Data from Those in Authority (NNPs, MD)*

On the authority-based information from MDs and NNPs, several nurses commented on the “collaborative effort”, the use of peers, and colleagues to assist with assessments. “I believe experience with all types of infants is vital. Participation in rounds and input of NNP and MD is important, also being able to ask questions”. Jenks (1993) pointed out that the interpersonal knowing of physicians and nursing staff is a key concept in clinical decision making by the nurse. In this respect, the interpersonal
knowing between the physician, NNPs, and nurses could be incorporated into personal knowing as one of the interpersonal relationships important in patient care.

*Use of Nursing Policies and Procedures*

On the use of nursing policies and procedures, one nurse stated “not in assessment. But with treatment, we often have to follow policies and guidelines”. Another nurse stated that she uses policies and procedures only “if available or have time to look up”. From the comments made and the scores on the POK, this item is not often by the experienced nurses in the NICU.

*Rating of Clinical Expertise*

*Self-rating of Clinical Expertise*

On their self-rating of their clinical expertise, nurses wrote that “with more years of experience you gain more knowledge” and that “there is ALWAYS more to learn!!!” It was noted that most NNPs marked “expert” under clinical expertise. Many nurses did not feel comfortable describing themselves as an “expert” so therefore stated that they could still learn more, even with many years of experience. The NNPs did not seem to have difficulty marking themselves as “experts”, but then they are seen as the expert practitioners in the NICU.

*Ratings of the Newborn Scale of Sepsis (SOS)*

The usefulness of the tool for the nurses was elicited from the 16 nurses who completed the two scales. One nurse stated: “It is a good tool for NICU nurses who maybe do not know what to look for” and another stated, “It made me look closer at the baby”. Three of the more expert nurses felt that the tool was not useful to pick up signs of
sepsis. One NNP with 12 years of NICU experience stated: …[it] “not really helped me. I used it in addition to, but I already had my plan of care that I was going to do despite what the SOS said. It did agree with my work-up, but I used it in addition to other assessment skills to figure out my orders”. Another NNP stated that the tool was easy to use, but not useful to her because “none of the babies I used it on had sepsis”. Most nurses found the tool useful in helping them look for signs of infection especially the more inexperienced nurses. Experienced nurses did not find the tool very helpful, probably due to their clinical expertise where they already are recognizing patterns of sepsis in newborns.

**Summary**

This research study was designed to examine the NICU nurses’ approaches to assessing infants for sepsis and to estimate the validity and reliability of the Newborn SOS as a screening tool for newborn. The NICU nurses’ approach to assessing infants for sepsis utilized all six ways of knowing based on the Nursing POK scale. As theorized, the more clinically experienced nurses used a more integrated approach in assessment as indicated by the tendency to score higher on the POK overall. Empirical knowing was used to a greater extent by nurses with higher ages, higher educational levels, more years of nursing and NICU experience and higher ratings of clinical expertise. Aesthetic knowing was used to a greater extent by nurses with more experiences and clinical expertise. Personal knowing was used to a greater extent by nurses with more years experience in the NICU and higher clinical expertise ratings. Authority-based knowing
was used to a greater extent by inexperienced nurses. Sociopolitical knowing was used to a greater extent by only those nurses who had worked in a large number of NICUs.

Validity of the POK was measured by correlation to the years of experience of the nurses and factor analysis. Reliability of the POK was measured by coefficient alpha, inter-item correlations, and item to scale correlations. Most scores fell within accepted ranges.

Validity of the Newborn SOS was measured by sensitivity, specificity, PPV, and NPV. Reliability was measured by coefficient alpha and interrater agreement. Predictive validity is measured with PPV and NPV.
Sepsis is a serious complication for newborn infants, especially the premature infant in the NICU. Nurses’ assessments of changes in the infants’ condition are vital in detecting neonatal infection. This study focused on various patterns used by nurses to identify sepsis in newborn infants. Nursing patterns of knowing serve as windows for inquiry into the complex and dynamic process of nurses’ assessment. This idea was derived from Carper’s (1978) patterns of knowing as well as from Newman’s (2002; 2005) conceptualization of pattern recognition and White’s (1995) and Cohen and Nagel’s (1934) ideas about areas of knowing. The following discussion is organized by the research questions, followed by sections addressing limitations of the study, and implications for research, education, and practice.

Research Question #1
What patterns of knowing do NICU nurses use when assessing infants for signs of infection?

*Nursing Patterns of Knowing Scale (POK)*

The Nursing Patterns of Knowing Scale was developed to examine the ways nurses integrate various patterns of knowing to realize that an infant is becoming seriously ill. This scale was an initial effort to develop an instrument to realize more exactly how NICU nurses acquire the clinical knowledge needed to assess sepsis in an
infant. Several of its psychometric properties indicate that the instrument is fairly reliable and valid, even in its initial stage of development.

**Reliability**

The Cronbach’s alpha and item-to-scale coefficients were well above the acceptable ranges, with inter-item correlations indicating a lack of item redundancy. This could be the result of the difficulty of finding items similar enough to test the same concept (pattern of knowing or clinical knowledge) but testing a different pattern of knowing.

**Validity**

The advisor’s and investigator’s assessment of the POK lent support to its face and content validity, but additional evaluations by nurses who are experts in both clinical practice and nursing epistemology would be helpful in determining its validity in the selection of items representative of each pattern of knowing. This is particularly in reference to items on personal knowledge, which some nurses questioned. In support of construct validity, all factors loaded together on the factor analysis of the instrument, indicating that the instrument is unidimensional as theorized, based upon Carper’s (1978) and Reed’s (1995; 1996) conceptualizations of patterns of knowing as interdependent and interrelated. Thus, the Nursing POK shows promise in its psychometric performance. With further refinement, it could become a more useful tool for inquiry into nursing patterns of knowing.

**Uses of Different Patterns of Knowing**

The range of scores on the Nursing POK indicated that the majority of NICU nurses employed an integrated pattern of assessing newborn infants for sepsis. Examining
individual patterns results showed that overall the NICU nurses used authority, empirical and aesthetic ways of knowing to the greatest extent. This differs from Lee’s (2002) findings of the use of empirical and ethical patterns of knowing as preferential in pediatric nurses. The differences could be related to the type of health care setting. Both used empirical knowing, but in pediatrics, there are probably more ethical issues relating to significant disease process like cancer and trauma, whereas in the NICU, the vast majority of the infants improve and are discharged over time (about 98%).

In reference to authority-based knowledge, there is very little research in the use of authority-based knowing with which to compare the current findings. The nurses in the NICU had access to both physicians (in-house) and neonatal nurse practitioners on a continuous basis. This availability could have increased their use of the authorities available to them. Also, the immediacy of the crisis of sepsis might have influenced nurses to depend more on authority than on other patterns of knowing. In a study of nurses who worked in various clinical settings, Rockett (2001) found that nurses followed the rules only when it made sense in the context of the clinical environment. It was found that because the rules often lagged behind the daily needs of nurses, nurses did not adhere to them as part of their pattern of coming to know their patients. Instead, they used what Rockett described as “social interactions” with patients, family, and other nurses and health care professionals in their assessment process. This finding crosses several patterns of knowing, namely personal, aesthetic, and authority.

The low use of sociopolitical knowing was probably due to the nurses’ view that social interaction or political climate of the unit does not and/or should not influence their
assessment of the infants. The inverse correlations found between this pattern and several indicators of nursing expertise (age, years of nursing experience, years of NICU experience, and their self-rated clinical expertise) suggested that the nurses viewed this pattern in a negative way, in comparison to correlations found on other patterns of knowing. The two sociopolitical items were seen as a negative influence on their assessment knowledge. This should be explored further relating to whether this should be a negatively correlated item or whether the question should be changed to a more positive use of the social atmosphere of the NICU. According to White (1995), the public associates nursing with nurturance, dependence, and intimacy which remind people of their pain and vulnerability. The context of hospital nursing within a physician-controlled environment with economic constraints by administration places the bedside nurse in a social-political structure that may limit the nurses’ participation in the profession of nursing and their use of sociopolitical ways of knowing. White proposes that nurses “explore and expose alternative constructions of health and health care, find means of enabling all concerned to have a voice in this care provision, and develop processes of shared governance for the future” (p. 85). Incorporating the use of context into the bedside care of nurses would strengthen their use of all the avenues available to them to “know” their patient.

Higher overall scores on the Nursing POK were associated with increased NICU experience, increased exposure to different NICUs, and with the nurses’ self-rating of their own clinical expertise. Yet the total years of nursing experience were not related to their overall score on the POK. This suggested that the POK scale may be more sensitive
to NICU nurses than other types of nurses. It may also suggest that nurses who acquire more clinical experience and expertise specific to the NICU may also be more likely to have a more integrated pattern of knowing for assessing infants than those with less clinical experience or expertise specific to the NICU.

Research Question #2:

Do the demographic factors of age and educational level relate to the type of patterns of knowing used by nurses in the NICU?

Age

There was no correlation with age and the total POK scale. After viewing the results on individual items, the correlation with age was run again using a modified POK that contained only Carper’s (1978) four patterns of knowing. This modified POK had a significant correlation with age of the nurse suggesting that the sociopolitical and authority-based items were influencing the scale and that without these two items, the use of an integrated pattern of knowing was positively associated with age as one would expect. Benner (1984) described the expert nurse, who has accumulated more experience with age, as one who can incorporate all areas of knowing simultaneously and interpret them to make correct assessments and treatment decisions.

The use of research-based knowledge (empirical), previous clinical experiences (aesthetic knowing) and personal experiences each were found to be positively related to the chronological age of the nurse. This finding is congruent with the cognitive psychology theories and research on adult development and reasoning. Changes in
reasoning patterns occur over adulthood whereby older adults use a more integrated approach that incorporates past events and personal experiences (Schaie & Baltes, 1974). Older nurses have had more personal experiences due to their age, and many have also had more clinical experiences. Similarly, the older nurses in this study used more evidence-based practice information or research findings in their assessments of newborns for signs of serious illness or infection.

*Education*

There was no correlation with level of education and the total POK scale. There was very little correlation with any patterns of knowing and educational level. The only significant correlation with nurses’ highest education level achieved was with the use of research-based information (empirical knowing). This is not surprising when one considers that advanced education at the baccalaureate and master’s level emphasizes the concepts of research and evidence-based practice.

Neither age nor educational level was related to the total POK score. As expected, the use of previous clinical and personal experiences that increase with age is related to the nurses’ age. The use of physiologic or scientific data, like heart rate, respiratory rate, saturations, and blood pressure, had no correlation with age or education level. This finding suggested that nurses, regardless of age or education, use physiologic data at the bedside.
Research Question #3

Do four dimensions of nursing experience (total years of nursing experience, years of NICU experience, number of intensive care units the nurse has worked in, and the nurses’ self-rated clinical expertise rating score) relate to the type of patterns of knowing used by nurses in the NICU?

Nursing and NICU Experience

It was hypothesized in the literature that inexperienced nurses use empirical and ethical ways of knowing more often than aesthetic and personal ways of knowing and that expert nurses use aesthetic knowing to a greater extent than novice or inexperienced nurses (Lee, 2002). Lee speculated that the aesthetic and personal patterns of knowing in nursing took years to fully master, and may not even need to be practiced or utilized to the same extent as empirical and ethical knowledge. This researcher hypothesized that all NICU nurses would use empirical ways of knowing, but that only the experienced or expert NICU nurses would use a more integrated approach, including the aesthetic ways of knowing, especially pattern recognition.

The results indicated that the more experienced nurses and the most experienced NICU nurses used an integrated pattern of knowing, and specifically aesthetic knowing to a greater extent than inexperienced nurses. But the use of empirical knowing was also positively correlated with both years of experience and years of NICU experience. This was mostly related to the “use of research-based information”, not the “use of physiologic data”. Again, all nurses at every experience level appeared to use physiologic data, but
nurses with more nursing experiences often used research-based knowledge to a greater extent than the nurses at a higher chronological age. Newer nurses may not have the experience to understand and use research-based information in their practice or may be more interested in clinical journals not research-based journals.

These data suggest that nurses with the most NICU experience use the empirical, aesthetic, and personal patterns of knowing to a greater extent than the nurses with less NICU experience. The NICU nurses use a combination of patterns of knowing; more so than the nurses with general nursing experience, but less NICU experience.

The item “use of nursing policies and procedures” was negatively related to both overall nursing experience and NICU nursing experience. This finding suggested that the more experienced nurses use less policies and procedures in their practice. The more experienced nurses may not need to use as much authority-based knowledge because of their years of clinical nursing experience. The more experienced nurses trusted themselves more than the “experts” or “designated authorities” in the field, e.g. physicians and nurse practitioners.

There was no correlation between years of nursing experience and ethical or sociopolitical knowing. This differed from the research of Franzen (1998) of nursing students with older adult patients and Lee (2002) with pediatric nurses. Franzen found that nursing students used ethical as well as aesthetic, personal and life experiences in their care of elderly patients. Lee found that pediatric nurses use empirical and ethical ways of knowing most. One interpretation of the differences in the findings is that the
nursing context may be related to the pattern of knowing. Further research into this question is indicated.

*Experience with Different NICUs*

Work in a number of different NICUs was included as a demographic variable because employment in multiple NICUs can provide nurses with a diversity of experiences that enhance patterns of knowing. Working with a variety of physicians and nurse practitioners can expand nursing knowledge about neonatology and influence a nurses’ practice. This item generated mixed results.

When the number of NICUs worked in was correlated with the frequency of use of patterns of knowing, there was an expected positive correlation with the aesthetic way of knowing, and more specifically with the item “use of previous clinical experiences”. Working in different NICUs gives the nurse more clinical experiences. There was also a small, positive correlation between the aesthetic knowing “doing what is expedient or necessary” with the nurses’ experience in different NICUs. This unexpected result could imply that nurses who travel, who experience many different intensive care environments, often feel it necessary to do what is expedient or necessary, rather than doing what may take more interaction with the physicians and practitioners or following their own direction. The traveling nurse may feel that it is necessary to do what the unit expects of them without challenging the system. They have a lot less invested in changing practices or making a difference in nursing care when they are on a temporary assignment of only 12 weeks in length.
Another finding indicated nurses with experience in a large number of intensive care nurseries use sociopolitical knowing to a greater extent than nurses who have less experience in different NICUs. This was also shown in the qualitative comments by nurses who stated that as a traveler, they tried not to get involved in the unit politics or social atmosphere.

Working in more NICUs was also related to the nurses self-rating of their clinical expertise. The positive correlation between the experience of working in different NICUs and the nurses’ expertise rating needs to be explored with further research.

**Clinical Expertise Self-Rating**

The nurses who rated themselves high in terms of clinical expertise used empirical, aesthetic, and personal knowing. The “use of intuition” and “use of previous clinical experiences” items under aesthetic knowing were positively correlated with the clinical expertise of the nurse (self-rated). This suggests that nurses who rated themselves as more clinically competent use intuition and previous clinical experiences to a greater extent than nurses with less competence. Therefore, it is believed that the use of pattern recognition based on previous clinical experiences is a good indicator of an expert nurse due to the medium, positive correlation that was seen.

The significant correlation between self-rated clinical expertise and use of research-based information (empirical way of knowing) suggests that the more clinically competent nurses use research-based knowledge to a greater extent than those nurses who rate themselves as less competent. There was also a relationship between the nurse’s self-rating of clinical expertise with “use of personal knowledge” and “use of personal
experiences”. Nurses who rate themselves as more clinically competent use personal knowing to a greater extent than nurses who rate themselves as less competent.

The nurses who rate themselves higher in their clinical expertise use a more integrated pattern of knowing. The specific patterns used in their assessments of infants for serious illness were empirical, aesthetic and personal knowing.

**Neonatal Nurse Practitioners**

Neonatal nurse practitioners rely more on their own expertise than relying on the physicians in the unit or others in authority. They also rely significantly less on nursing policies and procedures. The NNPs are usually the most highly experienced nurses in the NICU, and therefore, should rate themselves at a high expertise level as shown in the results. The NNP is considered the expert in the NICU. The NNP would be most likely to use research-based knowledge as an expert in the NICU as they often are the educators and mentors of the staff nurses. The NNPs had a significant, positive relationship with the use of personal experiences influencing their assessments. There is no known reason for this relationship, except for possibly the overall correlation with nursing experiences. Most NNPs have quite extensive nursing experience prior to becoming an NNP and NNP training requires many various types of experiences that can influence a person and expand their knowledge and expertise.

**Summary of POK Findings**

Overall, the NICU nurses used an integrated pattern of knowing, involving the use of empirical, aesthetic and authority-based knowing. The more experienced NICU nurses also used an integrated pattern of knowing, but instead they used empirical, aesthetic, and
personal knowing. Personal knowing became more important for the more experienced nurse, who now used less authority-based knowing. Authority-based knowing was inversely related to total years of nursing experience.

Nursing experience is a vital factor in the development of nursing knowledge in clinical practice. Use of sociopolitical ways of knowing is not vital in the NICU for assessment of newborns, but all other ways of knowing are evident in the NICU. Sociopolitical knowing was only related to the nurses’ experience working in many different NICUs.

Research Question #4:

What are the psychometric properties of the Newborn Scale of Sepsis (SOS)?

Reliability of the SOS

The Cronbach’s alpha was slightly below the acceptable range of .70 or higher, even for a new instrument. Since the Newborn SOS is a criterion-referenced instrument, based on theoretical assumptions as a tool for sepsis, a homogenous response rate would not be expected for the scale. Symptoms or signs of infection vary with the gestational age of the infant and the timing of the assessment in the course of infection, therefore, a consistent response would not be expected. The interrater reliability using percent agreement was well above the acceptable range.

Validity of the SOS

The face and content validity of the SOS were acceptable. The instrument was easy to read and understand. A group of experts in neonatal care rated the scale items as
relevant to the concept of newborn sepsis. The predictive validity of the Newborn SOS was unacceptable. The initial cut point was selected to achieve 95% sensitivity, but this was determined to be too high due to the very low specificity achieved. The cut point was thought to be the point at which a clinician would begin treatment based on the baby’s risk of sepsis from the scores the infant received on the tool. The higher the score on the neonatal SOS, the higher would be the infants’ risk of sepsis, and therefore, treatment with antibiotics could be initiated for scores above a certain level in order to prevent neonatal morbidity and mortality. Lowering the cut point decreased the sensitivity to a non-acceptable level. It was determined that the SOS is a very non-specific tool for diagnosing sepsis. A high score on the clinical criteria can indicate respiratory distress, a common problem in the transition or NICU. Therefore, the Newborn SOS is not a good diagnostic tool for newborn sepsis.

Qualitative Data

The qualitative data were obtained from the comment sections of the POK scale. The analysis included an examination of the content of each section of the POK scale. On the approaches to assessing newborn infants, the nurses discussed using a developmental approach, an overall, cursory observational approach, and an integrated approach. The integrated approach included many factors including the physical and research information (empirical), the psychological influences of personality and emotions (personal), the use of previous clinical experiences and intuition (aesthetic), the influence of parents and peers (personal and sociopolitical), and the influence of physicians and nurse practitioners (authority-based). The comments made by the nurses were consistent
with the statistical output from the correlation analysis, and helped to validate and understand the results of the study.

Limitations of the Study

The small sample size of the Newborn SOS scale limited the amount of testing of the instrument that could be done. It was expected to be able to do a logistic regression analysis with odds ratios on the Newborn SOS, but the sample size was too small. Also, the change in practice standards within the past 2-3 years, resulting in a large increase in the prophylactic dosing with antibiotics of mothers at risk for infection significantly decreased the number of cases of neonatal sepsis and positive blood cultures in term or near-term infants. This resulted in a significant decrease in the projected sample size of 200 infants for an evaluation of the sepsis scale.

There was a significant loss of subjects among the nurses who were evaluating the newborns using the Newborn SOS over the two year study period. Only 16 of the 28 nurses who were initially recruited and trained continued with the study to the end and filled out the POK scale. Therefore, no comparison of the nurses’ patterns of knowing could be evaluated with their use of the Newborn SOS scale.

The item “use of personal knowledge of self” on the POK was left unanswered by 5% of the participants. The missing data was replaced with the mean of the entire sample so as not to affect the outcome and use of the other items in the analysis. Because there were also comments concerning “not understanding” this question in the qualitative comment analysis even when the question was answered, this could jeopardize the
validity of this question. The question will have to be reformulated for improved understanding in future research studies.

Implications for Nursing Education, Practice and Research

*Nursing Research*

*Nursing POK*

The present study found that all items on the Nursing POK scale loaded on one factor. That factor could be hypothesized as being the concept of an “integrated pattern of clinical knowledge”. A further analysis of the concept of integrated pattern of clinical knowledge and the use of patterns of knowing in nursing should be examined.

The Nursing POK scale is a new instrument tested only on one population – NICU nurses. The POK scale appears to be more sensitive to NICU nurses with development of a more integrated pattern of knowing. The scale needs to be reformulated for other populations to be further tested with other samples. The scale could be reformulated for intensive care unit nurses on adult patients and for pediatric nurses in the pediatric intensive care unit. It would then be beneficial to examine the relationship between nursing experience in the NICU and in the adult intensive care unit (ICU) or Pediatric ICU and compare patterns of knowing. A comparison could also be made with nurses who work on a regular adult floor or pediatric floor in comparison to an ICU environment. It may be theorized that the intensive care nurses uses more integrated patterns of knowing than the non-intensive care nurses. A comparison of two or three groups of nurses working in different units could be researched to evaluate their use of
patterns of knowing and the integration of the patterns. The scale would have to be differentiated to work in other clinical settings for the assessment of ill patients.

The tool could also be tested in populations where there is more of a cultural mix of patients and an evaluation of the cultural aspects of a nurses’ assessment can be included. The sociopolitical knowing items on the scale need to be examined more closely as to their benefit to the entire pattern of knowing scale. The two items selected for measuring sociopolitical knowing may not be sensitive to the NICU environment.

Another approach to assessment of newborns was described by a nurse in the qualitative review. It involved the nurses’ evaluation of the infant and how the infant responds or reacts to the assessment. This item could be included under personal knowing where there is a relationship developing between the nurse and the infant.

Another nurse described “always going back to the way she was originally taught”, brings an aspect of another way of knowing – tradition. This was described as certain beliefs in nursing that are accepted as truths based mainly on customs (Polit, Beck & Hungler, 2001). Many of the customs and traditions in nursing today are being re-evaluated based on evidence-based practice (EBP). If there is no scientific basis for the tradition, nursing is either changing the practice or attempting to research the problem. Because many nurses are still practicing out of tradition, this area of knowing could be incorporated into a new POK scale to evaluate the strength of the responses in today’s nurses.

Besides reformatting the personal knowing question, other input from the qualitative evaluation involved the use of the sociopolitical and authority-based knowing.
Ingram (1994) agreed with some of the participants when she discussed how the interactions with the medical staff, residents, and practitioners were part of personal knowing. Many of the comments from the participants on the authority-based knowing question and on the sociopolitical question were showing that the participants may not have a sound appreciation of the ideas in each of these areas of knowing. Further research could be done incorporating these two patterns of knowing into the four basic Carper’s (1978) patterns or leaving them out entirely and looking at the instrument without these two patterns of knowing, like our Carper Subscale version. Further evaluation into the changed relationships could be explored further with the shortened version of the POK.

Areas of further research include the incorporation of other questions on specific ethical, cultural, or tradition-based knowledge areas, reformulating the personal knowing question, adding an “infant response or reaction to the assessment” question, and reassessing the sociopolitical knowing questions for validity. Further research also needs to be done on the specific items or groups of items used for each pattern of knowing. The item-item correlations need to be evaluated to examine if questions can be deleted that would not affect the reliability or validity of the instrument. Also, further investigation into the demographics and practice dimensions of the tool as a predictor of the use of various patterns of knowing should be done. This research may also inspire further study into nurses’ patterns of knowing as practiced in other clinical settings where patients are vulnerable or who potentially may face life threatening illness.
Combined Newborn SOS and Nursing POK

The two tools, the Newborn SOS and the Nursing POK scale, could be used together to investigate whether there is a correlation between accuracy in assessment of newborn sepsis and certain patterns of knowing. The more accurate assessments of newborn sepsis might be found to be related to certain patterns of knowing or an overall integrated pattern of knowing; results would be used to refine the theoretical framework. In addition, assessment patterns and accuracy could be explored across a variety of patient populations. Further development of whatever patterns are found to be significant could influence the use of accurate assessment skills.

Newborn SOS

The newborn SOS can be evaluated further as an assessment tool rather than a diagnostic tool. The Newborn SOS was completed by experienced nurses who were already competent or experts in the field of neonatal care. It was planned to have experienced nurses fill out the form in order to be able to test the accuracy of the instrument in diagnosing sepsis. But the scale needs to be used by novice nurses in a couplet care or normal nursery setting, where we can explore the usefulness of the instrument to the novice or inexperienced nurses, who may have no neonatal intensive care nursery experience in picking up signs of infection. Couplet care staff may recognize that something is different, but do not deal with infection on an everyday basis as they do in the NICU. The nurses who use the newborn SOS as an adjunct to their regular assessment process could be surveyed to assess how the tool is useful, whether the tool has helped their assessment process, and whether the tool has changed their thinking or
provided insight into newborn sepsis. Therefore, using the tool with couplet care staff would be a beneficial evaluation of its usefulness with this group of nurses.

*Nursing Practice & the Newborn Scale of Sepsis*

*Preterm Signs of Infection*

On the Newborn SOS, the infants with positive blood cultures were mostly the premature infants in the NICU. These infants presented with apnea as the most consistent symptom or marker of infection. This was also seen in the literature review of premature infants with infection present with increased apnea (Tollner, 1982; Rodwell, Leslie & Tudehope, 1988). The term or near-term infants presented with respiratory distress and poor perfusion as the initial signs of infection. Knowing and understanding these concepts can help nurses to accurately assess for signs of infection.

*Diagnostic Tool vs. Assessment Tool*

The Newborn SOS was initially developed and considered to be a diagnostic tool. A high score on the Newborn SOS was most predictive of sepsis, but the specificity was poor. To improve the specificity, the sensitivity would be compromised to an unacceptable level. The signs of infection are so varied and there is not one ideal test or symptom that indicates sepsis (Tollner, 1982; Gerdes & Polin, 1987). Most infants with sepsis start out with only one or two subtle signs of infection. Since it is so important to pick up these signs of infection at the earliest possible stage, a low score on the Newborn SOS may indicate early sepsis, rather than no sepsis. Therefore, the Newborn SOS is not
a good diagnostic tool but could be a wonderful assessment tool, especially for the new or inexperienced nurse.

An assessment tool is more important for nursing. The Newborn SOS help nurses, especially novice nurses, assess for signs of sepsis. The SOS facilitates the accuracy of the assessment done by inexperienced nurses. The SOS takes the empirical data seen by the nurse and translates that information into a pattern for the nurse. The tool can help the novice nurse experience what the infant with sepsis “looks” like, so that over time and experience, the nurse comes to the knowledge of the pattern of sepsis. An assessment tool will no longer be necessary as experiential knowledge of the nurse becomes internalized and an integrated pattern develops.

*Nursing Education*

The findings from this research suggest that patterns of knowing can be identified and measured for purposes of educating students. More specific teachings about patterns of knowing can enhance students’ assessment skills. The manifestations of pattern used by nurses can be incorporated into the curriculum and clinical training of new nurses (Rancourt, Guimond-Papai, & Prud'homme Brisson, 2000; Ruth-Sahd, 2003). The use of reflection in nursing is a key point in much of Benner’s work (Benner, 1984; Benner & Wrubel, 1982). Heath (1998) and Franzen (1998) recognized reflection as a means of understanding experiential knowledge and wrote that students will learn best by reflecting on their experiences in the clinical setting and sharing their knowledge with others. Using reflection and patterns of knowing can be helpful to the training of nurses in all clinical settings.
Recognizing the manifestations and seeing the pattern for identification of newborn sepsis can be used specifically in a NICU orientation program for new nurses. Both the use of a tool for assessment of newborn sepsis (Newborn SOS) and understanding of ways of knowing for NICU nurses (POK) can assist new nurses in their assessment process. Sources of knowledge for the NICU nurse include the nurse you get report from, the NNP making rounds, the parents during kangaroo care and the infant during your assessment or care. Understanding the various ways of coming to a realization that the infant’s condition is changing and being aware that there are many sources of input are important factors new nurses can be taught during an orientation training class.

Nurses need to be aware of the various methods of knowledge development. Nurses need to understand that intuitive knowledge, pattern recognition, cultural understanding, social situations, and your own personal and ethical experiences can influence the assessment process. Nurses need to be aware of the implications of relying on only the physiologic or empirical evidence in assessing their patients.

Summary

Benner theorized that expert clinical practitioners use all patterns of knowing in their clinical practice (Benner, 1984). Kidd and Morrison (1988) surmised that the stage of theory development not yet achieved by the nursing profession incorporates all areas of knowledge: self-knowledge, intuition, empirical studies, prior theoretical formulations and patient perceptions and feelings (Kidd & Morrison, 1988). “The goal of practice,
theory and research is to integrate knowledge to arrive at ultimate meaning” (Kidd & Morrison, 1988). Therefore, understanding the ways of knowing used by nurses in the clinical setting during the assessment of their infants can help all practitioners to expand and integrate multiple patterns of knowing and expand their expertise in picking up subtle signs of newborn sepsis.
APPENDIX A

HUMAN SUBJECTS APPROVAL LETTERS
Lorraine Rubarth, Ph.D. Candidate, R.N.
Advisor: Julie Erickson, Ph.D., R.N.
College of Nursing
P.O. Box 210203

RE: BSC B03.123 NEWBORN SCALE OF SEPSIS (SOS) INSTRUMENT DEVELOPMENT AND TESTING

Dear Ms. Rubarth:

We received your above referenced research proposal. The procedures to be followed in this study pose no more than minimal risk to participating subjects. Regulations issued by the U.S. Department of Health and Human Services (45 CFR Part 46.110(b)] authorize approval for this type of project through the expedited review procedures, with the condition(s) that subjects’ confidentiality be maintained. Additionally it has been determined that this research will not adversely affect the rights and welfare of subjects and could not practicably be carried out without a waiver of consent as provided under 45 CFR 46.116(d). Although full Committee review is not required, a brief summary of the project procedures is submitted to the Committee for their endorsement and/or comment, if any, after administrative approval is granted. This project is approved effective 30 June 2003 for a period of one year.

The Human Subjects Committee (Institutional Review Board) of the University of Arizona has a current Federalwide Assurance of compliance, FWA00004218, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made either to the procedures followed or to the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Theodore J. Glatik, Ph.D.
Chair
Social and Behavioral Sciences Human Subjects Committee

TJG:rd

cc: Departmental/College Review Committee
21 July 2003

Lorraine Rubarth, Ph.D. Candidate, R.N.
Advisor: Julie Erickson, Ph.D., R.N.
College of Nursing
PO Box 210203

RE: BSC B03.123 NEWBORN SCALE OF SEPSIS (SOS) INSTRUMENT DEVELOPMENT AND TESTING

Dear Ms. Rubarth:

This letter is in follow-up to the letter dated 30 June 2003. The IRB has determined that approval is granted with the understanding that only individuals who have signed both consent forms may participate in this study (the signed, original UA consent form and the Banner Health System consent forms and authorization forms must be maintained in the designated UA College of Nursing designated consent form storage site).

The Human Subjects Committee (Institutional Review Board) of the University of Arizona has a current Federalwide Assurance of compliance, FWA00004218, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made either to the procedures followed or to the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Theodore J. Glattke, Ph.D.
Chair
Social and Behavioral Sciences Human Subjects Committee

TJG:rd

cc: Departmental/College Review Committee
DUE DATE: 28 MAY 2004
HUMAN SUBJECTS COMMITTEE PERIODIC REVIEW FORM
APPROVAL EXPIRES: 6/30/2004

Lorraine Rubarth/B03.123/Nurs/Newborn Scale of Sepsis (SOS): Instrument Development and Testing
NAME OF INVESTIGATOR/PROJECT APPROVAL NUMBER/TITLE OF PROPOSAL

Human subjects approval for this activity expires on the date indicated above. Depending upon the activity status of the project, attachments may be required. Refer to IRB website (www.irb.arizona.edu) for detailed instructions. Note: If renewal is not granted before the expiration date, all study activities must stop at that time. If study procedures/treatment must be continued for subject safety, contact the IRB office immediately.

Activity Status – check one box only
Category A: attach items 1-13 listed on reverse
☐ Enrollment of new subjects in progress
☐ Enrollment not initiated, but still planned
☐ Enrollment closed to new subjects but current subjects are still undergoing study procedure or being entered into extensions and/or sub-studies

Category B: attach items 1-12 listed on reverse
☐ Enrollment closed, follow-up only (non-sensitive data collection via telephone contact, questionnaire and/or record review)
☐ Local data analysis only; no subject contact/no additional data collection (annual review required)

Category C: attach items 1-8 listed on reverse
☐ Concluded: enrollment and all participation/follow-up/local data analysis completed

Category D: no attachments required; complete and submit this form only
☐ Study not begun; permanent withdrawal of study

Subject Numbers (local enrollment)
If more than one study population is involved, report enrollment under number 2 of checklist (see reverse)

a) Number of new subjects enrolled (consented) since last reporting period
22
b) Total number of subjects enrolled (consented) since start of project
22

RNs
Infants
47
50.9%

Male/female ratio of total enrolled since start of project

Conflict of Interest Statement (COI): see COI policies at http://var2.admin.arizona.edu/ule/conflict_of_interest.htm

a) Do any of the investigators serve as a speaker or consultant to the sponsor, the manufacturer, or the owner of the test article?
☐ Yes ☐ No

b) Do any of the investigators (or their family members) derive a direct or indirect benefit equity and/or royalty relationship with the sponsor, manufacturer, or owner of the test article?
☐ Yes ☐ No

If yes to either of the above, attach copy of U of A Conflict of Interest and Commitment Disclosure form.

I certify that this research will be conducted in accordance with the currently approved protocol/amendments and that no changes to procedures or study documents will be made without the knowledge/approval of the IRB.

Signature of Principal Investigator (required for all projects) 7/1/04
Date
Signature of Departmental Review Chair (not required for concluded or not begun studies)

FOR COMMITTEE USE ONLY
☑ Approve ☐ Disapprove
Period of Approval: JUL 1 9 2004 — JUN 3 0 2005
Subject to the following conditions: Exclusionaries of infants less than 34 wks gestation and greater than seven days of age were deleted; in the future, all changes are to be submitted for IRB approval prior to implementation

Theodore J. Galaz, Ph.D., Chair
Social and Behavioral Sciences Committee
☐ Expedited Review ☐ Full Committee Review

Date Reviewed: JUL 19 2004
28 October 2004

Lori Rubarth, Ph.D. (c), R.N.
Advisor: Pam Reed, Ph.D., R.N.
College of Nursing
P.O. Box 210203

RE: BSC D03.123 NEWBORN SCALE OF SEPSIS (SOS) INSTRUMENT DEVELOPMENT AND TESTING

Dear Ms. Rubarth:

We received your 22 October 2004 letter and revised consenting documents, survey, and Verification of Human Subjects Training Form (VOTF) for the above-cited study. Permission is requested to:

- add 16 items to the previously approved survey to learn more about the usefulness of SOS and/or how nurses supplement their standard approaches to assessing infants; the revised survey will take approximately 15 minutes to complete.
- revise the VOTF to designate Dr. Pam Reed as advisor, and to remove Julie Erickson, Elaine Jones, Wendy Gamble and Donna Christensen from the study.
- revise the previously approved consent form to reflect these changes.
- add a new study population (N=90) who will complete the survey only. Nurses will be recruited using the previously approved recruitment mechanisms; surveys will also be placed in nurses’ mailboxes and distributed at a work-related conference. They will be asked to complete the survey at their leisure, and return it to a box designated by the PI. A new consenting document (signature waived per 45 CFR 46.117(c)(2)) was created for this population.

These changes do not impact subject safety. Approval of these changes is granted effective 28 October 2004.

The Human Subjects Committee (Institutional Review Board) of the University of Arizona has a current Federalwide Assurance of compliance, FWA00004218, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made either to the procedures followed or to the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

Sincerely yours,

[Signature]

Theodore J. Glasske, Ph.D.
Chair, Social and Behavioral Sciences Human Subjects Committee
TIG:nn

cc: Departmental/College Review Committee

Enclosure(s)
October 23, 2003

Lori Rubarth, PhD®, RNC, NNP  
NICU  
Banner Desert Medical Center  
1400 S. Dobson Rd.  
Mesa, AZ 85202

RE: Newborn Scale of Sepsis (SOS); Instrument Development and Testing

BHRI Study: 03-0132-589
Original IRB Approval Date: October 7, 2003

Dear Ms. Rubarth:

Thank you for the time and efforts you and your staff have put forth on submitting the above named research project to Banner Health Research Institute (BHRI). This serves as the official BHRI approval letter; you may now begin your study. Please retain this letter for your records.

Your study has been assigned to BHRI Study #03-0132-589. Please reference this number on any future correspondence with our office to ensure proper study identification.

This project has received all of the following required approvals to begin your project at Banner Desert Medical Center, Banner Baywood Medical Center and Banner Mesa Medical Center.

- Research Services Agreement
- Institutional Review Board Approval Letter
- Institutional Review Board Stamped and Approved Informed Consent

Enclosed you will find the documents outlined above. We value your efforts to work with us to ensure quality research and protection of patients who graciously volunteer their time to participate. If you have any questions please do not hesitate to contact me directly at 602-747-9709. Thank you for your support and continued interest in research.

Sincerely,

[Signature]

Linda Iovanni, BS, RN
Director, Regulatory Affairs
October 7, 2004

Lori Rubarth, PhD(c), RNC, NNP
NICU
Banner Desert Medical Center
1400 S. Dobson Rd.
Mesa, AZ 85202

RE: BHRI 03-0132-589
Newborn Scale of Sepsis (SOS): Instrument Development & Testing
Request for Continuation

Dear Ms. Rubarth:

This letter is to inform you that I have reviewed your request for continuation on the referenced study. I noted you have enrolled 40 infants, 27 registered nurses and continue to enroll subjects. I am hereby approving the study for conduction at Banner Desert Medical Center, Banner Mesa Medical Center and Banner Baywood Medical Center for one year with the understanding that no revisions will be made to the protocol or consent(s) without prior knowledge and approval of the Banner Health Institutional Review Board.

The consent(s) provided along with the request for continuation are acceptable. Please note that all subjects enrolling in the study must execute a copy of the approved consent with stamp, enclosed for your convenience. I am also in receipt of the Authorization to Use or Disclose Protected Health Information for Research and have enclosed the original with this letter.

Approval for the study will expire on October 7, 2005. The IRB requests that an Annual Request for Continuation be submitted on or before August 15, 2005. This will allow time for processing and IRB approval prior to the expiration date of the study. Any changes in the study protocol or consent(s), the results of the study and any additional information relative to the study must also be reported to the Board in a timely fashion. If the results of this study are published, please send a copy of the publication to the Banner Health Research Institute for inclusion in the study file.
The Board appreciates your participation in research. If you have any questions, please contact Julie Hector, IRB System Manager, at (602) 747-9718.

Sincerely,

Denise Erickson, PharmD, BCPS
Chairman, Institutional Review Board

Encls. as stated above

DE:jh
APPENDIX B

HUMAN SUBJECTS CONSENT FORMS
PARENTAL CONSENT FORM

Project Title: Newborn Scale of Sepsis (SOS): Instrument Development & Testing

I am being asked to read the following material to ensure that I am informed of the nature of this research study and of how my child will participate in it, if I consent for him/her to do so. Signing this form will indicate that I have been so informed and that I give my consent. Federal regulations require written informed consent prior to participation in this research study so that I can know the nature and risks of my child’s participation and can allow him/her to participate or not participate in a free and informed manner.

PURPOSE
My child is being invited to participate voluntarily in the above-titled research project. The purpose of this project is to evaluate the ability of a new screening tool to assist nurses in observing for signs of newborn infection and documentation of the nurses’ observations.

SELECTION CRITERIA
This study is being done to evaluate the documentation process of nurses in the Neonatal Intensive Care Unit (NICU) or the observation nursery. My child was admitted to the NICU or the observation nursery and was selected to have the additional documentation by the nurses performed. The reason for this consent is to allow access to information in my child’s medical record to test whether the SOS form helps the nurses to document her/his observations of signs of infection in newborns. About 60 nurses and 200 newborns will take part in this study, including about 150 newborns at Banner Desert, 25 newborns at Banner Mesa, and 25 newborns at Banner Baywood.

ALTERNATIVE TREATMENT(S)
This study does not affect my child’s treatment regimen or treatment choices by the physicians involved in my child’s care.

PROCEDURE(S)
If I agree to allow my child to be in this study, his/her participation will involve the following:

- Recording of information from my child’s chart onto the SOS form and information from my child’s chart and my chart will be recorded on a demographic form. Information obtained would be CBC results, blood gas results (if obtained), and blood culture results, as well as, prenatal history, birth history, gestational age, age at exam and physical assessment information.

RISKS
There are no risks for my child to participate in this study.
BENEFITS
There is no direct benefit from my child’s participation.

CONFIDENTIALITY
All information taken from the medical records will be kept confidential. Any information used for publication of data will be group data, and no individual private information will be shared.

PARTICIPATION COSTS AND SUBJECT COMPENSATION
There is no cost to me or my child for participating. Neither my child nor I will be compensated for my child’s participation.

CONTACTS
I can obtain further information from the principal investigator Lori Rubarth, RN, NNP, Ph.D. Candidate at (480) 512-3182. If I have questions concerning my child’s rights as a research subject, I may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721.

AUTHORIZATION
Before giving my consent by signing this form, the methods, inconveniences, risks, and benefits have been explained to me and my questions have been answered. I may ask questions at any time and I am free to withdraw my child from the project at any time without causing bad feelings or affecting his/her medical care. My child’s participation in this project may be ended by the investigator or by the sponsor for reasons that would be explained. New information developed during the course of this study which may affect either my willingness or that of my child to continue in this research project will be given to me as it becomes available. This consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator, Lori Rubarth, Ph.D(c), RN, NNP, or authorized representative of the Nursing department. I do not give up any of my or my child’s legal rights by signing this form. A copy of this signed consent form will be given to me.

__________________________________________
Subject’s Name (printed)

_________________________ _____________________________
Parent/Legal Guardian’s Signature Date / Time

__________________________________________
Printed Name of Parent/Legal Guardian

__________________________________________
Signature of Investigator (Person Obtaining Consent) Date Time

____ Lorraine B. Rubarth ________________
Printed Name of Investigator (Person Obtaining Consent)
SUBJECT’s CONSENT FORM

Project Title: Newborn Scale of Sepsis: Instrument Development and Testing

I AM BEING ASKED TO READ THE FOLLOWING MATERIAL TO ENSURE THAT I AM INFORMED OF THE NATURE OF THIS RESEARCH STUDY AND OF HOW I WILL PARTICIPATE IN IT, IF I CONSENT TO DO SO. SIGNING THIS FORM WILL INDICATE THAT I HAVE BEEN SO INFORMED AND THAT I GIVE MY CONSENT. FEDERAL REGULATIONS REQUIRE WRITTEN INFORMED CONSENT PRIOR TO PARTICIPATION IN THIS RESEARCH STUDY SO THAT I CAN KNOW THE NATURE AND RISKS OF MY PARTICIPATION AND CAN DECIDE TO PARTICIPATE OR NOT PARTICIPATE IN A FREE AND INFORMED MANNER.

PURPOSE
I am being invited to participate voluntarily in the above-titled research project. The purpose of this project is to evaluate the ease and ability of a new screening tool to assist nurses in the assessment of newborn infants for infection.

SELECTION CRITERIA
I am being invited to participate because I am a registered nurse (RN) in the Nursery Intensive Care Unit or transition nursery. There will be approximately 50-60 nurses enrolled in this study.

PROCEDURE(S)
If I agree to participate, I will be asked to consent to the following: a training session of approximately 30 minutes for teaching how to use the SOS form and checking my understanding of filling out the forms, a review session one month after the SOS form is in use, and documentation of my observations of a newborn on the Newborn Scale of Sepsis (SOS) form. The additional documentation on the SOS form will take approximately 3-5 minutes of additional time for each infant assessed in addition to my regular documentation in the medical record.

RISKS
There is no risk to the nurses who are the subjects of the study.

BENEFITS
The benefit of the study would be to assist nurses in documentation of their observations of the newborn infant.
CONFIDENTIALITY
All information collected on me will be kept confidential. Any information used for publication of data will be group data, and no individual names or private information will be shared.

PARTICIPATION COSTS AND SUBJECT COMPENSATION
There is no cost or compensation for participating in this study.

CONTACTS
I can obtain further information from the principal investigator, Lori Rubarth, PhD(c), RN, NNP at (480) 512-3282 or by pager at (602) 226-3868. If I have questions concerning my rights as a research subject, I may call the Human Subjects Committee office at (520) 626-6721.

AUTHORIZATION
BEFORE GIVING MY CONSENT BY SIGNING THIS FORM, THE METHODS, INCONVENIENCES, RISKS, AND BENEFITS HAVE BEEN EXPLAINED TO ME AND MY QUESTIONS HAVE BEEN ANSWERED. I MAY ASK QUESTIONS AT ANY TIME AND I AM FREE TO WITHDRAW FROM THE PROJECT AT ANY TIME WITHOUT CAUSING BAD FEELINGS OR AFFECTING MY MEDICAL CARE. MY PARTICIPATION IN THIS PROJECT MAY BE ENDED BY THE INVESTIGATOR FOR REASONS THAT WOULD BE EXPLAINED. NEW INFORMATION DEVELOPED DURING THE COURSE OF THIS STUDY WHICH MAY AFFECT MY WILLINGNESS TO CONTINUE IN THIS RESEARCH PROJECT WILL BE GIVEN TO ME AS IT BECOMES AVAILABLE. THIS CONSENT FORM WILL BE FILED IN AN AREA DESIGNATED BY THE HUMAN SUBJECTS COMMITTEE WITH ACCESS RESTRICTED TO THE PRINCIPAL INVESTIGATOR, Lori Rubarth, OR AUTHORIZED REPRESENTATIVE OF THE Nursing DEPARTMENT. I DO NOT GIVE UP ANY OF MY LEGAL RIGHTS BY SIGNING THIS FORM. A COPY OF THIS SIGNED CONSENT FORM WILL BE GIVEN TO ME.

_________________________________ __________________
Subject's Signature Date
INVESTIGATOR'S AFFIDAVIT
I have carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge the person who is signing this consent form understands clearly the nature, demands, benefits, and risks involved in his/her participation and his/her signature is legally valid. A medical problem or language or educational barrier has not precluded this understanding.

__________________________    ____________
Signature of Investigator      Date

4/2003
SUBJECT DISCLAIMER FORM

Title of Project: Newborn Scale of Sepsis: Instrument Development and Testing

You are being invited to voluntarily participate in the above-titled research study. The purpose of this study is to evaluate the usefulness of a new screening tool to assist nurses in the assessment of newborn infants for infection. You are eligible to participate because you are an RN working in the Neonatal Intensive Care Unit (NICU) or the transition/observation nursery.

If you agree to participate, your participation will involve 1) filling out a demographic information form on your nursing experience and education and 2) filling out a questionnaire about your experiences with assessing newborn infants for infection. The survey will take approximately 15 minutes. You may choose not to answer some or all of the questions.

Any questions you have will be answered and you may withdraw from the study at any time. There are no known risks from your participation and no direct benefit from your participation is expected. There is no cost to you except for your time and you will not be compensated for your participation.

Only the principal investigator and her faculty advisor will have access to the information that you provide. Demographic information and information obtained from the questionnaire will be locked in a cabinet in a secure place.

You can obtain further information from the principal investigator, Lori Rubarth, PhD(c), RN, NNP, at (480) 512-3182. If you have questions concerning your rights as a research subject, you may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721.

By participating in study, you are giving permission for the investigator to use your information for research purposes.

Thank you.

Lori Rubarth, PhD(c), RN, NNP
Authorization Form for Use and Disclosure of Protected Health Information (PHI) for Research

PARENTAL CONSENT FORM

Project Title: Newborn Scale of Sepsis (SOS): Instrument Development & Testing

The United States government has issued a new privacy rule to protect the privacy rights of individuals enrolled in research. The Privacy Rule is designed to protect the confidentiality of an individual’s health information. This document hereafter known as an “Authorization for Use and Disclosure of Protected Health Information for Research” describes my rights and explains how my health information will be used and disclosed for this study.

PURPOSE
My child is being invited to participate voluntarily in the above-titled research project. This study is being done to evaluate the documentation process of nurses in the Neonatal Intensive Care Unit (NICU) or the observation/transition nursery. My child was admitted to the NICU or the observation nursery and was selected to have the additional documentation by the nurses performed. The purpose of this project is to evaluate the usefulness of a new screening tool called the Newborn Scale of Sepsis (SOS) to assist nurses in observing for signs of newborn infection and documentation of the nurses’ observations. The SOS scale may help the nurses describe what they see in a child while being observed in the nursery.

USE AND DISCLOSURE OF PROTECTED HEALTH INFORMATION
The reason the investigator needs my and my child’s protected health information is to confirm the usefulness of the SOS screening tool for newborns. The following information will be obtained from my and my child’s medical record: Birth date and time, birthweight, gestational age, maternal history, pregnancy complications, birth information, laboratory results, and assessment data from the nurses’ observations of my child in the nursery. The reason for this consent is to allow access to information in my and my child’s medical record. Banner Health System is providing the information to Lori Rubarth, a neonatal nurse practitioner (NNP) at Banner Health System and doctoral student at the University of Arizona, in order to evaluate the usefulness of the SOS scale. The information will be linked to my child only until all the data has been collected. I have the right to access my PHI that may be created during this study as it relates to my child’s treatment or payment. My access to this information will become available only after the study analyses are complete. This study does not affect my child’s care or treatment in any way.

CONTACTS
I can obtain further information from the principal investigator Lori Rubarth, RN, NNP, Ph.D. Candidate at (480) 512-3182. If I have questions concerning my child’s rights as a research subject, I may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721.
AUTHORIZATION
I hereby authorize the use or disclosure of my individually identifiable health information. I may withdraw this authorization at any time by notifying the Principal Investigator in writing. The address for the Principal Investigator is Neonatal Intensive Care Unit (NICU), Banner Desert Medical Center, 1400 S. Dobson Road, Mesa, AZ, 85202. If I do withdraw my authorization, any information previously disclosed cannot be withdrawn and may continue to be used. Once information about me is disclosed in accordance with this authorization, the individual or organization that receives this may re-disclose it and my information may no longer be protected by Federal Privacy Regulations. I may refuse to sign this authorization form. If I choose not to sign this form, I cannot participate in the research study. Refusing to sign will not affect my present or future medical care and will not cause any loss of benefits to which I am otherwise entitled. This authorization will expire on the date the research study ends. I will be given a copy of this signed authorization form.

______________________________________________
Parent/Legal Guardian’s Signature                      Date

______________________________
Printed Name of Parent/Legal Guardian

______________________________
Relationship to the Infant (Father/Mother/Guardian)
APPENDIX C

INSTRUMENTS AND QUESTIONNAIRES
# Newborn Scale Of Sepsis (SOS)

**Rubarth ©2005**

<table>
<thead>
<tr>
<th>Date of Exam</th>
<th>Age at Exam (hours)</th>
</tr>
</thead>
</table>

**Laboratory Findings:**

- **White Blood Cell Count**
  - \(<5,000 = 5\), \(>30,000 = 2\), \(5,000-30,000 = 0\)

- **Immature:Total Neutrophil Ratio**
  - \(>0.3 = 5\), \(0.2 \leq 0.3 = 3\), \(<0.2 = 0\)

- **Platelet Count**
  - \(<100,000 = 3\), \(\geq 100,000 = 0\)

- **Blood Acidity**
  - \(\text{pH} < 7.25 = 2\), \(7.25 \leq \text{pH} < 7.34 = 1\), \(\text{pH} \text{ normal} = 0\)

- **Absolute Neutrophil Count**
  - \(<1000 = 5\), \(1000-2000 = 3\), \(>2000 = 0\)

**Clinical Indicators:**

- **Skin Color**
  - Ashen/Grey = 5, Dusky = 3, Mottled = 2, Acrocyanosis = 1, Pink = 0

- **Perfusion (Cap. Refill)**
  - Poor > 7 sec = 5, Moderate 6-7 sec = 3, Fair 4-5 sec = 1, Good < 4 sec = 0

- **Muscle Tone**
  - Flaccid = 5, Low tone = 3, Good tone = 0

- **Responsiveness to Pain**
  - No response = 5, Some response (withdrawal) = 2, Active Crying = 0

- **Respiratory Distress**
  - Present with grunting = 5, Present no grunting = 3, None = 0

- **Respiratory Rate**
  - Respiratory rate \(\geq 100 = 5\), RR 60-99 = 3, RR < 60 = 0

- **Temperature**
  - Low temp \(<97^\circ\ F = 3\), High temp \(>99^\circ\ F = 2\), Normal 97-99\(^\circ\ F = 0\)

- **Apnea**
  - Present = 2, Absent = 0

**Total Score**
Infant Demographic Data Collection Form

Name ___________________________ Age at Admission _____________

Birth Date __________________________ Birth Time ______________________

Gestational Age _________________________ Diagnosis ______________________

SVD or C-section __________________________ Wt = __________ Apgars _________

Maternal History:

Gravida/Para _____________ Birthdate ___________________ Age _________

Pregnancy Complications: NONE

______________________________________________________________

Delivery Complications: _________________________________________

Hours of Ruptured Membranes Prior to Delivery _________________

Maternal Fever: YES NO

Maternal Antibiotics: YES NO

No. of Doses: ________________

Times of Doses: __________________________________________________

Med Given: _____________________________________________________

UTI: YES NO

CHORIO: YES NO

GBS Status: POSITIVE NEGATIVE

GBS Previous Pregnancy: POSITIVE NEGATIVE

Internal Monitoring: YES NO Length of Time _________

Epidural Anesthesia: YES NO

Meconium Amniotic Fluid: YES NO Aspirated? YES NO

Baby’s Blood Culture: Positive (Type)___________________________ Negative
Nursing Demographic Questionnaire

Age: ____________  Sex: F _______ M________

Years of Education Beyond H.S.: ________________

Highest Education Level (Circle and Indicate Major as needed):

- **ADN Diploma**
- **BS (major?):** ______________
- **BSN MS/MSN (major?):** ______________
- **PhD or DNS (major?):** ______________

Years of nursing experience: ____________ Years of NICU experience ____________

Years of newborn nursery experience (if no NICU experience): ____________________

Number of different NICUs you have worked in: ________________________________

How would you realistically rate your expertise with newborn infants? (CIRCLE)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novice</td>
<td>Advanced Beginner</td>
<td>Competent</td>
<td>Proficient</td>
<td>Expert</td>
</tr>
</tbody>
</table>

The following items pertain to nurses who completed the Newborn Scale of Sepsis (SOS).

1. Did you use the SOS scale? ______ If so, how would you rate its ease of use?

<table>
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<tr>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to use</td>
<td>Somewhat easy</td>
<td>So-so</td>
<td>Somewhat Difficult</td>
<td>Very Difficult</td>
</tr>
</tbody>
</table>

2. Did using the SOS help you pick up any early signs of infection in the newborns? (Please circle one.)

- YES
- NO
- NA – Did not use the SOS

3. Are there any issues about using the SOS scale that you’d like me to know about? (If so, please comment here.)
Nursing Patterns of Knowing (POK) Scale

Rubarth and Reed ©2005

Directions: The following questions pertain to approaches to assessment that nurses may use. Please rate yourself by circling the number on the scale provided to indicate the extent that you use each approach in assessing newborns in your practice:

1. How often do you use physiologic or other scientific data like HR, RR or saturations in your assessment of infants for serious illness?

Do not use  
Sometimes use  
Use 1/2 the time  
Use frequently  
Use all the time

1  2  3  4  5

Comments:

2. How often do you use habits or routines in your assessment of infants for serious illness? (e.g. physical exam follows a routine pattern or approach)

Do not use  
Sometimes use  
Use 1/2 the time  
Use frequently  
Use all the time

1  2  3  4  5

Comments:

3. How often do you use intuition or “gut feelings” in your assessment of infants for serious illness?

Do not use  
Sometimes use  
Use 1/2 the time  
Use frequently  
Use all the time

1  2  3  4  5

Comments:

4. How often do you use your previous clinical experiences in your assessment of infants for serious illness?

Do not use  
Sometimes use  
Use 1/2 the time  
Use frequently  
Use all the time

1  2  3  4  5

Comments:
5. How often do you use your personal knowledge of yourself in your assessment of infants for serious illness?

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:

6. How often do you use empathy related to your encounters with the infant in your assessment of infants for serious illness?

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:

7. How often do you use data obtained from those in authority (e.g. preceptors, MD, NNPs, team leaders) in your assessment of infants for serious illness?

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:

8. How often do you use research-based information in your assessment of infants for serious illness? (information obtained from conferences, journals, scientific reports, etc)

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:

9. How often do you use input from the parents in your assessment of infants for serious illness?

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:
10. How often do you use nursing policies, procedures or guidelines in your assessment of infants for serious illness?

Do not use  Sometimes use  Use 1/2 the time  Use frequently  Use all the time

1  2  3  4  5

Comments:

11. How often does your ethical judgment play a role in your assessment of infants for serious illness? (focusing on what you know is right, or what ought to be done regardless of other sources of input.)

Not at all  Sometimes  1/2 the time  Frequently  All the time

1  2  3  4  5

Comments:

12. How often do the consequences of your actions influence your assessment of infants for serious illness? (what will happen if I do this vs. do not do this?)

Not at all  Sometimes  1/2 the time  Frequently  All the time

1  2  3  4  5

Comments:

13. How often does doing what is expedient or necessary influence your assessment of infants for serious illness?

Not at all  Sometimes  1/2 the time  Frequently  All the time

1  2  3  4  5

Comments:

14. How often do your own personal experiences in life influence your assessment of infants for serious illness?

Not at all  Sometimes  1/2 the time  Frequently  All the time

1  2  3  4  5

Comments:
15. How often does the social atmosphere of your unit influence your approach to assessing infants for serious illness? (friendships & non-friendships, the “fun” at work, other social issues)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Sometimes</th>
<th>1/2 the time</th>
<th>Frequently</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</table>

Comments:

16. How often does the political climate of your unit influence your approach to assessing infants for serious illness? (who you’re working under, who you are working with, what assignment you have, other politics)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Sometimes</th>
<th>1/2 the time</th>
<th>Frequently</th>
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</tbody>
</table>

Comments:

17. Are there any other approaches to assessment of infants that you use that were not addressed in these questions? Please explain. I am VERY interested in learning about any ideas you may have about how nurses assess infants with serious illnesses. (Continue on back if needed)
APPENDIX D

CONTENT VALIDITY INDEX (CVI)
Using your personal experience and expertise, please rate each of the following items as to their relevancy for predicting early-onset newborn sepsis. Please rate each item using a 4-point rating scale: (1) Not relevant, (2) somewhat relevant, (3) quite relevant, and (4) very relevant.

### Laboratory Findings:

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Relevancy Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Blood Cell Count</td>
<td></td>
</tr>
<tr>
<td>(&lt;5,000 = 5, &gt; 30,000 = 2, 5,000-30,000 = 0)</td>
<td></td>
</tr>
<tr>
<td>Immature:Total Neutrophil Ratio</td>
<td></td>
</tr>
<tr>
<td>(&gt;0.3 = 5, &gt; 0.2 = 3, &lt; 0.2 = 0)</td>
<td></td>
</tr>
<tr>
<td>Platelet Count</td>
<td></td>
</tr>
<tr>
<td>(&lt; 100,000 = 3, &gt; 100,000 = 0)</td>
<td></td>
</tr>
<tr>
<td>Blood Acidity</td>
<td></td>
</tr>
<tr>
<td>(pH &lt; 7.25 = 2, pH 7.25-7.34 = 1, pH normal 7.35-7.45 = 0)</td>
<td></td>
</tr>
<tr>
<td>Absolute Neutrophil Count</td>
<td></td>
</tr>
<tr>
<td>(&lt;1000 = 5, 1000-2000 = 3, &gt; 2000 = 0)</td>
<td></td>
</tr>
</tbody>
</table>

### Clinical Indicators:

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Relevancy Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Color</td>
<td></td>
</tr>
<tr>
<td>(Ashen/Grey=5, Dusky=3, Mottled=2, Acrocyanosis=1, Pink=0)</td>
<td></td>
</tr>
<tr>
<td>Perfusion (Cap. Refill)</td>
<td></td>
</tr>
<tr>
<td>(Poor &gt;7 sec=5, Moderate 6-7 sec=3, Fair 4-5 sec=1, Good &lt;4 sec=0)</td>
<td></td>
</tr>
<tr>
<td>Muscle Tone/Responsiveness</td>
<td></td>
</tr>
<tr>
<td>(Flaccid/No response = 5, Low tone/Some response = 3, Good tone = 0)</td>
<td></td>
</tr>
<tr>
<td>Respiratory Distress</td>
<td></td>
</tr>
<tr>
<td>(Present with grunting = 5, Present no grunting = 3, None = 0)</td>
<td></td>
</tr>
<tr>
<td>Tachypnea</td>
<td></td>
</tr>
<tr>
<td>(Respiratory rate &gt; 100 = 5, RR 60-99 = 3, RR &lt; 60 = 0)</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>(Low temp = 3, High temp = 2, Normal = 0)</td>
<td></td>
</tr>
<tr>
<td>Apnea</td>
<td></td>
</tr>
<tr>
<td>(Present = 2, Absent = 0)</td>
<td></td>
</tr>
</tbody>
</table>
Definitions of Sepsis Scale Items

Laboratory Findings:
1) White Blood Cell Count: The total number of white blood cells reported on a complete blood count (CBC) as counted by a Coulter counter after the nucleated red blood cells are removed.

2) Immature:Total Ratio of Neutrophils: This number is calculated by taking the reported number (%) of immature neutrophils (bands, metamyelocytes, myelocytes, promyelocytes, blast cells) on a CBC and divide it by the total number (%) of neutrophils reported (which includes the previously mentioned cell types as well as segmented neutrophils).

3) Platelet Count: The total number of platelets counted by a Coulter counter.

4) Blood Acidity: The acidity of the blood on evaluation of an arterial blood sample.

5) Absolute Neutrophil Count: The number of neutrophils reported on a CBC (see #2) as a percentage of the total number of white blood cells (see #1).

Clinical Indicators:
6) Skin Color: The color of the skin as noted by observation of the lip/mucus membranes and body color in regard to cyanosis/duskiness vs. pinkness. Ashen/grey is very poor skin color without any noticeable pinkness. Dusky is blue undertones to the skin. Mottled is a lacy pattern of blue capillaries on a pale background. Acrocyanosis is blue hand and feet with pink central color. Pink is a totally pink infant.

7) Perfusion: The lower extremity is blanched with the thumb or forefinger of the examiner and released. The seconds are counted until full return of superficial blood flow is noted.

8) Muscle Tone/Responsiveness: The tone is seen with a movement of an extremity. Flexion indicated good tone, flaccidity indicates no tone. An infant is often noted on heelstick (painful stimuli) to respond either with withdrawal of the extremity and crying, a mild withdrawal of the extremity with a weak cry, or with no response whatsoever.

9) Respiratory Distress: Difficulty breathing which includes some type of retractions, deep breathing and nasal flaring. Most severe respiratory distress includes grunting, which is the noise someone makes while trying
to exhale against a partially closed glottis, like an “ahhhhhh” sound.

10) **Tachypnea:** The number of times an infant completes a respiratory cycle of inspiration and expiration within one minute.

11) **Temperature:** An axillary temperature less than 97°F is low in a newborn. An axillary temperature greater than 99°F is high in a newborn. Temperature between these two extremes can be considered within the normal limits. The temperature will be taken by either electronic or mercury thermometers.

12) **Apnea:** The cessation of breathing for greater than 20 seconds. Its presence or absence will be noted.
REFERENCES


