

**THE INFLUENCE OF SHARED MENTAL MODELS OF NOSOCOMIAL
BLOODSTREAM INFECTIONS ON NEONATAL INTENSIVE CARE UNIT
INFECTION RATES**

A Thesis

Submitted to the Faculty

in partial fulfillment of the requirements for the

degree of

Doctor of Philosophy

in

The Evaluative Clinical Sciences

by

Diana M. Luan, R.N., M.P.A., M.S.

DARTMOUTH COLLEGE

Hanover, New Hampshire

March 30, 2006

Examining Committee:

(chair) Eugene C. Nelson, D.Sc., M.P.H.

Ann Barry Flood, Ph.D.

Paul B. Batalden, M.D.

Stephen M. Shortell, Ph.D., M.P.H.

Charles K. Barlowe, Ph.D.
Dean of Graduate Studies

Abstract

Statement of the Problem

Nosocomial bloodstream infections (NBSIs) are a significant source of morbidity and mortality for the very low birth weight babies (VLBW) in neonatal intensive care units (NICUs). Efforts to reduce the rates of infection have produced mixed outcomes, and significant variation in the rates exists. The objective of this research was to identify if a shared mental model of NBSI among NICU staff as preventable was associated with lower infection rates in NICUs.

Methods

Data came from surveys and interviews and site observations of six NICUs associated with the Vermont Oxford Network (VON) of staff to explore the relationship between mental models about prevention of infection and rates achieved.

Results

Staff were defined to have a Prevention Mental Model when they believed that NBSI are preventable events, it is possible to reduce the rate to near zero, and infections are perceived to be errors in the process of care. This mental model contrasted to an Inevitable Mental Model where NBSIs are inevitable events, attainment of a near zero rate is not possible, and NBSIs are expected complications of care.

NICUs with low NBSI rates were strongly associated with staff who shared the Prevention Mental Model. Such units were more likely to have active engagement of the unit staff in the improvement process, leadership who served as mentors, and organizational cultures that were more group-oriented. NICUs with high NBSI rates were more likely to share an Inevitable Mental Model. These NICUs were more likely to have very hierarchical approaches to the improvement process and leaders who took roles of policing and policy development. Staff at the two sites with exposure to the VON collaborative for improvement of care exhibited transitional thinking, moving from an Inevitable to a Prevention Mental Model.

Conclusions

These results suggest that the dominant mental model shared by staff influences their action and behaviors in ways that may contribute to lower NBSI infection rates. Policy makers and clinical leaders may benefit from establishing an appropriate prevention-orientation among staff when trying to improve care and reduce costs in neonatal intensive care.

Preface

I would like to express my gratitude to my dissertation committee for their patience and leadership through the years. Dr. Nelson for his thoughtful, patient conversations that guided and focused my research and learning. Dr. Flood for providing professional and academic direction. Dr. Batalden for instilling the concepts of systems and learning. Dr. Shortell whose work was the genesis for this research. Thank you all for making the past few years a rich and rewarding experience.

A special thank you to Bill Edwards, M.D. of Dartmouth Hitchcock Medical Center who introduced me to the concept of a shared mental model of infection and to the Vermont Oxford Network. This study would not have been possible were it not for his generous sponsorship. And to Dr. Jeffery Horbar, Director of the Vermont Oxford, who facilitated access to the NICUs.

I would also like to thank my parents, Lawrence and Barbara Luan, who provided me with the inner strength to stay the course. Most especially I am grateful to my son, Patrick, who gave me the daily support and aggravation that enriched my years of study, without you I would not have come this far.

Table of Contents

Abstract	ii
Preface	iv
Table of Contents	v
List of Tables	vii
List of Figures	ix
Chapter 1: Introduction	1
Overview	1
Chapter 2: Significance	3
Definition of Nosocomial Bloodstream Infections	3
Epidemiology of Nosocomial Bloodstream Infections	4
Process Associated with Nosocomial Sepsis	6
Mental Models	8
Organizational Culture	17
Related Studies	22
Chapter 3: Study Framework	26
Chapter 4: Qualitative Study	
Research Questions	29
Study Frame	30
Qualitative Methods	33
Qualitative Analysis Plan	35
Chapter 5: Qualitative Results	36
Observational Results	55
Chapter 6: Qualitative Study Discussion & Limitations	61
Chapter 7: Quantitative Study	
Research Question	66
Survey Site Selection	66
Pilot Test of Survey Administration	67
Survey Administration	68
Study Variables	69
Survey Data Analysis	69

Chapter 8: Quantitative Results	
Survey Descriptive Statistics	73
Missing Data	74
Item Analysis	74
Domain Analysis	75
Culture Analysis	76
Domain Reliability Analysis	80
Chapter 9: Quantitative Study Discussion & Limitations	82
Chapter 10: Conclusions	
Results Summary	85
Low NBSI Rate NICUs	86
High NBSI Rate NICUs	88
Chapter 11: Overall Study Strengths & Limitations	
Major Strengths	90
Major Limitations	91
Chapter 12: Implications & Future Research Needs	93
Chapter 13: References	97
Appendix 1: Data Collection Tools	102
Appendix 2: Low Nosocomial Bloodstream Infection Rate NICUs	116
Appendix 3: High Nosocomial Bloodstream Infection Rate NICUs	138
Appendix 4: Survey Statistics	168

List of Tables

Table 1:	Characteristics of the Study NICUs	36
Table 2:	Illustrative Statements to the Question: Are NBSI Inevitable or Preventable in pre-term babies of less than 32 weeks gestational age?	38
Table 3:	Illustrative Response to the Statement: “Researchers have stated that no baby of less than 32 weeks gestational age should have a NBSI.”	40
Table 4:	Illustrative Statements: NBSI as an Error, Anticipated Complication of Care, or Both	41
Table 5:	Illustrative Statements: What Respondents Tell Parents	43
Table 6:	Illustrative Statements: Concept of Personal Integrity	44
Table 7:	Illustrative Statements: Concept of Response Threshold	45
Table 8:	Illustrative Statements: Unit Leadership Role	49
Table 9:	Illustrative Statements: NICU Process of Change	52
Table 10:	Examples of Violations in Infection Control Measures in High NBSI Rate NICUs	60
Table 11:	Distribution of Survey Respondents’ Roles in the NICU	73
Table 12:	Distribution of Survey Respondents’ Work Hours	73
Table 13:	Distribution of Survey Respondents’ Experience	74

Table 14: Items with Statistically Significant Differences Between High and Low Infection Rate Facilities	75
Table 15: Crude Mean Difference of Domain Summative Rating Scales	76
Table 16: Mean Difference of Adjusted Domain Summative Rating Scales	78
Table 17: Crude Cultural Domains	78
Table 18: Association of Culture Domains with Shared Mental Model	79
Table 19: Difference in Culture Types by Role and Experience	79
Table 20: Survey Domains Comparative Cronbach's Alphas	80

List of Figures

Figure 1: Paradigm of Performance Characteristics	11
Figure 2: Kraiger and Wenzel Framework for a Shared Mental Model of Teams	13
Figure 3: Dickinson and McIntyre Framework	16
Figure 4: Competing Values Model of Organizational Effectiveness	21
Figure 5: Managerial and Organizational Factors Affecting ICU Performance	24
Figure 6: Proposed Model for Nosocomial Bloodstream Infections in NICUs	27

Chapter 1: Introduction

Overview

Nosocomial bloodstream infections (NBSIs) are a significant problem for Neonatal Intensive Care Units (NICUs) that care for a vulnerable population, the fragile very low birth weight (VLBW) infants weighing less than 1500 grams. Infections in this population are a major source of morbidity, mortality, cost and increased length of hospital stay [1-7]. Efforts to reduce the rate of infection have met with some success [8], but significant variation in the rates still exists even after improved practices [2, 9-11].

Difficulties in rate reductions may be associated with the organizational behavior of the NICU [8]. To address these concerns, Edwards proposed a framework where he hypothesized that the conceptual beliefs of staff about infections plays a role in the ability to control infections [12]. He proposed two opposing conceptual belief models, based upon observations made during site visits to benchmark NICUs [12]. In the “Entitlement Model,” staff believed that nosocomial infections are unavoidable events brought on by the vulnerability of the VLBW infants. Infection is seen as an expected outcome resulting from the infant’s gestational age at birth, size, compromised immune system, and the high number of invasive procedures to sustain the life of premature neonates. In the contrasting “Prevention Model” staff hold a different perspective on the unit’s role with respect to the vulnerability of the VLBW infants. They believe these infants pose unusually high risk, but that infections are preventable with good care which in turn leads the unit to focus on using extra-stringent standards of care and

designing systems that minimize risk. If the conceptual beliefs of staff about infections has a role in the control of infections, understanding the belief model and how it influences the behavior of staff becomes important for improving the safety and quality of care and the reduction of the NBSI rate. “Shared mental models” can be defined as the beliefs held in common by a group. In the culture of NICUs, the shared mental model regarding nosocomial infections is the common perception held by the physicians, nurses and ancillary staff who care for the neonates. This shared mental model influences their actions and behaviors with regard to infection prevention and may predict the outcomes of the neonates.

This research has the potential to improve the understanding of shared mental models held by the members of a NICU care team and if evidence of a link between shared mental models and infections rates is established this research can help understand how changing mental models toward a preventive model could improve the nosocomial bloodstream infection rate. The specific aim of this study is to examine NICUs selected because they have a high or low NBSI rate and observe whether they have an “Inevitable” or “Preventive” shared mental model of infection respectively.

Chapter 2: Significance

Nosocomial infections are a significant source of morbidity and mortality in NICUs. Efforts to reduce the infection rate require understanding the factors that influence the occurrence of infection and changing the processes of care. Successful change requires understanding the beliefs regarding nosocomial infections held in common by the care team have and how their beliefs affect behavior.

Definition of Nosocomial Bloodstream Infections

Nosocomial bloodstream infection (NBSI) rates are one standard used to compare the quality of NICUs. However, there are several different definitions of infection varying in regard to what types of pathogens are present, and what evidence of its presence is required. The Center for Disease Control (CDC) defines a NBSI as being an infection that is laboratory-confirmed with one or more blood cultures. If the pathogen is commonly found on the skin, two or more positive cultures are required and the patient must exhibit specific clinical symptoms of fever, hypothermia, apnea, or bradycardia [13]. The National Institute of Child Health and Human Development (NICHD) defines nosocomial infections as one or more positive blood cultures in the presence of clinical signs or symptoms of infection and antibiotic treatment for 5 days or more [2]. The Vermont Oxford Network (VON) definition says that if the pathogen is coagulase-negative staphylococcus or one from a specific list of bacteria, if the infection must occur after the third day of life (late onset sepsis) and must be confirmed by

a blood culture taken from either a peripheral vein, a central venous line, or from spinal fluid. In the case of coagulase-negative staphylococcus, the blood or spinal fluid must test positive for the organism, the patient must exhibit systemic illness, and have concurrent antibiotic therapy treatment for 5 days [8]. The definition differences are subtle, but even subtle differences in definition specification leads to significant differences in the calculated rates [14, 15], complicating comparisons across studies and institutions.

Epidemiology of Nosocomial Bloodstream Infections

VLBW infants have the highest rates of nosocomial bloodstream infection with a significant potential for morbidity and mortality. In a study of late-onset sepsis 25% of 6911 infants who lived beyond three days had one or more positive blood cultures, 77% were from gram-positive organisms, 55% due to coagulase-negative staphylococci [2]. Neonates with nosocomial bloodstream infections were at increased risk for dying especially if the infecting organism was gram-negative; 45% of the deaths that occurred after two weeks of age were infection related. In a study conducted in Italy, using the CDC definition for nosocomial bloodstream infection, almost 20% of the infants had nosocomial bloodstream infections, coagulase-negative staphylococci accounting for 25% of the infections [16]. Mortality was higher in infants who had at least one nosocomial bloodstream infection when compared to non-infected infants. Factors found to be associated with nosocomial bloodstream infections were low

gestational age, use of intravenous catheters, and continuous infusion of lipid mixtures.

A study in the United Kingdom (UK) of 13,515 consecutive admissions in 186 NICUs, examined the relationship between patient volume and morbidity and mortality [17]. Patient volume was defined as the number of VLBW (<1500 g) infants admitted per year: high volumes being greater than 57 admissions per year; medium-volume, 35-57 VLBW admissions per year; and low volume, less than 35 VLBW admissions per year. The outcomes measured were hospital mortality or major cerebral abnormality of probable postnatal origin and nosocomial bloodstream infections. After adjustment for clinical risk and illness severity there was no significant difference in the mortality and morbidity rates. Risk-adjusted mortality increased with increasing workload; a 10% increase in maximum occupancy of the unit at admission increased the odds of dying by 1.09 (1.01-1.18). Risk-adjusted nosocomial bloodstream infections were higher in NICUs with more than one neonatologist.

The Vermont Oxford Network examined the NBSI rate for the three-year period 2000 to 2002. The analysis was restricted to the 299 NICUs that treated more than 75 infants and used the VON definition for NBSI. The rates of infection varied with a mean of 19% and an inter-quartile range of 14-26%. The range in the lowest quartile was 0-8.9% and in the highest quartile the range was 32-54%. Standardization of the rates suggests that case mix and type of NICU did not account for the very low rates seen in the lowest quartile NICUs or the range of rates [18].

Processes Associated with Nosocomial Sepsis

Nosocomial bloodstream infections, as a clinical indicator, must be linked to variations in the process of care to be useful. Understanding the processes of care requires knowledge of the sources of infection and infection control measures. An observational study of provider practices during an infection outbreak revealed failures to follow through with infection prevention protocols that allowed rapid dissemination of the infection by means of contaminated providers and equipment. Violations to isolation protocols, aseptic techniques, hand hygiene and equipment or environment disinfections were prevalent. High patient to nurse ratios (6:1 for level II) and a high census were noted during the infection outbreak [19].

Hand hygiene involves actions that reduce the colonization of contaminants that could potentially be introduced into the body tissues of neonates during invasive procedures. Handwashing is the act of removing dirt and transient flora using water and non-medicated detergents; hygienic handwashing involves the use of soap with an antiseptic agent; and hand disinfection is the term used for cleansing with medicated soap or alcohol [20]. In a large cross-sectional survey of physicians that included individual observation of physician hand hygiene practices within a large teaching hospital, noncompliance with hand hygiene practices was the greatest when demand for hand hygiene was high [21]. Factors associated with noncompliance included: male gender, being a physician, working in an intensive care unit, working during

the week, use of gown and gloves, performance of procedures with high risk for cross-contamination, and intensity of patient care defined as the number of opportunity per hour of patient care [20].

Gaynes and his colleagues found that umbilical or central intravenous catheters were associated with 88% of the nosocomial bloodstream infections and 13-21% of the primary bloodstream infections were due to clinical sepsis, using the CDC prevention definitions [10]. Processes associated with umbilical catheters, central lines and peripheral intravenous lines have been studied and differences in the processes of care for high and low infection rate NICUs identified; removal of umbilical lines within 7 days, limited use of peripheral lines, use of sterile technique for manipulation of lines and dressing changes were observed to be associated with low infection rate NICUs [22]. Infants with known bacterial infections had fewer infection related complications if central lines were removed within 24 hours of organism identification [23].

In a national point-prevalence study of 29 hospitals, Sohn and colleagues found infants who weighed less than 1500 grams were 2.69 times more likely to have an infection when compared to all other patients in the study. Half of the bloodstream infections were caused by coagulase-negative staphylococci bacteria commonly found on skin and mucous membranes. Infection is introduced by a disruption of skin or mucous membrane integrity [24].

The Vermont Oxford Network (VON) collaborative of NICUs researched the literature to identify better practices for preventing nosocomial infections. Six units worked on infection reduction using multidisciplinary teams in conjunction

with a facilitator, implementing some or all of the identified better practices. After implementation of the identified better practices, the six units overall infection rate was 16.7% versus 22.8%, a 6% difference for the 65 units used as a comparison group. The rate of coagulase-negative staphylococcal infection was 12.3% at the 6 NICUs compared to 22.0% in the pre-intervention period, and for all other infections the rate in the 6 NICUs was 7.2% versus the 10.3% in the pre-intervention period [8].

Mental Models

Individual Mental Models

Mental models originated in the psychology literature to describe the cognitive images that an individual in a task environment creates of the task and the capabilities needed for performance of the task. The study of mental models has focused on understanding how human beings create models of knowledge of the world [25] and are used to understand reasoning and decision-making [26], mental health [27], and human-computer interactions [28]. Used this way, the concept is a powerful theoretical tool for understanding comprehension, inference, and individual cognitive thought processes.

Mental models are a structural framework to hold events and information, making phenomena easier to comprehend and predict. Some scientists portray mental models as an individual internal mechanism that enhances the description, explanation and prediction of events in the environment [29], by providing a mental map to organize knowledge about objects, situations, events,

and the relationships among the elements [30]. Some theorize that mental models serve as the source of expectations [30], creating a means for inference and prediction about new experiences and guiding responses to these new experiences.

Phillip Johnson-Laird used mental models to examine how the mind worked in terms of language [29]. He believed a repetitive process occurred that allowed the individual to understand the verbal exchange of ideas. In this process mental models of real and imagined meaning developed and reasoning facilitated the manipulation of models to create understanding. The Johnson-Laird framework accounted for “objects, events, and interactions of daily life; inferences and predictions; understanding of phenomena; and decisions of what action to take and how to execute the action [29].” Most importantly, mental models are a way “to experience events by proxy” by creating a common language to share with others to represent perceived meaning and experienced meaning, and to allow for comparison [29]. Mental models thus constantly evolve and are useful because they possess predictive and explanatory capabilities. It should be noted that they are not always technically accurate. Mental models are also limited by the background of the individual, his or her previous experience with similar events, and the structure of human information processing [31].

Perception is hypothesized to be the primary source of mental models and functions with interpretation and inference. Likewise, the framework of mental models, constructed from the content of perceptions, evolves from a small set of

elements and their repeated manipulation. The power of mental models to represent objects or events leads to perceptions and underlying intentions that determine action and communication [29]. These underlying features of mental models do not make their study is simple, since it involves what lies within the mind of an individual--the images, patterns and logic that are not readily available for inspection and often do not operate at a conscious level. At best the researcher is able to touch upon the belief system of the individual through observation or inference, and observe a correlation between what is hypothesized to be the belief of the individual and their actions.

Shared Mental Models

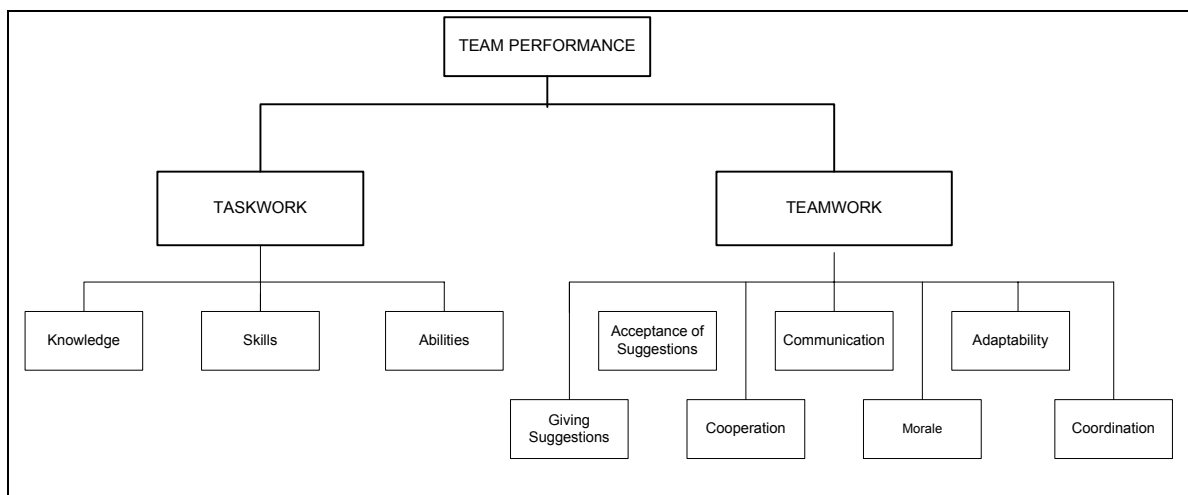
The individual mental model, as a cognitive tool, has been extended to examine the impact of a shared mental model, mental models held in common by the members of teams. Shared mental models are congruent perceptions, the structural framework or cognitive map that is used for information and events held in common by a defined group of individuals. A search of the literature found only research on shared mental models of teams and a single paper that poses a shared mental model of infection as a cultural element that impacts process improvement and infection rate [12].

In a study of military teams, two distinct mental models **Taskwork** and **Teamwork**, were hypothesized to be shared by the members (Figure 1) [32]. The *Taskwork* mental model was defined to be the knowledge, skills, and abilities (KSAs) associated with the execution of specific tasks; the *Teamwork* model

involved the behaviors for interaction and coordination of team members in the accomplishment of specified goals or tasks.

The hypothesis that *Taskwork* and *Teamwork* were two distinct mental models was tested in a study of 56 undergraduates using flight simulators. Using paired teams in flight simulators and with varying degrees of familiarity with the simulators, the study showed that the teamwork mental model significantly predicted team performance, whereas the taskwork mental model was not related [33].

Figure 1: Paradigm of Performance Characteristics [32]



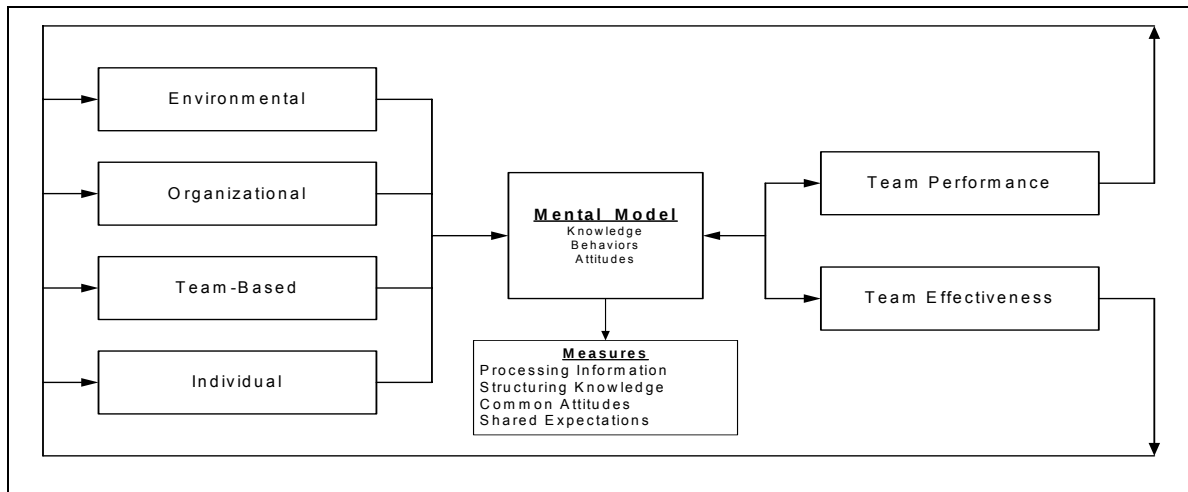
In a second study, the paradigm was used to examine *tactical decision-making* in complex, dynamic environments. Team was defined as “a distinguishable set of two or more individuals who interact interdependently and adaptively to achieve specified, shared, and valued objectives [34].” Using interviews and direct observations of Naval Gunfire Support Teams, Antisubmarine Warfare Teams, and Guided Missile Teams in training, teamwork was found to be a complex set of behaviors consisting of: performance

monitoring, feedback, closed-loop communication, and back-up behaviors, along with two performance norms of team self-awareness and fostering within-team interdependence [34].

In the hierarchical structure of the military, teams that performed the most effectively were those where everyone's opinions were valued equally, and where giving and accepting feedback was an important aspect of the communication patterns. Additionally, effective teams used closed-loop communication that included verification and feedback mechanisms.

Performance monitoring and back-up behaviors were the result of cross training and the tacit monitoring of team members and their tasks. Cross training had a strong influence on member's ability to evaluate the competency of others and to provide assistance in the performance of tasks and was enhanced by the attitudinal norms of team self-awareness and within-team interdependence. The shared value of success, where the success of the team is dependent upon being a team member first and an individual second, was important to team self-awareness. This fostered cohesion and mutual dependence within the team that in turn led to an overall synergy.

Figure 2: Kraiger and Wenzel Framework for a Shared Mental Model of Teams.



Kraiger and Wenzel proposed a framework for a shared mental model of teamwork based upon the work of Baker and Salas (Figure 2) [35]. Three additional core behaviors were seen in successful teams: cooperation, adaptive interaction, and differentiated role and responsibilities. Four constructs were proposed for measurement of the shared mental model: *processing information, organizing information, common attitudes, and shared expectations*.

Processing information measures how information or knowledge is “acted upon.” It is thought to be more important than understanding knowledge since knowledge is stored in understandable wholes (schema) that include attributes that make identification easy. Aggregation of individual schemas can then be used to represent how teams operate and accomplish tasks [36]. **Organizing information** measures how members perceive interrelationships among key concepts or knowledge. **Common attitudes** are beliefs strongly associated with team processes and performance. Two important attitudes are *collective efficacy* is the teams’ ability to function as a unit, the assessment of the team’s ability to

perform the task and be successful; *collective orientation* is a measure of the “oneness” of the unit, where the team approach is superior to any individual approach. Finally, diagnostic activities were associated with **shared expectations**, the team diagnostic activities; backups and coordinates activities; and understanding of functional responsibility and task contributions.

The **team-based** experience influences the shared mental models and is related to the task characteristics, process characteristics and shared efficacy. Tasks fall along a continuum from highly structured to abstract. Highly structured, simple tasks are associated with greater uniformity in mental models; abstract tasks are subject to interpretation and variation in the mental model is greater. Increasing task complexity requires a distribution of shared knowledge structures among team members to reduce individual cognitive load, as cognitive load is additive [37].

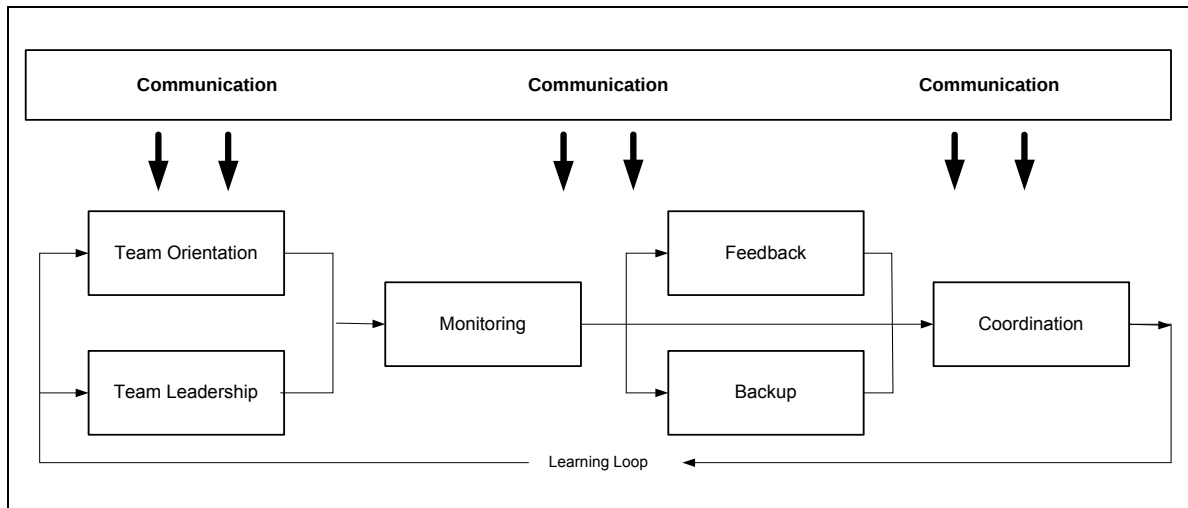
Team *process characteristics* are communication, coordination [30, 32, 38], and feedback. *Shared efficacy* is the teams’ ability to function as a unit and is influenced by previously shared experienced as a team, both successes and failures [38]. Therefore *team-based training* is important to a shared mental model, reinforcing the common understanding members have about task, goals, and behaviors [39-42]. *Team-based rewards* have a positive effect on collective orientation and efficacy and alignment of incentives is important to avoiding unintended consequences (Lawler, 1990; Weiner, 1980 in [35]). **Individual antecedents**, *personality and motivation*, influence individual learning. Teams that are homogenous in respect to the aforementioned variables are more likely

to have a shared mental model resulting from structural knowledge and information processing overlap.

In the Kraiger and Wenzel framework, **team effectiveness** and **performance** are the outcomes of a shared mental model of team. *Team effectiveness* has measurable outcomes that can include: productivity, quality, time, cost, and errors. *Team performance* are the intangible variables identified by McIntyre and Salas as elements of teamwork [35] and are indirect measures of the shared mental model. The fluid, implicit interactions observed in successful teams in dynamic and complex environments results from a shared mental model, the common understanding of problems and strategies for responding to the situation and solving problems [33, 34] .

Dickinson and McIntyre proposed another conceptual framework for measuring teamwork (Figure 3) [34] linking the elements of behavior associated with successful teams [32] to create a simple, logical and scientifically based framework. A major construct is communication, the active exchange of information in an appropriate manner [43], is linked to all other constructs of the framework. Communication has been identified as important to team interaction and development of a shared mental model [32, 34, 37-39, 44, 45], the exchange of information in complex dynamic systems using the appropriate terminology in a timely and acceptable format [38] supports all other components of the framework.

Figure 3: Dickinson and McIntyre Framework [43]



An observational study of flight crews in training exercises tested the hypothesis that shared mental models have a role in coordination, communication, and team performance [39]. The study found that communication-related problems accounted for more than half of the difficulties encountered. Difficulties were related to failure to communicate, inaccurate communication, untimely communication, and communication not received. In the “Hospital’s Internal Communications Project (HIC),” a multi-hospital cooperative communications and information-sharing project in London, improvements in internal communication led to a significant reduction in the mean length of stay. The nature of communication, the value of the solution, available resources and accuracy of information were associated with improved internal communication [46, 47]. Communication being the backbone to the development of shared mental models [29].

Important elements of the Dickinson and McIntyre framework of shared mental model are team orientation and leadership. **Team orientation** consists of

the attitudes that members display towards one another, tasks, and leadership. Leadership provides direction, structure, and support and must exhibit a willingness to orchestrate the behavior of the members and their tasks, while serving as a role model and earning the respect of the team.

Membership is important to the framework, like the Kraiger and Wenzel model. The collective orientation emphasizes team goals over individual goals [38]. It is a reflection of shared values, norms and cohesiveness of the team [38, 43]. Members of highly effective teams place a high priority on team goals, and willingly participate in all activities of the team.

Monitoring is the direct and tacit observation and awareness of activities and performance of other team members [34]; it is important to both feedback and back-up activities improves coordination and reinforces compatible mental models [38]. **Backup** is the interchangeability of members, and the willingness to provide and ask for assistance and to aid in the correction of mistakes [38, 43]. **Feedback** is the willingness to accept and give positive and negative criticisms about performance [38, 43]. Finally, there is **coordination**, the orchestration of team activities and behaviors toward the successful attainment of the desired goal or objective [38] guided by leadership. These elements are critical to developing and sustaining a shared mental model in teams.

Organizational Culture

The study of culture includes the study of a shared mental model. Organizations are intricate, dynamic human designs that seek to attain certain

objectives or goals. Like biological organisms, they strive to maintain and preserve their own existence while adapting to the impact of external forces [48]. Culture is a shared common thread, a pattern of behavior that evolves from shared ideas or mental models. Schein defines culture as: *“a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that worked well enough to be considered valid and therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems [48].”* This definition is applicable to the shared perception of small groups as well as large organizations and implies deeply embedded ideology, a fusion of complex and intricate accumulated learning involving behaviors, beliefs, and values assimilated into the routines of daily life. Tools, technology, and tasks are a part of the internal structure of the organization that facilitate goal attainment and lead to issues of roles, division of labor, territory, property, and rewards. These elements shape the cultural patterns that maintain and preserve the group through the process of adaptation and change.

Culture is the shared beliefs, values, norms and experiences of a group that guides their collective action and directs behavior. Beliefs are the cognitive images or mental models that represent perceived and experienced meaning about some event; a shared mental model is the shared beliefs or perceptions held in common by a group. Leadership must manage the internal structures and culture of an organization and balance organizational culture against

external demands [48], shaping and managing the experiences and therefore, the shared mental models held by the organization.

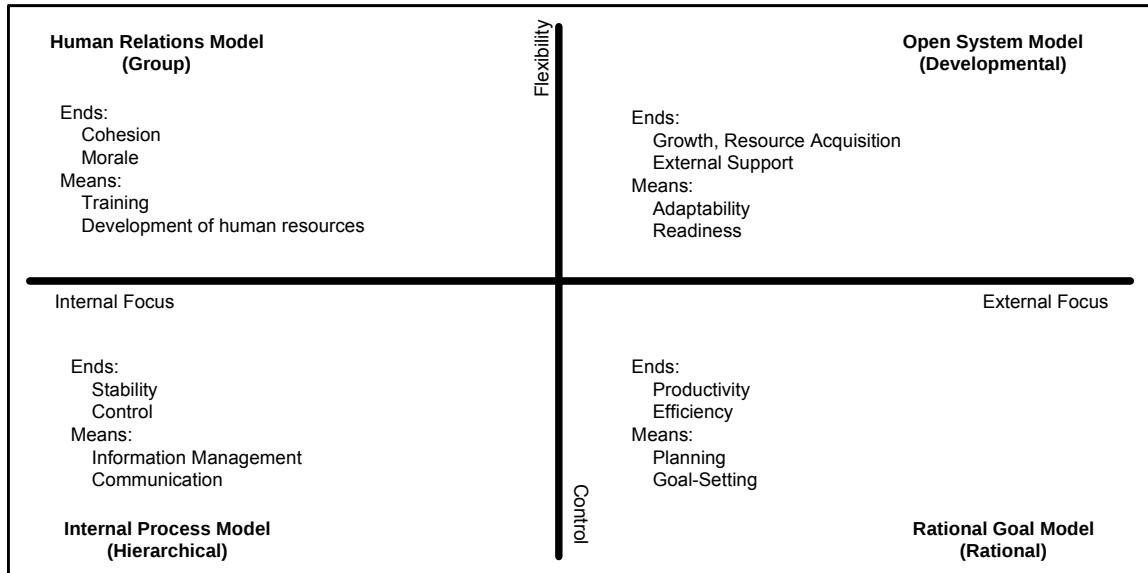
Organizational culture can be the primary cause of organizational success or failure [6, 50]. Shared beliefs or mental models influence collective action and can deceive an organization into ignoring issues related to performance. Cultural blind spots develop that rationalize the repetition of behaviors or action which produce poor outcomes [49]. The shared mental model that commits the team or organization to action also serves as justifications for action. Once committed, cues that are socially acceptable are used to rationalize action, drawing upon socially accepted norms and expectations to legitimize action. *“Tenacious justifications make it harder to learn, harder to discontinue the justified action, and easier to spot information that confirms their validity [49].”* People do not always behave in a manner congruent with what they say, but they do behave congruently with their mental model [50]. Mental models actively shape the actions and observations of an individual, leading to the highlighting of some cues and ignoring of others. Acceleration or impedance of organizational learning is associated with the shared mental model [39, 49, 50]; it is important to defining and sustaining organizational learning and change.

Zammuto, Gifford and Goodman examined the relationship between organizational culture and the outcomes of innovation. Organizational culture and ideology both involve the shared beliefs or mental models of members of a specific organization about shared experiences. The ideology, or shared beliefs that form culture, affect behavior of the organization and influences patterns of

authority and leadership, shaping the strategies and power structures [51]. Zammuto argues that although new ideologies may occur, the old ones never disappear and continue to influence how new ideologies are absorbed into the organization. Using the competing values framework developed by Robert Quinn and colleagues (Quinn & McGrath, 1985), a four-quadrant model was developed using two continuums (Figure 4). One axis reflects the degree to which an organization is internally (focused on internal organizational dynamics) or externally focused (focused on factors external to the organization), and the other axis represents the degree of structural flexibility or control of the organization. The four quadrants describe different sets of valued organizational outcomes and the type of managerial culture that attains those outcomes [51]. This perspective may also be applicable to the shared mental model within NICUs resulting from shared experiences and shaped by the influence patterns of physician and nursing leadership.

The ***internal process (hierarchical)*** oriented organization is one that views the organization as a means to attain specific goals. Strong organizational control and an internal focus produce formal rules, policies, and procedures for coordination. Communication and information flow down a hierarchical structure that also maintains stability and control of internal processes that allows management to closely monitor all activities. It also creates an environment where trust and morale are low and leadership has little credibility. Hierarchical organizations are highly resistant to change and plagued with conflict.

Figure 4: Competing Values Model of Organizational Effectiveness [51] Source: Adapted from Quinn and Rohrbaugh (1983)



In organizations that fall into the *human relations (group)* quadrant, employees are a valued resource and training is an important element to employee success. Leadership takes on the role of mentoring and facilitating teamwork. There is flexibility in the organizational structure to allow decentralized decision-making, and the internal focus produces strong group cohesion and high morale. High levels of trust, morale, leadership credibility, with low levels of conflict and resistance to change, characterize employee relationships in these organizations.

Rational goal (rational) organizations have strong organizational control and an external focus with centralized decision-making. Goal setting and planning is used to improve productivity and efficiency, and leadership has a strong role in the determination and initiation of actions for goal attainment. Strong organizational control generates interpersonal relationship with low levels

of trust and morale, and leads to poor leadership credibility. Rational goal modeled organizations are resistant to change and have higher levels of conflict. **Open system** (*developmental*) organizations are structurally flexible and externally directed. These organizations are characterized by adaptability, growth and resource acquisition. Leadership creates opportunities for innovation and change. They emphasize informal coordination and control systems, with horizontal communication. High levels of trust and morale exist, and there are low levels of conflict and resistance to change.

The four types of organizational culture can co-exist within any organization to varying degrees. Subunits within a larger organization can have very different cultures resulting from leadership and shared experiences of the members. As stated earlier, the development of common assumptions results from the collective learning experiences which are translated into a shared mental model [48]. These shared mental models are important to outcomes, adaptation, and change. Culture and its relationship to shared mental models determines how new practices and guidelines will be implemented or received within an organization and influences change and adaptation.

Related Studies

Studies of a shared mental model of nosocomial bloodstream infections have not been identified. The concept of a shared mental model has been limited to examination of teams and decision-making in the military and airline

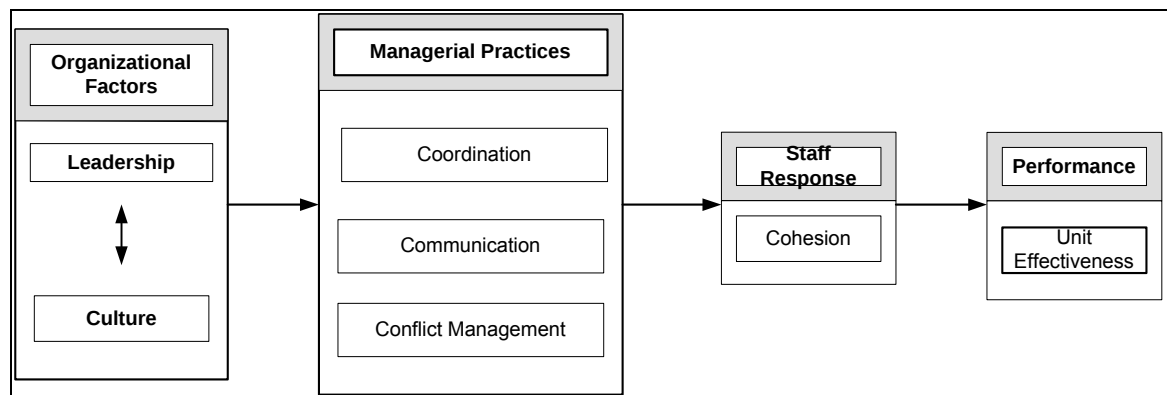
industry. The application of a shared mental model to diseases and in health care settings is only now being considered.

Studies of intensive care units (ICUs) have researched the impact of structure and process on outcome, examining elements common to the frameworks proposed for a shared mental model of teams. A case study of nine intensive care units examined organizational practices associated with high and low outcome units using risk-adjusted mortality and length of stay [52]. It was hypothesized that a strong patient-centered approach, effective communication and coordination, and open collaboration among the staff would be associated with high performing units. The study found variation in performance characteristics that did not support the hypothesis. Disease and case mix have a stronger relationship with mortality; mortality is only partially related to process and quality variables. The methods for attributing the cause of death to quality, safety or environmental variables are not sufficiently developed to allow mortality to be a sensitive measure and may have resulted in the lack of association.

In a second ICU study, technology, task diversity, nurse staffing ratio, and caregiver interaction were hypothesized to be strongly associated with risk-adjusted mortality and performance [45]. Performance was defined as: (a) efficiency of utilization, (b) evaluated quality of care, and (c) ability to meet family needs, as measured by questionnaires. No relationship between mortality and nurse staffing ratios or caregiver interaction was seen (Figure 5). Technology, defined as the presence of 39 pieces of equipment or services recommended in published guidelines, was associated with a lower risk-adjusted mortality ratio.

Caregiver interaction was found to be associated with risk-adjusted length of stay, technical quality of care, and ability to meet family needs. The inconclusive results may have been due to the insensitivity of mortality to the process measures [53]. Mortality as an outcome is more sensitive to the biological and treatment factors of care. Another more upstream outcome may be more sensitive to the process measures of this study.

Figure 5: Managerial and Organizational Factors Affecting ICU Performance (Shortell, Rousseau et al. 1991)



In a regional study of coronary artery bypass surgery (CABG) a decrease in mortality was associated with structural and process changes. A 24% reduction in the observed mortality rate from the expected rate was seen in the 27-month period following implementation of an intervention that led to structural and process changes [54]. The intervention consisted of three components: feedback of outcome data, training in continuous quality improvement techniques, and surgical team site visits to other medical centers. The interventions resulted in multiple process and structural changes being associated with 74 fewer deaths than expected. The use of multiple interventions, that included the use of quality improvement techniques, did not

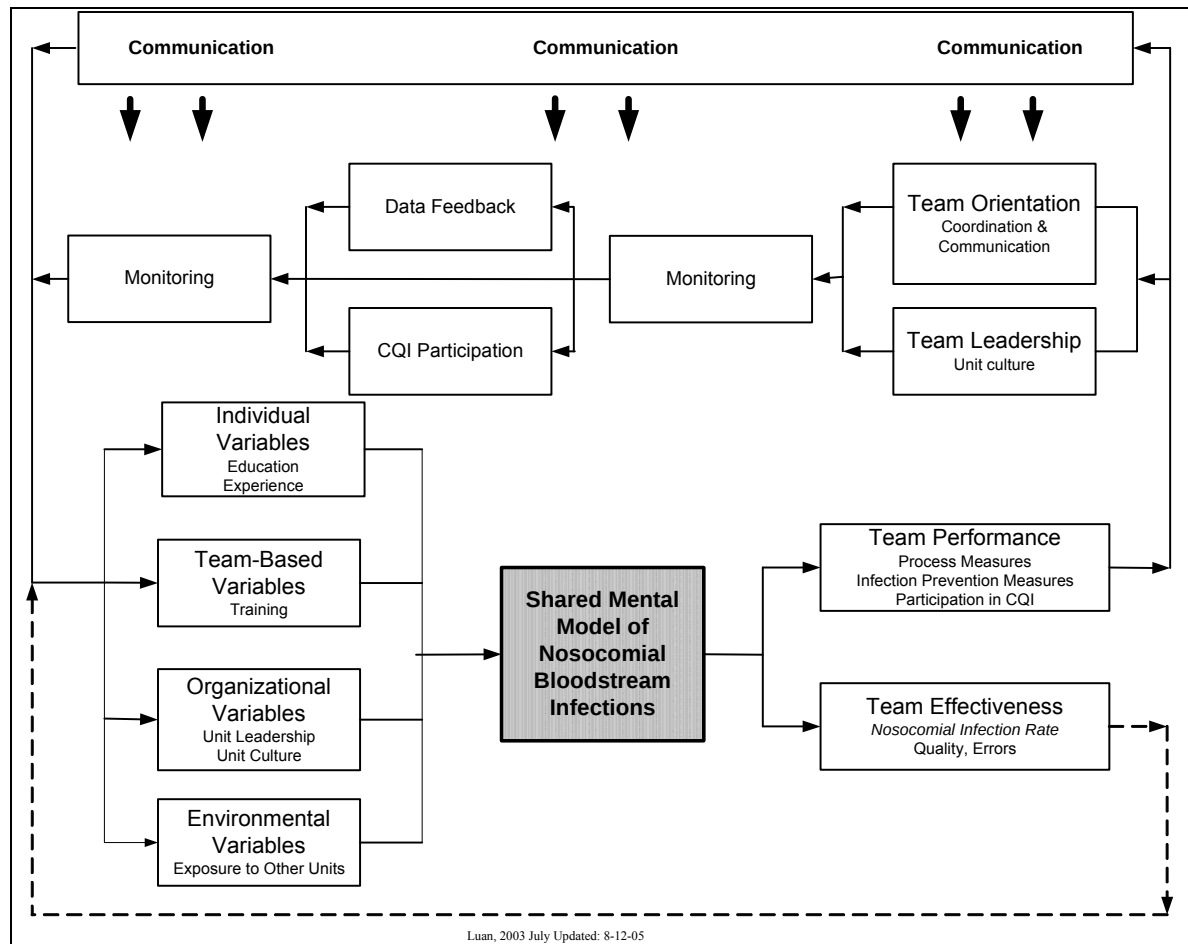
allow for the identification of individual component contribution to the improved outcome.

Chapter 3: Study Framework

Observations made during site visits for a quality improvement effort led to the hypothesis that unit culture, in the form of a shared belief construct or a shared mental model about infection, influenced outcome [12]. In the framework, Edwards proposed two conceptual models: a model of “entitlement” where the nosocomial bloodstream infections are perceived as inevitable and the result of the inherent vulnerabilities of premature infants; and a model of “prevention” where the vulnerabilities of the premature infants are an acknowledged risk and infections are due to a breakdown in care. This study builds upon Edwards’ conceptual framework and focuses on a shared mental model of infection to determine the shared mental model of nosocomial bloodstream infections (NBSIs) that are associated with high and low rates of infection within neonatal intensive care units (NICUs).

In this study “shared mental model” is the commonly held beliefs of a group. Neonatal intensive care units (NICUs) are microsystems within a larger hospital system with a dedicated team that cares for a defined population of patients. The patient care team in a NICU generally includes the physicians, nurses, respiratory and physical therapist, laboratory and x-ray technicians, dietitians and other ancillary providers that care for the neonate population. This study limits the patient care team to the physicians and nurses that provide the direct care to the neonate population. The mental model of infection held by these physicians and nurses is important to understanding the prevention actions taken during the process of delivering care and to successful behavior change.

Figure 6: Proposed Model for Nosocomial Bloodstream Infections in NICUs



A framework for understanding the shared mental model of NBSI in an NICU was constructed based upon the work of Baker-Salas [32], Dickinson and McIntyre [43] Kraiger-Wenzel [35] and Shortell and Rousseau [55] (Figure 6). The framework displays the complexity and intricacy of variable interactions; no simple measure of a shared mental model of either team or disease exists and no single activity serves as a measurement proxy. It includes the individual's attitude and beliefs about the concept of infection as well as the team, organizational, and environmental dynamics that influence perceptions and behavior. Understanding these variables and their relationship to the mental

model that staff shares about nosocomial infection is important for understanding process and outcome.

Chapter 4: Qualitative Study

Research Questions

What is the shared mental model of NBSI associated with high and low NBSI rate NICUs? Is a “prevention” shared mental model where nosocomial infections are perceived as preventable events associated with low infection rate NICUs? Is an “inevitable” shared mental model where nosocomial infections are perceived as inevitable events seen in high infection rate NICUs? What characteristics of the NICU sustain the prevailing mental model of NBSI?

It is hypothesized that the shared mental model of infection influences the rate of NBSI. The shared mental model that is shared among the providers of the NICU determines how infection is perceived and what behaviors are performed. Behavior is not always congruent to espoused values, but is congruent with the mental model. NICUs are well-defined microsystems of care within the larger hospital system; they have dedicated staff and a specific sub-population of patients that make them ideal for studying the influence of a shared mental model. If the shared mental model is that infection is a preventable event, then the behavior should reflect an emphasis on infection prevention. However, if the mental model holds that infections are inevitable events, then behavior will not strongly reflect an orientation toward infection prevention. This study was designed to determine the mental model that is “shared” among the care team of NICUs and observes the infection prevention behaviors associated with the mental model. If a shared dominant mental model exists within the NICU, it

should be reflected in the behavior and actions of the care team and directly impact outcome.

Study Frame

The NBSI rate is an aggregated measure of the average risk for a nosocomial infection in the NICU. For a factor to be a determinant of variation it must be a common enough condition or occurrence with sufficient variation between NICUs in the number or proportion of infants affected [15]. The sample for this study was purposefully selected from the extremes of the infection rate range to obtain information-rich cases that would illuminate the impact of a shared mental model on nosocomial bloodstream infections.

The study frame was the Vermont Oxford Network (VON) of 485 neonatal intensive care units, predominantly in the United States and including centers in Canada, Europe, Asia, Africa, and the Middle East. This study was restricted to facilities in the United States that provide Level B and Level C care. Level A units were excluded, because only Level B and Level C facilities provide ventilator care and advanced life support to neonates and had infants weighing 400 to 1500 grams and perform major surgery for neonates. Facilities were restricted to the United States to control for differences in health care systems. The concept of a shared mental model of infection as preventable events and the role of a prevention unit culture was introduced at the i-NICQ 2000 VON breakthrough collaborative; consequently, facilities that participated in the collaborative were excluded to reduce response bias.

Site Selection

To maintain data confidentiality requirements, the VON Director Jeffery Horbar, M.D., performed the site selection. Based upon the VON definition of nosocomial bloodstream infections, the observed/expected cases of nosocomial infections were calculated using indirect standardization for 361 of the 485 hospitals participating in the Vermont Oxford Network database using 2002 data. To reduce the rate of variation due to variation in the sampling procedure, a correction to the observed to expected ratio was made using the binomial distribution to produce “shrunk estimates” of the standardized ratios:

$$p_{\text{shrunk}} = p_o(1 + x * CV^2)/(1 + n * p_o * CV^2)$$

CV^2 is the estimated variance between hospitals for the O/E ratio [56]. “Shrunk estimates” can be considered the weighted averages of the observed rates at each hospital. Facilities were then rank ordered based on the point estimate of the standardized ratio. Using extreme case sampling, four facilities in the highest deciles, and four in the lowest deciles were contacted and asked to participate in the study. Failure to obtain a positive response resulted in contacting the next four facilities in ranked order until four facilities from the highest and lowest deciles agreed to participate.

The VON director sent the Medical Directors at the eight sites a letter to confirm their participation in the study. The letter explained the intent of the study and requested the designation of an individual to serve as the on-site coordinator to act as the point of contact for the administration of the survey prior

to the site visit and to coordinate the interviews for the site visit. The NBSI rate for each NICU was made available to the individual NICUs by VON, but was not revealed to the investigator; revelation of the NBSI ranking was left to the discretion of the medical director at each site.

The study received approval from each participating hospital's Institutional Review Board (IRB) as well as IRBs at Dartmouth Medical School and the Medical School at the University of Vermont.

Site Characteristics

After the completion of the six site visits, two low and 4 high NBSI rate NICUs were identified to have participated in the study. Two of the eight sites that confirmed an initial willingness to participate were dropped from the study. One site was excluded due to management changes at the facility that made participation impossible; another was excluded because delays in the Institutional Review Board approval process exceeded the data collection timeline. During the data collection period two sites were exposed to the work and concepts of the VON collaboratives. One site elected to participate in the i-NICQ online collaborative to improving infection rates. This site engaged a multidisciplinary team to participate in the online discussions and lectures and to initiate “best” practices. The other site had a clinical leader who participated in the VON NICQ 2000 collaborative as a quality improvement coach and discussed many of the concepts with the NICU staff. Discovery of these exposures were discovered during the site visits.

Qualitative Methods

Qualitative methods were used to explore the concept of a shared mental model of nosocomial bloodstream infections (NBSI) within neonatal intensive care units (NICU), where the NICU is the unit of analysis. Site visits were conducted to collect data through observation and interviews. Interviews were conducted with staff members who were working during the period of the site visit and willing to participate. Direct observation and documentation of activities within the NICU were made to complement the interview data and to understand the context for the interviews without judgments about the quality of the patterns of interaction or setting.

A cross-section of staff were interviewed at each site and included: physician and nursing leadership, staff physicians, nurse practitioners, and staff nurses. At each site, nine members of the team were to be interviewed, 3 physicians and 6 nurses. A total of 57 interviews were conducted with 18 physicians and 39 nurses or nurse practitioners. There were no refusals to participate in the interview portion of the study and only one physician who was asked to participate was unable to be interviewed due to scheduling difficulties. Open-ended and probative, semi-structured interview questions explored NICU members' knowledge, attitudes, and beliefs regarding nosocomial bloodstream infections (Appendix 1) with additional structured questions designed to probe the influence of other framework variables theorized to influence the shared mental model such as leadership, data feedback and process for change.

Questions were designed to explore the mental model of respondents and their perception of NBSI in the NICU. The questions were:

- *Are nosocomial bloodstream infections inevitable in pre-term babies of less than 32 weeks, or are they preventable? Please explain.*
- *Please respond to the following statement: “Researchers have stated that no pre-term baby of less than 32 weeks gestational age should experience a nosocomial bloodstream infection.” What are your feelings?*
- *Are nosocomial bloodstream infections an error or an anticipated complication of care? Please explain.*

These questions were designed to provoke respondents’ into responding to the extreme conditions to draw out perceptions regarding nosocomial infections in pre-term infants. Two shared mental models were hypothesized to exist in NICUs. In the “preventive” mental model infections were perceived as being a preventable event and staff behaviors were appropriate for prevention of nosocomial infections. Under this mental model NBSIs would be perceived as errors, failures in the process of care that resulted in exposure to infection. Infections as preventable events would allow for the possibility of a zero infection rate, as all infections are preventable. The “inevitable” shared mental model perceived infections as anticipated complications of care; they were inevitable due to the vulnerabilities of the infants. Staff behaviors with regard to infection prevention measures would not be rigorous and a zero NBSI rate would be perceived as unattainable.

Naturalistic inquiry is a “discovery-oriented” approach with no manipulation of the setting by the investigator [57]. It is the direct observation and documentation of interactions in real settings by a neutral observer [57]. The

investigator, as a neutral observer, was committed to understanding the context through direct observation of the setting without judgments about the goodness of documented patterns, and to serve as a counterpoint to the interview and survey data. A checklist of interactions was used to help standardize the observational format (Appendix 1).

All interviews were recorded and transcribed to ensure accuracy in the verbatim responses and to capture the interviewee's perspective. The individuals were only identified by role and NICU, and the individual NICUs were coded to allow for case study development. Informed consent protocols were used to describe the purpose of study, information to be collected during the interviews, use of a recording device, and addressed confidentiality. IRB approval for each site was obtained prior to the site visit.

Qualitative Analysis Plan

All raw interviews and observational notes were analyzed using QRS NUDIST 5.0. Each interview was treated as a case and coded with base information that included: site code, infection rate (high or low), exposure to collaborative, individual's role in the NICU, level of experience working in the specific NICU. Each interview was then coded for general concepts using standardized definitions. Additional coding within each concept was performed to refine and identify concepts and themes. Variable oriented, cross-case analysis of all interviews was conducted to determine differences between high and low infection rate sites.

Chapter 5: Qualitative Results

The six NICUs that participated in the study represented a sample of 4 high infection and 2 low infection rate NICUs. The sites represented three regions of the United States: east coast, west coast, and mid-west. Two sites were academic medical centers and one was associated with a medical school. Two of the NICUs were level B NICUs and provide major surgery for neonate except cardiac surgery. The four level C NICUs provided major surgery including cardiac surgery to neonates. All the NICUs provided ventilator and advance life support to neonates from 400 grams to 1500 grams. The associated hospitals ranged in size from 242 to 847 beds with 27 to 56 NICU beds.

Table 1: Characteristics of the Study NICUs

NBSI Rate	Hospital beds	NICU beds	Level of care	Academic Medical Center
Low	847	44	B	Associated
Low	483	35	C	No
High	755	50	C	Yes
High	375	40	C	No
High	242	27	B	No
High	581	56	C	Yes

To understand the mental model shared by the physicians and nurses' three questions were asked of all respondents. In response to the question, "*are NBSI inevitable in pre-term babies of less than 32 weeks GA, or are they preventable?*" 89% (16/18) of the individuals interviewed at the two low NBSI NICUs stated that nosocomial bloodstream infections were preventable events. (Table 1, Appendices 2 & 3) In the four high infection rate sites, 80% (31/39) of the respondents stated that NBSI were inevitable events. Two sites had been

exposed to VON collaboratives by the time the site visits were conducted, one site had a physician that was active in the NICU-Q 2002 collaborative and was a periodic attending and the other site had enrolled in the i-NICQ on-line collaborative to improve their infection rates prior to the site visit and after site selection had occurred. In the two NICUs exposed to the collaborative, 90% (18/20) of the respondents perceived NBSIs as inevitable. Of the 10% (4/20) that perceived NBSIs as preventable, two respondents had been associated with the unit for less than 5 years and two were participants in the infection improvement collaborative. These respondents felt that nosocomial infections were theoretically preventable *“in a perfect world”* but a baseline level of infections would always be present.

Perceptions at all high infection rate sites were influenced by experience and the concept of a baseline rate of infection: *“It is funny our incidence (here) is very similar to the incidence of (the unit I left), so I think that they will be with us forever.”* A strong belief that nosocomial infection would always be present was noted, but there was a belief that reduction to a lower baseline rate was possible. The individuals who perceived NBSIs as preventable were associated with the unit for less than 5 years, *“I think that there are a few of us that haven’t been here that long and I don’t know about their backgrounds, but they are stunned; then there are those who have been here a long time and well, I think that you get a mix of feelings.”*

Table 2: Illustrative Statements to the Question: Are NBSI inevitable or preventable in pre-term babies of less than 32 weeks gestational age?

Low NBSI Rate NICU	High NBSI Rate NICU
The majority (of infections) are preventable if you follow through with handwashing and keeping the sterile field and doing what we are supposed to do.	I think they are inevitable, I don't think anyone can completely eliminate them. If they think that (nosocomial infections) are preventable then more power to them, everyone is entitled to an opinion and that's what makes us all different.
I use to think 15 years ago that many of those small babies would get bloodstream infections or pneumonias during their hospitalization. But as we have evolved and looked at our practices and have seen what our outcomes are like it been really clear to me that that's not the case. I'd say they are preventable.	Inevitable from the experience we have in this unit. There are too many people handling the baby, their immune systems are suppressed due to their prematurity, and they have multiple lines, which places them at higher risk. They could be preventable, but they are inevitable.
Well we don't accept that in regard to infection because we are not used to it, we don't expect it, it doesn't happen here, and so if the baby has an infection everyone is surprised and upset about it.	Nosocomial infections are inevitable. With the babies' decreased immune system, the environment, how we care for and handle babies, and the pressure that antibiotics create make infection inevitable.

Further questioning regarding perceptions about infections included the statement: "Researchers have stated that no baby of less than 32 weeks gestational age should have a NBSI," a question designed to create controversy. Use of a zero rate in the statement produced two categories of responses, those supporting the statement and those who disagreed (Table 2, Appendices 2 & 3). At low NBSI rate NICUs 61% (11/18) agreed with the statement; all those interviewed at one site agreed that no baby should experience a nosocomial infection. Human imperfection was believed to have a role in the error generating process making sustaining a long-term zero rate impossible. *"There's*

going to be a certain amount. What's an acceptable level? I don't know how you are going to determine that, some low number, single digit percentage."

In the high NBSI rate facilities, 84% (33/39) of those interviewed disagreed with the statement that "no baby of less than 32 weeks gestational age should have a NBSI." The majority felt that a zero rate was a goal but that attainment would be difficult if not impossible and the perception was that nosocomial infections were inevitable and would remain significant. Fifteen percent (6/39) of those interviewed at these high infection site had been exposed to the concept of a prevention shared mental model either through active participation in an improvement collaborative or due to an exposure to the concept of a prevention shared mental model of infection through interaction with individuals participating in a collaborative. While these respondent generally agreed with the statement that "no baby of less than 32 weeks gestational age should have an NBSI" they were not sure how their units would ever attain that goal.

The concept of a "baseline" infection rate, a constant nominal rate of infection, was noted at all sites but most strongly at sites with high NBSI rates. A gestational age threshold was discussed where prevention was possible in babies between 25-32 weeks gestational age, but in babies of less than 25 weeks gestational age, infections would be inevitable. Three themes regarding the baseline rate concept emerged. The inevitability of infections was due to: (a) the characteristics of premature babies, (b) technique failures and interactions with people, and (c) past experience with high infection rates. Improvement in

the baseline rate was perceived to be possible; however, attainment of a zero rate was not considered possible.

Table 3: Illustrative Responses to the Statement: “Researchers have stated that no baby of less than 32 weeks gestational age should have a NBSI.”

Low NBSI Rate NICU	High NBSI Rate NICU
I think they can be preventable. It's that attitude, I think, that makes a difference. I believe it's possible for a baby not to, but as far as no baby I think it all depends upon where that baby is and how it's treated.	Not an accurate statement. There may be innate factors that lead to infection. 33% of infections are not preventable.
I think that is true, I don't think that (babies) should (experience a nosocomial infection). I don't think that in this day and age, with as far as we have come, that they should have a nosocomial infection.	I disagree with the statement nosocomial infections are a complication of prematurity. No matter what our efforts, there will be some degree of infection that is unavoidable
We certainly do not want (them to experience) an infection because these babies are fragile enough with enough hurdles to get past that we don't want to introduce an infection that would set that baby's progress back and in the worst case cause the baby's death. So they shouldn't have to experience (an infection).	Woo! Wherever they are I would like to work there. That's one clean unit and they have a lot of really good practices, and chances are they use breast milk. Those are really good things. There would have to be some really good consistent practices for that to happen.
Well I would agree with it. I don't think that any 32-week baby should have a nosocomial infection. Everything is preventable to a certain extent. If proper cautions are taken, then everything would be preventable, but we are only human and there is always going to be imperfections.	Lofty high goal, but it is unreasonable. The babies are here, they are here and they shouldn't be. So they just don't have what it takes to survive here, and they are going to get infections.

Respondents were asked if they believed that NBSIs were errors or complications of care, a complication being a risk of the care provided (Table 3, Appendices 2 & 3). At one low NBSI rate site, 61% (11/18) of respondents perceived infections as an error; all respondents at the other low infection site

perceived infections as an error, a failure due to a breakdown in the care process; respondents indicated that it was an error because infections were preventable while also being a risk, or complication, of invasive procedures.

Table 4: Illustrative Statements: NBSI as an Error, Anticipated Complication of Care, or Both

Low NBSI Rate NICU	High NBSI Rate NICU (No Collaborative Exposure)
Error-I think that they are an error. I don't think that you should anticipate them. Yes they are vulnerable (babies), and (infection) is something that can happen and you tell parents that it can happen. Other hospitals it is assumed that since they are premature that is what is going to be the normal outcome. That is not how we think here. It is a risk, but not a normal outcome.	Error-It is an error because in certain populations with the same risks, they don't have infections.
	Complication-They are an anticipated complication of care, they just happen here. It is hard to understand if what we do makes a difference, you just don't see it in the data.
	Both- Honestly I believe that they are both. I believe that there are going to be errors and I believe that they are inevitable. An error occurs and then they become inevitable. By errors I mean breeches in protocol, whether it is nursing or visitors like x-ray.
Complication-They are an anticipated complication because we have to do so many invasive procedures and they have vents and so much that is invasive. (Infection) is one of the most common complications that we have, but not every baby gets it, and we can do a lot to prevent it.	High NBSI Rate NICU (Collaborative Exposure)
	Error-I think that it used to be seen as an anticipated complication, but now we are acknowledging and admitting to ourselves that it is an error in management. It is an imperfection in the system and we can do better.
Both-An error because they are preventable and a complication of care because we put in so many lines and the babies are intruded upon in such a way that it breaks their skin integrity and decreases their immune system even more.	Complication- It is an anticipated complication, because our rate is so high that you just come to see it so often. If you see something so often and in so many infants that it is almost expected.
	Both- I guess they are an error because they are something that is not supposed to happen, so in that way they are an error. But they are a very COMMON outcome of our patient population. I guess they are an error, but they are expected too.

In high NBSI rate NICUs, 31% (12/39) of individuals interviewed at the four sites perceived infections as anticipated complications of care, a side effect of the invasive nature of the care. At the sites involved with the collaborative, those exposed to the collaborative expressed their perceptions were shifting toward perceiving infections as errors. One third of all those interviewed at high rate sites indicated that NBSIs were errors, while 35% (14/39) believed that infections were both an error and a complication of care, an error causing NBSI to become a complication of care. The diversity in response to the question regarding infection as an error or complication of care may be a result of exposure to the new concepts from the collaborative, but that the respondents were struggling with the notion of “error,” and the fallibility of providers in providing care, the “human piece.” The term “error” caused discomfort among respondents who perceived infection as inevitable. This discomfort may be the result of a strongly held belief that error implies blaming an individual and not the system.

To probe perceptions further, providers were asked about what they said to parents about infections in the NICU. Twenty-five percent (4/16) of respondents at high NBSI NICUs indicated that infection was preventable; but told parents that their babies would get an infection during their stay (Table 4, Appendices 2 & 3). The conflicting statements were not limited to any one NICU with a high NBSI rate. The inconsistent responses indicate that the deeper belief of infection as inevitable remained dominant over the learned and stated belief

for this group of respondents. All other respondents were consistent with their mental model of infection, consistently stating a belief that NBSIs are either preventable or inevitable and telling the parents the same.

Table 5: Illustrative Responses: What Respondents Tell Parents

Low NBSI Rate NICU	High NBSI Rate NICU (No Collaborative Exposure)
Well typically we tell parents that among the complications that extremely low birth weight babies have, a major one is infection. I usually point out that the initial problems are respiratory but these days, babies rarely die of respiratory problems. If they die, they usually die of infections and that we do everything that we can to avoid infections.	What I try to tell every parent, especially parents that have the tiny babies, not 32 weeks but the 23-27 week baby, three days into their stay they may still be stable but I always stress to the parents that the biggest complication the baby will face if they do well with their respiratory treatments is the possibility of having an infection.
I tell them that it is one of the risks of being in an NICU. It is not my expectation that they will get one.	I advise them that infections are one of the risks involved with being a patient in the unit.
Yes they are vulnerable (babies), and (infection) is something that can happen, and you tell parents that it can happen.	High NBSI Rate NICU (Collaborative Exposure)
I usual tell them that (infections) are something that we try very hard not to have happen, but because their immune system is not as developed as a term baby, that the chances of them picking up something are higher and because they are in the hospital setting it is higher also.	I don't call them nosocomial infections. I tell them it is likely that the baby will get an infection during the time that it is here. That they are treated with antibiotics and most of them recover without any bad long-term outcome from the infections.
	I tell them that their babies are very small and have very little resistance to infection and most of the time or most likely the baby will be contaminated and there will be an infection and there is not much that we can do about it.

“Personal integrity” was a theme that emerged from the interviews (Table 5, Appendices 2 & 3). In the low NBSI units, the medical and nursing director stated that personal integrity was an important issue and the responsibility of the organization was to develop a culture of integrity where *“the bedside nurse’s*

perception that she has responsibility, but also she has ability to impact (nosocomial infections). That she can and that she will. I think that part of it is the overall hospital's expectation that there is a shared responsibility, shared management of the unit, that there is shared accountability for the patients." One medical director perceived personal integrity as a sense of "professionalism" that develops in training, as socialization into their professional role occurs, and it is this sense of professionalism that drives staff to perform above and beyond the standard.

Table 6: Illustrative Statements: Concept of Personal Integrity

Low NBSI Rate NICU	High NBSI Rate NICU
People have to incorporate, like in the operating room when you did nursing training, a personal integrity. If you accidentally dropped your hands below the waist, or whatever the magic line is, well you just go change your gown and gloves, right? That's personal integrity, and I think it's the same thing (with infection). If you are getting ready to put in an IV in a baby in our unit, you've done it with your gloves on, you've prepped the skin in a certain way, if you break that technique you have to say, I have to stop and you do it. So a hundred and some people have to have that degree of personal integrity. I think that the organization has a lot to do with this.	Buy-in on accepting responsibility to make a difference. We are trying to develop a culture of personal responsibility versus a no blame culture and to have a system that allows that to occur. An environment that stresses personal accountability for doing the right thing.
Our infection control should be such that (the babies) should be in the safest environment that they can be in while they are here. Whether that happens or not depends on having more people willing to take the extra few seconds it takes to prevent (infection).	You do what you can do, but ultimately it is up to the individuals to individual practice. That is how you get lapses in standards in practice because (people believe that) I have always done it this way, and no one has ever said anything to me about it. So then that becomes a habit, a bad habit. I feel like there is a bar where the standards are set, but if you don't get up to the bar, that's okay as far as nurses go.

“Response threshold,” a term used to describe staff response time to heart and respiratory monitors (Table 6, Appendices 2 & 3); and conceptually a component of personal integrity. Babies with low oxygenation or heart rates require manual stimulation to induce breathing or increase their heart rate. In low NBSI NICUs, staff had longer threshold times for responding to babies needing manual stimulation; staff indicated there was sufficient time between the sounding of the alarm and the need for stimulation to allow for some form of hand hygiene. Staff in high NBSI NICUs had much shorter thresholds, and indicated that there was insufficient time for hand hygiene. Their sense of urgency was related to a fear of blame for the baby’s status; it was also related to the number of babies and level of activity. At these sites the staff felt that their workload and the critical nature of the patients simply did not allow the time for hand hygiene. The response threshold was supported in the observational study.

Table 7: Illustrative Comments: Concept of Response Threshold

Low NBSI Rate NICU	High NBSI Rate NICU
If you go from one baby and have to emergently help another baby, you always have that little pump thing (alcohol gel) in between. Having babies that spell a lot with people who aren’t taking the time to clean their hands between babies that definitely can contribute (to infection) and contribute to mistakes being made.	In certain cases, realistically in life, if you have a baby who is desating or deceling, I've seen it before, you can't always run to wash your hands and put on gloves before you save the baby. If the baby's heart rate is dropping, honestly, as a person you aren't going to waste time, honestly that is how it happens.
You hear the alarm, you stop what you are doing or you say I've got that, and you do your hands. It takes seconds to walk over there and put Purell on before you get in there.	Especially when you have 12 ventilators going in a nursery of our size and babies are crumping somebody is going to run over there sometimes and do something with their not necessarily clean hands.

The personal goals of the respondents differed by infection rate. Eighty-seven percent (13/15) of the respondents in low NBSI NICUs stated their goal was the provision of quality care and protection of the babies. In the high NBSI units only 21% (4/19) held as their personal focus quality care for the babies, 79% (15/19) had a administrative or disease specific focus. In the low NBSI NICUs, everyone's personal focus was on the care and protection of the babies; respondents in high NBSI NICUs reflected a disease or administrative-procedural orientation, the baby's well being was not the central focus. The concern for disease and administrative-procedural issues may be related to the threshold response seen in high NBSI NICUs, where nurses respond to the monitors out of a fear of criticism or blame. *"The nurses may think that they will get criticized for letting the baby's heart rate drop, but I think that you will have more criticism if the baby ends up with an infection that baby X has and now baby Y has it because the same nurse was taking care of both babies and didn't wash her hands."*

A culture of assigning blame was reflected in the staff response to alarms. It can be argued that a culture of blame may be an outgrowth of the lack of personal integrity, but it is difficult to determine which evolved first. A strong personal focus on the baby, and strong personal accountability and integrity for performing the appropriate infection prevention techniques was congruent with the mental model of prevention. Staff in low infection NICUs did not perceive blame and viewed errors to be a systems issue; their personal commitment to the safety and well being of the babies was reflected in their strong sense of

personal integrity, their stated personal goals and their observed actions. In high infection NICUs, the fear of blame was consistent with a mental model of inevitability and the personal focus on administrative policy and a disease process rather than the safety and well being of the babies. Errors were perceived to lead to blaming individuals, not a system failure. The mental model of infection was consistent within an NICU; medical and nursing respondents were congruent in their mental model of infection, sense of personal integrity and response threshold. This congruence was nearly uniform and reflects the degree that the mental model was shared.

The role of leadership in the creation of mental models is unclear, but they have a role in the changing of the mental models. The activities and processes within the organization have a feedback relationship to the mental model; in low NBSI NICUs, leadership encouraged staff to participate in the process for improvement, staff and leadership were actively engaged in the process of change that supported the prevention mental model. A nursing director indicated that *“It also involves inviting them to participate in decision-making and being part of the process as much as possible, to come up with ideas.”* In these NICUs, change resulted from a dialogue, discussion at different levels and engagement of everyone in the discussion and decision-making. Staff input and buy-in were important; one nurse stated that, *“We all decide that it is a good thing to do and we do it.”* Communication through engagement, discussion and feedback were important factors in promoting and sustaining change and the prevention mental model in the low NBSI NICUs. Staff felt supported by

leadership in taking ownership of change that generated a greater sense of personal integrity and responsibility. Data were collected, analyzed and the information was fed back to the staff in a variety of venues; the feedback cycle was the driver of improvement and sustained positive behavioral and perceptual changes.

Medical staff perceived themselves to be part of the unit leadership. The perceptions of the role of unit leadership differed between medical and nursing staff, and between high and low infection units (Table 8, Appendices 2 & 3). In low NBSI NICUs, leadership set the tone and shaped the culture. They provided the resources, served as guides to the staff and mentored their development. Staff perceived the leaders as colleagues and participants in the process of improvement. In high NBSI NICUs, the staff perceived the leadership as role models responsible for exhibiting ideal behavior and policing compliance to standards. The role of leadership in these units was perceived to involve problem identification and resolution, policy development, and education of the nursing staff. Nursing staff were passive participants in the improvement process and responsible only for the execution of changes mandated by leadership. Leadership's perception of their role matched the nurses, supporting the top-down flow of information, policy and change. In high infection rate NICUs, leaders were the drivers of change within a hierarchical structure with limited nursing participation, while leaders in low infection units acted more like colleagues participating in a unified effort to effect change.

Table 8: Illustrative Statements: Unit Leadership Role

Low NBSI Rate NICU	High NBSI Rate NICU
I really feel like my role is just to get the resources in for people, and to make sure that the relationships are good, and then good things just really kind of happen. We have new doctors that come in all the time and you have to acculturate them to what is the reality here. A big goal of mine is that I work with someone I acculturate them into our unit. Some of (acculturation) is more active, and some of it is well, leadership. A large part of leadership is role modeling, so I work really hard to see how I might affect other people's impressions about behavior.	If you don't get things from the top it isn't going to happen. If your partners don't support what the group wants to do you have a major problem.
	Leadership's role is to recognize that there is a problem and to be consistent with the application of policy and hold people accountable.
	To set the expectations and to give them the tools that they need. Whether it is education, product - the hand wash or gel, to listen to staff input because they are present and see what is going on. It is to keep them engaged and make sure that they are diligent. I see myself as a coach and mentor and the watcher of these things from a different perspective.
To monitor the incidence (of NBSI) and to try to evaluate their patient population with those of similar nurseries. To try to get a gauge as far a standard or comparable NICU and recognize simple and easy things that you can do to reduce risk and to try to identify what actually works. Two would be to identify those techniques that actually have been proven to reduce infection. Three is to prioritize risk and benefit of different procedures and identify the things that are simple and easy to do versus more elaborate procedures or more expensive procedures, which would require greater weight of evidence for you to implement something that's very personnel intensive or costly. Not only do we specifically identify infection, infectious diseases and infection control is a topic that we discuss, but it is also melded into everything that we discuss.	I handle things like policies and procedures, the physician that is in charge of policies and procedures for nursing and ancillary services in the unit. I work with the nurse managers and hospital administration to make decisions about new policies, new equipment and those sorts of things for the unit.
	Our role as clinical leaders is to investigate these other practices and ways that we can improve our practices. Also oversee the nurses. The nurse's look to us, even though they know more about line care than I do, they look to us to validate what they are doing, to look at it, look at the evidence and say that this is what we should do.

In high NBSI NICUs, communication and engagement was hierarchical; the top-down management style was seen in the approach to change and information dissemination (Table 7, Appendices 2 & 3). Eight-seven percent (20/23) of those who discussed the process of change at these high infection rate NICUs indicated that it was a top-down decision: *“It is not grass root nursing staff (initiating, researching and investigating problems). The nurse practitioners are good about investigating issues, but it doesn’t come from the staff nurses.”* Committees of selected individuals that did not always include physicians controlled the change process. A system of councils was used at all the high infection sites for the identification of issues, research of best practice and implementation of change. One physician said, *“Unfortunately our approach has been somewhat chaotic. We don’t use, in all instances, a clearly evidence-based approach or logical approach to infection prevention.”* Change just “trickles down” and email is the major mode of communication used at high NBSI units with limited in-service meetings. Data was sent upward to leadership, both nursing and physician, but the feedback of information back to staff was limited.

A data/information feedback cycle was perceived as important to changing behavior. In high infection units, feedback was limited; staff described data as being sent up to leadership, nursing and physician, with feedback of information back to staff being limited. Access to the data in the high NBSI units and interpretation of the data was limited to a few individuals involved in working with administration and the nursing councils; participation by the staff was not encouraged and was perceived as being only for the “selected” few. Access to

information was more difficult for staff who worked at night and night shift staff were generally less engaged with the issues within the units. However, all staff perceived data feedback as an important impetus for change and necessary to sustaining the appropriate behaviors; without data, they perceived change as difficult, as it was difficult to know if any of their efforts had any impact upon outcome, and leading to a drop off in the level of interest and commitment to change over time.

Low infection units had more participation from staff in the improvement and research activities of the unit. This included both day and night shift staff. Data feedback was seen to be important to changing behavior and understanding if changes had an impact. Data and information were readily available to staff; open access to information and staff active participation in data collection with regular feedback cycles using multiple venues, contributed to a greater understanding of the data and reinforced positive behaviors.

The staff at all six NICUs stated that feedback and data presentation were important to efforts to change behavior. Feedback of data needed to be done in a meaningful manner. Data presentation with graphic trend displays were perceived as useful especially for individuals who did not feel they had a strong analytic background to support understanding what the numbers implied. Being able to visualize the impact of change was important. Verbal recitation and written descriptions of statistics, the most common modes of feedback, were the least useful to staff. Feedback was universally viewed as important to changing or improving behavior.

Table 9: Illustrative statements: NICU process of change

Low NBSI Rate NICU	High NBSI Rate NICU
It is the constant meetings that we have. It is kind of interesting there is always, again these are Vermont Oxford type of meetings, but these are nutrition meeting, respiratory support meetings, where we get together and look at these things initially, all the potentially better practices and try to come up with certain ideas that may, say decrease nosocomial infections. And we discuss it, and it is brought forward to the management meetings, neonatal management meetings and medical staff meeting, and it is discussed at different levels. Then it is decided upon that this is a practice that we want to incorporate. So that is when we engaged the doctors, the nurses and our infectious control person. People are empowered to go out there and just do good things. We are very decentralized that way, we don't have a nurse educator for the unit. We are a big unit, but we don't have a clinical nurse specialist for the unit. Again the nurses get time and dollars to do their clinical ladder work and to do projects that are helpful for the organization.	Usually anyone has the choice of taking a new idea to the practice council. The council and the nursing director will talk about it some and form a plan for how to present it and usually the council members (eight of us) try and present it one-on-one. Physicians generally aren't participating in the councils unless they are specifically asked to be there. Change is largely driven by committees around here. There is a committee for everything. That's good, but sometimes it gets a little fragmented because you get two different committees working on the same problem and coming up with differing solutions. It depends, because our councils are so involved, whether it is practice, quality, education or management, I guess it depends if it is coming from the bottom up or the top down, the communication is tacit. No matter what, it will funnel through the appropriate council. The councils do keep minutes, but there is an internal (email) system, and the staff meetings where information is shared.
Policy and procedures that are nursing driven are fed through the continuous improvement committee first, assuming there is time for that. Occasionally there is something that has to be implemented immediately. In general they go to the committee, made up of all disciplines and all shifts. Things are discussed in committee and among staff and revisions are made if appropriate. The new policy is formally adopted and discussed at staff meetings.	We have a lot of policy changes that happen quickly here and people just don't know what is going on a lot of the time. It is NOT getting out well. They are supposed to be doing emails and that sort of thing, but half the things are happening more quickly than what people can keep up with. When I have talked to other people who work in different units, they don't have as many (changes).

At NICUs involved with the collaborative, change was perceived as overwhelming; changes were occurring faster than the diffusion of information. *“We have had a lot of changes and a lot of the changes that we have made, we have gone back to what we were doing before. That is where we are now. All this changing back is overwhelming and confusing.”* One physician described the situation at his NICU as, *“We are the worst in the nation in terms of infections, but it seems like a shotgun approach where many, many different avenues toward preventing infections were recommended (by the collaborative) and I guess if they all work that’s good, but in terms of scientific method you change multiple variables at the same time and it is difficult to make clear cut inferences if there is a change (in the infection rate).”*

At the collaborative sites, acceptance of change was a significant issue. One physician said, *“It would help if we could get the nurses to buy-in to the theory that we can knock our infection rate down.”* A nurse said, *I think that trying to get them to buy-in to that is very hard because they don’t see the importance of it.”* The failure to clearly communicate the reasons and evidence for the change, and the lack of feedback were often cited as issues. While nurses indicated that some of the changes conceptually had merit, but were not changes generated by the staff doing the work and therefore many of the changes, *“create unrealistic expectations for nurses to get their work done. I think it would be better if the people making these policies were here doing it, to*

see *what it is like*.” Top-down decision-making and policy implementation was associated with a lack of participation and ownership.

Barriers to change varied in the high NBSI NICUs. Seniority of the staff was seen as a significant barrier to change; senior members of the NICU often only worked in one NICU where they had also been trained. This was perceived to be a barrier, as they had a limited understanding of what other NICUs were doing and resisted change that would run counter to their mental models of the work. *“I think that there is a large population of nurses in this unit that want to do it the same way that they have for 20 years.”* This resistance to change was linked to a sense of professionalism; more experienced senior nurses tended to believe that this was only a job and they were the most resistant to changes in their routine. Senior medical staff received the same criticism from more junior colleagues. Additionally, the number of changes and the methods for implementing change were barriers. Staff in NICUs participating in the VON collaborative cited the number of changes resulting from participation as a barrier that overwhelmed both medical and nursing staff. A physician frustrated with all the changes indicated, *“All these changes have been frustrating. I have been frustrated so I assume that (the nurses) have been.”*

Staffing was a significant issue in high infection NICUs. The staffing ratio was often greater than two babies to one nurse on the intensive side of the nursery. Increasing the ratio was believed to lead to breeches in care. *“Sometimes we have census and staff issues that require us to take 3:1 in the (intensive) unit versus 2:1, which causes you to speed up the process and you*

don't always 100% do the handwashing, gown and glove." Crowding and poor staffing ratios were felt to cause interruptions in the care process with implications for the infection rate. *"Usually people are pressed for time and if they cut corners it is usually something that is going to be related to infection control."* In low infection NICUs, staffing ratios were perceived to be equitable: *"I think that the staffing ratio is really key here. This is probably the most well staffed unit I have ever worked in."*

Observational Results

Observations were made in each unit during the site visit. All units were wards except for one newly designed, private room format. Storage of extra equipment in all the units was an issue, and all the ward units had to utilize hallways for equipment storage. Environmental differences between high and low infection rate NICUs were evident in the noise, lighting and staff communication patterns. The differences were noticeable upon entering the units. The level of staff environmental awareness was most noteworthy. In low infection units the level of awareness and sensitivity to the environment was much greater and reflected in the quiet, gentle environments. The silence was a notable; monitor alarms were not loud or frequent, and conversations were conducted in soft, muted tones, with specific silent periods in the day where activity was minimized to allow the babies the opportunity to sleep undisturbed. Attention to positioning the babies was noted in one NICU; staff worked to position the babies in ways that were developmentally appropriate and to make

them feel physically secure and to improve later musculoskeletal development. The general unit environment was muted in both sound and lighting. Various types of lighting were available, lighting was often bounced off of the ceiling to create a more natural lighting environment and reduce the direct glare on the isolettes. Natural lighting was used when possible. These units were observed to be neat and clean, trash removal occurred at regular intervals during the day and the actions of cleaning staff in the unit were deliberate and thoughtful.

In high NBSI NICUs, there was a high degree of environmental, visual and auditory stimuli. The space was filled with the constant sounding of monitor alarms. Bright fluorescent ceiling lights fill the units, and the units were littered with trash and equipment. Cleaning staff conducted activities that had an adverse impact upon the patients. At one facility, the housekeeping staff dusted the ceiling and knocked dirt directly into the babies, their beds and all the surrounding equipment. Nurses noted the activity but did not stop housekeeping. Staff were observed to shout to one another across the unit. Laughter and joking could be heard from multiple points within the unit. No attempt to reduce environmental stimuli beyond blankets over the isolettes was observed. The degree of environmental awareness and staff behavior in high and low infection rate NICUs was associated with the shared mental model of infection.

Observation of infection control measures produced the most obvious differences between high and low infection NICUs. Infection prevention violations were most commonly seen in high NBSI units and included handwashing, gloving, sterile fields and line care. Many of the violations were

small lapses, but the number had an additive effect. In the low NBSI units, attention to detail and handwashing was obvious. Staff moved through the units very deliberately and were observed to be more attentive to the details of patient care and environment. Significant breeches in infection control measures were not noted in the low NBSI units.

In high NBSI NICUs, significant breeches in infection control measures were noted. Gloves were required for patient care to reduce babies' exposure to potential contaminants. Incongruity in glove use was noted; it was not clear if gloves were being used to protect babies from potential contaminants or used to protect the nurses from the babies' contaminants (a universal precaution). Gloves were used in place of handwashing, violating the standard of handwashing before and after gloving. Common sense use of gloving and handwashing was missing among nursing, medical and ancillary staff (Table 10). An awareness of the causal linkages between infection control measures and actions appeared to be missing.

Personal integrity in the form of an awareness of action regarding what was sterile and what hands have touched was noted to be absent. Staff in high infection rate NICUs were observed to perform a variety of procedures identified as requiring sterile technique on surfaces that included the administrative nursing station, dirty linen carts, and chairs. Violations of sterile technique were often observed. Sterile fields were established in one part of the NICU and carried across the room to the patient's bedside and placed on another surface. Gloving was used in place of handwashing, the standard of hand hygiene before and

after gloving was not observed. Alcohol gel dispensers were fixed at the bedside in some NICUs and completely portable in others. The mobile nature of the gel containers was believed to make the product more accessible and more likely to be used, but may be a factor in cross-contamination. Gloves were worn while the staff performed a variety of activities prior to patient care. Caregivers were noted to eat and drink with gloves that were also used to type on the computer and to manipulate equipment from one room to another. Patient care was rendered after these activities without changing gloves or performing some form of hand hygiene. In the situation of multiple births, physician staff were noted to have failed to use cap and gown as required by policy, for insertion of umbilical lines. Glove changes between examinations of the babies were not observed in every instance. Equipment was also shared among the babies.

In high NBSI NICUs communication between physicians and nurses was uni-directional in nature. Physicians communicated with nurses, but staff nurses did not openly communicate with physicians. Staff nurses tended to speak only when spoken to during rounds. Nurse practitioners were observed to have a similar relationships to staff nurses as physicians in these units, dressing in street clothes and wearing white lab coats. Seniority was a major factor in the communication pattern; nurses and physicians who had worked with each other for more than 10 years had more open communication patterns than those who had worked together for less than 10 years. A long working relationship allowed for more direct and open communication. Newer nurses were less likely to

question physicians and newer physicians were less likely to openly communicate with nurses.

In low infection rate NICUs, communication was open and bi-directional among physicians, nurse practitioners and staff nurses. Physicians were observed to communicate with staff nurses about the care of the neonates and to ask for their opinions. Nurse practitioners were observed providing bedside care to neonates and dressed in the same scrubs as staff nurses, making them indistinguishable from staff nurses. In one low infection NICU, the nursing director was observed to change into scrubs and provide bedside care when the unit census increased. Physicians were noted to have in-depth discussions with nursing staff regarding patient status. Opinions regarding possible reasons for clinical signs and symptoms were exchanged between physicians and nurses.

The nursing response to monitor alarms differed significantly between high and low infection units. Alarms in low infection units rarely sounded. Nursing staff were more attentive to the status of the babies and had wider threshold limits on the monitors; nurses tolerated more variation in the biological parameters. Babies needing physical stimulation heard gentle conversation from their nurse as they applied alcohol gel to their hands before assessing and stimulating the babies. In high infection units where the alarms were sounding in a never-ending cacophony, the threshold limits were narrow. The nurses were less comfortable trusting their understanding of the variation in the patients' biological and clinical indicators, preferring the machine decision-making process. However, there was a numbing effect noted, where the constant

sounding of alarms lead to a much slower response times, followed by a sense of urgency where stimulation must occur immediately without any form of hand hygiene. The contrast in the response thresholds was a distinguishing characteristic between the NICUs.

Table 10: Examples of Violations in Infection Control Measures in High NBSI NICUs

Violations in Infection Control Procedures
Days, senior nurse doing care on small 1-pound baby. Diaper change, no glove change before repositioning the baby. With same gloves used to diaper, clean the IV port and administered IV medication.
Nurse washes hands between line changes, but after washing her hands wipes them on the bottom of her uniform, the back bottom portion covering the buttocks.
RN washing only her finger tips before starting care on patient. Washed for less than 10 seconds.
Evening nurse does diaper change with gown and gloves on. After cleaning baby's bowel movement and putting on a new diaper, she proceeds with the same glove to rub baby on the head, and to check for sores on the ears. Also replaces oxygen to the nose and secures it in place with the same gloves used for diapering. At the same time she is drinking coffee.
MD moves between babies but does not change gloves or wash hands.
RT tech changes out equipment. Cords are dragging on the floor. With gloved hands changes out equipment and picks up cords that were on the floor and returns to patient care.
Long leads from monitors often drag onto the floor and below the 2-foot level of the half wall. Leads are often lifted up and put into the bassinets.
Nurse doing a sterile IV change, places the sterile field on the nursing station. No gown worn in violation of unit protocol. Sterile field at nursing station with other nurses standing around chatting and reaching under the field to use the computer or phone. Gloves stacked on pile of discarded wrappers. Nurse picked up sterile field and move to bedside. Some objects fell off field onto the floor.
Housekeeping dusting the ceiling, and particles fall from ceiling onto the bassinets below.
Resident refused to put long hair in a cap for umbilical line placement. She just tucked hair into her gown and it immediately slipped out and fell into the sterile field. Resident did not properly open sterile gown, touching the front of the gown.
Nurse arrives from nursing station outside the ICN and stimulates baby without washing her hands. Then after documenting in the baby's chart leaves to attend to another baby without washing hands or using gel.
Nurse rocking baby, suction hose falls to the floor and she picks it up and places it in the bed.

Chapter 6: Qualitative Study Discussion & Limitations

A shared mental model of infection may be a prominent variable that influences the behavior and actions of the care team and therefore outcome. It was hypothesized that a “prevention” mental model would be associated with low NBSI rate NICUs. In this study, a shared mental model of prevention was the dominant perception of staff in low NBSI NICUs. All the staff within these NICUs had a shared the same perception of nosocomial bloodstream infections as preventable events, and was consistent in the associated concepts. A sense of personal integrity, response threshold to clinical measures, and personal goals were concepts associated with a shared mental model and were consistent among most respondents.

Personal integrity was defined as the shared responsibility and accountability for the patient, a professional drive to perform beyond the standard. Respondents had a greater awareness of the environment, information, and expectations for the babies. Their personal goals reflected the integrity to provide and ensure the delivery of safe, high quality care. Individuals were observed to follow prevention protocols and engage in local research to identify factors that may improve the health and development of the babies. Participation in unit based research and data use were prevalent among the staff. The open collegial communication patterns supported interaction between medical and nursing staff and facilitated staff environmental and situational awareness. Complete elimination of NBSI was not seen as possible, even for those with a mental model of prevention, human imperfection in the process of

care was perceived to lead to a low level of infection that could not be completely eliminated. The use of the term “error” was perceived as a systems failure in low NBSI NICUs; respondents understood that the term referred to unintentional failings or system failures. The prevention mental model was consistent across questions and was observed to be consistent with the activities of the unit, and was consistent across roles within the NICU.

An “inevitable” mental model was hypothesized to be associated with high NBSI rate NICUs, and was found to prevail in high NBSI NICUs. Respondents were consistent in their shared mental model. Individuals exposed to the concepts of the VON collaborative made statements that were consistent with ideas stated in the collaborative, but upon further probing would revert to the inevitability mental model. High NBSI rate NICU respondents tended to have a gestational age threshold, stating that babies less than 24 weeks gestational age would have an infection due to the very invasive nature of their care. The perception of error focused more on individual failures to provide appropriate care and may have biased responses to the question, as respondents were less willing to admit to individually failing in the provision of appropriate care. Therefore, in high NBSI rate NICUs, infection as an error or complication of care was evenly dispersed; and may have been influenced by exposure to the collaborative and the use of the term “error.” The responses at the two sites with exposure to the Vermont Oxford Network collaborative were nearly equally divided between errors and complications of care. Infections were understood to be preventable and the result of errors, causing them to become complications of

care. The implication of the transitional perceptions indicates that change is possible but conversion to a deeply held belief is difficult. The mental model of the physician and nursing leadership must be consistent as their mental models are reflected in that of the staff. Leadership, including all physician staff, needs to have a clear mental model of infection as preventable that must resonate in their behaviors and dialogues with staff, the primary focus being the improvement of care.

The limited number of purposefully sampled sites and individuals interviewed limits the generalizability of the results. Eight sites were selected and six sites participated in the study. One site was dropped due to administrative changes that prevented participation and a second site was dropped when delays in the Institutional Review Board (IRB) approval process exceeded the data collection timeline. The six sites participating sites were chosen to provide information-rich opportunities to explore the concept of shared mental model. Exclusions used to restrict the cohort and the purposeful site selection process, limit generalizability of the conclusions, as the sample was not a representative of the entire sample frame. The logic of probability sampling used in quantitative studies cannot be applied in this study, as the validity (or meaningfulness) of the findings have more to do with the richness of the selected cases than the sample size or random selection. At the sites, a convenience sample of nurses and physicians was used. Self-selection to participate in the interviews may have increased the sampling bias among the health professionals. Respondents may have volunteered based upon their own

interest in the study topic. Those interviewed were not completely representative of the healthcare team. Respiratory therapy, physical therapy, housekeeping and administrative representatives were not interviewed even though they can be considered as members of the NICU healthcare team. A representative sample of team members at randomly selected sites with infection rates in the median range of infection rate may have additional or contrasting perceptions when compared to those in this study.

The questions used in the interviews were designed to represent extreme perception to provoke an opinion and were hypothetical. The wording of these questions may have facilitated the respondents' identification with one perspective versus the other. Additionally, the terminology used in the questions may have shaped participants' responses and increased their sensitivity to identification with infection as preventable versus inevitable, and as an error versus a complication of care. Further work might use more subtle and broader terminology to probe respondents' perceptions.

Observations in this study were limited to a single point in time and were conducted by a single investigator over a 3-day period of time. This did not allow sufficient time for an in-depth ethnographic or longitudinal study. The observational study was used to confirm whether statements made by the respondents were reflected in their actions and served as a secondary source of validation. It was not designed to capture all the nuances within the NICU and doing so was beyond the scope of this study.

Investigator bias may affect both data collection and analysis as the values and beliefs of the investigator can influence what is observed and interpretation of the data. No investigator is without bias; however, the intent was to be open-minded and allow patterns, explanations, and causal linkages to flow from the data. Quantitative research concentrates on measurement and precision. The empirical approach is powerful, but often does not provide the richness of content and detail that can come from a qualitative approach; quantitative research is based on precise definitions, control groups, objective data collection, use of the scientific method, and replicable findings. Qualitative research is a method that is open and interpretative [57]. The meanings of the data are subjective and not generally quantifiable, as the focus is upon the meaning of what is observed or said. The case study, as a qualitative method, has limitations. The findings of two cases that allow for meaningful comparison in terms of essential characteristics, is often difficult. Replication and verification of these studies are not possible, as time does not stop, nor does evolution of the organization. Additionally, the significance of qualitative findings is the result of the researcher's subjective interpretation of the data and further limits generalizations. The use of qualitative and quantitative methods provides comprehensiveness that either method alone cannot provide and reduces potential bias through data triangulation. However, the mere presence of the researcher may alter behavior (Hawthorne Effect [58]), as it is difficult to observe and not be observed.

Chapter 7: Quantitative Study

Research Question

Is a shared mental model of NBSI associated with infection rate? What is the predominant culture seen in the NICUs? What are the characteristics of a NICU associated with infection rate?

Survey Site Selection

Site selection is discussed in detail in Chapter 3. As previously stated the sample was purposefully selected to obtain information-rich cases to illuminate the impact of a shared mental model on the rate of nosocomial bloodstream infections.

Survey Instruments

The survey instrument, *Hospital Survey on Patient Safety Culture*, was developed by WESTAT under a grant from the Agency for Healthcare Research and Quality (AHRQ), and was sponsored by the Medical Errors Workgroup of the Quality Interagency Coordination Task Force (QuIC). The survey was designed to measure the patient safety culture in hospital systems and to provide a means to assess domains associated with a culture of safety. Extensive psychometric analyses were conducted on the survey and were found to be reliable and valid [59, 60]. Items were modified to include the concept of infection prevention and

additional questions, developed from pilot interviews to address the concept of shared mental model of NBSI were added. An organizational culture assessment was also added to the survey, an ipsative (constant sum) version of twenty Likert-type questions developed by Chang and Weibe based the competing values framework of Robert Quinn and his colleagues [51, 61]. The 12 survey dimensions provide quantitative measurement of the elements related to organizational and patient safety cultures including the shared mental model of infection. The 12 dimensions include: group, developmental, hierarchical and rational culture; quality improvement; unit and hospital teamwork; communication; unit and hospital coordination; staffing; and non-punitive environment.

Pilot Test of Survey Administration

A web-based format of the survey was pilot tested at three sites. The modifications to the survey wording were not significant and not believed to influence the validity or reliability of the survey [59, 60], therefore only the web-based administration methodology was tested. The web-based approach was found to be ineffective, in terms of computer access and respondent discomfort with the use of computers. Computers at the three sites were made available to the staff for the purpose of taking the survey. Of the 68 respondents, 44% preferred the paper format; they expressed a belief that management could identify them if a computer were involved and they expressed a general discomfort with the use of computers. The paper format provided respondents

with a sense of anonymity, reduced anxiety, and did not require additional time for completion. Both methods of administration required no more than 15 minutes to complete.

Survey Administration

Site coordinators administered the survey within each NICU. Coordinators were asked to send all members of the NICU a letter signed by the NICU Medical Director soliciting participation in completing the survey. The letter explained the purpose of the survey and requested that the survey be returned to the site coordinator. The site coordinators were also asked to uniquely number the surveys and provide similarly numbered response cards to allow follow-up with non-respondents. The response card merely asked the respondent to indicate whether they intended to take the survey or not. Those who indicated a willingness to complete the survey but did not complete it would receive a second follow-up letter and copy of the survey. All site coordinators attached the letter signed by the Medical Director explaining the purpose of the survey, but compliance with the survey administration instructions varied. Two coordinators assigned unique identifiers to the survey and none of the site coordinators used the designed follow-up protocol. Follow-up involved verbally asking individuals if they had completed the survey and offering them an additional copy. All site coordinators tracked the total number of surveys administered for response rate statistics. Administration to ancillary services included: administrative and clerical; respiratory and occupational therapy; and laboratory and x-ray staff.

Study Variables

Infection rate, the dependent variable, was measured empirically based upon the VON definition of NBSI and the “shrunk estimates” of the standardized ratios of observed/expected cases calculated using indirect standardization for the Vermont Oxford Network database for 2002. The dependent variable was dichotomous, high or low, since the exact rate was not available due to the VON data protection agreements. The *Hospital Survey on Patient Safety Culture* was designed to include multi-item, summated rating (Likert) scales that represent independent variables associated with a culture of patient safety. These domains were created based upon the survey instructions that indicated the items were associated with each domain (Appendix 1). The internal reliability of these multi-item summated rating scales was measured using Cronbach’s alpha and ranged from 0.63 to 0.84, where an alpha greater than or equal to 0.60 was considered acceptable [59]. The domain for measuring the presence or absence of a prevention shared mental model was developed from the qualitative interview questions (Appendix 1); the prevention shared mental model domain was analyzed in the same manner as domains associated with a safety culture.

Survey Data Analysis

The relationship between the independent variables (items and domain variables) and the outcome (infection rate) were analyzed using STATA 8.0.

Missing data was handled by explicit imputation of the mean for the specific variable. All responses that were negatively worded were reverse coded to maintain consistency in the response direction. The main outcome variable, infection rate, was coded using the nominal scale high or low (0,1). The frequencies, mean and standard deviation, for all items and domains were obtained (Appendix 4).

Individual item and domain analyses were conducted using t-test and univariate regression analysis to determine if a difference in response existed between high and low infection rate NICUs. Variance estimates were used to develop confidence intervals and tests of significance. The robust estimator of variance is a type of variance estimator used with survey data [62], and does not assume that the model is true but assumes that error is due to the measurement of error where:

$$Y_i = x_i b + c_i$$

And b is estimated by:

$$b^{\wedge} = (x'x)^{-1}x'y$$

Site selection was purposeful and not random, designed to obtain sites from the two extremes of the VON database. Therefore, the assumption of independence of the individual observations does not hold and requires relaxation of the independence criteria. The robust regression develops a more appropriate standard error that compensates for the possible correlation of the observations by site and only assumes independence across sites where variance is determined by the sum of the individual observations for each site.

Differences in responses by role, years of experience, and number of hours worked were examined by creating indicator variables. Some of the categories for role and years of experience contained less than 5 observations and required collapsing into larger categories.

Reliability and validity analysis on these data were conducted. The internal reliability (Cronbach's alpha) of the safety culture dimensions was calculated for these data and compared to the results obtained by the survey authors. Reliability being a measure of the internal reliability of a multi-item, summated rating scale based upon the average correlation between items and the number of items. A high coefficient indicates the items measure a single concept and a low coefficient indicates that the items may be measuring more than one concept. A standardized Cronbach's alpha that assumes a mean of 0 and a variance of 1 prior to summing [62] were used for these data since non-random site selection affects the assumption of independence for individual observations with implications for variance. In the determination of the Cronbach's alpha large correlation coefficients and large number of items will produce greater reliability since:

$$\alpha = (1 - \sum \delta_i^2 / \delta_s^2) (k / (k - 1))$$

Where δ is correlation, k is the number of items. Reliability analysis was performed to determine if the wording changes to the survey significantly changed the domain that they measure when compared to the original reported Cronbach's alpha coefficients. The domains were then correlated with one

another to determine construct validity. Correlations of 0.20 to 0.40 were considered moderate, and less than 0.20 were considered weak or non-existent.

Chapter 8: Quantitative Results

Survey Descriptive Statistics

Survey response statistics varied across sites. A total of 667 surveys were administered and 332 responses received, resulting in an overall response rate of 50%. The range of response rates across the six sites varied from 34% to 69%. The average number of respondents per NICU was 55 with a range of 33 to 111 respondents.

Few demographic questions were asked in the survey in anticipation of privacy concerns. Most respondents were nurses (79%) and the majority worked more than 20 hours per week (96%). Nearly one-third of those surveyed had worked in their profession for more than 21 years while 26% had less than five years of professional experience and 61% had been associated with the specific NICU for more than five years (Tables 10-12).

Table 11: Distribution of Survey Respondents' Roles in the NICU

Staff Roles	Frequency	Percentage
RN	244	76 %
NNP	14	4 %
LVN/LPN	5	2%
MD	14	4%
Unit Clerk	14	4%
Respiratory Therapy	19	6%
Administration	6	2%
Other	5	1%

Table 12: Distribution of Survey Respondents' Work Hours

Hours Worked	Frequency	Percentage
< 20 hrs/wk	13	4%
20-36 hrs/wk	106	33%
37-40 hrs/wk	206	63%

Table 13: Distribution of Survey Respondents' Experience

Years in Profession	Frequency	Percentage
Less than 1 year	7	2 %
1-5 years	78	24%
6-10 years	58	18%
11-15 years	45	14%
16-20 years	48	15%
21 years or more	90	28%
Years Associated with Specific NICU	Frequency	Percentage
Less than 1 year	21	6%
1-5 years	106	33%
6-10 years	69	21%
11-15 years	46	14%
16-20 years	43	13%
21 years or more	40	12%

Missing Data

Items did not have a large number of observations with missing data. The three items with large missing responses, 16-19% missing data, were related to infection reporting and not applicable to all facilities. All other items had less than 2% missing data. Missing data were replaced by the imputed mean for that item.

Item Analysis

Univariate analysis of individual items was performed to determine if any single items had a significant effect on outcome. Items were regressed with infection rate using a robust regression that compensated for the correlation of the observations by site and assumed independence only across sites. Of the 49 items, statistically significant differences between high and low infection rate facilities occurred in only five items (Appendix 4). Low infection rate NICUs did

not perceive having a problem with NBSI and respondents felt NBSIs occurred rarely or never. Respondents in low infection rate NICUs were not “afraid to ask questions when something (did) not seem right” nor did they perceive infections as “errors.” In high infection rate NICUs NBSIs were perceived as an anticipated outcome of care and invasive procedures were perceived as more of a contributing factor to infections. Low infection rate NICUs perceived the number of visitors to the NICU and the number of invasive procedures as contributing factors to infections (Table 21).

Table 14: Items with Statistically Significant Differences Between High and Low Infection Rate Facilities

	Item	Mean Response for:		Diff.	Robust Std Error	t	P value	95% Confidence Interval	
		High Rate	Low Rate						
A17r	We (do not) have an NBSI problem in this unit.	2.27	3.74	1.47	0.44	3.35	0.020	0.32	2.60
A19r	An NBSI is (not) an anticipated outcome in pre-term babies (gestational age 28 - 32 weeks).	2.80	3.82	1.02	0.30	3.38	0.020	0.25	1.80
A20	NBSI are perceived as an error in out unit.	3.11	2.62	-0.49	0.18	-2.75	0.040	-0.96	-0.03
C6r	Staff are (not) afraid to ask questions when something does not seem right.	3.51	3.86	0.34	0.11	3.03	0.029	0.05	0.63
D7r	In your NICU, NBSI occur (rarely or never)	2.61	6.51	0.88	0.23	3.79	0.013	0.28	1.48
H6	Contributing Factor: Invasive Procedures	4.49	4.18	-0.30	0.12	-2.55	0.051	-0.61	0.00
H12	Preventive Factor: Number of Visitors to NICU	3.67	4.02	0.36	0.06	6.01	0.004	-0.19	0.52

Nurses felt more strongly that prematurity (p=0.071, CI -0.96, 0.06), fragile integument (p=0.026, CI -0.77, -0.07), and invasive procedures (p=0.048, CI -0.82, -0.01) were contributing factors to infections than ancillary staff.

Nurses also felt more strongly about the number of visitors to the NICU as a contributing factor than the nurse practitioners ($p=0.042$, CI $-1.16, -0.03$).

Domain Analysis

Domains were created based upon the survey instructions. These domains are thought to reflect a culture of patient safety, and include a prevention mental model. Crude rates indicate statistically significant differences between high and low infection rate NICUs in several domains. Safety, unit teamwork, communication, and feedback were perceived as important in low infection rate NICUs along with a non-punitive environment. Adequate staffing was also important in low infection rate NICUs. The overall hospital management and teamwork were not perceived as important to high infection NICUs when compared to the low infection rate units. The crude shared mental model of prevention was statistically significant and higher in the low infection rate NICUs.

Table 15: Crude Mean Difference of Domain Summative Rating Scales

Domain	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
	High Rate	Low Rate						
Safety	14.29	15.18	0.25	0.10	2.49	0.013	0.052	0.442
Organizational Learning	11.58	11.68	0.10	0.21	0.49	0.623	-.305	0.508
Unit Teamwork	15.54	16.32	0.78	0.31	2.57	0.011	0.183	1.384
Unit Communication	10.37	11.27	0.93	0.25	3.77	0.000	0.445	1.419
Unit Feedback	10.72	11.33	0.61	0.27	2.27	0.024	0.082	1.139
Nonpunitive Environment	8.86	10.35	1.49	0.31	4.75	0.000	0.870	2.103
Staffing	12.10	13.13	1.03	0.30	3.48	0.001	0.448	1.616
Hospital Management	10.32	11.11	0.79	0.26	3.09	0.002	0.289	1.300
Hospital Teamwork	13.27	14.49	1.22	0.32	3.86	0.000	0.600	1.846
Hospital Handoffs	13.18	13.33	0.15	0.31	0.49	0.627	-.460	0.763
Shared Mental Model	21.09	25.88	4.79	0.45	10.67	0.000	3.904	5.670

Domains were regressed with infection rate using robust regression to compensate for the correlation of the observations by site. The difference between high and low infection rate NICUs for the “prevention mental model” domain was not statistically significant ($p=0.59$, CI -0.26 , 9.83). Low infection NICUs were more likely to report infections and to treat infections as unusual occurrence than high infection NICUs. All other domains displayed no difference between high and low infection rate NICUs (Table 14).

Analysis of domains across the subgroups was performed to determine if there were significant differences across subgroups. Perception of teamwork within the NICU, communication openness, non-punitive response to events, and handoffs and transitions differed by role. Physicians perceived that there was more teamwork within the NICU ($p=0.095$, CI -0.33 , 2.98) and a greater non-punitive response to events than the nurses ($p=0.053$, CI -0.03 , 2.90), while nurses felt that handoffs and transitions occurred more smoothly than did physicians ($p=0.039$, CI -1.80 , -0.07). Respondents with more than 15 years of experience had a greater sense of teamwork within the NICU compared with respondents with less than 5 years of experience ($p=0.011$, CI 0.25 , 1.21). Respondents that worked part-time (less than 20 hours per week) perceived that there was less feedback and communication about errors and infection ($p=0.010$, CI -3.62 , 0.92); hospital management support for patient safety and infection prevention ($p=0.020$, CI -1.33 , -0.18); teamwork across hospital units ($p=0.039$,

CI -3.76, -0.14); and poor hospital handoffs and transitions (p=0.014, CI -2.77, -0.51) when compared to respondents who worked full-time.

Table 16: Mean Difference of Adjusted Domain Summative Rating Scales

Domain	Mean		Diff.	Robust Std. Error	t	P value	95% Confidence Interval	
	High Inf. Rate	Low Inf. Rate						
Prevention Mental Model	21.09	25.88	4.79	1.964	2.44	0.059	-0.263	9.837
Supervisor Promotion of Safety and Infection Prevention	14.29	15.19	0.891	0.616	1.45	0.207	-0.691	2.475
Organizational Learning	11.58	11.68	0.101	0.451	0.23	0.831	-1.058	1.262
Teamwork within NICU	15.54	16.32	0.783	0.622	1.26	0.263	-0.815	2.381
Communication Openness	10.34	11.27	0.932	0.617	1.51	0.191	-0.655	2.518
Feedback about Error & Infections	10.72	11.33	0.611	1.050	0.58	0.586	-2.089	3.310
Non-punitive Response	8.86	10.35	1.487	1.446	1.03	0.351	-2.230	5.203
Staffing	12.10	13.13	1.031	0.847	1.22	0.278	-1.147	3.211
Hospital Management Support for Safety & Infection Prevention	10.32	11.11	0.794	0.726	1.09	0.324	-1.073	2.661
Teamwork Across Hospital Units	13.27	14.49	1.222	0.735	1.66	0.157	-0.666	3.111
Handoffs & Transitions	13.18	13.33	0.151	0.985	0.15	0.884	-2.380	2.682
Reporting of Errors	10.36	10.91	0.546	0.595	0.92	0.402	-0.985	2.076
Reporting of Infections	10.91	11.62	0.704	0.258	2.72	0.042	0.393	1.368

Culture Analysis

The developmental and hierarchical cultural crude means between high and low infection rate NICUs were statistically significant. A developmental culture was stronger in low infection rate NICUs and hierarchical culture was stronger in high infection rate NICUs. Group and rational culture were statistically insignificant.

Table 17: Crude Cultural Domains

Cultural Domain	Mean		Diff.	Std. Error	t	P value	95% Confidence Interval	
	High Inf. Rate	Low Inf. Rate						
Group	31.52	35.42	3.91	2.07	1.89	0.06	-0.17	7.98
Developmental	16.14	23.59	7.36	1.38	5.33	0.00	4.64	10.08
Hierarchical	30.53	18.65	-11.87	1.98	-6.01	0.00	-15.76	-7.99
Rational	22.14	22.53	0.40	1.49	0.27	0.79	-2.51	3.34

Multiple regression that controlled for shared mental model produced a significant association between infection rate for two culture types, developmental culture ($p=0.007$, CI .001, .009) and hierarchical culture ($p=0.027$, CI -.006, -.000). Infection rate had a statistically significant association ($p=0.000$, CI= 0.036, 0.059) with a shared mental model when controlling for the four culture types. This indicates that shared mental model may work in conjunction with culture in effecting the infection rates.

Table 18: Association of Culture Domains with Shared Mental Model

Shared Mental Model & Culture	Constant	Coeff	Std Error	t	p value	95% Confidence Interval	
Group	19.85	0.13	0.013	5.89	0.000	0.053	0.105
Developmental	20.28	0.12	0.019	6.06	0.000	0.079	0.155
Hierarchical	25.43	-0.11	0.013	-8.77	0.000	-.136	-.086
Rational	23.60	-0.05	0.019	-2.71	0.007	-.091	-.014

The four culture domains were regressed with infection rate using robust regression to compensate for the correlation of the observations by site. None of the cultural domains displayed a difference between high and low infection rate NICUs. When culture types were examined by role and experience, those with more than 15 years experience in the NICU and physicians had statistically significant stronger perceptions of the three culture types: group, rational and hierarchical (Table 19).

Table 19: Differences in Culture Types by Role and Experience

Culture	Physicians		Senior Staff	
	P Value	CI	P Value	CI
Group	0.03	2.46, 24.07	0.05	-0.12, 10.65
Rational	0.01	-12.68, -3.36	0.02	-5.56, -0.66
Hierarchical	0.04	-16.01, -0.77	0.02	-11.03, -1.34

Survey Domain Reliability Analysis

In the original analysis, the 12 domains of the survey had internal consistency reliability Cronbach's alpha coefficients ranging from 0.63 to 0.84. Using the NICU survey data, the Cronbach's alphas ranged from 0.55 to 0.83. Overall, the alphas were lower than the those obtained by Sorra [59, 60]. The lower alphas may be related to the item wording changes to include NBSI, and the number of observations.

Table 20: Survey Domains Comparative Cronbach's Alphas

Domain	Original Cronbach's Alpha	Average Inter-Item Correlation	Current Data Cronbach's Alpha
Shared Mental Model	New Domain	0.28	0.74
Supervisor Promotion of Safety and Infection Prevention	0.75	0.41	0.74
Organizational Learning	0.76	0.34	0.61
Teamwork within NICU	0.83	0.48	0.79
Communication Openness	0.72	0.45	0.71
Feedback about Error & Infections	0.78	0.54	0.78
Non-punitive Response	0.79	0.60	0.82
Staffing	0.63	0.24	0.55
Hospital Management Support for Safety & Infection Prevention	0.83	0.41	0.67
Teamwork Across Hospital Units	0.80	0.45	0.76
Handoffs & Transitions	0.80	0.39	0.72
Reporting of Errors	0.84	0.61	0.83
Reporting of Infections	New Domain	0.47	0.73

The domains were then correlated with one another to determine construct validity. Correlations of 0.20 to 0.40 were considered moderate, and less than 0.20 considered weak. Infection reporting had the lowest correlations to all other domains. The most non-significant correlation was 0.06 ($p=0.28$) for

the domain “handoffs and transitions” with a moderate correlation of 0.31 ($p=0.00$) for “feedback and communication about errors and infections.” The domain “shared mental model of infection” was moderately correlated to all the domains, with the weakest correlation 0.28 ($p=0.00$) associated with the domain “handoffs and transitions” and the highest correlation 0.48 ($p=0.00$) with “feedback and communication about errors and infections.”

Chapter 9: Quantitative Study Discussion & Limitations

Univariate analysis of a shared mental model with the culture domains indicates a statistically significant association. It is not clear if a shared mental model evolves from the culture or whether the reverse is the case. A mental model of infection as preventable had a marginally significant association with low NBSI rate NICUs after adjusting for the purposeful site selection. Multivariate analysis produced a statistically significant association ($p = 0.000$, CI .036, .059) between infection rate and shared mental model when controlling for the four culture domains, supporting the concept that culture may operate with the shared mental model of infection in effecting the infection rate. However, senior physicians and nursing staff (those with more than 15 years experience in the NICU) had stronger perceptions of some of the culture types. Medical staff had a stronger perception of teamwork within the NICU than nursing staff, but both nursing and medical staff were consistent in their mental model of infection. This study indicates that shared mental model has a role in effecting the infection rate, but there is an interaction between shared mental model and culture; the direction of the interaction is unclear.

The small number of sites in the study, the non-random site selection process and the lack of balance between high and low infection sites may account for the results. The site selection method limited the assumption of independence for individual observations, so independence could only be assumed to occur across sites. These survey results are not representative of all NICUs, as site selection was based upon NBSI rate and did not take into account

structural differences between NICU, such as number of beds, average daily census, staffing ratios and other characteristics of the NICU. Non-respondents were generally part-time staff that worked less than 20 hours per week. Access to these individuals was more difficult, and they are not fully represented in the sample.

The *Hospital Survey on Patient Safety Culture* modifications to include nosocomial infections may have confused respondents. The domains in this survey are appropriate to understanding a culture of patient safety but may not be important to understanding the shared mental model of infection. Domains important to building and shaping a shared mental model may overlap with a culture of safety in concept, but the wording of survey questions may need to be different. While reduction of nosocomial infections can be viewed as a patient safety issue, the perceptions of providers about infections are vastly different than those they hold for an error. A medication error is clearly seen as a mistake, with an immediate and unambiguous outcome. Actions to correct the failure that lead to the outcome are readily apparent. Infection control measures are often seen as optional. Failure to practice stringent hand hygiene does not produce the same effect as overdosing a patient or removing the wrong kidney. The effect of the infection prevention failure often lags behind the event by several days, creating a disconnection between the failure to practice stringent infection prevention and occurrence of the infection. The use of the terminology of “error” in relationship to infections provokes a hesitation in response. Failure to practice hand hygiene is rarely perceived as an error, except in the most

enlightened individuals who possess an understanding of systems thinking. Additional research on the terminology and definitions is needed to refine the scope of questions for determination of a shared mental model of NBSI using survey methods.

Chapter 10: Conclusions

Results Summary

The current findings have important implications for consideration in improving the rates of nosocomial bloodstream infections in neonatal intensive care units. In the quantitative survey of the NICUs, a shared mental model of infection as preventable had only a marginal association with low NBSI rate after controlling for the non-random site selection process. However, the association was statistically significant when controlling for the four types of culture ($p=0.000$, CI .036, .059) indicating that culture and shared mental model operate through one another in reducing the infection rate, but the direction of that interaction is not clear.

Open communication patterns that are bi-directional support both the culture and shared mental model and improves the degree to which the mental model is shared. The perceived mental model of infection was observed to be consistent among the physicians and nurses within each NICU. Members of the same NICU perceived infection as either inevitable or preventable; staff in the low NBSI units had a prevention mental model compared to the inevitable mental model held by the staff in high NBSI units. The causal relationship between infection rate and shared mental model was not part of this study so it is not possible to say which existed first, the shared mental model of infection or the infection rate. Low infection rate NICUs had more interactive cultures. Nursing and medical staff regularly discussed patient status and all staff participated in

activities to improve the infection rate and quality of care within the unit. In these units, the work to improve the quality of care was a constant effort that engaged everyone on a daily basis. This difference was significant between high and low infection rate facilities.

Leadership must be aware that unit culture and shared mental model are related and have a role in the ability or inability of a site to improve the NBSI rate. Mental models directly affect behavior ([39, 49, 50]; the perception of nosocomial infection held by the NICU physicians and nurses influences their performance of infection control behaviors. A strong culture of infection prevention exerts a social pressure to perform the appropriate behaviors influencing both the mental model and providers' intent and creating normative beliefs regarding infection prevention. Inconsistencies between the mental model and actual behaviors result from a lack of strong normative beliefs and culture that support prevention. While a distinct cultural characteristic was not associated with outcome in the quantitative study, staff descriptions of a group or developmental unit culture were noted during the interviews.

Low NBSI Rate NICUs

A shared mental model of NBSI as a preventable event was seen in low NBSI rate NICUs. Responses were consistent across questions; respondents believed that infections were the result of a failure to follow infection control measures, and infections were errors due to failures in the system of care. They believed that an infection rate of zero, while an attainable gold standard, was

subject to the imperfection of people and some level of infection would always be present. The staff at these units generally indicated that they had sufficient time to perform hand hygiene prior to responding to babies' alarms, a reflection of a stronger sense of "personal integrity," and a barometer of the prevention culture within the NICU. NICU culture was also reflected in the personal goals of the respondents. In these low infection NICUs, the focus was on protection and provision of high quality care. The quantitative and observational studies support these findings. The observational study indicated that the environment and infection prevention processes in the low infection rate NICUs support a shared prevention mental model. The strength of the association between a low infection rate and a shared mental model of infection became statistically significant when controlling for the four culture types.

Unit culture was not associated with infection rate in the robust analysis that adjusted for the non-random site selection. However, the qualitative study results indicate that information sharing and a participatory environment were important to changing and supporting the shared mental model of prevention. This was not seen in the quantitative results and may be due to the qualitative study emphasis on information sharing, diffusion of innovation and quality improvement. Survey respondents associated the unit culture questions with peer interactions versus the team interactions of the unit for quality improvement and diffusion of innovation.

Staff in these low NBSI units felt that leadership provided them with the resources and training for success. Leadership assumed a mentoring

relationship that facilitated teamwork and decentralized decision-making, providing opportunities for innovation. Participation in the improvement process through discussion and shared decision-making created staff ownership of the process and produced a greater sense of personal integrity and responsibility for the processes of care. In low NBSI units there was a pre-occupation with reducing the infection rate and protecting the babies.

High NBSI Rate NICUs

The inevitable mental model dominated high NBSI rate NICUs and responses to the questions were generally consistent. Two sites had exposure to the concepts of the VON collaborative for the improvement of care; these sites displayed some transitions in the mental model in their stated beliefs that were not reflected in infection control behaviors observed in the unit. Violations to infection control behaviors were strongly noted in the observational study, indicating incongruence between stated beliefs and actions; the incongruence indicates the dominance of the inevitable mental model. Observations of behavior in high NBSI rate NICUs revealed a low response threshold among nurses responding to alarms. Failure to perform any type of hand hygiene was often noted and was consistent with interview comments regarding the need to respond immediately, reflecting a lower degree of personal integrity for maintaining infection control standards and accounting for the numerous infection control violations that were observed.

Culture of NICUs with high NBSI indicated both a group and hierarchical orientation. In the interviews respondents indicated a group culture in peer-to-peer interactions, but a hierarchical orientation for information sharing, diffusion of innovation and quality improvement. The hierarchical orientation noted in the interviews may result from the use of various nursing councils that create a top-down approach to change. The council organizational controls led to the use of formal policies and procedures to control and coordinate. The flow of information and communications was hierarchical, council members controlling information and information flow. Leadership in these NICUs had the role of policing compliance to standards, and modeling ideal behaviors. Participation and decision-making was limited to a select group. Barriers to change were noted: among them, the seniority of the staff. Staff who had trained and worked in only one NICU were seen as more resistant to change due to a limited exposure to approaches used in other NICUs and a lack of professionalism. The personal goals of high infection respondents were primarily focused on disease-specific and administrative issues. The care of the babies was not the primary personal focus of respondents. NICUs exposed to the VON collaborative found the number of changes and the process for change in their NICU to be barriers. The orientation of high infection rate units tended to be more hierarchical with staff passive participants in the process of change. Group culture in these units was the result of length of time associated with the unit and friendships among staff members.

Chapter 11: Overall Study Strengths & Limitations

Major Strengths

No literature exists that examines the shared mental model of NBSI in NICUs. While this study was exploratory, the uniqueness of the study is related to the focus on a specific illness category for a specific population in a defined operational unit. The neonatal intensive care unit (NICU), a small, well defined healthcare unit within a large hospital system that has a defined population of patients and a defined team of providers. Using a specific category of illness, nosocomial bloodstream infections, provided a unique opportunity to examine the role of a shared mental model within the context of a healthcare system with specific infection prevention behaviors. Purposeful selection of NICUs from the extreme ends of the NBSI rate range provided information-rich contexts for the exploration of a shared mental model.

Three methods were used to explore and understand the role of a shared mental model. The use of a variety of data sources created balance and counter-balance. The interviews, observation and surveys provided both qualitative and quantitative data to create a much richer and more reliable understanding of perceptions of nosocomial infections and how those influenced infection prevention behaviors. Use of any one method would not have lead to the richness of understanding, nor allowed for a test of consistency. Different data types yielded different results stemming from the method's sensitivity to the nuances of the subject matter. These differences provided a deeper, richer understanding of the shared mental model.

Major Limitations

Extreme, purposeful sampling does not allow for the use of probability sampling and limits the generalizability of the findings in both the qualitative and quantitative studies. Investigator bias is always an issue for qualitative studies. In this study a single investigator performed all the interviews and analyzed all the data, therefore, inter-rater reliability could not be achieved and bias could easily have been introduced. The use of multiple researchers to verify observations and interpret interviews would have strengthened the study by providing multiple perspectives and improving the inter-rater reliability. Semi-structured interview questions were used to limit bias, but the framing of the questions and terminology used may introduce bias in the responses. The meanings gleaned from the data are subjective and not quantifiable, and subject to interpretation.

The site visits were snapshots into the activities of the NICU and did not allow for observation of changes over time. The observation period provided an opportunity to verify the congruence between stated perceptions of behavior and actual behavior. While certain behaviors were observed, determination of the exact influencing forces behind them could not be made. There is always the bias that occurs with the presence of an observer, no matter how unobtrusive, that may influence the behavior of individuals in the NICUs. Additionally there are the perceptions of the observer that can distort the data where description, interpretation and judgment can be difficult to separate out.

Replication and verification of these studies are not possible because culture in the NICU and individual mental models are evolving, as demonstrated by the exposure to the VON collaborative. The NICU was the unit of analysis and a limitation of this study. When the NICU is the unit of analysis, not every process is studied and every member of the NICU interviewed, so the sample of those observed, surveyed and interviewed is the average of the process or belief. This requires that a large number of NICUs be studied, as the number of staff does not determine sample size, rather the number of NICUs used for comparison [15].

Chapter 12: Implications & Future Research Needs

The role of shared mental models is being studied in the military to understand how teams and decision-making occur in highly successful teams [30, 33, 34, 36, 39, 43, 63, 64]. These studies have identified that a shared mental model influences outcome. Frameworks for understanding the role of the mental model in teamwork and decision-making have been proposed, but measurement remains elusive. Teamwork as a shared mental model is a dynamic, multi-faceted concept that involves multiple mental models and complex interactions. Thus, defining the shared mental model and the associated behaviors remains problematic.

A mental model of infection is a narrower concept with more defined behaviors. Refinement of the tools and methods to identify and measure the mental model of infection will enhance understanding of the role of mental models in health care. This could impact how providers and other staff are trained. However, currently insufficient information exists and no single measure has been identified that would allow for greater use of this variable in understanding the implications for the processes of care. This research is the first to examine a shared mental model of disease and much more research is needed to refine methods, measure, and determine the strength of association to infection rate variation.

The Joint Commission on the Accreditation of Healthcare Organizations announced, as one of the 2004 National Patient Safety Goals, the reduction of risk from healthcare-acquired infections [65]. In January 1, 2004 all JCAHO-

accredited healthcare organizations were evaluated for compliance with the goals and its requirements. Nosocomial infections required compliance with Center for Disease Control (CDC) hand hygiene standards and the management of all identified cases of death or impairment due to nosocomial infections as sentinel events. Understanding the shared mental model of providers will improve compliance with infection prevention measures and reduce the number of infections as the shared mental model of infection influences the likelihood that an individual will perform the infection control behaviors that impact outcome. This study does not demonstrate that having a shared mental model is the variable that accounts for the variation in NBSI rate, but it is a prominent variable that influences behavior and indirectly effects outcome.

It is important to understand how shared mental models are defined and shaped in the context of high reliability systems of care. Characteristics of high reliability organizations [66, 67] can be seen in NICUs with low nosocomial bloodstream infection rates. High reliability organizations focus on system failures, large and small, they learn from the system in an effort to avoid failures. Failure and system data guide system improvement, and these organizations strive to avoid marginalizing or normalizing system failures, errors. High reliability organizations are very deliberate in understanding system failures; they avoid the obvious, simple conclusions as solutions to the problem, and there is a dependence upon front line personnel who perform the real work to identify and resolve system anomalies, a result of the strong relationship between processes and personnel. Everyone within the organization has a responsibility to prevent

failure, which results in an awareness of the environment, a situational awareness of context, activities and personnel around them. Blame of the individual for failure or for speaking out is replaced with a drive to understand how the system failed the individual in the execution of the task and an acceptance of the individual as the most knowledgeable of the system failure or event. Decision-making decentralized, and the organization acknowledges that the knowledge and experience necessary for improvement resides with the front-line personnel. A high reliability orientation creates a culture that is systems and data driven, that encourages an in-depth understanding of the interactions between people and processes, and supports personnel in efforts to improve the system. These are the characteristics of NICUs with low infection rates.

Evolution of the shared mental model may be a reflection of the culture and the leadership of the unit. A Robert Wood Johnson Foundation sponsored study examined 20 high performing units within larger healthcare systems [68] and identified nine characteristics of success: leadership, culture, support, patient focus, staff focus, multidisciplinary care team, information environment, and a clear process for improvement that includes outcome measurement. These characteristics are important to the success of any organization. For successful NICUs with low infection rates, these were also defining characteristics. Additional research is needed to understand the characteristics of successful high reliable NICUs and the influence the characteristics of these organizations exert on mental models.

Nosocomial infections are associated with significant mortality, morbidity and cost. Patient Safety goals now target the reduction of the nosocomial infection rate as a goal. These infections are preventable, and this study indicates that a shared mental model has a prominent role in the performance of infection prevention measures and therefore the outcome. Institution of best practices for the prevention of infections will have little impact if the mental model prevents its consistent use.

Chapter 13: References

1. Sohn, A.H., et al., *Prevalence of nosocomial infections in neonatal intensive care unit patients: Results from the first national point-prevalence survey*. The Journal of Pediatrics, 2001. **139**(6): p. 821-7.
2. Stoll, B.J., et al., *Late-onset sepsis in very low birth weight neonates: the experience of the NICHD Neonatal Research Network*. Pediatrics. 2002 Aug;110(2 Pt 1):285-91, 2002.
3. Mehr, S.S., et al., *Sepsis in neonatal intensive care in the late 1990s*. Journal of Paediatrics & Child Health. 2002 Jun;38(3):246-51, 2002.
4. Lee, S.K., et al., *Variations in practice and outcomes in the Canadian NICU network: 1996-1997*. Pediatrics., 2000. **106**(5): p. 1070-9.
5. Payne, N.R., et al., *Marginal increase in cost and excess length of stay associated with nosocomial bloodstream infections in surviving very low birth weight infants*. Pediatrics, 2004. **114**(2): p. 348-55.
6. Weick, K.E. and K.M. Sutcliffe, *Hospitals as cultures of entrapment: A re-analysis of the Bristol Royal Infirmary*. California Management Review, 2003. **45**(2): p. 73-84.
7. Horbar, J.D., et al., *Trends in mortality and morbidity for very low birth weight infants, 1991-1999*. Pediatrics, 2002. **110**(1 Pt 1): p. 143-51.
8. Horbar, J.D., et al., *Collaborative quality improvement for neonatal intensive care. NIC/Q Project Investigators of the Vermont Oxford Network*. Pediatrics., 2001. **107**(1): p. 14-22.
9. Lemons, J.A., et al., *Very low birth weight outcomes of the National Institute of Child health and human development neonatal research network, January 1995 through December 1996*. NICHD Neonatal Research Network. Pediatrics. 2001 Jan;107(1):E1, 2001.
10. Gaynes, R.P., et al., *Nosocomial infections among neonates in high-risk nurseries in the United States*. National Nosocomial Infections Surveillance System. Pediatrics., 1996. **98**(3 Pt 1): p. 357-61.
11. Fanaroff, A.A., et al., *Incidence, presenting features, risk factors and significance of late onset septicemia in very low birth weight infants*. The National Institute of Child Health and Human Development Neonatal Research Network. Pediatric Infectious Disease Journal. 1998 Jul;17(7):593-8, 1998.
12. Edwards, W.H., *Preventing nosocomial bloodstream infection in very low birth weight infants*. Seminars in Neonatology., 2002. **7**(4): p. 325-33.
13. CDC, *CDC definitions for nosocomial infections*. Am J Infect Control, 1989. **17**(1): p. 42-3.
14. Kritchevsky, S.B., et al., *Definition and adjustment of Cesarean section rates and assessments of hospital performance*. International Journal for Quality in Health Care, 1999. **11**(4): p. 283-91.
15. Kritchevsky, S.B., et al., *Impact of hospital care on incidence of bloodstream infection: the evaluation of processes and indicators in infection control study*. Emerging Infectious Diseases, 2001. **7**(2): p. 193-6.

16. Auriti, C., et al., *Risk factors for nosocomial infections in a neonatal intensive-care unit*. Journal of Hospital Infection., 2003. **53**(1): p. 25-30.
17. Tucker, J. and U.K.N.S.S. Group, *Patient volume, staffing, and workload in relation to risk-adjusted outcomes in a random stratified sample of UK neonatal intensive care units: a prospective evaluation.[comment]*. Lancet., 2002. **359**(9301): p. 99-107.
18. Horbar, J.D. and J.H. Carpenter, *Nosocomial Bacterial Infection in Very Low Birth Weight Infants: We can do better!*, D.M. Luan, Editor. 2003, Vermont Oxford Network: Burlington, VT.
19. Pessoa-Silva, C.L., et al., *Infection due to extended-spectrum beta-lactamase-producing Salmonella enterica subsp. enterica serotype infantis in a neonatal unit*. Journal of Pediatrics, 2002. **141**(3): p. 381-7.
20. Pittet, D., *Improving adherence to hand hygiene practice: a multidisciplinary approach*. Emerging Infectious Diseases, 2001. **7**(2): p. 234-40.
21. Pittet, D., et al., *Hand hygiene among physicians: performance, beliefs, and perceptions.[see comment]*. Annals of Internal Medicine, 2004. **141**(1): p. 1-8.
22. Bloom, B.T., et al., *Reducing acquired infections in the NICU: observing and implementing meaningful differences in process between high and low acquired infection rate centers*. Journal of Perinatology, 2003. **23**(6): p. 489-92.
23. Benjamin, D.K., Jr., et al., *Bacteremia, central catheters, and neonates: when to pull the line*. Pediatrics, 2001. **107**(6): p. 1272-6.
24. Sohn, A.H., et al., *Prevalence of nosocomial infections in neonatal intensive care unit patients: Results from the first national point-prevalence survey*. Journal of Pediatrics., 2001. **139**(6): p. 821-7.
25. Stevens, A.L. and D. Gentner, *Introduction*, in *Mental Models*, A.L. Stevens, Editor. 1983, Lawrence Erlbaum Associates, Inc.: Hillsdale, New Jersey. p. 1-6.
26. Legrenzi, P. and V. Girotto, *Mental models in reasoning and decision-making processes*, in *Mental Models in Cognitive Science: Essays in Honour of Phil Johnson-Laird*, A. Garnham, Editor. 1966, Psychology Press: East Sussex, UK. p. 95-118.
27. Power, M. and T. Wykes, *The mental health of mental models and the mental models of mental health*, in *Mental Models in Cognitive Science: Essays in Honour of Pil Johnson-Laird*, A. Garnham, Editor. 1996, Psychology Press: East Sussex, UK. p. 197-222.
28. Ehrlich, K., *Applied mental models in human-computer interaction*, in *Mental Models in Cognitive Science: Essays in Honour of Phil Johnson-laird*, A. Garnham, Editor. 1996, Psychology Press: East Sussex, UK. p. 223-245.
29. Johnson-Laird, P.N., *Mental Models: Towardes a cognitive science of language, inference, and consciousness*. Cognitive science series; 6. 1983, Cambridge, Massachusetts: Harvard University Press. 513.
30. Cannon-Bowers, J.A., E. Salas, and S. Converse, *Shared mental models in expert team decision making*, in *Individual and Group Decision Making: Current Issues*, N.J. Castellan, Editor. 1993. p. 221-246.
31. Norman, D.A., *Some observations on mental models*, in *Mental models*, A.L. Stevens, Editor. 1983, Lawrence Erlbaum Associates, Inc.: Hillsdale, New Jersey. p. 7-14.

32. Baker, D.P. and E. Salas, *Analysing team performance: In the eye of the beholder?* Military Psychology., 1996. **8**(3): p. 235-245.
33. Mathieu, J.E., et al., *The influence of shared mental models on team process and performance.* Journal of Applied Psychology., 2000. **85**(2): p. 273-83.
34. McIntyre, R.M. and E. Salas, *Measuring and Managing for Team Performance: Emerging Principles from Complex Environments*, in *Team Effectiveness and Decision Making in Organizations*, Associates, Editor. 1995, Jossey-Bass, Inc.: San Francisco. p. 9-45.
35. Kraiger, K. and L.H. Wenzel, *Conceptual development and empirical evaluation of measures of shared mental models as indicators of team effectiveness*, in *Team Performance Assessment and Measurement: Theory, Methods, and Applications*, A. Prince, Editor. 1997, Lawrence Erlbaum Associates: Mahwah, New Jersey. p. 63-84.
36. Rentsch, J.R., M.D. McNeese, and K. Perusich. *Modeling, measuring, and mediating teamwork: The use of fuzzy cognitive maps and team member schema similarity to enhance BMC3I decision making.* 2000.
37. Morgan, B.B. and C.A. Bowers, *Teamwork Stress: Implications for Team Decision Making*, in *Team Effectiveness and Decision Making in Organizations*, Associates, Editor. 1995, Joseey-Bass, Inc: San Francisco. p. 262-290.
38. Cannon-Bowers, J.A., et al., *Defining competencies and establishing team training requirements*, in *Team Effectiveness and Decision Making in Organizations*, Associates, Editor. 1995, Jossey-Bass, Inc.: San Francisco. p. 333-380.
39. Rouse, W.B., J.A. Cannon-Bowers, and E. salas, *The role of mental models in team performance in complex systems.* IEEE Transactions of Systems, Man, and Cybernetics, 1992. **22**(6): p. 1296-1308.
40. Salas, E., C.A. Bowers, and L. Rhodenizer, *It is not how much you have but how you use it: toward a rational use of simulation to support aviation training.* International Journal of Aviation Psychology., 1998. **8**(3): p. 197-208.
41. Salas, E., et al., *Team training in the skies: does crew resource management (CRM) training work?* Human Factors., 2001. **43**(4): p. 641-74.
42. Salas, E. and J.A. Cannon-Bowers, *The science of training: a decade of progress.* Annual Review of Psychology., 2001. **52**: p. 471-99.
43. Dickinson, T.L. and R.M. McIntyre, *A conceptual framework for teamwork measurement*, in *Team Performance Assessment and Measurement: Theory, Methods, and Applications*, C. Prince, Editor. 1997, Lawrence Erkbayn Associated: Mahwah, New Jersey. p. 19-43.
44. Brannick, M.T., et al., *The measurement of team process.* Human Factors., 1995. **37**(3): p. 641-51.
45. Shortell, S.M., et al., *The performance of intensive care units: does good management make a difference?* Medical Care, 1994. **32**(5): p. 508-25.
46. Revans, R.W., *After the decade, An emollient review of The Hospitals' Internal Communications Project.* Lamp, 1976. **33**(7): p. 26-31.
47. Revans, R.W., *Hospital internal communications.* Nursing Times, 1968. **64**(11): p. Suppl:41-2.

48. Schein, E.H., *Organizational culture and leadership*. 2nd ed. 1992, San Francisco: Jossey-Bass Publisher.
49. Weick, K.E. and K.M. Sutcliffe, *Hospitals a Cultures of Entrapment: A Re-Analysis of the Bristol Royal Infirmary*. California Management Review, 2003. **45**(2): p. 73-84.
50. Senge, P.M., *The fifth discipline: The art and practice of the learning organization*. First ed. 1990, New York: Doubleday. 423.
51. Zammuto, R.F., B. Gifford, and E.A. Goodman, *Managerial ideologies, organization culture, and the outcomes of innovation: A competing values perspective*, in *Managerial Ideologies and Outcomes of Innovation*.
52. Zimmerman, J.E., et al., *Improving intensive care: observations based on organizational case studies in nine intensive care units: a prospective, multicenter study [see comments]*. Critical Care Medicine, 1993. **21**(10): p. 1443-51.
53. Shortell, S.M., et al., *Continuously improving patient care: practical lessons and an assessment tool from the National ICU Study*. QRB. Quality Review Bulletin, 1992. **18**(5): p. 150-5.
54. O'Connor, G.T., et al., *A regional intervention to improve the hospital mortality associated with coronary artery bypass graft surgery. The Northern New England Cardiovascular Disease Study Group [see comments]*. JAMA, 1996. **275**(11): p. 841-6.
55. Shortell, S.M., et al., *Organizational assessment in intensive care units (ICUs): construct development, reliability, and validity of the ICU nurse-physician questionnaire*. Medical Care, 1991. **29**(8): p. 709-26.
56. Gibberd, R., A. Pathmeswaran, and K. Burtenshaw, *Using clinical indicators to identify areas for quality improvement*. Journal of Quality in Clinical Practice, 2000. **20**(4): p. 136-44.
57. Patton, M.Q., *Qualitative research and evaluation methods*. 3rd ed. 2002, Thousand Oaks: Sage Publications, Inc.
58. Roethlisberger, F.J. and W.J. Dickson, *Management and the Worker*. 1939, Cambridge: Harvard University Press.
59. Sorra, J. and V. Nieva, *Pilot Study: Reliability and Validity of the Hospital Survey on Patient Safety*. 2004, WESTAT: Rockville, MD.
60. Sorra, J., *Survey Guide for the Hospital Survey on Patient Safety*. 2004, WESTAT: Rockville, MD.
61. Shortell, S.M., et al., *Assessing the impact of continuous quality improvement/total quality management: concept versus implementation*. Health Services Research, 1995. **30**(2): p. 377-401.
62. StataCorp, *Stata Statistical Software*. Release 8.0 ed. Vol. User Guide. 2003, College Station, Texas: Stata Press. 423.
63. Cannon-Bowers, J.A. and E. Salas, *A framework for developing team performance measures in training*, in *Team Performance Assessment and Measurement: Theory, Methods, and Applications*, C. Prince, Editor. 1997, Lawrence Erlbaum Associated, Inc.: Mahwah, New Jersey. p. 45-62.
64. Orasanu, J. and E. Salas, *Team decision making in complex environments*, in *Decision Making in Action: Models and Methods*, C.E. Zsombok, Editor. 1995, Ablex Publishing Corporation: Norwood, New Jersey. p. 327-345.

65. JCAHO, *Joint Commission Announces 2004 National Patient Safety Goals*. 2003, JCAHO.
66. Gaba, D.M., *Structural and Organizational Issues in Patient Safety: A Comparison of Health Care to Other High-Hazard Industries*. California Management Review, 2000. **42**(1): p. 83-102.
67. Weick, K.E. and K.M. Sutcliffe, *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. 1st edition ed. University of Michigan Business School Management Series: Innovative solutions to the pressing problems of business, ed. R.E. Quinn. 2001, San Francisco: John Wiley & Sons, Inc.
68. Nelson, E.C., et al., *Microsystems in health care: Part 1. Learning from high-performing front-line clinical units.[see comment]*. Joint Commission Journal on Quality Improvement, 2002. **28**(9): p. 472-93.

Appendix 1: Data Collection Tools

Appendix 1- 1: Semi-structured Guided Interview Questions	103
Appendix 1- 2: Observational Study Checklist	104
Appendix 1- 3: NICU Survey	105
Appendix 1- 4: Domains for NICU Survey	113

Appendix 1- 1: Semi-structured Guided Interview Questions
--

1. What is your role in the NICU?
 - a. How long have you worked here?
 - b. Tell me about your background and training that prepared you for your role.
2. In your own words, describe the main goal or focus of your NICU?
3. *An area that I am very interested in understanding is how nosocomial infections are cared for in NICUs.* Can you tell me about the last baby that you cared for that had a NBSI?
 - a. What do you believe was the cause of this infection?
4. How does the baby's pre-maturity play into its' vulnerability to infection?
5. So are NBSI inevitable in pre-term babies of less than 32 weeks GA, or are they preventable?
 - a. What causes the *inevitability* or *preventability*?
6. What is the role of senior leadership in the prevention of NBSI?
7. What about administrative leadership? What is their role?
8. Please respond to the following: *"Researchers have stated that no pre-term baby of less than 32 weeks GA should experience a NBSI."*
9. Are NBSI an error or an anticipated outcome/complication?
 - a. Please explain.
 - b. What do you believe is the opinion of the majority of your colleagues?
 - c. What do you tell parents?
10. How do you believe your unit ranks national in terms of NBSI rate? Do you believe you could improve and how?

Thank you for your time and cooperation. I appreciate your candor in answering my questions. Let me reiterate that everything that you have said today will be kept in confidence. All information will be reported only in the aggregate.

Do you have any questions that you would like to ask of me?

Is there any other information that you would like to impart?

Oh, one last question....

1. If you could change one thing in your NICU for improving care, what would it be?

Thank you very much for your time and consideration.

Appendix 1- 2: Observational Study Checklist

Describe the setting, the physical environment

- ✓ Access - anteroom
- ✓ Colors
- ✓ Space – number of beds
- ✓ Nursing station
- ✓ Machinery/Technology
- ✓ Walls
- ✓ Lighting - bright
- ✓ Sink locations
- ✓ Noise

Social Environment

- ✓ How do people organize themselves
- ✓ Decision making patterns
 - o PARENT INVOLVEMENT (inclusive or after-thought)
 - o Rounds decision making pattern
 - o Who participates in decision making process
 - o To what extent are decisions made openly
 - o How are participants made aware of decisions

Communication Patterns

Interaction Patterns

Infection control Violations



NICU Survey

Instructions

This survey asks for your opinions about patient safety issues, nosocomial bloodstream infections, medical error, and event reporting in your hospital and will take about 15 minutes to complete.

- NBSI = nosocomial bloodstream infection
- NICU = neonatal intensive care unit
- *Senior leadership = unit medical and nursing leadership*
- *Administrative leadership = CEO, COO, hospital administrative personnel*
- An “*event*” is defined as any type of error, mistake, incident, accident, or deviation, regardless of whether or not it results in patient harm.
- “*Patient safety*” is defined as the avoidance and prevention of patient injuries or adverse events resulting from the processes of health care delivery.

SECTION A: Your Work Area/Unit

In this survey, think of your “unit” as the NICU where you spend most of your work time or provide most of your clinical services.

Please indicate your agreement or disagreement with the following statements about your NICU. Circle your answer.

Think about your hospital work area/unit...	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
	▼	▼	▼	▼	▼
1. People support one another in this unit	1	2	3	4	5
2. We have enough staff to handle the workload	1	2	3	4	5
3. When a lot of work needs to be done quickly, we work together as a team to get the work done	1	2	3	4	5
4. In this unit, people treat each other with respect	1	2	3	4	5
5. Staff in this unit work longer hours than is best for patient care	1	2	3	4	5
6. We are actively doing things to improve NBSI rate	1	2	3	4	5
7. We use more agency/temporary staff than is best for patient care	1	2	3	4	5
8. Staff feel like their mistakes are held against	1	2	3	4	5

them

	Strongly Disagree ▼	Disagree ▼	Neither ▼	Agree ▼	Strongly Agree ▼
Think about your NICU...					
9. Mistakes have led to positive changes here	1	2	3	4	5
10. It is just by chance that more serious mistakes, including infections don't happen around here	1	2	3	4	5
11. When one area in this unit gets really busy, others help out	1	2	3	4	5
12. When an event is reported, it feels like the person is being written up, not the problem.....	1	2	3	4	5
13. After we make changes to improve patient safety including infection prevention, we evaluate the effectiveness	1	2	3	4	5
14. We work in "crisis mode" trying to do too much, too quickly	1	2	3	4	5
15. Infection prevention and patient safety is never sacrificed to get more work done	1	2	3	4	5
16. Staff worry that mistakes they make are kept in their personnel file.....	1	2	3	4	5
17. We have NBSI problems in this unit	1	2	3	4	5
18. Our procedures and systems are good at preventing NBSI from happening.....	1	2	3	4	5
19. A NBSI is an anticipated outcome in pre-term infants (gestational age 28-32 weeks).....	1	2	3	4	5
20. NBSI are perceived as an error in our unit	1	2	3	4	5
21. A NBSI is a preventable event in pre-term infants (gestational age 28-32 weeks).....	1	2	3	4	5

SECTION B: Your Supervisor/Manager

Please indicate your agreement or disagreement with the following statements about your immediate supervisor/manager or person to whom you directly report. Circle your answer.

	Strongly Disagree ▼	Disagree ▼	Neither ▼	Agree ▼	Strongly Agree ▼
1. My supervisor/manager says a good word when he/she sees a job done according to established patient safety and infection procedures	1	2	3	4	5
2. My supervisor/manager seriously considers staff suggestions for improving patient safety or infection prevention	1	2	3	4	5
3. Whenever pressure builds up, my supervisor/manager wants us to work faster, even if it means taking shortcuts	1	2	3	4	5
4. My supervisor/manager overlooks patient safety and infection problems that happen over and	1	2	3	4	5

over

SECTION C: Communications

How often do the following things happen in your work area/unit? Circle your answer.

Think about your hospital work area/unit...	Never ▼	Rarely ▼	Some- times ▼	Most of the time ▼	Always ▼
1. We are given feedback about changes put into place based on event reports	1	2	3	4	5
2. Staff will freely speak up if they see something that may negatively affect patient care	1	2	3	4	5
3. We are informed about errors including infections that happen in this unit.....	1	2	3	4	5
4. Staff feel free to question the decisions or actions of those with more authority.....	1	2	3	4	5
5. In this unit, we discuss ways to prevent errors and infections from happening again.....	1	2	3	4	5
6. Staff are afraid to ask questions when something does not seem right	1	2	3	4	5

SECTION D: Frequency of Events Reported

In your hospital work area/unit, when the following mistakes happen, how often are they reported? Circle your answer.

	Never ▼	Rarely ▼	Some- times ▼	Most of the time ▼	Always ▼
1. When a mistake is made, but is <u>caught and corrected before affecting the patient</u> , how often is this reported?	1	2	3	4	5
2. When a mistake is made, but has <u>no potential to harm the patient</u> , how often is this reported?.....	1	2	3	4	5
3. When a mistake is made that <u>could harm the patient</u> , but does not, how often is this reported?	1	2	3	4	5
4. When an NBSI occurs, it is reported to infection control	1	2	3	4	5
5. When an NBSI occurs, it is reported to quality control or quality assurance.....	1	2	3	4	5
6. When an NBSI occurs, it is reported as an unusual occurrence.....	1	2	3	4	5
7. In your NICU, NBSI occur	1	2	3	4	5

SECTION E: Nosocomial Bloodstream Infection Grade

Please give your NICU an overall grade on nosocomial bloodstream infections.

☐ **A** ☐ **B** ☐ **C** ☐ **D** ☐ **E**
 Excellent Very Good Acceptable Poor Failing

SECTION F: Your Hospital

Please indicate your agreement or disagreement with the following statements about your hospital. Circle your answer.

Think about your hospital...	Strongly Disagree ▼	Disagree ▼	Neither ▼	Agree ▼	Strongly Agree ▼
1. Hospital management provides a work climate that promotes patient safety	1	2	3	4	5
2. Hospital units do not coordinate well with each other	1	2	3	4	5
3. Things “fall between the cracks” when transferring patients from one unit to another.....	1	2	3	4	5
4. There is good cooperation among hospital units that need to work together	1	2	3	4	5
5. Important patient care information is often lost during shift changes.....	1	2	3	4	5
6. It is often unpleasant to work with staff from other hospital units	1	2	3	4	5
7. Problems often occur in the exchange of information across hospital units	1	2	3	4	5
8. The actions of hospital management show that infection reduction and patient safety is a top priority	1	2	3	4	5
9. Hospital management seems interested in infection reduction and patient safety only after an adverse event happens	1	2	3	4	5
10. Hospital units work well together to provide the best care for patients	1	2	3	4	5
11. Shift changes are problematic for patients in this hospital.....	1	2	3	4	5

SECTION G: Number of Events Reported

In the past 12 months, how many event reports have you filled out and submitted?

- | | |
|--|--|
| ☐ a. No event reported | ☐ d. 6 to 10 event reports |
| ☐ b. 1 to 2 event reports | ☐ e. 11 to 20 event reports |
| ☐ c. 3 to 5 event reports | ☐ f. 21 event reports or more |
| | ☐ g. Don't know |

SECTION H: Contributing Factors

Please indicate your opinion on whether the following are contributing factors to nosocomial bloodstream infections. Circle your answer.

Think about your hospital...	Insignificant Contribution				Significant Contribution
	▼	▼	▼	▼	▼
1. Deficient immune system.....	1	2	3	4	5
2. Prolonged hospital stay.....	1	2	3	4	5
3. Pre-maturity, gestational age 28-32 weeks ...	1	2	3	4	5
4. Pre-maturity, gestational age 32-36 weeks	1	2	3	4	5
5. Fragile integument	1	2	3	4	5
6. Invasive procedures.....	1	2	3	4	5
7. Number of visitors to NICU	1	2	3	4	5

Please indicate your opinion on whether the following are factors that lead to the prevention of nosocomial bloodstream infections. Circle your answer.

Think about your hospital...	Insignificant Contribution				Significant Contribution
	▼	▼	▼	▼	▼
8. Hand hygiene protocols	1	2	3	4	5
9. Stringent line care	1	2	3	4	5
10. Infection control measures.....	1	2	3	4	5
11. Gloving before touching infants	1	2	3	4	5
12. Number of visitors to NICU	1	2	3	4	5

SECTION I: NICU Culture

These questions relate to the type of NICU that your institution is most like. Each of these items contains four descriptions of NICUs. Please distribute 100 points among the four descriptions depending on how similar the description is to your facility. None of the descriptions is any better than the others; they are just different. For each question, please use all 100 points. For example: In question1 if Facility A seems very similar to mine, B seems somewhat similar, and D and D do not seem similar at all, I might give 70 points to A and the remaining 30 points to B.

NICU Character (Please distribute 100 points)

1. _____ NICU A is a very personal place. It is a lot like an extended family. People seem to share a lot of themselves.
2. _____ NICU B is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.
3. _____ NICU C is a very formalized and structured place. Bureaucratic procedures generally govern what people do.
4. _____ NICU D is very production oriented. A major concern is with getting the job done. People aren't very personally involved.

NICU's Managers (Please distribute 100 points)

5. _____ Managers in NICU A are warm and caring. They seek to develop employees' full potential and act as their mentors or guides.
6. _____ Managers in NICU B are risk-takers. They encourage employees to take risks and be innovative.
7. _____ Managers in NICU C are rule-enforcers. They expect employees to follow established rules, policies, and procedures.
8. _____ Managers in NICU D are coordinators and coaches. They help employees meet the hospital's goals and objectives.

NICU Cohesion (Please distribute 100 points)

9. _____ The glue that holds NICU A together is loyalty and tradition. Commitment to this hospital runs high.
10. _____ The glue that holds NICU B together is commitment to innovation and development. There is an emphasis on being first.
11. _____ The glue that holds NICU C together is formal rules and policies. Maintaining a smooth running operation is important here.
12. _____ The glue that holds NICU D together is the emphasis on tasks and goal accomplishment. A production orientation is commonly shared.

NICU Emphases (Please distribute 100 points)

13. _____ NICU A emphasizes human resources. High cohesion and morale in the organization are important.
14. _____ NICU B emphasizes growth and acquiring new resources. Readiness to meet new challenges is important.
15. _____ NICU C emphasizes permanence and stability. Efficient, smooth operations are important.
16. _____ NICU D emphasizes competitive actions and achievement. Measurable goals are important.

NICU Rewards (Please distribute 100 points)

17. _____ NICU A distributes its rewards fairly equally among its members. It's important that everyone from top to bottom be treated as equally as possible.
18. _____ NICU B distributes its rewards based on individual initiative. Those with innovative ideas and actions are most rewarded.
19. _____ NICU C distributes rewards based on rank. The higher you are, the more you get.
20. _____ NICU D distributes rewards based on the achievement of objectives. Individuals who provide leadership and contribute to attaining the hospital's goals are rewarded.

SECTION J: Background Information

This background information will help in the analysis of the survey results.

1. How long have you worked in this hospital?

- | | |
|--|--|
| ☐ a. Less than 1 year | ☐ d. 11 to 15 years |
| ☐ b. 1 to 5 years | ☐ e. 16 to 20 years |
| ☐ c. 6 to 10 years | ☐ f. 21 years or more |

2. How long have you worked in your current hospital NICU?

- | | |
|--|--|
| ☐ a. Less than 1 year | ☐ d. 11 to 15 years |
| ☐ b. 1 to 5 years | ☐ e. 16 to 20 years |
| ☐ c. 6 to 10 years | ☐ f. 21 years or more |

3. Typically, how many hours per week do you work in this hospital?

- ☐ a. Less than 20 hours per week
- ☐ b. 20 to 36 hours per week
- ☐ c. 36 to 40 hours per week or more

4. What is your staff position in this hospital? Check ONE answer that best describes your staff position.

- | | |
|--|---|
| ☐ a. Registered Nurse | ☐ h. Dietician |
| ☐ b. Physician Assistant/Nurse Practitioner | ☐ i. Respiratory Therapist |
| ☐ c. LVN/LPN | ☐ j. Physical, Occupational, or Speech Therapist |
| ☐ d. Attending/Staff Physician | ☐ k. Administration/Management |
| ☐ e. Resident Physician/Physician in Training | ☐ l. Other, please specify: _____ |
| ☐ f. Unit Assistant/Clerk/Secretary | |
| ☐ g. Technician (e.g., EKG, Lab, Radiology) | |

4. In your staff position, do you typically have direct interaction or contact with patients? Check ONE answer.

- ☐ a. YES, I typically have direct interaction or contact with patients.
☐ b. NO, I typically do NOT have direct interaction or contact with patients.

5. How long have you worked in your current specialty or profession?

- | | |
|--|--|
| ☐ a. Less than 1 year | ☐ d. 11 to 15 years |
| ☐ b. 1 to 5 years | ☐ e. 16 to 20 years |
| ☐ c. 6 to 10 years | ☐ f. 21 years or more |

SECTION I: Your Comments

Please feel free to write any comments about nosocomial bloodstream infections, patient safety, error, or event reporting in your hospital.

THANK YOU FOR COMPLETING THIS SURVEY.

1. Supervisor Expectations & Actions for Promoting Safety & Infection (Cronbach's alpha = .75) B1, B2, B3r, B4r

- a. My supervisor/manager says a good word when he/she sees a job done according to established patient safety and infection procedures.
- b. My supervisor/manager seriously considers staff suggestions for improving patient safety or infection prevention.
- c. Whenever pressure builds up, my supervisor/manager (does not) want(s) us to work faster, even if it means taking shortcuts.
- d. My supervisor/manager (does not) overlook(s) patient safety and infection problems that happen over and over.

2. Organizational Learning-Continuous Improvement (Cronbach's alpha = .76) A6, A9, A13

- a. We are actively doing things to improve NBSI rate.
- b. Mistakes have led to positive changes here.
- c. After we make changes to improve patient safety including infection prevention, we evaluate the effectiveness.

3. Teamwork within the NICU (Cronbach's alpha = .83) A1, A3, A4, A11

- a. People support one another in this unit.
- b. When a lot of work needs to be done quickly, we work together as a team to get the work done.
- c. In this unit, people treat each other with respect.
- d. When one area in this unit gets really busy, others help out.

4. Communication Openness (Cronbach's alpha = .72) C2, C4, C6r

- a. Staff will freely speak up if they see something that may negatively affect patient care.
- b. Staff feel free to question the decisions or actions of those with more authority.
- c. Staff are (not) afraid to ask questions when something does not seem right.

5. Feedback & Communication About Errors & Infections (Cronbach's alpha = .78) C1, C3, C5

- a. We are given feedback about changes put into place based on event reports.
- b. We are informed about errors including infections that happen in this unit.
- c. In this unit, we discuss ways to prevent errors and infections from happening again.

6. Nonpunitive Response to Error (Cronbach's alpha = .79) A8r, A12r, A16r

- a. Staff feel like their mistakes are (not) held against them.
- b. When an event is reported, it (does not) feel(s) like the person is being written up, not the problem.
- c. Staff (do not) worry that mistakes they make are kept in their personnel file.

7. **Staffing (Cronbach's alpha = .63) A2, A5r, A7r, A14r**
 - a. We have enough staff to handle the workload.
 - b. Staff in this unit (do not) work longer hours than is best for patient care.
 - c. We (do not) use more agency/temporary staff than is best for patient care.
 - d. We (do not) work in "crisis mode" trying to do too much, too quickly.
8. **Hospital Management Support for Patient Safety & Infection Prevention (Cronbach's alpha = .83) F1, F8, F9r**
 - a. Hospital management provides a work climate that promotes patient safety.
 - b. The actions of hospital management show that infection reduction and patient safety is a top priority.
 - c. Hospital management (is always) interested in infection prevention and patient safety (not) only after an adverse event happens.
9. **Teamwork Across Hospital Units (Cronbach's alpha = .80) F4, F10, F2r, F6r**
 - a. There is good cooperation among hospital units that need to work together.
 - b. Hospital units work well together to provide the best care for patients.
 - c. Hospital units do (not) coordinate well with each other.
 - d. It is often (un)pleasant to work with staff from other hospital units.
10. **Hospital Handoffs & Transitions (Cronbach's alpha = .80) F3r, F5r, F7r, F11r**
 - a. Things "fall between the cracks" when transferring patients from one unit to another.
 - b. Important patient care information is often lost during shift changes.
 - c. Problems often occur in the exchange of information across hospital units.
 - d. Shift changes are problematic for patients in this hospital.
12. **Shared Mental Model A10r, A15, A18, A17r, A19r, A21, D7r**
 - a. It is just by chance that more serious mistakes, including infections don't happen around here.
 - b. Infection prevention and patient safety is never sacrificed to get more work done.
 - c. Our procedures and systems are good at preventing NBSI from happening.
 - d. We (do not) have a NBSI problems in this unit.
 - e. A NBSI is (not) an anticipated outcome in pre-term infants (gestational age 28-32 weeks).
 - f. A NBSI is a preventable event in pre-term infants (gestational age 28-32 weeks).
 - g. In your NICU, NBSI occur (never or rarely).

- 12. Frequency of Event Reporting (Cronbach's alpha = .84) D1, D2, D3**
- b. When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported?
 - c. When a mistake is made, but has no potential to harm the patient, how often is this reported?
 - d. When a mistake is made that could harm the patient, but does not, how often is this reported?
- 13. Infection Reporting D4, D5, D6**
- a. When an NBSI occurs, it is reported to infection control.
 - b. When an NBSI occurs, it is reported to quality control or quality assurance.

When an NBSI occurs, it is reported as an unusual occurrence

Appendix 2: Low Nosocomial Bloodstream Infection Rate NICUs

Appendix 2- 1:	Prevention Mental Model seen in Low NBSI Rate NICUs	117
Appendix 2- 2:	Positive Response to the Statement in Low NBSI Rate NICUs	119
Appendix 2- 3:	Negative Response to the Statement in Low NBSI Rate NICUs	120
Appendix 2-4:	NBSI as Both an Error & Complication of Care in Low NBSI Rate NICUs	121
Appendix 2-5:	NBSI as a Complication of Care in Low NBSI Rate NICUs	121
Appendix 2-6:	NBSI as an Error in Low NBSI Rate NICUs	122
Appendix 2-7:	What Providers Tell Parents in Low NBSI Rate NICUs	123
Appendix 2-8:	Issue of Personal Integrity in Low NBSI Rate NICUs	124
Appendix 2-9:	Role of Unit Leadership Role in Low NBSI Rate NICUs	126
Appendix 2-10:	Process for Change in Low NBSI Rate NICUs	129
Appendix 2-11:	Culture/Experience in Low NBSI Rate NICUs	132
Appendix 2-12:	Personal Goals in Low NBSI Rate NICUs	135
Appendix 2-13:	Comments on the Issue of Personal Integrity in Low NBSI Rate NICUs	137

Appendix 2- 1: Prevention Mental Model seen in Low NBSI Rate NICUs

Site	Role	<i>Prevention Mental Model</i> <i>Low NBSI Rate NICUs</i>
5	MD Dir-9	I use to think 15 years ago that many of those small babies would get bloodstream infections or pneumonias during their hospitalization. But as we have evolved and looked at our practices and seen what our outcomes are like it been really clear to me that that's not the case. I'd say they are preventable.
5	MD1-9	I say that they are not inevitable, but preventable, yeah I think so.
5	RN Dir-9	Well we don't accept that in regard to infection because we are not use to it, we don't expect it, it doesn't happen here, and so if the baby has an infection everyone is surprised and upset about it. Well that is in many places I found the attitude towards infection, "oh man what can you do, they are premature, they're immature, so they are going to get an infection." So just backing up, they're potential is definitely there, they're vulnerability is definitely there, but just the fact that they all don't all have to get infections, there are things that you can do.
5	NNP1-9	No, they are preventable.
5	RN1-9	My answer would be that they are preventable because I have seen that they can be.
5	RN2-9	I'd say they are preventable.
5	RN3-9	Preventable, mostly preventable.
5	RN4-9	Oh I'd say they are preventable.
5	RN5-9	I don't think that they are inevitable I think that they are all preventable. We all think that.
6	MD Dir-9	I think that they are preventable. In a perfect world babies would never get them.
6	MD2-9	Largely preventable. I think that for an individual patient infections are not inevitable. I think that it is unlikely that we will eradicate the problem completely, but they are preventable in that there are number aspects of the care that can be manipulated and that will move you in the direction of less vulnerability.
6	NNP1-9	I think that they are preventable but I think we must deal with them. To ignore the fact that they might happen can be detrimental to the parents.

Appendix 2-1: Prevention Mental Model seen in Low NBSI Rate NICUs (continued)

<u>Site</u>	<u>Role</u>	<i>Prevention Mental Model</i> <i>Low NBSI Rate NICUs</i>
6	RN1-9	For less than 32-weeks, many of them are preventable. The tiniest babies with the more fragile skin, babies less than 26-weeks, I don't know if they are preventable. I like to think that they are, but the opportunity for entry in those babies are greater than the 32-week old babies. In a perfect world that would be the way it is, but I am not sure we will ever not have any nosocomial infections.
6	RN2-9	They are preventable. It starts with the people who have direct care of the babies, the nurses and the doctors.
6	RN3-9	They are preventable. I believe that they are preventable and not inevitable.
6	RN4-9	The majority (of infections) are preventable, if you follow though with handwashing and keeping the sterile field and doing what we are suppose to do.

Appendix 2- 2: Positive Response to the Statement in Low NBSI Rate NICUs

Site	Role	Positive Response to “No baby less than 32 weeks GA should have a NBSI.” Low NBSI Rate NICUs
5	MD Dir-9	Given our experience, I'd have to say that it's probably a true statement.
5	MD1-9	Well I would agree with it. I don't think that any 32-week baby should have a nosocomial infection. Everything is preventable to a certain extent. If proper cautions are taken, then everything would be preventable, but we are only human and there is always going to be imperfections.
5	NNP-9	Well, I agree but the reality is that we are not perfect. I think that's true, but as with anything in life, we are not perfect. There's going to be a certain amount. What's an acceptable level? I don't know how you are going to determine that, some low number, single digit percentage.
5	RN Dir-9	I think they can be preventable. It's that attitude, I think, that makes a difference. I believe it's possible for a baby not to, but as far as no baby I think it all depends upon where that baby is and how it's treated.
5	RN2-9	I probably agree that they shouldn't, but the fact is that at less than 32 weeks, they are inevitably going to have an IV if not an arterial line, and whenever you have a line you are opening up the line of infections.
5	RN3-9	They shouldn't have them, they are preventable, but we are human and things happen, processes breakdown.
5	RN4-9	I'd agree with that. That they should not experience (an infection) because a lot of it is preventable.
5	RN5-9	I personally don't think that it is an expected outcome. So I think that it can almost always be prevented.
6	NNP1-9	I think that is true, I don't think that (babies) should (experience a nosocomial infection). I don't think that in this day and age with as far as we have come that they should have a nosocomial infection.
6	NNP2-9	I know no baby should have an infection. That is the ideal goal.
6	RN1-9	We certainly do not want (them to experience) an infection because these babies are fragile enough with enough hurdles to get past that we don't want to introduce an infection that would set that baby's progress back and in the worst case cause the baby's death. So they shouldn't have to experience (an infection).

Appendix 2- 3: Negative Response to the Statement in Low NBSI Rate NICUs

Site	Role	Negative Response to “No baby less than 32 weeks GA should have a NBSI.” Low NBSI Rate NICUs
6	MD Dur-9	That would be ideal but it is not particularly practical given inadvertent skin abrasions and exposure to pathogens through formula or milk. Even if we were wonderful with cleaning our hands and using gloves when we are exposed to blood and body fluids we would avoid to transmit to other people, it would be nice to think that we could be 100%, but inevitably there's going to be some exposure but it can be minimized. It can't be completely eradicated.
6	MD1-9	That even with the best of care, optimal care, there will be occasionally children that will develop a nosocomial infection.
6	MD2-9	I think it is impossible to eradicate all infections from a NICU. Now why did I think that? I am not sure why I think that. I have never seen it happen I guess. It hasn't been my experience. I guess in theory it could be.
6	RN2-9	That would be very nice, but we know in this day and age and being in this world, that being in a hospital puts you at certain risks.
6	RN3-9	I think that you can't really say never. They are so compromised, their immune systems are compromised and we have to do everything that we can to prevent it, but you can ever say never.
6	RN4-9	I would like to agree but sometimes if something is contaminated like when putting in lines that can cause an infection.

Appendix 2- 4: NBSI as Both an Error & Complication of Care in Low NBSI Rate NICUs

<u>Site</u>	<u>Role</u>	<i>NBSI as Both an Error and a Complication of Care</i> Low NBSI Rate NICUs
6	MD Dir-9	They typically occur because of some breakdown in care but then some are inevitability that we just won't ever be able to eliminate unless we were to raise babies in a totally sterile environment, which isn't possible.
6	NNP1-9	I think they are a little of both. An error because they are preventable and a complication of care because we put in so many lines and the babies are intruded upon in such a way that it breaks their skin integrity and decreases their immune system even more.
6	RN2-9	A little bit of both. It should be a preventable thing. So we shouldn't have it happen hence it can be an error. But at the same time, with these micro premies we know that they are a very high-risk population and we are going to do our best to prevent it.

Appendix 2- 5: NBSI as a Complication of Care in Low NBSI Rate NICU

<u>Site</u>	<u>Role</u>	NBSI as a Complication of Care Low NBSI Rate NICUs
6	MD1-9	I don't know if anything in medicine is an absolute. They are side effects, risks one considers when evaluating the benefit of a procedure or therapy. Infection is a side effect when you place a catheter.
6	NNP1-9	I think it is an anticipated complication of care due to all the procedures.
6	RN3-9	They are an anticipated complication because we have to do so many invasive procedures and they have vents and so much that is invasive. (Infection) is one of the most common complications that we have, but not every baby gets it, and we can do a lot to prevent it.
6	RN4-9	A complication of care, sometimes it just happens.

Appendix 2- 6: NBSI as an Error in Low NBSI Rate NICUs

Site	Role	NBSI as an Error Low NBSI Rate NICUs
5	MD Dir-9	I would say that it is a break in our system. It's an error.
5	MD1-9	It is an error definitely. It is the frequency, it just doesn't happen very often.
5	RN Dir-9	Probably an error because contaminates somewhere have gotten into that baby. The more complicated that baby is and the more complicated the care, and the more invasive procedures they have, the greater the potential for them.
5	NNP-9	It is something from the care (they receive), from them being (in the NICU).
5	RN1-9	I think that they are considered an error, because it's just such a rare thing, it doesn't happen.
5	RN2-9	As an error. Because we do our best to get the lines out, we use our protocol of sterile gloves whenever you enter a line, the betadine first – allowing it to dry to kill the bugs then using the alcohol swabs, and starting as few site as possible, by doing that, if we do end up with an infection, that is what we are looking at, an error.
5	RN3-9	In my book they are an error, I don't know if they are reported as an error, but it was a breakdown in something we did here when caring for the babies, so it was an error.
5	RN4-9	An error not based upon the caregivers. It's just something that doesn't happen, so when it does happen it is like a big event.
5	RN5-9	I think that they are an error. I don't think that you should anticipate them. Yes they are vulnerable (babies), and (infection) is something that can happen, and you tell parents that it can happen. Other hospitals it is assumed that since they are premature that is what is going to be the normal outcome. That is not how we think here. It is a risk, but not a normal outcome.
6	MD2-9	I have thought of them as a complication of care. I have not thought of them as an individual error. As I learn more about how to provide quality care, how to measure it, how to set goals, I am coming to see that if you use error, not in individual terms, but as an NICU or system error, then yes I see it as an error, a systemic error.
6	RN1-9	An error, although I am not total sure that we can eliminate them. Nosocomial infections are caused by transmission of infection by the hospital staff.

Appendix 2- 7: What Providers Tell Parents in Low NBSI Rate NICUs

Site	Role	What Providers Tell Parents Low NBSI Rate NICUs
5	RN5-9	Yes they are vulnerable (babies), and (infection) is something that can happen, and you tell parents that it can happen.
6	MD Dir-9	Well typically we tell parents that among the complications that extremely low birth weight babies have, a major one is infection. I usually point out that the initial problems are respiratory, but these days, babies rarely die of respiratory problems. If they die they usually die of infections and that we do everything that we can to avoid infections.
6	MD1-9	I tell parents that there are a lot of reasons that premature infants are at greater risk for developing infections and that there is, as in any individual exposed to some of the things that we do.
6	NNP1-9	I usual tell them that (infections) are something that we try very hard not to have happen, but because their immune system is not as developed as a term baby, that the chances of them picking up something are higher and because they are in the hospital setting it is higher also.
6	NNP2-9	We don't specifically discuss hospital-acquired infections, but we don't hide that.
6	RN3-9	We address infection before it happens.
6	MD2-9	I tell them that it is one of the risks of being in an NICU. It is not my expectation that they will get one.
6	RN2-9	We don't actively discuss (infection) unless they bring up questions.
6	RN4	That there is a risk for infection, there is always that risk, but that we do our best to prevent them from happening.

Appendix 2- 8: Comments on the Issue of Personal Integrity in Low NBSI Rate NICUs

Site	Role	Personal Integrity Low NBSI Rate NICUs
5	MD Dir-9	People have to incorporate, like in the operating room when you did nursing training, a personal integrity. If you accidentally dropped your hands below the waist, or whatever the magic line is, well you just go change your gown and gloves, right? That's personal integrity, and I think it's the same thing (with infection). If you are getting ready to put in an IV in a baby in our unit, you've done it with your gloves on, you've prepped the skin in a certain way, if you break that technique you have to say, I have to stop and you do it. So a hundred and some people have to have that degree of personal integrity. I think that the organization has a lot to do with this.
5	RN Dir-9	I think that the bedside nurse' perception that she has responsibility, but also she has ability to impact (nosocomial infections). That she can and that she will. So that she is monitoring not only herself, but her co-workers and others that come in, the ancillary workers, the environment. I think that part of it is the overall hospital's expectation that there is a shared responsibility, shared management of the unit, that there is shared accountability for the patients.
5	RN1-9	You have to be really vigilant out there. We are very protective of our babies. Our neonatologists are very good, but you have to remind other coming in gently or constantly, to please wash your hands.
5	RN2-9	Sometimes when you are working and it is a busy assignment, your so busy just trying to keep on top of your assignment that you might not be looking to say, "hey why is this umbilical line still in? Or why is this PIC line still in?" As far as sterile technique, I am very cognizant of that, so I don't think that I can improve in that area, I do very well with that.
5	RN3-9	Taking care in what you do. Being careful. Some infections will be inevitable, but mostly we can prevent them. We need to be vigilant with handwashing, educate parents, and monitor staff.

Appendix 2- 8: Comments on the Issue of Personal Integrity in Low NBSI Rate NICUs (continued)

Site	Role	Personal Integrity Low NBSI Rate NICUs
5	RN4-9	So it is just ingrained into everyone here. You are constantly washing your hands. We have the Avaguard pump soap at every bedside, so there is no excuse. Working in a unit where everyone buys into the fact that we have to be really conscientious about hygiene.
6	MD Dir-9	60-70% of the staff nurses have associate degrees, and the sense of professionalism is a little different for them Whenever a staff nurse has a BSN and graduated from (one of the regional universities) they are very different. A BSN trained nurse lives it as a professional after they leave the unit and thinks about things and reads nursing journals and thinks about research. Whereas an associate degree staff nurse often thinks of it as a place to come work for eight hours and go home and forget about being a nurse, so it is more of a job than a profession.
6	MD2-9	The two ways that I see that we can answer those is for people to be mindful of it but also accountable for what they are doing with the patient.
6	NNP2-9	Our infection control should be such that (the babies) should be in the safest environment that they can be in while they are here. Whether that happens or not depends on having more people willing to take the extra few seconds it takes to prevent (infection).

Appendix 2- 9: Role of Unit Leadership Role in Low NBSI Rate NICUs

Site	Role	Unit Leadership Low NBSI Rate NICUs
5	MD Dir-9	I really feel like my role is just to get the resources in for people, and to make sure that the relationships are good, and then good things just really kind of happen. We have new doctors that come in all the time and you have to acculturate them to what is the reality here. A big goal of mine is that I work with someone I acculturate them into our unit. Some of (acculturation) is more active, and some of it is well, leadership. A large part of leadership is role modeling, so I work really hard to see how I might affect other people's impressions about behavior.
5	RN Dir-9	I see my role as supporting them in the best possible way to get that done and sometimes that includes helping to direct them in the best possible way also. Guiding the goals towards safety and quality, but also at the same time having to support that, giving them the supports they need in order to achieve that and feel good about what they are doing. I don't (put on scrubs and do bedside care) everyday, but if I'm needed I am happy to do that. I think that it sends a message to staff, we are drowning but the manager just walked out with her clipboard. That is not a good message. But if they see that she'll get in here and she'll get her hands dirty, well not literally, but that she'll get in there and help us when things are frantic. Providing resources and those kinds of things. When we are discussing and talking about things, letting them know that's important to me, that it's important to the leadership. And that we appreciate (their efforts), it is important that they know that we appreciate the good work that their diligence makes. That it is making a difference.
5	RN1-9	I think first of all they set a good example for one thing. Be vigilant, try to make sure that policies are being enforced that we have set up. I think the other thing is they try to make us part of the group. I've seen when there is a person that belittles somebody or rakes somebody over the coals, that's just wrong and our managers follow that up immediately and have a few chats with people until their behavior changes.

Appendix 2- 9: Role of Unit Leadership in Low NBSI Rate NICUs (continued)

Site	Role	Unit Leadership Low NBSI Rate NICUs
5	RN2-9	(The medical director) is big on making us feel like a family, making (the unit) comfortable for the parents, yet he was one of the biggest advocates for no siblings. They do give us feedback all the time whether it is good or bad feedback, we always hear about it, discuss it. They are really just big on it.
5	RN3-9	They treat families and staff gently, with care. The unit nursing and medical director, they are very important. They contribute to change. The medical director doesn't come around and scold you for doing something wrong he works with you. He is great, and really cares about making a difference. (The nursing director) is great, she is the glue that held the unit together and made change possible.
5	RN4-9	So there is always open meetings that the staff can go to. We have NICU management meetings, medical staff meetings, there's a meeting for just about everything around here. You are always welcome to go and put forth your thoughts, or offer input on a situation. So everyone is treated as a peer. There is no hierarchy, the doctor, then the NP, then the nurse. We all work together as a team.
5	RN5-9	Making sure that staff have the equipment that they need and have the protocols or procedures that they need, and to know about them in order work with these babies that have all these invasive lines. Training.
6	MD Dir-9	To establish standards for proper hygiene, proper skin care, encouraging the feeding of human milk. Setting a good example to others by demonstrating that in my own practice I wash my hands, use the emollient alcohol solutions.
6	MD1-9	To monitor the incidence (of NBSI) and to try to evaluate their patient population with those of similar nurseries. To try to get a gauge as far a standard or comparable NICU and recognize simple and easy things that you can do to reduce risk and to try to identify what actually works. Two would be to identify those techniques that actually have been proven to reduce infection. Three is to prioritize risk and benefit of different procedures and identify the things that are simple and easy to do versus more elaborate procedures or more expensive procedures, which would require greater weight of evidence you to implement something that's very personnel intensive or costly. Not only do we specifically identify infection, infectious diseases and infection control is a topic that we discuss, but it is also melded into everything that we discuss.

Appendix 2- 9: Role Unit Leadership in Low NBSI Rate NICUs (continued)

Site	Role	Unit Leadership Low NBSI Rate NICUs
6	MD2-9	So what I try to do in rounds is establish that the thinking is what is taking care of the patient, not the use of technology or drugs. That puts me in the position of actually taking care of the patient and I have thought out the process, made it explicit, but not necessarily assigned a therapy to it, I have laid out a therapeutic plan. So that is done out in the open with people who are training and also with the "physician extenders" so they can be given permission to hold off themselves when I am not there and so they will know they won't get into trouble for doing that.
6	NNP1-9	Peer pressure is a big thing. If somebody says, "you need to wash your hands," or "you didn't wash your hands when you were in there," catching them at the time they are doing it, which I would want them to do to me, it is reinforcing. Everybody's great, but you see lapses and it is our responsibility to push that, not when something happens, not when we have a baby with RSV, or not when we have a baby with MRSA. It has to be all the time.
6	NNP2-9	They help to make the policies, but they also when there is a problem, try to identify the source, help to educate the staff and residents, and things that we can do to prevent it from occurring again. (One of the physicians) when we had the MRSA outbreak, came to talk to the staff, answer questions, and help the staff understand what occurred, what could be done, and what the plan was. Their role could be supporting the staff and making sure that we have adequate staff and supplies available.
6	RN1-9	The medical director is very active in (the prevention of infection) and keeps a handle on everything that is going on.
6	RN2-9	It is one of those things that we always talk about and it is not just something that is shoved under the table and only brought out when there is an issue. Having the opportunity to sit on committees I have the opportunity to see how leadership handles things when there are no infection issues. Other staff members may not see how it is a fairly active process where we do talk about infection between outbreaks.
6	RN3-9	To model the best practices. To encourage and remind us. To keep track of the statistics that indicate the source or types of infections. To keep us informed of what our statistics are showing, to know what area we have lapses.
6	RN4-9	We need new guidelines, which they set.

Appendix 2- 10: Process for Change in Low NBSI Rate NICUs

Site	Role	Process for Change Low NBSI Rate NICUs
5	MD Dir-9	It is the constant meetings that we have. It is kind of interesting there is always, again these are Vermont Oxford type of meetings, but these are nutrition meeting, respiratory support meetings, where we get together and look at these things initially, all the potentially better practices and try to come up with certain ideas that may, say decrease nosocomial infections. And we discuss it, and it is brought forward to the management meetings, neonatal management meetings and medical staff meeting, and it is discussed at different levels. Then it is decided upon that this is a practice that we want to incorporate. So that is when we engaged the doctors, the nurses and our infectious control person who came very shortly afterwards. People are empowered to go out there and just do good things. We are very decentralized that way, we don't have a nurse educator for the unit. We are a big unit, but we don't have a clinical nurse specialist for the unit. Again the nurses get time and dollars to do their clinical ladder work and to do projects that are helpful for the organization.
5	RN Dir-9	They just bring their data, like an example, someone did a lit review on alcohol for cleaning cords and brought it to our management meeting and introduced that idea as a change of practice and showed the literature and that has becomes a new practice based on that. The committees are open for anyone to be on if they choose.
5	RN Dir-9	It involves all your equipment and human resources, but also education, information. It also involves inviting them to participate in decision making, and being part of the process as much as possible to come up with ideas. Often the (nurses) come up with the best ideas, because they are there with the patient.
5	RN1-9	I think that makes everybody excited, and people in the unit are encouraged to get involved. Whenever you have staff members being involved in committees or in research projects, it just increases their enthusiasm. That's what I like to see, I don't like a company that's really stagnant where day shift tells everybody else what to do, and we aren't going to change our practice because that's how we did it twenty years ago. It's not like that here.

Appendix 2- 10: Process for Change in Low NBSI Rate NICUs (continued)

Site	Role	Process for Change Low NBSI Rate NICUs
5	RN2-9	That is one thing that I have noticed with this unit, is when they start a program it is not just an email that says this is what we are doing, get on board. It is a big discussion. They always give an explanation so you can get on board with (with the new idea). It makes you understand why and makes you feel more participatory.
5	RN3-9	The senior leadership never forces us to make changes. They come to us at staff meetings and indicate that they are considering working on three projects, and get staff input. We vote on the project and when the going gets tough and we wonder why we are doing all this, we remember that we decided to do it. Yes (they get staff buy-in), they ask us and we all agree. Changes occur here rather seamlessly. We all decide that it is a good thing to do and we do it.
5	RN4-9	(One of the doctors) is a cheerleader for a lot of the events. A lot of things filter down through the docs, especially him, and will motive people, make us aware. He will bring out statistics, and we have a data coordinator who will put together from several years worth of data, what our infection rate was, this is where we are at, and this is where we could be. So there is always open meetings that the staff can go to. You are always welcome to go and put forth your thoughts, or offer input on a situation.
5	RN5-9	Good outcomes are important to everyone. A lot of things that we do are directly related to patient care and so that always perks up everyone's interest. We also, when someone reads something, we share it with each other, we bring it up to our management meetings where we have a lot of involvement. We have unit meetings that have all of the upper management there and they give us some stuff too. There are people who look at costs, they look at the products that we use, and if they find a cheaper product, they bring it to management and staff.

Appendix 2- 10: Process for Change in Low NBSI Rate NICUs (continued)

Site	Role	Process for Change Low NBSI Rate NICUs
6	MD Dir-9	We have a best practices program that is multi-disciplinary and the attempt is to standardize care and when we develop new best practices we ensure that all the staff nurses and others that work in the unit participate in the development of the protocol. Then in a very large way as we introduce (the protocol) we ensure that there is adequate education about the new practice and the reasons for it using evidence-based practice as much as you can. When we develop a best practices protocol, before we take it further than the development stage, we send it out to all the faculty and ask them to please review and send back comments.
6	MD2-9	So what happens here in terms of diffusion is that people will cycle on and discover that a practice has changed. So the people who are rounding will have to sometimes explain that we are not doing that anymore, we are doing this other thing.
6	RN1-9	Policy and procedures that are nursing driven are fed through the continuous improvement committee first. Assuming there is time for that, occasionally there is something that has to be implemented immediately. In general they go to the committee, made up of all disciplines and all shifts. Things are discussed in committee and among staff and revisions are made if appropriate. The new policy is formally adopted and discussed at staff meetings.
6	RN2-9	Now if involves just the doctors or nurse practitioner can do, nursing will get notified that this is going to be the procedure that is now going to be done and we will be notified as to our role. If it does involve nursing, before we are allowed to do anything, we have to come up with a policy, procedure or protocol. Typically it is a nurse practitioner or someone will try it before it gets put onto nursing to do. The nurses don't want to do something without a policy or procedure to protect them in the event that there is a negative outcome. If a nurse sees a pattern of something working or not working, they bring it to our committees.
6	RN4-9	They will usually post it at the desk and we have what we call "potty training" posting in the bathrooms, self-learning activities that they put in our mailbox that we are responsible for reading.

Appendix 2- 11: Culture/Experience in Low NBSI Rate NICUs

Site	Role	Culture/Experience Low NBSI Rate NICUs
5	MD Dir-9	(Trust is a) really important. A big goal of mine is that I work with someone I acculturate them into our unit. Some of (acculturation) is more active, and some of it is well, leadership. A large part of leadership is role modeling, so I work really hard to see how I might affect other people's impressions about behavior. Oh absolutely (I value our nurses), I mean they're the ones that do the care.
5	MD1-9	This is definitely different than the other institution I came from, is that we have our lactation person consultant here, involved in getting our moms pumping and getting that breast milk to the babies. Which again, is something I didn't see, I know they had a lactation specialist there but it wasn't as consistent. Having physicians on the unit is common, I think so, or maybe I just work slowly. I'm here all day in fact there is probably at least 3 physicians on the unit all day.
5	RN Dir-9	I don't (put on scrubs and do bedside care) everyday, but if I'm needed I am happy to do that. I think that it sends a message to staff, we are drowning but the manager just walked out with her clipboard. That is not a good message. But if they see that she'll get in here and she'll get her hands dirty, well not literally, but that she'll get in there and help us when things are frantic.
5	NNP-9	Right, so see how you are doing and you kind of know. Whereas if you are in isolation, you think whatever is going on in your unit is the norm. If everybody gets an infection and becomes the normal because this is what we experience here. For everybody (the norm is what they experience) unless they have worked multiple places. Some people do work multiple places but for the most part one unit is sort of home.
5	RN1-9	I see (the infection control nurse) walking around, and I'm sure that the medical director is the same way. That is the one thing nice about this unit is that you know how sometimes the doctors are just up there. They just don't tolerate that behavior. They really don't. I've seen when there is a person that belittles somebody or rakes somebody over the coals, that's just wrong and our managers follow that up immediately and have a few chats with people until their behavior changes. I don't think that there is anybody who comes in here that is not accepting of correction, like you just touched something or you need to put on sterile gloves. I don't think that they would have a problem with that.

Appendix 2- 11: Culture/Experience in Low NBSI Rate NICUs (continued)

Site	Role	Culture/Experience Low NBSI Rate NICUs
5	RN2-9	It is really an enjoyable place to work. NO, other than if it is your baby you always do feel guilty. But as far as the analysis, blame, no. The doctors don't just come in and write an order, they say "oh look his platelets are low." They say. "That's interesting, what's with that? What do you think?" Everything is an educational experience and discussion. If I leave here, I think that I would really miss that.
5	RN3-9	They treat families and staff gently, with care.
5	RN4-9	So everyone is treated as a peer. There is no hierarchy, the doctor, then the NP, then the nurse. We all work together as a team. It is not punitive here, and at a lot of institutions it is, so people don't report when they've made a mistake because they don't want it to go into their file. Here it is more of a learning tool (UORs and incident reports), "well this happened twice this month, what can we do to prevent it? Let's work on that," "So we are very supported by the staff, supported by the charge nurses. We support one another. It's just a really great place to work. The staff is like a really giant, big family, so we spend a lot of time joking with one another, and hear about the details of their lives, and you give them support if they are getting divorced. It's just a real supportive unit, a big extended family. It trickles down from above. The hospital respects the nurses, and treats us very well. So I think people come to work and enjoy being here, and enjoy their job. When you have supportive people that you work with, and supportive management, it is not intimidating at all.
5	RN5-9	I guess what I am think about is when we look at Vermont Oxford, when we did the infection study, we had such a low infection rate here, and it because we here don't like (infections), and we respond by looking at what we do procedure wise and taking corrective action. Other hospitals it is assumed that since they are premature that is what is going to be the normal outcome. That is not how we think here. It is a risk, but not a normal outcome.
6	RN3-9	It was not blaming individuals, but trying to understand where our system failed us. What was the entry point and what can we do to prevent this from happening the next time. Where did the system break down.

Appendix 2- 11: Culture/Experience in Low NBSI Rate NICUs (continued)

Site	Role	Culture/Experience Low NBSI Rate NICUs
6	MD2-9	We are all somewhat, "desensitized" is not the right word, but complications are normalized within the environment. Infections are seen as part of that. We are not desensitized to them, but we have come to seem them practically as part of the package and I don't know the extent to which colleagues would see infections as a systems error.
6	NNP1-9	Like the light that says, "quiet please." There is a level of immunity. Those lights in there will go off for anything, so people have gotten use to having them there and they don't even look at them anymore. The only time they react to the sign is when a new parent comes in there and asks about it.
6	NNP2-9	As long as they don't point a finger, if you hadn't done XYZ we wouldn't have this problem, but rather we have a problem what can we do to address this problem and what can we do to change our policies so that it doesn't happen more frequently than it does.
6	RN1-9	We have empowered our staff to say to the lab person, to the ancillary folks to say you really do need to wash your hands. We empower our staff to say that to a physician that might come into our unit without washing their hands. The goal of the hospital is that we experience the fewest number of nosocomial infection as possible. We didn't want to tell our staff that they caused (the infection) because they didn't wash there hands, but we wanted everyone to understand their part in the spread of nosocomial infections.

Appendix 2- 12: Personal Goals in Low NBSI Rate NICUs

Site	Role	Personal Goals Low NBSI Rate NICUs
5	MD Dir-9	Everything I do, I am thinking about how will this impact our ability to provide outstanding care and outstanding results.
5	MD1-9	My personal goals would just be in line with the unit, to be the best job that we can from every system stand point, respiratory, nutrition, infectious disease, and neuro-developmental stand point.
5	RN Dir-9	Personally I feel strongly that I am in a supportive role, although people may look at that a little backwards. But I feel like the people who provide care at the bedside need support in order to do that in the very best possible way.
5	NNP1-9	It would be the same, to provide top care.
5	RN1-9	Okay, okay, I really enjoy all aspects of NICU, I really like working with the family, and I really like to emphasize the family centered care and try to involve people, make things easier for the families. Obviously you want to provide the best care possible for our babies.
5	RN3-9	To provide the best care and protect of the patients.
5	RN5-9	To give the very best care I can. I'm not out to try and save every baby that comes through here. I think about quality of life, it's in my own personal thoughts. Making sure that the parents feel like they are parents, taking care of their babies, feeling comfortable with the care and outcome.
6	MD Dir-9	The collaboration is important to me personally.
6	MD1-9	The two primary areas of interest are nutritional informatics to study how physicians think about and make selections and decisions about nutrition, systems that are in place to monitor nutrition and some metabolic interests.
6	MD2-9	To make sure that the moral in the nursery is very high, and that the nurses as a consequence of that are able to interact in an easy and free and productive manner with the patients. I try to promote a mix of informality and accountability for getting things done.
6	RN Dir-9	As head nurse in this unit, my goal is to take care of the staff so they can provide the best patient and family care. When I care for my own patient load in the clinical setting, my goal is to provide excellent patient care.
6	NNP1-9	To teach my fellow nurse practitioners and the nursing staff about neonates to improve care.

Appendix 2- 12: Personal Goals in Low NBSI Rate NICUs (continued)

Site	Role	Personal Goals Low NBSI Rate NICUs
6	NNP2-9	To provide the best can that I can. I don't have children, but I take care of them like I would want my own taken care of if I had a child, or one that was sick.
6	RN3-9	To guess help each family to off to the best start that they possibly can as a family unit in terms of knowing how to care for the newborn infant that fits into their lifestyle and is best for the baby.
6	RN4-9	To establish a good rapport with the parents and families and treat the families as I would want to be treated.

Appendix 2- 13: Comments on the Issue of Personal Integrity in Low NBSI Rate NICUs

Site	Role	Personal Integrity High NBSI Rate NICUs
2	MD Dir-7	Just a higher sense of awareness has helped our own nurses to realize that they are in contact with the babies more than anyone else. And they are the ultimate police for their own child, advocate for their own child.
2	MD2-7	It's a culture, they have to realize how important it is and they have to care.
2	RN1-7	You can have all the equipment you want, all the policies in place you want, but if you don't have good staff awareness you are never going to solve the problem.
2	RN2-7	You what you can do, but ultimately it is up to the individuals to individual practice. That is how you get lapses in standards in practice because (people believe that) I have always done it this way, and no one has ever said anything to me about it. So then that becomes a habit, a bad habit. I feel like there is a bar where the standards are set, but if you don't get up to the bar, that's okay as far as nurses go.
3	RN Dir-9	The diligence, and being very, very careful. I can't say that the (burn unit) mindset was the pivotal point, but I think that helped most of us think that we have the wrong philosophy here.
3	RN3-9	It is an issue of compliance. Who cares if it won't change, it is not a criticism of the individual, but you need to have it.
3	RN6-9	There is no lea way there it is all or none. You must be very strict in how you handle the equipment and the preparation of the site. It amazes me that because it is not a central line that they are not as vigilant with that.
4	RN4-13	You make sacrifices, you say okay I am taking care of these babies and I am going to have to do this, give up that, and wash my hands.
4	RN5-13	It would be people's level of commitment to doing the best that they can, the best care. The most up-to-date care that we can. There are a lot of people here just for their 12 hours and then they go home and they never think about it again. I think for the large part of the staff this is just a job. I am not saying that they don't love the babies and they don't do the best that they can when they are here, but I don't that they go beyond just caring for them at the bedside.
4	RN7-13	Some of the registry nurses are just here to make their money. Most of our registry nurses were staff that use to work here either full-time or part-time and they cut back. They had conflicts and went to registry.

Appendix 3: High Nosocomial Bloodstream Infection Rate NICUs

Appendix 3-1:	Mental Model seen in Non-Collaborative High Rate NICUs	139
Appendix 3-2:	Mental Model seen in Collaborative High Rate NICUs	141
Appendix 3-3:	Negative Response to the Statement in Non-Collaborative High NBSI Rate NICUs	144
Appendix 3-4:	Positive Response to the Statement in Non-Collaborative High NBSI Rate NICUs	145
Appendix 3-5:	Negative Response to the Statement in Collaborative High NBSI Rate NICUs	146
Appendix 3-6:	NBSI as a Complication of Care in High NBSI Rate NICUs	148
Appendix 3-7:	NBSI as Both an Error & Complication of Care in High NBSI Rate NICUs	149
Appendix 3-8:	NBSI as an Error in High NBSI Rate NICUs	151
Appendix 3-9:	What Providers Tell Parents in High NBSI Rate NICUs	152
Appendix 3-10:	Comments on the Issue of Personal Integrity in High NBSI Rate NICUs	154
Appendix 3-11:	Response Threshold in High NBSI Rate NICUs	155
Appendix 3-12:	Role of Unit Leadership in High NBSI Rate NICUs	156
Appendix 3-13:	Process for Change in High NBSI Rate NICUs	160
Appendix 3-14:	Barriers to Change in High NBSI Rate NICUs	161
Appendix 3-15:	Culture/Experience in High NBSI Rate NICUs	164
Appendix 3-16:	Personal Goals in High NBSI Rate NICUs	167

Appendix 3- 1: Mental Model seen in Non-Collaborative High Rate NICUs

Site	Role	Mental Model High NBSI Rate NICUs (Non-collaborative Sites)
1	MD Dir-10	Nosocomial infections are inevitable. With the babies' decreased immune system, the environment, how we care for and handle babies, and the pressure that antibiotics create make infection inevitable.
1	MD1-10	I think they are inevitable, but I don't think anyone can completely eliminate them. If they think that (nosocomial infections) are preventable then more power to them, everyone is entitled to an opinion and that's what makes us all different.
1	MD2-10	In a perfect world they would be preventable, but here they are inevitable.
1	RN Dir-10	Small neonates are just going to get an infection. Nosocomial infections are inevitable in babies of 23-24 weeks.
1	RN1-10	I would like to say that they are preventable I believe that it can be done. Very rarely do we see it done, it has been done, so I know it can be done. Every now and then we will have a 29-30 week baby that leaves here and never has an infection. It is very rare but it has happened.
1	RN5-10	I would think that all nosocomial infections should be preventable, but I don't know if they are. Surely a lot of them are preventable and if we knew how to prevent them we would. I don't think that all babies over 32 weeks should have a nosocomial infection, I don't think that it is inevitable for them.
1	RN6-10	That's a hard question. A lot of them are preventable, but I'm not sure that they all are. There are times that no matter what you do if you do everything right from admission to discharge, that baby could still get an infection. I know that you never do everything right 100% of the time, if you did would that baby have an infection? Who knows because no one is perfect 100% of the time, no one practices that way we are human.
3	MD-Dir-9	Should be preventable, not inevitable but we can't seem to get there. In our unit they seem to be more inevitable.

Appendix 3- 1: Mental Model seen in Non-Collaborative High NBSI Rate NICUs (continued)

Site	Role	Mental Model High NBSI Rate NICUs (Non-collaborative Sites)
3	MD1-9	Nosocomial infection are not entirely preventable, there will be a certain number of infants that will have infections despite our best efforts. We can limit the severity of infections, but we can't bring the number to zero.
3	RN1-9	They are inevitable you don't have 100% control of the environment. There are other people who interact with the babies.
3	RN3-9	They are inevitable.
3	RN4-9	They are not inevitable, but I think most will have an infection.
3	RN5-9	Inevitable from the experience we have in this unit. There are too many people handling the baby, their immune system is suppressed due to their prematurity, and they have multiple lines, which places them at higher risk. They could be preventable, but they are inevitable.

Appendix 3- 2: Mental Model seen in Collaborative High NBSI Rate NICUs

Site	Role	Mental Model in Collaborative High NBSI Rate NICUs
2	MD Dir-7	Nosocomial infections are inevitable, with the babies decrease immune system, the environment and how we care for and handle babies and the pressure that antibiotics create make infection inevitable.
2	MD1-7	If you did everything perfectly, there would still be an incidence that would still occur. I don't think that you can absolutely prevent all infections.
2	MD2-7	Even though I think that it is anticipated that somebody is going to get (an infection).
2	NNP1-7	They are inevitable. I think you can reduce them, but I think that they are inevitable. If you have a premature baby with no immunity and you put them in the hospital setting with the invasive procedures that the have to undergo, there is going to be an infection process at some point, because they are so vulnerable to whatever comes by and they can't live in a bubble.
2	RN1-7	No they are not inevitable, they are preventable. At least just recently anyway. Until recently we had an alarmingly high rate of bloodstream infections in our babies. Especially if they had a central line. If they had a central line you could almost guarantee they were going to end up with a staph epi sepsis within two weeks. It was really sad, I'm sorry, and it was like it was accepted that that was going to be how it was. Over the past several months with stressing the importance of line care and aseptic technique when you are changing your fluids and handling lines, we have just seen our rates plummet to next to nothing. Everyone has seen that they just don't have the sepsis that we use to have.
2	RN2-7	Basically it is something that usually happens, but it can be decreased or prevented by the care, as far as handwashing and cleaning and things like that. When I first started (the collaborative) we had a big problem with sepsis, where it was routine. We changed a lot of things, and I believe that through good practice and standards it is preventable.

Appendix 3- 2: Mental Model seen in Collaborative High NBSI Rate NICUs (continued)

Site	Role	Mental Model High NBSI Rate NICUs (Collaborative Sites)
2	RN3-7	Of course the smaller gestational age, 24-26 weeks, it is probably inevitable that they will get one, but a in a 32 weeker it is possible that we could try to prevent that. No matter how much good care you get, some babies are going to get infections not matter what and that is probably based upon on their gestational age and what they are exposed too.
4	MD Dir-13	In small babies I think that infections are inevitable.
4	MD1-13	It is funny our incidence (here) is very similar to the incidence of (the unit I left). So I think that they will be with us forever.
4	MD2-13	I am not sure that I can say that they are totally preventable. I hope that we can do better than we are doing now, I don't want to automatically expect a 32 or 31-week old baby to get an infection.
4	MD3-13	I use to think that they were inevitable, not outside the norm. It was not seen as a sentinel event, it was see as "oh yeah another infection." Now it is a disappointment when it happens, rather than an expectation.
4	MD4-13	You can count on the fact that if you have a 26-week old baby you will have an infection it is a matter of when. It shouldn't be inevitable but a lot of them could be prevented. That is why we are working with Vermont Oxford to get the study protocols. We felt that it was inevitable, but also there are ways to prevent them.
4	RN1-13	You expect it. It is inevitable. You would like to think it is preventable, but it is a never ending battle, a cycle.
4	RN2-13	They are inevitable. This is a dirty world, parents aren't clean, and the environment isn't clean. There are germs everywhere. We just don't know how to prevent the infections.
4	RN3-13	I really hope that eventually we will be able to prevent them. At this point I think it is inevitable.
4	RN5-13	I don't know if they are preventable, but I think you can have patients that won't get them, but that it is the patient more than what we do (to them). So I guess I am saying that they are inevitable. I think that it depends more on the strength of the patient and their immune system rather than what we do.

Appendix 3- 2: Mental Model seen in Collaborative High NBSI Rate NICUs (continued)

Site	Role	Mental Model High NBSI Rate NICUs (Collaborative Sites)
4	RN6-13	I don't know if they are preventable, but I think you can have patients that won't get them, but that it is the patient more than what we do (to them). So I guess I am saying that they are inevitable.
4	RN7-13	I have had babies that have been sick almost from the time they came in until the time that they leave. They get one infection, you clear it and they get something else.

Appendix 3- 3: Negative Response to the Statement in Non-Collaborative High NBSI Rate NICUs

Site	Role	Negative Response to “ No baby less than 32 weeks GA should have a NBSI.” High NBSI Rate NICUs (Non-Collaborative Sites)
1	MD Dir-10	I don't believe it. Babies are vulnerable to infection and have zero tolerance for additional stresses. They require that the care they receive differ from day to day.
1	MD1-10	Clearly that is the holy Grail but I don't think it is reasonable to expect that to happen.
1	MD2-10	We anticipate a low level of infections, but to think none is unrealistic.
1	RN Dir-10	I have never seen a zero rate. That would be a great goal, but not an attainable one. There will always be a certain level of infection due to the patient's condition, their risk and the fact that they are in an NICU.
1	RN1-10	I would like to say that they are preventable I believe that it can be done. Very rarely do we see it done, it has been done, so I know it can be done.
1	RN3-10	I think it is great but I think that it is a hard thing to do, better said than done.
1	RN4-10	Realistically everyone tries as hard as they can. No one comes in here and says I want to give this baby an infection, nobody.
1	RN5-10	I think that is very optimistic because of all the issues we've just talked about.
1	RN6-10	I would like for that to be true, but you are dealing with human beings and human weaknesses.
3	MD1-9	I disagree with the statement. Nosocomial infections are a complication of prematurity. No matter what our efforts, there will be some degree of infection that is unavoidable.
3	RN Dir-9	I wish it didn't happen.
3	RN1-9	Impossible to get to zero, we just don't have enough control over what the babies are exposed to. There are too many people interacting with the babies, and not everyone's technique is ideal.
3	RN1-9	Not an accurate statement. There may be innate factors that lead to infection. 33% of infections are not preventable.
3	RN3-9	Compliance with all the best practices makes it a possibility, but we are a long way from attaining that.

Appendix 3- 3: Negative Response to the Statement in Non-Collaborative High NBSI Rate NICUs (continued)

Site	Role	Negative Response to “ No baby less than 32 weeks GA should have a NBSI.” High NBSI Rate NICU (Non-Collaborative Sites)
3	RN4-9	A wonderful goal, but not the reality. Infections are failures we know that but they still happen. Nothing seems to change that. We thought when we moved into the new unit with individual rooms that the infection rate would drop, but it hasn't.
3	RN5-9	That would be ideal, but difficult standard to keep or maintain. It is inevitable because of the number of contacts, the baby's prematurity and immune system, and the lines that break the integrity of the skin.
3	RN6-9	I would be able to support that if we were conscientious in maintaining the environment for (the babies), then I would believe that is possible.

Appendix 3- 4: Positive Response to the Statement in Non-Collaborative High NBSI Rate NICUs

Site	Role	Positive Response to “No baby less than 32 weeks GA should have a NBSI.” High NBSI Rate NICUs (Non-Collaborative Sites)
1	RN2-10	I believe that, but I don't know exactly how to accomplish that because we have babies in our unit that have nosocomial infections.
3	RN6-9	I would be able to support that if we were conscientious in maintaining the environment for (the babies), then I would believe that is possible. They should not have an acquired infection.

Appendix 3- 5: Negative Response to the Statement in Collaborative High NBSI Rate NICUs

Site	Role	Negative Response to “No baby less than 32 weeks GA should have a NBSI.” High NBSI Rate NICUs (Collaborative Sites)
2	MD Dir-7	If one takes zero as the goal, we certainly have a way to go. Can we ever reach there, I don't know. I tend to doubt it.
2	MD1-7	I think that we can get it down to very low numbers, as we have demonstrated, but I don't think you can absolutely get rid of them all.
2	MD2-7	I think you can get it down pretty low, but I don't think that exists.
2	NNP1-7	Woo! Wherever they are I would like to work there. That's one clean unit and they have a lot of really good practices, and chances are they use breast milk. Those are really good things. There would have to be some really good consistent practices for that to happen.
2	RN1-7	That should be your goal, but I am not sure that it can happen.
2	RN3-7	I think that is great, but it may not always be preventable. I think it is great but I think that it is a hard thing to do, better said than done.
4	MD Dir-13	I don't know how they can say that. Many of these babies that are less than 32 weeks have so many problems that you have to do invasive procedures upon.
4	MD1-13	In a perfect world that is true. I think that we are several years away from that. There are certain babies that don't get infections. I think that is a great goal to obtain, I don't know if we know enough to get there yet. I think that most of us think that we can decrease (the number), but I don't think we can eliminate them.
4	MD2-13	I guess in an ideal world I would hope that were true but I think that so far in my career I am hard pressed to remember taking care of a 23 or 24 week baby that survived that did not have an infection.
4	MD3-13	Is it completely attainable? I don't think so.
4	MD4-13	Will we ever get to no infections, it would be nice, but it is unrealistic.
4	RN2-13	Lofty high goal, but it is unreasonable. The babies are here, they are here and they shouldn't be. So they just don't have what it takes to survive here, and they are going to get infections.

Appendix 3-5: Negative Response to the Statement in Collaborative High NBSI Rate NICUs (continued)

Site	Role	Negative Response to “No baby less than 32 weeks GA should have a NBSI.” High NBSI Rate NICUs (Collaborative Sites)
4	RN3-13	I think it is a dream because babies that age are going to have an infection. They are going to need the IVs, they are going to need the ET tube. It would be nice, but I don't see that happening.
4	RN4-13	In a perfect world that may be true. In the most controlled environment you could possible construct. There are just so many variables.
4	RN5-13	I wish that they didn't. I think it is true that they shouldn't. If we ever get to that point, I don't know if we will get to none, but we should have fewer.

Appendix 3- 6: NBSI as a Complication of Care in High NBSI Rate NICUs

Site	Role	NBSI as a Complication of Care High NBSI Rate NICUs
1	MD Dir-10	They are an anticipated complication of care, they just happen here. It is hard to understand if what we do makes a difference, you just don't see it in the data.
1	MD1-10	I think that they are an anticipated complication of care and that the rate is variable. I don't think that any of them reasonably think that a 24-week, 24-week, or 26-week old is going to make it out of here without one bloodstream infection.
1	MD2-10	They are an anticipated complication of care.
1	RN4-10	I want to say anticipated (complication of care), but I don't want to think that every baby that comes in here will get a nosocomial infection.
2	MD1-7	Largely they are an anticipated complication. They're something that is undesirable, the incidence can be reduced significantly, but I don't think that it can be completely eliminated.
2	NNP1-7	It shouldn't happen but it does. More babies than not get them in this unit.
2	RN2-7	They are an anticipated complication. When I first started I was told that the baby is premature, a 24-25 week GA, they are going to get an infection before they leave this unit. More babies than not get them in this unit.
4	MD1-13	I look at it as an anticipated complication of care. I am not so sure that you can prevent them all.
4	RN Dir-13	I think that they are an anticipated complication. I think that they can be an error they can result from errors that are made. But I think that they are more anticipated complications.
4	RN2-13	It is an anticipated complication because of all the invasive procedures and the hurried situation in the unit. We have a lot of babies who need so much here.
4	RN3-13	Anticipated complication. If you say error it implies that somebody that has done something wrong to cause the infection. Sometimes your very best technique is not going to prevent it.
4	RN4-13	It is an anticipated complication, because our rate is so high that you just come to see it so often. If you see something so often and in so many infants that it is almost expected.

Appendix 3- 7: NBSI as Both an Error & Complication of Care in High NBSI Rate NICUs

Site	Role	NBSI as Both an Error and a Complication of Care High Infection Sites
3	RN1-9	Both. It is an error because we broke technique somehow, somewhere. We have seen some babies who made it through their stay without an infection. Generally, most babies just get an infection. We thought that the infection rate would drop when we moved into the new unit, but it hasn't.
3	RN3-9	Both. It is the human element. It is an anticipated complication of care due to non-compliance with best practices, but it is also error for the same reason. We failed to do something we should have and it led to the baby getting an infection.
3	RN5-9	Both. An infection is devastating and a setback event to the parents. Breaks in the skin produces outcome we will see. With VLBW babies maintaining the environment is important. My colleagues might not agree, but some might.
4	MD Dir-13	It is not an intentional error there may be a technique failure. So then it becomes an anticipated outcome.
4	MD2-13	Can I say both? I think it can be the result of an error in care. I am not sure where I draw the line in saying no it is not inevitable.
4	RN1-13	An error, but with the population that we serve it is an anticipated complication of care. It should be an error, but here it is an anticipated complication.
4	RN6-13	I guess they are an error because they are something that is not suppose to happen, so in that way they are an error. But they are a very COMMON outcome of our patient population. I guess they are an error, but they are expected too.
4	RN7-13	I think that it is an error, that somehow we have failed the baby. But there seem to be some babies that it doesn't matter what you do, it seems that they are always infected. I'm not sure what to think.

Appendix 3- 7: NBSI as Both an Error & Complication of Care in High NBSI Rate NICUs (continued)

Site	Role	NBSI as Both an Error and a Complication of Care High Infection Sites
1	RN Dir-10	Nosocomial infections are inevitable in babies of 23-24 weeks. They are an error in older babies those closer to 32 weeks.
1	RN1-10	Honestly I believe that they are both. I believe that there are going to be errors and I believe that they are inevitable. An error occurs and then they become inevitable. By errors I mean breeches in protocol, whether it is nursing or visitors like x-ray.
1	RN5-10	I think that they can be both. It would be an error if we as caregivers were somehow linked directly to that nosocomial infection if it is a breakdown in care and I can be linked to that then it would be an error.
1	RN6-10	It can be either or. I think that sometimes it is an error, somebody just has done or not done something that they were suppose to. They have not followed the appropriate protocol or procedure or they have dropped the ball somewhere. I think it can be an anticipated complication of care, I don't know if anticipated. I don't think it is always an error, but sometimes it is inevitable not anticipated.
2	RN3-7	Both, because anytime a baby has an infection, we try to see what caused it, could we have done something better to prevent it. It depends on what the baby has been exposed to even in utero and how sick the baby is when it comes out, determines whether they get sicker with other infections. You are going to have hospital error wherever you are, so sometimes it is both.
3	MD1-9	Both. It is an error because most of the infections can be prevented. They are the result of human failures. It is an anticipated complication of care, because some degree of infection is unavoidable.
3	RN Dir-9	We know we have babies at high risk. I don't want to say that they are an anticipated outcome. We try not to have a punitive environment, where it is a result of error or lack of knowledge, inadvertent lapse. The human piece is not to be overlooked.

Appendix 3-8: NBSI as an Error in High NBSI Rate NICUs

Site	Role	NBSI as an Error High Infection Sites
1	RN2-10	They are an error and that is new thinking for me. It was a gradual process. Now I know that is an error, that there is something that we are doing that is slipping through the cracks that we should be better at.
1	RN3-10	I guess it is probably an error it is because something we have done has caused it. It is an error on our part because we have brought some kind of infection or disease to this baby. This is something they taught us in nursing school.
2	MD Dir-7	I think that it use to be seen as an anticipated complication, but now we are acknowledging and admitting to ourselves that it is an error in management. It is an imperfection in the system and we can do better.
2	MD2-7	I think that you can call them an adverse event, because we have shown that you can basically get rid of it.
2	RN1-7	In the past they were an anticipated complication, but now they are being viewed as an error.
3	MD Dir-9	It is an error because in certain populations with the same risks they don't have infections.
3	RN2-9	Error. No one you can tell if it is due to break in procedure or handwashing. It is certainly not an anticipated outcome. No one should get an infection but they do.
3	RN4-9	They are an error, they are the one thing that we can't seem to control, but they should be preventable.
3	RN6-9	In my mind it is an error. I feel if we were all a lot more careful in how we practice, I just don't believe that it has to be an anticipated event.
4	MD3-13	Before participating in the collaborative it was an expected outcome, not an error. Now I am leaning towards it being an error, but I don't think that it will be completely preventable.
4	MD4-13	In my mind it is an error, a breakdown in good technique, a breakdown in some aspect of infection control.
4	RN4-13	I'll be strong on that one and go with error, because our goal should be that it is an error, that if we do all things well and appropriate 100% of the time, and that is our goal, then it would be an error.
4	RN5-13	They are an error they are definitely an error. They are a failure on our part. We didn't do what we needed to keep that from happening.

Appendix 3- 9: What Providers Tell Parents in High NBSI Rate NICUs

Site	Role	What Providers Tell Parents High NBSI Rate NICUs
1	MD1-10	What I tell the parents, the smaller they are the less mature their immune system and the less likely they are to handle bacteremia when they get (an infection).
1	RN2-10	We tell them how important handwashing is and we tell them that the staff tries to monitor and if we see someone forget to wash their hands we remind them, so feel to do that also. If the dreaded infection happens, we talk about it more in-depth.
1	RN4-10	I tell them that we will try every way possible to keep that baby from getting an infection.
1	RN5-10	Not always, like we tell our parents we try to do everything that we can in frequent handwashing and gloving, but sometimes they are not preventable for whatever reason. What I try to tell every parent especially parents that have the tiny babies, not 32 weeks but the 23-27 week baby, three days into their stay they may still be stable but I always stress to the parents that the biggest complication the baby will face if they do well with their respiratory treatments is the possibility of having an infection.
2	MD Dir-7	That their child will most likely get a nosocomial infection, depending on the gestational age of the child, less than 32 weeks, I wouldn't say probably. I think that our infection rate in 28-32 weeks is actually fairly low. But once you get below 28 weeks, it starts going up exponentially.
2	MD1-7	I don't call them nosocomial infections. I tell them it is likely that the baby will get an infection during the time that it is here. That they are treated with antibiotics and most of them recover without any bad long-term outcome from the infections.
2	MD2-7	It depends upon the baby. I might tell them that the baby is at risk for infection
2	RN2-7	When I was in training here I use to hear the nurses tell parent that, "your child will get an infection before they leave this unit, that's just the way it is." We have heard that (an infection) extends the length of stay by seven days, and it costs money, but this is just what is going to happen.

Appendix 3- 9: What Providers Tell Parents in High NBSI Rate NICUs (continued)

Site	Role	What They Tell Parents High Infection Sites
3	RN5-9	That the babies are at high risk for infection due to the lines, intubation and IVs that interrupt the skin's integrity. Their immune systems are immature and the parents need to watch their handwashing. We provide strong parent education on handwashing.
3	RN6-9	I advise them that infections are one of the risks involved with being a patient in the unit.
4	MD Dir-13	I tell them that their babies are very small and have very little resistance to infection and most of the time or most likely the baby will be contaminated and there will be an infection and there is not much that we can do about it.
4	MD1-13	I look at it as an anticipated complication of care. I am not so sure that you can prevent them all. That is what I tell parents, or else you have this microwave sterility. Parents become afraid of their babies, they are afraid to do kind of things that I think are necessary, to touch and cuddle, and to do the other things that are important.
4	RN3-13	I tell my parents that I can guarantee that their babies are going to have an infection, and I can guarantee that they will have feeding intolerance.
4	RN4-13	That because of the size and age of the baby they have not immunity, no ability to fight, and that they will more than likely have at least one infection.
4	RN5-13	No, in fact probably before I came here I would have been the first to tell parents that their baby is premature and is just going to get an infection.
4	RN6-13	I tell them that (infections are) a very common thing in premature babies. We deal with that on a regular basis and if that happens we know how to deal with it. It's a common thing and it is not unexpected. I'd like to tell them that it is unexpected but after 21 years I just tell them the truth about what is going to be like in (the NICU).

Appendix 3- 10: Comments on the Issue of Personal Integrity in High NBSI Rate NICUs

Site	Role	Personal Integrity High NBSI Rate NICUs
1	MD Dir-10	Buy-in on accepting responsibility to make a difference. We are trying to develop a culture of personal responsibility versus a no blame culture and to have a system that allows that to occur. An environment that stresses personal accountability for doing the right thing.
1	RN Dir-10	Buy-in on accepting responsibility to make a difference.
1	MD1-10	Part of it is just bad habits, and there are just some people that think it just doesn't make a difference if you clean the foot appropriately before you prick a baby for a blood sugar at 3am in the morning.
1	MD2-10	Carefree attitude toward technique, a lack of discipline in following the protocols and techniques. We have to establish a mindset that what we do has a direct correlation to outcome.
1	RN2-10	If you can get people to have the desire to be more careful, do more, clean more that would make a big difference. There is no personal responsibility that says we should be doing something to prevent that baby from getting an infection.
1	RN3-10	All the different people you have working with the babies and the different emergency things that happen in the ICN versus the intermediate side, it causes you to respond before you think about what you are doing.
1	RN4-10	I don't think that everyone is doing their personal best, I feel they try but could be better.
1	RN6-10	As good as these nurses are and as dedicated as they are to taking care of the babies, I still think that there is an attitude of "it's not me" mentality. I think that trying to get them to buy-in to that is very hard because they don't see the importance of it. Usually people are pressed for time and if they cut corners it is usually something that is going to be related to infection control like "well I don't need to put my glove on right now," "I don't have time to go wash my hands," "I'm just going to do this one little thing that isn't going to matter." It is not realizing the importance or effect what they are doing can have. They don't see the direct effect of what they are doing or not doing to that patient.

Appendix 3-11: Response Threshold in High NBSI Rate NICUs

Site	Role	Threshold Response in High NBSI NICUs
1	MD1-10	Especially when you have 12 ventilators going in a nursery of our size and babies are crumping somebody is going to run over there sometimes and do something with their not necessarily clean hands.
1	RN1-10	You have to weigh the risk if you have a baby with a heart rate of 30 and you were just touching another baby, sometimes you have to touch the baby because you can't have a heart rate of 30 and you don't have time to wash your hands.
1	RN3-10	All the different people you have working with the babies and the different emergency things that happen in the ICN versus the intermediate side, it causes you to respond before you think about what you are doing. You just respond to the baby desaturating you want to save the baby, so you are thinking about what kind of infections you are giving the baby.
1	RN4-10	A lot of times if you leave one bed and go to another if the baby's heart or breathing rate is decreasing rapidly. Sometimes you just have to just slip a glove on or sometimes nothing is done, you just stimulate them to get them back up. If you had to run to the sink and wash your hands the babies would be in trouble. In certain cases, realistically in life, if you have a baby who is desating or deceling, I've seen it before, you can't always run to wash your hands and put on gloves before you save the baby. If the baby's heart rate is dropping, honestly, as a person you aren't going to waste time, honestly that is how it happens.
1	RN5-10	If it is a quick response to react to a bradycardia you may have an infected hand. The break down in our prevention is the need for an immediate response without automatically washing your hands or putting the gown and gloves on. It is an event that happens so quickly that you just have to respond to it to support that patient at that time.
1	RN6-10	When you don't put on your gloves or don't follow your infection control policy or procedures, nobody thinks about the consequences, it becomes an option. They don't see the direct effect of what they are doing or not doing to that patient. There is no relationship between their actions and the outcome for the baby. You see more immediate effects from medication errors and surgical errors. You don't get that same immediate impact with infection control.
2	MD Dir-7	So simple hygiene, simple personal hygiene, and a cognizance that even if you are running to an emergency situation, you still have time to rub some cleanser on your hands before you start pumping on the child's chest or placing an IV.

Appendix 3-12: Role of Unit Leadership in High NBSI Rate NICUs

Site	Role	Unit Leadership High NBSI Rate NICUs
1	MD Dir-10	Our role is to set an example for the staff. To examine the data, like the Vermont Oxford data and understand what the issues are.
1	MD1-10	If you don't get things from the top it isn't going to happen. If your partners don't support what the group wants to do you have a major problem.
1	MD2-10	Leadership's role is to recognize that there is a problem and to be consistent with the application of policy and hold people accountable. They need to encourage people to tell "me" when I've violated a protocol and have an open door that allow people to remind others.
1	RN Dir-10	Our role is to get the resources staff need to do their job. Facilitating infection control. Getting evidence-based practices. Serving as a role model. Providing discipline and consequences. We have had physician participation and a physician champion for nutrition education.
1	RN1-10	They are just big advocates for protocols for very low birth weight babies. They are advocates of the RSV season precautions.
1	RN2-10	When we went back to gowning and gloving for VLBW babies, they tried to provide an example but also when you see someone breaking technique they will actually say something. (The medical director) says it is all or none here if you are breaking the technique you are breaking it no matter how you try to rationalize it. If (unit leadership) doesn't buy-in and they don't do it, staff isn't going to do it.
1	RN3-10	As far as the physicians, I have not seen one that has not done what we are told to do.
1	RN4-10	The (nursing director) is a big advocate. We have done studies, and the (nursing director) loves for us to do studies like using glow gel to study handwashing. The medical director is a good role model. If he saw us breaking technique he would say something.
1	RN5-10	Making us aware of the statistics, where we are, how we are doing, our infection rates percentage. There is a bulletin board near the staff wall that has the infection rates. I think that the council that does that gets their focus from the director.

Appendix 3-12: Role of Unit Leadership in High NBSI Rate NICUs (continued)

Site	Role	Unit Leadership High NBSI Rate NICUs
1	RN6-10	I think (the physicians) finally realized that they have to take control of the situation and set the example. They are ultimately responsible, they may not be the one's providing the care, but if you have done all that you can do, provided all the education and training, and the person knows what they are suppose to do and still flat out refuse to do it, then it comes back to management. Management has to say what is the problem and if it is a flat refusal to do something, then disciplinary action needs to be taken.
2	MD Dir-7	Many I guess, but the primary role would be to educate or facilitate the understanding of the individuals that work in the NICU about what their role can be in terms of prevention or even early diagnosis.
2	MD1-7	I handle things like policies and procedures, the physician that is in charge of policies and procedures for nursing and ancillary services in the unit. I work with the nurse managers and hospital administration to make decisions about new policies, new equipment and those sorts of things for the unit.
2	RN1-7	Educating staff is the big thing.
2	RN2-7	Our nurse manager came in January and one of the first things she tackled was our very high infection rate. I feel like a lot of the things that they have us do are effective, but they create unrealistic expectations for nurses to get their work done.
2	RN3-7	Leadership examines our policies.
3	MD1-9	Being able to work together is really important. We should have a positive communication flow that is collegial and supportive.
3	RN Dir-9	To set the expectations and to give them the tools that they need. Whether it is education, product - the hand wash or gel, to listen to staff input because they are present and see what is going on. It is too keep them engaged and make sure that they are diligent. I see myself as a coach and mentor and the watcher of these things from a different perspective.
3	RN1-9	Leadership should serve as role models, and provide the facts, why the practice is the best for everyone to follow.

Appendix 3-12: Role of Unit Leadership in High NBSI Rate NICUs (continued)

Site	Role	Unit Leadership High NBSI Rate NICUs
3	RN2-9	I proved support in alerting the nurses to better practices; networking; literature sharing; and support.
3	RN3-9	Letting everyone know how we are doing, telling us what our rates of infection is and, how we rank. They also serve as the infection control spy, monitoring the staff for lapses in compliance in handwashing or sterile technique.
3	RN4-9	Infections are tracked by the infection control nurses and the neonatologists.
3	RN5-9	Two of the physicians do a good job, and one physician is just scary at leading the effort. The Clinical Nurse Specialist (CNS) are resources, and the (nursing) counsels are helpful.
3	RN6-9	Being open to any ideas or suggestions and promoting those ideas. As far as our (nursing) director, she is very involved. She sits in the executive council. She is very approachable and accessible. She is part of the team, and if there are any problems or issues she will take them to the vice president of nursing. The VP is very supportive of nursing ideas.
4	MD Dir-13	My role is to educate the nurses and all the people who handle the babies.
4	MD1-13	I think that leadership is there to make sure that you stay abreast of what the latest and best evidence-based practices to use. It is also setting the bar, if you are doing it and I am doing it; if I gown and glove, wash my hands, then you need to do that. If I take off my rings and watch then you need to do that. I think that there is a role for leadership. And the other part of leadership is making everybody feel a part of the team so that they feel that their contribution is helpful.
4	MD3-13	Our role as clinical leaders is to investigate these other practices and ways that we can improve our practices. Also oversee the nurses. The nurses look to us, even though they know more about line care than I do, they look to us to validate what they are doing, to look at it, look at the evidence and say that this is what we should do.
4	MD4-13	To impress the staff of the fact that (infection) is an important issue. If the babies don't go home sooner, it costs the hospital a lot more money for every day that they stay.

Appendix 3- 12: Role of Unit Leadership in High NBSI Rate NICUs (continued)

Site	Role	Unit Leadership High NBSI Rate NICUs
4	RN Dir-13	It is to hold people accountable and make sure that they have the resources that they need, training that they need, and clarification on what the policy is to be. To interact with infection control. We do a lot of research on what the practice should be, which is something that I would really like to have a nurse educator or clinical nurse specialist to do.
4	RN1-13	In the unit, they examine data, form committees, and things just trickle down from there.
4	RN2-13	Within our unit, they had a sideline role, the delegate leadership to the team leaders.
4	RN3-13	I think their job is to collect the data. If there is a better technique out there to let us know about it.
4	RN5-13	We sit and just brainstorm with them once or twice a month. We are looking at everything we can think of that might cause (infections). They have taken a real leadership role. (Our nurse manager) is involved. The one thing about (our nurse manager) is that if you have an idea and you work it up and you make your case. She goes with that.
4	RN6-13	I suppose that they should set a good example first. Then provide education.
4	RN7-13	If you don't have the support to do what you need to do to prevent infections then it is like beating your head against the wall.

Appendix 3-13: Process for Change in High NBSI Rate NICUs

Site	Role	Process for Change High NBSI NICUs
1	MD1-10	Mostly through our NICU committee which is the physicians, head nurses and representatives from nursing in general from their practice advisory council that come and sit on our Neonatal Executive Committee.
1	RN Dir-10	We do small group in-services. With nutrition we have done peer-to-peer education and provided everyone with background information.
1	RN1-10	There are 5 or 6 members of the super council and they are responsible for so many staff members. They are responsible for doing little orientations. There are two nurses on the council that work nights.
1	RN2-10	Usually anyone has the choice of taking a new idea to the practice council. The council and the nursing director will talk about it some and form a plan for how to present it and usually the council members (eight of us) try and present it one-on-one. Physicians generally aren't participating in the councils unless they are specifically asked to be there.
1	RN4-10	We have a meeting for night shift and a meeting for day shift with the nursing director. We will all talk about it and (the nursing director) will talk about the pros and cons or why we are doing it. She discusses the facts and then everyone just starts doing it.
1	RN5-10	I think that the council that does that gets their focus from the director.
1	RN6-10	It is not grass root nursing staff, some of the nurse practitioners are good about investigating issues but it doesn't come from the staff nurses.
2	MD Dir-7	If you call a staff meeting you may get a third to two-thirds of the nurses showing up at the change of shift. So we use the bulletin boards as an educational tool. One of the first things we stopped doing, shortly after I came here we started having journal clubs, which is something that we weren't doing (now), so we would get together every couple months and talk about something. It is a multidisciplinary committee, a steering committee. They are not the workhorses they are more the facilitators.
2	MD1-7	*Mandating it doesn't work. Basically with my being the clinical medical director of the unit and with the head of the section, we are able to do things a little easier than someone else not in our positions. We discussed it among ourselves and decided as a group that although we could not come to a consensus and all do the same thing, that basically everyone else was willing to let the two of us try to not use vancomycin and to try to decrease our total antibiotic use, but specifically vancomycin.

Appendix 3-14: Barriers to Change in High NBSI Rate NICUs

Site	Role	Barriers to Change High NBSI Rate NICUs
1	MD Dir-10	We have many senior nurses, many of whom have only worked in this one unit. They have never seen or been anywhere else. Change here is difficult, many think that we have been doing things this way for 20 years why should we change we struggle with that a lot.
1	MD1-10	I think a big problem in a lot nurseries is people who have worked in there, particularly in one place, for 20 years, and think that the only way to do something is the way that they have done it for 20 years. I tell them to get out and see the world and they get mad at me. Some that go other places come back amazed that there are other ways to take care of babies and that it might actually be better than the way you have done it for 20 years.
1	MD2-10	However, people here are not early adopters, there is a wait until things are well documented in the literature before we change.
1	RN2-10	When clinical ladder stopped, most of the projects just fell by the wayside. Without the ladders you have just a handful of people who have that joy and enthusiasm and can keep going with it and the rest of the people just come to work.
1	RN5-10	If you are talking about to patient care, the unit is pretty open to change and there is a lot of senior staff in this unit and that is beneficial to making patient care changes. Most of us are open to change, just explain it to us, let us understand how this is better for the patient and then it doesn't matter how it is presented.
1	RN6-10	I think that trying to get them to buy-in to that is very hard because they don't see the importance of it. They have to believe what you are telling them, they have to buy-in to it and they have to have the education or understanding.
2	RN2-7	I feel like a lot of the things that they have us do are effective, but they create unrealistic expectations for nurses to get their work done. I think it would be better if the people making these policies were here doing it, to see what it is like.
4	MD Dir-13	The nurses who work during the day are very comfortable stopping me. The night staff nurses are very young and they won't mess with the physicians.
4	MD1-13	We have gone through a ton of changes and they haven't worked, and I have been here for a long time.

Appendix 3- 14: Barriers to Change in High NBSI Rate NICUs (continued)

Site	Role	Barriers to Change High NBSI Rate NICUs
4	MD3-13	All these changes have been frustrating. I have been frustrated so I assume that (the nurses) have been. Our nursing staff is very good if they understand what the rationale is we get their buy-in in a short period of time, from the core nursing staff. The single biggest problem with the nursing staff is we have a lot of nurses that work part-time, and registry. This is where a lot of break down is they are not always in the loop on what we do now.
4	MD4-13	There is some aspect of resistance (to change in senior staff), not just to infection control but to other changes.
4	RN Dir-13	I think that they think they are doing the right things. But it is frustrating when you think you are doing all the right things and you still don't get the outcome you want. We have a neonatal group. We have a single neonatal department. We meet every Thursday it is a standing meeting. Any major practice changes go to them after we have researched it and determined what the standard of practice is. If is something that they already know about or they are supportive of...we may have to research it some more or tweak it for a while.
4	RN2-13	The physicians are not fully engaged, some of the newer physicians just want to dictate the care we are to provide. The truly collegial physicians are the ones who have been associated with the unit for a long time.
4	RN4-13	We work days, nights, weekends, and we also cover for a smaller hospital so our perceptions may be different than for someone that is here on days or on nights. Day shift is probably a little more aware of what is going on and the changes.
4	RN5-13	I think that there is a large population of nurses in this unit that want to do it the same way that they have for 20 years. If you try to change things, they say, "Well we've did it this way for 20 years." It is my opinion that we have a bad infection rate, we have a long length of stay, we have a lot of feeding intolerance and that is where doing it the same way for 20 years has gotten us.

Appendix 3- -14: Barriers to Change in High NBSI Rate NICUs (continued)

Site	Role	Barriers to Change High NBSI Rate NICUs
4	RN6-13	Everything we do, try to do, doesn't seem to work. We try to be really, really careful. Everybody tries to be careful, but we seem to have infections anyway. Yeah, if I felt like they were really accomplishing something then I would have no problem. But sometimes I feel like we are changing the wrong thing sometimes and it is not really having an effect.
4	RN7-13	We have had a lot of changes. And a lot of the changes that we have made, we have gone back to what we were doing before. That is where we are now. All this changing back is overwhelming and confusing. We did a lot of (changes) at one time, the dressings, med system, three or four things that we did all at the same time. So we don't know what made the difference.

Appendix 3- 15: Culture/Experience in High NBSI Rate NICUs

Site	Role	Culture/Experience High NBSI Rate NICUs
1	MD Dir-10	Coag-negative staph is simply accepted in this unit. We have many senior nurses, many of whom have only worked in this one unit. They have never seen or been anywhere else.
1	MD1-10	Changing behavior or culture is very hard especially if you mostly have people who have only worked in one NIUC. They just don't see the causality of their actions to infection because it has happened for so long and for so many times and it is just so common in our nursery, infections.
1	MD2-10	We have to establish a mindset that what we do has a direct correlation to outcome.
1	RN Dir-10	There are other units that have the same infection rate as we do, so many people feel that they are being blamed for the infection rate few see it as a systems issue. The initiative is to move from a culture of inevitability to a culture of prevention. We need to move to a culture of prevention, but right now it is a culture of inevitability.
1	RN2-10	We had clinical ladder here once before and that did improve participation. We are trying to think about how change people's attitudes.
1	RN5-10	As far as all the all the nosocomial (infection) in our unit I don't think that they blame a systems failure or anything, it is more like "where is this coming from," of all the things that we have done to lower the infection rate why is it not working.
1	RN6-10	I don't think that they realize because they get so busy and so wrapped up in taking care of the babies that they don't realize what they are doing is NOT the best way to do it.
2	MD Dir-7	The data is theoretical to a large extent, and there is this mentality that, "We don't have this problem, so why should I worry. It is somewhere else in the hospital or some other hospital." Partly because I have worked in many institutions before I came here I have a different perspective. Some of my senior partners, whom I have a lot of respect for and are excellent physicians, but one thing that I think is a flaw in their make-up is that this is the only place that they have ever practiced in. So they have a very provincial attitude in some ways about neonatal care that doesn't really recognize what is going on around us in the world of neonatology. Everyone that they took care of had a nosocomial infection at some point they felt and that was just a natural thing for them to have.

Appendix 3- 15: Culture/Experience in High NBSI Rate NICUs (continued)

Site	Role	Culture/Experience I High NBSI Rate NICUs
2	MD2-7	I think that it is a very busy nursery, the population here needs to understand why it is important and they need the pats on the back. We don't want to fall into the trap and become complacent again. Now if someone sees somebody, you just remind them so it becomes in-service by committee kind of thing.
2	RN2-7	A lot more nurses are becoming more assertive because we are tired of getting the blame. It is always the nurses, the nurses, and the hospital isn't doing anything but reminding us that this is a problem and that its got to be the nurses. They make changes, but others are "don't bother me with this I know what I am doing." I feel like there is a bar where the standards are set, but if you don't get up to the bar, that's okay as far as nurses go. That when an attending leaves, the next attending that is on call for the night, that things aren't going to be changed the second they walk through the door because they have different practices.
2	RN1-7	If they had a central line you could almost guarantee they were going to end up with a staph epi sepsis within two weeks. It was really sad, I'm sorry, and it was like it was accepted that that was going to be how it was. Everyone has seen that they just don't have the sepsis that we use to have. Just being conscious of what you are doing and paying attention, that is almost always the issue with any patient problem you have is awareness, good staff awareness.
2	RN3-7	I will tell you that nurses are very protective over their children, and when x-ray comes in or a physician touches a baby without gloves on, or doing something, like going to the phone and coming back, we will ask if they have washed their hands. (In addition to hanging fluids differently) we have the handwashing police come in to monitor handwashing, and we had that for every shift for a while.
3	RN4-9	The majority of my colleagues here don't believe that babies shouldn't have infections. I don't know why, but it seems to be accepted.
3	RN5-9	Inevitable from the experience we have in this unit.
4	MD1-13	We can improve, by getting a new nursery with 150 square feet in between and single rooms. That changes the culture. It change the way that (people function). You don't have people walking back and forth, babies are in their own little milieu, they don't move. You have to have a change in culture, several changes to impact the culture.

Appendix 3- 15: Culture/Experience in High NBSI Rate NICUs (continued)

Site	Role	Culture/Experience High NBSI Rate NICUs
4	MD4-13	You can to some degree, but it is a culture thing. It is always hectic, always busy, people are moving around talking, but it needs to be a quieter environment, less hectic with less people jumping around talking across the unit.
4	RN Dir-13	Which surprises me, as I have gotten a lot of the surveys back and I have read the question on “how do you think we are doing?” There are few in there that think we are doing very well, and I thought did you not read the question? We have a problem with infections here. They think that our infection rate is fine. I was just thumbing through the surveys, I’ve seen a few answer that we are doing great. No we are not haven’t you been listening?
4	RN1-13	“A” group (the senior day shift) is much more favored here.
4	RN3-13	I don’t think that they necessarily blame the individual. They are constantly trying to educate us about technique and how we do things, but if a baby has an infection, they don’t blame us individual per se, they don’t say, “this is your fault.”
4	RN4-13	The neatest thing about this unit is that for the size of it, everyone gets along very well. Everyone is very considerate of each other’s feelings. No one ever tries to embarrass anyone else. I have never in the two years I have been here heard a doctor yell and embarrass a nurse. And they are very respectful of each other and NNPs as well. It is a very cozy nursery given how large it is.
4	RN5-13	I think that there is a large population of nurses in this unit that want to do it the same way that they have for 20 years. If you try to change things, they say, “Well we’ve did it this way for 20 years.” It is my opinion that we have a bad infection rate, we have a long length of stay, we have a lot of feeding intolerance and that is where doing it the same way for 20 years has gotten us.
4	RN6-13	It’s a common thing and it is not unexpected. I’d like to tell them that it is unexpected but after 21 years I just tell them the truth about what is going to be like in (the NICU). The people that I have worked with for 21 years, people who have done this for a long, long time probably have seen it happen over and over and probably share this perception.
4	RN7-13	I think when I started, and even in orientation they told me that most babies in the nursery will have at least one infection before they leave. We are failing the baby, but that was the mindset when I first got here (babies will have at least one infection before they leave) because infection has always been a problem.

Appendix 3- 16: Personal Goals in High NBSI Rate NICUs

Site	Role	Personal Goals High NBSI Rate NICUs
1	MD Dir-10	To provide the best care with each daily contact.
1	MD1-10	Nutrition is my most recent focus.
1	RN Dir-10	The professional growth of the staff.
1	RN2-10	For infants are cared for at the highest level, safely, and get them out as quick as we can.
1	RN3-10	To help the babies get better and stronger quicker too.
1	RN4-10	I try my best to protect the babies.
1	RN5-10	My personal goal would be that during the time that I am here that I am 100% able to meet the needs of the patient for that particular shift.
1	RN6-10	That's my job to make sure that these babies don't get sick while they are here.
2	NNP1-7	Education is a big concern of mine and I am the unit educator for the nurse practitioner group. So making sure that I am up on the latest educational offerings and making sure that those are available to my peer group, and providing informal teaching to the staff nurses and my peers.
2	MD1-7	My main area of interest is in infant nutrition and in diseases related to nutrition, such as necrotizing enterocolitis.
3	RN5-9	Personal focus, understanding the chronic care needs of the babies and working with the parents to understand and meet these needs.
3	RN6-9	Personal goal: to make sure that my parents, family are comfortable with me caring for their baby and that I try to keep environment safe as possible.
4	MD1-13	To see the infant mortality rate come down.
4	MD3-13	Educational things fall my way.
4	MD4-13	I am a little more interested in cardiac problems, lung problems.
4	RN Dir-13	To create something that I am personally proud of and that accomplishes what we hope it will accomplish.
4	RN2-13	I am very active and interested in communicating with the family, helping them to understand the needs of their baby, in education.
4	RN4-13	To provide the best care to the infants I am assigned to, and those that I go transport for, and to attend deliveries.
4	RN7-13	I like working with the families, teaching them and working with developmental issues.

Appendix 4: Survey Statistics

Appendix 4-1: Mean and Standard Deviation for All Survey Items	169
Appendix 4-2: Mean and Standard Deviation for all Survey Domains	171
Appendix 4-3: Crude Mean Response for Survey Items	172
Appendix 4-4: Crude Mean Response for Survey Domains	176

Appendix 4-1: Mean and Standard Deviation for all Survey Items

	Survey Item	Mean	Std. Dev.
A1	People support one another in this unit.	4.02	0.83
A2	We have enough staff to handle the workload.	3.01	1.12
A3	When a lot of work needs to be done quickly, we work together as a team to get the work done.	4.23	0.71
A4	In this unit, people treat each other with respect.	3.72	0.90
A5r	Staff in this unit (do not) work longer hours than is best for patient care.	2.39	1.38
A6	We are actively doing things to improve the NBSI rate.	4.19	0.63
A7r	We (do not) use more agency/temporary staff than is best for patient care.	3.79	1.02
A8r	Staff (do not) feel like their mistakes are held against them.	3.20	1.04
A9	Mistakes have lead to positive changes here.	3.63	0.84
A10r	It is (not) just by chance that more serious mistakes, including infections don't happen around here.	3.62	0.98
A11	When one area in this unit gets really busy, others help out.	3.80	0.85
A12r	When an event iv reported, it (does not) feel like the person is being written up, (but) the problem.	3.19	1.10
A13	After we make changes to improve patient safety including infection prevention, we evaluate the effectiveness.	3.79	0.81
A14r	We (do not) work in "crisis mode" trying to do too much, too quickly.	3.22	1.01
A15	Infection prevention is never sacrificed to get more work done.	3.08	1.07
A16r	Staff (do not) worry that mistakes they made are kept in their personnel file.	2.91	1.00
A17r	We (do not) have an NBSI problem in this unit.	2.70	1.21
A18	Our procedures and systems are good at preventing NBSI from happening.	3.44	0.98
A19r	An NBSI is (not) an anticipated outcome in pre-term babies (gestational age 28 - 32 weeks).	3.10	1.08
A20	NBSI are perceived as an error in out unit.	2.97	1.01
A21	An NBSI is a preventable event in pre-term infants (gestational age 28-32 weeks).	3.67	0.79
B1	My supervisor/manager says a good word when he/she sees a job done according to established procedures.	3.27	1.03
B2	My supervisor/manager seriously considers staff suggestions for improving patient safety or infection prevention	3.63	0.94
B3r	Whenever pressure builds up, my supervisory/manager (does not) want us to work faster, even if it means taking shortcuts.	3.74	0.91
B4r	My supervisor/manager overlooks patient safety and infection problems that happen over and over.	3.91	0.95
C1	We are given feedback about changes put into place based on event reports.	3.51	0.89
C2	Staff will freely speak up if they see something that may negatively affect patient care.	3.80	0.79
C3	We are informed about errors and infections that happen in this unit.	3.66	0.93
C4	Staff feel free to question the decisions or actions of those with more authority.	3.20	0.97

Appendix 4-2: Mean and Standard Deviation for all Survey Items (continued)

	Survey Item	Mean	Std. Dev.
C5	In this unit, we discuss ways to prevent errors and infections from happening again.	3.73	0.87
C6r	Staff are (not) afraid to ask questions when something does not seem right.	3.61	0.86
D1	When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported?	3.16	0.95
D2	When a mistake is made, but has no potential to harm the patient, how often is this reported?	3.39	0.92
D3	When a mistake is made that could harm the patient, but does not, how often is this reported?	3.98	0.84
D4	When an NBSI occurs, it is reported to infection control.	4.29	0.84
D5	When an NBSI occurs it is reported to quality control or quality assurance.	3.89	0.99
D6	When a NBSI occurs, it is reported to quality control or quality assurance	2.94	1.11
D7r	In your NICU, NBSI occur (rarely)	2.87	0.76
E	Nosocomial Bloodstream Infection Grade	3.18	1.09
F1	Hospital management provides a work climate that promotes infection control.	3.72	0.85
F2r	Hospital units coordinate well with each other.	3.08	0.97
F3r	Things (do not) "fall between the cracks" when transferring patients from one unit to another.	3.23	0.88
F4	There is good cooperation among hospital units that need to work together.	3.40	0.87
F5r	Important patient care information is (never) lost during shift changes.	3.38	0.92
F6r	It is often pleasant to work with staff from other hospital units.	3.57	0.84
F7r	Problems (do not) occur in the exchange of information across hospital units.	3.14	0.82
F8	The actions of hospital management show that infection reduction and patient safety is a top priority.	3.74	0.85
F9r	Hospital management seems interested infection reduction and patient safety only (before) an adverse event happens.	3.10	1.07
F10	Hospital units work well together to provide the best care for patients.	3.57	0.81
F11r	Shift changes are problematic for patients in this hospital.	3.47	0.86
G	Number of events reported by respondent in last 12 months (categorical)	2.52	1.79
H1	Contributing Factor: Deficient Immune System	4.54	0.75
H2	Contributing Factor: Prolonged Hospital Stay	4.40	0.84
H3	Contributing Factor: Prematurity, Gestational Age 28-32 Weeks	4.39	0.83
H4	Contributing Factor: Prematurity, Gestational Age 32-36 Weeks	3.44	1.00
H5	Contributing Factor: Fragile Integument	4.8	0.96
H6	Contributing Factor: Invasive Procedures	4.40	0.83
H7	Contributing Factor: Number of visitors to NICU	3.88	1.14
H8	Preventive Factor: Hand Hygiene Protocols	4.60	0.82
H9	Preventive Factor: Stringent Line Care	4.42	0.86
H10	Preventive Factor: Infection Control Measures	4.23	1.01
H11	Preventive Factor: Gloving Before Touching Infants	3.66	1.20
H12	Preventive Factor: Number of Visitors to NICU	3.73	1.23
J1	How long have you worked in this hospital?	3.44	1.53
J2	How long have you worked in your current hospital NICU?	3.32	1.51

	Survey Item	Mean	Std. Dev.
J3	Typically, how many hours per week do you work in this hospital?	2.59	0.57
J4	What is your position in this hospital?	2.23	2.67
J6	How long have you worked in your current specialty or profession?	3.98	1.61

Appendix 4- 2: Mean and Standard Deviation for all Survey Domains

Domain	Mean	Std. Dev.
Shared Mental Model of Nosocomial Bloodstream Infections	22.49	4.31
Supervisor/Manager Expectations & Actions Promoting Safety	14.55	2.85
Organizational Learning – Continuous Improvement	11.61	1.71
Teamwork within Hospital Units	15.77	2.55
Communication Openness	10.61	2.09
Feedback & Communication About Errors and Infections	10.90	2.24
Nonpunitive Response to Error	9.30	2.68
Staffing	12.40	2.50
Hospital Management Support for Patient Safety	10.55	2.16
Teamwork Across Hospital Units	13.63	2.68
Hospital Handoffs & Transition	13.22	2.57
Frequency of Event Reporting	10.52	2.34
Frequency of Infection Reporting	11.12	3.56
Contributing Factors	29.42	4.15
Preventive Factors	20.98	3.48

Appendix 4- 3: Crude Mean Response for Survey Items

	Survey Item	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
		High Rate	Low Rate						
A1	People support one another in this unit.	3.95	4.20	0.25	0.10	2.49	0.013	0.052	0.442
A2	We have enough staff to handle the workload.	2.86	3.35	0.05	0.13	3.67	0.000	0.226	0.747
A3	When a lot of work needs to be done quickly, we work together as a team to get the work done.	4.20	4.31	0.11	0.09	1.28	0.200	-.058	0.277
A4	In this unit, people treat each other with respect.	3.62	3.95	0.327	0.11	3.07	0.002	0.117	0.537
A5r	Staff in this unit (do not) work longer hours than is best for patient care.	2.45	2.25	0.20	0.17	-1.20	0.230	-.525	0.127
A6	We are actively doing things to improve the NBSI rate.	4.23	4.08	0.15	0.08	-1.95	0.052	-.296	0.001
A7r	We (do not) use more agency/temporary staff than is best for patient care.	3.66	4.10	0.44	0.12	3.62	0.000	0.201	0.678
A8r	Staff (do not) feel like their mistakes are held against them.	3.06	3.55	0.49	0.12	3.98	0.000	0.246	0.728
A9	Mistakes have lead to positive changes here.	3.60	3.71	0.11	0.10	1.10	0.272	-.088	0.311
A10r	It is (not) just by chance that more serious mistakes, including infections don't happen around here.	3.51	3.88	0.36	0.12	3.09	0.002	0.131	0.591
A11	When one area in this unit gets really busy, others help out.	3.77	3.87	0.10	0.10	0.97	0.331	-.102	0.302
A12r	When an event is reported, it (does not) feel like the person is being written up, (but) the problem.	3.05	3.53	0.48	0.13	3.66	0.000	0.219	0.730
A13	After we make changes to improve patient safety including infection prevention, we evaluate the effectiveness.	3.75	3.87	0.14	0.10	1.42	0.158	-.053	0.329
A14r	We (do not) work in "crisis mode" trying to do too much, too quickly.	3.13	3.43	0.30	0.12	2.52	0.012	0.067	0.543

Appendix 4-3: Crude Mean Response for Survey Items (continued)

	Survey Item	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
		High Rate	Low Rate						
A15	Infection prevention is never sacrificed to get more work done.	3.03	3.20	0.17	0.13	1.29	0.198	-.087	0.420
A16r	Staff (do not) worry that mistakes they made are kept in their personnel file.	2.75	3.28	0.53	0.12	4.48	0.000	0.295	0.756
A17r	We (do not) have an NBSI problem in this unit.	2.27	3.74	1.47	0.122	12.05	0.000	1.230	1.710
A18	Our procedures and systems are good at preventing NBSI from happening.	3.25	3.91	0.66	0.112	5.84	0.000	0.435	0.877
A19r	An NBSI is (not) an anticipated outcome in pre-term babies (gestational age 28 - 32 weeks).	2.80	3.82	1.02	0.118	8.68	0.000	0.793	1.257
A20	NBSI are perceived as an error in out unit.	3.11	2.62	0.49	0.119	-4.18	0.000	-.730	-.263
A21	An NBSI is a preventable event in pre-term infants (gestational age 28-32 weeks).	3.61	3.84	0.23	0.09	2.40	0.017	0.041	0.412
B1	My supervisor/manager says a good word when he/she sees a job done according to established procedures.	3.28	3.26	0.02	0.12	-0.15	0.879	-.263	0.225
B2	My supervisor/manager seriously considers staff suggestions for improving patient safety or infection prevention	3.56	3.78	0.22	0.11	1.97	0.049	0.001	0.443
B3r	Whenever pressure builds up, my supervisory/manager (does not) want us to work faster, even if it means taking shortcuts.	3.61	4.07	0.46	0.11	4.32	0.000	0.252	0.674
B4r	My supervisor/manager overlooks patient safety and infection problems that happen over and over.	3.85	4.07	0.22	0.11	1.98	0.048	0.002	0.449

	Survey Item	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
		High Rate	Low Rate						
C1	We are given feedback about changes put into place based on event reports.	3.41	3.74	0.33	0.11	3.16	0.002	0.126	0.542
C2	Staff will freely speak up if they see something that may negatively affect patient care.	3.74	3.95	0.21	0.09	2.24	0.026	0.025	0.399
C3	We are informed about errors and infections that happen in this unit.	3.62	3.77	0.15	0.11	1.39	0.166	-.065	0.377
C4	Staff feel free to question the decisions or actions of those with more authority.	3.09	3.46	0.37	0.12	3.29	0.001	0.152	0.605
C5	In this unit, we discuss ways to prevent errors and infections from happening again.	3.69	3.81	0.12	0.11	1.15	0.251	-.086	0.328
C6r	Staff are (not) afraid to ask questions when something does not seem right.	3.51	3.86	0.34	0.10	3.32	0.001	0.139	0.543
D1	When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported?	3.09	3.31	0.22	0.11	1.89	0.59	-.008	0.440
D2	When a mistake is made, but has no potential to harm the patient, how often is this reported?	3.32	3.53	0.21	0.11	1.92	0.056	-.005	0.430
D3	When a mistake is made that could harm the patient, but does not, how often is this reported?	3.94	4.06	0.12	0.10	1.16	0.248	-.082	0.316
D4	When an NBSI occurs, it is reported to infection control.	4.21	4.48	0.27	0.10	2.75	0.006	0.078	0.473
D5	When an NBSI occurs it is reported to quality control or quality assurance.	3.80	4.12	0.32	0.12	2.73	0.007	0.091	0.557
D6	When a NBSI occurs, it is reported to quality control or quality assurance	2.91	3.01	0.10	0.13	0.78	0.437	-.159	0.367
D7r	In your NICU, NBSI occur (rarely)	2.61	3.49	.088	0.08	11.30	0.000	0.729	1.037
E	Nosocomial Bloodstream Infection Grade	2.77	4.14	1.37	0.11	12.35	0.000	1.151	1.587

	Survey Item	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
		High Rate	Low Rate						
F1	Hospital management provides a work climate that promotes infection control.	3.61	3.96	0.34	0.10	3.37	0.001	0.142	0.541
F2r	Hospital units coordinate well with each other.	2.99	3.30	0.31	0.12	2.73	0.007	0.089	0.547
F3r	Things (do not) "fall between the cracks" when transferring patients from one unit to another.	3.22	3.26	0.04	0.11	0.34	0.732	-.172	0.246
F4	There is good cooperation among hospital units that need to work together.	3.30	3.65	0.35	0.10	3.41	0.001	0.149	0.555
F5r	Important patient care information is (never) lost during shift changes.	3.36	3.42	0.06	0.11	0.51	0.610	-.162	0.275
F6r	It is often pleasant to work with staff from other hospital units.	3.54	3.66	0.12	0.10	1.22	0.223	-.076	0.322
F7r	Problems (do not) occur in the exchange of information across hospital units.	3.12	3.18	0.06	0.10	0.63	0.532	-.133	0.258
F8	The actions of hospital management show that infection reduction and patient safety is a top priority.	3.70	3.84	0.14	0.10	1.34	0.181	-.064	0.338
F9r	Hospital management seems interested infection reduction and patient safety only (before) an adverse event happens.	3.00	3.32	0.32	0.13	2.47	0.014	0.064	0.567
F10	Hospital units work well together to provide the best care for patients.	3.45	3.88	0.43	0.10	4.50	0.00	0.242	0.617
F11r	Shift changes are problematic for patients in this hospital.	3.47	3.46	0.00	0.10	-0.04	0.968	-.209	0.200

Appendix 4- 4: Crude Mean Response for Survey Domains

Domain	Crude Mean Response for:		Diff.	Std Error	t	p value	95% Confidence Interval	
	High Rate	Low Rate						
Safety	14.29	15.18	0.25	0.10	2.49	0.013	0.052	0.442
Organizational Learning	11.58	11.68	0.10	0.21	0.49	0.623	-.305	0.508
Unit Teamwork	15.54	16.32	0.78	0.31	2.57	0.011	0.183	1.384
Unit Communication	10.37	11.27	0.93	0.25	3.77	0.000	0.445	1.419
Unit Feedback	10.72	11.33	0.61	0.27	2.27	0.024	0.082	1.139
Nonpunitive Environment	8.86	10.35	1.49	0.31	4.75	0.000	0.870	2.103
Staffing	12.10	13.13	1.03	0.30	3.48	0.001	0.448	1.616
Hospital Management	10.32	11.11	0.79	0.26	3.09	0.002	0.289	1.300
Hospital Teamwork	13.27	14.49	1.22	0.32	3.86	0.000	0.600	1.846
Hospital Handoffs	13.18	13.33	0.15	0.31	0.49	0.627	-.460	0.763
Shared Mental Model	21.09	25.88	4.79	0.45	10.67	0.000	3.904	5.670