IN SEARCH OF EXCELLENCE—THE NEONATAL INTENSIVE CARE QUALITY IMPROVEMENT COLLABORATIVE

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As part of its effort to improve the quality of care in the neonatal intensive care unit at Baylor University Medical Center (BUMC), the unit has participated in the Vermont Oxford Network. This network tracks outcomes and pools data, allowing comparisons and benchmarking. A group of 34 nurseries from the Vermont Oxford Network has collaborated in an innovative quality improvement initiative. This article describes this initiative, called the Neonatal Intensive Care Quality Collaborative 2000 project, and its impact on the neonatal service at BUMC. The project promotes the practice of 4 key habits: the habit for change, the habit for understanding the processes of care, the habit for collaborative learning, and the habit for using evidence-based practices of care.

Spectacular gains have occurred in neonatal intensive care. The survival of infants at the threshold of viability occurs routinely in many neonatal intensive care units (NICUs) around the world (1). Even infants as immature as 23 weeks gestational age admitted to the NICU at Baylor University Medical Center (BUMC) have a >50% chance of survival to discharge (2). Yet, these results are not without cost—both short- and long-term morbidities as well as high monetary costs. Length of hospital stay for infants at the threshold of viability often exceeds 100 days. Short-term morbidity includes chronic lung disease or bronchopulmonary dysplasia with ventilator and oxygen dependence. Long-term and even lifetime neurological and neurodevelopmental problems of varying severity can affect 50% of survivors. The search for methods and processes of care that minimize or eliminate both short- and long-term complications of neonatal intensive care has become a major commitment of many NICUs, including those in the Baylor Health Care System. This article describes some of the methods used within the NICU at BUMC to improve quality.

VERMONT OXFORD NETWORK

BUMC participates in the Vermont Oxford Network, a voluntary network of neonatal nurseries formed in 1989 (3). This network grew to 325 nurseries worldwide by 1999. The purpose of the network is to track the outcome of very low birthweight infants (401 to 1500 g). Quarterly reports enumerating key outcome variables are developed and then sent to member nurseries. Although the results for each center are confidential, comparisons at each center can be made quarter to quarter and year to year. Further, submitted data from all nurseries are pooled. This permits each nursery to compare itself with the network as a whole. For example, nosocomial infection with coagulase-negative Staphylococcus in very low birthweight infants is very common. In 1998, the percentage of infants with coagulase-negative Staphylococcus at BUMC was 12%. The network as a whole reported a 14% incidence for the same year (4).

Comparing a member nursery with the pooled network data represents a form of “benchmarking.” Yet, hidden in pooled network outcome data are comparable nurseries with very diverse outcomes—e.g., mortality rates vary enormously from nursery to nursery (4) (Figure 1). Some NICUs in the Vermont Oxford Network consistently perform in the best quartile; that is, only 25% or less of all reporting Vermont Oxford Network members have better outcomes. Clearly, learning the processes of care in these better-performing nurseries might be helpful in improving the effectiveness of care in one’s own NICU. A good example of collaborative learning was seen in the Northern New England Cardiovascular Project, where complications of coronary bypass surgery were substantially reduced as a result of the multi-disciplinary and multi-institutional collaboration (5).

Figure 1. The standardized mortality ratio (SMR) at 318 neonatal intensive care units participating in the Vermont Oxford Network in 1999. Values range from <0.5 to almost 2. The SMR, represented by the line, is the ratio of the number of observed deaths to the number of predicted deaths for infants weighing 501 to 1500 g. The bars show 95% confidence intervals. The open circle represents Baylor University Medical Center. Reprinted with permission from the Vermont Oxford Network.

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NEONATAL INTENSIVE CARE QUALITY IMPROVEMENT COLLABORATIVE

To focus on superior processes of care, the Vermont Oxford Network formed a pilot Neonatal Intensive Care Quality Improvement (NICQ) in 1994 consisting of 10 volunteer NICUs. Multidisciplinary teams from the nurseries collaborated in site visits and study groups to develop potentially better practices. As an example of the success of the early pilot collaborative, one participating NICU reduced its nosocomial infection rate in infants <1500 g from 39% in 1994 to 13% in 1997 (personal communication, Dr. William Edwards, 1999).

Spurred on by the early success of NICQ, a new active collaboration began in 1998 and is currently under way with 34 NICUs in the USA. The goal of NICQ 2000 is to improve the effectiveness and efficiency of neonatal intensive care in 3 areas: clinical, operational, and organizational. Four key habits are being taught (Figure 2):

- **The habit for change.** The key to more effective care is the willingness of staff to accept new ideas. New ideas may come from many sources—e.g., the literature, an analysis of internal and external processes, benchmarking with superior performers, site visits to other NICUs, and researchers' own experience and thinking. Resistance to new ideas and changes in process of care is common. Acceptance of change depends to some extent on the culture of the NICU: a unit may be strong in group culture, stressing affiliation between staff members, teamwork, and participation; developmental culture, stressing risk taking and willingness to change; hierarchical culture, stressing establishment and maintenance of bureaucratic work patterns; or rational culture, stressing efficiency and achievement. Although no NICU will reflect only 1 type of culture, the unit culture in the NICU at Baylor in 1998 was predominantly group and developmental. Baylor had mean scores of 33% group culture, 27% developmental culture, 22% rational culture, and 18% hierarchical culture. Units with strong group and developmental cultures, such as BUMC, are considered receptive to quality improvement efforts.

- **The habit for understanding the processes of care.** The multiple steps involved in providing care are often not appreciated.

The formulation of a flow process chart can be very helpful in identifying problems. For example, to understand why hypocapneic ventilation was occurring in very low birthweight infants admitted to the NICU at BUMC, we mapped the process of care in a flow chart (Figure 3). After educating the health care team about the importance of avoiding hypocapnia and the optimal way of selecting ventilator settings, we observed a significant decrease in variation of the first arterial PCO2 obtained after delivery (Figure 4).

- **The habit for collaborative learning.** By working with other NICUs with similar interests and carefully evaluating the care practices in better-performing NICUs with multidisciplinary site visits, potentially better practices can be formulated. Two focus groups formed at BUMC collaborated...
with other similar-minded groups among NICQ 2000 members. One focus group has concentrated on reducing nosocomial infection and has developed a potentially better practices work list. The other focus group has collaborated in developing strategies to reduce neonatal intraventricular hemorrhage and periventricular leukomalacia and also has produced a potentially better practices work list. Many of these practices will be implemented in each of the member NICUs after discussion with the local medical and nursing staff. Not all practices from a potentially better practices work list are appropriately applied in every nursery. As an example, a reduction in skin punctures and vascular line entries (known risk factors for infection) has been implemented at BUMC as a potentially better practice. The results of our early experience are shown in Figure 5.

- The habit for using evidence-based practice. Many of the routine practices in NICUs have not been well studied. Those interventions that have been subjected to randomized controlled trials need to be reviewed and, if appropriate, utilized in the NICU. Careful and critical evaluation and judicious application in one’s own care practices may be very helpful in improving effectiveness of care. The National Perinatal Epidemiology Unit at Oxford has pioneered this approach to practice. The Cochrane Collaboration is an outgrowth of this effort (6). Neonatology has a separate section within the Cochrane database that can be accessed free of charge on the Internet at http://www.nichd.nih.gov/cochrane.htm. This site and other Internet resources are available to the staff on NICU-based computer terminals at BUMC.

NICQ 2000 has promoted a very helpful technique for reviewing study results in a more rigorous fashion; the network calls this technique a critically appraised topic, or CAT (7). Part of the process of critical appraisal is the calculation of the number of patients that have to be treated with the experimental or new treatment to avoid the event in question. This number needed to treat (NNT) is calculated as follows: Determine the percentages of subjects in the experimental and control groups that experience the event in question (experimental event rate, EER; control event rate, CER). Then calculate the relative risk reduction (RRR) and absolute risk reduction (ARR) by using the following formulas: RRR = (CER – EER)/CER and ARR = CER – EER. By following this stepwise process of evaluation, the NNT can be calculated by applying the formula NNT = 1/ARR. The NNT value is especially useful in drawing conclusions about the clinical effectiveness of the proposed intervention. This topic has been well reviewed by Soll and Andruscavage (8).

Improving the quality of care in BUMC’s NICU is a journey. We have begun that journey. Our destination is effective, efficient neonatal care.

Acknowledgment

We thank Alice Morrow, RN, MSN, Pam McKinley, RN, Deana Black, RN, Rachel Cody, RN, and Jobeth Pilcher, RN, for their support and the entire staff of the NICU, who are dedicated to improving the care of neonates at BUMC.

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In this issue of Proceedings, Whitfield et al have chronicled their involvement in the Vermont Oxford Network’s Neonatal Intensive Care Quality Improvement Collaborative 2000 (NICQ 2000). The authors describe how their goals and objectives for improvement are supplemented by collaboration with other centers. The Baylor neonatal intensive care unit (NICU) physicians and staff should be commended for their efforts, as improvement work demands time and resources. With a clear vision, the resources required for participation, and the dedication of the Baylor NICU staff, improvements should be recognized from such projects.

Whitfield describes their work as “a search for methods and processes of care that minimize or eliminate both long- and short-term complications of neonatal intensive care.” Utilizing a systematic approach to improvement, taught by Paul Plesk, the Vermont Oxford NICQ 2000 team has embraced 4 key habits, which are detailed in the manuscript. To evaluate their project, we should look for evidence that adoption of these key habits results in significant reductions in morbidity or mortality.

Previous Vermont Oxford Network improvement work reported significant impact heterogeneity. Several centers noted degradation instead of improvement in the target outcomes. Impact heterogeneity suggests that unit culture might play an important role. Unit-based culture can be described in terms of several characteristics. The association of unit characteristics and their relationship with outcomes and other measures of quality should be tested. It appears that the NICQ 2000 project embraced, without testing, 4 key habits.

To respond to this project design, the following might be considered if teaching these 4 key habits does not result in universal benefit.

THE HABIT FOR CHANGE

“The key to more effective care is the willingness of staff to accept new ideas.” There is an implied link between this habit and the group, developmental, hierarchical, and rational cultural characteristics. It is presumed that specific patterns of these characteristics are linked to tolerance of rapid change. The NICQ 2000 project teams should be challenged to identify which patterns of cultural characteristics are associated with improvements in outcomes, not just rapid change. NICUs have an unfortunate past of rapidly adopting what seems to work. NICUs are not department stores where rapid alterations in interactions between client and clerk can at its worst result in dissatisfaction. Negative long-term impacts of interventions that appear to have short-term benefits are common in NICUs. Do we want a willingness to change, or do we want a willingness to test new ideas in a structured way? The unit characteristics of these 2 cultures may be very different.

THE HABIT OF UNDERSTANDING THE PROCESSES OF CARE

While this is identified in the key habits, it was not employed in the first phase of NICQ. The NICQ 2000 team should emphasize this aspect and document its value. Items published by the last team were labeled potentially better practices, not processes. Potentially better practices direct what is done, not how it is done. It can take years to detail all of the multiple layers of processes and subordinate processes in any one unit. Nursing policy and procedure books, which are inches thick, speak to an NICU’s complexity. Opportunities for improvement may be generated and introduced from the review of process descriptions. However, external deadlines for reporting the reams of detailed process analysis are distracting. Collaboration may delay understanding of how variation in local process impacts quality.

Benchmarking, as used by NICQ, assumes that a high-performing center can be observed and questioned about its practices and that these discussions can be linked to the outcome measure. On the contrary, it might be the artist, not the brush. Careful attention to detail, with consistent processes in a low-chaos environment, may overcome the lack of the newest “techno-intervention.” The challenge to the NICQ 2000 team is to demonstrate the value (by measurable improvements in target outcomes) of not just reviewing and writing but sharing the detailed process analysis information and implementing elements associated with improvements.

THE HABIT OF COLLABORATIVE LEARNING

The authors describe this activity well. In the previously published NICQ work, some of the potentially better practices came from critical analysis of the literature. Some came from observation and discussions with high-performing units. In the end, potentially better practices required a consensus of the participants. However, the implementation of potentially better practices was not reported in detail. The NICQ 2000 team should measure the improvements made in the target outcome and their relationship to the implemented potentially better practices.

THE HABIT OF USING EVIDENCE-BASED MEDICINE

An advocate of critical appraisal, I can only ask why the editors of major journals continue to accept underpowered,