Quality Improvement Initiatives in Neonatal Intensive Care Unit Networks: Achievements and Challenges

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ABSTRACT

Neonatal intensive care unit networks that encompass regions, states, and even entire countries offer the perfect platform for implementing continuous quality improvement initiatives to advance the health care provided to vulnerable neonates. Through cycles of identification and implementation of best available evidence, benchmarking, and feedback of outcomes, combined with mutual collaborative learning through a network of providers, the performance of health care systems and neonatal outcomes can be improved. We use examples of successful neonatal networks from across North America to explore continuous quality improvement in the neonatal intensive care unit, including the rationale for the formation of neonatal networks, the role of networks in continuous quality improvement, quality improvement methods and outcomes, and barriers to and facilitators of quality improvement.

KEYWORDS: continuous quality improvement; neonatal intensive care units; neonatology; health care research networks

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OVER THE LAST few decades, quality improvement as a discipline has received significant attention in the health care domain. Indeed, the Institute of Medicine reported in 2001 that between 44,000 and 98,000 Americans die every year from medical errors and highlighted the need to improve the quality of care delivered to prevent avoidable deaths and improve outcomes. The concepts of quality improvement, however, are not new. Deming and Shewhart pioneered them in the early 1920s,[1] and they have since been applied with success in many industries, ranging from manufacturing to aviation.[2] Nolan's Plan, Do, Study, Act (PDSA) model, using repeated cycles of action and reflection to create a culture of continuous reappraisal to achieve improvement,[3] is one of the methods for introducing continuous quality improvement (CQI) into health care that has been championed by organizations such as the Institute of Healthcare Improvement (IHI). Quality problems in health care can arise from variations in practice; underuse, overuse, or misuse of health care services; and disparities in quality of care.[4] Consequently, collaborative CQI efforts offer a pragmatic way to better understand and improve the performance of health care delivery in the neonatal intensive care unit (NICU).

RATIONALE FOR CQI INITIATIVES IN THE NEONATAL INTENSIVE CARE UNIT

An imperative for embracing CQI in the NICU is that from the 1960s to the 1990s, major advances in perinatal care, such as the regionalization of perinatal health care, administration of antenatal steroids, surfactant replacement therapy, and newer modalities of assisted ventilation and nutritional support, led to significant reductions in mortality and short-term morbidities for preterm and very low birth weight (VLBW) infants.[5–9] However, since then, several reports have suggested a concerning trend with little or only marginal further improvement in the outcomes of this population. Horbar et al reported that from 2000 to 2009, mortality was only reduced by 1.9%, while the incidence of 1 or more of the major neonatal morbidities was reduced by 4.9% among VLBW infants born at participating centers of the Vermont–Oxford Network (VON).[10] Similarly, Fanaroff et al reported only a 1% increase in the survival of VLBW infants born between 1997 and 2002 when compared with 1995 to 1996, while survival without major neonatal morbidities remained static at participating centers of the National Institutes of Child Health and Human Development Neonatal Research Network (NICHD-NRN).[11] In the Canadian Neonatal Network (CNN), Shah et al reported no difference in mortality for infants of <29 weeks' gestation born between 1996 and 1997 compared with 2006 to 2007, and also reported an increase in the incidence of bronchopulmonary dysplasia (BPD) for the later cohort.[12] In contrast, Kusuda et al reported that between 2003 and 2008, mortality decreased from 10.8% to 8.7% (a 19% decrease) for VLBW infants in Japan, with the greatest improvement in mortality noted for infants weighing between 501 and 750 g.[8]

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In concert with a plateau in the overall rates of neonatal mortality and morbidity was the existence of significant variation in practices and outcomes between different NICUs. In 1990, analysis of the 36 centers in the VON showed a wide variation between NICUs for all interventions and outcomes examined. For example, surfactant use in white inborn infants between 501 and 1500 g varied from 10% to 96%, while rates of BPD varied from 15% to 70%.[13] In the CNN, analysis of data on all infants admitted to 17 Canadian NICUs between 1996 and 1997 also showed variation in all aspects of NICU care, including the use of antenatal steroids, which ranged from 23% to 76%, and the survival rate, which ranged from 89% to 99%.[14] This range of variations was also observed within other neonatal networks, such as the NICHD-NRN[15] and the Neonatal Research Network of Japan (NRNJ),[16] and between countries.[17,18]

In order to more accurately compare the performance of NICUs and study the variation in outcomes, several comparison tools were developed in the early 1990s that take into account severity of illness, birth weight, gestational age, and other risk factors. These tools included the Clinical Risk Index for Babies (CRIB),[19] the Score for Neonatal Acute Physiology (SNAP),[20] and the Neonatal Therapeutic Intensity Scoring System (NTISS).[21] By adjusting for initial risk, CRIB, SNAP, and NTISS allow for a more accurate comparison of NICU performance and their use uncovered some alarming variations in outcomes that were less obvious than those identified by simply comparing rates of mortality and morbidity. For example, validation of CRIB in 9 tertiary and 4 nontertiary UK hospitals showed that infants of less than 1500 g birth weight or 31 weeks' gestational age were twice as likely to die in the nontertiary hospitals as in the tertiary hospitals, even though there was no clear difference in mortality between the 2 groups of hospitals.[19] This pioneering approach formed the foundations for consequent CQI initiatives to examine and address the risks associated with poor neonatal outcomes.

Role of Networks in CQI

The advent of networks focusing on CQI can be traced to Wennberg and colleagues, who showed that small-area variations can be used to study the relative effectiveness of differing medical practices and technologies, and that feedback of information concerning variation in practices can modify physician practices.[22,23] Variations in practices are important because they are natural experiments that reflect the practice patterns of small groups of physicians and because they can be used to examine whether certain practices are associated with good or poor outcomes. This information can then be used to inform the process of implementing changes in practice to improve outcomes using CQI methodology. Using this principle, the New England Cardiovascular Disease Study Group was among the first to publish evidence showing that benchmarking and feedback of outcomes, combined with mutual collaborative learning through a network of providers, resulted in a 24% reduction in hospital mortality rates for patients undergoing coronary artery bypass graft surgery.[24] Since then, many networks have been established for benchmarking and consequently implementing collaborative CQI efforts. In the NICU domain, these include national population-based networks (eg, Australia–New Zealand Neonatal Network [ANZNN], CNN), regional networks (eg, California Perinatal Care Collaborative [CPQCC], Ohio Perinatal Quality Collaborative [OPQC]), academic networks with selected membership (eg, NICHD-NRN, NRNJ), networks with open membership (eg, VON), and corporate health care provider networks that have a significant focus on CQI implementation and research (eg, Intermountain Healthcare [IH] and Pediatrix).

Fundamentally, all networks offer a system for standardizing data collection and definitions that permit benchmarking and reporting of outcomes, analysis of the root causes of variation, and potentially collaborative efforts to improve practices and outcomes. It may be argued that networks are best able to do this if there is some degree of homogeneity in patients and resources among participating NICUs, so that one is not comparing apples and oranges. However, comparison of outcomes in different settings and countries may provide different insights and are equally of value. For instance, a study by Isayama et al of outcome variations between Japan and Canada has led to significant changes in the approach to feeding in Canada and assisted ventilation in Japan.[18] It is likely that there is value in both types of comparisons, as long as the limitations of doing so are considered critically.

Risk Adjustment

A major concern about multi-institutional outcome comparisons, even within a country or region, is that one may be considering apples and oranges because of differences in patient risks, practices, resources, and other variables. Consequently, most networks use some form of risk adjustment in their benchmarking systems, which usually includes basic patient characteristics such as gestational age, birth weight, gender, perinatal risks, mode of delivery, and illness severity at admission. As described above, several scores measuring illness severity at admission are currently in common use, including version II of CRIB,[25] SNAP-II,[26] and the Transport Risk Index of Physiologic Stability (TRIPS).[27] CRIBS-II is validated for neonates under 1500 g birth weight, SNAP-II is validated for infants of all birth weights, and TRIPS can provide rapid sequential measurements for infants of all birth weights. Prediction of mortality by the respective scores, as measured by the area under the receiver operating curve, ranges from 0.8 to 0.9,[25–27] which is considered satisfactory.

CQI Methods in the NICU

Many definitions and frameworks for quality improvement have been developed and adapted for use in health care settings and contexts.[28–31] Within the specific setting of the NICU, CQI initiatives are ongoing across the

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