

Implementation of Potentially Better Practices for the Prevention of Brain Hemorrhage and Ischemic Brain Injury in Very Low Birth Weight Infants

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ABSTRACT. *Objective.* Using an evidence-based approach, a Vermont Oxford Network focus group whose goal was to reduce brain injury developed and implemented a number of potentially better practices. Each center approached implementation of the practices differently. Reducing the incidence of intraventricular hemorrhage and periventricular leukomalacia are important for improving long-term outcomes for low birth weight infants.

Methods. Implementation approaches for some but not all of the practices at the various centers are discussed. The practices reviewed include optimal peripartum management, such as resuscitation, avoidance of hypothermia, optimal surfactant delivery, early neonatal management by the most experienced providers, and measures to minimize pain and stress. Additional practices include maintenance of neutral head positioning, fluid volume therapy for hypotension, indomethacin prophylaxis, ventilator management, avoidance of routine suctioning, and limiting the use of sodium bicarbonate and postnatal dexamethasone.

Results. Approaches to implementation were center specific, and results vary. Although some practices were easier to implement than others, communication, education, and leadership were critical to the process.

Conclusions. The quality improvement multidisciplinary approach is a useful tool for finding ways to reduce the incidence of intraventricular hemorrhage and periventricular leukomalacia. *Pediatrics* 2003;111:e497–e503. URL: <http://www.pediatrics.org/cgi/content/full/111/4/e497>; *intraventricular hemorrhage, periventricular leukomalacia, potentially better practice, very low birth weight, cranial ultrasonography, collaborative quality improvement, NIC/Q 2000; NHRMC, New Hanover Regional Medical Center; HFOV, high-frequency oscillating ventilation.*

ABBREVIATIONS. PBP, potentially better practices; NICU, neonatal intensive care unit; IVH, intraventricular hemorrhage; PVL, periventricular leukomalacia; VLBW, very low birth weight; NIC/Q 2000, Neonatal Intensive Care Quality Improvement Col-

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laborative Year 2000; CHOI, Children's Hospital of Illinois at OSF St Francis Medical Center; LGCH, Lutheran General Children's Hospital; PCO₂, partial pressure of carbon dioxide; MBP, mean blood pressure; HFOV, high-frequency oscillating ventilation.

KEY POINTS OF ARTICLE

- Collaboration, communication, education, and a dedicated leader are key to developing and implementing successful potentially better practices (PBPs).
- Implementation of PBPs is not an exact science; it was unique for each participating hospital and depended on the processes that they already had in place.
- The culture in a busy neonatal intensive care unit (NICU) is often difficult to change.
- Implementation does not go smoothly all the time.

APPLYING LESSONS LEARNED TO PRACTICE

- It is critically important to identify and use the types of communication that work best in a particular unit; no 1 method of disseminating information on practice changes will be universally effective.
- Confusion can result when too many new practices are put in place over a short interval; limit the number implemented at any 1 time.
- When educating staff about practice changes, use a multidisciplinary approach and present the benefits of the practice change, as well the evidence to support it.
- In-service training should be repeated several times to give all staff the opportunity to attend. One-on-one and "hands on" in-service training proved to be very beneficial for most hospitals in the focus group.
- Keep the practice changes visible with continued monitoring and enforcement.
- Rewards are well received and help engage others in the process of change.

The negative impact of intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVL) on long-term outcomes for very low birth weight (VLBW) infants is well documented. Multidisciplinary teams from 5 NICUs that participated in the Neonatal Intensive Care Quality Improvement Collaborative Year 2000 (NIC/Q 2000)

formed a group with a common goal of decreasing the incidence of IVH and PVL among neonates ≤ 1500 g. Hospitals in the group were Baylor University Medical Center, Children's Hospital of Illinois at OSF St Francis Medical Center (CHOI), Lutheran General Children's Hospital (LGCH), New Hanover Regional Medical Center (NHRMC) and Parkview Hospital. With the use of an evidence-based quality improvement approach, PBPs were developed collaboratively by the group. The PBPs were the basis for a matrix that each of the 5 hospitals used for implementation (Table 1). The Model for Improvement was used, incorporating plan-do-study-act cycles in the process. The methods differed, but all teams addressed issues such as buy-in for change (getting staff to accept and adopt the changes), barriers, and lessons learned. Examples of implementation are given below, with specific process changes and measures implemented at each site.

METHODS

Practice 2d: Optimize Peripartum Management Through Delivery Room Resuscitation by a Neonatologist and an Experienced Team

CHOI already had a resuscitation protocol, which included administration of surfactant for pregnancies of < 30 weeks' gestation. They modified the process in the following ways: 1) limited the resident to an observer role, 2) used a manometer and tidal volume monitor to attempt to avoid hyperventilation, 3) used O_2

saturation monitoring, and 4) stipulated cardiorespiratory stability with heart rate > 100 and O_2 saturation $> 90\%$ before administering surfactant. Subsequently, CHOI evaluated the NeoPuff for resuscitation and will incorporate that in the resuscitation process. The aim is to have resuscitated and stabilized the infant and delivered surfactant by 20 minutes of age. The infant is then transported to the NICU for additional care. Measurement includes initial partial pressure of carbon dioxide (PCO_2) on admission.

At NHRMC, the resuscitation process was changed to have a neonatologist attend all deliveries ≤ 32 weeks' gestation. Attendance by a neonatologist is monitored over time as a process measure.

At Parkview Hospital, the most experienced personnel had always attended high-risk deliveries. Greater emphasis, however, is now placed on this practice, and the policy has been formalized. Attendance by the neonatologist is considered key.

Baylor established a resuscitation team from experienced staff and educated them about the importance of minimizing risks for IVH in the delivery room. A flowchart was designed and placed in the resuscitation area. Physiologic stability (heart rate > 100 , O_2 saturation $> 90\%$, and adequate perfusion) was stipulated before administration of surfactant. The infant is placed on a Drager ventilator to establish settings and tidal volume and transferred to the NICU. Outcome measurements collected on admission include initial PCO_2 , temperature, and tidal volume (Fig 1).

Practice 2e: Maintaining the Infant's Temperature at $\geq 36^\circ C$

NHRMC used information from literature reviews, benchmark site visits, a listserv poll, and brainstorming sessions to develop a "Baby in a Bag" protocol to improve their 40% hypothermia rate. A multidisciplinary team addressed supply, practice, and environmental issues, including operating room temperature. They

TABLE 1. Brainy Bunch PBPs Matrix

PRACTICE	Baylor	CHOI	NHRMC	Parkview	LGCH
1. Administer antenatal betamethasone	0	0	0	0	0
Avoid antenatal dexamethasone	0	0	0	0	0
2. Optimize peripartum management					
A. Delivery in tertiary center with NICU		0	0		0
B. Direct clinical management of labor and delivery by a MFM		X			0
C. Administer antenatal antibiotics for PROM	0	0	0	0	0
D. Delivery room resuscitation by Neo. and an experienced team	+	Y	+	+	+
E. Maintaining the baby's temperature $\geq 36^\circ C$	+	Y	X	X	Y
F. Maintaining CR stability while administering surfactant	+	X		+	X
3. Clinical management by Neos	+	+	0	0	+
4. Implement measures to minimize pain and stress					
A. Developmental care	0	+	Y	X	+
B. Decrease noise	0	0	Y	X	+
C. Minimize handling	0	+	Y	X	X
D. Minimize lighting	0	0	Y	X	+
E. Judicious use of narcotic sedation	+	0	+	+	+
F. Avoid early LP	0	0	0	0	0
5. Maintain neutral head position	0	+	+	X	+
6. Fluid volume therapy for hypotension					
A. Only treat "overt" hypovolemia	0	+	+	+	+
B. Without "overt" hypovolemic hypotension only use 2 boluses before initiating inotropes	0	+	+	+	+
C. Give bolus infusion over 30 min or more	X	0	Y	X	+
7. Indomethacin prophylaxis first 24 h after birth		0	+	0	0
8. A. Ventilator mgt. using SIMV/HFOV	0	0	0	0	0
B. Avoid hypocapnia	0	Y	+	X	0
C. Avoid CPT	0	+	0	0	+
D. No routine suctioning	0	0	+	Y	+
9. Limit sodium bicarbonate use/give over 30 min	0	0	+	+	+
10. Postnatal dexamethasone					
A. Avoid early use	+	0	0	0	0
B. Avoid prolonged course	0	0	0	0	0

MFM indicates maternal fetal medicine specialist; PROM, premature rupture of membranes; Neo., neonatologists; LP, lumbar puncture; SIMV, simultaneous intermittent measured volume; CPT, chest physical therapy.

0 = Already doing; X = in the process of doing or changing; Y = already doing but now making further changes related to IVH/PVL prevention; + = Going to do; Blank = no plans to implement.

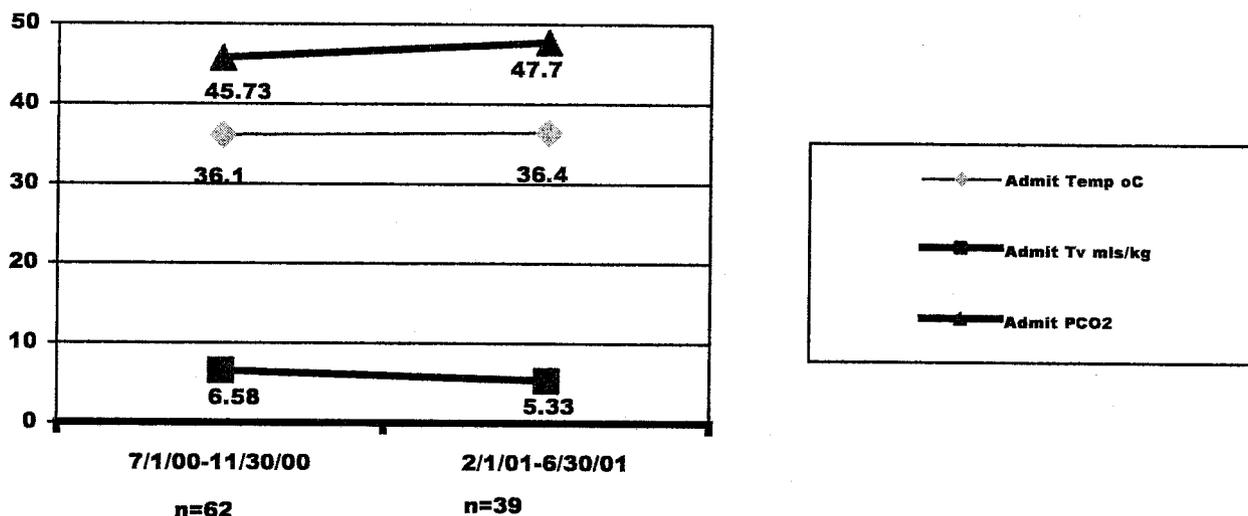


Fig 1. Baylor's temperature and carbon dioxide run charts.

also provided one-on-one, hands-on in-service training for staff. The protocol calls for use of a chemical warming mattress during resuscitation and transport. The infant and mattress both are placed in a plastic bag. Bags with an infant hat and chemical mattress are placed on the delivery carts in the unit and in labor and delivery. A data collection tool, completed by staff after each delivery, is used to identify where problems exist. Measurement includes monitoring of temperature on admission to the NICU and location of delivery (Fig 2). The problem of operating room temperatures persists.

LGCH used a similar approach. They determined that low birth weight infants were hypothermic on admission to the NICU. A multidisciplinary task force brainstormed and collected data on contributing factors. Implementation of PBP's included a trial of a new chemical warming mattress for infants <1500 g. Staff in-service training reviewed principles of thermoregulation and the use of the new chemical warming mattress. These pads are placed beneath the infant at delivery and accompany the infant through the admission process in the NICU. Other practices in place that affect thermoregulation include adhering to Neonatal Resuscitation Program guidelines for the delivery room and administering surfactant, which delays transport to the NICU for 10 to 15 minutes. Improvement is measured by monitoring admission temperatures.

From initial data collected, Parkview saw a correlation between low admission temperatures and severe IVH in a large proportion of infants. A short data collection project was done in which the resuscitation team took temperatures just before leaving the delivery room and on admission to the NICU. Data analysis showed that the infant's temperature frequently fell during transport. It was speculated that open portholes for hand bagging resulted in cooling of the interior of the transport isolette. Measures taken to prevent heat loss included using a warming mattress and placing

the infant on a transport ventilator so that portholes remain closed. The importance of temperature stabilization was reemphasized to resuscitation team members.

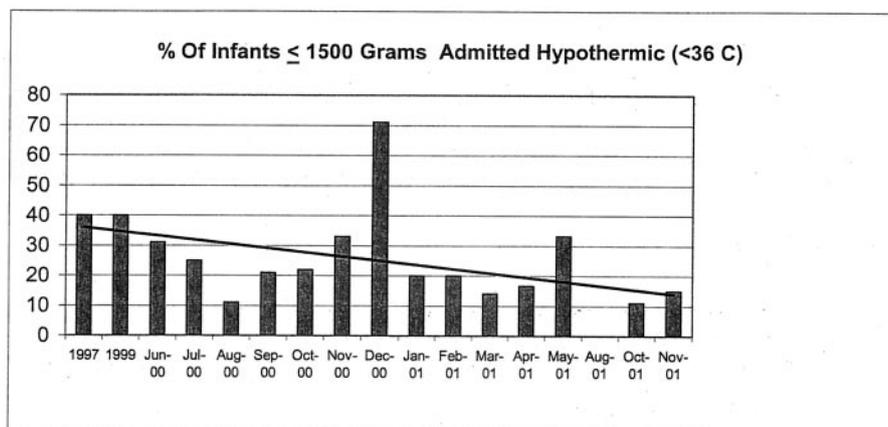
Practice 2f: Maintain Cardiorespiratory Stability While Administering Surfactant

NHRMC began implementation by forming a multidisciplinary surfactant team who defined stability as a heart rate ≥ 120 , saturation $\geq 90\%$, perfusion ≤ 3 seconds, and a mean arterial pressure greater than or equal to the infant's gestational age. The goal was to have surfactant administered within 20 minutes of birth. Baseline data showed that only 5.6% of patients could be considered stable when all 4 parameters were taken into account. Average administration time was 63 minutes. The surfactant administration protocol was revised, posters and one-on-one in-service training for the NICU team were completed, and the protocol was implemented and became part of the standards for nursing and respiratory care.

Implementation went smoothly, but staff had a problem documenting all 4 parameters. Follow-up data revealed that perfusion was not always being documented. Of the 3 parameters charted, all met the stable range. The percentage of infants considered stable rose to 38.5% (using the 4 parameters as indicators), and administration time came down to 34 minutes. The protocol was revised so that staff documents blood pressure or perfusion but not necessarily both. Protocol revisions were approved, and staff received in-service training. Measurements now include heart rate, saturation, and perfusion or mean arterial pressure immediately before administration of surfactant, as well as the time from birth to administration of the initial dose.

LGCH also formed a multidisciplinary committee to examine current practices of surfactant administration and areas for im-

Fig 2. NHRMC's thermoregulation graph.



NICU Pain Audit Scores

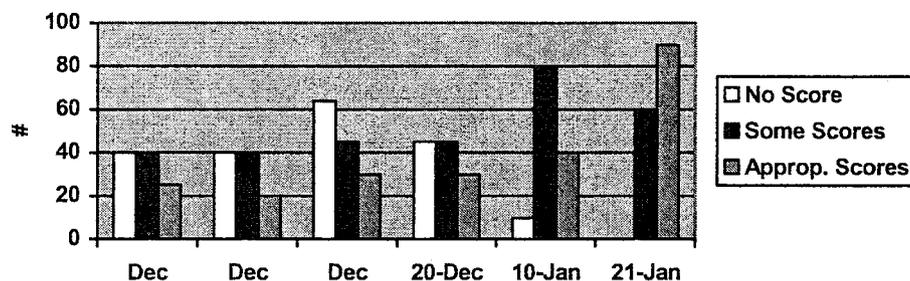


Fig 3. CHOI's pain table.

provement. In the past, surfactant was given immediately after birth in the delivery room, where monitoring was not available. After reviewing the research literature and other level 3 NICU practices, the Surfactant Committee revised the protocol to administer surfactant after admission to the NICU once stability (heart rate ≥ 100 and O_2 saturation $\geq 90\%$) is achieved. The goal is to provide surfactant to eligible infants within 20 minutes of birth. Using posters and lectures, the staff received extensive in-service training on the timing of surfactant and the method of administration. A training cart was made available on the unit 24 hours a day to provide hands-on teaching. Reinforcement of the change was provided through the first annual NICU Skills Fair. Literature and research supporting the change were made available to the staff. The Management of Change committee assisted with communication. Currently, steps in the admission process cause delays in achieving administration within 20 minutes of birth. These barriers are now being addressed. Measurement includes heart rate, O_2 saturation, and time from birth to administration of the initial dose of surfactant.

Practice 3: Clinical Management by Neonatologists/Neonatal Nurse Practitioners

CHOI decided that for the first 72 hours of life, infants < 1500 g would be managed by a neonatologist or neonatal nurse practitioner. Direct management would include placement of umbilical lines and chest tubes, reintubations, and other procedures, as well as all medical decision making. This concerned the residents because of a fear that clinical experience and procedural skills would be sacrificed. The concerns continued despite an explanation that this practice was only for the first 72 hours, when the majority of IVH occurs. After that period, residents could participate in managing these infants. A tally was required to prove that there were many more neonates in the NICU from whom to gain experience in both procedures and clinical management skills.

Practice 4: Measures to Minimize Pain and Stress

CHOI already had a multidisciplinary task force, the "Ouchless" Children's Hospital Movement. This task force concentrated on pain prevention and alleviation. The first step in implementation of measures to minimize pain was education to correct misconceptions about pain felt in neonates and outline physiologic parameters that can be altered by pain, possibly resulting in harm to infants. The task force defined the problem and explored possible solutions using input from NICU staff, benchmarking, and the literature on pain assessment tools.

The Neonatal Pain Assessment Scale was chosen for use, based on the Attia Scale developed by Susan Givens Bell. This scale incorporates both physiologic and behavioral parameters. Documentation forms were reformatted to include pain assessment. Definitions for the pain scale are now available in each room along with laminated pocket scales for nurses to carry. The task force provided a season-long education project. This included posting pain posters that focus on the harmful effects of unrelieved pain on an organ system. At the end of the season, there was a contest with a posttest on pain, and prizes were awarded for participation.

The focus now is on education of families, using signs in the family waiting room to inform parents that pain management for their infant is a priority. The parent handbook has been adapted to include information on how their infant's comfort is evaluated using a team approach. The task force has monitored compliance

in the use of the pain score and has achieved increased documentation of pain scores (Fig 3).

Practice 4a: Minimize Pain and Stress Through Developmental Care

Parkview had already begun implementation of developmental care and saw the Vermont Oxford Network initiatives as an appropriate extension of the efforts. The team developed the 72 Hour Protocol to guide the care of all infants < 1500 g birth weight and decrease stimulation by noise, light, and staff interactions. Occasionally, VLBW infants had been admitted directly into isolettes, eliminating the need to move the infants from warmer to isolette. The practice is emphasized in the protocol, along with neutral head positioning, with the infant side lying and swaddled rather than supine. This has worked well. The infants seem to be more comfortable and seem to require less sedation. Data monitoring after the changes indicates a significant decrease in the IVH rate. This reduction seems to be sustainable, but doing so will require diligence as well as fine-tuning of the protocol. Measurement includes spot checks for positioning and observing for decreased infant contact.

Practice 4b: Minimize Pain and Stress by Decreasing Noise

CHOI had identified noise as a problem in their unit before the formation of the NIC/Q 2000 collaborative group. A task force on noise had searched the literature and established 65 decibels as the peak acceptable noise level for the NICU. Decibel levels were measured in the unit for a 24-hour period. Peak levels corresponded to report times, admissions, rounds, and crisis situations. Unfortunately, the staff believed that conversations were being recorded and resisted the monitoring. The task force became frustrated and suspended the efforts.

Once the collaborative began, the group reformed with new leadership, members, and a name: the Quiet Infant Group. They reviewed literature and problems and established a measurable goal. A noise reduction poster was presented. Staff were assured that conversations were not being recorded and that data would be used only for noise reduction. The Quiet Infant Group implemented a number of new practices: 1) posters around the nursery; 2) buttons with the Quiet Infant logo worn by staff; 3) rounds conducted away from the infant's space; 4) adjustment of the paging system to a lower decibel level; 5) pagers for the resource nurse, transport nurse, and patient care technicians; and 6) encouragement to staff to use the neonatologist, neonatal nurse practitioner, and resident pagers when needed.

Most important, the group installed a visible monitoring system in each nursery to alert staff to noise levels above acceptable limits. Once the system was in place, sinks in each nursery triggered it and the sinks were adjusted, resulting in improved decibel levels (Fig 4). The fire alarm system measured > 80 decibels but could not be changed because of codes. Ceiling tiles were also a source of noise and were replaced with sound-absorbent tiles. The results were effective in lowering background noise, especially from the heating, ventilation, and cooling system. The staff have been very favorable, commenting that the stress from noise is much less. With continued success in consistently meeting a goal of 65 decibels, the plan is to gradually lower the trigger level on the signs and further decrease the noise level in the NICU.

Noise Levels of the Sinks in NICU Rooms

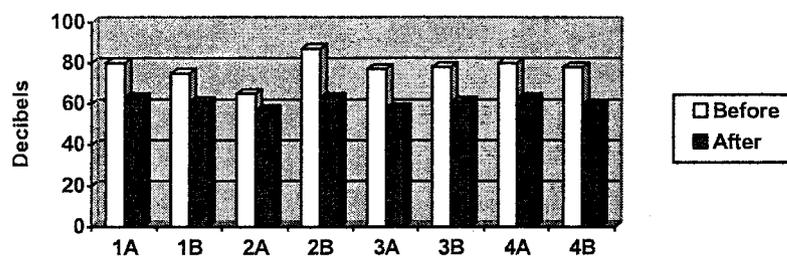


Fig 4. CHOI's noise table.

Practice 5: Maintenance of Neutral Head Position

NHRMC elected to use neutral head positioning for intubated infants for the first 7 days of life, although the IVH PBPs focus on the first 72 hours of life. The site also elevated the head of the bed 30 degrees. There was a lot of support for this because 1 of the longstanding team members, a respiratory therapist, and several of the newer co-workers (respiratory therapists and registered nurses) had practiced this standard at other hospitals. Initial data collection showed that before implementation, compliance with this standard was only 1.5%. The group began by getting suggestions from Parkview, where it had already been implemented.

Results of initial data collection were shared with staff, and an educational poster was placed in the unit. One-on-one in-service training was done with all NICU team members who perform direct, hands-on care. An education station was set up in the unit using a developmental doll. Staff were taught how to position the infant, as well as how to maintain neutral head positioning when changing positions (side, supine). Staff had the opportunity to practice with the doll for a month. In-service training was delayed by the December holidays, but finally the practice was incorporated into the standards of care. Team members made direct daily observations to reinforce the practice for staff. Currently, there is 100% compliance with neutral head positioning and 93% compliance with head of the bed elevated 30 degrees. Measurements include positioning of the head and elevation of the head of the bed.

Practice 6: Fluid Volume Therapy for Hypotension

The lack of uniformity in Baylor's approach to blood pressure management and the hope of reducing unnecessary volume and inotrope use prompted a review of the literature on acceptable blood pressure ranges for VLBW infants. A modified version of Watkin's criterion (Table 2) was selected for new acceptable blood pressure ranges (previously hypotension had been defined in their unit as a mean blood pressure (MBP) <30 mm Hg no matter what the infant's gestational age). A standardized protocol for the treatment of hypotension was developed. Staff received in-service training on the new blood pressure range and treatment options. Measurement of outcomes (IVH incidence and severity, inotrope

use, and volume use) were compared by retrospective and prospective chart reviews (Fig 5).

Practice 7: Indomethacin Prophylaxis in the First 24 Hours After Birth

Baylor addressed indomethacin prophylaxis as a PBP. Despite good level 1 evidence demonstrating that early administration of indomethacin significantly reduces severe IVH, the collaborative group had concerns about its short- and long-term adverse effects. The recently published TIPP study showed no difference in long-term outcomes between infants who received early indomethacin and those who did not. In addition, benchmark sites were not using indomethacin prophylaxis. Because of these concerns and through consultation with an expert, a protocol was developed at Baylor to target a high-risk population (infants <1500 g born to mothers who had incomplete or no antenatal steroids) to receive indomethacin prophylaxis.

Practice 8a: Manage Infants on the Ventilator Using Synchronized Intermittent Measured Volume/High-Frequency Oscillating Ventilation (HFOV)

LGCH developed and implemented a HFOV guideline to achieve optimal lung recruitment in infants <1000 g at birth to decrease the incidence of chronic lung disease and IVH. A multidisciplinary neonatal respiratory task force was organized, followed by a review of the literature and the practices of other tertiary care NICUs. A measurement tool was developed, and current practice was analyzed. Next, a guideline on HFOV use was drafted and an α trial was conducted to assess feasibility of the guideline.

Once the guideline was completed, the educational committee provided in-service sessions to staff, constructed an educational board with pretest and posttest analysis, printed information in the staff newsletter, and posted guideline flow diagrams on each high-frequency ventilator. Data were collected on 10 patients, including guideline compliance, and areas of the guideline needing clarification and improvement were identified. The guideline compliance goal was met, and optimal lung recruitment was achieved. However, the HFOV guideline was then expanded to include optimal arterial oxygen pressure and PCO_2 ranges, the frequency of blood gas analysis, and the ventilator weaning process while on HFOV.

As a result, the guideline has become highly detailed and difficult to follow unless one is very familiar with it. Compliance has fallen dramatically. The task force is currently looking at ways to simplify the guideline and improve compliance. Emphasis on optimal lung recruitment and optimal PCO_2 range will be the major focus. Staff will need to be reeducated before implementation of the new guideline.

Practice 8d: Avoid Routine Suctioning

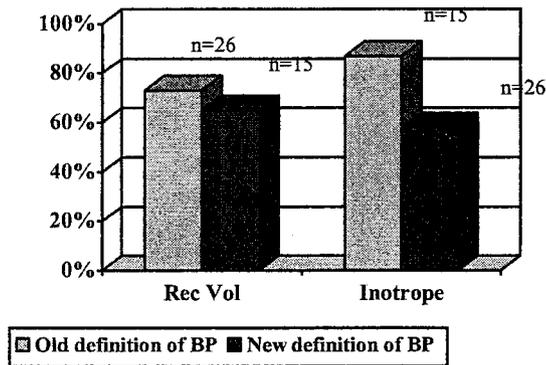
NHRMC implemented "no routine suctioning" as part of a minimal handling protocol. Baseline data were collected to determine the rate of routine suctioning before implementation of the new protocol. "No routine suctioning" was then adopted as a standard of care, with the expectation that staff would suction only when there were physiologic signs that the patient needed it and document the reason for suctioning. Assessment parameters included heart rate, breath sounds, activity level, O_2 saturation,

TABLE 2. Mean MBP Table

Birth Weight (Grams)	Hours Postnatal Age		
	3	12	14
500	35/23	36/24	37/25
600	35/24	36/25	37/26
700	36/24	37/25	38/26
800	36/25	37/26	39/27
900	37/25	38/26	39/27
1000	38/26	39/27	40/28
1100	38/27	39/27	40/29
1200	39/27	40/28	41/29
1300	39/28	40/29	41/30
1400	40/28	41/29	42/30
1500	40/29	42/30	43/31

Table of mean MBP and 10th percentiles by birth weight and postnatal age. The first figure is the mean MBP at the given weight and postnatal age, and the second figure is the 10th percentile.

Phase I - Spring 99
Redefining Acceptable BP



Complication Rates

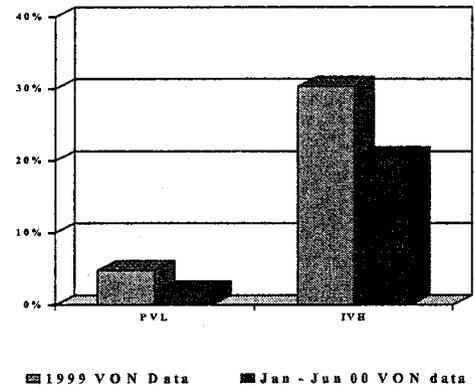


Fig 5. Baylor's results graph.

and chest movement. Routine suctioning was not to be done in ≤ 1500 -g infants unless there was a written order.

A poster in-service session was conducted, followed by one-on-one in-service sessions for staff. A high degree of resistance was recognized. The team still moved forward with implementation, but follow-up data revealed poor compliance. The percentage of infants who received routine suctioning had gone from 32% to 34%, probably as a result of resistance and new, inexperienced staff hired since the initial inservice sessions. New one-on-one in-service sessions were conducted using an evidenced-based approach, and the standard was reinforced. Routine suctioning decreased to 9%. Measurements include how the patient is suctioned (as needed or routinely), documentation of the reason for suction, the results of suctioning and patient tolerance of the procedure, and the shift (day or night).

Practice 9: Limit Sodium Bicarbonate Use/Give Over 30 Minutes

LGCH's nursing staff identified the use of sodium bicarbonate for the treatment of metabolic acidosis as a quality improvement project because there was considerable variation in physician practice. Variations in indications, dosage, and duration of infusion were targeted. A literature review did not reveal evidence to support the use of sodium bicarbonate for the treatment of metabolic acidosis in preterm infants. Current sodium bicarbonate guidelines were obtained from a participating collaborative hospital. These guidelines were reviewed and modified by attending neonatologists. Agreement was reached, and an outline was created with specific standards for the use of sodium bicarbonate, as well as acceptable lower limits of blood pH, blood base deficit, medication dosage, and duration of infusion. Before guideline implementation, the nursing and medical staff were educated on the guideline through in-service sessions and newsletters. For ensuring guideline compliance, retrospective chart reviews are performed. At present, the sodium bicarbonate guideline has become the standard of practice in the NICU with nearly 100% compliance.

Practice 10: Avoidance of Early Use and Prolonged Course of Postnatal Dexamethasone

Baylor discussed the avoidance of early use and prolonged course of postnatal dexamethasone not for IVH prevention but because of recently published reports on the neurotoxic effects of dexamethasone. The short-term benefits of dexamethasone use (earlier extubation and decreased chronic lung disease) were weighed against the increased risk of poor long-term neurologic outcomes. A protocol restricting postnatal Decadron use was developed and implemented.

RESULTS

A major key to success is communication. This point cannot be overstated. It is critically important to establish the types of communication that work best in a particular unit to keep everyone informed. A major component of communication is education. This is very important in making any type of change. In implementing PBPs in NICUs, the information provided should include not only the benefits of a new practice but also the evidence for changing an existing practice. In-service sessions should be repeated several times to give all staff the opportunity to attend. One-on-one in-service sessions proved to be very beneficial for most hospitals in the group. Staff had the opportunity to learn the new process as well as ask questions individually. Hands-on demonstrations were well received by all. Units set up stations or carts that enabled staff to practice some of the PBPs, such as midline head positioning and thermoregulation.

A dedicated implementation leader is key to keeping the group organized and moving forward. On-shift resources who are familiar with the new practice and can answer questions posed by staff and oversee the change are helpful. Educational posters in bathrooms are another excellent means to reach the staff. Visual aids such as graphs, flow charts, laminated pocket-sized cards for quick reference, written guidelines, and protocols help to disseminate information to a large group and improve understanding. Providing accessible resource tools (eg, a web site) is also helpful in improving compliance.

Other important lessons learned about implementation include the importance of encouraging active participation of multiple disciplines and other departments from the very beginning of the change process. Collaboration such as this enables better ownership of the work. It is important to distribute the work among group members, thereby making the change process more manageable. Collaboration

not only within a hospital but also among hospitals is beneficial. It helps to prevent a need to start at the beginning when a practice has been successfully implemented elsewhere.

Data should be shared among the group on an ongoing basis to keep everyone well informed of progress. When things go well, it is helpful to thank the staff to encourage continued participation. Ideas to update staff on the status of projects include newsletters, monthly meetings with pizza, and unit web sites. Because data collection can be cumbersome and boring, it should be kept as simple as possible.

Barriers

Implementation did not go smoothly all the time. Barriers included having multiple personnel responsible for implementation, not enough staff to help, and a large number of new or inexperienced staff. Old habits can be hard to break, and when changes

occur, feelings can get hurt. Other barriers included the amount of time needed to educate staff, budget issues related to obtaining new equipment, and documentation inconsistencies that impeded data collection. Confusion can result when many new practices are put in place in a short period. Implementing new practices around holidays can extend the implementation time frame. Finally, the culture in a busy NICU is often difficult to change.

DISCUSSION

Implementation of PBPs is not an exact science. It was unique for each participating hospital and depended on the processes already in place. With each plan-do-study-act cycle completed, more lessons were learned. Although not all units achieved the same successes, valuable information was gained and overall progress was made. Collaboration was the key to success!

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Implementation of Potentially Better Practices for the Prevention of Brain Hemorrhage and Ischemic Brain Injury in Very Low Birth Weight Infants

Debra McLendon, Jennifer Check, Patricia Carteaux, Laura Michael, Jim Moehring, Joel W. Secrest, Sue E. Clark, Howard Cohen, Sharon A. Klein, Diane Boyle, Jeffrey A. George, Susan Okuno-Jones, Debora S. Buchanan, Pam McKinley and Jonathan M. Whitfield

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