Management of High-Order Multiple Births: Application of Lessons Learned Because of Participation in Vermont Oxford Network Collaboratives

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ABSTRACT

OBJECTIVES. The delivery and care of sextuplets is complex. Potentially better practices that were developed as part of the Vermont Oxford Network improvement collaboratives were used to prepare for a sextuplet delivery at Akron Children’s Hospital.

METHODS. The team used potentially better practices that were learned from the Neonatal Intensive Care Quality Improvement Collaborative 2002 using multidisciplinary teams. There was extensive media coverage of the delivery.

RESULTS. The goal was to use nearly all potentially better practices that focused on the goals of reducing nosocomial infection, reducing chronic lung disease, reducing radiograph use, reducing length of stay, reducing blood gas use, promoting nutrition, reducing intraventricular hemorrhage, and enriching family-centered care. The center aimed to use these 97 potentially better practices. Of the 97 possible potential better practices as set by the Neonatal Intensive Care Quality Improvement Collaborative 2002, 96 (99%) were used.

CONCLUSIONS. This is a blueprint that any center that is faced with high-order multiple births could use as a reference point to begin planning. The team created a benchmark to achieve in every birth of very low birth weight infants and not just a special situation of high-order multiple births.

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Key Words
high-order multiple births, sextuplets, quality improvement

Abbreviations
VON—Vermont Oxford Network
NIC/Q—Neonatal Intensive Care Quality Improvement Collaborative
PBP—potentially better practice
GA—gestational age
NNP—neonatal nurse practitioner
LOS—length of stay
CPAP—continuous positive airway pressure
PDA—patent ductus arteriosus
PICC—peripherally inserted central catheter
HFOV—high-frequency oscillatory ventilation
IMV—intermittent mechanical ventilation

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The NICU at Akron Children’s Hospital has been participating in Vermont Oxford Network (VON) Neonatal Intensive Care Quality Improvement Collaboratives (NIC/Q) since 1996. The goal of these collaboratives has been to achieve measurable improvements in outcomes and safety in neonatal intensive care using 4 key habits: the habit for change, the habit for systems thinking, the habit for collaborative learning, and the habit for evidence-based practice. Ideas for change come from many sources; the predominant 1 is potentially better practices (PBPs). The improvement model used included plan-do-study-act cycles that were based on an overall aim, a measure of change, and changes to be accomplished.

Improvement changes were that of structure, process, or pattern and encompassed clinical, organization, and operational realms. There have been 3 collaboratives: NIC/Q, NIC/Q 2000, and NIC/Q 2002. During these collaboratives, a total of 106 PBPs were developed (Appendix 1). Akron Children’s Hospital committed to implementing 97 PBPs. In January 2004, the anticipated births of sextuplets presented an opportunity to use the knowledge gained during participation in the collaboratives to achieve the best possible organizational, operational, and clinical outcomes. PBPs were incorporated into planning and daily patient care of the sextuplets as described in this article.

Methods
Obstetric and perinatal care providers with parental consent notified the neonatal care providers about the existence and possible delivery of sextuplets. When the fetuses reached 20 weeks’ gestation, the neonatologists met with the family to become acquainted with them and review issues that may be involved. At 22 weeks’ gestation, the mother was hospitalized for preterm labor. The neonatologist again met with the family and reviewed local, national, and international data on morbidity and mortality at various gestational ages (GAs) between 22 and 26 weeks.

A recommendation was made to the family that resuscitation and neonatal intensive care would not be in the best interest of the infants at 22 or 23 weeks’ gestation. The family was in full agreement. They expressed the desire for use of full resuscitation and neonatal intensive care if the birth occurred at 24 weeks’ gestation or later. This plan was documented in the chart and widely communicated to all of the obstetric and neonatal care providers. All of these steps were in conformity with the PBPs that were developed by Wee Delivery group of the NIC/Q 2002.

The anticipated preterm delivery of sextuplets presented many operational and organizational challenges. The decision was made to use PBPs that were learned from the NIC/Q 2000. This challenge was magnified by the added challenge of dealing with extensive media coverage of the delivery. The delivery was to take place at the Perinatal Center, which houses a level II neonatal facility, whereas care requirement for the infants, if born before 29 weeks, would involve transfer to Akron Children’s Hospital level III NICU.

Two multidisciplinary teams were assembled, 1 at each facility, with some personnel common to both teams to enhance communication between teams. Teams were led by the directors of nursing. Disciplines invited were nursing, neonatal nurse practitioners (NNPs), neonatologists, respiratory care, radiology, security, volunteers, risk management, public relations, transport services, administration, telecommunications, and audiovisual personnel. Minutes of all meetings were kept and communicated. Agendas were prepared ahead of time, and each representative was given time for input.

During each meeting, the teams were encouraged to investigate, as much as possible, problems and solutions for potential logistic issues. Evidence was gathered by a review of literature. Benchmarking was done via personal e-mail and telephone communication with 5 centers that previously had handled high-order multiple birth situations. Ideas were generated for practices by participating disciplines. Leadership practiced a supportive role and a role of providing resources to implement these ideas and help create timelines. A plan evolved, and a staffing plan was created approximately at 24 weeks’ gestation (Appendix 2).

As the operational and organizational plan was evolving, the clinical multidisciplinary team started working on the clinical management plan. An important step in this plan was an agreement to follow as many PBPs as applicable. The goal was to create decreased variation and increased consistency, coordination collaboration, continuity, and communication between caregivers by following the PBPs (Appendix 1). A special concern surrounded patient safety issues, and a set of practices took form (Appendix 2).

Extra staff were on call for the delivery, including extra nursing staff, respiratory therapists, and secretarial staff to assist with paperwork. The resuscitation room was prepared with equipment for the sextuplet delivery. Extra equipment that was needed to care for 6 infant deliveries at once was obtained and stored in a closed room. Every infant had a box of anticipated equipment and supplies and was color-coded for each infant. Each infant was assigned a team that consist of 2 nurses and a neonatologist, and each team shared 1 respiratory therapist. Arrangements were made to ensure safe and secure transports of the infants with police escort, if necessary.

Once infants were admitted to the level III NICU, they were placed in a designated location on the basis of birth order and maintained these bed spots for the duration to ensure safety and consistency of care. Infants also had...
1:1 nursing care for the first 24 hours to ensure safety of laboratory orders and medications. Press conferences were held in a close but offsite location so as not to disturb pediatric inpatients. Media photographs and video from external sources were not allowed until after the fifth day.

Akron Children’s Hospital audiovisual department prepared daily video and still photograph updates that, with parental consent, were distributed to all media who requested audiovisual material. Daily updates were provided on the hospital Web site. All media and publicity requests were referred to the public relations department. Public relations coordinated all responses following guidelines that had been developed by multidisciplinary teams.

RESULTS
Process measures were evaluated on the basis of PBP implementation. The goal was to use nearly all PBPs that focused on the goals of reducing nosocomial infection (33 PBPs), reducing chronic lung disease (16 PBPs), reducing radiograph use (6 PBPs), reducing length of stay (LOS; 9 PBPs), reducing blood gas use (7 PBPs), promoting nutrition (7 PBPs), reducing intraventricular hemorrhage (12 PBPs), and enriching family-centered care (7 PBPs). The center aimed to use these 97 PBPs (Appendix 1).

Of the 97 possible PBPs as set by the NIC/Q 2000, 96 (99%) were used. The exception included the use of H₂ blockers, however, because 1 infant did receive these during a time of perceived illness. All infants were pre-determined to receive early administration of prophylactic exogenous surfactant before 15 minutes of age. There was a modification of 1 of the PBPs (starting enteral feeds on day of life 1 for the given gestation and birth weight). Although the infants were advanced with enteral feeds at a rate of 10 to 20 mL/kg per day, they all started enteral prime feeds after 24 hours, when breast milk was available.

Outcome measures included mortality, morbidity, LOS, hospital charges, and resource use. Resource use encompassed days on continuous positive airway pressure (CPAP), days on ventilator, total number of labs drawn, hyperalimentation days, intralipid days, time for the infants to receive surfactant, radiographs taken, antenatal steroids, and days of a central line in place. The sextuplets were delivered at 28 weeks’ gestation with birth weights of 1190, 1020, 705, 1153, 1099, and 1145 g.

The outcome measures of the sextuplets were compared with infants who were cared for within our center from 2002 to 2003 and were 28 weeks’ gestation and ranged from 750 to 1180 g (control infants). Some parameters were compared with 2003 VON data of infants with birth weights of 750 to 1250 g.² All (100%) sextuplets received antenatal steroids. With the control infants, 85% received antenatal steroids and 95% of all of the 2003 VON infants received antenatal steroids.³ There was no difference in regard to birth weights of the sextuplets or the control group of infants (Table 1). Cost using cost-to-charge ratio was evaluated only among the sextuplets. The average hospital charge for the sextuplets

### Table 1: Resource Use Measures for Sextuplets Compared With Control Neonates

<table>
<thead>
<tr>
<th>Measure</th>
<th>Sextuplets (N = 6)</th>
<th>Controls (N = 26)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average birth weight, g</td>
<td>1052.0 ± 180.0</td>
<td>999.0 ± 130.0</td>
<td>.2541a</td>
</tr>
<tr>
<td>LOS, d</td>
<td>63.0 ± 7.8</td>
<td>64.0 ± 27.0</td>
<td>.267b</td>
</tr>
<tr>
<td>CPAP days</td>
<td>4.2 ± 1.3</td>
<td>11.0 ± 9.0</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>CPAP days per days hospitalized</td>
<td>0.07 ± 0.03</td>
<td>0.16 ± 0.12</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>Ventilator days</td>
<td>2.3 ± 1.9</td>
<td>9.8 ± 15.0</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>Ventilator days per days hospitalized</td>
<td>0.04 ± 0.02</td>
<td>0.12 ± 0.11</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>Time to surfactant, min</td>
<td>13.5 ± 5.9</td>
<td>101.0 ± 151.0</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>Total No. of gases</td>
<td>2.0 ± 0.6</td>
<td>9.8 ± 14.7</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>No. of gases per day hospitalized</td>
<td>0.032 ± 0.012</td>
<td>0.13 ± 0.12</td>
<td>&lt;.01a</td>
</tr>
<tr>
<td>No. of radiographs</td>
<td>5.0 ± 3.9</td>
<td>9.9 ± 16.0</td>
<td>.79c</td>
</tr>
<tr>
<td>No. of radiographs per days hospitalized</td>
<td>0.08 ± 0.05</td>
<td>0.13 ± 0.13</td>
<td>.72c</td>
</tr>
<tr>
<td>Day of life at which started on enteral feeds</td>
<td>2</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Hyperalimentation days</td>
<td>17.0 ± 6.5</td>
<td>160.0 ± 160.0</td>
<td>.21b</td>
</tr>
<tr>
<td>Hyperalimentation days per days hospitalized</td>
<td>0.26 ± 0.1</td>
<td>0.23 ± 0.12</td>
<td>.31b</td>
</tr>
<tr>
<td>Intralipid days</td>
<td>9.0 ± 4.0</td>
<td>9.0 ± 14.0</td>
<td>.6b</td>
</tr>
<tr>
<td>Intralipid days per days hospitalized</td>
<td>0.14 ± 0.065</td>
<td>0.12 ± 0.12</td>
<td>.43b</td>
</tr>
<tr>
<td>Central line days</td>
<td>12.7 ± 10.4</td>
<td>114.8 ± 181.1</td>
<td>.22c</td>
</tr>
<tr>
<td>Central line days per day hospitalized</td>
<td>0.21 ± 0.17</td>
<td>0.16 ± 0.25</td>
<td>.45c</td>
</tr>
<tr>
<td>Total No. blood draws</td>
<td>19.0 ± 7.9</td>
<td>35.6 ± 31.8</td>
<td>&lt;.01c</td>
</tr>
<tr>
<td>Total No. blood draws per days hospitalized</td>
<td>0.3 ± 0.1</td>
<td>0.50 ± 0.19</td>
<td>.16c</td>
</tr>
</tbody>
</table>

Data are means ± SD.

- a Unpaired t test with Welch’s correction.
- b Mann-Whitney test.
- c t test.
was $117 530. This included a range from $91 524.15 to $158 094.80. The hospital charge per patient day averaged $1870.51.

There was no mortality among the sextuplets or the control infants. Morbidity essentially was nonexistent for the sextuplets, but there were morbidities with the control infants. There was no significant difference between the sextuplets, because only 2 of the 6 infants had a patent ductus arteriosus (PDA) as compared with 11 (43%) of the 26 control infants. The sextuplets had no severe morbidities: severe intraventricular hemorrhage, chronic lung disease, pneumothorax, periventricular leukomalacia, or any late infection. One of the sextuplets had suspected necrotizing enterocolitis; however, the workup was negative. By comparison, none of the control infants had severe intraventricular hemorrhage. Two (8%) had chronic lung disease, as defined by oxygen and radiographic changes at 36 weeks’ postmenstrual age, and 2 (8%) of the 26 control infants had a pneumothorax. Two (8%) infants had periventricular leukomalacia, 3 (11%) had late infections of culture-positive sepsis, and 1 (4%) had necrotizing enterocolitis.

In addition, there were no reported errors for the sextuplets, and the LOS was not shorter with the sextuplets as compared with the control infants (Table 1). The outcomes of resource use are described below, and the details of outcome results from resource use are referred to in Table 1. The sextuplets spent less time on CPAP as compared with control infants (4 vs 10 days). When evaluated on the basis of days hospitalized, the difference remained significant.

The sextuplets also were less likely to spend time on ventilators (2 days vs 9 days). Surfactant was given much faster to the sextuplets. The sextuplets averaged 12 minutes of age by the time they received surfactant, as compared with the control infants, who received surfactant in 66 minutes. When compared with the VON 2003 data7 for infants from birth weights of 751 to 1250 g, inborn infants received surfactant from 19 to 30 minutes, outborn infants received surfactant from 45 to 62 minutes, and all (inborn and outborn) received surfactant from 22 to 34 minutes.

The sextuplets had fewer blood gases taken (2.0 vs 9.8) as compared with control infants. There was no difference in total number of radiographs or in number of radiographs per days hospitalized. Enteral feeds were initiated for all of the sextuplets on day of life 2. Only average numbers for the sextuplets and control infants are listed in Table 1. There was no difference in hyperalimentation days between the sextuplets and the control infants. There also was no difference when the number days receiving hyperalimentation per days hospitalized was analyzed. The use of intralipids did not differ between the groups. There also was no difference the number days receiving intralipid per days hospitalized was evaluated.

The sextuplets had fewer total labs during the hospital course (19 vs 36 with the controls). However, when compared total labs per days hospitalized, there was no significant difference. There was no difference in central line days or in central line days per days hospitalized between the sextuplets and the control infants.

**DISCUSSION**

This article presents a satisfying and rewarding approach for taking care of high-order multiple births applying knowledge gained in principles of quality improvement because of participation in the VON NIC/Q. The team demonstrated very good multidisciplinary collaboration, coordination, and a cooperative blueprint to achieve good results while avoiding any dissatisfaction. The team discussed variation and achieved more consistency in clinical care practices and achieved lowest possible neonatal morbidities. The team also did it in a cost-effective manner by demonstrating no increase in charges in comparison with mostly singleton births (1 set of twins) of definitive weights and gestation.

No errors were made during the extended time of delivery and postdelivery care. The team has contributed a blueprint that any center that is faced with high-order multiple births could use as a reference point to begin planning. The team created an achievable but high benchmark with a challenge to achieve in every birth of very low birth weight infants and not just a special situation of high-order multiple births.

We do not claim that the success that was achieved in taking care of these high-order multiple births was attributable solely to lessons learned from participation in the VON NIC/Q. However, it made this delivery experience of taking care of high-order multiple births an orderly exercise that reduced variation and reduced errors.

**REFERENCES**


4. Happy crisis tests hospitals’ PR plan. Septuplets’ arrival swamps Iowa hospitals with national, international media. Blank Children’s Hospital, Iowa Methodist Medical Center, Des Moines. Profiles Health Mark. 1998;14:1, 4–6


**APPENDIX 1: PBPs**

**Reduce Nosocomial Infection**

**PBP 1:** Pay meticulous attention to hand-washing. Soap and water or Purell immediately before AND immediately after EACH patient contact for ALL staff, parents, and visitors. Gloves do not replace hand-washing; they are used in addition to hand-washing. Patient care and contact: perform “clean” things first, “dirty” things last. No rings except bands, no watches, and no bracelets. No sleeves below elbows.

**PBP 2:** Regular surveillance of hand-washing practice and monitoring of compliance. Watch each other, remind each other, and help each other practice good techniques.

**PBP 3:** Hyperalimentation not be altered once it has left the pharmacy.

**PBP 4:** Begin enteral feedings as early as possible. See nutrition/feeding guidelines.

**PBP 5:** Reduce exposure to hyperalimentation. Switch to clear intravenous fluids when enteral feedings have reached 80 to 100 mL/kg.

**PBP 6:** Reduce exposure to intralipid. Start as late in hospital course as possible, and discontinue as soon as possible.

**PBP 7:** Promote the use of breast milk.

**PBP 8:** Ensure proper collection and storage of breast milk.

**PBP 9:** Limit use of H₂ blockers.

**PBP 10:** Establish a skin care protocol for all neonates <1000 g. the goals of which are to promote maturation and prevent skin breakdown. Aquaphor to body, except head, every 12 hours for the first 7 days of life.

**PBP 11:** Reduce laboratory blood testing that requires direct venipuncture or heel stick to obtain the blood sample. Use low volume blood gas and chemical monitor/cluster labs and heel sticks.

No “routine” labs before ordering, ask yourself whether the test is really needed and what action will be taken on the basis of the results.

**PBP 12:** Develop a systematic approach to intravenous therapy that reduces the frequency and the number of skin punctures for placement of an intravenous catheter. Limit attempts for each individual. Always use assistance (2-person procedure). Save large veins (especially antecubital veins) for peripherally inserted central catheter (PICC) line. Follow PICC guidelines: anticipatory placement of PICC line in infants <1000 g.

**PBP 13:** Improve accuracy of diagnosis of infection: minimum sample size for a blood culture should be 1 mL per aerobic bottle.

**PBP 14:** Two samples of 1 mL each from 2 different sites in 2 culture bottles is preferred for nosocomial sepsis evaluations. Avoid central lines as blood culture site/source; peripheral venipunctures is preferred.

**PBP 15:** Develop a method to distinguish true infection from a contaminated culture. For *Staphylococcus epidermidis*, the major neonatal pathogen, if 1 bottle is positive and the other is negative, then it is considered a contaminant and antimicrobial therapy is discontinued.

**PBP 16:** Limit the number of sepsis evaluations.

**PBP 17:** Ensure appropriate skin site preparation for obtaining blood cultures and other specimens. When using alcohol and Betadine for prepping, allow it to dry for at least 30 seconds.

**PBP 18:** Minimize intubation days. Follow Delivery Room Management Trial protocol.

**PBP 19:** Minimize interruption of the ventilator-endotracheal tube circuit. Use Ballard In-line Suction System and Ballard Surfactant Administration System. Manipulate ventilator controls during suctioning, if needed, rather than hand-bagging.

**PBP 20:** Minimize use of central lines by minimizing number of days in use. Early and aggressive feeding: see nutrition/feeding guidelines.

**PBP 21:** When central lines are used, minimize the frequency of line entries and the duration of use. Remove soon after full enteral feedings are established; do not leave heparin-locked for >1 or 2 days.

**PBP 22:** Place central lines proactively when intravenous therapy will be lengthy.

**PBP 23:** Establish sound policies (standardized procedures) for line care and access to reduce hub colonization. Prepare intravenous hubs and ports for access or any line manipulation by scrubbing with alcohol at least 10 to 15 swipes with vigorous friction.

**PBP 24:** Regularly monitor compliance of line care and access.

**PBP 25:** Minimize the number of intravenous hubs and connections.

**PBP 26:** No reuse or reinsertion of intravenous devices. For butterfly needles, angiocatheter, Insytes, etc, puncture once and, if unsuccessful, throw away and use a new one.

**PBP 27:** Prepare all intravenous fluids in a laminar flow hood. Discuss with pharmacy on a case-by-case basis; if it is a fluid that they can or should make, then let them.

**PBP 28:** Discontinue peripheral intravenous lines when at 334.72 J/kg of feedings.

**PBP 29:** Have a dedicated PICC team. NNPs perform the insertions and troubleshooting.

**PBP 30:** Prepare intravenous hubs and connections with chlorhexidine. No adequate or appropriate formulation of this product is available yet for use in NICUs.

**PBP 31:** Use maximal barrier precautions for insertion of central catheters: gowns, gloves, and masks.

**PBP 32:** Promote developmentally supportive care with an emphasis on minimal handling. Do not touch the infant unless absolutely necessary. Coordinate assessments and interventions to promote/maximize the principles of developmental care.
PBP 33: Develop and maintain a culture of cooperation and teamwork that supports and encourages all team members to feel responsible for outcomes. Outcomes can be improved by quality improvement activities, and this is part of everyone’s work.

Reduce Chronic Lung Disease
PBP 34: Promote the use of antenatal steroids.

PBP 35: Surfactant will be administered as soon as possible to eligible extremely low birth weight infants who are <30 weeks postmenstrual age including at referring hospitals and/or during transport. A chest radiograph should be obtained AFTER surfactant has been given, not merely for endotracheal tube placement before surfactant. Umbilical lines and other procedures can be performed after surfactant is given. Target is 5 to 15 minutes after birth. Use Delivery Room Management Trial guidelines.

PBP 36: Practice gentle initiation of ventilation at birth. When required, the infant should be placed on mechanical ventilation as soon as possible to avoid hand-bagging. Measure calculated tidal volumes: target 4 to 6 mL/kg.

PBP 37: Use prophylactic bubble nasal CPAP soon after birth for infants who are >1000 g and have respiratory distress syndrome. Think “bubble first.”

PBP 38: Use prophylactic indomethacin. We take the approach of early diagnosis and treatment of PDA. Obtain echocardiogram if infant cannot be weaned to or stay in <0.30 fraction of inspired oxygen and has a murmur present and cardiomegaly on radiograph.

PBP 39: The goal of intubation is quick, elective extubation. Conduct morning ventilator rounds to plan daily as well as long-term weaning strategy. Registered respiratory therapists to be “champions” of this strategy to see that it gets done.

PBP 40: Decrease exposure to supraphysiologic steroids. Use of any postnatal steroids is strongly discouraged. The only indication is rescue therapy if infant is headed for lung death; 2 neonatologists need to agree. Parents must be informed of the risks and benefits.

PBP 41: Vitamin A supplementation: in our estimation, the evidence is not yet strong enough for us to implement this practice.

PBP 42: If ventilation is required, use synchronous intermittent mechanical ventilation (IMV) with a low tidal volume strategy or high-frequency oscillatory ventilation (HFOV) rather than time-cycled, pressure-limited ventilation. Abandoned time-cycled pressure-limited ventilation. Consider HFOV in an infant who is hemodynamically stable, 23 to 27 weeks, on conventional mechanical ventilation with respiratory distress syndrome, and does not quickly reach room air and continue to wean after 2 doses of surfactant. Consider HFOV in any infant who is aged 28 to 31 weeks and requires >0.30 fraction of inspired oxygen after appropriate stabilization. HFOV strategy: chest radiograph to confirm good inflation (8–9 ribs expansion) but not overinflation, blood saturation has risen after stabilization, chest radiograph every 6 to 8 hours until stabilization achieved, arterial blood gas should be obtained regularly at first to avoid overventilation, do not discontinue HFOV merely because infant reached room air, and conventional mechanical ventilation tidal volume goal will be 4 to 6 mL/kg.

PBP 43: No intubation for $P_{\text{CO}_2}>60$ or pH <7.25 unless the clinical situation mandates.

PBP 44: To reduce the duration of mechanical ventilation, practice permissive hypercarbia. Accept blood gas values of a $P_{\text{CO}_2}$ up to 65 as long as the pH is >7.2 without increasing support and wean ventilator settings at any $P_{\text{CO}_2}<50$.

PBP 45: Use postextubation bubble nasal CPAP to reduce the failure rate of extubation. For infants who are <1500 g, keep on bubble nasal CPAP for at least 48 to 72 hours. Use Delivery Room Management Trial guidelines.

PBP 46: Practice relative fluid restriction; decrease fluid administration. Be very aware of how much fluid is actually being administered. Fluid calculations should be based on actual weight, not birth weight. Exception may be made on the basis of edema. Fluids should be reported as actually administered in the last 24 hours, not fluids written for or intended to be given. ALL fluids should be included in calculations: all medications, fluid boluses, flushes, etc. Flush volumes for medications should be consistent and kept to the minimum amount necessary. Daily intravenous rate should be ordered as a specific TOTAL intravenous rate per hour, especially if the patient is on a number of intravenous fluids. No automatic daily increase in fluid intake in first week of life; decision should be based on weight, fluid balance, and electrolytes.

PBP 47: Early and aggressive weaning from endotracheal tube and IMV to bubble nasal CPAP when $O_2$ requirement is <35%. Remember that oxygen is a drug and should be used in the smallest dose possible. Pulse oximeter saturation limits will be 88% to 92%. Wean as long as the saturation is in this range. Avoid yo-yo $O_2$ therapy; give the infant a chance to recover. Increase $O_2$ incrementally to assist in recovery from desaturation episodes. Switch to intermittent pulse oximeter readings in infants who are older than 2 weeks age. $O_2$ weaning targets to be written in orders during rounds.

PBP 48: Optimize medical management of apnea. Use the Apnea Management Guidelines developed by the neonatologists along with use of theophylline and caffeine.

PBP 49: Weight, postmenstrual age, enteral feeding status, and weight gain patterns need not be factors in consideration of aggressive extubation.

PBP 50: Practice developmentally supportive care on
the basis of sleep–wake cycles and behavioral cues and recovery pauses with stressful procedures.

PBP 51: Practice developmentally supportive care by light and sound reduction. If infant needs to leave the unit for surgery or testing (radiology), then the patient MUST be transported with a ventilator in use. NO HAND-BAGGING during a transport. Suctioning should be performed only when clinically indicated; consider it a “last resort” intervention.

Reduce Radiograph Use
PBP 52: Radiographs should be ordered on the basis of current clinical indicators with specific expected benefit (ie, no “routine” radiograph); expected benefit would be identification/confirmation of suspected pathology with subsequent intervention.

PBP 53: Reduce the number of radiographs to evaluate endotracheal tube position.

PBP 54: Follow-up films to establish progression or resolution of radiographic findings should be done only when an alteration in management is expected; treat the infant, not the radiograph.

PBP 55: When an infant experiences a change in clinical status, physical assessment should precede radiographic evaluation.

PBP 56: When ordering radiographs, specific view(s) should be matched with the specific information needed.

PBP 57: Look for system changes in patient treatment that will maximize efficient use of radiographic imaging.

PBP 58: Involve a radiologist in the process to attain appropriate use of radiographs: dialogue and collaboration between the care team and the radiologist should precede the request for comparative or follow-up studies, and radiologist film reports should not advise or request that follow-up films be taken independent of clinical assessment of the patient.

Reduce LOS
PBP 59: Continue implementation and/or maintenance of PBP recommendations for the reduction of hospital-acquired infections and chronic lung disease.

PBP 60: Provide for consistent medical and nursing plans of care for individual patients.

PBP 61: Practice guidelines will be developed for apnea management, respiratory support at discharge, and nutritional management. Apnea management: discontinue caffeine at 32 weeks’ corrected gestational age; start Theolair if needed (do not restart caffeine); no infant should be discharged home on caffeine if possible. At 35 weeks, monitor for 5 days for apnea and bradycardia. If fails, consider home monitoring and begin teaching the families apnea monitor use and cardiopulmonary resuscitation. For respiratory support at discharge, consult the Apnea Center to teach the family monitor use and cardiopulmonary resuscitation. Synagis before discharge if applicable. Nutritional support: Attempt oral feeds at 32 weeks’ corrected gestational age. For multiple gestation infants, plan on instructing the families to use the same concentration of breastmilk or formula, and the same brand of formula if not supplying breastmilk. Lactation consultant prepares home breastfeeding plan and reviews it with the mother before discharge.

PBP 62: Medical and nursing models of care that promote continuity of care across the continuum of care will be developed for medically fragile infants who are discharged with home nursing visits and/or technology dependence. Provide parent pathway (“Neonatal Parent Path to Home”) to parent in first few days of hospitalization. Individualized Family Teaching Plans: Case managers to work with payers to provide in-network home services. Discharge plan discussed in multidisciplinary rounds each week. Follow-up care with each consultant arranged by case managers. Prescriptions filled for family before discharge if possible.

PBP 63: Provide for an integrated multidisciplinary team approach to the provision of care and discharge planning with clearly defined roles, responsibilities, and accountabilities for each of the team members. Case managers and the medical team decide each week which infants/families to discuss in multidisciplinary rounds. The following are involved as appropriate: medicine, case management, nursing, NNPs, social work, infant therapy team (occupational therapy, physical therapy, speech therapy, and team social worker), nutrition, chaplaincy, apnea team, follow-up clinic nurse, surgery nurse clinicians, Children’s Home Care nurse coordinator, respiratory care, psychiatric nurse clinician, and lactation. Everyone who attends presents his or her discharge plan to the other participants. The meeting is chaired by the neonatologist on service in Newborn Two (home going service).

PBP 64: The NICU will have a dedicated social worker for assessment of family needs and resources and for the provision and/or coordination of family support services. The NICU social worker reviews each admission for high-risk social needs.

PBP 65: Case management services will be provided for all high-risk and/or complex discharge patients. All admissions to the NICU are considered high risk. They participate in Newborn Two (home going service) rounds 3 to 4 times per week; Newborn One (acute care service) as needed. Utilization review is incorporated into their responsibilities for better awareness of the resources that are available to families.

PBP 66: The NICU will develop a unit-wide discharge philosophy and discharge criteria and an attitude focused on discharge; family involvement in care will be fostered as soon in the hospital course that the infant’s survival is determined to be likely. Discharge goals are determined early in the hospital course and documented on the NICU discharge plan screen in assessment.
Infants <1000 g: 37 weeks
Infants >1000 g: 36 weeks
Infants born at 35 weeks: 11 days
Infants born at ≥36 weeks: 7 days

Parent teaching is to be started as early as possible in the hospitalization and documented in some detail.

PBP 67: A philosophy and a program that fosters the development of the parental role in a high-tech environment will be developed. Twenty-four-hour visitation is allowed for parents and 4 others of their choosing. Sibling visitation is encouraged, as is kangaroo care. Parents are not to be asked to leave the unit for rounds or report.

Reduce Blood Gas Use
PBP 68: No “routine” blood gas orders.

PBP 69: Provide for regularly scheduled ventilator rounds to evaluate the need for clinically indicated blood gases.

PBP 70: Plan ventilator changes before obtaining blood gases in stable or weaning infants.

PBP 71: Respond to blood gases within an appropriate time frame, as soon as possible.

PBP 72: Consider the use of noninvasive monitoring of O$_2$ and CO$_2$ in situations in which >3 blood gases per day are being obtained (low volume blood gas and chemical monitors).

PBP 73: When possible, combine blood gas sampling with other laboratory evaluations to reduce the number of painful interventions.

PBP 74: Minimize blood losses by using analyzers that require the smallest volume possible.

Promote Nutritional Practices to Support Growth
PBP 75: Develop a consistent and comprehensive appraisal system to assess growth and nutritional adequacy by interdisciplinary team members, in conjunction with neonatal nutritionists. Measurements (length and head circumference) are done weekly. Length is done using a length board, not a measuring tape. In-bed scales are available for the smallest and/or sickest infants. The physician’s progress notes should contain the following information:

- Which weight is being used to calculate fluids and energy intake for that day
- What actual fluid and energy intake volume is intended for the day
- Clear statement of whether the total fluid volume ordered includes enteral feedings with the intravenous fluid or intravenous fluid only

PBP 76: Early initiation of minimal enteral nutrition: minimal enteral nutrition should be started at 48 hours of age for infants who are <1000 g. Special consideration is given to infants who are in >60% O$_2$, are on dopamine or dobutamine >10 µg/kg per minute, have a history of significant hypoxemia (low Apgar scores), have known gastrointestinal abnormality, or have a PDA that requires indomethacin within the first 48 hours of life. Infants are not to be made nil per os if feedings are being tolerated and indomethacin is started after 48 hours of life. However, feedings are not to be increased during indomethacin administration. For initiation of feeds, colostrum is preferred. If unavailable, then breast milk and, last, low iron premature formula may be used.

PBP 77: Consistent systematic advancement of enteral feedings. For infants who are 400 to 699 g, initial feeding at 48 hours of age is 0.5 mL every 4 hours (4–7 mL/kg per day). First advance, 48 to 72 hours after initial feed, is 0.5 mL every 2 hours. Second advance, 24 hours after first advance, is 0.5 mL/h. Third advance, 24 hours after second advance, is 15 to 20 mL/kg per day. For infants who are 700 to 999 g, initial feeding at 48 hours of age is 1 mL every 4 hours (6–8 mL/kg per day). First advance, 48 to 72 hours after initial feed, is 1 mL every 2 hours. Second advance, 24 hours after first advance, is 1 mL/h. Third advance, 24 hours after second advance, is 15 to 20 mL/kg per day. Increase daily until desired feeding goal is met. For infants who are >1000 g, start at 24 hours of age or sooner. Start feeds at 15 to 20 mL/kg per day every 2 to 3 hours and advance at 15 to 20 mL/kg per day.

PBP 78: Use a consistent definition of “feeding intolerance” (this PBP has not been formalized yet).

PBP 79: Promote and provide breast milk as the preferred substrate.

PBP 80: Early initiation of total parenteral nutrition preferably within the first 24 hours of life. Base hyperalimentation solution is taken and started on transport for all infants who are <1250 g. Basic metabolic panel is obtained by 12 to 24 hours of age and coordinated to occur before 1500 so that new hyperalimentation preparation will occur before 1700 g. Protein concentration advances by 0.5 g/kg per day to a maximum of 3.5 g/kg per day. Calcium 10 mEq/L is added to the base hyperalimentation. All other vitamins and minerals are added with the first new hyperalimentation mix.

PBP 81: Assess nutritional outcome (growth) measures at day of life 28 and at 34 weeks’ postmenstrual age. Report to the medical/rounding team.

PBP 82: Assess nutritional adequacy at regular intervals. Report to the medical/rounding team.

Reduce Intraventricular Hemorrhage
PBP 83: Promote antenatal betamethasone.

PBP 84: Optimize peripartum management. Wee Deliver exploratory group work.

PBP 85: Provide for clinical management by neonatologists and NNPs. The most high-risk infants are treated by the NNPs.
PBP 86: Minimize pain and stress responses by the provision of developmentally supportive care. Use the “NICU Pain Resource Book” (red binder in each pod) for the pain guidelines and the suggestions for procedure-specific pain management interventions.

PBP 87: Minimize pain and stress responses by the judicious use of medications. Document pain assessments and pain interventions, including medications, as well as the infant’s response.

PBP 88: Avoid early lumbar puncture.

PBP 89: Use optimal positioning techniques. This is related to developmental care. In infants who are <1500 g in the first week of life, keep the head in a neutral and midline position at all times. Avoid prone positioning. Avoid raising hips more than a few centimeters for diaper changes. Elevate head of bed 30 degrees. Gently turn body as a unit when changing linen and giving care.

PBP 90: Minimize fluid volume treatment of hypotension. Hypotension does not mean shock. Before giving a fluid bolus, ask the following questions: (1) What is the infant’s tone? (2) Is the infant tachycardic? (3) Is the infant pale? (4) How long has the blood pressure been low? (5) What is the infant’s urinary output? (6) What is the infant’s cap refill? (7) What is the infant’s oxygenation? (8) Have you spoken with the attending first? Protocol for hypotension: for treatment, 2 or more of the following must be present: (1) mean BP < [GA in weeks + (postnatal age in days × 2)] for >15 minutes; (2) cap refill >3 seconds; (3) cool, mottled extremities; (4) metabolic acidosis >0.6 mEq; (5) unexplained heart rate >170 (ie, no agitation, pain, or “fever”); and (6) decreased urinary output <1 mL/kg per hour over the previous 4 hours. Treatment: (1) normal saline 10 mL/kg over 30 minutes twice, (2) dopamine 5 µg/kg per minute and increase up to 10 µg/kg per minute if needed, (3) dobutamine 5 µg/kg per minute and increase up to 10 mcg/kg per minute if needed, (4) echocardiogram to assess cardiac function, (5) hydrocortisone 1.25 mg/kg per dose × 2 doses, 4 hours apart.

PBP 91: Use indomethacin prophylactically.

PBP 92: Optimize respiratory care by using synchronized IMV or HFOV.

PBP 93: Avoid hypocapnia.

PBP 94: Avoid chest physiotherapy. Limit suctioning.

PBP 95: Limit the use of sodium bicarbonate.

PBP 96: Use postnatal dexamethasone judiciously.

Enrich Family-Centered Care

PBP 97: Unit vision and philosophy addresses family-centered care principles. The NICU mission and philosophy statements both address family-centered care principles. NICU mission: to provide an environment and culture that promotes and supports the optimal provision of family-centered, developmentally supportive care; to facilitate cooperation and collaboration among the disciplines involved in providing our care; to enhance the effectiveness and efficiency of our care; and to promote our ethical and professional conduct. NICU philosophy: optimal neonatal care is provided by an interdisciplinary collaborative group of highly skilled professionals with expertise in many roles and activities. All neonates and their families have the right to this care. This group of specialists recognizes and accepts its responsibility and duty to ensure the provision of this care.

PBP 98: Provide leadership that promotes family-centered care. See “Rounds Reformation” document.

PBP 99: Build family-centered care into the unit culture reflecting ownership, teamwork, and a spirit of cooperation. See “Rounds Reformation” document.

PBP 100: Establish multidisciplinary collaboration as the foundation of the unit’s work. See “Rounds Reformation” document.

PBP 101: Design care processes with attention to the infant’s and the family’s experience of care. See “Rounds Reformation” document.

PBP 102: Support active family participation in care. Give the family a copy of the “Neonatal Parent Path to Home” (parent pathway) at admission. Encourage parent presence at the bedside, including during patient care rounds and change of shift report. Inform parents of the Parent Mentor Program (information in the Infant Care Book).

PBP 103: Create a family-centered physical environment.

PBP 104: Continuous quality improvement is supported and expected; quality improvement plans include indicators related to the promotion of family-centered care. NICU scope of responsibility: to develop and support research, quality, and performance improvement activities that incorporate 4 key habits: (1) the habit for change, (2) the habit for collaborative learning, (3) the habit for evidence-based practice, and (4) the habit for systems thinking.

PBP 105: Create opportunities for families to serve as advisors.

PBP 106: Provide staff development education, resources, and support to actualize family-centered care changes.
APPENDIX 2: SEXTUPLE CALL TREE

Call comes into NICU from perinatal center

Nurse manager or clinical nursing coordinator initiates call tree

1. Transport call tree initiated
2. Respiratory care call tree initiated
3. NNP call, nursing staff, and neonatologist tree initiated
4. Administration call tree initiated: includes public relations, telecommunication, and security
Management of High-Order Multiple Births: Application of Lessons Learned Because of Participation in Vermont Oxford Network Collaboratives
Anand D. Kantak, Jennifer L. Grow, Judy Ohlinger, Heather J. Adams, Amy M. Knupp and Justin P. Lavin, Jr
Pediatrics 2006;118;S159
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The online version of this article, along with updated information and services, is located on the World Wide Web at:
/content/118/Supplement_2/S159.full.html