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A Survey of Delivery Room Resuscitation Practices in the United States

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ABSTRACT

OBJECTIVE. To determine current resuscitation practices of neonatologists in the United States.

METHODS. A 15-question survey was developed and mailed to neonatal directors in May 2004.

RESULTS. Of the total of 797 surveys mailed, 84 were returned undeliverable or unanswered and 450 were returned completed (63% response rate). Respondents were mainly (70%) from level III NICUs. Most programs resuscitate newborns in the delivery room (83%), rather than in a separate room. The number and background of individuals attending deliveries vary greatly, with 31% of programs having <3 individuals attending deliveries. Flow-inflating bags are most commonly used (51%), followed by self-inflating bags (40%) and T-piece resuscitators (14%). Pulse oximeters are used during resuscitation by 52% of programs, and 23% of respondents indicated that there was a useful signal within 1 minute after application. Blenders are available for 42% of programs, of which 77% use pure oxygen for the initial resuscitation and 68% use oximeters to alter the fraction of inspired oxygen. Thirty-two percent of programs use carbon dioxide detectors to confirm intubation, 48% routinely and 43% when there is difficulty confirming intubation. Preterm infants are wrapped with plastic wrap to prevent heat loss in 29% of programs, of which 77% dry the infant before wrap application. A majority of programs (76%) attempt to provide continuous positive airway pressure or positive end expiratory pressure (PEEP) during resuscitation, most commonly with a flow-inflating bag (58%), followed by a self-inflating bag with PEEP valve (19%) and T-piece resuscitator (16%). A level of 5 cm H₂O is used by 55% of programs.

CONCLUSIONS. Substantial variations exist in neonatal resuscitation practices, some of which are not addressed in standard guidelines. Future guidelines should include recommendations regarding the use of blenders, oximeters, continuous positive airway pressure/PEEP, and plastic wrap during resuscitation.

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Key Words

neonatal resuscitation, survey, practice variation, delivery room

Abbreviations

NRP—Neonatal Resuscitation Program
PEEP—positive end expiratory pressure
CPAP—continuous positive airway pressure
PPV—positive pressure ventilation
ELBW—extremely low birth weight

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ATEMPTS TO REVIVE depressed newborns immediately after birth have been made for hundreds of years. Dr James Blundell's description of the resuscitation of a "still-born" infant in 1834 is remarkably similar to procedures practiced currently, including evaluating the chord pulsations and attempting artificial respirations with a "tracheal pipe."¹ The procedures involved in neonatal resuscitation have been organized into a sequential process of evaluation and interventions. With the help of the American Heart Association and the American Academy of Pediatrics, the Neonatal Resuscitation Program (NRP) was devised as a method of teaching large numbers of providers this organized process of neonatal resuscitation. The manual, printed originally in 1987 and now in its fourth edition, has been revised through discussions with experts in the field and consideration of available evidence. The program has been taught to >1.5 million providers and is used by many as a clinical guideline.²

A number of randomized trials have compared the use of room air versus 100% oxygen for initial neonatal resuscitation,^{3,4} and there is increasing interest in the use of continuous positive airway pressure (CPAP) starting at birth for extremely low birth weight (ELBW) infants. In addition, advancements in technology, including improved pulse oximetry, small, colorimetric, carbon dioxide detectors, and a variety of devices for providing positive pressure ventilation (PPV), have become available in recent years. Many of these practices are not discussed in the current resuscitation guidelines. To define current neonatal resuscitation practices, we surveyed neonatal directors throughout the United States.

METHODS

A survey was developed to address delivery room resuscitation practices and to determine the extent of variation or consistency that exists in neonatal programs in the United States. The survey consisted of 15 questions regarding the level of care, areas where infants are resuscitated, types of PPV used during resuscitation and transport, individuals attending deliveries, use of blended oxygen, pulse oximeters, and monitors, use of plastic wrap for ELBW infants, use of carbon dioxide detectors for intubation, and use of CPAP or positive end expiratory pressure (PEEP) during resuscitation (Appendix). The survey was mailed to all neonatal directors listed in the 2002 American Academy of Pediatrics directory of neonatologists/perinatologists in the United States. A second mailing was sent to nonrespondents 6 to 8 weeks after the initial mailing.

RESULTS

Surveys were mailed to 797 neonatal directors in the United States in May 2004. A total of 450 surveys (response rate: 63%) were completed and returned after

the 2 mailings, plus 84 returned as undeliverable or unanswered; of those, 5 were from hospitals that did not have a delivery service. In a review of the responses, it was determined that 6 hospitals were represented by >1 survey response. These duplicate responses were not included in the results. Respondents were from all 50 states. Most respondents (314 respondents, 70%) were from level III, community, or regional NICUs. Another 63 respondents (14%) were from level IV or extracorporeal membrane oxygenation centers.

Most programs (374 programs, 83%) resuscitate newborns in the delivery room. The remaining programs resuscitate newborns in a room near the delivery room (75 programs, 17%) or in the NICU (30 programs, 7%). Usual resuscitation teams are composed of <3 individuals in 31% of programs. Team members may include neonatal attending physicians in 366 programs, fellows in 80 programs, attending pediatricians in 36 programs, pediatric residents in 177 programs, neonatal nurse practitioners in 214 programs, neonatal nurses in 400 programs, and respiratory therapists in 299 programs.

Oxygen blenders are available in the delivery room in 189 programs (42%). Among programs with blenders available, 146 (77%) initiate resuscitation with a fraction of inspired oxygen of 1.0. The decision to vary oxygen levels is made with the help of pulse oximetry in 129 programs (68%) with blenders. The remaining programs with blenders use color or other clinical signs to adjust the fraction of inspired oxygen. Among all responding programs, pulse oximeters are available in the delivery room in 233 programs (52%). Among programs using oximeters, 53 (23%) reported that the oximeters are applied and functioning within the first 1 minute of life in most cases. Respondents reported the use of other types of monitors, such as heart rate or temperature monitors, in the delivery room in 274 programs (61%).

PPV is provided in the resuscitation area with flow-inflating bags in 231 programs (51%), self-inflating bags in 178 programs (40%), and T-piece resuscitators in 63 programs (14%). When infants are being transported from the resuscitation area to the NICU, devices used to provide PPV include flow-inflating bags in 198 programs (44%), self-inflating bags in 144 programs (32%), transport ventilators in 110 programs (24%), and T-piece resuscitators in 49 programs (11%). More than 1 device is used to provide PPV in the resuscitation area in 30 programs (7%) and during transport to the NICU in 71 programs (16%).

CPAP or PEEP is used in the delivery room in 342 programs (76%). Devices used to provide CPAP or PEEP in the delivery room include flow-inflating bags (198 programs, 58%), self-inflating bags with PEEP valves (88 programs, 25%), T-piece resuscitators (66 programs, 19%), ventilators (46 programs, 13%), and other devices (26 programs, 7%). More than 1 device is used in

65 programs that provide CPAP or PEEP in the delivery room. The level of CPAP used is 5 cm H₂O in 191 programs (56%), 4 cm H₂O in 49 programs (14%), 6 cm H₂O in 47 programs (14%), and 7 cm H₂O in 2 programs (0.5%). Criteria for providing CPAP/PEEP are delivery to all infants requiring PPV in 214 programs (63%), to all preterm infants of <1500 g in 66 programs (19%), and to select infants in 95 programs (27%).

A carbon dioxide detector is used to confirm intubation in 145 programs (32%), of which 136 programs use a qualitative carbon dioxide detector (eg, Pedicap [Nellcor Puritan Bennett, Pleasanton, CA]) and 9 programs use a quantitative carbon dioxide detector (eg, end-tidal carbon dioxide detector). Of programs using carbon dioxide detectors, 69 (48%) use the device for every intubation and 63 (43%) use the device when there is difficulty determining successful intubation.

ELBW infants are wrapped in plastic to prevent heat loss in 129 programs (29%). When plastic wrap is used for ELBW infants, it is applied after the infant is dried in 99 programs (77%).

DISCUSSION

This survey of neonatal directors in the United States is, to our knowledge, the largest survey of delivery room resuscitation practices available. Because we solicited responses from directors, the actual practices of individual providers may not be represented. However, much of the information obtained in this survey is related to available equipment and intent to use different practices. The results of this survey are most reflective of practices in advanced-level neonatal units; 84% of our responses were from level III or IV units. Therefore, the survey is less representative of resuscitation practices in level I and level II units. We are reporting the level of unit that was indicated by the respondents on the survey forms. According to the directory used to identify directors, 85% of the units included were considered at least level III (subspecialty care including the designations IIIA–IIID) or were listed as a freestanding children's hospital. Therefore, the response rate among levels does not seem to be different. Since the mailing of our survey, an American Academy of Pediatrics policy statement from the Committee on Fetus and Newborn provided new recommendations for levels of neonatal care. Therefore, what was labeled as level IV (extracorporeal membrane oxygenation) on our survey would now be called level IIIC.⁵

There is a lack of uniformity in the numbers of individuals who attend deliveries, as well as the composition of the team. The NRP manual states that there should be a minimum of 2 resuscitators attending every delivery. In our own experience, the tasks involved in a complicated resuscitation, including airway management, suctioning, heart rate monitoring, and oxygen saturation monitoring, are performed more easily with a minimum

of 3 individuals. We asked participants to indicate the number and discipline of members of their "usual resuscitation team." It was of interest that 31% of programs have usual teams composed of 2 individuals. We received a number of comments indicating that institutions select the team, size, and composition on the basis of the expected problems at delivery. In fact, it is probably frequent practice that the number of team members and the team composition are determined by the specific circumstances of the delivery.

Providing adequate thermoregulation for preterm infants is especially important. The EPICure study showed that admission temperatures of $\leq 35^{\circ}\text{C}$ among infants of <26 weeks' gestation were associated with increased mortality rates.⁶ The occurrence of hypothermia (admission temperature of $\leq 35^{\circ}\text{C}$) in that study was 29.6% among infants born at 25 weeks, 42.7% among infants born at 24 weeks, and 58.3% among infants born at 23 weeks. At least 2 prospective randomized trials reported the benefit of polyethylene wrap for preventing heat loss among ELBW infants.^{7,8} In those studies, the resuscitators dried the infants' head and placed the polyethylene wrap over the body without drying, and they found an improvement in admission temperatures for infants of <28 weeks' gestation. Direct application of the wrap without drying reduces evaporative and convective heat losses.⁹ Additional measures to improve infant admission temperatures may include elevation of the temperature of the room, use of a preheated radiant warmer, and, in our own experience, use of servo-controlled probes to prevent the radiant warmer from shutting down after 15 minutes of non-servo-controlled operation.¹⁰ Although more studies are needed to determine the short- and long-term benefits of the use of occlusive wrap, the data available at the present time suggest that this is a relatively simple intervention that can prevent heat loss among ELBW infants.

Although there have been studies evaluating the use of pulse oximetry during neonatal resuscitation,^{11,12} there have been no prospective randomized trials comparing resuscitation with and without pulse oximetry. However, all infants with any form of distress are monitored continuously with pulse oximetry after admission to a NICU. Pulse oximeters not only provide information about oxygen saturation but also provide a continuous audible heart rate signal, allowing all team members to perform other tasks. In 1993, the American Association for Respiratory Care made a recommendation that pulse oximetry should be available for neonatal resuscitation.¹³ Of our survey respondents who use pulse oximeters, 23% indicated that they had useful readings within 1 minute. Although the onset of functionality may be variable, oximeters remain useful for monitoring the subsequent care of infants and are essential if clinicians wish to use a blender and to provide <100% oxygen. In the delivery room, the ideal pulse oximeter should be set

to its lowest averaging time and highest sensitivity; one manufacturer has developed a probe that adjusts the oximeter to these settings automatically (LNOP Hi-Fi Trauma; Masimo Corp, Irvine, CA).

Although the current NRP recommendation is to resuscitate infants with 100% oxygen, increasing information suggests that room air may be as efficacious, especially for near-term and term infants, and may be associated with lower mortality rates.^{3,4} Almost all of these trials excluded infants of <1000 g; therefore, more information is required for very preterm infants. A compressed air source and a blender are required to deliver ranges of oxygen between 21% and 100%. When blenders and a compressed air source are available, teams can use pulse oximeters to adjust the amount of oxygen delivered to an appropriate level for the condition of the infant. Our experience in evaluating neonatal resuscitation suggests that infants spend far more time in the resuscitation area than is anticipated, and the use of blenders and oximeters in such circumstances can reduce unnecessary exposure to excessive oxygen levels, with associated toxicity.

For the delivery of positive pressure breaths, 51% of programs use flow-inflating bags and 40% use self-inflating bags. More than 1 device is available for resuscitation in 30 programs (7%). Although the current edition of the NRP guidelines does not mention the use of a T-piece resuscitator, 14% of programs surveyed use such a device. In an international survey of resuscitation practices, O'Donnell et al¹⁴ determined that a T-piece resuscitator was used in 30% of centers. In that survey, a self-inflating resuscitator was used most frequently, possibly reflecting the World Health Organization guidelines¹⁵ and the lack of an available gas source in some areas.

We have performed 2 mannequin-based evaluations of neonatal resuscitation devices, comparing flow-inflating bags, T-piece resuscitators, and, most recently, self-inflating bags.^{16,17} Our observations from these studies indicated that the T-piece resuscitator delivers the desired pressures most consistently and that both T-piece resuscitators and flow-inflating bags are capable of delivering end expiratory pressure as well as prolonged inflations. Self-inflating bags have a greater tendency to permit excessive pressures. Previous observations confirm that the T-piece resuscitator delivers desired pressures more consistently and may be easier to use for a variety of operators.¹⁸ To date, there has been no prospective study actively comparing any of these 3 types of

devices in actual human resuscitations, and we think that such a study is necessary.

All infants who require assisted ventilation receive PEEP during mechanical ventilation, and numerous infants are treated for respiratory distress with various forms of CPAP. No current recommendation exists for the use of CPAP or PEEP in the delivery room, and there have been no prospective studies evaluating the efficacy of CPAP or PEEP in this environment. Many animal studies have demonstrated that CPAP/PEEP helps establish and maintain functional residual capacity, improve surfactant function, and reduce signs of lung injury.¹⁹⁻²² The severity of respiratory distress syndrome has correlated with the functional residual capacity at birth.²³ In a previous survey, we determined that >70% of neonatologists used CPAP,²⁴ and the current survey demonstrated that 76% of programs attempt to deliver CPAP/PEEP. This survey did not distinguish specifically between the use of CPAP and PEEP. It is apparent that CPAP and PEEP are used frequently during neonatal resuscitation and that future resuscitation guidelines need to discuss the appropriate role of CPAP and PEEP during resuscitation. Although our findings indicate that 56% of respondents target a pressure of 5 cm H₂O, the optimal level of CPAP has not been determined and requires additional research.

Current NRP guidelines recommend the use of a carbon dioxide detector if there is any doubt about the placement of an endotracheal tube. Our survey revealed that 32% of programs use carbon dioxide detectors for confirmation of intubation. Interestingly, only 48% of programs that use carbon dioxide detectors do so routinely for every intubation. Previous studies by Repetto et al²⁵ and Aziz et al²⁶ demonstrated clearly that the use of carbon dioxide detectors reduces the amount of time required to determine that an endotracheal tube is in an incorrect location.

CONCLUSIONS

We think that the results of this survey will be useful in developing future revisions of the guidelines for neonatal resuscitation. Discussions within the guidelines should include all types of resuscitation devices currently being used, the role of blenders and pulse oximeters during resuscitation, and the use of plastic occlusive wrap for the prevention of heat loss among ELBW infants. We hope that this survey will help define areas where there is lack of uniformity and encourage the performance of prospective evaluations, so that future recommendations can be evidence based.

APPENDIX: DELIVERY ROOM RESUSCITATION SURVEY

Delivery Room Resuscitation Survey
UCSD Medical Center

Please circle answers and fill in blank where appropriate.

Name _____ Institution _____

If you do not provide delivery room resuscitation services in your institution or program please check here, skip to question 15 and return the form.

1. Please indicate the highest level of care provided in your unit and circle your unit type if applicable.

- A. I, low level neonatal care
- B. II, intermediate level neonatal care
- C. III, advanced level neonatal care, Community, or Regional NICU
- D. IV (ECMO)

2. Where do you resuscitate high-risk/unstable infants after delivery?

- A. In the delivery room
- B. In a separate room near the delivery room
- C. In the NICU or separate room adjacent to NICU
- D. Other (please specify) _____

3. If you need to transport infants to the NICU after resuscitation, how do you provide ventilation during transport?

- A. Transport ventilator
- B. Self-inflating bag
- C. Flow-inflating bag or Anesthesia-type Bag
- D. T-piece resuscitator (eg. Neopuff[®])
- E. Other (please specify) _____

4. Which of the following members compose your **usual** resuscitation team, (circle all that apply and indicate in the space provided how many people of that discipline attend each delivery)

- | | Number |
|-----------------------------------|--------|
| A. Attending neonatologist | _____ |
| B. Neonatology Fellow | _____ |
| C. Attending pediatrician | _____ |
| D. Pediatric Resident | _____ |
| E. Neonatal nurse practitioner | _____ |
| C. Neonatal nurse | _____ |
| D. Neonatal respiratory therapist | _____ |
| E. Other _____ | _____ |

5. When providing positive pressure ventilation with a mask in the delivery room is you device of choice a:

- A. Self-inflating bag
- B. Flow-inflating bag or Anesthesia-type Bag
- C. T-piece resuscitator (eg. Neopuff[®])
- D. Other (please specify) _____

6. Do you have an oxygen blender in any of your delivery room resuscitation areas?

- A. Yes
- B. No

7. If you have oxygen blenders available, what is your initial FiO₂ used during resuscitation?

- A. 100%
- B. Other (please specify)_____

How do you decide to change FiO₂?

- A. Based on saturation from a pulse oximeter
- B. Based on color
- C. Other (please specify)_____

8. Do you have pulse oximeters in any of your delivery room resuscitation areas?

- A. Yes
- B. No

If "Yes", how frequently do you find that they are applied and provide a heart rate and SpO₂ in the first 1 minute of life?

- A. On **most** occasions (>75%)
- B. On **some** occasions (25-75%)
- C. On **few** occasions (<25%)

9. Do you have any other type of monitoring in the delivery room? (Circle all that apply)

- A. Separate heart rate monitoring
- B. Temperature monitoring
- C. Other (please specify)_____

10. Do you routinely apply plastic/thermal wrap to ELBW infants immediately after delivery?

- A. Yes
- B. No

If "Yes", do you dry the infants before applying the wrap?

- A. Yes
- B. No

11. Do you use CO₂ detectors in the delivery room to confirm intubation?

- A. Yes – Qualitative (eg. Pedicap®)
- B. Yes – Quantitative (eg. End tidal CO₂)
- C. No

If "Yes", how often do you use the CO₂ detector?

- A. With every intubation.
- B. Only when there is difficulty determining if intubation is successful.

12. Do you use CPAP or PEEP in the delivery room?

- A. Yes
- B. No

If "Yes", which device do you use to provide CPAP/PEEP? (please circle all devices used)

- A. Self inflating bag
 - a. With PEEP valve
 - b. Without PEEP valvePlease specify bag used _____
- B. Flow inflating bag
- C. T-piece resuscitator
- D. Ventilator

If more than one device is used which is used most frequently? _____

13. If you use CPAP/PEEP in the delivery room, what level of pressure do you use?

- A. 4
- B. 5
- C. 6
- D. 7
- E. Other _____

14. If you use CPAP/PEEP in the delivery room, for which patients do you use it? (circle all that apply)

- A. All infants who require positive pressure ventilation.
- B. All preterm infants <1500 grams.
- C. Select infants (please specify) _____

15. May we acknowledge your participation in this survey in any future publication of the results?

- A. Yes
- B. No

Please provide your name, title and institutional information as you would like it to appear in any publication.

Name _____
Title _____
Institution _____
Address _____

Thank you for your participation!

Please add any additional comments:

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