Neonatal resuscitation: raising the bar.

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PURPOSE OF REVIEW: To provide an overview of neonatal resuscitation practices with an emphasis on interventions that are not currently accepted or adapted into existing resuscitation guidelines. RECENT FINDINGS: Current resuscitation guidelines do not contain specific guidelines for the approach to the extremely low birth weight infant. The differences in environment and management between the neonatal ICU and delivery room are striking and are magnified in the resuscitation of extremely low birth weight infants for whom maintenance of a neutral thermal environment is essential. The use of a polyethylene wrap applied at delivery has been shown to reduce the occurrence of hypothermia and decrease mortality. There is substantial evidence that term and near-term newborn infants can be effectively resuscitated with room air, and recent follow-up studies have demonstrated that this approach is not associated with increased significant differences in neurologic handicap, somatic growth, or developmental milestones when compared with the use of 100% oxygen. The safety and potential benefits of this approach require prospective evaluation in the premature and especially extremely low birth weight infant. There is preexisting evidence that demonstrates that the use of prolonged inflations and t-piece resuscitators may be advantageous during resuscitation, but not all guidelines support these interventions. Although regulated continuous positive airway pressure, pulse oximeters, and blenders are routinely used once an infant is admitted to the neonatal ICU, none of these interventions is recommended in the delivery area. Although prospective studies have demonstrated that the use of colorimetric CO2 detectors significantly decreases the time to recognize misplaced endotracheal tubes placed during resuscitation, their use is not required by current guidelines. The duration of an intubation attempt during resuscitation had never been prospectively evaluated, and our recent findings suggest that a limit of 30 seconds is well tolerated and provides adequate time for a successful attempt. SUMMARY: There is significant potential for improvement in current resuscitation environments and interventions that will only be realized through further prospective research.

Publication Types:
  Review
  Review Literature

PMID: 15021194 [PubMed - indexed for MEDLINE]


[Neonatal resuscitation in the delivery room: educational process and evaluation]

[Article in French]

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Based upon a three necessities basis: public health, biological and medico-legal, this article presents the state of the art about teaching neonatal resuscitation in the delivery room. The educational process is present worldwide; main experiences are described. Evaluation of these actions varies in the literature. We analyze the evaluation of the process of the trained professionals, their satisfaction, the changes in their practices, their theoretical and practical levels, and the impact on newborns' health. We propose a few measures to make official this kind of teaching in France, with a certificate for instructors and trained professionals.

Publication Types:
Review
Review, Tutorial

PMID: 15005079 [PubMed - indexed for MEDLINE]

Neonatal transfers by advanced neonatal nurse practitioners and paediatric registrars.

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OBJECTIVE: To evaluate the safety and practicality of using advanced neonatal nurse practitioners (ANNPs) to lead acute neonatal transfers. DESIGN: Comparison of transport times, transport interventions, and physiological variables, covering the first four complete years of operating a transport service that uses ANNPs and specialist paediatric registrars (SpRs) interchangeably. SETTING: Tertiary neonatal transport service. PATIENTS: The first 51 transfers of sick infants under 28 days of age by an ANNPs led transport team into Nottingham compared with the next consecutive SpR led transfer after each ANNPs led one. MAIN OUTCOME MEASURES: Transport times; interventions and support given during stabilisation for transfer and during transfer; condition on completion of transfer, assessed from blood glucose, systolic blood pressure, pH, oxygenation, and temperature. RESULTS: The ANNPs led team responded more rapidly to requests for transfer and took longer to stabilise babies. The groups undertook similar numbers of procedures during stabilisation, and there were no differences in the ventilatory and other support that infants needed in transit. The infants transferred by the doctor led group had worse values for pH (doctor led, 7.31 (6.50-7.46); ANNPs led, 7.35 (7.04-7.50), p = 0.02) and PaO(2) (doctor led, 6.7 (2.4-13.1); ANNPs led, 8.7 (3.5-17.0); p = 0.008) before transfer (all values median (range)). Comparisons of the infant's condition before and after transfer showed a significant improvement in temperature for the infants transferred by ANNPs led teams (36.8 degrees C (34.0-37.8) v 37.0 degrees C (34.6-36.0), p = 0.001) and in oxygen saturation (96% (88-100) v 98% (92-100), p = 0.01). There were no differences between the ANNPs and doctor led groups in the values obtained for any variable after transfer. CONCLUSIONS: Clinical condition on completion of transport is similar for babies transferred by ANNPs and doctor led teams. ANNPs led transport appears to be practical and safe.

PMID: 14602700 [PubMed - indexed for MEDLINE]

Organization of neonatal care services and its importance.

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Universally 4 million newborns die and another 4 million are stillborn every year. 98% of these neonatal deaths take place in the developing countries. Looking at the state of the world's newborns one can see that neonatal mortality rate is about 4-5 per 1000 in the developed countries and nearly 10 fold this in the developing world. Causes that underlie these newborn deaths differ according to a country's development rank. According to the WHO estimates for the year 2001, newborns die due to infections (32%), birth asphyxia and trauma (29%), prematurity (24%) and congenital anomalies (10%), mostly in the developing countries. When organizing neonatal care services in a country or a region, priorities should be decided by looking at neonatal and perinatal mortality rates and causes of neonatal and perinatal deaths. Causes of neonatal and perinatal deaths in the developing countries have been documented and reflect some common underlying problems in the health systems. Starting points in the organization of neonatal health care services seem to include: improving women's health and social status, family planning practices, antenatal care and safe delivery conditions. Attention should also be paid to neonatal resuscitation, essential newborn care and sick newborn care practices. Communities and health professionals should be advocates of newborn health in order to seek and deliver newborn health care. Existing health systems should be re-organized to host regionalized perinatal care.

Publication Types:
Review
Review, Tutorial

PMID: 14601260 [PubMed - indexed for MEDLINE]


Resuscitation of premature infants: what are we doing wrong and can we do better?

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Neonatal resuscitation is based on experience with little evidence to support the methods advocated. Current guidelines make no distinction between the techniques for term and very premature infants. The guidelines support the use of 100% cold, dry oxygen delivered with devices that provide variable peak inspiratory pressures and tidal volumes with no positive end-expiratory pressure (PEEP). It is possible that these techniques damage the lungs. Self-inflating resuscitation bags give no indication about leaks, produce variable inflating pressures, do not provide PEEP and cannot deliver prolonged inflations. Flow-inflating bags will not work if there is leak at the facemask and also have variable inflating pressures. Although they can provide PEEP and deliver prolonged inflations, they require considerable skill to use. The Neopuff is relatively easy to use, provides PEEP and steady inflating pressure and does not achieve the set pressures if there is a mask leak. Continuous positive airway pressure and PEEP are used in the neonatal intensive care unit to maintain lung volume. It is surprising they are not routinely recommended for resuscitation.
when establishing the lung volume is paramount. Volutrauma is a potential problem in neonatal resuscitation and yet none of the devices give any indication of the tidal volume delivered. There is considerable potential for improvement in techniques of neonatal resuscitation through the application of evidence already available and much scope for further research in this field.

Publication Types:
Review
Review, Tutorial

PMID: 12890941 [PubMed - indexed for MEDLINE]


A prospective clinical audit of neonatal resuscitation practices in Canada.

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PURPOSE: This is a prospective audit to determine the frequency of resuscitation interventions in the clinical setting and to compare self-reports of clinical performance with the existing Neonatal Resuscitation Program (NRP) and Canadian National Guidelines for Neonatal Resuscitation. SUBJECTS: Fifty-six level I, II, and III hospitals in Canada participated. Any infant requiring resuscitation, as defined by the need for at least positive pressure ventilation (PPV), was eligible for inclusion (n = 783 resuscitations). DESIGN AND METHODS: A prospective self-report audit was chosen and data were collected over a 6-month period in 1998. The audit focused on the use of PPV, intubation, chest compressions, free-flow oxygen, or medications during the resuscitation. The infant's temperature at the end of resuscitation was also noted. The data were analyzed with descriptive statistics. The composition of the resuscitation team and their NRP certification status were recorded. PRINCIPAL RESULTS: The need for resuscitation was not anticipated in 76% of the cases (596 of 783). Errors in the sequencing of care, such as delays in initiating PPV, provision of chest compressions before or without establishing an airway and ventilatory support, and administering naloxone before PPV, were reported. Resuscitations attended by a team of NRP certified providers had improved sequencing when compared with those in which only some individual providers were certified. Chest compressions were provided in 8% of the cases (65 of 783). Medications were used in 14% (113/783) of all cases. Providers in level I hospitals performed chest compressions more frequently than those in level II and III settings. At the end of the resuscitation, 27% of the infants were hypothermic (142 of 520), and 25% were hyperthermic (128 of 520). Overall, 52% were out of the normal neutral range. CONCLUSIONS: Clear differences between the NRP guidelines and actual clinical practice were shown. A high rate of unanticipated resuscitations, delivery room medications, and chest compressions was described. Postresuscitation hypothermia or hyperthermia were common. Improved sequencing was noted when the entire resuscitation team was NRP certified. Certification in NRP does not assure competency, nor does it ensure compliance with established standards of care.

PMID: 12881944 [PubMed - indexed for MEDLINE]
Neonatal emergencies. A case-based approach to treating medical emergencies of newborns from birth to 28-days-old.

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Publication Types:
Case Reports

PMID: 12872073 [PubMed - indexed for MEDLINE]


Neonatal resuscitation.

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Ten million or more newborns worldwide each year need some type of resuscitation assistance. More than 1 million babies die annually from complications of birth asphyxia. Over the past 3 decades, neonatal resuscitation has evolved from disparate, word-of-mouth teaching methods to organized programs. The most widely-used curriculum is the Neonatal Resuscitation Program, which is supported by the American Academy of Pediatrics and the American Heart Association. To date, more than 1.5 million individuals have been trained in the Neonatal Resuscitation Program. Resuscitation efforts are geared toward avoiding or mitigating the adverse sequelae of asphyxia neonatorum. Certain characteristics distinguish the preterm infant, including propensity to become hypothermic and higher potential for adverse neurologic and pulmonary complications from resuscitation efforts. In this era of evidence-based medicine, the most recent Neonatal Resuscitation Program guidelines were developed to provide recommendations based on the best currently-available science. A number of major proposals received considerable scrutiny during the evaluation process. Many areas of neonatal resuscitation still need to be studied.

PMID: 12667278 [PubMed - indexed for MEDLINE]


Practice Tips: Umbilical cord model. Useful for teaching neonatal resuscitation.

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PMID: 12602840 [PubMed - indexed for MEDLINE]

Resuscitation of the newly born.

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International guidelines developed recommendations in the resuscitation of the new-born: at least one person trained in resuscitation of the newly born should attend every delivery. A minority of the new-borns require active resuscitation to achieve regular respiration, heart rhythm above 100/min, pink colour and adequate tone. Establishment of adequate ventilation should be of primary concern. Most new-borns who require positive-pressure ventilation can be adequately ventilated with a bag and mask. All healthcare providers, who may be asked to deal with an emergency delivery, should master such technique. In case of meconium-stained amniotic fluid, thorough oropharyngeal suctioning should be perform before the delivery of the chest. Tracheal aspiration of meconium should be perform only in depressed child. Very few infants require chest compressions and much less administration of drugs. Umbilical access remains the most widely recommended access in new-born. Adequate transfer to Neonatal Unit improves outcome.

Publication Types:
Guideline
Review
Review, Tutorial

PMID: 12503356 [PubMed - indexed for MEDLINE]


Neonatal resuscitation for small for gestational age babies.

Agadi S.

Publication Types:
Letter

PMID: 12493321 [PubMed - indexed for MEDLINE]


Comment in:


Wu TJ, Carlo WA; Neonatal Resuscitation Program.

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Based on extensive evaluation of the existing evidence and consensus development, there are new recommendations in the Neonatal Resuscitation Program.
(NRP) guidelines 2000. These guidelines are described along with a brief review of the supporting evidence. The goal is to establish a framework for practice of neonatal resuscitation with a more scientific, evidence-based approach.

Publication Types:
Guideline
Practice Guideline

PMID: 12380601 [PubMed - indexed for MEDLINE]


Using mnemonics and visual imagery to teach the new neonatal resuscitation program.

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Mnemonics have long been used to help learners remember facts in various disciplines of medicine. With the introduction of the revised Neonatal Resuscitation Program (NRP), it is vital for learners to know and remember important changes to the NRP curricula. While teaching the new curricula, we found that learners appeared confused, being unable to provide the correct sequence of answers to the questions posed during the assessment phase of the course. Mnemonics were developed to aid memory recall and optimize resuscitation skills.

PMID: 12082479 [PubMed - indexed for MEDLINE]


Zaichkin J; Neonatal Resuscitation Program.
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In 2000, the American Academy of Pediatrics and the American Heart Association formulated new international evidence-based guidelines for neonatal resuscitation. Whereas the earlier Neonatal Resuscitation Program guidelines incorporated a hierarchical approach to resuscitation, the revised program bases interventions on simultaneous assessment of breathing, heart rate, and color. Resuscitation success builds on the concepts of resuscitation readiness, knowledge and skills, teamwork, and self-efficacy. Six case reports illustrate revised Neonatal Resuscitation Program guidelines for managing selected resuscitation emergencies of newborns.

Publication Types:
Case Reports
Guideline

PMID: 12033549 [PubMed - indexed for MEDLINE]


Neonatal resuscitation: toward improved performance.

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BACKGROUND: As part of a continuous quality assurance process which we instituted in 1999, we review videotapes of selected high-risk deliveries at our hospital. We utilized our reviews to evaluate the occurrence of errors, and to evaluate team and leader functions during neonatal resuscitation. METHODS: We established accepted behavior for members of resuscitation teams and the team leader. The actual conduct of the resuscitation was judged against the standard of the guidelines of the Neonatal Resuscitations Program of the American Heart Association, and the American Academy of Pediatrics. The videotapes of resuscitations were reviewed, and significant deviations from accepted practices were noted, and discussed by a specifically developed quality assurance committee, including, whenever possible, the actual resuscitators. RESULTS: We were able to detect a number of problems, which included inappropriate leader and team member activities, inappropriate preparation, communication, and coordination, and made a number of changes to our practice. CONCLUSIONS: We believe that neonatal resuscitation may be improved by the provision of teaching about team and leader functions, encouraging debriefing following complicated resuscitations, developing a minimal form to be completed for any patient requiring compressions or epinephrine within the delivery room, and providing more direct observations regarding the actual conduct of resuscitation.

PMID: 11947979 [PubMed - indexed for MEDLINE]


Procedural training for pediatric and neonatal transport nurses: part 1-training methods and airway training.

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PMID: 11753197 [PubMed - indexed for MEDLINE]


Comparison of methods of bag and mask ventilation for neonatal resuscitation.

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BACKGROUND: There are a variety of manual bagging devices used for neonatal resuscitation. To our knowledge, there has been no comparison of the ability of different operators to utilize such devices for the delivery of predetermined inspiratory and end-expiratory pressures. In addition, the use of prolonged inflation may be of benefit for infants who require bag and mask ventilation, and there has been no evaluation of the ability of a variety of operators to reliably deliver such breaths using currently available equipment. METHODS: We utilized a neonatal manikin (Laerdal Armonk, NY) with a functional larynx and lungs, and a clear cushioned mask (Owens-Briant, Morganton, NC). We studied a latex-free disposable anesthesia type bag (Model 5126 Vital Signs, Totawa, NJ), a Jackson-Rees (JR) type anesthesia bag (Model E191 Anesthesia Associates, San Marcos, CA) fitted with a Norman elbow and a flow-control tail-piece (Dupaco, Oceanside, CA), and the Neopuff (Fisher and Paykel, Auckland, New Zealand), an FDA approved mechanical device that is flow-controlled and pressure-limited, specifically designed to facilitate neonatal resuscitation. The ventilating pressures were continuously recorded throughout the process. We evaluated neonatal nurses, neonatal nurse practitioners, neonatal staff and fellows, pediatric residents and neonatal respiratory therapists. RESULTS: The peak inspiratory pressure (PIP) was significantly different between operators using either anesthesia bag, P<0.001. Similar results were found for positive end-expiratory pressure (PEEP) with a significant difference among the operator groups, P<0.001. All the differences in post hoc analysis were between the therapists and the other groups, P<0.05. Therapists produced significantly higher pressures than the other groups for both PIP and PEEP (P<0.001). The PIP was similar for all groups using the Neopuff device. The PIP and PEEP delivered by the Neopuff differed from the other two devices independent of the operators (P<0.05). On post hoc analysis, there was a significant difference between the disposable anesthesia bag and Neopuff for both PIP and PEEP for the therapists, whereas among the non-therapists, there was a difference in PIP with the JR device producing a greater PIP (26.6+/−3.8 cmH(2)O) compared with the Neopuff and disposable anesthesia bag (24.8+/−2.1 cmH(2)O), 24.8+/−4.3 cmH(2)O). The level of PEEP was significantly different among all three devices for the non-therapists (1.3+/−1.6 cmH(2)O, Disposable; 2.9+/−1.2 cmH(2)O, JR; 4.7+/−0.5 cmH(2)O, Neopuff; P<0.05). Only the therapists were able to consistently deliver PEEP with the anesthesia bags, whereas all operators could generate the target PEEP with the Neopuff (P<0.05). We compared the pressure delivered during the first second to the pressure delivered during the fifth second during prolonged 5-s inflations. The absolute differences between the first and fifth second for the Neopuff versus the anesthesia bags were significantly different with a median of 7.1 cmH(2)O for the anesthesia bags compared with 0.2 cmH(2)O for the Neopuff, P<0.001, reflecting the difficulty in obtaining and maintaining the target inflation pressures. CONCLUSIONS: Our experience suggests that the Neopuff, a purpose-built neonatal resuscitator ventilator, facilitates the delivery of the desired airway pressures while maximizing the operators ability to obtain and maintain a patent airway, and facilitates the delivery of prolonged inflations. Further research is required to determine the clinical benefit of end-expiratory pressure and prolonged inflations in neonatal resuscitation.

Publication Types:

Evaluation Studies

PMID: 11719125 [PubMed - indexed for MEDLINE]


A survey of neonatal resuscitation training provided to general professional trainees at neonatal units in England and Wales.

Rangaraj S, Rangaraj J, Scholler I, Fuss P.

Publication Types:
Letter

PMID: 11710322 [PubMed - indexed for MEDLINE]


Videoconferencing can be used to assess neonatal resuscitation skills.

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OBJECTIVE: To examine the hypothesis that an instructor in a remote site can accurately assess the practical skills of a provider performing a simulated neonatal resuscitation (megacode) using videoconferencing. METHODS: Using volunteer NRP providers and instructors, two local telemedicine sites were linked using six telephone lines. Camera angles, sound settings and equipment placement were optimized. Instructors tested providers at the other site. Instructors recorded their observations on checklists based on those of the Neonatal Resuscitation Program (NRP), and all participants completed feedback forms and gave verbal feedback. Based on the results of the pilot study, the protocol and recording tools were developed, and providers at a rural centre were tested. Tests were carried out with local and remote instructors. Observations of local and remote instructors were collected independently, and compared. Opinions of providers were also collected. RESULTS: Observations of the local and remote instructors on the performances of the providers were consistent; 15 of 18 megacodes reached the required standard. Six telephone lines were required for transmission without noticeable delay in sound transmission. Viewing quality was sufficient for remote instructors to provide feedback on ventilation technique. Providers indicated that videoconferencing did not interfere with their performance and would willingly repeat the experience. Cronbach's alpha for assessment of the technical features was 0.80 or greater for all groups. CONCLUSIONS: Videoconferencing can be used to test resuscitation providers in remote centres. It can enhance neonatal resuscitation education in areas where experienced instructors are in short supply.

PMID: 11703637 [PubMed - indexed for MEDLINE]


Evaluation of the effectiveness of the standardized neonatal resuscitation program.

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OBJECTIVE: To determine if health care personnel trained in the Neonatal Resuscitation Program (NRP) used the NRP guidelines in the resuscitation of newborn babies. To determine differences between self-reporting and documentation of resuscitation in medical records. STUDY DESIGN: Using a
validated questionnaire, individuals participating in resuscitation of newborns voluntarily phoned and answered questions on an Interactive Voice Response (IVR) system. The study was undertaken in level II hospitals in Southern Alberta with 7500 deliveries per year. RESULTS: Of the 5155 babies delivered during the study, 16% required resuscitation (bag and mask ventilation 10.6%, intubation for meconium or intermittent positive pressure ventilation, IPPV, 3.6%, cardiac massage, CM, 0.3%, epinephrine 0.1%, naloxone 6.9%). Of babies whose interventions could be assessed, bag and mask was correct in 99%, endotracheal intubation for IPPV in 100%, and CM in 100%. Only 75% of babies had meconium managed correctly and 92% had naloxone administered according to guidelines. There were more instances where IVR (48) reported a procedure, which was not charted versus charted and not reported by IVR (21). Educational needs identified by IVR included skills of resuscitation and NRP indications for management. CONCLUSION: Bag and mask ventilation and intubation for neonatal resuscitation are more common than previously reported. Management of the meconium-stained baby and use of naloxone require further education. Compared to charts, use of IVR system allows more complete documentation with rationale of interventions and identification of continuing educational needs.

Publication Types:
Evaluation Studies
Multicenter Study

PMID: 11593374 [PubMed - indexed for MEDLINE]


A national review of neonatal resuscitation programmes for midwives.
Gnanalingham MG, Robinson C, Mir NA.

Publication Types:
Letter

PMID: 11561546 [PubMed - indexed for MEDLINE]


Pathophysiology of neonatal resuscitation: application in a global context.
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Despite the adoption of evidence-based guidelines for neonatal resuscitation, formulated with international consensus, the process of resuscitating a newly born infant remains a uniquely local activity. Variations in the physical environment, cultural and medical beliefs, and available resources mediate significant difference in practices worldwide. Yet, the universal nature of the physiology surrounding birth, and its disturbances, provides a common basis for reference. Recognition of the importance of assistance available at the moment of birth, management of the thermal environment, and establishment of adequate ventilation is nearly universal. Differences in specific practices arise from local differences in the risks and challenges to perinatal health, which, in turn, stem from the environment or the available resources. Valuable information
can be learned through comparison and evaluation of different techniques. In such a way, the evidence base for neonatal resuscitation can be strengthened and infants around the world can share in the benefits realized. Copyright 2001 Harcourt Publishers Ltd.

Publication Types:
  Review
  Review, Tutorial

PMID: 11520185 [PubMed - indexed for MEDLINE]


Evaluation of the role of the neonatal nurse practitioner in resuscitation of preterm infants at birth.

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BACKGROUND: Changes in the work patterns and numbers of medical staff in training grades pose a significant challenge to those responsible for the provision of an effective clinical neonatal service. Advanced neonatal nurse practitioners (ANNPs) may have a role in this changing neonatal service. The effectiveness of the ANNPs has been established in North America but has not been properly evaluated in the United Kingdom. AIM: To evaluate the effectiveness of ANNPs in resuscitation of preterm babies at birth against the standard set by junior medical staff. SETTING: Regional neonatal intensive care unit. METHOD: Retrospective analysis of resuscitation details, other basic data, and clinical outcomes of 245 preterm (< 33 weeks gestation) babies born in Liverpool Women's Hospital between January 1998 and April 1999. RESULTS: Resuscitation teams led by ANNPs provided the same resuscitation interventions as those provided by medically led teams. Although babies resuscitated by ANNPs were likely to be intubated, they were intubated more quickly and received surfactant sooner (p = 0.0001) than babies resuscitated by medically led teams. Babies attended by ANNPs were less likely to be hypothermic on admission to the neonatal unit (p = 0.013). CONCLUSION: ANNPs are effective in the resuscitation of preterm babies at birth.

Publication Types:
  Evaluation Studies

PMID: 11517201 [PubMed - indexed for MEDLINE]


Who's teaching neonatal resuscitation to housestaff? Results of a national survey.

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OBJECTIVE: This study was designed to investigate current patterns of training
METHODS: A questionnaire was mailed to the chief residents and directors of all US residency programs in general pediatrics to determine who provides supervision and teaching of neonatal resuscitation in the delivery room and neonatal intensive care unit. This questionnaire also inquired as to the use of these residency programs of standardized resuscitation training courses such as Pediatric Advanced Life Support and Neonatal Resuscitation Program.

RESULTS: Residents in their third and second years of training are most often cited as responsible for supervision and teaching of neonatal resuscitation in the delivery room, whereas attending neonatologists are cited most frequently as being responsible for these tasks in the neonatal intensive care unit. Pediatric Advanced Life Support is required by virtually all US residency programs, followed in frequency by Neonatal Resuscitation Program and Advanced Cardiac Life Support.

CONCLUSIONS: Because those in training collectively provide much of the supervision and teaching of neonatal resuscitation, vigilance is required so that appropriate resuscitation skills are developed and maintained. Objective performance markers may be useful in assessing competency in caring for sick newborns. Neonatal resuscitation, delivery room, Neonatal Resuscitation Program, Pediatric Advanced Life Support, Advanced Cardiac Life Support.

PMID: 11158454 [PubMed - indexed for MEDLINE]


Time for a new paradigm in pediatric medical education: teaching neonatal resuscitation in a simulated delivery room environment.

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OBJECTIVES: Acquisition and maintenance of the skills necessary for successful resuscitation of the neonate are typically accomplished by a combination of completion of standardized training courses using textbooks, videotape, and manikins together with active participation in the resuscitation of human neonates in the real delivery room. We developed a simulation-based training program in neonatal resuscitation (NeoSim) to bridge the gap between textbook and real life and to assess trainee satisfaction with the elements of this program.

METHODS: Thirty-eight subjects (physicians and nurses) participated in 1 of 9 full-day NeoSim programs combining didactic instruction with active, hands-on participation in intensive scenarios involving life-like neonatal and maternal manikins and real medical equipment. Subjects were asked to complete an extensive evaluation of all elements of the program on its conclusion.

RESULTS: The subjects expressed high levels of satisfaction with nearly all aspects of this novel program. Responses to open-ended questions were especially enthusiastic in describing the realistic nature of simulation-based training. The major limitation of the program was the lack of fidelity of the neonatal manikin to a human neonate.

CONCLUSION: Realistic simulation-based training in neonatal resuscitation is possible using current technology, is well received by trainees, and offers benefits not inherent in traditional paradigms of medical education.

PMID: 11015540 [PubMed - indexed for MEDLINE]

Video recording as a means of evaluating neonatal resuscitation performance.

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OBJECTIVE: To determine the compliance to Neonatal Resuscitation Program (NRP) guidelines in our institution, by the use of videotaped newborn resuscitations. BACKGROUND: NRP is the standard of care for newborn resuscitation. The application of NRP guidelines and resuscitation skills in actual clinical settings is undocumented. DESIGN/METHODS: A video recorder, mounted to the radiant warmer in the main obstetrical operating room, was used to record all high-risk resuscitations. All members of the resuscitation team were NRP-certified. The videotapes were reviewed within 14 days of the resuscitation and then erased. This ongoing review was approved as a quality assurance (QA) project ensuring confidentiality under California law. The first 100 resuscitations were evaluated to assess NRP compliance. Each step in the resuscitation (positioning, oxygen delivery, ventilation, chest compressions, intubation, and medication) was graded. A score was devised, with 2 points being awarded for every correct decision and proper procedure, 1 point for delayed interventions or inadequate technique, and zero points for indicated procedures that were omitted or for interventions that were not indicated. The total points were divided by the total possible points for that patient. The scores for the first 25 resuscitations (group 1) and the last 25 resuscitations (group 2) were compared. RESULTS: Fifty-four percent of the 100 resuscitations had deviations from the NRP guidelines. Ten percent received overly aggressive stimulation and 22% had poor suction technique. Of the 78 infants given oxygen, this decision was considered incorrect in 15% and the delivery technique was poor in 10% of the infants given oxygen. Of those requiring mask ventilation (n = 18), 24% had poor chest expansion, 11% used an incorrect rate, and 17% had inadequate reevaluation. Twelve infants were intubated; only 7 were successfully intubated on the first attempt and only 4 were intubated in <20 seconds. The longest intubation attempt was 50 seconds. Naloxone was given to 2 patients. One was breathing spontaneously with a heart rate >100. Resuscitations receiving a perfect evaluation score were more likely to occur in infants needing less intervention. The level of resuscitation required for groups 1 and 2 were statistically similar. There was no difference in resuscitation scores between the 2 groups. Only the inappropriate use of deep suctioning improved, with 8 of 25 events in group 1, and 0 of 25 in group 2. CONCLUSIONS: We have found a significant number of deviations from the NRP guidelines. Video recording of actual clinical practice is a useful QA tool for monitoring the conduct of newborn resuscitation. We are now conducting repeat video assessments of individual NRP providers to determine whether there is improved performance.

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Video Recording as a Means of Evaluating Neonatal Resuscitation Performance

Douglas N. Carbine, MD; Neil N. Finer, MD; Ellen Knodel, RRT; and Wade Rich, RCP

ABSTRACT. Objective. To determine the compliance to Neonatal Resuscitation Program (NRP) guidelines in our institution, by the use of videotaped newborn resuscitations.

Background. NRP is the standard of care for newborn resuscitation. The application of NRP guidelines and resuscitation skills in actual clinical settings is undocumented.

Design/Methods. A video recorder, mounted to the radiant warmer in the main obstetrical operating room, was used to record all high-risk resuscitations. All members of the resuscitation team were NRP-certified. The videotapes were reviewed within 14 days of the resuscitation and then erased. This ongoing review was approved as a quality assurance (QA) project ensuring confidentiality under California law. The first 100 resuscitations were evaluated to assess NRP compliance. Each step in the resuscitation (positioning, oxygen delivery, ventilation, chest compressions, intubation, and medication) was graded. A score was devised, with 2 points being awarded for every correct decision and proper procedure, 1 point for delayed interventions or inadequate technique, and zero points for indicated procedures that were omitted or for interventions that were not indicated. The total points were divided by the total possible points for that patient. The scores for the first 25 resuscitations (group 1) and the last 25 resuscitations (group 2) were compared.

Results. Fifty-four percent of the 100 resuscitations had deviations from the NRP guidelines. Ten percent received overly aggressive stimulation and 22% had poor suction technique. Of the 78 infants given oxygen, this decision was considered incorrect in 15% and the delivery technique was poor in 10% of the infants given oxygen. Of those requiring mask ventilation (n = 18), 24% had poor chest expansion, 11% used an incorrect rate, and 17% had inadequate reevaluation. Twelve infants were intubated; only 7 were successfully intubated on the first attempt and only 4 were intubated in <20 seconds. The longest intubation attempt was 50 seconds. Naloxone was given to 2 patients. One was breathing spontaneously with a heart rate >100. Resuscitations receiving a perfect evaluation score were more likely to occur in infants needing less intervention. The level of resuscitation required for groups 1 and 2 were statistically similar. There was no difference in resuscitation scores between the 2 groups. Only the inappropriate use of deep suctioning improved, with 8 of 25 events in group 1, and 0 of 25 in group 2.

Conclusions. We have found a significant number of deviations from the NRP guidelines. Video recording of actual clinical practice is a useful QA tool for monitoring the conduct of newborn resuscitation. We are now conducting repeat video assessments of individual NRP providers to determine whether there is improved performance. Pediatrics 2000;106:654–658: newborn, resuscitation, video recording.

ABBREVIATIONS. NRP, Neonatal Resuscitation Program; QA, quality assurance; NICU, neonatal intensive care unit; PL, pediatric intern; ATLS, advanced trauma life support.

The Neonatal Resuscitation Program (NRP) was developed by the American Academy of Pediatrics and the American Heart Association and endorsed in 1987. The course has been widely taught in the United States and has become the standard of care in newborn resuscitation. Competency in the course material is demonstrated by successful completion of a written examination, a performance checklist, and a megacode. Renewal is required every 2 years. The assumption is that the NRP guidelines will be followed by individuals who have completed the course. In 1998, Kaczorowski et al2 showed a significant deterioration of resuscitation knowledge and skills, when providers were retested 6 to 8 months after completion of the NRP course. The NRP program does state that completion of the course material does not ensure that the student can successfully resuscitate an infant in an actual clinical environment. The crucial step from completion of this program to actual clinical competence has not been adequately evaluated.

Video recordings were first reported as an educational tool in teaching emergency medicine in 1969 by Pelletier et al. Hoyt et al4 reported effective use of videotaping trauma resuscitation in 1988, and demonstrated that videotape critique sessions significantly improved house staff performance over a 3-month period, compared with controls. Videotaping trauma and cardiac arrests in emergency departments has become accepted practice in the United Kingdom and Australia.5-7 To date there have been no reports of the use of videotaping as a means of assessing the quality of neonatal resuscitations.

We believed that the use of videotaping of neonatal resuscitation would allow us to: 1) determine the actual conduct of neonatal resuscitation in our institution; 2) compare that resuscitation against the stan-
METHODS
The UCSD obstetric service delivers ~200 infants per month. This is a high-risk service with a disproportionate number of deliveries requiring intervention. A 40-bed level III neonatal intensive care unit (NICU) adjoins the labor and delivery suite. All high-risk deliveries are attended by at least 1 of the following: a staff neonatologist, neonatal fellow, neonatal nurse practitioner, or a senior pediatric resident (PL-2 or -3). The remainder of the resuscitation team includes a neonatal nurse, neonatal respiratory therapist, and a pediatric intern (PL-1). All members of the team are required to have a current NRP course completion card.

Resuscitation is performed on overhead radiant warmers in each obstetric OR and delivery room. An 8-mm video recorder (Sony Hi8 Model 8EVC200, Sony Corp, Tokyo, Japan), which also records sound, was permanently mounted to the radiant warmer (Ohmeda, Columbia, MD) in the main obstetric operating room. The recorder was mounted ~1 meter above the warmer and was zoomed so as to provide a field of view that included the entire infant and the hands of the resuscitation team. The video recorder displays a continuous date and time readout at the bottom of the recorded image allowing timing of performed procedures to the nearest second.

As video recording and evaluation are performed as a quality assurance (QA) exercise, confidentiality is assured under California evidence code sections 1156 and 1157. The project was approved by the University of California, San Diego Medical Center as a QA project without the requirement for parental consent.

The recorder is loaded with a fresh tape and switched on by the respiratory therapist when the resuscitation team arrives. The tape is removed after the resuscitation. Every 2 weeks these tapes are reviewed by an ad hoc committee whose representatives include at least 1 of the researchers, at least 1 physician, and representatives from nursing and respiratory therapy. The meetings are open to all NICU staff including house staff.

An evaluation sheet was designed to evaluate adherence to NRP guidelines and is completed for each resuscitation. Each step of resuscitation was evaluated. These included the equipment check, positioning and stimulation, administration of oxygen, bag-mask ventilation, chest compressions, intubation, and administration of medications. Each step was scored as to whether an intervention was provided and whether that decision was appropriate. Each intervention provided, the procedure was then evaluated for technique, success, and proper reevaluation of the patient. Problems that were not covered by the checklist were noted under the comments section. Items frequently noted in the comments section were the lack of communication regarding the infant's heart rate to the lead resuscitator, the number of deep suction procedures, the time for completion of intubation, and the number of intubation attempts. Current NRP guidelines were used as the objective measure by which scoring decisions were based. Each resuscitation was graded by the overall consensus of the committee members present.

The results of these reviews are discussed at the monthly NICU QA meetings. After formal review, these tapes are erased. Selected excerpts are retained for teaching purposes in monthly house staff lectures, the annual house staff NRP course, and for review with individual house officers when appropriate.

One hundred nonconsecutive resuscitations have been evaluated to date. All 100 resuscitations were evaluated to assess the relative frequency of NRP protocol deviations and to review the actual times and duration of procedures including intubation.

To assess the role of videorecording as an educational tool, the first 25 resuscitations (group 1) and last 25 resuscitations (group 2) were compared. Each level of resuscitation was evaluated and scored. A composite score was devised to assign a numerical score for each resuscitation. Two points were awarded for every correct decision and every properly performed procedure. One point was awarded if the intervention was delayed or the technique for a given procedure was inadequate. No points were awarded for indicated procedures that were omitted or for performed procedures that were not indicated. The sum of the awarded points was divided by the total possible points for that patient to obtain a percent score.

The scores for both groups were compared and tested for statistical significance using analysis of variance. The level of required intervention and individual components of the resuscitations were compared and tested for significance using the χ² test. Statistical significance was defined as P ≤ .05.

RESULTS
One hundred nonconsecutive resuscitations were reviewed over a 9-month period (January 1999 to September 1999). Group 1 resuscitations were conducted and graded from January 1999 to March 1999. Group 2 resuscitations were conducted and graded from July 1999 to September 1999. Using the described scoring tool, 46/100 were deemed perfect resuscitations (ie, followed NRP guidelines without deviation). The likelihood of a resuscitation being conducted perfectly was significantly related to the level of care required. Less complicated resuscitations were more likely to be conducted without deviation (Table 1).

Because of this association, group 1 and group 2 were compared as to the degree of resuscitation required. The relative number of infants requiring blow by oxygen, bag-mask ventilation, intubation, chest compression, and medication were compared and were statistically similar. There was a nonstatistically significant trend for less intervention being required in group 2 (Table 2). There were no significant differences in test scores or number of perfect scores between the 2 groups. When each component of resuscitation was analyzed separately, only 1 aspect of resuscitation improved significantly in group 2. This was the use of deep nasogastric suctioning with a suction catheter. This was frequently applied during resuscitation, often before the infant was fully stable, and repetitive deep suctioning was common. There were 9 infants who had deep suctioning in group 1. Five infants had 1 suction each, 1 had 2, 1 was suctioned on 4 occasions, and 1 infant was suctioned 8 times. There were no episodes of deep suctioning in group 2 (P < .002). No other aspects of resuscitation differed significantly between the 2 groups. The resuscitation scores are presented in Table 3.

The relative frequencies of NRP protocol deviations were analyzed for all 100 resuscitations. Those deviations that occurred >10% of the time are presented in Fig 1. The percent of incorrect actions for each resuscitation category is shown in the graph.

Common minor deviations included: overly aggressive stimulation, enthusiastic drying which interfered with attempts at suctioning, and the heart

<table>
<thead>
<tr>
<th>TABLE 1.</th>
<th>Maximum Level of Required Intervention and Perfect Resuscitation Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Intervention</td>
<td>Perfect Score (n)</td>
</tr>
<tr>
<td>Stimulation only</td>
<td>22</td>
</tr>
<tr>
<td>Blow by oxygen</td>
<td>58</td>
</tr>
<tr>
<td>Mask ventilation</td>
<td>7</td>
</tr>
<tr>
<td>Intubation</td>
<td>10</td>
</tr>
<tr>
<td>Chest compression</td>
<td>0</td>
</tr>
<tr>
<td>Medication</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

NS indicates not significant.
TABLE 2. Comparison of Groups One and Two for Level of Resuscitation Required

<table>
<thead>
<tr>
<th>Maximum Level of Intervention</th>
<th>Group 1 (n = 25)</th>
<th>Group 2 (n = 25)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulation only</td>
<td>5</td>
<td>9</td>
<td>NS</td>
</tr>
<tr>
<td>Blow by oxygen</td>
<td>14</td>
<td>12</td>
<td>NS</td>
</tr>
<tr>
<td>Mask ventilation</td>
<td>1</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Intubation</td>
<td>4</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Chest compression</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Medication</td>
<td>1</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS indicates not significant.

TABLE 3. Comparison of Resuscitation Scores Between Groups One and Two

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n = 25)</th>
<th>Group 2 (n = 25)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total points</td>
<td>661</td>
<td>660</td>
<td>—</td>
</tr>
<tr>
<td>Total possible points</td>
<td>748</td>
<td>700</td>
<td>—</td>
</tr>
<tr>
<td>Mean score (%)</td>
<td>92%</td>
<td>98%</td>
<td>NS</td>
</tr>
<tr>
<td>Perfect score (n)</td>
<td>9</td>
<td>14</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS indicates not significant.

The research by Kaczorowski et al. demonstrated that retention of NRP skills deteriorates rapidly after completion of the course. Residents who had successfully completed and passed the NRP course were eligible for the study. The residents were divided into 3 groups. Group 1 received hands on training 3 to 5 months after NRP course completion. Group 2 was required to view a 26-minute video refresher course 3 to 5 months after initial NRP course completion. Group 3 received no follow-up instruction and served as the control. The standard NRP written examination and a practical examination (which included 5 clinical scenarios) was administered 6 to 8 months after initial NRP course completion. All 3 groups had significantly lower scores on the written examination. Only 59% of the residents passed the practical. There were no differences among the 3 groups in the number of residents achieving a passing score. Periodic course renewal is not an effective means of keeping resuscitation skills current.

In 1996, Santora et al. reported on use of videotaped trauma resuscitations over a 13-month period. Videotape reviews uncovered system problems in the study hospital that impacted on trauma resuscitations and revealed a lack of strict compliance with advanced trauma life support (ATLS) protocols. Use of the videotapes as a teaching tool reduced noncompliance with ATLS protocols from 30% to 20%. A 1998 survey showed an estimated prevalence rate of 20% in the use of videotaping as an educational tool in US Trauma Centers. The use of video recording in the current format was considered as a result of the use of videotaping in our institution as a QA tool for assessing trauma resuscitations.

We selected the main obstetric operating room for placement of the video recorder, because this is where the majority of cesarean sections and complicated vaginal deliveries are performed. This site allowed us to evaluate a higher risk group of infants. We are in the process of adding a second camera, which is mobile and can capture resuscitations at other sites. Our initial intentions were to define the degree of NRP deviations and to use this information to improve the conduct of neonatal resuscitation in our hospital. Our use of the videotape format was designed to determine the actual practice of neonatal resuscitation at our institution.

Our current format has certain limitations. In this initial prospective cohort of resuscitations, individual resuscitators were not followed longitudinally. The turnover of housestaff in the NICU is very rapid with PL-1s having only two 4-week rotations during the year, and PL-3s having only one 4-week rotation. This limited our ability to demonstrate statistical improvements in resuscitation. The opportunity to follow their performance over time requires that they be captured on the videotape on more than one occasion. We are now beginning to collect such information and will be able to assess their performance on repeat resuscitations. The composition of the resuscitation teams changed randomly, with the likelihood of the same team being reviewed longitudinally being small. The identity of the resuscitators was kept anonymous during the review and scoring.

DISCUSSION

We present this data as the first prospective real-time analysis of neonatal resuscitation in a clinical setting. To date, there have been no other studies that have evaluated the actual application of neonatal resuscitation in the delivery room environment. By presenting our observations, we hope to illustrate the potential of this relatively simple QA tool.
process. Only if significant problems were noted during a resuscitation, were the operators then identified. In these instances, the performance of the resuscitation was discussed with them, and in certain circumstances the videotape were replayed for them. Finally, the bulk of the resuscitations in group 2 occurred in July. Because this coincides with the onset of a new house staff-training cycle, we expected an increase in NRP deviations. Our results do show a slight improvement in resuscitations in group 2, although this was not statistically significant and could be explained by the population in group 2 requiring less intense resuscitation.

The current protocol is capable of detecting and correcting systems problems. The frequent and aggressive use of deep suctioning in our unit was previously undocumented. With the advent of video recording, the prevalence of this practice was noted and corrected. In group 2, the practice had been completely eliminated, with no episodes of deep suctioning being recorded. Another early problem was poor communication of heart rate to the lead resuscitator. After the first few review sessions, this concern was discussed with our caregivers and we have subsequently noted much better verbal and nonverbal communication of the heart rate to the lead resuscitator. This change was so rapid that it actually occurred within the first 25 patients.

The primary purpose of this study was to critically evaluate our current practice of NRP. Our review has demonstrated that a high prevalence of providers, who have successfully completed the NRP course, does not guarantee that the protocol is being implemented as taught. Our observations support the notion that NRP protocols are not always closely followed. The more complicated the resuscitation, the
more likely that NRP deviations will occur. Continuous monitoring of resuscitations in a QA format should result in more consistent application of neonatal resuscitation. We believe that the current limitations of our QA process can be improved by making house staff attendance mandatory, conducting repeat assessments of individual resuscitators, and providing constructive feedback on individual performance when appropriate.

The 1999 International Liaison Committee on Resuscitation advisory statement on newborn resuscitation identified multiple aspects of current NRP practice, which need further research. The optimal approach for the meconium stained infant, the appropriate indications and technique for chest compressions, the indications and dosage of resuscitation drugs, and the ideal concentration of oxygen are aspects of resuscitation that require further evaluation. There are a number of other practices, such as the use of longer slower breaths to assist in the establishment of functional residual capacity, which have not been incorporated into NRP teaching. Should extremely low birth weight infants be approached in a similar manner as the term infant?

Are the current recommendations for intubation appropriate and being followed for the very low birth weight infant? Is naloxone indicated and of benefit in the delivery room under any circumstances? Up until very recently, delivery room use of cardiac massage and epinephrine were said to be associated with a uniformly fatal outcome for infants of <750 g birth weight. Our recent reviews suggest that this is not the case. The current recommendations and teaching of NRP are not all evidence-based. There is a need for further prospective studies evaluating different modalities of resuscitation and their implementation.

Use of video recording of resuscitations not only serves as a valuable tool in QA and education, but also has a potentially invaluable role in assessing new approaches to resuscitation. We believe that the limitations of this system (ie, single view of patient or inability to capture all resuscitations in all delivery rooms) are minor relative to the strengths of the system. The system is very simple to use and we have found that our staff have adapted very quickly to the presence of the recorder. Although the presence of the video recorder may alter conduct in the delivery room, this is usually a change for the better. The recorder is unobtrusive and does not interfere with resuscitation. Permanent mounting of the camera has provided consistently high quality video and audio and has avoided accidental damage to the equipment. The recorded images are unalterable and provide extremely objective data. The simple addition of pulse oximetry during the resuscitation, captured on videotape, will provide even more objective data. This system can be easily duplicated at relatively low cost in any hospital and need not be limited to the delivery room or emergency department environment.

Neonatal resuscitation is probably the most frequently practiced form of acute resuscitation in any environment. NRP was designed to standardize and optimize newborn resuscitation. The use of video recording has demonstrated that, at least in our institution, we are not consistently following NRP guidelines. As we continue to teach and implement changes to NRP, there is a need to confirm that the knowledge and skills taught are consistently and reliably applied during actual clinical practice.

ACKNOWLEDGMENTS

We thank all of the registered nurses, respiratory therapists, and physicians of the Infant Special Care Center at the University of California, San Diego Medical Center for their participation in and support of this project.

REFERENCES