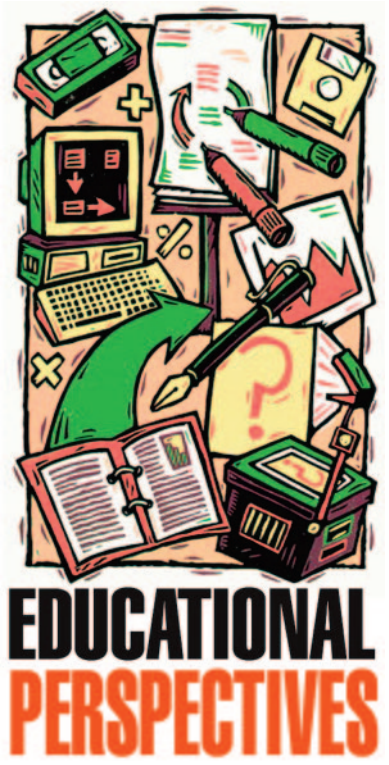

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Simulation-based Training in Neonatal Resuscitation

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Introduction

Some 100 million babies are born worldwide each year; 4 million in the United States alone. Approximately 10% of all newborns need some assistance to begin breathing at birth, and 1% require intensive resuscitative efforts such as endotracheal intubation and chest compressions. (1) Babies not receiving such timely help can die or suffer lifelong morbidity.

Traditional and Emerging Training

Historically, training in neonatal resuscitation, as in most of medicine, has been accomplished by assuming graduated responsibility in the care of real patients. This apprenticeship model of medical education places a trainee in a supervised environment for a set period of time, with the expectation that guided experience will lead to acquisition of skills adequate enough for independent, competent practice in the community. Underlying this model is an assumption that the number and variety of cases experienced will be of sufficient depth and breadth to ensure competence at the close of the training period. Often, this is not the case. Thomas Krummel, MD, Chair, Department of Surgery, Stanford University, has termed this type of training "education by random opportunity."

The Accreditation Council for Graduate Medical Education, the body responsible for the accreditation of post-MD medical training programs in the United States, establishes program requirements for pediatric residency education. The program requirements state that the neonatal intensive care curriculum must be designed to teach resuscitation and care of newborns in the delivery room. These same guidelines, however, limit the time that pediatric residents can spend in a neonatal intensive care unit. (2) Investigations in anesthesia have shown that 40 to 60 intubation attempts are required for proficiency. (3)(4)(5) Pediatric residents rarely have more than 20 chances to intubate during their residency training. (6) One institution found that fewer than two thirds of their graduating third-year pediatric residents were competent (defined as success on the first or second attempt more than 80% of the time) in neonatal intubation. (7) Another determined the intubation success rate (number of successful intubations divided by the number of attempts) to be 40% for their senior pediatric residents and 68% for their neonatal fellows. (6)

The need for neonatal resuscitation often can be anticipated from risk factors associated with the pregnancy, labor, or delivery, but significant resuscitative efforts are required in 1% to 3% of "low-risk" pregnancies. (8) Despite this need, fewer general pediatricians are functioning as the primary responders to newborns in need of resuscitation. In 1995, 70% of pediatricians reported that they were involved in the resuscitation, stabilization, and management of critically ill newborns. (9) That number decreased to 45% in

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1999 and 36% in 2003. (7)(10) The ongoing need for neonatal resuscitation is being met by the emergence of neonatal nurse practitioner and hospitalist programs. These professionals, under the supervision of neonatologists, serve as in-house neonatal resuscitation teams in many community hospitals. (11)(12)(13)

In 1985, the American Academy of Pediatrics and the American Heart Association jointly developed a training program in neonatal resuscitation that has trained more than 1.5 million health care professionals. Training programs vary slightly between institutions, but typically, the day-long course consists of textbook readings, lectures with accompanying slide presentations and videos, and skills stations where trainees practice individual technical skills on part-task trainers (eg, intubating plastic heads). Studies have shown that the cognitive and technical skills learned in standardized courses such as these are retained for only 6 to 12 months. (14)

Simulation-based Training

Research in adult education has identified several key characteristics of adult learners. (15) They are independent, self-directed, and internally motivated to learn; their eagerness to learn is related to the social and professional roles of their day-to-day lives; they seek immediate applications for the knowledge gained; and they have accumulated a wealth of experience that serves as a resource and foundation for their ongoing intellectual development. When training health care professionals, these expectations are best met through hands-on practice in immersive simulated medical environments.

Simulation-based training involves immersion of a trainee in a realistic situation (scenario) created within a physical space (simulator) that replicates the real environment with fidelity sufficient to achieve suspension of disbelief on the part of the trainee.

Figure 1. Neonatal resuscitation manikin with an omphalocele.

Such training has been adopted as the standard in professions characterized by highly technical, complex, dynamic environments in which crises evolve rapidly and the risk to human life is high (eg, aerospace, the military, and nuclear power). Simulation-based methodologies were used initially in the medical field in the 1980s for training in the management of critically ill patients in the operating room. (16)(17) The first high-fidelity simulation-based training program in neonatal resuscitation was developed at Stanford University in the mid-1990s. (18) Similar programs are beginning to emerge at other centers across the country and around the world.

Simulation-based training in neonatal resuscitation takes place in a physical space that closely resembles an actual delivery room with real, functional medical equipment. The "patients" (both mother and neonate) are commercially available medical manikins. Current neonatal manikins lack the ability to generate heart and lung sounds and internal mathematical models to drive changes in physiologic variables. Models with realistic airways for intubation and umbilical cords for catheterization are available; their level of fidelity is sufficient to create a sense of realism for trainees. The manikins can be modified to simulate a variety of congenital anomalies (Fig. 1), and artificial blood and pea soup (in place of meconium) can be used to provide realistic cues to trainees. Bedside patient monitors, controlled remotely by handheld computers, provide information about the newborn's vital signs. Simulator instructors, playing roles as family members and health care professionals, help to create the human interactions, stressful conditions, and complex environmental cues that exist in a real delivery room. Scenarios are easily tailored to the level of the trainee and can realistically simulate medical issues (eg, meconium aspiration), equipment failures (eg, an empty oxygen tank), psychosocial issues (eg, an obstructive parent), or a combination of all three (Fig. 2). Each scenario is videotaped and reviewed with trainees in a constructive, facilitated debriefing session (Fig. 3). The video VIDEO shows trainees resuscitating a baby born after a severe placental abruption.

Simulation-based neonatal resuscitation training has been well re-

Figure 2. A simulated sick neonate receives positive pressure ventilation through an endotracheal tube, while trainees perform chest compressions and auscultate for breath sounds.

ceived. Trainees feel that the simulator adequately recreates real delivery room situations and offers beneficial training experiences. (18) They find simulation-based training more relevant to their hospital practice than traditional teaching methods. The trainees spend more time in active learning processes and feel that this type of training engages their intellect more; better develops their technical, behavioral, and critical thinking skills; and gives them the ability to transfer these skills to the real environment. (19) A prospective, controlled trial to evaluate objectively the transfer of skills from the simulator to the real environment is currently underway. (20)

Simulation-based training has many advantages. It provides trainees with increased clinical experience because rare but devastating events can be simulated and practiced many times. It is convenient; trainees can schedule simulation sessions at times that fit into their schedules. It decreases the use of hospital resources by reducing the time spent teaching in expensive clinical environments. It is also much safer to train on patient simulators than on real patients. Many national and international organizations have recommended simulation-based resuscitation training, including the Joint Commission on Accreditation of Healthcare Organizations and the International Liaison Committee on Resuscitation. (21)(22)

Figure 3. Simulator instructors and trainees learn from a scenario while reviewing the videotape during a facilitated debriefing.

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