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Case Study

Feasibility of Air Transport Simulation Training: A Case Series

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A B S T R A C T

Limited clinical site availability and an increased need for clinical training experiences often make it difficult for prehospital health care providers to complete new and annual training requirements. Medical simulation provides an alternative learning environment that provides trainees the opportunity to acquire and perfect new clinical skills without compromising patient care. The following is a detailed description of an air medical transport simulation of a neonate with hypoxic ischemic encephalopathy requiring transport to a higher level of care. Patient parameters were altered during flight to simulate potential complications unique to air medical transport. Use of this training strategy is particularly beneficial for low-volume, high-risk patients, and these lessons can be applied across all age patient groups, making the experience broadly applicable.

According to the Commission on Accreditation of Medical Transport Services (CAMTS), initial and recurrent clinical experiences of transport nurses must be based on the air medical program's mission, scope of care, and patient population.[1] To meet this requirement and industry standard, orientation and continuing education must address critical medical and trauma care for all relevant patient populations including high-risk neonates.

However, clinical site availability is limited and shared with community college and university students in nursing, paramedicine, and medicine. The human patient simulation laboratory has emerged as an alternative learning environment to train medical professionals, particularly in the fields of emergency medicine and trauma care. A recent study found that simulation-based team training could improve teamwork processes and contribute to improvements in patient outcomes.[2] This finding suggests that simulation training could satisfy the training requirements established by the CAMTS, namely to ensure teamwork, root cause analysis, and problem solving.[1]

To apply these concepts and implement these standards in training, the Arizona Simulation Technology and Education Center at the University of Arizona and Arizona LifeLine, a Med-Trans Corp air medical program based in southern AZ, collaborated on 4 real-time precepted air transport simulations of a critical neonatal patient using a high-fidelity neonatal simulator and a Bell-407 medically configured aircraft. The purpose of these exercises was to assess the feasibility of operating a simulated mannequin on a live flight and the effectiveness of such an exercise to meet the training requirements currently fulfilled by live patient transports. This case series outlines the technical components of loading and operating a simulated mannequin during live flight and lessons learned in the process. The clinical case described later was chosen for its relevance and frequency of respiratory emergencies in the neonatal and pediatric patient population. Emergent response to critical changes in patient condition must take place to insure the best possible outcome for these patients. These lessons and care strategies can be applied across patient groups, making the experience broadly applicable. Use of this training strategy is particularly beneficial for low-volume, high-risk patients such as neonates, pediatrics, or obstetrics, whether they are transported by air or ground by a specialty team or a critical care flight crew.

Case Report

Learning Objectives

The learning objectives for this scenario are as follows:

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Table 1
Simulation Flow for Neonatal Air Transport Simulation

State	Patient Status	Learner Actions	Operator
Pretransport	Relatively stable and nonreactive Heart rate 135 Respiratory rate 35 (vented) BP 65/40 SpO_2 95% Temperature 35.0°C Limp, no movement	• Obtain history • Update family member • Perform assessment to include vital signs, ETT placement, ventilation needs, UVC placement, fluids infusing, temperature setting • Call medical director • Obtain proper paperwork and signatures • Transfer neonate to incubator • Check another set of vitals • Transport to helicopter • Load incubator	Program initial state and observe for potential errors. Be able to make simulator respond appropriately (eg, if ventilator not connected properly, infant will desaturate). Assist with simulation equipment during transfer (link box, umbilical reservoir, compressor hose, and so on)
Transport	Infant will have an unexplained desaturation midflight	• Recognize desaturation • Check ETT placement • Assess chest rise • Check ventilator settings and connections • Turn up the FiO_2	Program desaturation episode to low 80s. If learner does not complete all of the learner actions, sats will drop to the low 70s.
Post-transport	Relatively stable and nonreactive	• Unload incubator • Transfer infant to receiving facility • Perform assessment • Give report to nurse and medical team at bedside • Pack up equipment and return to base	Program simulator to post-transport state after desaturation episode has been resolved. Be able to make simulator respond appropriately to possible learner errors.

BP = blood pressure; ETT = Endotracheal tube; FiO_2 = fraction of inspired oxygen; UVC = umbilical venous catheter.

1. Perform an assessment of the neonate in preparation for transport including patient history and physical examination.
2. Demonstrate problem solving and safe patient care within the transport environment.
3. Communicate effectively with family members and medical personnel.

Case Stem

The patient care scenario was developed using the CAMTS simulation learning gap analysis from the accreditation standards manual.[1] The patient is a 40-week gestation, 1-hour-old, 4.2-kg neonate born via prolonged vaginal delivery complicated by shoulder dystocia to a 32-year-old woman, gravida 4, para 4. The maternal laboratory values were as follows: blood type AB positive, antibody negative, serology nonreactive, group B strep unknown, hepatitis B surface antigen negative, and human immunodeficiency virus negative. Rupture of membranes occurred 4 hours before delivery; fluid was clear. At birth, the neonate was limp and dusky with no respiratory effort. Resuscitation included bag mask ventilation, intubation at 2 minutes of age, chest compressions, intravenous epinephrine × 2, and a 10-mL/kg normal saline bolus. The neonate's Apgar scores were 1 at 1 minute, 1 at 5 minutes, 3 at 10 minutes, and 3 at 15 minutes. In the nursery, the Umbilical Venous Catheter (UVC) was replaced under sterile conditions; the team was unable to place a Umbilical Artery Catheter (UAC). A venous blood gas, complete blood count, and blood culture were drawn and sent to the laboratory. Initial venous blood gas at 30 minutes of age was $pO_2 = 54$, pH = 6.9, $pCO_2 = 52$, $HCO_3 = 8$, and base deficit = 16. The neonate was noted to be hypotensive at that time. Hypotension was treated with a 20-mL/kg bolus. Bedside blood glucose was 134 mg/dL. The neonate started to seize at 45 minutes of age and received 1 loading dose of phenobarbital (20 mg/kg), which controlled the seizures. The neonate also received ampicillin and cefotaxime for rule-out sepsis.

Simulation Confederates

The following 4 roles were filled by participants with very specific assignments to create a realistic training environment for the transport nurse.

1. Sending/receiving nurse: the sending/receiving nurse provides and receives historic and treatment information at the bedside.
2. Mother of patient: the mother is instructed to ask questions about the neonate's condition and prognosis.
3. Sending/receiving physician: the administrative medical director of the transport team or an online specialty neonatologist should perform this role. The physician takes the report via phone from the transport nurse, which should include key information from the physical assessment, history of events, and pertinent medical findings.
4. Respiratory therapist: a preceptor nurse and/or advance practice neonatal nurse practitioner is preferred for this role. The respiratory therapist (RT) provides key information to the learner, including ventilator settings.

Expected Progression of Simulation Case

Upon arrival, the simulation operator is expected to provide the flight transport nurse with an orientation to the simulation mannequin and equipment. Orientation should include an explanation of the learning objectives and expectations for this training.

The transport nurse should arrive to find the neonate on the radiant warmer (heat turned off). The neonate is prepped with a UVC, secured 11 cm at the skin, and a 3.5 endotracheal tube (ETT) placed 10 cm at the gum. The sending nurse is ventilating the neonate using the Neo-Tee® Infant T-Piece Resuscitator (Mercury Medical, Clearwater, FL). There is minimal spontaneous respiratory effort. The sending nurse should comment on the blood gas from 10 minutes ago ($pO_2 = 61$, pH = 7.25, $pCO_2 = 58$, $HCO_3 = 10$, base deficit = 15), report a glucose measurement of 128 mg/dL, and state that she cannot tell if the neonate is tremulous or seizing. The mother will be at the bedside appearing anxious.

The transport nurse is expected to go through the steps of assessing the neonate, consulting with the medical director, making ventilator changes as necessary, discussing the plan with the family, and transferring the neonate to the transport incubator. There are no planned changes in the vital signs during this stage. Changes should only occur if the transport nurse makes a mistake (eg, fails to connect ventilator tubing after transferring the neonate). The RT can assist with this process but should not initiate any of the actions and allow the transport nurse the autonomy to complete the process by him or herself.

Simulation should continue with the transport nurse and team transporting the neonate to the helipad, loading the incubator,