

Development of a Pediatric Critical Care Transport Team: Experience at a Military Medical Center

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Introduction: A pediatric critical care transport program was initiated and organized at Naval Medical Center San Diego in January 1994. The primary goal of the program was to formally train military pediatric residents in the early stabilization and transport of the critically ill neonatal and pediatric patient. It was also felt that such a program would generate significant cost savings to the Department of Defense. We present the statistics, training protocol, and the cost savings. In addition, we surveyed previous residents who had been involved with this program to determine its perceived benefit. **Methods:** In the first phase of this project, the pediatric critical care transport program database from January 1994 to December 1997 was reviewed. The number and types of transports were recorded. Next, we determined cost savings for the transport program for fiscal year 1996-1998 (the period for which fiscal data were available). In the second phase of this project, we sent surveys to the 23 graduating residents who had participated in the pediatric critical care transport program. The survey sought to determine the perceived value of the transport training experience and the degree to which that training is now being used. All investigators were blinded to the responses. Statistical analysis consisted of determining the percentage of each response. **Results:** During the 4-year period reviewed, 404 transports were performed (198 neonatal and 206 pediatric). During fiscal year 1996-1998, there was a cost avoidance of \$1,962 per transport. In the second phase, 91% of the surveys were returned and analyzed. The majority of residents were practicing in overseas or isolated communities. All respondents rated their experience in the pediatric critical care transport program as worthwhile and educational, and they complemented their training in the neonatal and pediatric intensive care units. Seventy-one percent of the respondents had transported a critically ill neonate or child to another facility within the last year. **Conclusions:** In summary, we report our experience with the development of a pediatric critical care transport program. The program was developed to provide military pediatric residents instruction and experience in the stabilization and transport of critically ill children. In addition, we were able to demonstrate a significant cost avoidance.

Introduction

In 1994, a pediatric critical care transport program was initiated and organized at Naval Medical Center San Diego (NMCS D) by the military pediatric residents, who clearly saw a

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need for more formalized training in the early stabilization and transport of the critically ill neonatal and pediatric patient. In addition, it was felt at that time that such a program could provide transport services at a significant cost savings, both to the government and the military active duty member. We provide both the demographic and financial statistics from this program. We also provide the current training protocol for the program. In addition, we surveyed all of the military residents who have been involved with this program to determine its perceived benefit.

Methods

In the first phase of this project, we retrospectively reviewed the demographic data for pediatric critical care transports performed from January 1994 to December 1997. The number of transports performed, as well as the type of transport (i.e., neonatal or pediatric), were recorded. All of the transports performed were ground-based. In January 1997, we began using a comprehensive transport database that allowed accurate tracking of transport statistics, including transport times, patient demographic information, referral patterns, and complications (database created by Dr. Mike Cinoman, Wake Forest Medical Center, Raleigh, North Carolina, and modified with permission). Financial data were obtained using the assistance of the managed care department at NMCS D. Fiscal data for fiscal year (FY) 1996-1998 were determined using the Medical Expense and Performance Reporting System and the maximum allowable charge of the Civilian Health and Medical Program for the Uniformed Services. Financial data were obtained with permission from the civilian pediatric critical care team that was used for all transports not performed by the NMCS D pediatric critical care transport team.

In the final phase of this project, we sent surveys to each graduating resident who participated in the pediatric critical care transport program between January 1994 and July 1997. The residents surveyed represent a heterogeneous group of pediatricians working in the continental United States and overseas. Participants were asked to rank each question on a five-point scale (strongly agree, agree, neutral, disagree, strongly disagree). The survey is reproduced in "Appendix A." In addition, we asked each pediatrician whether they were stationed in the continental United States or overseas and their proximity to a pediatric tertiary care center. We also asked each pediatrician how many patients they had referred to another facility and whether they had performed any transports in the preceding year. All investigators were blinded to the responses.

All surveys were received after the first mailing. Each response was collected and placed in a database. Statistical analysis consisted of determining the percentage of each response.

Results

The pediatric critical care transport program database was reviewed from January 1994 to December 1997. During the period reviewed, 404 transports were performed (Fig. 1). These transports were divided relatively equally among neonatal and pediatric transports. Transport statistics for 1997 are summarized in Table I. The annual decrease in neonatal patients was attributed to both an increased delivery rate at NMCS D (3,480 births in 1995 vs. 3,744 births in 1997) and an overall decrease in deliveries within the region. There were 81 pediatric critical care transports in 1997, of which 33 were neonatal patients and 48 were pediatric patients. The NMCS D pediatric critical care transport team performed 64 of these transports. Transports were not performed by our team for the following reasons: air transport (eight times), no physician availability (five times), no nurse availability (three times), and another transport team activated first by the referral hospital (one time). Diagnoses for pediatric and neonatal transports are summarized in Table II. The procedures performed by the pediatric critical care transport team during a 6-month period in 1997 are summarized in Table III. There were no procedural complications during this period.

The maximum allowable charge of the Civilian Health and Medical Program for the Uniformed Services paid for the 16 transports not performed by the NMCS D pediatric critical care transport team during FY 1996-1998 ranged from \$550 to \$5,100, with an average of \$1,962 per transport. The current cost of a transport performed by the NMCS D pediatric critical care transport team is \$152 (based on the Medical Expense and Performance Reporting System), for a savings of more than \$1,800 per transport. Clearly, the military cost does not include the purchase and depreciation of equipment; however, development of the transport team required minimal purchases of additional equipment because the needed components had already been purchased for both in-hospital and medical evacuation transports. The creation of the pediatric critical care transport team did not require the hiring of any additional personnel. Military and civilian contract nurses and respiratory therapists were used in such a fashion that overtime pay was not required. Military pediatric residents were used on all transports performed by the NMCS D team.

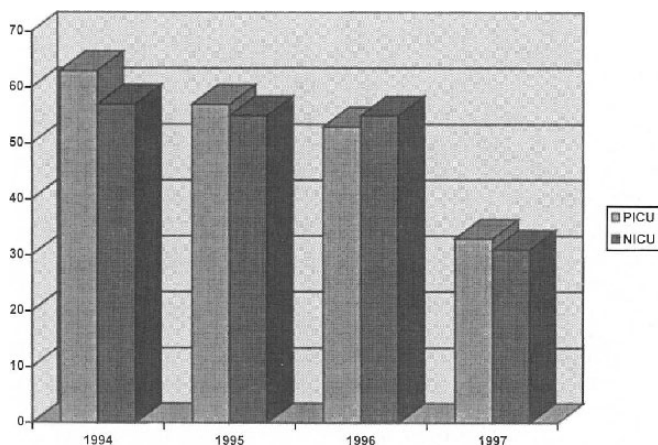


Figure. Yearly statistics for the NMCS D Pediatric Critical Care Transport Program.

TABLE I

1997 STATISTICS FOR THE NMCS D PEDIATRIC CRITICAL CARE TRANSPORT PROGRAM

Total transports	64
Neonatal transports	31
Pediatric transports	33
Intubated patients	15 (19%)
Average age (pediatric)	2.4 years
Average call to departure time (all transports)	49 minutes
Average call to departure time (excluding 13 delayed transports)	34 minutes
Delayed responses	13
Waited for vehicle	10
Vehicle problem	2
Waited for doctor	1

TABLE II

DIAGNOSES FOR PEDIATRIC AND NEONATAL TRANSPORT FOR THE NMCS D PEDIATRIC CRITICAL CARE TRANSPORT PROGRAM (1997)

Respiratory	33 (41%)
Asthma	3
Bronchiolitis	3
Croup	3
Foreign body	1
Meconium aspiration	1
Near drowning	1
PPHN ^a	3
Pneumonia	2
Pulmonary atresia	1
Respiratory distress	14
Neurologic	10 (12%)
Closed head injury	1
Other neurologic	4
Seizure	5
Prematurity	7 (9%)
Cardiac	7 (9%)
Cardiomegaly	1
Congenital heart	5
Other heart disease	1
Infection/sepsis	5 (6%)
Sepsis	4
Meningitis	1
Poisoning/ingestion	4 (5%)
Surgical	3 (4%)
Acute abdomen	2
Malrotation	1
Metabolic/endocrine	2 (2%)
Diabetes	1
Other endocrine	1
Other	10 (12%)
Anaphylaxis	1
Anemia	1
Asphyxia	2
Child abuse	1
Dehydration	1
Hyperbilirubinemia	1
Unspecified	3

^aPersistent pulmonary hypertension of the newborn.

TABLE III

PROCEDURES PERFORMED BY THE NMCS D PEDIATRIC CRITICAL CARE TRANSPORT PROGRAM (JANUARY 1 TO JUNE 30, 1997)

Arterial puncture	4
Umbilical artery catheters	4
Umbilical venous catheters	9
Endotracheal intubation	9
Peripheral intravenous access	13

In the second phase of this project, surveys were mailed to all graduating residents who had participated in the program. Twenty-three residents have graduated from the pediatrics program at Naval Medical Center San Diego since the pediatric critical care transport program's inception. Nine of the 23 residents are stationed overseas (39%). The majority, however, are practicing in a community setting, often 2 to 3 hours from a major medical center with pediatric critical care capabilities. The response after the first mailing was 91%. A second mailing was not performed.

The survey and the percentages of responses to each category are shown in "Appendix A." All 21 respondents rated their experience in the pediatric critical care transport program as a worthwhile and educational experience that complemented the training received in the neonatal and pediatric intensive care units. Furthermore, all 21 respondents agreed with the statement, "As a pediatrician in the Navy, I needed more training than my civilian counterparts in both pediatric critical care and pediatric transport medicine." In addition, all 21 respondents agreed that all military pediatricians, especially those assigned to overseas locations, should receive training in pediatric transport medicine. The respondents disagreed, however, on whether or not civilian pediatricians needed this type of training. Although the majority (71%) felt that some exposure to transport medicine would be beneficial to civilian pediatricians, 29% were either undecided or disagreed.

Fifteen of the 21 former residents (71%) surveyed stated that they had personally transported a critically ill neonate or child to another facility within the last year. The remaining respondents stated that they either had not had the opportunity to transport a critically ill child or a regional medical center performed all of the transports in their area. In some cases, the respondents stated that their experience in the pediatric critical care transport program had allowed them to prepare for what the tertiary care transport team needed, thus minimizing the actual time the transport team spent at their office or hospital.

Discussion

The idea of emergency transport of the critically ill or injured patient originated long ago. The first organized transport systems were developed and organized by the military. During the battle of Blenheim in the 18th century, the Duke of Marlborough ensured that his wounded soldiers were transported to the hospital "by all available wagons from the surrounding countryside."¹ Napoleon Bonaparte and his surgeon-in-chief, Baron Jean-Dominique Larrey, however, are credited with developing the first emergency medical service (EMS) system during the late 18th century. Wounded soldiers were transported by carts from the battlefields to aid stations, where they would receive care.²

Air transportation was first introduced, again by the military, during the Franco-Prussian War. In 1870, 160 battlefield casualties were transported from the siege of Paris in hot-air balloons.³ Transport systems were organized further during the Korean and Vietnam Wars. Civilian transport systems developed as an offshoot of military transport systems.

The National Highway Safety Act of 1966 ensured better training of emergency medical technicians and paramedics.⁴ Furthermore, the EMS Systems Act of 1973 led to the development of the modern EMS system that we have today.⁵ Pediatric critical care transport developed when it became clear that children were different from adults and required more specialized care. Regionalization of pediatric intensive care has only intensified the need for specialized pediatric critical care transport teams with the capability to transport the critically ill or injured child from smaller community hospitals to tertiary care centers and children's hospitals.⁶

In November 1986, primarily to address the need for a more formalized organization of pediatric transport programs throughout the country, the American Academy of Pediatrics (AAP) Committee on Hospital Care published Guidelines for Air and Ground Transportation of Pediatric Patients.⁷ These guidelines were updated in 1993 by the American Academy of Pediatrics Task Force on Interhospital Transport.⁸ These guidelines address a number of issues related to the organization and administration of a pediatric transport program and have been instrumental in developing and formalizing standards of care for pediatric transport medicine.

The need for specialized pediatric critical care transport teams in the military is obvious. Military members and their dependents are often deployed overseas to isolated locations where specialized pediatric care is unavailable. Therefore, critically ill children may require air transport to military medical centers in the United States where specialized care is available. Furthermore, regionalization of both neonatal and pediatric intensive care in the United States translates into a need for a system to transport critically ill children from smaller military hospitals to tertiary military medical centers.

A need for the development of a specialized pediatric and neonatal critical care transport program at Naval Medical Center San Diego was recognized. Before the development of this program, transport of critically ill patients was performed by a transport team based at the local children's hospital, often at significant expense to the military and the active duty member. The purpose of developing a military pediatric transport program was 2-fold. First, the transport team was designed to serve as a training program for active duty pediatrics residents, nurses, and respiratory therapists. Many active duty pediatrics residents and nurses are assigned to overseas locations where pediatric transport is performed by the local military pediatrician. Based on the results of our survey, it is clear that the residents graduating from the program found it a highly worthwhile experience and a significant contribution to their education. Despite the recent emphasis on primary care, general pediatricians are still often called upon to evaluate and treat critically ill patients in their offices.⁹⁻¹¹ We feel that our residents, as a result of their participation in the pediatric critical care transport program, will be well equipped with the knowledge and experience to recognize, evaluate, and stabilize criti-

cally ill patients before transfer to facilities with critical care capabilities. The current training protocol for pediatric residents is described in "Appendix B" and is in compliance with current Residency Review Committee requirements of the Accreditation Council for Graduate Medical Education.

The second goal of the transport team was to provide access to military pediatric tertiary care at significant cost savings to the government and the active duty member. Based on our results, the pediatric critical care transport program at Naval Medical Center San Diego has clearly met this goal. The transport program generated a cost avoidance of almost \$2,000 per transport during FY 1996–1998. There are other incidental costs associated with the program that we were not able to calculate, such as equipment maintenance and the costs associated with running a yearly training course. However, these costs are more than offset by the overall savings each year. In addition, there are no out-of-pocket expenses to the military beneficiary, which can be quite expensive if a civilian pediatric transport program performs the transport. It is clear that the transport program saves costs to both the government and the active duty member.

The development of a transport program of this type was not without difficulties. With a small pool of available medical, nursing, and respiratory staff and the inherent personnel turnover associated with a military facility, meeting and maintaining transport qualifications required almost constant training. This was accomplished by our annual transport training course and completion of supervised transports. The relatively small number of transports performed each year required careful attention to providing training personnel to almost every transport to meet our training requirements for all staff members. In addition, there were too few nursing and respiratory therapy staff members to justify a separate on-call schedule dedicated to transport. This would often result in shifts of personnel between units to provide coverage during transport times. These obstacles were overcome by the commitment to provide the best patient care possible and the training benefits to the residents and nurses as discussed above.

In summary, we report our experience with the development of a largely resident-initiated pediatric critical care transport program. The program was developed to meet two main objectives. The most important objective was the education of pediatric residents in the recognition, evaluation, stabilization, and transport of critically ill children. A secondary objective was to provide cost savings to the Department of Defense and the military service member. Based on our results, we conclude that our program has met both of these stated objectives.

Appendix A

Percentages of responses to each question, by category, are shown in parentheses. Percentages may not equal 100% because of rounding.

1. Experience in the pediatric critical care transport program greatly enhanced my training in the initial evaluation, stabilization, and transport of the critically ill neonate.

- (1) Strongly agree (71%)
- (2) Agree (24%)
- (3) Neutral (0%)
- (4) Disagree (5%)

(5) Strongly disagree (0%)

2. Experience in the pediatric critical care transport program greatly enhanced my training in the initial evaluation, stabilization, and transport of the critically ill child.

- (1) Strongly agree (71%)
- (2) Agree (29%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

3. As a pediatrician in the military, with a unique mission and the possibility of serving in an isolated duty station, I needed more training than my civilian counterparts in pediatric critical care medicine.

- (1) Strongly agree (76%)
- (2) Agree (24%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

4. As a pediatrician in the military, with a unique mission and the possibility of serving in an isolated duty station, I needed more training than my civilian counterparts in transport medicine.

- (1) Strongly agree (86%)
- (2) Agree (14%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

5. My experience in the pediatric critical care transport program made me a better pediatrician.

- (1) Strongly agree (67%)
- (2) Agree (29%)
- (3) Neutral (5%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

6. My experience in the pediatric critical care transport program complemented the training I received in the neonatal and pediatric intensive care units.

- (1) Strongly agree (71%)
- (2) Agree (29%)
- (3) Neutral (5%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

7. My experience in the pediatric critical care transport program was worthwhile.

- (1) Strongly agree (67%)
- (2) Agree (33%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

8. My experience in the pediatric critical care transport program was a waste of my time.

- (1) Strongly agree (0%)
- (2) Agree (0%)

- (3) Neutral (0%)
- (4) Disagree (29%)
- (5) Strongly disagree (71%)

9. I would suggest that all military pediatric residents receive training in pediatric transport medicine.

- (1) Strongly agree (81%)
- (2) Agree (19%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

10. I would suggest that all pediatric residents, both military and civilian, receive training in pediatric transport medicine.

- (1) Strongly agree (33%)
- (2) Agree (38%)
- (3) Neutral (19%)
- (4) Disagree (10%)
- (5) Strongly disagree (0%)

11. My experience in the pediatric critical care transport program has been useful.

- (1) Strongly agree (62%)
- (2) Agree (38%)
- (3) Neutral (0%)
- (4) Disagree (0%)
- (5) Strongly disagree (0%)

12. The skills and knowledge I gained during my experience in the pediatric critical care transport program have been used in my current assignment.

- (1) Strongly agree (57%)
- (2) Agree (33%)
- (3) Neutral (5%)
- (4) Disagree (5%)
- (5) Strongly disagree (0%)

Appendix B

Training Requirements for Participation in the Pediatric Critical Care Transport Program. I. Physicians

Participation in the pediatric critical care transport program is highly integrated with the resident's experience in both the neonatal intensive care unit (NICU) and the pediatric intensive care unit (PICU). During the first year of training, residents are exposed to the care of critically ill children through two 4-week blocks in the NICU, three 4-week blocks on the inpatient ward, and one 4-week block in the emergency department. In addition, residents participate in a closely supervised procedure laboratory, where they receive instruction and experience in procedures used in the care of critically ill children. These procedures include vascular access procedures such as venous cutdowns, central venous line placement using the Seldinger technique, and placement of intraosseous lines. Other procedures include cricothyrotomy, thoracentesis, chest tube placement, abdominal paracentesis, and pericardiocentesis. Also during the first year of training, residents receive certification in Advanced Cardiac Life Support (American Heart Association), Pediatric Advanced Cardiac Life Support (American Heart Association, American Academy of Pediatrics), Neonatal Advanced Life Support/Neonatal Resuscitation Program (American Academy of Pediatrics), and Advanced Trauma Life Support (American College of Surgeons).

During the second year of training, residents are further exposed to the care of critically ill children through the following rotations: a 4-week block in the NICU, a 2-week block of pediatric anesthesia, a 2-week block in the PICU, and a 4-week block of pediatric emergency medicine. The third year of training includes the following 4-week rotations: NICU, PICU, and pediatric emergency medicine. During these rotations, the resident has more of a supervisory role than during the first year. Further exposure to care of the critically ill child is received in the pediatric critical care transport program. Requirements for participation include:

1. completion of the rotations in the NICU, PICU, and pediatric anesthesia during the second year
2. certification in Advanced Cardiac Life Support, Pediatric Advanced Cardiac Life Support, and Neonatal Advanced Life Support/Neonatal Resuscitation Program
3. completion of the pediatric critical care core lecture series, which consists of:
 - (a) airway management
 - (b) vascular access
 - (c) acid-base disturbances and arterial blood gas interpretation
 - (d) shock
 - (e) resuscitation of the pediatric patient
 - (f) introduction to mechanical ventilation
 - (g) medicolegal issues and ethics in the PICU
4. completion of the pediatric critical care transport course, which consists of:
 - (a) introduction to transport medicine
 - (b) airway adjuncts and endotracheal intubation
 - (c) monitoring of the critically ill child
 - (d) pediatric trauma
 - (e) transport of the critically ill neonate
 - (f) pediatric surgical emergencies
 - (g) air transport physiology
 - (h) small group discussions/lectures in:
 - (1) vascular access
 - (2) transport equipment
 - (3) airway management scenarios
 - (4) X-ray interpretation scenarios
5. demonstration of technical competency in procedural skills, including:
 - (a) minimum of three neonatal intubations and three pediatric intubations
 - (b) minimum of three umbilical artery and vein catheterizations
 - (c) minimum of one chest tube placement
6. completion of supervised NICU and PICU transports (minimum of three each)
7. certification by the transport coordinator, with final approval of the director of pediatric transport services

Acknowledgment

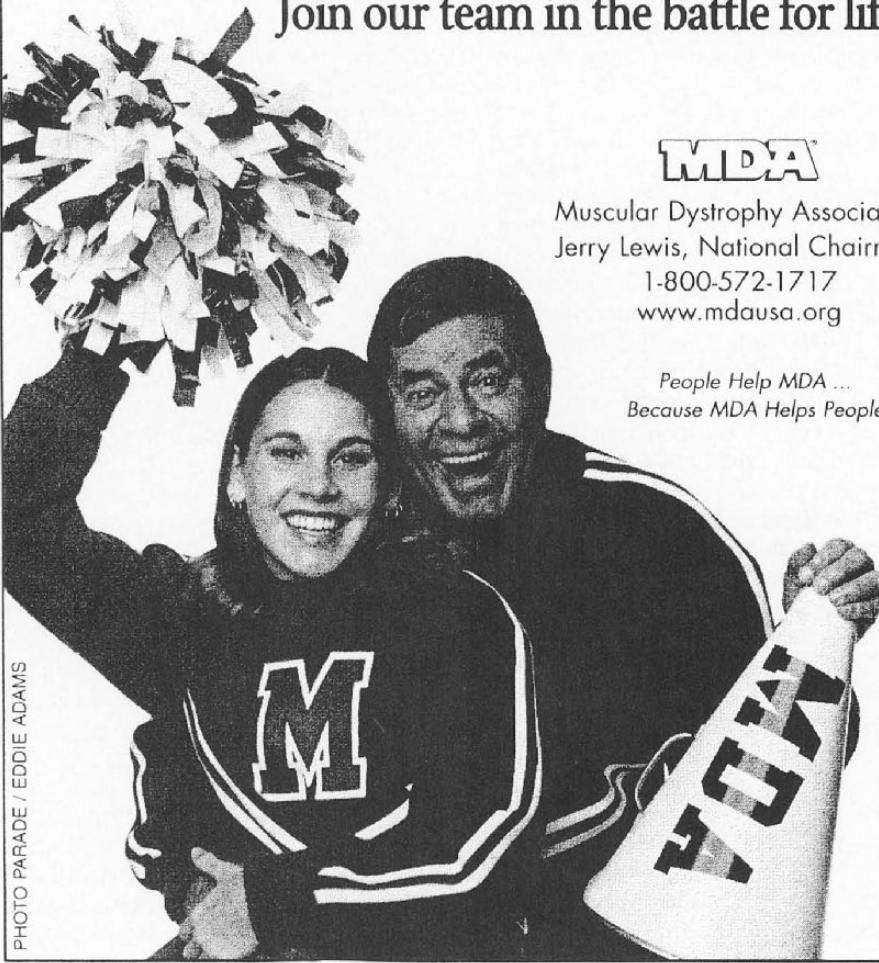
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