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1991-1992 & 1996 Utah Usage of EMS Services by Children: Year III Research Report

Intermountain Injury Control Research Center

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Abstract

RO1 HS09057 Utah Usage of EMS Services by Children

This study examined how Utah children used emergency medical services (EMS) and related hospital care in 1991-1992. The EMS and hospital records were linked using special software (probabilistic linkage). The principal findings of the study concerned the care of young children less than 5 years of age. They received fewer procedures prior to being transported to a hospital and required more time at the scene for assessment. Some interventions such as splinting of fractured arms prior to transport to a hospital were related to reduced hospital charges.

Ambulance and hospital charges for children were estimated to by $35,000,000 not counting physician charges, prescriptions, and rehabilitation care. A training program in intravenous (IV) line placement for ambulance personnel resulted in a reduction in the amount of time EMS personnel spent at the scene. This study raised several hypotheses which could be the subject of future research.

Executive Summary

RO1 HS09057 Utah Usage of EMS Services by Children

This report summarizes the findings of a study about the delivery of emergency medical services (EMS) to children in Utah. The majority of the report concerns delivery in 1991-1992. The study was funded by the Agency for Health Care Policy and Research (AHCPR) and carried out by investigators from the University of Utah School of Medicine. The study was made possible by the cooperation of the Bureau of EMS of the Utah Department of Health and the Utah Hospital Association.

The study used information from both ambulance records and hospital records. The information was linked using special software (probabilistic linkage) because identifying information sometimes differed in the two sources. The study also examined aeromedical (helicopter and fixed wing aircraft) EMS transports to Primary Childrens' Medical Center (PCMC) which is a tertiary care hospital that treats critically ill and injured children.

This report differs from the *Utah Prehospital EMS Incident Profile Statewide Summary Report 1996* which was published by the Utah Department of Health, Bureau of EMS. It includes information from hospital treatment and diagnosis of children. The inclusion of hospital data allowed us to estimate injury severity and to identify specific injuries, such as leg or arm fractures. We then examined EMS interventions such as splinting in children with leg or arm fractures. This report does not include a county-by-county analysis as was in the 1996 report. Because electronic submission of EMS reports for 1991 and 1992 by local agencies to the Bureau of EMS was not complete, reporting for Utah rural and frontier areas is incomplete.

Disclaimer

The findings of this study are those of the authors. They do not necessarily indicate the opinions of or carry the endorsement of any Utah state agency or of members of the advisory board. Because this was a study of existing data we were unable to completely control for variability in severity of illness or injury in children receiving the EMS procedures. We expect that EMS procedures, such as splinting of fractures, will improve outcomes for injured children. EMS personnel are trained to do those procedures for that very reason. This study was not a randomized clinical trial, where some children received interventions and others (controls) did not.

Findings concerning EMS usage

For 1991-1992, there were 20,272 ambulance (EMS) runs whose reports were submitted to the Bureau of EMS which contained enough demographic information to determine that the run was for a child age 0 through 17 years. We did not have information on canceled EMS runs. We used the 1991-1992 Utah population information to calculate rates. EMS use was 15 per 1,000 children per year, excluding canceled runs. Rates were highest for 16-17 year olds, followed by children less than 1 year of age. We matched 80% of EMS runs for children to the hospital records.

Trauma accounted for 67% of ambulance usage by children. Severely ill or injured children were more likely to receive advanced life support (ALS) EMS care. Children with special health care needs were more likely to use EMS for illness and were more likely to be transferred by EMS from one health care facility to another.

In 1991 and 1992, EMS dispatch times and times to get to the scene were somewhat longer than reported in the 1996 study. Average time from receiving a call to arrival at the scene was 15 minutes, with a median time of 11 minutes. Ambulance personnel spent more time at the scene for children less than 5 years of age who had illness as the principal diagnosis, probably because accurate EMS assessment of the youngest children took more time and not because additional procedures were performed for the youngest children. Regression analysis showed that each minute of EMS response time was associated with an additional $72 in subsequent hospital charges.

We estimated how severe injuries were by using the Injury Severity Score (ISS). We judged severity of illness by whether the child was admitted to the hospital. Children who were more severely ill or injured were more were more likely to have ALS level care and to have EMS procedures such as intravenous (IV) therapy or oxygen administration. This indicates appropriate care. In Utah urban areas both ALS and basic life support (BLS) services may respond to a call if the dispatcher requests. After assessment at the scene the child is transported by the appropriate level of EMS service.

We identified children whose principal body region of injury was the head, neck, or face from hospital records. We found that immobilization of the neck with a cervical collar was done in 62%, and immobilization by spine board in 56%. During the period of this study, a limited number of sizes of cervical collars and spine boards were available on ambulances. Children less than 5 years of age were less likely to have either a cervical collar or spine board applied. The EMS run form did not contain coding to allow us to determine whether an appropriate size device was available on the ambulance for use on small children, so we do not know the reason for the for decreased usage.

Ambulance personnel applied splints to 49% of children with fractured arms. Children who had splints applied prior to transport to the hospital had, on average, $300 lower hospital charges than non-splinted children. Both groups of children had similar ISS scores and do the difference in charges was not explained by differences in injury severity.

In 1991-1992 there were 847 children transported to PCMC by helicopter or fixed wing aircraft. Most (97%) of the flights originated in Utah. Most helicopter transport was for transports less than 100 miles. Fixed wing aircraft were used for flights greater than 100 miles. Younger children were more likely to be transported for illness than injury. Children age 5 and older were more likely to be transported for trauma. Compared to children transported by ground ambulance, children transported by air were more severely ill or injured. They were more likely to have EMS interventions, such as fluid resuscitation or drug therapy, prior to arrival at the hospital.

Findings concerning hospital charges

Utah children used EMS mostly because of trauma. The average hospital charge for care of an injured child in 1991 was $3,093.32. In 1992 this increased to $3752.24. Estimated total charges for EMS, emergency department, and inpatient hospital care for Utah children were approximately $35,000,000. This did not include physician charges, medication, rehabilitation care, and indirect costs related to lost time from school and/or employment. About 15% of acute care charges for trauma were for children who had head injury as the main injury. As would be expected for trauma, males accounted for the majority of injuries and had the highest hospital charges. For children with illness those with congenital anomalies and birth-related conditions accounted for the highest charges.

Findings concerning training of EMS personnel in IV access

Following a pediatric vascular access training program in 1992-93 there were differences in placement of IV lines prior to transport to a hospital. We compared IV placement prior to the training program (1991-92) with IV placement in 1996. EMS and hospital data for 1993-95 were not available in suitable form to include in the comparison. The training program emphasized not only how to establish an IV in a child but also to omit IV placement when near a hospital and transport the child rapidly. Therefore, we chose to examine IV placement in Utah children when the transport time was less than 6 minutes to a hospital versus when it was 6 minutes or more. When near a hospital, IV placement by EMS decreased significantly following the training program. When the transport time to the hospital was 6 minutes or more, the amount of time spent at the scene when an IV was placed decreased significantly. The vascular access training program improved use of EMS resources.

Use of IV fluids and medications changed significantly following the training program. When a child was injured, he or she was more likely to receive isotonic IV fluids such as Ringers' lactate rather than 5% dextrose in water following the program. When a child's principal diagnosis was respiratory illness, he or she was significantly more likely to receive albuterol following the training program. Due to the small number of observations for certain medical conditions such as diabetes, we were unable to measure changes related to training program.

This study provides population-based information concerning EMS services to children. A number of hypotheses arise from the findings, such as whether splinting of extremity injuries reduces hospital charges. These hypotheses could be the subject of future research. The study provides evidence that training EMS personnel in IV placement has beneficial outcomes.

Hospital Charges and Costs Related to Usage of Emergency Medical Services (EMS) for Children in Utah, 1991-1992

and

The Effect of EMS Training on Prehospital Care of Children, a Comparison of 1991-92 and 1996

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Section III

Results

Executive Summary

This is the final report of a study of Emergency Medical Services (EMS) usage by Utah children. The third year of this study originally proposed to examine 1991-92 EMS and related hospital data for the purpose of identifying the effect of EMS training on delivery of services such as intravenous (IV) and drug therapy to Utah children. During the course of the study it became apparent that EMS training had not been completed in 1992 and that it would be difficult to assess the effect of training using only 1991-92 data as some of the training continued through 1995. We had 1996 EMS and hospital data available and used these to measure increases in IV and drug therapy provided to Utah children prior to transport to a hospital.

This study also proposed to examine costs and charges of EMS and related hospital care. We were able to estimate acute care hospital charges and costs using emergency department (ED) and hospital discharge data for 1991-92.

None of the above analyses would have been possible without the ability to link EMS, ED, and hospital discharge data using probabilistic linkage techniques. This enabled us to assign a specific medical diagnosis for each EMS run that was linked to a hospital record. This, in turn, allowed us to examine EMS interventions for specific health conditions, such as respiratory illness.

Disclaimer

The findings of this study are those of the authors and do not necessarily indicate the opinions of or carry the endorsement of any Utah state agency. This study used existing data that had been collected for other purposes. We were unable to control for variability in the severity of illness of children transported by EMS.

Findings

The majority of EMS usage by Utah children is for trauma. The mean hospital charge for care of an injured child in 1991 was $3,093.32; in 1992 this increased to $3,752.24. Estimated total charges for EMS, emergency department, and inpatient hospital care for Utah children were approximately $35,000,000 exclusive of physician charges, medication, rehabilitation care, and indirect costs related to lost time from school and/or employment. Head injuries accounted for approximately 15% of acute care charges for children with trauma as the principal diagnosis. Children with congenital anomalies and birth-related conditions accounted for the highest charges for children with illness as principal diagnosis.

As would be expected for trauma, males accounted for the majority of injuries and had the highest hospital charges.

There were differences in IV placement following a Pediatric Vascular Access training program in 1992-93. Because the training program emphasized not only how to establish an IV in a child, but also to omit IV placement when near a hospital and to transport the child rapidly to the hospital; we chose to examine IV placement in Utah children when the transport time was less than 6 minutes to a hospital, and when it was 6 minutes or more to a hospital. When near a hospital, IV placement by EMS decreased significantly following the training program. When the transport time to the hospital was 6 minutes or more, the amount of time spent at the scene when an IV was placed decreased significantly. The Vascular Access training program improved utilization of EMS resources.

There were significant changes in usage of IV fluids and medications following the Emergency Medical Services for Children (EMSC) training program. When a child was injured, he or she was more likely to receive isotonic IV fluids such as Ringers' lactate rather than 5% dextrose in water following the training program. When a child's principal diagnosis was respiratory illness, he or she was significantly more likely to receive albuterol following the training program. Due to the small number of observations for certain medical conditions such as diabetes, we were unable to measure whether administration of medications such as 50% dextrose changed following the training program.

The significance of this report is that it provides information concerning EMS usage by children, hospital charges related to this EMS usage, and changes in EMS care following a training program.

Section I

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Section I

Background

In 1984, Congress approved a demonstration grant project to expand access to and improve the quality of Emergency Medical Services for children (EMS-C). It became clear that several important components of EMS systems that provided services to children had the primary function of serving adults and may not have had the equipment, expertise, or training to provide services to children. In 1993, the Institute of Medicine (IOM) published a report, "Emergency Medical Services for Children" that pointed out there was very limited data available on how many children need emergency care, the type of injuries and illnesses they experience, and the nature and outcome of the care they receive (IOM, 1993).

Children use ambulance services less frequently than adults (Maio et al., 1996). Children have been reported to account for approximately 10% of usage of Emergency Medical Services (Tsai and Kallsen, 1987). As children are estimated to account for 25% to 35% of patients seen in hospital emergency departments in the U.S. (IOM, 1993), many of these children are probably transported to hospitals by private vehicles. The most seriously ill and injured children may require transport by EMS from hospitals or other health care facilities to pediatric specialty centers, such as Primary Children's Medical Center.

Improvement of EMS systems in the U.S. began in the 1960s with support from the Department of Transportation and the Department of Health, Education, and Welfare for development of Advanced Life Support (ALS) ambulance services and for development of regional trauma systems. During the 1970s, pediatricians and pediatric surgeons recognized the need for special training in pediatrics and for special training of emergency department personnel and EMS providers.

The findings presented in this report are from a research study funded by the Agency for Health Care Policy and Research (AHCPR) for a study of the Epidemiology and cost of EMS provided to children. This report is the second in a series and reports the findings of Year III of this study. The previous report "*Utah Usage of EMS Services by Children*" published by University of Utah Intermountain Injury Control Research Center (IICRC) and distributed in August 1998, described the Year II findings. These findings were also published in the journal *Injury Prevention* (Suruda A et al., 1999) and *Prehospital Emergency Care* (Diller E et al., 1999).

Utah is an ideal state in which to study health problems of children in that it has good vital records, excellent cooperation among public and private agencies that collect data pertinent to children's health, and has the highest percentage of children (30%) in the population of any U.S. state. The University of Utah investigators have expertise in linkage of EMS and hospital data.

The study used 1991 and 1992 data for the initial analysis. Much of the EMS training, such as pediatric Vascular Access, which is described in Section III of this report, was begun in 1992 and completed in later years. Once a training program was completed, it became a requirement for new EMS personnel whose level of practice (paramedic) utilized that procedure. We had available EMS, emergency department, and hospital data for 1996. We linked these data in the same manner as the 1991 and 1992 data. We used the 1996 data for comparison to the 1991-92 period prior to EMS training (described in Section III below) to evaluate the effectiveness of the EMS training programs with respect to whether EMS procedures were performed prior to transporting children to a hospital.

How the data were obtained

Population-based records for 1991-1992 were gathered from a variety of sources. Most Utah EMS agencies submit standardized run reports in electronic form to the Bureau of EMS in the Utah Department of Health. These reports were obtained for 1991-1992. A few agencies submitted reports in paper form for those years (approximately 10% of all EMS runs). These were keypunched into electronic form.

Hospital records for 1991- 1992 were obtained with the cooperation of the Utah Hospital Association and individual hospitals. Data included demographic information, length of stay, primary and additional diagnoses, and charge information. Diagnostic and charge information was complete for 1992 only. 1996 EMS, emergency department, and hospital data were obtained from the Utah Department of Health.

Confidentiality

Prior to obtaining data, approval for this study was obtained from the University of Utah Health Sciences Center, Institutional Review Board (IRB). This approval is required for any research involving human subjects.

EMS and hospital records contained personal identifiers. These identifiers were retained for the purpose of performing the probabilistic linkage of EMS to hospital records (see below). Once this linkage was performed, identifiers were deleted from the data set.

Record linkage of EMS run data to hospital data

Linking data from various sources allows us to answer questions such as "What is the relationship between the severity of injuries, which children sustain and whether a particular EMS procedure, such as IV placement, is done at the scene prior to transport to a hospital?"

EMS run reports and hospital inpatient and outpatient records were linked using probabilistic linking software developed for the Bureau of the Census (Jaro, 1995; Felligi and Sunter, 1969). Probabilistic linking was done using electronic records matched on various demographic factors and date of EMS run and hospital admission. Multiple matching was done to identify hospital records for which more than one EMS record corresponded in order to identify patients for whom multiple EMS run reports were filed. Overall, 80% of EMS run reports were linked to either inpatient or outpatient (emergency department) hospital records (Suruda et al., 1999).

Determining Advanced Life Support (ALS) runs

In theory, it was possible to determine whether a particular EMS run had ALS-level service from the license number of the EMS service or from the EMS disposition code marked on the incident report code sheet. Most EMS agencies, which provide ALS service, have separate license numbers for ALS and basic life support (BLS) services. After review of the electronic EMS reports, it was clear that agencies which had multiple licenses submitted some ALS runs under the BLS license number, and vice versa. We chose, therefore, to assign ALS service by the disposition code on the incident report code sheet.

Determining severity of injury from hospital data

The hospital data included underlying diagnosis and contributing diagnoses according to the International Classification of Diseases, 9th revision (ICD-9), procedure codes, charge information, and length of stay. None of these data elements specifically identify severity of injury. A standardized, widely accepted method for assessing the severity of injuries includes assigning Abbreviated Injury Severity (AIS) scores to injuries in various body regions from the hospital ICD-9 diagnoses, and then assigning Injury Severity Scores (ISS) from the three greatest AIS scores. AIS and ISS scoring were originally developed to predict survival from severe injury. AIS scores and ISS scores were assigned from hospital discharge diagnoses using ICDMAP-90 software developed by Ellen MacKenzie and Tri-Analytics, Inc. This software also creates variables which indicate the body region of most severe injury. Analysis of ISS scores was done after eliminating patients with ISS=0 (no injury) or with invalid ISS values, identified by ICDMAP-90 as ISS=99.

Determination of EMS times

The number of minutes for EMS dispatch, travel en route to the scene, scene time, and transport time to the hospital were calculated from the 24-hour times recorded on the EMS incident report code sheet for time of call, time en route, arrival at scene, departure from scene, and arrival at the hospital. Analysis of various EMS times such as transport time was done after excluding negative times and the upper 1% of observations. The exclusion of the upper 1% was done to eliminate excessively high values (outliers).

Determination of diagnosis

EMS run forms contain dispatch & injury/illness codes that identify the reason for the EMS run. In the report "*Utah Usage of EMS Services by Children*" published by IICRC and distributed in August 1998, we noted that for children whose principal problem was some sort of injury, there was reasonable agreement between the EMS dispatch and injury/illness coding and a hospital diagnosis of injury. For children whose principal health problem was illness, this agreement was poor. For this reason we decided to use the hospital diagnosis to establish whether a child was ill or injured, and what the particular problem was.

If the child was transported by EMS and admitted to the hospital, we used the hospital inpatient primary diagnosis to determine the type of injury or illness. If the child was transported by EMS and not admitted, we used the outpatient (emergency department) primary diagnosis.

Determination of age

For those EMS runs that linked to hospital records, age 0 through 17 years were identified from the hospital record. For those EMS runs that did not link to hospital records, age 0 through 17 was identified from information on the EMS run record.

Determination of EMS procedures

Identification of EMS procedures such as intravenous (IV) placement or spine board usage was done from treatment coding on the EMS run form. Up to six treatment codes were listed for each run. Similarly, administration of medication was identified from coding on the EMS run form.

Completeness of the data used for analysis

For 1991-1992, EMS run data in electronic format was not available for all Utah counties. These years were the beginning of the period when the Bureau of EMS received run reports in electronic format. Reporting was more complete for urban than for rural areas. There were a greater number of reports received for 1991 than 1992. 1996 data are believed to be complete; an analysis of the 1996 EMS data were published in the *Utah Prehospital EMS Incident Profile Statewide Summary Report* 1996 published by the Bureau of EMS, Utah Department of Health

Because of missing data elements for some items, the total number of observations may differ among the tables in this report.

Section II

Calculation of EMSC care and related hospital charges for 1991 & 1992

Section II

Calculation of EMSC care and related hospital charges for 1991 & 1992

There were 20,272 EMSC ambulance runs for 1991-1992, which were linked to 12,250 hospital records. Because there were approximately 1.3 EMSC runs for each patient due to multiple EMS agencies responding, the actual linkage rate to hospital records was 80%.

Calculations of charges for EMSC and related inpatient and outpatient charges are tabulated in this section. Charge information was not available for a substantial number of records. They are based on 7,025 linked records for 1991 and on 5,225 records for 1992. Of the 7,025 records for 1991 there were 2,344 records that did not contain complete hospital information regarding illness or injury. For 1992 this information was missing in 658 records. Imputed values for these records were based on the assumption that injury information was complete for 1991 (4,180 records) and that illness information was complete for 1992 (1,691 records). Thus there were 5,871 hospital records linking to EMSC runs, 29% for illness and 71% for injury. Based on an estimate of 7,000 EMSC runs per year there would be 2,030 hospital records linked for illness and 4,970 for injury. Adjustments for missing diagnostic information were based on the assumption that the distribution of injuries, illnesses, and charges for the missing information matched the distribution for complete records. Estimates for imputed charges involved trimming the data to exclude influential observations where total hospital charges (inpatient and outpatient) exceeded $100,000 or were less than $10.00.[1] Using mean values from the complete records and by assuming the mean values for the missing values would be the same, imputed charges were obtained. Total hospital charges include inpatient and outpatient charges plus ambulance charges based on procedures, mileage, and time.[2] Physician charges are not included.

For 1991 total charges associated with EMSC runs linked to injuries amounted to $12,930,085. For 1992, the total associated with injuries was $ 18,643,665. This increase in charges is primarily due to increases in hospital related charges. The mean charge in 1991 was $3,093.32 and in 1992 rose to $3751.24.[3] Charges associated with illness for 1992 totaled $14,684,852 based on 1,691 complete hospital records and estimates for 339 missing records. In 1991 there were only 501 complete records for illnesses that required a significant imputation of charges. Due to the large average charge of linked illness $9,882 records in this year (compared with $7,233 in 1992) the total observed and imputed charges amount to $20,061,900 for 1991. These results are presented in Table **2-A**. Table **2-B** details injury charges based on the principal body region of the injury as determined by the AIS code and Table **2-C** is based on the ISS code.[4]

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[1] With this adjustment the mean hospital charge changed from $3,231.00 (median $264.00) to a mean of $3,332.00 (median of $414.00).

[2] These tables are based on charges and not estimated costs. A reliable cost/charge ratio of .54 could be used to deflate the charges. This ratio is based on J. Vaul and C.R. Goodall, *The Guide to Benchmarking Hospital Value*, Reston, VA, St. Anthony Publishing, 1995.

[3] For 1992 $7,855,096 in charges were imputed to total charges relating to injury based on 2,094 records for which information was missing. Total charges of $10,788,568 were tabulated from 2,876 complete records for this year.

[4] It should be noted that there is a modest discrepancy between the totals of injury in Table 1.1 and Tables 1.2 and 1.3 for both years due to the imputation of total charges based due to missing observations.

Illness charges are summarized in Table **2-D**.[5] Demographic tabulations by age group, sex, and urban/rural classifications are shown in Tables **2-E** through **2-F**. Total charges for these two tables are based on the observed values in the data (7,526 records for 1991 and 5,225 records for 1992) and no imputations are made. Charges associated with special health care needs for children are presented in Table **2-G**. These children have increased risk of having chronic physical, developmental, behavioral, or emotional conditions and require services beyond those generally used.[6] Because of the relatively small sample size for these records, data for 1991 and 1992 were merged.

Tables **2-H** through **2-O** summarize the distribution and average hospital charges (inpatient and outpatient charges) and ambulance charges for 1991 and 1992 using the trimmed data set where total hospital charges (inpatient and outpatient) exceeded $100,000 or were less than $10.00 were excluded.

Table 2-A

Total charges including inpatient, outpatient, and ambulance charges by classification of incident and by year

YEAR	Class	Observed	Imputed*	Total
1991	Illness	$4,951,237	$15,110,664	$20,061,900
1991	Injury	$12,930,086	$2,443,723	$15,373,808

YEAR	Class	Observed	Imputed*	Total
1992	Illness	$12,232,554	$2,452,299	$14,684,852
1992	Injury	$10,788,569	$7,855,097	$18,643,665

Note: *Charges imputed to missing records without complete diagnostic information based on the average charges for complete records.

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[5] Because of severely limited disease information for 1991 the tabulations for Table 1.4 for 1991 differ from the illness tabulation in Table 1.1.

[6] See Anthony Suruda, Donald D. Vernon, Edma Diller, and J. Michael Dean, "Usage of Emergency Medical Services by Children with Special Health Care Needs," *Prehospital Emergency Care*, in press.

Table 2-B

Total charges including inpatient, outpatient, and ambulance charges by AIS region of principal injury and by year

Year	AIS Region	Observed	Imputed*	Total
1991	Head	$4,576,315.27	$1,391,915.99	$5,968,231.26
1991	Face	$652,476.90	$198,454.07	$850,930.97
1991	Neck	$15,003.95	$4,563.55	$19,567.50
1991	Thorax	$311,919.07	$94,872.28	$406,791.35
1991	Abdomen	$586,331.02	$178,336.68	$764,667.70
1991	Spine	$747,470.00	$227,347.25	$974,817.25
1991	Upper Extremity	$574,220.51	$174,652.29	$748,872.80
1991	Lower Extremity	$1,647,312.84	$501,041.23	$2,148,354.07
1991	External	$2,490,688.09	$757,558.42	$3,248,246.51

Year	AIS Region	Observed	Imputed*	Total
1992	Head	$3,205,424.68	$1,854,286.15	$5,059,710.83
1992	Face	$493,831.58	$285,674.84	$779,506.42
1992	Neck	$26,300.76	$15,214.57	$41,515.33
1992	Thorax	$305,067.49	$176,476.52	$481,544.01
1992	Abdomen	$933,539.86	$540,038.17	$1,473,578.03
1992	Spine	$736,452.29	$426,026.82	$1,162,479.11
1992	Upper Extremity	$483,234.25	$279,544.17	$762,778.42
1992	Lower Extremity	$1,656,347.43	$958,171.51	$2,614,518.94
1992	External	$1,793,273.50	$1,037,379.78	$2,830,653.28

Note: *Charges imputed to missing records without complete diagnostic information based on the average charges for complete records.

Table 2-C

Total charges including inpatient, outpatient, and ambulance charges by ISS region of principal injury and by year

YEAR	ISS Region	Observed	Imputed*	Total
1991	Head/Neck	$4,925,523.91	$1,498,130.49	$6,423,654.40
1991	Face	$243,976.95	$74,207.29	$318,184.24
1991	Chest	$418,360.71	$127,247.19	$545,607.90
1991	Abdomen and Pelvic Contents	$627,079.31	$190,730.07	$817,809.38
1991	Extremities or Pelvic Girdle	$1,966,221.65	$598,039.38	$2,564,261.03
1991	External	$3,091,280.04	$940,231.36	$4,031,511.40
1991	Not Assigned	$329,295.08	$100,157.21	$429,452.29

YEAR	ISS Region	Observed	Imputed*	Total
1992	Head/Neck	$3,653,367.57	$2,113,416.45	$5,766,784.02
1992	Face	$190,603.49	$110,261.11	$300,864.60
1992	Chest	$367,296.63	$212,475.18	$579,771.81
1992	Abdomen and Pelvic Contents	$916,000.77	$529,892.08	$1,445,892.85
1992	Extremities or Pelvic Girdle	$1,954,116.75	$1,130,426.09	$3,084,542.84
1992	External	$2,370,920.01	$1,371,538.01	$3,742,458.02
1992	Not Assigned	$181,166.62	$104,801.88	$285,968.50

Note: *Charges imputed to missing records without complete diagnostic information based on the average charges for complete records.

Table 2-D

Total charges including inpatient, outpatient, and ambulance charges classified by type of illness and by year

Year	TYPE	Observed	Imputed*	Total
1991	Infectious Disease	$128,161.37	$96,341.94	$224,503.31
1991	Neoplasia	$114,687.86	$86,213.64	$200,901.50
1991	Endocrine/Metabolic	$53,900.10	$40,518.04	$94,418.14
1991	Blood/Circulatory	$314,615.44	$236,504.01	$551,119.45
1991	Psychiatric	$254,891.56	$191,607.97	$446,499.53
1991	Neurological	$214,607.51	$161,325.57	$375,933.08
1991	Respiratory	$453,021.23	$340,546.60	$793,567.83
1991	Digestive	$73,605.71	$55,331.21	$128,936.92
1991	Urologic	$18,568.45	$13,958.37	$32,526.82
1991	Pregnancy/Childbirth	$128,878.39	$96,880.95	$225,759.34
1991	Congenital Anomalies	$3,017,815.05	$2,268,564.51	$5,286,379.56
1991	Other Diseases	$195,795.27	$147,184.14	$342,979.41

Year	TYPE	Observed	Imputed*	Total
1992	Infectious Disease	$469,686.78	$77,509.83	$547,196.61
1992	Neoplasia	$384,687.97	$63,483.00	$448,170.97
1992	Endocrine/Metabolic	$173,257.19	$28,591.70	$201,848.89
1992	Blood/Circulatory	$769,489.81	$126,984.73	$896,474.54
1992	Psychiatric	$36,834.58	$6,078.62	$42,913.20
1992	Neurological	$569,254.11	$93,940.87	$663,194.98
1992	Respiratory	$3,125,518.96	$515,787.54	$3,641,306.50
1992	Digestive	$305,668.46	$50,442.78	$356,111.24
1992	Urologic	$68,969.05	$11,381.59	$80,350.64
1992	Pregnancy/Childbirth	$165,482.63	$27,308.72	$192,791.35
1992	Congenital Anomalies	$5,427,425.69	$895,658.98	$6,323,084.67
1992	Other Diseases	$746,089.28	$123,123.40	$869,212.68

Note: *Charges imputed to missing records without complete diagnostic information based on the average charges for complete records.

Table 2-E

Total charges including inpatient, outpatient, and ambulance charges by age group and by year

Year	Age Group (Years)	Observed Total
1991	0-4	$8,073,480.67
1991	5-9	$2,284,773.47
1991	10-14	$4,180,165.75
1991	15-17	$4,610,522.79

Year	Age Group (Years)	Observed Total
1992	0-4	$13,524,804.11
1992	5-9	$2,695,664.54
1992	10-14	$3,905,780.06
1992	15-17	$4,024,070.96

Table 2-F

Total inpatient, outpatient, and ambulance charges by sex and by year

Year	Sex	Observed Total
1991	Female	$7,582,151.92
1991	Male	$11,517,840.77

Year	Sex	Observed Total
1992	Female	$8,997,381.60
1992	Male	$14,997,990.13

Table 2-G

Mean hospital charges, ambulance charges, and total charges for children with special health care needs for 1991 & 1992

Special*	Total Hospital Charges	Total Ambulance Charges	Total Charges	(N)	Mean Total Charges
1	$10,306,601.41	$137,717.00	$10,444,318.41	405	$25,788.44
2	$10,341,026.28	$135,775.00	$10,476,801.28	397	$26,389.93

Note: *Special categories are discussed in Suruda, et al. (2000, in press). Special 1 is based on ICD-764.0-779.9, and 798.0. Special 2 is based on a listing of ICD-9 codes.

Table 2-H

Hospital & ambulance charges for illnesses, 1991 & 1992

Illness Classification	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Mean Total Charges	Total Charges
Infectious Disease	4.46%	$5.945.12	$278.96	$6.224.08	$563.570.29
Neoplasia	0.72%	$24,472.62	$279.87	$24,752.49	$361,493.20
Endocrine/Metabolic	3.26%	$3,003.49	$337.06	$3,340.55	$221,165.24
Blood/Circulatory	4.94%	$7,955.21	$348.52	$8,303.73	$832,722.74
Psychiatric	3.88%	$3,270.73	$319.82	$3,590.54	$283,161.87
Neurological	7.34%	$4,066.92	$331.26	$4,398.17	$655,169.12
Respiratory	23.84%	$6,293.00	$303.43	$6,596.43	$3,191,944.46
Digestive	3.26%	$5,284.83	$283.93	$5,568.75	$368,685.97
Urologic	1.63%	$2,229.25	$321.32	$2,550.57	$84,431.82
Pregnancy/Childbirth	2.30%	$5,734.21	$398.31	$6,132.52	$286,596.04
Congenital Anomalies	13.53%	$16,658.09	$346.47	$17,004.56	$4,668,791.57
Other Illness	30.84%	$1,153.97	$309.16	$1,463.13	$915,975.52

Table 2-I

Hospital, ambulance, and total charges by sex, 1991 & 1992

Sex	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Mean Total Charges	Total Charges
Female	45.33%	$3,020.86	$295.16	$3,316.02	$10,522,126.02
Male	54.67%	$3,607.92	$301.54	$3,909.46	$14,961,038.25

Table 2-J

Hospital, ambulance, and total charges by principal body region as determined by ISS region of principal injury, 1991 & 1992

Principle Body Region ISS Code	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Mean Total Charges	Total Charges
Head/Neck	30.04%	$3.438.38	$301.04	$3.739.42	$5.583.085.75
Face	2.41%	$2,645.50	$291.43	$2,936.93	$351,464.65
Chest	1.74%	$6,090.63	$301.30	$6,391.93	$551,580.11
Abdomen & Pelvic Contents	4.10%	$4,950.88	$302.70	$5,253.58	$1,069,217.55
Extremities or Pelvic Girdle	16.61%	$3,570.66	$285.75	$3,856.41	$3,183,404.87
External	41.05%	$1,188.58	$271.46	$1,460.04	$2,978,629.88
Not Assigned	4.06%	$1,743.01	$295.92	$2,038.93	$411,646.77

Table 2-K

Hospital, ambulance, and total charges by principal body region as determined by AIS region of principal injury, 1991 & 1992

Principal Body Region AIS Code	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Mean Total Charges	Total Charges
Head	21.79%	$4,242.97	$315.84	$4,558.81	$4,935,985.25
Face	17.87%	$776.34	$263.61	$1,039.94	$923,642.17
Neck	0.10%	$6,463.79	$380.00	$6,843.79	$33,428.64
Thorax	2.51%	$3,719.84	$307.61	$4,027.45	$501,640.17
Abdomen & Pelvic Contents	6.01%	$3,221.22	$291.80	$3,513.02	$1,049,584.50
Spine	14.40%	$1,296.58	$264.06	$1,560.64	$1,116,766.38
Upper Extremity	11.22%	$1,274.43	$260.89	$1,535.32	$856,170.38
Lower Extremity	15.61%	$3,170.22	$288.34	$3,458.56	$2,683,236.39
External, burns, and other trauma	10.50%	$3,581.21	$306.21	$3,887.42	$2,028,571.01

Table 2-L

Hospital, ambulance, and total charges by principal body region as determined by maximum severity, 1991 & 1992

Maximum Severity Code	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Total Charge (Mean)	Total Charges
0	3.91%	$820.20	$287.12	$1,107.31	$215,445.71
1	61.43%	$579.64	$267.23	$846.87	$2,585,346.38
2	21.70%	$3,265.71	$311.21	$3,576.92	$3,858,298.51
3	7.63%	$11,686.39	$337.79	$12,024.18	$4,561,546.50
4	1.75%	$15,965.18	$377.54	$16,342.72	$1,423,570.04
5	1.15%	$23,171.27	$355.80	$23,527.07	$1,340,715.42
6	0.03%	$30,658.51	$296.00	$30,954.51	$50,399.32
Not Assigned	2.39%	$517.25	$271.25	$788.49	$93,717.30

Table 2-M

Hospital, ambulance, and total charges by principal body region as determined by ISS score, 1991 & 1992

ISS Score	Percentage of Cases	Mean Hospital Charges	Mean Ambulance	Mean Total Charges	Total Charges
1	54.60%	$545.12	$267.62	$812.74	$2,205,437.79
2	4.86%	$954.43	$265.50	$1,219.94	$294,862.09
3	0.53%	$697.54	$242.46	$940.00	$24,663.16
4	16.24%	$2,832.58	$297.18	$3,129.76	$2,525,712.82
5	3.44%	$3,071.52	$346.86	$3,418.38	$584,340.10
6	0.32%	$4,604.42	$351.45	$4,955.87	$78,805.55
8	0.59%	$10,608.48	$391.16	$10,999.64	$323,584.03
9	4.67%	$9,023.42	$333.25	$9,356.67	$2,172,256.24
10	1.22%	$6,869.10	$339.28	$7,208.37	$435,569.59
11	0.05%	$4,817.73	$246.67	$5,064.39	$12,079.68
12	0.08%	$14,557.45	$317.40	$14,874.85	$59,132.94
13	0.85%	$15,412.54	$356.04	$15,768.58	$664,469.95
14	0.40%	$9,386.44	$340.92	$9,727.36	$193,348.98
16	0.96%	$14,917.69	$391.67	$15,309.36	$730,323.33
17	0.46%	$16,184.96	$354.55	$16,539.51	$381,353.32
18	0.19%	$32,128.24	$334.58	$32,462.82	$309,723.66
19	0.06%	$28,208.15	$460.75	$28,668.90	$91,175.45
20	0.22%	$21,958.10	$305.29	$22,263.39	$247,814.22
21	0.05%	$13,842.82	$566.33	$14,409.15	$34,368.97
22	0.22%	$32,123.37	$404.29	$32,527.66	$362,066.00
24	0.05%	$12,655.60	$309.00	$12,964.60	$30,923.40
25	0.56%	$17,181.93	$379.37	$17,561.30	$488,687.91
26	0.11%	$11,117.47	$391.86	$11,509.33	$64,055.29
27	0.08%	$41,252.86	$396.40	$41,649.26	$165,570.97
29	0.16%	$25,143.27	$344.90	$25,488.17	$202,649.50
30	0.06%	$37,117.58	$450.25	$37,567.83	$119,476.64
32	0.02%	$31,710.21	$485.00	$32,195.21	$25,597.54
33	0.03%	$39,223.24	$364.50	$39,587.74	$62,950.27
34	0.18%	$24,125.21	$324.36	$24,449.57	$213,831.07
35	0.05%	$49,596.36	$286.67	$49,883.03	$118,981.92
38	0.06%	$17,684.88	$310.50	$17,995.38	$57,230.55
41	0.03%	$50,260.04	$440.50	$50,700.54	$80,621.24
43	0.03%	$32,450.21	$407.50	$32,857.71	$52,248.54
50	0.03%	$21,103.24	$257.50	$21,360.74	$33,966.69
75	0.03%	$30,658.51	$296.00	$30,954.51	$49,222.18
Not Assigned	6.16%	$1,337.45	$558.36	$1,895.80	$301,942.11

Table 2-N

Hospital, ambulance, and total charges by age group, 1991 & 1992

Age Group (Years)	Percentage of Cases	Mean Hospital Charges	Mean Ambulance Charges	Mean Total Charges	Total Charges
0-4	29.39%	$5,061.93	$305.37	$5,367.30	$11,040,952.74
5-9	14.61%	$2,778.17	$290.65	$3,068.83	$3,138,894.61
10-14	25.34%	$2,681.78	$294.39	$2,976.17	$5,279,644.04
15-17	30.66%	$2,475.35	$298.41	$2,773.76	$5,952,818.26

Table 2-O

Hospital, ambulance, and total charges by year, age group & classification

Year	Age Group (Years)	CLASS	Percentage of Cases	Hospital Charges	Ambulance Charges	Mean Total Charges	Total Charges
1991	0-4	Illness	2.69%	$3,873,265.70	$70,566.00	$16,229.76	$3,943,831.70
1991	0-4	Injury	8.50%	$3,017,681.37	$249,171.00	$3,935.97	$3,266,852.37
1991	5-9	Illness	0.50%	$134,787.70	$13,540.00	$3,224.52	$148,327.70
1991	5-9	Injury	7.21%	$1,832,258.22	$196,272.00	$3,009.69	$2,028,530.22
1991	10-14	Illness	0.83%	$220,967.82	$24,909.00	$3,278.36	$245,876.82
1991	10-14	Injury	13.32%	$3,428,788.56	$372,308.00	$3,028.77	$3,801,106.46
1991	15-17	Illness	1.51%	$562,750.37	$50,450.00	$4,475.92	$613,200.37
1991	15-17	Injury	15.25%	$3,420,839.52	$412,757.00	$2,697.82	$3,833,596.52

Year	Age Group (Years)	CLASS	Percentage of Cases	Hospital Charges	Ambulance Charges	Mean Total Charges	Total Charges
1992	0-4	Illness	11.71%	$9,300,568.75	$338,662.00	$9,050.92	$9,639,230.80
1992	0-4	Injury	6.09%	$2,926,351.84	$156,719.00	$5,657.01	$3,083,070.84
1992	5-9	Illness	1.65%	$866,678.80	$50,109.00	$5,914.76	$916,787.80
1992	5-9	Injury	5.44%	$1,519,209.26	$137,058.00	$3,400.96	$1,656,267.41
1992	10-14	Illness	2.42%	$931,494.41	$66,477.00	$4,475.21	$997,971.41
1992	10-14	Injury	8.89%	$2,609,892.64	$226,269.00	$3,576.50	$2,836,161.64
1992	15-17	Illness	2.23%	$598,797.25	$79,766.00	$2,736.14	$678,563.50
1992	15-17	Injury	11.75%	$2,905,042.89	$308,026.00	$3,057.15	$3,213,068.99

Section III

The effect of EMS training on the prehospital care of Utah children

Training in other regions

Training in Utah

Pediatric Prehospital Provider course

Data analysis

Statistical analysis

Section III

The effect of EMS training on the prehospital care of Utah children

The Emergency Medical Services for Children (EMSC) program created by 1985 legislation was based in the Health Resources and Services Agency (HRSA). It later became a joint initiative of HRSA and the National Highway Traffic Safety Administration. The goal of the EMSC program was to reduce child and youth mortality and morbidity sustained due to severe illness or trauma. Some problems in the current EMS/EMSC system were identified at a 1991 conference, *A Report to the Nation* (Seidel & Henderson, 1991) and were further discussed in the 1993 Institute of Medicine (IOM) report, *Emergency Medical Services for Children* (IOM, 1993). These reports noted that many ambulance personnel had not been trained in specific emergency procedures for the care of children and called for prehospital Emergency Medical Services providers to receive pediatric training which emphasize procedures that may be performed in the EMS system. As a result, the EMSC program funded a number of training programs.

Training in other regions

Evaluation of the effectiveness of these training programs in other regions has been done by review of EMS run records for groups of children or for children brought to a single hospital.

Following the completion of a specialized training course, paramedics have shown improvement in vascular access in critically ill children (Losek et al., 1994). A study of pediatric EMS runs in Toronto examined the success rate of IV placement by paramedics in children likely to need IV therapy (Lillis & Jaffe, 1992). IV line placement was attempted less frequently and was less often successfully placed in children less than 6 years of age. Whether prehospital IV therapy is appropriate for critically ill children may depend upon the distance to the nearest hospital providing emergency services. Some EMS systems discourage attempting IV placement in children less than 6 years of age if the transport time to a medical facility is less than 6 minutes (Tsai & Kallsen, 1987).

Training in Utah

The Utah Department of Health, Bureau of Emergency Medical Services began an EMSC instructional program for prehospital providers in March 1991. In March 1992, a training program for advanced life support (ALS) providers (paramedics) concerning pediatric vascular access was implemented. The program included a skill station with three hours of practice in scalp and extremity IV placement, and one-hour practice in intraosseous therapy (IO) using chicken bones. The statewide program's target was vascular access for children less than 8 years of age and was completed by March 1993. After this time, completion of the program was required for all newly hired paramedics, and all EMS providers authorized to start IVs were required to repeat the skills station every four years.

The training program included a discussion of field assessment of shock in the pediatric patient by means of tachycardia, delayed capillary refill, weak or absent peripheral pulses, and hypotension. Recommended field treatment of shock included airway management, administration of 100% oxygen, control of hemorrhage, application of anti-shock trousers in shock due to hemorrhage, and fluid resuscitation with isotonic fluids. The training emphasized that establishment of IVs is difficult in young children, especially when dehydration or shock was present, and that the risks of prolonging scene time when establishing an IV should be weighed against the amount of transport time to the receiving facility and the patient's condition. When near a hospital, rapid transport following assessment was emphasized. There was no specific time in minutes suggested for "load and go" rather than attempting establishment of an IV in the field prior to transport.

From March 1993 through October 1993, a similar program was conducted for hospital emergency department (ED) personnel who might provide medical control for prehospital Emergency Medical Services (EMS) and could authorize procedures such as IO. Intermediate level and some basic life support (BLS) level providers received similar training in 1993 and 1994. We analyzed the impact of this training program on reported vascular access by pre-hospital EMS, timelines of EMS response, and the length of time EMS personnel spent at the scene prior to transporting the ill or injured child.

Pediatric Prehospital Provider course

The Pediatric Vascular Access program described above became part of a *Pediatric Prehospital Provider* course that was offered to ALS providers in 1993 on a continuing basis and which became a mandatory part of the paramedic program in 1998. Unlike the Vascular Access training program, the other components of the *Pediatric Prehospital Provider* course were not taught to all ALS providers prior to 1996.

The *Pediatric Prehospital Provider* course is a two day course and contained the following components:

Didactic lectures:

- Pediatric Overview and Basics Lecture
- Airway Management and Respiratory Disease
- Pediatric Shock and Shock Management
- Newborn Resuscitation
- Pediatric Trauma
- Sudden Infant Death Syndrome, Non-accidental Trauma, Critical Incident Stress
- Common Pediatric Medical Emergencies

Practical Stations:

- Pediatric Assessment
- Airway Management
- Vascular Access (described previously in this section)
- Pediatric Rhythm Disturbances

Teaching Stations:

- Multitrauma
- Shock
- Near-Drowning
- Immobilization
- Seizures

The program emphasized that EMSC interventions should be "age-related" and depend upon both the age and size of the child.

We were not able to determine from EMS run reports which ALS providers had not completed the *Pediatric Prehospital Provider* course by 1996, but the majority of providers had received this training by 1996.

Data analysis

Probabilistic record linkage, determination of ALS runs, assignment of Injury Severity Scores, and identification of EMS treatments are described in Section I of this report. We restricted the analyses presented in this section of the report to those EMS runs and related hospital records which involved EMS runs that responded to a scene and resulted in transport to a hospital, as determined by coding recorded on the EMS run form. We excluded EMS runs that did not result in transport to the hospital. Unless marked otherwise, we also excluded EMS runs whose purpose was to transfer a patient from a health care facility to a hospital because we were unable to identify, in most cases, whether the health care facility from which the child was transferred was another hospital or another type of health care facility.

Determination of whether an IV or interosseous infusion was started was made from coding in the EMS record. For the purpose of comparing changes in scene times and transport times associated with IV or I/O administration before and after the training program for vascular access, we chose the application of a spine board as a comparison EMS intervention, because it is a common intervention that may take minutes to perform and it was not the subject of an EMSC training program during the observation period.

The tables in the analysis that indicate results for "children" refer to those age less than 18 years. Because the Vascular Access training program was targeted for children less than 8 years old, we also examined reported EMS procedures and other factors in this age group prior to, during, and after the training program in this group and compared them to older children (9-17 years old) and to adults (age 18 and older).

The label "prior to training" refers to 1991 and January and February 1992, and "following training" refers to 1996.

Statistical analysis

The Wilcoxson sign-rank tests, one-way ANOVA, and Fisher's exact test were used to test statistical significance. Multivariate modeling was done using logistic regression.

Results

Vascular Access Training

Relationship of ALS level care & injury severity to prehospital IV placement

EMSC treatments and the Pediatric Prehospital Provider course

Respiratory disease

Results

Vascular Access training

There were approximately 500 EMS runs per month for children for the pretraining and post-training periods and slightly less during the 1992 portion of the training period (Table **3-A**). While the percentage of EMS responses, which included an ALS provider, was approximately the same among the three periods, there was a decline over time in multiple EMS providers identified for a single response from the ambulance run reports. ISS scores calculated from hospital records linked to the EMS runs did not vary substantially over the time period.

Table 3-A

Characteristics of EMSC and data for Utah children prior to, during, and following a Vascular Access training program

	1991-92 Prior to training	1992 During training	1996 Post training
Observation period	14 months	10 months	12 months
Number of EMSC runs*	7,586	4,381	6,884
Percentage of EMSC responses for which an ALS provider was identified	36%	40%	37%
Percentage of EMSC runs with multiple agencies responding and completing an EMS run form	29%	25%	23%
Mean ISS score for children with trauma	3.2	3.3	2.7
Mean CRAMS score	9.6	8.0	9.6

Note: *Excludes EMSC runs which were interfacility transfers or which did not result in transport to a hospital

EMS response times, scene times, transport times, and recorded vascular access are shown in Table **3-B**. There was a decrease of 1.5 minutes in EMS scene time following the training program, and a total reduction of EMS run time of two minutes ($p<.05$). A slight increase occurred in the percentage of children who had vascular access by EMS, from 16% prior to training to 18% post training. There were only nine intraosseous placements identified for 1996.

Table 3-B

Characteristics of EMSC runs; times & intervals

	1991-92 Prior to training	1992 During training	1996 Post training
Average response time (minutes)	7.6	8.4	6.1
Average scene time (minutes)	18.4	18.3	16.9
Average transport time (minutes)	13.3	13.9	14.3
Average total EMSC run time (minutes)	39.3	40.6	37.3
IV therapy (percent)	16%	15%	18%
Interosseous therapy (total number)	0	0	9

Prior to the training program, placement of an IV in the prehospital setting was associated with an average scene time of 6.2 minutes greater than for children who did not have an IV placed. In 1996, following the training program, this difference was reduced to 2.6 minutes ($p<.05$). For purposes of comparison, application of a spine board to a child prior to the vascular access training program was associated with 1.2 minutes greater scene time prior to the training program and 1.2 minutes greater scene time after the training program.

When prehospital IV therapy was examined by age group (Table **3-C**), there was a slight decrease in IV administration in children less than 8 years of age, and a slight increase in older children and in adults. The decrease in IV placement was related to children whose transport time to the hospital from a scene was less than 6 minutes, for whom there was a decrease in IV placement in children less than 8 years of age from 11% pre-training to 5% following the vascular access training program ($p<.05$).

Table 3-C

Prehospital IV placement, by age group

Age group	1991-92 Prior to training	1992 During training	1996 Post training
0-7 years	12%	10%	10%
8-17 years	16%	17%	20%
18 years and older	31%	34%	37%

When the analysis was restricted to children whose transport time to a hospital was 6 minutes or more, there was no change in IV placement pre-training and post-training, as indicated in Tables **3-D** and **3-E** on the following page. Although the Vascular Access training program emphasized rapid transport to a hospital when transport times were short, there was no formal change in EMSC protocols to affect this. That is, there were not mandated policies concerning " load and go" following the vascular access training program.

When transport time to a hospital was less than 6 minutes, IV placement was less frequent for all age groups (Table **3-D** and **3-E**) but the reduction following the training program was seen only in children less than 8 years of age, for whom the training program was targeted.

Table 3-D

Prehospital IV placement, by age group when EMS transport time to a hospital was less than 6 minutes

Age group	1991-92 Prior to training	1992 During training	1996 Post training
0-7 years	11%	10%	5%
8-17 years	11%	14%	14%
18 years and older	25%	29%	30%

Table 3-E

Prehospital IV placement, by age group when EMS transport time to a hospital was 6 minutes or more

Age group	1991-92 Prior to training	1992 during training	1996 Post training
0-7 years	12%	10%	12%
8-17 years	17%	17%	21%
18 years and older	32%	35%	38%

Another effect of the Vascular Access training program was a reduction in the amount of time needed to place an IV. Table **3-F** shows that there was a significant decrease in the EMS scene time when an IV was placed in a child after the training program ($p<.05$). This decrease was greatest in young children less than 8 years of age.

Table 3-F

Average EMS scene times (minutes) for IV placement for pediatric patients

Age group	1991-92 Prior to training	1992 During training	1996 Post training
0-7 years	25.3	22.0	19.4
8-17 years	22.8	18.6	19.0
All children	23.6	19.5	19.1

Of course it would be desirable to determine which children would have benefited from having an IV placed, determine what proportion of such children had IV placement by EMS, and then examine whether this changed following the Vascular Access training program. In order to do this we would need some sort of measure of how sick the child was. Such a measure is not readily available from the EMS and hospital data.

Injury Severity Scores (ISS) can be assigned to children with trauma, based upon their hospital diagnoses. The description of how we assigned ISS scores are in Section I of this report. ISS scores were devised to predict survival from injury. Assuming that having a measurable ISS score predicts that a child could benefit from having an IV placed, we performed multivariate analysis to determine which factors best predicted whether a child had an IV placed prior to transport to a hospital.

Relationship of ALS level care and injury severity to prehospital IV placement

A regression model was constructed to analyze IV placement in children whose primary diagnosis was trauma, who were taken to a hospital from a scene, and where the scene was 6 minutes or more from the hospital. Prehospital IV placement prior to and after the training program was the dependent variable, and ALS care, Vascular Access training, ISS score, age, and transport time as independent variables and the results are shown in Table **3-G**. The best predictor of having prehospital IV placement was receiving ALS level care ($p<.05$). Vascular Access training, increasing injury severity, increasing age, and increasing transport time to a hospital were also predictive of having an IV placed ($p<.05$).

Table 3-G

Prehospital IV placement in children with trauma whose transport time to a hospital exceeded 6 minutes, Utah 1991-1996, with inclusion of the Vascular Access training program in a multivariate model

Variable	Odds Ratio	95% Confidence Interval
ALS care	15.12	12.03 - 19.00
Vascular access training	1.39	1.12 - 1.73
Age (years)	1.14	1.11 - 1.17
ISS	1.12	1.10 - 1.15
Transport time	1.03	1.02 - 1.04

Dependent variable: IV placement

EMSC treatments and the Pediatric Prehospital Provider course

For purposes of determining EMSC treatments before commencement of the course, we chose to use the same observation period as for the Vascular Access training program, which was all of 1991 and January and February 1992. By 1996, the majority of providers had completed the *Pediatric Prehospital Provider* course.

We compared the frequency or proportion, as indicated in the tables, of EMS interventions before the training and in 1996 using the same age groupings as for the analysis of the Pediatric Vascular Access training program.

In the following tables, EMS medications are listed by age group. The notation "prior to PALS training" indicates EMS runs prior to the training program, and the notation "after completion of the majority of PALS training" indicates EMS runs in 1996.

The comparisons, which follow, compare changes in the following prehospital treatments:

Administration of IV fluids.

Usage of 5% dextrose in water, albuterol, and aminophylline in patients whose primary diagnosis was respiratory disease.

Usage of 50% dextrose, 5% dextrose, luminal, and Valium in patients whose primary diagnosis was a neurological disorder.

Usage of ipecac syrup in patients whose primary diagnosis was poisoning.

Usage of 50% dextrose in patients whose primary diagnosis was an endocrine, nutritional, or metabolic disorder, a category which includes diabetes.

Note: If the change in usage was statistically significant, this is indicated.

Table 3-H

Prehospital EMS usage of intravenous fluids for children less than 8 years of age who had an ICD-9 diagnosis assigned from hospital records

	MEAN	N	STD
5% Dextrose in water*	0.03	322.00	0.17
Normal saline	0.03	322.00	0.17
Ringers lactate*	0.02	322.00	0.15

Prior to PALS training

	MEAN	N	STD
5% Dextrose in water*	0.00	843.00	0.00
Normal saline	0.01	843.00	0.11
Ringers lactate*	0.10	843.00	0.30

After completion of the majority of PALS training (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

* $p<.05$

Table 3-I

Prehospital EMS usage of intravenous fluids for children 8-17 years of age who had an ICD-9 diagnosis assigned from hospital records

	MEAN	N	STD
5% Dextrose in water*	0.03	275.00	0.18
Normal saline	0.08	275.00	0.27
Ringers lactate*	0.13	275.00	0.33

Prior to PALS training

	MEAN	N	STD
5% Dextrose in water*	0.00	790.00	0.00
Normal saline	0.04	790.00	0.19
Ringers lactate*	0.21	790.00	0.41

After completion of the majority of PALS training (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

* $p<.05$

Table 3-J

Prehospital EMS usage of intravenous fluids for adults who had an ICD-9 diagnosis assigned from hospital records

	MEAN	N	STD
5% Dextrose in water*	0.14	6069.00	0.35
Normal saline	0.10	6069.00	0.30
Ringers lactate*	0.12	6069.00	0.32

Prior to PALS training

	MEAN	N	STD
5% Dextrose in water*	0.00	14858.00	0.05
Normal saline	0.08	14858.00	0.27
Ringers lactate*	0.36	14858.00	0.48

After completion of the majority of PALS training (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

* $p<.05$

Respiratory disease

The training program included instruction on respiratory disease in both the lecture and in the practical stations. The lecture included instruction on proper assessment of children with respiratory problems, how to use assisted ventilation and intubation, and field treatment of croup and asthma. Croup treatment with cool, humidified oxygen and aerosol was recommended, along with avoiding invasive procedures such as IV placement. Treatment of asthma with supplemental oxygen was recommended. For severe asthma, bronchodilator treatment by inhalation, such as with albuterol, was recommended, and it was also recommended to avoid usage of aminophylline in the field.

There was coding on the EMS run form to identify delivery of oxygen therapy, aminophylline, and albuterol.

Table 3-K

Prehospital EMS usage of albuterol and aminophylline, and intravenous fluids for children less than 8 years of age whose diagnosis assigned from hospital records was respiratory disease

	MEAN	N	STD
5% Dextrose in water	0.02	127.00	0.15
Albuterol	0.01	127.00	0.09
Aminophylline	0.00	127.00	0.00

Prior to Pediatric Prehospital training program

	MEAN	N	STD
5% Dextrose in water	0.00	225.00	0.00
Albuterol	0.13	225.00	0.34
Aminophylline	0.00	225.00	0.00

After completion of the majority of the Pediatric Prehospital training program (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

Table 3-L

Prehospital EMS usage of albuterol and aminophylline, and intravenous fluids for children 8-17 years of age whose diagnosis assigned from hospital records was respiratory disease

	MEAN	N	STD
5% Dextrose in water	0.07	30.00	0.25
Albuterol*	0.00	30.00	0.00
Aminophylline	0.00	30.00	0.00

Prior to the Pediatric Prehospital training program

	MEAN	N	STD
5% Dextrose in water	0.00	103.00	0.00
Albuterol*	0.25	103.00	0.44
Aminophylline	0.00	103.00	0.00

After completion of the majority of the Pediatric Prehospital training program (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

* $p<.05$

Table 3-M

Prehospital EMS usage of albuterol and aminophylline, and intravenous fluids for adults whose diagnosis assigned from hospital records was respiratory disease

	MEAN	N	STD
5% Dextrose in water*	0.15	602.00	0.36
Albuterol*	0.01	602.00	0.10
Aminophylline	0.01	602.00	0.09

Prior to the Pediatric Prehospital training program

	MEAN	N	STD
5% Dextrose in water*	0.00	1469.00	0.04
Albuterol*	0.12	1469.00	0.33
Aminophylline	0.00	1469.00	0.00

After completion of the majority of the Pediatric Prehospital training program (1996)

Note: The number of observations differs for the two periods because the 1991-92 data had less complete (ICD-9) diagnostic information than 1996.

* $p<.05$

Table 3-N

Prehospital EMS administration of 50% dextrose, 5% dextrose, luminal, and Valium for children less than 8 years of age whose diagnosis assigned from hospital records was a neurological disorder

	MEAN	N	STD
50% Dextrose	0.00	30.00	0.00
5% Dextrose in water	0.07	30.00	0.25
Luminal	0.00	30.00	0.00
Valium	0.00	30.00	0.00

Prior to the Pediatric Prehospital training program

	MEAN	N	STD
50% Dextrose	0.00	66.00	0.00
5% Dextrose in water	0.00	66.00	0.00
Luminal	0.00	66.00	0.00
Valium	0.11	66.00	0.31

After completion of the majority of the Pediatric Prehospital training program

Table 3-O

Prehospital EMS usage of 50% dextrose, 5% dextrose, luminal, and Valium for children age 8-17 years whose diagnosis assigned from hospital records was a neurological disorder

	MEAN	N	STD
50% Dextrose	0.00	25.00	0.00
5% Dextrose in water	0.04	25.00	0.20
Luminal	0.00	25.00	0.00
Valium	0.00	25.00	0.00

Prior to the Pediatric Prehospital training program

	MEAN	N	STD
50% Dextrose	0.00	24.00	0.00
5% Dextrose in water	0.00	24.00	0.00
Luminal	0.00	24.00	0.00
Valium	0.04	24.00	0.20

After completion of the majority of the Pediatric Prehospital training program (1996)

Table 3-P

Prehospital EMS usage of 50% dextrose, 5% dextrose, luminal, and Valium for adults whose diagnosis assigned from hospital records was a neurological disorder

	MEAN	N	STD
50% Dextrose	0.02	244.00	0.14
5% Dextrose in water	0.05	244.00	0.23
Luminal	0.00	244.00	0.00
Valium	0.04	244.00	0.19

Prior to completion of the Pediatric Prehospital training program

	MEAN	N	STD
50% Dextrose	0.01	336.00	0.12
5% Dextrose in water	0.00	336.00	0.00
Luminal	0.00	336.00	0.00
Valium	0.02	336.00	0.13

After completion of the majority of the Pediatric Prehospital training program (1996)

Table 3-Q

Prehospital EMS usage of ipecac syrup when the diagnosis assigned from hospital records was poisoning

Age less than 8 years

	MEAN	N	STD
Ipecac syrup	0.03	101.00	0.17

Age 8-17 years

	MEAN	N	STD
Ipecac syrup	0.04	202.00	0.20

Adult

	MEAN	N	STD
Ipecac syrup	0.03	997.00	0.16

Prior to the Pediatric Prehospital training program

Age less than 8 years

	MEAN	N	STD
Ipecac syrup	0.03	101.00	0.17

Age 8-17 years

	MEAN	N	STD
Ipecac syrup	0.04	188.00	0.19

Adult

	MEAN	N	STD
Ipecac syrup	0.01	994.00	0.09

After completion of the majority of the Pediatric Prehospital training program (1996)

Note: Whether ipecac was administered prior to EMS arrival is unknown.

Table 3-R

Prehospital EMS usage of 50% dextrose when the diagnosis assigned from hospital records was an endocrine, nutritional, or metabolic disorder

Age less than 8 years

	MEAN	N	STD
50% Dextrose	0.20	5.00	0.45

Age 8-17 years

	MEAN	N	STD
50% Dextrose	0.07	14.00	0.27

Adult

	MEAN	N	STD
50% Dextrose	0.23	331.00	0.42

Prior to the Pediatric Prehospital training program

Age less than 8 years

	MEAN	N	STD
50% Dextrose	0.00	3.00	0.00

Age 8-17 years

	MEAN	N	STD
50% Dextrose	0.18	22.00	0.39

Adult

	MEAN	N	STD
50% Dextrose	0.26	678.00	0.44

After completion of the majority of the Pediatric Prehospital training program

Table 3-S

Prehospital EMS scene times (minutes) for patients with trauma as the primary diagnosis

Age < 8 years — Prior to the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	17.44	1060.00	12.21

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	15.99	947.00	11.02

Age 8-17 years — Prior to the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	18.67	2789.00	12.44

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	17.62	2986.00	11.11

Adult — Prior to the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	19.46	11818.00	13.08

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Time at Scene*	18.22	12057.00	10.95

* = p<.05

Table 3-T

Prehospital EMS treatments for children less than 8 years of age with trauma as the primary diagnosis

Prior to Completion of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.37	1060.00	0.48
Spine board application	0.41	1060.00	0.49
Splint application	0.08	1060.00	0.27
Mast application	0.00	1060.00	0.05

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.36	947.00	0.48
Spine board application	0.39	947.00	0.49
Splint application	0.06	947.00	0.24
Mast application	0.00	947.00	0.05

Table 3-U

Prehospital EMS treatments for children age 8 through 17 with trauma as the primary diagnosis

Prior to Completion of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.56	2789.00	0.50
Spine board application	0.60	2789.00	0.49
Splint application	0.15	2789.00	0.36
Mast application	0.01	2789.00	0.08

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.59	2986.00	0.49
Spine board application	0.61	2986.00	0.49
Splint application	0.14	2986.00	0.35
Mast application	0.00	2986.00	0.04

Table 3-V

Prehospital EMS treatments for adults with trauma as the primary diagnosis

Prior to Completion of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.47	11818.00	0.50
Spine board application	0.52	11818.00	0.50
Splint application	0.13	11818.00	0.34
Mast application	0.01	11818.00	0.09

After completion of the majority of the Pediatric Prehospital Provider course

	MEAN	N	STD
Cervical immobilization	0.48	12057.00	0.50
Spine board application	0.52	12057.00	0.50
Splint application	0.12	12057.00	0.33
Mast application	0.00	12057.00	0.04

Discussion

Pediatric Vascular Access training

EMSC treatments and the Pediatric Prehospital Provider course

Strengths and weaknesses of this study

Discussion

Pediatric Vascular Access training

The main findings associated with the Vascular Access training program were the saving of several minutes scene time in children who had an IV established prehospital by EMS. A reduction in IV placement in young children occurred when a hospital was less than 6 minutes away. There was also an increase in IV placement in older children and adults.

The reduction in EMS scene time when placing an IV was significant and was greatest in young children less than 8 years old, the population for which the Vascular Access training program was designed. We would expect that, other things being equal, a reduction of almost 5 minutes in EMS scene time prior to transport to a hospital is of benefit to the emergency care of an ill or injured child (Meislin et al., 1999). In addition, average scene times when an IV was placed (Table **3-F**) were reduced following the training program to less than 20 minutes, an amount considered to be excessive in one recent study of preventable pediatric death from trauma (Esposito et al., 1999).

This study indicates the difficulty in evaluating a training program that was designed to facilitate IV placement and also to instruct paramedics that it might be better to "load and go" without attempting IV placement when the transport time was short. The IV placement rate alone prior to and after the training may not be the best measurement of the program's effectiveness. We found that when the transport time was less than 6 minutes, "load and go" occurred more frequently as would be expected from a successful training program. There was an increase in IV placement in children age 8-17 and adults' following the training program suggests that the skill station in extremity IV placement was effective. For children with trauma, as determined from hospital diagnosis, there was a significant relationship between injury severity as estimated by ISS score and having IV placement (Table **3-G**), suggesting that paramedics correctly assessed the need for IV placement in children with trauma.

Our findings are consistent with the Toronto study (Lillis & Jaffe, 1992) in indicating that young children are less likely to have prehospital IV placement by paramedics. We did not have a means to determine whether all children who could have benefited from IV placement prior to transport received this intervention because the hospital and EMS data files do not contain sufficient information to determine this.

EMSC treatments and the Pediatric Prehospital Provider course

The changes in usage in EMSC treatments following completion of the majority of the *Pediatric Prehospital Provider* course is generally consistent with the content of the course and indicates that recommendations for treating ill and injured children were followed.

The training program emphasized the use of isotonic fluids (Ringers lactate or normal saline) in children with trauma, rather than 5% dextrose in water. This is an accepted treatment practice for all trauma patients. Tables **3-H** through **3-J** indicate a significant decrease in usage of 5% dextrose in water and a corresponding increase in usage of Ringers lactate in 1996. This was seen for both children and adults.

The training program encouraged the use of albuterol by inhalation in patients with respiratory disease. It discouraged IV placement and prehospital administration of aminophylline.

Tables **3-K** through **3-M** indicate a significant increase in albuterol usage.

The training program discouraged usage of 50% dextrose in young children, and recommended usage of Valium rather than Luminal for children with seizures. Tables **3-N** through **3-P** indicate that usage of Valium increased. There were only a small number of patients whose primary diagnosis was a neurological disorder, and perhaps for this reason the increase in Valium usage was not statistically significant.

The training program included discussion of management of poisoning with administration of activated charcoal and ipecac in selected cases. Field treatment was not recommended when the transport time to the hospital was less than 20 minutes and consultation with the regional Poison Control Center was recommended for longer transport times. Table **3-Q** indicates no significant change in ipecac usage. It should be noted that the EMS run form does not allow for coding whether ipecac had been administered prior to arrival of EMS.

There were very few young children transported by EMS whose primary diagnosis was an endocrine, nutritional, or metabolic disorder, which includes diabetes. The training program discouraged usage of 50% dextrose in diabetic children with hypoglycemic coma. Usage of 50% dextrose in these patients is shown in Table **3-R**.

In contrast to the treatments for children with illness there was little change in prehospital treatment for trauma except for reduction in scene times. Table **3-S** shows that EMS scene times decreased significantly for all age groups. The decrease was largest (1.45 minutes) for children less than 8 years of age, for whom the training program was targeted. Tables **3-T** through **3-V** show that there were not substantial changes in EMS application of cervical immobilization, spine boards, splints, or MAST trousers for children or adults.

Strengths and weaknesses of this study

The strengths of this study are that it is population-based and utilized EMS and hospital data prior to, during, and after the training period for pediatric vascular access. None of the investigators were involved in conducting the training program nor did they receive funding from the Utah agency that conducted the program. The structure and coding of EMS and hospital records changed little over the period of observation. The study provides evidence that training of EMS personnel in pediatric vascular access is associated with more efficient IV placement and, thus, the earlier arrival of children at the receiving hospital.

The weaknesses of this study are the reliance on existing data collected for other purposes, and availability of only crude measures such as ISS to estimate whether a child actually needed an IV prior to transport by EMS. Development of coding systems to assess mild to moderate injury and illness would facilitate research in prehospital EMS and allow investigators to better assess the effectiveness of training such as was provided for Pediatric Vascular Access.

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13. ABSTRACT *(Maximum 200 words); This study examined how Utah children used emergency medical services (EMS) and related hospital care in 1991-1992. The EMS and hospital records were linked using special software (probabilistic linkage). The principal findings of the study concerned the care of young children less than 5 years of age. They received fewer procedures prior to being transported to a hospital and required more time at the scene for assessment. Some interventions such as splinting of fractured arms prior to transport to a hospital were related to reduced hospital charges.*

Ambulance and hospital charges for children were estimated to be $35,000,000 not counting physician charges, prescriptions, and rehabilitation care. A training program in intravenous (IV) line placement for ambulance personnel resulted in a reduction in the amount of time EMS personnel spent at the scene. This study raised several hypotheses which could be the subject of future research.

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