EMS VS. CIVILIAN TRANSPORTATION OF SEVERELY INJURED PATIENTS

Grant #R49-CCR911730-01
A Technical Report Submitted to the Center for Disease Control and Prevention (CDC)

Principle Investigator: Edward E. Cornwell III, M.D.
Co-Investigators: Karen Hennigan, Ph.D., Cheryl Maxson, Ph.D., Thomas Berne, M.D., Howard Belzberg, M.D., Demetrios Demetriades, M.D., Ph.D., Linda Chan, Ph.D.

From the EMS study group: Department of Surgery, Division of Trauma/Critical Care and the Social Science research Institute, University of Southern California, Los Angeles, California and The Johns Hopkins Medical Institution, Baltimore, Maryland.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 26, 1999	

4. TITLE AND SUBTITLE

EMS VS. Civilian Transportation of Severely Injured Patients

5. FUNDING NUMBERS

G-R49-CCR-911730-01

6. AUTHOR(S)

Edward E. Cornwell III, M.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

The Johns Hopkins Medical Institutions
Associate Professor of Surgery
600 North Wolfe Street, Osler 625
Baltimore, Maryland 21287-5675

8. PERFORMING ORGANIZATION REPORT NUMBER

R49-CCR-911730-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Centers for Disease Control and Prevention
National Center for Injury Prevention and Control
4770 Buford Highway NE, K58
Atlanta, GA 30341-3724

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

R49-CCR-911730-01

11. SUPPLEMENTARY NOTES

n/a

12a. DISTRIBUTION/AVAILABILITY STATEMENT

n/a

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Reducing the impact of traumatic injury, the leading cause of death and disability in young Americans, is a crucial public health issue. Two elements of pre-hospital care have been recognized as central to improving outcome of traumatic injury: reduction of time between injury and arrival at a trauma center, and pre-hospital stabilization by EMS providers. Preliminary data at a large urban trauma center show that severely injured patients (blunt trauma 43%, penetrating trauma 57%) transported by civilians have an improved survival compared to those transported by EMS providers. Unfortunately, there is no reliable way to obtain data that addresses the element of time between injury and arrival at the trauma center.

14. SUBJECT TERMS

n/a

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet optical scanning requirements.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	PR	- Project
G	- Grant	TA	- Task
PE	- Program Element	WU	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- DOE - See authorities.
- NASA - See Handbook NHB 2200.2.
- NTIS - Leave blank.

Block 12b. Distribution Code.

- DOD - Leave blank.
- DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- NASA - Leave blank.
- NTIS - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

TABLE OF CONTENTS:

ABBREVIATIONS:

EMS	Emergency Medical System
LAC+USC	Los Angeles County - University of Southern California Medical Center
ISS	Injury Severity Score
SSRI	Social Science Research Institute
GSW	Gunshot Wound
I.V.	Intravenous

FIGURES: None

TABLES:

Table I: Comparison of 3 groups by demographic and injury parameters.

Table II: Consensus time estimates (injury-to-hospital) among investigators.

Table III: Prolonged scene times among penetrating trauma patients transported to LAC+USC.

SIGNIFICANT FINDINGS:

Non-EMS transported patients (ISS ≥ 13) arrived at the hospital earlier after their injuries, but had shorter transport distances.

USEFULNESS OF FINDINGS:

Non-EMS patients represent the purest form of "scoop and run". We believe that the combined findings of the two reports from LAC+USC have important policy implications in the prehospital arena, particulary regarding penetrating trauma patients. Not one of the over 3000 patients with penetrating injuries in these studies were even theoretically benefitted by formal thoraco-lumbar immobilization (i.e. a patient with an unstable vertebral column injury and a less than complete neurologic deficit).

Several published reports raise doubts regarding the time invested pursuing I.V. fluid resuscitation. Accordingly we believe that in an urban trauma setting, the prehospital care of a penetrating trauma victim who is spontaneously breathing and moving his legs should place the highest priority on rapid transport (as opposed to I.V. resuscitation, intubation, or spinal immobilization).

ABSTRACT:

Objective: A previous report of 5782 trauma patients demonstrated higher mortality among those transported by EMS than among their non-EMS transported counterparts. This study was performed to test the hypothesis that the two groups differed in the injury-to-hospital arrival time interval.

Design: Prospective cohort matched observation study.

Setting: Level I trauma center, multidisciplinary study group.

Patients: All non-EMS patients were matched with the next appropriate EMS patient by an investigator who was blinded as to outcome and mode of transport. Matching parameters: age, Injury Severity Score (ISS), mechanism of injury, head Abbreviated Injury Score, presence of hypotension. An interview tool was developed to determine time of injury and applied to patients, witnesses, and friends; and combined with data obtained from police, sheriff and medical examiner reports/ Every tenth EMS patient with ISS ≥ 13 was also randomly enrolled. Transport distance was determined by Geographical Information System software.

Outcome measures: Mortality, morbidity, length of stay.

Results: 103 patients enrolled (38 non-EMS, 38 EMS matched, 27 random EMS). Injury tome estimates using all available data made on 100 patients (96%). Independent raters agreed in 81%. Deaths, complications, length of stay equal between two groups. Although time intervals were similar among the two groups. Overall, more critically injured non-EMS patients (ISS ≥ 13) got themselves to the trauma center in less time than their EMS counterparts (15 mins. vs. 28 mins., $p<.05$).

Conclusion: Non-EMS transported patients (ISS ≥ 13) arrived at the hospital earlier after their

injuries, but had shorter transport distances.

INTRODUCTION:

A previous report of 5782 trauma patients demonstrated higher mortality among those transported by EMS than among their non-EMS transported counterparts[1]. This study was performed to test the hypothesis that the two groups differed in the injury-to-hospital arrival time interval.

TEXT OF REPORT

PATIENTS AND METHODS:

In order to prospectively test the hypothesis, an interview tool, a method for combining time estimates, and a screening method to identify a sample of carefully matched patients, were developed. To accomplish these tasks, the EMS study group, consisting of members of the division of Trauma/Critical Care, trauma registry personnel, and members of the Social Science Research Institute of USC, was formed. An interview tool was developed to determine the time of injury and the factors affecting decision to access the EMS system. Graduate students in the social sciences were trained to apply this tool to patients, witnesses and friends, and to use it in conjunction with data obtained from police and sheriff reports with cooperation from the Los Angeles Police Department and the Los Angeles County Sheriff's office. Medical examiner reports for non-surviving patients were also utilized.

In constructing time estimates from the interviews, all data that would reveal that EMS was involved with a case was temporarily removed from each patient's file. Two independent raters (a clinician and a social scientist) reviewed all of the available information from time of injury for each case and gave estimates for the time of injury. The hospital arrival time was recorded by emergency department personnel who are specifically assigned the task of documenting that for all patients. With this method, injury-to-hospital arrival time interval was estimated by investigators who were blinded as to mode of transport or patient outcome. Each rater was free to devise his/her own system for arriving at the best estimate of the injury time and avoided discussing any system of weighting of the available information before the reviews. These raters agreed in 81% of cases. A third rater reviewed the information (including the independent ratings) in each case where there was a discrepancy and made a final determination.

In addition to the data obtained from the aforementioned interviews and reports, patient demographics, pattern, mechanism and severity of injury, physiologic criteria (vital signs, Glasgow Coma Score), need for surgical intervention and intensive care, and clinical course including survival and complications were studied for victims of major trauma (as defined by the Los Angeles County EMS Authority). All patients were treated according to standard trauma care principles by a dedicated team led by an in-house trauma attending.

Patient Entry

This was a cohort-matched observation study. The period of patient entry was January - October, 1997. All patients admitted to the trauma center directly from the scene during the previous 24 hours were evaluated each morning by one of the clinician investigators for appropriateness of enrollment. The clinicians made an initial estimate of the ISS and considered patients with an ISS $\geq$ 13, or shock on admission (systolic BP $\leq$ 90 mmHg) as eligible for inclusion. These patients were recorded in order of hospital arrival times. Patients were entered without regard to gender or ethnicity. The general population of trauma victims (during the study period) include approximately 15% females, and is approximately 80% Hispanic and 10% African-American. Complete information regarding severity of injury and arrival to the hospital was immediately gathered for each seriously injured patient. Non-EMS patients were enrolled and the next EMS-patient to arrive who met the matching criteria described below was enrolled in the study as well. Every tenth seriously injured EMS patient (not counting those who were used

as matches) was enrolled in a control group. Matching was accomplished with no knowledge of outcomes.

Matching Parameters

Patients transported by non-EMS means were matched with their EMS-transported counterparts according to the following parameters:

1. Age

Patients were matched with cohorts who were either within a 5-year umbrella or fell within the same age-category, as listed below:

14-17 years
18-29 years
30-44 years
45-55 years

For example, a 42-year-old could be matched with a 46-year-old.

2. Injury Severity Score (ISS)

Patients were originally considered on the basis of clinician-estimated ISS on admission. Ultimate matching was on the basis of final (discharge) ISS.

Patients were matched by ISS 13-24 versus ISS 25-75, so that patients with an Abbreviated Injury Scale (AIS) of 5 in any body region were automatically classified in the higher group (as $5^2 = 25$).

If a non-EMS-transported patient with an ISS < 13 was included by virtue of a blood pressure ≤ 90, then the patient was matched with an EMS-transported patient who was likewise included for a blood pressure ≤ 90 with an ISS < 13.

3. Head Abbreviated Injury Scale (AIS)

Patients with head AIS ≥ 3 were likewise matched with similarly head-injured patients.

4. Mechanism of Injury

The categories for matching mechanism of injury were blunt injury versus penetrating injury.

Exclusion criteria

Patients who did not have a theoretic choice of transport (age < 14, patients under arrest, patients transported directly from prison) were excluded from consideration.

To improve enrollment (discussed below), non-EMS-transported patients with lower injury severities were subsequently included (May - October, 1997). Therefore, patients were entered in the study by three possible means: 1) all non-EMS-transported patients were entered, and were matched with 2) an EMS-transported counterpart matched on the basis of age, Injury Severity Score (ISS), head Abbreviated Injury Scale (AIS), mechanism of injury, and presence or absence of hypotension on admission; 3) every tenth EMS-transported patient experiencing sufficient severity of injury to have potential for morbidity or mortality (ISS > 12 or hypotension on admission) was also included.

RESULTS:

Three hundred fifty-nine patients were screened for enrollment. After cohort-matching of non-EMS patients, and random sampling of EMS patients with ISS ≥ 13, 105 patients were ultimately enrolled in the study. Hospital arrival time was not documented for two patients, leaving 103 for analysis. There were 38 non-EMS patients, 38 EMS matched patients, and a separate group of 27 random EMS patients who met the inclusion criteria (Table I). The 3 groups were similar in terms of gender, and ethnicity. The random EMS group was more likely to have sustained blunt trauma, and to be older and more severely injured.

Time

From all available sources, a time element was available on 100 of 103 patients (96%); 37 non-EMS, 37 EMS-matched, 26 EMS random). There was strong agreement among the estimates of the independent raters, which were generated with the benefit of the information available from police and coroner reports and patients' and witness interviews.

Among patients with ISS ≥ 13, the non-EMS patients arrived at the hospital in significantly less time then the EMS-matched group (Table II, 15 minutes vs. 28 minutes, $p < .05$). Indeed, critically injured non-EMS patients had the shortest time interval among all subgroups studied.

Outcomes

No significant differences were observed between the seriously injured matched EMS and non-EMS groups regarding mortality, length of stay, days in ICU, complications or infections.

A composite outcome variable was constructed by combining three key outcomes: length of stay, days in ICU and mortality. The ordinal-level variable formed was defined as follows:

1 = short stay (< 4 days) no days in ICU, lived
2 = long stay (≥ 4 days) or some days in ICU, lived
3 = long stay and some days in ICU, lived
4 = died

In order to test whether more rapid transport among matched critically injured patients was associated with better outcomes, three variables --ISS, minutes between injury and arrival, and miles between injury and hospital--were entered into a regression analysis predicting this composite outcome variable.

The adjusted R^2 for this analysis was .640, ISS scores were strongly related to outcomes ($\beta = .84, p < .001$), and while time failed to reach statistical significance, there was a trend in the predicted direction (*shorter time interval - better outcome),* $\beta = .12, p < .133$).

DISCUSSION:

That actual time interval between time of injury and the beginning of in-hospital acute care is not generally known. This is because although detailed records are available from the time the EMS is notified, information from victims or witnesses are generally not obtained regarding the actual time of injury. Very little is known regarding *any* component of the time interval in the non-EMS population. Although many trauma centers receive patients transported by non-EMS means (4 to 15% of all patients among six urban trauma center surveyed and as high as 16% in a hospital in Northern Ireland)[2] this circumstance had not been sufficiently analyzed. A multidisciplinary research team, formed to focus on these issues, has developed procedures for accessing previously neglected factors necessary for illuminating these gaps in knowledge.

Two major developments occurred that may well have affected patient enrollment and the time interval being analyzed in this study. First, there has been a well documented decrease in violent assault, and therefore penetrating trauma in Los Angeles County in the four years since the previously mentioned findings were reported.[3] At the same time, the non-EMS-transported were more likely victims of penetrating trauma.

With non-EMS-transport becoming less common, we decided to enroll, interview and analyze all non-EMS-transported patients meeting major trauma criteria, even with a final ISS < 13. This created two additional subsets to be considered in the data analysis phase of the project: non-EMS patients with ISS < 13, and their EMS-matched counterparts with ISS < 13.

Another development that may have affected our study was our immediate response to the observation of different outcomes by transport mode, made in our initial retrospective review. As a major trauma center that has some involvement in the oversight of the prehospital phase of acute care following injury, we felt compelled to intervene where possible to decrease the paramedic scene times for critically injured patients. This intervention took the form of a focused quality improvement program which included extensive written reviews of all scene times > 20 minutes. The liaison overseeing this review was the Medical Director of the LA City Fire Department (the EMS entity that transports the largest proportion of trauma patients to LAC+USC). This quality improvement program has resulted in a progressive decrease in the proportion of patients with penetrating trauma experiencing prolonged scene times (Table III). In summary, the decrease in the number of penetrating trauma admissions, combined with the implementation of a quality improvement program to decrease scene times (and hopefully preventable deaths) have the effect of requiring a longer study period to enter the number of patients necessary to identify outcome differences, if they exist. The time differences identified in Table II, may well have been even more dramatic, but for the concurrent intervention designed to reduce EMS scene times.

A look at the actual magnitude of the times in Table II yields gives the impression that critically injured non-EMS patients appreciated the urgency of their situation. Their time interval dropped significantly as their ISS rose above 13 (15 vs. 39 min., $p<.05$) Among the protocol-driven EMS group, however, there was relative consistency in terms of how quickly they arrived at the hospital regardless of the severity of their injury (mean time 28 minutes for ISS > 12 and 33 minutes for EMS-matched with ISS ≤ 12). Given the effort involved in determining the actual time of injury for each individual patient, it will require more time and a larger sample size to assess in a multivariate fashion, the effect of time on outcome parameters.

CONCLUSIONS:

Future study will be directed at more severely injured patients where time and distance differences were confirmed and a trend toward outcome differences identified. A longer study period is clearly required to enroll sufficient number of patients with the more severely injured inclusion criteria.

Given that the non-EMS patients represent the purest form of "scoop and run" we believe the combined findings of the two reports from LAC+USC have important policy implications in the prehospital arena, particulary regarding penetrating trauma patients. Not one of the over 3000 patients with penetrating injuries in these studies were even theoretically benefitted by formal thoraco-lumbar immobilization (i.e. a patient with an unstable vertebral column injury and a less than complete neurologic deficit).

Several published reports raise doubts regarding investing time pursuing I.V. fluid resuscitation [4-8]. Accordingly, we believe that in an urban trauma setting, the prehospital care of a penetrating trauma victim who is spontaneously breathing and moving his feet should place the highest priority on rapid transport (as opposed to I.V. resuscitation, intubation, or spinal immobilization).

REFERENCES:

1. Demetriades D, Chan L, Cornwell III EE, et al. Paramedic vs. private transportation of trauma patients. *Arch Surg* 1996; 131:133-38.
2. McNicholl BP, Lee J. Patients with major trauma who do not use emergency ambulances. *BMJ* 1995; 310:1442.
3. Cornwell III EE, Berne TV, Belzberg, H. et al. Health care crisis from a trauma center perspective. *JAMA* 1996; 276:940-944.
4. Sampalis JS, Lavoie, A, Williams JI, Mulder DS, Kalima M. Impact of on-site care, prehospital time, and level of in-hospital care on survival in severely injured patients. *J Trauma* 1993; 34:252-261.
5. Bickell WH, Wall MJ Jr, Pepe PE, et al. Immediate versus delayed fluid resuscitation for hypotensive patients with penetrating torso injuries. *NEJM* 1994; 331:1105-1109.
6. Ciraulo DL, Cowell V, Murphy D, et al. Prehospital administration of blood products in the resuscitation of traumatic injury by an air medical program: an analysis of outcome in comparison to volume resuscitation limited to crystalloid. *Crit Care Med* 1998; 26 (suppl 1):A51.
7. Sampalis JS, Tamin H, Denis R, et al. Ineffectiveness of on-site intravenous lines: Is pre-hospital time the culprit? *J Trauma* 1997; 43:608-615.
8. Kaweski SM, Sise MJ, Virgilio RW. The effect of prehospital fluids on survival in trauma patients. *J Trauma* 1990; 30:1215-1219.

PRESENT AND FUTURE PUBLICATIONS:

1) Cornwell III EE, Belzberg H, Hennigan K, Maxson C, Rosenbluth A, Montoya G, Berne T, Demetriades D. Emergency medical service (EMS) vs. Non-EMS transport in critically injured patients: Time, outcome, and use of an interview tool. Submitted to *Arch Surg*.

2) Hennigan K, Maxson C, Cornwell E, Belzberg H. "Scoop and Run" Reconsidered: A Multidisciplinary Experience. Accepted for Publication *U.S.C. Health Atlas*.

3) Hennigan K, Maxson C, Cornwell E, Montoya J, Rosenbluth A, Belzberg H. An approach to measuring time of injury among trauma victims: Reliability and validity of injury time estimates. Submitted to *Am J Publ Hlth*.

PRESENTATIONS: (Edward E. Cornwell III, M.D.)

1) EMS vs. non-EMS transport of critically injured patients. CDC Work-in-Progress Workshop, San Francisco, California, July 11, 1997.

2) Paramedics vs. private transport to a trauma center, Trauma (CDC) study. National Association of Emergency Medical Services Physicians, Lake Tahoe, Nevada, July 12, 1997.

3) "EMS vs. non-EMS transport of critically injured patients." Surgical Grand Rounds Visiting Professor, Southern Illinois University, Springfield, Illinois, September 12, 1998.

4) "EMS vs. non-EMS transport of critically injured patients." Keynote address, Careflight/Trauma EMS Symposium, Dayton, Ohio, September 19, 1998.

5) "EMS vs. Non EMS Transport of Critically Injured Patients", Maryland Annual E.M.S. Seminar, Ocean City, MD March 21, 1999.

6) "EMS vs. Non EMS Transport of Critically Injured Patients", Department of Health Sciences, University of Maryland - Baltimore County (UMBC), Baltimore, Maryland April 12, 1999.

Table I

Comparison of 3 groups by demographic and injury parameters.

	all non-EMS	all EMS matched	EMS random (ISS > 12)
n	38	38	27
mean age (yrs)	22	24	29*
male (%)	97	90	85
Hispanic (%)	76	76	80
pen. injury (%)	89	89	67*
mean ISS	13	11	21*
Head AIS ≥ 3 (%)	11	11	19

($p < .05$)

Table II

Consensus time estimates (injury-to-hospital) among investigators

	N	Mean ISS	Mean time (min.)
Non-EMS (all)	37	13	26
EMS-matched (all)	37	11	30
Non-EMS (< 13)	18	3	39+
EMS-matched (ISS < 13)	19	2	33
Non-EMS (ISS ≥ 13)	19	19	15*+
EMS-matched (ISS ≥ 13)	18	23	28*
EMS random (ISS ≥ 13)	26	21	37

* $p < .05$ when non-EMS ISS ≥ 13 is compared to EMS-matched ISS ≥ 13
+ $p < .05$ when non-EMS ISS ≥ 13 is compared to non-EMS ISS < 13

Table III

Prolonged scene times among penetrating trauma patients transported to LAC+USC.

	1993	1994	1995	1996
# penetrating trauma pts.	1361	1314	1396	1005
# of fallouts*	207 (15.2%)	250 (19.0%)	85 (6.1%)	37 (3.7%)

* a fallout is a case with a paramedic scene time of > 20 minutes.

FINANCIAL STATUS REPORT: See attached.

EQUIPMENT: None

INVENTIONS: None