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An Analysis of Selected Statistics From Trauma Calls In a Large Urban EMS System

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INTRODUCTION

An essential component of any well organized EMS system is a method of performance evaluation. Such an evaluation determines how closely a system approximates optimum performance as measured by the criteria it develops itself or accepts from outside sources. The implementation of this evaluation component seeks to collect and store relevant data concerning its activity in a manner which will facilitate productive analysis of the data.

Collection of data at the system level is usually accomplished by selecting information from the individual run reports used in the system. Depending on the extent of the evaluation, this information may include times (response times, on-scene times, transport times, out of service times, etc.), types of calls (ALS, BLS, public assist, medical, trauma, etc.), therapeutic interventions (IV therapy, medications, EKG monitoring, defibrillation, etc.), mode of transport (air, ground, POV, etc.), and other categories deemed pertinent to the system. The quality of the data collected at the system level is dependent on the accuracy and attention of the paramedics recording the information as each call unfolds. Obviously, if data is recorded in a careless manner, the entire process of system evaluation is questionable.

With many of the issues concerning advanced life support care in medical emergencies settled, EMS systems are now struggling with appropriate management of trauma cases. The organization of geographical systems of trauma centers is one response to the recognition that trauma is a specialized problem in which the outcome depends on how quickly patients are treated in the surgical suite. Such a system matches the limited surgical specialty resources of a community with the pattern of major trauma incidence. Where such systems exist, many seriously injured patients are seen at specialized centers, few in number, which draw patients from a large surrounding area. Those cases occurring close to a trauma center are usually transported by ground ambulance, unless traffic patterns will prolong transport time. Cases occurring distant from a trauma center, as well as those affected by traffic patterns, are transported by helicopter air ambulance.

This paper summarizes a modest retrospective study of serious trauma cases in a large EMS system. Only those patients with recorded trauma scores of twelve or less are considered. The study seeks differences in care between ground transported and air transported trauma patients with regard to on-scene times and level of care as demonstrated by IV therapy and EKG monitoring.

METHODOLOGY

The EMS System Used in this Study

Pinellas County is a large, urban county on Florida's Gulfcoast with a resident population of 858,489, swollen annually by an influx of approximately 3,661,000 visitors. The county consists of 280 square miles of land, which is occupied by large and small municipalities and a sizeable unincorporated area. The topography of the county's land ranges from pasture land to the highly populated beaches along its coast. EMS is provided under a county system which currently funds forty-seven first response ALS units, run largely by fire departments, and contracts with one private ambulance service, which fields thirty units for ALS and BLS transportation. Unincorporated areas of the county are served under contract with municipal or private providers. The county is served by two Level II trauma centers certified by the State Department of Health and Rehabilitative Services. One is located in the south part of the county, and the other in the south-central part, both more populous areas of the county. Only the southmost trauma center has facilities to receive air- transported patients. This center operates a helicopter transport unit which serves the entire county. Protocols for assigning patients to ground- or air-transport units are based on transport times from key areas of the county at times of normal traffic flows.

The county's medical protocols are set forth in the Medical Operations Manual, which is generated by a consortium of emergency physicians and medical directors within the system with the assistance of provider representatives. This manual prescribes and limits the practice of paramedics in an extensive list of situations. The absolute indications for transport to a trauma center are trauma scores of twelve or less or Glascow Coma Scale scores of ten or less in trauma incidents. Guidelines for mechanisms of injury indicating potential need for transport to one of the trauma centers include: rapid deceleration injury, falls from heights greater than fifteen feet; vehicle accidents with prolonged extrication time or invasion of passenger space by more than one foot; patients ejected from vehicles; death of another passenger in a vehicle; pedestrians

under twelve years of age struck by vehicles; penetrating injuries to head, neck, or torso; major blunt trauma to head, neck, trunk, or pelvis; and, two or more proximal long bone fractures.

A facsimile of the Pinellas County EMS run report is shown in Figure 1. This form, currently under revision, is completed by the ALS crew responsible for initial treatment of the patient. All times on the form are recorded by dispatchers using a computer-aided system, which responds to keyboard input based on verbal radio traffic (a digital vehicle status radio system is under development). The EMS dispatching system also answers the countywide 911 telephone system, so that no call hand-off is necessary and times are tracked from the time of receipt by a single system. All patient identification information and medical information is completed by paramedics at the scene or at completion of the run. Finally, a computer generated form analogous to the hard-copy form is completed by the paramedic at a CRT and terminal in the substation after the conclusion of the run. Thus, data is stored on paper and electronically for each run. Many categories of information are stored as number codes which can be manipulated easily for analysis by computer program.

Data Selection

The volume of runs in this system is large enough to warrant a selection for this study. A computer program was written to select those runs from the calendar year 1987, which were coded as trauma calls, and in which trauma scores of twelve or less were recorded (cases for mandatory transport to a trauma center). Execution of this program yielded a list of 260 calls, for which the following data was retrieved on each: run number, description of situation found, ALS arrival time, time of transport from the scene, trauma score, use of first and second IV, use of intubation, use of EKG monitor, use of CPR, code for action taken, code for which mode of transportation was used.

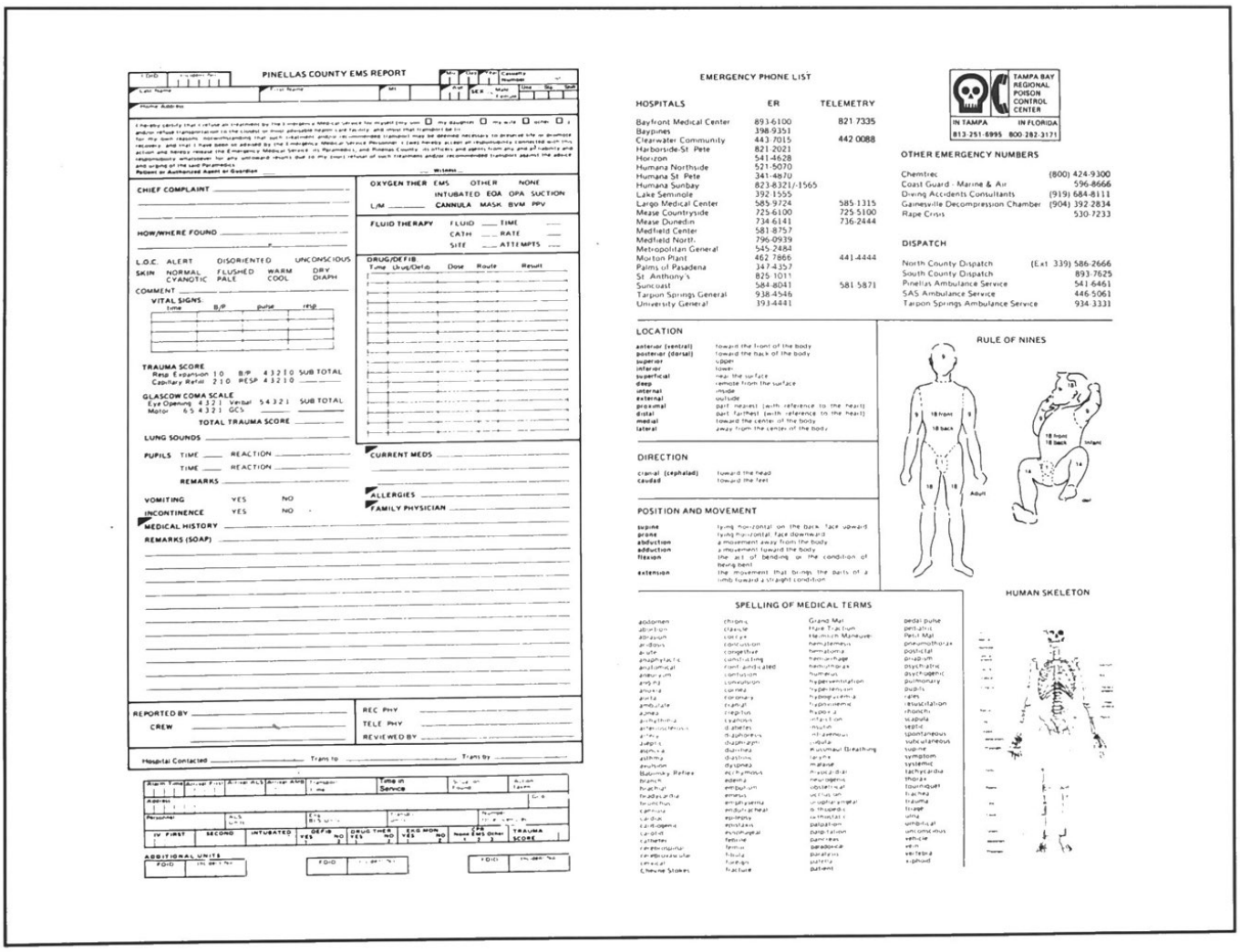


Figure 1 - Pinellas County EMS Run Report Form

Trauma Scores <13	**N=260**
All times and Codes Good	**N=155**
Ground Transport	**N=113**
Air Transport	**N=42**

Table 1 - Raw Data Characteristics

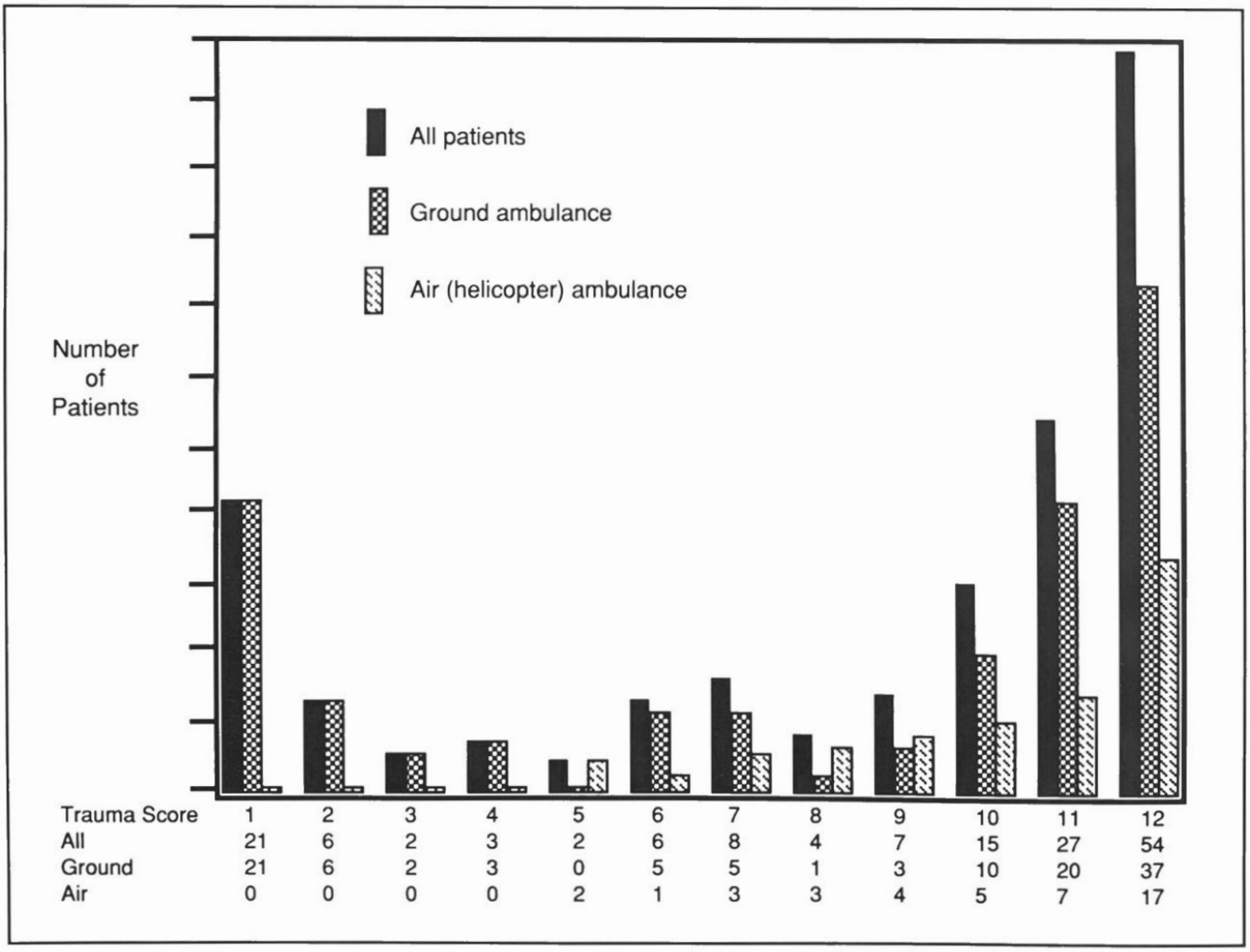
Additionally, the program created and retrieved one time not normally tracked on the report form as a separate field, the on-scene time. This field was created by having the computer report the difference between the ALS arrival time and the patient transport time fields. Next the computer was asked to generate a list of all calls where the calculated on-scene time was a positive number. This selection eliminated a large number of runs for which either no arrival time or no patient transport time was recorded by paramedics and six runs which straddled the time change from 2359 hours to 0001 hours, as well as one run in which the transport time was recorded as preceding the arrival time. This reduced sample was then divided into two lists, one for helicopter transport and one for ground transport. Table 1 describes the successive samples generated by the computer program.

For subsequent analysis the first sample is discarded. The second sample is labeled ALL; the third sample is labeled GROUND; and the final sample is labeled AIR.

RESULTS

Table 2 summarizes the distribution of runs in the three samples by trauma score. The bulk of the runs in the ALL sample are categorized by paramedics in scores 1 and in the range 10-12. One hundred seventeen of 155 runs in the ALL sample are in these categories.

The concept of "the golden hour" has adjusted the behavior



Trauma Score	1	2	3	4	5	6	7	8	9	10	11	12
All	21	6	2	3	2	6	8	4	7	15	27	54
Ground	21	6	2	3	0	5	5	1	3	10	20	37
Air	0	0	0	0	2	1	3	3	4	5	7	17

Table 2 - Run Distribution by Trauma Score

Sample	Mean on-scene time
GROUND(ALS/BLS)	18.41 minutes
GROUND(ALS/BLS with extrication)	27.55 minutes
AIR(ALS/BLS)	26.55 minutes
AIR(ALS/BLS with extrication)	30.27 minutes

Table 3 - On-Scene Times

of paramedics at trauma scenes. Life-threatening airway and perfusion problems are corrected, the C-spine is protected, and the patient is rapidly transported to the receiving facility. Estimates for appropriate on-scene time at trauma calls vary from ten to twenty minutes. Even in urban EMS systems, the helicopter is seen as a tool for reducing the time before the patient is seen in the trauma center. A comparison of on-scene times for the AIR and GROUND samples demonstrates interesting facts. As summarized in Table 3, the on-scene times for helicopter transported patients in this sample are considerably longer than for the ground transported sample. For the purpose of this analysis, only runs coded ALS or BLS (with and without extrication) are considered.

The difference in on-scene time between AIR and GROUND patients with prolonged extrication is small although the time is longer for the AIR sample. The difference in mean (half the sample falls above and half below this point) on-scene times between the two samples for patients not requiring extrication is considerable, with GROUND patients mean on-scene time eight minutes shorter than that of AIR patients.

The Medical Operations Manual, accepting widely held opinion on appropriate levels of trauma therapy, suggests that two large bore IV lines be established, providing that IV therapy does not delay transport (IV's are to be started enroute to the trauma center, if necessary). Table 4 summarizes the level of IV therapy on patients in the AIR sample by trauma score. Patients with higher trauma scores are less likely to receive one or two IV lines. Seventeen percent of these patients received no IV therapy and 70% did not receive a second IV.

The linear relationship between trauma score and level of IV therapy does not exist in the GROUND sample, as illustrated in table 5. Of this larger sample, over 37% received no IV therapy and 73% did not receive a second IV.

Among the least time consuming of ALS activities is EKG monitoring. Table 6 illustrates the number of cases in which EKG monitoring occurred in a selection of patients from our larger sample. In this case, the statistically most salvageable patients (those with trauma scores from 10-12) are examined as to level of IV therapy and presence of EKG monitor. The sample is further divided in each segment (AIR and GROUND) by time of day. Mean on-scene time for the AIR sample in these patients is approximately equal in each time frame, but in the GROUND sample, mean on-scene time during the time frame 0700-2259 hours is much shorter. Of particular interest is the fact that during this time frame in the GROUND sample, less than 65% received EKG monitors.

DISCUSSION

First, it is important to keep in mind that the selection of statistics for this modest analysis was made by the author, who has prejudices and interests of his own. Second, the conclusions which may be drawn from these statistics depend on the definition of optimum performance in this system, the techniques of statistical analysis chosen, and the biases of the person drawing the conclusions. With these two caveats in mind, a number of questions emerge from a review of these statistical manipulations. These questions stray into the field of opinion.

If a system wishes to maximize the chance of accurate recording by paramedics of the data it deems important for system evaluation, that system must make the instruments used for recording the data simple, easy to use, and as mistake-proof as possible. These samples consist only of information on patients whose trauma scores require mandatory transport to a trauma center. The assumption that these runs would be consid-

TS*	5	6	7	8	9	10	11	12	Total
N	2	1	3	3	4	5	7	17	42
1 IV	2(100)	1(100)	3(100)	3(100)	4(100)	4(80)	6(86)	12(70)	35(83)
2 IV	1(50)	0(0)	1(33)	2(66)	3(75)	1(20)	1(14)	3(18)	12(29)

*** this sample had no trauma scores below 5**

Table 4 - Level of IV Therapy in Air Transports - The top line shows the trauma score categories while the next line shows how many patients were in the air transport category. The number of patients in that category that had at least 1 IV is shown with the percentage in parentheses. Next, the number and percentage of patients having 2 IV's are displayed.

TS	1	2	3	4	6*	7	8	9	10	11	12	Total
N=	21	6	2	3	5	5	1	3	10	20	37	113
1 IV	8(38)	5(83)	1(50)	2(66)	5(100)	5(100)	1(100)	2(66)	6(60)	14(70)	27(73)	73(63)
2IV	5(24)	1(17)	0(0)	0(0)	2(40)	0(0)	1(100)	0(0)	2(20)	13(65)	7(19)	31(27)

* no trauma scores of 5 exist in this sample

Table 5 - Level of IV Therapy in Ground Transports - The top line shows the trauma score categories while the next line shows how many patients were in this ground transport category. The number of patients in that category that had at least 1 IV is shown with the percentage in parentheses. Next, the number and percentage of patients having 2 IV's are displayed.

ered ALS runs is belied by a look at the number of runs in each action taken code for each trauma score in the sample (See table 7). Possible action taken codes (AT) include advanced life support (ALS), advanced life support with extrication (ALSE), basic life support (BLS), basic life support with extrication (BLSE), patient refused treatment(RE), transport by private vehicle (POV), dead on scene (DOS), and other investigation (OI). Of the 155 run sample fourteen were coded BLS or BLSE and one (with a trauma score of 10) coded as transport by POV. The five runs in trauma scores one and two which are coded BLS may result from confusion of paramedics as to how to code patients dead on the scene or worked for a brief time. It would, however, seem that all patients in this survey who were treated should have been classified in one of the ALS categories. The patient coded as transported POV is probably a coding error. The numerical code for POV is 34 and the code for DOS is 35. Perhaps a slip of the finger occurred. The practice of separating differing categories' codes by one digit may increase the chances of such errors. In this system's EMS run report, a slip of the finger between 4 and 5 on a keyboard or number pad can change an action taken code from dead on scene to POV transport. The likelihood of this kind of error can be minimized by structuring the code system differently. Some consideration should be given to the ergonomics of the recording instruments, both paper and electronic.

In the ground transport sample, the assignment of low trauma score patients to a number of action taken codes other than ALS can be avoided by communicating policy on how such patients who are not afforded full resuscitation efforts are assigned action taken codes. The lack of patients with scores 1-4 in the AIR sample may reflect the unwillingness of paramedics to use the helicopter resource on patients regarded as unsalvageable.

Paramedics are indoctrinated in the use of the run report as a legal document as well as a medical report. If a system wishes to increase the attention which paramedics pay to recording times on the report, the paramedics must be educated to appreciate their role in the research portion of the system. One explanation for the disparity in on-scene times between air and ground transport samples is that the times are not accurately recorded for the helicopter sample. This is an hypothesis which cannot be tested. The statistics collected are the statistics with which the system must live. These data will be the source of evaluation of system performance by system researchers and outsiders alike. The salient axiom is "garbage in, garbage out." Finally, in this regard, the collection of statistics is not the prime goal of any competent EMS system; patient care is. The system can be structured so that these two goals amicably coexist.

The fact that 37% of patients in the GROUND sample received no IV therapy and 73% did not receive a second IV may reflect a system-wide emphasis on the importance of transport in preference to prolonged attempts to establish IV therapy. On the other hand, the establishment of IV therapy in transit is desirable. Perhaps system paramedics are not sufficiently trained or sufficiently confident in the technique of IV's on the hoof. Whether these numbers represent a problem for the system depends on which explanation is accurate. Training and medical control personnel in the system should address the issue.

As far as EKG monitoring goes, no reasonable explanation is possible for the failure to provide this simple, noninvasive procedure for any patient in this sample. System training personnel need to emphasize the propriety of this technique in

Sample	Time	N	Mean OST	1IV	2IV	EKG
AIR	2300-0659	9	27.1	6	2	8
AIR	0700-2259	20	28.7	16	3	19
GROUND	2300-0659	11	22.45	10	2	9
GROUND	0700-2259	56	18.71	35	12	35

Table 6 - IV and EKG Monitoring Use by Time of Day - The table shows the number of pateints (N), threir mean on-scene time (Mean OST), and now many had at least 1 IV, 2 IV's and EKG monitoirng

TS	1	2	3	4	5	6	7	8	9	10	11	12
AT												
ALS	13	4	2	3	1	4	8	5	4	10	27	40
ALSE	2				1	1			3	4	1	9
BLS	3	2				1					4	3
BLSE												1
RE												1
DOS	2											
POV										1		
OI	1											

Table 7 - Action Taken by Trauma Score Category - The paramedics must code each call for general category of action taken (AT), to include advanced life support (ALS), ALS with extrication (ALSE), basic life support (BLS), BLS with extrication (BLSE), patient refusal (RE), dead on scene (DOS), transport by privately owned vehicle (POV) and other investigation (OI). The number of patients in each action taken category, separated by trauma score (TS) are shown.

any patient bound for the trauma center.

The disparity of mean on-scene times between air and ground transportation is the one area of this analysis which begs explanation. Several possibilities, other than errors in recording data mentioned above exist. Paramedics may be waiting too long to call the helicopter. No statistic on arrival time of the helicopter is available in the electronically stored report form, although that information could be culled from real time radio tapes. That process is cumbersome to say the least. Another possibility is that the helicopter crews are by design or circumstance prolonging the ground time of the patient by repeating activities already accomplished by first-response paramedics. Last, the protocols for the helicopter crews may diverge significantly enough from those of ground crews to require additional on-scene time. Certainly this statistical anomaly requires some consideration.

CONCLUSION

The run statistics considered here reveal apparent differences between the level of care afforded air transported and ground transported patients. If these differences are not the system to modify its response to trauma. Protocols for ground and air transport should be examined. Ultimately, the conclusions drawn from a system's self-analysis should guide its training program to reinforce desired performance and alter deficient performance. In order to accomplish this goal, the self-analysis must be regular and formulated for communication to training officers in provider agencies. Unfortunately, the only statistic (an important one albeit) current in publication is response time (not considered here). Certainly a reasoned examination of what goes on after system units arrive is worthwhile.