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Emergency Medical Response to Occupational Locations in West Virginia

DANNIE C. MIDDLETON* and ROGER B. TRENT

Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, WV 26505 (U.S.A.)

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ABSTRACT

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Injury surveillance by the National Institute for Occupational Safety and Health (NIOSH) indicates that an estimated 3,795,352 work injuries in 1986 were treated in hospital emergency rooms, but data is lacking on the number and timeliness of emergency medical service (EMS) responses to occupational locations. The computerized EMS data for West Virginia were obtained in order to evaluate the timeliness of emergency responses to identifiable worksites between July 1, 1984 and June 30, 1986. The analysis showed that the time required to respond to worksites and transport the patient to a hospital was often prolonged, especially when responding to mining injuries. Employers should plan for emergencies, which includes communicating with the local EMS to learn their capabilities and response time.

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) has targeted ten leading work-related diseases and injuries for reduction by 1990 (Millar and Myers, 1983; Association of Schools of Public Health, 1986). Eight of the ten may require an emergency medical service (EMS) response (Table 1). NIOSH injury surveillance indicates that an estimated 3,795,352 work injuries in 1986 were treated in hospital emergency rooms (NIOSH, 1987a), but no one has examined the timeliness of EMS responses to occupational emergencies. This paper addresses this gap in knowledge by presenting an analysis of responses to traumatic injuries and medical emergencies occurring at West Virginia worksites.

*Dr. Middleton is currently with the Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, OH 45226, U.S.A.

TABLE 1

Ten leading work-related diseases and injuries

Class of disease or injury		Example of problem requiring EMS
*1.	Occupational lung diseases	Occupational asthma
*2.	Musculoskeletal injuries	Herniated nucleus pulposus
3.	Occupational cancers	-
*4.	Severe traumatic injuries	Amputations
*5.	Occupational cardiovascular diseases	Myocardial infarction
*6.	Disorders of reproduction	Spontaneous abortion
*7.	Neurotoxic disorders	Toxic encephalitis
8.	Noise-induced hearing loss	-
*9.	Dermatologic conditions	Scalding or burn
*10.	Psychologic disorders	Drug dependency (overdose)

*Indicates that some problems in the category could require an EMS response.
Note: Adapted from Millar and Myers (1983) and Association of Schools of Public Health (1986).

There is no national consensus on the best way for an EMS to respond to traumatic injuries. Debates continue over whether paramedics should "scoop and run" or begin treatment on the scene (Committee on Trauma Research, 1985). Nevertheless, one concept which is recognized in trauma care is the "time to definitive care" (Morris et al., 1986). Time to definitive care is the interval between EMS notification and the provision of "definitive care" at an appropriate facility. One hour has been used as a standard, as evidenced by the popular phrase, "the golden hour", which was coined by Cowley with reference to trauma care (Campbell and McMahan, 1985). Time to definitive care is not precisely accurate when the appropriateness of care available at the receiving hospital is not recorded. "Transport time" can be used to describe the time interval between EMS notification and arrival in a hospital emergency room (Baker et al., 1980), even when definitive care is not assured. One hour has also been used as a standard for "transport time" after traumatic injuries (Baker et al., 1980). Particularly in cases where the trauma involves intracranial bleeding or exsanguination, delays in definitive treatment beyond one hour increases the likelihood of death (Trunkey, 1983).

Of course, not all occupational emergencies are traumatic injuries (Association of Schools of Public Health, 1986). Medical emergencies, whether identified as "occupationally related" or not, may occur in the workplace. For many medical emergencies and some traumatic injuries (e.g., electrocutions) the care provided by EMS personnel on the scene can be critical to the outcome (1985 National Conference on CPR and ECC, 1986; NIOSH, 1986). In these cases, "response time" (the interval between EMS notification and EMS arrival on the scene) becomes a major consideration. To analyze response times, one must first choose an appropriate standard for comparison. Consider the emergency requiring the most timely provision of medical care: cardiopulmonary arrest. The 1985 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC) found that the best results were achieved in patients for whom CPR followed cardiac arrest within approximately 4 minutes and advanced cardiac life support (ACLS) was begun within approximately 8 minutes of the arrest (1985 National Conference on CPR and ECC, 1986). CPR can be provided by trained lay persons, and even basic EMS squads should be equipped and trained to provide defibrillation (Stults, 1986), a critical component of ACLS. A reasonable goal, then, would seem to be a response time (interval between notification and arrival of EMS on the scene) of 8 minutes or less. Even though not all emergencies occurring at work are cardiopulmonary arrests, one would want to choose the more stringent time constraints when evaluating EMS response capability.

In assessing the timeliness of care provided in occupational emergencies by an EMS system, then, two intervals stand out as important for analysis: response time and transport time. It is appropriate to apply both concepts to all EMS runs, since in reality it is EMS response to the location (worksite), rather than the specific medical problem or injury, which is important in this analysis. The goal for response time and transport time should be the same for any occupational location.

OBJECTIVE

This paper considers the "post event" (Haddon, 1980) phase of traumatic injuries and medical problems which present as emergencies in the workplace. Actual EMS times are compared with benchmarks at 8 and 60 minutes.

DATA AND METHODS

This analysis is based on EMS responses recorded during the two West Virginia fiscal years beginning July 1, 1984 and ending June 30, 1986. During this two-year interval, all EMS squads in the state used the same form. (Before and after the interval studied, different forms were used.)

This analysis concerns only "jobsite emergencies", defined as calls which were identified as "emergency" EMS runs to a location identified as a "jobsite". This is a conservative definition, since it excludes some unknown number of work-related injuries and medical problems. In particular, EMS responses to locations not clearly identifiable as worksites, for example to highway accidents, are likely to be excluded.

Jobsite emergencies were divided into those identified by EMS reports as "medical problems" and "traumatic injuries" (Fig. 1). Cases not falling into these categories ("other") were excluded from the analysis. Injuries were fur-

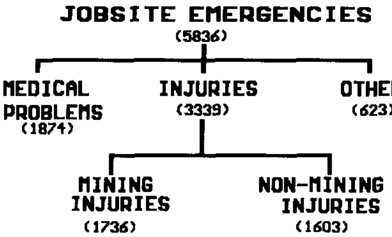

Fig. 1. Breakdown of jobsite emergencies (number of runs shown in parentheses).

ther separated into those identifiable as "mining" versus all other jobsite injuries. This division recognizes the fact that mines are distinct from most other worksites. In the study area, most "mining" refers to work in underground bituminous coal mines. Mining, as an industrial activity (major division "B" in the Standard Industrial Classification), deserves special consideration since it has the highest occupational fatality rate in the U.S. (NIOSH, 1987b; Cotter and Macon, 1987) and the highest rate of lost workdays due to injuries (Bureau of Labor Statistics, 1986). Indeed, over half of the occupational injuries in this analysis occurred at mines. The data collection form did not permit the investigators to classify "medical problems" according to mining versus non-mining sites. Thus, the three types of EMS runs in this analysis are medical problems, mining injuries, and non-mining injuries. Within these categories the number of cases available for analysis varies due to recording lapses on EMS run records.

RESULTS

It is generally accepted that EMS systems should minimize the time required to make contact with an emergency patient and transport that patient to a hospital emergency room. In this analysis benchmarks for comparison are 8 minutes for response time and 60 minutes for transport time.

Table 2 shows the major categories of suspected problems by type of run. The percentages in Table 2 cannot be added because EMS crews could check more than one problem per patient. Aside from the broad category "acute illness", chest pain and respiratory distress prompted the largest number of medical EMS responses. Mining and non-mining traumatic injuries were principally associated with two problems: fractures and lacerations.

Differences between the mean response times for the three types of runs are statistically significant at the 0.05 level (Table 3). Figure 2 shows these data as cumulative percent of runs by response time, broken down according to whether the emergency was a medical problem, non-mining injury, or mining injury. Response time is based on EMS arrival at the scene, which does not include any extra time required to bring victims of mining injuries out of the mine. In specific reference to the 8-minute benchmark, 63% of responses to

TABLE 2

Major categories of suspected problem for EMS runs to worksite emergencies

Type of run	Suspected problems	Percentage[a]	*N*
Medical problems (*N*=1874)	Acute illness	35	651
	Chest pains	27	512
	Breathlessness	13	243
Non-mining injuries (*N*=1603)	Fractures	44	751
	Lacerations	40	636
Mining injuries (*N*=1736)	Fractures	49	844
	Lacerations	31	540

[a]Problem categories can overlap as some patients have multiple suspected problems. Therefore, percentages cannot be added.

TABLE 3

Response miles and response times for EMS runs to worksite emergencies

	Mean	95% CI	*N*[a]
Response time			
Medical problems	9.1	8.59- 9.61	1053
Non-mining injuries	11.6	10.91-12.28	919
Mining injuries	20.0	19.40-20.60	1039
Response miles			
Medical problems	5.8	5.28- 6.32	721
Non-mining injuries	6.9	6.43- 7.37	735
Mining injuries	10.7	10.37-11.04	1057

[a]*N*s vary because of incomplete data on EMS report forms.

medical emergencies could be considered timely. Further inspection of Fig. 2 reveals that within 8 minutes, the EMS had responded to 51% of non-mining injuries, but only to 9% of mining injuries. This corresponds to greater mean response miles for mining injuries (10.7), compared to medical problems (5.8) and non-mining injuries (6.9) (Table 3). Response time to rural locations is a general problem. In 1985, for example, EMS response times recorded in the National Highway Traffic Safety Administration's Fatal Accident Reporting System averaged 6.4 minutes for urban locations and 12.3 for rural locations (National Highway Traffic Safety Administration, 1987).

In comparing both response times and transport times for the three types of runs, an assumption is made that the proportion of runs perceived as urgent is

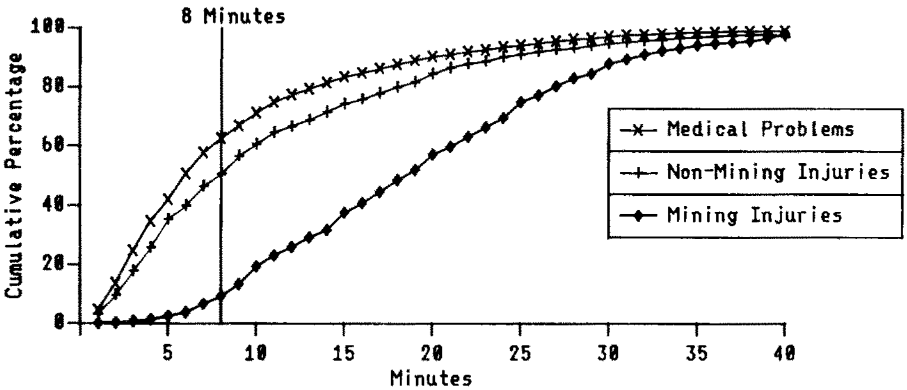

Fig. 2. Response time for jobsite emergencies.

TABLE 4

Percentage of runs perceived as urgent and use of emergency lights or emergency lights and sirens by type of run

	Percentage	95% CI	*N* [a]
Perceived as urgent			
Medical problems	87.0	95.5–88.5	1838
Non-mining injuries	86.5	84.8–88.2	1579
Mining injuries	88.0	86.5–89.5	1692
Lights or lights and sirens			
Medical problems	84.3	82.5–86.1	1631
Non-mining injuries	83.8	81.9–85.7	1441
Mining injuries	88.5	86.9–90.1	1560

[a] *N*s vary because of incomplete data on EMS report forms.

the same for each type. Table 4 is presented to test this assumption. The upper panel of Table 4 shows the percent "perceived as urgent" by EMTs (emergency medical technicians), which includes runs marked by EMTs as "urgent" or "life threatening". There is no statistically significant difference between the percent of runs perceived as urgent for medical problems, mining injuries, and non-mining injuries. In the lower panel of Table 4 are the percentages of runs using emergency lights, either with or without sirens. There is no significant difference between medical problems and non-mining injuries. In contrast, mining injuries are significantly more likely to require "lights" or "sirens and lights". Therefore, the data do not indicate that mining runs are slower because EMTs perceive fewer of them to be urgent.

Transport time manifests the same basic pattern observed for response times. Cumulative percent curves shown in Fig. 3 were based on 1078 medical problem

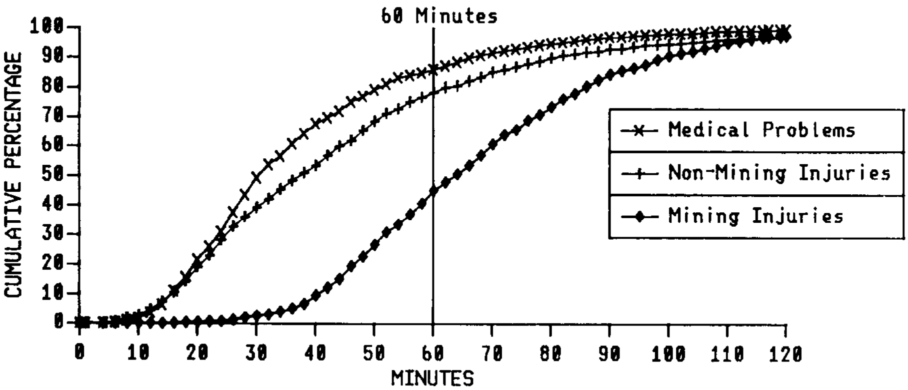

Fig. 3. Transport time for jobsite emergencies.

runs, 940 non-mining injury runs, and 1039 mining injury runs. Again, mean differences are statistically significant at the 0.05 level. After 60 minutes, 86% of the patients with medical problems and 78% of patients with non-mining injuries had reached a hospital emergency room, while only 45% of the patients with mining injuries had.

DISCUSSION AND RECOMMENDATIONS

Response times for medical problems and non-mining injuries were significantly better than those for mining injuries (Fig. 2). However, many occupational locations in West Virginia do not have EMS response times under 8 minutes. While many companies depend solely on the EMS, there is an increasing expectation that they plan for emergencies (1985 National Conference on CPR and ECC, 1986). Training workers in basic CPR is one component, but large companies should also communicate with the local EMS (Starr et al., 1986) and determine if ACLS is available and can be provided in a timely manner (1985 National Conference on CPR and ECC, 1986). If defibrillation is not available, the company may want to work to upgrade the local EMS. Basic EMS personnel can readily learn to defibrillate with automatic external defibrillators (AEDs), which analyze the patient's cardiac rhythm electronically and deliver a defibrillatory countershock if appropriate (Eisenberg and Cummins, 1986). Larger facilities in rural locations, where distance may preclude a timely EMS response, may want to discuss with their plant physicians the possibility of obtaining an AED. This solution should be attractive to many larger West Virginia mines, which are already required to have EMTs on each shift (State of West Virginia Mining Laws: Article 12).

The analysis showed that after 60 minutes, 86% of patients with medical problems and 76% of those with non-mining injuries had been transported to a hospital emergency room. In the same interval, only 45% of the patients with mining injuries had arrived at a hospital (Fig. 3). Data on transport time should be viewed with some caution, since it does not consider the level of care necessary or that available at the receiving hospital. Still, the differences in transport time between mining and non-mining locations are large and the differences do not appear to be due to differences in urgency (Table 4). Bringing injured patients to the surface of a mine can be time consuming, but the contribution to overall transport time cannot be determined from the data. In any case, delayed transport may partially explain the high fatality rates in mining (NIOSH, 1987b; Cotter and Macon, 1987), since it decreases the chance of survival after a traumatic injury (Baker et al., 1980). The solution is beyond the scope of this paper, but several possibilities exist for providing timely care after mining injuries occur. Upgrading the training of EMTs in the mines could make more advanced medical care immediately available, but in that setting it would be difficult for them to maintain such complex skills as starting intravenous fluids or endotracheal intubation (Stults, 1986). Keeping an emergency transport vehicle at mines can provide for rapid transport, which may be more important for trauma patients than field intervention by EMTs (Smith et al., 1985). For more remote locations, helicopter evacuation, which has been shown to be effective for trauma victims (Urdaneta et al., 1984), could be used more often in life-threatening situations to transport the victim directly from the mine to a trauma center.

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REFERENCES

Association of Schools of Public Health/National Institute for Occupational Safety and Health (NIOSH), 1986. Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries: Part 1.

Baker, C.C., Oppenheimer, L., Stephens, B., Lewis, F.R. and Trunkey, D.D., 1980. Epidemiology of trauma deaths. Amer. J. Surg., 140: 144–150.

Bureau of Labor Statistics, 1986. Occupational injuries and illnesses in the United States by industry, 1984. Bulletin 2259.

Campbell, J.E. and McMahan, P., 1985. Trauma care - A race against time. Alabama Medicine, J. Med. Assoc. State of Alabama, 10–13.

Committee on Trauma Research, 1985. Injury in America. National Academy Press, Washington, D.C.

Cotter, D.M. and Macon, J.A., 1987. Deaths in industry, 1985: BLS survey findings. Mon. Labor Rev., 110: 45–47.

Eisenberg, M.S. and Cummins, R.D., 1986. Latest advances in defibrillation. Med. Times, 114: 31–35.

Haddon, W. Jr., 1980. Advances in the epidemiology of injuries as a basis for public policy. Public Health Rep., 95: 411–421.

Millar, J.D. and Myers, M.L., 1983. Occupational safety and health: Progress toward the 1990 objectives for the nation. Public Health Rep., 98: 324–336.

Morris, J.A., Auerback, P.S., Marshall, G.A., Bluth, K.R.F., Johnson, L.F. and Trunkey, D.D., 1986. The trauma score as a triage tool in the prehospital setting. J. Amer. Med. Assoc., 256: 1319–1325.

1985 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC), 1986. Standards and Guidelines for CPR and ECC. J. Amer. Med. Assoc., 257: 752–757.

National Highway Traffic Safety Administration, 1987. Fatal Accident Reporting System, 1985. U.S. Department of Transportation.

National Institute for Occupational Safety and Health, 1986. Alert: Request for Assistance in Preventing Fatalities of Workers Who Contact Electrical Energy. DHHS (NIOSH) Publication No. 87-103, Cincinnati, OH.

National Institute for Occupational Safety and Health, 1987a. Analysis of National Electronic Injury Surveillance System (NEISS) Data for 1986. Unpublished.

National Institute for Occupational Safety and Health, 1987b. National Traumatic Occupational Fatalities, 1980–1984. Unpublished.

Smith, J.P., Bodai, B.I., Hill, A.S. and Frey, C.F., 1985. Prehospital stabilization of critically injured patients: A failed concept. J. Trauma, 25: 65–70.

Starr, L.M., Bush, D.F., Borak, J., Waymaster, S. and Somerfield, M., 1986. Emergency teams, industry have different perceptions of each other. Occup. Health Saf., 55: 20–24.

State of West Virginia Mining Laws: Article 12, Section 22-12-1.

Stults, K.R., 1986. EMT-Defibrillation in Rural America. Physician Assistant, 10: 111–124.

Trunkey, D.D., 1983. Trauma. Sci. Amer., 249: 28–35.

Urdaneta, L.F., Sandberg, M.K., Cram, A.E., Vargish, T., Jochimsen, P.R., Scott, D.H. and Blommers, T.J., 1984. Evaluation of an emergency air transport service as a component of a rural EMS system. Amer. Surg., 50: 183–187.