# Trained Lay First Responders Reduce Trauma Mortality: A Controlled Study of Rural Trauma in Iraq

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**Abbreviations:**
ISS = Injury Severity Score
MTV = major trauma victims
PSS = physiological severity score
TRTS = Triage Revised Trauma Score

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## Abstract
**Introduction:** Recent studies demonstrate that early, in-field, basic life support by paramedics improves trauma survival where prehospital transport times are long. So far, no case-control studies of the effect of layperson trauma first responders have been reported. It was hypothesized that trained layperson first responders improve trauma outcomes where prehospital transit times are long.
**Methods:** A rural prehospital trauma system was established in the mine and war zones in Iraq, consisting of 135 paramedics and 7,000 layperson trauma first responders in the villages. In a non-randomized clinical study, the outcomes of patients initially managed in-field by first-responders were compared to patients not receiving first-responder support.
**Results:** The mortality rate was significantly lower among patients initially managed in-field by first responders (n = 325) compared to patients without first-responder support (n = 1,016), 9.8% versus 15.6%, 95% CI = 1.3–10.0%.
**Conclusions:** Trained layperson first responders improve trauma outcomes where prehospital evacuation times are long. This finding demonstrates that simple interventions done early—by any type of trained care provider—are crucial for trauma survival. Where the prevalence of severe trauma is high, trauma first-responders should be an integral element of the trauma system.

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## Introduction
Almost 90% of trauma deaths occur in low- and middle-income countries, and the epidemic of trauma is growing.[1] To manage this heavy load of trauma—in disastrous events as well as chronic emergencies, such as wars and the epidemic of landmines—copies of Western, high-cost trauma systems are hardly feasible. In most low-income countries, and also in middle-income countries ridden by wars, there are no formal emergency medical services outside the main urban centers. Poor countries are trying to accelerate the production of medical doctors, but an extensive brain-drain steadily increases the gap between needs and in-country resources.[2] At most rural district hospitals in Sub-Saharan Africa, life-saving surgery is performed by non-doctors.[3] Antother challenge is that the "humanitarian space" is under attack.[4] The wars in 2009 in Gaza and Sri Lanka clearly demonstrate that access to the scene has become difficult, with external medical relief operations being systematically obstructed. Hence, it is due time to explore non-traditional strategies of trauma care, building on the local resources that might be available. Surveys of post-invasion deaths as a consequence of war in Iraq estimate an excess death rate corresponding to 2.5% of the population in the survey area, with gun fire and bomb blasts being the most common causes of mortality.[5] Thus, Iraq may provide a challenging testing ground for new rescue system models.

What determines survival where the surgical hospital is hours away? In a major recent study of 2,700 patients managed by a rural prehospital trauma system in Iraq, the authors documented that a network of 135 trained paramedics reduced trauma mortality rates.[6] The key measures for improved sur-

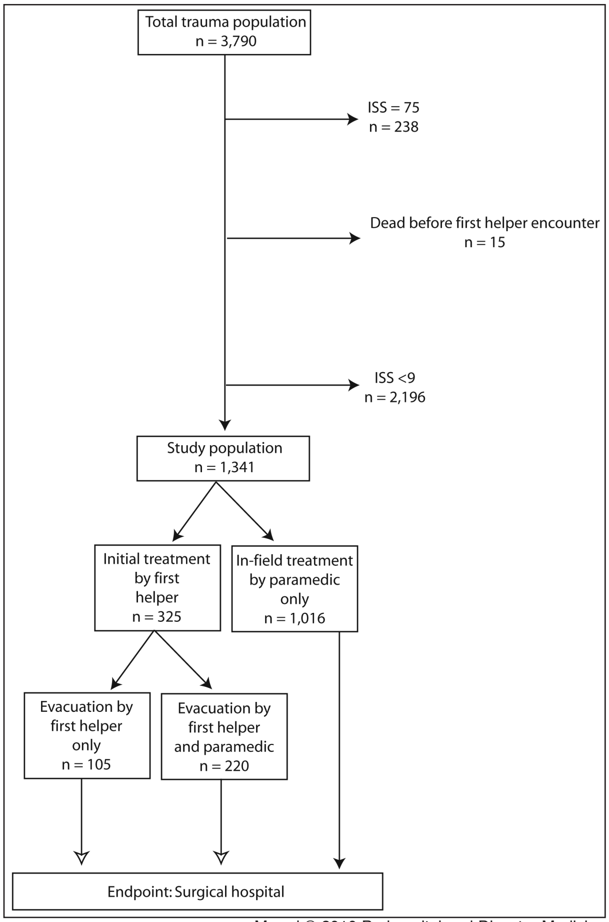




**Figure 1**—Allocation of study patients

vival proved to be early and simple first aid rather than advanced life support measures. Informal trauma care also can make a difference; in a study from Ghana, Mock *et al* reported that first-aid training of taxi drivers improved outcome indicators in urban trauma.[7]

The actual trauma system in Iraq consists of scores of layperson first responders in the villages, all of them trained by the trauma system paramedics. The aim of this study is to examine if early the provision of in-field first aid by village first responders contributes to improved trauma outcome, using trauma death and physiological severity score on hospital admission as result indicators.

## Methods

The study was conducted as a non-randomized, controlled intervention with parallel-block design (Figure 1). The reference population is trauma patients with long prehospital transport times.

### *Setting*

The intervention was conducted from 1997 to 2006 in the mine fields and war zones of North and Central Iraq. The pre-intervention survey documented high mortality rates among land mine victims (40%). Therefore, a chain-of-survival trauma system was implemented on request from the local health authorities.

### *Intervention*

The chain-of-survival trauma system comprises of three elements: (1) layperson, trauma first responders at the village level; (2) trained paramedics at rural health centers; and (3) emergency department staff at referral surgical centers. During the first stage of the intervention, 20 paramedics at rural health centers—all of them with previous hands-on experience in trauma care—were trained by the authors to provide advanced life support on-site and during protracted evacuations (Table 1). The training courses were conducted at district hospitals located inside the vast mine belt along the Iraq-Iran border. In order to reduce the in field response time, spread knowledge, and capability of treatment in the local community, the paramedics also were trained to teach basic life support measures to layperson villagers in their area. The training of village first responders was done in two-day courses in the villages with one-day rehearsal courses after 6–8 months. Each training course included approximately 1/3 male, 1/3 female, and 1/3 child trainees. Participation was voluntary but villagers engaged in high-risk activities were encouraged to attend. The training activities focused on the sectors most affected by trauma and also remote areas with poor infrastructure. The training curriculum emphasized local real-life case stories and hands-on training on resuscitation dummies and buddies. This training model is called the Village University.[8] The basic life support protocol for the first-responders is given in Table 1.

Trauma registry analysis in 2003 documented that the pilot trauma system reduced trauma mortality.[9] Therefore, the system was expanded and adapted to also target increasing numbers of road traffic crashes along the highways in North Iraq. At this second stage, another 48 paramedics were trained and equipped, including emergency department staff at district hospitals and referral surgical centers. Since the invasion of Iraq in 2003, the trauma system was further expanded to include the war zones of Baquba and Kirkuk. By the end of 2006, the entire trauma system comprised of 135 paramedics and 7,000 layperson first responders supervised by six medical doctors. Evaluation of 10-year material documents the overall mortality rate was low (6%), the paramedic trauma system performs well; despite 30% of the patients having had serious injuries (Injury Severity Score >8). However, the specific effect of first-helper treatment was not included in this study.[6]

### *Inclusion of Patients*

All trauma patients managed by the trauma system from January 1997 to December 2006 were consecutively included for study.

### *Data Collection and Processing*

The data were gathered at three points: (1) at the first in-field encounter with the first-responder; (2) at the first contact with the paramedic; and (3) on admission at the referral hospital. The first-responder registers the cause of injury, type of injury, the time from injury to first in-field contact, and the kind of first assistance provided. At the first in-field encounter, the medics register the in-field response time (from injury to the first encounter with the medic), and total prehospital transit time (from injury to end-point admission).

| First Helper | Paramedic |
|---|---|
| Airway<br>Head tilt-chin lift, head tilt-jaw thrust<br>Recovery position<br>Stabilization of neck injuries<br>Heimlich maneuver for choking | Airway<br>Head tilt-chin lift, head tilt-jaw thrust<br>Oral airway, suction<br>Recovery position<br>Endotracheal intubation/crico-thyrotomy<br>Stabilization of neck injuries<br>Heimlich maneuver for choking |
| Breathing<br>Rescue breathing/cardiopulmonary resuscitation<br>Half-sitting position | Breathing<br>Rescue breathing/advanced CPR<br>Half-sitting position<br>Gastric-tube decompression<br>IV ketamine pain relief |
| Circulation<br>External bleeds: proximal artery compression + sub-fascial packing + compressive dressing<br>Splinting of fractures<br>Hypothermia prevention: External warming, blankets | Circulation<br>External bleeds: proximal artery compression + sub-fascial packing + compressive dressing<br>Splinting of fractures<br>Pelvic bleeds: external compression of abdominal aorta<br>Hypothermia prevention: External warming + warm IV fluids<br>External jugular cannulation, venous cut-down<br>Electrolyte fluid resuscitation |
| Organizational<br>Evacuate victims from danger zone<br>Assist paramedic during treatment<br>Organize transport, follow patient to hospital if medic is not available<br>Take care of relatives | Drugs<br>Pain relief: Ketamin, Pentazocine, Atropine. Diazepam<br>Antibiotics: Penicillin. Ampicillin Metronidazole |



**Table 1**—Treatment protocol for first-helpers and paramedics (IV = intravenous)

The diagnosis and prehospital management was registered by the medic on an injury chart and also with a compact camera. Later, all in-field data were scrutinized by the trauma system supervisor (MKM) at monthly meetings with the paramedics. The data used for anatomical severity grading (Injury Severity Score, (ISS)) were collected by the trauma system supervisors at the referral surgical centers. Autopsies on trauma fatalities have not been performed due to the local cultural tradition. The anatomical severity (ISS) is graded in three groups: moderate, ISS <9; serious, ISS 9–15; and major trauma victims (MTV), ISS>15. The anatomical diagnoses were classified in five group: (1) superficial injury; (2) burn; (3) extremity injury; (4) critical area injury (head, face, neck, chest, abdomen, pelvic content, and spine); and (5) multiple major injury. The injuries also were classified as blunt or penetrating, burns being classified as blunt injuries.

*Outcome Indicators*

The primary outcome variable was trauma death. Trauma deaths included fatalities during the prehospital phase and trauma-related in-hospital deaths (no time limits for in-hospital time of death). The secondary outcome variable was the physiological condition of the patient on hospital admission. For evaluation of the physiological impact of injury the medic, not the first-responder, registered the physiological severity score (PSS-1) at the first in-field contact with the patient, and again at the end point (PSS-2). The scenes of the accidents often are chaotic, overcrowded, and dangerous; the victims may be under fire in a local combat, and mass casualties are common. For this reason, a simplified version of the Triage Revised Trauma Score (T-RTS) was used in which the Glasgow Coma Scale element was replaced with a five-grade conscious-level scale (Table 2).[6,12] The accuracy of the PSS was validated in a previous study of the actual study population; it proved to predict trauma death with high accuracy (Receiver Operating Statistics, area-under-curve 0.93).[12]

*Study Sample and Subsamples*

The system managed a total of 3,790 patients during the study period. According to the Abbreviated Injury Scale protocol, ISS-value of 75 was given only to patients with injuries incompatible with survival; therefore, patients with ISS = 75 (n = 238) were excluded from the study. As the primary outcome variable for the first-responder treatment effect is trauma death, all patients found dead at the scene (n = 15) were excluded from the study. Life support measures were not expected to make a difference in survival for patients with moderate injuries, and no trauma deaths were registered for this group of patients. Therefore, patients with ISS <9 were excluded from study. This left a study population of 1,341 trauma patients (Figure 1).

*Subsamples*—In most cases, the first responder tries to get to the patient as soon as possible after the injury, give basic life support, then evacuate the patient to the medic and assist in further trauma care and evacuation. In other cases, there are no first responders around; hence the patient is taken by bystanders directly to the medic—either at rural clinics or at district hospital emergency departments—and then, to the surgical center. Accordingly, the study population consisted of two main subsamples: (1) patients receiving initial first-responder treatment ("first-responder group", n = 325) and (2) patients going directly for paramedic treatment ("no-first-responder group", n = 1,016). There is a third subset of

| | 4 | 3 | 2 | 1 | 0 | score |
|---|---|---|---|---|---|---|
| respiratory rate | 10–30 | >30 | 6–9 | 1–5 | no breathing | |
| systolic blood pressure | >90 | 76–89 | 50–75 | 1–49 | no carotid pulse | |
| level of consciousness | awake | confused | responds to sound | responds to pain only | no response | |
| | | | | | | PSS SUM |



**Table 2**—Physiological Severity Score

| | Initial first helper treatment n = 325 (95% CI) | No first helper treatment n = 1,016 (95% CI) |
|---|---|---|
| Age (years) | 28 (26–30) | 26 (25–27) |
| Gender, % male | 85 (81–89) | 77 (74–80) |
| Penetrating injuries (% of total) | 67 (62–72) | 38 (35–41) |
| Critical area injuries (% of total)* | 18 (14–22) | 28 (25–30) |
| Extremity injuries (% of total) | 53 (48–58) | 38 (35–41) |
| Multiple major injuries (% of total) | 21 (17–26) | 21 (19–24) |
| Time (hours) from injury to first in-field encounter (Time 1) | 1.2 (1.0–1.4) | 1.0 (0.9–1.1) |
| Time (hours) from injury to hospital admission | 3.9 (3.6–4.2) | 3.1 (2.9–3.3) |
| Anatomical injury severity (ISS) | 14 (13–15) | 14,5 (14–15) |
| Physiological severity in-field (PSS1) | 8.7 (8.4–9) | 8.5 (8.3–8.7) |
| Physiological severity on hospital admission (PSS2) | 11.0 (10.7–11.3) | 10.9 (10.8–11.0) |
| Mortality | 32/325 9.8% (7.0–13.6) | 158/1,016 15.6% (13.5–17.9) |



**Table 3**—Patients with and without first-helper treatment. Estimates expressed by 95% confidence intervals.
* Critical Area: Head and/or torso

patients exclusively managed by first responders: When the paramedic was not available or the first responder found that the evacuation via the medic would unreasonably prolong the evacuation, the first responder alone undertook prehospital care and evacuation up to the end-point ("first responder-only group", n = 105) (Figure 1). The allocation of patients to the three treatment groups were not randomized, but based on the conditions at the actual time and place. The conditions vary, some paramedics have trained many first responders, but in other areas, less first responders were trained; some paramedics operate a well-organized network of first helpers, other medics pay less attention to the first-level response; and the first responders also may be more or less dedicated to provide trauma care under rough conditions.

*Data Processing*

All assumed continuously distributed variables are expressed by mean values with 95% confidence intervals (95% CI) constructed by the Student's procedure. Analysis of variance was used to compare groups regarding continuously distributed variables.[13] Contingency table analysis was used for comparison of categorical data, prevalence given in percentage with 95% CI.[14] All comparisons were performed two-tailed with a significance level 95% confidence level. Logistic regression was used for determination of mortality predictors. Regression analysis was done by first including all potential death predictors. A backward selection process identified the heaviest predictors of mortality; statistical significance level of 5% was required for the independent variable to be included in the model. The data were stored in an Excel database and analyzed with JMP 7.0 software packet.[15]

*Ethical Considerations*

The intervention was conducted under supervision by the Ministry of Health, Kurdistan Region of Iraq. The data were stored and processed according to permission from the Norwegian Social Science Data Service (ref. no. 2006/13702).

**Results**

Of 1,341 patients with a mean value for the ages of 26 years, 79% were male and 21% were children (age <15 years). Landmine, gunshot, and projectile injuries accounted for

| | Initial first helper treatment n = 32 (95% CI) | No first helper treatment n = 158 (95% CI) |
|---|---|---|
| Dead in-field before medic encounter | 2/3 26% (2–20) | 61/158 39% (31–46) |
| Dead in-field during life support | 5/32 16% (7–32) | 23/158 15% (10–21) |
| Dead in hospital | 25/32 78% (61–89) | 74/158 47% (39–55) |



**Table 4**—Fatalities (n = 190), patients with and without first-helper treatment. Results expressed by 95% CIs.

| | Treated only by first helpers n = 105 (95% CI) | Treated by first helpers plus paramedics n = 220 (95% CI) |
|---|---|---|
| Age (years) | 29 (26–32) | 27 (25–29) |
| Gender, % male | 90 (83–95) | 83 (77–87) |
| Penetrating injuries (% of total) | 81 (72–87) | 60 (54–66) |
| Critical Area injuries (% of total)* | 15 (10–23) | 19 (15–25) |
| Extremity injuries (% of total) | 66 (57–74) | 47 (40–53) |
| Multiple major injuries (% of total) | 14 (9–22) | 24 (19–30) |
| Time (hours) from injury to first-helper encounter | 0.8 (0.6–0.9) | 0.6 (0.5–0.7) |
| Time (hours) from injury to medic encounter | -- | 1.4 (1.1–1.6) |
| Time (hours) from injury to hospital admission | 3.7 (3.4–4.0) | 4.0 (3.6–4.3) |
| Anatomical injury severity (ISS) | 13 (12–14) | 14.5 (13–15) |
| Physiological severity on hospital admission (PSS2) | 11.5 (11.2–11.8) | 11.0 (10.7–11.3) |
| Mortality | 5/105 4.7% (2.1–10.6) | 30/220 13.4% (9.6–18.6) |



**Table 5**—Patients evacuated by first-helpers only versus patients evacuated by first-helpers plus paramedics. Estimates expressed by means with 95% confidence intervals.
*Critical Area: Head and/or torso

42% of patients, 32% were injured in road traffic crashes, and 12% had burns. There were 936 patients with serious injuries (ISS 9–15) and 405 moderate trauma victims (ISS>15).

There were relatively more penetrating injuries and more extremity injuries in the first responder subset than in the subset without first responders, but the anatomical and physiological severity was not statistically different between the two subsets. Even if the total prehospital transport time was higher, the mortality rate was lower in the first-helper group compared to the group without first reponders, a difference of 6% (95% CI = 2–10%) (Table 3). Regression analysis demonstrates that ISS, diagnosis, blunt/penetrating injury, and first helper treatment (Yes/No) explains 57% of the mortality variation in the study population; of the four explanatory variables, ISS was the heaviest.

The positive effect of first responder treatment also can be seen in fatality analysis; there were significantly fewer early in-field deaths in the first helper subset (95% CI for the difference 21–44%) (Table 4). There was no statistically significant difference in physiological condition on hospital admission between the two main subsets (Table 3). Most deaths occurred in the group of patients with an ISS >15 (n = 405). Also, in this subset, the mortality rate was lower in the first-responder group (38%) compared to the no first responder group (51%; 95% CI = 1–24%).

The outcome of patients managed exclusively by first responders (first responder-only group) versus patients for whom the first responder worked with medics during the prehospital treatment and evacuation (first-responder-plus-medic group) also was examined. There were more penetrating injuries and more extremity injuries in the first-responder-only group. The mortality rate was significantly lower in the first helper-only group (95% CI = 3–15%). Also, for the secondary outcome indicator, physiological score on hospital

| | Cause of inury | Time of death | ISS | Diagnosis |
|---|---|---|---|---|
| 1 | RTA | Died three hours after injury, before medic encounter | 36 | Multiple major injuries |
| 2 | Fragmentation mine | Died one hour after injury, before medic encounter | 31 | Double amputation, multiple major injuries |
| 3 | Blast mine | Died two hours after injury, under medic treatment | 45 | Double amputation, penetrating skull injury with severe TBI<br>Unconscious at first encounter |
| 4 | Fragmentation mine | Died 2 hours after injury, under medic treatment | 41 | Amputation, penetrating skull injury with severe TBI.<br>Unconscious at first encounter |
| 5 | RTA | Died one hour after injury, under medic treatment | 36 | TBI, multiple major injuries.<br>Unconscious at first encounter |
| 6 | RTA | Died four hours after injury, under medic treatment | 50 | Severe TBI, multiple major injuries.<br>Deep unconscious at first encounter |
| 7 | Gunshots | Died one hours after injury, under medic treatment | 16 | Penetrating skull injury with TBI.<br>Unconscious at first encounter |



**Table 6**—Patients initially managed by first-helpers: Case description of in-field fatalities (n = 7) (RTA = road traffic accident; TBI = traumatic brain injury)

admission, this group came out better (95% CI = 0.06–1.0) (Table 5).

To identify avoidable deaths in the first responder-only group, the fatality cases were examined. Two patients died in the hands of the first responder before getting to the paramedic; both patients had severe injuries with very high severity scores. The five victims dying while the first responder was working with the medic had high ISS ratings and traumatic brain injuries with severe physiological scores (Table 6).

## Discussion

This is the first report of a controlled study of the effect of layperson trauma first-responders. The results document that early, in-field basic life support provided by trained first responders reduces trauma mortality when the prehospital transport times are long.

For the secondary outcome indicator in the study, the physiological condition of prehospital survivors on hospital admission, there were no significant differences between the two main subsets, the mean physiological rating on admission being close to 11 in both subsets. Ratings of PSS 12 indicate normal vital signs. Even under optimal conditions, full normalization of physiological indicators in severe injuries cannot be expected; 30% of the study patients were major trauma victims (ISS >15). Therefore, it was concluded that the prehospital treatment effect was equal and good in both of the main subsets.

Also, other studies report positive effects of trauma care by layperson trauma first responders. The study from the city of Khumasi in Ghana indicates that taxi drivers, after a six-hour training course were able to provide some basic life support. However, the study result is based exclusively on self-reports from the trainees, and not on medical outcome data.[7] Shah *et al* reports improved knowledge in basic trauma care among village healthcare workers in rural Nepal after participating in local training workshops. Again, the results reported are based on self-reports from the trainees, practical skills and not by medical data.[16] A major multi-center study from Canada concluded that emergency medical technicians were able to provide adequate life support in major, but survivable, trauma. However, the study was conducted on an urban population with access to Level-1 Trauma Centers, and prehospital transit times were not given in the report.[17] Therefore, the results of the Canadian study are hardly relevant for the reference population for the actual study.

What are the clinical implications of the actual study? Even if the study documents that early first-responder intervention by itself reduces trauma mortality, it should not be concluded that rural trauma systems can be built without trained paramedics. Where the hospital is far and the scene of injury difficult, the backbone of a prehospital trauma system is the network of paramedics and first-responders. The best results probably are gained by the paramedic who is able to build good local teams of first responders, give self-confidence to the first responder, and orchestrate an integrated and effective response in any emergency. Equally important is close professional follow-up and guidance from medical doctor trauma system supervisors. When case performance is evaluated every month in meetings with the paramedics, also the network of first-helpers gets feedback on the trauma care they have provided. Thus, continuous, case-based teaching helps the system mature, and also gain in sustainability.

Several limitations of the study should be addressed:

1. *Validity of the main outcome variable*—There may be unregistered prehospital fatalities. However, accord-

ing to prevailing religious beliefs, people who die should be found and buried as soon as possible. As the trauma system consists of medics and first responders rooted in the local communities, it is believed that few local accidents will escape the attention of local health workers;

2. *Validity of explanatory variables*—Since the prehospital physiological severity variables are registered by non-graduate paramedics under rough conditions and during difficult evacuations, no independent validation was possible. However, the paramedics were trained well in physiological trauma scoring. Also, the medical documentation in each case by first responders as well as by medics was scrutinized in retrospect at monthly meetings with the author (MKM). In most cases, the ISS scoring of in-field fatalities are based on clinical examination only; for religious reasons, autopsy could not be done. Hence, severity grading in these cases was systematically conservative;
3. *Lack of randomization*—Because there were reasons to assume that trauma patients would profit from early first-responder treatment, randomization of the intervention would have been unethical. As the study is non-randomized and conducted with parallel block design, and only a few explanatory variables being gathered, it may be that uncontrolled variables to some extent may have affected the comparisons of subsamples. Still, the main finding is valid for the actual study population, especially since the first-responder group had significantly longer prehospital transport times than did the control group; despite this adverse factor, the group produced better outcomes. However, generalizations to other study populations in other trauma scenarios cannot be justified; and
4. *Small study cohort*—There were relatively few study patients in the first-responder-only subset (n = 105) and only two trauma deaths. The sample size still was sufficient for analysis of variance, and the subset came out with statistically better outcomes than did the control group (Table 5). Still, it may be that a larger cohort would prove differently. Therefore, it should not be concluded that first responders alone will do.

The finding demonstrates that simple things done early—by and trained type of care provider—are crucial for trauma survival. Thus, the difference in death rates between the two main subsamples are real and valid. The positive effect of the first-responder intervention is supported further by the case examination of fatalities—all seven patients who died outside of the hospital in the first-responder group had injures of high anatomical and physiological severity, five of them with severe traumatic brain injury. These fatalities were considered unavoidable.

## Conclusions

Where prehospital transport times are long, a network of trained lay first-helpers and paramedics reduce trauma mortality, even in patients with high injury severity.

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**References**

1. Mathers CD, Joncar D: Updated projections of global mortality and burden of disease, 2002–2030: data sources, methods, and results. Available at http://www.who.int/healthinfo/statistics/bod_projections2030_paper.pdf Accessed 30 March 2009.
2. Ike SO: The health workforce crisis: The brain drain scourge. *Niger J Med* 2007;16(3):204–211.
3. McCord C, Mbaruku G, Pereira C, Nzabukakwa C, Bergstrom S: The quality of emergency obstetrical surgery by assistant medical officers in Tanzanian district hospitals. *Health Aff (Millwood)* 2009;28(5):876–885.
4. Thürer D: Dunant's pyramid: Thoughts on the "humanitarian space". *Int Red Cross Rev* 2007;89(865):59–60.
5. Burnham G, Lafta R, Doocy S, Roberts L: Mortality after the 2003 invasion of Iraq: A cross-sectional cluster sample survey. *Lancet* 2006;368(9545):1421–1428. Erratum in: *Lancet* 2009;373:810.
6. Murad M, Husum H: What makes a survivor? Ten-year results from a prehospital trauma system in Iraq. *Bull World Health Org* 2010.
7. Mock C, Tiska M, Adu- Ampofo M, Boakye G: Improvement in prehospital trauma care in an African country with no formal emergency medical services. *J Trauma* 2002;53(1):90–97.
8. Husum H, Gilbert M, Wisborg T: Training prehospital trauma care in low-income countries: the "Village University" experience. *Med Teach* 2003;25(2):142–148.
9. Husum H, Gilbert M, Wisborg T, Heng YV, Murad M: Rural prehospital trauma systems improve trauma outcome in low-income countries: A prospective study from North Iraq and Cambodia. *J Trauma* 2003;54(6):1188–1196.
10. Champion HR, Copes WS, Sacco WJ, Lawnick MM, Keast SL, Bain LW Jr, Flanagan ME, Frey CF: The Major Trauma Outcome Study: Establishing national norms for trauma care. *J Trauma* 1990;30(11):1356–1365.
11. Husum H, Gilbert M, Wisborg T, Heng YV, Murad M: Respiratory rate as prehospital triage tool in rural trauma. *J Trauma* 2003;55(3):466–470.
12. Zweig MH, Campbell G: Receiver-Operating Characteristic (ROC) Plots: A fundamental evaluation tool in clinical medicine. *Clin Chem* 1993;39(4):561–577.
13. Altman DC: *Practical Statistics for Medical Research*. London: Chapman & Hall/CRC, 1999.
14. Agresti A: *Categorical Data Analysis*. New Jersey: John Wiley & Sons; 2002.
15. JMP 6.0.2. SAS Institute Inc: Cary, NC, 2007.
16. Shah RK, Thapa VK, Jones DHA, Owen: Improving primary orthopaedic and trauma care in Nepal. *Edu Health* 2003;16(3):348–356.
18. Liberman M, Mulder D, Lavoie A, Denis R, Sampalis JS: Multicenter Canadian study of preshospital trauma care. *Ann Surg* 2003;237(2):153–160.