Prehospital trauma systems reduce mortality in developing countries: A systematic review and meta-analysis

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BACKGROUND: The majority of trauma deaths in the developing world occur outside of the hospital. In the mid-1990s, preliminary studies of prehospital trauma systems showed improvements in mortality. However, no empirical data are available to assess the overall benefit of these systems. We undertook a systematic review and meta-analysis to assess the effectiveness of prehospital trauma systems in developing countries.

METHODS: We conducted multiple database and bibliography searches (from inception until December 2010) to identify articles assessing the effectiveness of prehospital trauma systems in developing countries. The primary outcome was mortality. Secondary outcomes were physiologic severity score, Injury Severity Score, and prehospital time. We calculated relative risks (95% confidence intervals [CIs]), performed a sensitivity analysis, and pooled estimates using a fixed effects method.

RESULTS: Fourteen studies met our inclusion criteria for qualitative analysis. Eight studies representing seven countries (n = 5,607) were included in the meta-analysis. Our pooled estimates show a 25% decreased risk of dying from trauma in areas that have prehospital trauma systems (relative risk [RR], 0.75; 95% CI, 0.66–0.85), with no significant heterogeneity ($\chi^2 = 3.71$, $p = 0.72$). Rural settings showed slightly enhanced treatment effect compared with urban settings (RR, rural 0.71; 95% CI, 0.59–0.86 vs. urban 0.79; 95% CI, 0.65–0.94). In-field response time was reduced in both rural (without an ambulance system, 66 minutes, 95% CI: 24–108) and urban (with an ambulance system, 6 minutes, 95% CI: 5.47 to 6.53, $p < 0.0005$) settings.

CONCLUSION: Prehospital trauma systems in developing countries, particularly middle-income countries, reduce mortality. These data should inform and encourage developing countries to adopt prehospital trauma systems at the policy level. (*J Trauma Acute Care Surg*. 2012;73: 261–268. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Meta-analysis, level III+.

KEY WORDS: Prehospital; rural trauma system; first responder; developing countries; ATLS.

Injury is a major cause of death and disability worldwide, ranking number nine in the Global Burden of Disease estimates.[1] An estimated five million people die from both intentional and unintentional injuries worldwide.[2] If left unchecked, by 2020, injury will occupy the number three position in the Global Burden Of Disease rankings.

Current injury control strategies focus on primary or secondary prevention.[3] An essential tenet of trauma care is the "golden hour," the immediate time after injury when resuscitation and stabilization will be most beneficial to the patient.[4] Thus, from the point of trauma, there is a brief window of time in which to provide emergency care and rapid transport of victims if mortality and morbidity are to be minimized. Unfortunately, the capacity to provide this basic level of care is lacking in many poor countries. The majority of trauma deaths in the developing world occur in the out-of-hospital setting.[5] One study found that 81% of trauma deaths occurred in the prehospital setting in a low-income country (Ghana) compared with 72% in a middle-income country (Mexico) and 59% in a high-income country (United States).[6] Transport times have been noted to range from an average of 4 hours to 8 hours to days in rural areas of low-income countries.[7] The lack of basic infrastructure (e.g., roads) and the relative isolation of some areas of the world provide additional challenges.

In 2000, the World Health Organization (WHO) noted that there was "a pressing need to strengthen the quality and availability of systems of prehospital trauma care throughout the world."[3] In 2005, the WHO's Violence and Injury Prevention and Disability department released a manual entitled "Prehospital Trauma Care Systems," which describes the core strategies, equipment, supplies, and organizational structures needed to create effective prehospital trauma systems for injured persons worldwide. The manual provides guidance on two complementary approaches to trauma care. Tier 1 involves first responders while tier 2 involves an ambulance service. The manual notes, however, that the "lack of empirical data on the benefit of many prehospital care interventions is a serious problem."[3]

In the mid-1990s, Husum et al.[7] developed a basic, low-cost, two-tiered emergency response system built on existing informal prehospital systems in the mine-infested villages of Cambodia and Northern Iraq, which produced a reduction in trauma deaths from 40% to 14.9%. Jayaraman et al.[8] demonstrated the feasibility of a context-specific and low-cost

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prehospital trauma training system employing key stakeholders (e.g., commercial drivers, police officers, and local district government officials) in the African setting.

To date, empirical evidence of the benefits of prehospital trauma systems in developing countries has been lacking. No systematic review or meta-analysis on the effectiveness of such systems has been done. The assessment of this intervention is critical, however, as it provides an evidence-based, practical solution for resource-constrained areas. We aimed to summarize existing published data on the effectiveness of prehospital trauma systems to address this large gap in knowledge in the field. The result of this study has the potential to direct policies in prehospital trauma systems and interventional studies in developing countries.

MATERIALS AND METHODS

Inclusion Criteria

We included all trials assessing the effectiveness of a prehospital trauma system in a country classified as an emerging or developing economy in the International Monetary Fund's World Economic Outlook Report (April 2010). Prehospital trauma system refers to a set of interacting elements of prehospital trauma care that includes triage, airway management, oxygen administration, intravenous fluid administration, splinting, spinal immobilization, wound care, and patient transport. All studies, while representing variations of the primary intervention, were considered under "prehospital trauma systems" in so much as they represent efforts to create a system to manage injuries and train individuals to provide prehospital care. Only studies published in a peer-reviewed journal were considered.

Search Strategy

We searched Pubmed, Medline, WEB ISI, Google Scholar, and LILACS for articles and reviews (from inception until December 14, 2010) using the keywords "prehospital trauma systems," "developing country," and "low-and-middle-income countries." We also searched bibliographies and contacted journals to find additional references. No restrictions were put on language or study design, but studies were included only if a comparison group was evaluated. All titles and abstracts were examined, and the relevant articles were obtained for review.

Data Extraction

Data extraction was done according to a predefined form, which included information on study setting, study population, sample size, method of prehospital trauma training system, and comparison group. Our primary endpoint was mortality. Secondary outcomes were injury severity, physiologic severity, and prehospital time. Injury severity was assessed by an anatomic scoring system, the Injury Severity Score (ISS). Each injury is assigned an Abbreviated Injury Scale score allocated to one of six body regions (head and neck, face, chest, abdomen, extremities [including pelvis], and external). The three most severely injured body regions have their score squared and added together to produce a score, which correlates linearly with mortality, morbidity, hospital stay, and other measures of severity. The scores range from 0 to 75. When the score is <15, there is <10% risk of mortality, whereas an ISS >25 increases linearly with mortality.[9] Only ISS tabulated across different categories were considered. Physiologic severity was assessed by the physiologic severity score (PSS), a scoring system calculated from a simplified version of the Revised Trauma Score that incorporates a patient's level of consciousness (Glasgow Coma Scale), systolic blood pressure, and respiratory rate. Revised Trauma Score values range from 0 to 7.8408, with a higher value indicating increased probability of survival.[10] Prehospital time includes in-field response time (i.e., mean time from injury to first medical contact in the field) and scene time (i.e., time from when prehospital providers arrive at the scene until transport of patient). We judged study quality from a design and methodological standpoint according to criteria developed by Liberman et al.,[11] which assessed comparability of groups, adequacy of sample size, and selection bias (Table 1). Scores were not included in the meta-analysis.

TABLE 1. Design and Methodological Criteria for Assessment of Study Quality (Liberman et al.)[11]

Design Criteria	Score	Methodological Criteria	Score
Randomized controlled study with comparable groups	10	Suitable choice of reference group	8
Randomized controlled study with noncomparable groups, with statistical adjustment	9	All trauma patients included	3
		Sample size (>100 patients)	5
Nonrandomized controlled study with comparable groups	8	Selection bias accounted for	6
Nonrandomized controlled study with noncomparable groups, with statistical adjustment	7	Objective criteria for eligibility of subjects (inclusion and exclusion)	5
Randomized controlled study with noncomparable groups, without statistical adjustment	6	Comparability of groups under comparison demonstrated (n within 20%)	10
Nonrandomized controlled study with noncomparable groups, without statistical adjustment	5	Comparable severity of injury (ISS within 20%)	15
		Any method to attempt comparability between groups, other than randomization (except logistic regression)	8

Design Assessment Score: 0 to 3, poor quality; 4 to 7, average quality; and 8 to 12, good quality. Experimental and control groups were considered comparable if both the number of patients (n) and ISS were within 20% of each other, noncomparable if injury severity was not described or not stratified within the groups. Methodological Assessment Score: 0 to 14, poor methodological quality; 15 to 29, average quality; 30 to 44, good quality; and 45 to 60, excellent quality.

Statistical Analysis

We calculated the relative risk (RR, 95% confidence interval [CI]) of the primary outcome mortality using original data from the studies by dividing the probability of death given the presence of a prehospital trauma system by the probability of death given the absence of a prehospital trauma system. Relative risks greater than one signified an increased risk of death in the absence of prehospital trauma care, whereas less than one signified a protective effect of prehospital trauma care. One article[12] captured data from two independent studies done in Mexico. They were treated as two separate measures. Two articles[13,14] reported data derived from a single study that assessed three groups of injuries. Overlapping data were excluded.

Standardized mean differences (SMD) for PSS were calculated from studies with available data. The SMD is the difference in means divided by an estimate of within-group standard deviation.[15] This method was used to account for the different scales used for physiologic severity. The value of the pooled SMD (Cohen's *d*) is the number of standard deviations by which the intervention changes the outcome. By convention, a Cohen's *d* of 0.2 indicates a small effect size, 0.5 a medium effect size, and 0.8 a large effect size.[16]

Meta-Analysis

Study outcomes were pooled using the fixed effects inverse variance weighting method and DerSimonian-Laird[17] random effects method, which incorporates within-study heterogeneity. If significant heterogeneity among the studies was found, the random effects model was reported. The Shore method, which directly weighs individual studies by their precision,[18] was used to calculate the CI. We calculated the I^2 statistic for each analysis as an estimation of the fraction of variation in the effect estimate caused by heterogeneity. Significant heterogeneity was found when the χ^2 test statistic was greater than the degrees of freedom, the p value was <0.20, and the I^2 value was greater than 50%. We ran a sensitivity analysis to assess the effect of individual studies on the summary estimate to determine which study, if any, exerted an undue amount of influence on the overall effect estimate. This test was performed by computing estimates while omitting one study at a time. A Forest plot was generated to assess heterogeneity. Significant overlap of the studies' effect sizes and CIs signified homogeneity. Publication bias was explored through a funnel plot (i.e., effect size vs. precision) and Begg's test. Absence of publication bias was indicated by the even dispersion of effect sizes around the pooled effect estimate. A p value of <0.20 for Begg's test indicated the presence of bias.[19] All meta-analyses, graphs, and plots were done using STATA software (version 11; STATA corporation, College Stn, TX). Findings were reported based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which is an evidence-based 27-item checklist and a four-phase flow diagram, which represents the minimum set of items for reporting systematic reviews and meta-analyses.

RESULTS

Figure 1 shows the flow diagram of study selection. Screening of the title and abstract yielded 32 publications. Of the 18 articles excluded, five were abstracts and 13 were full-text articles. Overall, 14 articles met the inclusion criteria for qualitative synthesis. Eight studies from seven countries were included in the meta-analysis (Table 2): two from Mexico[12] and Iran,[13,14] and one each from Trinidad and Tobago,[20] Afghanistan,[21] Brazil,[22] Iraq,[23] and Cambodia.[23] The studies comprised one retrospective cohort study and seven prospective nonrandomized interventional studies (i.e., 4 were before/after comparisons, whereas the rest were side-by-side comparisons). Four of the studies were in rural areas without an ambulance system, three of which instituted a two-tiered response system with lay first responders.[13,14,23] One study trained paramedics in advanced trauma life support in a combat zone in Afghanistan to provide in-field trauma care.[21] The remaining four studies were done in urban areas, three of which had an existing but uncoordinated ambulance system. These were later organized along with training of ambulance personnel.[12,20] One study trained firemen along with institution of an ambulance system. These studies represented over 10 years of prehospital trauma care system experience, treating 5,607 injuries between 1997 and 2009, and with a range of interventional training courses, from prehospital trauma life support (75%), basic trauma life support (12.5%), and advanced trauma life support (12.5%).

Study Quality

When we assessed the quality of the articles, only the study by Ali et al. was deemed to have a good study design, whereas the other seven were average. Two studies were considered to have average methodology,[21,23] three studies with good methodology,[12,13,22] and two studies with excellent methodology.[14,20]

Demographics

The mean age of the patients (n = 4,398) was 32.73 years and did not differ between the pre-and post-intervention groups (33.16 years vs. 34.12 years, respectively) in five studies (n = 6,170). 77.69% of the patients (n = 3,730) were male, and the proportion was similar in the pre- and post-intervention groups (n = 6,170 patients; 76.49% vs. 77.52%, respectively). The injuries treated were war casualties, landmine injuries, road traffic accidents (e.g., car, motorcycle, bike, and pedestrian injuries), gunshot wounds, and burns. There was no difference in the distribution of the type of trauma (blunt vs. penetrating) between pre-and post-intervention groups (blunt trauma, 79.59% vs. 77.39%, respectively) in three studies (n = 2,058).

Meta-Analysis

Institution of prehospital trauma systems reduced the risk of mortality in seven of eight studies, statistically significant in four studies (Table 2). The combined relative risk indicated a protective effect of prehospital trauma systems (RR, 0.67; 95% CI, 0.56–0.81; I^2 = 57.7%); however, heterogeneity was noted (χ^2 = 16.56; p = 0.020). Sensitivity analysis showed that the study by Husum[21] was an outlier, prompting omission from the analysis (Fig. 2). Done in a combat zone, the data used to calculate the risk of dying in the study included patients who were dead on arrival at the sites of prehospital care. This factor explains the high risk of

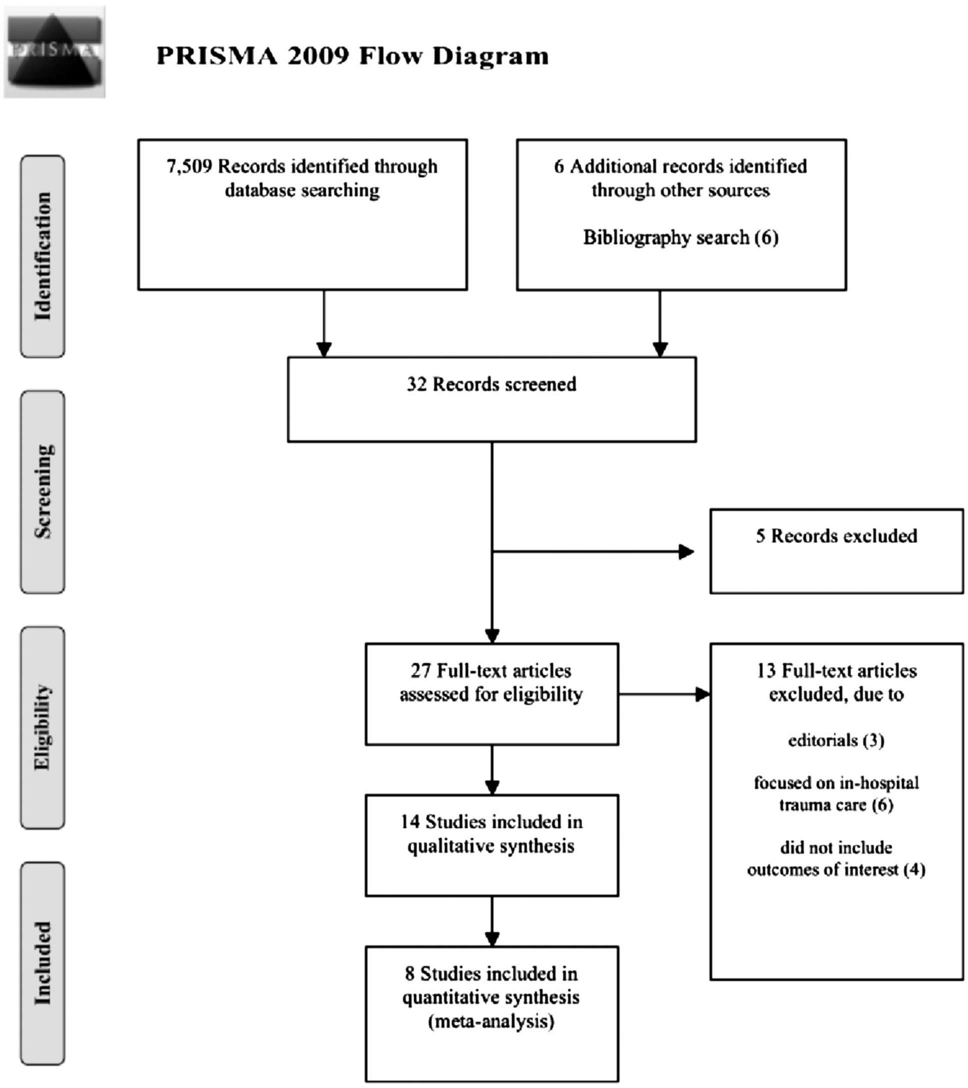

Figure 1. Diagram of systematic search. Reproduced from Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic review and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6.

mortality in both the pre- and post-intervention setting and the heterogeneity in the pooled estimate. The remaining studies indicated that prehospital trauma systems reduce mortality by 25% (RR, 0.75; 95% CI, 0.66–0.85) with no evidence of heterogeneity (χ^2 = 3.71, *df* = 6, *p* = 0.72, I^2 = 0%) or publication bias based on Begg's test (*Z* = −0.75, *p* = 0.55) and funnel plot (Fig. 3). The Forest plot showed significant overlap between the studies (Fig. 4).

To evaluate potential sources of interaction, the studies were stratified by the study setting (rural, without an ambulance system vs. urban, with an ambulance system). The pooled relative risks showed a slightly greater treatment effect in the rural setting compared with the urban setting (29% risk reduction vs. 21%, respectively; RR, rural 0.71; 95% CI, 0.59–0.86 vs. urban 0.79; 95% CI, 0.65–0.94). Table 3 summarizes the pooled relative risks.

Table 4 shows mortality and patient distribution by ISS from three studies. Among 195 deaths, 72.82% were in the ISS 25 to 75 (critically injured) category, whereas 23.56% were in the ISS 16 to 24 (severely injured) category. Among 1,287 injuries, 76.53% were in the ISS 1 to 15 (minor to moderate to seriously injured), 11.73% were in the ISS 16 to 24 (severely injured), and 11.73% were in the ISS 25 to 75 (critically injured) category. We pooled three studies with mean PSS scores and found a small treatment effect (SMD, 0.26; 95% CI, −0.11−0.63)[12,13] with significant heterogeneity (χ^2 = 30.53, *df* = 2, *p* < 0.0005, I^2 = 93.4%). Three studies provided data on prehospital time. Husum et al.[7] reported a decrease of 66 minutes (95% CI, 24–108) in the in-field response time in rural areas without an ambulance system, 5 years after the institution of a prehospital trauma system (n = 1,061), whereas Arreola-Risa et al.[12] reported a decrease of 6 minutes (95% CI, 5.47–6.53; *p* < 0.0005) in an urban area, 5 years after the institution of an ambulance system (n = 866). Husum[21] reported a decrease of 70 minutes in the in-field response time in a combat zone in Afghanistan 2 years

TABLE 2. Summary of Studies Included in the Meta-analysis

Author	Year of Publication	N	Location of Study	Study Design	Intervention	Ambulance System	Injuries	RR	95% CI
Ali et al.[20]	1997	682	Trinidad and Tobago (urban)	Prospective Pre vs. Post	PHTLS	Yes	All trauma	0.46	(0.23–0.92)
Husum[21]	1999	380	Afghanistan (rural)	Prospective Pre vs. Post	ATLS	No	WC	0.52	(0.45–0.60)
Marson and Thomson[22]	2001	1941	Brazil (urban)	Retrospective cohort Pre vs. Post	PHTLS	Yes*	MVC	0.84	(0.66–1.07)
Husum et al.[23]	2003	578	Northern Iraq, Cambodia (rural)	Prospective VFR vs. NVFR	PHTLS	No	LM, GSW, burns, RTA	0.53	(0.29–0.98)
Arreola-Risa et al.[12]	2004	866	Monterrey, Mexico (urban)	Prospective Pre vs. Post	PHTLS	Yes	All trauma	0.71	(0.46–1.10)
Arreola-Risa et al.[12]	2004	510	San Pedro, Mexico (urban)	Prospective Pre vs. Post	BTLS	Yes	All trauma	1.10	(0.44–2.74)
Nia et al.[13]	2008	362	Iran (rural)	Prospective PTS vs. NPTS	PHTLS	No	MVC, GSW	0.51	(0.21–1.26)
Saghafinia et al.[14]	2009	288	Iran (rural)	Prospective PTS vs. NPTS	PHTLS	No	LM	0.74	(0.61–0.91)

N, number of injuries; Prospective, nonrandomized prospective interventional study; Pre, preintervention (no prehospital trauma system); Post, post-intervention (prehospital trauma system); VFR, village first responder; NVFR, no village first responder; PTS, prehospital trauma system; NPTS, no prehospital trauma system; PHTLS, prehospital trauma life support; ATLS, advanced trauma life support; BTLS, basic trauma life support; Yes, existing uncoordinated ambulance system in place; Yes*, newly instituted ambulance system; No, no formal ambulance system but other forms of patient transport instituted; WC, war casualty; MVC, motor vehicle collision; LM, landmine injury; GSW, gunshot wound; RTA, road traffic accident; RR, relative risk (mortality risk ratios).

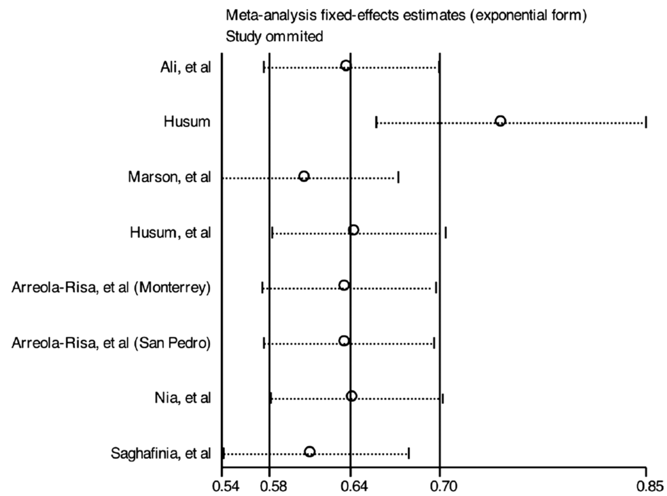

Figure 2. Influence analysis of the studies' fixed effects ordered by weight.

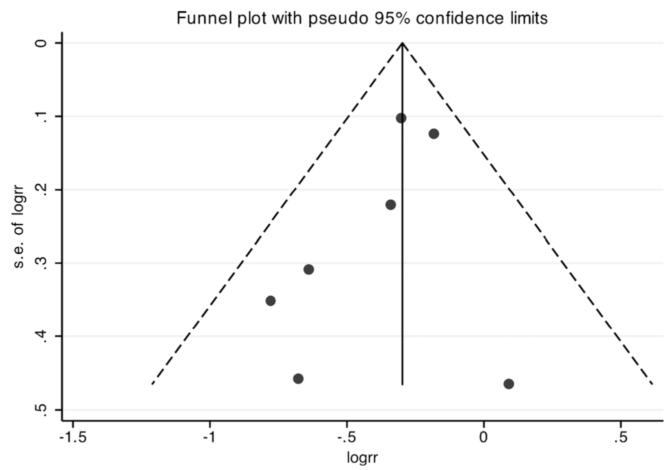

Figure 3. Funnel plot of the studies' effect sizes assessing publication bias.

post-intervention. Two studies by Arreola-Risa et al.[12] reported mean scene times in urban areas (n = 1,376) that did not differ between the pre-and post-intervention periods.

DISCUSSION

The results presented here suggest that in a young population of mostly male patients, prehospital trauma systems reduce mortality by 25% in developing countries. In-field response time was reduced in both rural and urban settings. Correspondingly, mortality was reduced substantially, albeit more in rural settings than in urban settings.

This analysis provides empirical evidence of the effectiveness of prehospital trauma systems in developing countries, mostly in middle-income economies. It is important to highlight that the intervention affects mostly working age adults, the most economically productive segment of society. Although the outcome in trauma patients is a function of multiple variables, studies assessing trauma system efficacy rely on mortality as the primary indicator of effectiveness.[24] Pooled mean

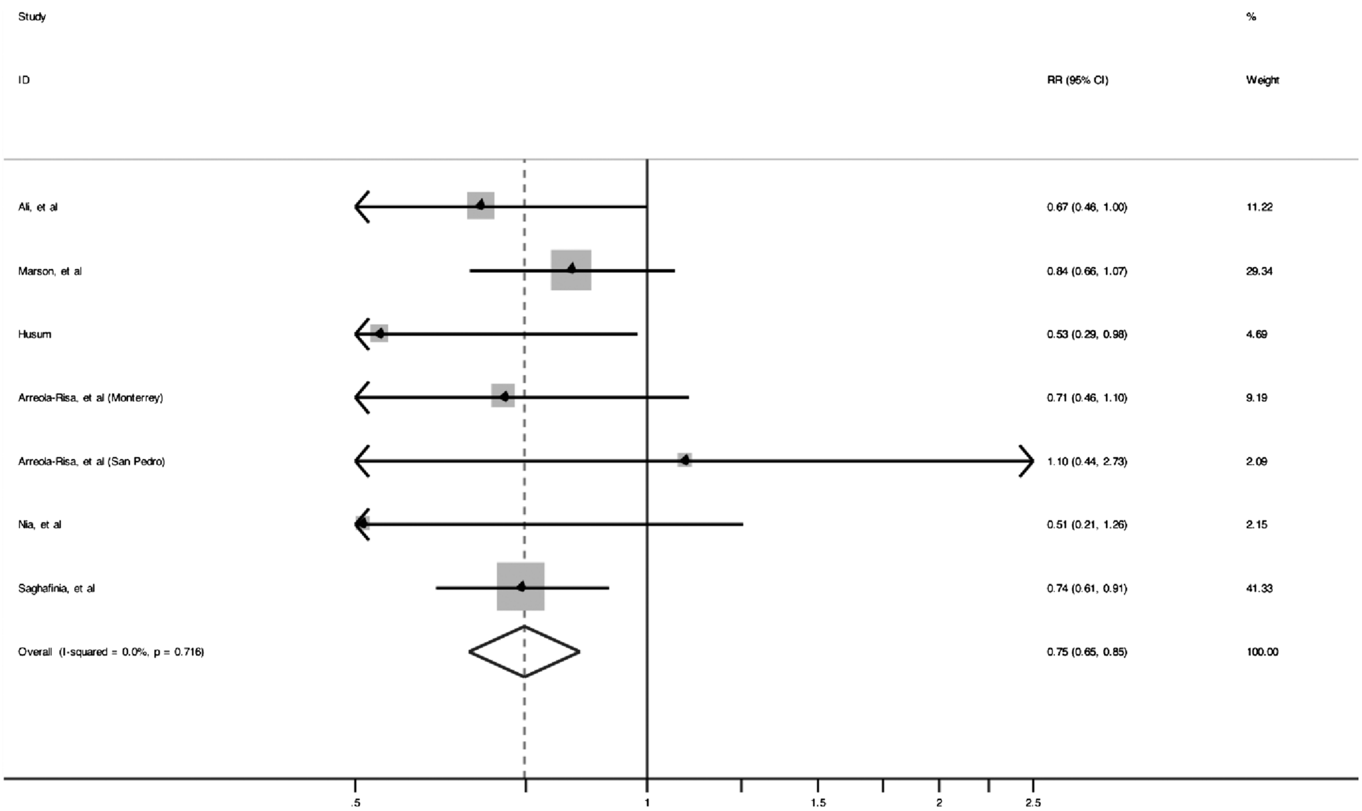

Figure 4. Fixed effects meta-analysis of prehospital trauma systems and mortality. Numbers reflect RR. Pooled RR, 0.75; 95% Shore CI, 0.65–0.84; $\chi^2 = 3.71$ ($df = 6$) $p = 0.72$.

TABLE 3. Summary of Pooled Relative Risks

Group	Studies (N)	Fixed Effects		Random Effects		Shore	Heterogeneity	
		RR	95% CI	RR	95% CI	95% CI	χ^2 (*df*)	*p*
Overall	8	0.64	(0.58–0.70)	0.67	(0.56–0.81)	(0.44,0.69)	16.56 (7)	0.02
Excluding Husum[21]	7	0.75	(0.66–0.85)	0.75	(0.66–0.85)	(0.65–0.84)	3.71 (6)	0.72
Rural studies	4	0.58	(0.52–0.66)	0.60	(0.46–0.77)	(0.48–0.70)	7.85 (3)	0.05
Rural studies excluding[21]	3	0.71	(0.59–0.86)	0.71	(0.59–0.86)	(0.60–0.83)	1.58 (2)	0.45
Urban studies	4	0.79	(0.65–0.94)	0.79	(0.65–0.94)	(0.64–0.96)	1.53 (3)	0.68

RR, relative risk (mortality risk ratios).

TABLE 4. Patient and Mortality Distribution by Injury Severity

Authors	Year of Publication	N	Location of Study	Minor–Moderate Injury (ISS, 1–8)	Serious Injury (ISS, 9–15)	Severe Injury (ISS, 16–24)	Critical Injury (ISS, 25–75)
Mortality by ISS							
Ali et al.[20]	1997	37	Trinidad and Tobago	0	0	15	22
Husum et al.[23]	2003	158	Northern Iraq, Cambodia	3	4	31	120
Total mortality (%)		195		3 (1.54)	4 (2.05)	46 (23.56)	142 (72.82)
Distribution of patients by ISS							
Husum et al.[23]	2003	1061	Northern Iraq, Cambodia	490	322	98	151
Nia et al.[13]	2008	226	Iran	75	98	53	
Total patients (%)		1287		565 (43.9)	420 (32.63)	151 (11.73)	151 (11.73)

difference of PSS in three studies showed small treatment effect. However, data were derived from only three studies that were highly heterogeneous; therefore, conclusions cannot be reliably drawn. Timeliness of the response to a severe injury is an important variable in the outcome. Prompt response and intervention can save lives and reduce the likelihood of permanent disability. In this review, there was a substantial decrease in the mean in-field response time, more dramatic in rural compared with urban settings. The model developed by Husum et al. trained "village first responders" to provide prehospital trauma care. In rural areas with rudimentary transportation systems where the mean transport time is 4 hours to 8 hours and where there are no formal emergency medical services systems, immediate provision of basic life support (BLS), stabilization, and bleeding control by trained lay people can save lives and prevent disability.

In the study by Arreola-Risa et al., done in San Pedro, Mexico, additional training in prehospital advanced life support (ALS) involving advanced airway management was used. Results show that there was no change in mortality rates compared with the study done in Monterrey, Mexico, which primarily used BLS. This finding underscores the ongoing debate concerning the benefit of ALS in the prehospital setting. In a recent study by Stiell et al.,[25] prehospital ALS conferred no additional benefit over BLS (overall survival to discharge rate 81.1% vs. 81.8%, respectively) in developed countries. Thus, the focus should be on provision of BLS in prehospital trauma systems in developing countries because in resource-poor settings, the cost of additional training and lack of educated manpower becomes a serious problem.

The limitations of this report include absence of randomized controlled trials to assess prehospital trauma systems, although ethical concerns make such studies very difficult to perform. Given the fact that the studies included in this meta-analysis were nonrandomized interventional trials, the potential for selection bias is large and poses a significant limitation. The use of allocation methods other than concealed randomization raises the question of comparability between the two groups. Unblinded assessment of outcomes by trial personnel may be vulnerable to ascertainment bias, where knowledge of treatment allocation may inadvertently cause inaccurate scores. Studies with inadequate treatment allocation or studies that are not double-blind can result in inflated estimates of treatment effect.[19] Despite the difficulty of assessing the risk of bias in nonrandomized studies; in cases where a randomized study is impractical, unethical, or impossible, these challenges can be overcome in a well-planned, rigorous, prospective study with sufficient control for potential confounders whether by study design or statistical analysis. In this meta-analysis, five studies performed comparisons in the same population living within the same geographic region before and after the institution of a prehospital trauma system. Barring any major historical event (e.g., natural disaster) that may have caused a rapid shift in the mortality probability in the group before or after the intervention, and excluding Husum, whose study was done in a combat zone, the remaining four studies were fairly comparable. Three studies performed side-by-side comparisons in the same population of patients in the same geographic region. Only Ali et al., reported an adjusted effect estimate using logistic regression (controlling for age, type of injury, and injury severity) while unadjusted effect estimates were computed for the other studies, thus representing crude relative risks. This raises important questions on the possible role of confounders such as age, type of injury, and severity of injury that may not be accounted for in the generation of effect estimates. The mean age of patients in the studies did not differ between the comparison groups. The distributions of type of injury were fairly similar in five of eight studies. Injury severity was not uniformly assessed; only two studies provided data on the distribution of patients by injury severity and only one study provided the ISS in the pre- and post-intervention groups.

Our findings suggest that prehospital trauma systems provide substantial benefit to trauma victims in developing countries, particularly in middle-income countries. Basic, low-cost, and rudimentary techniques have shown reductions in mortality and should be explored in low-income countries. However, because of the scarcity of data and of the uncertain benefit of prehospital trauma systems in low-income countries where health facilities have no surgical capacity (i.e., no qualified staff, equipment, or supplies), further studies are urgently needed to firmly establish the robustness of this system. Moreover, well-controlled studies with carefully designed statistical analyses measuring standardized trauma outcome variables are still needed to provide a clearer picture of the effectiveness of prehospital systems against other trauma outcomes (i.e., ISS, PSS, long-term effects, cost effectiveness, and sustainability). Given the nature of the empirical evidence in this study, however, developing countries should be encouraged to adopt prehospital trauma systems at the policy level.

AUTHORSHIP

J.A.H. was responsible for the study concept, design, literature search, data collection, analysis and interpretation of data, generation of tables and figures, and drafting of the report. A.L.R. critically reviewed, revised, proofread, and edited the manuscript. Both authors read and approved the final report.

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DISCLOSURE

The authors declare no conflicts of interest.

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