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Designing and implementing a practical prehospital emergency trauma care curriculum for lay first responders in Guatemala

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ABSTRACT

Background Injury disproportionately affects low-income and middle-income countries, yet robust emergency medical services are often lacking to effectively address the prehospital injury burden. A half-day prehospital emergency trauma care curriculum was designed for first responders and piloted in the Sacatepéquez, Chimaltenango, and Escuintla departments in Guatemala.

Methods Three hundred and fifty-four law enforcement personnel, firefighters, and civilians volunteered to participate in a 5-hour emergency care course teaching scene safety, triage, airway management, cardiopulmonary resuscitation, fracture management, and victim transport. A validated 26-question pretest/post-test study instrument was contextually adapted and used to measure overall test performance, the primary study outcome, as well as test performance stratified by occupation, the secondary study outcome. Pretest/post-test score distributions were compared using a Wilcoxon signed-rank test. For test evaluation, knowledge acquisition on a by-question and by-category basis was examined using McNemar's χ^2 test, whereas item difficulty indices used frequency-of-distribution tests and item discrimination indices used point biserial correlation.

Results Two hundred and eighty-seven participants qualified for inclusion. Participant mean pretest versus post-test scores improved 24 percentage points after course completion (43% vs 68%, p<0.001). Cronbach's alpha yielded values of 0.86 (pretest) and 0.94 (post-test), suggesting testing instrument reliability. Between-group analyses demonstrated law enforcement and civilian participants improved more than firefighters (p<0.001). Performance on 23 of 26 questions improved significantly. All test questions except one showed an increase in their PPDI.

Discussion A 1-day, contextually adapted, 5-hour course targeting laypeople demonstrates significant improvements in emergency care knowledge. Future investigations of similar curricula should be trialed in alternate low-resource settings with increased civilian participation to evaluate efficacy and replicability as adequate substitutes for longer courses. This study suggests future courses teaching emergency care for lay first responders may be reduced to 5 hours duration.

Level of evidence Level II.

INTRODUCTION

Nearly 6 million deaths from injury occur annually, representing 10% of the world's deaths and accounting for more deaths than malaria, tuberculosis, and HIV/AIDS combined.[1] Injury disproportionately affects low-income and middle-income countries (LMICs), where 90% of injury-related deaths occur.[2] Additionally, 80% of injury-related deaths occur in the prehospital setting in LMICs compared with just 59% in developed settings.[3] Despite the disproportionate burden of injury, emergency medical services (EMS) are lacking in most LMICs, even with increasing rates of injury.[4–6] Formal EMS utilization has remained low in these countries, despite its potential to impact 45% of all mortality and 36% of the total disease burden, as bystanders and law enforcement have historically provided a large proportion of prehospital emergency care.[7 8]

Guatemala is a middle-income country that suffers high rates of injury, primarily due to firearm violence and road traffic injuries (RTIs).[9 10] Physical injury resulting from both road trauma and firearms has been recognized as a global health priority, as RTIs account for 1.35 million deaths and 50 million injuries annually.[11–13] Guatemala is among the top six countries for firearm-related homicides, which together account for 50.5% of the global toll from firearms along with Brazil, the USA, Mexico, Colombia, and Venezuela.[10] Its mortality rate from firearms was measured to be 32.3 per 100 000 people in 2016, compared with 10.6 per 100 000 in the USA.[10]

Guatemala's current prehospital care system is fragmented between two principal organizations and several private ambulance agencies. Municipal firefighters (*bomberos municipales*) and volunteer firefighters (*bomberos voluntarios*) are the two predominant ambulance-based organizations providing the majority of all prehospital care in Guatemala and compete to respond first to emergencies. *Municipales* are funded by the government, whereas *Voluntarios* are sustained entirely by public donations and philanthropic contributions. Both organizations provide "Basic Life Support"-level care, whereas a few stations have paramedic-level personnel who have paid for Prehospital Trauma Life Support (PHTLS) training courses and then teach other firefighters informally. Organizations are under-resourced, normally reusing single-use

materials like splints and bag-valve masks, with the few Guatemalan paramedics purchasing medications themselves. PHTLS courses are available in Guatemala but are expensive, whereas ATLS courses have not yet penetrated the country.[14 15] No legal regulations regarding prehospital medicine exist, as there is no evidence of a Good Samaritan Law in Guatemala. Both organizations are codispatched with local police to scenes of injury. Though patients are expected to pay in full prior to transport, many are unable and do not, further straining Guatemalan EMS financially.[16]

Thus, first responders (firefighters and police/law enforcement) often lack formal training or the supplies to manage injury. Additionally, there is no robust country-wide trauma registry to guide evaluation and coordination of the necessary activities related to the care of the critically injured. Though the implementation of formally organized, integrated EMS is the ultimate goal, a high-yield, validated, half-day prehospital emergency trauma care curriculum for lay first responders was designed to address the prehospital injury burden and implemented in the Chimaltenango, Escuintla, and Sacatepéquez Departments of Guatemala. We hypothesized that training of the first responders on scene to provide emergency care was possible through a short, practical, high-yield curricula. We used measurements of performance on precourse and postcourse assessments (pretest/post-tests) using a prevalidated study instrument to assess improvement in fundamental trauma management skills.

METHODS

Course development

Two American national registry-certified emergency medical technicians and a National Association of EMS Educators-certified emergency medical responder instructor developed the lay first responder course, building on prior experience studying, developing, and launching lay first responder programs in Chad and Uganda.[17] The final curriculum was revised in collaboration with two local Guatemalan physicians from Jocotenango Municipal Clinic (located in Antigua Guatemala), given their experience and knowledge of local trauma and injury mechanisms. The curriculum was informed by the WHO's guidelines, the Red Cross, and the American College of Surgeons Prehospital Trauma Life Support Course and "Stop The Bleed" Initiative. The 5-hour course was taught in Spanish in a lecture format, interspersed with five hands-on breakout sessions, administered in a 44 slide-slideshow using graphics for learning objective reinforcement.[18]

Participant learning objectives began by first focusing on the principles, definitions, and responsibilities of competent first aid providers and the goals of providing rapid care. The curriculum's seven categories then consisted of "Scene Safety," "Triage," "Airway and Breathing," "Resuscitation," "Hemorrhage Control," "Fracture Management," and "Transport," with the latter five objectives as the subject of each breakout session. To maximize practicality for participants, each course lasted 5 hours in total and was taught during a single day to accommodate participant work schedules and maximize convenience. The number of participants per session varied between 10 and 40 as participant availability fluctuated, and investigators attempted to iteratively analyze a target course size, which was decided to be 25, based on trainer feedback. Two instructors led each course, with an additional assistant present during hands-on breakout sessions. For the practical sessions, participants were divided into groups of two to four (depending on course size). Trainees practiced skills using supplies similar to those included in the first aid kits provided to each participant at the end of the course: gauze (hemorrhage control), bandages (hemorrhage control), cardboard splints (fracture management), pens and fabric strips for improvised tourniquets (hemorrhage control), and tourniquets (hemorrhage control). During the cardiopulmonary resuscitation and choking component, mannequins were used by instructors to demonstrate skills and allow participants to practice and receive instructor feedback.

Study design

Investigators collaborated with local and international stakeholders, including municipal and volunteer firefighter departments (*bomberos municipales* and *bomberos voluntarios*), "LFR International," an American non-governmental, not-for-profit organization committed to EMS development, police divisions including the Division of Nature Protection (División de Protección a la Naturaleza—DIPRONA), which operates within rural and remote regions of Guatemala, and the Division of Tourism Security (División de Seguridad Turística—DISETUR), which focuses on protecting tourists. Participants were verbally recruited 3 weeks before course dates from law enforcement and firefighting organizations, which are the first to respond to common trauma-causing events in Guatemala. Fourteen 1-day sessions were organized during May and June 2019 across Chimaltenango, Escuintla, and Sacatepéquez. Courses were administered exclusively to each organization's members in a venue provided by the participating organization. Although a certificate and first aid kit were awarded to each participant on course completion, no food or monetary incentives were provided to participants.

Participants provided verbal consent at the beginning of the course for study inclusion. On signing in, participants were asked to complete a criterion-referenced test that had been based on one previously validated by Boeck *et al* to assess the knowledge of participants in a layperson trauma first responder pilot course in La Paz, Bolivia.[19] The test was administered before and after the course by investigators to measure baseline knowledge and subsequent improvement. Some pre-existing questions were lightly edited, whereas various new questions were created by PGD, JF, and ZJE to accurately reflect course content not included in the previous test. The final version of the test comprised 23 multiple choice and 3 true-false questions to examine participant first aid knowledge. On the post-test, the same questions were used with both the question and answer orders scrambled randomly. Matched questions are listed first with a question's pretest number followed by its corresponding post-test number, written as pre(post) [#(#)]. The survey test was initially written in English and was later translated to Spanish by a bilingual, native Spanish-speaking author (JAF). The validity of the translation was then confirmed by EH, a local Guatemalan physician, who ensured question appropriateness for the local setting. Participants were excluded from the study if they did not consent or if they only took either the pretest or post-test.

The reliability of the testing instrument was assessed using Cronbach's alpha (r) to assess internal consistency, and the SE of measurement (SEM) was calculated, lying between zero to the SD of each sample.[20] Significance was recorded with each statistical test, determining any value $p<0.05$ to be statistically significant.[21]

Study setting

The departments of Chimaltenango, Escuintla, and Sacatepéquez were selected as they lie adjacent and are proximate to Guatemala City, increasing convenience to conduct the study, and are

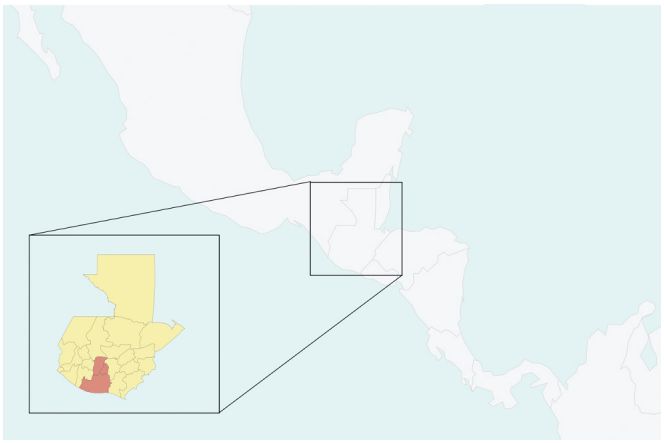

Figure 1 Map of Chimaltenango, Escuintla, and Sacatepequez Departments of Guatemala.

located in Guatemala's southern region (figure 1). Chimaltenango has a population of 741 176 residents, Escuintla has 803 488 residents, and Sacatepéquez has 362 539 residents, comprising 10.9% of the country's population.[22] Poverty in Guatemala is localized to rural areas and socioeconomically, the incidence of poverty in Chimaltenango, Escuintla, and Sacatepéquez ranges between 13.7% and 23.2%, compared with 29.1% nationally.[23] Guatemala's literacy rate was 81.29% in 2014, and for persons between the ages 15 and 24, it was 94.35% in 2014.[24] Between July 1, 2017 and June 30, 2018, the 528 homicides across Chimaltenango, Escuintla, and Sacatepéquez amounted to a homicide rate of 27.68 per 100 000 people.[22] Additionally, 1570 people have been killed and 6235 more injured in road traffic incidents between 2014 and 2018 across the three departments (65.38 per 100 000 people injured and 16.46 per 100 000 killed).[25]

Data analysis

Data were compiled in Microsoft Excel (Microsoft, Redwood, Washington, USA) and analyzed in R (R Foundation for Statistical Computing, Vienna, Austria). In a binary fashion, correct answers were assigned a score of one point, whereas incorrect, blank, or multiple answers were assigned a score of zero points. The primary outcome of interest was demonstrated by participant knowledge acquisition and was quantified as the difference between pretest and post-test scores. The secondary outcome of interest included an analysis of participant knowledge acquisition with respect to occupational demographics, and psychometric analyses replicating those employed by Boeck *et al* were used to evaluate and validate the assessment questions.[19]

To assess participant knowledge acquisition, the interquartile mean score and SD were determined for both the pretest and post-test. Distributions of total scores for the pretest and post-test were compiled and compared using a Wilcoxon signed-rank test for nonparametric analysis. Occupational affiliation of each participant was then mapped to their corresponding total score and analyzed using a Wilcoxon Rank-Sum (Mann-Whitney) test for between-group differences.

Each individual question from the pretest was mapped to its corresponding post-test analog and was compared using McNemar's χ^2 test to examine knowledge acquisition on a by-question basis. Item difficulty indices were then assigned to each question via frequency-of-distribution tests and item discrimination indices were assigned via point biserial correlation, to analyze whether or not each individual question is able to differentiate between a high-scoring and low-scoring participant. Participants were then divided into quartiles by total score to determine the proportion of each question correctly answered per quartile, with well-discriminating items showing a sequential increase in correct answers. The proportion of questions that improved, worsened, or remained static was then recorded.

To assess participant knowledge acquisition in terms of discrete topics in first aid, questions were then grouped according to which course topic was tested. The seven categories consisted of "Scene Safety," "Triage," "Airway and Breathing," "Resuscitation," "Hemorrhage Control," "Fracture Management," and "Transport." The proportion of correct answers on both the preassessment and postassessment were recorded, and each category was assessed for significance using McNemar's test.

Table 1 Participant demographics

Law enforcement officers: 180 (62.7%)	
Municipal employment	50 (27.8%)
National employment	130 (72.2%)
Firefighters: 86 (30.0%)	
(Municipal) Volunteer	75 (87.2%)
(Municipal) Professional	11 (12.8%)
Civilians: 20 (7.0%)	

RESULTS

Participant demographics

A total of 354 individuals underwent training, of which, 81.1% (n=287) of participants met study inclusion criteria. Participant demographics are reported in table 1. Examining participant breakdown by employer, 47.4% of 287 participants (n=136) reported working for a municipality, whereas 45.3% (n=130) of participants reported national employment. Point three percent (n=1) of individuals did not report an occupation or affiliated institution.

Participant assessment performance

The interquartile mean of participant scores was 42.0% on the pretest compared with 71.2% on the post-test (figure 2), yielding an increase of 29.2% between the preassessment and postassessment ($p<0.001$), improving significantly across each of the seven discrete testing categories (table 2). Categorical percent change was increased by an interquartile mean of 26.9%.

Both civilians and law enforcement officers improved significantly over firefighters ($p<0.001$), whereas only civilians had significantly higher post-test scores as compared with both firefighters and law enforcement officers ($p<0.005$) (table 3). There was no significant difference in improvement or post-test score between those employed by municipal or national organizations.

Reliability

Cronbach's alpha yielded a value of 0.86 for the preassessment and 0.94 for the postassessment, where a value above 0.7 is generally considered reliable.[26] As with previous implementation of the study instrument, the SEM were calculated to assess the effects of measurement error on individual test scores. As the value for SEM decreases, the proportion of test score due to errors in measurement will decrease with an increase in reliability.[16 17] The SEM for the pretraining assessment was 0.0081 where the SEM for the post-test was 0.0085. An acceptable value

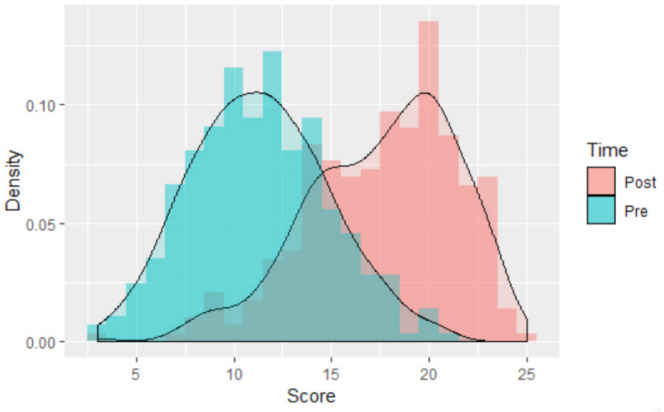

Figure 2 Distribution of pretraining and post-training assessment scores. Legend: Title—"Time," Red Label—"Post," and Blue Label—"Pre." The depicted curves represent the densities of the distributions of the preassessment and postassessment scores and have been overlaid with the corresponding histogram. The Shapiro-Wilks test for normality yielded p values of p<0.001 and p=0.014 for the fit of the predistribution and postdistribution, respectively. Thus, the null hypothesis that both distributions are normally distributed may be rejected, implying that nonparametric testing methods must be used in data analysis.

for the SE of measurement would fall 5% within the range of possible test scores (0–1), and as such the SEM values for both the pretest and post-test were acceptable.

To further evaluate the testing instrument, four additional analyses were used: test item analysis, item-difficulty indices, item-discrimination indices and proportion correct by quartile. Test item analysis found performance on each question improved significantly, except for questions 7 (7), 12 (23) and 22 (10). The item-difficulty indices found that all questions showed an increase in pretest/post-test difference index (PPDI), except for question 23 (12). The item-discrimination index found pretest point biserial correlation ranged between −0.08 and 0.54, whereas post-test values ranged from 0.08 to 0.52. Investigating proportion correct by quartile to confirm well-discriminating items, 22 of 26 (84.6%) pretest questions (all but question 17, 24, 25, and 26) and all post-test questions showed that the highest quartile contained the highest proportion of correct answers. For details regarding further analysis of the testing instrument, please refer to online supplementary materials.

DISCUSSION

The key finding of this study of Guatemalan first responders is that it is possible to successfully train lay first responders with a course that lasts no longer than 5 hours, using critical content that has previously been tested in other environments and evaluated with a previously validated study instrument. Three hundred and fifty-four first responders participated in half-day emergency trauma care courses across three Guatemalan departments and were equipped with first aid kits. In this study, law enforcement personnel and firefighters were prioritized for inclusion as they are the first responders to emergency scenes in Guatemala, similar to Boeck *et al*'s study in Bolivia that had prioritized healthcare professionals and first responders.[19] Similar to the results of the study from Bolivia that the criterion-referenced test was implemented during, the study instrument demonstrated reliability through appropriate item difficulty indices, item discrimination indices, and internal consistency. Knowledge improved significantly during the course, with an interquartile mean difference between pretest/post-test of 29.2%. Compared with the study from Bolivia that used a nearly identical testing instrument, the demonstrated increase in this study was just over a percent higher (29.2% vs 28%). Our results suggest very similar participant knowledge improvement can be achieved within 5 hours, indicating future courses may not need to span a full day or even multiple days to achieve significant results. This means shorter courses may be more convenient and practical for lay participants and may also be as effective in supporting knowledge acquisition.

There was no significant difference in performance on the test between participants employed by municipal or national organizations; however, there was a statistically significant difference between professions. Participants in law enforcement improved significantly more than firefighters (as did civilians), with their interquartile mean final score falling just 4% below the firefighters'. Though law enforcement participants were not formally surveyed on prior participation in a formal first aid training course, law enforcement supervisors and participants in the course informally reported an absence of any such previous training; law enforcement's dramatic increase was thus expected, though a mean post-test score so close to the firefighters' mean post-test score was surprising. Participants improved significantly across each of the seven discrete testing categories, with skills in scene safety improving most (42.0%) and airway and breathing improving by the lowest margin (18.2%). This suggests that airway and breathing should be prioritized in future training curricula. There were no issues with literacy observed when administering pretest/post-tests. Of the 26 questions included on

Table 2 Participant performance by topic category

Curriculum topic categories	Preproportion correct (%)	Postproportion correct (%)	Percentage point difference (post–pre score)	P value*
Scene safety	44.1	86.1	42.0	<0.0001
Hemorrhage control	31.8	67.9	36.1	<0.0001
Transport	48.2	76.4	28.2	<0.0001
Fracture management	44.7	70.0	25.3	<0.0001
Triage	45.6	69.9	24.3	<0.0001
Resuscitation	39.8	60.5	20.7	<0.0001
Airway and breathing	50.3	68.5	18.2	<0.0001

*P value determined using McNemar's χ^2 test.
†Test Questions by Category: Scene Safety—2 (1), 6 (3), 16(4), 17(5); Hemorrhage Control—1 (14), 9 (16), 14(17), 26(13); Transport—4 (25), 5 (26), 13(15); Fracture Management—10(21), 11(22), 12(23), 21(24); Triage—7 (6), 15(7), 18(2), 23(8); Resuscitation—20(18), 24(19), 25(20); Airway and Breathing—3 (9), 8 (11), 19(12), 22(10).

Table 3 Interquartile mean of participant test scores and differences

Occupation	Prescore % (IQR)	Postscore % (IQR)	Percentage point difference (post–pre score)	Within group p value*	Between group p value†
Civilian	40.4 (33.7–48.1)	80.8 (71.5–86.2)	40.4	<0.001	0.007
Law enforcement	38.4 (25.9–43.3)	69.2 (59.6–78.8)	30.8	<0.001	<0.001
Firefighter	50.0 (40.4–59.6)	73.1 (61.5–84.6)	23.1	<0.001	<0.001

*Wilcoxon signed-rank test used for preassessment and postassessment scores.
†Mann-Whitney test used for distributions of improvements between groups, referenced against two other groupings.

the test, just three were problematic: question 7 (7), regarding a triage scenario, question 12(23), regarding specific splinting benefits, and question 22(10), regarding what a first responder can learn about the physiologic and anatomic nature of a patient on hearing a response. Moving forward, these problematic questions will be rewritten and piloted more intensely with local collaborators to ensure poor test performance was not due to problematic question wording.

LMICs bear much of the brunt of the prehospital injury burden and are in need of EMS development. The results of this study are promising for future cost-effective, pragmatic course design in low-resource settings, and though it is probable these results from a middle-income setting will translate to low-income country settings additional studies regarding the impact of lay first responder programs on mortality and morbidity rates is an area of research that is needed and should be prioritized, for which the development of trauma registries is paramount.[27] Leveraging community-driven emergency response, similar to the emergency first aid responder system developed in South Africa by Sun and Wallis or lay first responder programs promoted by World Health Organization since 2004, is important for improvement of prehospital care in underdeveloped areas.[28 29] Training lay people to provide emergency care in the prehospital setting appears to be a cost-effective, scalable mechanism of performance as previously demonstrated.[19 29] In middle-income settings, often where limited fee-for-service prehospital facilities have already been developed, patients are expected to pay in full prior to transport continues to be a significant impediment to care, as a study investigating willingness to pay in Guatemala demonstrated.[16] The authors plan to return to Guatemala in 2020 to conduct 12 month follow-up surveys and interviews with the original course participants to measure knowledge retention and skill decay, while establishing a training-of-trainers (TOT) program to ensure sustainability, including conducting further trainings in obstetric and medical emergencies. Future pilot projects developing community-driven, lay first responder programs as an effective, affordable alternative to traditional high-income country EMS models should be explored in addition to studies examining the long-term clinical and socioeconomic impact of such programs.

Our study has limitations. We preferred to train police officers and firefighters, as they are consistently the first responders to unintentional injuries in Guatemala. The same cannot be said of emergency response in low-income countries where prehospital systems are less robust. The findings presented in the current article may not directly translate to other countries with a different etiologic makeup of trauma and regular first responders. Larger scale pilot projects must be initiated on provincial or national levels to obtain population-level data for reliable mortality-related outcomes evaluating future model efficacy.[30 31]

CONCLUSION

With increased injury-related mortality rates, LMICs require the development of more robust EMS to address the disproportionate injury burden present. This study suggests that future courses teaching emergency care for first responders could be reduced to 5 hours duration. Future investigations of similar curricula should be trialed in alternate low-resource settings with more civilian participation to evaluate if they may be adequate substitutes for longer courses in resource-limited environments.

Contributors All authors made substantial contributions to the conception/design of the study, acquisition/analysis of data, and in drafting and revising the article.

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Map disclaimer The depiction of boundaries on this map does not imply the expression of any opinion whatsoever on the part of BMJ (or any member of its group) concerning the legal status of any country, territory, jurisdiction or area or of its authorities. This map is provided without any warranty of any kind, either express or implied.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Ethical approval for this study was received by the Washington University in St. Louis School of Medicine Institutional Review Board and Human Research Protections Office (ID: 201904088). All participants provided written and verbal informed consent before participation in this research study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information. Deidentified participant data is available from PGD, who can be reached at peter.delaney1995@gmail.comRe-use is permitted for additional follow-up studies or meta-analyses.

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REFERENCES

1 World Health Organization. *Injuries and violence: the facts*. Geneva: World Health Organization, 2010.
2 World Health Organization. *Injuries and violence: the facts*. Geneva: World Health Organization, 2014.
3 Mock CN, Jurkovich GJ, nii-Amon-Kotei D, Arreola-Risa C, Maier RV. Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development. *J Trauma* 1998;44:804–14.
4 Sasser S, Varghese M, Kellermann A, Lormand JD. *Prehospital trauma care systems*. Geneva: World Health Organization, 2005.

5 Mould-Millman N-K, Dixon JM, Sefa N, Yancey A, Hollong BG, Hagahmed M, Ginde AA, Wallis LA. The state of emergency medical services (EMS) systems in Africa. *Prehosp Disaster Med* 2017;32:273–83.
6 Gosselin RA, Spiegel DA, Coughlin R, Zirkle LG. Injuries: the neglected burden in developing countries. *Bull World Health Organ* 2009;87:246.
7 Kobusingye OC, Hyder AA, Bishai D, Joshipura M, Romero Hicks E, Mock C. Emergency Medical Services. In: Jamison DT, Breman JG, Measham AR, eds. *Disease control priorities in developing countries*. 2nd ed. New York: Oxford University Press, 2006:p.1261–79.
8 Nielsen K, Mock C, Joshipura M, Rubiano AM, Zakariah A, Rivara F. Assessment of the status of prehospital care in 13 low- and middle-income countries. *Prehosp Emerg Care* 2012;16:381–9.
9 The World Bank. Guatemala. https://data.worldbank.org/country/guatemala.
10 Global Burden of Disease 2016 Injury Collaborators, Naghavi M, Marczak LB, Kutz M, Shackelford KA, Arora M, Miller-Petrie M, Aichour MTE, Akseer N, Al-Raddadi RM, *et al*. Global mortality from firearms, 1990-2016. *JAMA* 2018;320:792–814.
11 World Health Organization. *Global status report on road safety 2018*. Geneva: World Health Organization, 2018.
12 World Health Organization. *World report on road traffic injury prevention (injuries and violence prevention databases)*. Geneva: World Health Organization, 2020.
13 Richmond TS, Foman M. Firearm violence: a global priority for nursing science. *J Nurs Scholarsh* 2019;51:229–40.
14 NAEMT. NAEMT Education Worldwide. https://www.naemt.org/education/naemt-education-worldwide.
15 Regions. http://web20.facs.org/atls_cr/InternationalRegions14-17.pdf.
16 Bose SK, Bream KDW, Barg FK, Band RA. Willingness to pay for emergency referral transport in a developing setting: a geographically randomized study. *Acad Emerg Med* 2012;19:793–800.
17 Delaney PG, Bamuleke R, Lee YJ. Lay first Responder training in eastern Uganda: Leveraging transportation infrastructure to build an effective prehospital emergency care training program. *World J Surg* 2018;42:2293–302.
18 LFR International Guatemala Page. Encino, CA2019. 2019. http://LFRinternational.org/Guatemala.
19 Boeck MA, Callese TE, Nelson SK, Schuetz SJ, Fuentes Bazan C, Saavedra Laguna JMP, Shapiro MB, Issa NM, Swaroop M. The development and implementation of a layperson trauma first Responder course in La PAZ, Bolivia: a pilot study. *Injury* 2018;49:885–96.
20 Tavakol M, Dennick R. *Post-examination analysis of objective tests, medical teacher, 33:6, 447-458 and the index of drug involvement: a partial validation, Anna C. Paul and Walter W. Hudson, social work / volume 42, number 6 / November 1997*, 2011.
21 Greenland S, Senn SJ, Rothman KJ, Carlin JB, Poole C, Goodman SN, Altman DG. Statistical tests, P values, confidence intervals, and power: a guide to misinterpretations. *Eur J Epidemiol* 2016;31:337–50.
22 La Asociación Civil Diálogos. "Informe sobre la violencia homicida en Guatemala, del 1 de julio del 2017 al 30 de junio del 2018.". http://www.dialogos.org.gt/wp-content/uploads/2018/07/Informe-SEMESTRAL-sobre-la-Violencia-Homicida-en-Guatemala-2018-ver-FINAL.pdf.
23 Queen Elizabeth House, University of Oxford. "Global MPI Country Briefing 2018: Guatemala (Latin America and the Caribbean)." Oxford Poverty and Human Development Initiative (OPHI), Oxford Department of International Development. https://ophi.org.uk/wp-content/uploads/CB_GTM_2018.pdf.
24 UNESCO Institute for Statistics: Guatemala. Education and literacy: literacy rate. 2019. http://uis.unesco.org/en/country/gt.
25 El Instituto Nacional de Estadística (INE) – Guatemala. *"Datos de accidentes de tránsito, vehículos involucrados y víctimas fallecidas y lesionadas."*, 2018.
26 Taber KS. The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Res Sci Educ* 2018;48:1273–96.
27 Sun JH, Wallis LA. The emergency first aid Responder system model: using community members to assist life-threatening emergencies in violent, developing areas of need. *Emerg Med J* 2012;29:673–8.
28 Mock C, Lormand J, Goosen J, Joshipura M, Peden M. *Guidelines for essential trauma care*: World Health Organization, 2004.
29 Callese TE, Richards CT, Shaw P, Schuetz SJ, Issa N, Paladino L, Swaroop M. Layperson trauma training in low- and middle-income countries: a review. *J Surg Res* 2014;190:104–10.
30 Vyas D, Hollis M, Abraham R, Rustagi N, Chandra S, Malhotra A, Rajpurohit V, Purohit H, Pal R. Prehospital care training in a rapidly developing economy: a multi-institutional study. *J Surg Res* 2016;203:22–7.
31 Mock CN, Tiska M, Adu-Ampofo M, Boakye G. Improvements in prehospital trauma care in an African country with no formal emergency medical services. *J Trauma* 2002;53:90–7.