

Assessing barriers to quality trauma care in low and middle-income countries

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1 - Title:

Assessing barriers to quality trauma care in low and middle-income countries: a Delphi study

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Keywords: Delphi, Injury, Trauma, Health System, Developing Countries, Access to Care.

Title:

Assessing barriers to quality trauma care in low and middle-income countries: a Delphi study

Abstract:**Background:**

Most deaths from injury occur in Low and Middle Income Countries (LMICs) with one third potentially avoidable with better health system access. This study aimed to establish consensus on the most important barriers, within a Three Delays framework, to accessing injury care in LMICs that should be considered when evaluating a health system.

Methods:

A three round electronic Delphi study was conducted with experts in LMIC health systems or injury care. In round one, participants proposed important barriers. These were synthesized into a three delays framework. In round 2 participants scored four components for each barrier. Components measured whether barriers were feasible to assess, likely to delay care for a significant proportion of injured persons, likely to cause avoidable death or disability, and potentially readily changed to improve care. In round 3 participants re-scored each barrier following review of feedback from round 2. Consensus was defined for each component as $\geq 70\%$ agreement or disagreement.

Results:

There were 37 eligible responses in round 1, 30 in round 2, and 27 in round 3, with 21 countries represented in all rounds. Of the twenty conceptual barriers identified, consensus was reached on all four components for 11 barriers. This included 2 barriers to seeking care, 5 barriers to reaching care and 4 barriers to receiving care. The ability to modify a barrier most frequently failed to achieve consensus.

Conclusion:

11 barriers were agreed to be feasible to assess, delay care for many, cause avoidable death or disability, and be readily modifiable. We recommend these barriers are considered in assessments of LMIC trauma systems.

Keywords: Delphi, Injury, Trauma, Health System, Developing Countries, Access to Care.

Introduction:

Trauma represents a major global health problem with injuries accounting for more deaths than TB, malaria and HIV combined, with 90% occurring in Low and Middle Income Countries (LMICs) ¹. Economic growth in LMICs is associated with a rapidly growing trauma burden; with projections that Road Traffic Collisions will be the third leading cause of death globally by 2030 ². Non-fatal injuries are also common, with 1 billion people sustaining an injury in 2013 warranting health care ³. If survival rates following injury in LMICs were improved to rates seen in High Income Countries (HICs), one third of global trauma deaths could be avoided ⁴, a strong argument for research and investment in health systems caring for injured patients.

Considering and developing the whole system of trauma care from injury to rehabilitation has resulted in improvements in trauma care outcomes in HIC settings, particularly amongst the most severely injured ⁵⁻⁷. Good trauma care reflects wider emergency health system performance ^{8,9}. The Lancet Global Health Commission on High Quality Health Systems highlights the disparity between the global injury burden and the limited available data on care quality provided by health systems. Better assessment of such care is a stated research priority ⁹.

Whilst a universal framework for understanding access to complex healthcare systems, such as for trauma care, may not exist, the choice of framework should fit a purpose ¹⁰. The Three Delays model was developed to evaluate barriers to care causing delays driving maternal mortality in LMICs ¹¹. Widely adopted in maternal, neonatal and child health ¹²⁻¹⁶, this model has been proposed for evaluating emergency healthcare systems more generally including trauma ¹⁷. It considers barriers resulting in delays seeking care (Delay 1), reaching care (Delay 2) and receiving appropriate care (Delay 3) ¹¹. The WHO Emergency Care Systems framework describes important functions of an effective emergency health system response ¹⁸. It has a comparable tripartite structure, of scene, transport and facility. However, by explicitly considering barriers to care access, rather than care provided, the Three Delays framework encourages a broader conceptualisation of health systems and the problem of non or delayed access to formal health services.

Multiple wide-ranging barriers to emergency care exist in LMICs including: ethnic, cultural, transport related, financial and barriers related to availability of physical, consumable and human resources ^{19,20}. However, prioritising the most important barriers to assess informs health system assessment development. The aim of this study was to develop expert consensus on barriers to care, which are important to assess in order to effectively evaluate an LMIC trauma care health system.

Material and Methods:

A three round electronic modified Delphi study was conducted between November 2018 and February 2019. The Delphi technique has been widely adopted since its inception by the RAND Corporation, and has been used to study a variety of subjects across healthcare research²¹⁻²⁷. Delphi studies evaluate the views of experts in a given field to measure or establish any consensus of opinion, often employed when little research exists or in areas of controversy or debate²⁸. Although modifications exist, defining features of a Delphi study include: anonymity of participant responses; the use of multiple rounds or iterations; and the opportunity for participants to reflect on feedback and change their views if they wish^{29, 30}.

Participant Identification

Individuals with a holistic health systems overview of barriers to accessing trauma care were invited to contribute. Participants were required to have at least six months clinical experience treating injured patients in LMICs in the preceding two years, or two or more publications on LMIC health systems research or trauma research in the preceding two years.

Experts from geographically and economically diverse settings were approached to ensure generalisability across LMIC contexts. Participants were identified through international injury care and health system research organisations including; Health Systems Global network, the Primary Trauma Care network, the College of Surgeons of East, Central and Southern Africa (COSECSA), the GlobalSurg Collaborative and other personal contacts. Potential participants were informed of the study through both direct face-to-face and email communication and via electronic advertisement. The electronic Delphi method was considered suitable as it enables drawing upon a geographically disparate group for whom it would be logistically difficult to bring together for in person group discussions.

Round 1

During round 1, participants were asked to propose barriers that they judged important to assess when evaluating a trauma care health system in an LMIC. Participants were asked to propose barriers for each Delay category, as well as an unassigned “other” category, and to provide free text explanation. Two authors (JW and DN) independently reviewed and synthesized the responses into distinct conceptual barriers within each Delay. Barriers were assigned to each of the Three Delays and any disagreements between authors were discussed until an agreement was reached.

Round 2

During round 2, barriers proposed during round one were presented to participants within a Three Delays theoretical framework. Participants were asked to indicate agreement on a 5 point Likert scale (strongly agree, agree, neither agree nor disagree, disagree or strongly

disagree) as to whether each barrier was; easy to assess (feasible), likely to delay care for a significant proportion of injured persons (large scale), likely to cause avoidable death or disability for affected injured persons (high impact), or readily changed to improve care for injured patients (modifiable). No barriers were removed between rounds 2 and 3.

Round 3

During round 3, the results of consensus with these four components for each barrier from round 2 were summarized and presented. This was to allow participant reflection on others' results before repeating the same scoring process as round two. Space was provided for optional free text to justify responses.

Primary Outcome

The *a priori* primary outcome was the proportion of participants strongly agreeing or agreeing with each barrier's four components (feasible, large scale, high impact, modifiable).

Consensus agreement was defined as $\geq 70\%$ participants strongly agreeing or agreeing, whilst consensus disagreement was defined as $\geq 70\%$ participants strongly disagreeing or disagreeing. The number of components achieving consensus for each barrier was calculated.

Secondary Outcome

To allow further comparison and differentiation between each barrier, each of the 5 points on the Likert scale were also assigned a score from 2 to -2. Strongly agree scored 2, agree scored 1, neither agree nor disagree scored 0, disagree scored -1 and strongly disagree scored -2. For each barrier, for each individual participant, the total score for all four components for that barrier was calculated, this was summed for all participants and the total divided by the number of participants to create an average score per barrier (figure 1).

Study Conduct

Each Delphi round lasted 2 weeks with participants receiving email reminders at day 6 and 12. The authors and three additional individuals not involved with the study piloted each round to ensure clarity and comprehension. The study was conducted using REDCap electronic survey tool³¹. The study was conducted in English. The UK Ministry of Defence Ethics Subcommittee regarded that, as a Delphi study of colleague opinions, formal ethics review was not required.

Results:

Participants

Forty-nine participants expressed interest in the study and were invited into round 1. There were 37 eligible responses to round 1, 30 to round 2 and 27 to round 3 (figure 2). 8 round 1 participants had responded to direct invitation, whilst 29 participants had responded to a request through a professional network. This fell to 5 and 22 respectively by round 3. Experts from 24 different countries participated in round 1, with 22 and 21 different countries represented by rounds 2 and 3 respectively (table 1). Round 3 participants had experience working across 5 low-income, 5 lower middle-income, 6 upper middle-income and 5 high-income countries. The participants were predominantly male (25/27 in round 3), from urban settings (22/27 in round 3) and reported expertise in both clinical and research eligibility criteria (12/27 in round 3). 11/27 reported clinical expertise only and 4/27 research expertise only (table 2). Between the rounds the balance between work settings, gender and area of expertise remained similar, although all participants from low and high income countries completed all three rounds (table 2).

Round 1

Twenty conceptual barriers were identified. As an illustration of the process, when proposing barriers to seeking care, three participants presented comments related to health insurance; *“Absence of health insurance”, “Lack of health insurance”, “Type of payment for medical care: national insurances, out-of-pocket payment, private insurances”*. Eleven participants provided responses considered to be referring to the cost of care and a further two related to the cost of transport. Following discussion these were subsumed into the overarching barrier *“Cost - The financial costs associated with seeking care are too great”*. Resultant barriers are detailed in table 3. In many cases the barriers represent broad categories. For example the conceptual barrier *“Staff”*, within Delay 3, incorporates staff availability, training and motivation. Similarly the conceptual barrier *“Roads”* within Delay 2 incorporates reliability, congestion and prioritization of emergency vehicles.

Round 2

No consensus of disagreement was achieved for any component of any barrier. Overall, 7 of 20 barriers achieved consensus (>70%) agreement across all 4 components (table 4).

Round 3

Following completion of round 3, no consensus of disagreement was achieved for any barrier component. Consensus agreement had been reached for all 4 components in 11 of 20 barriers (table 4). Only 2 of 7 barriers from Delay 1 achieved consensus agreement for all components, compared to 5 of 6 from Delay 2 and 4 of 7 from Delay 3. For barriers with fewer than 4 components achieving consensus agreement, the “modifiable” component consistently

failed to achieve consensus agreement (table 5). The 8 barriers with the highest average score were all from Delays 2 and 3, with “*communication*”, “*staff*” and “*transport*” (table 4).

Discussion:

This study identified 20 distinct barriers potentially delaying care following injury in LMICs. Categorised within a Three Delays framework, expert participants reached consensus of agreement that 11 barriers were easy to assess, likely to delay care for a significant proportion of injured persons, likely to cause avoidable death or disability for affected injured persons, and could potentially be readily changed to improve care for injured patients. This provides support for their use in the evaluation of LMIC trauma systems.

The 9 of 20 barriers not achieving consensus agreement for all components were not considered modifiable. *“Capacity”*, *“roads”* and *“perceived physical access”*, were otherwise high impact, large scale and feasible to assess. *“Delayed discovery”* was considered both high impact and large scale but neither modifiable nor feasible to assess. A related free text explanation that this was *“very complex”* and involved *“social cultural factors”*. Study participants may feel that they lack agency to change these barriers compared to policy makers in positions of authority.

Delay 1 had fewest barriers achieving consensus. The dominance of facility-based participants could explain an emphasis towards facility barriers. Edem et al found that although delay 3 contributed to 59% of avoidable trauma deaths, the contribution of delay 1 to avoidable mortality was substantial at 18%³². In our study, *“traditional healers”*, *“cultural norms”* and *“healthcare literacy”* were not considered large scale or high impact. Up to 1/3 of patients in some low-income settings have been found to seek traditional healers prior to death from surgical conditions, including injury³³. And some prefer traditional healers even with proven fractures³⁴. This is likely culturally context specific as traditional healers are sought more commonly in some countries³³. Other community-based studies assessing population understanding of barriers to emergency and trauma care have also proposed health seeking behaviour and perception of costs of care as barriers to seeking care³⁵⁻³⁸

5 of 6 Delay 2 barriers achieved consensus agreement across all components, consistent with very high pre-hospital traumatic death rates (up to 80%) in some LMICs^{4, 39}. A lack of timely affordable emergency transport following trauma achieved the third highest average score; this barrier could be broken down into several components which this Delphi didn't address, but others have focused on. For example, in a study in Malawi, the lack of effective pre-hospital communication, coordination mechanisms and ambulance transport were all highlighted as priority challenges with feasible solutions⁴⁰. Although a human and physical resource challenge, improvements in formal pre-hospital trauma care in LMICs have been shown to reduce mortality, with an enhanced effect in rural environments⁴¹. Similarly studies

in LMICs of attempts to train bystanders in first aid following trauma, although low in quality, report improved knowledge and skills, with mortality reduction in some cases⁴².

4 of 7 Delay 3 barriers achieved consensus, however “*payment*”, “*patient cooperation*” and, “*capacity*” failed to achieve consensus. The barrier “*payment*” focused on timely payment for care, referring to patients who have already sought and reached care. This contrasts with “*costs*” within delay 1, (the real or perceived costs of seeking care) and “*transport*” including associated expenditure. This suggests participants believed that if costs have not prevented seeking or reaching care, they are unlikely to inhibit receiving care once at a facility. Understanding the role of financial resource in accessing injury care may benefit from community-based enquiry.

Much literature on LMIC trauma care focuses on facility care. Staff availability and training is frequently reported as deficient⁴³⁻⁴⁷. Equipment and supplies essential for trauma care delivery, are commonly reported as inadequate⁴³⁻⁴⁷. Attempts to evaluate injury care process quality have identified deviations from best practice possibly contributing to avoidable death^{48, 49}.

Other studies have categorised the barriers to trauma care, however, few have considered all barriers to healthcare access from the point of injury occurring to receipt of high quality care, or attempted to prioritise these. One review of barriers to pre-hospital emergency care highlighted 6 categories (Transport, Equipment, Personnel, Community/Culture, Infrastructure and Communication/Coordination) with less than 20% of articles discussing more than 4 of these²⁰. Another described barriers as: financial and non-financial; religious and cultural beliefs; geographical access; transportation; health care worker and patient interface; physical and human resource deficiency; and organisational deficiency¹⁹.

Although we approached a wide and diverse network of potential participants, those that responded were predominantly urban facility-based males. This likely, influenced the importance given to Delays 2 and 3 over Delay 1. However, that 27 participants completed 3 rounds represents acceptable levels of drop out and sufficient expertise for developing informative consensus opinions²³. The observed gender imbalance may partly reflect the male dominance in specialties such as surgery seen in high and low income settings^{50, 51}.

Focusing on LMICs limits opportunity to learn from HIC systems, but was justified given the scale of injury burden in these settings and to provide clear focus for the Delphi study. The slight dominance of participant African experience (9 of 21) may have resulted in bias towards issues pertinent to that continent where, for example, staff workforce density is particularly low^{52, 53}. It is possible that in other settings such as Asia or South America barriers relating to Delay 1 may have been more prevalent. Ideas and insights from participants from more

diverse clinical settings, including non-trauma emergency care and primary care, may have influenced the study results. Nevertheless, we think that the participant balance of research and injury care provision experience, provided a suitable breadth of opinion. The study was conducted in English limiting participation from non-Anglophone countries and lacked an overt patient voice that may also have offered a different perspective on barriers to care.

Conclusion:

This study has enabled presentation of barriers to access of trauma care using a three delays framework, enabling deficiencies in access to be conceptualized from the point of injury occurring to the receipt of quality care in a facility. Additionally experts have prioritized which should be assessed as part of health system strengthening based upon a whether the barriers were considered feasible to assess, impacting many people, causing avoidable mortality and morbidity, and potentially amenable to change. This study therefore provides valuable guidance to researchers and practitioners wishing to evaluate and strengthen injury care health systems in LMIC settings.

References:

- [1] Gosselin RA, Spiegel DA, Coughlin R, Zirkle LG. Injuries: the neglected burden in developing countries. *Bull World Health Organ.* 2009;87:246-a.
- [2] Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med.* 2006;3:e442.
- [3] Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. *Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention.* 2016;22:3-18.
- [4] Mock C, Joshipura M, Arreola-Risa C, Quansah R. An estimate of the number of lives that could be saved through improvements in trauma care globally. *World J Surg.* 2012;36:959-63.
- [5] Cole E, Lecky F, West A, Smith N, Brohi K, Davenport R, et al. The Impact of a Pan-regional Inclusive Trauma System on Quality of Care. *Ann Surg.* 2016;264:188-94.
- [6] Celso B, Tepas J, Languard-Orban B, Pracht E, Papa L, Lottenberg L, et al. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. *J Trauma.* 2006;60:371-8; discussion 8.
- [7] Moran CG, Lecky F, Bouamra O, Lawrence T, Edwards A, Woodford M, et al. Changing the System - Major Trauma Patients and Their Outcomes in the NHS (England) 2008-2013. *EClinicalMedicine.*
- [8] Sayed MJE. Developing Emergency and Trauma Systems Internationally: What is Really Needed for Better Outcomes? *Journal of Emergencies, Trauma, and Shock.* 2017;10:91-2.
- [9] Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. *Lancet Glob Health.* 2018.
- [10] van Olmen J, Marchal B, Van Damme W, Kegels G, Hill PS. Health systems frameworks in their political context: framing divergent agendas. *BMC Public Health.* 2012;12:774.
- [11] Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med.* 1994;38:1091-110.
- [12] Combs Thorsen V, Sundby J, Malata A. Piecing together the maternal death puzzle through narratives: the three delays model revisited. *PloS one.* 2012;7:e52090.
- [13] Wilmot E, Yotebieng M, Norris A, Ngabo F. Missed Opportunities in Neonatal Deaths in Rwanda: Applying the Three Delays Model in a Cross-Sectional Analysis of Neonatal Death. *Maternal and child health journal.* 2017;21:1121-9.
- [14] Waiswa P, Kallander K, Peterson S, Tomson G, Pariyo GW. Using the three delays model to understand why newborn babies die in eastern Uganda. *Tropical medicine & international health : TM & IH.* 2010;15:964-72.

- [15] Upadhyay RP, Rai SK, Krishnan A. Using Three Delays Model to Understand the Social Factors Responsible for Neonatal Deaths in Rural Haryana, India. *Journal of Tropical Pediatrics*. 2013;59:100-5.
- [16] Pajuelo MJ, Anticona Huaynate C, Correa M, Mayta Malpartida H, Ramal Asayag C, Seminario JR, et al. Delays in seeking and receiving health care services for pneumonia in children under five in the Peruvian Amazon: a mixed-methods study on caregivers' perceptions. *BMC Health Serv Res*. 2018;18:149.
- [17] Calvillo EJ, Skog AP, Tenner AG, Wallis LA. Applying the lessons of maternal mortality reduction to global emergency health. *Bull World Health Organ*. 2015;93:417-23.
- [18] Reynolds TA, Sawe H, Rubiano AM, Shin SD, Wallis L, Mock CN. Strengthening Health Systems to Provide Emergency Care. In: Jamison DT, Gelband H, Horton S, Jha P, Laxminarayan R, Mock CN, et al., editors. *Disease Control Priorities: Improving Health and Reducing Poverty 3rd edition*: The World Bank; 2017.
- [19] Cannoodt L, Mock C, Bucagu M. Identifying barriers to emergency care services. *Int J Health Plann Manage*. 2012;27:e104-20.
- [20] Kironji AG, Hodkinson P, de Ramirez SS, Anest T, Wallis L, Razzak J, et al. Identifying barriers for out of hospital emergency care in low and low-middle income countries: a systematic review. *BMC Health Serv Res*. 2018;18:291.
- [21] Williams PL, Webb C. The Delphi technique: a methodological discussion. *J Adv Nurs*. 1994;19:180-6.
- [22] Junger S, Payne SA, Brine J, Radbruch L, Brearley SG. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat Med*. 2017;31:684-706.
- [23] Diamond IR, Grant RC, Feldman BM, Pencharz PB, Ling SC, Moore AM, et al. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol*. 2014;67:401-9.
- [24] Banerjee T, Taylor N, Brett S, Young K, Peskett M. The Use of a Modified Delphi Technique to Create a List of 'Top Ten Tips' for Communication with Patients and Relatives in Intensive Care. *Journal of the Intensive Care Society*. 2014;15:314-9.
- [25] Blair KJ, Paladino L, Shaw PL, Shapiro MB, Nwomeh BC, Swaroop M. Surgical and trauma care in low- and middle-income countries: a review of capacity assessments. *J Surg Res*. 2017;210:139-51.
- [26] Blaschke S, O'Callaghan CC, Schofield P. Identifying opportunities for nature engagement in cancer care practice and design: protocol for four-round modified electronic Delphi. *BMJ Open*. 2017;7:e013527.
- [27] Stennett A, De Souza L, Norris M. Physical activity and exercise priorities in community dwelling people with multiple sclerosis: a Delphi study. *Disability and Rehabilitation*. 2018;40:1686-93.
- [28] Iqbal S, Pipon-Young L. The Delphi method 2009.

- [29] Chalmers J. AM. The Delphi Technique. In: P L, editor. Handbook of Research Methods in Health and Social Sciences. Singapore: Springer; 2018.
- [30] Xiao J, Douglas D, Lee AH, Vemuri SR. A Delphi evaluation of the factors influencing length of stay in Australian hospitals. *Int J Health Plann Manage.* 1997;12:207-18.
- [31] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics.* 2009;42:377-81.
- [32] Edem IJ, Dare AJ, Byass P, D'Ambruoso L, Kahn K, Leather AJM, et al. External injuries, trauma and avoidable deaths in Agincourt, South Africa: a retrospective observational and qualitative study. *BMJ Open.* 2019;9:e027576.
- [33] Forrester JD, Forrester JA, Kamara TB, Groen RS, Shrestha S, Gupta S, et al. Self-reported Determinants of Access to Surgical Care in 3 Developing Countries Determinants of Access to Surgical Care in Developing Countries Determinants of Access to Surgical Care in Developing Countries. *JAMA surgery.* 2016;151:257-63.
- [34] Aries MJ, Joosten H, Wegdam HH, van der Geest S. Fracture treatment by bonesetters in central Ghana: patients explain their choices and experiences. *Tropical medicine & international health : TM & IH.* 2007;12:564-74.
- [35] Broccoli MC, Calvillo EJ, Skog AP, Wachira B, Wallis LA. Perceptions of emergency care in Kenyan communities lacking access to formalised emergency medical systems: a qualitative study. *BMJ Open.* 2015;5:e009208.
- [36] Broccoli MC, Cunningham C, Twomey M, Wallis LA. Community-based perceptions of emergency care in Zambian communities lacking formalised emergency medicine systems. *Emergency medicine journal : EMJ.* 2016;33:870-5.
- [37] Wesson HK, Stevens KA, Bachani AM, Mogere S, Akungah D, Nyamari J, et al. Trauma systems in Kenya: a qualitative analysis at the district level. *Qual Health Res.* 2015;25:589-99.
- [38] Mock C, Ofosu A, Gish O. Utilization of district health services by injured persons in a rural area of Ghana. *The International Journal of Health Planning and Management.* 2001;16:19-32.
- [39] Yeboah D, Mock C, Karikari P, Agyei-Baffour P, Donkor P, Ebel B. Minimizing preventable trauma deaths in a limited-resource setting: a test-case of a multidisciplinary panel review approach at the Komfo Anokye Teaching Hospital in Ghana. *World J Surg.* 2014;38:1707-12.
- [40] Chokotho L, Mulwafu W, Singini I, Njalale Y, Maliwichi-Senganimalunje L, Jacobsen KH. First Responders and Prehospital Care for Road Traffic Injuries in Malawi. *Prehospital and disaster medicine.* 2017;32:14-9.
- [41] Henry JA, Reingold AL. Prehospital trauma systems reduce mortality in developing countries: a systematic review and meta-analysis. *J Trauma Acute Care Surg.* 2012;73:261-8.

- [42] Balhara KS, Bustamante ND, Selvam A, Winders WT, Coker A, Trehan I, et al. Bystander Assistance for Trauma Victims in Low- and Middle-Income Countries: A Systematic Review of Prevalence and Training Interventions. *Prehospital Emergency Care*. 2018;1-46.
- [43] Chokotho L, Mulwafu W, Singini I, Njalale Y, Jacobsen KH. Improving hospital-based trauma care for road traffic injuries in Malawi. *World J Emerg Med*. 2017;8:85-90.
- [44] Mock C, Nguyen S, Quansah R, Arreola-Risa C, Viradia R, Joshipura M. Evaluation of Trauma Care capabilities in four countries using the WHO-IATSIC Guidelines for Essential Trauma Care. *World J Surg*. 2006;30:946-56.
- [45] Stewart BT, Quansah R, Gyedu A, et al. Serial assessment of trauma care capacity in Ghana in 2004 and 2014. *JAMA surgery*. 2016;151:164-71.
- [46] Hanche-Olsen TP, Alemu L, Viste A, Wisborg T, Hansen KS. Trauma care in Africa: a status report from Botswana, guided by the World Health Organization's "Guidelines for Essential Trauma Care". *World J Surg*. 2012;36:2371-83.
- [47] Wong EG, Gupta S, Deckelbaum DL, Razek T, Kamara TB, Nwomeh BC, et al. The International Assessment of Capacity for Trauma (INTACT): an index for trauma capacity in low-income countries. *J Surg Res*. 2014;190:522-7.
- [48] Zafarghandi MR, Modaghegh MH, Roudsari BS. Preventable trauma death in Tehran: an estimate of trauma care quality in teaching hospitals. *J Trauma*. 2003;55:459-65.
- [49] Roy N, Kizhakke Veetil D, Khajanchi MU, Kumar V, Solomon H, Kamble J, et al. Learning from 2523 trauma deaths in India- opportunities to prevent in-hospital deaths. *BMC Health Serv Res*. 2017;17:142.
- [50] de Costa J, Chen-Xu J, Bentounsi Z, Vervoort D. Women in surgery: challenges and opportunities. *IJS Global Health*. 2018;1:e02.
- [51] O'Flynn E, Andrew J, Hutch A, Kelly C, Jani P, Kakande I, et al. The Specialist Surgeon Workforce in East, Central and Southern Africa: A Situation Analysis. *World J Surg*. 2016;40:2620-7.
- [52] Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA Global Anesthesia Workforce Survey. *Anesth Analg*. 2017;125:981-90.
- [53] Daniels KM, Riesel JN, Meara JG. The scale-up of the surgical workforce. *Lancet* (London, England). 2015;385 Suppl 2:S41.

Table 1 Participant country of work by round (2 participants reported working in more than one country)

Country of Work (Income Classification)	Round 1	Round 2	Round 3
Burundi (Low)	1	1	1
Egypt (Low Mid)	1	1	1
Ethiopia (Low)	1	1	1
Ghana (Low Mid)	2	1	1
Greece (High)	1	1	1
Guatemala (Up Mid)	1	0	0
Italy (High)	3	3	3
Kenya (Low Mid)	2	2	1
Malaysia (Up Mid)	1	1	1
Namibia (Up Mid)	2	2	2
Nigeria (Low Mid)	2	0	0
Pakistan (Low Mid)	2	2	2
Palestine (Low Mid)	2	1	1
Romania (Up Mid)	3	3	3
Russia (Up Mid)	1	1	1
Rwanda (Low)	1	1	1
S. Africa (Up Mid)	4	2	0
Tanzania (Low)	1	1	1
The Netherlands (High)	1	1	1
Turkey (Up Mid)	2	2	2
Uganda (Low)	2	2	2
United Kingdom (High)	1	1	1
USA (High)	2	2	2
Venezuela (Up Mid)	1	1	1

Table 2 Participant work setting, gender, expertise and country of work income classification through each Delphi round

	Round 1	Round 2	Round 3
Work Setting:			
Rural	8	5	5
Urban	29	25	22
Gender:			
Female	3	2	2
Male	34	28	25
Area of Expertise:			
Clinical	13	12	11
Research	5	4	4
Both	19	14	12
Country of Work by World Bank Income Classification (2 participants reported working in more than one country)			
Low	6	6	6
Lower Middle	11	6	6
Upper Middle	15	12	10
High	8	8	8

Table 3 Round 1 results: the conceptual barriers to injury care in LMICs identified by Delphi participants.

Delay 1 – Seeking Care	Delay 2 – Reaching Care	Delay 3 – Receiving Care
COST - The financial costs associated with seeking care are too great	COMMUNICATION - There is a lack of accessible emergency assistance communication mechanism (e.g. emergency call centre)	STAFF - In regards to staffing, there is a lack of reliably available, suitably trained and motivated clinical staff
PERCEIVED PHYSICAL ACCESS - People perceive that care is too difficult to physically access	TRANSPORT - There is a lack of timely affordable emergency transport (formal or informal)	SPECIALISTS - There is a lack of reliable timely access to specialist injury care services
PERCEIVED CARE QUALITY - People perceive that available facility care is poor quality	PRE-HOSPITAL CARE - There is a lack of timely available pre hospital emergency care (formal or informal/bystander)	PHYSICAL RESOURCES - There is a lack of reliably available necessary physical resources (e.g. infrastructure, equipment and consumable material)
DELAYED DISCOVERY - There are delays in discovering injured people, including because of intoxication	DISTANCE - There is a large physical distance from place of injury to an appropriate healthcare facility	PATIENT COOPERATION - There is a lack of patient and family cooperation with care processes
TRADITIONAL HEALERS - People prefer traditional healers	COORDINATION - There is a lack of emergency care service coordination, including bypassing unsuitable facilities or transferring between facilities	QUALITY PROCESSES - There is a lack of good quality, consistent, structured, clinical priority driven injury care processes
HEALTHCARE LITERACY - People don't understand about health and available healthcare	ROADS - There is a lack of reliable uncongested roads with priority for emergency vehicles	PAYMENT - Difficulties with timely payment for care
CULTURAL NORMS - Normal cultural behaviours delay seeking care such as gender roles, family responsibilities and requiring someone else's permission to seek care		CAPACITY - In regards to patient demand, there is insufficient facility capacity to meet patient demand (e.g. overcrowding)

Table 4 Round 2 and 3 Results in order of Round 3 average barrier score

Barrier Listed in order of position by score in round 3	Round 2			Round 3 ¹		
	Number of components achieving consensus agreement	Average barrier score	Position by score	Number of components achieving consensus agreement	Average barrier score	Position by score
DELAY 2 Communication There is a lack of accessible emergency assistance communication mechanism (e.g. emergency call centre)	4	5.23	1	4	5.52	1
DELAY 3 Staff In regards to staffing, there is a lack of reliably available, suitably trained and motivated clinical staff	4	5.13	2	4	5.04	2
DELAY 2 Transport There is a lack of timely affordable emergency transport (formal or informal)	4	4.73	5	4	4.93	3
DELAY 2 Distance There is a large physical distance from place of injury to an appropriate healthcare facility	3	4.23	7=	4	4.89	4
DELAY 3 Physical Resources There is a lack of reliably available necessary physical resources (e.g. infrastructure, equipment and consumable material)	4	4.83	3	4	4.78	5
DELAY 2 Coordination There is a lack of emergency care service coordination, including bypassing unsuitable facilities or transferring between facilities	4	4.8	4	4	4.74	6
DELAY 3 Specialists There is a lack of reliable timely access to specialist injury care services	3	4.5	6	4	4.70	7
DELAY 2 Pre-Hospital Care There is a lack of timely available pre hospital emergency care (formal or informal/bystander)	4	4.23	7=	4	4.48	8
DELAY 1 Costs The financial costs associated with seeking care are too great	2	2.7	15	4	4.22	9
DELAY 3 Quality Processes There is a lack of good quality, consistent, structured, clinical priority driven injury care processes	4	4.13	9	4	3.59	10=
DELAY 3 Capacity In regards to patient demand, there is insufficient facility capacity to meet patient demand (e.g. overcrowding)	3	3.7	10	3	3.59	10=
DELAY 2 Roads There is a lack of reliable uncongested roads with priority for emergency vehicles	1	2.73	14	3	3.44	12

DELAY 1 Perceived Care Quality People perceive that available facility care is poor quality	3	2.93	13	4	3.41	13
DELAY 1 Perceived Physical Access People perceive that care is too difficult to physically access	2	2.63	16	3	2.93	14
DELAY 3 Payment Difficulties with timely payment for care	0	3	11	1	2.52	15
DELAY 1 Healthcare literacy People don't understand about health and available healthcare	1	2.43	17	0	2.41	16=
DELAY 1 Delayed Discovery There are delays in discovering injured people, including because of intoxication	1	1.7	18	2	2.41	16=
DELAY 1 Traditional Healers People prefer traditional healers	0	2.97	12	1	2.26	18
DELAY 1 Cultural Norms Normal cultural behaviours delay seeking care such as gender roles, family responsibilities and requiring someone else's permission to seek care	0	1.27	19	0	1.81	19
DELAY 3 Patient Cooperation There is a lack of patient and family cooperation with care processes	0	0.73	20	0	1.37	20
¹ One participant partially completed round 3, providing responses for barriers in delays 1 and 2 only. As this participant did not provide responses for the 7 barriers within delay 3 they were assigned a score of Neither Agree Nor Disagree and a mark of 0 for ease of comparison.						

Table 5 Components not achieving consensus agreement, per barrier

Barrier	Components that did not reach consensus	Selected Free Text Explanation
DELAY 3 Capacity In regards to patient demand, there is insufficient facility capacity to meet patient demand (e.g. overcrowding)	Not modifiable	<i>Pressure on physicians is a big problem, 5,000 patients apply per day. (But).... 4900 patients are not urgent in my hospital.</i>
DELAY 2 Roads There is a lack of reliable uncongested roads with priority for emergency vehicles	Not modifiable	<i>Major structural reforms are needed....not readily made in developing world</i>
DELAY 1 Perceived Physical Access People perceive that care is too difficult to physically access	Not modifiable	<i>It is difficult to get cooperation from the very people who do not get involved with mainstream media, and in those people the issue in question is most pressing.</i> <i>it is not only the transport but also the fact on itself of moving and getting around in an unusual environment with other people and customs</i>
DELAY 3 Payment Difficulties with timely payment for care	Neither large scale, high impact nor modifiable	<u>No comments</u>
DELAY 1 Healthcare literacy People don't understand about health and available healthcare	All	<i>Health education is a very large task</i>
DELAY 1 Delayed Discovery There are delays in discovering injured people, including because of intoxication	Neither feasible to assess, nor modifiable	<i>Very complex item including sociocultural factors</i>
DELAY 1 Traditional Healers People prefer traditional healers	Neither large scale, high impact nor modifiable	<i>Traditional beliefs are difficult to address. However, from my experience, I do not think a large proportion of the population would seek traditional healing in the setting of trauma.</i> <i>they tell stories of treatment of old trends and heart by heart, They are cheap, excess to them is easy.</i>
DELAY 1 Cultural Norms Normal cultural behaviours delay seeking care such as gender roles, family responsibilities and requiring someone else's permission to seek care	All	<i>This is again directed at the vary fabric of each society, and difficult to address.</i> <i>is more a background phenomenon which should be respected</i>
DELAY 3 Patient Cooperation There is a lack of patient and family cooperation with care processes	All	<u>No comments</u>

Figure Legends

Fig. 1 Demonstrating how the primary and secondary outcomes were derived

Fig. 2 Flow chart of progress of participants through the Delphi study

EXAMPLE BARRIER QUESTION

INSERT BARRIER has been proposed as a barrier to SEEKING care that is important to assess.

Please indicate to what extent you agree or disagree with each of the following statements.

INSERT BARRIER is likely to be relatively easy to assess (feasible)

PARTICIPANT RESPONSE

Strongly Agree, Agree, Neither Agree Nor Disagree, Disagree, Strongly Disagree

PRIMARY OUTCOME

Did 70% or more participants Agree / Strongly Agree? Or Disagree / Strongly Disagree?

Yes = Consensus achieved for feasibility

No = Consensus not achieved for feasibility

How many components (Feasibility, Large Scale, High Impact, Modifiable) achieved consensus agreement = 0 - 4

SECONDARY OUTCOME

A score per component per person is calculated (Strongly Agree = 2, Agree = 1, Neither Agree Nor Disagree = 0, Disagree = -1, Strongly Disagree = -2)

$\sum^{(1-n)} F_i$ is the sum of the feasibility scores for the n participants.

L_i is the large scale score for person i

H_i is the high impact score for person i

M_i is the modifiable score for person i

$$\text{Average barrier score} = \frac{\sum^{(1-n)} (F_i + L_i + H_i + M_i)}{n}$$

49 invited to Round 1 survey
Participants proposed barriers important to assess within each of the conceptual three delays to care

37 completed round 1
2 authors synthesised the free text answers into distinct conceptual barriers.
Round 2 survey assessing agreement of 4 components of importance for each barrier

30 completed round 2
Round 2 results summarised and presented with round 3 survey for participant reflection.
Round 3 survey re-assessing agreement of 4 components of importance for each barrier

27 completed round 3
Results analysed for consensus of agreement or disagreement per component of importance. Average score per barrier calculated.

10 did not reply, 2 were not eligible

7 did not complete round 2

3 did not complete round 3