



A checklist for trauma quality improvement meetings: A process improvement study

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ARTICLE INFO

Article history:

Accepted 6 April 2019

Keywords:

Wound and injuries
Quality
India

ABSTRACT

Background: Each year approximately five million people die from injuries. In countries where systems of trauma care have been introduced, death and disability have decreased. A major component of developed trauma systems is a trauma quality improvement (TQI) program and trauma quality improvement meeting (TQIM). Effective TQIMs improve trauma care by identifying and fixing problems. But globally, TQIMs are absent or unstructured in most hospitals providing trauma care. The aim of this study was to implement and evaluate a checklist for a structured TQIM.

Methods: This project was conducted as a prospective before-and-after study in four major trauma centres in India. The intervention was the introduction of a structured TQIM using a checklist, introduced with a workshop. This workshop was based on the World Health Organization (WHO) TQI Programs short course and resources, plus the developed TQIM checklist. Pre- and post-intervention data collection occurred at all meetings in which cases of trauma death were discussed. The primary outcome was TQIM Checklist compliance, defined by the discussion of, and agreement upon each of the following: preventability of death, identification of opportunities to improve care and corrective actions and a plan for closing the loop.

Results: There were 34 meetings in each phase, with 99 cases brought to the pre-intervention phase and 125 cases brought to the post-intervention phase. There was an increase in the proportion of cases brought to the meeting for which preventability of death was discussed (from 94% to 100%, $p=0.007$) and agreed (from 7 to 19%, OR 3.7; 95% CI:1.4–9.4, $p=0.004$) and for which a plan for closing the loop was discussed (from 2% to 18%, OR 10.9; 95% CI:2.5–47.6, $p<0.001$) and agreed (from 2% to 18%, OR 10.9; 95% CI:2.5–47.6, $p<0.001$).

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Conclusion: This study developed, implemented and evaluated a TQIM Checklist for improving TQIM processes. The introduction of a TQIM Checklist, with training, into four Indian trauma centres, led to more structured TQIMs, including increased discussion and agreement on preventability of death and plans for loop closure. A TQIM Checklist should be considered for all centres managing trauma patients.

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Background

Each year approximately five million people die from injury. Injury accounts for 9% of all deaths - more than human immunodeficiency virus (HIV) related illnesses, malaria and tuberculosis combined [1]. In countries where systems of trauma care have been introduced, deaths have decreased and functional outcomes have improved [2–4].

A major component of developed trauma systems is a trauma quality improvement (TQI) program [5]. TQI programs are generally implemented through the conduct of dedicated hospital-based meetings which can be broadly described as trauma quality improvement meetings (TQIMs). Types of TQIMs include morbidity and mortality (M&M) conferences and panel reviews examining preventability among deaths [5]. Ideally, these meetings are informed by data, the tracking of audit filters (including complications and sentinel events), and measures of injury severity. TQI programs, through effective TQIMs, offer an affordable and sustainable means to monitor trauma care services, detect problems in care, and effectively enact and evaluate measures identified to improve care and reduce death from injury [5].

In a systematic review of 36 studies of the impact of TQI programs, 34 reported reductions in mortality and improvements in other patient outcomes or processes of care [6]. These outcomes can be realised rapidly. There are several examples of mortality reduction following the introduction of TQI programs [7–9]. One example originates from Thailand, where regular M&M meetings and preventable death reviews (a common form of TQIM) were associated with a one-third reduction in the preventable death rate within two years [10,11].

Despite the importance of TQIMs, they are absent or infrequent in most hospitals providing trauma care [12,13]. Furthermore, where TQIMs do occur, the procedures followed are variable and often ad hoc or informal. An audit of TQI activities at all 26 trauma centres in Australia found considerable variations in practice and a desire for improvement and standardisation [14]. Similarly, a study among clinical and policy leaders in the Asia-Pacific region identified variable implementation of TQI activities, with the main gaps and barriers being limited injury data, lack of training in TQI methods, heavy clinical workloads, and organisational cultures focused on medico-legal concerns [15]. Variable and incomplete use of a system-wide approach in TQIMs in advanced trauma systems have also been demonstrated, with calls for the development of a practical tool to standardize and integrate TQIMs across trauma systems.

The World Health Organization (WHO) and the International Association for Trauma Surgery and Intensive Care (IATSI) have developed guidelines and training resources for TQI programs, including TQIMs [5]. Although it has been hypothesised that the value of TQIMs can be augmented by improvements to their structure, including the general conduct of the meetings and the procedures used to review specific cases, this has not been formally evaluated. Furthermore, notwithstanding the existence of TQI guidelines, there is a scarcity, in the medical literature, of published tools serving as procedural checklists for TQIMs. Indeed, published tools for measuring and monitoring TQIMs are virtually non-existent. To address this gap in evidence, a structured TQIM (using a TQIM Checklist) was developed, introduced and evaluated (using a TQIM evaluation tool) in trauma hospitals in India, as part

of a broader initiative, the Australia-India Trauma Systems Collaboration (AITSC).

Commencing in 2013, the Australia-India Trauma Systems Collaboration (AITSC) was created to facilitate trauma system development in India, and improved trauma care in Australia [16]. It studied four separate simple interventions in: prehospital notification, improved trauma reception and resuscitation, trauma quality improvement, and post trauma rehabilitation.

Aims

The aim of this study was to develop, implement and evaluate a checklist for a structured TQIM in India.

Methods

Design

This project was conducted as a prospective before-and-after study, with the intervention occurring between pre- and post-intervention phases.

Setting

The project was conducted in four major trauma centres in India: The Jai Prakash Narayan Apex Trauma Center, All India Institute of Medical Sciences (AIIMS), New Delhi admits approximately 4000 severely injured (with an Injury Severity Score greater than 12) patients per year. Guru Tegh Bahadur (GTB) Hospital is a 1500-bed hospital situated in the National Capital Region of Delhi, India, with a trauma census of approximately 1500 patients per year with limb or life-threatening injuries. The Lokmanya Tilak Municipal General (LTMG) Hospital is a level 1 trauma centre, which caters to the megapolis of Mumbai and receives about 2500 patients with limb or life-threatening injuries per year. The Sheth Vadilal Sarabhai General (VS) Hospital caters to areas in and around Ahmedabad with an average annual admission secondary to limb or life-threatening injuries of about 1200 per year.

Population

The study population included all new cases of in-hospital death following trauma which were discussed at a TQIM at any of the four study sites in India. A TQIM was defined as any meeting at one of the four study sites where cases of death following trauma were brought and discussed. TQIMs (and cases) were excluded from the analysis if they were not caused by injury or did not result in death.

Intervention

The intervention was the introduction of a structured TQIM to the four sites. This required a period (the intervention phase) during which the TQIM checklist was introduced and linked with an intensive training period of key hospital stakeholders. The content of the formal training included the conduct of a structured TQIM (and TQI program in general). The training was delivered using the World Health Organization (WHO) Trauma Quality Improvement Programs short course and online resources [5]. The TQIM Checklist was also incorporated into the training program. This TQIM

Checklist was available in both paper (see Supplementary File 1) and a hand-held device-based application. It was determined that the period of intervention would be 3 months to include delivery of the TQIM and TQIM Checklist course across the study sites, followed by refinement of the TQIM Checklist for both paper and technological applications.

Study phases

The phases of the study are outlined in [Table 1](#).

Outcomes measured

The primary outcome was TQIM Checklist compliance. The purpose of a TQIM is to discuss and identify opportunities to improve care, including preventability of death, and thereby determine corrective actions and make a plan to close the loop. To facilitate this goal, cases might be pre-selected for a discussion at a TQIM on the basis that they might inform improvements in care. The number of cases considered at a TQIM (the denominator) may therefore not include *all* trauma deaths. A positive primary outcome was pre-determined to be TQIM Checklist compliance, defined by the discussion of, and agreement upon the following: preventability of death, identification of opportunities to improve care and corrective actions, and a plan for closing the loop.

Data collection

Pre- and post-intervention data collection occurred at all meetings at the four trauma hospitals at which trauma deaths were discussed. The details (department, location and timing) of the meetings already being conducted were determined by site visits

Table 1
Study phases.

Phase	Activities
Pre-intervention	Data collection (Meeting level) – TQIMs Intervention development <ul style="list-style-type: none"> • Survey and interview of trauma care stakeholders at study sites <ul style="list-style-type: none"> ◦ Current TQI activities, including features of TQIMs • Synthesis of key components of a structured TQIM into a draft checklist <ul style="list-style-type: none"> ◦ Primary resource: WHO “Guidelines for trauma quality improvement programmes” • Pilot of TQIM Checklist in setting independent of study sites • Development of TQIM Checklist App version: TraumaMeet
Intervention	Data collection (Meeting level) – TQIMs Intervention implementation <ul style="list-style-type: none"> • Focus group meetings with trauma care stakeholders at study sites <ul style="list-style-type: none"> ◦ Review of TQIM Checklist (paper and App), TQIM procedures and governance • Pilot of TQIM Checklist (paper and App) at study sites • Intense training period (intervention phase) covering: <ul style="list-style-type: none"> ◦ Conduct of TQIM (using WHO TQI programs course) ◦ Utilisation of TQIM Checklist • Review (focus group) and finalization of TQIM Checklist (paper and App)
Post-intervention	Data collection (Meeting level) – TQIMs Intervention maintenance <ul style="list-style-type: none"> • Utilisation of TQIM Checklist (paper and / or App) at study site TQIMs

and survey. Trained research officers, independent of members of the forum discussing trauma deaths used bespoke data collection forms (Supplementary Files 2 and 3) to measure compliance with the recommended conduct of a TQIM, as per the WHO “Guidelines for trauma quality improvement programmes” and the TQIM Checklist [5].

Analyses

Continuous data have been summarised using the mean with standard deviation if normally or near-normally distributed or with the median and inter-quartile range if skewed. Ordinal data have been summarised using the median and inter-quartile range. Categorical data have been presented as frequencies with proportions. Statistical significance was pre-defined as $p < 0.05$. A difference between means was tested for statistical significance using the Student's t-test while the Wilcoxon Rank Sum test was used for determining statistical significance for a difference between medians. The chi-square test or Fisher's exact test was used for proportions according to cell frequencies. All analyses were performed using Stata v15.1 (Statacorp, College Station, Texas, USA).

Sample size

Regarding the primary outcome, it was hypothesised that the proportion of cases for which preventability or a problem in care was agreed at the TQIM would actually *increase* (as a positive outcome). For a power of 0.80 and alpha of 0.05, to demonstrate a doubling in the proportion of trauma deaths brought to a TQIM for which preventability and/or a problem in care was agreed increased from 20% to 40%, 82 trauma death cases were required in each of the pre- and post-intervention periods. On the basis that each of the study sites would consider at least four cases per month, on average, in its TQIMs, it was determined that the two phases would be of 6 months duration each, with a 3 month intervention phase.

Ethics

Ethical approval was obtained from the All India Institute of Medical Sciences (AIIMS), New Delhi, India (IEC/NP-327/2013), and site-specific approval was acquired from the relevant trauma services. The AITSC project has also been approved by the Human Research Ethics Committee of Monash University (CF16/1814-2016000929). Study results have been disseminated among hospital clinicians across participating sites.

Registration

This before-after study with pre- and post-intervention phases was registered with ClinicalTrials.gov (Identifier NCT03005509). Its unique protocol ID was GCF020013-TQI.

Results

There were 34 meetings in both the pre- and post-intervention phases, with 99 cases brought to the pre-intervention phase and 125 cases brought to the post-intervention phase. The TQIM details are provided in [Table 2](#). The mean duration of the meetings increased (19 minutes, 95% CI 0 to 39, $p = 0.049$), but there was no statistically significant change in staff attendance or the number of cases considered per meeting.

The results of the analysis of the primary outcome, TQIM Checklist compliance, are provided in [Table 3](#). There was an increase in the proportion of cases brought to the meeting for which preventability of death was discussed (from 94% to 100%,

Table 2
TQIM Meetings.

Meeting characteristics	Pre-Phase – 6 months (1 January to 30 June 2017) n = 34 TQIMs Mean (SD) or Number (%)	Post-Phase – 6 months (1 October 2017 to 31 March 2018) n = 34 TQIMs Mean (SD) or Number (%)	Difference in Means or Odds Ratio (95% confidence interval)	p-value
Number of cases	2.9 (2.2)	3.7 (1.0)	0.8 (–0.2 to 1.7)	0.12
Duration (minutes)	87 (34)	106 (44)	19 (0 to 39)	0.049
Staff – Total number	26 (9)	22 (10)	–4 (–9 to 1)	0.15
Craft group representation (at least one) (number of TQIMs)				
Surgery	29 (85%)	34 (100%)	Undefined/infinity	0.05
Emergency	3 (9%)	7 (21%)	2.7 (0.6 to 11.4)	0.31 ^a
Anaesthesia	0 (0%)	7 (21%)	Undefined/infinity	0.01 ^a
Intensive Care	24 (71%)	10 (29%)	0.2 (0.1 to 0.5)	0.001
Radiology	2 (6%)	2 (6%)	1.0 (0.1 to 7.5)	1.00 ^a
Pathology	0 (0%)	0 (0%)	Indeterminate	–
Nursing	24 (71%)	23 (68%)	0.9 (0.3 to 2.4)	0.79
Administration – Hospital	15 (44%)	4 (12%)	0.2 (0.0 to 0.6)	0.01 ^a
Administration – Department	29 (85%)	24 (71%)	0.4 (0.1 to 1.4)	0.24 ^a
Other	0 (0%)	6 (18%)	Undefined/infinity	0.03 ^a

^a Using Fisher's Exact test.

$p=0.007$) and agreed (from 7 to 19%, OR 3.7; 95% CI:1.4 to 9.4, $p=0.004$) and for which a plan for closing the loop was discussed (from 2% to 18%, OR 10.9; 95% CI:2.5 to 47.6, $p < 0.001$) and agreed (from 2% to 18%, OR 10.9; 95% CI:2.5 to 47.6, $p < 0.001$).

There was no statistically significant change in the proportion of cases for which an opportunity to improve care was agreed (from 18% to 22%, OR 1.3; 95% CI:0.7 to 2.6, $p=0.41$), and at least one corrective action was agreed (from 15% to 18%, OR 1.2; 95% CI: 0.2 to 6.3, $p=1.00$).

Table 4 compares the pre- and post-intervention phases of additional case details brought to the TQIM, including case documentation, autopsy report and Injury Severity Score (ISS). There was no statistically significant change in the proportion of TQIMs for which there was case documentation, or a report of the autopsy or ISS, between pre- and post-intervention phases.

Discussion

The introduction of a TQIM Checklist to TQIMs at four trauma centres in India was associated with an improvement in the pro-

cesses effective for improving trauma care and reducing trauma deaths. In particular, following the checklist and workshop intervention, there was a greater proportion of trauma cases brought to the TQIMs for which preventability of death was discussed and agreed, and for which a plan for closing the loop was discussed and agreed.

In most settings across the world, meetings where trauma deaths are discussed are not designed or structured to focus upon preventability, determine opportunities to improve care through targeted corrective actions and check that these actions have been effective (closing the loop). This was the first study to systematically assess the impact of structured TQIMs. A novel TQIM Checklist based on the WHO Guidelines for Trauma Quality Improvement Programs was developed for both paper and technological applications; data collection forms were designed to capture meeting- and case-based data.

Previous work has demonstrated the impact of TQI programs for improving the care and outcomes following major trauma; but the vast majority of previous research has been conducted in high-income settings [7–11]. This study was undertaken in the country with the greatest burden of trauma in the world, but with a

Table 3
TQIM Cases – Checklist compliance.

Procedures by Case	Pre-Phase – 6 months (1 January 2017 to 30 June 2017) n = 99	Post-Phase – 6 months (1 October 2017 to 31 March 2018) n = 125	Odds Ratio (95% confidence interval)	p-value
Preventability – Discussed	93 (94%)	125 (100%)	Undefined/infinity	0.007 ^d
Care could be improved (overall) – Agreed	17 (18%)	27 (22%)	1.3 (0.7 to 2.6)	0.41
Care could be improved and death preventable – Agreed	6 (7%)	24 (19%)	3.7 (1.4 to 9.4) ^a	0.004 ^a
			14.7 (3.1 to 69.7) ^b	0.001 ^{b,d}
Corrective action – Discussed	17 (17%)	26 (21%)	1.3 (0.6 to 2.5) ^a	0.49 ^a
			Undefined/infinity ^b	1.00 ^{b,d}
Corrective action – Agreed	15 (15%)	23 (18%)	1.3 (0.6 to 2.6) ^a	0.52 ^a
			1.2 (0.2 to 6.3) ^b	1.00 ^{b,d}
Loop closure – Discussed	2 (2%)	23 (18%)	10.9 (2.5 to 47.6) ^a	<0.001 ^{a,d}
			43.1 (7.0 to 265.6) ^b	<0.001 ^{b,d}
			Undefined/infinity ^c	<0.001 ^{c,d}
Loop closure – Agreed	2 (2%)	23 (18%)	10.9 (2.5 to 47.6) ^a	<0.001 ^{a,d}
			43.1 (7.0 to 265.6) ^b	<0.001 ^{b,d}
			Undefined/infinity ^c	<0.001 ^{c,d}

^a All cases.

^b Amongst cases where agreed that care could have been improved.

^c Amongst cases where corrective action agreed.

^d Using Fisher's Exact test.

Table 4
TQJM – Cases.

Procedures by Case	Pre-Phase – 6 months (1 January 2017 to 30 June 2017) n = 99	Post-Phase – 6 months (1 October 2017 to 31 March 2018) n = 125	Odds Ratio (95% confidence interval)	p-value
Documentation of case details (Powerpoint slides or Minutes)	91 (91.9%)	121 (96.8%)	2.3 (0.7 to 8.2)	0.22 ^a
Autopsy result reported	2 (2.0%)	9 (7.2%)	3.8 (0.8 to 17.8)	0.12 ^a
ISS reported	30 (30.3%)	49 (39.2%)	1.4 (0.8 to 2.5)	0.21

^a Using Fisher's Exact test.

relatively overwhelmed system to manage that enormous and growing burden.

The WHO, in its efforts to bring cost-effective and context-relevant resources to resource-limited settings, published its guidelines for TQI programs almost a decade ago [5]. This manual, and the corresponding course materials, introduced the key feasible ingredients of an effective TQI program and TQIM, including, for example, a menu of potential corrective actions such as clinical skills training and clinical guidelines. However, it did not synthesize these lessons into a single simplified tool or checklist. This study has augmented the value of the guidelines and workshop by developing, implementing and evaluating such a practical resource.

There were some potential limitations to this study. The control and intervention groups were occurring at different time periods (pre- and post-intervention phases). Consequently, it is likely, and mostly unavoidable, that the study results have been confounded by other time-dependent variables, including other interventions being studied as part of the Australia-India Trauma Systems Collaboration. Furthermore, this study evaluated the impact of the intervention upon TQIM processes across the four sites; further analyses are planned to determine how the effect of the TQIM Checklist differed between sites.

The baseline proportion of cases considered at a meeting for which the preventability of death was discussed (at 94%) was relatively high compared to the baseline for the remaining main outcome components (at between 2% and 18%), limiting the potential for a meaningful increase (i.e. 100% was the maximum which could be achieved post-intervention). This disparity between baseline processes demonstrated that, for the majority of cases considered at a meeting, the study sites were already at least discussing preventability, prior to the intervention. However, the process of reaching a consensus regarding preventability, and then to go further and discuss and agree on corrective actions and plans for closing the loop, was not well established prior to the intervention.

The success of introducing (and measuring) a structured approach to the conduct of TQIMs, such that the identification of opportunities to improve care and preventable deaths is considered a progressive and positive development, will likely be the result of more than one intervention. That is, the observed changes in TQIM processes, including the pre-TQIM selection of cases with the potential for informing improvements in care, would be expected to be dependent upon a multitude of system-level factors external to a simple TQIM checklist, including the passage of time, changes in governance and hospital culture and shifts in priorities. It is clear that separate studies will be required to determine, qualitatively, the facilitators and barriers to TQIM process development in each study site and, quantitatively, whether an improvement in TQIM processes is associated with better outcomes for trauma patients.

Furthermore, the WHO guidelines for TQI programs offers approaches, menus and tables for how to: classify opportunities to improve care; select and implement corrective actions; and undertake monitoring to confirm loop closure. To complement these

guidelines, it would be of considerable value to study the actual experience of sites in the implementation of activities (corrective actions with monitoring of loop closure) generated from decisions made at TQIMs.

Conclusion

The burden of injury is large and growing in India and across Asia. The effectiveness of TQI programs in reducing mortality and improving trauma care is well established. This study has evaluated, using novel TQIM Data Collection forms, the development and implementation of a TQIM Checklist; it has then demonstrated the effectiveness of the TQIM Checklist and TQIM Workshop in the improvement of TQIM processes. A TQIM Checklist, the implementation of which requires few resources, should be considered for all centres managing trauma patients.

Acknowledgments

This project was part of the Australia-India Trauma Systems Collaboration (AITSC), funded by the Indian (Department of Science and Technology) and Australian (Department of Industry, Innovation and Science) governments through the Australia India Strategic Research Fund Grand Challenge scheme.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.injury.2019.04.003>.

References

- [1] Naghavi M, Wang H, Lozano R, Davis A, Liang X, Zhou M, et al. Global, regional, and national age–sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the global burden of disease. *Lancet* 2015;385:117–71.
- [2] Atkin C, Freedman I, Rosenfeld JV, Fitzgerald M, Kossmann T. The evolution of an integrated state trauma systems in Victoria, Australia. *Injury* 2005;36:1277–87.
- [3] Cameron PA, Gabbe B, Cooper DJ, Walker T, Judson R, McNeil J. A statewide system of trauma care in Victoria: effect on patient survival. *Med J Aust* 2008;189:546–50.
- [4] Gabbe BJ, Simpson PM, Sutherland AM, Wolfe R, Fitzgerald MC, Judson R, et al. Improved functional outcomes for major trauma patients in a regionalized, inclusive trauma system. *Ann Surg* 2012;255(6):1009–15.
- [5] Mock C, Juillard C, Brundage S, et al. Guidelines for trauma quality improvement programmes. Geneva: World Health Organization; 2009.
- [6] Juillard C, Mock C, Goosen J, Josphipura M, Civil I. Establishing the evidence base for trauma quality improvement: a collaborative WHO-IATSC review. *World J Surg* 2009;33(5):1075–86.
- [7] Di Russo S, Holly C, Kamath R, Cuff S, Sullivan T, Scharf H, et al. Preparation and achievement of American College of Surgeons level I trauma verification raises hospital performance and improves patient outcome. *J Trauma* 2001;51(2):294–300.
- [8] Ruchholtz S, Waydhas C, Aufmkolk M, Tager G, Piepenbrück K, Stolke D, et al. [Interdisciplinary quality management in the treatment of severely injured patients. Validation of a QM system for the diagnostic and therapeutic process in early clinical management]. *Unfallchirurg* 2001;104(10):927–37.

- [9] Yates DW, Bancewicz J, Woodford M, Driscoll PA, Jones RAC, Kishen R, et al. Trauma audit – closing the loop. *Injury* 1994;25(8):511–14.
- [10] Chadbunchachai W, Sriwiwat S, Kulleab S, Saranrittichai S, Chumsri J, Jaikwang P. The comparative study for quality of trauma treatment before and after the revision of trauma audit filter, Khon Kaen hospital 1998. *J Med Assoc Thai* 2001;84(6):782–90.
- [11] Chadbunchachai W, Saranrittichai S, Sriwiwat S, Chumsri J, Kulleab S, Jaikwang P. Study on performance following key performance indicators for trauma care: Khon Kaen hospital 2000. *J Med Assoc Thai* 2003;86(1):1–7.
- [12] Mock C, Lormand JD, Goosen J, et al. Guidelines for essential trauma care. Geneva: World Health Organization; 2014.
- [13] Bear H, Mok MT, Farrow N, Curtis K, Mitra B, Fitzgerald M, et al. Morbidity and mortality meetings at Australian major trauma centres: a proof of concept study. *Trauma* 2018;20(4):268–72.
- [14] Caring for the severely injured in Australia: inaugural report of the Australian Trauma Registry 2010 to 2012. Alfred Health; 2014. Accessed 17 January 2019 at <http://journals.sagepub.com/eprint/n26mrkyi4yUKMtRFSYYb/full>.
- [15] Stelfox HT, Joshipura M, Chadbunchachai W, Ellawala R, O'Reilly G, Nguyen TS, et al. Trauma quality improvement in low and middle income countries of the Asia-pacific region: a mixed methods study. *World J Surg* 2012;36:1978–92.
- [16] Mitra B, Mathew J, Gupta A, Cameron P, O'Reilly G, Soni KD, et al. Protocol for a prospective observational study to improve prehospital notification of injured patients presenting to trauma centres in India. *BMJ Open* 2017;7(7).