ORIGINAL ARTICLE

A procedure based alternative to the injury severity score for major incident triage of children: results of a Delphi consensus process

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Background: Triage at the site of a major incident is key to effective scene management. A number of triage algorithms have been suggested to assist the triage officer to determine triage priorities. However, many advocated scores were not specifically developed for use in major incidents, nor are they designed for multiple age groups.

Many of these algorithms have not been validated: those that have were validated against the Injury Severity Score, which is of little relevance in a major incident—it is the urgency of medical intervention that is of importance in this setting.

Objectives: To develop a set of criteria against which major incident triage algorithms can be tested.

Methods: Sixteen experts from the UK and South Africa took part in a three round Delphi consensus method in order to develop clinical criteria against which major incident triage algorithms may be tested.

Results: Thirty nine statements were initially identified as possible determinants of triage priority: 29 statements reached consensus. These associate specific clinical interventions with triage priority.

Conclusion: Delphi may be used to identify which clinical criteria define triage priority in a major incident setting. These criteria and the associated triage categories may be used as for the validation of specific major incident triage algorithms. This method may be used to develop specific criteria for other triage algorithms.

For the health services, a major incident may be defined as ''an event that owing to the number, severity, type or location of live casualties requires special arrangements by the health services''.[1] Triage is an essential component of successful major incident management. It occurs in two phases: primary triage, at the scene, is a rapid ''once over'' to quickly identify those patients in need of immediate intervention and those who can wait for longer; secondary triage occurs at the location of the main treatment centre, where time and resources allow for a more in depth triage process.

Triage is designed to differentiate patients in terms of how unwell they are and how urgently they may require care. The potential for over triage of injured patients may put unnecessary pressure on limited medical resources. Similarly, under triage (where patients with serious injury are missed) must also be avoided for obvious reasons. Although it is ideal for a triage algorithm to act as a perfect discriminator, realistically this is not possible.

It is also important to clearly understand the purpose of a major incident triage algorithm, which is to only discriminate patients into categories that relate to the urgency of clinical intervention. The severity of injury sustained, or the specific injury patterns, are of secondary importance at the scene of a major incident.

Previous studies on triage scores have used final anatomical injury, physiological derangement, or both, to determine their accuracy and validity.[2–8] Inevitably this is a circular argument as all scores use anatomical and/or physiological data in their calculation. The use of the Injury Severity Score (ISS)[8] as the main tool against which most of these studies have been performed is also flawed: ISS bears little relation to the urgency of requirement for medical intervention at the scene of a major incident.

None of the major incident primary triage tools currently available have been formally validated, for ethical and practical reasons.

AIM

We sought to develop a set of criteria that form a procedure based outcome tool that may be used in place of the ISS in the major incident setting: this tool may then be used for the future testing of major incident triage algorithms (specifically, for this study, the Paediatric Triage Tape[9]).

We have described the derivation of these criteria in order that they are available to other researchers in the field.

METHOD

A three round Delphi study was used to determine clinical conditions and interventions that could be used as alternative outcome markers for studies of major incidents.

The initial Delphi process consisted of the authors identifying experts in major incident triage. The experts were selected to include specialists in major incident management and planning, or emergency care. Twenty were approached to take part in a three round Delphi study: 16 agreed.

Participants were selected from the work locations of the authors: the UK and South Africa. They were chosen for recognised expertise in the field of major incidents, and represented the Ambulance Service, Immediate Care, Emergency Medicine, Paediatric Emergency Medicine, General Paediatrics, Emergency Medical Services, Paediatric Trauma, Paediatric Surgery, and Paediatric Intensive Care.

Abbreviations: CNS, central nervous system; CT, computed tomogram; ISS, Injury Severity Score

A single author (LAW) undertook the Delphi process and collected and analysed all data on a Microsoft Excel® spreadsheet.

The Delphi process

Round 1

Delphi group members were asked to identify clinical interventions that may occur to patients injured in a major incident. These interventions were collated and summarised into a single document for presentation at round two.

Round 2

Thirty nine interventions were identified in round one (table 1). These were sent to all group members who were then asked to determine the appropriate triage category for that patient—for example, what category should a triage score classify a patient who requires a needle cricothyroidotomy OR needs a laparotomy within an hour. The accompanying text can be found in the appendix.

Group members were required to indicate whether they would triage each item as Priority T1 (immediate), T2 (urgent), T3 (delayed), or dead. The expectant category was not considered in this Delphi. Items reaching consensus (80% group agreement) were not reiterated in round three.

Table 1 Group derived list of clinical interventions

	Intervention
1	Blood within 30 minutes of arrival at ED
2	Cardiac arrest protocol (pulse present on first triage)
3	Chest drain insertion
4	Cricothyroidotomy
5	CT abdomen/chest within 1 hour of arrival
6	CT head within 1 hour of arrival
7	Direct pressure to control severe haemorrhage
8	DPL or FAST ultrasound in ED
9	Escharotomy in ED
10	External pelvic fixation within 1 hour
11	Fluid resuscitation in excess of 20 ml/kg
12	Intravenous analgesia in ED
13	Intubation and ventilation (unless non-emergent—for example, CT)
14	Laryngeal mask airway (unless non-emergent)
15	Long bone splint application (femur)
16	Long bone splint application (lower leg)
17	Nasopharyngeal airway insertion for airway protection
18	Needle cricothyrotomy
19	Needle thoracocentesis
20	Opiate analgesia (not intravenous)
21	Oropharyngeal airway insertion for airway protection
22	Pericardiocentesis
23	Plaster of paris application (forearm)
24	Plaster of paris application (long arm)
25	Plaster of paris application (long leg PoP)
26	Simple dressing application
27	Sling application
28	Sutures
29	Tourniquet to control severe haemorrhage
30	Need a laparotomy within 1 hour
31	Need a laparotomy within 6 hours
32	Need a laparotomy within 1 day
33	Need a thoracotomy in ED
34	Need a thoracotomy within 1 hour
35	Need a thoracotomy within 6 hours
36	Need a thoracotomy within 1 day
37	Need theatre within 1 hour (other operation)
38	Need theatre within 6 hours (other operation)
39	Need theatre within 1 day (other operation)

CT, computed tomography; DPL, diagnostic peritoneal lavage; ED, emergency department; FAST, focused abdominal sonogram for trauma; PoP, plaster cast application.

Round 3

Those items that did not achieve consensus in round two were represented to all members of the group, together with a summary of the rest of the group's findings. Members were then able to change their assigned triage category after considering the opinions of the rest of the group.

Consensus was sought from group members: items reaching 80% group agreement were considered to have the consensus of the Delphi panel.

RESULTS

Twenty nine of the 39 items from round one achieved consensus (80% or higher) after round three. The consensus items are shown in table 2.

Of the remaining 10 items, three achieved agreements of two thirds or higher (T2—need a laparotomy within six hours, need a thoracotomy within six hours; T3—need a thoracotomy within one day). All other items had a wide spread of opinions.

DISCUSSION

Formal validation of any triage tool would ideally occur in the setting in which that tool is to be used. However, in the case of major incident tools this is not possible, for practical and

Table 2 Specific interventions by triage category

Triage category		
T1	**T2**	**T3**
Blood within 30 minutes of arrival at ED	DPL or FAST ultrasound in ED	PoP application (long leg)
Chest drain insertion	Intravenous analgesia in ED	PoP application (forearm)
Cricothyrotomy	Femoral splint application	PoP application (long arm)
Direct pressure to control severe haemorrhage		Simple dressing application
External pelvic fixation within 1 hour		Sling application
Fluid resuscitation in excess of 20 ml/kg		Sutures
Intubation and ventilation (unless non-emergent)		Need a laparotomy within 1 day
Laryngeal mask airway (unless non-emergent)		Need theatre within 1 day (other operation)
Nasopharyngeal airway insertion for airway protection		
Needle cricothyrotomy		
Needle thoracocentesis		
Oropharyngeal airway insertion for airway protection		
Pericardiocentesis		
Tourniquet to control severe haemorrhage		
Need a laparotomy within 1 hour		
Need a thoracotomy in ED		
Need a thoracotomy within 1 hour		
Need theatre within 1 hour (other operation)		

DPL, diagnostic peritoneal lavage; ED, emergency department; FAST, focused abdominal sonogram for trauma; PoP, plaster cast application.

ethical reasons. Expert opinion therefore has to be used: it is the basis for the ISS (although the directory upon which this is based was achieved by committee rather than a more scientifically sound arrangement), and has recently been used by both Baxt and Upenieks[10] and Garner *et al*[11] to test triage algorithms.

Current major incident triage methodologies, such as the triage sieve,[1] have been adapted from scores designed to triage individual patients (predominantly adults). Progress on major incident methods is hampered by the lack of a gold standard for what a major incident triage score must do. When determining the success of a triage score it is important to define what factors it is trying to discriminate. To truly determine the success of a major incident score it must be measured against what it is intended to achieve—that is, the need for clinical intervention not just injury or physiological derangement (although these will often coexist).

It is standard practice to validate these triage tools against the ISS: an ISS of 16 or higher is associated with approximately 10% mortality and has therefore been used as the cut off for defining serious injury. Triage tools are typically validated in the USA, where the ISS is used to identify those patients in need of trauma centre care.

Baxt and Upnekies[10] challenged the use of the ISS in validating triage tools on the basis that it is not only the severity of injury sustained that is important in determining whether a patient should be assigned a high medical priority. Clearly, if a patient has a reduced conscious level and, as a result, is unable to protect their airway adequately then they require immediate intervention: this will not be detected by ISS scoring. Similar arguments can be used for a number of outcomes and interventions that may occur.

Baxt considered the major operative and resuscitative interventions that patients often require following injury—the need for (non-orthopaedic) operative intervention, aggressive fluid replacement (more than 1000 ml), and invasive central nervous system (CNS) monitoring (or a positive head computed tomogram (CT)). They also studied those patients who died from their injuries. They found that the ISS did not correlate well with the requirement for these interventions: indeed, if an ISS of 15 or higher was considered as the marker of serious injury, the ISS under correlated 20% of the time. They observed that the ISS missed a significant number of seriously inured patients, who can be identified by the intervention that they require rather than the specific injury that they sustain. Their findings are strongly suggestive that ISS is not an appropriate means by which to validate pre-hospital triage algorithms, which aim to identify patients in need of urgent medical interventions.

This work was further developed by Garner *et al*[11] in 2001: they modified Baxt's original criteria to be more appropriate for a major incident setting. Garner compared three primary triage algorithms by their ability to predict five criteria:

- (Non-orthopaedic) operative intervention within 6 hours (Baxt used 48 hours, but in a major incident setting these patients can be in a less urgent category).
- Fluid resuscitation of 1000 ml or more.
- Invasive CNS monitoring or a positive head CT scan.
- A procedure to maintain the airway, or assisted ventilation.
- Decompression of a tension pneumothorax.

Garner *et al* used these criteria to identify critically injured patients who should be triaged as priority one (immediate) by the triage tool being tested. This thereby presents a means of determining a triage algorithm's ability to identify those patients in need of the most urgent medical intervention.

Both of these papers derived their criteria from expert opinion. Such a method is preferable to the use of the ISS as it allows for correct identification of casualties based upon medical need rather than on specific injury severities alone. This method can be applied in the validation of specific triage tools. The derivation of appropriate criteria to test against may be by committee, as is the case in the Abbreviated Injury Score (the system on which ISS scoring is based),[12] or by alternative means.

Principal findings

We aimed to develop the work of Garner *et al* by determining similar clinical criteria, but through the use of a Delphi process rather than the authors' own expert opinion. The 29 consensus criteria that we have derived are not intended to be used to triage patients in a real major incident, but rather provide an alternative means by which a triage algorithm can be validated, by testing its ability to identify patients in need of such clinical interventions.

Strengths and weaknesses of the study

We acknowledge that the criteria derived by this study are specific to the situation detailed in this article (although the general principal may be used in other situations to test other tools). This methodology may be used to derive further specific lists of criteria against which other current and future triage tools may be tested (both for paediatric and adult major incidents). The list of conditions in this Delphi is unlikely to be exclusive but may serve as a benchmark in future studies: such work is currently being undertaken by the authors. Specific intervention lists may be derived by future researchers in this area for other major incident triage tools.

The Delphi design was chosen for this study as the outcome—that is, the relative need for clinical intervention in major incidents—can only be determined by an expert group with knowledge of major incident management and clinical care. There are no more objective methods that could have been used. The strength of our approach is that we have combined opinion in a structured and anonymous way. However, the decisions made are determined entirely by the group members and these are potentially influenced by past experience or work in the field.

The experts used in this Delphi study were chosen to represent a wide range of specialities and experience in major incidents. However, it is accepted as a potential source of bias that the Delphi panel was restricted to experts in two countries only (the use of alternative experts in other locations may have produced different results). Furthermore, the experts involved were those identified as having the requisite experience by the authors: other experts may well have been available but were not contacted to partake in the study. The lack of nursing input into the study is also acknowledged: two nurses were approached to take part but declined.

The definition of consensus being achieved at 80% agreement was chosen arbitrarily before the study was undertaken. This level of agreement (13 of 16 participants) was felt to be sufficiently high to represent group agreement. However, it is accepted that higher (or indeed lower) levels of agreement could have been chosen. It is of note that only 32 statements achieved over 66% consensus; of the 29 achieving 80% agreement, six were in complete agreement and a further seven achieved 94% (15 of 16). We

believe that the use of 80% as a consensus agreement level is appropriate.

Strengths and weaknesses in relation to other studies

There are no directly comparable studies available. However, we have followed from the work of Baxt and Upnekies[10] and Garner *et al*[11] (as described above) in using expert opinion to determine appropriate criteria.

Meaning of the study

We have taken the approach of using an expert Delphi panel to determine specific criteria that a major incident triage algorithm should be able to discriminate into standard triage categories. These criteria may be used as an alternative to the ISS in testing major incident triage algorithms.

Unanswered questions and possible future research

We have acknowledged that the criteria derived by this study are unlikely to be exhaustive or to apply to every major incident situation. However, they form an expert based tool against which specific major incident triage tools may be validated. Such work is being undertaken by the authors, evaluating paediatric major incident triage algorithms in a clinical setting, through a prospectively developed database of children receiving these interventions post injury. These algorithms are being validated through the comparison of ISS and the findings of this Delphi.

CONCLUSION

We have described a novel use of an existing research tool as a means to test paediatric major incident triage algorithms. This process involved the use of an expert Delphi panel to formulate a list of interventions against which the algorithm may be tested.

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SC had the original idea for the paper. LAW undertook the study and wrote the first draft. All authors contributed to the final draft. LAW is the guarantor of the article.

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APPENDIX

Background

In a major incident with multiple casualties, the medical response is heavily influenced by the rapid and accurate identification of those patients in need of immediate attention. At the same time, those whose needs can wait must also be identified to avoid overburdening the limited medical resources.

There are many triage instruments available to assist in this process, most of which have not been formally validated. In the context of paediatric casualties, the paediatric triage tape is one such triage tool. The tape relies upon physiological parameters related to height (or weight) to determine the child's triage category. This tape is currently undergoing prospective validation in South Africa.

Part of the problem with validating triage instruments lies in determining which outcomes are considered to represent serious injury. The most commonly used is the injury severity score, but this has many limitations. Some papers have used a short list of outcomes, such as death or the need for surgery within six hours, as indicators of serious injury. All methods have flaws.

I propose a different way to determine the outcomes that will be used to validate this tape: the use of an expert panel in South Africa and the UK. This Delphi study consists of 16 experts, including yourself, and I thank you for taking part.

Method

With hindsight, knowing the interventions performed on an individual child, it is possible to state what the preferred triage category would have been in order to treat the child within the optimum time from injury. This is, of course, in the context of multiple casualties: not every patient can be treated immediately.

When triaging patients for treatment, consideration must also be given to the amount of equipment available to you, the number of trained staff at hand, and the environment. For this exercise, please consider that there was access to just enough of everything needed to avoid the introduction of an expectant category into the triage scheme.

Please assume that triage is at the scene of the incident. Furthermore, no treatment has been undertaken before these children are triaged.

On the following pages you will find paediatric patients from a major incident. Please consider each patient in turn, and then, using this hindsight, indicate whether you believe that patient should receive *immediate, urgent*, or *delayed* treatment, or whether they should be triaged as *dead*.

Mark your choice in the columns next to each patient as follows:

For ***immediate*** treatment, tick P1

For ***urgent*** treatment, needing intervention within 2–4 hours, tick P2

For ***delayed*** treatment, needing interventions that can wait over 4 hours, tick P3

For ***dead***, tick DEAD.

Please add any comments that you wish to by any of the patients.

Now read through the scenario, and then turn to the list on pages 4–7.

Scenario
A major incident has occurred involving children. You must triage the injured children. You need to decide whether each child needs *immediate*, *urgent*, or *delayed* treatment, or whether, in a major incident setting, they are *dead*.

Using the hindsight of the clinical information provided, look at the following children that are injured and triage them for treatment priority.