Paediatric Major Incident Triage: A Delphi process to determine clinicians' attitudes and beliefs within the United Kingdom and Ireland.

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JV and ML conceived the study idea, with survey content designed by JV, JES, PC, ML. The study was conducted by JV and ML. JV, SB, ML conducted the analysis and interpretation. SB wrote the initial draft of the manuscript. All authors contributed with critical revisions to the manuscript and approved the final manuscript. JV takes responsibility for the manuscript as a whole.

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ABSTRACT

AIMS

Triage is key to effective management of major incidents, yet there is scarce evidence surrounding the optimal method of paediatric major incident triage (MIT). This study aimed to derive consensus on key components of paediatric MIT among healthcare professionals responsible for triage during paediatric major incidents.

METHODS

Two-round online Delphi consensus study delivered July 2021-October 2021, including participants from pre-hospital and hospital specialities responsible for triage during paediatric major incidents. A 5-point Likert scale was used to determine consensus, set a priori at 70%.

RESULTS

111 clinicians completed both rounds; 13 of 17 statements reached consensus. Positive consensus was reached on rescue breaths in mechanisms associated with hypoxia or asphyxiation, mobility assessment as a crude discriminator, and use of adult physiology for older children. Whilst positive consensus was reached on the benefits of a single MIT tool across all adult and paediatric age ranges, there was negative consensus in relation to clinical implementation.

CONCLUSION

This Delphi study has established consensus among a large group of clinicians involved in the management of major incidents on several key elements of paediatric major incident triage. Further work is required to develop a triage tool that can be implemented based on emerging and ongoing research, and which is acceptable to clinicians.

Key Notes:

- We conducted a large (over 100 respondents), online Delphi study to determine consensus on key components of paediatric major incident triage.
- Consensus was reached on the inclusion of rescue breaths in mechanisms associated with hypoxia or asphyxiation, the use of mobility assessment as a crude discriminator of injury and the use of adult physiology for older children.
- Whilst consensus was reached on benefits related to use of a single tool across all age ranges (adult and paediatric), the expert panel did not support this approach for actual clinical practice

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INTRODUCTION

Major incidents occur worldwide on a regular basis and are characterised by the need for additional resources with which to respond to the incident; furthermore, they have the potential to overwhelm healthcare resources and cause patient harm.[1,2] Whilst these occur in either pre-hospital or hospital settings, the challenges and risks faced are broadly similar. Major Incident Triage (MIT) tools aim to mitigate these risks by prioritising patients with high clinical acuity and need for life-saving intervention, whilst also identifying a cohort at lower risk.[1] Major incidents involving children are less common, but they also carry potential for long-lasting negative psychological effects on clinicians.[3,4] The ideal paediatric MIT tool should therefore be simple and rapid to apply, demonstrate good performance accuracy, and provide decision making support to clinicians.[5]

Whilst a number of MIT tools are used internationally, the Modified Physiological Triage Tool-24 (MPTT-24, *supplementary figure 1*) has recently been implemented as the MIT tool of choice for adults in UK in-hospital practice due to its performance accuracy.[2,6,7] The two most widely used paediatric MIT tools in the UK are JumpSTART [8] for hospital settings, and the Paediatric Triage Tape (PTT) [9] for the pre-hospital setting (*supplementary figures 2 and 3*). The MPTT-24 (and a paediatric version, *supplementary figure 4*) have recently been found to outperform existing paediatric MIT tools on a trauma registry dataset, in their ability to identify patients in need of a life-saving intervention.[10,11] However, limitations of existing evidence, patient and professional factors, and existing life support guidance cloud direct translation of these findings to practice.[12]

Although the MPTT-24 incorporates physiological variables, translation into paediatric clinical practice is more complex as normal physiological ranges differ with age. The consequent potential for operator error has led to suggestions that physiological variables should be removed from paediatric MIT tools, or that adult variables should be used for adolescents. Whilst rescue breaths are recommended in resuscitation guidance for individual children [12] and in JumpSTART, this is likely to delay the assessment of subsequent patients when faced with multiple casualties. Both mortality and the need for life-saving interventions are highest in the youngest age cohort,[10] yet these patients are the most difficult to rapidly assess. For example, mobility assessment is a key factor in several MIT tools, but often does not account for young children being developmentally pre-mobile. Some have therefore suggested that all patients below a lower age threshold should be assigned the highest priority (Priority 1; P1).

The aim of this study was to seek consensus opinion of healthcare professionals involved in the triage and management of paediatric patients at major incidents. This determined the level of agreement with existing practice and concepts arising from emerging evidence, in order to inform policymakers of the optimum manner in which paediatric MIT should be conducted.

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METHODS

An online modified Delphi consensus study,[13,14] consisting of two rounds, was undertaken between July and October 2021 **(supplementary file).** Round 1 ran for 4 weeks (23/07/2021-20/08/2021) and Round 2 for 3 weeks (15/09/2021-06/10/2021), with a maximum of three reminders sent in each round. Surveys were delivered using Research Electronic Data Capture tools (REDCap), a secure, web-based software platform.[15,16] Data were stored securely on a server within University Hospitals Bristol and Weston NHS Foundation Trust.

Potential participants were identified by accessing subject matter expert groups across the UK and Ireland including the National Ambulance Services Medical Directors (NASMeD) Group, Faculty of Pre-Hospital Care (FPHC), Paediatric Emergency Research in the UK & Ireland (PERUKI)[17] and the Paediatric Critical Care Society Study Group (PCCS-SG). These groups were selected to ensure representation across fields in which patients may be involved in a major incident. Participants were invited by email, using a link containing relevant background study information. This included existing and emerging research, example scenarios, and the MIT tools used in children. The invitation highlighted the need for participation in both rounds, anticipated time for completion, and the link to the consensus statements. Those who did not complete Round 1 were ineligible to complete the subsequent round, and no new invitations were sent after completion of Round 1. Participants could exit either round, at any stage, if they no longer wished to continue. Participants were identifiable through their email address, but these were only available to the data manager, and all data extracted for analysis were anonymised.

Consensus statements were developed iteratively by the study team following a review of relevant literature, and adult and paediatric MIT tools. Statements were grouped in categories, with supplementary information provided for each topic area: (i) rescue breaths, (ii) mobility assessment, (iii) physiological variables and age ranges, (iv) older paediatric patients, and (v) very young children. A five-point Likert scale, from strongly disagree (score of 1) to strongly agree (score of 5), was used for categorical statements. For statements seeking opinion on continuous variables (for example, upper or lower age thresholds), a range of options was presented using a drop-down list. Consensus was agreed a priori and set at 70% (either agree/strongly agree or disagree/strongly disagree) for both categorical and continuous statements.

Round 1 consisted of 16 statements; any that reached the pre-specified level for consensus were removed in Round 2. Statements not reaching consensus in Round 1 were reviewed in line with respondent feedback, provided in free text form and with the opportunity for respondents to submit new statements. Statements were either repeated verbatim or modified for Round 2 where

necessary. In keeping with best practice recommendations for Delphi studies, prior to Round 2, respondents were sent summary results and their individual responses from Round 1, and a document providing the rationale for any changes to statements in Round 2.[18] One question was modified for Round 2, differentiating the use of rescue breaths into cohorts of blunt and penetrating trauma. No new areas in which to seek consensus on were identified from the free text responses following Round 1.

Data were analysed anonymously. Following each round, responses were grouped into three categories consisting of "Agree" (agree/strongly agree – score of 4 or 5), "Neither Agree/Disagree" (score of 3) and "Disagree" (disagree/strongly disagree – score of 1 or 2). Incomplete responses were excluded in each round; however, if a participant's response was incomplete only for Round 2, their responses to Round 1 were included. For statements not reaching consensus following Round 2, no further attempts at deriving consensus were undertaken. An analysis of these statements was undertaken and is presented in Table 3. Consensus agreement is presented as proportions for both categorical and continuous variables; medians and interquartile ranges are presented using the 5-point Likert to show spread of opinion. Analyses were conducted in Microsoft Excel (Version 2016).

Ethical Approvals

As this was a survey of health professionals identified via existing collaborative networks, formal ethical approval was not required according to the Health Research Authority framework decision tool.[19]

RESULTS

In total 157 participants completed Round 1, of which 111 (70.7%) provided complete responses in Round 2. Participants were predominantly from a pre-hospital (47%) or Paediatric Emergency Medicine (PEM; 41%) background, with 63.7% being of consultant grade and 24.2% either paramedics or extended-scope paramedics. Specialities and grades of participants are presented in Table 1.

Table 1: Demographics of study participants.

Of the 16 statements in Round 1 (R1), nine reached positive consensus; none reached negative consensus. Of the eight statements in Round 2 (R2), four reached consensus (2 positive, 2 negative); four statements did not meet the threshold for consensus. Figure 1 shows the flow of statements throughout the study.

Figure 1: Flow of statements through study

The breakdown of responses for statements reaching consensus are presented in Table 2; those not reaching consensus after both rounds are presented in Table 3. The median score was 4 (equivalent to agree) for all statements reaching positive consensus and 2 (equivalent to disagree) for statements reaching negative consensus; the majority had an IQR of 1.

Table 2: Percentages of consensus and median (IQR) scores for statements on which consensus was reached (based on ≥ 70% cut off)

Statements reaching consensus agreement

Rescue Breaths

Consensus was reached in Round 1 that rescue breaths should be used in major incidents secondary to submersion/immersion/drowning (88%), and smoke inhalation/chemical exposure (70%).

Mobility Assessment

It was agreed that an assessment of mobility should be included as a crude discriminator for serious injury (R1, 79%) and that this assessment should only be used in patients who are normally mobile (R2, 81%). In patients too young to self-mobilise, being alert and moving limbs was felt to be useful in determining absence of serious injury (R2, 71%).

Physiological variables, and age ranges for tools

Use of a single MIT tool was felt to convey benefits in training healthcare providers (R1, 87%), delivery (application of a tool in a major incident; R1, 81%), human factors (R1, 87%), and

"bandwidth" (R1, 84%) for those performing triage. However, in contrast with these findings, the consensus of participants was that a single tool should not be used across all age groups. (R2, 82%)

Older paediatric patients

It was agreed that if adult and paediatric physiological values are well correlated, an adult triage tool should be used in 12-16 year-olds (R1, 90%). Adult physiology was also agreed to be valid for use in patients above an age threshold (R1, 71%) with the majority (92%) suggesting >12 years.

Very young children

Consensus was reached that children younger than a given age threshold should not automatically be assigned P1 status. (R2, 70%)

Statements not reaching consensus agreement

For statements where consensus was not reached (Table 3), predominantly positive, negative, or neutral responses are shown in bold. Responses were reviewed in line with the clinical background of respondents to determine whether there were any marked differences between professional groups. With regard to rescue breaths in blunt trauma, consultants were more likely to agree that they had a role in MIT (62%), whilst paramedics were more likely to disagree (52%). Incongruity was less marked between speciality groups and grades for other statements not reaching consensus (Supplementary Table 1).

Table 3 – Percentages of consensus and median (IQR) score for statements that did not reach consensus (Round 2 scores)

DISCUSSION

There is a relative paucity of evidence surrounding paediatric major incident triage (MIT), with studies providing an analysis of triage tool performance, rather than questioning the methods of delivery. A strength of this study is to go beyond looking at simple quantitative measures of triage tool performance accuracy, and to look to derive consensus in how we may operationalise these paediatric MIT tools. In this modified Delphi study, we have achieved consensus on thirteen statements regarding paediatric MIT, from a range of expert healthcare professionals likely to be responsible for decision making in a paediatric major incident in either the hospital or pre-hospital environment. Agreement was reached that rescue breaths should be included when the mechanism related to hypoxic or asphyxiating injury, and that adult physiology thresholds should be used for older children. An assessment of mobility as a discriminator for serious injury should be used in children who are normally mobile, and for younger non-mobile patients, being alert and moving limbs was felt to be an appropriate surrogate.

Whilst positive consensus was reached supporting use of a single MIT tool from the perspective of training and systems delivery, we derived negative consensus regarding clinical implementation of a single tool across all ages. This was despite recent evidence which demonstrates the MPTT-24 outperformed existing paediatric MIT tools at identifying patients in need of life-saving interventions using trauma registry data.[10] As there was no opportunity for a face-to-face meeting in which to explore the reasons behind this, we can only hypothesise that clinicians felt uncomfortable adopting a completely new approach to paediatric MIT (i.e., not using a bespoke paediatric tool). Specific to the paediatric age range, consensus was not reached as to whether a single MIT tool should be used across all ages. This uncertainty may represent mixed opinion on the trade-off between incorporating physiological variables against ease of use. For example, the Sheffield Paediatric Triage Tool has physiological thresholds which vary with age, which increases sensitivity within age bands; however, these require greater cognitive input by operators, rendering the tool more complicated and potentially reducing its effectiveness in the pre-hospital setting of a major incident.

Consensus could not be reached on incorporating rescue breaths for blunt or penetrating trauma. For blunt trauma, participant responses showed a trend against their use, but this did not meet the pre-specified criteria for consensus. Between respondent groups, there was disagreement between consultants and paramedics, which was not replicated in the context of penetrating trauma. Whilst rescue breaths were felt to be appropriate in mechanisms associated with hypoxia or asphyxiation (e.g., smoke inhalation or immersion), and are clinically appropriate in single patient incidents, they may be impractical in the major incident setting for a variety of reasons. Firstly, if multiple patients require rescue breaths this will require multiple bag-valve-masks (and potentially airway adjuncts) of

varying sizes. Secondly, if being performed as a sole practitioner (which may well be the case initially), achieving successful ventilation can be difficult.[12] Lastly, and what may be of particular significance in large marauding terrorist incidents, there will be an increased time allocation for patients receiving rescue breaths, with a resultant deleterious effect on patients who are yet to be triaged (who may for example have catastrophic haemorrhage requiring immediate intervention).

Evidence from a trauma registry demonstrated that younger children (aged under 2 years) have the highest mortality and need for life-saving interventions.[10] As this cohort is potentially difficult to assess on scene, one suggested strategy has been that all such children be automatically categorised as P1 to reduce cognitive burden for operators.[11] However despite this evidence being presented, negative consensus was reached in regard to this approach. Similarly, although consensus was not reached, two-thirds of participants stated that non-mobile children should not be automatically categorised as P1. This may be due to concerns surrounding unnecessary prioritised conveyance, potentially to the detriment of more seriously injured patients pre- and in-hospital. Given this offset between opinion and evidence of risk, this area is worthy of further study. In contrast, for normally non-mobile children, consensus was reached that being alert and moving limbs is a useful discriminator for exclusion of serious injury, in keeping with current practice.

Limitations

We acknowledge the limitations associated with our study. Firstly, only healthcare professionals working in the UK and Ireland were included, and our findings may not be generalisable to other settings (for example those in low resource countries, or with different frequency and characteristics of paediatric major incidents). Secondly, whilst the methodology allowed for maximal uptake engagement of relevant professionals, we are unable to determine the 'denominator' for our participants' responses, and we acknowledge the possibility of selection bias. However, we believe this is offset by a high completion rate across both rounds (71%). Thirdly, we acknowledge that not being able to facilitate a face-to-face component within the study design may constitute a limitation, specifically when considering the management of statements that failed to reach consensus. We have presented statements not reaching consensus both factually and with context, in order to enable policymakers to make decisions surrounding these areas, rather than making unilateral decisions as a study team. Furthermore, a lack of personal discourse may explain to a certain degree the discourse between existing evidence and the Delphi results. Lastly, the exclusion of incomplete responses may have influenced whether consensus was reached for statements; however, in a secondary analysis which included partial responses, there was no change in our findings. Finally, contextual evidence provided to participants was from analysis of trauma registry data, rather than major incident datasets. No such datasets exist, and the unpredictable nature of major incidents

makes prospective research difficult and potentially unethical. The use of trauma registry data to develop and validate MIT tools has been used successfully in development of adult MIT tools.

Conclusion

This Delphi study has established consensus among a large group of clinicians involved in several key elements of paediatric major incident triage, which will be of use to those involved in planning and preparing the response to a major incident involving children. We would encourage further work to develop a triage tool that can be implemented based on emerging and ongoing research in addition to the consensus opinion demonstrated in this study.

Acknowledgements

Ethical Approval

No formal research ethics approval was required for this study as it was a survey of health professionals identified via networks. Participation was deemed as consent.

Abbreviations:

MIT – major incident triage

PTT – paediatric triage tape

MPTT-24 – Modified Physiological Triage Tool 24

REFERENCES

1. ALSG. Major Incident medical management and support: the practical approach at the scene. BMJ Books; 2011.

2. Clinical Guidelines for Major Incidents and Mass Casualy Events [Internet]. [cited 2021 Sep 5]. Available from: https://www.england.nhs.uk/wp-content/uploads/2018/12/B0128-clinical-guidelines-for-use-in-a-major-incident-v2-2020.pdf

3. Dark P, Smith M, Ziman H, Carley S, Lecky F. Healthcare system impacts of the 2017 Manchester Arena bombing: Evidence from a national trauma registry patient case series and hospital performance data. Emerg Med J. 2021 Apr 22;38.

4. Skryabina E, Betts N, Reedy G, Riley P, Amlôt R. UK healthcare staff experiences and perceptions of a mass casualty terrorist incident response: a mixed-methods study. Emerg Med J. 2021;38(10):756–64.

5. Lerner EB, McKee CH, Cady CE, Cone DC, Colella MR, Cooper A, et al. A consensus-based gold standard for the evaluation of mass casualty triage systems. Prehospital Emerg care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir. 2015;19(2):267–71.

6. Bazyar J, Farrokhi M, Khankeh H. Triage Systems in Mass Casualty Incidents and Disasters: A Review Study with A Worldwide Approach. Open access Maced J Med Sci [Internet]. 2019 Feb 12;7(3):482–94. Available from: https://pubmed.ncbi.nlm.nih.gov/30834023

7. Vassallo J, Smith JE, Wallis LA. Major incident triage and the implementation of a new triage tool, the MPTT-24. J R Army Med Corps. 2018 May;164(2):103–6.

8. Romig LE. Pediatric triage. A system to JumpSTART your triage of young patients at MCIs. JEMS. 2002 Jul;27(7):52-58,60-63.

9. Hodgetts T, Hall J, Maconochie I, Smart C. Paediatric Triage Tape. Pre-hospital Immed Care. 1998;2:155–9.

10. Vassallo J, Chernbumroong S, Malik N, Xu Y, Keene D, Gkoutos G, et al. Comparative analysis of major incident triage tools in children: a UK population-based analysis. Emerg Med J

[Internet]. 2021; Available from: https://emj.bmj.com/content/early/2021/10/27/emermed-2021-211706

11. Chernbumroong et al. Paediatric major incident triage and the use of machine learning techniques to develop an alternative triage tool with improved performance characteristics.

12. ALSG. Advanced Paediatric Life Support: A practical approach to emergencies. 6th ed. Wiley Blackwell;

13. Powell C. The Delphi technique: myths and realities. J Adv Nurs. 2003 Feb;41(4):376–82.

14. 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 Apr;67(4):401–9.

15. 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. J Biomed Inform. 2009 Apr;42(2):377–81.

16. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: Building an international community of software platform partners. J Biomed Inform. 2019 Jul;95:103208.

17. Lyttle MD, Sullivan R, Hartshorn S, Bevan C, Cleugh F, Maconochie I, et al. Pediatric Emergency Research in the UK and Ireland (PERUKI): developing a collaborative for multicentre research. Alcock R, Barling J, Bayreuther J, Bevan C, Blackburn C, Bolger T, et al., editors. Arch Dis Child [Internet]. 2014;99(6):602–3. Available from: https://adc.bmj.com/content/99/6/602

18. Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and reporting the Delphi method for selecting healthcare quality indicators: a systematic review. PLoS One 2011;6(6):e20476

19. NHS Health Research Authority Decision Tool [Internet]. [cited 2021 Oct 20]. Available from: http://www.hra-decisiontools.org.uk/research/