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UK-wide major trauma center tertiary trauma survey pro forma review and aggregation and consolidation into a redesigned document

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ABSTRACT

Objectives The trauma tertiary survey (TTS) is an essential part of the continued care for major trauma patients which is performed to ensure that all injuries have been identified and none have been overlooked during the patient's stay. Although the Advanced Trauma Life Support Course states a need for a tertiary survey, there is currently no standard for what this survey comprises.

Methods Using local consultant expert opinion and a literature search we identified a set of 32 TTS potential features that may be included within a TTS pro forma. Major trauma center (MTC) documents were requested from every MTC within the UK. 4 investigators sequentially interrogated each MTC TTS document looking for (1) presence of each feature and (2) how well the feature was represented on the document (0 to 4 Likert Scale). Any previously unidentified potential TTS features were noted and later reviewed for a second round of document analysis.

Results A total of 21 out of all 26 UK MTCs had a TTS pro forma document. A total of 68 possible features were identified. Respiratory and Abdominal assessment sections were the most frequently identified features (present in 90.4% of the TTS pro formas; n=19. Neck assessment and neurological assessment were included within 85.7% of the TTS pro formas (n=18). Further aspects identified for Round 2 analysis typically included features that were thought to be important but highly specific. For example, pregnancy test and DNACPR discussions were found in 1 MTC TTS each (4%).

Conclusion This article presents a review of the existing documents at 21 MTCs in the UK, identification of features used and proposes a gold standard TTS which can be used by any doctor to perform the tertiary survey and reduce the risk of missed injuries in trauma patients.

Level of Evidence 3.

BACKGROUND

The trauma tertiary survey (TTS) is an essential part of the continued care for major trauma patients and is performed to ensure that all injuries have been identified and none have been overlooked.[1] At The Royal Sussex County Hospital, Brighton, a previous internal audit (Pickard A, Davies W. Audit of secondary and tertiary survey completion for trauma patients in Critical Care. *Internal audit, Royal Sussex County Hospital, unpublished*. 2020) discovered poor completion rates of the TTS for patients admitted to Critical Care. Our current TTS pro forma is a single A4 page situated on the last page of the trauma booklet which was thought to be easily missed and insufficient to capture the aspects required from TTS. We felt that we could improve on this by having a complete document to facilitate a thorough patient review and ultimately improve patient care. An initial literature search revealed that there are no universally accepted standards for a TTS.[2] The authors are unaware of any previous literature attempting to define a set of standards through a thorough research-based process. We have produced an evidence-based document which will guide and enhance tertiary assessment of patients after trauma.

AIMS

1. To improve the Royal Sussex County Hospital Tertiary Survey Document using a systematic review of current UK major trauma practice and current literature on missed injuries.
2. To produce a document that could be used in other hospitals as either:
   a. A comparator to their currently used TTS document which may highlight areas of possible improvement.
   b. A model TTS standalone document, with or without modifications.

METHOD

Using local consultant expert opinion, direct communication with the Royal College of Surgeons and the Advanced Trauma Life Support manual, we identified a set of 32 TTS potential discrete 'features' that could be included within a TTS pro forma. Every UK major trauma center (MTC) was contacted and asked to send their local TTS document to the investigative team—a total of 21 out of 26 UK MTC had TTS pro forma documents. The newly opened MTC at the University Hospital of Wales was excluded from analysis as its launch was after data collection had already commenced.

Round 1 data collection used four investigators, blinded to each other, who were assigned to interrogate each MTC document in turn. They reported on: (1) presence of our identified standard and (2) how well the standard was represented on the document (0 to 4 Likert Scale). These data were input onto a Google Sheets[3] spreadsheet pro forma. After all investigators had finished their data input, they met online using Zoom Video conference software.[4] The primary aim of this meeting was to

assess if there were any disagreements in the standard presence or absence. These disagreements were automatically highlighted though a formatting change in a separate 'Results' Google Sheets document. The investigators discussed the reasons for the disparity and came to a consensus. No Likert scales scores were discussed.

Additionally, during the Round 1 MTC interrogation process, each of the investigators were asked to highlight previously unidentified additional potential TTS features that could be proposed for inclusion for repeat analysis of the MTC TTS pro formas. These potential features were discussed at the end of all data input from Round 1, compiled and agreed on. This revealed a further 36 standards which were interrogated in a second round of MTC TTS document analysis as per the method described in Round 1.

Missed injuries

The TTS plays an important part in the identification of injuries that are typically not life threatening but if left untreated may become life changing (eg, ligamentous injuries). A literature search was performed to find (1) the most frequently missed injuries and (2) injuries with the highest potential for morbidity/mortality if left undiscovered. With this information, we planned to include specific trigger points to ensure these injuries were picked up during the TTS (eg, tick box). We used the Standards for QUality Improvement Reporting Excellence (SQUIRE) checklist when writing our report (online supplemental file 1).[5]

RESULTS AND ANALYSIS

Each reviewer assessed the MTC documents against a total of 68 features and a total of 1428 data points. Full review of all features is out of the scope of this short report; however, highlights are included below.

Respiratory and abdominal assessment sections were the most frequently identified (present in 90.4% of the TTS pro formas; n=19). Neck, limbs and neurological assessment were included within 85.7% of the TTS pro formas (n=18).

Spine assessment was seen in 10 MTCs and back assessment was contained in nine MTCs. Back or spinal assessment was seen in 16 MTCs. Spine and back assessment was seen in three MTC pro formas. This may reflect differing terminology between hospitals; however, arguably these two standards reflect different aspects of patient assessment and could be interpreted differently between clinicians.

Specific neck assessment was seen in 18 of the MTC pro formas. Immobilization plan or spine clearance comment has an important role inpatient management, comfort and physiotherapy which ultimately aids rehabilitation. Neck immobilization comment was seen in nine MTC pro formas and spine cleared comment was seen in eight MTC pro formas. Neck immobilization or spine cleared comment was seen in 13 MTC pro formas.

New features identified in Round 1 and assessed in Round 2 included items that could be considered more focused and specific features to a TTS; for example, pregnancy test and DNACPR discussions were found in 1 MTC TTS each (4%).

One investigator was removed from Likert analysis due to skew on their Likert scoring. After discussion, this was revealed to be due to the individual not following the proposed methodological Likert scale. Likert analysis interassessor agreement with the remaining three investigators was 'poor'[6] with an average interclass correlation Score of 0.49.

Missed injuries

The literature search attempted to identify potential 'missed injuries triggers' was performed and revealed that for polytrauma patients who received some form of CT scan as part of their initial work-up. The compiled research identified trauma registry interrogation and meta-analysis which showed upper and lower limb extremity fractures were by far the most commonly missed at initial presentation,[7–9] in particular, fractures of the hand and wrist, ankle, foot and shoulder.[10]

A single-center study[11] showed injuries covered anatomically by CT but still missed on the scan report included:

- Bowel/mesentery
- Thoracic/lumbar spine
- Pelvis.

Another single-center study[12] showed that injuries most likely to be completely missed (ie, patient discharged home without ever being diagnosed) were:

- Hand fractures.
- Rotator cuff tears.
- Soft tissue knee injuries (menisci/ligaments).

Few eye and ear injuries were missed, and these were found to be rarely commented on. In patients who do not receive a CT scan, missed injuries are commonly chest, ribs and upper extremities,[13] and spines and heads were the most commonly missed injuries.[14]

From this work, we identified that within our 'model' TTS document, we should include:

- A consultant review of CT images to ensure adequate anatomic coverage.
- Inspection, palpation and range of motion assessment of the bones of the arm, hand, leg, ankle and foot for fractures.
- Formal re-examination of the abdomen for delayed presentation of abdominal injuries.
- Assessment of active range of movement of the shoulder for rotator cuff tears.
- Assessment of the knee—straight leg raise, inspection, palpation, range of movement. If there is knee swelling or tenderness X-ray should be recommended. Although drawer signs and ligamentous testing could be done in intensive care unit, it is often too painful in the severely injured patient. Where there are concerns about significant soft tissue knee injury, the patient should be reviewed by the orthopedic team.

DOCUMENT PRODUCTION

Our model TTS document (see Appendix 1) contains all identified features from all MTCs and highlights areas for potential missed injuries. The design of each feature in the model pro forma was based on those which scored highly on the Likert analysis where agreement was high. Features grouped together in an intuitive way in a sequential order to facilitate comprehensive patient review and efficient clinical documentation.

Checkboxes screening for commonly missed injuries are designed so that abnormal findings will be clearly visible in the 'Yes" columns. This also allows all findings within a table to be reported with one line if negative. Aspects where there was potential for overlap (eg, cranial nerves examination) has been integrated into other areas of examination to avoid duplication.

Highest Likert scoring sections for blood results were those that included trends. We opted against tables of serial results to allow the reviewer independent practice and flexibility to document only relevant results and avoid extraneous information detracting from the salient findings of the review.

DISCUSSION

Overall, the authors feel we have implemented a systematic way of approaching MTC document analysis and collating results into a unified document from several sources. Methodologically having four investigators means we feel we have a robust identification of feature presence for each of the MTC pro formas and the features it contained within. This is highlighted by the times when a sole individual investigator identified a feature where the others had missed.

The poor Intraclass Correlation Coefficient of the Likert analysis was disappointing. However, an ICC of 0.49 was on the upper border of this classification bracket, between 0.5 and 0.75 would have been classified as 'moderate'. An increased number of Likert scale points may have led to a more meaningfully reported data and therefore greater statistical weight and insight. Methodologically speaking, better training and calibration of the investigators by analyzing an initial TTS document collectively at the start; or agreeing explicitly on hypothetical examples of each of the Likert scale points for each of the features may have improved agreement. However, this ICC score may just reveal the differences in subjective opinion of different specialties. During our 'model' document production, individual features with high scoring Likert did aid identification of effective TTS pro forma design which was useful.

Our research and analysis of the 21 documents was designed to compare the features included in a TTS by all UK MTCs against the 68 features identified from multiple literary sources and from the documents themselves. Ultimately, we have demonstrated a large disparity between them. The analysis process itself identified variation between investigators in agreeing on the presence or quality of each standard, a problem that likely plagues all MTCs when developing these pro formas. Recognizing this and using our iterative process we identified a larger number of features to review in Round 2 that integrated into our core standards.

We appreciate the 'model' pro forma that we have produced is a relatively large document. However, we have chosen to present this to group all ideas from around the UK in one area to give interested parties an unabridged overview of what could be included in a TTS document and a way to reflect on their local TTS document.

CONCLUSION

It has now been over 40 years since the first publication of the ATLS manual and the introduction of a systematic approach to trauma resuscitation to improve trauma patient outcomes. Many changes to practice have been instigated as the evidence evolved and helped define the national standards of the initial trauma resuscitation phase, but the TTS has stood still and remains undefined in terms of a systematic process, despite studies dating back 25 years demonstrating the impact of missed injuries.

The overall purpose of the research was not to focus on the known impact of missed injuries, but rather to define a set of standards that would reduce missed injuries. At the time of writing, the authors are unaware of any previous literature attempting this and think that this study is the first of its kind to define a set of standards through a thorough research-based process. We feel we have produced an evidence-based document which will guide and enhance assessment of patients after trauma. We feel it is a systematic collation of UK-wide MTC hospital practice and could easily be modified for local requirements. We hope that using it as a separate document will highlight the importance of the TTS. With the new TTS pro forma designed, the authors think that it will lead to a reduction in missed injuries and better trauma patient care that will improve trauma patient care locally and, potentially, nationally if this document is adopted across all MTCs.

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Contributors MP was the lead on this project and was involved in conception of the article, planning, acquisition of data, designed data collection tools, monitored data collection for the whole trial and drafted and revised the article. He was also involved in the design of the pro forma as presented in this article. He is the guarantor. AP was involved in planning, analysis of data and interpretation of data, revision of the final article as well as designing and revision of the finalized proposed model TTS. DS was involved in the planning, conception and design of the research, contacted major trauma centers for acquisition of data, analysis and interpretation of the data and revision of the final article. He was also involved in the design of the pro forma as presented in this article. MT did literature review and contributed to the missed injuries section and revision of the final article. LR was involved in the conception, planning and design of the study, analysis and interpretation of data, revision of the final article and contacted the ATACC group for information on ATLS guidance for Tertiary Survey. She was also involved in the design of the pro forma as presented in this article.

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Competing interests None declared.

Patient and public involvement statement This research was performed with no involvement of patients. Requests were made to tertiary centers to provide pro formas; however, no other center was involved in the data collection or analysis.

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REFERENCES

1 Abuznadah W, Acker J, Agarwal S, Ali J, Allan H, Al Turki S, Asselstine M, Ayyaz M, Bagnall M, Baker A. American College of Surgeons.. *ATLS advanced trauma life support student course manual*. 10th ed.. Chicago: American College of Surgeons, 2018.
2 Enderson BL, Reath DB, Meadors J, Dallas W, DeBoo JM, Maull KI. The tertiary trauma survey: a prospective study of missed injury. *J Trauma* 1990;30:666–70.
3 Google LLC. Google Sheets online spreadsheet platform. 2021. https://www.google.co.uk/sheets/about/ (6 Jul 2021).
4 Zoom Video Communications. Zoom Cloud Meetings video teleconferencing software. 2021. https://zoom.us/ (6 Jul 2021).
5 Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. Squire 2.0 (standards for quality improvement reporting excellence): revised publication guidelines from a detailed consensus process. -.
6 Koo TK, MY L. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research [published correction appears in J Chiropr Med. 2017 Dec;16(4):346]. *J Chiropr Med*. 2016;15:155–63.
7 Hajibandeh S, Hajibandeh S, Idehen N. Meta-Analysis of the effect of tertiary survey on missed injury rate in trauma patients. *Injury* 2015;46:2474–82.

8 Tammelin E, Handolin L, Söderlund T. Missed injuries in Polytrauma patients after trauma tertiary survey in trauma intensive care unit. *Scand J Surg* 2016;105:241–7.
9 Vles WJ, Veen EJ, Roukema JA, Meeuwis JD, Leenen LPH. Consequences of delayed diagnoses in trauma patients: a prospective study. *J Am Coll Surg* 2003;197:596–602.
10 Pfeifer R, Pape H-C. Missed injuries in trauma patients: a literature review. *Patient Saf Surg* 2008;2:20.
11 Lawson CM, Daley BJ, Ormsby CB, Enderson B. Missed injuries in the era of the trauma scan. *J Trauma* 2011;70:452–8.
12 Ferree S, Houwert RM, van Laarhoven JJEM, Smeeing DPJ, Leenen LPH, Hietbrink F. Tertiary survey in polytrauma patients should be an ongoing process. *Injury* 2016;47:792–6.
13 Hensgens RL, El Moumni M, IJpma FFA, Harbers JS, Duis KT, Wendt KW, Govaert GAM. High delayed and missed injury rate after inter-hospital transfer of severely injured trauma patients. *Eur J Trauma Emerg Surg* 2020;46:1367–74.
14 Tompsett L, Baxter M, Eynon A. 21MAJOR TRAUMA IN THE OVER 65'S: TOO LITTLE, TOO LATE. *Age Ageing* 2017;46:i1–22.