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Clinician tasking in ambulance control improves the identification of major trauma patients and pre-hospital critical care team tasking

Neil Sinclair[a], Paul A. Swinton[a], Michael Donald[a,b], Lisa Curatolo[a], Peter Lindle[a], Steph Jones[a], Alasdair R. Corfield[a,c,*]

[a] ScotSTAR, Scottish Ambulance Service, United Kingdom
[b] Emergency Department, Ninewells Hospital, United Kingdom
[c] Emergency Department, Royal Alexandra Hospital, United Kingdom

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ABSTRACT

Introduction: Trauma remains the fourth leading cause of death in western countries and is the leading cause of death in the first four decades of life. NICE guidance in 2016 advocated the attendance of pre-hospital critical care trauma team (PHCCT) in the pre-hospital stage of the care of patients with major trauma. Previous publications support dispatch by clinicians who are also actively involved in the delivery of the PHCCT service; however there is a lack of objective outcome measures across the current reviewed evidence base. In this study, we aimed to assess the accuracy of PHCCT clinician led dispatch, when measured by Injury Severity Score (ISS).

Methods: A retrospective cohort study over a 2 year period pre and post implementation of a PHCCT clinician led dispatch of PHCCT for potential major trauma patients, using national ambulance data combined with national trauma registry data.

Results: A total of 99,702 trauma related calls were made to SAS including 495 major trauma patients with an ISS >15, and a total of 454 dispatches of a PHCCT. Following the introduction of a PHCCT clinician staffed trauma desk, the sensitivity for major trauma was increased from 11.3% to 25.9%. The difference in sensitivity between the pre and post trauma desk group was significant at 14.6% (95% CI 7.4%–21.4%, $p < .001$).

Discussion: The results from the study support the results from other studies recommending that a PHCCT clinician should be located in ambulance control to identify major trauma patients as early as possible and co-ordinate the response.

Introduction

Trauma remains the fourth leading cause of death in western countries and is the leading cause of death in the first four decades of life [1]. Annually in Scotland there are approximately 1200 patients who are classified as major trauma patients [2]. Patients with defined major trauma have a mortality risk of 10% [3]. The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report of 2007 included the provision of advanced airway management (including rapid sequence induction (RSI)) [1] in pre-hospital care and more recently, NICE guidance advocated the attendance of physician led trauma team in the pre-hospital stage of their care [4]. Delivery of pre-hospital care to these patients is the responsibility of the Scottish Ambulance Service (SAS).When dealing with the most critically injured patients, the SAS crews are supported by three physician led pre-hospital critical care teams (PHCCT).

In 2011 a panel, consisting of European experts in physician-based pre-hospital Critical Care, was invited to participate in a consensus process. The consensus process was based upon a four-stage modified nominal group technique (NGT) that included a consensus meeting [5–8]. The group identified five top priority areas for research of which the dispatch criteria for pre-hospital Critical Care services were included [9].

Dispatchers working in Ambulance Control Centres (ACC) are currently supported in their tasking decision making by a number of mechanisms, common to systems around the world. These can be broadly broken down into dispatch according to Medical Priority Dispatch System (MPDS) [10]; "Autolaunch" based on physiological, anatomical or mechanism based criteria [11–22]; physician presence in ACC guiding dispatch [23]; self-tasking by

* Corresponding author at: ScotSTAR, Scottish Ambulance Service, United Kingdom.
E-mail address: a.corfield@nhs.net (A.R. Corfield).

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clinician remote from ACC and clinician interrogated dispatch [24–27]. These systems are not always mutually exclusive and some overlap may exist however the scarce evidence that exists indicates that the optimal system with regards to accuracy of tasking appears to advocate the use of clinician involved in the delivery of PHCC for tasking of PHCCT [23,24,28,29].

Evidence from other PHCCT [23,24] advocates the use of clinicians involved in delivery of PHCC for tasking of PHCCT to improve accuracy of tasking. Although there is positive support from these publications supporting clinician led dispatch, there is a lack of objective outcome measures across the current reviewed evidence base.

Previously in the Scottish system, the decision to dispatch a PHCCT has been led by non clinical staff (Dispatchers), with occasional input from a Clinical Advisor. The Clinical Advisors are Paramedics or Nurses working in ACC whose primary role is to re-triage 999 requests and manage clinical risk in waiting calls. However, the Clinical Advisors do not have any training specifically in the area of critical care and are not involved in the delivery of PHCC when not working in the Ambulance Control Centre (ACC).

A review of the available evidence to optimise identification of major trauma cases in ACC was followed by a recommendation in "Trauma Care Scotland" [30], which led to the Scottish Ambulance Service introducing a "trauma desk" in the ACC on 1st October 2012. This was staffed by either a Helicopter Emergency Medical Service (HEMS) paramedic or retrieval practitioner experienced in the delivery of PHCC, with the aim of using their clinical knowledge and gestalt to identify patients who would benefit from a pre-hospital trauma critical care team across Scotland. Retrieval practitioners are staff from either a nursing or paramedic background with an extended clinical skillset who undertake their clinical work with a PHCCT. The effective tasking of the finite and expensive resource of a PHCCT to a small group of traumatically injured patients can be complex, with the early identification of these patients being the key component to begin their access to clinical care commensurate with their clinical needs.As well as information collected by call handlers and displayed on the ACC computer system, PHCCT clinicians working on the trauma desk gather additional information on trauma related calls using two methods.In silent listening, the PHCCT clinician will listen in to the call handler receiving the call in real time to gather further information. Interrogated dispatch can occur after silent listening or as a primary intervention. During interrogated dispatch, the PHCCT clinician will phone back the reporter (the person making the emergency call) and gather further information. This may include asking specific questions about mechanism and injuries but also "listening to the scene" where background information may prove useful in making the decision about PHCCT dispatch.

The aim of this study is to investigate the accuracy of the trauma desk tasking system to defined major trauma patients and compare to the previous tasking model.

Methodology

This study uses a quantitative approach, utilising retrospective comparative study methodology. A consecutive sample of data was collected over a 24-month period and divided into pre and post desk samples. The pre-introduction sample was taken from dates 1st October 2011 to 30th September 2012 and post-introduction sample from 1st October 2012 to 30th September 2013. The method of call handling and dispatch of PHCCT during these two periods is shown in Fig. 1.

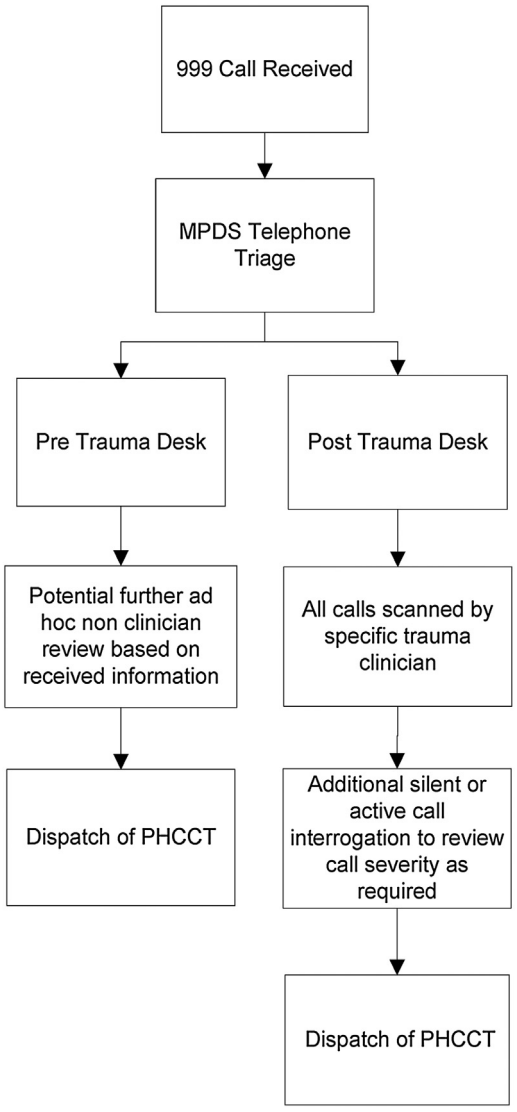

Fig. 1. Call handling diagram.

Data collection

Data was requested and collected from two national databases, from SAS and Scottish Trauma Audit Group (STAG). STAG is a national trauma registry covering >90% of all hospitalised trauma in Scotland. Inclusion and exclusion for STAG are listed in Appendix A. Arrangements in place in Scotland allow the use of anonymised patient data from the Scottish Trauma Audit Group to be used without ethical approval when the data is handled according to agreed guidelines. Approval for access to these data bases and use for this study was requested and received from SAS Medical Director and STAG research committee. Data was compiled and stored in Microsoft Excel computer programme documents. All patient identifiable information was removed and patients were identified by their unique SAS incident number. Data was matched using a number of demographic variables. Where insufficient data was available, matching was declared incomplete and the patient was excluded from the study. As well as data matching errors, there are a small number of major trauma patients that arrive without input from the Scottish Ambulance Service (self presentation or via Search and Rescue aircraft). These patients were also unable to be matched and were excluded.

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Data definitions

Trauma related calls to SAS were defined using the Advanced Medical Priority Dispatch System AMPDS [8]. Major trauma was defined as an Injury Severity Score (ISS) >15 [31]. Dispatch of a PHCCT was defined as when a PHCCT was tasked by SAS control to attend a pre-hospital incident, and includes taskings where a PHCCT was stood down before reaching the incident locus.

Statistical analysis

Further analysis where required was completed using Stata v 13.0 (StataCorp, College Station, TX). Data were collected for descriptive statistical analysis relating to patient demographics and ISS score. Comparisons for age between groups were made using Students *t*-test. Comparison between proportions was made using chi-squared test with Yates' continuity correction. To investigate the main research question a sensitivity and specificity calculation was conducted on each sample to investigate the accuracy of trauma team tasking to ISS >15 trauma patients. This was calculated using a 2×2 table and standard definitions of specificity and sensitivity. The definition of the sensitivity/specificity categories were defined as;

True Positive was defined as a PHCCT dispatched to a patient who, from review of their ISS, is defined as a major trauma patient (ISS >15).

False Negative was defined as the non dispatch of a PHCCT to a patient who, from review of their ISS, is defined as a major trauma patient (ISS >15).

False Positive was defined as the dispatch of a PHCCT to a patient who, from the review of their ISS, is defined not to be a major trauma patient (ISS <16).

True negative was defined as the non-dispatch of a PHCCT to patients who, from review of their ISS, defined not to be a major trauma patient (ISS <16).

Inclusion criteria

Patients age >16 years,

Within the hours of 08:00 and 18:00 (operational h for the trauma desk).

Exclusion criteria;

Patients who self presented to the Emergency Department

Patients where data records could not be matched.

Ethics

This study methodology uses the retrospective analysis of secondary datasets. No live staff, patients or operational practice was involved. Access and approval for use of the data base had been granted by the appropriate gatekeepers. This study was considered to be service evaluation and no ethics approval was deemed necessary or requested. Arrangements in place in Scotland allow the use of anonymised patient data from the Scottish Trauma Audit Group to be used without ethical approval when the data is handled according to agreed guidelines.

Results

Over the 24 month period of the study between the hours of 0800 and 1800, a total of 99,702 trauma related calls were made to SAS. Within the study period there were a total of 599 major trauma patients with an ISS >15, complete matched data was available for 495 (82.6%). In addition during the study period, there were a total of 454 dispatches of a PHCCT.

In the pre trauma desk group from 1st October 2011 to the 30th September 2012, there were a total of 50,411 trauma related calls. Within the pre trauma desk group there were a total of 205 major trauma patients with ISS >15, and a total of 115 dispatches of a PHCCT.

In the post trauma desk group from 1st October 2012 to the 30th September 2013, there were a total of 49,291 trauma related calls. Within the post trauma desk group there were a total of 290 major trauma patients with ISS >15, and a total of 339 dispatches of a PHCCT.

Patients who had a PHCCT dispatched

A total of 454 patients were available for analysis in the study period, this included 115 patients in the pre trauma desk group and 339 patients in the post trauma desk group. There was no difference in age, gender or ISS between the two groups. These demographics for the pre and post trauma desk groups are summarised in Table 1.

Sensitivity and specificity

The two datasets from the PHCCT dispatches and national trauma registry (STAG) were combined to allow calculation of sensitivity and specificity. The patient inclusion pathway is shown in Fig. 2.

From the pre trauma desk group there was a total of 115 trauma team tasking and 203 major trauma patients in the sample. Further analysis refined these into four defined categories. There were a total of 23 true positive dispatches, where a PHCCT was tasked to a major trauma patient. There were a total of 182 false negative dispatches, where a major trauma patient did not have a PHCCT dispatched to the scene of the incident. There were a total of 92 false positive dispatches, where a trauma team was dispatched but this was not to a major trauma patient. Finally, there were 50,065 true negatives where no team was dispatched and there were patients with traumatic injury, but not defined as major trauma. The 49 unmatched patients were not included in these totals.

From the post trauma desk group there was a total 339 trauma team tasking and 290 defined major trauma patients in the sample. There were a total of 75 true positive dispatches, where a PHCCT was tasked to a major trauma patient. There were 215 false negative dispatches, where a major trauma patient did not have a PHCCT dispatched to the scene of the incident. There were 264 false positive dispatches, where a trauma team was dispatched but this was not to a major trauma patient. Finally, there were 48,682 true negatives where no team was dispatched and there were patients with traumatic injury, but not defined as major trauma. The 55 unmatched patients were not included in these totals.

The sensitivity and specificity of the results were analysed in a 2×2 table. These results are summarised in Table 2.

Discussion

The results of this study demonstrate that the dispatch model using a clinician actively involved in delivery of PHCC, is more effective than the previous model in identifying major trauma patients and dispatching a PHCCT to scene. The results demonstrate a significant increase in sensitivity from 0.11 to 0.26 in the identification of major trauma patients. Although there was a

Table 1
Demographics of patients with PHCCT dispatched (pre and post trauma desk).

	Pre Trauma Desk	Post Trauma Desk	p
Number	115	339	
Age in years mean (SD)	43.1 (19.2)	41.1 (17.2)	0.296
Male gender (%)	84 (73.0%)	262 (77.3%)	0.349
Major Trauma ISS >15 (%)	23 (20.0%)	75 (22.1%)	0.637

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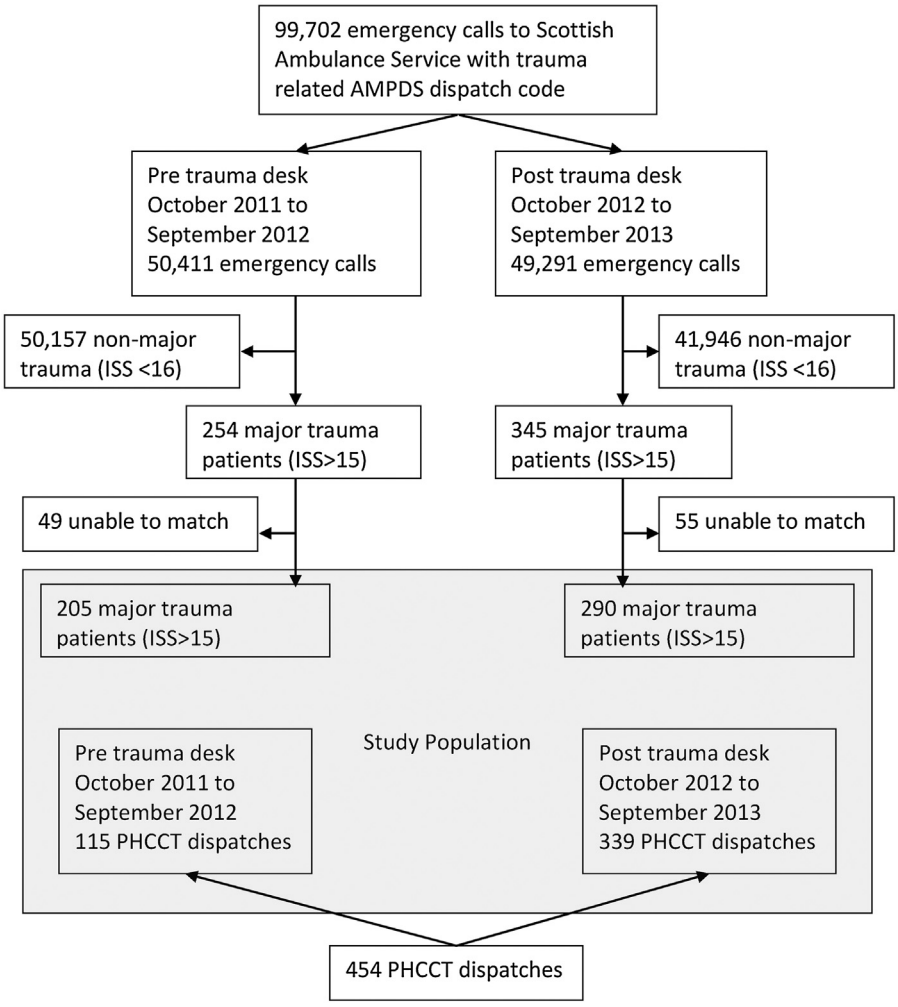

Fig. 2. Patient inclusion in study.

Table 2
Comparison of Sensitivity, Specificity, PPV and NPV for study groups.

	Pre Trauma Desk Group (95% CI)	Post Trauma Desk Group (95% CI)	p
Sensitivity	0.112 (0.073 to 0.164)	0.259 (0.209 to 0.313)	<0.001
Specificity	0.998 (0.998 to 0.998)	0.995 (0.993 to 0.995)	<0.001
Positive Predictive Value	0.200 (0.139 to 0.279)	0.221 (0.184 to 0.263)	0.728
Negative Predictive Value	0.996 (0.996 to 0.996)	0.995 (0.995 to 0.996)	0.060

statistically significant drop in specificity from 0.998 to 0.994, the positive predictive value showed no significant difference between the groups despite the fact that clinician led dispatch demonstrated a three-fold increase in the number of major trauma patients that received pre-hospital critical care. As highlighted previously, major trauma is a relatively rare disease in the context of the volume of emergency calls received by ACC with PHCCT availability a limited resource. This study demonstrates a more effective use of this resource however the trade off of increased sensitivity and reduced specificity with the introduction of the clinician led dispatch model and trauma desk system requires rigorous ongoing audit as the costs (both financial i.e. the requirement to have a clinically active member of a PHCCT in the ACC in addition to baseline ACC staffing, and safety) of deploying a team to a false positive case are significant and even more so if this is at the expense of a true positive case. It is inevitable that a pre-hospital service delivering care to trauma patients will have to accept a degree of over-triage in order to minimise under-triage of severely injured patients. The current literature is unable to determine where exactly this dispatch threshold falls and there are no published, agreed quality indicators to guide PHCCT. It is also of note that despite this improvement, sensitivity remained relatively low at 26%, suggesting more work needs to be done in optimising identification of major trauma at the pre-hospital stage whilst being mindful that a proportion of ISS >15 patients will rarely be identified on scene. An important observation that might explain the relative low sensitivity in this study is the relative heterogeneity of PHCCT availability across Scotland and the current inability to deploy a team in some areas of major Scottish conurbation.

This study uses a different methodology from previous studies, as this study has had the advantage to access national ISS data, to use as an objective categorisation of patient injury. It is one of a few published studies that has discussed and considered false negative tasking or missed major trauma patient's tasking, to further

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analyse the effectiveness of the dispatch model and provide a whole system overview of the response to major trauma patients [25,29]. The Scottish Trauma Network has recently commenced a test of change with the introduction of a national Major Trauma Triage Tool, based on the CDC trauma triage tool [32], which takes in to account patient physiology, anatomical injury and mechanism of injury and the authors believe that a future study would optimally compare the performance of the trauma desk dispatch system against the trauma triage tool as well as ISS.

The access to national ISS data for this study has allowed for an objective assessment of the accuracy of control centre identification of significantly injured patients and the dispatch of trauma teams. This has also allowed an objective overview of the volume of false positives or missed tasking to major trauma patients.

Our study took place within a national ambulance service, covering a diverse urban and rural geography and injury demographic. We believe this is a representative patient population. The systems used within the trauma desk are common to many UK, European and global EMS systems and we therefore believe our findings are generalisable to other EMS systems.

Limitations

This study focused exclusively on major trauma patients and the dispatch of trauma team to the location of the incident. Moderate trauma patients were excluded for the purpose of this initial study, although this patient group may also benefit from the skills of a trauma team. There was no assessment of the clinical interventions made at the scene of the incident for non-major trauma patients and this may have added further validity and depth to the results. A total of 104 major trauma patients, who were excluded due to the inability to match data effectively, may have altered our results. The assessment of non-tasking due to remote location with no trauma team available or very close proximity to a hospital was not possible and may have added more validity to the results. Lastly, during the study period, a dedicated clinician was only available between the hours of 08:00 and 18:00, and a further study is required to validate our results across a whole 24 h period.

Conclusion

The results of this study demonstrate that the dispatch model that utilises a clinician actively involved in delivery of PHCC to staff the trauma desk is more effective than the previous dispatch model in identifying major trauma patients and dispatching a PHCCT to scene. A PHCC clinician located in ambulance control can identify major trauma patients as early as possible and ensure appropriate resource tasking to those patients. This should allow early access to critical care and definitive care pathways, improving morbidity and mortality for major trauma patients.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.injury.2018.03.034.

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