Original Article

Trigger team activation in the emergency department at a tertiary university hospital

Stefan Posth[1, 2], Lonnie Froberg[3], Søren Bak[4], Lisette Okkels Jensen[5], Mikkel Brabrand[2, 6, 7] & Annmarie Lassen[1, 2]

1) Clinical Institute, University of Southern Denmark, 2) Department of Emergency Medicine, Odense University Hospital, 3) Department of Orthopaedic Surgery, Odense University Hospital, 4) Department of Neurology, Odense University Hospital, 5) Department of Cardiology, Odense University Hospital, 6) Institute of Regional Health Research, University of Southern Denmark, 7) Department of Emergency Medicine, Hospital of South West Jutland, Denmark

ABSTRACT

INTRODUCTION The aim of this study was to describe the diversity in the incidence, diagnosis and prognosis of patients met by the trigger teams for trauma, STEMI, stroke and medical emergency patients (MEP).

METHODS This was a single-centre, retrospective cohort study of all patients admitted to Odense University Hospital (OUH) from November 2012 to September 2015 with trauma, STEMI, stroke or MEP trigger team activation on arrival. OUH is a tertiary referral centre for patients with severe trauma, STEMI (directly referred to the catheterisation laboratory), stroke and MEP.

RESULTS A total of 8,075 trigger team activations were recorded, a median of eight calls per day (range: 1-18), covering 16.7% trauma calls, 28.3% STEMI calls, 19.7% stroke calls and 35.3% MEP calls. This corresponds to 160/100,000 person years (py) trauma calls, 65/100,000 py STEMI calls, 73/100,000 py stroke calls and 339/100,000 py MEP calls. Seven-day mortality was 10% (95% confidence interval (CI): 9-12%) for patients with trauma calls, 6% (95% CI: 5-7%) for STEMI calls, 3% (95% CI: 3-4%) for stroke calls and 16% (95% CI: 15-17%) for MEP calls. Patients from trauma, STEMI and stroke calls were discharged with a diagnosis within 3-5 International Classification of Diseases (version 10) main coding areas, whereas patients from MEP calls had discharge diagnoses within 13 main coding areas.

CONCLUSION Patients with MEP calls are more frequent, have a more diverse aetiology and a higher mortality than patients in the other trigger teams. A need exists for further guidelines and research regarding MEP with a view to reducing the high mortality rate among MEP in the future.

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TRIAL REGISTRATION The study was approved by the Danish Health Authority (Record no. 3-3013-1385/1) and the Danish Data Protection Agency (Record no. 2013-41-2435).

People in medical distress who are not already admitted to a hospital activate the emergency medical system. In Denmark, an ambulance is then dispatched and – if the situation is deemed to be sufficiently severe – a physician-staffed unit (mobile emergency care unit) is also deployed. When patients arrive at the hospital, their paths diverge.

A dedicated trauma team receives trauma patients [1]. Patients with suspected ST-elevation myocardial infarction (STEMI) are sent to the cardiac catheterisation laboratory and a neurologist promptly evaluates

patients with suspected stroke for potential thrombolysis.

Severely ill patients with less discrete exposure or presenting symptoms including many patients with shock, respiratory distress or depressed levels of consciousness do not fall into any of these categories. They are typically received in the emergency department (ED). Some are medical emergency patients (MEP) in an acute life-threatening situation who require immediate care [2-6]. As their pathway through the ED is not as well defined as that of patients with trauma, stroke, and STEMI, many EDs have in place a dedicated pathway or team to receive, assess and treat these patients [7, 8]. This is especially important because reliably matching patient needs with ED resources for time-dependent illness is a critical component of a coordinated emergency care system [9]. In contrast to the pathways for trauma, STEMI and stroke teams, most MEP teams are developed locally and are rarely described and evaluated. The aim of this study was to describe variance in incidence, diagnosis and prognosis of patients received by the trigger teams for trauma, suspected STEMI, suspected stroke and MEP.

METHODS

This was a population-based cohort study including patients received by a trigger team at Odense University Hospital (OUH), a tertiary referral hospital in Denmark. The OUH is one of three centres in the Region of Southern Denmark performing stroke thrombolysis and the only centre receiving level 1 orthopaedic trauma patients and patients with prehospitally suspected STEMI. MEP may be admitted to five different hospitals in the region and OUH serves as the primary hospital for MEP in the local area.

The catchment area covered by the different trigger calls varies and is described in **Figure 1.** The number of inhabitants provided for each trigger call catchment area is based on information from Statistic Denmark with 290,000 inhabitants in the primary catchment area for severe trauma (1,220,000 for selected trauma patients), 1,220,000 for suspected STEMI, 754,000 for suspected stroke and 290,000 for MEP.

FIGURE 1 Catchment areas.

STEMI = ST-elevation myocardial infarction.

All trigger teams at OUH are staffed by specialised physicians and nurses. Some of the trigger teams have further staffing. The characteristics of the OUH trigger teams are described in **Table 1.**

TABLE 1 Patient inclusion, staffing and location of the various Odense University Hospital trigger teams.

Trigger team call	Indication	Staffing	Location at hospital
Major trauma	After physical trauma with an objective or suspected life-threatening injury or an injury of > 1 organ system: Penetrating trauma to the head/torso, massive bleeding, massive blunt trauma, unstable pelvic fracture, ≥ 2 major fractures, flail chest, ABCDE unstable, fall > 6 m or trapped > 30 min.	Orthopaedic surgeon, anaesthesiologist, anaesthesiology nurse, 2 ED nurses, radiologist, 2 radiology technicians, laboratory assistant, orderly and secretary.	ED resuscitation room with direct access to CT scanner.
Suspected STEMI	Patients with typical symptoms of myocardial infarction for < 12 h and electrocardiogram findings suggesting STEMI Patients with cardiac arrest with a suspected cardiac reason are also included in this group. Based on prehospital visitation but can be activated in the hospital.	Interventional cardiologist, 3 specialised nurses.	Directly at the cardiac catheterisation laboratory.
Suspected stroke	Patient, previously self-reliant, with suspected acute ischaemic stroke < 4.5 h after the onset of symptoms. Based on prehospital visitation but can be activated in the hospital.	Neurology consultant, ED nurse, neurology nurse, laboratory assistant, secretary.	ED resuscitation room with direct access to CT scanner.
MEP	≥ 1 of the following: Threatened airway, systolic blood pressure < 80 mmHg, pulse rate > 130/min., respiratory rate > 35/min., O_2 saturation < 80% or Glasgow Coma Scale < 8	Medical consultant on duty in the ED, senior medical resident, 2 ED nurses, secretary, orderly, laboratory assistant, radiology technician. If the patient's airway is threatened or the patient is unconscious with a Glasgow Coma Scale of < 8, an anaesthesiologist and anaesthesiology nurse are also part of the MEP trigger team.	ED resuscitation room with direct access to CT scanner.
	Patients with cardiac arrest of suspected non-cardiogenic cause are also included in this group.		

CT = computed tomography; ED = emergency department; MEP = medical emergency patients; STEMI = ST-elevation myocardial infarction.

In Denmark, all inhabitants have access to universal free healthcare. Systematic use of the patient's personal identification number in relation to healthcare system contacts enables cross-sectorial follow-up of patients.

All MEP and patients with severe trauma, suspected stroke and suspected STEMI who were received with a specialised team response at OUH between 1 November 2012 and 30 September 2015 were identified via local OUH logistic registration systems and included in the study. Patients under the age of 18 years were excluded. Mortality data was collected from the Danish Civil Registration System and discharge diagnoses were collected from the National Patient Registry.

Data sharing statement

The datasets used and/or analysed during the present study are available from the corresponding author on reasonable request.

Analysis

Data are presented as proportions, median and interquartile range (IQR). Where appropriate, 95% confidence intervals (CI) are calculated based on a binominal distribution for proportion estimates and Poisson distribution for incidence estimates.

The trigger call incidence is presented as number of calls per 100,000 person years (py).

Patients are followed until death or the end of the defined mortality period, whichever comes first. Crude 7-day, 30-day and 90-day mortality are presented as unadjusted crude mortality based on incident trigger call contacts. Kaplan Meier curves provide univariate survival overview.

Missing data are treated as such.

Data were analysed using Stata/IC (version 15), College Station, Texas, USA.

Trial registration: The study was approved by the Danish Health Authority (Record no. 3-3013-1385/1) and the Danish Data Protection Agency (Record no. 2013-41-2435). The reporting of this study conforms to the STROBE statement [10].

RESULTS

In the 35 observation months, trigger teams were activated 8,075 times for adult patients on their arrival to the OUH (median = 8, IQR: 6-9, range: 1-18 per day). An additional trigger team was activated in 36 cases (0.5%), for

example, when an initial trauma trigger call was supplemented by a MEP trigger call. In the same period, 165,786 adult patients visited the ED at OUH.

Whereas 7,568 patients (94.7%) experienced a single trigger call during the inclusion period, 374 (4.6%) experienced two trigger calls at different times. The number of trigger calls per person ranged from 1 to 13 in the period.

Of all the trigger team activations, 1,347 (16.7%) were for major trauma, 2,284 (28.3%) for suspected STEMI, 1,594 (19.7%) for suspected stroke and 2,850 (35.3%) for MEP. This corresponds to 160/100,000 py for trauma calls (95% CI: 152-169/100,000 py), 64/100,000 py (95% CI: 62-67/100,000 py) for STEMI calls, 73/100,000 py (95% CI: 69-77/100,000 py) for stroke calls and 339/100,000 py (95% CI: 33-35/100,000 py) for MEP calls.

Table 2 presents demographic characteristics and provides the prognosis of patients by trigger call type. Patients with a trigger call for severe trauma were younger than were patients in the other trigger call categories. MEP had a significantly higher mortality than patients in the other calls with a seven-day mortality of 16%. Increasing age was related to seven-day mortality for all trigger calls (Supplemental Table s1 https://ugeskriftet.dk/files/a04210317_-_supplementary.pdf).

TABLE 2 Demographic information on all included patients.

| Trigger team call	Activations, n	Activations/ day, n, median (IQR)	Activations/100,000 inhabitants/yr, n (95% CI)	Female/ male, %	Age, yrs, median (IQR)	LOS, days, median (IQR)	Mortality, % (95% CI)			Anaesthesiologic assistance and/or ICU, % (95% CI)
							7-day	30-day	90-day	
Trauma	1,347	1 (0-2)	160 (152-169)	29/71	47 (29-62)	3 (1-12)	10 (9-12)	12 (10-14)	13 (11-15)	37 (35-40)
STEMI	2,284	2 (1-3)	65 (61-67)	27/73	65 (54-75)	3 (2-5)	6 (5-7)	8 (7-9)	9 (8-10)	11 (10-12)
Stroke	1,594	1 (1-2)	73 (69-77)	42/58	68 (56-76)	3 (1-9)	3 (3-4)	5 (4-6)	7 (6-8)	8 (7-9)
MEP	2,850	3 (1-4)	339 (327-352)	47/53	69 (55-80)	4 (1-9)	16 (15-17)	24 (22-26)	30 (28-31)	27 (25-28)

CI = confidence interval; ICU = intensive care unit; IQR = interquartile range; LOS = length of stay; MEP = medical emergency patients; STEMI = ST-elevation myocardial infarction.

Time of death among patients in the different trigger calls is presented by Kaplan-Meier survival graphs (Supplemental Figure s1 https://ugeskriftet.dk/files/a04210317_-_supplementary.pdf).

Most trigger team patients arrive during daytime, with the number of trauma patients peaking in the early evening, STEMI patients around noon and MEP patients in the morning. Few patients suspected of having a stroke arrive in the early morning hours (Supplemental Figure s2 https://ugeskriftet.dk/files/a04210317_-_supplementary.pdf). Arrival weekday was not associated with the number of trigger calls arriving at OUH (Supplemental Figure s2).

Whereas the patients from trauma, STEMI and stroke calls were discharged within 3-5 diagnostic main groups in the International Classification of Diseases, version 10 (ICD-10), patients from MEP calls had discharge diagnoses within 13 main ICD-10 coding areas (Figure 2). Further details regarding diagnostic discharge diagnosis for each trigger call are provided in Supplemental Tables s2a-d https://ugeskriftet.dk/files/a04210317_-_supplementary.pdf.

FIGURE 2 Final diagnosis, International Classification of Diseases, version 10.
A. Trauma patients. **B.** ST-elevation myocardial infarction patients. **C.** Stroke patients.
D. Medical emergency patients.
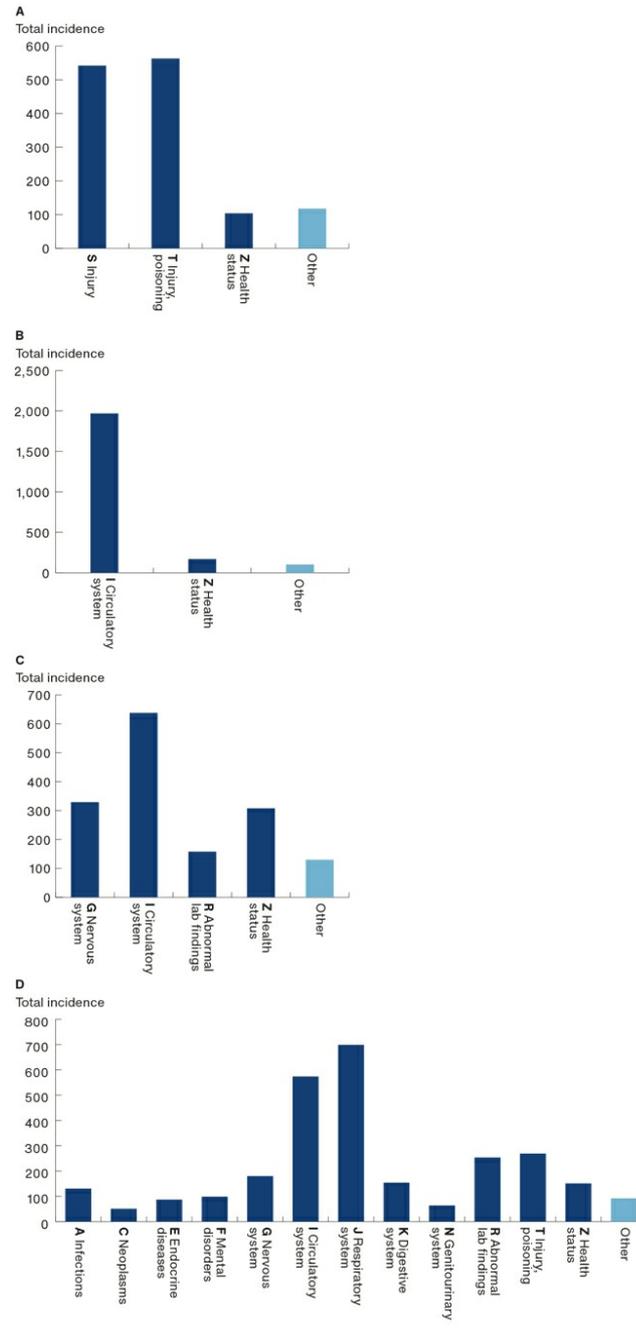
DISCUSSION

In the present study, we found that MEP with trigger calls had a higher incidence, a more diverse aetiology and a higher mortality than patients with trauma, STEMI and stroke trigger calls.

In recent years, considerable improvements in outcome have been achieved for patients with trauma, stroke and STEMI owing to a combination of focused research and systematic work to improve the quality of patient treatment. Well-established databases are in place for patients with trauma, STEMI and stroke (Supplemental Table s3 https://ugeskriftet.dk/files/a04210317_-_supplementary.pdf). As systematic quality improvement in

these time-dependent conditions has triggered the development of the trauma, STEMI and stroke trigger teams , this may also be achieved for MEP.

In the present study, survival rates and base characteristics for patients with trauma, STEMI and suspected stroke at the OUH match those published in the international databases and are in line with earlier studies [4, 5, 7, 11-15]. In the present study, MEP had a higher mortality rate than patients received by the other trigger teams. Part of the explanation for this is a lower age among trauma patients than among the other trigger teams – but differences in comorbidity, systematic work with improved care related to national guidelines and prehospital patient selection are probably further important prognostic factors. Unfortunately, we were unable to explore this further using the present data.

It is unsurprising that the final discharge diagnoses for patients with trauma, suspected stroke and STEMI are each limited to narrow spectrums of the ICD-10 categories as their exposure or presenting symptoms are highly specific. MEP are typically identified when they present with severely impaired vital signs, which - alone or in combination – indicate that the patients might suffer from a highly time-dependent condition. Among MEP, we found a wide distribution of diagnoses covering the entire ICD-10 catalogue. This underlines the diversity of the MEP group and illuminates the complexity of developing diagnostic and treatment guidelines for MEP that cover all possible aspects.

So far, no international consensus exists on the indications, staffing and use of MEP trigger calls, and a review from 2017 concluded that it was impossible to suggest practice recommendations for MEP due to a complex situation and lack of data in the area [16]. In Denmark, one previous study focusing on MEP was published. It revealed a high mortality and wide range of diagnoses for MEP but failed to compare them to other trigger call patients [12]. A few further studies have described MEP [4, 5, 7, 11, 13-15]. These studies reported similar MEP outcomes.

In 2014, a national register and a MEP definition were requested in Germany to better define the patient population and develop guidelines [14]. Following this, a German consensus document was published with a focus on patients arriving at the hospital with sepsis, among other diseases [17]. A possible effect of MEP trigger calls was evaluated in an Australian cohort study, which showed that MEP received by an ICU-based trigger team had a shorter length of stay [16].

In the present study, we identified all patients within the specified catchment areas who had a trigger call. In contrast to previous studies, we are therefore able to provide high-quality incidence estimates. This adds a public health perspective to the different trigger calls. The combination of the high incidence of the MEP trigger calls, their complexity and a high mortality underlines the need for further systematic quality improvement at the individual hospitals as well as at the national level.

Suggestions for trauma team staffing exists [18], but the optimal trigger call staffing remains unknown. From a clinical point of view, a need exists for qualified trigger team staffing 24/7/365. Tailoring of the catchment areas to the different trigger teams ensures sufficient specialised care and guarantees that the critical minimal size of the patient population is reached, thereby ensuring that the necessary level of expertise is available and that sound use of economic resources is exercised. In contrast to MEP teams, trauma, stroke and STEMI teams all follow Danish national standards that consider the need for access to specialists, a sufficient clinical training volume and economic efficiency.

One important issue in relation to all trigger calls is awareness of patient wishes, end-of-life decisions and other ethical considerations that occasionally need to be honoured within a very short time frame. This is a general issue for all types of trigger calls where systematic evaluation and documentation seem to leave room for improvement [19]. These issues are an integrated part of the prehospital referral of patients to STEMI and stroke

calls, but are issues that hospitals need to consider in relation trauma and MEP calls.

Our study has limitations. This was a single-centre study and it therefore reflects the local setup of the trigger teams. We had no information on base values, Charlson Comorbidity Index values or laboratory findings with which to compare the different trigger call patients. As no consensus exists on MEP inclusion criteria, the ones categorised locally might be too selective or not sufficiently selective to be included in an optimal solution. Some patients with out-of-hospital cardiac arrest may mistakenly have been coded as STEMI patients or MEP thereby causing registration bias.

CONCLUSION

Trauma, STEMI and stroke trigger teams treat a prehospitally well-defined patient population. Patients with MEP calls are more frequent, have a diverse aetiology and a higher mortality than patients covered by the other trigger teams.

A need exists for further guidelines and research regarding MEP to ensure that the high mortality rate recorded in this group of patients may be reduced in the future.

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