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Trauma Response for Elderly Anticoagulated Patients: An Initiative to Reduce Trauma Resource Utilization in the Emergency Department

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ABSTRACT

Background: Trauma centers are challenged to have appropriate criteria to identify injured patients needing a trauma activation; one population that is difficult to triage is injured elderly patients taking anticoagulation or antiplatelet (ACAP) medications with suspected head injury.

Objective: The study purpose was to evaluate a hospital initiative to improve the trauma triage response for this population.

Methods: A retrospective study at a Level I trauma center evaluated revised trauma response criteria. In Phase 1 (June 2017 to April 2018; $n = 91$), a limited activation occurred in the trauma bay for injured patients 55 years and older, taking ACAP medications with evidence of head injury. In Phase 2 (June 2018 to April 2019; $n = 142$), patients taking ACAP medications with evidence of head injury received a rapid emergency department (ED) response. Primary outcomes were timeliness of ED interventions and hospital admission rates. Differences between phases were assessed with Kruskal–Wallis tests.

Results: An ED rapid response significantly reduced trauma team involvement (100%–13%, $p < .001$). Compared with Phase 1, patients in Phase 2 were more frequently discharged from the ED (48% vs. 68%, $p = .003$), and ED disposition decision was made more quickly (147 vs. 120 min, $p = .01$). In Phase 2, time to ED disposition decision was longer for patients who required hospital admission (108 vs. 179 min, $p < .001$); however, there were no significant differences between phases in reversal intervention (6% vs. 11%, $p = .39$) or timeliness of reversal intervention (49 vs. 118 min, $p = .51$).

Conclusion: The ED rapid response delivered safe, timely evaluation to injured elderly patients without overutilizing trauma team activations.

Key Words

Anticoagulation, Emergency department, Geriatric patients, Trauma team activation

BACKGROUND

As the average age of the population increases (Roberts, Ogunwole, Blakeslee, & Rabe, 2018), so does the number of older adults presenting to the hospital after traumatic injury (Bergen, Stevens, & Burns, 2016; Calland et al., 2012; Kozar et al., 2015). In addition, there is an increased use of anticoagulation and antiplatelet (ACAP) medications among aging adults (Barnes, Lucas, Alexander, & Goldberger, 2015), which can elevate the risk of bleeding and overall morbidity and mortality, especially for patients with traumatic intracranial hemorrhages (Ayoung-Chee et al., 2014; Boltz, Podany, Hollenbeak, & Armen, 2015; Pieracci, Eachempati, Shou, Hydo, & Barie, 2007). Older adults taking ACAP medications at the time of injury comprise a large and growing group of patients who present to emergency departments (EDs), and appropriate triage and identification of injury are challenges for many hospitals (Bergen et al., 2016; Kozar et al., 2015).

The American College of Surgeons Committee on Trauma requires trauma activation protocols to provide early identification of time-critical injuries while ensuring appropriate use of resources (Committee on Trauma, 2014). Most hospital initiatives to evaluate and revise trauma activation criteria have focused on preventing delayed detection of severe injury (Bardes, Benjamin, Schellenberg, Inaba, & Demetriades, 2019; Bradburn et al., 2018;

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Brown et al., 2015; Calland et al., 2012; Kehoe, Rennie, & Smith, 2015; Kehoe et al., 2016; Newgard et al., 2016). However, it is also important to monitor and manage activation criteria to protect hospital resources and prevent trauma team overuse. Monitoring includes evaluation of whether trauma resuscitation and EDs are used appropriately with minimization of the personnel burden that comes with trauma activations that can draw physicians and nurses away from other tasks and priorities (Jammula et al., 2018; Najafi, Abbaszadeh, Zakeri, & Mirhaghi, 2019; Tominaga et al., 2017).

Previous studies have described the challenges of appropriate triage for elderly patients who take ACAP medications (Bardes et al., 2019; Boltz et al., 2015; Callahan et al., 2020; Carr et al., 2018; Kehoe et al., 2015, 2016; Mason et al., 2017). Elderly injured patients can fail to meet traditional triage activation criteria for physiology and mechanism due to nonspecific symptoms, unreliable physical examination, or delayed presentation to the ED (Calland et al., 2012; Kehoe et al., 2015, 2016; Kozar et al., 2015). Hospitals must continually monitor criteria and activation processes to simultaneously provide prompt detection of severe injury while optimizing trauma and ED resource use (Bradburn et al., 2018; Rittenhouse et al., 2015; Tominaga et al., 2017).

OBJECTIVE

This study aims to evaluate an initiative to improve the trauma triage response at a Level I trauma center for patients taking ACAP medications with evidence of head injury. We hypothesized that implementing an ED-driven rapid response for this patient population would decrease ED resource utilization for relatively uninjured patients without delaying detection of injury and intervention for injured patients.

METHODS

Study Design

A retrospective, pre-/poststudy was performed at a Level I adult trauma center in the Midwest. The trauma center has a two-level trauma activation framework staffed by trauma surgeons taking in-house call 24 hr a day and immediately responding to all full (L1) and limited (L2) activations in the ED. Triage criteria were revised in 2014 to address unacceptably high undertriage rates (Mason et al., 2017). At that time, a "high-risk" category was added to the L2 activation criteria for patients 55 years and older who were taking an ACAP medication and sustained a fall from any height with evidence of head injury. The revised criteria effectively reduced undertriage but also increased overtriage to unacceptable levels (Mason et al., 2017).

Triage criteria were revised again in May 2018, and a third-level (L3) rapid ED response was created. Patients who met L1 activation criteria or other L2 activation criteria still received the appropriate activations following the *Resources for Optimal Care of the Injured Patient* (Committee on Trauma, 2014). Patients who arrived from the scene of injury and previously met the high-risk criterion for an L2 activation were given an L3 ED rapid response. This required evaluation by an ED provider within 30 min of arrival and high priority for the computed tomography (CT) scanner, laboratory tests, and radiology interpretation. If injury was detected or the patient required hospital admission for a medical issue, the trauma team or another specialty service (e.g., orthopedic surgery, neurosurgery, and internal medicine) was consulted to evaluate the patient and manage admission to the hospital. At the study hospital, the staffing model for L2 activations and L3 rapid ED responses is illustrated in Figure 1. A minimum of eight trauma and ED staff respond to an L2 activation, whereas two ED staff respond to an L3 rapid ED response.

To determine the effect of change, the current study compares two study periods: an 11-month period prior to initiating the L3 rapid ED response (Phase 1: June 2017 to April 2018) and an 11-month period after the change (Phase 2: June 2018 to April 2019). Ethical approval for this study was obtained from the hospital's institutional review board. Because data were collected retrospectively, the requirement of informed consent was waived. To ensure safety and appropriate patient triage during Phase 2, all L3 ED responses were reviewed by the trauma program manager, and any variations were addressed through the performance improvement and patient safety program.

Patient Sample

The study sample included patients 55 years and older with blunt mechanism of injury who presented to the ED and were taking an ACAP medication at the time of injury. Patients were excluded from the study sample if they met criteria for an L1 or L2 trauma activation based on physiology, anatomy, or mechanism of injury; therefore, all patients in the sample had a Glasgow Coma Scale >13 and no neurologic focal deficits. Patients who received an L2 trauma activation in Phase 1 were identified from the trauma registry, and patients who received an L3 rapid ED response in Phase 2 were ascertained from ED activity logs. The trauma center specifically excluded aspirin or medications with aspirin (such as aspirin/extended-release dipyridamole) from activation criteria, but patients were included if they took aspirin in combination with another ACAP medication. If a patient had multiple encounters during the study periods, only the first encounter was included in the analyses.

Chart review of the electronic medical record was conducted for data not included in the trauma registry.

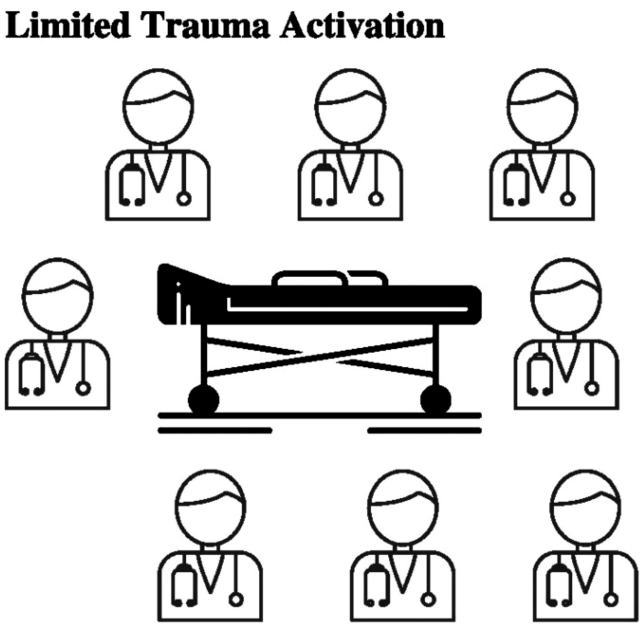

Figure 1. Personnel required for limited trauma activation (Phase 1) and emergency department rapid response (Phase 2).

A standardized data abstraction form and coding rules were used, and two separate abstractors independently reviewed 20% of charts to ensure consistency.

Study Variables

Variables in the analysis included age, sex, entry to ED (ambulance or private vehicle), involvement of hospital services (e.g., neurosurgery, orthopedic surgery, and internal medicine), inhospital mortality, arrival time of day, and ED discharge dispositions. We report on timely interventions for providers at bedside, order for CT imaging, report of CT results, first laboratory results international normalized ratio, ACAP reversal intervention, and total time between ED arrival and ED discharge disposition. Because the Injury Severity Score (ISS) is only available for patients in the trauma registry, a proxy variable for injury was created such that patients were considered injured if an ISS ≥ 4 or there was documentation of fracture requiring outpatient follow-up. Patients were considered uninjured if an ISS <4, or if they were admitted to the hospital only for medical reasons.

Statistical Procedures

Analyses were performed with IBM SPSS Basic Statistics for Windows, v20.0 (IBM Corp, Armonk, NY). Descriptive statistics were examined and reported for continuous data as medians and interquartile range; categorical data were reported as counts and percentages. Because sample sizes were unequal across phases, nonparametric methods were used. Differences between medians were assessed using Kruskal–Wallis tests, and differences between nominal variables were assessed using χ^2 tests.

RESULTS

Demographic characteristics of the study sample are shown in Table 1. There were no significant differences between phases for patient sex, age, or specific ACAP medications. Arrival by ambulance and arrival time of day did not differ between phases. There was a significant change in involved services between Phase 1 and Phase 2, with trauma surgery involvement decreasing (100% vs. 13%, $p < .001$) and emergency medicine involvement increasing (11% vs. 100%, $p < .001$). Involvement of internal medicine, cardiology, and neurosurgery did not differ by phase, but orthopedic surgery was consulted less frequently in Phase 2.

ED disposition differed significantly by phase, with 48% of patients discharging home from the ED in Phase 1, compared with 68% of patients in Phase 2 ($p = .003$) (see Table 2). Of the study patients who required hospital admission, the trauma service was less frequently the admitting service in Phase 2 (82% vs. 13%, $p < .001$). Figure 2 illustrates hospital admission status and admitting service for Phase 2, indicating that the majority of admitted patients in Phase 2 were admitted to the internal medicine service.

Thirty percent of patients in Phase 1 sustained an injury, compared with 23% of patients in Phase 2 ($p = .27$) (see Table 2). There were no significant differences between phases in need for ACAP reversal intervention or mortality. As shown in Table 3, patients were evaluated and received interventions more quickly in Phase 1. Time between ED arrival and provider at bedside differed statistically by phase (0 vs. 7 min, $p < .001$), but there was no significant difference in the percentage of patients who were evaluated by a provider within 30 min

TABLE 1 Demographic Characteristics of Emergency Department Visits

Total $n = 233$	Phase 1 $n = 91$	Phase 2 $n = 142$	p Value
Male, *n* (%)	48 (53%)	67 (47%)	.41
Age, *Mdn* (IQR)	81 (72, 86)	82 (71, 88)	.58
Anticoagulation or antiplatelet, not mutually exclusive, *n* (%)			
Warfarin	34 (37%)	50 (35%)	.74
Clopidogrel	21 (23%)	36 (25%)	.69
Apixaban	10 (11%)	23 (16%)	.27
Dabigatran	4 (4%)	8 (6%)	.68
Rivaroxaban	16 (18%)	18 (13%)	.30
Aspirin[a]	49 (54%)	57 (40%)	.05
Arrival to ED by ambulance, *n* (%)	74 (81%)	108 (76%)	.34
Arrival time of day, *n* (%)			.42
Daytime (7 a.m. to 3 p.m.)	34 (37%)	65 (46%)	
Afternoon (3 p.m. to 11 p.m.)	40 (44%)	56 (39%)	
Evening (11 p.m. to 7 a.m.)	17 (19%)	21 (15%)	
Services involved, not mutually exclusive, *n* (%)			
Trauma surgery	91 (100%)	18 (13%)	<.001
Emergency medicine	10 (11%)	142 (100%)	<.001
Internal medicine	19 (21%)	36 (25%)	.43
Orthopedic surgery	12 (13%)	7 (5%)	.03
Neurosurgery	12 (13%)	15 (11%)	.54
Cardiology	9 (10%)	17 (12%)	.62

Note. ED = emergency department; IQR = interquartile range.
[a]*Aspirin alone is not an activation criterion. Data presented for aspirin are only for patients taking aspirin in combination with another agent.*

of ED arrival (80% vs. 85%, $p = .32$). The time between ED arrival and international normalized ratio result and time between ED arrival and CT report were significantly longer in Phase 2 ($p < .001$ and $p = .01$, respectively). For patients who received ACAP reversal, the time between CT report and ACAP reversal was a median of 69-min longer in Phase 2 when compared with Phase 1, but the difference was not statistically significant ($p = .51$). Patients who were discharged home from the ED were dispositioned more quickly in Phase 2 ($p = .01$), whereas patients who were admitted to the hospital were dispositioned more quickly in Phase 1 ($p < .001$).

TABLE 2 Patient Outcomes

Total $n = 233$	Phase 1 $n = 91$	Phase 2 $n = 142$	p Value
Emergency department disposition to home, *n* (%)	44 (48%)	96 (68%)	.003
Admitted to hospital by trauma service, *n* (%)	36 (82%)	12 (13%)	<.001
Sustained injury, *n* (%)	27 (30%)	33 (23%)	.27
Received reversal intervention, *n* (%)	5 (6%)	15 (11%)	.39
Mortality, *n* (%)	1 (1%)	3 (2%)	.56

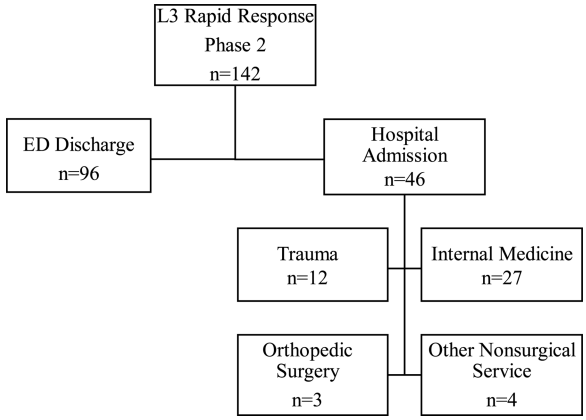

Figure 2. Consort diagram of hospital admission and admitting service in Phase 2.

DISCUSSION

Verified trauma centers continuously monitor and revise triage criteria to ensure that injured patients are evaluated efficiently, and interventions are delivered promptly. In 2014, the study hospital adopted aggressive trauma activation criteria that improved timeliness of resource delivery for elderly patients taking ACAP medications (Mason et al., 2017). However, in the years that followed, an unacceptably large proportion of patients who received the limited trauma activation were ultimately found to be uninjured, which overused ED resources and contributed to staff dissatisfaction. The present study reports on maintaining priority for this at-risk population while using hospital resources more discriminately. Findings indicate that relatively few patients in either study period sustained a significant injury, and only a small minority of patients were injured severely enough to necessitate ACAP reversal. Notably, the L3 rapid ED response allowed for a more efficient process of care but did not adversely affect clinical outcomes or delay timeliness of interventions. This effort reduced overall admissions to the hospital and involvement of the trauma team.

It is noted that, in Phase 2, some resources took slightly longer to deploy. For example, the time between ED arrival and provider at bedside was longer in Phase 2, but 85% of patients were evaluated within 30 min of arrival. Similarly, reversal intervention took approximately 1 hr longer in Phase 2, but in both phases, only a minority of patients required reversal, and the delays were neither statistically nor clinically significant compared with Phase 1. Although resource delivery may have been slightly delayed with the L3 rapid ED response, resources were still deployed in a timely manner that maintained priority for this patient population and met hospital guidelines and best practice parameters.

Although quantification of staff satisfaction was not part of this project, anecdotally, the change in response criteria resulted in improvements in nursing and physician morale. During the 11-month study period of Phase 2, 142 patients received an L3 response who would have otherwise received an L2 activation in Phase 1. This translates to 852 fewer health care worker instances of involvement with patients who, as a group, were predominantly uninjured (six fewer health care workers per L3 vs. L2 response, Figure 1). It is important to recall that the primary goal of a trauma activation is to provide rapid resuscitation and quickly mobilize trauma-related resources to address time-sensitive injuries; the previous criteria were overusing trauma-related resources and staff. The L3 rapid

TABLE 3 Timeliness of Interventions

Total *n* = 233	Phase 1 *n* = 91 *Mdn* (IQR)	Phase 2 *n* = 142 *Mdn* (IQR)	*p* Value
Time between ED arrival to provider at bedside (min)	0 (0, 3)	7 (2, 11)	<.001
Percentage of provider to bedside within 30 min of arrival	73 (80%)	121 (85%)	.32
Time between ED arrival to INR result (min)	38 (33, 48)	57 (40, 76)	<.001
Time between ED arrival and CT report (min)	52 (39, 61)	57 (43, 82)	.01
Time between CT report and reversal intervention (min)	49 (−12, 213)	118 (29, 165)	.51
Time between ED arrival to ED disposition decision			
ED discharges	147 (105, 198)	120 (89, 153)	.01
Hospital admissions	108 (83, 167)	179 (135, 275)	<.001

Note. CT = computed tomography; ED = emergency department; INR = international normalized ratio; IQR = interquartile range.

ED response avoided unnecessary mobilization of trauma staff. In hindsight, it would have been interesting to investigate trauma and ED staff morale during Phase 1 versus Phase 2.

In both phases, most patients with an L2 (Phase 1) or L3 (Phase 2) rapid ED response were discharged home from the ED, indicating that, in Phase 1, the criteria were overly aggressive with low detection of injury. Hospital admission was reduced from 52% in Phase 1 to 32% in Phase 2, and admission to the trauma service was reduced dramatically. At six fewer health care worker instances of automatic involvement in each Phase 2 L3 rapid ED response (Figure 1), this should translate to health care savings.

It is noteworthy that there was a significant difference between Phase 1 and Phase 2 in the amount of time between ED arrival and ED disposition decision for patients admitted to the hospital (108 vs. 179 min, $p < .001$). We suspect that the appearance of a delay between ED arrival and hospital admission in Phase 2 reflects ED physician time determining that the patient required admission and then identifying and contacting the appropriate service to admit the patient to the hospital. In contrast, in Phase 1, the trauma service would have both seen the patient initially and been the hospital admitting service. Therefore, any time involved in any subsequent transition to a different service (e.g., internal medicine and cardiology) would not be present in the Phase 1 ED arrival to hospital admission time.

We know this effort could not be accomplished without commitment from ED and radiology staff, who worked with the trauma team to design a collaborative and safe approach that did not cause undue burden or increase the workload of otherwise busy providers. Specifically, ED physicians had to assume primary evaluation for this population and agree to see these patients within 30 min of arrival; this is similar to responsiveness for other alerts (e.g., cardiac and stroke) and was easily adopted into existing workflow. In addition, the workload for radiologists did not change in terms of volume or timeliness of interpreting CT scans, but a revised process was required for radiologists to communicate results to ED staff. Finally, this initiative was heavily driven by an obligation to support ED nurses and improve ED staff allocation, especially during high census times. The effort would not have been successful or sustainable without support and commitment from ED nurses.

Limitations

This study has several limitations. First, we are unable to calculate specific cost savings due to significant changes in hospital billing during the study periods. There is an additional patient charge for any full or limited trauma activation; therefore, we know that the L3 rapid ED response was a more cost-effective approach for both the hospital and patients. Second, we are unable to report the ISS for the majority of Phase 2 patients because they were not included in the trauma registry. We know that the majority of patients in Phase 2 were diagnosed with superficial lacerations and hematomas, which would translate to an ISS of 0–1 if coded in the registry. In turn, this does not allow us to compute a traditional undertriage and overtriage rate that relies on the ISS. Third, we did not track subsequent ED visits or missed injuries in either phase of the study.

CONCLUSION

Study results indicate that a rapid ED trauma response protects trauma resources while maintaining safe, timely evaluation to elderly patients.

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KEY POINTS

- It is safe to provide a rapid ED response for head-injured elderly patients taking anticoagulation medications.
- The rapid response dramatically reduced trauma team involvement and allowed for better nurse utilization in the ED.
- The rapid response allowed for quicker ED disposition for patients who did not require hospital admission.

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