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Systematic review

Emergency Department Initiated Versus Trauma Team Initiated Massive Transfusion Protocols After Injury: A Review of Activation, Time to Transfusion, and Clinical Outcomes

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Abstract

Background: Massive transfusion protocols coordinate urgent blood delivery after injury. Activation authority varies in trauma systems and frequently overlaps between emergency physicians and trauma teams. This review examined activation practices, transfusion timing, and clinical outcomes. Methods: Ten original studies published before June 2026 were examined through structured narrative synthesis. Evidence addressed clinician decisions, prehospital activation, automatic activation, blood delivery, and protocol implementation. Direct specialty comparisons were distinguished from indirect workflow data. Results: One prospective cohort reported transfusion initiation by trauma surgeons in 35% and emergency clinicians in 19%, without comparative specialty outcomes. A multicenter analysis associated each additional minute to initial cooler delivery with increased adjusted mortality odds. Simulation informed improvement reduced activation to blood administration from 11.6 to 9.1 minutes. Implementation cohorts reported faster blood availability, with inconsistent mortality findings. A contemporary cohort documented protocol reactivation in 7.5% of patients, illustrating the importance of reassessment after initial activation. Conclusion: Data supports rapid recognition, coordinated activation, and efficient transfusion delivery after injury in routine clinical practice. Comparative research requires clinician attribution, standardized timing intervals, and adjustment for injury severity, shock, blood availability, and resuscitation changes in participating trauma systems and different treatment environments.

Keywords: Massive transfusion; trauma; emergency department; protocol activation; transfusion timing.

Introduction

Traumatic hemorrhage requires rapid coordination of resuscitation, bleeding control, and transfusion support from the moment an injured patient reaches hospital. European guidance emphasizes early recognition of bleeding, repeated assessment of coagulation, and organized treatment pathways across emergency, surgical, and transfusion services (1). Acute traumatic coagulopathy is present in a large proportion of patients at admission, with one foundational cohort identifying coagulopathy in 24.4% of evaluable patients and higher mortality among affected patients (2). These observations establish the clinical importance of recognizing hemorrhage before transfusion requirements accumulate over several hours (1,2).

Massive transfusion protocols (MTPs) coordinate the rapid provision of red blood cells, plasma, and platelets while definitive hemorrhage control proceeds (1,3). In the PROPPR trial, a 1:1:1 transfusion strategy increased hemostasis and reduced deaths from exsanguination relative to 1:1:2, without a statistically significant difference in overall mortality at either primary endpoint (3). The PROMMTT investigation associated higher early plasma and platelet ratios with improved early survival, highlighting the importance of when blood components are administered (4). These studies support early hemostatic resuscitation, while leaving the separate question of who activates the protocol unresolved (3,4). Activation decisions combine physiological assessment, anticipated bleeding, injury characteristics, and clinician judgment within a local response system (5,6). The Assessment of Blood Consumption score uses penetrating injury, focused ultrasonography, systolic hypotension, and tachycardia as immediately available predictors. Its original evaluation reported 75% sensitivity and 86% specificity for massive transfusion at a threshold of two points (5). Protocol development literature additionally emphasizes coordinated responsibilities in emergency medicine, surgery, anesthesia, nursing, and transfusion medicine, demonstrating that activation represents one stage within a broader multidisciplinary process (6).

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Institutional activation arrangements is heterogeneous, with a United States survey reporting trauma surgeon activation in 80% of responding centers and automatic activation in 24%. The study also documented substantial variation in component packaging and emergency department blood storage across the participating trauma centers (7). Because an emergency physician also participates in a trauma team, the location of initial treatment does not independently identify the activating specialty. This distinction complicates comparisons labeled emergency department initiated versus trauma team initiated and demands explicit reporting of authority, trigger, and timing (6,7). The present review examines activation practices, transfusion intervals, and clinical outcomes after injury, with particular attention to whether reported findings support a comparison between activating clinicians or instead describe the performance of the surrounding transfusion system.

Methods

This review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework (Fig 1). The review examined massive transfusion protocol activation after injury, focusing on activating clinicians, transfusion timing, and clinical outcomes. Direct comparisons between emergency physician and trauma team initiation were distinguished from studies evaluating activation criteria, prehospital notification, automatic activation, or transfusion logistics.

PubMed, Scopus, and Web of Science were searched from database inception through 31 May 2026. The searches combined controlled vocabulary, where available, and free-text terms relating to trauma, injury, massive transfusion, major hemorrhage, protocol activation, emergency departments, trauma teams, and transfusion timing. Reference lists of relevant publications were also examined to identify additional reports. Duplicate records were removed before screening.

Original observational studies, interventional studies, and implementation evaluations were eligible when they reported activation practices, transfusion intervals, or clinical outcomes in injured patients. Mixed-age cohorts were retained when relevant trauma transfusion data were available. Reviews, editorials, isolated case reports, studies reporting simulation outcomes alone, and reports with inseparable non-traumatic populations were excluded from the results synthesis. Background references were considered separately from studies contributing original outcome data.

Two authors independently screened titles and abstracts and subsequently assessed potentially eligible full texts. Both authors independently extracted study design, setting, eligibility criteria, sample size, activating clinician, activation criteria, timing definitions, blood product availability, transfusion exposure, and clinical outcomes. Disagreements concerning eligibility or extraction were resolved through discussion. Overlapping recruitment periods and participating institutions were examined to avoid duplicate representation of patient populations.

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The primary outcome was time from hospital arrival to first transfusion. Recognition-to-activation, activation-to-delivery, and activation-to-administration intervals were evaluated separately because they represented different stages of care. Secondary outcomes included early and hospital mortality, hemostasis, blood component utilization, wastage, complications, and protocol reactivation. Methodological limitations were examined through selection criteria, historical comparators, confounding, exposure classification, outcome measurement, and missing information. Adjusted and unadjusted estimates were distinguished, and original denominators and timing definitions were retained. Findings were synthesized narratively because activating roles, interventions, populations, and outcome definitions differed across studies. A pooled comparison between initiating specialties was not calculated.

Treatment location alone was not used to infer activating specialty. Protocol implementation effects were interpreted within accompanying changes in transfusion composition, resuscitation practice, and the organization of hemorrhage management. Evidence addressing activation authority was presented separately from evidence addressing blood delivery, since these exposures reflected different clinical decisions and operational processes.

Results

Sisak et al. described 91 transfused patients, with first transfusion initiated by trauma surgeons in 35% and emergency clinicians in 19%; outcomes were not compared between these specialties (8). Motameni et al. examined 3,421 trauma admissions and found that 81% of operating room activations based on clinical judgment met criteria for earlier emergency department activation using the Assessment of Blood Consumption score (9). Botteri et al. documented 219 prehospital activations, of which trauma team leaders confirmed 146 after hospital arrival (10). Weykamp et al. reported 142 reactivations among 1,884 patients, within a system featuring automatic initial activation for most patients and joint emergency medicine and trauma surgery leadership (11).

Meyer et al. analyzed 680 patients from 12 trauma centers, reporting median arrival to activation and activation to first cooler intervals of nine and eight minutes, respectively. Each additional minute to cooler delivery was associated with adjusted mortality odds ratios of 1.05 at both 24 hours and 30 days, representing associations rather than randomized timing effects (12). Gray et al. reduced mean activation to administration time from 11.6 to 9.1 minutes following simulation informed process improvement; the mean reduction was 2.5 minutes, with a 95% confidence interval of 0.03-5.08 minutes (13). O'Keeffe et al. compared 132 protocol patients with 46 historical controls, reporting a reduction in the interval between first and second shipments from 42 to 18 minutes and no mortality improvement (14).

Riskin et al. compared 37 post-implementation patients with 40 historical controls, finding mortality of 19% versus 45% despite identical plasma to red cell ratios. Mean time to first crossmatched red cells decreased from 115 to 71 minutes, and time to first plasma decreased from 254 to 169 minutes; these measures did not represent time to the first emergency uncrossmatched transfusion (15). Cotton et al. evaluated 211 patients and reported a 74% adjusted

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reduction in mortality odds after introduction of an exsanguination protocol, alongside reduced component consumption (16). Dente et al. compared 73 protocol patients with 84 historical controls and reported 24-hour mortality of 17% versus 36%, with changes in plasma exposure and crystalloid administration accompanying implementation (17).

Activation criteria, workflow redesign, and protocol implementation represented distinct exposures rather than interchangeable versions of an activating specialty comparison. Tables 1 and 2 summarize study designs and selected process outcomes, preserving the distinction between clinician decisions, product shipment, bedside arrival, and transfusion administration. Dente's eligibility criteria excluded 15 patients who died without receiving ten red cell units, identifying a source of selection bias. This exclusion limits interpretation of the reported mortality difference as an unbiased estimate applicable to every injured patient assessed for emergency massive transfusion protocol activation in clinical practice (17). Implementation studies frequently changed several elements simultaneously, preventing attribution of their mortality findings to emergency department initiation or trauma team initiation alone (14-17). The reviewed evidence therefore supported a narrative assessment of activation systems and transfusion timeliness without producing a pooled comparative effect for the two initiating teams.

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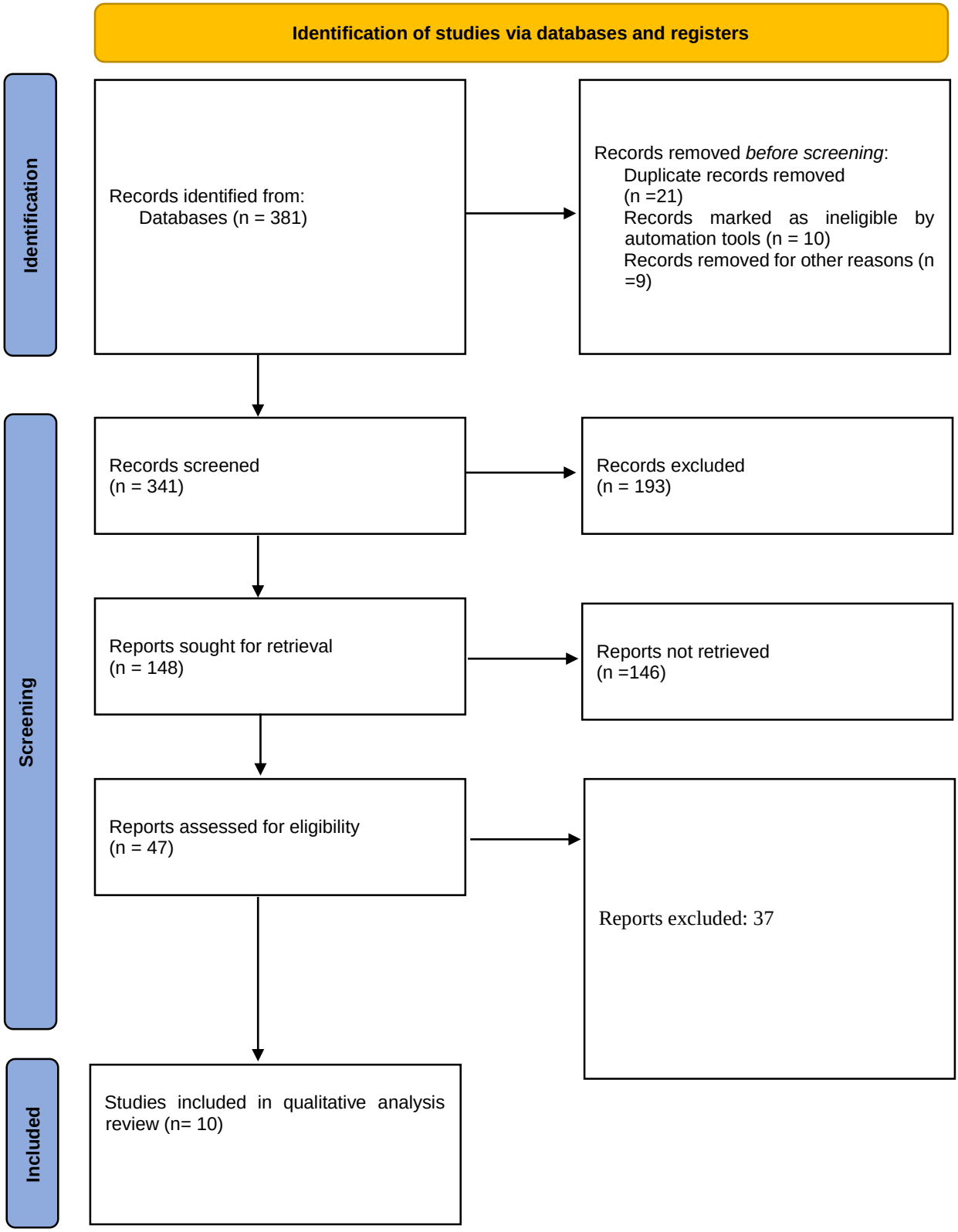


Figure 1: PRISMA flow chart

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Table 1. Original studies informing the synthesis

Study	Design	Patients
Sisak (8)	Prospective cohort	91
Motameni (9)	Retrospective cohort	3,421
Botteri (10)	Retrospective cohort	219
Weykamp (11)	Retrospective cohort	1,884
Meyer (12)	Secondary analysis	680
Gray (13)	Before-after evaluation	NR
O'Keeffe (14)	Historical controls	178
Riskin (15)	Historical controls	77
Cotton (16)	Historical controls	211
Dente (17)	Historical controls	157

Table 2. Selected reported timing measures

Study	Interval	Minutes
Meyer (12)	Arrival to activation	9, median
Meyer (12)	Activation to cooler	8, median
Gray (13)	Activation to administration	11.6 to 9.1, mean
O'Keeffe (14)	First to second shipment	42 to 18
Riskin (15)	First crossmatched red cells	115 to 71, mean

Discussion

We found that that the available studies characterize activation systems more clearly than they compare activating specialties, leaving the independent effect of emergency physician versus trauma team initiation unresolved. Earlier recognition, explicit communication, and rapid

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blood movement emerge as relevant process targets in different institutional arrangements (9,10,13-15). This interpretation aligns with data that clinician judgment has limited predictive accuracy, Pommerening et al. reported sensitivity of 65.6% and specificity of 63.8% for clinical gestalt in predicting massive transfusion (18). The strongest inference concerns reliable access to an organized hemorrhage response, with specialty attribution requiring separate investigation (6,18).

The distinction between prediction and successful treatment is relevant when evaluating overactivation (9,19). A patient receiving fewer than ten red cell units after prompt hemorrhage control does not necessarily represent an unnecessary activation, because the intervention changes the subsequent transfusion requirement. Savage et al. proposed the critical administration threshold to address the timing limitations and survivor bias of conventional massive transfusion definitions (19). Stanworth et al. found no discrete mortality threshold at ten units, reinforcing the limitations of classifying activation success solely through a retrospective transfusion total (20).

Time measures require careful interpretation because activation, shipment, blood arrival, and administration reflect different operational stages (13-15). The association between slower cooler delivery and mortality supports attention to logistics, while the observational timing analysis does not establish a causal mortality increment for each minute of delay (12). Gray's process improvement study provides evidence that addressing activation, transport, and team awareness reduces administration delays, with no direct specialty comparison establishing which clinician produces the improvement (13). Riskin's shorter crossmatched product intervals similarly describe improved product availability rather than a measured reduction in time to the first emergency transfusion (15).

Reported survival improvements remain inseparable from changes in component ratios, crystalloid exposure, protocol adherence, and the broader evolution of trauma care (14-17). Emergency physicians and trauma surgeons also work within shared resuscitation structures, as illustrated by the joint leadership and automatic activation system described by Weykamp et al. (11). An implementation inference is therefore that a locally agreed activation pathway needs prompt access for the clinician recognizing major hemorrhage, with simultaneous trauma team engagement and continuing reassessment after stand down (1,11). The absence of an established specialty effect does not diminish the clinical importance of avoiding preventable activation and transfusion delays (10,13).

Interpretation of this data requires transparent reporting of search methods, study selection, and the separation of direct from indirect findings in accordance with PRISMA 2020 (21). Historical control comparisons also require assessment of confounding, selection, exposure classification, and outcome measurement, which are central domains within ROBINS-I (22). Future comparative studies need explicit activating clinician records, shared timing definitions, adjustment for shock and injury severity, and documentation of concurrent transfusion system changes (21,22). Their value lies in identifying measurable delays and improving shared clinical accountability. These design requirements follow directly from the methodological limitations of using protocol

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implementation cohorts to answer a question about the specialty initiating treatment.

Conclusion

Rapid hemorrhage recognition, coordinated protocol activation, and efficient blood delivery are impoartant features of effective transfusion systems after injury. The ten original studies reviewed provide data on activation practices, operational delays, and protocol implementation. They do not establish that emergency department initiation produces better survival or faster transfusion than trauma team initiation. Reported mortality improvements accompany broader resuscitation changes, limiting attribution to activating specialty. Clinical pathways benefit from clearly assigned responsibilities, accessible activation, reliable blood transport, and repeated reassessment. Future studies require clinician attribution, consistent timing outcomes, and adequate adjustment for patient severity and institutional differences in transfusion resources.

Abbreviations

ABC: Assessment of Blood Consumption; MTP: massive transfusion protocol; NR: not reported; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; ROBINS-I: Risk of Bias In Non-randomized Studies of Interventions.

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