Medical Science

To Cite:
Alanazi MM, Alsuwaigh MAA, Twair AAA, Alkraidis AS. Impact of Massive Transfusion Protocol Implementation on Survival, Blood Product Utilization, and Quality Indicators in Trauma: A Systematic Reviews. *Medical Science* 2026; 30: e25ms3759
doi: https://doi.org/10.54905/disssi.v30i168.e25ms3759

Authors' Affiliation:
[1]Saudi and Jordanian Board Emergency Medicine, Emergency Department, Head of Emergency Research Unit, First Health Cluster, Riyadh, Saudi Arabia; Email: moazi99@hotmail.com; Orcid: 0009-0003-5836-8086
[2]Saudi Board Emergency Medicine Resident, Emergency Department, First Health Cluster, King Saud Medical City, Riyadh, Saudi Arabia Email: mr.mohammed.3ss@gmail.com
[3]Saudi Board Emergency Medicine Resident, Emergency Department, Second Health Cluster, King Fahad Medical City, Riyadh, Saudi Arabia; Email: aa.twair@gmail.com
[4]Assistant Consultant General Surgery, Department of general surgery, Prince Mohammad bin Abdulaziz Hospital, Riyadh, Saudi Arabia; Email: as.ns.2014@gmail.com; Orcid: 0009-0001-4537-5880

Peer-Review History
Received: 09 August 2025
Reviewed & Revised: 18/August/2025 to 21/January/2026
Accepted: 30 January 2026
Published: 9 February 2026

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

Impact of Massive Transfusion Protocol Implementation on Survival, Blood Product Utilization, and Quality Indicators in Trauma: A Systematic Reviews

Mazi Mohammed Alanazi[1], Mohammed Aamer A Alsuwaigh[2], Abdullah Ahmad A Twair[3], Abdulmajeed Salem Alkraidis[4]

ABSTRACT

Background: Massive transfusion protocols (MTPs) decrease traumatic hemorrhage mortality, allow balanced blood component replacement, and decrease the delays in hypothermia correction. *Method*: We reviewed the original studies on MTP implementation, and we include eight single and multicenter cohorts. The included studies evaluated performance indicators (KPIs), protocol adherence, WB timing, rural WB program implementation, sociodemographic patterns in MTP use, and effects of protocol adoption. *Result*: according to the included studies earlier WB use and more balanced transfusion ratios were associated with lower mortality. Eight original studies were included in January 2020 to July 2025. Two cohort studies assessed MTP implementation, one cohort examined the association between protocol adherence and survival, and a large U.S. cohort evaluated whether earlier WB was associated with improved survival. A study in U.S described outcomes and wastage after implementing a WB program. One Indian study developed KPIs for MTP. MTP implementation and performance monitoring are associated with improved outcomes and processes in trauma systems. *Conclusion*: Current research deficits persist, notably the lack of consensus regarding criteria for therapeutic futility and the absence of standardized definitions for clinical outcomes. A critical remaining gap is the evaluation of viscoelastic guided, precision resuscitation protocols. To address these issues, we advocate for the development of a practice-oriented evidence map that delineates key priorities for standardization and facilitates quality improvement initiatives focused on equity in care delivery.

Keywords: massive transfusion; trauma; damage control resuscitation; whole blood; protocol adherence; time to transfusion

1. INTRODUCTION

Hemorrhage is an important cause of preventable death after trauma. Damage control resuscitation (DCR) is a coordinated approach that integrates rapid

hemorrhage control with targeted resuscitation to decrease blood loss and prevent trauma induced coagulopathy. The American Association for the Surgery of Trauma and American College of Surgeons Committee on Trauma protocol states that DCR "aims to limit blood loss and prevent and treat coagulopathy" and achieves this by "combining early definitive hemorrhage control, hypotensive resuscitation, and early and balanced use of blood products" (LaGrone et al., 2024). Earlier practice management guidelines indicate benefits of massive transfusion (MT), higher plasma and platelet to RBC ratios (Cannon et al., 2017).

MTPs are widely adopted, and the measured impact of implementation differ in institutions, patient populations, and protocol designs. In an updated systematic review, Consunji and colleagues reported a significant reduction in mortality following MTP implementation and indicate the need for standard nomenclature, indicators, protocols and patient populations to improve comparability across studies (Consunji et al., 2020). The efficacy of viscoelastic assays in guiding goal directed therapy is subject to mixed results in clinical trials. Whole blood (WB) resuscitation is increasingly used in trauma care because of operational advantages (Lin et al., 2025).

This systematic review study analyzed original articles evaluating MTP implementation, and utilization. Our study aim is to summarize effects on survival and blood product use, to assess protocol performance, examine associations between adherence and outcomes, and describe criteria and outcomes related to transfusion futility.

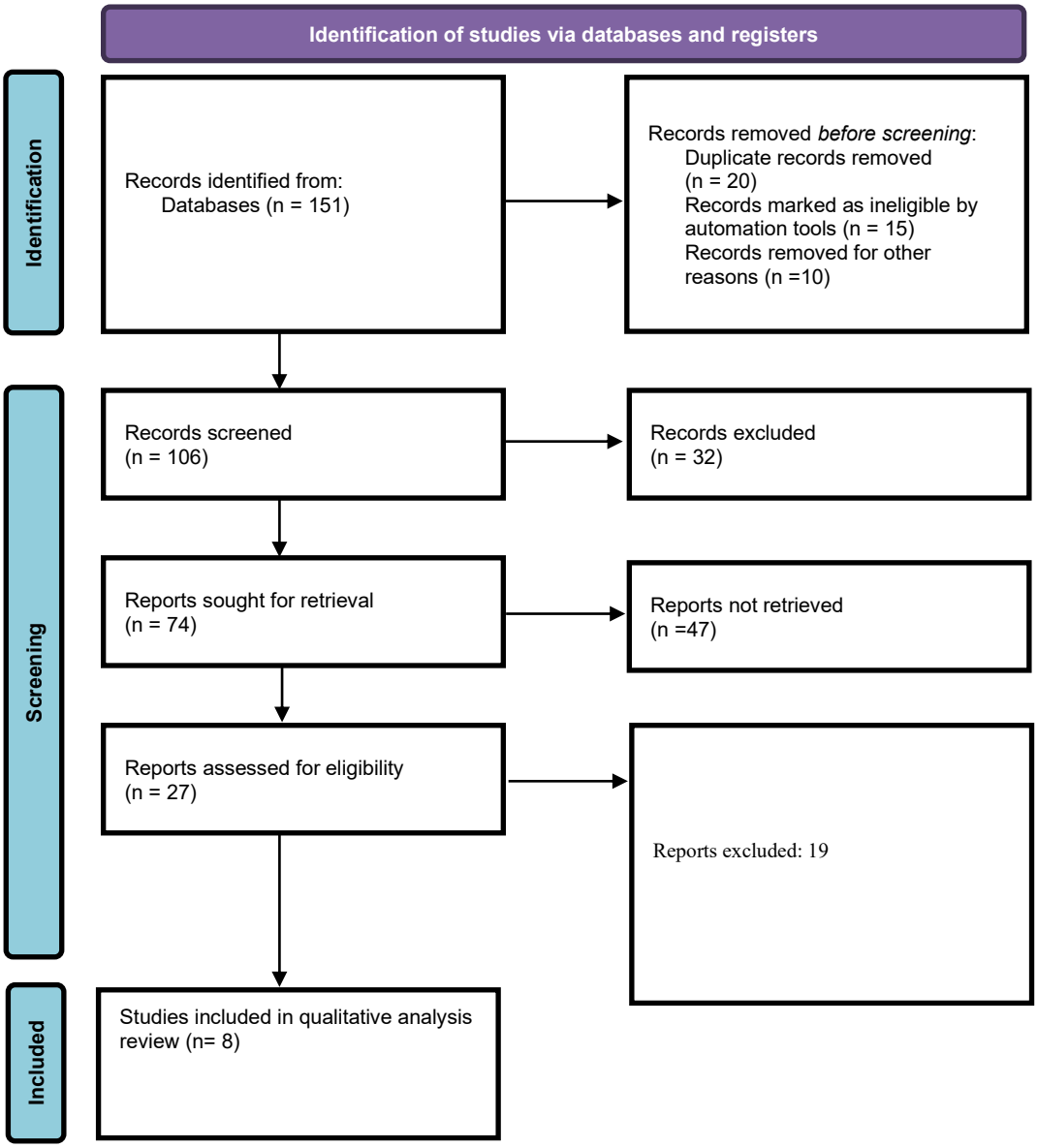

Figure 1: PRISMA consort chart

2. REVIEW METHODS

Protocol and question: We conducted a systematic review of MTP activation in adult trauma patients. In injured adults with severe hemorrhage, we assessed how MTP implementation, timing, and utilization patterns affect mortality and blood product use. We include eight original studies reported MTP implementation process or clinical outcomes in trauma. No additional databases were queried, in order to avoid introducing unvetted material (Fig 1).

Inclusion criteria: We included 8 original studies of trauma populations. We include studies evaluateed MTP implementation, adherence, transfusion timing, or utilization patterns and report clinical or process outcomes. Only English language publications were eligible. We exclude studies with pediatric only population, obstetric only, non-trauma surgical cohorts, and purely modeling, simulation without clinical outcomes.

Primary outcome was mortality (early: 4 to 24 h, in hospital, 30 day) and secondary outcome include time to first transfusion, product ratios (FFP: RBC), product use (PRBC, FFP, platelets, cryoprecipitate), MTP adherence, KPIs, wastage, activation, utilization patterns.

Study selection and data extraction: Two reviewers used study files to screen the title, abstract, content against criteria. We extracted the following variables in data extraction table (setting, design, sample size, MTP exposure, implementation, adherence, timing, WB program, and outcomes). We grouped studies by MTP implementation effects, process, adherence and outcomes. We prepared two prespecified tables: study characteristics and key findings.

3. RESULTS

Study overview

Eight original studies in January 2020 to July 2025 and diverse systems were included. Two Korean cohort studies assessed MTP implementation. A U.S. cohort examined the association between protocol adherence and survival. A large U.S. cohort evaluated whether earlier WB was associated with improved survival. A rural U.S. level II trauma center described outcomes and wastage after implementing a WB program. One Indian study developed KPIs for MTP. One study discussed how differing definitions of MTP affect futility thresholds. Study characteristics are summarized in Table 1.

Table 1. Characteristics of the included studies

Study	Design and study setting	Population and sample size	Intervention and exposure	Comparator	Main outcomes	Key results
Margolin et al., 2023	Retrospective descriptive Nov 2018 to Oct 2020	Trauma patients with MTP activation n=95	Provider adherence to revised MTP	Higher vs lower adherence	24 hr survival	24 hr survival 75%; survival to discharge 68%. Median adherence higher in survivors than nonsurvivors
Torres et al., 2024	Retrospective cohort 2019 to 2020	Adult trauma with severe hemorrhage n=1394	Earlier time to first whole blood transfusion	Later WB transfusion timing	Survival at 24h and 30 days	Earlier WB associated with improved survival: 24h aHR 0.40; 30-day aHR 0.32; survival benefit evident early after ED arrival.
Orr et al., 2024	Nonrandomized retrospective observational; single rural Level II trauma center 2020 to 2022	Adult MTP activations (WB n=37; component n=31)	Cold stored whole blood program	Component therapy only	Mortality; wastage rates; compliance monitoring	Mortality lower with WB.
Arnold et al., 2025	Retrospective database analysis Jan 2017 to Jun 2022	ED trauma activations; n=8670	Likelihood of MTP activation and MTP transfusion and sociodemographic factors	-	MTP activation; MTP transfusion; in ED mortality	MTP activation and transfusion linked to higher in ED mortality Penetrating trauma strongly increased odds Models AUC 0.876

						(activation) and 0.935 (transfusion).
Ninan et al., 2024	Cross sectional data analysis Jan 2021 to Dec 2022	Adult massive transfusion events; n=92	KPI development using DMAIC	Evaluation comparisons and inappropriate activations	KPI metrics mortality; LOS	Appropriate activation 43.47%. TAT within benchmark in 85.8%
Lee et al., 2022	Retrospective single-center; regional trauma center 2014 to 2016	MT patients n=185	Massive transfusion protocol implementation and transfusion ratio tracking	Pre and post protocol periods	Transfusion ratios time to first transfusion, mortality	After protocol, FFP:RBC ratio improved and time to first transfusion shortened Higher FFP:RBC associated with lower mortality.
Sun et al., 2020	Retrospective before and after Jan 2016 to Sep 2019	Trauma patients receiving ≥10 PRBC units MT total 370 n=84 MTP n=55	MTP implementation	Pre implementation	Time to transfusion; blood product use ratios; outcomes	Time to transfusion decreased Cryoprecipitate use and cryo: PRBC ratio increased; no significant differences in PRBC/FFP/PLT unit.

4. DISCUSSION

The development of MTPs have been associated with a reduction in mortality and overall blood product use (ACS TQIP, 2014). In its introduction, the guideline also emphasizes that exsanguination accounts for more than 80 percent of deaths in the operating room and nearly half of deaths within 24 hours, underscoring why a prepared MTP matters (ACS TQIP, 2014).

This aligns with the updated meta-analysis reporting that MTP significantly reduced the overall mortality (OR 0.71, 95% CI 0.56–0.90) and concluding it should be recommended to all institutions managing acutely injured patients. The authors also call for standard nomenclature, indicators, protocols and patient populations to clarify which elements drive benefit (Consunji et al., 2020).

At the same time, evidence syntheses stress real-world constraints: heterogeneity of trauma patient populations and lack of standard reporting still constrain the ability, to conduct more optimal analysis (Consunji et al., 2020). Our interpretation therefore prioritizes reproducible, guideline-anchored processes while recognizing study-design limits.

Activation & prediction. ACS TQIP notes that mortality is improved with rapid activation but warns of complications from unnecessary exposure; it highlights the Assessment of Blood Consumption (ABC) score, pulse > 120, SBP < 90, positive FAST, penetrating torso injury, and states that a score of two or more warrants MTP activation. (ACS TQIP, 2014). The same CPG reports that giving blood in the pre hospital setting as early as possible after injury improved 24 hour and 30-day survival, this support earlier blood-based resuscitation within a DCR framework (Marinho et al., 2025).

5. CONCLUSION

MTP implementation and performance monitoring are associated with improved outcomes and processes in trauma systems. Current research deficits persist, notably the lack of consensus regarding criteria for therapeutic futility and the absence of standardized definitions for clinical outcomes. A critical remaining gap is the evaluation of viscoelastic guided, precision resuscitation protocols. To address these issues, we advocate for the development of a practice-oriented evidence map that delineate key priorities for standardization and facilitate quality improvement initiatives focused on equity.

Acknowledgments

The authors have no acknowledgments to disclose.

Informed consent

Not applicable.

Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

Funding

This research did not receive any external funding like specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Conflict of interest

The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on reasonable request to the Corresponding Author.

REFERENCES

1. American College of Surgeons. ACS TQIP Massive Transfusion in Trauma Guidelines. 2014.
2. Arnold M, Sharma B, Conn M, Twelker K, Bhatia ND, Agriantonis G, Dave J, Mestre J, Shafaee Z, Whittington J. Analysis of Massive Transfusion Protocol Utilization in Trauma Across Sociodemographic Groups. Medicina (Kaunas) 2025;61(7):1133. doi: 10.3390.medicina61071133.
3. Cannon JW, Khan MA, Raja AS, Cohen MJ, Como JJ, Cotton BA, Dubose JJ, Fox EE, Inaba K, Rodriguez CJ, Holcomb JB, Duchesne JC. Damage control resuscitation in patients with severe traumatic hemorrhage: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg 2017;82(3):605-617. doi: 10.1097.TA.0000000000001333.
4. Consunji R, Elseed A, El-Menyar A, Sathian B, Rizoli S, Al-Thani H, Peralta R. The effect of massive transfusion protocol implementation on the survival of trauma patients: a systematic review and meta-analysis. Blood Transfus 2020;18(6):434-445. doi: 10.2450.2020.0065-20.
5. LaGrone LN, Stein D, Cribari C, Kaups K, Harris C, Miller AN, Smith B, Dutton R, Bulger E, Napolitano LM. American Association for the Surgery of Trauma, American College of Surgeons Committee on Trauma: Clinical protocol for damage-control resuscitation for the adult trauma patient. J Trauma Acute Care Surg 2024;96(3):510-520. doi:10.1097.TA.0000000000004088.
6. Lee MA, Park H, Yu B, Choi KK, Park Y, Lee GJ. Implementation of a massive transfusion protocol: A single trauma center experience from South Korea. Ulus Travma Acil Cerrahi Derg 2022;28(10):1412–8. doi:10.14744.tjtes.2021.07824.
7. Lin T L, Liu H T, Hsieh C H. Current controversies and advances in massive transfusion: Balancing evidence and practice. J Formos Med Assoc. 2025;S0929-6646(25)00383-3. doi:10.1016.j.jfma.2025.07.016.
8. Margolin AM, Silva SG, McLaughlin KET, Pereira KC, Flowe AM, Poisson JL. Massive transfusion protocol adherence: relationship to trauma patient outcomes. J Trauma Nurs 2023;30(3):164–70. doi:10.1097.JTN.0000000000000722.
9. Marinho DS, Brunetta DM, Carlos LMB, Carvalho LEM, Miranda JS. A comprehensive review of massive transfusion and major hemorrhage protocols: origins, core principles and practical implementation. Braz J Anesthesiol 2025;75(2):844583. doi:10.1016.j.bjane.2024.844583.
10. Ninan A, Krishnan V, Shastry S, Mohan G, Chenna D, Madkaiker D. A comprehensive approach to continuous quality improvement of massive transfusion by developing key performance indicators. Vox Sang 2024;119:1183–90. doi:10.1111.vox.13732.
11. Orr LC, Peterson AL, Savell TC, McCotter EL, Palm CE, Arnold SL. Whole blood program: implementation in a rural trauma center. J Trauma Nurs 2024;31(5):258–65. doi:10.1097.JTN.0000000000000810.
12. Sun HW, Lee SB, Park SJ, Park CI, Kim JH. Effects of massive transfusion protocol implementation in trauma patients at a level I trauma center. J Trauma Inj 2020;33(2):74–80. doi: 10.20408.jti.2020.022.
13. Torres CM, Kenzik KM, Saillant NN, Scantling DR, Sanchez SE, Brahmbhatt TS, Dechert TA, Sakran JV. Timing to First Whole Blood Transfusion and Survival Following Severe Hemorrhage in Trauma Patients. JAMA Surg 2024;159(4):374-381. doi: 10.1001.jamasurg.2023.7178.