Blood and Blood Product Transfusion in Orthopedic Trauma: Clinical Practices and Optimization Strategies

Arvind Vatkar[1], Sachin Kale[2], Sumedha Shinde[3], Ashok Shyam[4]

Abstract

The immense and growing burden of orthopaedic trauma in India, primarily due to road traffic accidents, necessitates a complete overhaul of blood management and clinical practices to achieve efficiency. Current practices are plagued by systemic inefficiencies, reflected in an orthopaedic Cross-match to Transfusion Ratio (CTR) of 1.9. This habitual over-ordering unnecessarily depletes blood bank resources and escalates patient costs. The mandated evolution requires a transition from "anecdotal requisitioning"—ordering based on routine or habit—to robust, evidence-based protocols such as the Maximum Surgical Blood Ordering Schedule (MSBOS). Concurrent clinical strategies, including the prophylactic use of Tranexamic Acid (TXA) to safely reduce blood loss by up to 50% and the rigorous application of Venous Thromboembolism (VTE) prophylaxis, are fundamental. The successful implementation of these protocols will ensure the judicious use of precious resources, significantly enhance patient safety, and align surgical preparedness with documented clinical requirements.

Introduction: The Escalating Trauma Burden and Resource Strain in India

The strategic management of blood bank inventory has ascended to a critical clinical priority as India contends with a severe trauma epidemic. The ceaseless rise in road traffic accidents has imposed an unprecedented and unsustainable strain on blood bank infrastructure, often exceeding the technical capacity for the preparation and long-term storage of vital blood components. Historically, the process of blood ordering in surgical settings has been compromised by "anecdotal requisitioning"[1]. This practice involves clinicians dictating requests based solely on rigid hospital routines, ingrained surgical habits, or speculative overestimation rather than being grounded in objective, patient-specific, or procedural data [2].

This pervasive culture of over-ordering creates a significant, artificial shortage: large volumes of valuable blood are cross-matched and subsequently sequestered, making them unavailable for other emergent or life-saving cases for up to 72 hours [3]. The eventual loss of shelf life and outdating of these units represents not only a massive administrative overburdening but also a direct financial waste and a moral squandering of a limited resource [4]. To mitigate this systemic inefficiency, clinical practice within the orthopaedic trauma setting must decisively shift toward a structured, predictive, and data-driven approach. This evolution is necessary to reconcile the need for absolute surgical preparedness with the high-stakes imperative of resource conservation, thereby sustaining the nation's blood supply.

Epidemiology of Transfusion Practices in Orthopaedic Trauma

Quantifying the precise epidemiological patterns of transfusion is a non-negotiable first step in identifying and addressing systemic resource wastage [4]. Within tertiary care medical facilities, the orthopaedic department invariably acts as a major consumer of blood products. Despite this heavy consumption, the sector consistently registers suboptimal utilization metrics, signaling a need for intervention. The internationally recognized gold standard for optimal efficiency in blood utilization is a Cross-match to Transfusion Ratio (CTR) of 1.0, indicating that virtually every unit cross-matched is ultimately transfused.5 However, audits reveal that the orthopaedic sector operates at significantly higher CTR levels due to a pervasive, and clinically unwarranted, mismatch between the anticipated surgical blood loss and the actual volume of blood required by the patient.

Key metrics derived from multiple Northern Indian tertiary care audits underscore this challenge:

A rigorous assessment of these epidemiological markers reveals an overall Non-usage Probability (NUP) of 47.5% and a CTR of 1.9, which are clear indicators of inefficient practice as shown in table 1. The highest NUP is observed within the trauma subdivision (52.6%). This statistic suggests that more than half of all blood units requested for trauma cases are ultimately never transfused. This wastage creates severe logistical issues for blood banks, leading to administrative overburdening and the preventable outdating of life-saving units.

The root causes of this clinical inefficiency are multi-factorial and include premature transfusion requests often initiated by less

[1]Department of Orthopaedics, MGM Medical College, Nerul, Navi Mumbai, Maharashtra, India.
[2]Department of Orthopaedics, Dr. D.Y. Patil Medical College, Nerul, Navi Mumbai, Maharashtra, India.
[3]Department of IHBT, Grant Government Medical College & Sir J.J. Group of Hospitals, Byculla, Mumbai, Maharashtra, India.
[4]Head of Research, Department of Orthopaedics, Sancheti Hospital, Pune, Maharashtra, India.

Address of Correspondence
Dr. Sachin Kale,
Head of Unit, Department of Orthopaedics, Dr. D.Y. Patil Medical College, Nerul, Navi Mumbai, Maharashtra, India.
E-mail: sachinkale@gmail.com

Submitted: 06/01/2026; Reviewed: 01/02/2026; Accepted: 05/03/2026; Published: 10/04/2026

experienced junior doctors—which are subsequently cancelled upon senior consultant review—and the frequent, unpredictable postponement of operative procedures due to overwhelmed theater schedules or inadequate patient preparation. Further analysis of specific fracture types in subsequent studies emphasizes this: procedures for minor injuries, such as upper limb fractures, often exhibit staggeringly high CTRs (up to 16.0), confirming the pervasive over-ordering for cases that rarely require transfusion [3].

High-Risk Injury Patterns: Identifying the True Demand for Major Transfusion

Aggressive, pre-emptive blood management is absolutely imperative when dealing with specific fracture patterns and major orthopaedic procedures where life-threatening hemodynamic instability is an inherent, high-level risk. Audits tracking the actual number of blood units transfused in Northern Indian centers provide a clear, empirical ranking of injuries and procedures based on their significant impact on blood bank reserves:

1. Bilateral Total Knee Replacement (TKR): 59 units
2. Fracture Femur: 50 units
3. Polytrauma (Multiple Bone Fractures): 37 units
4. Diabetic Foot (Debridement/Amputation): 23 units
5. Fracture Tibia: 18 units
6. Pelvic Fractures: 13 units
7. Spine Surgery: 11 units 6

The clinical rationale for the high consumption in these categories is clear: bilateral TKR involves extensive dissection and blood loss in two large joints concurrently; femoral fractures are notorious for significant occult bleeding into the thigh; and complex pelvic fractures often involve high-energy trauma leading to major vascular and visceral compromise, necessitating massive transfusion.

While the Maximum Surgical Blood Ordering Schedule (MSBOS) provides a necessary standardized baseline for elective procedures, the Surgical Blood Ordering Equation (SBOE) represents a superior and more precise alternative, particularly for these critical trauma cases. The SBOE moves beyond historical averages by incorporating crucial patient-specific variables into the predictive model. These variables include factors known to influence circulating blood volume and transfusion trigger thresholds, such as short stature (associated with reduced blood volume), female sex, the patient's preoperative hemoglobin level, and the availability of autologous donation options. By leveraging SBOE, surgeons can effectively retire reliance on anecdotal ordering and instead employ a precise predictive model to accurately determine when a "type and screen" policy is sufficient and when it is clinically necessary to reserve fully cross-matched units [7].

Alternatives to Red Blood Cell (RBC) Transfusion and Blood Conservation Strategies

Blood conservation represents a profound strategic imperative, primarily aimed at minimizing inherent risks such as disease transmission, transfusion-associated circulatory overload (TACO), and acute transfusion reactions. For low-risk procedures that have historically low blood usage, such as simple forearm fractures or unilateral Total Knee Replacement (TKR), the "Type and Screen" (T&S) policy has been firmly established as the standard of care. T&S is a cost-effective protocol that performs blood grouping and screening for irregular antibodies, but defers the full cross-match [6].

An even more efficient iteration of this is the implementation of the Type, Screen, Save, and Abbreviated Cross-match (TSSAC) protocol. By conducting the initial irregular antibody screening and deferring the full cross-match until a transfusion is actually deemed necessary, blood banks can perform a rapid "quick spin" cross-match in a matter of minutes. The crucial advantage of TSSAC is logistical: it allows blood units to remain in the general circulation pool, available for any patient facing an emergent need, rather than being sequestered and reserved exclusively for a specific patient for the standard 72-hour holding period [8].

Beyond these ordering policies, proactive physical strategies for blood conservation are equally vital. These include the use of intraoperative cell salvage, which involves collecting shed blood from the surgical field, processing it, and reinfusing the patient's own washed red blood cells. Cell salvage has been empirically shown to significantly reduce allogeneic transfusion needs, particularly in complex high-blood-loss surgeries like revision arthroplasty. Furthermore, for patients presenting with confirmed or suspected coagulopathy, the targeted use of factor VIII concentrates or other component therapies may be required to manage specific clotting deficiencies without resorting to non-targeted RBC transfusion[9].

Massive Transfusion Protocols (MTP) in Polytrauma

In the acute setting of severe polytrauma, the immediate activation of the Massive Transfusion Protocol (MTP) is absolutely essential for the rapid hemodynamic stabilization of patients experiencing massive, life-threatening hemorrhage. MTP is a rapid response system designed to deliver a pre-defined ratio of blood components (typically Red Blood Cells, Fresh Frozen Plasma, and Platelets) [10].

Triggers for MTP activation in the orthopaedic setting include complex, unstable pelvic fractures, polytrauma cases involving significant visceral injury, high-risk bone tumor surgeries, and complex revision procedures such as revision Total Knee Replacement (TKR) or Total Hip Replacement (THR).

The overriding clinical objective of MTP is to rapidly disrupt the self-perpetuating "vicious cycle of coagulopathy, acidosis, and hypothermia" that rapidly leads to irreversible shock and death. While MTP is designed to save lives, clinicians must maintain vigilant oversight to manage its associated metabolic risks. These risks include potentially lethal complications like citrate toxicity, which results from the anticoagulant in stored blood, leading to hypocalcemia and related electrolyte disturbances. Other critical management issues include the inherent risk of transfusion-transmitted infections and the need to prevent volume overload as the patient stabilizes. Once hemodynamic stability is definitively achieved and active hemorrhage is controlled, the protocol must immediately transition from the empirical MTP component ratio strategy to a targeted, evidence-based transfusion strategy guided by real-time laboratory metrics to prevent unnecessary complications [11, 12].

Managing Perioperative Bleeding: Risks and Pharmacological Mitigation

Effective management of perioperative bleeding requires a finely tuned

Table 1- Non-usage probability and CTR ratio in orthopaedics[3].

Clinical Subdivision	Non-usage Probability (NUP) %	Cross-match to Transfusion Ratio (CTR)
Trauma	52.6	2.1
Replacement Surgeries	39.6	1.7
Others	40.9	1.7
Overall Orthopedics	47.5	1.9

Table 2: The economic and logistical impact of adopting these standardized schedules is significant[6].

Surgical Procedure	Calculated MSBOS (Mead's)	Recommended MSBOS (Units)
Spine Surgery	1.8	2
Fracture Femur	2.2	2
Pelvic Fractures	2.2	2
Polytrauma	2.2	2
Total Hip Replacement (THR)	1.8	2
Diabetic Foot	1.9	2
Fracture Humerus	2	1
Fracture Tibia	1.7	1
Fracture Forearm	1.5	Type & Screen (T&S)
Unilateral TKR	1.5	Type & Screen (T&S)
Bilateral TKR	2	2

balance between comprehensive preoperative stabilization and strategic pharmacological intervention.

Preoperative Hemostasis and Risk Management

A key preoperative concern involves patients who are maintained on antiplatelet or anticoagulant medications. The management of these patients requires careful planning for medication interruption, bridging therapy, and reversal protocols to minimize surgical risk. In the acute trauma setting, surgery must often be delayed until true hemodynamic stability is confirmed. This confirmation is based on reliable clinical indicators, including stable vital signs, a stable trend in hemoglobin and hematocrit levels, and documentation of adequate urine output.

The Role of Tranexamic Acid (TXA)

Tranexamic Acid (TXA) has rapidly become the cornerstone of contemporary pharmacological blood conservation, owing to its powerful antifibrinolytic properties. When administered intravenously in doses of 10 mg/kg or 15 mg/kg, TXA prevents the breakdown of blood clots and offers clinically profound benefits[13].

The benefits of routine TXA administration in orthopaedic trauma and surgery are empirically supported:

• Substantial Reduction in Blood Loss: TXA has been shown to reduce total blood loss by 14.29% in hip fractures, as documented by Sahni et al.. Furthermore, it can reduce blood loss by up to 50% in procedures like Total Knee Arthroplasty (TKA), according to Shinde et al. [14].

• Reduced Transfusion Requirements: The study by Kaur et al. demonstrated the transformative impact of TXA in lower limb trauma, where its administration at the time of surgical incision dramatically plummeted post-operative transfusion requirements from 80% of patients in the control group to a mere 14% of patients in the TXA group [13].

• **Hemoglobin Maintenance:** Patients receiving TXA consistently maintain significantly higher postoperative hemoglobin levels, which directly facilitates a faster recovery and reduces the need for allogeneic blood transfusion.

• **Proven Safety Profile:** Despite its mechanism of action, large-scale trials, including those conducted by Sahni et al., indicate that when established protocols are adhered to, there is no significant increase in the incidence of adverse thromboembolic events, such as deep vein thrombosis (DVT) or pulmonary embolism (PE) [14].

Venous Thromboembolism (VTE) Prophylaxis in the Indian Context

A pervasive and clinically dangerous myth suggests that Indian patients possess a natural or cultural protection against the development of Venous Thromboembolism (VTE). This belief must be decisively and urgently debunked, as neglecting prophylaxis carries substantial risk. Without appropriate prophylaxis, the true, documented incidence of VTE in patients undergoing major orthopedic trauma procedures is approximately 14.49%. This rate is reduced to a more acceptable 8% when appropriate and consistent prophylaxis protocols are administered [15].

The recommended standard of care for orthopaedic trauma is a "Combined Prophylaxis" strategy. This comprehensive approach utilizes both pharmacological and mechanical methods. Pharmacological prophylaxis typically involves the administration of Low-Molecular-Weight Heparin (LMWH) [15]. Mechanical methods are critical and include devices such as graduated compression stockings or intermittent pneumatic compression (IPC) devices. In specific clinical scenarios where chemoprophylaxis is strictly contraindicated—such as in cases of active, uncontrolled bleeding, severe thrombocytopenia, or concurrent head injuries—mechanical methods must take unequivocal precedence to ensure patient safety while still mitigating the high risk of VTE.

Implementation of the Maximum Surgical Blood Ordering Schedule (MSBOS)

The systematic implementation of the Maximum Surgical Blood Ordering Schedule (MSBOS) delivers substantial clinical, logistical, and economic value by standardizing the blood ordering process. MSBOS eliminates the guesswork of habitual over-ordering and ensures blood preparation is aligned with proven historical usage.

MSBOS guidelines are typically established based on Mead's criterion. This criterion dictates that blood should be ordered in a quantity equal to 1.5 times the Transfusion Index (TI). The Transfusion Index (TI) itself is defined as the average number of units transfused per patient for a specific procedure (TI = Total units transfused / Total patients cross-matched) [6].

MSBOS is defined as a standardized table specifying the maximum number of blood units to be routinely cross-matched pre-operatively for common elective surgical procedures. It is formulated through a retrospective analysis of the actual historical blood usage for specific surgeries and is designed to safely cover the needs of 85% to 90% of patients undergoing a given procedure.

The following table 3 summarizes the recommended ordering based on documented evidence for common orthopaedic procedures:

- **Cost Reduction:** Implementation can lead to an estimated 60% reduction in costs associated with blood management for patients.
- **Resource Conservation:** By eliminating unnecessary pretransfusion compatibility testing, MSBOS significantly decreases the outdating and expiration of valuable blood units, thereby conserving inventory.
- **Efficiency:** It simultaneously decreases the unnecessary workload on already overworked blood bank personnel and guarantees that adequate reserves remain available for genuine emergency situations.

Blood Transfusion Data in Orthopaedic Trauma

The following comprehensive data, synthesized from multiple studies,

Table 3- Statistics of different studies regarding blood transfusions and requisitions in orthopaedics[6].

Study & Year	Type of Orthopaedic Trauma / Procedure	Patients / Requests (n)	Units Crossmatched (CM)	Units Transfused	CTR (Crossmatch to Transfusion Ratio)	Key Transfusion Insights
Kumari S. (2017)	General Orthopaedics Trauma	158	274	130	2.1	**17.7% of all units unutilized**; CTR of 2.1 indicates moderate over-ordering.
Arulselvi S. et al. (2010)	Multiple fractures	354	1591	609	2.6	**Poor utilization**; significant over-ordering of blood.
	Fracture upper limb	68	172	41	4.1	**Extremely high CTR**; massive blood wastage.
	Fracture lower limb	572	1737	611	2.8	Over-ordering for lower extremity trauma.
	Fracture pelvis & spine	179	777	476	1.6	**Efficient usage**; blood ordered closely matched actual need.
	Crush injury	42	60	43	1.3	**Highly efficient usage**; most cross-matched blood was required.
	Traumatic amputation	44	166	89	1.8	Efficient usage within standard limits.
Soleimanha M. et al. (2016)	Shoulder fracture	16	64	6	10.66	**Extreme wastage**; <10% of prepared blood was used.
	Arm fracture	24	96	6	16	**Highest CTR in the study**; vast over-ordering.
	Forearm fracture	12	44	6	7.33	Significant over-ordering.
	Hip fracture	36	110	18	6.11	High preoperative requests compared to actual transfusions.
	Femur fracture	166	644	140	4.6	Most frequent fracture type, but still exhibited excessive over-ordering.
	Knee fracture	14	48	4	12	Severe over-preparation of blood.
	Leg fracture	50	188	12	15.66	**Almost no cross-matched blood was used**.
Kumari S. et al. (2017) (MSBOS)	Fracture humerus	15	26	13	2	Optimal/borderline usage.
	Fracture tibia	23	29	18	1.6	Efficient utilization.
	Fracture femur	64	107	50	2.1	**Most common trauma** requiring highest volume of transfused blood.
	Fracture forearm	4	5	1	5	High CTR; researchers recommended **"Type and Screen"** policy instead.
	Pelvic fractures	9	20	13	1.5	Efficient usage.
	Polytrauma	35	84	37	2.2	Borderline excessive ordering.
Subramanian A. et al. (2010)	Internal fixation w/ compression plating	165	444	147	3.02	High over-ordering; less than 44% of patients required a transfusion.
	Interlocking nail	181	505	246	2.05	Efficient utilization (approx 60% of patients transfused).
	Dynamic compression screw	21	66	23	2.87	Excessive cross-matching.
	Dynamic hip screw	26	65	16	4.06	High CTR; indicated significant waste.
	External fixation	17	52	29	1.79	Efficient usage.
	Decompression & fixation for spine fracture	27	83	35	2.37	Acceptable utilization.
Kaur G. et al. (2021)	Lower limb trauma (Control Group)	50	-	43 units (40 pts)	-	**80% of patients** required post-operative transfusion.
	Lower limb trauma (TXA Group)	50	-	7 units (7 pts)	-	**Only 14% of patients** required post-operative transfusion after Tranexamic Acid (TXA) use.
Sahni G. et al. (2021)	Hip fracture (Placebo Group)	30	-	21 units (17 pts)	-	Placebo patients had higher total blood loss (448.7 mL).
	Hip fracture (TXA Group)	30	-	17 units (14 pts)	-	TXA patients had **14.29% less total blood loss** (384.6 mL) and required fewer RBC units.

highlights the variation in blood utilization and the extent of over-ordering across different orthopaedic trauma scenarios:

Conclusion

While the therapeutic administration of blood and blood products remains a fundamental, life-saving intervention in the context of acute injury, its use in orthopaedic trauma must be strictly governed by defined clinical need and evidence-based protocols. The present data consistently confirms that orthopaedic practices in India exhibit excessive cross-matching, particularly for procedures involving the upper limb and minor fractures, where the implementation of a Type and Screen policy is strongly advocated to prevent resource wastage.

Optimizing patient safety and simultaneously ensuring the long-term sustainability of the national blood supply necessitates a profound, multifaceted commitment from surgical and blood bank teams. This commitment involves the routine conduct of regular clinical audits to monitor CTR and NUP; the mandatory implementation of standardized MSBOS and resource-conserving TSSAC protocols; and the routine, evidence-backed application of both Tranexamic Acid and rigorous VTE prophylaxis for all high-risk trauma patients. By shifting decisively away from historical, anecdotal ordering habits and fully embracing these data-driven safety and conservation strategies, surgical teams can significantly enhance patient outcomes and secure the viability of the Indian blood supply for emergency use.

Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

Conflict of Interest: None, **Source of Support:** None

References

1. Hasan O, Khan EK, Ali M, Sheikh S, Fatima A, Rashid HU. "It's a precious gift, not to waste": is routine cross matching necessary in orthopedics surgery? Retrospective study of 699 patients in 9 different procedures. BMC Health Serv Res [Internet]. 2018 Oct 20;18(1):804. Available from: http://dx.doi.org/10.1186/s12913-018-3613-9
2. Juma T, Baraka A, Abu-Lisan M, Asfar SK. Blood ordering habits for elective surgery: time for change. J R Soc Med [Internet]. 1990 Jun;83(6):368–70. Available from: http://dx.doi.org/10.1177/014107689008300610
3. Kumari S. Blood transfusion practices in a tertiary care center in Northern India. J Lab Physicians [Internet]. 2017 Apr-Jun;9(2):71–5. Available from: http://dx.doi.org/10.4103/0974-2727.199634
4. Sayers M, Centilli J. What if shelf life becomes a consideration in ordering red blood cells? Transfusion [Internet]. 2012 Jan;52(1):201–6. Available from: http://dx.doi.org/10.1111/j.1537-2995.2011.03412.x
5. Bansal K, Kakkar R. Study of the ratio of cross-matching to transfusion of blood or blood component, i.E. Packed red blood corpuscles to develop good practices for the utilisation of blood. J Evol Med Dent Sci [Internet]. 2017 May 1;6(35):2909–14. Available from: https://www.jemds.com/data_pdf/kanika%20bansal-.pdf
6. Kumari S, Kansay R, Kumar S. Proposed maximum surgical blood ordering schedule for common orthopedic surgeries in a Tertiary Health - Care Center in Northern India. J Orthop Allied Sci [Internet]. 2017;0(0):0. Available from: https://joas.org.in/proposed-maximum-surgical-blood-ordering-schedule-for-common-orthopedic-surgeries-in-a-tertiary-health-care-center-in-northern-india/
7. Subramanian A, Rangarajan K, Kumar S, Sharma V, Farooque K, Misra MC. Reviewing the blood ordering schedule for elective orthopedic surgeries at a level one trauma care center. J Emerg Trauma Shock [Internet]. 2010 Jul;3(3):225–30. Available from: http://dx.doi.org/10.4103/0974-2700.66521
8. Ness PM, Rosche ME, Barrasso C, Luff RD, Johnson JW Jr. The efficacy of type and screen to reduce unnecessary cross matches for obstetric patients. Am J Obstet Gynecol [Internet]. 1981 Jul 15;140(6):661–4. Available from: http://dx.doi.org/10.1016/0002-9378(81)90200-3
9. Das SS, Kamilya R, Mukherjee S, Chowdhury S. Perioperative blood transfusion requirements and predictive factors in total hip replacement: A retrospective study from Eastern India. Asian J Transfus Sci [Internet]. 2026 Feb 4; Available from: https://journals.lww.com/10.4103/ajts.ajts_181_25
10. Arulselvi S, Rangarajan K, Sunita S, Misra MC. Blood transfusion practices at a level one trauma centre: a one-year retrospective review. Singapore Med J [Internet]. 2010 Sep;51(9):736–40. Available from: https://www.ncbi.nlm.nih.gov/pubmed/20938616
11. Rangarajan K, Subramanian A, Gandhi JS, Saraf N, Sharma V, Farooque K. Coagulation studies in patients with orthopedic trauma. J Emerg Trauma Shock [Internet]. 2010 Jan;3(1):4–8. Available from: http://dx.doi.org/10.4103/0974-2700.58652
12. Beale E, Zhu J, Chan L, Shulman I, Harwood R, Demetriades D. Blood transfusion in critically injured patients: a prospective study. Injury [Internet]. 2006 May;37(5):455–65. Available from: http://dx.doi.org/10.1016/j.injury.2005.12.008
13. Kaur G, Selhi HS, Delmotra NJ, Singh J. Tranexamic acid and reduction of blood transfusion in lower limb trauma surgery: a randomized controlled study. SICOT J [Internet]. 2021 Oct 28;7:53. Available from: http://dx.doi.org/10.1051/sicotj/2021053
14. Sahni G, Sood M, Girdhar D, Sahni P, Jain AK, Kumar S. To Analyze the Role of Intravenous Tranexamic Acid in Hip Fracture surgeries in Orthopedic Trauma. Int J Appl Basic Med Res [Internet]. 2021 Jul 19;11(3):139–42. Available from: http://dx.doi.org/10.4103/ijabmr.IJABMR_638_20
15. Sen RK, Tripathy SK, Singh AK. Is routine thromboprophylaxis justified among Indian patients sustaining major orthopedic trauma? A systematic review. Indian J Orthop [Internet]. 2011 May;45(3):197–207. Available from: http://dx.doi.org/10.4103/0019-5413.80037

How to Cite this Article

Vatkar A, Kale S, Shinde S, Shyam A | Blood and Blood Product Transfusion in Orthopedic Trauma: Clinical Practices and Optimization Strategies | January-June 2026; 12(1): 01-05 | https://doi.org/10.13107/ti.2026.v12.i01.70