بنام یگانه ایزدی هستی

# Shock Hemorrhagic and Trauma Induced Coagulopathy

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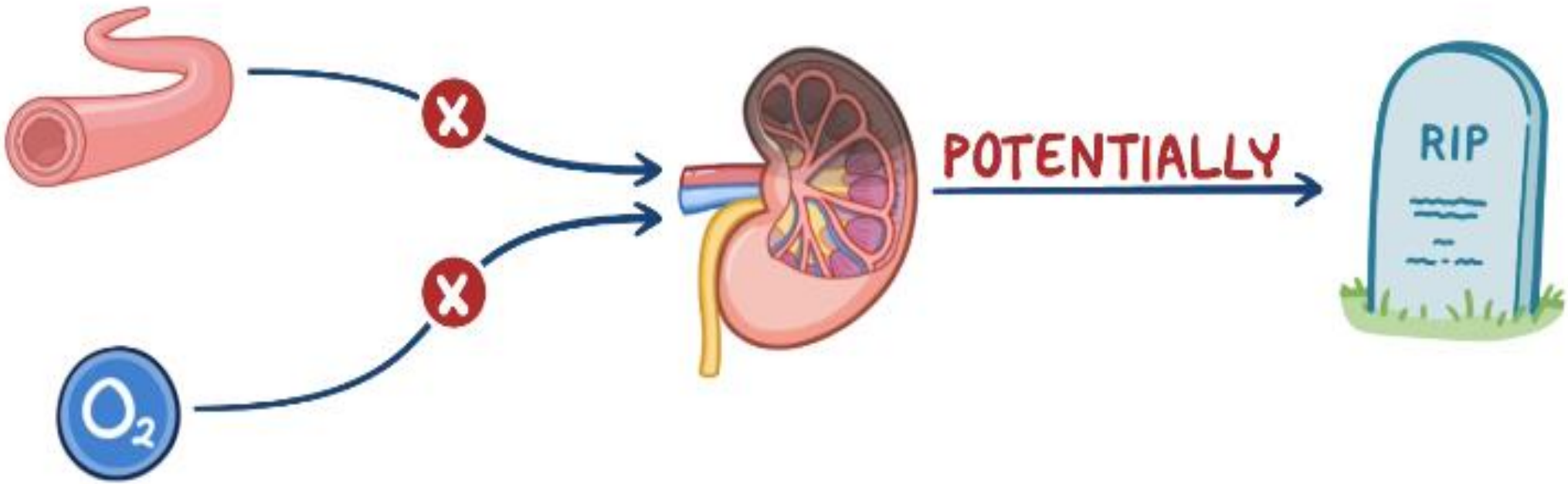
# SHOCK
## LIFE-THREATENING CONDITION

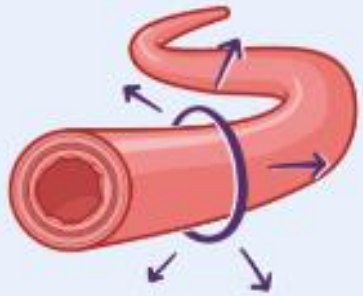


# SHOCK

## LIFE-THREATENING CONDITION

### DISTRIBUTIVE

EXCESSIVE VASODILATION



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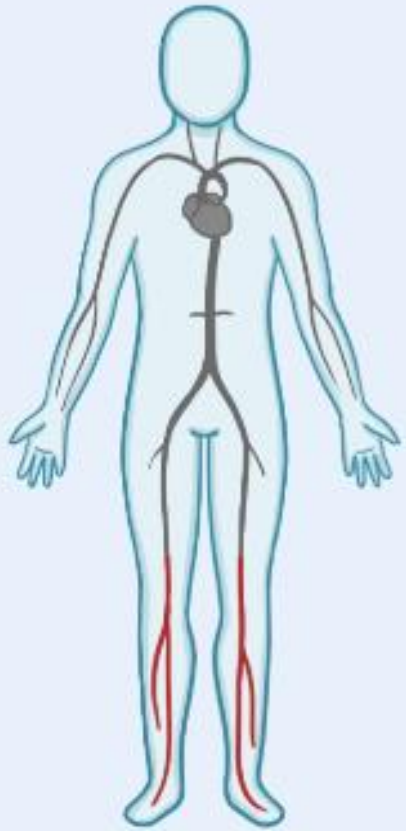
IMPAIRED BLOOD FLOW DISTRIBUTION

### HYPOVOLEMIC



### CARDIOGENIC

COMPROMISE of MYOCARDIAL PERFORMANCE



↓

↓↓ OUTPUT

### OBSTRUCTIVE

OBSTRUCTION
- FILLING HEART
- EJECTING into GREAT VESSELS

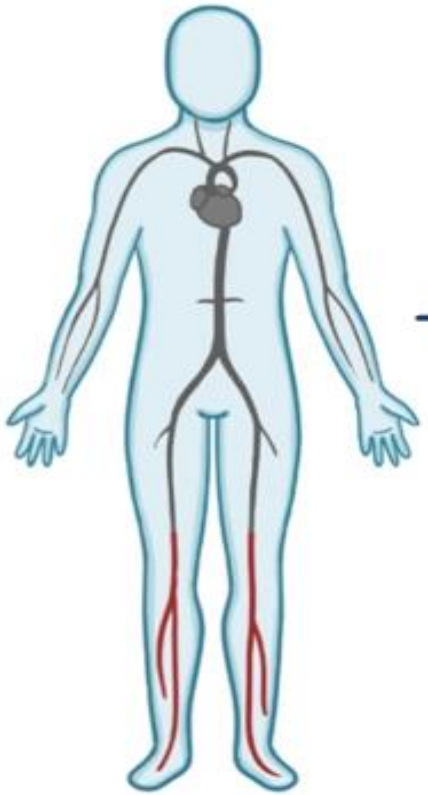


↓

↓↓ OUTPUT

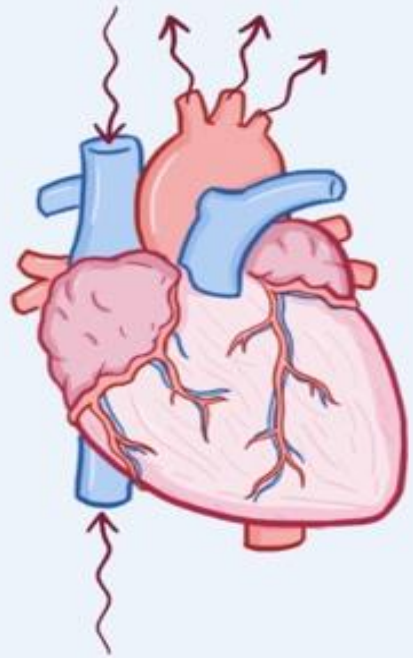
# HYPOVOLEMIC SHOCK
## LIFE-THREATENING CONDITION

↓↓ INTRAVASCULAR VOLUME





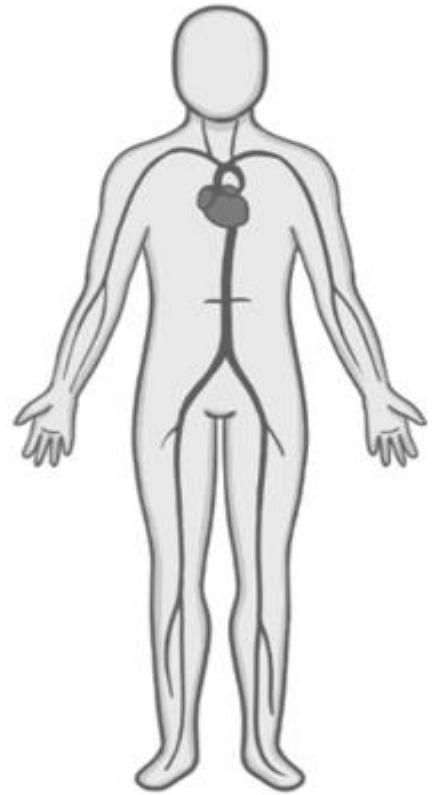
↓↓ VENOUS RETURN



↓↓ CARDIAC OUTPUT



SHOCK



# Hemorrhagic Shock (HS)

- A “physiological classification” of hemorrhagic shock (HS) has been proposed since 2010, based conceptually upon the right definition of shock, the body’s natural hemostatic mechanisms, the essential role of the microcirculation/arteriolar system, the concept of ‘cardiac/circulatory reserve’, and physiological considerations such as the significance of fluid-resistant hypotension.
- The “revised physiological classification” is the only classification that frames the current hemodynamic situation, dictates timely intervention, and suits tactics like titrated hypotensive resuscitation and iatrogenic vasoconstriction, or strategies like titrated-to-response anesthesia and damage control surgery.
- In vivo peripheral microcirculation visualization and continuous cardiac output(CO) monitoring through trans-thoracic echocardiography (TTE) can add to clinical assessment in predicting the degree of compensation or decompensation.
- Further methods and the integration of artificial intelligence (AI) are being tested.

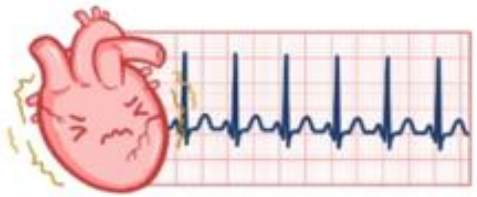
Bonanno FG. Management of Hemorrhagic Shock-Update 2025

# FOCUSED HISTORY & PHYSICAL

## PE

* SIGNS of SHOCK
  - HYPOTENSION
  - TACHYCARDIA

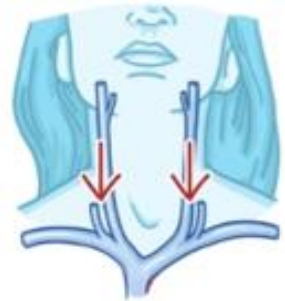


* WEAK PERIPHERAL PULSES



* LOW JUGULAR VENOUS PRESSURE



* PALE, CLAMMY SKIN



* ↓↓ SKIN TURGOR

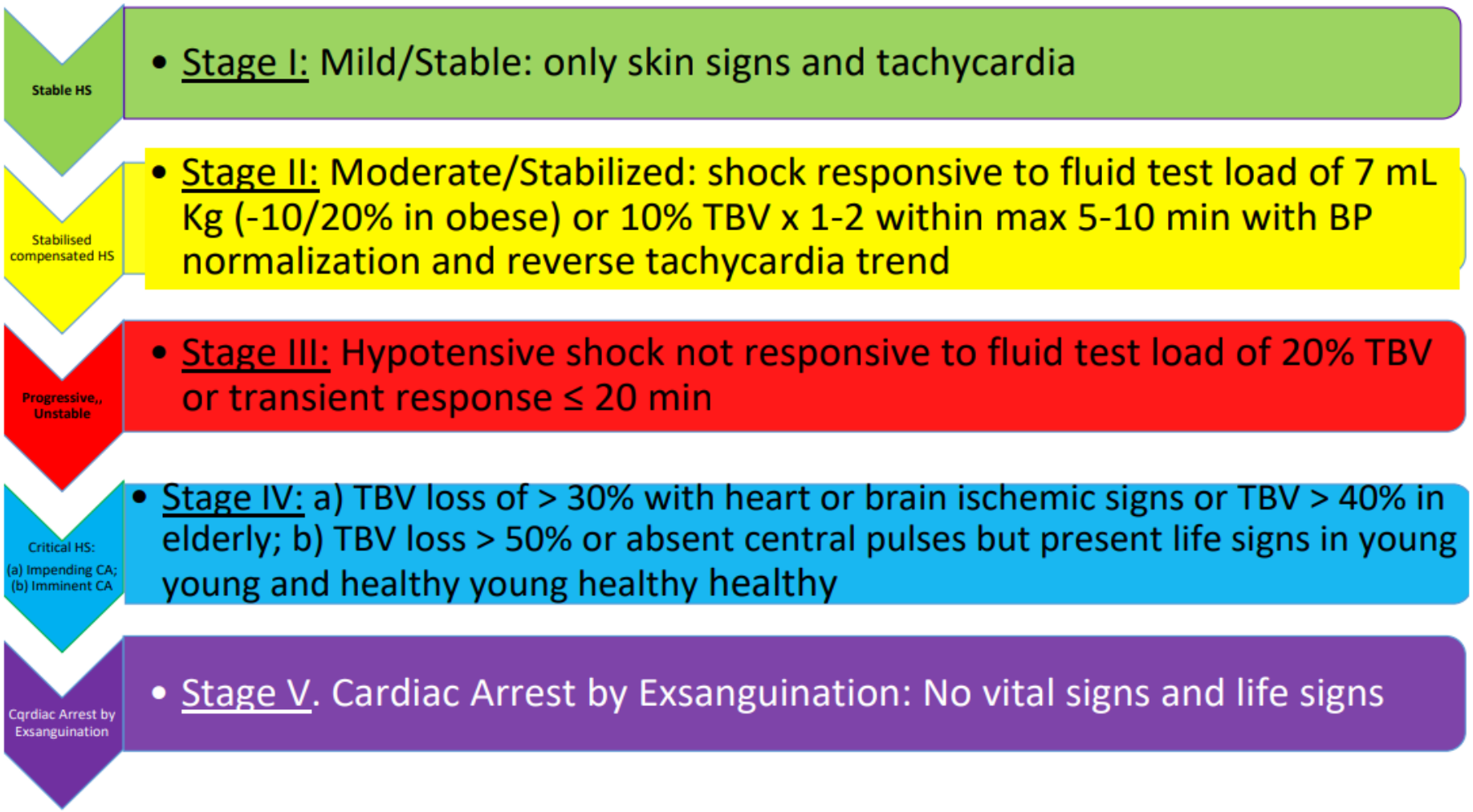


* DRY MUCOUS MEMBRANES



* COLD EXTREMITIES



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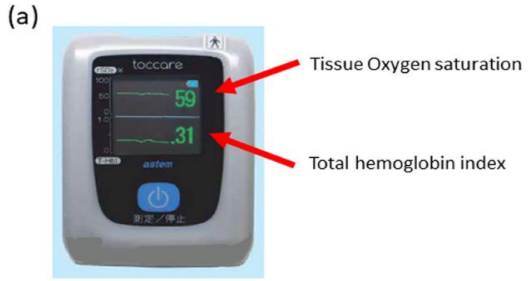
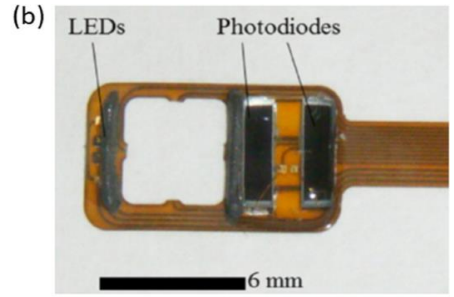
# Tissue Oxygenation

- Advances in the measurement of tissue oxygenation have also recently been achieved with near-infrared spectroscopy (NIRS) differentiating on admission tissues oxygen saturation (StO2) parameters on admission of traumatic haemorrhagic shock between patients who had an improvement in organ failure in the first 72 hours and those who had unchanged or worse conditions.










Bonanno FG. Management of Hemorrhagic Shock-Update 2025

# Hemorrhagic Shock (HS)

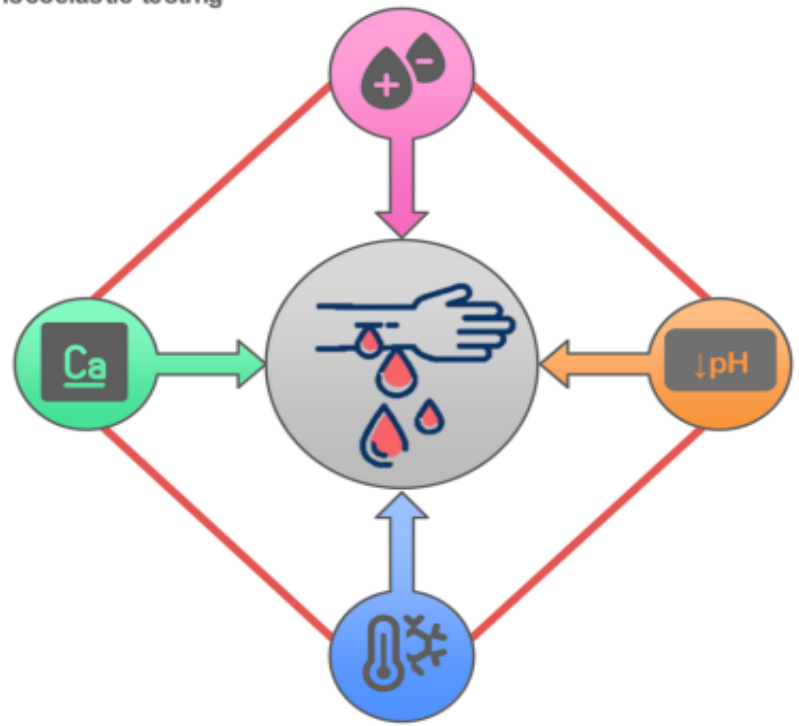
- Hypovolemic shock, most often secondary to hemorrhage, accounts for one-third of shock presentations to the emergency department.
- Hemorrhagic shock is a major cause of mortality, particularly in young patients; leading causes in the United States include trauma, ruptured abdominal aortic aneurysm, and peptic ulcer disease.
- In the absence of overt bleeding, suspicion for occult hemorrhage should arise with progressive hypotension, narrow pulse pressure, and pale, cool extremities.
- Appropriate resuscitation of hemorrhagic shock requires meticulous attention to detail, as suboptimal management can precipitate dilutional coagulopathy, acidemia, hypothermia, and hypocalcemia – collectively termed the lethal diamond which synergistically worsen shock.

Popovich JJ, Patel HH. Hemorrhagic shock and the “lethal diamond”. ATS scholar. 2026 Jun;7(2):162-3.

# The Lethal Diamond

## DILUTIONAL COAGULOPATHY

*Etiology*: Consumption of platelets and factors, compounded by crystalloid- or PRBC-only resuscitation
*Consequence:* Worsening coagulopathy as resuscitation progresses
*Solution:* Provide balanced transfusions, ideally guided by viscoelastic testing




## HYPOCALCEMIA

*Etiology:* Citrate in blood products binding calcium
*Consequence:* Worsening coagulopathy and impairment of cardiac contractility
*Solution:* Monitor closely, replete calcium empirically or as needed

## ACIDEMIA

*Etiology:* Malperfusion and shock
*Consequence:* Impairment of platelet and coagulation factor function
*Solution:* Resuscitation, vasopressors and sodium bicarbonate if necessary

## HYPOTHERMIA

*Etiology:* Blood loss, exposure, and room-temperature infusions
*Consequence:* Impairment of coagulation factor activity
*Solution:* Limit exposure, use warmed infusions

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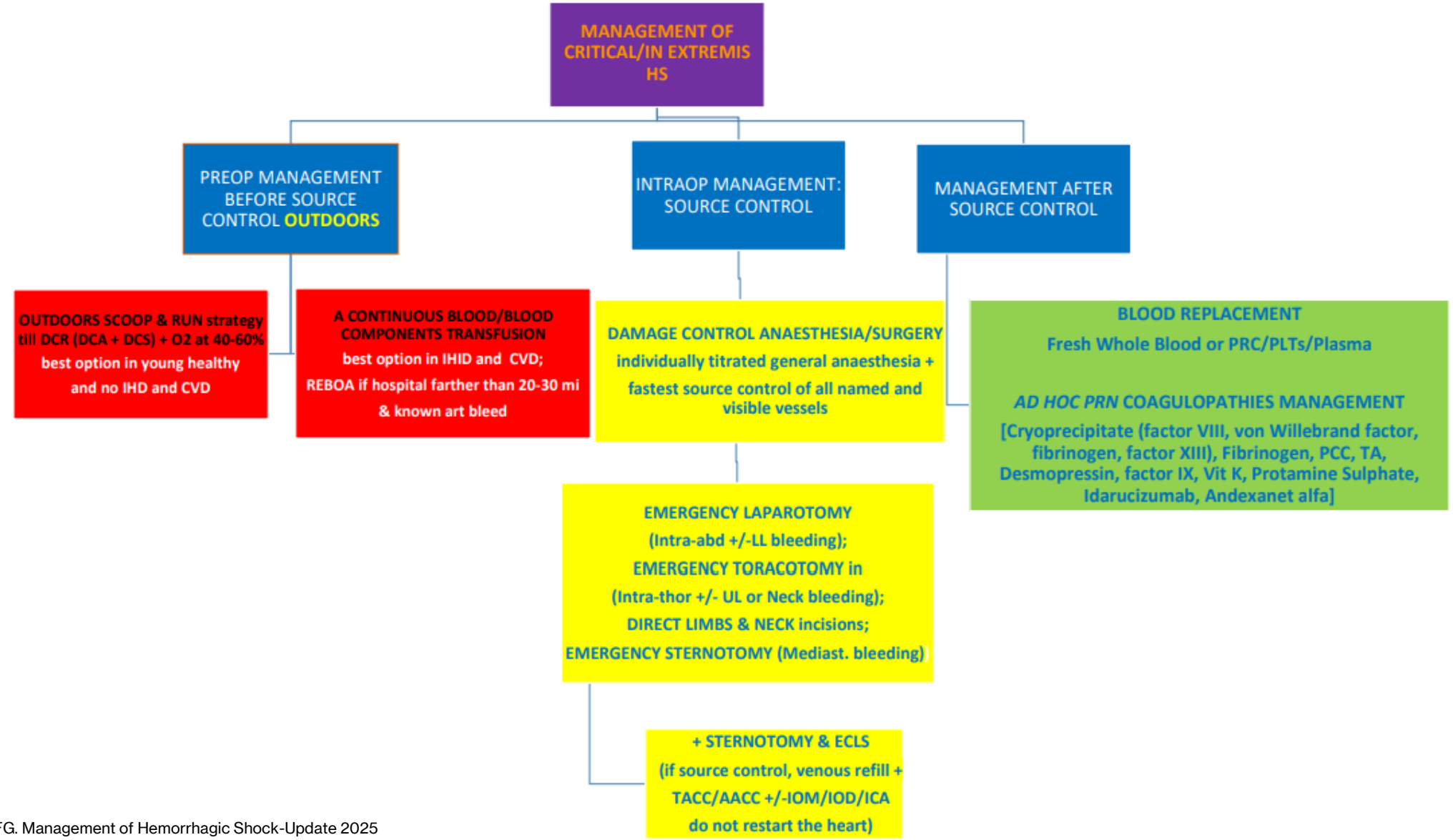


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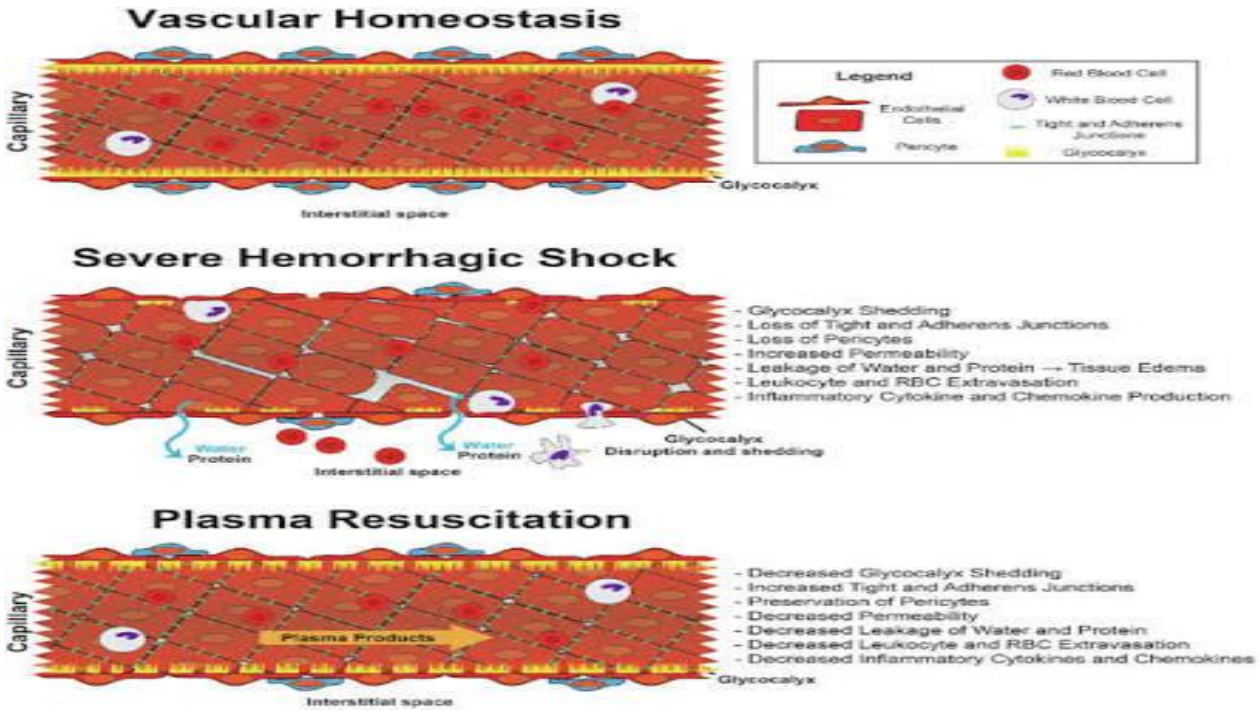
# Trauma-induced coagulopathy (TIC)

- Trauma-induced coagulopathy (TIC) remains one of the key drivers of early deterioration after severe injury and continues to challenge both trauma teams and intensivists. Uncontrolled hemorrhage is still among the most important preventable causes of death after trauma, and many severely injured patients already have detectable hemostatic derangements by the time they reach the hospital.
- In daily practice, TIC is consistently associated with greater transfusion needs, more organ dysfunction, and higher mortality .
- Global Burden of Disease 2021 analyses indicate that injuries were associated with approximately 4.34 million deaths worldwide in 2021. Within this burden, exsanguinating hemorrhage remains a leading cause of early preventable death and supports the growing emphasis on immediate bleeding control and hemostatic resuscitation in contemporary trauma care.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).
Ünal E, Akoğuz T. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# Trauma-induced coagulopathy (TIC)

- Current evidence suggests that it begins with tissue injury and hemorrhagic shock and is then amplified by
- endothelial dysfunction,
- platelet impairment,
- fibrinogen depletion,
- dysregulated fibrinolysis,
- inflammation,
- hypothermia,
- acidosis,
- hypocalcemia,
- and dilutional effects related to resuscitation




Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

## 1 Rapid Blood Loss



## 2

Hemorrhagic Shock ≥ Class III
Overwhelmed Compensatory Mechanisms




## 3 Inflammatory Cascade



DAMPS

Cytokines

Chemokines

Biphasic inflammatory response

- Early hyperinflammatory phase
- Later immunosuppressive period

Interaction between inflammation, coagulation, and tissue repair

## 4 MODS



## 5



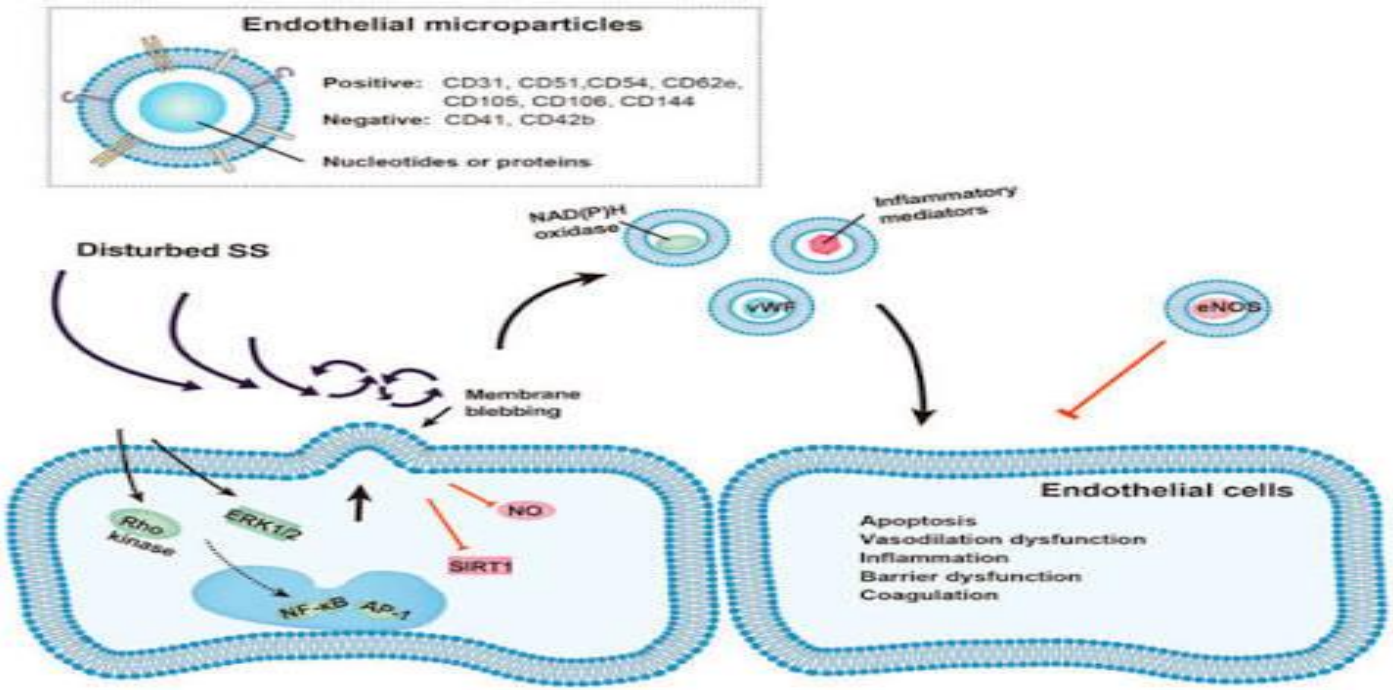
# Trauma-induced coagulopathy (TIC)

- Trauma-induced coagulopathy refers to the spectrum of coagulation and fibrinolytic abnormalities that arise as a direct consequence of traumatic injury.
- It is no longer useful to think of TIC as a single laboratory disturbance; instead, it is better viewed as **a dynamic hemostatic disorder** that begins early after trauma and evolves according to the extent of tissue damage, the severity of hemorrhagic shock, endothelial activation, inflammatory signaling, and the effects of resuscitation .
- In its early phase, TIC is usually associated with hypocoagulability and bleeding, whereas later stages may shift toward a hypercoagulable pattern linked to venous thromboembolism and organ dysfunction
- From a mechanistic standpoint, TIC includes both the endogenous alterations triggered by trauma itself and the exogenous disturbances worsened by hypothermia, acidosis, hypocalcemia, hemodilution, and ongoing blood loss.
- For that reason, many authors distinguish acute traumatic coagulopathy from resuscitation-associated coagulopathy; clinically, however, both frequently overlap and together contribute to hemostatic failure in the severely injured patient.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Trauma-induced coagulopathy (TIC)

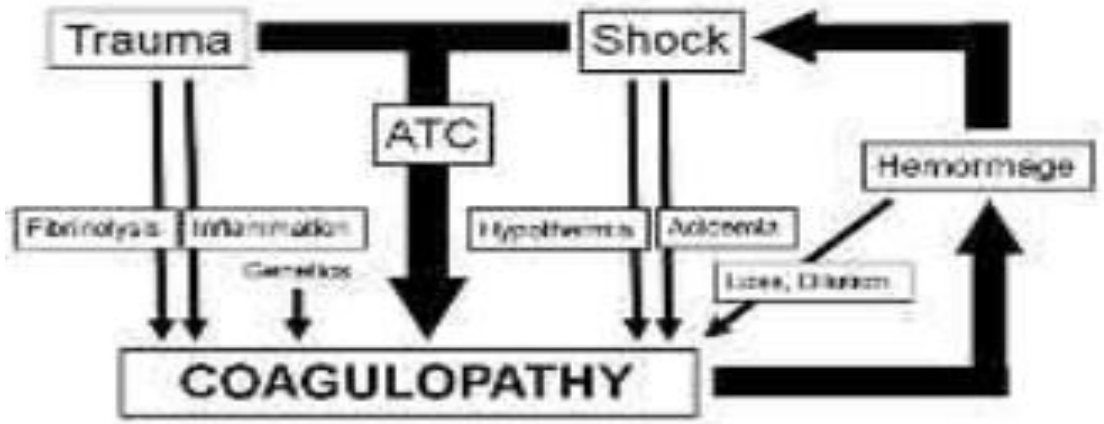
- Post-traumatic coagulopathy may be present even before the onset of resuscitation, and correlates with severity of trauma.




Chalkias A. Shear stress and endothelial mechanotransduction in trauma patients with hemorrhagic shock: hidden coagulopathy pathways and novel therapeutic strategies. International Journal of Molecular Sciences. 2023 Dec 15;24(24):17522

# Clinical relevance

- Just as importantly, TIC is not only a marker of severity but also a therapeutic target. Once recognized, it should trigger a structured bedside response that combines hemorrhage control, restoration of tissue perfusion, correction of reversible metabolic disturbances, and individualized hemostatic resuscitation
- For the intensivist, TIC is best interpreted as part of a broader **syndrome of shock, endothelial injury, inflammation, and evolving hemostatic dysfunction** rather than as a static abnormality on coagulation testing alone.

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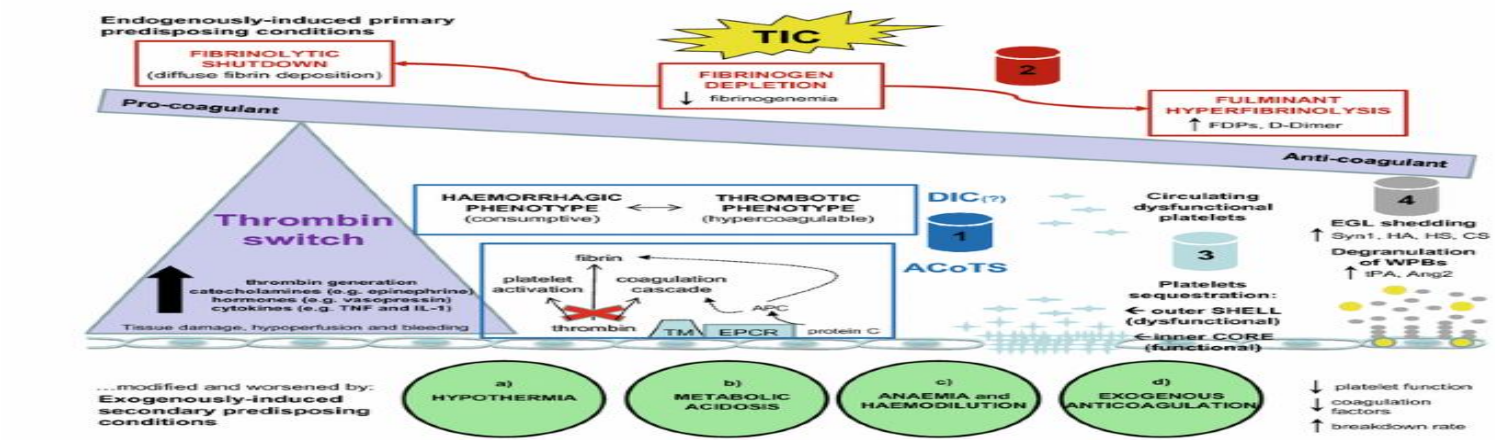
# Epidemiology and impact on clinical outcomes

- TIC is common in major trauma and becomes more frequent as injury burden and physiological derangement increase. Approximately one quarter of patients with severe trauma develop TIC, which makes it not only a diagnostic issue but also an epidemiologic signal of a subgroup at particularly high risk of bleeding and in need of aggressive hemostatic intervention
- Its prognostic impact is substantial. TIC is associated with greater transfusion requirements, persistent hemorrhage, multiple organ dysfunction, and early death, especially when accompanied by hemorrhagic shock and tissue hypoperfusion .
- Its consequences do not end with the initial bleeding phase: among patients who survive early hemorrhage, the hemostatic profile may later shift toward hypercoagulability, microthrombosis, and venous thromboembolism, underscoring that TIC is both heterogeneous and time-dependent.

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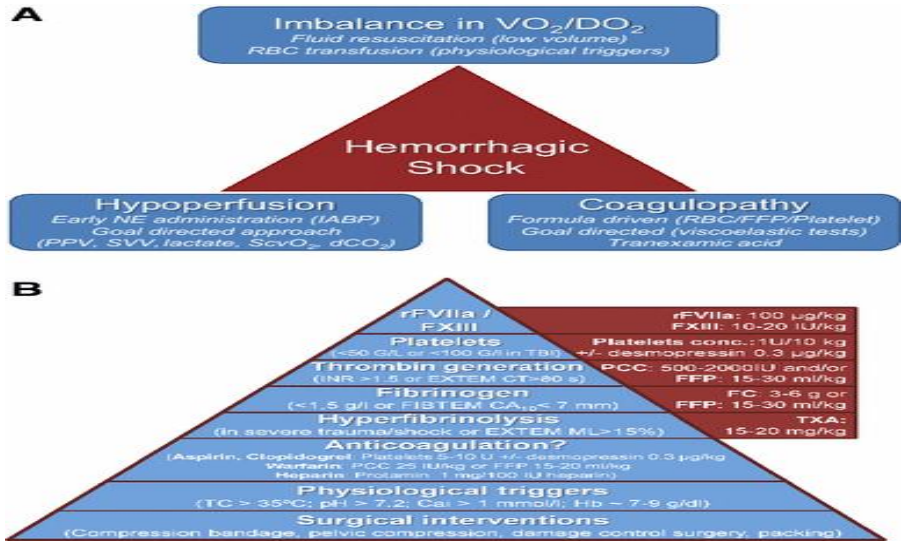
# Pathophysiology of trauma-induced coagulopathy

- TIC is a **dynamic, time-dependent, and multifactorial disorder of hemostasis** that emerges after severe trauma. Rather than being caused by one isolated defect, it reflects the combined effects of extensive tissue injury and hemorrhagic shock, which together impair clot formation and clot stability, favor ongoing bleeding, and sustain a vicious cycle of worsening shock and hemostatic failure. Mechanistically, TIC involves endothelial activation and glycocalyx shedding, platelet dysfunction, factor consumption and degradation, dysregulated anticoagulation, hyperfibrinolysis, and a strong interplay between inflammation and coagulation.

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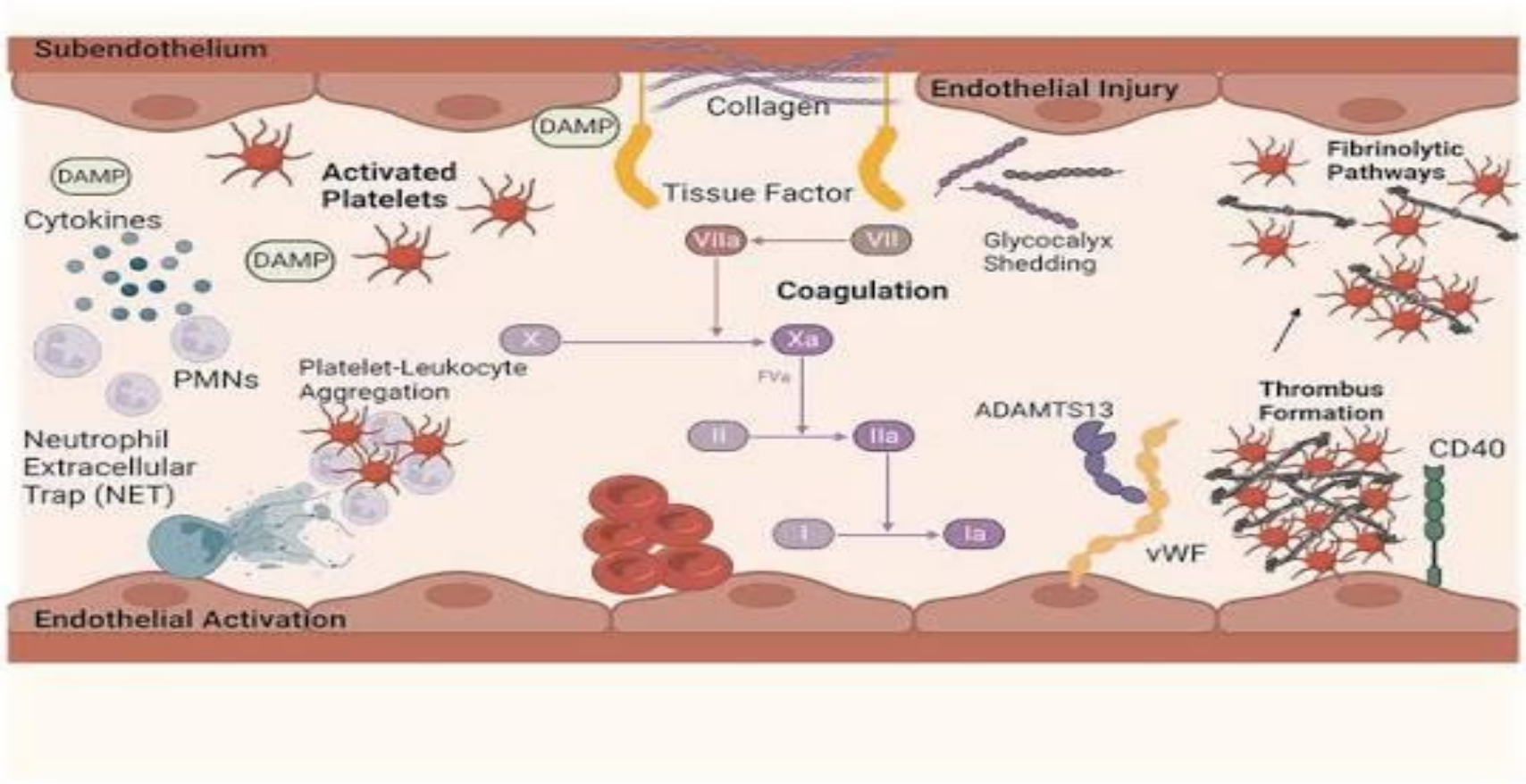
# Tissue injury and hemorrhagic shock
# Endothelial dysfunction and glycocalyx injury
# Inflammation and its interaction with coagulation

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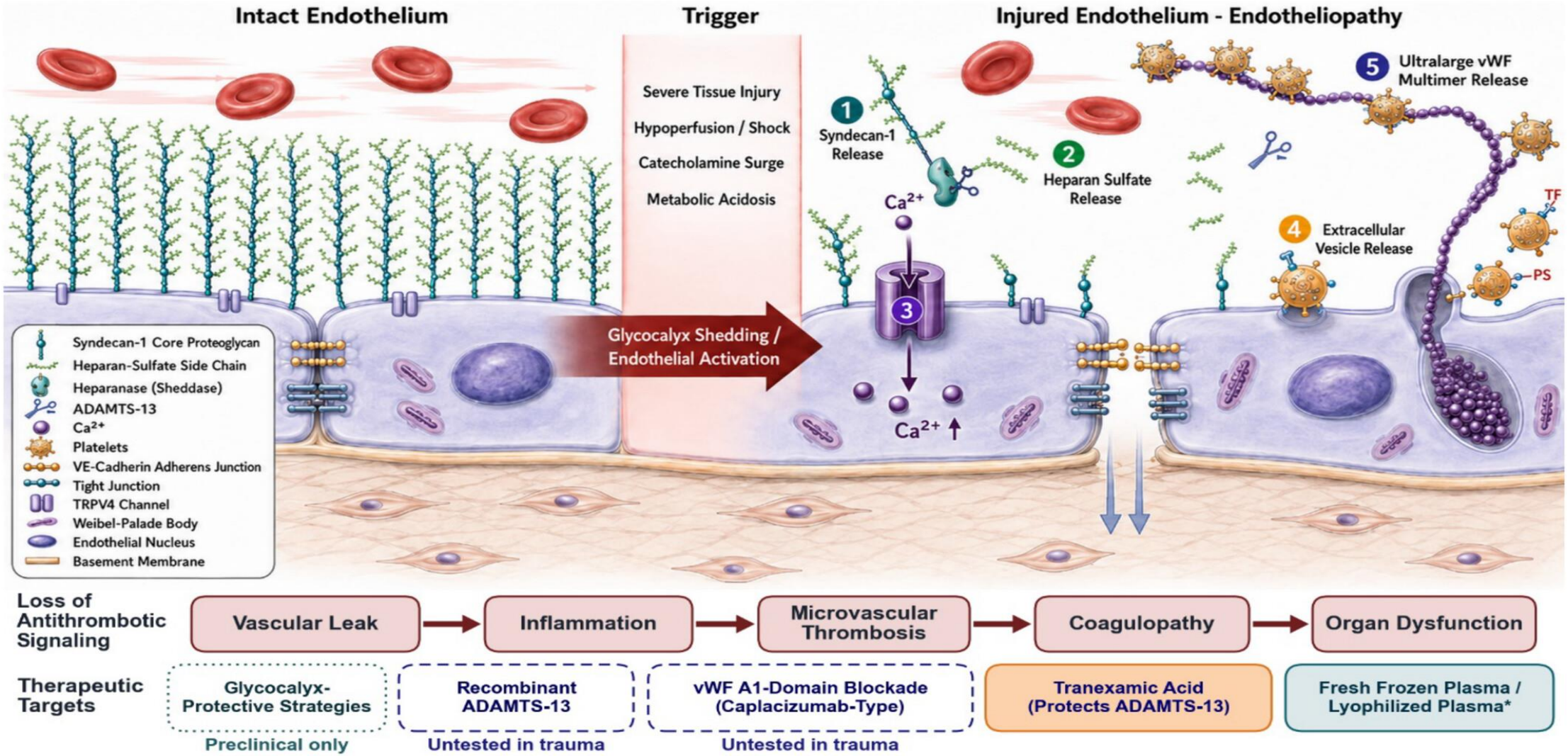
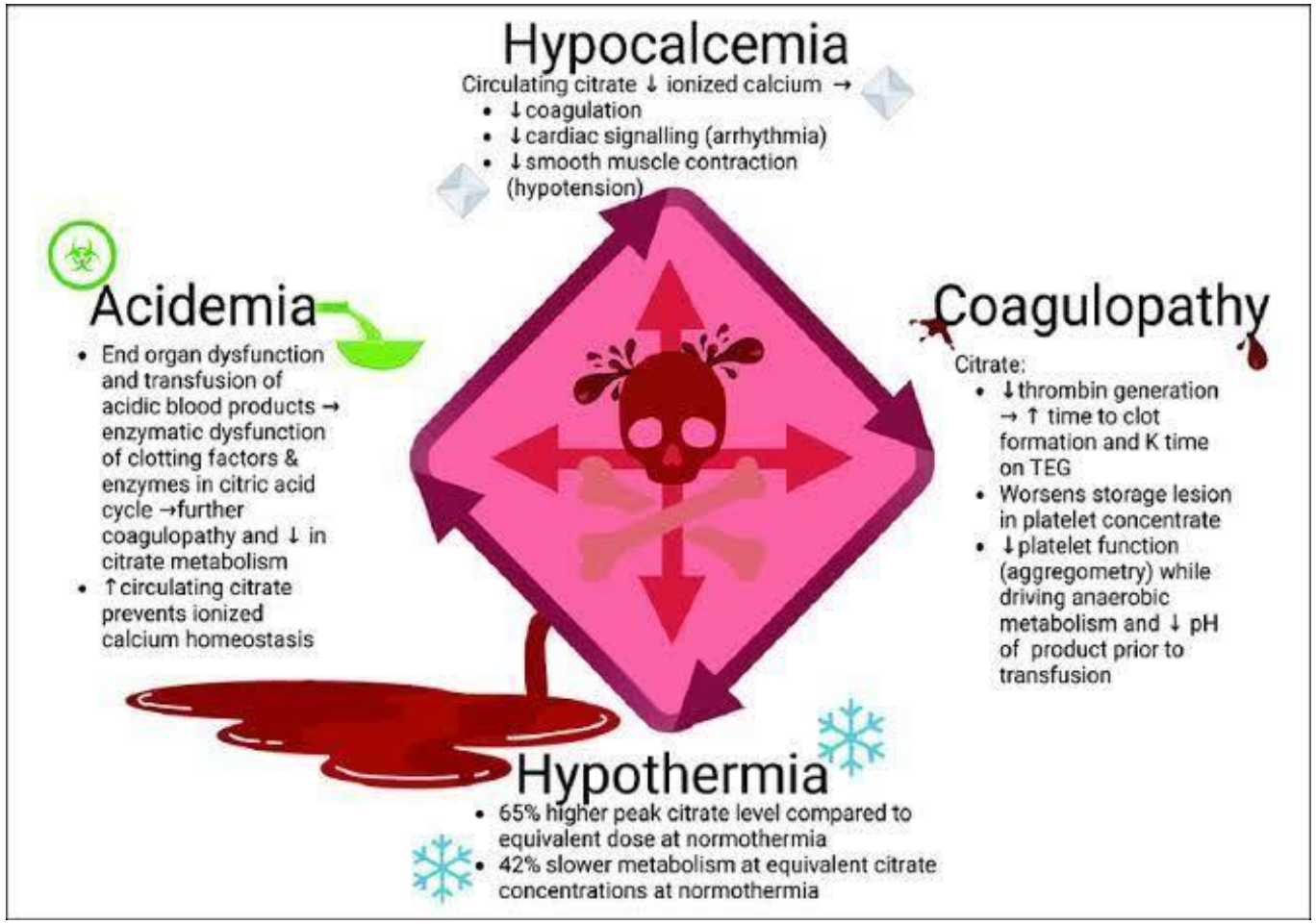



Meister R, Kim Y, Landry TC, LaVasseur C, Shatzel J, Deloughery T. Trauma-Induced Coagulopathy: From Endotheliopathy and Fibrinolysis Phenotypes to Viscoelastic-Guided Resuscitation. European journal of haematology. 2026 Sep 1.

# Platelet dysfunction, fibrinogen depletion, metabolic derangements, and dilutional coagulopathy associated with resuscitation

- Platelet dysfunction,
- fibrinogen depletion,
- metabolic derangements,
- and dilutional
- Fibrinogen
- Acidosis, hypothermia, and hypocalcemia

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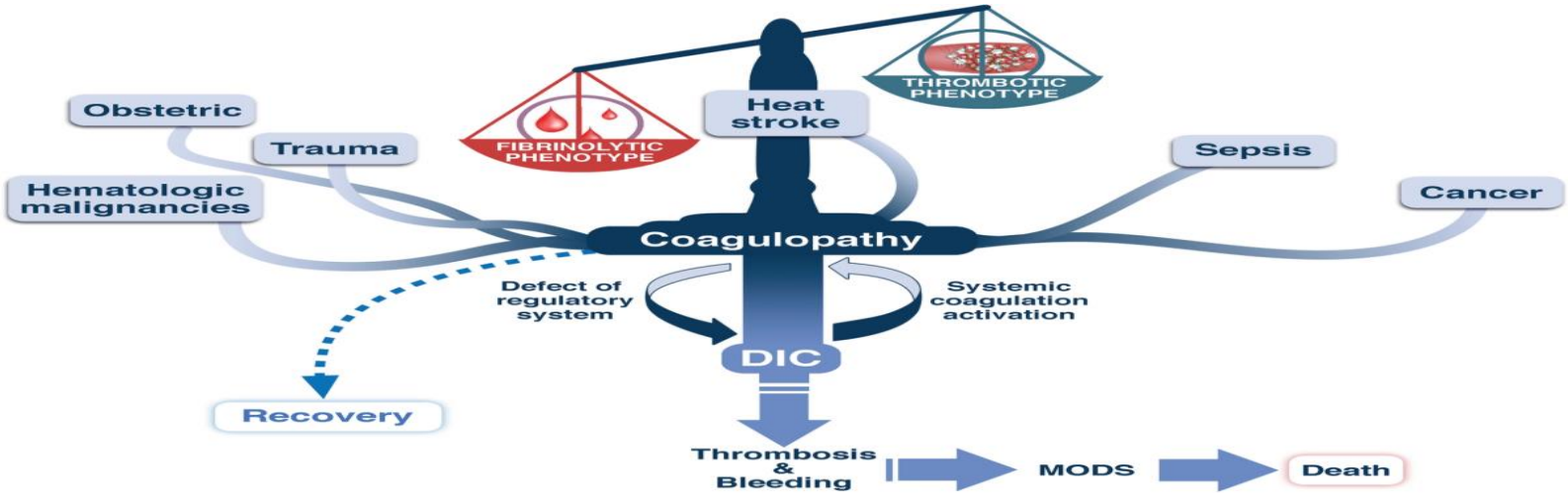
# Phenotypes and temporal evolution of trauma-induced coagulopathy

- TIC is not a uniform disorder
- an early, predominantly hemorrhagic and hypocoagulable phenotype
- fibrinolytic shutdown,
- hypercoagulable states associated with thrombosis and organ dysfunction

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# Diagnosis and hemostatic monitoring

- The diagnosis of TIC should not rest on a single abnormal coagulation test. It is better approached as a dynamic process that integrates the clinical picture of bleeding, the severity of hemorrhagic shock, the patient's physiological trajectory, and the serial interpretation of laboratory and functional monitoring tools .
- Although TIC has classically been defined by a prothrombin ratio ≥ 1.2, that threshold alone does not capture the complexity of hemostatic derangement in severe trauma.
- Similarly, fibrinogen levels below 1.5 g/L are common and associated with worse outcomes, but they do not by themselves describe the full pathophysiological spectrum of the syndrome.

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FOCUSED HISTORY & PHYSICAL

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SUSPECTED HYPOVOLEMIC SHOCK

↓

## OBTAIN LABS



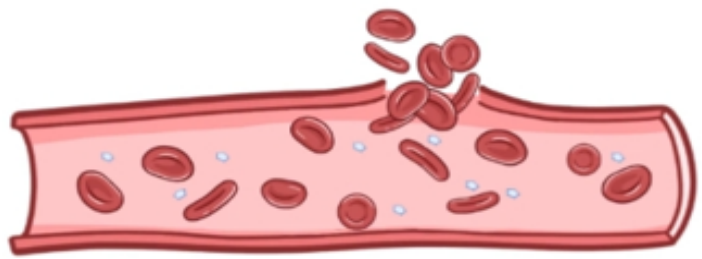
* CBC
* LACTATE
* CMP
* PT
* PTT
* INR



## OBTAIN LABS

| Hx | CBC | LACTATE | CMP | PT, PTT, INR |
| --- | --- | --- | --- | --- |
| TRAUMA or BLEEDING | ↓ HEMOGLOBIN | ELEVATED | HIGH BUN, CREATININE, & TRANSAMINASES | NORMAL or ELEVATED |

BLEEDING DISORDER or COAGULOPATHY



1 : 1 MIXING STUDY

↓

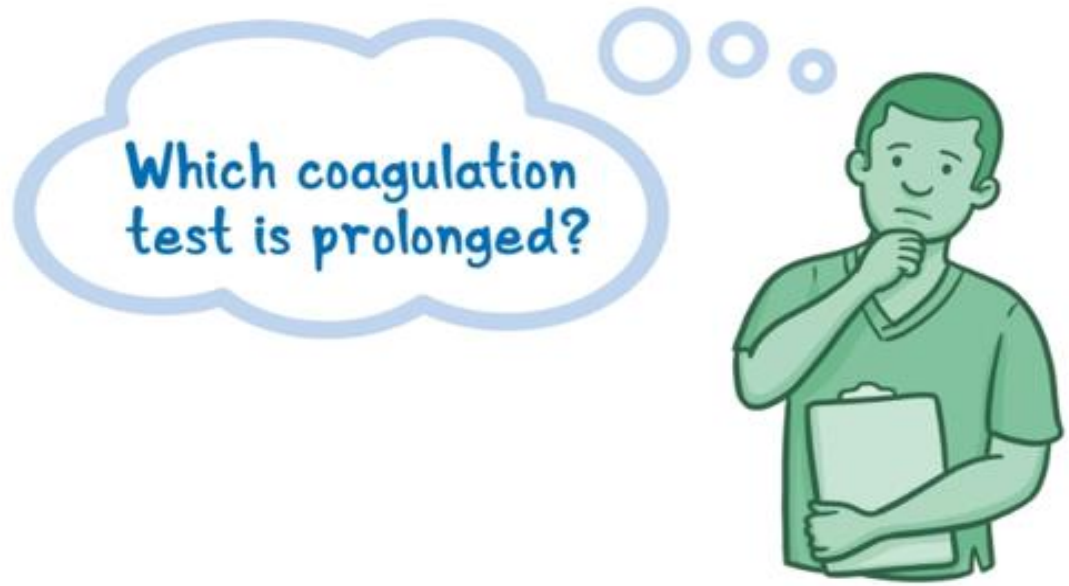
PT/aPTT improve

↓

**FACTOR DEFICIENCY**



NORMAL FACTORS in DONOR PLASMA
OVERCOME FACTOR(s) that
are DEFICIENT in PATIENT'S PLASMA



# Conventional coagulation tests

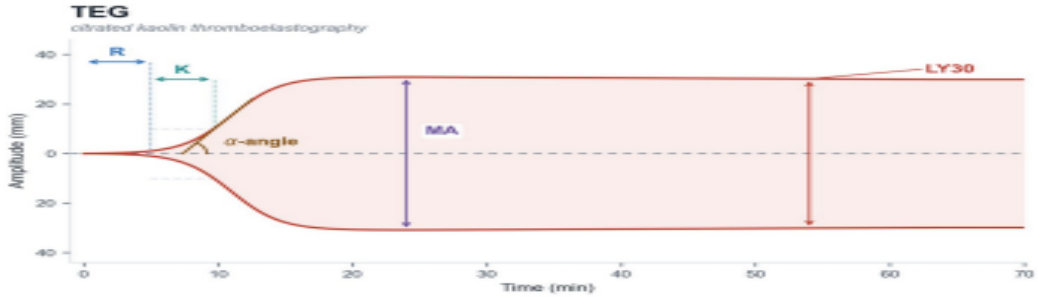
- Conventional coagulation tests remain the foundation of the initial evaluation of patients with severe trauma and suspected TIC. The most commonly used measures include platelet count, fibrinogen measurement by the Clauss method, prothrombin time, INR, activated partial thromboplastin time, and, in some settings, thrombin time .
- These tests are widely available, standardized, and useful for identifying global coagulation abnormalities, estimating bleeding risk, and establishing a baseline hemostatic profile.
- Their limitations matter just as much. Results may be delayed by as much as 60 minutes; they provide only a static and partial view of coagulation; they do not assess clot strength or resistance to lysis; and they do not capture platelet function .
- Platelet count, in particular, tells us how many platelets are present, not how well they are functioning. For that reason, conventional tests remain indispensable, but they are insufficient when interpreted in isolation.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

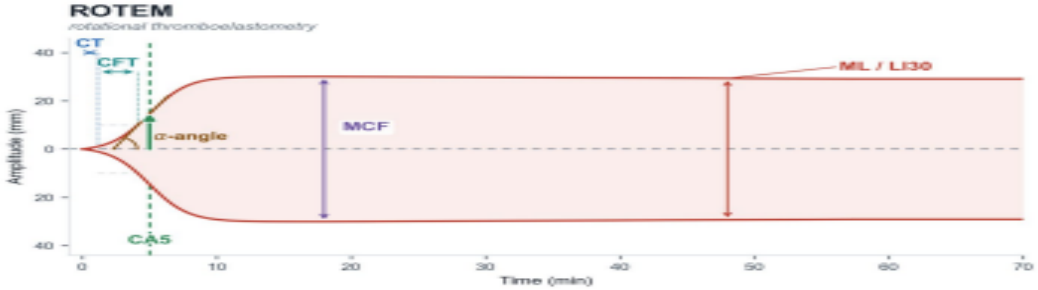
# Viscoelastic assays

- Viscoelastic assays, particularly thrombelastography (TEG) and rotational thromboelastometry (ROTEM), have become increasingly relevant in TIC because they provide a real-time functional assessment of clot formation and dissolution using whole blood.
- Their best role remains as complementary tools embedded in structured institutional algorithms rather than replacements for conventional testing.
- The role of viscoelastic testing in goal-directed hemostatic resuscitation .

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

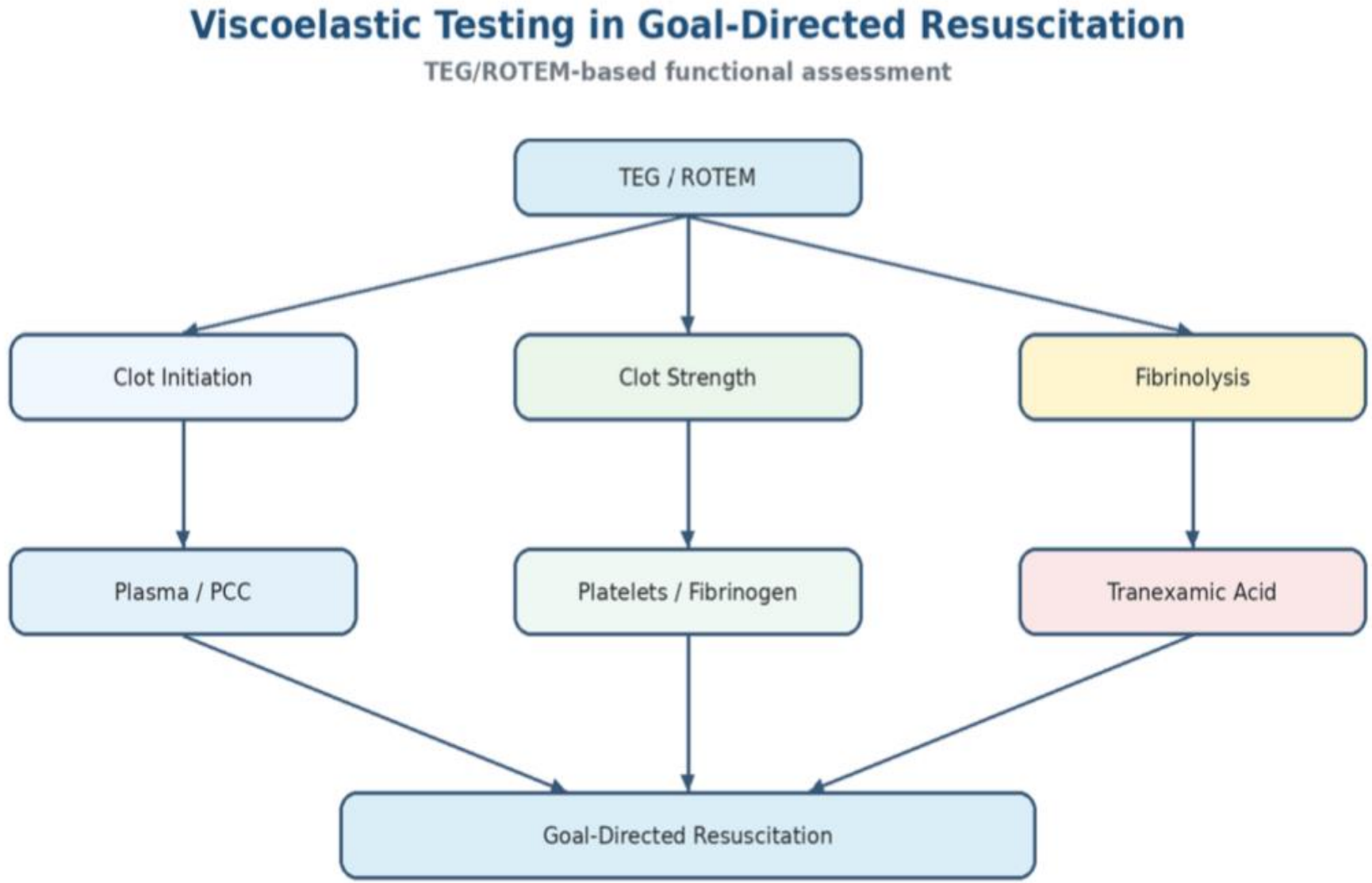



| Parameter | Clinical meaning | Reference range |
|---|---|---|
| R-time | Clot initiation; coagulation factor activity | 3 to 8 min |
| K-time | Fibrin formation; fibrinogen-driven kinetics | 1 to 3 min |
| α-angle | Rate of fibrin buildup and cross-linking | 55 to 78 deg |
| MA | Peak clot strength (~80% platelet, ~20% fibrin) | 51 to 69 mm |
| LY30 | Fibrinolysis; % clot lysis 30 min after MA | 0 to 3% |




| Parameter | Clinical meaning | Reference range |
|---|---|---|
| CT | Clot initiation; coagulation factor activity | 42 to 74 s |
| CFT | Fibrin formation; fibrinogen-driven kinetics | 46 to 148 s |
| α-angle | Rate of fibrin buildup and cross-linking | 63 to 81 deg |
| CA5 | Early clot amplitude at 5 min; rapid surrogate for MCF | ≤40 mm (MT threshold) |
| MCF | Maximum clot firmness | 49 to 71 mm |
| ML / LI30 | Maximum lysis / lysis index at 30 min | ML <15% (LI30 >85%) |

Meister R, Kim Y, Landry TC, LaVasseur C, Shatzel J, Deloughery T. Trauma-Induced Coagulopathy: From Endotheliopathy and Fibrinolysis Phenotypes to Viscoelastic-Guided Resuscitation. European journal of haematology. 2026 Sep 1.

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| Channel | Activator or reagent | Pathway or component isolated | Conventional analog | Representative reference range (ROTEM delta)[a] | Primary clinical use |
|---|---|---|---|---|---|
| EXTEM | Tissue factor | Extrinsic pathway: combined effect of coagulation factors, fibrinogen, and platelets | PT | CT: 42–74 s; CFT: 46–148 s; α: 63–81°; MCF: 49–71 mm | Global screen of clot initiation, propagation, and strength |
| INTEM | Ellagic acid plus phospholipid (contact activation) | Intrinsic (contact) pathway | aPTT | CT: 137–246 s; CFT: 40–100 s; α: 71–82°; MCF: 52–72 mm | Screen of the intrinsic/contact system; baseline for HEPTEM comparison |
| FIBTEM | Cytochalasin D[b] | Fibrinogen/fibrin contribution to clot strength | Correlates with Clauss fibrinogen[c] | MCF: 9–25 mm | Low FIBTEM MCF or CA5 identifies hypofibrinogenemia |
| APTEM | Aprotinin[d] | Fibrinolysis confirmation | None | Similar to EXTEM if no hyperfibrinolysis | Lysis on EXTEM corrected on APTEM confirms hyperfibrinolysis |
| HEPTEM | Heparinase[e] | Heparin effect | None | Similar to INTEM if no heparin present | HEPTEM vs. INTEM identifies heparin as the cause of a prolonged CT |

Meister R, Kim Y, Landry TC, LaVasseur C, Shatzel J, Deloughery T. Trauma-Induced Coagulopathy: From Endotheliopathy and Fibrinolysis Phenotypes to Viscoelastic-Guided Resuscitation. European journal of haematology. 2026 Sep 1.

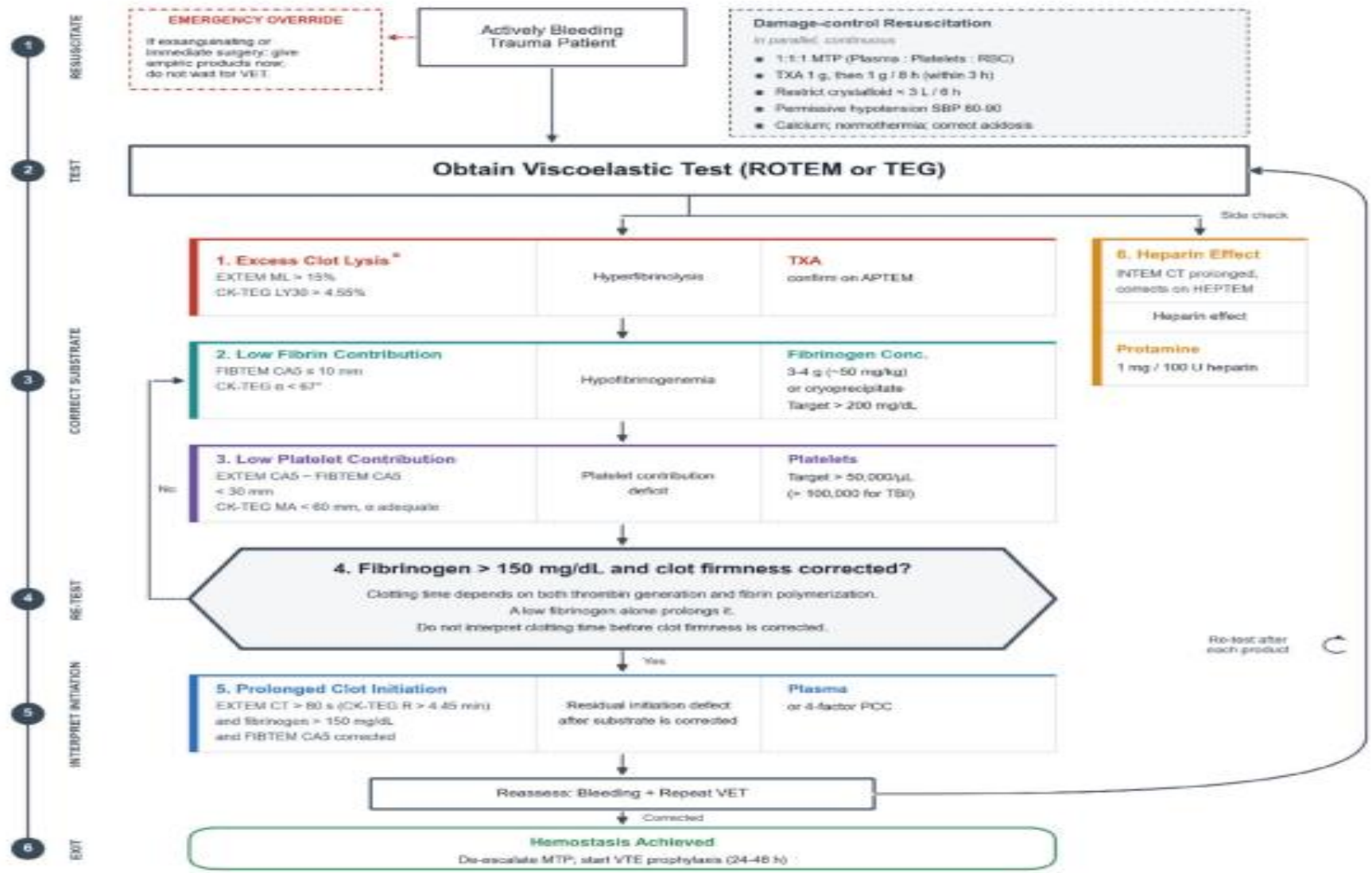
# Point-of-care assessment

- Point-of-care assessment is central to TIC because it allows hemostatic information to be translated into treatment decisions in real time.
- It should not be to the use of bedside devices alone; rather, it reflects the immediate integration of clinical, physiological, and hemostatic data during ongoing resuscitation .
- Persistent visible bleeding, hypotension, poor response to initial resuscitation, evidence of hypoperfusion, hypothermia, acidosis, and increasing transfusion requirements should all raise concern for clinically significant hemostatic failure.





Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).




Meister R, Kim Y, Landry TC, LaVasseur C, Shatzel J, Deloughery T. Trauma-Induced Coagulopathy: From Endotheliopathy and Fibrinolysis Phenotypes to Viscoelastic-Guided Resuscitation. European journal of haematology. 2026 Sep 1.

| Feature | Conventional tests | TEG/ROTEM |
|---|---|---|
| Turnaround | Laboratory delay | Rapid bedside |
| Whole-blood assessment | No | Yes |
| Clot strength | Indirect | Direct dynamic assessment |
| Fibrinolysis | Limited | Highly sensitive |
| Therapeutic guidance | Less individualized | Goal-directed therapy |

*Source: Adapted from [1].*

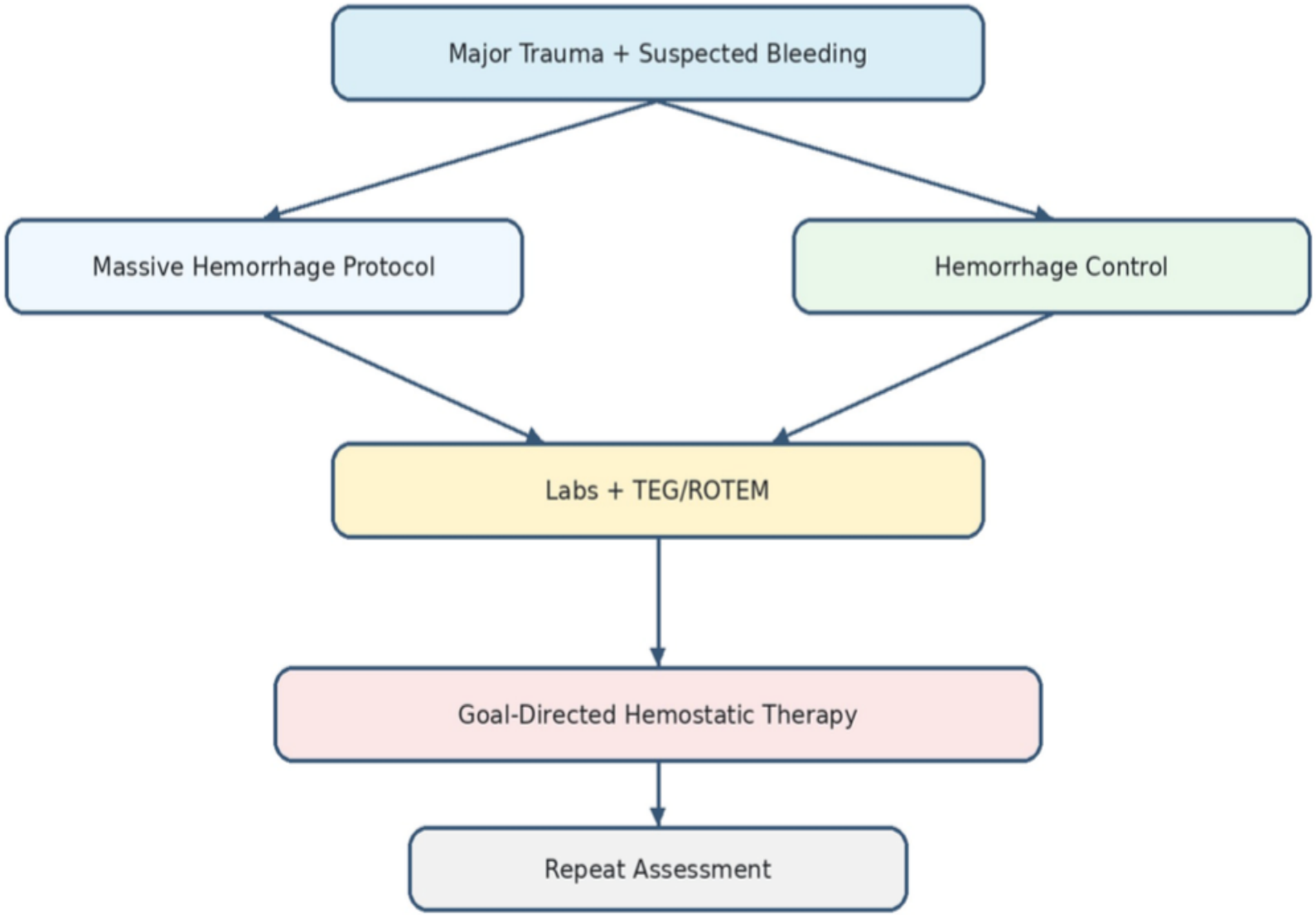
Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Strengths and limitations of current monitoring strategies

- Current monitoring strategies are valuable because they are complementary.
- Conventional tests provide accessibility, standardization, and serial follow-up; viscoelastic assays add functional and dynamic information; and point-of-care assessment improves timeliness and bedside decision-making .
- The major limitation is that no single tool fully captures the temporal and phenotypic complexity of TIC.
- In practice, the most useful approach remains one that combines clinical assessment, conventional tests, fibrinogen and calcium measurement, physiological variables, and, when available, viscoelastic assays .




Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).




Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Risk-adjusted mortality

- Injury severity scores and trauma scores allow the hospitals to compare themselves against predetermined national norms.
- Hospitals with higher risk-adjusted death rates may warrant evaluation of the individual unexpected deaths along with evaluation of their systems of care, to identify elements that might be contributing to such higher risk-adjusted mortality For all of the methods noted above, the primary principle is to identify the problems that are arising due to correctable factors.
- Injury Severity Score (ISS)
- Trauma and Injury Severity Score (TRISS),
- Rapid Emergency Medicine Score (REMS),
- and Shock Index




Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
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. Ay MO, Yüksel M, Çalışkan FB, Keski C, Fidan Yolay I, Eraybar S, Işler Y, Ocak U, Kaya H. Predictive Performance of Trauma Scoring Systems for Mortality in Patients with High-Energy Trauma in the Emergency Department. Journal of Clinical
Medicine. 2026 Jul 24;15(15):5791.

# Injury Severity Score (ISS)

| Body Region |
| --- |
| Head |
| Face |
| Neck |
| Thorax |
| Abdomen |
| Spine |
| Upper Extremity |
| Lower Extremity |
| External and other |

| Score | Abbreviated Injury Scale (AIS) |
| --- | --- |
| 1 | Minor |
| 2 | Moderate |
| 3 | Serious |
| 4 | Severe |
| 5 | Critical |
| 6 | Unsurviveable |

| Parameter | Injury Description | Grade |
|---|---|---|
| **Injury severity score (ISS)** | A2 + B2 + C2 (A, B, C are the AIS scores of the three most injured ISS body regions) | 34 |
| **Head and neck AIS** | Subarachnoid hematoma | 3 |
| **Face AIS** | Aches around glob | 1 |
| **Chest AIS** | Chest wall stiffness | 1 |
| **Abdomen AIS** | Mild liver contusion | 3 |
| **Extremities AIS** | Bilateral femoral fracture | 4 |
| **External AIS** | Multiple abrasions | 1 |

Abbreviation: AIS, abbreviated injury scale.

**Table 1 Definition and scoring system of the Trauma Induced Coagulopathy Clinical Score (TICCS)**

| Criteria | Number of points attributed |
|---|---|
| General severity | |
| Critical (to be admitted in resuscitation room) | 2 |
| Non critical (regular ED room) | 0 |
| Blood pressure | |
| SBP below 90 mmHg at least once | 5 |
| SBP always above 90 mmHg | 0 |
| Extent of significant injuries | |
| Head and neck | 1 |
| Left upper extremity | 1 |
| Right upper extremity | 1 |
| Left lower extremity | 1 |
| Right lower extremity | 1 |
| Torso | 2 |
| Abdomen | 2 |
| Pelvis | 2 |
| Total possible score | 0 to 18 |

[a]ED, Emergency department; SBP, Systolic blood pressure.

## Trauma Score and Injury Severity Score (TRISS)

Estimates the probability of survival for trauma patients.

When to Use | Pearls/Pitfalls | Why Use

| | | |
|---|---|---|
| Trauma type | Blunt<br>Penetrating | |
| Revised Trauma Score (RTS) | Norm: 4 - 8 | points |
| Injury Severity Score (ISS) | Norm: 0 - 75 | points |
| Age, years | ≤54 | >54 |

**Result:** Please fill out required fields.

# Revised Trauma Score

Quantifies severity of trauma injuries based on GCS, blood pressure, and respiratory rate.

**Instructions**

Use the first set of data obtained on the patient.

**Pearls/Pitfalls**

| | | |
|---|---|---|
| Glasgow Coma Scale | 5 | points |
| Systolic BP | 90 | mm Hg |

**5 points**

Some trauma protocols recommend patient treatment at a trauma center for a Revised Trauma Score <4, although other protocols use a higher number; the RTS correlates strongly with patient survival.

Copy Results

Next Steps

**Instructions**

Use the first set of data obtained on the patient.

**Pearls/Pitfalls**

| | | |
|---|---|---|
| Glasgow Coma Scale | 5 | points |
| Systolic BP | 90 | mm Hg |
| Respiratory Rate | 16 | breaths/min |

**5 points**

Some trauma protocols recommend patient treatment at a trauma center for a Revised Trauma Score <4, although other protocols use a higher number; the RTS correlates strongly with patient survival.

Copy Results

Next Steps

## Injury Severity Score (ISS)

Standardizes severity of traumatic injury based on worst injury of 6 body systems.

### Instructions

Rate only the *most severe* injury from each body system. Used primarily in research settings, so calculation of the ISS should not delay initial management of patients with traumatic injuries.

When to Use | Pearls/Pitfalls | Why Use

Head and neck worst injury?

- No injury
- Minor

**0** points

Out of a possible 75 points

Copy Results | Next Steps

Head and neck worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

Face worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

Chest worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

Abdomen worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

External worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

Extremity (including pelvis) worst injury?

- No injury
- Minor
- Moderate
- Serious
- Severe
- Critical
- Unsurvivable

## Trauma Score and Injury Severity Score (TRISS)

Estimates the probability of survival for trauma patients.

When to Use | Pearls/Pitfalls | Why Use

- Helps translate different severities of injuries into a quantitative characterization.
- Intended for quality assurance reviews or research to compare actual and predicted outcomes.

Trauma type: Blunt / Penetrating

Revised Trauma Score (RTS): Norm: 4 - 8 points

Injury Severity Score (ISS): Norm: 0 - 75 points

Age, years: ≤54 / >54

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Quantifies severity of trauma injuries based on GCS, blood pressure, and respiratory rate.

## Instructions

Use the first set of data obtained on the patient.

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Copy Results

Next Steps

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Rate only the *most severe* injury from each body system. Used primarily in research settings, so calculation of the ISS should not delay initial management of patients with traumatic injuries.

When to Use | Pearls/Pitfalls | Why Use

Head and neck worst injury?

- No injury
- Minor

**0** points

Out of a possible 75 points

Copy Results | Next Steps

| | | |
|---|---|---|
| Injury Severity Score (ISS) | Norm: 0 - 75 | points |
| Age, years | ≤54 | >54 |

# Result:

Please fill out required fields.

» Next Steps | Evidence | Creator Insights

## ADVICE

- We are not aware of any treatment recommendations based on TRISS results.
- Results are primarily utilized for research, quality assurance, and performance improvement within trauma systems.



*UNSTABLE PATIENTS MIGHT PRESENT w/ HEMORRHAGIC SHOCK



↳ QUICKLY LOCATE SOURCE of BLEEDING



~ NEUROLOGICAL CHANGES

~ HEMATEMESIS or HEMATOCHEZIA





~ VAGINAL BLEEDING



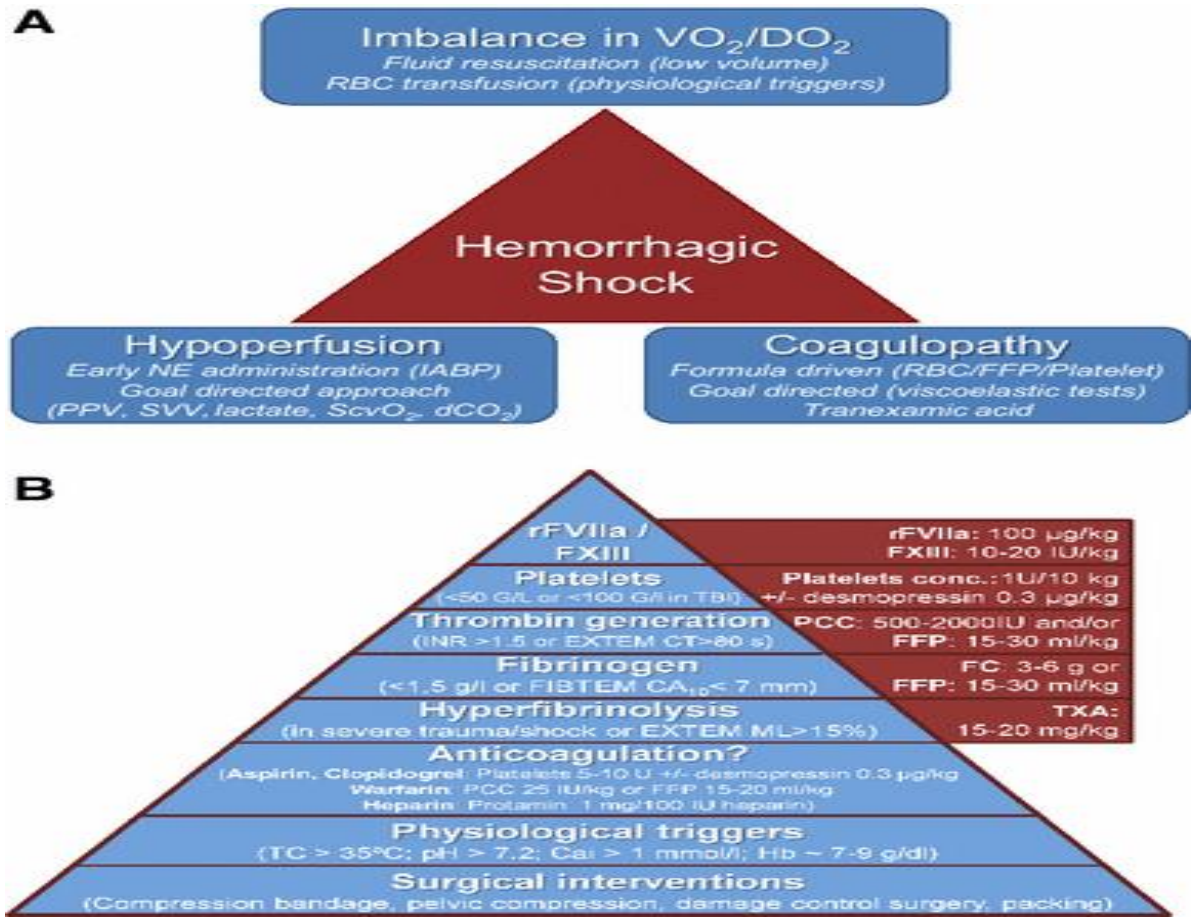
if unclear

↳ CT ANGIOGRAPHY or ENDOSCOPY



↳ CONSULT SURGERY TEAM

# Treatment


A
Imbalance in $VO_2/DO_2$
Fluid resuscitation (low volume)
RBC transfusion (physiological triggers)
Hemorrhagic Shock
Hypoperfusion
Early NE administration (IABP)
Goal directed approach
(PPV, SVV, lactate, $ScvO_2$, $dCO_2$)
Coagulopathy
Formula driven (RBC/FFP/Platelet)
Goal directed (viscoelastic tests)
Tranexamic acid
B
rFVIIa / FXIII
rFVIIa: 100 µg/kg
FXIII: 10-20 IU/kg
Platelets
(<50 G/L or <100 G/l in TBI)
Platelets conc.:1U/10 kg
+/- desmopressin 0.3 µg/kg
Thrombin generation
(INR >1.5 or EXTEM CT>80 s)
PCC: 500-2000IU and/or
FFP: 15-30 ml/kg
Fibrinogen
(<1.5 g/l or FIBTEM $CA_{10}$< 7 mm)
FC: 3-6 g or
FFP: 15-30 ml/kg
Hyperfibrinolysis
(In severe trauma/shock or EXTEM ML>15%)
TXA:
15-20 mg/kg
Anticoagulation?
(Aspirin, Clopidogrel: Platelets 5-10 U +/- desmopressin 0.3 µg/kg
Warfarin: PCC 25 IU/kg or FFP 15-20 ml/kg
Heparin: Protamin: 1 mg/100 IU heparin)
Physiological triggers
(TC > 35ºC; pH > 7.2; Cai > 1 mmol/l; Hb ~ 7-9 g/dl)
Surgical interventions
(Compression bandage, pelvic compression, damage control surgery, packing)

# Guidelines for Essential Trauma Care

- Airway Management(endotracheal intubation and cricothyroidotomy or tracheostomy)

| | Facility level[a] | | | |
|---|---|---|---|---|
| **Airway: Knowledge and skills** | **Clinic** | **First** | **Second** | **Tertiary** |
| Assessment of airway compromise | Co | Co | Co | Co |
| Manual maneuvers (chin lift, jaw thrust, recovery position, etc.) | Co | Co | Co | Co |
| Insertion of oral or nasal airway | Ex | Co | Co | Co |
| Use of suction | Ex | Co | Co | Co |
| Assisted ventilation using bag–valve–mask | Ex | Co | Co | Co |
| Endotracheal intubation | Ex | Ex | Co | Co |
| Cricothyroidotomy (with or without tracheostomy) | Ex | Ex | Co | Co |
| Airway: Equipment and supplies | | | | |
| Oral or nasal airway | Ex | Co | Co | Co |
| Suction device: At least manual (bulb) or foot pump | Ex | Co | Co | Co |
| Suction device: Powered: Electric/pneumatic | Ex | Ex | Co | Co |
| Suction tubing | Ex | Co | Co | Co |
| Yankauer or other stiff suction tip | Ex | Co | Co | Co |
| Laryngoscope | Ex | Ex | Co | Co |
| Endotracheal tube | Ex | Ex | Co | Co |
| Intubating bougie/stylet | Ex | Ex | Co | Co |
| Esophageal detector device | Ex | Ex | Co | Co |
| Bag–valve–mask | Ex | Co | Co | Co |
| Basic trauma pack[b] | Ex | Co | Co | Co |
| Magill forceps | Ex | Co | Co | Co |
| Capnography | NA | Ex | Co | Co |
| Laryngeal mask airway/supraglottic airway | Ex | Ex | Co | Co |
| Other advanced airway equipment (Appendix 2) | NA | Ex | Ex | Ex |

Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
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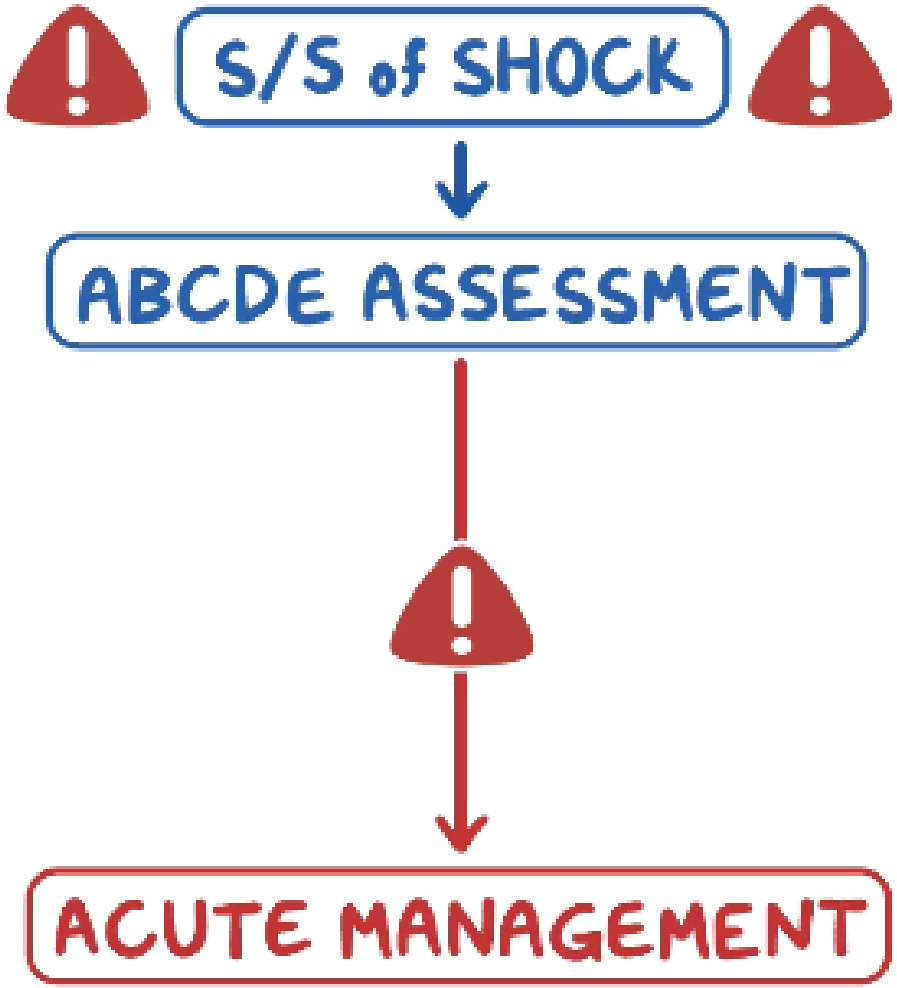
S/S of SHOCK
ABCDE ASSESSMENT
ACUTE MANAGEMENT

S/S of HYPOVOLEMIC SHOCK

↓

ABCDE ASSESSMENT

↓



## ACUTE MANAGEMENT

* STABILIZE AIRWAY, BREATHING, & CIRCULATION
  ↳ MIGHT NEED to INTUBATE
* OBTAIN IV ACCESS w/ 2 LARGE BORE IVs
  ↳ START IV FLUIDS
* CONTINUOUS VITAL SIGN MONITORING
  ↳ PULSE OXIMETRY, BP, HR





# ACUTE MANAGEMENT

* **STABILIZE AIRWAY, BREATHING, & CIRCULATION**
  ↳ MIGHT NEED to INTUBATE
* **OBTAIN IV ACCESS**
  ↳ CONSIDER FLUIDS
* **CENTRAL VENOUS CATHETER**
  ↳ ADMINISTRATION of MEDS & HEMODYNAMIC MONITORING
* **ARTERIAL CATHETER**
  ↳ CONTINUOUS MONITORING of MAP







ABCDE ASSESSMENT → UNSTABLE

STABILIZE AIRWAY, BREATHING, & CIRCULATION



OBTAIN IV ACCESS



GIVE IV FLUIDS



+/- TRANSFUSION



CONTINUOUS VITAL SIGN MONITORING



+/- SUPPLEMENTAL $O_2$

# Airway Management




- Every trauma airway should be treated as potentially difficult.
- Video laryngoscopy (VL) is now the recommended first-line intubation tool
- Rapid sequence intubation (RSI) in hemodynamically unstable patients can trigger cardiovascular collapse.
- Induction agents reduce sympathetic tone, and positive pressure ventilation decreases venous return.
- For this reason, hemostatic resuscitation should be optimized before intubation. When this is not possible, short-term vasopressor support during the peri-intubation period should be considered as a bridge to hemodynamic stabilization .

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# Breathing – Management of Respiratory Distress

- The recognition of tension pneumothorax, its primary treatment by needle (or “finger”) thoracostomy and definitive treatment by tube thoracostomy are core at all hospital-level facilities

| | Facility level[a] | | | |
|---|---|---|---|---|
| **Airway: Knowledge and skills** | **Clinic** | **First** | **Second** | **Tertiary** |
| Assessment of airway compromise | Co | Co | Co | Co |
| Manual maneuvers (chin lift, jaw thrust, recovery position, etc.) | Co | Co | Co | Co |
| Insertion of oral or nasal airway | Ex | Co | Co | Co |
| Use of suction | Ex | Co | Co | Co |
| Assisted ventilation using bag–valve–mask | Ex | Co | Co | Co |
| Endotracheal intubation | Ex | Ex | Co | Co |
| Cricothyroidotomy (with or without tracheostomy) | Ex | Ex | Co | Co |
| Airway: Equipment and supplies | | | | |
| Oral or nasal airway | Ex | Co | Co | Co |
| Suction device: At least manual (bulb) or foot pump | Ex | Co | Co | Co |
| Suction device: Powered: Electric/pneumatic | Ex | Ex | Co | Co |
| Suction tubing | Ex | Co | Co | Co |
| Yankauer or other stiff suction tip | Ex | Co | Co | Co |
| Laryngoscope | Ex | Ex | Co | Co |
| Endotracheal tube | Ex | Ex | Co | Co |
| Intubating bougie/stylet | Ex | Ex | Co | Co |
| Esophageal detector device | Ex | Ex | Co | Co |
| Bag–valve–mask | Ex | Co | Co | Co |
| Basic trauma pack[b] | Ex | Co | Co | Co |
| Magill forceps | Ex | Co | Co | Co |
| Capnography | NA | Ex | Co | Co |
| Laryngeal mask airway/supraglottic airway | Ex | Ex | Co | Co |
| Other advanced airway equipment (Appendix 2) | NA | Ex | Ex | Ex |

Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
50.

# Breathing – Management of Respiratory Distress

- When ventilation is inadequate, it can be supported manually (e.g., self-inflating bag–valve–mask) or mechanically (e.g., ventilator)
- In general, in respiratory failure in trauma patients, invasive mechanical ventilation is used (i.e., delivered through an endotracheal tube).
- Noninvasive mechanical ventilation modalities (such as continuous positive airway pressure and bileve positive airway pressure) have some use in select trauma patients, such as:
    - (1) patients with impairments in oxygenation, but patent airways, adequate ventilation, stable hemodynamics, and alert mental status;
        - (2) after weaning and extubation from invasive mechanical ventilation

Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
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# Circulation – Management of Shock

- Assessment of Shock and Control of External Hemorrhage

| | Facility level | | | |
|---|---|---|---|---|
| | Clinic | First | Second | Tertiary |
| Assessment and external control of haemorrhage | | | | |
| Assessment of shock | Co | Co | Co | Co |
| Compression for control of haemorrhage | Co | Co | Co | Co |
| Arterial tourniquet in extreme situations | Co | Co | Co | Co |
| Splinting of fractures for haemorrhage control | Co | Co | Co | Co |
| Deep interfascial packing for severe wounds (e.g., landmine) | Ex | Co | Co | Co |
| Pelvic wrap for haemorrhage control | Ex | Co | Co | Co |
| Fluid resuscitation | | | | |
| Knowledge of fluid resuscitation | Ex | Co | Co | Co |
| Peripheral percutaneous intravenous access | Ex | Co | Co | Co |
| Peripheral cutdown access | Ex | Co | Co | Co |
| Central venous access for fluid administration | NA | Ex | Co | Co |
| Intraosseous access for children under 5 years | Ex | Ex | Co | Co |
| Transfusion knowledge and skills | NA | Co | Co | Co |
| Monitoring | | | | |
| Knowledge of resuscitation parameters | Ex | Co | Co | Co |
| More advanced monitoring (central venous pressure and/or point of care ultrasound) | NA | Ex | Co | Co |
| Other | | | | |
| Differential diagnosis of causes of shock | Ex | Co | Co | Co |
| Use of vasoactive medications | NA | Ex | Ex | Co |
| Use of fluids and antibiotics for septic shock | NA | Co | Co | Co |
| Recognition of hypothermia | Co | Co | Co | Co |
| External rewarming in hypothermia | Co | Co | Co | Co |
| Use of warmed fluids | NA | Ex | Co | Co |
| Knowledge of core rewarming | NA | Ex | Co | Co |

Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
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# ASSESS SOURCE of BLEEDING



## EXTERNAL SOURCE of BLEEDING/ TRAUMA

* SURGICAL CONSULT



* RESTORE BLOOD VOLUME w/ TRANSFUSION
  - RBCs & PLATELETS



* COAGULOPATHY?
  - FRESH FROZEN PLASMA (FFP)



## INTERNAL SOURCE of BLEEDING/ TRAUMA

* NO OBVIOUS or EXTERNAL CAUSE of BLEEDING

**TYPE or SOURCE of BLOOD LOSS**

TYPE or SOURCE of BLOOD LOSS

OVERT BLEEDING

CONCEALED BLEEDING

IMAGING STUDIES
* CT
* ULTRASOUND





ARTERIAL RUPTURE or HEMATOMA

AXIAL CT SCAN of ABDOMEN

CONSULT SURGICAL TEAM

# Basic Management Plan for Tactical Field Care

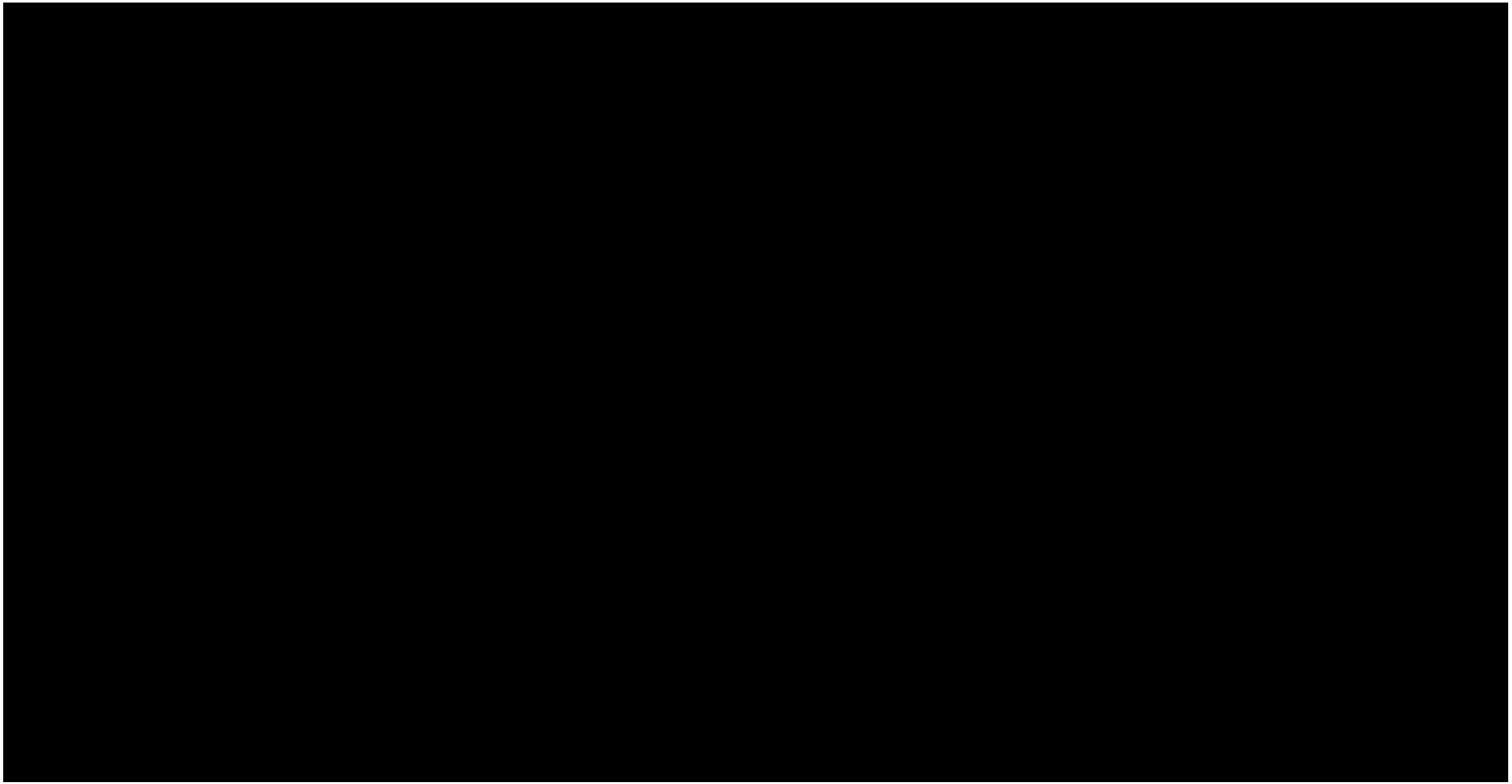
- 1-Establish a security perimeter in accordance with unit tactical standard operating procedures and/or battle drills. Maintain tactical situational awareness.
- 2. Triage casualties as required. See Triage Recommendations in Supplement A – Triage in TCCC.
- 3. Massive Hemorrhage
- 4-Airway Management
- 5-Respiration/Breathing
- 6-Circulation
    - a. Bleeding
    - b. Assess for hemorrhagic shock
    - C. IV/IO Access
    - d. Tranexamic Acid (TXA)
    - e. Fluid Resuscitation
    - f. Refractory Shock
- 7. Hypothermia Prevention
- 8. Traumatic Brain Injury:

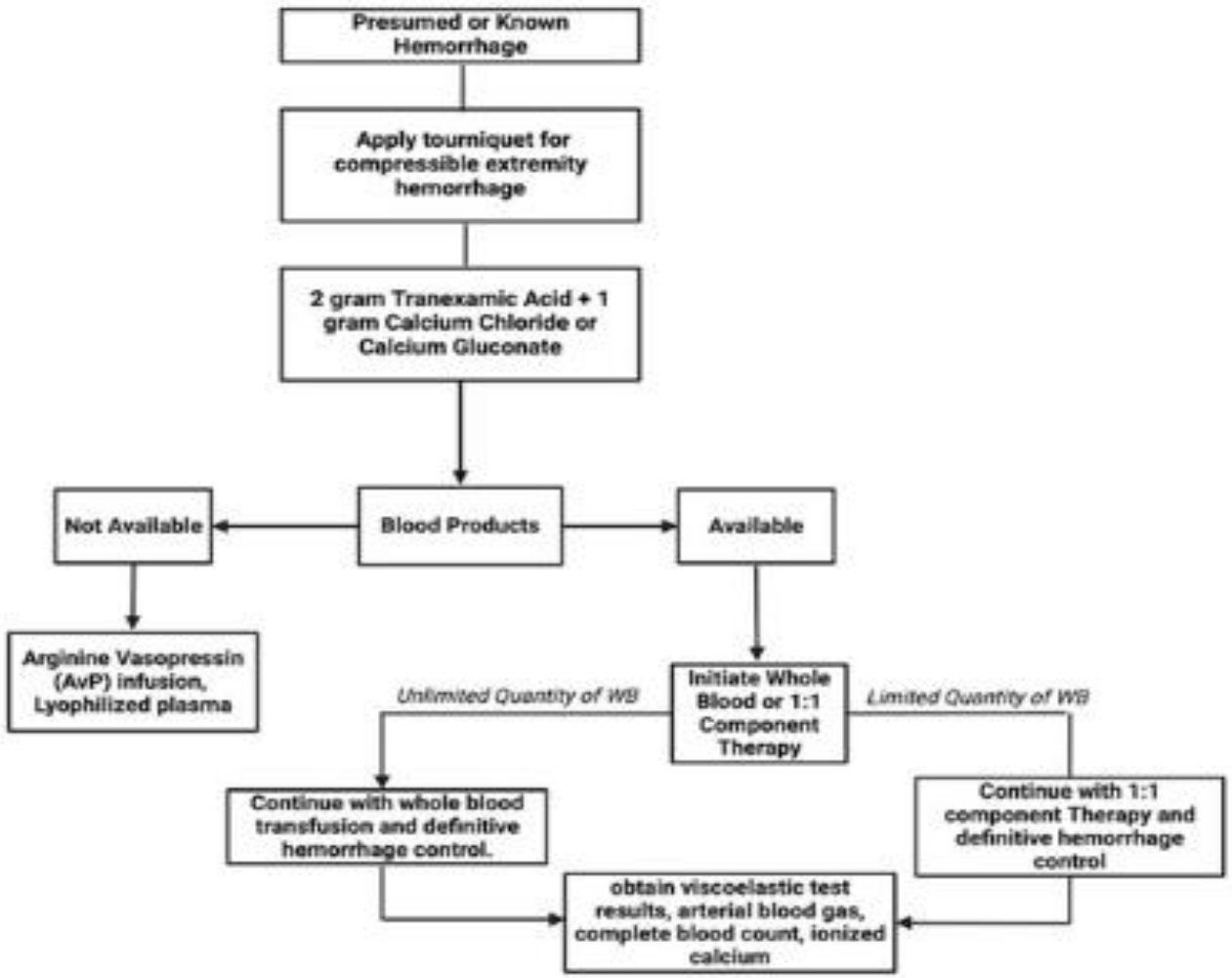
Deaton TG, Drew B, Montgomery HR, Butler Jr FK. Tactical combat casualty care (TCCC) guidelines: 25 January 2024. Journal of special operations medicine: a peer reviewed journal for SOF medical professionals.MAY2026

# Basic Management Plan for Tactical Field Care

- 9. Penetrating Eye Trauma
- 10. Monitoring
- 11. Analgesia
- 12. Antibiotics
- 13. Inspect and dress known wounds.
- 14. Check for additional wounds.
- 15. Burns.
- 16. Splint fractures and re-check pulses.
- 17. Cardiopulmonary resuscitation (CPR).
- 19. Documentation of Care.
- 20. Prepare for Evacuation.

Deaton TG, Drew B, Montgomery HR, Butler Jr FK. Tactical combat casualty care (TCCC) guidelines: 25 January 2024. Journal of special operations medicine: a peer reviewed journal for SOF medical professionals.MAY2026






Anand T, Shin H, Ratnasekera A, Tran ML, Huckeby R, Butts L, Stejskal I, Magnotti LJ, Joseph B. Rethinking balanced resuscitation in trauma. Journal of Clinical Medicine. 2025 Mar 19;14(6):2111.

# Fluid Resuscitation

The capability for monitoring a patient in shock for response to fluid therapy is deemed core at all hospital levels.
This includes an understanding of the stages of hemorrhagic shock.
It also includes the following basic equipment: clock or watch with second hand, stethoscope, blood pressure cuff and urinary catheter with collection bag (or improvised equivalent)




Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):1409-50.
Anand T, Shin H, Ratnasekera A, Tran ML, Huckeby R, Butts L, Stejskal I, Magnotti LJ, Joseph B. Rethinking balanced resuscitation in trauma. Journal of Clinical Medicine. 2025 Mar 19;14(6):2111.

# LIBERAL

VERSUS

# RESTRICTIVE

## FLUID REGIMEN



# Restrictive crystalloid strategy and balanced transfusion resuscitation

- A restrictive crystalloid strategy is essential because large-volume crystalloid administration may worsen dilutional coagulopathy, promote fibrinolysis, aggravate acidosis, and contribute to poorer outcomes
- For that reason, trauma resuscitation has shifted toward early blood product-based support. The bleeding patient is losing not only blood volume but also red blood cells, plasma proteins, platelets, fibrinogen, calcium, and the ability to sustain effective clot formation
- Balanced transfusion resuscitation has become a central principle in severe traumatic bleeding.
- Early activation of massive transfusion protocols using an approximate 1:1:1 ratio of red blood cells, plasma, and platelets seeks to restore oxygen-carrying capacity and hemostatic potential in a coordinated way . Rather than simple quantitative replacement, the goal is to re-establish the physiological conditions needed for effective clot formation while minimizing iatrogenic worsening of TIC

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Fluid Resuscitation

- Crystalloids: foundational yet limited
- Crystalloids, especially balanced formulations, remain first-line agents for initial resuscitation due to their accessibility, low cost, and familiarity. However, their limitations are well-documented:
    - Poor intravascular retention: Only ~18% remains intravascular 20 minutes post-infusion
    - Risk of tissue edema: May exacerbate compartment syndromes and impair organ perfusion
    - Dilutional coagulopathy: Large volumes dilute clotting factors and fibrinogen
    - Hyperchloremic acidosis: Associated with saline-based fluids
- Balanced crystalloids, such as lactated Ringer's or Plasma-Lyte, are increasingly preferred over normal saline. Studies show they better preserve acid–base balance and mucosal perfusion, although conclusive mortality benefits remain elusive.

Markl-Le Levé A, Haller I, Bachler M. Fluid management in hemorrhagic shock. Current Opinion in Anesthesiology. 2025 Jun 1;38(3):316-22
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| Fluid Type | Volume Expansion | Coagulopathy Risk | Renal Risk | Mortality Data | Cost |
|---|---|---|---|---|---|
| **Crystalloids** | Low | Moderate (dilutional) | Low | Neutral | Low |
| **HES** | High | High | High | Potentially harmful | Moderate |
| **Gelatin** | Moderate | Low–Moderate | Low | Inconclusive | Moderate |
| **Albumin** | High | Moderate | Low | Worse in TBI | High |
| **FFP** | Moderate | Variable | Moderate | Uncertain | High |
| **Factor concentrates** | Targeted | Low | Low | Promising | Variable |

# Blood transfusion

- Blood transfusion may encompass transfusion of whole blood (whether fresh or banked) or use of components, including packed red blood cells, fresh frozen (or lyophilized freeze-dried) plasma, and platelets.
- Use of any of these will be influenced by capabilities of the institution's blood bank and the policies and practices of the institution or country.

- The use of blood also implies that it is being ordered by a clinician who knows the indications for transfusion in a trauma patient and is capable of recognizing and treating the potential complications of transfusion, monitoring the patient's response to transfusion and other fluid resuscitation, and assessing the patient for continued bleeding and the need for surgical intervention.



Mock C, Hardcastle TC, Gaarder C, Gupta A, Gyedu A, Joshipura M, Steyn E, Essential Trauma Care revision author group, Adjei V, Alcock R, Amado V. Guidelines for Essential Trauma Care: (2026). World journal of surgery. 2026 Jun;50(6):140
50.


AB
LyoPlas N – W



| Therapy | Primary indication | Key consideration |
|---|---|---|
| Packed RBCs | Hemorrhagic shock | Avoid isolated RBC resuscitation |
| Plasma | Factor replacement | Volume overload risk |
| Platelets | Low clot strength | Functional dysfunction matters |
| Cryoprecipitate/fibrinogen concentrate | Hypofibrinogenemia | Rapid fibrinogen restoration |
| Tranexamic acid | Hyperfibrinolysis | Greatest benefit within 3 h |

*Source: Expert synthesis based on contemporary trauma and hemostatic resuscitation literature.*

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Principles of damage control resuscitation

- Damage control resuscitation is one of the core principles of TIC management.
- Its aim is not simply to restore hemodynamic numbers, but to interrupt early the vicious cycle linking bleeding, shock, hypoperfusion, acidosis, hypothermia, and progressive hemostatic failure .
- Unlike traditional, fluid-heavy approaches, it prioritizes early and coordinated interventions: hemorrhage control, permissive hypotension when appropriate, limitation of hemodilution, early use of blood products, correction of critical metabolic derangements, and continuous physiological reassessment




Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

| Clinical Domain | Previous Practice | Current Recommendation |
|---|---|---|
| Primary Survey | ABCDE — airway first | x-ABCDE: control exsanguinating hemorrhage before airway |
| Resuscitation Strategy | Aggressive crystalloid bolus (2 L) | Damage control resuscitation; LTOWB or 1:1:1 component therapy |
| Lethal Coagulopathy Pattern | Lethal triad: hypothermia, acidosis, coagulopathy | Lethal tetrad: adds hypocalcemia as the fourth component |
| MTP Activation | Empirical or clinical judgment | ABC Score ≥ 2 triggers MTP |
| Pediatric Fluid Limit | Up to 3×20 mL/kg crystalloid boluses; 10 mL/kg pRBC if bleeding persists (ATLS 10th ed.) | 10–20 mL/kg (<20 kg); max 1 L (>20 kg) |
| Intubation Tool | Direct laryngoscopy (primary) | Video laryngoscopy — first-line for all trauma airways |
| Pre-intubation Hemodynamics | Optimize after intubation | Mandatory hemostatic resuscitation before RSI; vasopressors as a bridge if needed |
| Hypotension in TBI/SCI | Permissive hypotension applied broadly | Contraindicated; target SBP ≥ 100–110 mmHg |
| TXA in TBI | Inconsistent use | 2 g bolus (or 1+1 g) within 3 h — reduces mortality |
| Cervical Immobilization | Routine rigid collar + backboard | Selective SMR; MILS during intubation; backboard for extrication only |
| Team Communication | Variable, informal | IMIST-AMBO handoff; S-xABCDE-BAR transfer; TIC as standard practice |
| Pre-arrival Preparation | No formal protocol | Zero Survey: assess resources and environment before the patient arrives |
| Post-resuscitation Transfer | Primary/secondary survey only | Quaternary Survey: logistical check before transfer in resource-limited settings |

# Early hemorrhage control

- Early and aggressive hemorrhage control is the first principle of damage control resuscitation. As long as the bleeding source remains active, transfusional, hemostatic, or pharmacological measures will have only limited effect, because ongoing blood loss perpetuates hypoperfusion and worsens .
- Hemorrhage control is therefore not merely an anatomic or surgical measure; it is a decisive intervention aimed at interrupting the pathophysiological cycle that sustains hemostatic collapse .
- In practice, bleeding must be identified and contained from the earliest phases of care, including the prehospital setting. Depending on injury location, this may involve direct compression, wound packing, tourniquets, pelvic binders, tamponade maneuvers, rapid transfer for definitive surgery, interventional radiology, or advanced damage control strategies.
- The success of all subsequent hemostatic measures ultimately depends on achieving source control as early as possible.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# From ABCDE to x-ABCDE

- The principle "treat the greatest threat first" has prompted a revision to the primary survey. In the updated framework, the "x" step — control of eXsanguinating external hemorrhage precedes airway assessment .
- The reasoning is straightforward: uncontrolled massive external bleeding causes irreversible circulatory collapse within seconds, while airway obstruction develops over minutes.
- Hemorrhage control is therefore the immediate priority, and it does not replace the rest of the ABCDE sequence.
- On arrival, the first action is to control compressible bleeding from extremity and junctional wounds using direct pressure, wound packing, or a tourniquet. These steps are fast, require minimal equipment, and can be done simultaneously with airway management by other team members. A 2024 multicenter study confirmed that prioritizing circulatory support over intubation in patients with exsanguinating injuries was independently associated with improved survival, and that post-intubation hypotension was associated with significantly worse outcomes .
- Tourniquets must be applied with enough pressure to exceed systolic blood pressure and eliminate the distal pulse.

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

- Damage Control Resuscitation, ABC Score, and Pediatric Fluids High-volume crystalloid resuscitation worsens trauma induced coagulopathy and contributes to the "lethal tetrad": hypothermia, acidosis, coagulopathy, and hypocalcemia
- Hypocalcemia is now recognized as an independent fourth component that impairs both myocardial function and coagulation. Current European guidelines recommend calcium supplementation in combination with blood products for patients with massive bleeding .
- Damage control resuscitation (DCR) replaces crystalloid-first approaches with early hemostatic resuscitation.
- The preferred strategy is low-titer O-negative whole blood (LTOWB) or a balanced 1:1:1 ratio of packed red blood cells (pRBCs), fresh frozen plasma (FFP), and platelets.




Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.



# *Permissive Hypotension*

# Permissive hypotension

- Permissive hypotension seeks to avoid excessive and premature restoration of blood pressure before definitive hemorrhage control has been achieved.
- Early elevation of intravascular pressure may increase bleeding, destabilize the forming clot, and favor ongoing loss of volume and coagulation factors .
- The aim is therefore not immediate normalization of blood pressure, but preservation enough organ perfusion while limiting renewed hemorrhage and the progression of TIC.
- Its hemostatic value is two fold: it reduces the need for large crystalloid volumes and limits worsening of acidosis and hypothermia. In that sense, permissive hypotension is not only a hemodynamic strategy but also a way of protecting clot integrity while definitive source control is pursued .
- It must, however, always be applied with clinical judgment according to injury pattern, shock severity, and organ-perfusion requirements.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

Table 1: Parameters used to monitor shock state and the effectiveness of resuscitation.

| Vital Signs and Physical Findings | Non-Invasive Hemodynamic Monitoring (to estimate cardiac output) | Invasive Hemodynamic Monitoring | Systemic Oxygenation Parameters | Tissue-Specific Measures of Perfusion and Oxygenation |
|---|---|---|---|---|
| Tachycardia/bradyasystole | Cuff blood pressure | Arterial catheterization | Serum Markers of Shock | Skin, muscle and subcutaneous tissue. |
| Tachypnea/dyspnea | Echocardiography | Central venous pressure (CVP) | Base deficit | GI mucosa. |
| Marked pallor on the skin | Thoracic electrical bioimpedance | Thermodilution | Lactate | Near-infrared spectroscopy (NIRS). |
| Decreased urine output(below 0.5 mL/kg/h in adults) | | Pulmonary capillary wedge pressure (PCWP) | | Cerebral perfusion. |
| Confusion and/or altered mental status | | | | Brain tissue oxygen tension. |
| Angor animi/ sense of impending doom | | | | Jugular venous O2 saturation. (SjvO2) |
| Hypotension | | | | |

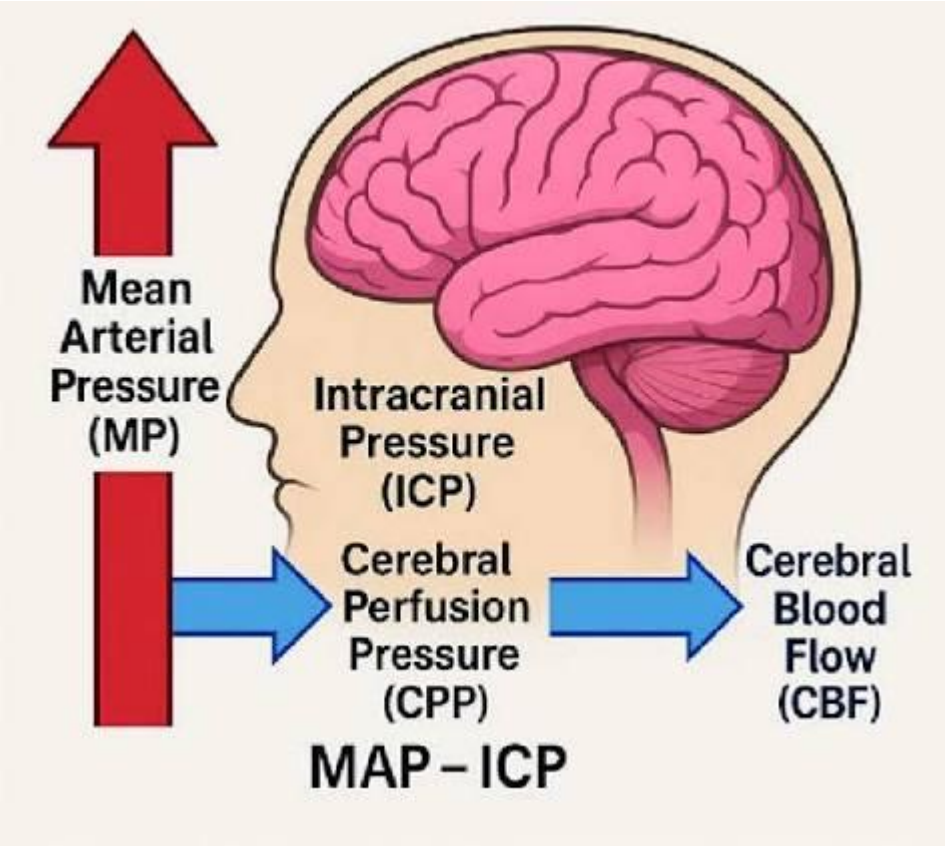
# Permissive hypotension

- In actively bleeding patients without TBI or spinal cord injury (SCI), **a target systolic blood pressure (SBP) of 80–90 mmHg is** recommended until definitive hemorrhage control is achieved.
- Vasopressors are not a primary resuscitation tool in hemorrhagic shock. They may be used as a short-term measure when blood products are unavailable or when hemodynamics remain unstable despite adequate volume resuscitation .
- The management of massive hemorrhage encompasses not only external bleeding but also potentially fatal sources of internal bleeding.
- In hemodynamically unstable patients, hemorrhage originating from major pelvic ring fractures and associated retroperitoneal venous or arterial systems can lead to exsanguination within minutes.
- In trauma patients with suspected pelvic fractures and unexplained hypotension (especially if the FAST exam is negative), a pelvic binder or sheet must be applied as soon as possible to reduce pelvic volume, limit the movement of fracture ends, and promote a tamponade effect to halt bleeding. For the device to be effective, it is anatomically imperative that it be centered over the greater trochanters rather than the iliac crests. Furthermore, internally rotating the patient's legs and securing the ankles together reduces pelvic volume and helps control bleeding.

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# Neuroprotection and Critical Neuro worsening

- Permissive hypotension is contraindicated in TBI and SCI.
- Cerebral perfusion pressure (CPP) equals mean arterial pressure (MAP) minus intracranial pressure (ICP).
- Any drop in MAP reduces CPP and worsens secondary brain injury.
- **A minimum SBP of 100–110 mmHg** is recommended in adult TBI patients — revised upward from the previous 90 mmHg threshold — based on evidence linking lower blood pressure to worse neurological outcomes




Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# ABC Score and Massive Transfusion Protocol

- One point is assigned for each of the following: SBP ≤ 90 mmHg, heart rate ≥ 120 bpm, positive FAST, and penetrating torso mechanism. A score ≥ 2 indicates a likely need for MTP and should prompt immediate activation
- Pediatric Fluid Limits To reduce the risk of fluid overload and dilutional coagulopathy in children, crystalloid limits were defined in the ATLS 10th edition as up to three sequential **20 mL/kg isotonic crystalloid boluses, followed by 10 mL/kg packed red blood cells** if bleeding continued after the third bolus.
- The ATLS 11th edition has revised this approach toward earlier blood product use: after an initial 20 mL/kg crystalloid bolus, if the patient does not demonstrate a sustained response, transition to 10 mL/kg of packed red blood cells or whole blood is now preferred over additional crystalloid. For pediatric damage control resuscitation, the ATLS 11th edition further defines: 10–20 mL/kg for children under 20 kg, and a maximum of 1 L for those over 20 kg.
- Pediatric DCR protocols using these limits have shown lower rates of coagulopathy and mortality compared to conventional crystalloid resuscitation.

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# Temperature and metabolic optimization

- Preservation of normothermia and early correction of metabolic derangements are essential components of damage control resuscitation. Hypothermia, acidosis, and hypocalcemia are not passive findings; they actively amplify both coagulopathy and shock
- Hypothermia impairs platelet and coagulation factor function, acidosis diminishes coagulation enzyme activity and accelerates fibrinogen consumption, and hypocalcemia compromises calcium-dependent reactions within the coagulation cascade
- Metabolic optimization, then, is best understood as restoration of the physiological environment in which coagulation can actually occur.
- Heat preservation, active warming, warmed fluids and blood products, restoration of tissue perfusion, limitation of hemodilution, and early calcium correction all belong to this strategy
- Effective resuscitation is therefore not just about transfusing products, but about creating the conditions in which a clot can form, stabilize, and resist fibrinolysis.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# HYPOTHERMIA

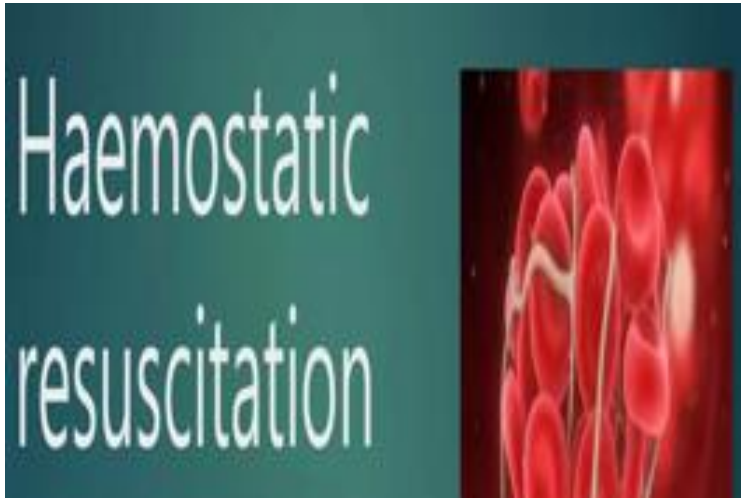
- 66% of trauma patients arrive in emergency departments manifesting some degree of hypothermia (temperature < 96.8°F or 36°C)



- **HEAT LOSS AREAS**:
  - Environmental
  - Exposure during resus
  - Open body cavities
  - Ongoing patient fluid loss
  - Iatrogenic cold fluids (IVF)

# Hemostatic resuscitation and blood product therapy

- Hemostatic resuscitation is the therapeutic core of care for the patient with traumatic hemorrhage and TIC. Its purpose is not merely to replace volume, but to restore the capacity to form and maintain an effective clot while hemorrhage control is being pursued
- Blood product therapy should therefore be understood as a pathophysiologically directed intervention aimed at correcting the simultaneous loss of red blood cells, coagulation factors, fibrinogen, platelets, and calcium, while limiting the progression of shock and hemostatic failure




Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Balanced transfusion strategies

- Balanced transfusion strategies are central to hemostatic resuscitation because massive blood loss produces simultaneous depletion of red blood cells, plasma factors, platelets, and fibrinogen.
- An approach based only on red blood cell replacement or excessive crystalloid use may aggravate dilutional coagulopathy and perpetuate instability
- Early activation of massive transfusion protocols using an approximate **1:1:1 ratio of red blood cells, plasma, and platelets** remains a reference strategy in many contemporary guidelines and reviews
- In practice, balanced transfusion should always be integrated with hemorrhage control, restriction of crystalloids, metabolic correction, and continuous reassessment of the hemostatic profile.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Component-based hemostatic support: Plasma, platelets, fibrinogen, and calcium

- Component-based hemostatic support should be directed at correcting specific defects rather than providing nonspecific product replacement. Plasma remains important because it supplies coagulation factors at a stage in which these have been lost, consumed, or diluted, and its greatest value is realized when incorporated into balanced transfusion rather than used as isolated rescue therapy
- Platelets are equally important because TIC is not only a disorder of plasma factors but also of cellular hemostasis. Meaningful platelet dysfunction may be present even when the count appears preserved, which is why platelet support must be interpreted in the context of active bleeding, the dynamics of resuscitation, and, when available, functional or viscoelastic testing
- Fibrinogen occupies a particularly critical position. It is one of the first coagulation factors to decline during major traumatic hemorrhage, and low levels are associated with reduced clot firmness, massive transfusion, and adverse outcomes
- Early replacement – whether by cryoprecipitate or fibrinogen concentrate, depending on institutional availability – should therefore be regarded as a central intervention when active bleeding occurs in the setting of suspected or confirmed hypofibrinogenemia
- Calcium correction is likewise essential, since citrate exposure from transfused products may aggravate ionized hypocalcemia and worsen hemostatic failure
- Taken together, plasma, platelets, fibrinogen, and calcium are best viewed as elements of an integrated hemostatic support strategy. Treatment is most effective when the predominant defect is identified and a physiologically coherent, reassess able replacement plan is built around it

Suastegui, Xiuhtaulli Lopez, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Events in Critical Care." (2026)

# Pharmacological adjuncts

- Pharmacological adjuncts are complementary rather than substitutive tools in TIC management.
- They do not replace early hemorrhage control, balanced transfusion, or physiological correction, but they may help modulate specific coagulation or fibrinolytic defects when used in a timely way within a damage control framework
- Because TIC is dynamic and may evolve from hyperfibrinolysis to fibrinolytic shutdown or hypercoagulability, the usefulness of these agents depends on the predominant defect, the phase of illness, and the risk– benefit profile of the intervention

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Tranexamic acid, prothrombin complex concentrates, factor concentrates, and emerging hemostatic therapies

- Tranexamic acid remains the pharmacological adjunct with the strongest clinical support. Its rationale is to limit plasmin generation and reduce premature clot breakdown during the early phase of traumatic hemorrhage, especially when hyperfibrinolysis is suspected or likely
- Its benefit is most closely tied to early administration and to its integration into the initial hemostatic strategy rather than its use as a late rescue measure.
- Other procoagulant agents, including prothrombin complex concentrates (PCCs), have also been explored in patients with major bleeding and TIC
- PCCs are attractive because they deliver vitamin K-dependent factors in small volumes and can be available quickly; however, current evidence does not show a consistent reduction in mortality, and concern persists regarding thrombotic risk, particularly in later, more procoagulant phases
- Likewise, factor-concentrate strategies – especially fibrinogen concentrates – may be useful in selected scenarios but should be applied within protocols that take into account the patient's hemostatic phenotype and biological phase. The safest approach remains to use pharmacological adjuncts as targeted tools embedded in a broader hemostatic strategy

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Spinal Motion Restriction

- Universal rigid cervical immobilization has been replaced by selective spinal motion restriction (SMR).
- Rigid backboards should be used only for short-term extrication and transport, not as a prolonged stabilization method.
- Cervical collars should be applied selectively. Rigid collars have been shown to increase intracranial pressure, reduce venous drainage, and interfere with airway management
- Airway and hemostatic resuscitation must not be delayed by spinal restriction measures. In an agitated patient, a forcibly applied collar may produce more cervical movement than no collar at all. During difficult airway management, the anterior portion of the collar should be removed, and manual in-line stabilization (MILS) applied throughout the procedure .

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

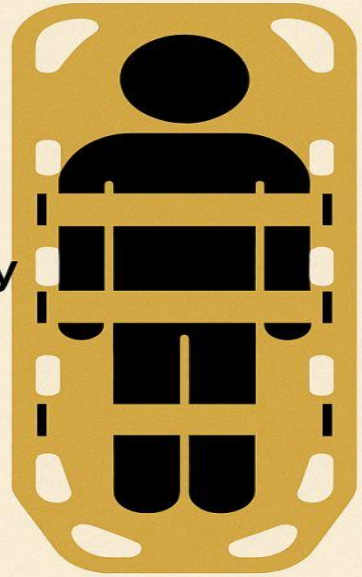
# Spinal Motion Restriction

## SPINAL MOTION RESTRICTION (SMR)

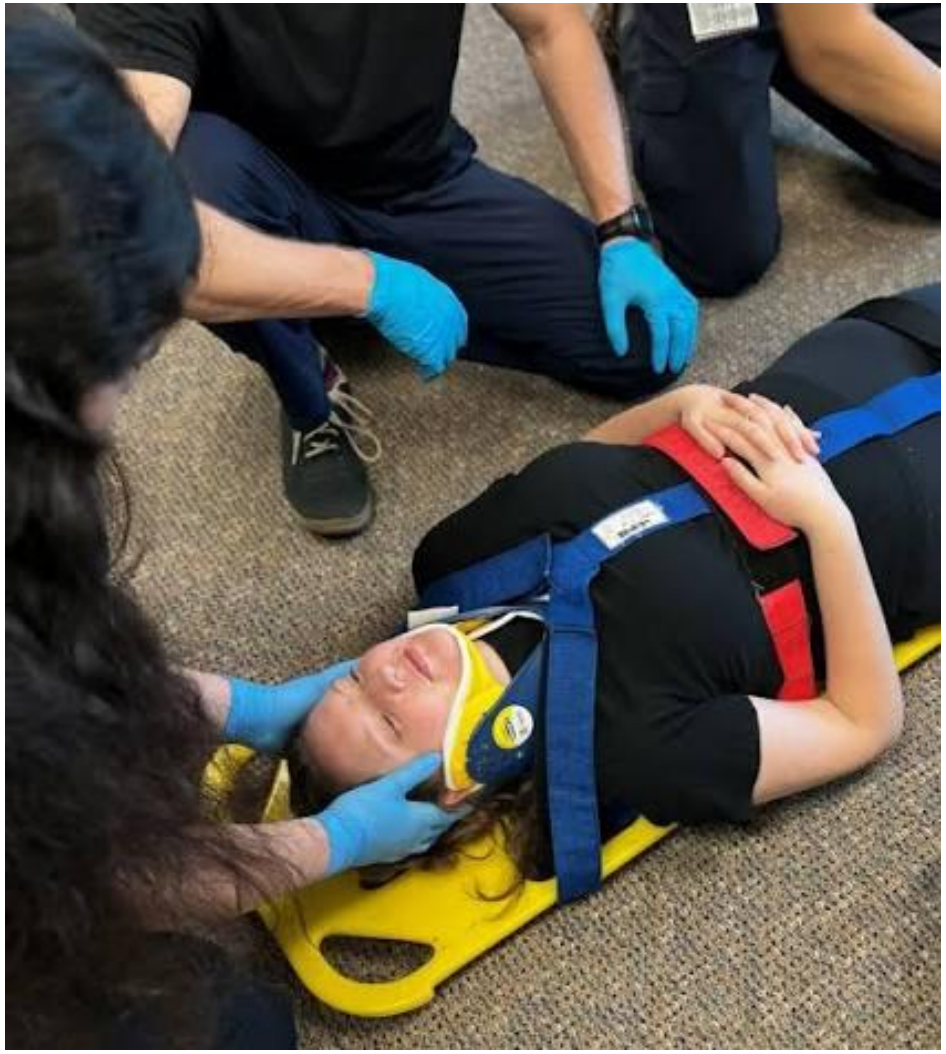
**Indications:**

- Neck/back pain
- Neurological deficit
- Distracting injury
- Altered LOC
- Intoxication

**Think before you strap.**



**Stabilize the spine — Don't immobilize the whole person.**



# Special Populations, Human Factors, and Trauma-Informed Care

- Geriatric Trauma: With the rapid growth of the aging population, geriatric trauma management has become a critical priority, with the ATLS 11th edition introducing "ageism" as a significant factor that can lead to implicit bias, undert riage, and suboptimal management. Geriatric patients are frequently under triaged because subtle physiological changes and atypical presentations – such as severe injury resulting from low energy ground-level falls – often mask the underlying severity.
- A landmark update in current practice is the upward revision of the hemodynamic threshold for shock; for patients aged ≥65 years, a systolic blood pressure (SBP) < 110 mmHg is now the recognized threshold for hypotension, as conventional "normal" readings often mask occult hypoperfusion in this population.
- Furthermore, age-related decline in physiological reserve and the prevalent use of beta-blockers mean that tachycardia – the classic sign of hypovolemia – is frequently absent. Given the high prevalence of anticoagulant use, rapid assessment of the coagulation profile and prompt reversal with targeted agents, such as prothrombin complex concentrate (PCC), are essential to prevent the fluid overload associated with fresh frozen plasma.
- Finally, selective spinal motion restriction (SMR) is paramount, as rigid cervical collars in older adults significantly increase the risks of swallowing difficulties, aspiration, and airway management challenges .

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):6277

# Individualized and goal-directed management

- Management of TIC cannot rely on a single, uniform approach. TIC is a dynamic, heterogeneous, and time-dependent syndrome whose expression varies according to the magnitude of injury, shock severity, inflammation, endothelial activation, and the patient's biological phase
- Contemporary care, therefore, increasingly favors individualized, goal-directed management, in which decisions are adapted to the predominant hemostatic defect and to the patient's clinical response
- The first step is clinical integration: persistent bleeding, the anatomical source of hemorrhage, shock severity, response to initial resuscitation, transfusion requirements, and the pace of physiological deterioration remain fundamental determinants of management
- The second step is functional monitoring, ideally combining conventional coagulation tests, fibrinogen, ionized calcium, temperature, and, when available, viscoelastic assays
- The third step is therapeutic adaptation according to the dominant defect: hemorrhage with hypoperfusion calls for bleeding control and balanced resuscitation; clot weakness suggests fibrinogen replacement; cellular hemostatic impairment increases the relevance of platelets; and hyperfibrinolysis supports early tranexamic acid
- This strategy also requires attention to the phase of care. In the emergency department, the priority is rapid recognition of impending hemostatic collapse; in the operating room, continuous reassessment of the dominant defect during active bleeding; and in the intensive care unit, recognition of the transition toward hypofibrinolysis, hypercoagulability, venous thromboembolism, and organ dysfunction

Suárez-Xuhuila, J. López, and Alejandro Rivera Nofal. "Trauma-induced coagulopathy: Mechanisms, Monitoring and Clinical Reasons in Critical Care." (2026).

# Clinical pearls

- TIC begins early and may already be present on admission; the absence of immediate laboratory results does not exclude clinically relevant coagulopathy
- Persistent bleeding does not always reflect a simple lack of volume; it often signals unresolved hemostatic failure, especially when factor consumption, fibrinogen depletion, platelet dysfunction, or hyperfibrinolysis are present
- Anatomical control of bleeding remains the most important intervention.
- No blood component, factor concentrate, or antifibrinolytic can fully compensate for uncontrolled hemorrhage
- A normal platelet count does not exclude functional platelet impairment, and fibrinogen deserves early attention because it is one of the first factors to fall during major traumatic hemorrhage
- Correcting TIC is not only about transfusion; it is about restoring the physiological environment in which coagulation can work. Hypothermia, acidosis, and hypocalcemia actively amplify hemostatic failure
- Fewer crystalloids usually mean better hemostasis; balanced transfusion is more than a ratio; tranexamic acid is most useful when given early; and viscoelastic tests are most helpful when they actually change management
- Above all, TIC must be reassessed serially, because the best hemostatic decision is the one that addresses the predominant defect at that particular moment

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Zero and Quaternary Surveys in Austere and Disaster Settings

- Trauma care in resource-limited settings — including disaster zones, mass-casualty incidents, and areas with extended evacuation times — requires adaptations beyond the standard primary and secondary surveys. Two additional assessment phases address this need. Zero Survey
- The Zero Survey takes place before the patient arrives. It involves a systematic check of available personnel, blood products, equipment, logistical resources, and institutional capacity . Originally described as the "Zero Point Survey" within the STEP UP resuscitation framework, it has been incorporated into standard trauma training to support decision-making in multiple-casualty and mass-casualty incidents. Quaternary Survey The Quaternary Survey is performed after initial resuscitation, before the patient is transferred to a higher level of care. In austere settings, patients often need sequential transfers over long distances with limited resources, sometimes while resuscitation is still ongoing. The Quaternary Survey checks transport platform capabilities, expected delays, continued resuscitation needs, and the risk of deterioration during transfer

Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# Common pitfalls

- A common mistake is to treat TIC as a static laboratory abnormality rather than as a dynamic pathophysiological syndrome. Reliance on a single laboratory value or one-time measurement can lead to incomplete or misleading management.
- Another frequent error is to delay treatment while waiting for full laboratory confirmation; in the bleeding, shocked patient, TIC should be suspected and managed in parallel with hemorrhage control .
- Excessive reliance on crystalloids is another major pitfall because it may worsen dilutional coagulopathy, acidosis, and fibrinolysis.
- Likewise, apparently normal conventional coagulation tests do not exclude clinically relevant hemostatic dysfunction since they do not adequately capture platelet function, clot strength, or fibrinolysis.
- Other recurrent problems include failing to prioritize fibrinogen, underestimating temperature and metabolic optimization, using pharmacological adjuncts indiscriminately without regard to phenotype or timing, and continuing to think of TIC only in terms of bleeding while overlooking its later transition toward thrombosis.
- Management becomes unsafe when it is rigid, delayed, or disconnected from the patient’s evolving biology.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

| Clinical pearl | A common pitfall |
| --- | --- |
| Fibrinogen decreases early | Waiting for severe INR prolongation |
| Platelet count does not equal platelet function | Ignoring qualitative dysfunction |
| Correct calcium aggressively | Overlooking citrate-induced hypocalcemia |
| Avoid excessive crystalloids | Worsening dilutional coagulopathy |
| Source control is essential | Trying to transfuse uncontrolled bleeding |

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).

# Future directions

- Future progress in TIC will depend on a more precise understanding of biological heterogeneity and temporal evolution. TIC is increasingly recognized as a syndrome with multiple phenotypes, including early hyperfibrinolysis, clot weakness related to fibrinogen depletion or platelet dysfunction, and later hypofibrinolysis or hypercoagulability
- Another priority is refinement of functional and serial monitoring.
- The unmet need is not simply more technology but a better integration of clinical assessment, biomarkers, viscoelastic monitoring, and therapeutic algorithms that truly allow resuscitation to be individualized
- Targeted therapies – including fibrinogen, cryoprecipitate, specific factor concentrates, and PCCs – remain under active investigation, and the current evidence reflects both promise and uncertainty
- Overall, the field is moving toward a more dynamic, phenotype-guided model of precision hemostatic care.

Suástegui, Xiuhtlaulli López, and Alejandro Rivera Mora. "Trauma-Induced Coagulopathy: Mechanisms, Monitoring and Clinical Pearls in Critical Care." (2026).


SAFETY
IS A...
TEAM
EFFORT

# SUMMARY

- 1- Trauma-induced coagulopathy should be understood as a dynamic, multifactorial, and time-dependent hemostatic syndrome that not only accompanies severe hemorrhage but also helps sustain it and shapes later progression toward organ dysfunction, hypercoagulability, and thrombosis
- 2- Current evidence supports an early, integrated, and pathophysiologically directed approach to management. Early hemorrhage control, damage control resuscitation, balanced transfusion, targeted fibrinogen and calcium replacement, correction of hypothermia, acidosis, and hypocalcemia, and judicious use of pharmacological adjuncts remain the main pillars of contemporary care
- 3- Controlling hemorrhage early — before airway management — reduces preventable death
- 4- Emergency trauma resuscitation has shifted from highvolume, crystalloid-first care to targeted, physiology-guided management
- 5- DCR with LTOWB or balanced component therapy is more effective than crystalloid resuscitation in hemorrhagic shock.




Ünal E, Akoğlu H. Updates in Emergency Department Trauma Management: A Narrative Review. Anatolian Journal of Emergency Medicine. 2026 Mar 3;9(1):52-7.

# SUMMARY

- 6-Video laryngoscopy improves first-pass intubation success and should be the default tool in all trauma airways
- 7- In TBI and SCI, strict blood pressure targets (SBP ≥ 100–110 mmHg) and early TXA administration within 3 hours are key neuroprotective measures
- 8- Recognition of Critical Neuro-worsening allows timely intervention before herniation.
- 9- LTOWB
- 10- structured communication, team coordination

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# Thank you for your attention

