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Management of Trauma in Elderly and Frail Patients: A Master Summary of the 2023 WSES Guidelines

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Abstract

Background:

As global populations age, trauma in elderly and frail patients has emerged as a major public health challenge. Older adults experience disproportionately high morbidity and mortality after injury due to diminished physiological reserve, multimorbidity, polypharmacy, and frailty. In response to these growing complexities, the World Society of Emergency Surgery (WSES) developed the 2023 Guidelines on the Management of Trauma in Elderly and Frail Patients. This master summary synthesizes the core recommendations, evidence, and clinical principles to support standardized, frailty-oriented care throughout the trauma pathway.

Methods:

This work summarizes the main evidence and recommendations of the 2023 WSES Guidelines. The original guideline was produced through PRISMA-compliant

systematic reviews and GRADE-based evidence appraisal by multidisciplinary international working groups. Consensus was finalized during the 10th WSES Congress. This summary organizes findings into key clinical domains to facilitate practical implementation.

Results:

The guidelines highlight frailty as the central determinant of outcomes, superseding chronological age. Early identification through validated tools (CFS, TSFI, GTOS) is recommended. A lower threshold for trauma activation, comprehensive imaging, and serial assessment of lactate/base deficit are essential to detect occult shock. Resuscitation should prioritize restrictive fluids, early correction of coagulopathy, judicious vasopressor use, and individualized hemodynamic targets. Additional core recommendations address anticoagulant reversal, multimodal analgesia, antibiotic stewardship, venous thromboembolism prophylaxis, nutritional support,

delirium prevention, and structured end-of-life communication. System-level approaches, including geriatric trauma pathways, multidisciplinary teams, and outcome monitoring, are emphasized for implementation.

Conclusions:

The WSES guidelines reframe geriatric trauma care around individualized, frailty-driven assessment and management. Integrating physiologic principles, ethical sensitivity, and multidisciplinary coordination, they provide a comprehensive roadmap to improve survival, functional recovery, and quality of life in elderly trauma patients.

Keywords

Geriatric trauma; Frailty; Elderly patients; Trauma management; WSES guidelines

Background

In the past decades, the continuous improvement of healthcare and living standards has profoundly changed the demographic landscape of modern societies. The proportion of individuals aged 65 years or older now exceeds one fifth of the population in most European countries, and this trend is mirrored worldwide. Longer life expectancy, greater mobility, and an active lifestyle have, however, resulted in a paradox: while the elderly live longer and healthier lives, they are increasingly exposed to traumatic injuries¹.

Today, trauma in older adults represents a silent epidemic. Patients over 65 years already account for up to 40% of trauma admissions in developed countries, and their outcomes remain significantly worse than those of younger individuals, even when controlling for injury severity. This disproportionate mortality is not merely a reflection of age, but of frailty, a multidimensional syndrome characterized by diminished physiological reserve, vulnerability to stressors, and impaired recovery capacity².

Traditional trauma systems were designed around the physiology of young, otherwise healthy individuals. In the elderly, however, mechanisms of injury are often low-energy—such as ground-level falls but the consequences are devastating due to bone fragility, comorbidities, and altered responses to shock. The clinical picture is further complicated by polypharmacy, anticoagulation, and cognitive impairment, all of which may mask symptoms and delay recognition of critical injuries^{3–4}.

Recognizing this growing gap between current trauma models and the needs of older adults, the World Society

of Emergency Surgery (WSES) undertook a comprehensive effort to develop the 2023 Guidelines on the Management of Trauma in Elderly and Frail Patients⁵. These guidelines aim to redefine priorities, promote frailty-based rather than age-based decision-making, and integrate principles of geriatric medicine, critical care, and palliative support into trauma management.

By synthesizing the best available evidence and expert consensus, the document aspires to guide clinicians through the complex journey of caring for elderly trauma patients, from pre-hospital triage to end-of-life decisions, striving not only for survival, but for the preservation of dignity and quality of life.

Methodology and Scope

This paper does not represent a new systematic review of the literature but rather a master summary of the 2023 WSES Guidelines on the Management of Trauma in Elderly and Frail Patients⁵. The aim of this work is to summarize the core evidence and recommendations that emerged from the guideline process, organized according to the main clinical topics addressed by the expert working groups.

The original guideline was developed through a structured and transparent process. Six international teams of acute care and trauma surgeons reviewed the existing literature according to PRISMA methodology and formulated evidence-based statements following the GRADE framework^{6–7}. Consensus was finalized during the 10th WSES Congress held in Pisa in 2023.

Table 1 summarizes the essential statements for practice.

Definitions and Frailty Assessment

Recommendations:

- WSES suggests early trauma protocol activation in patients aged ≥ 55 years old [Weak recommendation based on a low level of evidence 2C].
- We recommend to carefully evaluate injured patients aged ≥ 55 -year-old for potential high risk of mortality and to avoid under-triage [Strong recommendation based on a low level of evidence 1C].
- WSES suggests an early and rapid assessment of the patient including vital signs on presentation, mechanism of injury, injury severity and frailty including comorbidities and medication history to identify vulnerable trauma patients [Weak recommendation based on low level of evidence 2C].

Table 1: Key practice statements based on the master summary of the WSES guidelines for the management of elderly and frail patients.

Topic	Key Practice Points
Triage and Initial Assessment	• Even low-energy mechanisms can cause severe injury in older adults. • Vital signs may be unreliable: HR >90 bpm or SBP <110 mmHg should trigger trauma activation. • Shock Index ≥ 1 indicates possible occult shock. • Early lactate and base deficit help detect concealed hypoperfusion. • Maintain a low threshold for whole-body CT. • Systematically perform head CT in anticoagulated patients after any fall.
Resuscitation and Hemodynamic Management	• Prioritize early recognition of hypoperfusion and coagulopathy. • Use serial lactate and base deficit, not isolated values. • Avoid fluid overload; start with balanced crystalloids. • Early transition to blood products if perfusion fails to normalize. • Vasopressors only after adequate volume and only when needed; prefer norepinephrine. • Avoid permissive hypotension below SBP 110 mmHg unless strictly damage-control driven. • Frequent reassessment of mental status and urine output.
Coagulation and Anticoagulant Reversal	• Always obtain PT, aPTT, INR, TT and anti-Xa levels on arrival. • Use 4F-PCC + IV vitamin K for VKA reversal in life-threatening bleeding. • Avoid FFP unless PCC unavailable. • Avoid rFVIIa as first-line therapy. • For dabigatran: idarucizumab 5 g IV. • For apixaban/rivaroxaban: andexanet alfa (dose-based) or PCC 2000 U if unavailable. • Reserve DOAC reversal to critically ill patients with measurable drug levels.
Imaging Strategy	• Perform early CT because exam findings are unreliable. • Whole-body CT is often safer than selective imaging in frail/unstable patients. • Do not delay imaging for lab results or borderline vital signs. • CT head mandatory in all anticoagulated elderly trauma patients.
Analgesia and Pain Control	• Prefer multimodal analgesia to reduce opioids. • Avoid over-sedation—linked to delirium and respiratory depression. • Use regional anesthesia when feasible. • Regularly reassess pain in cognitively impaired patients.
Infection Prevention and Antibiotic Use	• No strong evidence supports >24h prophylaxis in penetrating abdominal trauma without contamination. • Use single-dose prophylaxis unless hollow viscus injury confirmed. • Thoracic trauma: prophylactic antibiotics reduce empyema only in penetrating injuries. • Use narrow-spectrum antibiotics whenever possible. • Tailor therapy to peritoneal contamination and sepsis severity.
VTE Prophylaxis	• Elderly trauma patients have significantly higher VTE risk. • Use validated scores (Greenfield's risk assessment, TESS). • LMWH is superior to UFH; adjust dose by anti-Xa when possible. • Delay chemoprophylaxis only in active bleeding, severe TBI, or unstable solid-organ injuries. • Mechanical prophylaxis if pharmacologic is contraindicated.
Nutrition and Metabolic Support	• Screen for malnutrition within 24–48 h (NRS-2002 or MNA). • Start enteral feeding within 24–48 h if the gut is functional. • Aim for 25–30 kcal/kg/day and 1.2–1.5 g protein/kg/day (up to 2 g/kg/day in severe trauma). • Maintain glycemic control 140–180 mg/dL. • Combine nutrition with early mobilization to counteract sarcopenia.
Delirium Prevention and Cognitive Care	• Delirium affects up to 60% of older trauma patients. • Risk factors: hypotension, anemia, polypharmacy, sensory deprivation. • Use validated tools (4AT, CAM-ICU). • Preventive measures: orientation cues, mobilization, pain control, avoid benzodiazepines, optimize sleep. • Strict hemodynamic stability reduces delirium risk.
End-of-Life, Goals of Care and Ethics	• Early palliative care screening improves outcomes. • Use structured tools (PPS, Best Case/Worst Case). • Identify futile or non-beneficial interventions early. • Communication must be honest, values-guided, and multidisciplinary. • Document goals of care clearly and early.

Abbreviations: HR=Heart Rate; SBP = Systolic Blood Pressure; CT = Computed Tomography; PT = Prothrombin Time; aPTT = Activated Partial Thromboplastin Time; INR = International Normalized Ratio; TT = Thromboplastin Time; anti-Xa = Anti-Factor Xa Activity; 4F-PCC = Four-Factor Prothrombin Complex Concentrate; FFP = Fresh Frozen Plasma; rFVIIa = Recombinant Activated Factor VII; IV = Intravenous; VKA = Vitamin K Antagonist; DOAC = Direct Oral Anticoagulant; PCC = Prothrombin Complex Concentrate; LMWH = Low-Molecular-Weight Heparin; UFH = Unfractionated Heparin; TESS = Trauma Embolic Scoring System; NRS-2002 = Nutritional Risk Screening 2002; MNA = Mini Nutritional Assessment; 4AT = 4 A's Test; CAM-ICU = Confusion Assessment Method for the Intensive Care Unit; PPS = Palliative Performance Scale.

- WSES recommends assessing frailty in all elderly trauma patients [Strong recommendation based on a moderate level of evidence 1B].
- WSES suggests evaluating elderly patients for trauma through the Geriatric Trauma Outcome Score (GTOS) to predict in-hospital mortality and the Trauma-Specific Frailty Index to identify patients at highest risk of poor outcome [Weak Recommendation, based on Moderate Quality of Evidence, 2B].

In trauma care, chronological age has long been used as a surrogate for physiological vulnerability. Yet, mounting evidence shows that age alone is an inadequate predictor of outcome after injury. Two patients of the same age may differ profoundly in their biological reserve, response to stress, and recovery potential³⁻⁴. For this reason, the WSES guidelines emphasize that the focus should shift from “elderly” defined by years of life to “frail” defined by physiology.

Although the age of 65 years remains the conventional threshold for defining an older or geriatric patient, studies have demonstrated that trauma-related mortality begins to rise significantly from the age of 55⁸⁻⁹. Consequently, the WSES recommends early activation of trauma protocols for patients aged ≥ 55 years, in order to avoid under-triage and delayed treatment. This threshold reflects not a chronological limit, but the point at which comorbidities, decreased physiological reserve, and polypharmacy begin to alter the normal response to trauma.

Frailty represents the central paradigm of modern geriatric trauma care. It is a multidimensional condition encompassing physical, cognitive, and social decline, leading to increased vulnerability to even minor injuries. In this context, frailty is a stronger predictor of mortality, complications, and poor functional recovery than age or injury severity alone¹⁰. Screening tools such as the Trauma-Specific Frailty Index (TSFI), which integrates comorbidities, cognitive status, mobility, and functional independence, or the Clinical Frailty Scale (CFS),

have been validated as reliable methods for identifying high-risk patients upon admission¹¹⁻¹⁵.

In addition to frailty instruments, the Geriatric Trauma Outcome Score (GTOS) has been proposed as a trauma-specific tool to estimate in-hospital mortality in older patients. GTOS combines age, Injury Severity Score (ISS), and the need for transfusion in the first 24 hours, offering a simple bedside calculation¹⁶⁻¹⁷. The WSES guidelines suggest using GTOS to support risk prediction in elderly trauma patients, together with the TSFI, to identify individuals at highest risk of poor outcomes. However, recent evidence indicates important limitations. A 2024 meta-analysis including over 118,000 geriatric trauma patients showed that the predictive performance of GTOS (AUC 0.80) is inferior to that of Trauma and Injury Severity Score (TRISS) (AUC 0.82) and only modestly better than ISS, with none achieving optimal discrimination¹⁷. This highlights that even trauma-specific scoring systems do not fully capture the complexity of aging physiology and reinforces the need for multidimensional frailty assessment rather than reliance on anatomical or physiological scores alone.

Elderly trauma victims frequently present with polypharmacy, often five or more concurrent medications, reflecting the burden of chronic diseases such as cardiovascular, renal, hepatic, or oncologic conditions. These factors not only increase the risk of bleeding and hemodynamic instability but also blunt the physiological response to shock, making diagnosis and early resuscitation particularly challenging.

Recognizing frailty early in the emergency department is therefore pivotal. Incorporating frailty assessment into pre-hospital triage, emergency evaluation, and decision-making allows clinicians to better stratify risk, individualize care, and, when appropriate, initiate timely discussions about goals of treatment. The shift from an age-based to a frailty-based approach marks a turning point in the management of elderly trauma patients, one that privileges precision and tailored patient's overall trajectory rather than numerical age.

Primary Evaluation and Diagnostic Approach Recommendations:

- WSES recommends keeping a lower threshold for trauma protocol activation in geriatric patients, with triage set points of heart rate 90 bpm and systolic blood pressure less than 110 mmHg [Strong Recommendation, based on Moderate Quality of Evidence, 1B].
- WSES recommends performing an early blood gas (arterial or venous) for baseline base-deficit or a lactic acid assessment in geriatric trauma patients [Strong Recommendation, based on Moderate Quality of Evidence, 1B].
- WSES recommends a low threshold for initial imaging with CT scan in geriatric trauma patients. The diagnostic yield of a contrast-enhanced CT outweighs the risk of contrast-induced nephropathy, especially in view of the potential, dramatic effects of under-triage [Strong Recommendation, based on Moderate Quality of Evidence, 1B].

The initial evaluation of an elderly trauma patient is often complex. Mechanisms of injury are frequently low-energy, a simple ground-level fall or a minor collision, yet the consequences can be catastrophic because of reduced bone density, fragile vasculature, and limited physiological reserve. Moreover, the clinical presentation is often subtle: pain may be blunted, the response to blood loss delayed, and mental status changes may be mistakenly attributed to baseline cognitive decline rather than to shock or hypoperfusion¹³.

For these reasons, early and accurate triage plays a crucial role. The traditional physiological thresholds used in trauma scoring systems for younger adults often fail in older patients. Tachycardia may be absent because of β -blockers or intrinsic cardiac dysfunction, while “normal” systolic pressures can mask critical hypoperfusion^{4–12}. The WSES guidelines therefore recommend lowering the thresholds for trauma activation, considering a heart rate above 90 beats per minute or a systolic blood pressure below 110 mmHg as potential signs of instability. Likewise, a shock index (heart rate divided by systolic pressure) ≥ 1 should trigger immediate reassessment and potential transfer to a higher level of care.

Beyond vital signs, biochemical markers offer valuable insight. Early measurement of lactate and base deficit, through arterial or venous blood gas analysis, helps detect occult hypoperfusion, which is common in this

population. Persistently elevated lactate levels (> 2.5 mmol/L) or a base deficit ≤ -4 mEq/L are strongly associated with early mortality and prolonged intensive care stay. Continuous monitoring of these parameters provides a dynamic picture of perfusion, complementing traditional hemodynamic indices¹⁸.

Imaging strategies must also adapt to the particularities of geriatric trauma. Because the physical examination may be unreliable due to pain, sedation, or cognitive impairment, the threshold for Computed Tomography (CT) scanning should be low. The diagnostic yield of contrast-enhanced whole-body CT largely outweighs the potential risk of contrast nephropathy, even in patients with moderate renal impairment¹⁹. Early comprehensive imaging allows prompt identification of hidden injuries and helps prevent the consequences of under-triage, which remains a major source of excess mortality in the elderly.

However, the optimal extent of imaging in geriatric trauma remains a matter of debate. Whole-body CT (pan-CT) offers the advantage of rapidly identifying occult injuries in patients whose clinical presentation may be misleading, but it is associated with increased costs. Recent evidence, including the study by Percy et al., suggests that selective-CT may provide comparable outcomes without differences in missed injury rate, mortality, ICU or hospital length of stay when compared to pan-CT [20]. Yet, because older adults often exhibit blunted physiological responses, atypical symptoms, and high rates of under-triage, many clinicians continue to favor a more liberal use of pan-CT in this population. In practice, imaging decisions should be individualized, balancing diagnostic safety with resource stewardship, while recognizing that missed injuries in frail geriatric patients can carry disproportionately severe consequences. Early comprehensive imaging allows prompt identification of hidden injuries and helps prevent the consequences of under-triage, which remains a major source of excess mortality in the elderly.

In the presence of anticoagulation, vigilance must be even greater. Elderly patients taking vitamin K antagonists or direct oral anticoagulants are at particularly high risk for intracranial bleeding, sometimes without neurological symptoms. Accordingly, head CT should be systematically performed after any significant fall or minor head trauma, regardless of the apparent mechanism or initial neurological status²⁰.

Ultimately, the evaluation of the elderly trauma patient requires an integrated approach, one that combines

careful physiological assessment, targeted laboratory testing, and judicious imaging. The guiding principle is that a normal appearance does not exclude serious injury, and early activation of trauma protocols can make the difference between recovery and preventable deterioration.

Resuscitation and Hemodynamic Management

□ Practice Box – Hemodynamic Assessment and Resuscitation

- Mandatory components: exam, vital signs, ABG/lactate, base deficit, complete drug history (especially anticoagulants).
- Treat HR > 90 bpm or SBP < 110 mmHg as potential shock in older adults.

Hypoperfusion Monitoring

- Use serial (not single) values:
 - Lactate (target clearance)
 - Base deficit
 - Trend analysis of HR, SBP, RR, UO, and mental status
 - Normal vital signs do not rule out shock.

Coagulopathy Management

- Rapid recognition and correction of trauma- or drug-related coagulopathy.
- Minimize unnecessary fluids; prioritize balanced crystalloids and early blood products when indicated.

Hemodynamic Monitoring

- Choose non-invasive vs invasive tools case-by-case.
- POCUS recommended where expertise exists (cardiac function, IVC dynamics).
- Reserve invasive monitoring for unstable, severely injured, or diagnostically uncertain elderly patients.

Use of Inotropes & Vasopressors

- Avoid vasopressors in hemorrhagic hypotension (unless absolutely necessary).
- If shock persists despite fluids/blood:
- Norepinephrine = first choice (esp. neurogenic shock)
- Use lowest effective dose, monitor for arrhythmias
- Avoid epinephrine except in selected cases.
- Consider dobutamine only for documented cardiac dysfunction.

Permissive Hypotension

- Elderly patients tolerate hypoperfusion poorly.
- Avoid SBP < 110 mmHg.
- If using permissive hypotension, monitor continuously:
 - lactate
 - base deficit
 - urine output
 - neurological status

Fluid Strategy

- Restrictive crystalloids, early blood product transition.
- Prevent iatrogenic overload; tailor to comorbidities (heart failure, chronic kidney disease).

Delirium Prevention

- Assess risk factors early (frailty, cognitive impairment, anemia, hypotension).
- Avoid prolonged hypotension and excessive vasopressor use.
- Maintain stable hemodynamics to protect cerebral perfusion.

Recommendations

- WSES recommends that every trauma center provides meticulous triage criteria to recognize the need to early activate resuscitative protocols for elderly patients. These triaging criteria should include physical examination, vital signs, blood gas analysis, and medical history, emphasizing clinical conditions and drug history that may guide resuscitative therapies, early coagulative support, and the need to correct coagulopathies, and minimise fluids [Strong recommendation based on moderate quality of evidence 1B].
- WSES recommends rapid recognition and correction of coagulation disorders related to trauma or chronic medication intake in elderly patients. [Strong recommendation based on moderate quality of evidence 1B].
- WSES recommends performing serial base deficit assessment and lactate levels as markers of occult hypoperfusion in addition to close monitoring of vital parameters trend (heart rate, blood pressure, respiratory rate, urinary output), and mental status in elderly patients in a dedicated intensive geriatric care unit [Strong recommendation based on moderate-low level quality of evidence 1B].
- WSES suggests considering carefully to administer

inotropic agents in selected non-responding elderly patients to target resuscitation [Weak recommendation based on low level of evidence 2C].

- WSES recommends evaluating the indication for invasive versus non-invasive hemodynamic monitoring on a case-by-case basis in injured elderly patients. Hypoperfusion should be ruled out by serial base deficit assessments and lactate concentration [Strong recommendation based on moderate-low level of evidence 1B].
- WSES suggests the implementation of POCUS in monitoring the cardiac function and blood volume in elderly injured patient, if skills are present. Invasive hemodynamic monitoring should be reserved in selected cases, to critically ill elderly trauma patients who have hypotension, significant injuries (as defined by an Abbreviated Injury Score >3 or a Trauma Score <15), or uncertain cardiovascular and/or fluid status [Weak recommendation based on moderate and low level of evidence 2B].
- WSES recommends against the routine use of vasopressors in elderly injured patients presenting with hypotension caused by hemorrhage [Strong recommendation based on high-moderate level of evidence 1A].
- WSES recommends identifying the cause of hypoperfusion and assessing preexisting conditions and pharmacologic history before choosing a vasopressor in managing trauma in an elderly patient [Strong recommendation based on a high-low quality level of evidence 1A].
- WSES suggests using norepinephrine in elderly patients suffering from neurogenic shock. The dose to be used must be the lowest to guarantee tissue perfusion. The possible onset of cardiac arrhythmia and possible hypotensive effects should be monitored [Weak recommendation based on a moderate-low quality level of evidence 2B].
- WSES recommends to carefully evaluate to implement permissive hypotension in managing selected elderly trauma patients. Tissue perfusion has to be constantly monitored by base excess level, arterial lactate dosage, urine output, and when possible, neurologic assessment. [Strong recommendation based on a high-low quality level of evidence 1A].
- WSES suggests assessing, as early as possible, the risk factors for the onset of delirium because it is related to unfavourable outcomes in trauma geriatric patients. (Weak recommendation based on a moderate-low quality level of evidence 2B).

Early resuscitation in geriatric trauma represents one of the most delicate and decisive phases of management. The physiological response to injury in the elderly is profoundly altered by aging, comorbidities, and polypharmacy. Conventional clinical parameters such as blood pressure, heart rate, and urine output often fail to reflect the true hemodynamic status of these patients. Age-related reduction in cardiac reserve, decreased baroreceptor sensitivity, and the widespread use of beta-blockers, pacemakers, and antihypertensive agents may blunt the tachycardic response and delay recognition of hypovolemia. As a result, tissue hypoperfusion and oxygen debt frequently occur even in the presence of apparently normal vital signs, making early identification and continuous monitoring essential²².

Current evidence does not support a single standardized resuscitation protocol for elderly trauma patients. The overall strategy should focus on the early detection of occult hypoperfusion, rapid correction of coagulopathy, and the prevention of iatrogenic fluid overload. Resuscitation must be individualized, taking into account pre-existing cardiovascular disease, frailty, chronic medications, and laboratory findings²³. Since mortality increases markedly when heart rate exceeds 90 bpm and systolic blood pressure drops below 110 mmHg, thresholds traditionally considered safe in younger adults cannot be applied to older patients²⁴. The use of serial measurements of lactate and base deficit, rather than isolated readings, allows a more accurate assessment of perfusion and response to therapy. A restrictive approach with balanced crystalloids is recommended as initial management, while early transition to blood products should be undertaken when perfusion parameters fail to normalize.

The hemodynamic targets of resuscitation in the elderly differ from those in the general trauma population. Normotension, absence of tachycardia, or a normal respiratory rate should not be interpreted as indicators of adequate perfusion²⁵. Dynamic evaluation of perfusion using lactate clearance, base deficit trends, mental status, and urine output provides more reliable guidance. Point-of-care ultrasound may serve as a valuable, non-invasive adjunct for assessing cardiac function and intravascular volume, supporting decisions on fluid administration. Invasive monitoring, such as pulmonary artery catheterization, should be reserved for selected high-risk or unstable cases. Studies have shown that elderly trauma survivors demonstrate higher cardiac output and lower vascular resistance compared to non-survivors, suggesting that

targeted optimization of cardiac index and oxygen delivery may improve outcomes.

The use of vasopressors in this population remains controversial. Early administration before adequate volume replacement can be deleterious, exacerbating tissue ischemia and impairing microcirculatory flow. When persistent hypotension occurs despite appropriate fluid therapy, norepinephrine is the vasopressor of choice, particularly in cases of neurogenic or septic shock. Epinephrine, on the other hand, has been associated with higher mortality and should be avoided except in specific circumstances. In patients with cardiac dysfunction, low-dose dobutamine may help improve contractility and oxygen transport. However, catecholamine use should be cautious and individualized, as excessive doses are associated with worse outcomes and increased risk of arrhythmia or organ failure^{26–27}.

The debate between permissive hypotension and early vasopressor support remains unresolved in geriatric trauma care. While damage-control resuscitation principles advocate for limiting fluids and maintaining lower arterial pressures until bleeding is controlled, these thresholds may not be appropriate in older patients, who are less tolerant of ischemia. Evidence indicates that systolic pressures below 110 mmHg correlate with higher mortality in the elderly, suggesting that aggressive hypotensive strategies should be avoided. Management must be individualized, integrating the mechanism of trauma, baseline blood pressure, and comorbidities. When permissive hypotension is considered, perfusion must be closely monitored through serial lactate and base excess measurements, urine output, and neurological assessment to prevent tissue hypoxia^{28–34}.

Resuscitation should continue into the postoperative and critical care phases, with particular attention to the prevention of postoperative delirium, a frequent and serious complication in elderly trauma patients. Delirium, which may affect up to 60% of older trauma or surgical patients, is associated with increased morbidity, prolonged hospitalization, and long-term cognitive decline. Several studies have linked intraoperative hypotension, excessive vasopressor use, and perioperative anemia to a higher incidence of postoperative delirium and subsequent dementia. Early identification of patients at risk, especially those with pre-existing cognitive impairment or frailty, and strict control of hemodynamic parameters are essential preventive strategies^{35–37}. Maintaining adequate cerebral perfusion, minimizing fluctuations in

blood pressure, and avoiding prolonged hypotension can significantly reduce this risk.

Ultimately, early resuscitation in geriatric trauma should be guided by the principles of individualized care, physiological monitoring, and multidisciplinary coordination. Aggressive yet judicious management of hypoperfusion and coagulopathy, coupled with careful titration of fluids and vasoactive agents, can improve outcomes and restore pre-injury function in this vulnerable and growing patient population.

Management of Anticoagulant and Antiplatelet Therapy

□ Practice box - Coagulation and anticoagulant reversal

Initial Laboratory Assessment

- Obtain coagulation tests immediately: PT, aPTT, TT, INR, anti-Xa levels (to detect DOAC exposure).
- Routine use of TEG/ROTEM not supported in elderly trauma (insufficient evidence).
- Early involvement of hematology + critical care teams.

Vitamin K Antagonists (Warfarin) — Reversal Strategy

Indications for Reversal

- Active or life-threatening bleeding
- Bleeding in critical sites (CNS, thorax, abdomen)
- Urgent surgery or invasive procedures
- Failure to respond to supportive therapy

Preferred Reversal Protocol

- 4-factor PCC (4F-PCC) + 5 mg IV Vitamin K
- Repeat PCC doses as needed → target INR < 1.5

Alternatives

- FFP only if PCC unavailable (slower, less predictable)
- Do NOT use rFVIIa as first-line reversal

Direct Oral Anticoagulants (DOACs) — Assessment & Reversal

Laboratory Strategy

- Measure quantitative DOAC levels whenever available before reversal
- Avoid empirical reversal unless:
 - critical bleeding AND
 - shock refractory to resuscitation AND
 - measurable drug levels

Reversal Agents

• Dabigatran:

→ Idarucizumab 5 g IV

→ If unavailable: APCC 50 U/kg IV

• Rivaroxaban / Apixaban:

→ Andexanet alfa

Low dose: 400 mg bolus → 480 mg infusion / 2h

High dose: 800 mg bolus → 960 mg infusion / 2h

→ If unavailable: PCC 2000 U

Antiplatelet Agents

Aspirin, clopidogrel, dual therapy:

- Platelet transfusion only in severe or intracranial bleeding (evidence limited)
- Emphasize: stop the agent if it is indicated, correct coagulopathy if it is present, meticulous hemostasis

Clinical Principles for Anticoagulated Elderly Trauma

Do not reverse anticoagulation indiscriminately:

→ **weigh bleeding control vs thrombosis risk**

- Avoid unnecessary correction of mild INR elevations without bleeding
- Integrate: hemodynamics, imaging, injury pattern, anticipated surgery
- Maintain careful balance between intervention and physiological restraint

Recommendations:

- WSES recommends performing routinely the common coagulation assays in elderly patients including the Activated Partial Thromboplastin Time (aPTT), Thromboplastin Time (TT), Prothrombin Time (PT), INR, and anti-Xa levels to assess early anticoagulants exposure in the trauma setting. There is not enough evidence to support the routinely use of TEG or ROTEM in elderly trauma patients. Further studies are necessary to determine their role. [Strong recommendation based on a moderate level quality of evidence 1B].
- WSES recommends administering a reversal agent in elderly trauma patients anticoagulated with oral vitamin K antagonists who present with bleeding, not responding to supportive measures, major life-threatening bleeding, bleeding located in critical organs (central nervous system, abdominal, thoracic), or needing urgent surgical or invasive procedures

[Strong recommendation based on a moderate level quality of evidence 1B].

- WSES recommends using the reversal protocol including intravenous factor prothrombin complex concentrates (4F-PCCs) and 5 mg intravenous vitamin K in case of life-threatening bleeding and/or urgent surgical procedures. Further doses should be administered if needed to achieve $INR < 1.5$ [Strong recommendation based on a high level quality of evidence 1A].
- WSES recommends giving Fresh frozen plasma (FFP) as oral vitamin K antagonists (VKA) agent reversal only if no other treatment is available [Strong recommendation based on a moderate quality level of evidence 1B].
- WSES do not recommends the use of recombinant activated coagulation factor VII (rFVIIa) as first-line VKA reversal agent [Strong recommendation based on a low level of quality evidence 1C].
- WSES recommends an early assessment of laboratory coagulation tests and direct measurements of DOAC levels, if quantitative tests are available, in elderly trauma patients receiving or suspected of having received a DOAC before deciding for reversal due to the thromboembolic risk [Strong recommendation based on a moderate level quality of evidence 1B].
- WSES suggests the administration of DOACS reversal agents only in critically ill patients with dosable plasma DOAC levels and presenting with hemorrhagic shock not responding to resuscitation, when level of DOACS can be assessed [Weak recommendation based on a moderate-low quality of evidence 2B].
- If the trauma patient with uncontrolled life-threatening bleeding, was treated with dabigatran (anti-FIIa activity), the suggested reversal protocol is to administer idarucizumab 5 g IV. If idarucizumab is not available, 50 units/kg IV of activated prothrombin complex concentrates (APCC) may be administered [Weak recommendation based on a moderate-low quality level of evidence 2B].
- In patients with rivaroxaban-associated or apixaban-associated (FX inhibitors) life-threatening and uncontrolled bleeding, the suggested reversal protocol is the administration of andexanet alfa as an intravenous bolus of 400 mg over 15 min followed by a continuous infusion of 480 mg over 2 h (low dose) or 800 mg over 30 min followed by a continuous

infusion of 960 mg over 2 h (high dose), according to the last dose of DOAC and the size of the dose. If andexanet alfa is not available, 2000 units of four-factor prothrombin complex concentrates (PCC) may be administered [Weak recommendation based on a moderate-low quality level of evidence 2B].

One of the defining characteristics of the modern geriatric trauma population is the widespread use of anticoagulant and antiplatelet medications. Whether prescribed for atrial fibrillation, venous thromboembolism, ischemic heart disease, or mechanical valves, these drugs significantly increase the risk of bleeding and complicate both diagnosis and resuscitation. The management of trauma in anticoagulated elderly patients therefore requires immediate recognition, rapid laboratory assessment, and early coordination with hematology and critical care teams^{38–57}.

Upon arrival, a coagulation profile should be obtained without delay. The WSES guidelines recommend measuring prothrombin time (PT), activated partial thromboplastin time (aPTT), international normalized ratio (INR), and, when feasible, anti-Xa levels to quantify exposure to direct oral anticoagulants (DOACs). Point-of-care viscoelastic testing (e.g., TEG or ROTEM) may offer additional insight, although its role in geriatric trauma remains to be clearly established.

For patients receiving vitamin K antagonists (VKAs) such as warfarin, prompt reversal is essential in the presence of active bleeding, life-threatening injury, or when urgent surgery is required. The recommended protocol includes the administration of four-factor prothrombin complex concentrate (4F-PCC), combined with 5 mg intravenous vitamin K. The dose of PCC should be titrated to achieve a target INR below 1.5, and repeat administration may be necessary in cases of persistent coagulopathy. Fresh frozen plasma should be reserved for situations in which PCC is unavailable, as it offers slower and less predictable correction. The use of recombinant factor VIIa as first-line therapy is not supported by current evidence and is discouraged^{40–41}.

The management of patients taking direct oral anticoagulants (DOACs) demands an individualized approach. When quantitative assays are available, plasma drug levels should be measured before reversal to balance bleeding control against thrombotic risk. For patients on dabigatran, the specific antidote idarucizumab (5 g IV) provides rapid and effective neutralization. For rivaroxaban or apixaban, the recommended reversal agent

is andexanet alfa, administered as a bolus followed by continuous infusion, according to the last dose and timing of ingestion. In centers where andexanet alfa is not available, four-factor PCC (approximately 2,000 units) remains an acceptable alternative^{44–52}.

Importantly, the WSES guidelines emphasize that reversal strategies should not be used indiscriminately. In hemodynamically stable patients without major bleeding or need for emergency surgery, the risks of thrombosis and rebound hypercoagulability may outweigh potential benefits. Decisions should therefore be multidisciplinary and context-specific, integrating hemodynamic status, imaging findings, and anticipated surgical needs.

Elderly patients often take antiplatelet agents, such as aspirin or clopidogrel, either alone or in combination with anticoagulants. Although platelet transfusion has been considered for those with severe bleeding or intracranial injury, evidence supporting its efficacy is limited. Whenever possible, discontinuation of the offending agent, coupled with correction of coagulopathy and meticulous surgical hemostasis, remains the most rational strategy.

The management of anticoagulated trauma patients thus epitomizes the balance between intervention and prudence that defines geriatric surgery. Rapid laboratory diagnostics, knowledge of reversal agents, and coordinated decision-making can significantly reduce preventable mortality. Yet, clinicians must remember that not every abnormal INR requires correction and that thoughtful restraint, grounded in physiology and risk assessment, is often the safest path to recovery.

Antibiotic Prophylaxis, Analgesia, and Thromboprophylaxis

The perioperative management of elderly trauma patients requires a delicate balance between preventing complications and avoiding the unintended consequences of overtreatment. Infection, pain, and venous thromboembolism (VTE) are among the most frequent and interrelated challenges encountered in this population. Each must be addressed proactively but with careful consideration of age-related physiological changes, comorbidities, and drug interactions.

Antibiotic Prophylaxis and infection control

□ Practice Box – Antibiotic Prophylaxis and Infection Control

- Evidence quality = low; tailor to contamination grade.

- **Abdominal trauma:** single pre-op dose; stop ≤ 24 h after source control.
- **Thoracic trauma:** prophylaxis useful only in penetrating injuries.
- **Open fractures:** 1st-gen cephalosporin ≤ 24 h (type III = broaden).
- Avoid prolonged regimens $\rightarrow$ resistance risk.

Recommendations:

- WSES recommends antibiotic prophylaxis in penetrating (abdominal, thoracic) trauma, in severely burned and in open fractures in elderly patients to decrease septic complications [Strong recommendation based on a high-moderate quality level of evidence 1A].
- WSES recommends early empiric antibiotic therapy in patients presenting with signs of sepsis and septic shock and high risk patients (obesity, immunocompromised, high ASA score) in penetrating abdominal trauma, which should be active against common bacteria causing surgical site infections in peritonitis, such as *Escherichia coli* or other Enterobacteriales or Clostridiales [Strong recommendation based on a moderate quality level of evidence 1B].
- WSES recommends against the administration of antibiotics in blunt trauma in absence of signs of sepsis and septic shock [Strong recommendation based on a moderate-low quality level of evidence 1B].

Infection remains a major determinant of morbidity and mortality in elderly trauma patients, reflecting both the physiological decline of immune function and the cumulative burden of comorbidities. Yet, evidence supporting antibiotic prophylaxis in this population remains weak and largely extrapolated from younger cohorts. Most recommendations originate from expert consensus or low-quality trials, and no randomized controlled studies specifically address antibiotic prophylaxis in geriatric trauma^{53–57}.

For abdominal trauma, both penetrating and blunt, prophylactic antibiotics are commonly administered empirically, typically a single preoperative dose of a broad-spectrum agent covering aerobic and anaerobic organisms, extended up to 24 hours in the setting of laparotomy or laparoscopy. When hollow viscus perforation or peritoneal contamination is found, antibiotics should be continued as therapeutic treatment, guided by intraoperative findings and microbiological cultures.

A systematic review of 29 randomized trials including more than 4400 participants demonstrated no clear benefit of prolonged antibiotic administration (>24 hours) compared with shorter regimens for preventing surgical site infections, intra-abdominal abscesses, or mortality [54]. Similarly, no specific drug regimen proved superior, provided that coverage against common enteric flora including Gram-negative bacilli, Gram-positive cocci, and anaerobes, was ensured.

Among older adults, infection risk is further amplified by frailty, malnutrition, diabetes, and immunosenescence. Therefore, prophylactic antibiotics may be indicated even for clean-contaminated procedures or in the presence of risk factors such as ASA ≥ 3 or obesity. However, the chosen regimen should remain as narrow as feasible to prevent antimicrobial resistance. Correct dosing according to weight, renal and hepatic function, and timing of administration is crucial to ensure optimal plasma and tissue concentrations. Once sepsis or peritonitis develops, antimicrobial therapy must be promptly escalated and later de-escalated according to microbiological findings and clinical response. No advantage has been shown for prolonged antibiotic courses once adequate source control has been achieved, even in critically ill patients⁵⁵.

In thoracic trauma, up to 90% of severe cases require tube thoracostomy, which carries a risk of empyema or pneumonia, especially when hemothorax or penetrating injury is present. Evidence supports antibiotic prophylaxis to reduce empyema and pneumonia in penetrating chest trauma, while no clear benefit has been demonstrated in blunt injuries. A single peri-procedural dose or ≤ 24 -hour coverage with a first-generation cephalosporin is generally sufficient^{57–58}.

In orthopedic trauma, fracture-related infection is a common postoperative complication and a significant cause of morbidity in the elderly. Risk factors include diabetes, obesity, ASA ≥ 3 , and open or high-energy fractures. There is no evidence that extending postoperative prophylaxis beyond 24 hours reduces infection in closed fractures. In open fractures, a short course of single-agent cephalosporin remains the standard, with broader regimens reserved for heavily contaminated wounds. The Surgical Infection Society guidelines discourage the use of extended-spectrum antibiotics in type I–II open fractures and recommend limiting therapy to ≤ 24 hours after injury for type III fractures when there is no ongoing infection. The adjunctive use of local antibiotic delivery systems, such as gentamicin-coated implants, may

further reduce infection risk in complex cases, though data in geriatric patients remain limited⁵⁹.

In burns and extensive soft-tissue injuries, infection prevention relies primarily on early source control, debridement, and coverage rather than systemic prophylaxis. Meta-analyses show no clear mortality benefit from routine topical or perioperative antibiotics, and some topical agents, notably silver sulfadiazine, have been associated with increased infection rates and longer hospital stay⁶⁰. Short-course systemic prophylaxis may be considered in high-risk elderly burn patients with large total body surface area involvement or immunosuppression, but this approach must remain individualized⁶¹.

Across all trauma settings, antimicrobial stewardship is particularly critical in older adults, who often exhibit altered pharmacokinetics, renal impairment, and high susceptibility to *Clostridioides difficile* infection⁶¹.

The overarching principle emerging from current evidence and WSES recommendations is that prophylaxis should be early, narrow, and short, with escalation reserved for confirmed infection and de-escalation guided by microbiological results. Rational antibiotic use, coupled with timely surgical control of contamination and vigilant post-operative monitoring, remains the cornerstone of infection prevention in the frail trauma population.

Analgesia and Pain Control

□ Practice Box – Pain Management & Multimodal Analgesia

- Undertreated pain → ↑ delirium and mortality.
- **Acetaminophen q6 h** = first-line; add NSAIDs cautiously.
- Limit opioids to breakthrough pain; reduce dose ≈ 20 % per decade > 55 y.
- **MMA protocol:** acetaminophen + NSAID + gabapentinoid + regional block.
- Early **nerve blocks** (fascia iliaca, paravertebral) reduce opioids and delirium.

Recommendations:

- WSES recommends a regular administration of intravenous acetaminophen every 6 h as first line treatment in managing acute trauma pain in the elderly in a multimodal analgesic approach [Strong recommendation based on high quality level of evidence 1A].
- WSES suggests considering to add NSAIDs in elderly patients presenting with severe pain, taking into account potential adverse events and pharmacological

interactions [Weak recommendation based on a moderate quality level of evidence 2B].

- WSES recommends the implementation of Multi-Modal-Analgesia approach (MMA) in trauma setting for elderly injured patients including acetaminophen, gabapentinoids, NSAIDs, lidocaine patches, and tramadol and opioids only for breakthrough pain for the shortest period of administration at the lowest effective dose [Strong recommendation based on a moderate quality level of evidence 1B].
- WSES recommends peripheral nerve blocks placement in elderly patients with acute hip fractures at the time of presentation to reduce preoperative and post-operative opioid use for analgesia [Strong recommendation based on a high quality level of evidence 1A].
- WSES suggests the adoption of epidural analgesia and regional anaesthesia to control severe pain in acute hip fractures in selected elderly patients [Weak recommendation based on a moderate quality level of evidence 2B].
- In elderly patients with ribs fractures, we recommend the association of systemic analgesic treatment with thoracic epidural and paravertebral blocks to offer an adequate pain control with limited contraindications and improvement in respiratory function, reducing opioid consumption, infections and delirium, if skills are available [Strong recommendation based on a high quality level of evidence 1A].
- WSES recommends to routinely consider the use of epidural or spinal analgesia for management of post-operative pain in elderly patients who undergo major thoracic and abdominal procedures for trauma, if skills are available [Strong recommendation based on a high-quality level of evidence 1A].
- WSES recommends carefully evaluating the use of neuraxial and plexus blocks for patients receiving anticoagulants to avoid bleeding and complications [Strong recommendation based on a high-quality level of evidence 1A].
- WSES suggests the implementation of non-pharmacological measures such as immobilizing limbs and applying dressings or ice packs in conjunction with drug therapy, in control acute pain in elderly patients in the trauma setting [Weak recommendation based on a very low level of evidence 2D].

Pain control in elderly trauma patients is complex and often suboptimal. Cognitive impairment, communication

difficulties, and underestimation of pain contribute to inadequate analgesia, which in turn increases agitation, delirium, immobility, pulmonary complications, and chronic pain development. Evidence consistently shows that older adults experience pain of similar intensity as younger patients after comparable injuries, yet they receive less frequent and less effective treatment. Therefore, systematic and repeated pain assessment using validated tools, numeric rating, verbal descriptor, visual analogue, or faces pain scales, should be routine. In patients with dementia or communication deficits, observational scales such as PAINAD, Doloplus-2, or the Behavioral Pain Scale should be employed, integrating caregiver input to ensure reliable evaluation⁶².

A multimodal analgesic approach (MMA) is the cornerstone of pain management in geriatric trauma. This strategy combines systemic, regional, and non-pharmacological interventions to achieve synergistic analgesia with minimal opioid exposure. Scheduled intravenous or oral acetaminophen every six hours is recommended as first-line therapy due to its safety and efficacy. Non-steroidal anti-inflammatory drugs (NSAIDs) may be added cautiously in selected patients with severe pain, after considering renal function, gastrointestinal risk, and potential drug interactions; gastroprotection is mandatory. Opioids should be reserved for breakthrough pain and administered at the lowest effective dose for the shortest duration, with dose reduction of approximately 20–25% per decade after age 55 to mitigate the risks of oversedation, respiratory depression, and delirium. Concomitant use of other central nervous system depressants should be avoided outside of closely monitored settings^{63–64}.

Among non-opioid adjuncts, tramadol, gabapentinoids, lidocaine patches, and low-dose ketamine may be employed to enhance analgesia and reduce opioid requirements. Tramadol offers moderate analgesic efficacy with fewer respiratory effects but may cause confusion and should be avoided in patients with a history of seizures⁶⁵. Low-dose ketamine (0.3 mg/kg) provides analgesia comparable to morphine with fewer respiratory events, although transient hallucinations may occur. Intravenous lidocaine infusion and magnesium have shown potential opioid-sparing effects, but their use should be individualized and closely monitored for adverse reactions^{66–67}.

Regional and neuraxial techniques are strongly supported for geriatric trauma pain. Peripheral nerve blocks, especially fascia iliaca compartment blocks for

hip fractures, reduce opioid use, delirium, and time to mobilization, improving outcomes even in cognitively impaired patients. Continuous or single-shot administration is safe and effective when performed by experienced teams. In rib fracture patients, thoracic epidural or paravertebral blocks, now increasingly complemented by erector spinae plane and serratus anterior plane blocks, provide superior analgesia, improve ventilation, and decrease the incidence of pneumonia, infections, and delirium [68]. Epidural or spinal analgesia is also recommended for major thoracic or abdominal trauma surgery, provided coagulopathy and anticoagulant therapy are carefully evaluated to minimize bleeding risk⁶⁸.

Non-pharmacological measures, including immobilization, proper positioning, and application of dressings or ice packs, should complement pharmacologic therapy and are particularly useful during prehospital and early emergency phases⁶⁸.

Overall, current evidence supports early, multimodal, and opioid-sparing analgesia as the optimal strategy for elderly trauma patients. This approach not only enhances comfort but also facilitates respiratory function, mobility, and recovery, while reducing complications and hospital stay. Effective pain management in the frail trauma population must balance efficacy with safety, aiming for steady analgesia rather than reactive rescue dosing, and should always be guided by regular reassessment and multidisciplinary coordination.

Thromboprophylaxis

□ Practice Box – VTE Prophylaxis

- Assess risk (Greenfield RAP or TESS).
- Start **LMWH 30 mg BID** once hemostasis achieved; delay only if bleeding/CNS injury.
- Combine pharmacologic + mechanical methods.
- **LMWH > UFH** for DVT/PE and mortality reduction.
- Adjust dose for renal impairment; monitor anti-Xa in frail patients.

Recommendations:

- WSES recommends administering venous thromboembolism prophylaxis with LMWH or UFH as soon as possible in high and moderate risk elderly patients in the trauma setting according to the renal function, weight of the patient and bleeding risk [Strong recommendation based on a low quality level of evidence 1C].

- If pharmacological prophylaxis of venous thromboembolism is contraindicated, we recommend mechanical prophylaxis [Strong recommendation based on a low quality level of evidence 1C].

The prevention of venous thromboembolism (VTE) remains a cornerstone of trauma care, yet the evidence base for elderly patients is limited and predominantly retrospective. No randomized controlled trials have specifically addressed pharmacologic or mechanical VTE prophylaxis in geriatric trauma, and most available data are derived from orthopedic and neurotrauma populations rather than torso injuries. Consequently, current recommendations largely extrapolate from studies conducted in younger or mixed adult cohorts.

Older age itself is an established and independent predictor of VTE in trauma patients, reflecting the combined effects of endothelial dysfunction, reduced mobility, pro-inflammatory and pro-coagulant states, and frequent comorbidities. Several observational studies and national trauma registry analyses confirm a marked increase in thromboembolic risk beyond 60–65 years, with rates approaching 3–5% in hospitalized elderly trauma patients [69–70]. In the decade-long analysis by Kim et al., among 2,500 patients older than 65 years, the VTE rate was 3.2%, with traumatic brain injury, high chest AIS score, mechanical ventilation, major surgery, and prior VTE identified as independent predictors⁷¹. Similarly, a national cohort of more than 354,000 trauma patients aged > 65 years demonstrated that male sex, prolonged ICU or hospital stay, spine and lower-limb injuries, severe head trauma, plasma transfusion, and ventilator dependence were all associated with increased VTE risk⁷².

Two scoring systems frequently applied to stratify VTE risk in trauma, the Greenfield Risk Assessment Profile (RAP) and the Trauma Embolic Scoring System (TESS), include advanced age as a major determinant. In both tools, patients aged > 55–65 years typically transition into moderate-to-high-risk categories, warranting pharmacologic prophylaxis when not contraindicated [72–73]. The WSES and EAST guidelines emphasize the importance of individualized assessment: patients with active bleeding, coagulopathy, hemodynamic instability, solid-organ injury, traumatic brain injury, or spinal trauma may require temporary deferral of pharmacologic agents, during which mechanical prophylaxis (intermittent pneumatic compression or graduated stockings) should be instituted whenever feasible.

Evidence from the general trauma literature indicates that pharmacologic prophylaxis is more effective than mechanical methods alone. A Cochrane review reported that, compared with no prophylaxis, both mechanical and pharmacologic strategies reduce the incidence of deep vein thrombosis (DVT), with relative risks of 0.55 and 0.48, respectively. However, pharmacologic prophylaxis doubles the risk of bleeding ($RR \approx 2.0$). Low-molecular-weight heparin (LMWH) was superior to unfractionated heparin (UFH) in preventing DVT (RR 0.68) and showed additional benefit when combined with mechanical devices (RR 0.34)⁷⁴.

The comparative effectiveness of different agents in elderly patients has been evaluated in several large retrospective series. In a national database of 40,000 trauma patients ≥ 65 years, LMWH use was associated with significantly lower rates of DVT, pulmonary embolism, bleeding complications, transfusion requirement, sepsis, myocardial infarction, and mortality compared with UFH. These benefits persisted in patients aged > 75 years and were most evident among those with Injury Severity Scores < 16, supporting LMWH as the preferred agent whenever renal function allows. Similar findings were reported in hip fracture surgery: while factor Xa inhibitors provided comparable DVT prevention, LMWH achieved lower pulmonary embolism rates and fewer bleeding complications, remaining the agent of choice despite higher costs of newer drugs⁷⁵.

Optimal dosing must account for age-related pharmacokinetics and renal clearance. For most elderly trauma patients, enoxaparin 30 mg twice daily is recommended, while UFH 5,000 U every eight hours remains appropriate for those with renal impairment. Dose adjustment using anti-Xa level monitoring can improve efficacy without increasing bleeding risk⁷⁶.

In special populations, such as frail, immobilized, or cognitively impaired patients, mechanical prophylaxis should be initiated early, and pharmacologic agents introduced as soon as hemostasis and clinical stability permit. Combined approaches achieve the lowest incidence of DVT and should be preferred whenever feasible⁷⁴.

Overall, despite the lack of high-quality trials, the converging evidence supports early, individualized, and multimodal VTE prophylaxis in elderly trauma patients. LMWH remains the reference standard, while careful balancing of thrombotic and bleeding risks, particularly in the presence of organ injury or anticoagulant use, is essential. Vigilant reassessment during hospitalization and



at discharge is warranted, as delayed or omitted prophylaxis continues to be a preventable source of morbidity and mortality in this vulnerable population.

Nutritional and Metabolic Support

□ Practice Box – Nutrition and Rehabilitation

- Start enteral feeding ≤ 48 h if possible.
- Goals: 25–30 kcal/kg/day and 1.2–1.5 g protein/kg/day.
- Correct sarcopenia and vitamin D deficit.
- Early mobilization and physiotherapy shorten LOS and improve independence.
- Create individualized nutrition-rehab plans from acute to post-acute phase.

Malnutrition is highly prevalent among elderly trauma patients and is a key determinant of adverse outcomes, including infection, delayed wound healing, prolonged hospitalization, and mortality. Studies report that up to 50% of older adults admitted with major injury show biochemical or clinical signs of undernutrition at baseline. The physiological stress of trauma induces a pronounced catabolic response, leading to rapid muscle wasting, impaired immune function, and metabolic instability, all exacerbated by frailty and chronic comorbidities common in this population^{77–78}.

According to the ESPEN Practical Guideline on Clinical Nutrition and Hydration in Geriatrics, all elderly patients should undergo structured nutritional screening within 24–48 hours of admission, using validated tools such as the Nutritional Risk Screening (NRS-2002) or Mini Nutritional Assessment (MNA). These tools allow early identification of malnutrition or risk thereof, enabling prompt initiation of individualized nutrition therapy. Key laboratory markers such as albumin, prealbumin, and C-reactive protein may help identify acute-phase catabolism but should not be used in isolation to diagnose malnutrition⁷⁸.

Early enteral nutrition (EN), ideally within the first 24–48 hours after stabilization, is strongly recommended whenever gastrointestinal continuity and function are preserved. In elderly trauma patients, early EN reduces infectious complications, supports gut barrier integrity, and lowers the incidence of multiple organ dysfunction. Parenteral nutrition (PN) should be reserved for patients with contraindications to EN (e.g., bowel ischemia, perforation, or discontinuity) or persistent intolerance despite optimal management. Combined or sequential EN–

PN approaches may be considered in selected cases with high metabolic demand^{78–79}.

Elderly trauma patients require higher protein intake than healthy older adults to counteract hypercatabolism and promote recovery. ESPEN and ASPEN/SCCM guidelines recommend 1.2–2.0 g of protein/kg/day (up to 2.5 g/kg/day in severe trauma or burns) and an energy target of 25–30 kcal/kg/day, with adjustments for renal function, obesity, and activity level. Micronutrient supplementation, particularly of vitamin D, zinc, selenium, and vitamin C, is essential to support immune function, collagen synthesis, and bone repair^{77–78, 80}.

The American Diabetes Association (ADA) advises maintaining blood glucose levels between 140–180 mg/dL (7.8–10 mmol/L) for most critically ill and hospitalized patients, avoiding intensive insulin therapy due to increased hypoglycemia risk. Elderly trauma patients are particularly vulnerable to fluctuations in glucose metabolism; thus, moderate control and close monitoring are recommended. Overfeeding should be avoided, as it increases carbon dioxide production and may exacerbate respiratory failure in frail individuals⁸¹.

Nutritional therapy should not be viewed in isolation but as part of an integrated rehabilitative strategy. Early mobilization, physiotherapy, and resistance training, when feasible, synergize with adequate protein intake to mitigate sarcopenia and restore functional independence. Regular multidisciplinary collaboration among surgeons, intensivists, dietitians, and physiotherapists is fundamental to optimize recovery and long-term outcomes⁸².

Delirium and Cognitive Dysfunction

□ Practice Box – Delirium and Cognitive Dysfunction

- Screen daily (CAM/CAM-ICU/4AT); document baseline status.
- Prevent via multicomponent bundles: orientation, mobility, hydration, sleep hygiene.
- **Avoid benzodiazepines**; use low-dose haloperidol only if dangerous agitation.
- Opioid-sparing analgesia reduces risk.
- Ensure cognitive follow-up after discharge.

Delirium is one of the most frequent and serious complications among elderly trauma patients, with reported incidence ranging from 20% to 60% during hospitalization and up to 80% among those requiring intensive care. It represents an acute neuropsychiatric syndrome

characterized by fluctuating disturbances in attention, awareness, and cognition, often reflecting the interplay of pre-existing brain vulnerability (frailty, dementia, sensory impairment) and acute systemic stressors such as pain, infection, or surgery^{83–84}.

Delirium markedly increases mortality, length of stay, and institutionalization rates after discharge. Its onset in the trauma setting is multifactorial: advanced age, polypharmacy (especially psychoactive and anticholinergic drugs), alcohol withdrawal, sepsis, hypoxia, sleep deprivation, and unrelieved pain are major contributors. Surgical stress, anesthetic exposure, and prolonged immobilization further potentiate risk. Importantly, the presence of pre-injury cognitive impairment or frailty is the most powerful independent predictor of postoperative delirium⁸⁵.

The Confusion Assessment Method (CAM) and its intensive care variant, CAM-ICU, remain the most validated tools for early detection of delirium and should be systematically used at least once daily in all elderly trauma patients, including those mechanically ventilated [86]. The 4AT (Alertness, Abbreviated Mental Test-4, Attention, Acute Change) is an alternative rapid bedside tool validated for emergency and postoperative settings⁸⁷. Differentiating delirium from pre-existing dementia or depression requires baseline cognitive documentation, often best obtained from family or caregivers.

Preventing delirium is more effective than treating established episodes. Evidence supports a multicomponent prevention strategy that includes⁸⁸:

- Optimized pain management using multimodal, opioid-sparing approaches;
- Adequate sleep–wake regulation (reducing nocturnal noise/light and promoting daytime mobilization);
- Early removal of invasive devices and physical restraints;
- Maintenance of hydration, oxygenation, and electrolyte balance;
- Avoidance of benzodiazepines and anticholinergic agents whenever possible;
- Early mobilization and sensory aids (glasses, hearing devices) to maintain orientation.

These interventions derived from the Hospital Elder Life Program (HELP) and endorsed by the European Society of Intensive Care Medicine (ESICM) and the Society of Critical Care Medicine SCCM ICU guidelines, can reduce the incidence of delirium by up to 40%⁸⁹.

Once delirium occurs, management must address underlying causes (infection, hypoxia, metabolic derangements, drug withdrawal). Pharmacologic therapy should be reserved for severe agitation that jeopardizes patient or staff safety. Haloperidol remains the best-studied antipsychotic, but should be used in the lowest effective doses and for the shortest possible duration. Atypical antipsychotics (e.g., quetiapine, olanzapine) may be considered in selected cases, although their efficacy and safety in elderly trauma patients remain limited by small sample data. Benzodiazepines should be avoided except in alcohol withdrawal–related delirium. Non-pharmacologic reassurance, reorientation, and family involvement are more effective first-line strategies in most cases.

Delirium in the acute phase is strongly associated with persistent cognitive decline and functional dependence^{90–91}. Up to one-third of elderly trauma survivors develop long-term neurocognitive impairment resembling accelerated dementia. Therefore, post-discharge follow-up with cognitive screening and rehabilitation should be incorporated into the continuum of trauma care for older adults.

End-of-Life Care and Ethical Considerations

□ Practice Box – Ethical and End-of-Life Care

- Begin goals-of-care discussion within 48 h of admission.
- Align treatment with patient values and baseline quality of life.
- Palliative care = comfort & dignity, not withdrawal.
- Use structured communication (SPIKES, Best-Case/Worst-Case).
- Record advance directives and decision-makers.

Recommendations:

- WSES recommends discussing in a multidisciplinary approach the end of life in an elderly patient in the trauma setting. The decision should be considering the patient's directives, family feelings and representatives' desires and should be shared [Strong recommendation based on a low-very low quality of evidence 1D].
- WSES recommends involving as soon as possible the palliative care team in managing an elderly severely injured patient at the end-of-life status [Strong recommendation based on a low-very low quality level of evidence 1C].

Few moments in surgical practice test the clinician's humanity as deeply as the care of an elderly trauma patient approaching the end of life. When severe injury intersects with frailty, comorbidity, and limited physiological reserve, the probability of meaningful recovery can become exceedingly low. Yet, the reflex to "do everything possible" often persists, driven by the culture of acute care and the difficulty of acknowledging futility^{92–104}. The WSES guidelines confront this uncomfortable reality with clarity and compassion, calling for early recognition of the end-of-life trajectory and for decisions guided by shared values rather than by reflex interventions.

Elderly trauma patients rarely fit into traditional prognostic categories. Their outcomes depend as much on pre-injury functional status and frailty as on the anatomical severity of trauma. For this reason, the guidelines stress the need to identify those in whom further escalation of care may no longer serve the patient's goals. Physiological parameters such as persistent hypotension, refractory hypoxia, or multiple organ failure provide objective markers, but the decision to limit invasive measures must also account for the patient's wishes, family perspectives, and quality of life before injury.

Prognostication should therefore extend beyond immediate survival to encompass recovery of cognitive function and independence. Several validated scoring

systems may assist clinicians in estimating mortality and functional outcomes. The **Geriatric Trauma Outcome Score (GTOS)** combines age, Injury Severity Score, and early transfusion needs, achieving high accuracy (AUC $\approx$ 0.84) in predicting in-hospital death¹⁵. The **quick Elderly Mortality After Trauma (qEMAT)** score integrates hemodynamic, neurologic, and comorbidity variables, outperforming GTOS and TRISS (AUC $\approx$ 0.87)⁹⁷. Similarly, the **Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA)** and the **Trauma-Specific Frailty Index (TSFI)** have been validated for short-term mortality and discharge outcomes, while the **Palliative Performance Scale (PPS)** and the **FRAIL Questionnaire** help anticipate long-term recovery and functional decline as summarised in Table 2^{98–100}

Despite their promise, none of these tools should be used in isolation or as a trigger for withdrawal of active care. Instead, they can support structured, transparent communication with families and facilitate early palliative involvement when prognosis is poor.

In patients with severe traumatic brain injury (TBI), prognosis is especially uncertain. Mortality doubles in those over 65 compared to younger counterparts, and functional recovery is limited. Current evidence suggests that lack of neurological improvement within the first 72 hours—particularly persistence of a Glasgow Coma

Table 2: Prognostic and Frailty Assessment Scores in Elderly Trauma Patients

Score / Tool	Main Variables Included	Validation Population	Outcome Predicted	Key Notes / Advantages
Geriatric Trauma Outcome Score (GTOS)	Age, Injury Severity Score (ISS), packed RBC transfusion within 24 h	18,282 patients aged 65–102 years	In-hospital mortality	Simple to use; fewer variables; does not require ER physiological data
quick Elderly Mortality After Trauma (qEMAT)	Systolic BP, pulse, GCS, penetrating injury, CHF, renal failure, cirrhosis	243,270 patients >65 years	In-hospital mortality	Outperforms GTOS and TRISS; rapid bedside tool
Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA)	Age, GCS, mechanism, AIS-head/neck, AIS-extremity, Charlson Comorbidity Index	1,470 patients	48-h and in-hospital mortality	Excellent discrimination; prospectively validated
Trauma-Specific Frailty Index (TSFI)	15 items: comorbidities, cognition, mobility, ADLs	200 patients >65 years	Unfavorable discharge disposition	Identifies frailty (>0.27 = high risk); simple bedside screening
Palliative Performance Scale (PPS)	Ambulation, activity, self-care, intake, consciousness	>54-year-old trauma patients	Mortality and poor outcome at discharge / 6 months	Derived from oncology; predicts survival and functional decline
FRAIL Questionnaire	Fatigue, Resistance, Ambulation, Illnesses, Weight loss	188 patients >65 years	1-year functional status and mortality	Quick 5-item tool; useful for ED frailty screening

Scale ≤ 8 —strongly correlates with poor outcome or death, despite maximal therapy. Nevertheless, even in this context, frailty remains a more reliable predictor than chronological age, and decisions about limiting therapy should always consider individual resilience, comorbidities, and patient preferences^{101–102}.

However, cornerstone of this process is the early involvement of a palliative care team, not as an alternative to active treatment but as an integral component of it. Palliative professionals help facilitate communication, manage pain and dyspnea, and support both families and healthcare teams in navigating emotionally charged decisions. Their presence transforms the focus of care from prolonging survival at all costs to preserving comfort, dignity, and relational integrity.

Shared decision-making lies at the heart of ethical trauma management. Whenever possible, conversations about prognosis and treatment preferences should occur with the patient and family before critical deterioration, ensuring that choices reflect informed consent and not crisis-driven reactions. Multidisciplinary meetings involving surgeons, intensivists, anesthesiologists, and geriatricians can provide the moral and clinical framework for such deliberations. The documentation of advance directives, previously expressed patient wishes, and family input is essential to align the plan of care with individual values^{103–104}.

The WSES guidelines underscore that palliative and trauma care are not mutually exclusive. Pain relief, delirium prevention, and compassionate communication are as vital in the resuscitation bay as in the hospice ward. Even in the presence of potentially reversible injuries, the frail elderly patient benefits from an approach that balances curative intent with comfort-oriented priorities.

Ultimately, the ethical management of end-of-life situations in trauma requires humility, the recognition that survival is not always the ultimate measure of success. It invites surgeons to shift from a purely technical mindset to a humanistic vision of care, where every act, whether to operate, to withdraw, or to comfort, is guided by respect for the patient's narrative, values, and dignity. In this sense, trauma surgery becomes not only a science of repair but also a practice of compassion.

Implementation and Future Directions

□ Practice Box – System and Multidisciplinary Approach

- Adopt Geriatric Trauma Pathways with frailty screening and standardized bundles.

- Create multidisciplinary teams (surgery, geriatrics, anesthesia, rehab, nursing).
- Monitor KPIs: mortality, delirium rate, functional recovery.
- Provide ongoing education and simulation training.

Transforming evidence into practice is often more difficult than generating the evidence itself. The implementation of comprehensive trauma care for elderly and frail patients requires not only new protocols, but also a shift in mindset from reactive, procedure-oriented medicine to proactive, patient-centered care. The WSES guidelines mark an important step in this direction, but their true value lies in their capacity to inspire systemic change.

The first challenge is organizational. Many hospitals continue to operate within trauma systems designed for younger patients with high-energy injuries. In this setting, older adults are easily under-triaged or admitted to non-specialized wards where physiological fragility and cognitive vulnerability are underestimated. The WSES advocates the creation of dedicated Geriatric Trauma Units, where trauma surgeons, anesthesiologists, geriatricians, nurses, and rehabilitation specialists collaborate from the moment of admission. Such multidisciplinary environments facilitate early recognition of frailty, optimize perioperative care, and improve functional outcomes through shared decision-making and early mobilization.

Education and training represent the second pillar of implementation. Surgeons and emergency physicians must develop a deeper understanding of the physiology of ageing, the pharmacology of polypharmacy, and the ethical complexity of decision-making at the end of life. Simulation-based courses, multidisciplinary workshops, and continuous professional development programs are essential to build a culture of competence and empathy in the management of geriatric trauma.

The third frontier involves integration of technology and data-driven tools. Artificial intelligence, predictive analytics, and digital health platforms offer unprecedented opportunities to refine risk assessment, monitor physiological trends, and support decision-making¹⁰⁵. Incorporating frailty indices, real-time hemodynamic data, and clinical trajectories into AI-assisted algorithms could help clinicians identify patients at highest risk for deterioration or poor recovery, allowing earlier intervention or palliation. The WSES encourages further research in this domain, emphasizing the need for explainable, ethically

grounded models that complement clinical judgment.

Implementation also depends on public health strategies. Prevention of trauma in the elderly begins long before admission to the emergency department. Fall-prevention programs, home safety assessments, and community-based exercise initiatives have been shown to reduce injury rates and maintain independence¹⁰⁶. Public awareness campaigns, coupled with collaboration between healthcare providers and social services, can strengthen this preventive framework.

Finally, sustained progress demands prospective research and continuous audit. Multicenter registries dedicated to geriatric trauma should collect standardized data on frailty, comorbidities, management strategies, and outcomes. Only through systematic evaluation can the global surgical community refine its understanding of what truly improves survival, function, and quality of life in this growing patient population.

The implementation of the WSES guidelines, therefore, is not an endpoint but a beginning, an invitation to redesign trauma systems around the realities of an ageing world. It calls for integration rather than specialization, compassion rather than protocolism, and for a renewed commitment to the principle that excellence in surgery is measured not only by technical mastery but by the capacity to serve the most vulnerable with wisdom and respect.

Conclusions

Trauma in the elderly and frail patient is not merely a surgical emergency, it is a mirror reflecting the demographic, ethical, and human challenges of modern medicine. As populations age and life expectancy increases, the traditional paradigms of trauma care must evolve to meet new realities: physiology altered by time, vulnerability magnified by comorbidity, and priorities redefined by the patient's own perception of dignity and independence.

The 2023 WSES Guidelines on the Management of Trauma in Elderly and Frail Patients represent a milestone in this evolution. They reframe the approach to geriatric trauma around frailty rather than chronological age, promoting early recognition, individualized resuscitation, rational use of imaging, and judicious management of anticoagulation. They also reaffirm the essential role of multidisciplinary collaboration, multimodal analgesia, infection prevention, and thromboprophylaxis, not as isolated interventions, but as interconnected components of comprehensive, humane care.

Perhaps most importantly, these guidelines restore meaning to trauma surgery in an ageing society. They remind us that successful management is not defined solely by survival, but by the preservation of autonomy, comfort, and human connection. By integrating scientific rigor with ethical awareness and compassion, the WSES offers a model for the future of acute care, one in which technology and empathy coexist, and where the surgeon's duty extends beyond repair to the deeper mission of healing.

The challenge now is to translate this vision into everyday practice, to ensure that every elderly and frail trauma patient, wherever they are treated, receives care that is not only effective, but wise, respectful, and profoundly humane.

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