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Impact of Early Recognition and Management of Hemorrhagic Shock by Nursing and Emergency Medical Services Professionals on Patient Outcomes

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ABSTRACT: The early recognition and management of hemorrhagic shock are crucial for improving patient outcomes, particularly in emergency settings. Nursing and emergency medical services (EMS) professionals play a pivotal role in identifying the clinical signs of shock, such as altered mental status, tachycardia, hypotension, and signs of decreased perfusion. Timely assessment and intervention by these professionals can lead to rapid initiation of fluid resuscitation, blood product administration, and appropriate transport to specialized care facilities. Effective communication and collaboration between nursing staff and EMS can ensure that shock patients receive the necessary interventions as soon as possible, significantly reducing morbidity and mortality associated with hemorrhagic shock. Recent studies underscore the importance of continuous training and guideline adherence among nursing and EMS personnel to facilitate swift recognition and management of hemorrhagic shock. Enhanced education programs that focus on the latest evidence-based practices can improve the capabilities of healthcare providers in emergency situations. Implementing systematic protocols for early intervention not only streamlines care but also fosters a culture of accountability and vigilance. Ultimately, the impact of early intervention by nursing and EMS professionals leads to decreased hospital stays, better recovery rates, and improved long-term outcomes for patients suffering from hemorrhagic shock.

INTRODUCTION

Hemorrhagic shock is one of the most time-sensitive conditions in emergency and trauma care, and the interval between the onset of bleeding and the delivery of effective hemostatic and resuscitative care is a decisive determinant of survival. Recent prehospital studies have focused on predictive tools, shock indices, and point-of-care measurements that can identify traumatically injured patients at risk of deterioration before conventional vital signs become overtly abnormal [1]. At the same time, observational data from ambulance services show that bleeding patients are frequently managed with standard care that may not fully reflect current evidence on early resuscitation, underscoring a persistent gap between recognition and action [2]. The therapeutic landscape has also expanded: prehospital blood transfusion has been evaluated systematically as an intervention that may improve survival and physiological status in traumatized patients when delivered early [3]. Within this landscape, nursing and Emergency Medical Services (EMS) professionals occupy a uniquely influential position because they are often the first clinicians to assess the bleeding patient, to recognize the earliest signs of shock, and to initiate interventions that shape the patient's trajectory. Nursing-led management of postoperative hemorrhagic shock in intensive care illustrates how continuous surveillance, correction of the lethal triad, and protocolized care can convert early recognition into survival without major morbidity [4]. In territorial emergency medical services, emergency nurses are frequently the first health professionals to manage acute hemorrhage and play a fundamental role in early stabilization and continuous monitoring [5].

Epidemiology and Clinical Burden of Hemorrhagic Shock

The epidemiological profile of hemorrhagic shock explains why early recognition is not an abstract quality-improvement aspiration but an epidemiological necessity. Hemorrhage remains a leading cause of preventable death in trauma patients, and the timing of these deaths is particularly consequential: a substantial proportion of hemorrhagic deaths occur rapidly after injury, often before hospital arrival, which means that in-hospital advances cannot reach patients who die in the field or during transport [2]. Prehospital care for penetrating trauma has therefore been reframed as a time-critical intervention rather than a transport function, because the physiological state at hospital arrival is largely shaped by what happens before arrival [6]. The clinical burden is compounded by the fact that bleeding is not always externally obvious, and patients may present with compensated physiology in which blood pressure remains near normal while perfusion is already failing. This reality places a premium on EMS and nursing assessment that goes beyond a single blood pressure measurement and incorporates trends, indices, and repeated clinical evaluation [1, 2]. The burden also extends beyond trauma: major hemorrhage in surgical, obstetric, and critical care settings contributes substantially to preventable morbidity and mortality, and nursing surveillance is often the

mechanism by which deterioration is first detected [4, 5]. Consequently, the impact of early recognition is not confined to a single specialty or setting; it is a cross-cutting clinical competency that determines whether patients reach definitive care in a physiologically salvageable state.

Pathophysiology of Hemorrhagic Shock and the Lethal Triad

Effective early recognition requires a working model of why hemorrhagic shock kills, and that model must extend beyond the simple equation of blood loss and falling blood pressure. Acute blood loss initially reduces preload and cardiac output, provoking baroreceptor-mediated sympathetic activation with tachycardia and peripheral vasoconstriction. These compensatory responses maintain central perfusion pressure while sacrificing peripheral and splanchnic circulation, which is why a patient may appear hemodynamically stable while regional oxygen delivery is already failing. As hemorrhage continues, anaerobic metabolism produces lactic acidosis, and the combination of hypoperfusion, acidosis, and progressive coagulopathy initiates the lethal triad of trauma—hypothermia, acidosis, and coagulopathy—that markedly amplifies mortality risk. Trauma-induced coagulopathy is not simply a downstream consequence of dilution or hypothermia; it is an endogenous process driven by tissue injury, shock, and hyperfibrinolysis, and antifibrinolytic strategies such as tranexamic acid are directed precisely at this component of the pathophysiology [7]. This pathophysiology carries a direct message for nursing and EMS practice: waiting for hypotension to declare itself is biologically indefensible, because systolic blood pressure is a late and insensitive marker of early shock. Blood pressure does not fall meaningfully until a substantial proportion of blood volume has been lost, and a systolic pressure of 90 mm Hg or below is associated with high mortality. Recognition must therefore be built on trends, indices, and composite clinical judgment rather than on a single threshold [1, 7]. The same physiology explains why prehospital interventions that target coagulopathy and oxygen-carrying capacity may be more effective when delivered early than when delayed until after hospital arrival [3, 7].

Recognition of Hemorrhagic Shock: From Classic Staging to Modern Indices

The traditional Advanced Trauma Life Support classification of hemorrhagic shock into four classes remains a foundational educational framework (Table 1). Class I represents minimal loss with normal vital signs; Class II is marked by tachycardia, narrowed pulse pressure, and anxiety; Class III produces overt hypotension, marked tachycardia, tachypnea, and confusion; and Class IV is a preterminal state with profound hypotension, negligible urine output, and lethargy or unconsciousness [8, 9]. The clinical value of this schema lies less in its precision than in its demonstration that shock progresses along a continuum and that the earlier classes are precisely those in which compensatory mechanisms can still be harnessed to prevent deterioration. However, the classification also illustrates the limitation of relying exclusively on blood pressure and heart rate: Class I and early Class II shock may present with entirely normal vital signs, and individual variation in compensatory reserve is considerable [8][9]. Recognition therefore requires a shift from threshold-based diagnosis to risk stratification that incorporates validated indices and repeated assessment.

Table 1. ATLS Classification of Hemorrhagic Shock

Parameter	Class I	Class II	Class III	Class IV
Blood loss (mL)	<750	750–1500	1500–2000	>2000
Blood loss (% volume)	<15%	15–30%	30–40%	>40%
Heart rate (beats/min)	<100	>100	>120	>140
Blood pressure	Normal	Normal	Decreased	Greatly decreased
Pulse pressure	Normal	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	>35
Urine output (mL/h)	>30	20–30	5–15	Negligible
Mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic

Note. Adapted from ATLS and military prehospital teaching materials [8, 9].

Because vital-sign thresholds alone are insufficient, prehospital and emergency clinicians increasingly rely on composite indices that capture the physiological disequilibrium of early shock. The Shock Index, calculated as heart rate divided by systolic blood pressure, rises before blood pressure falls, and a value above 1.3 identifies patients at substantially elevated risk of transfusion requirement and mortality [1]. The reverse Shock Index multiplied by the Glasgow Coma Scale incorporates neurological status and has demonstrated strong predictive accuracy for mortality, and the National Early Warning Score has shown high discriminatory power for massive transfusion and 24-hour mortality in EMS-transported trauma patients [11]. Prehospital transfusion strategies and scoring systems are increasingly linked, because early risk stratification can trigger blood bank notification, prehospital transfusion, or expedited transport without delaying definitive care [10, 11]. The global burden of bleeding and hemorrhagic shock, including limitations in blood supply and access, further reinforces the need for recognition tools that are feasible in resource-constrained environments [12]. Table 2 summarizes the comparative performance of commonly used prehospital tools. The practical implication for nursing and EMS professionals is that validated indices can be incorporated into field assessment and triage protocols, converting a subjective impression of "looking unwell" into an actionable, communicable risk estimate [1, 11].

Table 2. Performance of Prehospital Scoring Tools for Predicting Massive Transfusion and Mortality

Scoring tool	Components	AUROC for massive transfusion	AUROC for 24-hour mortality	Key threshold or finding
Shock Index (SI)	Heart rate / systolic BP	0.78	—	>1.3 associated with increased mortality risk
rSIG	(Systolic BP / heart rate) × GCS	0.83	0.91	≤16 provides balanced sensitivity and specificity
NEWS	Aggregate vital-sign score	0.84	0.93	≥4 sensitive for massive transfusion
ABC score	Penetrating mechanism, positive FAST, SBP <90, HR >120	0.69	—	Lower discrimination in prehospital cohort
RABT score	Age, mechanism, SBP, HR, GCS	0.74	—	Trauma-specific but less accurate than NEWS/rSIG

Note. AUROC values from a five-year retrospective cohort of EMS-transported trauma patients; SI threshold from ambulance-service data [1, 11].

Prehospital Management by EMS Professionals:

Once shock is recognized, the therapeutic priorities of EMS professionals are governed by the principles of damage control resuscitation: stop the bleeding, avoid exacerbating coagulopathy, restore perfusion with the most physiologically appropriate fluid available, and minimize the time to definitive hemostasis. External hemorrhage control is the most immediate and impactful intervention. Tourniquet application for extremity hemorrhage has strong evidence of benefit when applied early, and wound packing with hemostatic dressings is standard for junctional and compressible bleeding. These interventions are within the scope of practice of EMS clinicians and, in many systems, of nurses working in prehospital or emergency settings, and their effectiveness depends on prompt recognition that external bleeding is the dominant threat. The corollary is that efforts to secure an airway or establish intravenous access should not displace hemorrhage control as the first priority in the exsanguinating patient [6, 13]. Delays in early resuscitative intervention are independently associated with both 24-hour and 30-day mortality in patients at risk for hemorrhagic shock, and every additional minute of prehospital time in hypotensive penetrating trauma has been associated with worse outcome [13, 14]. The chain of survival for traumatic hemorrhage therefore emphasizes early recognition, early hemorrhage control, early resuscitation, and rapid transition to definitive care [15]. Chinese expert consensus on prehospital major trauma management similarly emphasizes structured assessment, hemorrhage control, and physiological resuscitation as linked prehospital priorities [16].

Beyond mechanical hemostasis, prehospital pharmacological and transfusion strategies have transformed the therapeutic landscape. Tranexamic acid reduces hemorrhage-related mortality when administered early, with the greatest benefit observed when given within the first hour after injury and diminishing benefit thereafter, and prehospital tranexamic acid has been associated with reduced mortality, decreased transfusion requirements, and improved shock physiology in patients receiving whole blood [7]. Prehospital coagulation management and fluid replacement guidelines further support early attention to coagulopathy, avoidance of excessive crystalloid, and use of balanced resuscitation strategies in patients with multiple or severe injuries [17]. Prehospital blood product administration represents a further paradigm shift: massive transfusion protocols are established in-hospital practices, yet critical bleeding accounts for a large share of trauma deaths before hospital arrival, a reality that has driven interest in extending transfusion into the prehospital environment [3, 10]. Fluid resuscitation strategy must be aligned with these principles: for patients with uncontrolled hemorrhage, permissive hypotension with limited crystalloid is recommended to maintain minimum hemodynamic stability without disrupting clot formation, and balanced crystalloid solutions are preferred over normal saline when crystalloid is used [17]. These interventions are most effective when they are embedded in a protocolized system rather than delivered as isolated tasks, because coordination and timeliness determine whether the physiological benefit is realized [16, 17].

The Nursing Role in Early Recognition and Management

The nursing contribution to hemorrhagic shock outcomes is both distinctive and indispensable, operating at the intersection of surveillance, coordination, and advocacy. Nurses are frequently the first clinicians to identify physiological deterioration, whether in the emergency department, the intensive care unit, the operating room, or the prehospital environment where emergency nurses function as autonomous or semi-autonomous providers [5]. In the Italian territorial emergency medical service, emergency nurses are often the first health care professionals to manage patients with acute hemorrhage and play a fundamental role in early stabilization and continuous monitoring [5]. A structured nursing approach begins with an ABCDE assessment and rapid identification of active bleeding, followed by continuous monitoring of blood pressure, heart rate, oxygen saturation, respiratory rate, level of consciousness, and electrocardiographic rhythm, because these parameters collectively detect the early signs of hemorrhagic shock that any single measurement would miss [4, 5]. The nurse's proximity to the patient over time—the ability to compare trends rather than isolated values—is a diagnostic asset that no single laboratory result can replace.

In the intensive care setting, specialized nursing management of postoperative hemorrhagic shock has been shown to be decisive for patient outcomes, particularly in older surgical patients in whom physiological reserve is limited and deterioration is rapid. A case report of an 89-year-old woman who developed hemorrhagic shock after emergency gastrojejunostomy illustrates the breadth of nursing priorities: perfusion restoration and correction of the lethal triad, multimodal analgesia, continuous monitoring, prevention bundles for infection and pressure injury, and structured family communication, all guided by standardized nursing language that improved the traceability and continuity of care [4]. The patient progressively stabilized, with hemoglobin rising from a nadir of 5.8 g/dL to 9.6 g/dL, lactate falling to below 1 mmol/L, restoration of normothermia, discontinuation of vasopressors, and no documented ICU-acquired complications [4]. This case exemplifies how skilled nursing surveillance converts early recognition into timely intervention and, ultimately, into survival without major morbidity. Nursing also contributes through the initiation and coordination of protocols that bridge recognition and treatment: nurses may administer tranexamic acid under standing orders in suspected major hemorrhage, establish intravenous access, initiate fluid resuscitation according to permissive hypotension principles, manage thermal support, and ensure rapid transport to an appropriate facility [4- 7]. The nursing role is therefore not confined to task execution; it encompasses the cognitive work of pattern recognition, the relational work of communication across teams, and the systems work of protocol adherence and quality improvement.

Education and Training as Levers for Improvement

If recognition is a skill, it can be taught, and the evidence supports targeted educational interventions for nursing and EMS professionals. Simulation-based education has been shown to improve practical skills and knowledge retention in hemorrhage control, with even a single two-hour "Stop the Bleed"–style course significantly increasing self-confidence and competence among healthcare students [18]. Low-cost task trainers combined with high-fidelity simulation environments have been found to improve hemorrhage-control skills and produce lasting effects, making this approach feasible for resource-constrained programs [18]. The evidence further suggests that the best learning method for bleeding control in nursing students is the

PTEBL method with a simulator, which improved learning outcomes compared with conventional instruction [18]. For practicing professionals, virtual reality simulation, in-service education, seed-mentor teaching models, and digital learning resources have been implemented to disseminate hemorrhage-control competencies [19]. The implication is that early recognition is not simply a matter of individual vigilance; it is a competency that can be systematically built into curricula, onboarding, and continuing education, and that investment in this competency yields measurable improvements in the speed and quality of clinical response [18, 19].

Outcomes Associated with Early Recognition and Management

The outcomes literature consistently demonstrates that timeliness of recognition and intervention is the dominant modifiable determinant of survival in hemorrhagic shock. Prehospital shock indices predict not only mortality but also the need for massive transfusion, allowing pre-arrival notification and blood bank preparation without delaying transport [1, 11]. The association between time and outcome is quantifiable: in bleeding adults, the risk of mortality increases with every minute of delay in transfusing blood products, and earlier resuscitative intervention is associated with reduced 24-hour and 30-day mortality [13]. Prehospital blood transfusion has been linked to improved field physiology and survival, while the converse—crystalloid-heavy resuscitation without hemostatic adjuncts—is associated with a dose-response increase in mortality among patients who meet criteria for blood product administration [3, 10]. These findings converge on a single conclusion: the physiological state at hospital arrival, which is largely shaped by prehospital and emergency nursing and EMS care, is a powerful predictor of what happens thereafter [13- 15].

Long-term outcomes beyond survival are also affected. Survivors of severe trauma with hemorrhagic shock are at risk of chronic critical illness, a trajectory characterized by persistent organ dysfunction, prolonged intensive care dependence, and poor long-term functional outcomes; among blunt trauma patients with hemorrhagic shock who survived beyond 48 hours, a substantial proportion progressed to chronic critical illness in one cohort [20]. Early, effective resuscitation that minimizes the depth and duration of shock may reduce the inflammatory and ischemic burden that contributes to this trajectory, although the evidence base for long-term functional outcomes remains less developed than that for mortality [20]. What is clear is that the benefits of early recognition are not exhausted at the point of hospital discharge; they extend into the recovery phase, where the difference between a patient who walks out of the hospital and one who transitions to chronic critical illness may have been determined in the first minutes and hours after injury [15, 20].

Advanced Recognition Technologies and Prehospital Decision Support

Emerging technologies are beginning to extend the reach of early recognition beyond conventional vital signs. Prehospital extended focused assessment with sonography in trauma, combined with 5G-enabled real-time telesupervision, has been evaluated for the early detection of intra-abdominal hemorrhage and trauma team activation, potentially shortening the interval between injury and definitive surgical care [21]. Visual scoring of photoplethysmography morphology has also been studied for risk stratification in hemorrhagic shock, offering a noninvasive signal of circulatory compromise that may precede overt hypotension [22]. These technologies do not replace clinical judgment or validated indices; rather, they add another layer of information that nursing and EMS professionals can integrate into repeated assessment. Their value depends on whether they can be applied without delaying transport or hemorrhage control, and on whether the resulting information is communicated clearly to receiving teams [21, 22]. The most promising models combine technology with structured clinical assessment, so that a positive finding triggers a predefined response rather than remaining an isolated data point [1, 11, 21].

Advanced Prehospital Strategies and System Design

Prehospital low-titer group O whole blood has emerged as a preferred product in some civilian EMS systems because it simplifies logistics, reduces donor exposures, and provides physiologic component ratios. Operational analyses of multi-agency civilian EMS programs have described field-to-emergency-department physiological improvements, including mean systolic pressure increases and pulse reductions, with high 24-hour and 30-day survival in transfused patients [23]. Prehospital transfusion strategies more broadly have been associated with improved physiological status and survival when integrated into damage control resuscitation, although implementation varies widely across systems [10, 25]. EMS tactical damage control resuscitation protocols provide a structured framework for prioritizing hemorrhage control, limiting crystalloid, preventing hypothermia, and coordinating early blood product administration when available [24]. The effectiveness of these strategies depends on system-level design: protocols, training, blood product logistics, cold-chain maintenance, regulatory approval, and

audit and feedback are all necessary to convert a promising intervention into routine practice [23- 25]. When these elements are aligned, prehospital and emergency nursing and EMS professionals can deliver a coordinated early response that addresses both the mechanical and the physiological components of hemorrhagic shock [3, 17].

Toward an Integrated Model of Early Recognition and Management

The evidence reviewed here supports an integrated model in which nursing and EMS professionals function as a coordinated early-response system rather than as separate professional silos. Such a model has several defining features. First, recognition is structured and index-based: validated tools such as the Shock Index, rSIG, and NEWS are incorporated into field and triage assessment, and trends are communicated in handoffs [1, 11]. Second, hemorrhage control is prioritized and protocolized: tourniquets, wound packing, and hemostatic dressings are applied without delay, and airway or vascular access do not displace this priority [6, 16]. Third, pharmacological and transfusion adjuncts are delivered early when available: tranexamic acid within the therapeutic window and prehospital whole blood where systems permit [7, 23]. Fourth, resuscitation strategy is physiologically informed: permissive hypotension and balanced crystalloid, with early transition to blood products for patients in severe shock [10, 25]. Fifth, nursing surveillance is continuous and trend-based, extending from the prehospital phase through the emergency department and into critical care, with structured communication across transitions [4, 5]. Sixth, education and quality improvement are continuous, using simulation, audit, and feedback to close the gap between evidence and practice [18, 19]. Table 3 summarizes the principal prehospital interventions and their outcome associations within this integrated model.

Table 3. Prehospital Interventions for Hemorrhagic Shock and Associated Outcomes

Intervention	Rationale	Evidence of benefit	Implementation considerations
Tourniquet application	Arrest extremity arterial hemorrhage	Strong evidence; early application improves survival	Must not be delayed for airway or IV access [6, 16]
Wound packing / hemostatic dressing	Control junctional and compressible bleeding	Standard of care for non-tourniquet–amenable hemorrhage	Requires training and rehearsal [16, 18]
Tranexamic acid	Attenuate hyperfibrinolysis	Reduced 24-hour mortality; reduced transfusion requirements; greatest benefit within 1 hour	Underutilized; protocol and education gaps [17]
Prehospital blood products (LTOWB)	Restore oxygen-carrying capacity and hemostatic balance	Improved field physiology and high survival in observational programs	Logistical, regulatory, and storage challenges [3, 25]
Permissive hypotension	Avoid disrupting nascent clot	Recommended for uncontrolled hemorrhage	Requires protocolized target and monitoring [17, 24]
Damage control resuscitation bundle	Integrate hemostasis, limited fluids, hypothermia prevention	Reduces coagulopathy progression	Demands team coordination and training [16, 24]

Note. LTOWB = low-titer group O whole blood. Evidence synthesized from prehospital trauma, transfusion, and nursing literature [3, 6, 16- 18, 24, 25].

Barriers to Early Recognition and Management

Despite the strength of the evidence, early recognition and management of hemorrhagic shock remain inconsistently implemented, and the barriers are as much organizational and educational as they are clinical. Underutilization of proven interventions is a recurring theme: in a Swedish ambulance cohort, tranexamic acid was administered to only a minority of patients with severe bleeding, and the authors suggested that this low rate reflected prioritization of other life-saving interventions in hemodynamically unstable patients rather than a lack of awareness of benefit [2]. Prehospital transfusion programs face logistical and regulatory challenges, including blood product storage, cold-chain maintenance, training

requirements, and financial sustainability, which limit their availability in many systems [23, 25]. Diagnostic uncertainty in the field—where vital signs may be confounded by pain, anxiety, medications, or compensated physiology—can delay recognition, particularly when clinicians rely on blood pressure as the primary trigger for action [1, 11]. Nursing and EMS professionals also practice within scope-of-practice frameworks that vary across jurisdictions, determining whether they can administer tranexamic acid, initiate blood products, or perform advanced procedures independently [5, 24]. Addressing these barriers requires a systems approach: protocol standardization, audit and feedback, simulation-based training, and the development of prehospital prediction scores that can be applied without delaying transport [16, 18, 19].

CONCLUSION

Hemorrhagic shock requires timely intervention, significantly affecting survival rates and outcomes. It is primarily managed by nurses and EMS personnel. Key actions include early hemorrhage control, antifibrinolytic therapy, and physiologically targeted resuscitation, which can lower mortality rates. Continuous surveillance and proactive protocols by nursing professionals, combined with EMS's rapid transport and resuscitation efforts, are crucial. Challenges to optimal care stem from organizational issues such as underutilization of critical treatments and diagnostic uncertainties. Early recognition of hemorrhagic shock is a proactive, team-driven process essential from the first point of contact. The effective application of established evidence into practice is vital for improving patient outcomes.

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