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“Beyond Vital Signs: Advancing Triage Systems Specific to Pediatric Emergencies for Safer and Smarter Acute Care”

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Abstract: Triage in pediatric emergency settings is a critical process that determines the prioritization of care for infants, children, and adolescents presenting with a wide spectrum of clinical conditions. Unlike adult triage, pediatric triage must account for developmental variations, age-specific physiological norms, communication barriers, dependency status, and distinct disease patterns. Errors in triage may result in delayed treatment, adverse outcomes, and increased mortality. Over the past two decades, several structured triage systems have been developed and validated internationally, including the Emergency Severity Index (ESI), Manchester Triage System (MTS), Canadian Triage and Acuity Scale (CTAS), and the Australasian Triage Scale (ATS). Many of these include pediatric adaptations or dedicated pediatric modifiers. This review article critically examines pediatric-specific triage systems, their theoretical underpinnings, reliability, validity, implementation challenges, and implications for nursing practice. The article also explores innovations such as pediatric early warning scores and digital triage tools. Strengthening pediatric triage processes is essential for enhancing patient safety, optimizing resource allocation, and improving clinical outcomes in emergency departments worldwide.

Keywords: *Pediatric emergency; Pediatric triage systems; Emergency Severity Index; Manchester Triage System; Canadian Triage and Acuity Scale; Australasian Triage Scale; Pediatric Early Warning Score; Emergency nursing; Acuity assessment; Child health emergency care.*

Introduction

Triage is a structured clinical decision-making process used in emergency departments (EDs) to categorize patients based on urgency and resource needs. In pediatric emergencies, triage assumes even greater importance because children often deteriorate rapidly, may be unable to articulate symptoms effectively, and exhibit age-dependent physiological parameters that differ significantly from adults. Pediatric patients represent a heterogeneous population ranging from neonates to adolescents, each with distinct anatomical, physiological, psychological, and developmental characteristics.

Globally, emergency departments are experiencing rising pediatric patient volumes. Overcrowding, limited pediatric-trained staff, and variability in triage interpretation increase the risk of under-triage or over-triage. Under-triage can delay life-saving interventions, while over-triage can strain already limited emergency resources. Consequently, pediatric-specific triage systems have evolved to improve the precision and safety of emergency care prioritization.

This review synthesizes current knowledge on pediatric emergency triage systems, compares major international models, examines evidence supporting their reliability and validity, and discusses emerging innovations tailored to pediatric populations.



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Conceptual Foundations of Pediatric Triage

Pediatric triage is guided by principles of rapid assessment, risk stratification, and resource allocation. However, several unique pediatric considerations influence triage decision-making:

1. **Age-specific vital sign norms** – Heart rate, respiratory rate, and blood pressure vary significantly by age group.
2. **Communication limitations** – Infants and young children may present with non-specific symptoms such as irritability or lethargy.
3. **Physiological reserve** – Children compensate well initially but may deteriorate suddenly.
4. **Family-centered care** – Parental input is often essential in clinical assessment.
5. **Developmental and psychosocial factors** – Fear and anxiety may alter clinical presentation.

These factors necessitate structured tools that incorporate pediatric-specific modifiers.

Major Pediatric-Specific and Adapted Triage Systems

Several internationally recognized triage systems include pediatric adaptations. Although originally designed for general ED populations, they incorporate pediatric-specific criteria.

Emergency Severity Index (ESI) – Pediatric Adaptation

The Emergency Severity Index is a five-level triage algorithm widely used in the United States. It prioritizes patients based on acuity and anticipated resource utilization. Pediatric modifications include age-adjusted vital sign thresholds and fever risk criteria for infants under 28 days.

The ESI algorithm classifies patients into Levels 1–5:

- Level 1: Immediate life-saving intervention required.
- Level 2: High-risk situation or severe distress.
- Level 3: Multiple resources required.
- Level 4: One resource required.
- Level 5: No resources required.

In pediatric cases, febrile neonates, altered mental status, severe respiratory distress, or abnormal vital signs automatically elevate triage priority.

Manchester Triage System (MTS) – Pediatric Flowcharts

The Manchester Triage System uses symptom-based flowcharts and discriminators to assign one of five urgency categories. Pediatric-specific flowcharts address conditions such as feverish child, crying baby, breathing difficulty in children, and non-blanching rash.

MTS emphasizes structured questioning and clinical discriminators such as:

- Consciousness level
- Airway compromise
- Shock indicators
- Pain severity
- Temperature thresholds

The system is widely implemented across Europe and has demonstrated moderate to high inter-rater reliability in pediatric populations.

Canadian Triage and Acuity Scale (CTAS) – Pediatric Guidelines

The Canadian Triage and Acuity Scale includes pediatric-specific modifiers and detailed guidelines for age-based vital signs, fever assessment, asthma severity, dehydration, and trauma.

CTAS categorizes patients into five levels:

- Level I: Resuscitation
- Level II: Emergent
- Level III: Urgent
- Level IV: Less Urgent
- Level V: Non-Urgent

Pediatric CTAS guidelines provide structured descriptors for common childhood emergencies such as bronchiolitis, croup, seizures, and diabetic ketoacidosis.

Australasian Triage Scale (ATS) – Pediatric Considerations

The Australasian Triage Scale is a five-category system used in Australia and New Zealand. While not exclusively pediatric, it incorporates age-adjusted physiological criteria and pediatric emergency training modules.

ATS emphasizes:



- Time-to-treatment benchmarks
- Clinical urgency
- Immediate life-threatening assessment

Factors influencing reliability include:

- Nurse training level
- Pediatric clinical experience
- Workload and crowding
- Institutional protocols

Comparative Overview of Pediatric Triage Systems

Feature	ESI	MTS	CTAS	ATS
Origin	USA	UK	Canada	Australia/New Zealand
Levels	5	5	5	5
Pediatric-Specific Modifiers	Yes	Yes	Yes	Yes
Resource-Based Component	Yes	No	Partial	No
Symptom Flowcharts	Limited	Extensive	Moderate	Moderate
Widely Used In	North America	Europe	Canada	Australasia

All systems demonstrate acceptable reliability; however, differences exist in complexity, training requirements, and pediatric specificity.

Pediatric Early Warning Scores (PEWS) in Triage

Pediatric Early Warning Scores complement triage systems by identifying children at risk of deterioration. PEWS integrates physiological parameters such as heart rate, respiratory rate, oxygen saturation, capillary refill time, and behavioral changes.

PEWS does not replace triage systems but enhances risk detection, particularly in inpatient and observation settings. Integration of PEWS into ED triage has improved early identification of sepsis and respiratory failure.

Reliability and Validity of Pediatric Triage Systems

Studies evaluating pediatric triage tools demonstrate moderate to substantial inter-rater reliability (kappa values ranging 0.4–0.8). Validity assessments commonly use hospital admission, ICU transfer, or mortality as outcome indicators.

Under-triage rates remain a concern in infants and children with atypical presentations. Over-triage, while safer, contributes to overcrowding.

Challenges in Pediatric Emergency Triage

Pediatric triage faces several operational and clinical challenges:

Communication Barriers

Infants and toddlers cannot verbalize symptoms. Non-verbal cues must be interpreted accurately.

Rapid Physiological Changes

Children may maintain normal blood pressure until late shock stages, leading to false reassurance.

High Patient Volume and Overcrowding

Overcrowding reduces triage accuracy and increases cognitive load on nurses.

Limited Pediatric-Specific Training

Not all emergency departments have pediatric emergency specialists.

Role of Emergency Nurses in Pediatric Triage

Emergency nurses are the frontline decision-makers in pediatric triage. Their responsibilities include:

- Rapid primary assessment
- Identification of high-risk symptoms
- Accurate documentation
- Family communication
- Escalation of care

Continuous professional education in pediatric life support, simulation-based training, and competency validation improves triage accuracy.

Technological Innovations in Pediatric Triage

Digital triage systems incorporating artificial intelligence and electronic health records are emerging. Automated vital sign alerts, predictive analytics, and clinical decision support systems assist nurses in identifying high-risk children.



Tele-triage models have expanded in remote and rural settings, enabling early pediatric assessment before hospital arrival.

Table: Key Pediatric Red Flags in Emergency Triage

Systemic Category	Red Flag Indicators
Respiratory	Grunting, stridor, severe retractions, apnea
Cardiovascular	Delayed capillary refill, weak pulses, mottled skin
Neurological	Altered consciousness, seizures, bulging fontanelle
Infectious	Non-blanching rash, high fever in neonate
Trauma	High-impact injury, altered mental status

Recognition of these red flags is central to safe triage prioritization.

Global Perspectives on Pediatric Triage

High-income countries have well-structured triage systems, while low- and middle-income countries often rely on modified or simplified tools. Resource limitations influence triage implementation, including staffing ratios and infrastructure constraints.

Standardization and adaptation to local epidemiological patterns are essential.

Future Directions in Pediatric Triage

Future developments include:

- Integration of machine learning algorithms
- Standardized global pediatric triage guidelines
- Enhanced simulation-based nurse training
- Cross-cultural validation studies
- Development of pediatric-specific tele-triage protocols

Research must focus on improving predictive validity and minimizing under-triage in vulnerable age groups.

Conclusion

Pediatric triage systems play a fundamental role in ensuring safe, timely, and effective emergency care for children. While internationally recognized systems such as the Emergency Severity Index, Manchester Triage System, Canadian Triage

and Acuity Scale, and Australasian Triage Scale provide structured frameworks, ongoing refinement is necessary to address pediatric-specific challenges. Incorporating early warning tools, digital decision support, and specialized training enhances triage accuracy. Strengthening pediatric emergency triage practices is critical to reducing morbidity and mortality and improving health system responsiveness to the unique needs of children.

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