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COMMENTARY

Optimizing Pediatric Sepsis Diagnosis: A Narrative Review of Two Decades of Evolution from SIRS to Phoenix Consensus

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Abstract: Pediatric sepsis definitions have evolved significantly from the 2005 International Pediatric Sepsis Consensus Conference (IPSCC) to the 2024 Phoenix Sepsis criteria. However, inconsistencies in previous models, including Systemic Inflammatory Response Syndrome (SIRS) and Sepsis-3, impacted diagnosis and treatment. A global task force conducted clinician surveys, meta-analysis, and validation studies, culminating in the Phoenix Sepsis Score as a refined diagnostic model. The Phoenix Sepsis Score assesses four organ systems, improving diagnostic accuracy and overcoming limitations seen in earlier models. This narrative review examines the evolution of pediatric sepsis definitions over the past two decades, from the 2005 International Pediatric Sepsis Consensus Conference (IPSCC) criteria to the recently published Phoenix Sepsis Score; providing a standardized and globally relevant approach to improving early detection and treatment outcomes.

Keywords: pediatric sepsis, Phoenix sepsis score, SIRS, sepsis definitions

Background

Sepsis is a life-threatening condition that arises when the body's response to an infection injures its own tissues and organs. It is a significant cause of morbidity and mortality in children worldwide. However, the definition and clinical criteria for sepsis in children vary across different medical guidelines and literatures, leading to inconsistencies in diagnosis, treatment, and research. This lack of a universally accepted definition can lead to underdiagnosis or overdiagnosis of sepsis, impacting the quality of care and outcomes for pediatric patients. Recently, the International Pediatric Sepsis Consensus Conference (IPSCC) came up with a new definition of sepsis in the pediatric population. This commentary manuscript aims to discuss the different definitions of sepsis across literature and their implications in clinical practice and research. It also highlights the need for a universally accepted definition and clinical criteria for sepsis in children, which would facilitate consistent diagnosis, treatment, and research in this field. The manuscript concludes with a call for further research and consensus-building efforts to address this critical issue in pediatric healthcare.

This narrative review is primarily educational, aiming to synthesize and critically appraise the evolution of pediatric sepsis definitions over the past two decades. By integrating historical developments, recent consensus updates, and practical considerations for both high- and low-resource settings, it seeks to inform clinicians, researchers, and policy-makers, and to advocate for the adoption of standardized, evidence-based diagnostic criteria.

This commentary draws on a targeted review of the literature from January 2005 to January 2025 to examine the evolution of pediatric sepsis definitions and their implications for clinical practice and research. To inform this commentary, we conducted a targeted literature search in PubMed, Scopus, and Google Scholar for articles published between January 2005 and January 2025. The following keywords and Boolean operators were used: "pediatric sepsis" OR "child sepsis" AND "definition" OR "criteria" OR "diagnostic criteria" OR "SIRS" OR "Phoenix criteria" OR "International Pediatric Sepsis Consensus Conference" OR "IPSCC". We included peer-reviewed articles, consensus

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statements, and guideline documents relevant to pediatric sepsis definitions, and excluded non-English publications without available translations, single-patient case reports, and conference abstracts. Priority was given to sources with pediatric-specific data or broad clinical applicability. Additional relevant articles were identified through reference lists of key publications and recent consensus statements.

Definitions of Sepsis

The diagnostic criteria for pediatric sepsis have undergone significant changes over the past two decades, transitioning from the broad SIRS-based IPSCC 2005 framework to the more nuanced Sepsis-3 2016 and the recently proposed Phoenix 2024 consensus. These shifts reflect a growing emphasis on organ dysfunction, clinical context, and global applicability. Table 1 provides a comparative overview of these three definitions, highlighting key differences in terminology, diagnostic thresholds, and clinical relevance across diverse healthcare settings.

Historical Evolution

In 2005, the IPSCC updated the definitions of sepsis, severe sepsis, and septic shock specifically for the pediatric population. This revision adapted the adult criteria for SIRS and sepsis, incorporating pediatric physiological variables suitable for different child subcategories: newborns, neonates, infants, children, and adolescents. Sepsis was defined as a Systemic Inflammatory Response Syndrome (SIRS) occurring due to a suspected or confirmed infection.[1]

Table 1 Comparative Table: Sepsis Definitions (2005 IPSCC vs Sepsis-3 vs Phoenix Score)

Dimension	2005 IPSCC (Pediatrics)	Sepsis 3 (Adult, 2016)	Phoenix Score (Pediatric, 2024)
Target population	Children	Adult	Children (validated across high- and low-resource settings)
Core definition	Suspected infection + ≥2 SIRS + organ dysfunction	Suspected infection + SOFA score ≥2	Suspected infection + Phoenix Score ≥2 (organ dysfunction points)
Use of SIRS Criteria	Required	Removed	Removed
Organ Dysfunction Thresholds	Any organ system; consensus-based cutoff	SOFA sub-scores across 6 systems	≥1 point in any of 4 systems: respiratory, cardiovascular, coagulation, neurological
Severe Sepsis Term	Explicitly defined: sepsis + organ dysfunction	Removed (considered redundant)	Removed (replaced by graded organ dysfunction scoring)
Septic Shock Definition	Sepsis + cardiovascular dysfunction	Sepsis + vasopressors + lactate >2 mmol/L	Sepsis + ≥1 cardiovascular point in Phoenix Score
Validation Methodology	Expert consensus	Retrospective adult ICU cohorts	Delphi consensus + >3 million pediatric encounters
Clinical Performance	Low specificity; poor PPV for sepsis and shock	Improved mortality prediction in adults	Higher PPV and sensitivity for pediatric sepsis and shock
Global Applicability	Limited in LMICs due to reliance on labs and SIRS	Adult-focused; not pediatric-specific	Designed for both high- and low-resource pediatric settings
Implementation Barriers	SIRS criteria may over diagnose; organ dysfunction poorly define	Requires full lab panels and ICU-level monitoring	Some components (eg, lactate, coagulation) may be unavailable in LMICs
Adaptability in LMICs	Limited; lacks flexibility for resource constraints	Not applicable to pediatric LMIC settings	Can be adapted using simplified tools (eg, clinical surrogates)

The Systemic Inflammatory Response Syndrome (SIRS) was defined by the occurrence of at least two of the following criteria, with the requirement that either an abnormal temperature or leukocyte count must be present: A core temperature that exceeds 38.5°C or falls below 36°C, measured via rectal, bladder, oral, or central probe; The presence of tachycardia, signified by a mean heart rate that is more than two standard deviations above the normal for the individual's age.[1] For children under one year of age, bradycardia is defined as a mean heart rate that falls below the 10th percentile for their age; A mean respiratory rate that is more than two standard deviations above the normal for the individual's age, or the need for mechanical ventilation due to an acute pulmonary process; An abnormal leukocyte counts for the individual's age, either elevated or depressed, or the presence of more than 10% immature neutrophils.[1]

Establishing vital signs values in the context of sepsis presents a unique challenge in the pediatric population. This is due to the fact that the clinical parameters used to define Systemic Inflammatory Response Syndrome (SIRS) and organ dysfunctions undergo various physiological changes throughout childhood. Therefore, the following age-specific criteria were employed to categorize different groups within the pediatric population: newborn: 0 to 1 week; neonate: 1 week to 1 month; infant: 1 month to 1 year, toddlers and preschoolers: 2 to 5 years; school-age children: 6 to 12 years and adolescents and young adults: up to <18 years.[1]

Severe sepsis was defined as sepsis accompanied by either cardiovascular organ malfunction, or an acute respiratory distress syndrome (ARDS), or a combination of two or more dysfunctions, which could be respiratory, renal, neurologic, hematologic, or hepatic. Septic shock was defined as sepsis plus cardiovascular dysfunction.[1]

Limitations of the 2005 IPSCC Criteria

The above definitions, as set by the International Pediatric Sepsis Consensus Conference (IPSCC) in 2005, faced several challenges. It was reported that sepsis as defined in this expert conference had low sensitivity and specificity because some patients with sepsis did not present with SIRS and some patients with SIRS did not have sepsis.[2,3] When other clinical and laboratory investigations (serum lactate, central venous saturation, blood pressure, capillary filling) were carried out, none could define and guide the sepsis treatment.[3] On the other hand, in a study, which involved 7000 children admitted to 128 Pediatric Intensive Care Units (PICUs) across 26 countries, revealed a low concordance rate (46%) between the preliminary diagnosis of severe sepsis made by the attending physician and the diagnosis based on the International Pediatric Sepsis Consensus Conference (IPSCC) guidelines.[4] The clinical diagnosis was made using a more lenient approach, which resulted in fewer laboratory abnormalities, lower mortality rates, and less organ failure compared to the group that strictly adhered to the consensus criteria.

The Sepsis-3 Era and Pediatric Adaptations and Limitations of Sepsis-3 in Pediatric Populations

In 2016, the Third International Consensus Definitions for Sepsis and Septic Shock, also known as Sepsis-3, assembled a task force of 19 experts in the fields of sepsis pathobiology, clinical trials, and epidemiology. Their goal was to assess and update the definitions for sepsis and septic shock as necessary. This initiative marked a significant advancement in our understanding and management of sepsis, offering a more precise and clinically applicable definition that facilitates the early detection and treatment of patients suffering from this life-threatening condition. Sepsis was defined as a life-threatening organ dysfunction resulting from a dysregulated host response to infection.[5] For practical clinical application, the concept of Sequential (Sepsis-related) Organ Failure Assessment (SOFA≥2) score was introduced to define organ dysfunction. This definition was primarily developed for the adult population; however, the sepsis 3 definitions were revised and have been modified to be applicable to the pediatric population as well.[6] The Pediatric Sequential Organ Failure Assessment (pSOFA) score is calculated based on the analysis of six organ systems, which include respiratory, hepatic, coagulative, cardiovascular, neurological, and renal. Each system is assigned a score that can vary from zero to four points.[6] Hence, by adopting the Sepsis-3 definitions adapted for children, sepsis was defined as suspected or confirmed infection associated with an acute increase in the pSOFA score >2 points (within the prior 48 h up to 24 h of infection); and septic shock as sepsis in children receiving vasoactive drugs associated with a serum lactate level >2 mg/dL.[3] The primary concern with the application of the Sepsis-3 definition in children is that it fails to capture the complexity of sepsis in this

population, who often have different physiological responses to infection compared to adults. Also, there were problems applying this definition equally in different world regions. For example, in a retrospective study conducted in the United States of America, involving 8500 children in PICU over a period of 7 years, the Sepsis-3 was a better predictor of mortality.[6] However, when pediatric Sepsis-3 was evaluated in a smaller population number and mortality more than 40%, it showed high specificity but lower sensitivity, because it failed to identify more than 18% of children with sepsis diagnosed by IPSCC.[7] Therefore, there was a need for more pragmatic and sensitive diagnostic algorithms that are tailored to the clinical settings and physiological responses observed in children. This would help in early diagnosis and timely intervention, which are crucial in managing sepsis effectively.

Development of the Phoenix Sepsis Criteria

Therefore, in 2024, with the aim of updating and evaluating the criteria for sepsis and septic shock in children, the Society of Critical Care Medicine (SCCM) assembled a task force. This group consisted of 35 pediatric experts from six continents, specializing in critical care, emergency medicine, infectious diseases, general pediatrics, nursing, public health, and neonatology. The discussion primarily centered on the use of the Systemic Inflammatory Response Syndrome (SIRS) as a key factor in defining sepsis, as recommended by the 2005 International Pediatric Sepsis Consensus Conference (IPSCC). It was acknowledged that SIRS has a low sensitivity and specificity.[8] Unlike Sepsis 3, which used data from adults in only one high-income country (USA), the task force, with the purpose of developing new criteria, conducted a comprehensive global survey involving 2835 clinicians. This was followed by a systematic review and meta-analysis. The process was supplemented by a data-driven derivation and validation study, all of which led to the development of a modified Delphi consensus process. Throughout each phase, the task force incorporated data from both resource-constrained and resource-abundant settings, always mindful of the challenges posed by limited resources. It was noticed following, a survey data, most pediatric clinicians define sepsis as an infection causing life-threatening organ dysfunction.[8] This differs from previous pediatric sepsis criteria that relied on the less predictive Systemic Inflammatory Response Syndrome (SIRS) and redundantly used the term “severe sepsis”.

Following the above, Sepsis in children was defined using the Phoenix sepsis criteria: any child < 18 years with suspected or confirmed infection presented with a Phoenix Sepsis Score of 2 or more points, while Septic shock is defined as sepsis plus least 1 point in the cardiovascular component of the Phoenix Sepsis Score.[8]

The Phoenix Sepsis Score: Structure and Rationale

The Phoenix Sepsis Score integrates the levels of dysfunction across four organ systems (cardiovascular, respiratory, neurological, and coagulation) to define organ dysfunction.[8] When compared to an 8-organ system model that also includes renal, hepatic, endocrine, and immunological dysfunction (Phoenix-8 Score 36), it demonstrated similar performance. The task force endorsed the final 4-organ system model due to its performance and simplicity. This model was then converted into an integer-based score, known as the Phoenix Sepsis Score, to maximize its practicality.[8]

Clinical Applicability and Global Relevance

Over the past two decades, the definition of pediatric sepsis has undergone substantial refinement, transitioning from the 2005 IPSCC criteria[1] to the 2024 Phoenix Sepsis Score.[8,9] Earlier models such as the SIRS-based IPSCC and the adult-focused Sepsis-3[5] faced notable limitations in sensitivity, specificity, and applicability across diverse healthcare settings.[2,4,6,7] The Phoenix Score addresses these gaps by offering a data-driven, pediatric-specific framework that assesses organ dysfunction across four systems: cardiovascular, respiratory, neurological, and coagulation.[8,9] A minimum score of 2 is required to identify life-threatening organ dysfunction in children with suspected or confirmed infection.[9]

The adoption of the Phoenix consensus criteria offers important diagnostic value by harmonizing pediatric sepsis definitions and improving specificity compared with earlier SIRS-based models.[9] This alignment facilitates targeted interventions, supports epidemiological comparisons, and strengthens the evidence base for pediatric sepsis management globally. Its development from over 3 million pediatric encounters lends it strong epidemiological credibility and positions it as a robust tool for both clinical care and research.[9]

Implementation Challenges in Low-Resource Settings

However, its clinical applicability is not without challenges. Several organ dysfunction variables such as serum lactate measurement, vasoactive drug use, arterial blood gas analysis, and coagulation profiling may be difficult to obtain in low-resource settings without intensive care infrastructure.[10] This raises concerns about underdiagnosis or delayed recognition in such environments, particularly where laboratory and monitoring capabilities are limited.

To mitigate these barriers, pragmatic surrogate measures have been proposed. Mean Arterial Pressure (MAP), measured with a manual or automated sphygmomanometer, is a reliable indicator of cardiovascular dysfunction and is endorsed as a hemodynamic target in pediatric septic shock by the Surviving Sepsis Campaign International Guidelines for Children.[11] Platelet count, available through routine complete blood count testing, serves as a sensitive marker of sepsis-associated coagulopathy and correlates with disease severity.[12,13] The SpO_2/FiO_2 ratio, derived from pulse oximetry and estimated inspired oxygen fraction, has been validated as a non-invasive alternative to PaO_2/FiO_2 for assessing respiratory dysfunction, including in pediatric populations.[14]

Incorporating these accessible measures into clinical assessment can enhance early recognition and management of sepsis in primary care and district hospital settings, thereby extending the applicability of the Phoenix framework to resource-limited environments. This adaptability is a key strength of the Phoenix Score, allowing for tiered diagnostic pathways that reflect local resource availability while maintaining diagnostic integrity.

Nonetheless, further research is needed to validate simplified, Phoenix-aligned scoring systems that integrate these surrogate measures and assess their predictive accuracy for outcomes in diverse low-resource contexts. Collaborative, multicenter studies particularly those linking high- and low-income country institutions could facilitate the development of scalable diagnostic strategies, ensuring that the benefits of consensus definitions are equitably realized.

Additionally, the removal of the term "severe sepsis" reflects a conceptual shift: sepsis itself now implies life-threatening organ dysfunction, streamlining terminology and aligning pediatric criteria with adult definitions.[8] The International Consensus Criteria for Pediatric Sepsis and Septic Shock reinforce this evolution by recommending the exclusion of outdated SIRS-based definitions and emphasizing the Phoenix Score's utility across resource settings.[8]

Conclusion

The Phoenix Sepsis Score represents a major step forward in pediatric sepsis diagnosis, offering a data-driven, organ dysfunction-based framework that improves specificity and global applicability. Its flexibility across resource settings makes it especially valuable for harmonizing care and research. To fully realize its potential, future efforts should focus on validating simplified scoring tools, integrating surrogate measures, and building collaborative pathways between high- and low-resource institutions. By advancing standardization and equity, the Phoenix framework can help transform pediatric sepsis recognition and outcomes worldwide.

Abbreviations

FiO_2, Fraction of inspired oxygen; IPSCC, International Pediatric Sepsis Consensus Conference; ICU, Intensive care Units; LMICs, Low- and middle-income countries; MAP, Mean Arterial Pressure; pSOFA, Pediatric Sequential Organ Failure Assessment; PICUs, Pediatric Intensive Care Units; SIRS, Systemic Inflammatory Response Syndrome; SOFA, Sequential Organ Failure Assessment; SCCM, Society of Critical Care Medicine; SpO_2, Peripheral capillary oxygen saturation.

Data Sharing Statement

All data generated and material supporting the conclusion of this review are included in the article.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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