CHILDREN'S HOSPITAL ASSOCIATION

Improving Pediatric Sepsis Outcomes

CHANGE PACKAGE

Produced on behalf of Children's Hospital Association's Improving Pediatric Sepsis Outcomes collaborative.

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Background

Impact of Sepsis on Children

Every year, an estimated 24 million children develop sepsis worldwide. Nearly 3 million die (Rudd et al, 2020), and more than a third of those who survive experience significant long-term health issues, failing to return to their baseline health after a year (Ravikumar, 2022). Given the significant burden of this disease, its designation as an improvement priority area by The Joint Commission and the World Health Organization, and its impact on all domains of health care quality, pediatric sepsis is a vital area for quality improvement (QI).

Early recognition and prompt treatment of sepsis optimizes outcomes, according to care guidelines for pediatric patients (Weiss et al, 2020b; Davis et al, 2017). However, recognizing and treating sepsis in children poses a challenge due to the heterogenic presentation of multiple similar conditions (Emr et al, 2018). Additionally, sepsis has a different pathophysiology and clinical presentation in children than in adults and requires different therapeutic approaches. Finally, studies indicate that disparities exist in pediatric sepsis care related to social drivers of health (Phelps et al, 2023; Mitchel et al, 2021).

Improving Pediatric Sepsis Outcomes Collaborative

To address these issues and improve sepsis care for all children, Children's Hospital Association (CHA) launched the Improving Pediatric Sepsis Outcomes (IPSO) collaborative. From 2016 to 2023, 66 children's hospitals came together to reduce sepsis-attributable mortality using multimodal QI science, evidence-based bundles of care, and data-driven performance evaluation (Larsen et al, 2021). Leveraging data collected from over 100,000 pediatric sepsis episodes (based on IPSO's intention-to-treat definition) in both emergency department (ED) and inpatient settings, IPSO created a change package to help hospitals develop, implement, and sustain high-quality pediatric sepsis programs.

8 Years


570+ Estimated Lives Saved


100k+ Cases Analyzed


66 Hospitals

Introduction to the Change Package

The change package summarizes the collaborative's learnings and recommendations, including:

- Optimal bundle of care, with implementation guidance for each key component
- Performance measurement considerations
- Guidance for sepsis program development
- Library of tools designed and implemented by the IPSO collaborative hospitals

The change package is intended to guide teams in emergency rooms and inpatient hospital settings through the process of establishing a coordinated sepsis program. It should be used in conjunction with the latest pediatric sepsis literature, and teams should continue to consult with pediatric sepsis experts for real-time guidance when caring for patients.

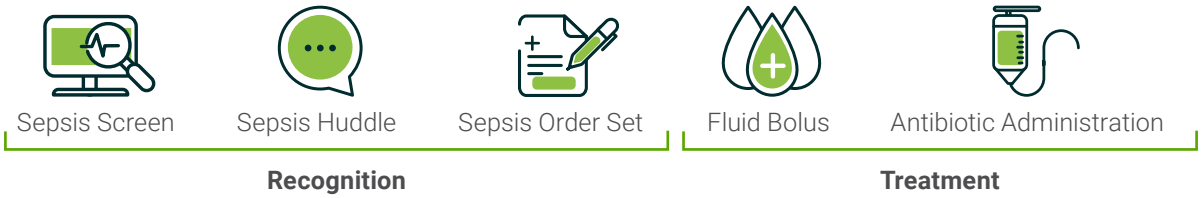
We do not recommend implementing all interventions at once, and all options may not be relevant for a particular hospital or care setting. Instead, hospitals should start by assessing their current state, gaps, and opportunities. Each hospital will have a variety of experience levels, expertise, and existing practices related to pediatric sepsis care. The readiness inventory can help hospitals assess current state and consider opportunities to integrate IPSO recommendations with existing practices.

02

Change Concepts

1. Introduction to the IPSO Bundle of Care

Leveraging existing evidence, guidelines, and expert opinion, the IPSO collaborative developed five key processes associated with improved outcomes for children with sepsis (Paul et al, 2023). The first three processes—sepsis screen, huddle, and order set—relate to the timely and appropriate recognition of pediatric sepsis. The final two processes—fluid bolus and antibiotic administration—relate to the timely and appropriate treatment of sepsis. Compliance with each key process is recommended and in line with the Surviving Sepsis Campaign International Guidelines for the Management of Septic Shock and Sepsis-Associated Organ Dysfunction in Children (Weiss et al, 2020b).



All-or-None Bundle Compliance

Evidence from the IPSO collaborative demonstrated that performing these interventions together, as a bundle of care, resulted in lower sepsis-attributable mortality (Figure 1). IPSO evaluated this bundle of care with thresholds for time to fluid bolus and antibiotic administration, finding that adherence to moderate threshold goals (Table 1) resulted in the best outcomes for patients when performed as part of the bundle (Paul et al, 2023).

Figure 1

Association Between Sepsis-Attributable Mortality and Bundle Compliance

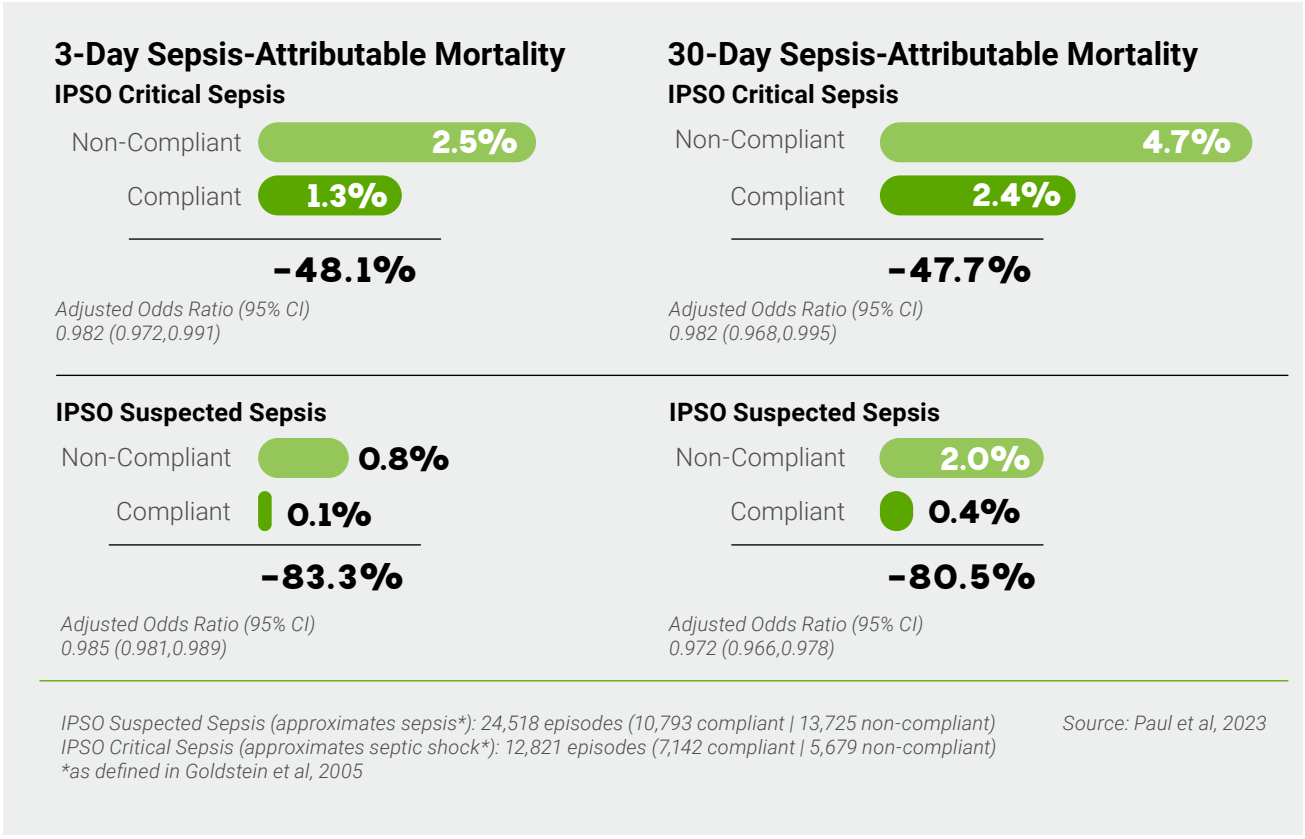


Table 1

All-or-None Bundle Compliance Components

Key Process	Threshold
Recognition	Positive screen, positive huddle, *or* order set utilization
Fluid bolus	Within 60 minutes of sepsis onset*
Antibiotic administration	Within 180 minutes of sepsis onset*

*see Approximating Sepsis Onset

Exceeding IPSO's maximum time thresholds for therapeutic interventions is associated with worse outcomes. If a hospital exceeds a threshold or doesn't comply with the whole bundle, IPSO recommends a review within safety event reporting structures.

The IPSO key processes have the greatest impact when performed together as a bundle.

Individual Key Process Targets

The recommended thresholds reflect the **minimum requirements** for bundle compliance. However, hospitals should establish more stringent targets for each process to optimize recognition and ensure treatment times are in accordance with national guidelines (Weiss et al, 2020b). For more guidance on establishing stringent individual key process targets, see Individual Key Process Targets and Individual Targets vs Bundle Compliance Thresholds.

2. Key Process Recommendations

The following sections describe IPSO recommendations for each key process of the bundle, including implementation guidance, common barriers and mitigation strategies, and resources.

Recognition

Using one or more of the sepsis recognition processes is independently associated with lower sepsis-attributable mortality, fewer hospital days, and fewer intensive care unit (ICU) days (Paul et al, 2023). In addition, standardizing recognition processes reduces disparities in sepsis recognition (Rutman et al, 2024; Diversity Kids Data, 2024).

Sepsis recognition processes include:

- Sepsis screen
- Sepsis huddle
- Sepsis order set

For examples of comprehensive recognition processes, see Recognition.

Recognition

Sepsis Screen

International guidelines recommend systematic screening to detect sepsis early and improve the timeliness of interventions. Multiple strategies using the electronic health record (EHR) or a paper screen have been published in the literature.

IPSO recommendation	**Implement a screening tool adapted for a specific care setting.**
Implementation guidance	• Start with a paper screen if clinical informatics resources are limited. • Two-tiered screens may improve specificity. For example, tier one is based on vital signs while tier two includes additional indicators such as the presence of high-risk conditions, altered mental status, or poor perfusion. • Thresholds for a "positive screen" may vary and should be determined locally. • Vital sign measures can include temperature, heart rate, respiratory rate, and blood pressure parameters as delineated by Pediatric Advanced Life Support (PALS) or other standard references. To improve specificity, consider temperature-adjusted heart rate. • Vital-sign-based screens are often oversensitive, so specificity and sensitivity must be analyzed. • Screens used later in the clinical course can incorporate laboratory values indicative of organ dysfunction. • Screens used to detect sepsis can also detect other critical conditions. Consider integrating sepsis screening with other organizational escalation-of-care protocols. • Screen performance can vary by care setting due to complexity of patient population; consider customization before spreading to new care areas. • Follow positive screens with a bedside clinician huddle.
Strategies for common barriers	**Alert fatigue** • Trial screens in the background (without clinician alerts) to optimize sensitivity and specificity before "go-live." • Once live, continuously evaluate the balance of positive predictive value (PPV) and sensitivity of screens. • Adapt lockout times based on care settings. For example, longer lockout times may be needed in intensive care areas and for chronically ill children. • Monitor alert fatigue as a balancing measure and consider adapting screening criteria, frequency, or lock out intervals to optimize specificity.

Strategies for common barriers (continued)	**Anchoring bias** • Ensure standardized approach to screening. **Staff buy-in** Currently, no screens detect sepsis with 100% sensitivity and specificity. In fact, in a survey of IPSO hospitals who measured screen performance, sensitivities ranged from 3-92% and specificities ranged from 44-100%. No individual screen had over 90% sensitivity and specificity. Because screens are not always accurate, staff may not buy into the screening process. Strategies to overcome this include: • View screens as a supplement to clinical judgement, not a replacement; set expectations across the organization accordingly. • Empower bedside nurses to initiate huddles based on clinical judgement. **Information technology (IT) resources** • Include IT early in the process as a key stakeholder. • Consider starting with a paper screening tool and performing small tests of change to optimize the screen before embedding it in the EHR. • Establish procedures for evaluating the impact of IT updates on sepsis EHR workflows.
Resources	**Library of tools:** IPSO screening tools **Reference links:** • Surviving Sepsis Campaign – Screening Criteria section (2020) • Temperature Adjusted Tachycardia Alert (2012) • Vital Sign Screen plus Clinical Evaluation (2017)

Recognition

Sepsis Huddle

Huddles are just-in-time, team-based discussions about a patient's clinical condition and next steps. Huddles can improve sepsis recognition and raise situational awareness, ensuring the team has a shared mental model and a coordinated plan of care. Huddles can be useful when potential sepsis is recognized and when there are concerns for clinical deterioration or unexpected responses to treatment. Huddles can be called at any time by any care team member.

IPSO recommendation	**When potential sepsis is identified, or if there is concern about continued deterioration from sepsis at any point, conduct a huddle to review the clinical findings, determine if sepsis is evolving, and plan next steps in care.** Some triggers for huddles include: • Positive sepsis screens • High early warning score • Clinician concern • Deterioration from sepsis at any point A positive sepsis huddle should prompt a sepsis order set, pathway, or a clear action plan for further diagnostic testing and sepsis treatment.
Implementation guidance	• Complete the huddle within 15 minutes of a trigger. • Keep the huddle brief and focused. • Include a nurse, provider, and additional staff as needed. Establish processes for including an attending physician or other experienced clinician. • Conduct a structured clinical assessment during the huddle if not already completed as part of a sepsis screen. Include an assessment of mental status, perfusion, high-risk conditions, and parental impression of severity of illness. • Use standard tools to communicate huddle findings and plan. • If the huddle indicates concern for sepsis, provisionally categorize the findings as possible sepsis and initiate a sepsis order set or other standardized ordering process. • The huddle drives interventions for sepsis and determines plans for monitoring patients at high risk for sepsis.

Strategies for common barriers	**Staff capacity/competing priorities** • Build on other local successful processes (e.g., watcher programs, rapid response teams, or other real-time huddles). • Thoughtfully include only necessary personnel. • Utilize virtual options. • Consider simulation. **Staff buy-in** • Communicate wins, set expectations regarding huddle duration (they do not take long), and optimize huddle frequency (minimize interruptions of other vital work). • Provide positive feedback to staff members who call necessary huddles. • Incorporate huddle and sepsis processes into hospital-wide educational modules to ensure staff can recognize signs and symptoms of sepsis and understand the huddle purpose and process. **Psychological safety** • Use standardized scripts or checklists to ensure all concerns are heard. • Empower staff of all disciplines to use their clinical judgement to identify huddle opportunities. **Unclear huddle outcomes** • Pair huddles with processes to initiate order sets and facilitate timely interventions (e.g., have sepsis cart stocked with necessary supplies brought to huddle). • Use scripts, checklists, and/or clinical pathways to ensure important clinical aspects (e.g., mentation, perfusion) are reviewed and next-steps plan and escalation parameters are set (e.g., standardized communication or documentation tool that includes key steps). **Suboptimal huddle documentation** • Use the EHR to document the huddle and include in data reports. • Ensure huddle documentation aligns with nursing workflow in each care area – this may require different processes in different care settings.
Resources	**Library of tools** IPSO huddle tools **Resource links** • Vital Sign Screen plus Clinical Evaluation (2017) • IHI SBAR Tool (n.d.) • Shared Mental Model Sepsis Webcast

Recognition

Sepsis Order Set

An order set is a pre-made, standardized list of provider orders that facilitate prompt and efficient ordering and administration of all necessary care for a specific condition or disease state.

Note: The IPSO collaborative considers order sets the final component of sepsis recognition because their use signifies an intention-to-treat sepsis that is communicated to the entire care team. While the order set is used after sepsis is recognized through a screen, huddle, or clinician judgement, it ultimately serves to support the timeliness and standardization of interventions. Though IPSO classifies order sets as a measure of recognition, **order sets are ultimately a link between recognition and timely treatment.**

IPSO recommendation	• **Use an evidence-based guideline to standardize evaluation and treatment orders for patients with suspected sepsis.**
	• **Ensure the order set is built to support rapid workup and treatment (e.g., "STAT" for labs and antibiotics).**
	
	Include priority orders:
	  • Cultures (blood, urine, and additional cultures)
	  • First fluid bolus
	  • STAT antibiotic (with weight-based dosing recommendation)

Implementation guidance	• Create a multidisciplinary team of key stakeholders (including EHR experts) from the beginning to develop a sepsis order set and periodically update as needed. • Use order sets as a tool to accompany a clinical pathway. • Design order sets to support bundle compliance and timely care delivery. Ensure alignment between the sepsis pathway and order set. **Make key decisions** • Single order set vs. multiple options based on risk assessment • Inclusion vs. exclusion of specific orders for patients with high-risk conditions • Hospital-wide vs. care-setting specific order sets • Priority orders for "STAT" delivery (e.g., fluids, antibiotics)

Strategies for common barriers	**Staff buy-in** • Enlist key stakeholders in the development and review of an order set (e.g. physicians, nurses, pharmacists, laboratory specialists, respiratory therapists). • Before "go-live," perform simulations with clinicians to assess opportunities for improvement. • Include physician trainees in order set development, testing, and education, as they use the order set most frequently. **Low utilization** • Streamline EHR workflow to facilitate ease of use (e.g., link directly from a sepsis screen or huddle documentation). • Provide feedback on successful utilization and non-compliant episodes to demonstrate how order sets improve timely interventions.
Resources	**Library of tools** IPSO order sets

Treatment

In conjunction with sepsis recognition, timely and appropriate treatment of sepsis improves outcomes (Paul et al, 2023).

Sepsis treatment processes include:


Fluid bolus administration


Antibiotic administration

For examples of comprehensive sepsis pathways, see Pathways.

Treatment

Fluid Bolus Timeliness

Patients with sepsis, including septic shock, may have ineffective circulating intravascular volume and decreased organ perfusion. The cause is often multifactorial: Patients with sepsis may experience hypovolemia, vasodilation (distributive shock), and impaired cardiac function. Restoring intravascular volume is a core element of international sepsis guidelines (Weiss et al, 2020b). Though evidence for the exact amount of fluid to administer remains dynamic, the goal of intravenous (IV) fluid resuscitation is to restore normal perfusion and blood pressure.

IPSO recommendation	**Within the first 60 minutes of recognition, administer up to 40-60 ml/kg in bolus fluid (10-20 ml/kg per bolus; maximum of 1 liter per bolus) by push-pull, pressure bag, or rapid infuser method.** • For patients with significant cardiac or renal dysfunction, consider smaller bolus volumes (e.g., 5-10 milliliters per kilogram (mL/kg)). **After each bolus, reassess the patient's clinical status and discuss with the team.** The assessment should include: • Evaluate for clinical signs of fluid overload (rales, gallop rhythm, increased work of breathing, or increased oxygen need). • Evaluate for persistence of shock state and consider need for additional fluid bolus. • Consider point of care ultrasound to assess intravascular volume status and cardiac function for centers that utilize this modality (Singh et al, 2020).

Implementation guidance	• Ensure enough fluids are stocked in each unit.
	• Develop sepsis pathways and order sets that:
	  • Include establishing early intravenous access (IV) and intraosseous (IO) access if unable to obtain.
	  • Emphasize rapid administration methods (e.g., rapid infuser, push-pull, pressure bag).
	  • Guide appropriate fluid choices (balanced, lactated ringers vs. 0.9% saline).
	  • Prompt regular reassessments to monitor for fluid overload and/or need for additional fluid boluses.
	• Develop a method to accurately document IV fluid start times (e.g., EHR, laminated tool, sepsis checklist).

Strategies for common barriers	**Delay in IV access** • Leverage individuals with the highest likelihood of peripheral IV success (e.g., trauma charge RN, IV team, transport team). • Establish a standard escalation process for difficult IV access. • Use existing central venous lines when present. • Include IO access in the sepsis management pathway and identify a clear threshold for IO placement (e.g., number of unsuccessful peripheral IV attempts, maximum time elapsed). **Staff awareness** • Incorporate training into orientation and ongoing education for all stakeholders (e.g., nurses, physician trainees, additional disciplines.) • Use multimedia educational campaigns to maintain awareness. **Bedside staff competing priorities** • Develop a method to alert clinicians to target administration time (e.g., EHR timers, in-room timer "countdown," laminated tool with target times displayed). **Staff buy-in** • Provide education (e.g., didactic, simulation lab, interactive media) to overcome hesitancy to deliver IV fluid before a sepsis diagnosis can be confirmed. • Provide evidence-based guidance that supports resuscitation strategies. • Ensure pathways include specific conditions that prevent large-volume resuscitation (e.g., cardiac failure) and provide specific guidance for alternative management.
Resources	**Library of tools** • IPSO bolus tools • IPSO IV access tools • IPSO checklists **Resource links** • Association Between First Hour Fluid Volume and Mortality (2022) • Improving Adherence to Pediatric Advanced Life Support Septic Shock Guidelines (2014) • Surviving Sepsis Campaign – Fluid Therapy section (2020)

Treatment

Antibiotic Timeliness

Antibiotics are a key component of timely pediatric sepsis management and imperative to treating bacterial pathogens associated with sepsis. It is important to give parenteral antibiotics quickly, as they directly target bacteria causing infection. Studies have found that using a set of interventions that includes administration of parenteral antibiotics leads to improved outcomes (Lane et al, 2023).

IPSO recommendation	**Initiate timely empiric antibiotics.** • As soon as possible and within 1 hour of recognition of septic shock • Within 3 hours of recognition of sepsis without shock* **Provide appropriate empiric antibiotic therapy.** • Empiric treatment should be broad spectrum with one or more antibiotics to cover all likely pathogens and should be guided by the suspected site of infection. **Provide source control if appropriate.** • Consider surgical consult for source control if indicated (e.g., concern for foreign body, infected device, appendicitis, or infected joint/space). • Modify or stop immunosuppressive therapy if appropriate. • Narrow empiric antibiotic therapy as appropriate once the pathogen(s) and sensitivities are available. *In some conditions, a more stringent time interval may apply. If a more stringent time interval is widely accepted, it should be followed.

Implementation guidance	• Include pharmacy staff in developing antibiotic ordering, delivery, and administration procedures.
	• Develop sepsis pathways and order sets that:
	  • Include establishing early IV and IO access if unable to obtain.
	  • Emphasize rapid administration methods when appropriate (e.g., intramuscular antibiotic administration, appropriate antibiotics for IV push).
	  • Provide prompt reassessment and ability to narrow therapy.
	• Develop a method to accurately document IV antibiotic start times (e.g., laminated tool, sepsis checklist).
	• Provide a guideline for empiric antibiotic choices that considers sites of infection, high-risk/immunocompromised patients, and patients with history of multidrug-resistant organisms (MDROs).
	• Consider local resistance rates and antibiotic availability.

Strategies for common barriers	**Delay in IV access** • Leverage individuals with the highest likelihood of IV success (e.g., trauma charge RN, IV team, transport team). • Establish a standard escalation process for difficult IV access. • Use existing central venous lines when present. • Include intramuscular (IM) antibiotic administration and IO access in the sepsis management pathway, and identify a clear threshold for each (e.g., number of unsuccessful peripheral IV attempts, maximum time elapsed). **Staff awareness** • Incorporate training into orientation and ongoing education for all stakeholders, including nurses, physician trainees, and other relevant staff members. • Use multimedia educational campaigns to maintain awareness. **Bedside staff competing priorities** • Develop a method to alert clinicians to target administration time (e.g., EHR timers, in-room timer "countdown," laminated tool with target times displayed). **Staff buy-in** • Provide education (e.g., didactic, simulation lab, interactive media) to overcome hesitancy to deliver IV antibiotics before a sepsis diagnosis can be confirmed. • Align sepsis antibiotic work with related quality improvement initiatives (e.g., antimicrobial stewardship, fever/neutropenia pathways). **Delays in antibiotic ordering/delivery** • Encourage the use of the sepsis order set. • Provide empiric antibiotic therapy guidance and weight-based dosing recommendations. • Use Gemba walks (observe where the real work happens) and staff feedback to identify opportunities to improve timeliness (e.g., availability of medication within unit vs. pharmacy delivery, mixing medication challenges, tube system issues). • Consider local process differences (e.g., day vs. night shift staffing, unit-based proximity to pharmacy). Adjust process accordingly.
Resources	**Library of tools** • IPSO Empiric Antibiotic Therapy Algorithm • IPSO Empiric Antibiotic Therapy Algorithm by site of infection • IPSO antibiotic tools • IPSO IV access tools • IPSO checklists **Resource links** • Delays in Antibiotics in the ED and Risk of Mortality in Children with Sepsis (2023) • Surviving Sepsis Campaign – Antimicrobial Therapy section (2020)

3. Measurement Recommendations

Measuring sepsis epidemiology, key processes, and outcomes is critical to improving care and sustaining improved outcomes. Data allows teams to readily identify gaps and target improvement efforts.

This section provides recommendations for:

- Defining sepsis for quality improvement (QI)
- Choosing key performance measures
- Approximating sepsis onset
- Tracking and benchmarking

Defining Sepsis for Quality Improvement

The Surviving Sepsis campaign defines *septic shock* as "severe infection leading to cardiovascular dysfunction (including hypotension, need for treatment with a vasoactive medication, or impaired perfusion)" and *sepsis-associated organ dysfunction* as "severe infection leading to cardiovascular and/or non-cardiovascular organ dysfunction" (Weiss et al, 2020b). These definitions are used broadly in real-time clinical practice to inform care decisions but are difficult to operationalize in data collection, limiting their utility in quality improvement.

Furthermore, there is no widely accepted standard definition for pediatric sepsis appropriate for quality improvement, making it difficult to track epidemiology and measure improvement. Work in this area continues to evolve rapidly. To evaluate progress over time, hospitals must reach local consensus on a standard definition. In addition, hospitals should consider data abstraction capabilities, areas of QI focus, and local or state reporting requirements.

Several sepsis definitions have been used in pediatric QI work and research. The IPSO collaborative used a retrospective, intention-to-treat criteria set to define the cohort (Scott et al, 2020). This definition was successfully standardized across the IPSO collaborating hospitals and is the cohort in which the IPSO bundle of care demonstrated improved outcomes. Therefore, if local capacity and infrastructure allow, **we recommend adopting the IPSO sepsis definition.**

The table below includes multiple proposed sepsis definitions along with their pros and cons for quality improvement work. This list is not exhaustive and continues to evolve. New pediatric sepsis definitions are expected in the next few years.

NOTE: With any definition of sepsis, hospitals will encounter episodes which originated from an outside hospital. (IPSO specifically defined these as episodes with a time zero within 24 hours of transfer to your hospital.) These can complicate performance analysis given your institution's limited ability to impact timeliness of recognition and interventions. Hospitals may consider excluding this subset of patients from patient identification and analysis or implementing filters to evaluate this cohort independently.

Table 2

Pediatric Sepsis Definitions

Sepsis Definition	Description	Pros	Cons
IPSO Sepsis (Scott et al, 2020)	Intention-to-treat based plus International Classification of Diseases (ICD) codes	• Developed for QI • Adapted and used across multiple institutions • Demonstrates strong content, criterion, and convergent construct validity (Scott et al, 2020) • Automatable from most EHRs • Feasible for large-scale data abstraction	• Weakness in reliability (Scott et al, 2020): captures some patients who do not go on to develop sepsis • Significant initial burden to implement; however, reliable once established
IPSO Critical (subgroup of IPSO Sepsis) (Scott et al, 2020)	Intention-to-treat based plus ICD codes (IPSO Sepsis criteria plus third bolus or vasoactive medication)	• Developed for QI • Adapted and used across multiple institutions • Demonstrates strong content, criterion, and convergent construct validity (Scott et al, 2020) • Automatable from most EHRs • Captures a sicker population	• Weakness in reliability (Scott et al, 2020): may still capture some patients without sepsis • Significant initial burden to implement; however, reliable once established
ICD codes (Balamuth et al, 2015)	ICD codes (for septic shock, sepsis, or infection plus organ dysfunction)	• Easily abstractable from the EHR	• May under-capture sepsis, especially if septic shock codes (instead of infection plus organ dysfunction) are used
Pediatric Sequential Organ Failure Assessment (pSOFA) (Matics & Sanchez-Pinto, 2017)	Organ dysfunction based	• Validated internationally	• Developed in the ICU setting only • May ultimately exclude patients who present with sepsis, were recognized early, were treated appropriately, and did not progress to a shock state; however, given the impact of early interventions on outcomes, it is important to capture these suspected cases of sepsis in QI work • Requires ability to capture organ dysfunctions that are complex and may not be automatable

Sepsis Definition	Description	Pros	Cons
Children's Hospital of Philadelphia surveillance definition (Weiss et al, 2020a)	Organ dysfunction based	• Developed across hospital settings (ED, inpatient, ICU)	• Developed in a single center • May ultimately exclude patients who present with sepsis, were recognized early, treated appropriately, and did not progress to a shock state; however, given the impact of early interventions on outcomes, it is important to capture these suspected cases of sepsis in QI work • Requires ability to capture organ dysfunctions that are complex and may not be automatable
International Consensus Criteria for Pediatric Sepsis and Septic Shock, 2024 ("Phoenix criteria") (Schlapbach et al, 2024)	Organ dysfunction based	• Derived and validated internationally • Not intended (and should not be used) for screening or early identification	• May ultimately exclude patients who present with sepsis, were recognized early, treated appropriately, and did not progress to a shock state; however, given the impact of early interventions on outcomes, it is important to capture these suspected cases of sepsis in QI work • Requires ability to capture organ dysfunctions that are complex and may not be automatable
International pediatric sepsis consensus conference: Definitions for sepsis and organ dysfunction in pediatrics, 2005 ("Goldstein criteria") (Goldstein et al, 2005)	Vital sign and organ dysfunction based Intended for clinical trials	• Well-known/familiar to clinicians • Used in previous pediatric sepsis studies • May be useful for consistency	• Consensus based • Frequently used in various modified forms due to challenges with shock definition (requires prerequisite of 40ml/kg bolus) • Requires ability to capture organ dysfunctions that are complex and may not be automatable • May become obsolete given newer consensus definitions
Surviving Sepsis (Weiss et al, 2020b)	Clinical definition emphasizing altered perfusion and organ dysfunction	• Useful in clinical practice	• Based on clinical variables with subjectivity (perfusion) • May not be automatically abstractable from EHRs

Key Performance Measures

Due to the complex nature of pediatric sepsis care, measuring performance is challenging. Evaluating the timeliness of interventions requires a standardized approach to approximating the time of sepsis onset (see Approximating Sepsis Onset). In addition, sepsis outcome data may be scarce due to the relatively low incidence of mortality among children within an individual institution.

Despite the complexities, tracking performance data over time is vital to driving and sustaining improvement. When choosing key performance measures to track, hospitals must consider local factors that influence data availability, such as automatability from the EHR, local reporting requirements, and hospital strategic priorities, as well as external factors such as standardized definitions to facilitate comparative benchmarking.

The table below suggests outcome, process, and balancing measures for sepsis improvement work, as well as recommendations by both IPSO and the Centers for Disease Control and Prevention (CDC) for operationalizing each measure. The table lists top priorities and additional measures, but there are many more measures hospitals could track. Note that some states may have additional regulatory requirements to consider. Additionally, a standardized, system-wide approach to collecting social drivers of health data on children with sepsis is imperative to evaluating the equity of sepsis improvement initiatives.

Find comprehensive lists of sepsis performance measures from the IPSO collaborative and the CDC Hospital Sepsis Program Core Elements.

Table 3

Pediatric Sepsis Performance Measures (Priority and Additional Measures)

	IPSO Collaborative	CDC Sepsis Core Elements
Outcome Measures		
Mortality • Sepsis-attributable (SA) • Overall, in-hospital	• 3-day and 30-day SA mortality	• In-hospital mortality, overall • In-hospital mortality, subgroup (e.g., community-onset, hospital-onset, septic shock)
Sepsis epidemiology • Count • Severity • Community-onset vs hospital-onset • Sepsis pathogens	• Hospital-onset IPSO critical sepsis • Incidence of IPSO critical sepsis per 1,000 hospital admissions	• Rate of hospital-onset sepsis • Rate of sepsis episodes • Rate of sepsis episodes with and without shock

	IPSO Collaborative	CDC Sepsis Core Elements
Process Measures (Bundle Compliance*)		
Recognition/identification • Compliance with screens (sepsis triggers or alert system) • Compliance with huddles • Utilization of standard pathways or order sets	• Percent trigger activations • Percent huddle activations • Percent order set utilization	• Use of sepsis order sets
Management • Fluid bolus timeliness • Antibiotic timeliness • Blood culture prior to antibiotics (additional) • Check lactate (additional) • Vasopressor timeliness (additional)	• Time to first fluid bolus • Time to first antibiotic • Time to first vasopressor	• Time to antibiotics in community-onset sepsis with hypotension • Time from antibiotic order to administration • Proportion receiving fluid resuscitation in sepsis episodes with shock • Fluid bolus type and timeliness (additional)
All-or-none bundle compliance	• Bundle compliance	N/A
Balancing Measures		
Antibiotic stewardship	• Total IV antibiotic days	• Antibiotic choice (additional) • Days to narrowing (additional)

*Bundle compliance = recognition + bolus in 60 minutes + antibiotic in 180 minutes

Approximating Sepsis Onset

To accurately assess time-bound sepsis metrics (such as time to first fluid bolus or antibiotic), teams must standardize how they approximate the beginning of a sepsis episode. For this, IPSO implemented a **functional time zero** definition. This prospective approach leveraged EHR surrogates used in measure calculations.

IPSO Functional Time Zero

Due to lessons learned during IPSO—including that huddles and order sets sometimes occur before a sepsis screen and that it may be difficult to determine functional time zero for outside hospital transfers—we propose the revised functional time zero logic below.

Functional time zero is:

1. The earliest time of screen, huddle, or order set (if any is reported)
2. Otherwise, the earlier of first antibiotic time or first bolus time (if either is reported)
3. Else emergency department or hospital arrival time (if community onset case)
4. Else cannot be determined or you may use some other proxy for time zero (such as transfer to ICU time)

View IPSO's time zero cheat sheet.

Functional time zero becomes the basis of comparison for other reported values. If functional time zero cannot be determined, exclude these episodes from measure calculations where functional time zero is used.

Optional: Clinically Derived Time Zero
IPSO also tracked the time of physiological sepsis onset. This process was optional and required manual chart review. In IPSO, we recommended using the Goldstein criteria for this determination. However, alternative sepsis definitions developed since then may be considered as long as they are used consistently. Because clinically derived time zero is retrospective, it is not a potential functional time zero. Clinically derived time zero can be compared to functional time zero to measure the gap between physiological onset of sepsis and recognition of sepsis.

The CDC Hospital Sepsis Program Core Elements recommends time of emergency department or hospital arrival for community-onset cases.

Tracking and Benchmarking

Hospitals should establish a standardized local process of abstracting data and tracking identified measures. For examples of sepsis dashboards from IPSO hospitals, see Dashboards.

Implementing IPSO's standardized patient identification and measure definitions allows for benchmarking against peer hospitals. Members of Children's Hospital Association can participate in sepsis data tracking through the Pediatric Health Information System® (PHIS) and Inpatient Essentials (IE) databases.

4. Sepsis Program Development Recommendations

Establishing an interdisciplinary sepsis program is key to successful bundle implementation and sustaining improvement in sepsis care and outcomes. The CDC Sepsis Core Elements provides a comprehensive framework for a successful sepsis program. Note that specific structures and functions will be unique according to local needs. The recommendations below are intended to supplement the CDC guidance.

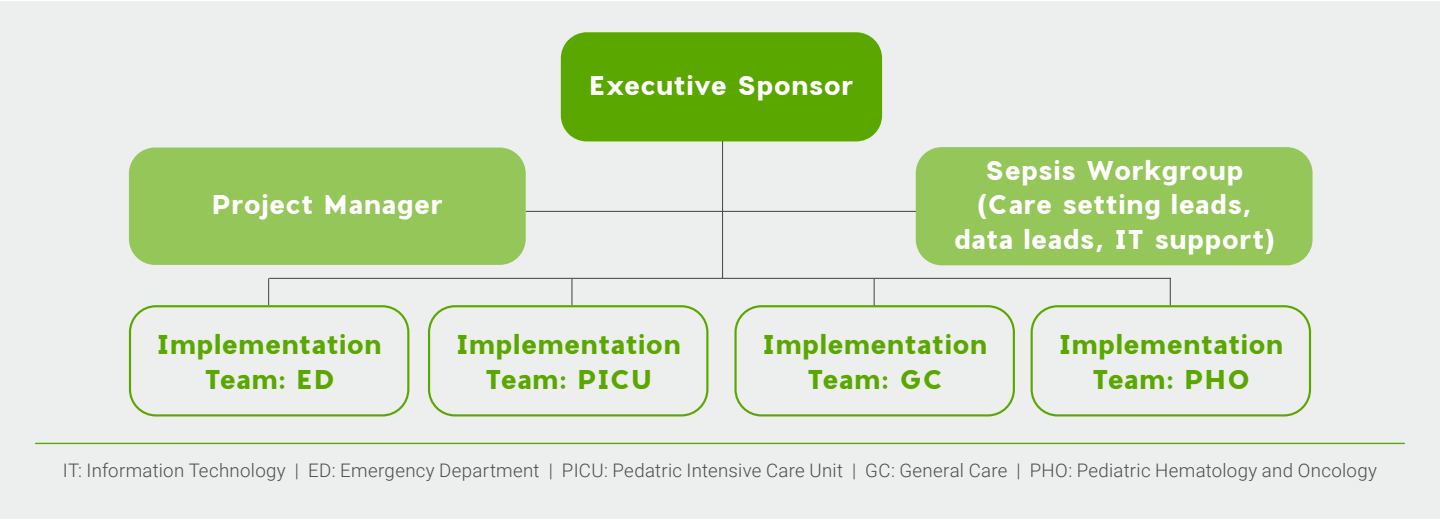
Team Structure

Include key stakeholders in the workgroup, such as pharmacists, education specialists, quality improvement specialists, data support, project managers, and front-line staff. Balance the need to include all relevant disciplines, care areas, and perspectives with the need to maintain a lean and flexible team structure.

See Figure 2 for an example of a basic sepsis team structure. For additional examples from IPSO hospitals, see Team Structure.

Figure 2

Sepsis Workgroup Structure



Education

Embed sepsis education into existing educational opportunities for all disciplines and establish a process for updating sepsis policies and procedures.

Education should empower all team members. Here are a few tips:

- Educate staff on the valuable perspective parents and guardians bring to the team.
- Focus on a culture of safety where all staff feel comfortable elevating concerns – empower staff to say "sepsis."
- Include physician trainees in the development and deployment of sepsis education. They are often among the first responding to a positive sepsis screen, so education must meet their needs.

For education resources, see Education.

Sustainability

Consider sustainability from the outset of program development and periodically when looking for new opportunities to cement learnings and further embed this work within your hospital's structure. A sustainability planning worksheet can help. When planning for sustainability, make sure to align sepsis with organizational priorities, create enduring processes for front-line staff, and foster external partnerships.

Organizational Prioritization of Sepsis Work

Consider early and often how sepsis work aligns with:

- Hospital administrative requirements and achievements
  - All-or-none bundle compliance
  - Individual key process targets
- Academic deliverables
  - Research publications and presentations, national awards, grant receipts, etc.
- Impact on other hospital strategic priorities
  - Central line-associated bloodstream infections (CLABSI), escalation of care, transitions in care, microsystems, EHR optimization, equity work, etc.

Front-Line Structure and Processes

Consider the following concepts in building sepsis structures and processes:

- Integrate evolving evidence.
  - Sepsis evidence is rapidly evolving; initial structures and processes will likely require adaptation over time. Develop a plan for ensuring new knowledge is properly evaluated and incorporated.
- Integrate into data strategy.
  - Table 4 shows data strategies to consider during program development.
  - Consider developing local dashboards to track progress and drive improvement.

External Partnerships

The IPSO collaborative model accelerated improvement by facilitating seamless sharing of knowledge and tools. Explore opportunities to collaborate with other hospitals and partner organizations early and often. Members of Children's Hospital Association can participate in the Pediatric Sepsis Community of Practice, which facilitates collaborative knowledge-sharing and mutual learning to drive continuous improvement.

Table 4

Data and Analytic Strategy Recommendations

	Description	Objectives
Data Governance	• Decision-making about data and data assets	• Operationalize framework of people, policy, process, and technology required to manage data assets • Align this operationalization effort to key use cases tied to strategic initiatives/imperatives
Data Literacy	• Ability to filter vast amounts of data and to read, understand, and communicate data as information	• Foster analytics culture • Build analytics competency and leadership in all roles • Lead education/training efforts to improve data literacy
Analytics Tools (platforms)	• Self-service analytics tools for the end user • Graphical representation of information and data	• Facilitate analytics tools access • Establish best practices and guidelines for analytic tools • Provide end-users with ability to perform queries, manipulate data, generate reports, and identify opportunities

	Description	Objectives
Data & Analytics Operations (front door access)	• Design mechanisms to request and access data • Develop processes to support self-service analytics	• Define workflows required to efficiently process data and analytics requests in accordance with data governance framework
Talent & Community	• Data and analytics talent required to foster a Learning Healthcare System • Analytics community to foster shared learning and growth	• Align on core set of data and analytics roles — standardize job descriptions • Develop a capability matrix for skill sets needed • Identify current talent and gaps in current resources • Develop succession plan framework

Spread

After developing and optimizing a hospital sepsis program, organizations may consider spreading it to additional hospital care areas, system-wide practice, and community hospitals.

Spread ensures health equity, accelerates progress in care improvements, and enhances collaboration through a culture of learning (Jeffcott, S. et al, 2014). In the United States, an estimated 88.6% of pediatric hospitalizations occur in general hospitals rather than free-standing children's hospitals (Freyleue et al, 2023). Because the recognition and treatment of sepsis is different for children, spreading pediatric sepsis improvement work to general or community hospitals is crucial to ensuring equitable care of children in all health care settings.

Spread is typically undertaken once outcomes and sustainability can be reliably demonstrated. The following resources provide important considerations, as well as detailed guidelines, when planning for spread of impactful improvement practices:

- IHI Framework for Spread (Massoud et al, 2006) provides a structured approach to planning and launching the spread of improvement methods to ensure system-wide change.
- Healthcare Improvement Scotland (Jeffcott, S. et al, 2014) outlines key factors for rapid and widespread implementation of effective improvement structures.

For examples of spread initiatives from IPSO hospitals, see Spread.

03

Considerations for Special Populations

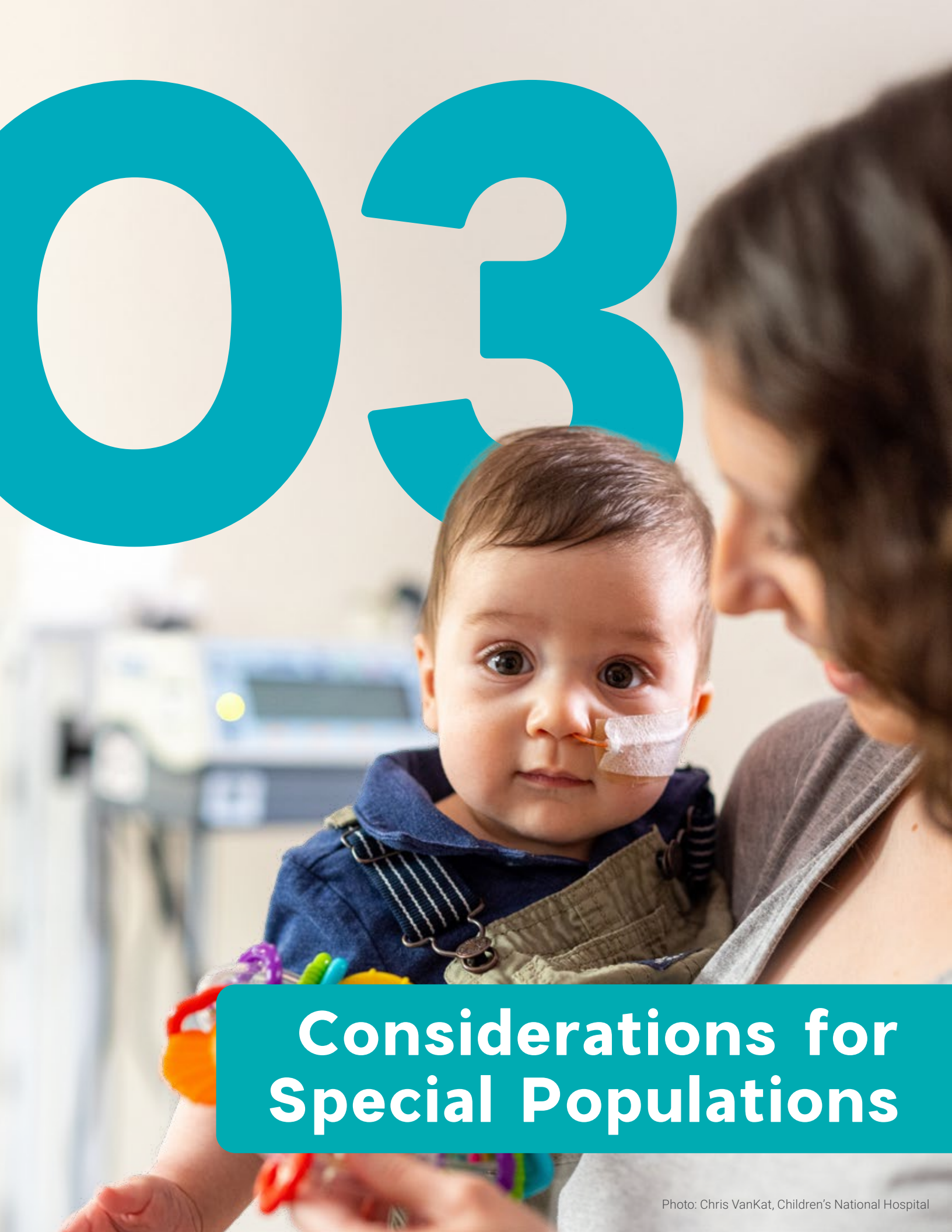


Photo: Chris VanKat, Children's National Hospital

Introduction to Special Populations

When implementing the pediatric sepsis bundle, unique populations require specialized strategies. This guidance is intended to assist in program development and does not replace the real-time guidance of population experts. Please continue to consult local pediatric specialists for these populations during care of high-risk patients.

Hematology and Oncology

Special Considerations	Strategies
Patients in the hematology/oncology and bone marrow transplant (BMT) populations may be at higher risk of sepsis development due to: • Immunocompromise at baseline or due to medications • Central line presence • Decreased splenic function (due to splenectomy, radiation, or dysfunction)	Incorporate strategies to identify these patients as high-risk early. For example, flag the risk in the EHR and include it in sepsis screen/huddle process. Discharge teaching for families should include signs and symptoms of sepsis and instructions for when to bring the child back to the hospital. Antibiotics should be tailored to the patient population's unique risk for bacteremia events due to underlying immunocompromise, prior infection, and local antibiogram.
Optimal timing and type of first antibiotic for febrile neutropenic patients is still being evaluated (De Castro et al, 2024; Hausler et al, 2024).	Develop and maintain a relationship with pediatric hematology/oncology and infectious disease experts to ensure adherence to latest guidelines for this population.
Vital sign abnormalities in this population may be due to underlying pathophysiology such as: • Tachycardia due to anemia • Fever and hypotension due to cytokine release syndrome	Begin with a broad differential; continue to consider sepsis in a differential diagnosis and focus on developing screening tools to allow treatment of multiple potential etiologies. The screening of hematology/oncology patients may involve different vital sign or lab triggers than other care settings.

Critical Care

Special Considerations	Strategies
Pediatric critical care patients are more commonly fluid overloaded prior to onset of initial or repeat sepsis.	In some cases, low-volume boluses and/or vasoactive medications only may be indicated. Consider chart review to determine reasons for deviations from bundle.
Pediatric critical care patients often have abnormal vital signs even when not septic.	Begin with a broad differential; continue to consider sepsis in a differential diagnosis and focus on developing screening tools to allow treatment of multiple potential etiologies. Screening critical care patients may involve different vital sign or lab triggers than other care settings. Recognition is more difficult in this population but is key in contributing to lowering mortality.
Many pediatric critical care environments respond to their own emergencies rather than hospital-wide emergency response teams (e.g. medical emergency team, rapid response team, etc).	Sepsis huddles in the ICU may involve a smaller response team with some combination of these roles: charge nurse, bedside nurse, resident/fellow/attending.
Congenital cardiac disease patients have: • Unique physiology which can make sepsis recognition challenging and change treatment guidance • Increased risk factors for sepsis (e.g. indwelling lines and hardware)	Consider second-tier screening tools that incorporate patient-specific physiology and risk factors. Include pediatric cardiac experts in the development of sepsis recognition tools and treatment pathways.
Many pediatric critical care patients are technology-dependent at baseline.	See additional special populations for strategies for technology-dependent patients.

Caring for Children in Systems Serving Adult and Pediatric Populations

The following strategies are intended for teams caring for children outside of free-standing children's hospitals and may include general, community, and rural hospitals and children's hospitals within health systems.

Special Considerations	Strategies
Adult-focused protocols will require adaptations for children.	Adult recognition and treatment protocols for older teens may be acceptable; however, children will need tailored protocols: • Adult sepsis screens do not perform as well in children. Consider running EHR-based screening tools silently and optimizing before "go-live" or utilizing a pediatric-specific screen. • Pediatric-specific screening protocols will require age-based vital sign parameters and different lab reference ranges. Establish and maintain a process for training front-line staff on pediatric-specific protocols. Specialized training should include: • Pediatric medication dose calculations • Location and use of pediatric resources and references
Appropriately sized pediatric equipment for all weights is essential to providing high-quality sepsis care.	Ensure appropriately sized pediatric equipment is available: 1. IV start kits 2. Blood pressure cuffs 3. Airway supplies 4. IO supplies Establish and maintain a process for training front-line staff on use of pediatric equipment. Have the highest-skilled staff insert IVs (e.g. charge nurse, NICU team, CRNA, anesthesiologist). If unable to obtain pediatric equipment, ensure protocols are modified for implementation with available equipment.

Special Considerations	Strategies
Leverage partnerships with adult sepsis teams.	Align common sepsis metrics as able. This may include time-to-antibiotics, time-to-fluids, lactate, and more. Collaborate on additional common elements of sepsis data tracking, including commitments to data accuracy, scrutiny of workflows, and reporting. Consider building on existing adult-focused structures by adding pediatric-specific expertise (e.g., vitals norms, lab norms, bundle specifics, pediatric equipment considerations).
Sepsis reporting systems are different for pediatric care than for adult care. While SEP-1 reporting requirements exist for adults, there is no current national mandated reporting for pediatric sepsis.	Align pediatric sepsis improvement work with established adult SEP-1 reporting systems. Assess and adhere to any applicable state-mandated reporting requirements for pediatric sepsis. Consider participating in pediatric-specific benchmarking through national efforts such as Children's Hospital Association's Sepsis Data Tracking. Track data locally to evaluate the impact of process metric improvements on mortality and quality outcomes. Harness existing cultures of high-quality care.

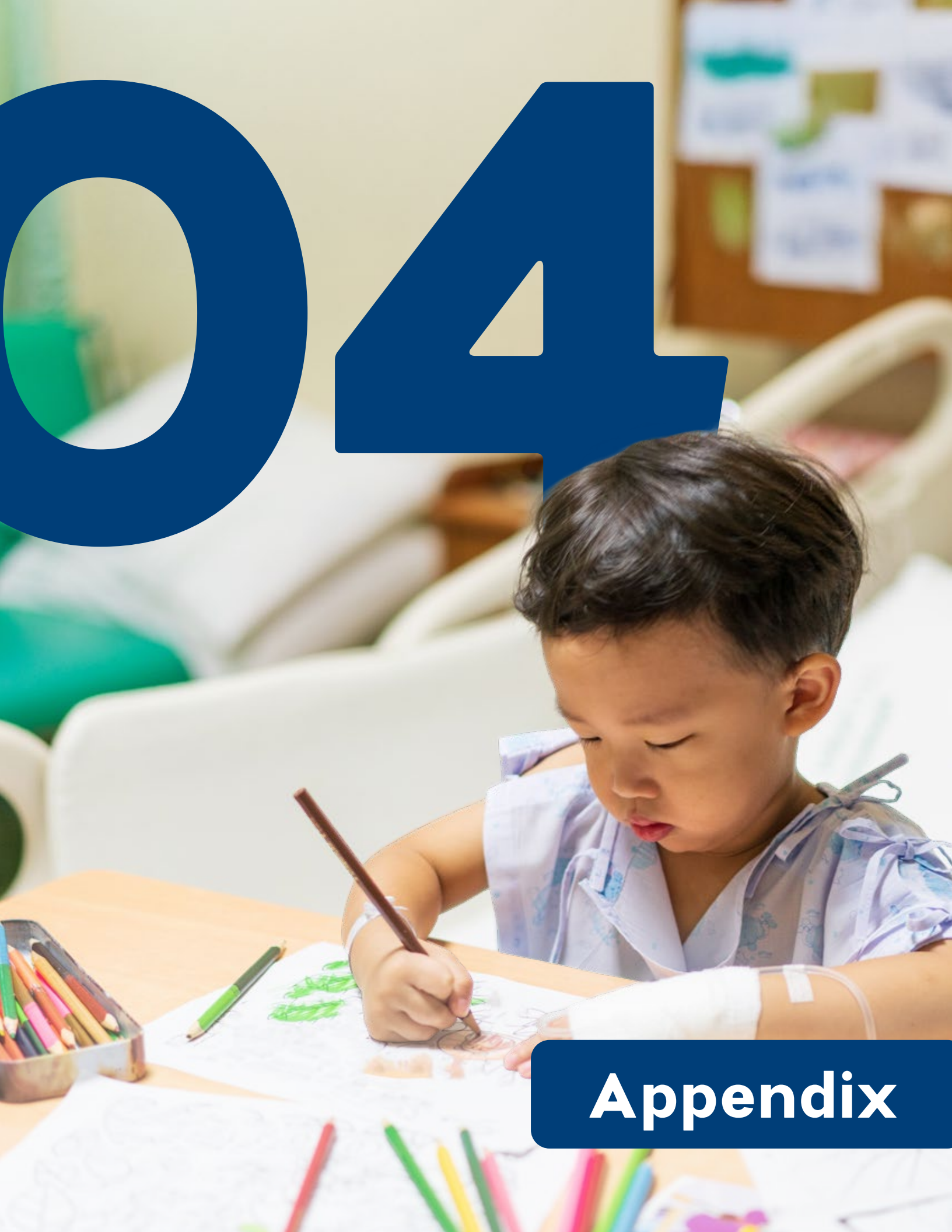
Transport

Special Considerations	Strategies
Pediatric sepsis recognition is different than adult sepsis recognition.	Adopt a pediatric-specific sepsis scoring tool to use during transport. Align the tool with existing screens to facilitate clear communication of patient status. This can be on paper first until it can be integrated into the transport team's charting system.
Pediatric patient IV access may be more challenging to obtain.	Ensure stable IV access prior to transport: • Have the highest-skilled staff insert IVs (i.e. charge nurse, CRNA, anesthesiologist). • Consider using tools to assist with IV access such as a vein viewer or ultrasound. • Identify a clear threshold for IO placement after a certain number of unsuccessful IV attempts or a certain amount of time.
If onset of sepsis occurs prior to hospital arrival, recognition and care initiation in transport will improve the timeliness of interventions.	Implement a transport sepsis protocol that aligns with the hospital sepsis protocol. However, it must account for supply and personnel differences and importance of collaboration with medical control. Transport sepsis protocols may include the following: • Notify medical control of patient's positive sepsis score • Place on cardiac monitor • Place on oxygen • Obtain blood gas, lactate, blood glucose, and blood cultures • Establish IV access • Administer fluid bolus • Administer antibiotics

Additional Special Populations

Special Considerations	Strategies
Neonates (newborn infants under 28 days old)	Any fever >100.4 degrees Fahrenheit in this population requires a full or partial sepsis workup (Pantell et al, 2021). The IPSO bundle was not designed for neonates.
Nonverbal children	Be especially attentive to those with abnormal vital signs and use a lower threshold for lab workups. Partner with parents and guardians to understand child's baseline mental status and patient-specific cues.
Unvaccinated or partially vaccinated children	Include high-risk conditions in the calculation for sepsis trigger tools. Consider broader empiric antibiotic coverage.
Technology-dependent children	Indwelling devices place patients at higher risk of infection. • Include high-risk conditions in the calculation for sepsis trigger tools. Children with medical complexity can have abnormal baseline vital signs which confounds positive sepsis screens. • Use percent changes vs. absolute vital sign values for inpatients. • Establish clear, individualized vital sign parameters when indicated. When choosing empiric antibiotic coverage: • Evaluate for history of prior infections, including MDROs, and adjust empiric coverage accordingly. • Consider common device-related infections based on site of indwelling device.

Special Considerations	Strategies
Pediatric patients from long-term care facilities	See "technology-dependent children" above. Communication with both the family and the facility are vital to ensuring continuity of care: • Admission – Review the sequence of events, treatments provided, and patient-specific information with facility caregivers and patients/families. • During hospitalization – Provide regular status updates to family and facility. • Discharge – Ensure complete documentation of care provided and anticipatory guidance.
Immunocompromised (other) Includes but not limited to: • Autoimmune disorders • Splenectomy • Short bowel syndrome • Systemic corticosteroid therapy • Immunomodulatory therapy	Include high-risk conditions in the calculation for sepsis trigger tools. Consider broader empiric antibiotic coverage. Consult with primary service based on underlying condition.



04

Appendix

Resource Library

The following tools were developed by Children's Hospital Association and participants of the Improving Pediatric Sepsis Outcomes collaborative and have been shared for use and adaptation for local sepsis improvement work. Please use the suggested citation in presentations or publications. Latest revision dates are noted where available.

Bundle Implementation

- Recognition
  - Screen
  - Huddle
  - Order Set
- Antibiotic
- Bolus
- IV Access
- Checklists
- Pathways

Education

- Staff Education
- Patient/Family Education

Measurement

- Dashboard
- Time Zero Cheat Sheet

Program Development

- Team Structure
- Readiness Inventory
- Sustainability
- Spread

Special Populations

- High-Risk Conditions

Acronyms

- **BMT** – Bone Marrow Transplant
- **CDC** – Centers for Disease Control and Prevention
- **CHA** – Children's Hospital Association
- **CLABSI** - Central line-associated bloodstream infection
- **CRNA** – Certified Registered Nurse Anesthetist
- **ED** – Emergency Department
- **EHR** – Electronic Health Record
- **ICD** – International Classification of Diseases
- **ICU** – Intensive Care Unit
- **IE** – Inpatient Essentials
- **IM** – Intramuscular
- **IO** – Intraosseous
- **IPSO** – Improving Pediatric Sepsis Outcomes
- **IT** – Information Technology
- **IV** – Intravenous
- **MDRO** – Multi-Drug Resistant Organism
- **ml/kg** – Milliliters Per Kilogram
- **PALS** – Pediatric Advanced Life Support
- **PHIS** – Pediatric Health Information System®
- **PPV** – Positive Predictive Value
- **QI** – Quality Improvement
- **RN** – Registered Nurse
- **SA** – Sepsis Attributable

Collaborative Hospitals

- Advocate Children's Hospital
- Akron Children's Hospital
- Ann & Robert H. Lurie Children's Hospital of Chicago
- Arkansas Children's Hospital
- Arnold Palmer Hospital for Children
- Atrium Health Levine Children's Hospital
- Beacon Children's Hospital
- Boston Children's Hospital
- The Bristol-Myers Squibb Children's Hospital at Robert Wood Johnson University Hospital
- C.S. Mott Children's Hospital
- Children's Health, Dallas
- Children's Healthcare of Atlanta
- The Children's Hospital at Saint Francis
- Children's Hospital Colorado
- Children's Hospital of Orange County
- Children's Hospital of Philadelphia
- Children's Hospital of Richmond at VCU
- Children's Memorial Hermann Hospital
- Children's Mercy Kansas City
- Children's National Hospital
- Children's Nebraska
- Children's of Alabama
- Children's Minnesota
- Children's Wisconsin
- Cincinnati Children's
- Cohen Children's Medical Center
- Cone Health Women's & Children's Center at Moses Cone Hospital
- Connecticut Children's Medical Center
- Cook Children's Medical Center
- Corewell Health Helen DeVos Children's Hospital
- Dell Children's Medical Center
- El Paso Children's Hospital
- Goryeb Children's Hospital
- Hasbro Children's Hospital at Rhode Island Hospital
- Hassenfeld Children's Hospital at NYU Langone
- Hoops Family Children's Hospital
- Inova L.J. Murphy Children's Hospital
- Janet Weis Children's Hospital at Geisinger
- Johns Hopkins All Children's Hospital
- Loma Linda University Children's Hospital
- Mary Bridge Children's Hospital & Health Network
- Mayo Clinic Children's Center
- MercyOne Children's Hospital - Des Moines
- Monroe Carell Jr. Children's Hospital at Vanderbilt
- MUSC Shawn Jenkins Children's Hospital
- Nationwide Children's Hospital
- Nemours Children's Hospital, Delaware
- Nemours Children's Hospital, Florida
- Nicklaus Children's Hospital
- Niswonger Children's Hospital
- North Carolina Children's Hospital
- Oklahoma Children's Hospital OU Health
- Penn State Children's Hospital
- Phoenix Children's
- Primary Children's Hospital
- Seattle Children's
- St. Jude Children's Research Hospital
- St. Luke's Children's Hospital St. Luke's Regional Medical Center
- Texas Children's Hospital
- UH Rainbow Babies & Children's Hospital
- University of Maryland Children's Hospital
- University of New Mexico Children's Hospital
- UPMC Children's Hospital of Pittsburgh
- Upstate Golisano Children's Hospital
- Valley Children's Healthcare
- Yale New Haven Children's Hospital

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This change package was created in March 2025 by Children's Hospital Association quality improvement consultants and Improving Pediatric Sepsis Outcomes thought leaders and reflects best evidence to date at the time of publication. Pediatric sepsis evidence is always evolving, and readers should make every effort to ensure incorporation of the latest best evidence during implementation of sepsis improvement projects.