2025 Application Summary
John M. Eisenberg Patient Safety and Quality Award
National Innovation Awardee

Children's Hospital Association
Improving Pediatric Sepsis Outcomes (IPSO) Collaborative

Executive Summary

Sepsis is a leading cause of death and morbidity in children worldwide. Despite national guidelines, adherence to evidence-based care processes remained poor, and disparities in care existed related to social determinants of health. The Children's Hospital Association (CHA) Improving Pediatric Sepsis Outcomes (IPSO) collaborative engaged 66 children's hospitals in a seven-year quality improvement (QI) initiative to reduce sepsis-attributable mortality. Following a learning health systems model, IPSO established and supported the implementation of evidence-based care bundles to improve early recognition and timely treatment of sepsis. Utilizing QI tenets, advanced data analytics, and national collaboration, IPSO's approach accelerated learnings, successfully improving compliance with sepsis care processes, resulting in reduced care disparities, health care utilization, and mortality. Improvements demonstrated resilience through the pandemic challenges. IPSO not only focused on hardwiring local processes but broadly published findings and created inclusive, accessible analytics and shared learning networks to foster continued pediatric sepsis improvement after the collaborative.

Describe why the focus area for your initiative is//was important for patient safety and quality.

Sepsis contributes to nearly a fifth of global deaths, with almost half of all cases occurring in children (Fleischman-Struzek et al, 2018). A third of pediatric sepsis survivors fail to return to their baseline health-related quality of life at one year follow-up (Ravikumar, 2022). Sepsis is a leading cause of diagnostic errors resulting in high-severity preventable harm (Newman-Toker et al, 2019). Pediatric sepsis is challenging to recognize, often presenting with common, undifferentiated symptoms. Inequities in care and outcomes based on social drivers of health exist. (Mitchell et al, 2021).

Sepsis impacts all quality domains, as outlined by the Agency for Healthcare Research and Quality. In addition to addressing the safety implications above, standardizing sepsis recognition and treatment with a family-centered approach improves timeliness and equity of care while minimizing system inefficiencies. A collaborative QI model accelerates learnings by allowing adoption of tools across hospitals. Aggregating national data contributes more evidence to support best practice. Given the high burden of disease, potential for serious patient harm, and impact on all domains of healthcare quality, sepsis was a vital area for QI work.

Describe how the problem was identified within your setting/organization.

In 2015, CHA identified an overarching quality aim of achieving the Triple Aim for Children by 2025. Primary drivers included improving outcomes, care, and value in episodic care and chronic illness, safety, population health, and patient and family engagement. CHA convened an advisory committee representing multiple geographic regions, hospital types, and subspecialities to identify a new QI focus area. The committee evaluated more than 30 conditions for the following criteria: alignment with key drivers, high impact, potential to improve value, and wide applicability within health care systems. Pediatric sepsis emerged as a leading contender. Prior sepsis programs included single-center and small multi-center pilot initiatives with limited data sets. These

demonstrated that bundled care improved outcomes, yet overall compliance remained low (Cruz et al, 2011; Larsen et al, 2011; Paul et al, 2014). Many national sepsis programs faced data integrity issues that inhibited accurate final analysis interpretation. Considering the disease burden, lack of large-scale programs with high-quality data to inform practice, and potential for high impact, pediatric sepsis was identified as a critical topic for a large-scale QI initiative.

Explain how the project/initiative was implemented.

Sixty-six member hospitals (Figure 1) enrolled from 2017 to 2021 with programming continued through 2023. Teams aligned in purpose around patient stories, regulatory requirements, and a desire to improve outcomes to motivate this work. IPSO leadership was composed of stakeholders from various disciplines, care settings, and hospital types (Figure 2).

IPSO workgroups utilized best evidence and expert consensus to develop a key driver diagram and data architecture. Secondary drivers were distilled into five key processes, including three formal methods of sepsis recognition (screen, huddle, and order set utilization) and two interventions (timely fluid bolus and antibiotic administration). IPSO leaders refined these tools over time, updating bundles of care to align with evolving evidence including the 2020 Surviving Sepsis Campaign Pediatric Guidelines (Weiss et al, 2020), revising measures based on lessons learned, and leveraging performance data to identify foci for shared learning.

IPSO developed a data pipeline to assess improvements and inform activities. Despite lack of a clinical consensus definition of pediatric sepsis, IPSO standardized a criteria-based QI definition that allowed for automated case identification across diverse electronic health record (EHR) systems. Standardization of time zero (recognition of sepsis) was critical for evaluating timely therapeutics. Importantly, most IPSO variables were automatically abstracted from the EHR, contrary to preceding sepsis work, allowing for sustainable evaluation over time.

IPSO's data were governed by principles of transparency and confidentiality. Site level and aggregate statistical-process control charts for key metrics were accessible via the IPSO data portal. Customized site-specific QI reports were shared biannually and top performing and most improved teams for key metrics were highlighted quarterly. IPSO followed an "all teach, all learn" model, creating a culture where data, ideas, and tools were freely shared. Venues for collaboration included an online community with tools, resources, and a forum for open discussion; regular QI and data focused webinars; and in-person workshops. IPSO also ran workgroups specific to interventions, research, care settings, and data. CHA provided QI coaching and data support for sites and facilitated connections for peer-to-peer support. This multi-modal approach to collaboration allowed for sharing of insights and resources, accelerating improvement.

Describe your achievements and improved state.

IPSO demonstrated that recognition processes are associated with more than 50% lower mortality (Figure 3; Paul et al, 2023). Hospitals improved screen, huddle, and order set usage, resulting in overall recognition improvement from 57% to 76.5% in year four and sustained through year five (Figure 4). IPSO identified baseline disparities in recognition for inpatients; lower child opportunity index (COI) was associated with lower recognition compliance. Recognition improved for all COIs: the greatest improvement was in the lowest COI, eliminating baseline disparities (Rutman et al, 2024; Diversity Kids Data, 2024; Figure 5). IPSO also found that when recognition processes are used, sepsis is recognized earlier and time from recognition to fluids and antibiotics is faster, resulting in initial resuscitation occurring 74 minutes sooner (Figure 6). Mortality also decreased from 2.2% to 1.5% (Figure 7). Secondary outcome improvements included increased ICU-free

days with no increase in hospital days. Antibiotic days, IPSO's balancing measure, decreased by 1.2 days (Figure 8). These results demonstrate that IPSO achieved the right care sooner, reducing disparities, mortality, avoidable morbidity, and wasteful health care utilization.

Describe how the project/initiative represents an innovation or novel approach.

IPSO stands out for its innovative design process, ability to accelerate improvement in late adopters, and approach to sustainability. Representing the largest cohort of pediatric sepsis data studied to date with over 100,000 episodes, IPSO was the first large-scale sepsis collaborative to work across four acute care settings: emergency department (ED), intensive care unit (ICU), general care floor (GC), and hematology/oncology (PHO). Most prior collaboratives and published sepsis literature limited focus to the ED or ICU, included fewer hospitals, and spanned a shorter duration. IPSO's approach brought together all stakeholders and included metrics across the care continuum, allowing for a more comprehensive and clinically relevant dataset, and therefore more robust assessment of the impact sepsis care processes have on mortality and other clinical outcomes.

IPSO's wave-based enrollment method and culture of transparency accelerated learning in later waves. Most Wave 1 hospitals were highly resourced and engaged in prior sepsis improvement work. These early adopters were key to learning the process of building a data pipeline, obtaining buy-in, and iterating to optimize recognition processes. Later waves started with overall lower sepsis recognition compliance; however, by applying learnings from Wave 1, Waves 2-3 were able to more quickly establish automatable data pipelines and implement bundles. While Wave 1 improved recognition by 23% (63.9% to 78.5%) and reduced mortality by 29% (2.1% to 1.5%), Waves 2-3 saw greater process and outcome improvements in less time, with recognition improving by 300% (18.5% to 74%) and mortality decreasing by 55% (3.3 to 1.5%) (Figure 9).

IPSO employed an upstream approach to sustainability during all phases of the work. In addition to prioritizing data automation as described previously, IPSO focused on hardwiring improvements through EHR capabilities, aligning sepsis work with other hospital priorities, and embedding sepsis work within existing hospital structures. Upon conclusion of IPSO, CHA established a Sepsis Community of Practice, led by a steering committee of key stakeholders, to support ongoing virtual shared learning at no cost and available to all 200+ CHA member hospitals.

CHA has developed an evaluation method in which the effectiveness of these approaches to sustainability will be assessed at key time points post-collaborative.

How do you monitor that the improvement is sustained?

IPSO tracked sepsis process, outcome, and balancing measures over time via statistical process control charts using the eight-point rule for special cause variation. Because improved recognition has the potential to identify less critical patients, sepsis incidence was monitored to ensure improvements reflected a real change rather than denominator inflation (Figure 8). IPSO's improvements in recognition and mortality occurred in year four and sustained through year five (Figure 7). Wave 1 saw continued sustainment through year seven (Figure 9). Additionally, each care setting's recognition and mortality improvements occurred prior to year five and were sustained, except for PHO, where continued improvements were seen in year five (Figure 7).

In its final year, IPSO identified data tracking and collaboration as essential elements to site-level sustainment. Thus, CHA created an opportunity for sites to continue to track key sepsis metrics within its comparative benchmarking database at minimal cost to hospitals. With 28 former IPSO sites currently enrolled, aggregate sustainment can be monitored. CHA's Sepsis Community of Practice described previously provides a mechanism for continued collaboration to further support sustainment.

Describe how the project/initiative has been or could be replicated across departments or organizations. Share experiences or suggestions on how others could implement.

IPSO has already demonstrated effective spread across its 66 hospitals. Additionally, many IPSO hospitals have spread their programs beyond the four care settings to transport teams, ambulatory settings, outlying affiliate hospitals, and broader communities. IPSO hospitals within large health systems have spread system-wide, extending the impact to children receiving initial sepsis care in many community hospitals.

IPSO has broadly shared its clinical and methodological findings through numerous publications and presentations to enable widespread replication (see references in supplement). Several publications share strategies for implementing large-scale QI and developing and validating standardized quality measures across sites. Multiple clinically focused publications advanced the quality of available evidence to support medical decision-making. Additional manuscripts are in process with enormous potential to improve the quality and rigor of evidence available. IPSO work has been and will continue to be presented in national forums.

A summary of best practices and a library of sepsis tools developed by IPSO teams is now publicly available in the IPSO Change Package.

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*IPSO Presentations and Publications

FIGURE 1 - IPSO Participating Hospitals
Advocate Children's Hospital Oak Lawn/Park Ridge, IL (2016-2023)
Akron Children's Hospital Akron, OH (2019-2023)
Ann & Robert H. Lurie Children's Hospital of Chicago Chicago, IL (2016-2022)
Arkansas Children's Hospital Little Rock, AR (2019-2023)
Arnold Palmer Hospital for Children Orlando, FL (2016-2023)
Atrium Health Levine Children's Hospital Charlotte, NC (2017-2023)
Beacon Children's Hospital South Bend, IN (2018-2022)
Boston Children's Hospital Boston, MA (2016-2023)
C.S. Mott Children's Hospital Ann Arbor, MI (2016-2020)
Children's Health, Dallas Dallas, TX (2016-2023)
Children's Healthcare of Atlanta Atlanta, GA (2021-2023)
Children's Hospital of Orange County (CHOC)
Orange, CA (2016-2023) Children's Hospital Colorado Aurora, CO (2016-2023)
Children's Hospital of Philadelphia Philadelphia, PA (2016-2023)
Children's Hospital of Richmond at VCU Richmond, VA (2017-2023)
Children's Memorial Hermann Hospital Houston, TX (2016-2023)
Children's Mercy Kansas City Kansas City, MO (2016-2023)
Children's Minnesota Minneapolis, MN (2016-2017)
Children's National Hospital Washington, DC (2016-2022)
Children's Nebraska Omaha, NE (2020-2023)
Children's of Alabama Birmingham, AL (2017-2023)
Children's Wisconsin Milwaukee, WI (2016-2023)
Cincinnati Children's Cincinnati, OH (2016-2021)
Cohen Children's Medical Center New Hyde Park, NY (2016-2023)
Cone Health Women's & Children's Center at Moses Cone Hospital Greensboro, NC (2017-2023)
Connecticut Children's Medical Center Hartford, CT (2016-2023)
Cook Children's Medical Center Fort Worth, TX (2016-2023)
Corewell Health Helen DeVos Children's Hospital Grand Rapids, MI (2016-2023)
Dell Children's Medical Center Austin, TX (2020-2023)
El Paso Children's Hospital El Paso, TX (2017-2023)
Goryeb Children's Hospital Morristown, NJ (2016-2023)
Hasbro Children's Hospital at Rhode Island Hospital Providence, RI (2017-2023)
Hassenfeld Children's Hospital at NYU Langone New York, NY (2016-2023)
Hoops Family Children's Hospital Huntington, WV (2016-2021)
Inova L. J. Murphy Children's Hospital Falls Church, VA (2018-2022)
Janet Weis Children's Hospital at Geisinger Danville, PA (2019-2023)
Johns Hopkins All Children's Hospital St. Petersburg, FL (2018-2023)
Loma Linda University Children's Hospital Loma Linda, CA (2016-2023)
Mary Bridge Children's Hospital & Health Network Tacoma, WA (2019-2023)
Mayo Clinic Children's Center Rochester, MN (2016-2023)
MercyOne Children's Hospital Des Moines, IA (2016-2019)
Monroe Carell Jr. Children's Hospital at Vanderbilt Nashville, TN (2021-2023)

MUSC Shawn Jenkins Children's Hospital Charleston, SC (2018-2023)
Nationwide Children's Hospital Columbus, OH (2016-2023)
Nemours Children's Hospital, Delaware Wilmington, DE (2016-2021)
Nemours Children's Hospital, Florida Orlando, FL (2016-2023)
Nicklaus Children's Hospital Miami, FL (2021-2023)
Niswonger Children's Hospital Johnson City, TN (2021-2023)
North Carolina Children's Hospital Chapel Hill, NC (2017-2023)
Oklahoma Children's Hospital OU Health Oklahoma City, OK (2016-2023)
Penn State Children's Hospital Hershey, PA (2019-2023)
Phoenix Children's Phoenix, AZ (2016-2023)
Primary Children's Hospital Salt Lake City, UT (2016-2023)
Seattle Children's Seattle, WA (2016-2023)
St. Jude Children's Research Hospital Memphis, TN (2016-2023)
St. Luke's Children's Hospital St. Luke's Regional Medical Center Boise, ID (2018-2019)
Texas Children's Hospital Houston, TX (2016-2020)
The Bristol-Myers Squibb Children's Hospital at Robert Wood Johnson University Hospital New Brunswick, NJ (2020-2022)
The Children's Hospital at Saint Francis Tulsa, OK (2016-2023)
UH Rainbow Babies & Children's Hospital Cleveland, OH (2020-2023)
University of Maryland Children's Hospital Baltimore, MD (2016-2023)
University of New Mexico Children's Hospital Albuquerque, NM (2021-2023)
UPMC Children's Hospital of Pittsburgh Pittsburgh, PA (2016-2023)
Upstate Golisano Children's Hospital Syracuse, NY (2016-2023)
Valley Children's Healthcare Madera, CA (2017-2021)
Yale New Haven Children's Hospital New Haven, CT (2016-2023)

FIGURE 2 – IPSO Leadership Group
Jeffery Auletta, MD Nationwide Children's Hospital Columbus, OH
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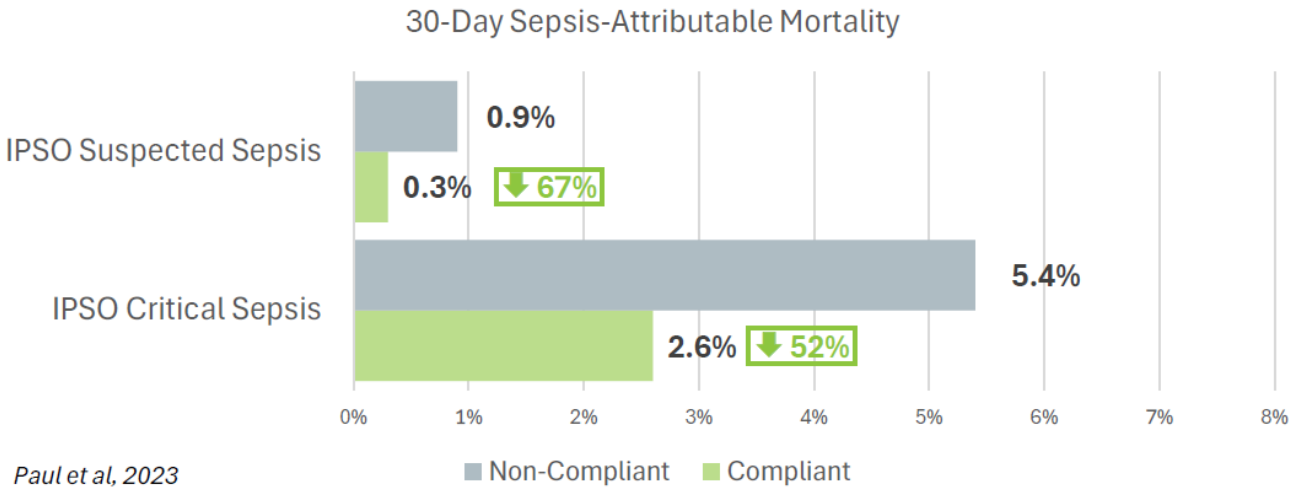
Erika Stalets, MD, MS Cincinnati Children's Cincinnati, OH
Jennifer Wilkes, MD, MSCE Seattle Children's Seattle, WA
*IPSO Co-Chair

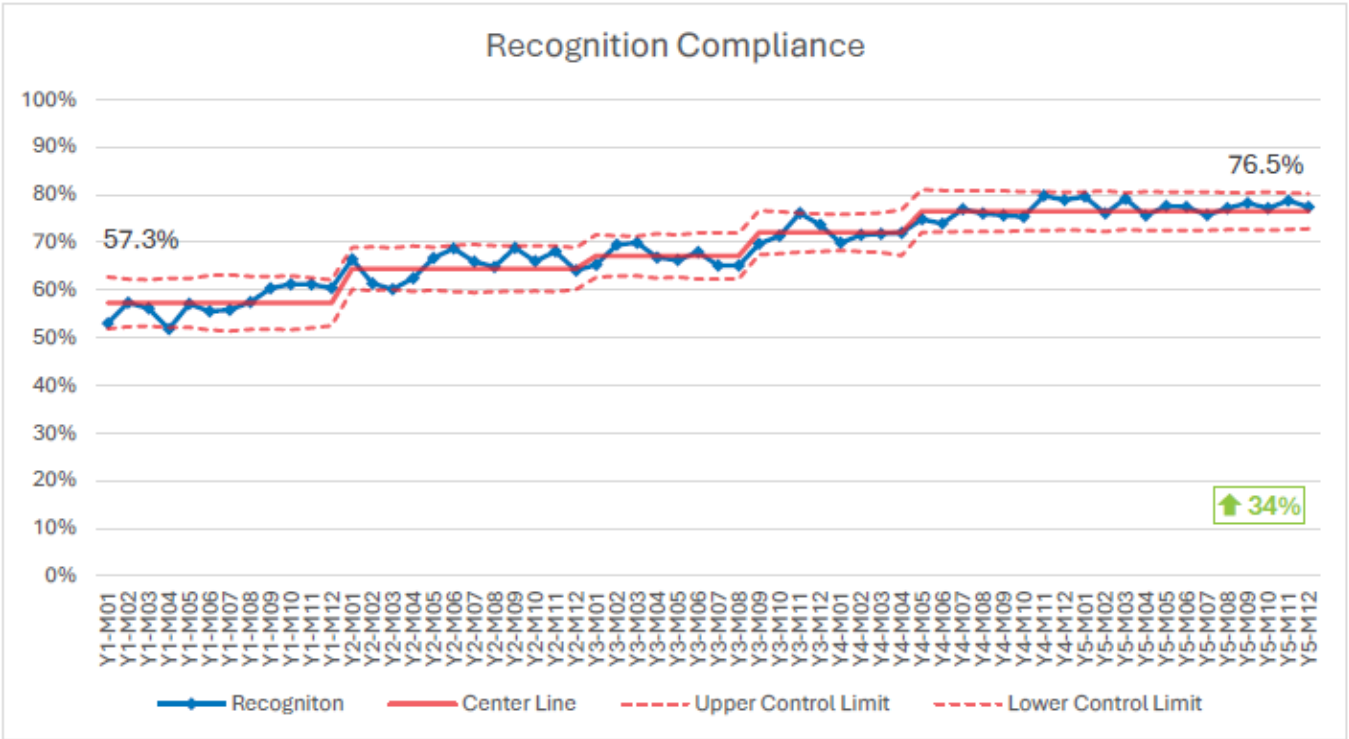
FIGURE 3 – Association Between Recognition Compliance and 30-Day Sepsis-Attributable Mortality

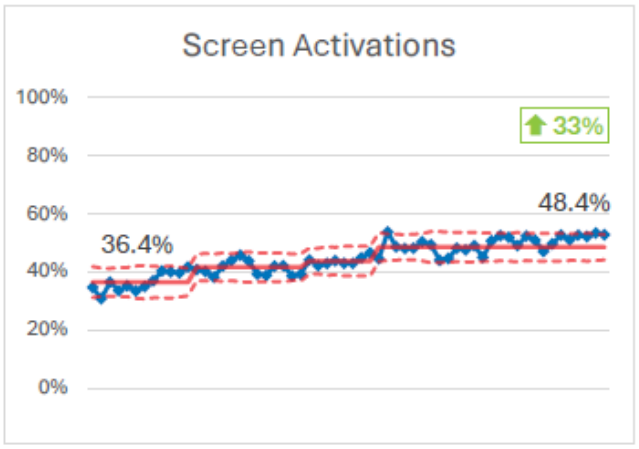


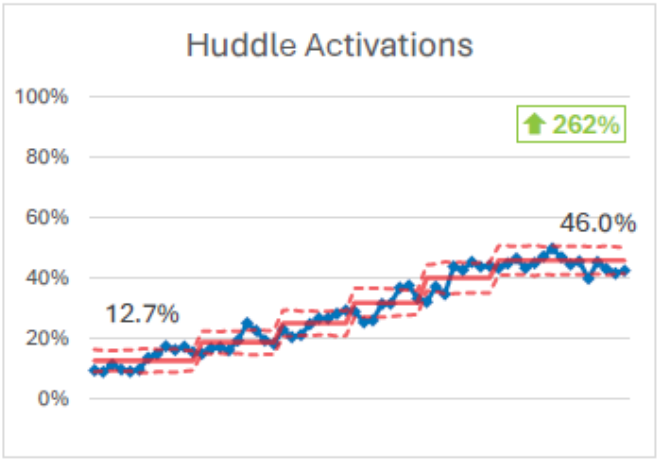
Paul et al, 2023

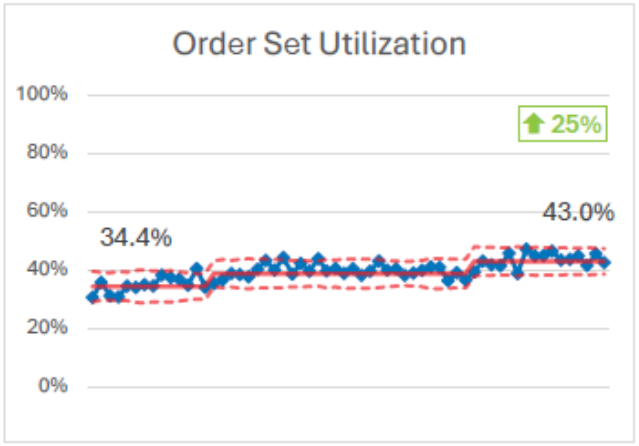
- *Recognition Compliant: use of a positive screen, positive huddle, or sepsis order set*
- *IPSO Critical Sepsis: a subset of IPSO Sepsis where a third bolus or pressor was initiated (approximates severe sepsis with shock)*
- *IPSO Suspected Sepsis: a subset of IPSO Sepsis where neither a third bolus nor pressor was initiated*

FIGURE 4 – Recognition Compliance Improvement (Waves 1-3, Participation Years 1-5*)



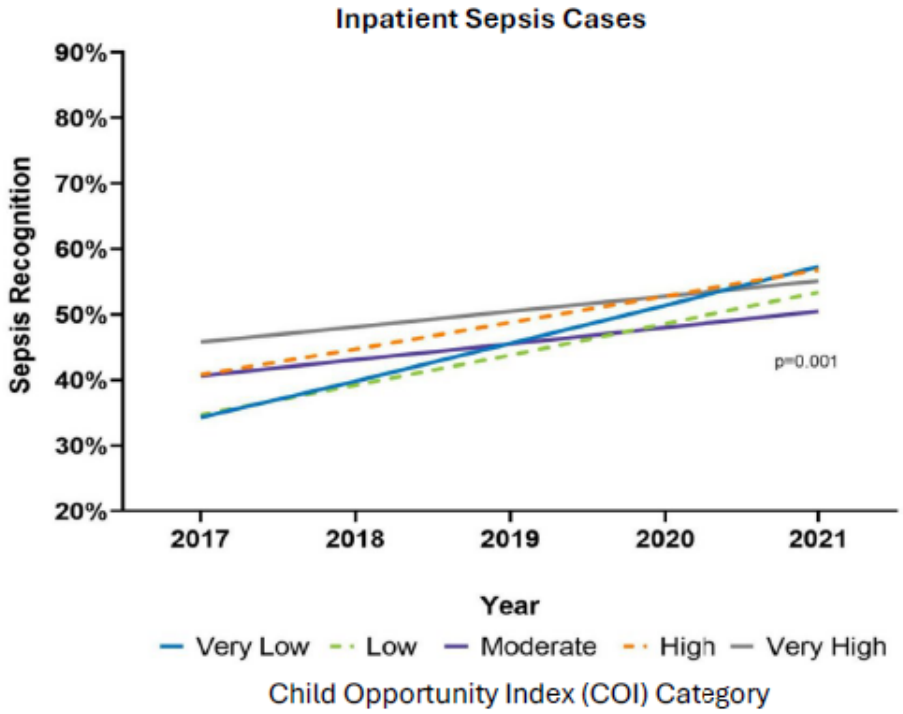






* *Due to IPSO teams joining in waves over five years between 2017-2021, this analysis aligns data based on year of participation in the collaborative to reflect aggregated improvement over time. Year 1 establishes the baseline and the maximum timeframe all five waves participated is three years. For this analysis we included five years of data from Waves 1-3.*

FIGURE 5 – Recognition Compliance Improvement by Child Opportunity Index



Rutman et al, 2024

FIGURE 6 – Time to Recognition and Interventions in Minutes When Recognition Processes are Used vs Not Used (Data from January 2017 to December 2023)

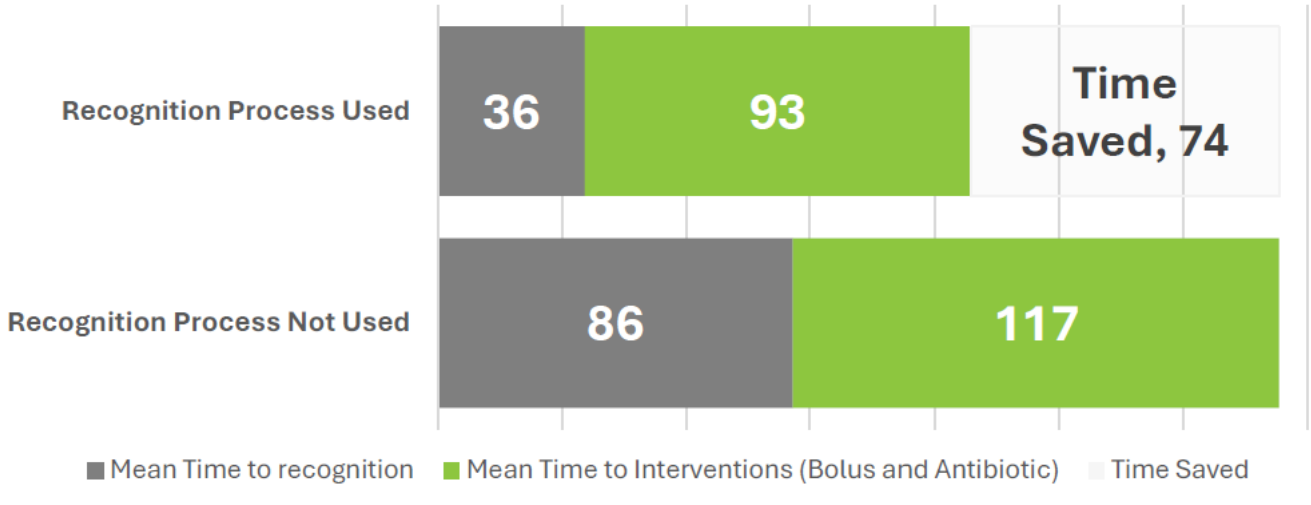
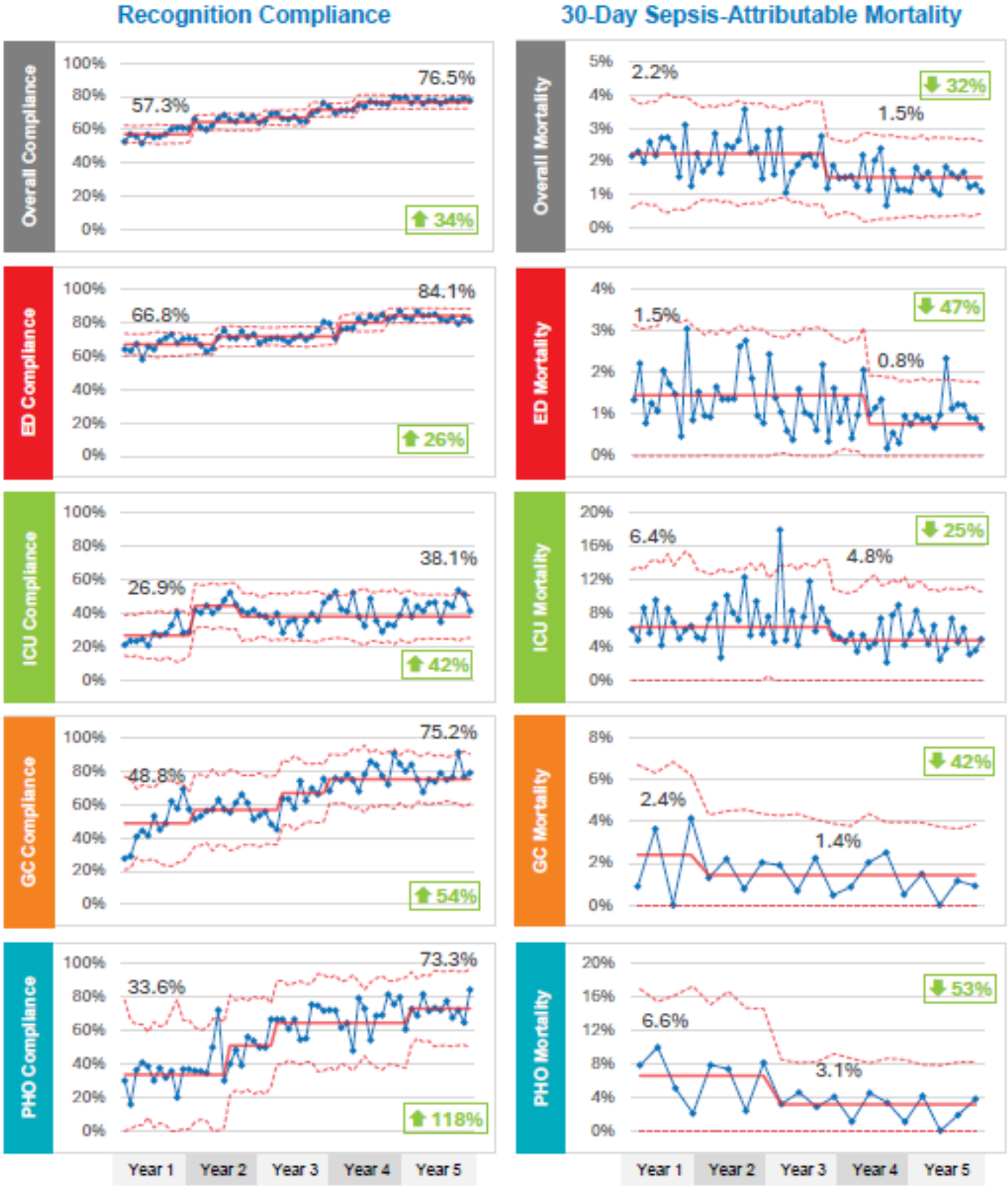


FIGURE 7 – Recognition Compliance and Associated 30-Day Sepsis-Attributable Mortality by Care Setting (Waves 1-3, Participation Years 1-5)



Overall = All Care Settings (n = 56,419)
ED = Emergency Department (n = 34,101)
ICU = Pediatric Intensive Care Unit (n = 6,615)
GC = General Care Floor (n = 3,474)
PHO = Pediatric Hematology/Oncology (n = 1,772)

FIGURE 8 – Secondary Outcomes, Incidence, & Balancing Measure (Waves 1-3, Participation Years 1-5)

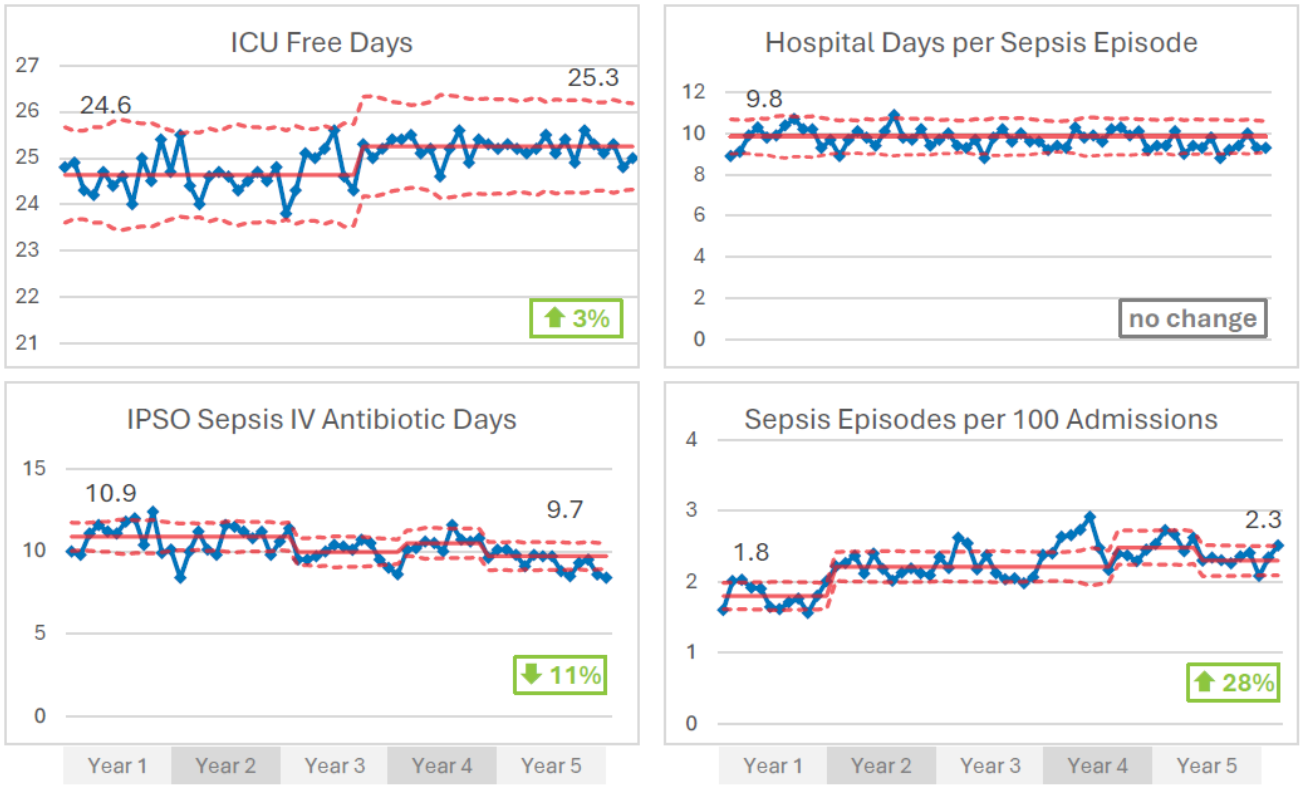


FIGURE 9 – Recognition Compliance and 30-Day Sepsis-Attributable (SA) Mortality by Wave