Evaluation of a Digital Phenotype for the Early Recognition of Pediatric Sepsis

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Background: Sepsis is a life-threatening response to infection that results in significant morbidity and mortality in children. International standardized guidelines have been developed by organizations such as the Surviving Sepsis Campaign to improve patient outcomes, including implementing systematic screening for timely recognition of sepsis and starting antibiotics within 1 hour of recognition. However, sepsis can be very difficult to recognize in children due to varied presentations and a constellation of nonspecific signs and symptoms. Our primary objective in this study was to develop and validate a digital phenotype to identify pediatric patients in real-time who are at high risk of sepsis.

Methods: Our retrospective cohort consisted of 28,399 pediatric hospitalizations at Duke Children's Hospital from 2016 – 2023. The primary outcome of this study was the Duke Pediatric Sepsis Phenotype (DPSP), which consists of the intersection between (1) a previously described retrospective informatics-based definition of sepsis requiring 4 days of antibiotics (Full Weiss definition), modified to be usable in real-time (Real-Time Weiss); and (2) the Duke Children's Trigger Tool (TT), a local consensus-based phenotype to direct empiric antibiotic use which was developed by our local multi-specialty team.

Results: The DPSP showed good performance for retrospective definitions of sepsis, with sensitivity of 0.79 and positive predictive value (PPV) of 0.18 for International Classification of Diseases (ICD-10) codes for sepsis and sensitivity of 0.95 and PPV of 0.30 for the Full Weiss definition for sepsis. Patients meeting DPSP had significantly longer mean hospital length-of-stay (23.48 vs 6.72 days, $p < 0.001$), higher mortality (5.67% vs 0.74%, $p < 0.001$), lower mean age (6.99 vs. 7.79, $p < 0.001$) and were more likely to be Black/African American than the full retrospective cohort, which is consistent with previously described populations.

Conclusions: The Duke Pediatric Sepsis Phenotype (DPSP) can accurately identify patients who meet retrospective definitions of sepsis. Patients fulfilling the DPSP have significantly higher mortality, longer hospital length-of-stay, and are more likely to be Black/African American. Validation of DPSP lays the groundwork for future efforts to train machine learning models and improve pediatric sepsis outcomes.