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Real-Time Acute Kidney Injury Risk Stratification–Biomarker Directed Fluid Management Improves Outcomes in Critically Ill Children and Young Adults

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BASED ON ARTICLE

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ABSTRACT

Objective: Critically ill admitted patients are at high risk of acute kidney injury (AKI). The renal angina index (RAI) and urinary biomarker neutrophil gelatinase-associated lipocalin (uNGAL) can aid in AKI risk assessment. We implemented the Trial in AKI using NGAL and Fluid Overload to optimize CRRT Use (TAKING FOCUS 2; TF2) to personalize fluid management and continuous renal replacement therapy (CRRT) initiation based on AKI risk and patient fluid accumulation. We compared outcomes pre-TF2 and post-TF2 initiation.

Methods: Patients admitted from July 2017 were followed up prospectively with the following: (i) an automated RAI result at 12 hours of admission, (ii) a conditional uNGAL order for RAI ≥ 8, and (iii) a CRRT initiation goal at 10% to 15% weight-based fluid accumulation.

Results: A total of 286 patients comprised 304 intensive care unit (ICU) RAI+ admissions; 178 patients received CRRT over the observation period (2014–2021). Median time from ICU admission to CRRT initiation was 2 days shorter ($P < 0.002$), and ≥15% pre-CRRT fluid accumulation rate was lower in the TF2 era ($P < 0.02$). TF2 ICU length of stay (LOS) after CRRT discontinuation and total ICU LOS was 6 and 11 days shorter for CRRT survivors (both $P < 0.02$). Survival rates to ICU discharge after CRRT discontinuation were higher in the TF2 era (P ¼ 0.001). These associations persisted in each TF2 year; we estimate a conservative $12,500 healthcare cost savings per CRRT patient treated after TF2 implementation.

Conclusion: We suggest that automated clinical decision support (CDS) combining risk stratification and AKI biomarker assessment can produce durable reductions in pediatric CRRT patient morbidity.

COMMENTARY

Acute kidney injury (AKI) is common, affecting approximately one-third of critically sick children with diverse etiology. Higher stages of AKI are associated with both short-term and long-term morbidity and mortality. The traditional marker by which AKI has been diagnosed for years is serum creatinine, which cannot distinguish true structural AKI from functional volume-responsive AKI. Besides serum creatinine levels are influenced by several nonrenal factors such as age, gender, muscle mass, medication use, hydration status, and nutrition status. Currently, the usage of uNGAL has been established as an early AKI biomarker to improve the detection of AKI and the provision of early interventions.

Irrespective of underlying causes, once AKI, the treatment is primarily supported by dialytic or non-dialytic therapy (kidney replacement therapy), essentially focusing on the management of fluid and electrolytes. Risk stratifications by RAI (≥ 8) is a reliable tool in predicting the high risk of severe AKI in critically sick children.

Fluid overload may not just indicate but also lead to AKI by affecting multiple organs. Several studies indicate that the degree of fluid overload correlates with mortality, with a 19% increase in risk for every liter of fluid overload and 6% for every percentage point increment. However, the decision for the timing of initiation of CRRT is still debatable and variable. The current trial integrated uNGAL ($\geq$ 500ng/ml) with RAI (≥ 8) and fluid overload to optimize CRRT use (TAKING FOCUS 2; TF2) to personalize fluid management and continuous renal replacement therapy (CRRT) initiation. The study compares pre-TF-2(n=71) with TF-2 (n=107) cohorts, which showed 1) median time from ICU admission to CRRT initiation was 2 days shorter ($P < 0.002$), 2) $\geq$ 15% pre-CRRT fluid accumulation rate was lower in the TF2 ($P < 0.02$), 3) TF2 ICU length of stay (LOS) after CRRT discontinuation and 4) total ICU LOS were 6 and 11 days shorter for CRRT survivors with reduced health care cost.

Therefore, prevention of AKI is the key to avoiding complications in acute care settings by clinical decision support (CDS) combining risk stratification and AKI biomarker assessment can produce durable reductions in pediatric CRRT patient morbidity.

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