TAKING FOCUS 2: Using a Clinical Decision Algorithm to Risk Stratify and Manage Critically Ill Pediatric Patients at Risk for Acute Kidney Injury

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Background

- Acute Kidney Injury (AKI) develops in over 25% of critically ill pediatric patients during their first week in the PICU, with more than 10% suffering from severe AKI[1]
- Prospectively identifying children at highest risk of AKI may help mitigate associated poor outcomes
- The Renal Angina Index (RAI) has been validated to predict patients most likely to have AKI after PICU admission[2]
- Urinary biomarkers neutrophil-gelatinase-associated lipocalin (NGAL) can be used in conjunction with RAI to enhance risk stratification[2,3]
- RAI and NGAL are combined with a standardized furosemide stress test (FST) to develop a clinical decision algorithm (CDA) used in our PICU to risk stratify patients for the development of severe AKI[4]

Clinical Decision Algorithm and Research Methods

- Utilized prospectively for all patients admitted to the PICU beginning July 2018 as part of standard of care
- As part of the TAKING FOCUS 2 study, all patients were tracked through PICU Day 28 from July 2018 to June 2019
  - RAI+ patients admitted from July 2019 to June 2021 were also followed for the research study and are included in this analysis

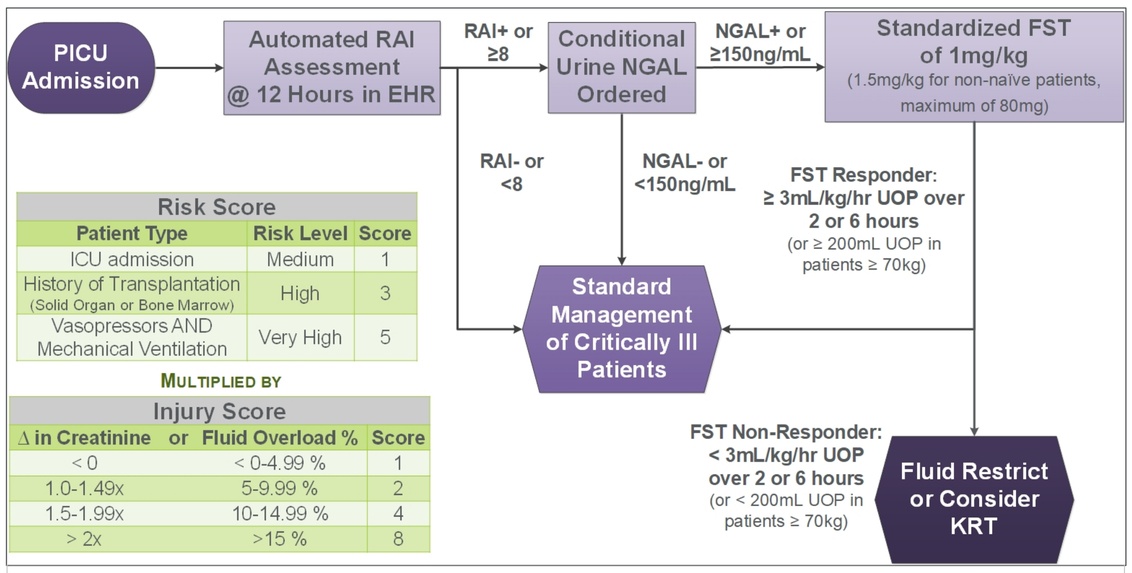

Figure 1. Clinical Decision Algorithm for AKI Risk Stratification in PICU Patients

- Patients with ESKD or kidney transplant within the previous 90 days were excluded by the RAI algorithm in the EHR
- All patients that were oliguric at the time of RAI result were treated as NGAL+
- Primary outcome of interest was severe AKI, defined as KDIGO Stage 2 or 3 using serum creatinine criteria on PICU Days 2, 3, and/or 4
  - Patients discharged from the PICU before Day 2 were excluded from analysis
- Categorical variables were assessed using Chi-square
- Normally distributed, continuous variables were analyzed by means, standard deviations (SD), and t-test
- Non-normally distributed, continuous variables were summarized using median, 25th-75th interquartile ranges (IQR), and the Mann-Whitney U-test

CDA Operationalization

- 1,772 patients were included, of which 351 (19.8%) were RAI+
- 158 (56.8% of RAI+ patients) were NGAL+
- For the 262 RAI+ patients with a NGAL result, the median time between RAI result and NGAL collection was 3.1 hours (IQR 0.95, 6.85)
- FST performed on 46 (29.1% of RAI+NGAL+)
  - 30 of the 46 were Responders
  - FST was performed 21.9 hours (SD 19.8) after RAI resulted

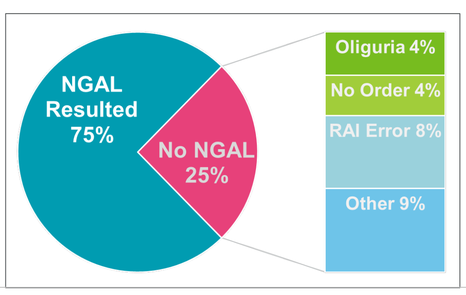

Figure 2. Conditional NGAL Completion

Patient Outcomes by CDA Risk Stratification

- Severe AKI rates were significantly higher in the RAI+ patients (44.7%) compared to the RAI- patients (1.8%, *p<0.001*)
- After NGAL assessment, 69.0% of RAI+ patients went on to develop severe AKI compared to 3.7% of the RAI- and RAI+NGAL- patients

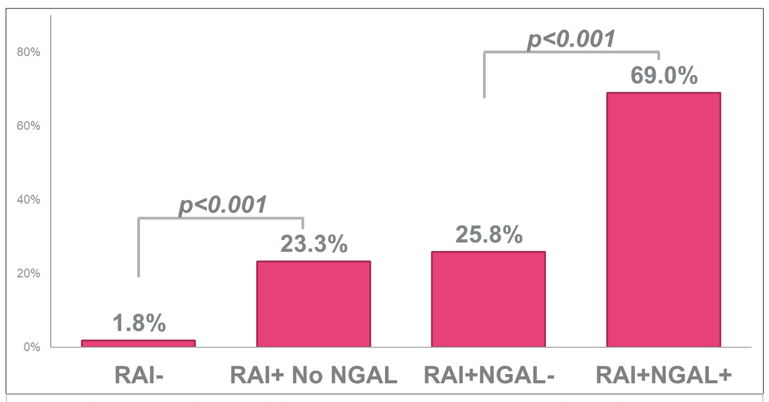

Figure 3. Rate of Severe AKI by RAI and NGAL Result

- AKI rates significantly increased as patients continued through the CDA for risk stratification – refer to Figure 3 above
- The addition of NGAL improves the Positive Predictive Value of the CDA compared to RAI alone and still maintains a high Negative Predictive Value.

Table 1. Performance of RAI and NGAL to Predict Severe AKI

Statistic for Predicting AKI	RAI Alone *Score (95% CI)*	RAI and NGAL *Score (95% CI)*
Positive Predictive Value	44.7% (41.2-48.3)	69.0% (62.3-75.0)
Negative Predictive Value	98.2% (97.4-98.7)	96.3% (95.5-97.0)
Sensitivity	85.8% (79.9-90.5)	65.7% (57.9-72.9)
Specificity	87.8% (86.1-89.4)	96.8% (95.8-97.6)

Standardized FST Results

- For patients who received a FST, there was no difference in AKI rates or mean percent fluid overload (FO) prior to the FST based on their response or non-response
  - Percent FO pre-FST 9.4% in Responders vs 7.9% in Non-Responders (*p=0.62*)
  - 66.7% of Responders had severe AKI vs 93.8% of Non-Responders (*p=0.07*)
- Non-responders were significantly more likely to require kidney replacement therapy (KRT) compared to responders (43.8% vs 10%, *p=0.02*)
- Excluding those requiring KRT, there was no difference 48 hours after FST in AKI rates (47.6% in Responders vs 71.4%, *p=0.4*) or percent FO (9.1% in Responders vs 5.3%, *p=0.3*)

Conclusions

- EHR-embedded CDA provides timely information about severe AKI risk to clinical team / bedside providers
- RAI-NGAL-FST CDA reliably rules out patients at low risk for severe AKI
- Identified highest risk patients may benefit from earlier, proactive management, including provision of KRT

References

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Acknowledgements

Support provided by NIH National Institute of Diabetes and Digestive and Kidney Diseases P50 DK096418. The study is registered at ClinicalTrials.gov as NCT03541785.