# SIRI Index as a Predictor of Acute Kidney Injury in UTI Children: A Cross-Sectional Study

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**ABSTRACT**

**Background:**

Urinary tract infections (UTIs) in paediatric patients are a frequent cause of hospitalization and may progress to acute kidney injury (AKI). The Systemic Inflammatory Response Index (SIRI) has emerged as a biomarker in inflammatory conditions, but its role in predicting AKI in paediatric UTIs is underexplored.

**Objectives:**

To evaluate the association of SIRI and other CBC (complete blood count) driven ratios with the risk of developing AKI in UTI children.

**Materials and Methods:**

This cross-sectional study was conducted in 58 children in a tertiary care centre where SIRI and CBC ratios were calculated and compared in UTI children. Participants were stratified into three groups based on SIRI levels: ≤2.5, 2.6–7.5, and ≥7.6. AKI diagnosis was made using KDIGO guidelines. Statistical analysis was performed using SPSS v21. Mann–Whitney U and Kruskal–Wallis tests were used to assess differences across groups, with significance set at $p < 0.05$.

**Results:**

AKI was diagnosed in 45% (n = 26) of participants. A significant association was found between higher SIRI values and AKI occurrence ($p = 0.002$), with 88% of AKI cases falling in SIRI Group 3 (≥7.6). Serum creatinine and urea levels were significantly elevated in the AKI group, while eGFR was markedly reduced ($p < 0.001$). MLR was the only secondary marker significantly associated with AKI ($p = 0.02$), whereas others were not. Progressive worsening of renal function was noted across ascending SIRI groups.

**Conclusion:**

Higher SIRI values are strongly associated with renal dysfunction and AKI in children with UTIs enabling timely monitoring and management.

**Keywords:** Systemic Inflammatory Response Index, Acute Kidney Injury, Urinary Tract Infection, Biomarkers

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**WHAT IS ALREADY KNOWN IN THIS TOPIC?**

SIRI has been shown to be a good predictor of prognosis in various diseases mainly in chronic kidney disease, major artery blockage by mechanical thrombectomy, rheumatoid arthritis, hyperuricemia, intracerebral hemorrhage, and cancer.[5,6,7]

**WHAT THIS STUDY ADDS ON THIS TOPIC?**

SIRI is a useful tool for the early detection and treatment of individuals who are at risk for AKI in complicated and recurrent UTI in children, which may lead to better clinical results through prompt interventions.
Higher SIRI values are associated with a greater likelihood of developing AKI.

## INTRODUCTION:

A Paediatric ailment that can cause serious morbidity if not identified and treated properly is urinary tract infection (UTI) which is the commonest infection occurring in children.[1]Acute kidney injury (AKI) can result from complicated and recurrent UTIs in children, especially if the infection spreads to the kidneys and causes acute pyelonephritis or in certain congenital conditions such vesicoureteral reflux.[2]

"**AKI** is defined as a rise in serum creatinine of at least 0.3 mg/dL in 48 hours, a rise of at least 1.5 times the baseline level in 7 days, or a urine output of less than 0.5 mL/kg/hour for 6 hours.[3] "Paediatric AKI can appear as anything from a little increase in blood creatinine levels to anuria causing renal failure. In paediatric intensive care units (PICUs), the incidence of AKI is approximately 30–40%, and the fatality rate is 40–50%.[4]

By identifying at-risk patients early on, the Systemic Inflammatory Response Index (SIRI) may help improve outcomes through prompt monitoring and therapies. SIRI has been shown to be a good predictor of prognosis in various studies.[5,6,7]

SIRI's predictive ability was compared with other CBC-derived ratios, such as NLR (Neutrophil to lymphocyte ratio), PLR (Platelet to lymphocyte ratio), MLR ( Monocyte to lymphocyte ratio), and CRP (C – reactive protein), in order to assess the relationship between SIRI and AKI risk in children with UTIs.

**The SIRI index**, which is derived from neutrophil, monocyte, and lymphocyte blood counts, has demonstrated potential as a predictor of acute kidney injury (AKI) across a range of patient demographics.[8]

Numerous factors, such as dehydration, sepsis, nephrotoxic drugs, and congenital defects, can induce AKI in infants. It has been discovered that children who are having significant procedures, such heart surgery, are more likely to develop AKI if their SIRI is high.[9]

SIRI can assist in stratifying paediatric patients based on their likelihood of having AKI. Paediatric patients with disorders that are making them susceptible to AKI can have their inflammatory status monitored with SIRI.[10]

According to research, patients who have a SIRI above a particular threshold have a higher chance of developing AKI during the first week of hospitalization than patients with lower SIRI values.[11] SIRI's capacity to predict AKI can help with early intervention and possibly avoid further kidney damage. Because of this, SIRI is a useful in detecting and treatment of individuals who prone for the risk of AKI, which may lead to better clinical results through prompt interventions. Changes in SIRI can also give information on the efficacy of anti-inflammatory therapies.

Research on using the SIRI to predict children's AKI is only getting started. This discovery may result in rigorous monitoring of renal function. Numerous observational studies have not fully investigated the role of SIRI in UTI. As a result, in this study, we investigated the correlation between SIRI and AKI risk in UTI patients, as well as the predictive significance of NLR, PLR, MLR, and CRP in AKI.

## METHODOLOGY:

This cross-sectional study was done in paediatric wards in a tertiary care hospital, Chennai. The sample size was determined by using Cochran's formula for cross-sectional prevalence studies. Considering expected AKI prevalence of 14.6% based on a recent multicentre study of children hospitalised for febrile UTI by Marzuillo et al[12] and absolute precision of 9.1% at 95% confidence interval, the sample of 58 was derived. Assuming simple random sampling (design effect = 1) and complete ascertainment in a hospital-based study, the final required sample was 58 participants. The

study population comprised of patients diagnosed with UTI between may 2025 and November 2025. Sociodemographic data of these children such as age, gender, clinical history and available laboratory results were collected.

**ETHICAL APPROVAL AND CONSENT TO PARTICIPATE:**

The study procedure was accepted by the Institutional Ethics Review committee and was conducted in compliance with best clinical practices. This study was approved by the Ethics Committee of XXX (approval number: IHEC-I/3756/25, date: may 22, 2025). Informed consent from the parents and guardians was obtained in accordance with ethical standards.

**INCLUSION AND EXCLUSION CRITERIA:**

Children with complicated UTI and recurrent UTI who were between the ages of 1 and 18 were included in this study. Children receiving prolonged corticotherapy, those with insufficient medical records, and those with previous medical illnesses known to alter hematological parameters—such as autoimmune or hematologic diseases—were excluded from the study. This study included 58 children with UTI who fulfilled the inclusion criteria during the study period.

Children with complicated UTI Complicated/atypical UTI include:

- ✓ Fever > 39°C
- ✓ Sick looking and lethargy
- ✓ Dehydration and vomiting
- ✓ Refusal to feed
- ✓ Renal angle tenderness
- ✓ Elevated serum creatinine
- ✓ Non-Escherichia coli UTI

Children with recurrent UTI include:

- ✓ Recurrent UTI
- ✓ Two episodes of febrile UTI
- ✓ First UTI <6 months age
- ✓ Presence of known risk factors: poor hygiene and CAKUT (congenital anomalies of kidney and urinary tract)

The Kidney Disease Improving Global Outcomes guidelines (KDIGO) defined the serum creatinine parameters that were used to identify acute kidney damage.[4] AKI was diagnosed based on this definition " A rise in serum creatinine of at least 0.3 mg/dL in 48 hours, a rise of at least 1.5 times the baseline level in 7 days, or a urine output of less than 0.5 mL/kg/hour for 6 hours.[3]" In this study, the AKI and non-AKI groups were classified according to age-specific creatinine values.

Based on earlier research, the patients were subsequently divided into three groups: Group 1 (SIRI ≤ 2.5), Group 2 (2.5 < SIRI < 7.6), and Group 3 (SIRI ≥ 7.6)[13]. Baseline hemolotogic parameter values were gathered, including those for Complete blood count-neutrophils, monocytes, lymphocytes, platelets, CRP, RFT parameters were done. The CBC driven ratios are Neutrophil Lymphocyte Ratio (NLR), Platelet Lymphocyte Ratio (PLR), Monocyte Lymphocyte Ratio (MLR) and C-Reactive Protein (CRP).

The collected samples were evaluated and the data was analysed and SIRI ([neutrophil count*monocyte count]/lymphocyte count) was calculated in addition to other CBC-driven ratios and correlation of the RFT parameters with SIRI index and AKI status was done.

**STATISTICAL ANALYSIS:**

Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS) v21 software. The patients, who were divided into three study groups based on their SIRI tertiles, were defined using descriptive statistics including percentages, medians, and interquartile ranges. Categorical variables were represented by numbers and percentiles, and the correlation was determined using the Chi-square test. A two-tailed p-value of less than 0.05 was considered a statistically significant finding.

**RESULTS:**

The mean age of the children was found to be 2.5 ± 2.1 years. Male children were 64% and female were 36% in this study. Out of the 58 UTI children admitted, AKI was diagnosed in 45% of the children. The mean SIRI was 12.71 ± 15.44 with minimum and maximum values 1.2 and 80.3.

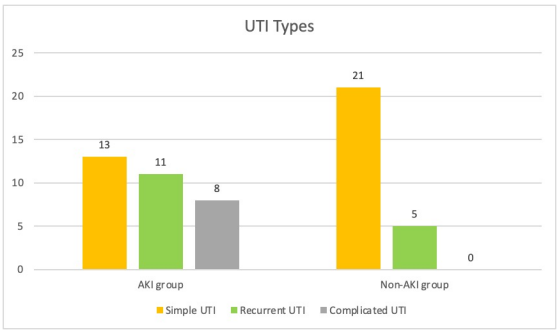



**Figure 1: Distribution of UTI types in AKI and non-AKI patients**

The bar chart illustrates the distribution of different types of urinary tract infections (UTIs) among patients with and without acute kidney injury (AKI). In the AKI group, simple UTI was the most common presentation, accounting for 40.6% of cases,

followed by recurrent UTI (34.4%) and complicated UTI (25.0%). In contrast, the non-AKI group showed a predominance of simple UTI, comprising 80.8% of cases, while recurrent UTI accounted for 19.2%. Notably, no cases of complicated UTI (0%) were observed in the non-AKI group (Figure 1).

Renal function tests showed marked differences between AKI and non-AKI children. Median serum creatinine was significantly elevated in the AKI group (1.8 [1.4–2.2] vs non-AKI 0.7 [0.6–0.8] mg/dL, p<0.001), urea was higher (52 [43–61] vs. 32 [26–38] mg/dL, p<0.001), and eGFR was markedly reduced (44 [37–52] vs. 88 [76–96] mL/min/1.73 m², p<0.001) However, the distribution of gender did not differ significantly between patients with and without AKI (p = 0.779). In contrast, a significant association was observed between SIRI groups and AKI status (p = 0.002), with a higher proportion of AKI cases clustered in SIRI Group 3, while no AKI cases were noted in Group 1. (**Table 1**).

Among haematological inflammatory indices, the median monocyte-to-lymphocyte ratio (MLR) was significantly higher in patients with AKI compared to those without AKI (0.29 vs 0.21; p = 0.02). No statistically significant differences were observed in neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), or C-reactive protein (CRP) levels between the two groups. **(Table 1).**

**Table 1: Demographic, inflammatory, and renal function parameters in AKI and non-AKI patients**

| Variable | AKI | | P - Value |
|---|---|---|---|
| | Absent | Present | |
| **Gender[#]** | | | |
| Male | 18 | 19 | 0.779 |
| Female | 14 | 7 | |
| **SIRI [#]** | | | |
| Group 1 | 7 | 0 | **0.002*** |
| Group 2 | 16 | 3 | |
| Group 3 | 9 | 23 | |
| **CBC parameters[$] (Median (IQR))** | | | |
| **NLR** | 1.6 (0.9–2.4) | 1.5 (0.8–2.3) | 0.08 |
| **MLR** | 0.29 (0.18–0.36) | 0.21 (0.15–0.28) | **0.02*** |
| **PLR** | 0.15 (0.10–0.20) | 0.13 (0.09–0.17) | 0.98 |
| **CRP** | 58 (41–72) | 44 (32–59) | 0.18 |
| **RFT Parameter[$] (Median (IQR))** | | | |
| Serum Creatinine (mg/dL) | 1.8 (1.4-2.2) | 0.7 (0.6-0.8) | **<0.001*** |
| Urea (mg/dL) | 52 (43-61) | 32 (26-38) | **<0.001*** |
| eGFR (mL/min/1.73 m²) | 44 (37-52) | 88 (76-96) | **<0.001*** |

IQR- Inter- Quartile Range, SIRI - Systemic Inflammatory Response Index, NLR - neutrophil-to-lymphocyte ratio, MLR - monocyte-to-lymphocyte ratio, PLR - platelet-to-lymphocyte ratio, CRP - C-reactive protein, AKI - Acute Kidney Injury, eGFR - estimated Glomerular Filtration Rate. [#]Chi-square test, [$]Mann-Whitney U test, *statistically significant (p < 0.05)

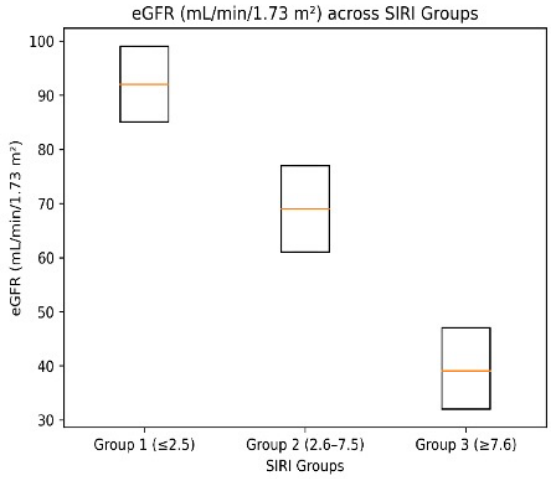
**Table 2: Correlation of SIRI Groups with RFT Parameters**

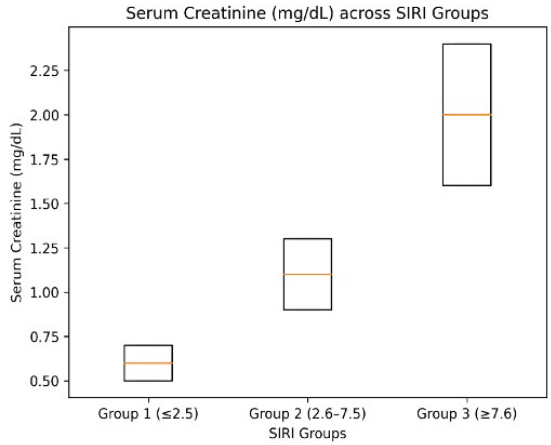
| SIRI Group | Serum Creatinine Median (IQR) | Urea Median (IQR) | eGFR Median (IQR) | p-value |
|---|---|---|---|---|
| **Group 1 (≤2.5)** | 0.6 (0.5–0.7) | 30 (25–34) | 92 (85–99) | **<0.001*** |
| **Group 2 (2.6–7.5)** | 1.1 (0.9–1.3) | 40 (34–46) | 69 (61–77) | **<0.001*** |
| **Group 3 (≥7.6)** | 2.0 (1.6–2.4) | 56 (48–63) | 39 (32–47) | **<0.001*** |

Kruskal Wallis test, *statistically significant (p < 0.05)

Renal function parameters showed a significant and progressive deterioration across increasing SIRI groups. Median serum creatinine levels rose significantly from SIRI Group 1 to Group 3 (0.6, 1.1, and 2.0 mg/dL, respectively; p < 0.001), accompanied by a corresponding increase in urea levels (30, 40, and 56 mg/dL; p < 0.001).

Conversely, median estimated glomerular filtration rate (eGFR) demonstrated a stepwise decline with increasing SIRI severity, decreasing from 92 mL/min/1.73 m² in Group 1 to 69 mL/min/1.73 m² in Group 2 and 39 mL/min/1.73 m² in Group 3 ($p < 0.001$). These findings indicate a strong association between higher systemic inflammatory burden, as reflected by SIRI, and worsening renal function. **(Table 2, Figure 2).**



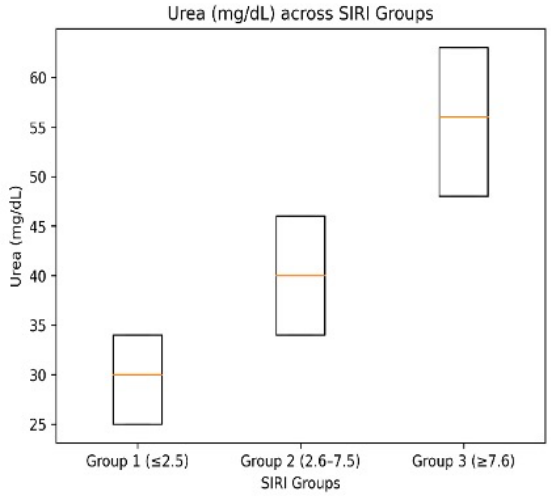




**Figure 2: Correlation of SIRI Groups with RFT Parameters**

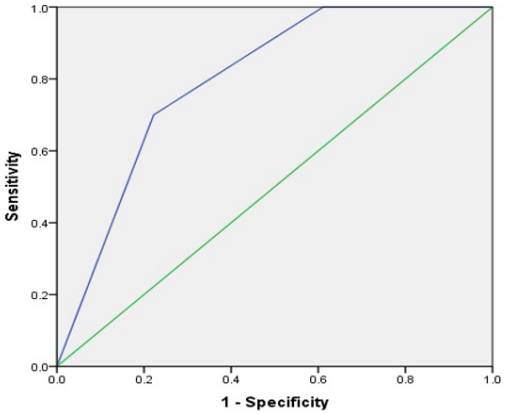



**Figure 3: Receiver operating characteristic (ROC) curve for prediction of acute kidney injury (AKI).**

The ROC curve demonstrates the diagnostic performance of the SIRI in distinguishing patients with and without AKI in UTI population studied. The curve lies above the line of no discrimination with AUC of 0.79 (CI: 0.70–0.89), indicating good discriminatory ability, with higher sensitivity achieved at relatively low false-positive rates. This could be a useful marker in clinical practice.

**DISCUSSION:**

AKI, which appears early in infancy and significantly raises the risk of death and morbidity, can be brought on by untreated UTIs.[14] To combat an infection, the body produces an overly strong inflammatory response. This inflammatory response is the principal host defence mechanism against infection and is essential for starting and sustaining the repair processes required for functional recovery after injury. The white blood cell count and its variations, such as the neutrophil and lymphocyte counts, are conventional indicators of inflammation that are frequently employed in healthcare settings.[15] By combining these numbers, the SIRI becomes a complete biomarker for determining the level of inflammation in the body.[16]

Neutrophils are the initial line of defence for the innate immune system. In some inflammatory circumstances, neutrophils emit a range of substances, including proteases and reactive oxygen species, that damage healthy cells.[17] These can mediate the breakdown of the extracellular matrix, causing damage that may be rapid and possibly irreversible.[18] Monocytes and their offspring, macrophages, create a variety of inflammatory mediators, including tumor necrosis factor (TNF). These mediators may potentially exacerbate inflammatory responses and hasten damage to

tissues and organs.[19] However, the dynamics of lymphocytes differ.[20]

In this analysis of 58 children admitted with UTIs, AKI was detected in 45% of patients. Our findings support the predictive value of the Systemic Inflammatory Response Index (SIRI) in detecting AKI. Among children with SIRI ≥ 7.6 (Group 3), a significant proportion also had higher blood creatinine and urea levels in addition to lower eGFR readings. This suggests that in children UTI cases, systemic inflammation as determined by SIRI and renal failure are strongly correlated.

RFT measurements (serum creatinine, urea, and eGFR) showed significant variations between people with and without AKI, suggesting their diagnostic value. Likewise, renal impairment rose in SIRI groups in a gradient fashion, with SIRI Group 3 showing the worst biochemical disturbance.

The numbers of neutrophils and monocytes significantly increased in this study, highlighting the role of monocyte-driven inflammation in renal injury but the number of lymphocytes decreased. Monocytes are key mediators of cytokine release and endothelial and tubular damage, and an elevated MLR may reflect sustained immune activation and lymphocyte suppression contributing to AKI progression.[21,22] The stronger and more consistent association of SIRI with AKI, compared with individual markers, underscores the advantage of composite indices that integrate neutrophil, monocyte, and lymphocyte responses, thereby more accurately capturing the inflammatory burden underlying AKI in children with UTIs.[23,24]

The results of our investigation align with those of other studies, such as Tang et al. [13], Li X et al. [25], Vunvulea V et al.[11], Gu L et al. [26] and Biyik et al.[27] These investigations found that SIRI functions as a prognostic biomarker in predicting the development of AKI. Additionally, it was discovered that people with higher SIRI values were more likely to get AKI. Additionally, MLR's sustained statistical significance ($p = 0.02$) as a predictor supports its usefulness in conjunction with SIRI, possibly providing a streamlined diagnostic panel for early childhood AKI identification.

While our analysis revealed MLR to be more predictive than NLR, several investigations by Parlar et al.[28], Yang et al.[29], have found NLR to be more predictive than MLR. Comparing the effectiveness of NLR, MLR, PLR, and CRP in AKI, Jiang F et al.[30] discovered that MLR was the most sensitive marker for AKI in comparison to NLR and other markers.

When combined, these results support the usefulness of SIRI as an inflammation-based predictor of renal injury by indicating that higher SIRI values are highly correlated with aberrant RFTs and an increased risk of AKI.

**LIMITATIONS:**

- ✓ In order to confirm these correlations and assess their clinical usefulness in directing early therapies may be validated with large proportion of studies.
- ✓ Increase in duration of study and follow up of these children may further validate our results.

**CONCLUSION:**

SIRI's use in clinical settings simple, practical and cost-effective. SIRI may be used to monitor inflammatory responses in children who are at risk for AKI as well as a tool for risk stratification. Progressive worsening of renal function was also noted across ascending SIRI groups, So patients who are at risk for negative outcomes may be identified early with the help of the Systemic Inflammatory Response Index (SIRI).

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**CONFLICT OF INTEREST**

No conflict of interest is disclosed by the authors.

**AUTHOR CONTRIBUTIONS**

All authors contributed to the design, data collection, analysis, and manuscript preparation.

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