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Impact of Chronic Kidney Disease on Toxicity Patterns and Economic Burden in CAR T-Cell Therapy for Multiple Myeloma: A National Analysis

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Abstract

Background

Chronic kidney disease (CKD) may impair physiologic resilience during chimeric antigen receptor (CAR) T-cell therapy for multiple myeloma (MM). While cytokine release syndrome (CRS) and immune cell-associated neurotoxicity syndromes (ICANS) have been described in MM CAR-T recipients with CKD, the broader cardiopulmonary, infectious, renal, and economic implications of CKD remain insufficiently defined. We examined the national impact of CKD3a+ on mortality, immune-effector toxicities, organ dysfunction, infections and resource utilization.

Methods

Adult MM hospitalizations receiving CAR T-cell therapy were identified from the National Inpatient Sample (2018–2022) using ICD-10-PCS codes. Patients with ESRD were excluded. CKD was categorized as CKD3a+ (eGFR <60 mL/min) versus no CKD/CKD1–2. Outcomes included in-hospital mortality, CRS (2021–2022), ICANS (2022), arrhythmias, acute kidney injury (AKI), renal replacement therapy, acute respiratory failure, infections and total hospitalization cost.

Comparative analyses used chi-square testing. Multivariable regression adjusted for demographics, comorbidities, and hospital characteristics.

Results

Among 2,045 weighted MM CAR-T hospitalizations, 7.6% had CKD3a+. Overall CRS rates were similar (66.7% vs 64.9%; $p=0.839$) between CKD3a+ vs no/CKD1–2. Overall ICANS rates were also comparable (16.7% vs 17.3%; $p=0.941$). Differences in CRS/ICANS grades were not significant. CKD3a+ patients experienced sharply higher AKI (58.1% vs 13.0%; $p<0.001$; adjusted Odds ratio [OR] 9.2, $p<0.001$). Renal replacement therapy was more frequent in CKD3a+ but not statistically significant (3.2% vs 0.8%; $p=0.196$). Acute respiratory failure was more frequent (9.7% vs 2.9%; $p=0.045$) in patients with CKD. Arrhythmias were numerically higher but non-significant (25.8% vs 20.6%; $p=0.527$; adjusted OR 1.3, 95% CI 0.4–4.9; $p=0.673$). Infections were amplified, including gram-negative bacteremia (3.2% vs 0.3%; $p=0.026$), sepsis (9.7% vs 2.6%; $p=0.040$), and septic shock (3.2% vs 0.3%; $p=0.027$) in patients with CKD. Inpatient mortality was numerically

higher (6.5% vs 1.9%; $p=0.101$), though nonsignificant after adjustment (OR 6.9; $p=0.319$). Hospital costs were substantially higher in CKD3a+ (USD 346,769 vs 239,175; $p=0.006$), though not significant in adjusted models (OR 1.3; $p=0.120$).

Conclusion

CKD3a+ is associated with markedly increased AKI, higher respiratory failure and infections,

with a trend towards higher hospitalization costs. Inpatient mortality, CRS and ICANS rates were similar. CKD3a+ represents a significant vulnerability that amplifies downstream complications in MM CAR-T recipients, warranting enhanced pre-treatment risk stratification, infection surveillance, and renal-preserving strategies.

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