Healthcare Professional Perspectives on Creatinine During Critical Illness

AKI & CRRT Conference

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Abstract

Purpose
Creatinine remains the standard biomarker for assessing kidney function, but its accuracy in critical illness is limited by profound muscle wasting, subsequent non-steady state creatinine generation, and altered volume of distribution. This study aimed to evaluate healthcare professionals' ability to interpret kidney function based on creatinine values taking these limitations into account using theoretical critical illness scenarios.
Methods
Twelve hypothetical clinical scenarios, reflective of typical critical care patients, were developed. Each scenario detailed demographics, comorbidity, acute condition, and 7-day clinical course. A kinetic model was used to predict the trajectory of serum creatinine based on physiological principles, expected alterations in muscle mass, underlying glomerular filtration rate (GFR) and fluid balance. The study was created in the form of an online survey and distributed through social media and healthcare professional networks in critical care nephrology. Participants were encouraged to complete one or more scenarios.
Results
Out of a total of 103 respondents, 100 completed the survey, representing 16 countries; 43 (43%) were attending grade and 74 (74%) worked primarily in critical care medicine. Over the first 7-days of all twelve scenarios, an average of 43% of participant responses correctly estimated the true GFR category (< 5, 5- 14, 15 – 29, 30 – 44, 45 – 59, 60 – 90 or >90ml.min^{-1}.1.73m^{-2}) from the modelled creatinine trajectory. Similarly, 63% of respondents correctly adjudicated the presence or absence of a fall in GFR compatible with AKI stages 1-3 (33%, 50% or 66% GFR decrease from baseline). At discharge from critical care (scenario range 12-42 days), only 17.6% of responses accurately predicted the true GFR category from the modelled creatinine at that time point.
Conclusion
Within a group of largely expert clinicians with an interest in critical care nephrology, there was great variation in the estimation of underlying kidney function based on provided creatinine values. This may be due to difficulty simultaneously accounting for non-steady state conditions and acute alterations in creatinine generation and distribution. Notably, prolonged critical illness is associated with significant sustained muscle wasting, substantially reducing creatinine production and participants were particularly poor at estimating underlying GFR at discharge from provided creatinine values. These findings highlight the need for alternative, unbiased measures of kidney function during and after critical illness.

Introduction

Acute Kidney Injury (AKI) has a significant impact, affecting approximately 50% of critical care admissions (1). It is associated with significant morbidity and mortality during the acute phase but also has long-term complications, including major adverse cardiovascular events, the development of chronic kidney disease, and reliance on renal replacement therapy (RRT) (2). Recognizing this diagnosis is therefore paramount, given the profound implications it holds for this patient population.
Currently, serum creatinine stands as the gold standard biomarker for estimating renal function in critical care settings. While it is effective under steady-state conditions, its utility is limited in non-steady-state scenarios, especially among critically unwell patients. Influenced by factors such as sarcopenia, trauma, inflammation, and fluid overload, serum creatinine can lead to inaccurate estimates of renal function (3). This carries significant consequences, impacting crucial aspects like drug dosage, mislabelling AKI recovery, and determining when to initiate RRT.
In response to these challenges, we conducted a survey-based study assessing the ability of healthcare professionals to interpret renal function based on creatinine values across a spectrum of theoretical inpatient scenarios mirroring critical care admissions. We hypothesise that health care professionals may struggle to interpret renal function accurately in these scenarios due to the inherent limitations of creatinine within critical care settings, as highlighted above.

Methods and Materials

This study utilised a survey methodology, focusing on 12 constructed hypothetical critical care scenarios. Each of these scenarios spanned a 7-day timeline from the patient's admission to the critical care unit, encompassing a detailed overview of admission and critical care parameters, such as fluid balance, urine output, and the level of organ support provided. Following the presentation of each scenario, participants were posed with a series of questions asking them to predict both the glomerular filtration rate and the staging of AKI throughout the initial 7 days of admission, as well as at the point of the patient's discharge from critical care.

Survey generated on Microsoft forms

Distributed via social media and health care professional networks

Open from 6th June – 18th August 2023

References

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Results

103 participants 100 actively participated 16 countries

43% attending grade 74% work primarily within critical care medicine

Self-rated expertise median 4/5 (IQR 2) in critical care nephrology

Over the first 7-days of all twelve scenarios, only an average of 43% participant responses correctly estimated the true GFR category (< 5, 5- 14, 15 – 29, 30 – 44, 45 – 59, 60 – 90 or >90ml.min^{-1}.1.73m^{-2}) from the modelled creatinine trajectory (Figure 1). Of those who did not correctly predict the GFR category, participants were more likely to predict a lower GFR category (Figure 1).

At discharge from critical care (scenario range 12-42 days), only an average of 17.6% of participant responses correctly predicted the true GFR category from the modelled creatinine at that time point (Figure 2). The remaining responses were more likely to predict a higher GFR category.

Participants rated the use of creatinine as a marker of renal function on both admission and discharge at a median of 3/5. They stated non-steady state conditions being the largest confounding factor in critical care settings.

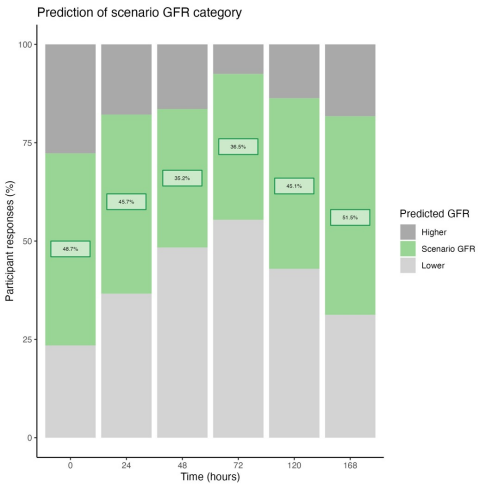

Figure 1. Summary graph of all 12 scenarios, demonstrating whether participants correctly predicted the GFR category during the first 7 days of critical care admission

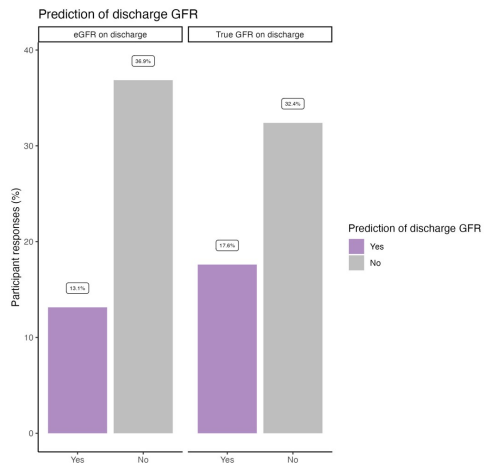

Figure 2. Summary graph of all 12 scenarios, demonstrating whether participants correctly predicted the GFR category on discharge from critical care when compared with measured and eGFR as calculated by CKD-Epi 2021.

Discussion

Our study has demonstrated that within a cohort predominantly comprised of largely expert healthcare professionals, there was substantial variability in the estimation of underlying renal function based on creatinine values, with fewer than half of the participants accurately predicting the GFR across all scenarios.
Notably, our findings also highlighted that an even more modest proportion of participants were able to correctly predict the GFR at the point of discharge compared to the initial 7 days of critical care admission.
These variations may be explained by the reduction of creatinine generation during critical illness, a phenomenon which is well-documented in the literature (4) . Sarcopenia is a large contributor to this dynamic, exerting a more pronounced impact with escalating illness severity and prolonged hospitalization (5,6). The reduction in muscle mass diminishes the creatinine generation rate, resulting in lower creatinine values that can erroneously exaggerate renal function.
Intriguingly, our study found a tendency among participants to underestimate renal function during the first 7 days of critical care admission. However, on discharge from critical care, participants were more likely to overestimate renal function, and this is likely due to the above factors.

Conclusions

Whilst creatinine is a useful biomarker for renal function in steady state, its use in critical illness is limited due to several confounding factors such as sarcopenia, inflammation and non-steady state conditions. As such, alternatives to creatinine should be sought in these settings to more accurately determine renal function, given its significant short- and long-term implications.

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