Follow-up Care of Critically Ill Patients With Acute Kidney Injury: A Cohort Study

Rachel Jeong, Matthew T. James, Robert R. Quinn, Pietro Ravani, Sean M. Bagshaw, Henry T. Stelfox, Neesh Pannu, Alix Clarke, Ron Wald, Tyrone G. Harrison, Daniel J. Niven, and Ngan N. Lam

Rationale & Objective: To evaluate follow-up care of critically ill patients with acute kidney injury (AKI).

Study Design: Retrospective cohort study.

Setting & Participants: Patients admitted to the intensive care unit (ICU) with AKI in Alberta, Canada from 2005 to 2018, who survived to discharge without kidney replacement therapy or estimated glomerular filtration rate <15 mL/min/1.73 m^2.

Exposure: AKI (defined as ≥50% or ≥0.3 mg/dL serum creatinine increase).

Outcomes: The primary outcome was the cumulative incidence of an outpatient serum creatinine and urine protein measurement at 3 months postdischarge. Secondary outcomes included an outpatient serum creatinine or urine protein measurement or a nephrologist visit at 3 months postdischarge.

Analytical Approach: Patients were followed from hospital discharge until the first of each outcome of interest, death, emigration from the province, kidney replacement therapy (maintenance dialysis or kidney transplantation), or end of study period (March 2019). We used non-parametric methods (Aalen–Johansen) to estimate the cumulative incidence functions of outcomes accounting for competing events (death and kidney replacement therapy).

Results: There were 29,732 critically ill adult patients with AKI. The median age was 68 years (IQR, 57-77), 39% were female, and the median baseline estimated glomerular filtration rate was 72 mL/min/1.73 m^2 (IQR, 53-90). The cumulative incidence of having an outpatient creatinine and urine protein measurement at 3 months postdischarge was 25% (95% CI, 25-26). At 3 months postdischarge, 64% (95% CI, 64-65) had an outpatient creatinine measurement, 28% (95% CI, 27-28) had a urine protein measurement, and 5% (95% CI, 4-5) had a nephrologist visit.

Limitations: We lacked granular data, such as urine output.

Conclusions: Many critically ill patients with AKI do not receive the recommended follow-up care. Our findings highlight a gap in the transition of care for survivors of critical illness and AKI.

Visual Abstract included

Complete author and article information provided before references.

Correspondence to N.N. Lam (ngan.lam@ucalgary.ca)

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Acute kidney injury (AKI) occurs in nearly one-quarter of all hospitalized patients and more than half of critically ill patients in the intensive care unit (ICU).[1,2] The mortality associated with AKI increases in a graded manner based on the severity of AKI,[2] as does the likelihood of recurrent AKI events, progression to chronic kidney disease (CKD), and the development of kidney failure.[1] Chronic kidney damage can occur even when AKI seems to resolve, as serum creatinine measurements can be misleadingly low due to loss of muscle mass and hemodilution in the setting of critical illness.[1,3] Given the poor outcomes associated with AKI, the 2012 Kidney Disease Improving Global Outcomes (KDIGO) guideline for AKI recommends evaluation at 3 months for AKI resolution and new-onset or worsening of pre-existing CKD.[4-6]

Follow-up of critically ill patients with AKI, especially those with KDIGO stage 3 AKI, may be influenced by the variable provision of acute dialysis by either intensivists or nephrologists. Many ICUs function as closed units worldwide, and acute dialysis is often prescribed by intensivists,[7-9] who typically do not have outpatient follow-up clinics. In addition, survivors of critical illness often have multiple hospital providers outside of the ICU before hospital discharge, which may be a barrier to effective transition of care from the hospital to the community. Therefore, patients with AKI in the setting of critical illness may not receive follow-up to assess for CKD at 3 months.

Currently, it is unclear if survivors of critical illness with AKI are receiving follow-up care in line with guideline recommendations. We conducted this study to determine the proportion of critically ill patients with AKI in Alberta, Canada who receive laboratory testing for CKD at 3 months of hospital discharge.

METHODS

Design and Setting

We conducted a population-based retrospective cohort study in Alberta, Canada, which utilizes a single-payer, public health system. Over 99% of Alberta residents are registered with Alberta Health and have universal access to health services. We used linked health care databases within the Alberta Kidney Disease Network.[10] These databases have been used extensively for similar research on health services and outcomes in Alberta.[11-18] We followed guidelines for observational studies (Table S1),[19,20] and the protocol was approved by the research ethics boards at

PLAIN LANGUAGE SUMMARY

More than half of patients in the intensive care unit (ICU) are diagnosed with kidney injury. Kidney injury in the ICU is usually managed by ICU doctors, not kidney doctors. That means, when patients get better and goes home, they may never see a kidney doctor, even if there is still kidney damage. We studied how often these patients have follow-up bloodwork done to check kidney health once they go home. We used a database to study 29,732 patients who had kidney injury in the ICU from 2005 to 2018 in Alberta, Canada. We found that only 1 in 4 patients received follow-up bloodwork within 3 months. This means that we are missing an important opportunity to diagnose and treat kidney disease.

the University of Alberta and the University of Calgary, with a waiver of patient consent granted.

Data Sources

We obtained baseline characteristics and outcome data from the Alberta Kidney Disease Network (Table S2). We linked these data sources to a provincial laboratory repository (which captures all laboratory data in Alberta) via unique patient identifiers held by the Alberta Kidney Disease Network.

Population

The cohort creation is shown in Figure S1, and the study design is summarized in Figure S2. We included all hospitalized adult patients (≥18 years old) with an ICU admission between January 1, 2005 and March 31, 2018 in Alberta. We identified ICUs using specialty care unit codes, excluding step-down, pediatric, and neonatal units (Table S2). Only the first (index) hospitalization and first ICU stay were considered. We included patients with at least 1 outpatient creatinine measurement in the preceding 7-365 days to establish baseline kidney function and at least one inpatient or emergency room creatinine measurement 1 day before, during, or 1 day after their ICU stay to ascertain AKI. We excluded anyone on kidney replacement therapy (maintenance dialysis or kidney transplantation), as these patients receive active nephrology follow-up. We excluded those with baseline estimated glomerular filtration rate (eGFR) <15 mL/min/1.73 m^2 before admission or at hospital discharge (based on the last inpatient creatinine before discharge). We also excluded patients who died before discharge and anyone with a prolonged length of hospital stay (>180 days) to exclude patients awaiting disposition.

We identified patients with AKI, defined as ≥50% or ≥0.3 mg/dL creatinine increase from baseline, using the peak creatinine (inpatient or emergency room) 1 day before, during, or 1 day after their ICU stay. Baseline creatinine was defined using the mean of all outpatient creatinine values within the 7-365 days before the hospitalization date, as previously used.[21] Severity of AKI was categorized according to the 2012 KDIGO stages of AKI based on changes in creatinine or initiation of dialysis (Table S3).[4]

Baseline Characteristics

Baseline characteristics were obtained on the date of hospitalization, the date of discharge from the ICU, or the date of hospital discharge, as appropriate, using validated algorithms whenever possible (Table S2). Baseline eGFR was calculated using the 2011 Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI) equation (without inclusion of the coefficient for Black race) and categorized based on the 2012 KDIGO categories (Table S3).[22] Albuminuria was captured by outpatient albumin-creatinine ratio, protein-creatinine ratio, or urine dipstick measurements within 7-365 days before the hospitalization date and categorized based on the KDIGO definition (Table S3).[10,22] If multiple measurements were available, the median value was used. Albumin-creatinine ratio was the primary measure of albuminuria, and if unavailable, protein-creatinine ratio measurements were used. If both albumin-creatinine and protein-creatinine ratios were unavailable, dipstick urinalysis was used. Discharge creatinine was the last measurement before hospital discharge. Recovery of kidney function was assessed comparing the discharge and baseline creatinine and categorized as full recovery (within 20% above baseline creatinine), 20%-60% above baseline creatinine, or greater than 60% above baseline creatinine.[23]

Outcomes

The primary outcome was the cumulative incidence of both an outpatient serum creatinine and urine protein measurement (albumin-creatinine ratio, protein-creatinine ratio, or urine dipstick) at 3 months of hospital discharge. Secondary outcomes included the cumulative incidence of an outpatient serum creatinine measurement, outpatient urine protein measurement, or an outpatient visit to a family physician, nephrologist, internist, or cardiologist at 3 months of hospital discharge.

Statistical Analyses

Categorical variables were expressed as counts (and percentages) and continuous variables were expressed as median and interquartile ranges (IQRs). Patients were followed from the date of hospital discharge (index date) until the first of each outcome of interest, death, emigration from the province, kidney replacement therapy (defined as maintenance dialysis or kidney transplantation), or end of study period (March 31, 2019). Patients were censored at the time of rehospitalization within the surveillance period for the primary and secondary outcomes, as re-hospitalized patients would not

have the opportunity for outpatient follow-up. We determined the quantiles of the potential follow-up time distribution based on the Kaplan–Meier method applied to the censored times, using the prodlim package in R.[24] We used non-parametric methods (Aalen–Johansen) to estimate the cumulative incidence functions of outcomes accounting for competing events of death, kidney replacement therapy (maintenance dialysis or kidney transplantation), and re-hospitalization and reported visual summaries of these functions over time. We also reported the cumulative incidence of kidney replacement therapy (maintenance dialysis or kidney transplantation) and death, removing rehospitalization as a censoring event. We estimated the association between baseline characteristics and the primary outcome using cause-specific Cox regression. Covariates included age, sex, income, urban residence, baseline eGFR, index albumin, hypertension, diabetes mellitus, myocardial infarction, percutaneous coronary intervention or coronary artery bypass grafting, heart failure, stroke or transient ischemic attack, and peripheral vascular disease. Hospitalization era was also included in the model to evaluate trends before and after 2012 (when the KDIGO clinical guideline for AKI was published). All other baseline characteristics (Table 1) were screened for a statistically significant contribution to the model. We also determined the cumulative incidence of outcomes at 6 months and 12 months. A P value of <0.05 was used to define statistical significance.

RESULTS

Baseline Characteristics

There were 29,732 patients admitted to the ICU with AKI with a median follow-up of 11 months (IQR, 2-35) and a maximum follow-up of 14 years. Baseline characteristics are shown in Table 1. The median age was 68 years (IQR, 57-77), and 11,580 (39%) patients were female. The median eGFR was 72 mL/min/1.73 m^2 (IQR, 53-90), 14,681 (49%) patients had normal/mild albuminuria, and 1,132 (4%) patients had evidence of having received acute dialysis before the time of cohort entry. In the year before the index hospitalization, 29,042 (98%) had a family physician visit. Comorbid conditions included hypertension in 19,556 (66%), diabetes mellitus in 10,904 (37%), heart failure in 5,894 (20%), and chronic pulmonary disease in 8,055 (27%) patients.

The median length of ICU stay was 13 days (IQR, 7-24), and 14,978 (50%) patients received invasive mechanical ventilation. Overall, 20,783 (70%), 5,204 (18%), and 3,745 (13%) patients experienced stage 1, stage 2, and stage 3 AKI, respectively, with 1,460 (5%) patients receiving acute dialysis. Nephrology consultation occurred in 6,031 (20%) patients. At discharge, the median creatinine was 1.1 mg/dL (IQR, 0.8-1.4), and 20,150 (68%) patients had full recovery of kidney function.

Outcomes

Cumulative incidences for the outcomes and competing events are shown in Figure 1 and Table 2. At 3 months of hospital discharge, 25.4% (95% confidence interval [CI], 24.8-25.9) had both outpatient serum creatinine and urine protein measurements. At 3 months of hospital discharge, 64.1% (95% CI, 63.5-64.7) of patients had an outpatient creatinine measurement, and 27.8% (95% CI, 27.2-28.3) of patients had an outpatient urine protein measurement, with a median time to creatinine measurement of 37 days (IQR, 11-130) and median time to urine protein measurement of 181 days (IQR, 56-449). The cumulative incidence of an outpatient visit to a family physician, nephrologist, internist, and cardiologist were 89.3% (95% CI, 88.9-89.7), 4.6% (95% CI, 4.4-4.9), 28.0% (95% CI, 27.5-28.6), and 29.2% (95% CI, 28.6-29.8), respectively. The cumulative incidence of death, kidney replacement therapy, and rehospitalization at 3 months was 4.6% (95% CI, 4.4-4.9), 0.09% (95% CI, 0.06-0.13), and 25.1% (95% CI, 24.6-25.6) respectively. The cumulative incidence of having both an outpatient serum creatinine and urine protein measurement at 6 and 12 months was 37.9% (95% CI, 37.3-38.6) and 54.5% (95% CI, 53.8-55.2), respectively.

Variables Associated With Laboratory Follow-up

In multivariable analysis, variables associated with receiving both an outpatient serum creatinine and urine protein measurement at 3 months of hospital discharge were female sex, urban residence, lower baseline eGFR, moderate or severe albuminuria, prior nephrology or internal medicine visit in the 1 year before hospitalization, history of diabetes mellitus, higher stage of AKI, receipt of acute dialysis, receipt of kidney biopsy, and higher serum creatinine at discharge (Figure 2, Table S4). Most responsible diagnoses of infection, gastrointestinal, genitourinary, and other categories, as well as severe sepsis, were associated with the primary outcome.

Variables associated with lower likelihood of laboratory follow-up at 3 months of discharge were lower socioeconomic status, missing baseline albuminuria, prior emergency room visit, prior acute dialysis, atrial fibrillation, chronic pulmonary disease, and dementia, and being in the ICU after 2012.

DISCUSSION

In this cohort study of nearly 30,000 survivors of critical illness with AKI, only 1 in 4 patients received outpatient serum creatinine and urine protein measurements at 3 months of hospital discharge. Though most patients had a family physician visit by 3 months, more than a third of patients did not have an outpatient serum creatinine measurement, and most patients did not receive an outpatient urine protein measurement. Nephrology follow-up was rare, despite a third of the cohort having experienced KDIGO stage 2 or 3 AKI. Given the long-term

Table 1. Baseline Characteristics at the Time of Hospitalization and Discharge of Critically Ill Patients With AKI.

	Total N=29,732
Demographics on admission	
Median age, y	67.9 [57.2-77.1]
≥65 y	17,048 (57%)
Female	11,580 (39%)
SES[a]	
Lowest (level 1)	8,335 (28%)
Second (level 2)	6,981 (23%)
Middle (level 3)	5,672 (19%)
Fourth (level 4)	4,629 (16%)
Highest (level 5)	4,115 (14%)
Urban residence[b]	25,912 (87%)
Baseline kidney function	
eGFR (mL/min/1.73 m^2)	72.0 [52.9-89.8]
≥90	7,358 (25%)
60-89	12,280 (41%)
45-59	5,235 (18%)
30-44	3,522 (12%)
15-29	1,337 (4%)
Albuminuria	
Normal/Mild	14,681 (49%)
Moderate	2,164 (7%)
Severe	1,826 (6%)
Missing	11,061 (37%)
Prior acute dialysis	1,132 (4%)
Health care utilization in the year before admission	
Family physician visit	29,042 (98%)
Median number of family physician visits	9 [5-14]
Specialist visit	18,863 (63%)
Nephrology	2,043 (7%)
Cardiology	9,622 (32%)
Internal Medicine	13,895 (47%)
Median number of specialist visits	1 [0-4]
ER visit	25,977 (87%)
Hospitalization	10,041 (34%)
Comorbidities on admission	
Hypertension	19,556 (66%)
Diabetes mellitus	10,904 (37%)
Myocardial infarction	590 (2%)
PCI or CABG	713 (2%)
Heart failure	5,894 (20%)
Atrial fibrillation	3,824 (13%)
Stroke/TIA	3,152 (11%)
Peripheral vascular disease	1,296 (4%)
Chronic pulmonary disease (including asthma)	8,055 (27%)
Peptic ulcer disease	1,147 (4%)
Liver disease	1,450 (5%)
Cancer	5,178 (17%)
Dementia	1,123 (4%)
ICU characteristics	
ICU hospitalization era	
2005–2011	14,725 (50%)
2012–2018	15,007 (50%)
Length of ICU stay (days)	13 [7-24]
Length of hospital stay (days)	15 [8-31]
Most responsible diagnosis	
Infection	1,817 (6%)
Respiratory	2,709 (9%)
Cardiovascular	13,491 (45%)
Gastrointestinal	2,605 (9%)
Genitourinary	1,021 (3%)
Cancer	2,202 (7%)
Other	5,887 (20%)
Mechanical ventilation	14,978 (50%)
Sepsis	9,055 (30%)
Severe sepsis	7,486 (25%)
Severity of AKI	
Stage 1	20,783 (70%)
Stage 2	5,204 (18%)
Stage 3	3,745 (13%)
Acute dialysis	1,460 (5%)
Hospitalization characteristics	
Nephrology consultation	6,031 (20%)
Kidney biopsy	86 (0.3%)
Discharge creatinine, mg/dL[c]	1.1 [0.8-1.4]
Recovery of kidney function	
Full recovery	20,150 (68%)
20-60% above baseline creatinine	7,462 (25%)
>60% above baseline creatinine	2,120 (7%)

Note: Data are presented as n (%) or median [interquartile range].
Abbreviations: AKI, acute kidney injury; CABG, coronary artery bypass grafting; eGFR, estimated glomerular filtration rate; ER, emergency room; ICU, intensive care unit; PCI, percutaneous coronary intervention; SES, socioeconomic status; TIA, transient ischemic attack.
[a]Income was categorized according to fifths of average neighborhood income. For missing SES (<1%), income was inputed as middle (level 3).
[b]For missing residence (<1%), residence was inputed as rural.
[c]Conversion factor for serum creatinine in mg/dL to μmol/L, times by 88.4.

risks for adverse outcomes after AKI, our findings illustrate an important gap in care for survivors of critical illness and AKI.

Our study findings are consistent with current literature regarding follow-up after AKI, although studies in the critically ill population are limited. Although serum creatinine measurements occur frequently postdischarge, urine protein measurements and nephrology follow-up do not. In a study of 433 critically ill patients with dialysis-requiring AKI, at 3 months, serum creatinine and urine protein were measured in 88% and 12% of survivors, respectively.[25] Similarly, Kirwan et al[26] assessed 219 critically ill patients with dialysis-requiring AKI; only 57% of patients had creatinine checked between 3 and 6 months postdischarge, and 12% were seen by a nephrologist within 3 months. Our low incidence of nephrology follow-up of 5% at 3 months is similar to Ransley et al,[27] where only 6% of critically ill patients with AKI had nephrology follow-up at 3 months.

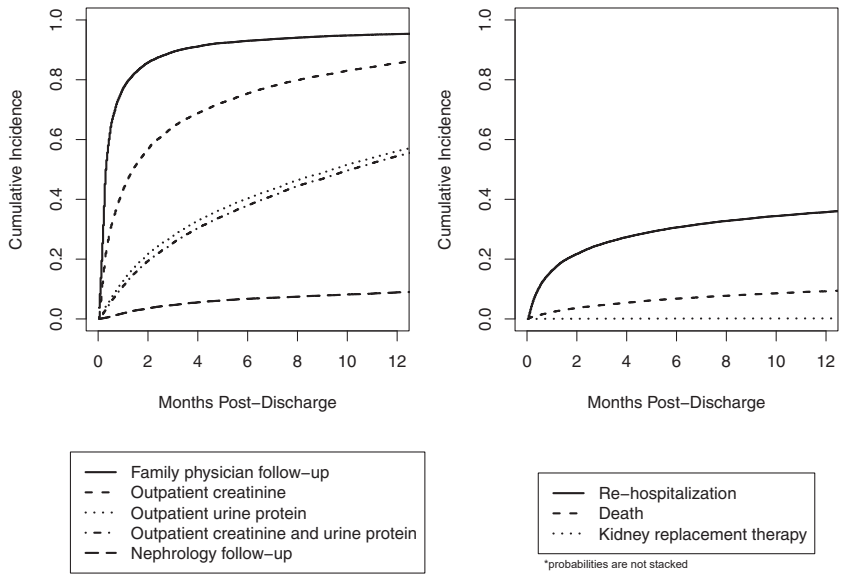

Figure 1. Cumulative incidences of (A) outcomes and (B) competing events postdischarge.

Our study highlights a gap in care relative to guideline recommendations and expert consensus related to follow-up post-AKI. An expert consensus in 2019 recommended a step-wise approach to post-AKI care with labs within 3-6 weeks for prolonged stage 1 or stage 2 AKI, labs within 1-2 weeks for prolonged stage 2 AKI, labs within days of discharge for stage 3 AKI, and nephrology follow-up with increasing severity of AKI.[28] We found that a higher stage of AKI, receipt of acute dialysis, and worse kidney function at the time of discharge were associated with a higher likelihood of receiving outpatient serum creatinine and urine protein measurements. However, the rate of laboratory testing (especially urine protein measurement) and nephrology follow-up remained low. The low rate of urine protein measurements is concerning, as the presence of proteinuria post-AKI is associated with increased risk of developing CKD.[29] Despite the publication of the 2012 KDIGO guideline, hospitalization era did not improve our outcome, suggesting that the guideline recommendations did not result in a change in clinical practice in Alberta, Canada. However, given the growing evidence for post-AKI care, we hypothesize that there will be an increase in laboratory monitoring post-AKI in future years.

There are several potential reasons for the disparity between recommendations and actual practice, particularly in this critically ill population. First, there may be a lack of awareness of the significance of AKI by the ICU and hospital providers, patients, and families. Patients may not remember their AKI experience, owing to their critical illness, sedation strategies in the ICU, and the lack of

Table 2. Cumulative Incidences for Outpatient Laboratory Measurements, Physician Follow-up Visits, Death, and Kidney Replacement Therapy.

Outcomes	3 mo	6 mo	12 mo
Primary outcome			
Outpatient serum creatinine and urine protein measurement	25.4 [24.8, 25.9]	37.9 [37.3, 38.6]	54.5 [53.8, 55.2]
Secondary outcomes			
Outpatient creatinine measurement only	64.1 [63.5, 64.7]	75.4 [74.9, 76.0]	85.6 [85.1, 86.0]
Outpatient urine protein measurement only	27.8 [27.2, 28.3]	40.3 [39.6, 40.9]	56.2 [55.5, 56.9]
Family physician visit	89.3 [88.9, 89.7]	93.0 [92.7, 93.3]	95.3 [95.0, 95.6]
Nephrology follow-up visit	4.6 [4.4, 4.9]	6.7 [6.4, 7.1]	8.9 [8.5, 9.3]
Internal medicine visit	28.0 [27.5, 28.6]	36.6 [36.0, 37.3]	45.2 [44.5, 45.8]
Cardiology visit	29.2 [28.6, 29.8]	36.3 [35.6, 36.9]	40.6 [40.0, 41.3]
Competing events			
Death	4.6 [4.4, 4.9]	6.8 [6.5, 7.1]	9.2 [8.9, 9.6]
Kidney replacement therapy[a]	0.09 [0.06, 0.13]	0.13 [0.09, 0.18]	0.17 [0.13, 0.23]
Rehospitalization	25.1 [24.6, 25.6]	30.6 [30.1, 31.1]	35.7 [35.2, 36.3]

Note: Cumulative incidence probabilities expressed as percentages and 95% confidence intervals.
[a]Includes maintenance dialysis or kidney transplantation.

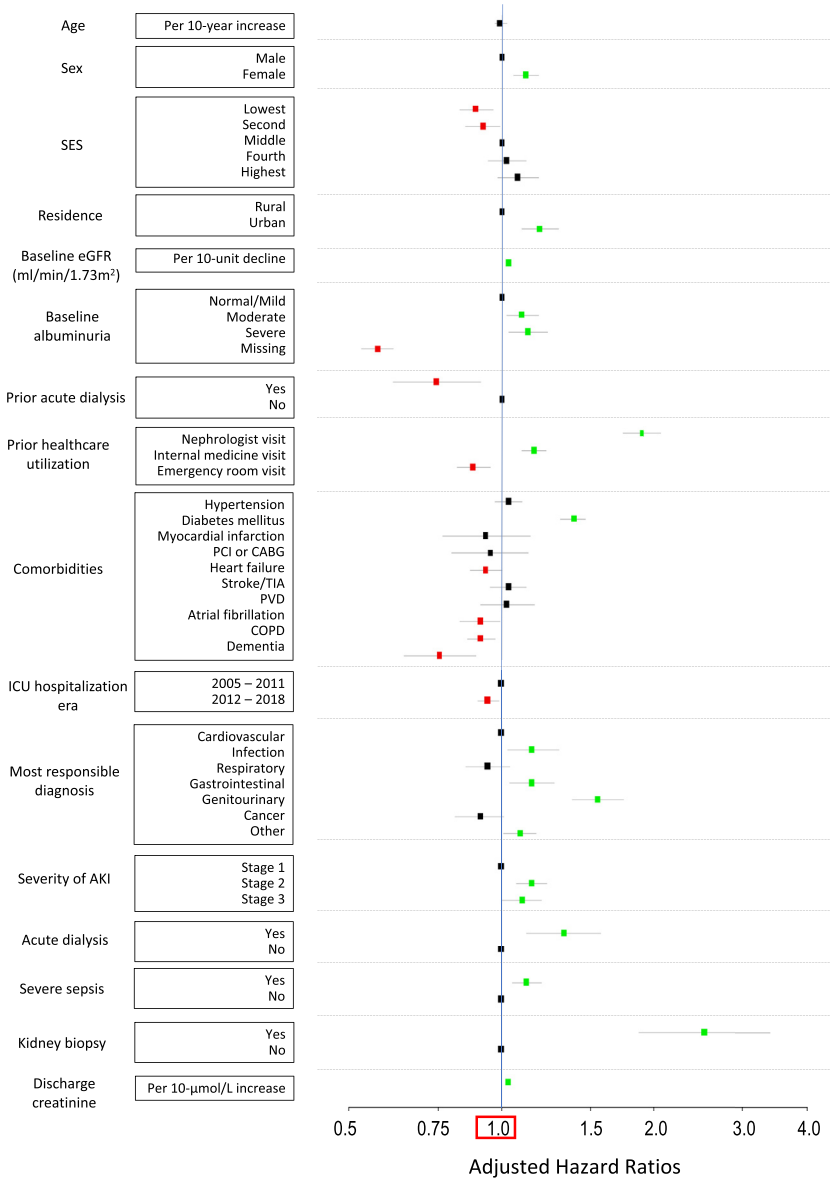

Figure 2. Adjusted associations of baseline characteristics with receiving both an outpatient serum creatinine and urine protein measurement at 3 months of hospital discharge. Abbreviations: AKI, acute kidney injury; CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate; ICU, intensive care unit; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; SES, socioeconomic status; TIA, transient ischemic attack.

physical findings of AKI. In a study of hospitalized patients who survived after stage 2 or 3 AKI, 80% of patients were unaware that they had experienced AKI.[30] Second, despite the increasing incidence of dialysis-requiring AKI in critically ill patients,[31] the role of nephrologists may be declining. Since ICUs became a closed unit, intensivists commonly prescribe continuous kidney replacement therapy. In Alberta, Canada, this effect may be more pronounced as continuous kidney replacement therapy (and even intermittent dialysis modalities in some centers) is prescribed by intensivists. Reflecting this declining role, only 20% of our cohort received an inpatient nephrology consultation, and less than half of critically ill patients with dialysis-requiring AKI were seen by inpatient nephrology in Ransley et al.[27] Third, there may be a breakdown in the transition of care from the hospital to the community. Though nearly all patients had a family physician visit 6 months postdischarge, many patients did not receive creatinine and especially urine protein measurements. Choon et al[25] found that AKI and the receipt of dialysis were mentioned in 85% and 82% of critical care discharge summaries, respectively, and monitoring of kidney function postdischarge was recommended in only 36% of hospital discharge summaries.

Enhanced follow-up of AKI survivors may improve outcomes in this vulnerable population. Follow-up labs may identify those at high risk for CKD early on, leading to timely referral to nephrology. Nephrology follow-up may enable a comprehensive assessment of kidney disease, management of risk factors, and appropriate re-institution of reno-protective medications, such as renin-angiotensin-aldosterone system inhibitors and sodium/glucose cotransporter 2 inhibitors. Both nephrologists and primary care providers support a multi-disciplinary post-AKI care model.[32] In a recent propensity-matched cohort study, attendance at an AKI follow-up clinic after hospital discharge was associated with a 29% lower relative risk of death and a higher likelihood of receiving statins, beta-blockers, and sodium/glucose cotransporter 2 inhibitors (though not renin-angiotensin-aldosterone system inhibitors).[33] Harel et al[34] found that a nephrologist visit within 90 days of discharge after dialysis-requiring AKI was associated with a 24% lower risk of death at 2 years when compared with propensity score-matched AKI patients without follow-up. In survivors of critical illness and AKI, patients who were followed in a post-AKI clinic had a lower risk of rehospitalization in the first 6 months post-discharge when compared with usual care.[35] These findings are hypothesis-generating and warrant further study regarding the potential outcome benefits of post-AKI care. Additionally, there are important health systems and financial implications for Canada's single-payer, public health care system.[5]

Our study had several strengths. We had a large sample size of survivors of critical illness with AKI over a 13-year period that allowed us to characterize follow-up care in Alberta, Canada. Our serum creatinine measurements in the Alberta Kidney Disease Network have been standardized across provincial laboratories, reducing inter-laboratory variation in measurements. There are also limitations worth noting. We were not able to determine which prescribers ordered the laboratory testing and whether the lack of testing was physician or patient driven. We did not have granular ICU data to assess and control for the severity of critical illness. However, we did determine the presence of mechanical ventilation as a surrogate measure of severity of critical illness. We did not have urine output data for staging of AKI, which may explain the lower incidence of stage 3 AKI in our cohort when compared with previous studies.[8,36] Therefore, our primary outcome may be underestimated in our study. We did use serum creatinine measurements during the ICU portion of their hospitalization to assess for the stage of AKI, as well as validated algorithms to identify the requirement of acute dialysis.

In summary, in this Canadian cohort of 29,732 critically ill patients with AKI, only 1 in 4 patients received the recommended follow-up laboratory testing with serum creatinine and urine protein measurements at 3 months of hospital discharge. Despite a high rate of follow-up with a family physician, many did not receive an outpatient serum creatinine measurement, and urine protein measurements were particularly low. Better recognition of the long-term implications of AKI and effective communication between patient providers during transitions of care may advance the follow-up care of critically ill patients with AKI. Further research is needed to determine if post-AKI care can improve long-term outcomes for survivors of critical illness and AKI.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Cohort creation.

Figure S2: Study design.

Table S1: STROBE and RECORD Statement Checklist.

Table S2: Databases and Coding Definitions for Inclusion/Exclusion Criteria, Baseline Characteristics, and Outcome Measurements.

Table S3: KDIGO Definitions.

Table S4: Adjusted Associations of Baseline Characteristics With Receiving Both an Outpatient Serum Creatinine and Urine Protein Measurement at 3 Months of Hospital Discharge.

ARTICLE INFORMATION

Authors' Full Names and Academic Degrees: Rachel Jeong, MD, Matthew T. James, MD, PhD, Robert R. Quinn, MD, PhD, Pietro Ravani, MD, PhD, Sean M. Bagshaw, MD, MSc, Henry T. Stelfox, MD, PhD, Neesh Pannu, MD, MSc, Alix Clarke, MSc, Ron Wald, MDCM, MPH, Tyrone G. Harrison, MD, PhD, Daniel J. Niven, MD, PhD, and Ngan N. Lam, MD, MSc

Authors' Affiliations: Division of Nephrology, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada (RJ, MTJ, RRQ, PR, AC, TGH, NNL); Department of Critical Care Medicine, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada (RJ, HTS, DJN); Department of Community Health Sciences, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada (MTJ, RRQ, PR, HTS, TGH, DJN, NNL); Department of Critical Care Medicine, Faculty of Medicine and Dentistry, University of Alberta, and Alberta Health Services, Edmonton, AB, Canada (SMB); O'Brien Institute for Public Health, Cumming School of Medicine, University of Calgary, Calgary, AB, Canada (HTS, DJN); Division of Nephrology, Department of Medicine, University of Alberta, Edmonton, AB, Canada (NP); Division of Nephrology, St. Michael's Hospital and the University of Toronto, Toronto, ON, Canada (RW); and Li Ka Shing Knowledge Institute of St. Michael's Hospital, Toronto, ON, Canada (RW).

Address for Correspondence: Ngan N. Lam, MD, MSc, Health Research Innovation Centre, 3230 Hospital Drive NW, University of Calgary, Calgary, AB, Canada, T2N 4Z6. Email: ngan.lam@ucalgary.ca

Authors' Contributions: Study conception and research design: RJ and NNL; data acquisition and data analysis: RJ, AC, and NNL; data interpretation: all authors. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

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Data Sharing: The data underlying this article cannot be shared publicly due to our contractual arrangements with the provincial health ministry (Alberta Health), who is the data custodian. Similar data can be requested from the Alberta SPOR support unit.

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Do critically ill patients with AKI receive kidney follow up after discharge?

Kidney Medicine

STUDY

Alberta, Canada

Retrospective cohort study 2005 - 2018

N = 29,732 ICU patients with AKI

Survived to discharge No maintenance KRT eGFR > 15ml/min

COHORT

Median age
68 years
IQR 57 - 77

Median stay
13 days
IQR 7 - 24

Median creatinine at discharge
1.1 mg/dL
IQR 0.8 - 1.4

5% received acute dialysis

RESULTS AT 3 MONTHS

Primary outcome

Cumulative incidence of both an outpatient serum creatinine & urine protein measurement

25%
95% CI 25 - 26

Secondary outcomes

Outpatient visit

Family Physician	**89%**	95% CI 89 - 90
Nephrologist	**5%**	95% CI 4 - 5
Internist	**28%**	95% CI 28 - 29
Cardiologist	**29%**	95% CI 29 - 30

Conclusion: Most critically ill patients with AKI do not receive recommended follow-up care, highlighting a gap in the transition of care for survivors of critical illness and AKI.

Reference: Jeong R, James MT, Quinn RR, et al. Follow-up care of critically ill patients with acute kidney injury: a cohort study. *Kidney Medicine, 2023.*

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