

# Follow-up Care in Acute Kidney Injury: Lost in Transition



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**Acute kidney injury (AKI) is an increasingly common condition that is associated with long-term health outcomes. Recent studies have demonstrated that AKI, particularly when severe or persistent, is associated with all-cause mortality, CKD, ESRD, cardiovascular events, and reduced quality of life. However, data from multiple health care systems indicate that most patients do not see a nephrologist, although 1 study has suggested patients with AKI requiring dialysis may benefit from doing so. These observations raise the greater questions of what are the elements of care that may improve outcomes in survivors of AKI and which survivors need to be seen. Potential opportunities to improve care include appropriate risk stratification, closer monitoring of kidney function, management of CKD complications, blood pressure control, medication reconciliation, and education. Nephrologists are in an ideal position to lead and advocate for outpatient care pathways for survivors of AKI. In this article, we review the evidence supporting patient follow-up after AKI, describe the current state of follow-up care, and examine strategies to improve long-term outcomes for this high-risk population.**

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**Key Words:** Acute kidney injury, Care transitions, Long-term outcomes, Quality improvement

## INTRODUCTION

Acute kidney injury (AKI) is a common complication of acute illness that affects as many as 20% of hospitalized patients.<sup>1,2</sup> Efforts to improve outcomes have traditionally focused on preventing and treating the early phases of this condition. However, few innovations have emerged over the past few decades, and there is now a growing population of survivors of AKI for whom optimal follow-up care remains to be defined.<sup>3-5</sup> Currently, many of these patients are discharged with variable degrees of kidney function recovery with little to no routine follow-up kidney care.

The importance of the latter has become evident in studies showing that individuals who survive an episode of AKI are at increased risk of adverse outcomes that include both kidney and non-kidney sequelae (Fig 1).<sup>6</sup> Although the causal nature of the relationship remains debated,<sup>7,8</sup> there is no doubt that an episode of AKI can herald an ominous prognosis. Unfortunately,

under-recognition of the post-discharge implications of AKI may be common and compounded by fragmentation and poor coordination of care after hospital discharge.

With the incidence of AKI estimated to increase, these long-term consequences will carry with them a significant public health burden.<sup>9-11</sup> This review will briefly examine the kidney and non-kidney complications associated with a hospitalization for AKI, the current state of AKI post-discharge care, and potential care pathways for patients after an episode of AKI that may improve long-term outcomes.

## PATIENT OUTCOMES AFTER AN AKI HOSPITALIZATION

A meta-analysis of 13 studies demonstrated that compared with patients without AKI, those who survive an AKI episode have a 2-fold higher risk of death, a 3-fold higher risk of ESRD, and a 10-fold higher risk of developing either incident or progressive CKD.<sup>12</sup> The associations between AKI and mortality have been observed across several patient populations, including general inpatients,<sup>13-16</sup> myocardial infarction,<sup>17,18</sup> critical care,<sup>19</sup> general surgery,<sup>20</sup> and cardiac surgery.<sup>21</sup> The effect size in the above meta-analysis was not small, with a pooled mortality rate of 17/100 person-years.<sup>12</sup>

The pooled rates of ESRD and CKD in the same study were 9/100 person-years and 26/100 person-years, respectively.<sup>12</sup> The risk for adverse kidney outcomes increased in a graded manner with the equivalent of Kidney Disease Improving Global Outcomes (KDIGO) AKI Stage 1 (hazard ratio [HR] 2.0, 95% confidence interval [CI] 1.4-2.8), Stage 2 (HR 3.3, 95% CI 1.7-6.2), and Stage 3 (HR 28.2, 95% CI 21.1-37.5).<sup>12</sup> In another study, the need for dialysis increased the likelihood of progression to Stage 4 CKD by 500-fold (over 5000%).<sup>22</sup> As expected, kidney outcomes are worse if the serum creatinine does not return to its pre-existing baseline after an episode of AKI.<sup>23,24</sup> Pannu and colleagues<sup>24</sup> found in their population-based study that survivors of AKI who did not recover to within 25% of their baseline serum creatinine were at increased risk for a doubling of serum

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creatinine or ESRD (HR 4.1, 95% CI 3.4-5.0). However, the association between AKI and adverse kidney events is present even among patients with mild and rapidly reversible AKI.<sup>25,26</sup> In patients with a baseline estimated glomerular filtration rate (eGFR) over 60 mL/min/1.73 m<sup>2</sup>, Bucaloiu and colleagues<sup>25</sup> matched 1600 patients with AKI who recovered to within 10% of the baseline value to a control group of patients who did not experience AKI. After a median follow-up of 3 years, the rate of incident CKD was 28 cases/1000 person-years in the AKI group and 13 cases/1000 person-years in the control group. Whether this indicates incomplete recovery not captured by serum creatinine, a marker of lower renal reserve or unappreciated intrinsic kidney disease itself is unknown. Regardless of the mechanism, these findings suggest that survivors of AKI, even among patients with mild or reversible injury, may be at increased risk for adverse kidney outcomes.

AKI is also associated with long-term cardiovascular events. A recent meta-analysis of 25 cohort studies in 55,150 patients with AKI showed an 86% increase in cardiovascular mortality, a 58% increased risk of heart failure, a 40% increased risk of myocardial infarction, and a 15% increased risk of stroke.<sup>27</sup> These elevated risks persisted among several subgroups, including AKI severity, recovery, and in patients with and without pre-existing cardiovascular disease or CKD. Therefore, the association between AKI and cardiovascular events may not be simply explained by reduced kidney function after an episode of AKI. One potential mediator may be the potential effects of AKI on blood pressure. In a retrospective cohort study of 2451 previously normotensive patients who survived an AKI hospitalization, Hsu and colleagues<sup>28</sup> found that survivors of AKI were more likely than patients without AKI to develop hypertension over a 2-year follow-up period (46% vs 41%). This difference became evident within 180 days (31% vs 23%), persisted after multivariable adjustment, and remained present after exclusion of patients with pre-existing CKD.

Last, more proximal adverse outcomes after AKI include the morbidity and cost associated with rehospitalization. A recent population-based study from Ontario, Canada, in 156,690 patients with AKI demonstrated that 1 in 3 patients who survived a hospitalization complicated by AKI died, were readmitted to hospital (median time to all-cause readmission of 11 days), or visited the emergency department within 30 days of hospital discharge.<sup>29</sup> Increased rates of 30-day readmission have also been noted in patients with KDIGO AKI Stage 1,<sup>30</sup> patients with AKI in the critical care unit,<sup>31</sup> and those with heart failure who experience

AKI.<sup>32</sup> Recurrent AKI is another important outcome to consider because each episode of AKI was found to double the risk of Stage 4 CKD in patients with diabetes.<sup>33</sup> Among 11,683 AKI hospitalizations in a regional Veterans Administration database, 25% of patients were rehospitalized with AKI in the next year.<sup>34</sup> The median time to recurrent AKI was 64 days and close to 60% of these episodes occurred within 90 days of hospital discharge. Reducing the risk for these interim outcomes within the first few weeks to months after discharge may be an underappreciated opportunity to improve the long-term prognosis for these patients.

## CURRENT STATE OF AKI FOLLOW-UP CARE

### Follow-up Nephrology Care

Multiple studies have observed low rates of nephrology follow-up care after an episode of AKI across different settings and countries. In Medicare patients aged 66 years and older,<sup>35</sup> 75% of patients see a primary care physician within 3 months of discharge, whereas 37% and 13% see a cardiologist or nephrologist, respectively. Follow-up increases with time, but the percentage of patients seen by a nephrologist at 12 months after an AKI hospitalization is still only 19%. Follow-up by a nephrologist also remains low in patients with pre-existing CKD (23% at 12 months) and diabetic nephropathy (29% at 12 months), which are 2 strong risk factors for post-AKI adverse events (Table 1).<sup>23,24,34,36,37</sup> Notably, AKI was detected using administrative codes, which tend to capture more severe AKI than current consensus definitions using creatinine-

based criteria.<sup>38,39</sup> A similar pattern of follow-up care has been observed using creatinine-based criteria for AKI in a regional Veterans Administration database for 3929 patients whose eGFR remained less than 60 mL/min/1.73 m<sup>2</sup> 30 days after peak serum creatinine. Siew and colleagues<sup>40</sup> used a competing risk approach to determine patient outcomes. At 3 months, 4% of patients were referred to a nephrologist before experiencing recovery, death, or dialysis. At 1 year, only 9% were referred to a nephrologist before any evidence of recovery, death, or dialysis. Results from public and single-payer health care systems are consistent with these results. In a critical care unit from England,<sup>41</sup> 12% of patients with AKI requiring dialysis saw a nephrologist by 3 months and 41% of patients requiring dialysis for AKI saw a nephrologist by 3 months in a population-based study from Ontario, Canada.<sup>42</sup> Therefore, current practice is for less than half of the highest risk patients with the most severe forms of AKI to receive specialized nephrology follow-up on discharge.

### CLINICAL SUMMARY

- Patients who survive an episode of acute kidney injury (AKI) are at increased risk for kidney events (CKD, ESRD, recurrent AKI), non-kidney events (myocardial infarction, stroke, all-cause readmission), and lower quality of life.
- Important risk factors for adverse events after AKI include pre-existing CKD, AKI requiring dialysis, and a serum creatinine that fails to return to its pre-AKI baseline.
- Across multiple health care systems, less than half of high-risk patients will see a nephrologist within 1 year of an episode of AKI.
- Although the most effective care elements remain to be determined, simple interventions such as careful monitoring for kidney recovery, medication reconciliation, blood pressure control, and patient education should be considered for most patients after an AKI episode.

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