Reconfiguring Health Care Delivery to Improve AKI Outcomes

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AKI is the most common reason for inpatient nephrology consultation and has been shown to carry an increased risk of morbidity and mortality in a variety of clinical settings (1–3). These characteristics coupled with the often delayed recognition of AKI, the lack of specific pharmaceutical therapies, and primary reliance on supportive care as treatment represent major challenges and have potentially hindered progress improving the care of patients with AKI. Nephrologists have sought to transform the care of patients with AKI through changing these factors. Although little has changed with regard to novel therapies for AKI, the past several years have seen progress in the earlier recognition and standardization of supportive care in the setting of evolving AKI (4–10).

Early recognition of AKI has been an area of intense investigation over the last decade, with efforts focused on blood and urinary biomarkers of AKI and electronic alerts. Electronic alerts have come in two flavors: those seeking to predict the development of AKI and adverse events before they happen (6,7) and those that notify the physician that AKI has just been diagnosed in a specific patient (4,10). Although clinical implementation of the former, predictive algorithms, has been limited, these complex risk scores show a large degree of promise owing to their utilization of the data available in the electronic health record, advancements in machine learning, and prior successes in other clinical settings (6,7,11). Conversely, electronic algorithms for the notification of recently diagnosed AKI have shown more progress and promise. Although an initial investigator-masked, parallel group, randomized, controlled trial of such alerts did not show improved outcomes, this trial did not link the alert to an AKI-focused specific intervention but rather, solely notified the primary treating physician and pharmacist to the presence of AKI (12). Since this trial, Selby and colleagues (4,13,14) have published a series of papers documenting their experiences in implementing a real-time electronic AKI alert and then linking the alert to an AKI-focused care bundle. They showed that a care bundle focused on history and physical examination, limited diagnostics, and treatment strategies, such as ensuring euvolemia and preventing fluid overload; identifying the underlying cause of AKI (stopping nephrotoxins, relieving obstruction, *etc.*); treating the complications of AKI; and dose adjusting medications facilitated improved patient outcomes. More specifically, those patients who had their care bundle completed within the first 24 hours ($n=306$ of 2997; 12% of the cohort) experienced better outcomes (fewer severe AKI events and lower mortality) (4). Care bundle completion provided a dose-response effect, with those having their bundle completed in >24 hours having better outcomes compared with those who never had the bundle completed. Thus, adherence to a simple kidney focused care bundle in the setting of early AKI may improve inpatient outcomes.

This concept has been recently extended in a randomized, controlled trial using tissue inhibitor of metalloproteinase 2 and IGF binding protein 7 (Nephrocheck) instead of an electronic alert (5). In the Prevention of Cardiac Surgery-Associated AKI by Implementing the KDIGO Guidelines in High Risk Patients dentified by Biomarkers (PrevAKI) Trial, patients who had recently undergone cardiac surgery and were found to have [tissue inhibitor of metalloproteinase 2] × [IGF binding protein 7] levels >0.34 hours after cardiac surgery were randomized to receive a "[Kidney Disease Improving Global Outcomes–]based care bundle" consisting of optimization of volume status and hemodynamics, avoidance of nephrotoxins, and prevention of hyperglycemia. As with the electronic alert studies, the development and severity of AKI were significantly reduced in those randomized to the bundle compared with usual care. AKI of any stage occurred in 76 of 138 (55%) in the bundle group compared with 99 of 138 (71%) in the usual care ($P=0.04$), whereas the incidence of severe AKI (stage 2 or 3) occurred in 41 of 138 (30%) in the bundle group compared with 62 of 138 (45%) in the control group ($P=0.01$) (5). Thus, the timely identification of those with early postoperative AKI coupled with a systematic kidney protective care plan led to improved patient outcomes (5).

In this issue of the *Clinical Journal of the American Society of Nephrology*, Acedillo *et al.* (15) report on a population-based retrospective cohort study, in which they examine the outcomes of patients who were discharged from the emergency department (ED) with AKI. In this study, which analyzed 9 years of emergency room visits in Ontario, Canada, the authors found 6346 ED discharges with serum creatinine–defined Kidney Disease Improving Global Outcomes AKI. Although 95% of these discharges only had stage 1 AKI, they showed that ED discharges with AKI were associated with lower long-term mortality compared

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with a matched cohort hospitalized after having AKI in the ED. One hundred and thirty of those discharged from the ED with AKI (3%) died within 30 days compared with 522 (12%) of those admitted with AKI (relative risk, 0.3; 95% confidence interval [95% CI], 0.2 to 0.3; $P<0.01$). Importantly, this effect was driven by the higher mortality in those patients admitted to the hospital with mild AKI (stages 1 and 2 AKI). There was no difference in the mortality for those who went on to develop stage 3 AKI, regardless of whether they were admitted or discharged home from the ED (7 of 44 died; 16% identical rates in both groups; relative risk, 1.0; 95% CI, 0.4 to 2.6; $P>0.99$). There was no statistical difference in the 30-day receipt of hospital-based RRT when comparing those discharged home with AKI with those admitted to the hospital, although there was a trend to more RRT in the hospitalized cohort (0.4% versus 0.8%; relative risk, 0.6; 95% CI, 0.3 to 1.0; $P=0.06$).

ED discharges home with AKI were associated with higher mortality (relative risk, 1.6; 95% CI, 1.2 to 2.0; $P=0.01$) and higher rates of 30-day hospital-based RRT (relative risk, 2.7; 95% CI, 1.2 to 6.0; $P=0.01$) compared with a separate matched cohort of ED home discharges without AKI ($n=6188$) (15). Event rates were slightly lower in the discharged home without AKI cohort, with 136 (2%) and 87 (1%) of those with and without AKI experiencing 30-day mortality, respectively, and 19 (0.3%) and seven (0.1%) going on to receive hospital-based RRT, respectively. Although all of these analyses suffer from the inherent limitations of a retrospective cohort study, importantly, the results highlight two separate aspects of AKI care. First, the treating ED physicians were able to identify, manage, treat, and discharge home a cohort of patients with AKI in the setting of other acute on chronic medical issues and risk stratify them as lower risk for morbidity and mortality compared with the other patients who were admitted to the hospital from the ED with AKI. However, it also highlights that ED-based AKI, although it was almost exclusively stage 1, carries a significant degree of morbidity and mortality, which often go under-recognized by physicians all over the hospital, not just in the ED.

Second, this study emphasizes that every patient with an incident case of AKI is an opportunity to improve patient care and prevent morbidity and mortality, regardless of the AKI setting or severity. It is important to acknowledge that, in individual patients, the link between AKI and adverse outcomes may not be causal, because the AKI (defined by a change in serum creatinine) may serve as a marker of another disease process that driving the risk for morbidity and mortality (*e.g.*, cancer, cardiac disease, liver disease, or the impending need for a surgical procedure). Regardless of its underlying cause and severity, AKI needs to be identified, treated, and managed. Several of the aforementioned methods, including incorporating biomarkers of kidney injury, electronic medical record detection of AKI, and AKI care bundles, can facilitate improved patient outcomes in the setting of AKI. Some have advocated for and piloted programs around an AKI-focused rapid response team, which may improve patient outcomes across a variety of clinical settings (16,17). Over the last decade, this multidisciplinary rapid response team approach has been increasingly accepted and effective in improving patient care and outcomes (18–21). Identifying patients with early AKI (defined by creatinine, urine output, and/or biomarkers) and then adopting a multifaceted kidney-focused care bundle to be implemented by a multidisciplinary AKI-focused rapid response team may be the first steps in improving patient outcomes. Linking this AKI-focused inpatient care with the necessary nephrology outpatient follow-up will help us completely reconfigure the delivery of health care to those at risk for and diagnosed with hospital- and ED-based AKI (22).

Disclosures

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See related article, "Characteristics and Outcomes of Patients Discharged Home from an Emergency Department with AKI," on pages 1215–1225.