Electronic Alerts for Acute Kidney Injury

Paul M. Palevsky

The use of electronic alerts linked to embedded clinical decision support tools has been anticipated as a benefit of electronic health record adoption. The benefits of electronic alerts have been demonstrated in multiple domains ranging from notification of critical laboratory and imaging findings to mitigation of hazardous drug interactions, enhanced use of immunizations, venous thromboembolism prophylaxis, and antiplatelet therapy among hospitalized patients. However, alerts are not a panacea; excessive alerts may lead to “alert fatigue” or may have unintended consequences that undermine their utility. Thus, the effectiveness and burdens of individual alerts need to be carefully analyzed before widespread deployment.

Acute kidney injury (AKI) has been fertile territory for the development of clinical alerts. Enhanced recognition of AKI can be provided based on automated calculation of changes in serum creatinine concentrations. However, prior efforts implementing AKI alerts to improve clinical outcomes have yielded variable results. During sequential 6-month periods in a hospital in the United Kingdom, implementation of an electronic AKI alert coupled with hospital-wide, intranet-hosted guidelines (including a care bundle of management recommendations for AKI) was associated with a progressive decline in 30-day mortality for patients with AKI. In contrast, at a teaching hospital in the United States, implementation of an electronic alert with a link to an internal website listing AKI practice guidelines was not associated with improved clinical outcomes.

In this issue of AJKD, Park et al describe the effect of an electronic AKI alert system linked to an automated nephrology consultation on outcomes at a single university hospital in the Republic of Korea. The authors electronically identified AKI based on an increase in serum creatinine concentration of at least 1.5-fold or 0.3 mg/dL as compared to baseline (defined as the minimum serum creatinine value within 2 weeks of admission or the first value after admission if preadmission values were not available). The alerts were processed nightly and were available). The alerts were processed nightly and were delivered the following morning rather than being delivered in real time. In addition to providing notification of AKI, the alert provided a prompt to request a nephrology consultation. Results from the first year after the alert was introduced were compared with retrospective data from the prior year. A total of 1,884 patients with AKI were included in the prealert analytic cohort (period prevalence of 8.7%) as compared with 1,309 patients in the alert cohort (period prevalence of 5.1%).

There were significant demographic and clinical differences in the 2 cohorts. Compared to the prealert cohort, the alert cohort was older and had more men, more patients having surgery during the index hospitalization, lower baseline kidney function, greater frequency of anemia and hypoalbuminemia, and higher rates of diabetes mellitus, hypertension, and heart disease. After implementation of the alert, the frequency with which a follow-up serum creatinine concentration was not rechecked within 2 weeks after the onset of AKI decreased from 18.1% to 5.9%, while the rate of nephrology consultation increased from 10.6% to 32%. In addition, the frequency of severe (stage 2 or 3) AKI decreased from 31.6% to 27.1%, and recovery of kidney function within 30 days (defined as a return of serum creatinine to <1.2 times baseline or <0.2 mg/dL above baseline) increased from 55.6% to 80.3%. When analyzed independently of the alert, early nephrology consultation was associated with higher rates of severe AKI, lower rates of failure to follow up kidney function, and higher rates of recovery of kidney function.

Although the results reported by Park et al suggest promise for the use of AKI alerts, these data must be interpreted with caution. First and foremost, AKI alerts based solely on change in serum creatinine concentration cannot differentiate among the panoply of causes of AKI. AKI is not a single disease, and no data are provided regarding the distribution of causes of AKI occurring during the prealert and intervention periods. Second, as noted, characteristics of patients with AKI during the 2 periods were substantially different, with older patients having lower baseline kidney function and greater co-morbid conditions during the intervention phase. These changes did not reflect a secular change in the overall characteristics of the hospitalized population as similar trends were not seen among patients without AKI during the 2 phases. Although these patient characteristics are associated with higher risk for the development of AKI, the period prevalence of AKI during the intervention phase was lower than in the preintervention phase, suggesting the possibility of variability of ascertainment across the 2 periods. Furthermore, ascertainment of the severity and recovery of AKI may have been biased by differences in baseline serum creatinine concentrations in the 2 cohorts. Assessment of recovery of kidney function may also have been subject to ascertainment bias, with differential rates and timing of measurement of follow-up serum creatinine. Third, there was no change in mortality associated with the intervention and no data for the need for renal replacement therapy. The primary motivation for implementation of AKI alerts is the markedly excessive morbidity and mortality rate associated with AKI. The
absence of observed benefit with regard to mortality even after adjustment for differences in the characteristics of the pre- and postintervention cohorts could represent a degree of residual confounding or may reflect issues related to sample size. Regardless, this should raise concern regarding the utility of this strategy. Finally, the intervention coupled to the alert was used in only a minority of patients; the frequency with which early nephrology consultation was requested increased by only slightly >20% and in more than two-thirds of patients for whom the alert was triggered no consultation was requested. Despite this low response rate to the alert, the total number of renal consults attributable to the alert increased the workload for the nephrology consultation service substantially; the economic impact of this increased workload must also be considered, particularly given the absence of a decrease in mortality.

What then should be the next steps in using alerts to improve the care of patients with AKI? Alerts are more likely to be useful if they can be generated in real time rather than delayed until the next day, as was used in the current study. Given the low rate of nephrology consultation triggered by the alert, the use of other linked interventions should be considered. Unfortunately, directed therapy for established intrinsic AKI is lacking and interventions will need to focus on enhanced supportive care. As electronic health records become more sophisticated, robust linkages between medication orders and kidney function can be developed to provide real-time decision support on the need to discontinue or modify dosing of renally excreted or nephrotoxic medications. Examples of such alerts exist. Although implementation of a passive alert in one pilot trial resulted in minimal change in provider behavior, an interruptive alert for contraindicated or high-toxicity medications resulted in more rapid medication discontinuation. Implementation of an alert triggered by more than 3 days of exposure to aminoglycosides or to 3 or more other nephrotoxic medications among non–critically ill pediatric patients resulted in a significant reduction in both nephrotoxic exposure and AKI episodes. One can envision even more sophisticated alerts in the future that simultaneously identify early changes in kidney function and trends in vital signs or other laboratory data to guide fluid administration or early assessment for infection. However, implementation of alerts must be based on rigorous assessment of their utility in improving patient outcomes and their associated costs, and with recognition of the potential for alert fatigue that may result if excessive alerts are generated.

References