Advancing the Use of Clinical Decision Support to Prevent Drug-Associated AKI

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Key Words

Acute kidney injury · Clinical decision support systems · Drug-related side effects and adverse reactions · Adverse drug events

Abstract

Clinical decision support (CDS) has repeatedly been successful in improving the physicians' drug prescribing for patients with kidney disease. Alerts aimed at drug dosing may address prevention of drug accumulation, but might miss situations when a high-risk patient still receives a nephrotoxin. Alert advancement requires CDS that is focused on the appropriate use of potentially nephrotoxic medications. Unfortunately, the literature is replete with examples of inaccurate or ineffective alerts. However, analyzing these efforts will allow us to advance CDS to be more effective and to better understand how to include early detection of drug-associated acute kidney injury. Attempts have been made to address these limitations of CDS, but there are still opportunities for improvement.

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Introduction

Clinical decision support (CDS) is a tool that clinicians use to aid in the detection of patients at risk for medication errors and adverse drug events (ADEs). Inappropri-

ate prescribing is one type of a medication error occurring at the first step of the medication use continuum. Medication errors are of concern because of the possibility of progressing to patient injury, known as a preventable ADE. CDS has repeatedly been successful in improving the physicians' drug prescription for patients with kidney disease [1]. Alerts aimed at drug dosing may address prevention of drug accumulation, but might miss situations when a high-risk patient still receives a nephrotoxin. Alert advancement requires CDS that is focused on the appropriate use of potentially nephrotoxic medications. Preventing dosing errors with CDS is important, and the next goal should be to reduce the progression of drug-associated acute kidney injury (AKI) with early detection of events, at the point of a drug-related hazardous condition [2].

Unfortunately, the literature is replete with examples of inaccurate or ineffective alerts [3, 4]. However, analyzing these efforts will allow us to advance CDS to be more effective and to better understand how to include early detection of drug-associated AKI. This manuscript will provide a discussion of overcoming ineffective alerts and provide suggestions for alert advancement.

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Overcoming Ineffective Alerts

Use of Standardized Definitions for Alert Rules

The variables included in the logic for the rules that generate alerts for AKI vary among studies but all of them use serum creatinine in one way or another. More recent alerts have incorporated Kidney Disease Improving Global Outcomes (KDIGO) or Acute Kidney Injury Network criteria. Variation in alert accuracy arises when trying to determine the optimal baseline creatinine to use (i.e. 12 months prior to admission; 6 months prior to admission, median value). Also, further complications arise when a baseline creatinine is unavailable. A standardized approach for rule logic to identify AKI events, based on optimal alert performance, needs to be applied.

Develop Alerts Specific to ADEs

An effort to develop alerts that are specific to ADEs would begin with CDS rules that detect abnormal laboratory values in patients who are receiving drugs that may cause those abnormal values [5]. Another approach to develop ADE-specific alerts is to look for nephrotoxic drug combinations that can identify patients at risk for AKI, before injury occurs. This latter approach has been studied in non-critically ill children [6].

Present Alerts Outside the Workflow of the Prescriber

Efforts have been made to improve CDS for patients with AKI. Roberts et al. [7] developed a CDS system in the absence of computerized prescriber order entry (CPOE). The CDS included estimates of kidney function and dose adjustments for renally cleared drugs outside of the normal workflow. Academic detailing was completed to assure that users were aware of CDS capabilities. The CDS system was available on a local computer but prescribers were not mandated to use the software. A before-and-after evaluation was completed to determine the impact of CDS availability and noted a 24% increase in holding the dose of renally cleared drugs after the intervention was implemented ($p = 0.01$).

We continue to make advancements in drug-associated AKI alerts with systems that are outside the workflow of the prescriber, which sends alerts to the consultant pharmacist for nursing home patients at multiple sites [8]. The pharmacist receives the alerts and verifies drug causality before proceeding to the prescriber with a recommendation. This model provides the benefit of reducing prescriber alert fatigue, includes pharmacist engage-

ment in the execution of recommendations approved by the physician and should be further explored for the impact on ADE reduction.

Provide Active Alerts with Patient Care Recommendations

CDS demonstrates some benefit when it provides advice on patient care [9]. A parallel group, randomized controlled trial demonstrated that automated alerts for AKI detection did not have an effect on outcomes [10]. Perhaps the reason for the ineffective alert was the passive advice provided to the clinician receiving the alert, being simply a link to the KDIGO guidelines. Leung et al. [9] compared a CPOE-only method, CPOE and passive display of serum creatinine when renally cleared drugs were ordered, and display of serum creatinine plus suggestions for drug dosing and monitoring to no system. The more advanced approach with recommendations for management demonstrated the largest reduction in preventable ADEs from 12.4 to 0 per 100 admissions ($p < 0.001$).

Another study of a combined approach to the advancement of drug-associated AKI alerts included a tiered system with alerts specific to ADEs and provision of advice about patient care along with requiring a forced response [11]. Both passive and interruptive alerts were provided to the prescriber in a tiered fashion based on the potential severity of harm. For example, a passive alert was provided in patients receiving a nephrotoxin for a rise in serum creatinine of 0.5 mg/dl. An interruptive alert was presented on exit from the electronic chart for a patient with a rising serum creatinine and a prescribed nephrotoxin. Prescribers could access a graph of the patient's urine output, serum creatinine and a recommendation about modifying the drug order. A forced response by the physician was required for interruptive alerts. This system demonstrated an improvement in the rate and timeliness of drug order discontinuation or modification.

A tiered approach in the provision of CDS for drug-drug interaction alerts has been applied and has reduced alert burden and improved prescribers' response to alerts. This same concept could work for providing drug-associated AKI alerts [11]. Also, the idea of a tiered approach could be applied to recommendations made by the pharmacist in the model described in 'outside the workflow'. So, a tiered management approach would send an email for less severe events, an immediate notification (i.e., text) for a more severe event and a rapid response structure for a patient requiring immediate attention.

Additional Considerations for Alert Advancement

Risk Models for Early Detection

Attempts have been made to advance drug-associated alerts that are consistent with the literature on faulty systems, but there is an opportunity to further advance alerts. For example, risk stratification models have been developed to identify patients at risk for ADEs. The generality of an all-encompassing model for ADEs may miss specific types of events. The idea of a risk model for early detection of drug-associated AKI could be beneficial. We have an understanding of the risk factors for AKI and many likely apply to drug-associated AKI, although this should be confirmed [12, 13].

Alerts Applied through a Continuum of Care

Advanced alerts would include an evaluation of kidney function in the continuum of care. Alerts could be developed for a health system that include both inpatient and outpatient surveillance when serum creatinine concentrations are available in the system. Also, using CDS to monitor patients who transfer between institutions such as long-term care facilities would allow for early AKI detection [8].

Measuring Alert Performance

Improving CDS requires that the changes made for optimal alert generation are assessed using quality measures such as performance characteristics and the ability to identify medication errors and ADEs. Furthermore, we want to reduce the number of actual ADEs and intercept more potential ADEs at the level of a drug-related hazardous condition. Once CDS is adequately developed then sustainability should be the next step as practices change; then evidence-based, adaptive CDS will be necessary.

Summary

The use of CDS that encourages prescribers to adjust drug dosing for patients with kidney disease is effective. We are developing an understanding of faulty alerts and need to use this knowledge to develop more advanced alerts that optimize the CDS as a tool for early detection of drug-associated AKI so that we may mitigate AKI progression. There is still a need to fully comprehend the performance characteristics of alerts and determine opportunities for more improvements.

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