A Study to Evaluate the Effectiveness of the currently utilized Acute Kidney Injury (AKI) Alert: A Use Case Example for a Learning Health System

Dilhari DeAlmeida             Mohammed Al-Jaghbeer     Mervat Abdelhak        John Kellum
University of Pittsburgh        University of Pittsburgh     University of Pittsburgh        University of Pittsburgh
Medical Center            Medical Center

drd7@pitt.edu mjagber@yahoo.com Abdelhak@pitt.edu kellumja@ccm.upmc.edu

Abstract

Acute kidney injury (AKI) is common among hospitalized patients with significantly worse outcomes even with mild degrees of severity. We collected data on AKI e-alerts in a university medical center in November 2013. A sample of 100 non-ICU patients was analyzed for “possible AKI” e-alert present in the laboratory data section of the EMR. We found that all cases in which the alert fired were true cases of AKI with 100% Specificity and 97% Sensitivity.

1. Introduction

Acute Kidney Injury (AKI) is a devastating illness with no known cause and unsatisfactory treatment. AKI is common among hospitalized patients with significantly worse outcomes even with mild degrees of severity. AKI affects more than 10% of all hospitalized patients and more than 2/3 of all ICU admissions. Current evidence suggests that even very small changes in serum creatinine or transient alterations in urine flow are associated with adverse outcomes. The 2012 KDIGO Clinical Practice guideline (Kidney Int, Suppl 2012, 2:1-138) on AKI recommends that patients be identified with high risk for AKI and in those patients close monitoring should occur. Furthermore, the guideline recommends that susceptibilities and exposures leading to AKI should be sought and patients managed according to these risk factors. Early detection and management may therefore be helpful in improving outcomes from AKI in hospitalized patients. Electronic Medical Record (EMR) is a substantial source of information that can be used to detect early changes in serum creatinine and help alert the physician of a possible AKI.

The primary goal of this project is to identify opportunities for practice improvement and ultimately improving patient care. The Overall objective is to:

- Develop and test methods for extracting AKI from the EMR using changes in serum creatinine over time by building a basic clinical alert system.
- To study the effect of electronic alerts (e-alerts) of AKI on physician decision-making.

As a first step, we have examined the specificity and sensitivity of the alert. The second phase of the study is underway and will assess the impact of physician decision making and the evaluation of the computer based decision support for AKI.

This project is an example of how healthcare facilities could contribute towards the cycle of Learning Health Systems such that higher quality of care which is safe and affordable is provided through the empowerment of a health information technology tool. By utilizing the clinical alert in the Electronic Medical Record, the clinician is provided with real-time data and feedback on the possibility of a patient developing AKI and the subsequent change in the current management of the patient. Key areas related to the Learning Health Systems that are being addressed in the study include: Early detection of patients at risk, Physician intervention and continuous quality measure to improve the system.

The alert would focus on the identification of patients at risk for AKI and the possibility of either delay and possibility prevent progression from moderate to severe risk, physician intervention and decision support on the cohort of patients who might be identified as being progressing to a severe state and the importance of a collaborative team providing means of effective communication, generation of trust and dissolution of boundaries.

With the use of predictive and prescriptive analytics, the clinical alert would be able to identify the patients at risk who may be at an AKI of stage 2, and conduct
appropriate decision support to treat them and prevent/delay their progression to stage 3.

2. Population at Risk

Acute kidney injury (AKI) is common during critical illness occurring in approximately 30-60% of patients and is associated with a case fatality rate of approximately 60% independent of requirement of renal replacement therapy \(^4-6\). With no known unifying mechanism and unsatisfactory treatment, AKI is a devastating illness. Urine output and serum creatinine have been used in the standardization of the AKI definitions with the RIFLE (Risk, Injury, Failure, Loss, End Stage) and AKIN (Acute Kidney Injury Network) classifications systems. Previously, the lack of a consistent definition of AKI had hindered studies of the epidemiology and outcomes of AKI. The introduction of the RIFLE,\(^7\) and later, the AKIN\(^8-9\), definitions and staging systems for AKI has provided a more consistent framework for the objective identification and stratification of patients with AKI. The application of the RIFLE and/or AKIN criteria in studies of AKI has become standard practice, which has facilitated cross-study comparisons and advanced the understanding of AKI incidence and associated outcomes.

3. Multi-disciplinary Approach

For an effective clinical alert tool to be successful there needs to be an effective collaboration among multidisciplinary teams within a healthcare setting. This study incorporated professionals in the areas of clinicians/physicians, information technology, and Health Information Management (HIM).

To execute effective analytics strategies, information systems combined with current data standards and governance initiatives along with data analytics approaches need to be taken to consideration. This approach ensures that both technical and non-technical issues are balanced in the design of key features of data warehousing such as the mapping and translation of data elements. In order to have implemented an effective clinical alert tool, the team needs to plan out the data elements that would need to be captured along with data definitions and data dictionaries alongside the elements. Further, the technical team was consulted for the effective implementation of the alert within the Electronic Medical Record. Finally, once the alert was underway, there needed to be a plan in place to collect the data and analyze the data such that the team could continuously monitor the effectiveness of the alert and provide feedback to the technical team so that we were able to capture the needed data for the project.

Table 1: Multidisciplinary collaboration among the teams

<table>
<thead>
<tr>
<th>Roles</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>-Developed the alert logic and implementation</td>
</tr>
<tr>
<td></td>
<td>-Chart Review for AKI adjudication</td>
</tr>
<tr>
<td></td>
<td>-Review and Feedback for process improvement</td>
</tr>
<tr>
<td>HIM</td>
<td>-Leadership in data and information governance</td>
</tr>
<tr>
<td></td>
<td>-Data Content</td>
</tr>
<tr>
<td></td>
<td>-Privacy/Security</td>
</tr>
<tr>
<td></td>
<td>-Continuous communication with the teams with weekly meetings</td>
</tr>
<tr>
<td>IT</td>
<td>-Review the scope of the alert</td>
</tr>
<tr>
<td></td>
<td>-Create the algorithm</td>
</tr>
<tr>
<td></td>
<td>-Beta testing of the alert</td>
</tr>
</tbody>
</table>

The engagement and interaction among different stakeholders would provide a decentralized approach which would highlight the individual expertise of the different members of the team and have the team be fluidic such that the individuals could exchange ideas and best practices with each other.

5. Methodology

The alert was implemented for all inpatient facilities within a large medical center. There were 14 different sites in total. Some of the key data elements that we are seeking to capture are: the ability of the alert to capture the creatinine change over a retrospective data set (date and time of the first creatinine encounter along with date and time of the subsequent creatinine encounter), demographic data, severity of illness, location of the patient, and the total number of patients involved and the possible staging of AKI.

We collected data on AKI e-alerts in a university medical center in November 2013. A sample of (100) non-ICU patients matched for age, sex, race and
location was analyzed for “possible AKI” e-alert present in the laboratory data section of the EMR.

AKI was defined as in the kidney disease improving global outcomes (KDIGO) clinical practice outline for acute kidney injury \(^\text{10}\). The staging of AKI as per the KDIGO guidelines is depicted in Table 1. We reviewed the laboratory data, physician notes and diagnostic test results to determine if an AKI event had occurred. We compared the results from our chart review to the e-alert.

Table 2: Staging of AKI

<table>
<thead>
<tr>
<th>Stage</th>
<th>Serum creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5–1.9 times baseline OR ( \geq 0.3 \text{ mg/dl} (\geq 26.5 \text{ (\mu)mol/l}) ) increase</td>
</tr>
<tr>
<td>2</td>
<td>2.0–2.9 times baseline</td>
</tr>
<tr>
<td>3</td>
<td>3.0 times baseline OR Increase in serum creatinine to ( \geq 4.0 \text{ mg/dl} (\geq 353.6 \text{ (\mu)mol/l}) ) OR Initiation of renal replacement therapy OR, In patients &lt;18 years, decrease in eGFR to &lt; (35 \text{ ml/min per } 1.73 \text{ m}^2)</td>
</tr>
</tbody>
</table>

The initial phase of the study involved examining the effectiveness of the alert. The current paper discusses the results of this portion of the study.

The second phase of the study involved evaluating the consistency of the staging of the AKI alert and the implications it provides for physicians in terms of patient care. A sample of 100 patients matched for age, sex, race and location are being currently analyzed. We developed a data collection form as depicted in Table 2.

Table 3: Sample Data Collection Form

<table>
<thead>
<tr>
<th>Data Collection Form - AKI Alert</th>
<th>Data Collection Form - AKI Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient ID</td>
<td>Patient ID</td>
</tr>
<tr>
<td>Demographics</td>
<td>Age/Sex/Rac</td>
</tr>
</tbody>
</table>

Data | e  | Date Admitted |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
<td>Date Alert Fired</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional alerts?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Window of activity (10 day window)</td>
</tr>
<tr>
<td>Creatinine</td>
<td>Admission and Baseline</td>
<td></td>
</tr>
<tr>
<td>Progress Note</td>
<td>Date Alert Fired</td>
<td></td>
</tr>
<tr>
<td>Stage 1, 2 or 3</td>
<td>creat</td>
<td>Day 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Discharged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window of activity (10 day window)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date Alert Fired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional alerts?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window of activity (10 day window)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The initial phase of the study involved examining the effectiveness of the alert. The current paper discusses the results of this portion of the study.
6. Results

The preliminary results are from analysis of 100 cases to assess the sensitivity and specificity of the e-alert. We found that 97% of AKI alerts were confirmed as AKI events by chart review.

<table>
<thead>
<tr>
<th>Alert (+)</th>
<th>AKI (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>99</td>
</tr>
<tr>
<td>103</td>
<td>99</td>
</tr>
</tbody>
</table>

Figure 1: Results from the initial phase of the study

We found that all cases in which the alert fired were true cases of AKI (100% Specificity).

We found 1 case of AKI in which the alert failed to fire, and upon further review identified that the lab results were from an outpatient facility and the alert would only fire on inpatient admissions. In addition, further examination of the 100 alert positive cases revealed: Two cases were involved a rise in creatinine of more than 0.5 mg/dL within 52 hours or a rise of creatinine of more than 50% of the lowest measured creatinine of the past year with no alert e-alert. We are in the process of modifying the alert to treat all patients with a gap in creatinine measurement >52hr as new admissions –Therefore the team is planning on implementing the 50% change from baseline rule.
6. Impact on Physician Decision Support

The successful use of the alert on the impact of physician decision support would render outcomes such as, detecting the rate of AKI (since it will have progressed from less to severe), the appropriate diagnosis and management of AKI and ultimately, improving survival and reducing hospital cost by lowering the length of stay (LOS).

For the utilization of the alert and for the impact on physician decision making capabilities, the second phase of the study would be examining a cohort of 100 patients’ pre-alert, examining the nature of physician actions and the decisions that were made and comparing that to physician’s decision making capabilities to the current state with the alert in place. Some questions that we will address are: what clinical decisions did the clinical team make pre and post alert and what impact did the alert have in forming such decisions. The results of this phase of the project would be forthcoming and will be included in the presentation.

10. Conclusions

The main outcome of this project is to assess the validity of the e-alert system in utilizing the EMR in identifying the patients at risk of AKI per the KDIGO guidelines. The alert resulted in 100% specificity and 97% sensitivity. The reasons for the lack of sensitivity in some cases were due to the uniqueness of the patient’s circumstance at the time as described in the methodology section of the paper.

Having a multi-disciplinary team working together on different aspects of the project and leveraging the expertise of each of the disciplines, helped in providing continuous learning opportunities and areas for improvement.

As next steps, the study could further expand to incorporate consumer engagement, where knowledge of the demographical and other healthcare information on the cohort would enable clinicians to make decisions on treatment plans. For example, what are the risk factors associated in developing AKI for consumers who are 65 years and older.
11. References


