Use of machine learning directed interventions to reduce fluid related hospital admissions in hemodialysis patients

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Background and Aims: Patients with end-stage kidney disease (ESKD) are hospitalized nearly two times per year on average; volume overload, infections and other cardiovascular complications are amongst the most common causes of hospitalization. We developed a machine learning (ML) model to predict haemodialysis (HD) patients at imminent risk of hospitalization due to fluid overload within the next 7 days. Patients identified as high risk by the model were assessed, intervened, and triaged by on group of telephonic nurses. The goal of this analysis is to evaluate the impact of the ML model-directed interventions on fluid related hospital admissions and all cause hospital admissions.

Method: We used data from a group of ESKD patients on HD modality who were identified as high risk by the ML model between baseline months April 2022 and June 2023. These high-risk patients were eligible to receive an assessment by telephonic nurses. The follow-up months were defined as the month immediately following the baseline month. Intervention group was identified as the high-risk patients where a clinical chart review was performed with needs identified, clinical chart review was performed and patients were managed by the clinic, some contact was made over phone/mail by the telephonic nurse, or some clinical recommendation was made. High-risk patients without any intervention or activity documented by the telephonic nurse served as the control population. We used linear regression analysis with repeated measures to account for within patient variability to produce estimated outcome rates with 95% confidence intervals adjusting for baseline factors such as average ML model risk score, average albumin, gender, age, race, vintage, comorbidities like chronic heart failure, diabetes, hypertension, ischemic heart disease, and primary insurance.

Results: There were 15,878 patients (36,932 patient months) in the group that received intervention; there were 51,800 patients (398,594 patient months) in the group that did not receive intervention. The pooled analysis (Table 1) showed a 38% reduction in all cause hospital admission rate between the baseline and follow-up months for the group that received intervention and there was a 34% reduction in all cause hospital admission rate for the group that did not receive any intervention. There was a 36% reduction in the fluid related hospital admission rate between the baseline and follow-up months for the group that received intervention and there was a 32% reduction in the fluid related hospital admission for the group that did not receive any intervention.

Conclusion: There is a larger magnitude reduction in fluid related hospital admissions and all cause hospital admissions between the baseline and follow-up months for the high-risk group as identified by the ML model that received intervention from the nurses compared to those that did not receive any intervention. Further studies are necessary to prove this association.

Table 1:

<table>
<thead>
<tr>
<th>Hospital Admission Type</th>
<th>Intervention Baseline</th>
<th>Follow-up</th>
<th>% Change</th>
<th>No Intervention Baseline</th>
<th>Follow-up</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-Cause Hospital Admission Rate (PPY, 95% CI)</td>
<td>4.97 (4.78, 5.17)</td>
<td>3.01 (2.90, 3.22)</td>
<td>-38%</td>
<td>4.12 (3.96, 4.28)</td>
<td>2.73 (2.59, 2.87)</td>
<td>-34%</td>
</tr>
<tr>
<td>Fluid Overload Hospital Admission Rate (PPY, 95% CI)</td>
<td>1.46 (1.35, 1.58)</td>
<td>0.94 (0.85, 1.03)</td>
<td>-36%</td>
<td>1.31 (1.22, 1.41)</td>
<td>0.89 (0.82, 0.99)</td>
<td>-32%</td>
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