A Predictive Model of Initial Hospitalization Cost in Patients with Multiple Sclerosis

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BACKGROUND
Recent seismic healthcare reforms are focused on curtailing rising healthcare expenditures. In patients with multiple sclerosis (MS), limited or no data exists identifying potential modifiable targets associated with high-hospitalization cost.

OBJECTIVE
To create a baseline predictive model of initial cost for patients in patients admitted with MS.

METHODS
Data Source & Cohort Definition: In a retrospective, observational study, the National Inpatient Sample (NIS) database for the years 2001-2014 was utilized to identify adult patients (>18 years) hospitalized with a diagnosis of MS (ICD-9-CM 340) with complete data on hospital costs.

Outcome Measure: Initial hospitalization costs for MS [inflation adjusted to 2017 dollar value].

Model Variables:
- Age, gender, race, income, payer;
- Hospital characteristics [bedsize, teaching status/localization, region];
- Admission characteristics [weekend, elective, inpatient procedures];
- Comorbidities [Stroke, seizures, hypertension, congestive heart failure (CHF), chronic renal failure (CRF), obesity, alcohol abuse, smoking, DM, peripheral vascular diseases (PVD), osteoporosis, anemia, coagulopathy, plegia, bowel/bladder dysfunction, myelopathy, visual loss, slurred speech, lack of coordination and gait abnormalities]; and disease modifying agents.

Statistical Analysis:
A split-sample approach (1:1 randomization) created a derivation (model) and validation (training) cohort.

Logarithmically transformed hospital cost data was modelled using ordinary least square to identify potential drivers impacting initial hospitalization cost. Subsequently, the model was applied to the validation cohort for internal validation.

Model validation was tested by assessing the difference in the variance explained by the models. Despite potential limitations, the sheer volume of patient records across diverse clinical outcomes, pharmacological and radiological parameters. However, limited literature exists exploring baseline drivers of costs in patients with MS.

RESULTS

Table 1: Factors Associated with Increased Costs

<table>
<thead>
<tr>
<th>Patient demographics</th>
<th>% change in cost (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years)</td>
<td>+0.3% (&lt;0.001)</td>
</tr>
<tr>
<td>African Americans</td>
<td>+6.6% (&lt;0.001)</td>
</tr>
<tr>
<td>Hispistic</td>
<td>+9.8% (&lt;0.001)</td>
</tr>
<tr>
<td>Asians</td>
<td>+10.0% (&lt;0.001)</td>
</tr>
<tr>
<td>Other races</td>
<td>+5.2% (&lt;0.001)</td>
</tr>
<tr>
<td>Second income quartile</td>
<td>+1.8% (0.001)</td>
</tr>
<tr>
<td>Third income quartile</td>
<td>+3.7% (&lt;0.001)</td>
</tr>
<tr>
<td>Highest income quartile</td>
<td>+9.6% (&lt;0.001)</td>
</tr>
</tbody>
</table>

Hospital specific factors
- NDX
- NPR
- Length of stay
- Elective admission
- Urban non-teaching hospital
- Urban teaching hospital
- Large bed size hospitals
- West region hospitals
- Prior Comorbidities
- Paralysis
- Obesity
- COPD
- CHF
- Seizures
- Coagulopathy
- Anemia
- Slurred speech
- Previous ischemic stroke
- Myelopathies

In-hospital complications
- DVT
- ARF
- Procedure/treatment related
- Lumbar puncture
- Plasma exchange

In comparison with:
- $ uninsured patients;
- ‡ Caucasian race; and
- † lowest income quartile

In comparison with hospitals:
- § located in north-east region;
- ¶ rural hospitals, and
- * small bed-size

Pertinent drivers impacting cost include advancing age (+0.3%), female gender (+2.2%), Medicaid (+3.2%), African American (+6.6%), Hispanic (+9.8%), and Asian race (+10.0%), length of hospital stay (+4.8% extra hospital stay), patient comorbidities [paralysis (+3.0%), obesity (+3.1%), COPD (+4.1%), CHF (+4.5%), Seizure disorder (+2.2%), coagulopathy (+8.6%), previous ischemic stroke (+20.1%), and myelopathies (+21.4%), alcohol abuse (-14.2%)]

Inpatient Sample (NIS) database for the years 2001-2014 was utilized to identify adult patients (>18 years) hospitalized with a diagnosis of MS (ICD-9-CM 340) with complete data on hospital costs.

RESULTS

Table 2: Factors Associated with Decreased Costs

<table>
<thead>
<tr>
<th>Patient demographics</th>
<th>% change in cost (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female gender</td>
<td>-2.3% (&lt;0.001)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>-3.3% (&lt;0.001)</td>
</tr>
<tr>
<td>Other payers</td>
<td>-4.1% (&lt;0.001)</td>
</tr>
</tbody>
</table>

Hospital specific factors
- Weekend admission
- Midwest region hospital
- South region hospital
- Comorbidities
- Alcohol abuse

Procedure/treatment related
- CT scans
- DVT
- Intravenous steroids

- The model could explain a considerable proportion of variance (R² 0.51). A variation of less than 2.0% was noted in the derived R² following model training (R² = 0.50) from that of model testing. The model demonstrated a significant strength of association (p<0.001) to predict in an independent cohort as assessed by testing model fit by plotting predicted values against observed values using the validation cohort. (Figure 1)

DISCUSSION
In the backdrop of seismic healthcare reforms directed at improving value in healthcare delivery at optimal costs, several national initiatives are focused on cost-containment.

Recent studies have proposed clinical utility tools (apps) for cost-estimation risk-estimation in patients undergoing extracranial-intracranial bypass for stroke, moyamoya disease and also cerebral aneurysms.[1-3] However, limited literature exists identifying baseline drivers of costs in patients with MS.

Using an all-payer, national administrative cohort, the study quantifies risk estimates associated with initial hospitalization costs in MS patients.

Predictive Model Application: The identified drivers impacting hospitalization costs in MS patients could potentially be used for in-hospital auditing or budgeting, providing framework for creation of data driven policies, impact reimbursement criteria, and an adjunct in the cost containment debate.

Limitations include those pertaining the use of administrative databases and registries. This includes but not limited to coding inaccuracies, residual confounding arising from lack of functional outcomes, pharmacological and radiological parameters. Despite potential limitations, the sheer volume of patient records across diverse clinical practice settings permits generalization of outcomes and baseline assessments for future framework.

REFERENCES