Assessment of Risk Stratification Methods
Identifying Patients for Care Coordination within a Medical Home

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Overview

• Introduction
  • Medical Home
  • Identifying Patients

• Methods
  • Study Design, Setting, Population
  • Outcomes
  • Risk Stratification Methods
  • Statistical Analysis

• Results

• Conclusions and Recommendations
Introduction

Overview

• Attention has grown on patients with complex health care needs.
  • High health care expenditures
  • Frequent hospitalizations
  • Care in multiple settings from many providers

• Care coordination within the Medical Home has been presented as a promising strategy to improve the care for patients with multiple chronic illnesses.
Introduction

Medical Home – Care Coordination

• Medical Home
  • Consistent primary care
  • Care coordination

• In 2008, the State of Minnesota authorized prospective payment for care coordination through the Medical Home.
  • Medically complex patients
  • Mayo Clinic certified in 2011
Introduction

Identify Patients

• Stratifying the population
  • Patients who are most likely to benefit
  • Number of models to risk stratify populations of patients
Objective

• To compare multiple models for identifying patients for care coordination within a medical practice.

• 6 methods:
  • Adjusted Clinical Groups (ACG)
  • Hierarchical Condition Categories (HCC)
  • Elder Risk Assessment (ERA)
  • Chronic Comorbidity Counts (CCC)
  • MN Tiering
  • Charlson Comorbidity Measure
Methods

Study Design, Setting and Patient Selection

- Retrospective cohort analysis
- All paneled primary care patients age 18 and older in 2009.
- The methods were assessed on health care utilization and costs incurred for calendar year 2010.
  - All adults (83,187) must have been assigned to a primary care provider for all 12 months in both 2009 and 2010 (12 months or death).
Methods

Outcomes

• The outcomes of interest were:
  • Hospitalizations
  • Emergency Department Visits (ED)
  • 30-day Readmission
  • Total Standardized Cost (includes hospital but no outpatient pharmacy charges), inflation-adjusted

• These are health care utilization components believed to be most amenable to the benefits of care coordination. (Shelton et al 2000, Miller et al 2000)
Overview of Risk Stratification Models

ACG

• The ACG – “Adjusted Clinical Group” is a widely used classification system developed by Johns Hopkins
  • Based on administrative diagnosis data
• The ACG methodology uses:
  • Presence or absence of diagnoses along with age and sex
  • Classifies each person into one of 93 discrete ACG categories with similar utilization patterns

Weiner JP, Starfield BH et al Med Care 1991
Overview of Risk Stratification Models

Chronic Comorbidity Count

• The chronic comorbidity count (CCC) a method derived by Naessens et al from a modification of Hwang’s method.
  • Based on publically available AHRQ Clinical Classification Software
    • Total sum of selected comorbid conditions
    • Grouped into six categories of 0, 1, 2, 3, 4, and 5 or more

Naessens JM, Stroebel RJ et al Am J Manag Care 2011
Hwang W, Weller W et al Health Aff 2001
Overview of Risk Stratification Models

**ERA Score**

- ERA was designed for adults over 60.
- ERA Index utilizes administrative data to identify risk of hospitalization and emergency room visits.
- The ERA Index incorporates:
  - Age
  - Gender
  - Number of hospital days in prior 2 years
  - Marital Status
  - Selected comorbid medical illnesses (diabetes, CAD, CHF, MI, stroke, COPD, dementia)

Crane SJ, Tung EE et al BMC Health Serv Res 2010
Overview of Risk Stratification Models

**HCC Model**

- HCC used for Medicare Advantage Program
- Model Contains 191 Condition Categories
  - CMS-HCC final model contains 70 HCCs
    - Selects significant diseases
    - Includes conditions with significant expected health expenditures
- Demographic Markers
  - Age
  - Gender

Pope GC, Kautter J et al Health Care Financ Rev 2004
Overview of Risk Stratification Models

**MN Tiering**

- The State of MN Tiering model is based on Major Extended Diagnostic Groups (MEDCs), part of ACG package.

- Tiering - group patients based on their number of condition categories.
  - Five patient complexity level categories:
    - Tier 0: Low (0 Conditions)
    - Tier 1: Basic (1-3 Conditions)
    - Tier 2: Intermediate (4-6 Conditions)
    - Tier 3: Extended (7-9 Conditions)
    - Tier 4: Complex (10+ Conditions)
Overview of Risk Stratification Models

Charlson Comorbidity Measure

- Charlson index developed to predict risk of one-year mortality from comorbid illness
  - Based on administrative data
  - Presence/absence of 17 comorbidity definitions
  - Total sum of selected conditions

Methods
Statistical Analysis

• Logistic regression analyses was used to compare predictive ability for ED visits, hospitalizations and readmissions within 30-days.
  • C-statistic was used to compare models for ED, hospitalizations and readmissions.

• Generalized linear model to compare predictive ability of total cost.
  • R-squared was used to compare models for cost.
### Results

**Base Year Demographics (N=83,187)**

<table>
<thead>
<tr>
<th>Baseline Year Demographics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (y)</strong></td>
<td></td>
</tr>
<tr>
<td>18 – 44</td>
<td>46.5%</td>
</tr>
<tr>
<td>45 – 64</td>
<td>34.8%</td>
</tr>
<tr>
<td>65 – 84</td>
<td>15.9%</td>
</tr>
<tr>
<td>85 +</td>
<td>2.1%</td>
</tr>
<tr>
<td><strong>Mean age (y)</strong></td>
<td>46.9</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>54.6%</td>
</tr>
<tr>
<td><strong>Married</strong></td>
<td>63.1%</td>
</tr>
<tr>
<td><strong>Insurance Status</strong></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>21.8%</td>
</tr>
<tr>
<td>Private</td>
<td>63.1%</td>
</tr>
<tr>
<td>No Insurance</td>
<td>1.6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>13.5%</td>
</tr>
<tr>
<td>(No encounter or insurance unknown in 2009)</td>
<td></td>
</tr>
<tr>
<td><strong>Medical Conditions</strong></td>
<td>(based on prior 12 months)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>8.1%</td>
</tr>
<tr>
<td>CAD/MI/CHF</td>
<td>3.7%</td>
</tr>
<tr>
<td>Stroke</td>
<td>2.2%</td>
</tr>
<tr>
<td>Cancer</td>
<td>4.6%</td>
</tr>
</tbody>
</table>
Results

*Health Care Utilization & Costs (N=83,187)*

- **Emergency Department (ED)**: 13% in 2009, 13% in 2010.
- **Hospitalization**: 8% in 2009, 8% in 2010.
- **Preventable Hospitalization**: 10% in 2009, 11% in 2010.
- **Readmission 30-day**: 11% in 2009, 14% in 2010.

**Costs**

- **Mean**:
  - 2009: $3,185
  - 2010: $3,180
- **Median**:
  - 2009: $616
  - 2010: $575
Results

Concentrated Health Care Costs

32.4% of the most expensive 10% in 2009 were also in the top 10% of patients in 2010.
## Performance of Risk Stratification Models in Predicting Outcomes

<table>
<thead>
<tr>
<th>Model</th>
<th>ED Visits (c-statistic, 95% CI)</th>
<th>Hospitalizations (c-statistic, 95% CI)</th>
<th>Readmission (c-statistic, 95% CI)</th>
<th>Total Cost R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACG</td>
<td>0.67 (0.66-0.68)</td>
<td>0.73 (0.72-0.73)</td>
<td>0.81 (0.80-0.83)</td>
<td>0.362</td>
</tr>
<tr>
<td>CCC</td>
<td>0.61 (0.60-0.62)</td>
<td>0.69 (0.69-0.70)</td>
<td>0.77 (0.76-0.79)</td>
<td>0.218</td>
</tr>
<tr>
<td>ERA</td>
<td>0.61 (0.60-0.61)</td>
<td>0.71 (0.70-0.72)</td>
<td>0.78 (0.76-0.79)</td>
<td>0.177</td>
</tr>
<tr>
<td>CMS-HCC</td>
<td>0.58 (0.58-0.59)</td>
<td>0.67 (0.67-0.68)</td>
<td>0.74 (0.73-0.77)</td>
<td>0.170</td>
</tr>
<tr>
<td>MN Tiering</td>
<td>0.66 (0.65-0.66)</td>
<td>0.71 (0.70-0.72)</td>
<td>0.79 (0.78-0.81)</td>
<td>0.297</td>
</tr>
<tr>
<td>Charlson</td>
<td>0.59 (0.59-0.60)</td>
<td>0.68 (0.67-0.68)</td>
<td>0.75 (0.73-0.77)</td>
<td>0.182</td>
</tr>
</tbody>
</table>
Top Decile and Percentages of Predicted and Actual Hospitalizations

Predicted Hospitalizations (top decile for each model)

- ACG: Predicted 26.6%, Actual 26.8%
- Charlson: Predicted 23.1%, Actual 22.9%
- CMS-HCC: Predicted 21.9%, Actual 24.5%
- CCC: Predicted 24.1%, Actual 24.4%
- ERA: Predicted 24.7%, Actual 27.3%
- MN Tier: Predicted 24.8%, Actual 25.1%
Current Look at Complexity Tiers:  
*Clinical Implementation (Hybrid)*

- Low (0) n=18,395
- Basic (1-3) n=40,815
- Intermediate (4-6) n=17,783
- Extended (7-9) n=4,712
- Complex (10+) n=1,482

Mean: ~$18,501
Hybrid Model Compared to other Models

*Tier 4 or Tier 3 with ERA > 10*

<table>
<thead>
<tr>
<th>Model</th>
<th>N</th>
<th>Mean Age</th>
<th>%Hybrid</th>
<th>% Any Hospitalization</th>
<th>Hospitalizations per 1,000</th>
<th>% Any ED Visit</th>
<th>Mean Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid</td>
<td>2347</td>
<td>67</td>
<td>100%</td>
<td>41%</td>
<td>834</td>
<td>38%</td>
<td>$18,501</td>
</tr>
<tr>
<td>ACG</td>
<td>2347</td>
<td>69</td>
<td>61%</td>
<td>40%</td>
<td>791</td>
<td>34%</td>
<td>$18,101</td>
</tr>
<tr>
<td>Tier</td>
<td>2347</td>
<td>71</td>
<td>76%</td>
<td>37%</td>
<td>741</td>
<td>36%</td>
<td>$16,575</td>
</tr>
<tr>
<td>CCC</td>
<td>2347</td>
<td>72</td>
<td>55%</td>
<td>35%</td>
<td>705</td>
<td>30%</td>
<td>$16,399</td>
</tr>
<tr>
<td>HCC</td>
<td>2347</td>
<td>74</td>
<td>46%</td>
<td>39%</td>
<td>761</td>
<td>30%</td>
<td>$17,541</td>
</tr>
<tr>
<td>ERA</td>
<td>2347</td>
<td>76</td>
<td>58%</td>
<td>38%</td>
<td>727</td>
<td>30%</td>
<td>$15,204</td>
</tr>
<tr>
<td>Charlson</td>
<td>2347</td>
<td>75</td>
<td>41%</td>
<td>34%</td>
<td>637</td>
<td>27%</td>
<td>$15,291</td>
</tr>
<tr>
<td>ALL</td>
<td>2347</td>
<td>71</td>
<td>71%</td>
<td>43%</td>
<td>872</td>
<td>35%</td>
<td>$18,828</td>
</tr>
</tbody>
</table>
Results

Key Points

• The ACG model predicted ED visits, hospitalizations and readmissions slightly more accurately than the other models (c-statistic of 0.67, 0.73, 0.81, respectively).

• The $R^2$ for use of ACGs to predict total cost was highest, 0.362.

• The addition of age, gender and marital status to the models improved the c-statistic in all instances.

• MN Tiering followed closely behind the ACG model for those likely to be readmitted or to require hospitalization.
Future Directions

- Incorporating other factors into prediction model
- Investigate non-overlapping cases between models
  - Renal failure
  - Psychosocial conditions
  - Are there comorbidities that shouldn’t be weighted equally?
- Potentially improve identification of cases benefiting from care coordination interventions
  - Medication management
  - Multiple specialists
  - Care transitions
  - Telemonitoring
Conclusion

- Utilization of any of these models may help identify patients for care coordination. Any of the 6 methods identify patients with high use in the next year.

- ACG classification was generally better than the other models in predicting healthcare utilization.

- Focusing care coordination efforts within the medical home on patients that will most benefit requires appropriate identification of the highest risk, highest utilizing patients.
Questions & Discussion