Approaches to Predictive Modeling for Palliative or Hospice Care Management

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Approaches to Predictive Modeling for Engagement in Palliative or Hospice Care Management

- Description of need
- Program framework
- Value of predictive model
- Approaches to predictive modeling
- Results and summary
Services are Expensive and Often Unwanted

- **20-25% of all health care costs are spent in the last year of life**
  - Costs for patients who died in hospital inpatient settings were twice those for patients who died in other settings
  - Hospice reduced Medicare costs by an average of $2,309 per hospice patient

- **84% of the public favors laws giving patients the right to decide about end of life care, yet only**
  - 29% have living wills to actually exercise those rights
  - 24.9% of Americans die at home although more than 70% say that is their wish

Kelly and Meier (2010); NHPCO (2009); Ciemins et al. (2007); Taylor et al. (2007); Brumley et al. (2003); Last Acts (2002); Hogan et al. (2001); Field and Cassel (1997); SUPPORT (1995)
Palliative Care Coordination

- An effective and caring program that
  - Helps educate members, families, and providers about important choices for care at the end of life
  - Improves adoption of advance directives and election of hospice benefits
  - Helps members and their providers prevent delivery of unwanted and intrusive services

- A population health management program that
  - Incorporates elements of traditional complex case management, disease management, and care coordination
  - Requires application of health informatics to identify candidates and stratify by risk
Effective Intervention Starts with Stratification

Client Interventions and Engagement Determined by Need and Ability to Effect Change

- Highest need clients get most intensive support
- Continuous assessment of service use for increase in risk
- All clients receive self help info and access to support
**Program Continuum - Members**

**Patient Identification:**
- Referral from physicians
- Predictive modeling
- Referral from community
- Self/family referral

**Engagement and Assessment:**
- Patient functionality, prognosis determines action with patients and families

**Inform, support, coordination, monitoring:**
- Care and transition management lead to either hospice referral or ongoing monitoring, education, and planning

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**Disease and Case Management**

**Intensive Intervention**
Predictive Modeling to Prioritize Patient Outreach

- **Benefits of Predictive Modeling**
  - Provide clinicians, healthcare managers, and hospice care management with an effective method to identify patients and families who may benefit from timely discussion of advance planning
  - Timely discussions leading to appropriate care near the end of life may improve quality of life, control costs, and extend life in some cases
Approaches to Predictive Modeling

- Null model: Random selection
- Linear model: Outcome is cost
- Logistic model: Outcome is high cost
- Survival model: Outcome is life expectancy
Null Model: Random Selection

- Not really a model; rather, a “null hypothesis”
- Represents expectation in the absence of a model
- A straw-man to compare with real models and to reject if real model is better than blind chance
- The diagonal reference line in ROC graph
- Hypothesis: “end of life is unpredictable”
Linear Model: Outcome is Cost

- Linear regression of health care cost on demographic and diagnostic factors
- Chronic Illness and Disability Payment System (CDPS)
- A CMS-approved health risk measurement system
- Public domain SAS program
- Hypothesis: “end of life is proportional to health risk”

Kronick et al. (2000)
Logistic Model: Outcome is High-cost

- Logistic regression of odds of being in the top 5% of costs on demographic and diagnostic factors
- Johns Hopkins ACG Case-mix System “probability of high total cost” model
- CMS-approved proprietary health risk measurement system
- Hypothesis: “end of life is proportional to very high health risk”

Weiner et al. (2003); Long (1997)
Survival Model: Outcome is Life Expectancy

- Proportional hazards “Cox Regression” of survival time on demographic, diagnostic, and utilization factors
- Requires both statistical and clinical expertise to construct and validate
- Alternate specification of a logistic model for end of life within a certain time period
- Hypothesis: “life expectancy depends on a specific combination of demographic, diagnostic, and utilization factors”

Allison (1995); Cox and Oakes (1984)
ROC Curve for the Models

Diagonal segments are produced by ties.
### Area under the ROC: “C-Statistic”

<table>
<thead>
<tr>
<th>Test Result Variable(s)</th>
<th>Area</th>
<th>Std. Error</th>
<th>Asymptotic Sig.</th>
<th>Asymptotic 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDPS</td>
<td>.735</td>
<td>.003</td>
<td>.000</td>
<td>.730 - .740</td>
</tr>
<tr>
<td>ACG</td>
<td>.753</td>
<td>.002</td>
<td>.000</td>
<td>.743 - .758</td>
</tr>
<tr>
<td>Survival</td>
<td>.872</td>
<td>.002</td>
<td>.000</td>
<td>.868 - .875</td>
</tr>
</tbody>
</table>

The test result variable(s); CDPS, ACG, Survival has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5
APS Palliative Care Predictive Model

- A logistic model to predict the end of life with a terminal disease or a hospice admission within 24 months
- Diagnosis, utilization, and demographic factors derived from administrative claims
- 120 risk factors identified from literature and guidelines for end of life care
- Backward stepwise selection retained 54 statistically significant factors
ROC Curves for Logistic v Survival Model

Diagonal segments are produced by ties.
Statistical Validation

- Validation with an independent sample
- C-Statistic same as survival model

<table>
<thead>
<tr>
<th>Percentile of Population</th>
<th>Positive Predictive Value</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>99 (top one percent)</td>
<td>49.6%</td>
<td>8.4%</td>
</tr>
<tr>
<td>90 (top ten percent)</td>
<td>34.1%</td>
<td>55.1%</td>
</tr>
</tbody>
</table>
Summary

- Palliative care coordination can improve quality of life and quality of care, and can extend life for those with terminal prognosis

- Traditional models used to predict cost are not ideal to identify patients in need of palliative care coordination; a new model was developed

- Statistical validation confirms that the predictive model for palliative or hospice care is useful for case identification and risk stratification
References