

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)

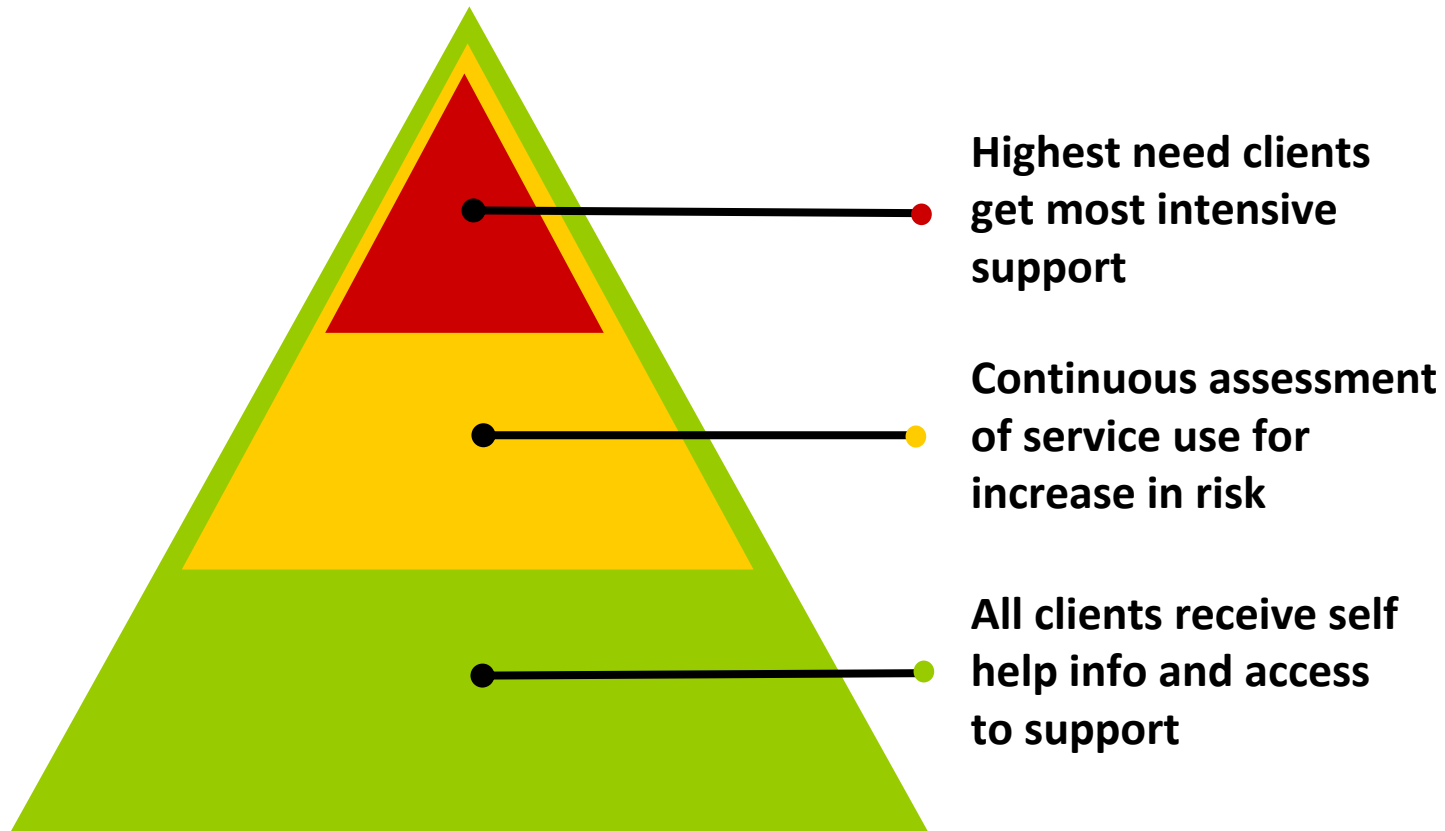


Palliative Care Coordination

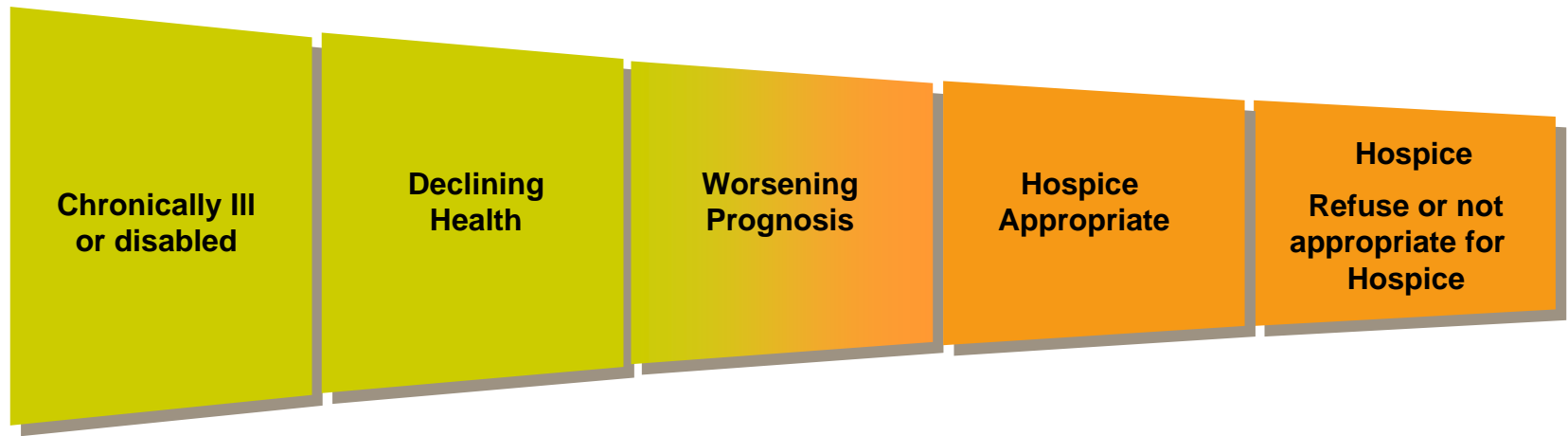
- **An effective and caring program that**
 - Helps educate members, families, and providers about important choices for care at the end of life
 - Improves adoption of advance directives and election of hospice benefits
 - Helps members and their providers prevent delivery of unwanted and intrusive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

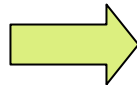


Program Continuum - Members



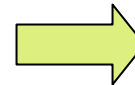
Patient Identification:

- 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

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”**

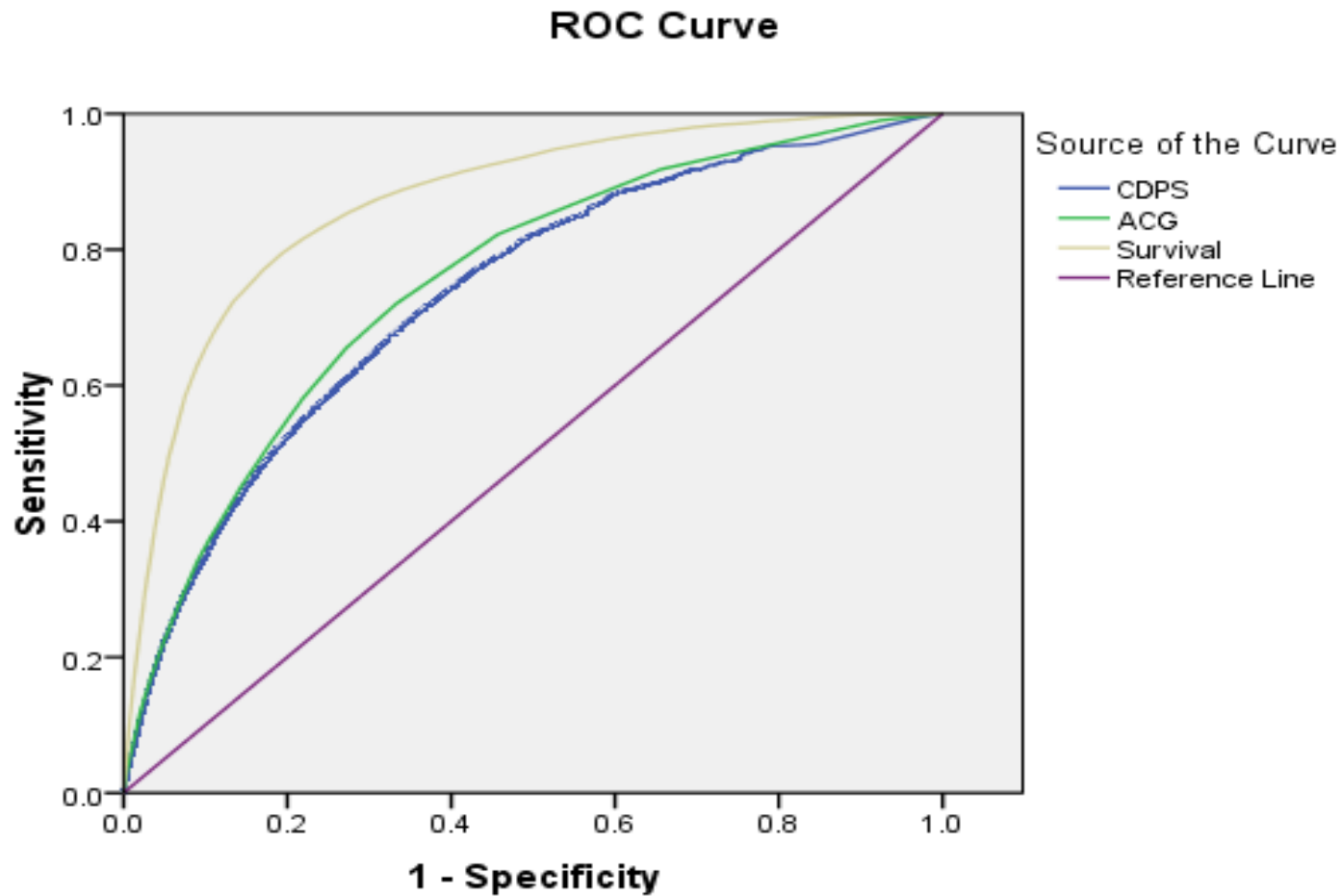
Weiner et al. (2003); Long (1997)

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.

Survival Model is Best

Area under the ROC: “C-Statistic”

Area Under the Curve

Test Result Variable(s)	Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
CDPS	.735	.003	.000	.730	.740
ACG	.753	.002	.000	.748	.758
Survival	.872	.002	.000	.868	.875

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.

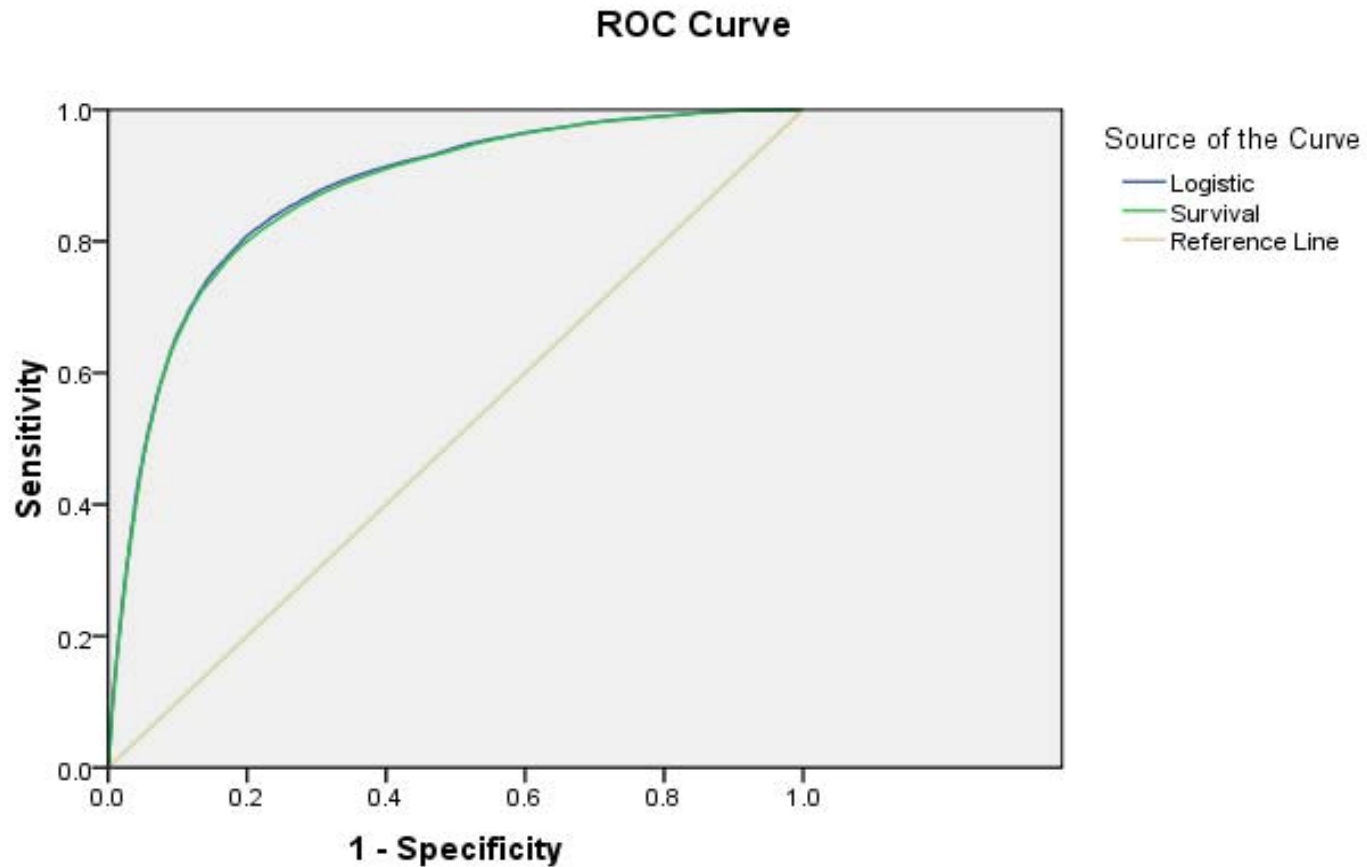
- a. Under the nonparametric assumption
- b. Null hypothesis: true area = 0.5



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**

Percentile of Population	Positive Predictive Value	Sensitivity
99 (top one percent)	49.6%	8.4%
90 (top ten percent)	34.1%	55.1%

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**

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