

# 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

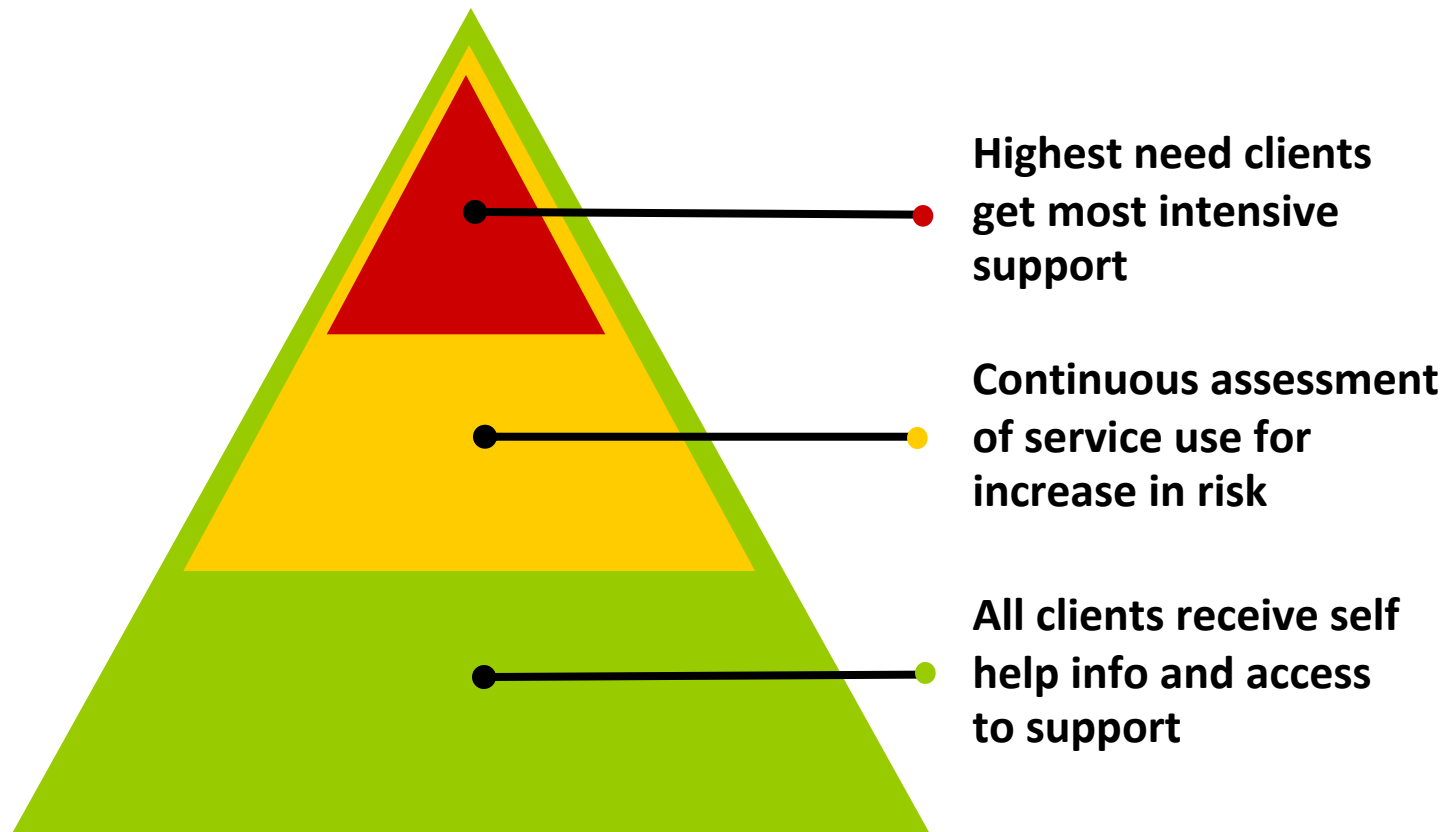
Kelly and Meier (2010); NHPCO (2009); Ciemins et al. (2007); Taylor et al. (2007); Brumley et al. (2003); Last Acts (2002); Hogan et al. (2001); Field and Cassel (1997); SUPPORT (1995)

# Palliative Care Coordination

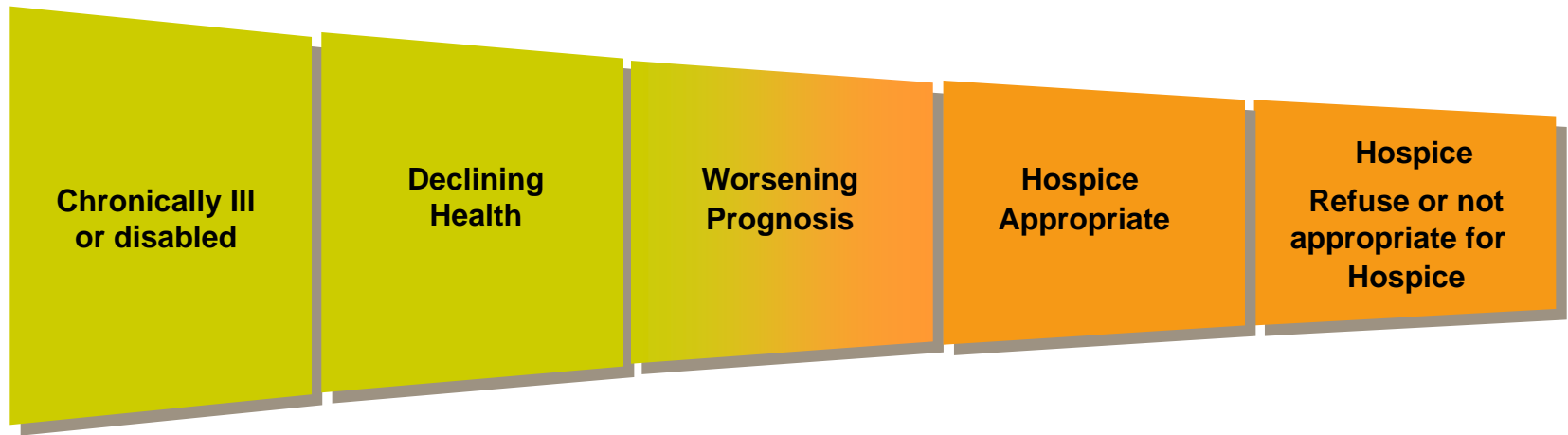
- **An effective and caring program that**
  - Helps educate members, families, and providers about important choices for care at the end of life
  - Improves adoption of advance directives and election of hospice benefits
  - Helps members and their providers prevent delivery of unwanted and intrusive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

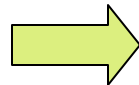


# Program Continuum - Members



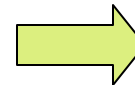
## Patient Identification:

- 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”**

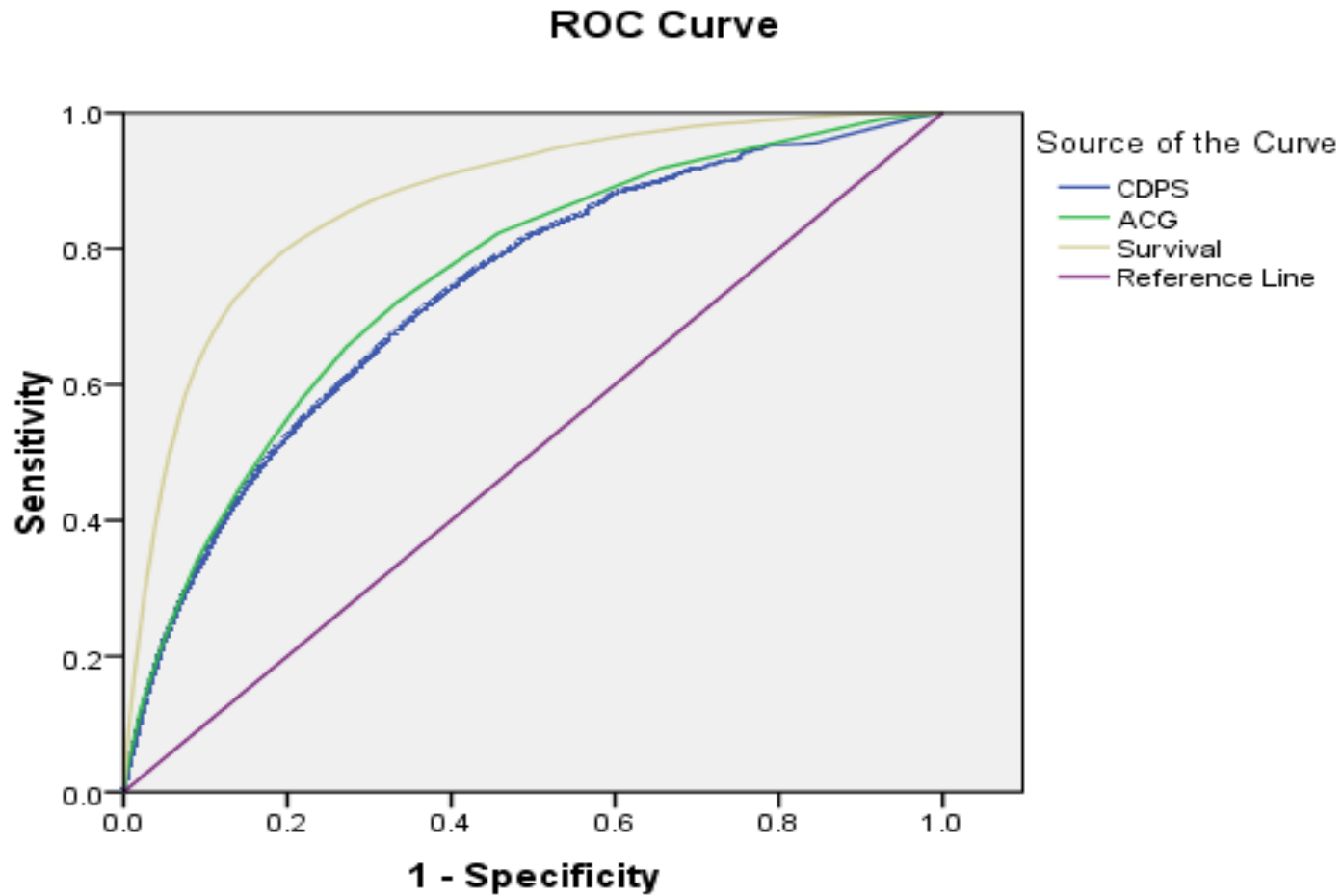
Weiner et al. (2003); Long (1997)

## 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 <sup>a</sup>	Asymptotic Sig. <sup>b</sup>	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.

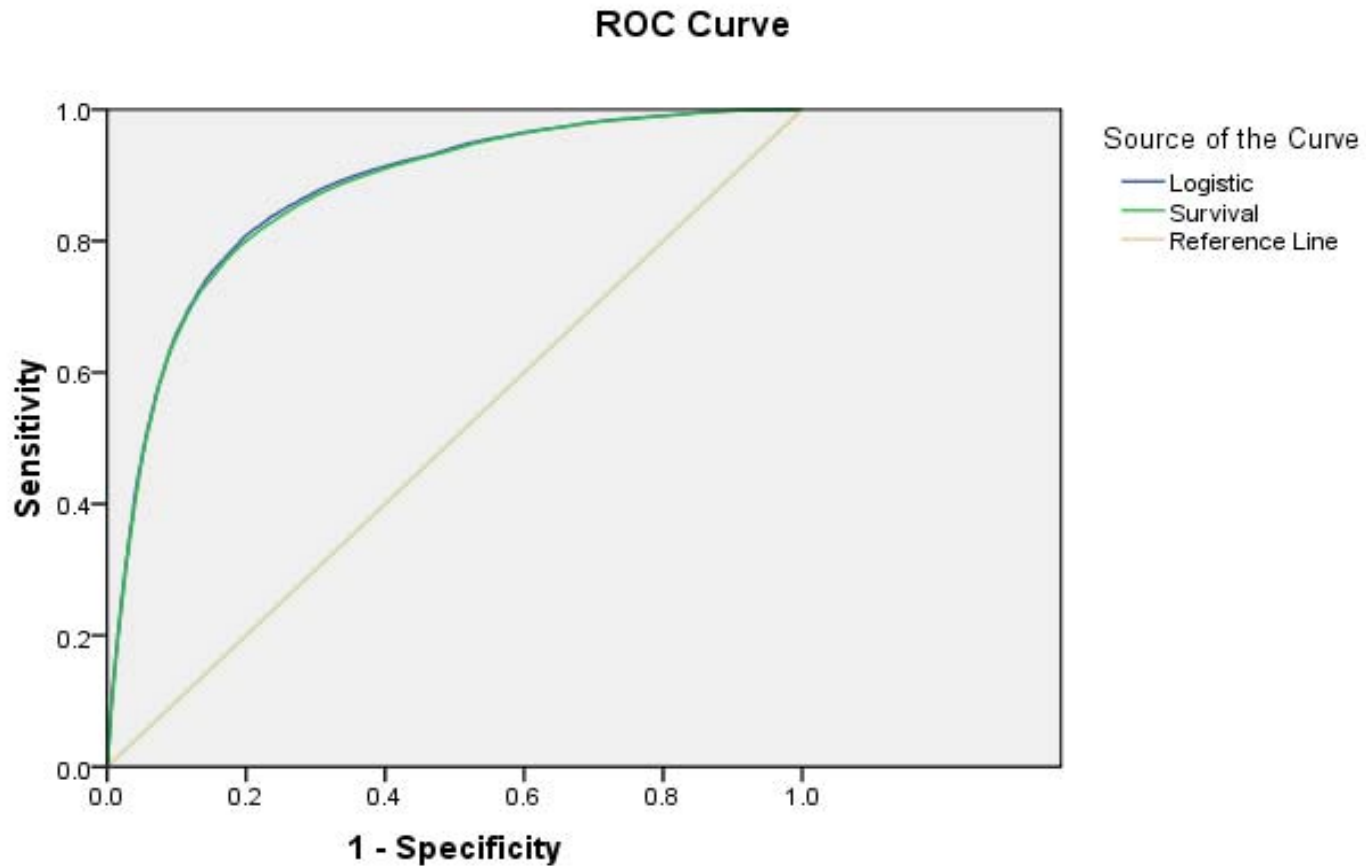
- a. Under the nonparametric assumption
- b. Null hypothesis: true area = 0.5

# 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**

<b>Percentile of Population</b>	<b>Positive Predictive Value</b>	<b>Sensitivity</b>
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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