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Photo: Tom and Borris (aka Tarzan?)

Prospective Modelling of End-of-Life Utilization and Costs *

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Background

- Hospice introduced as alternative to aggressive end-of-life care.
- Rapid growth in hospice population
  - 1991=108,000 patients 2001=580K patients.
- Nursing homes management of end of life care increased
  - 16% of 65+y/o dying in NHs in 1990→28% in 2003
- Potential for saving?
  - About 25% Medicare budget is spent on patients during last year of life
  - Little research to show saving of hospice in NHs

Background

- Prior cost studies criticized for selection biases:
  - Patients electing hospice are potentially different
  - Nursing home residents can only elect hospice if nursing home has contract with hospice provider
  - Select retrospective sample of patients who died

Study Aims

- Study the **causal effect** of hospice on health care expenditures of nursing home residents.
- Control for **selection bias** of patients and nursing home facilities.
- Control for differences in costs due to **informative attrition** due to survival differentials among patients.

Hospice Selection

- Hospice treatment is not randomly assigned (selection bias potential).
- Hospice is both an outcome of health and a predictor of costs.
- In other words: hospice selection is an endogenous process to both mortality and expenditures.
- ORDINARY REGRESSION MODELS WILL PROVIDE BIASED CAUSAL EFFECT ESTIMATES

Informative Censoring

- Residents who are more likely to die are more likely to choose hospice
- Residents who are more likely to die are more likely to accumulate higher expenditures
- Survival process is endogenous to both hospice and expenditure processes

Outline

- Data and cohort selection
- Model and Model simplification
- Estimation
- Results
- Discussion

Data Sources (Florida,1999)

- Expenditures and utilization:
  - Medicare eligibility (denominator) and claims (SAF): inpatient, skilled nursing services (SNF), hospice, home health, outpatient
  - Medicaid buckets
- Resident nursing home assessment: Minimum Data Set Resident Assessment Instrument (MDS RAI)
- Nursing homes: Online Survey of Certification Annual Records (OSCAR)

Medicare & Medicaid Expenditure Data

- Aggregate all expenditure categories
- Average daily expenditures in period
- Period usually 1 week (96%)
  - Period shorter in week of death
  - Daily periods during week of transition to hospice (2.8%)
- Prospective data for 6 months in periods

Healthcare Utilization Data

- In each period
  - Hospital days
  - Hospice days in nursing home
  - Hospice days in hospital
  - Medicare skilled services days (SNF)
- Prior 3 months utilization/expenditure history
  - Hospitalizations
  - SNF use
  - Home health care use
  - Total prior expenditures

Resident and Facility Data

- Clinical data from nursing home assessments (MDS) at baseline:
  - Demographics
  - Diagnoses, conditions, medications
  - Advance directives (care preferences)
- Nursing home data from OSCAR:
  - Organizational structure (profit, chain, size)
  - Staffing
  - Available services
  - Resident casemix acuity index (summarizing diagnoses, treatments, symptoms, ADL…)

Cohort Selection

- Nursing home residents in Florida with MDS assessment in 4-6/1999
- No prior hospice
- Hospice eligible
  - Upper quartile of predicted probability:
  - Predicted Pr(Death in 6 months) > 0.2
- For data completeness:
  - Age 65+
  - No HMO throughout 1999
  - Dual Medicare-Medicaid eligible

Data Summary

- During time interval *(t-1,t]* resident *i* in nursing home *j* accumulates expenditures X_{jit} .
- Let:
  - Y_{jit} = sqrt(X_{jit}) square-root expenditures
  - C_{jit} = I(died in time interval) or survival time $T^* = (T, \delta)$
  - H_{jit} = I(hospice in time interval) or time till hospice selection S
- Covariates $Z_{jit} = (U_{jit}, V_{ji}, W_i)$

Joint Modeling Approach

- Endogenous processes in time
  - Model joint distribution $(Y,C,H)_{jit}$
  - Joint underlying frailty V ~ F(α)
  - Follows Lancaster & Intrator (JASA, 1998): assumes conditional independence of Y, C, H given V
- Model implications can be tested using simulations. For example:
  - E(Y|T*=x, T*-S=u, z)
  - E(Y|T*-S>0) / E(Y|T*-S=0)

“Bagging” Joint Modeling

- Estimation requires MCMC and data augmentation methods
- Subject to criticisms: parametric, simple frailty distribution, conditional independence
- Difficult/ desirable to allow for clustering of residents in NHs, time varying covariates, unobserved frailty depending on time

Model Simplification

- Given covariates Z_{jit} model:
- $E(Y_{jit} | h_{jit}, c_{jit}, z_{jit})$
  - Y_{jit} is average expenditure in period
  - May depend on time since hospice selection
- GEE methods to account for repeat observation per resident, and per facility
  - Distributional assumptions about Y are not required
  - The within-patient correlation matrix does not have to be correctly specified.

Adjusting for Selection

- Informative attrition is considered another selection process
  - $E(H_{jit}, C_{jit}) = E(H_{jit} \mid c_{jit})\, E(C_{jit})$
- Inverse probability weighting using propensity scores
  - Potentially better control for unobserved confounders
  - Use time-specific weights
  - Stabilized by using ratio of time-specific propensity to overall or resident-specific propensity

Survival and Hospice Selection Model Estimation

- Assume hospice selection is “terminal”
- Markovian data structure for repeat observation of survival and hospice selection
- Assume independent periods within resident
- Adjust for within-nursing home correlation

Estimation of Weights

- Estimate intensities of hospice selection and mortality at each time period
  - Logit $\Pr(H_{jit} \mid c_{jit}=0, Z_{jit-1})$
  - Logit $\Pr(C_{jit}=1 \mid Z_{jit-1}, H_{jit})$
- Kaplan-Meier estimates of propensity scores
- Combine weights:
  - $E(H_{jit}, C_{jit}) = E(H_{jit} \mid c_{jit})\, E(C_{jit})$

Inverse Probability-of-Treatment Weighting (IPTW)

- Alternative to Propensity Score Matching or Stratification
  - Potentially better control for unobserved confounders
  - Use time-specific weights
- Stabilized by using ratio of time-specific propensity to overall or resident-specific propensity

Results

- Separate analyses for Short (<90 days) and Long Stay (90+ days) NH residents
- Separate analyses by Main Diagnostic group:
  - Cancer
  - No Cancer, any dementia
  - Other

“Other” Diagnoses Cohorts

Short Stay

- 53,525 periods
- 2,474 residents
- 588 facilities
- 161 residents with hospice in 129 facilities
- 588 (24%) died
- Median hospice LOS = 19days

Long Stay

- 62,591 periods
- 2,846 residents
- 564 facilities
- 228 residents with hospice in 167 facilities
- 793 (28%) died
- Median hospice LOS = 19days

Short Stay NH Residents with Dx="Other"

	Hospice (N=161)	Non-Hospice (N=2,313)
Age 85+	53	50
Non-white	20	26
Eating Limitation	43	37
Self-Sufficiency Deterioration	53	47
Cognitive Impairment	58	51
Hypertension	27	36
DNR	22	16
High Medicare expend in last 3 months	21	25

Short Stay with Dx="Other" Multivariate Average Daily Total Expenditures

	Non-Weighted Estimate (95% CI)	With Stabilized Weights for Hospice Selection Estimate (95% CI)	With Stabilized Weights for Hospice Selection and Mortality Estimate (95% CI)
Intercept	4.9 (3.1, 6.7)***	16.1 (10.9, 21.3)***	33.1 (26.2, 40.0)***
Additional Week of Life	-0.1 (-0.1, -0.1)***	-0.8 (-1.0, -0.6)***	-0.8 (-1.0, -0.6)***
Medicaid Week	6.8 (5.5, 8.1)***	6.0 (3.8, 8.1)***	-9.2 (-10.8, -7.6)***
Only Hospice Inpatient	12.3 (10.5, 14.1)***	11.4 (5.8, 17.0)***	14.6 (9.1, 20.1)***
1st Hospice Week	-0.4 (-1.4, 0.6)	-5.0 (-8.4, -1.6)**	-7.0 (-10.7, -3.2)***
2nd Hospice Week	0.4 (-0.6, 1.4)	-2.1 (-3.4, -0.7)**	-0.0 (-4.0, 4.0)
3rd Hospice Week	0.9 (-0.0, 1.9)	-1.6 (-2.4, -0.7)***	-1.8 (-2.8, -0.9)***
Each Subsequent Hospice Week	0.2 (0.1, 0.3)***	0.3 (-0.0, 0.7)	0.1 (-0.2, 0.4)

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Adjusted to other resident and facility factors

LONG Stay NH Residents with Dx="Other"

	Hospice (N=208)	Non-Hospice (N=2,835)
Age 85+	76	71
Non-white	10	15
Transfer Limitation*	82	78
Self-Sufficiency Deterioration	19	15
Pressure Ulcers*	6	3
Hypertension	13	8
DNR	32	24
South Florida Region*	35	30

Long Stay with Dx="Other" Multivariate Average Daily Total Expenditures

	Non-Weighted Estimate (95% CI)	With Stabilized Weights for Hospice Selection Estimate (95% CI)	With Stabilized Weights for Hospice Selection and Mortality Estimate (95% CI)
Intercept	4.4 (2.5, 6.3)***	4.6 (2.6, 6.6)***	5.2 (3.3, 7.1)***
Additional Week of Life	0.0 (0.0, 0.0)***	0.0 (0.0, 0.0)***	0.0 (0.0, 0.0)***
Medicaid Week	7.5 (5.6, 9.3)***	7.3 (5.4, 9.2)***	7.2 (5.4, 9.0)***
Only Hospice Inpatient	14.7 (11.6, 17.8)***	14.9 (11.6, 18.1)***	11.4 (8.2, 14.5)***
1st Hospice Week	-1.5 (-2.5, -0.6)**	-1.7 (-2.9, -0.4)*	-0.8 (-2.6, 1.1)
2nd Hospice Week	0.4 (-0.4, 1.3)	0.6 (-0.8, 2.0)	1.2 (-0.8, 3.3)
3rd Hospice Week	0.5 (-0.4, 1.4)	1.1 (-0.6, 2.7)	1.8 (-0.6, 4.1)
Each Subsequent Hospice Week	0.1 (-0.1, 0.2)	0.1 (-0.1, 0.4)	0.2 (0.0, 0.4)*

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Summary

- Controlling for hospice selection and attrition is important.
- Biggest hospice effect for Short-Stay NH residents: SAVINGS in first 3 weeks and no significant difference afterwards.
- Long-stay resident have HIGHER EXPENSES after the 3rd week in hospice.

Comparison with Retrospective Study

- Retrospective model of hospice effect on expenditures in last month of life
  - Florida NH residents
  - Died in NH 7-12/1999
  - Hospice savings effect was greater for short-stay NH residents
  - Difference in effect of residents with short/long time in hospice
- Prospective model provides better control for LOS in hospice

Limitations

- Effects on “intensity” of costs, not total costs.
  - How to draw inference regarding effects on total costs?
- Hospice selection estimated only on residents in NHs offering hospice (82% in Florida):
  - May not adequate for other states.
- Results are not of a joint model
  - potential for effects on costs to be confounded with effects on death

Extensions

- Generalize hospice choice model
  - Interaction between nursing home and hospice providers in hospice contracting
- Estimate joint model of end-of-life expenditures, with hospice selection and survival censoring.
- Examine cost-effectiveness of hospice using quality of end-of-life measure

FIN

Thank you for your attention!

Comments welcome…

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