Quality choice with reputation effects: Evidence from hospices in California

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Motivation

Hospices provide palliative care to dying patients.

Useful to study because:

1. **Large healthcare industry and patient welfare**

   Hospice industry growing in importance:
   - 1.6 million Medicare patients.
   - Medicare spent $21 billion in 2019.
   - ACA $\implies$ greater hospice use.

   Important to study hospice quality:
   - Patient welfare.
   - OIG: serious concerns about hospice quality.
   - NHPCO: patients enroll too late.
   - Switch from ineffective costly treatment $\implies$ cost savings and improved end-of-life.

Motivation

2. **Insightful for regulated-price healthcare markets**
    - Govt sets a fixed price per patient/diagnosis.
      E.g. Medicare's DRG scheme, UK, Germany, France.
    - Firm behavior and policy design with regulated prices.
3. **Study quality choice under reputation effects**
    - Firm reputation is important in healthcare markets.
    - Reputation of a firm reflects its past quality choices.
    - Current quality $\uparrow \implies$ reputation $\uparrow \implies$ future sales $\uparrow$

I study quality choice by hospices, uncover the importance of hospice reputation, and explore counterfactual policies that can incentivize better hospice quality.

Hospice industry

Hospices provide palliative care to dying patients.

- Serve patients at residences.
- Regular visits for pain-control, living arrangements.
- More visits $\implies$ higher quality.

  > Hospice quality = Average visits per patient in a year.

- Paid fixed rate per-patient per-day by Medicare.

Hospices

Reputation may be an important driver of choice.

- Quality not contractible: hospice unilaterally decides visits.
- Goodwill and name recognition $\rightarrow$ patient's choice.
- Good track record $\implies$ greater referrals, better known and reviewed $\implies$ greater market share.

Structural model

Estimate structural model of hospice industry using yearly firm-level data from California for 2002-2018.

> Reputation of a hospice = function of its current and past quality choices.

1. Demand: Consumers choose from a set of hospices.
   - Influenced by hospice characteristics and reputations.
   - Assumption: consumers accurately observe hospice's quality choices.
2. Supply: Firms choose quality every year.
   - Dynamic oligopoly model.
   - Trade off improving reputation with higher cost.
   - All patients receive same quality.

Results: Estimation

Demand estimation:

1. Reputation plays important role in consumer choice.
    - Hospices which chose high quality in the past have higher current market share.
2. Reputation decays at annual rate of 53%.
    - Quality choices 4 years ago affect current market share.

Results: Estimation

Supply estimation:

1. Additional visit per patient costs the hospice around \$200.
    - Includes staff wages, cost of medical supplies and operation.
2. For-profits more efficient than non-profits by \$75-105 per visit.
3. Rural hospices suffer cost disadvantage of \$18-30 per visit.

Results: Counterfactuals

Simulating effects of alternative policies:

1. Persistence of reputation $\uparrow \implies$ Quality $\uparrow$
   - E.g. review sites
2. Medicare prices $\uparrow \implies$ Quality $\uparrow$
   - Response varies with differentiation from rivals.
3. Compared to current per-day scheme, a hybrid per-day and per-visit scheme achieves same quality at lower cost.

Contributions

1. First to build and estimate a structural dynamic oligopoly model of reputation accumulation through quality choice.
   - Additional factor that influences a firm's quality choice.
2. Construct a novel way of measuring reputation using market share data.
3. Demonstrate importance of reputation for i) patients choosing medical providers and ii) medical providers choosing quality.
4. Shed light on policies in regulated price settings.
5. Contribute to a very scarce literature on hospices.

Literature review

Related to three strands of literature:

1. Effect of reputation on firms' choices: Tadelis (2016), Saeedi (2019), Bai (2022)
2. Quality choice by healthcare providers: Lin (2014), Hackmann (2019), Gaynor et al (2016)
3. Hospices: Chung and Sorensen (2018)

Quality provision

Hospices typically provide care at residence of patient.

- Regular visits to patient.
- Hospice **unilaterally decides** how many visits to provide.

Type of care is relatively low-skill.

- No curative treatment.
- Pain management and ease-of-living.
- Content of visits similar across hospices.

Examples of hospice care

Reputation

How a hospice is chosen:

- Social worker at hospital.
- Patient's physician.
- Word-of-mouth from community and support groups.
- Online search.

Common suggestions when choosing a hospice:

- Reputable, long-serving.
- Regular visits, emergencies, handling complexities.
- Co-managing, respite for family.

Sources

Reputation

These suggest:

1. Quality of care = total visits to patient.
   - More visits $\implies$ regular checkups and adjustments, symptom management, availability during emergencies.
2. Reputation matters.
   - Good track record $\implies$ greater referrals, better known and reviewed $\implies$ greater market share.
3. Past information on service quality can **persist and diffuse over time** via social workers, physicians, and surrounding community.

Reimbursement

The majority of patients in my data are paid for by Medicare.

Payer	% of patients
Medicare	83.7
Medi-Cal	7.37
Private insurance	6.37
Selfpay	1.65
Charity	0.82

Table 1: Percentage of total patients covered by each payer type.

Reimbursement

Under Medicare:

1. Patient: hospice care is essentially free.
2. Hospice: paid a **fixed rate per-day** of patient enrollment.
    - Payment does **not** vary by number of visits.
    - Payment varies across counties and over time. Reflects a "national" rate and a cost index of the county.

Data

Data on hospices in California :

- Home Health Agencies And Hospice Annual Utilization Reports.
- 2002-2018.
- Yearly data at the **firm level**.
- For each hospice-year: total patients served, total visits made by staff, hospice characteristics, etc.

Combine with: data on population sizes (by age), mortality rates, and Medicare hospice reimbursement rates.

Data

Market defined at county level.

- Can rule out broader market definitions using data.

Restrict attention to 28 counties.

- Some do not see hospice presence.
- Drop markets with > 24 hospices: numerical challenges and different industry dynamics.
- Sample selection in line with majority of IO papers using dynamic oligopoly models.

Data

	10%	25%	50%	75%	90%
patients	63.0	149.0	289.5	511.75	765.0
% of hospice patients	2.77	7.37	19.71	40.04	100.0

Table 2: Distribution of patients and within-hospice market share. Each observation is at the hospice-year level.

Data

$$\text{Measure of quality of a hospice} = \frac{\text{total visits}}{\text{total patients served}}$$

	10%	**25%**	**50%**	**75%**	**90%**
Visits-per-patient	17.17	21.88	27.83	37.66	52.48

Table 3: Distribution of average visits-per-patient.

Data

	Min	10%	25%	50%	75%	90%	Max
firm count	1.0	1.0	1.0	2.0	4.0	7.0	23.0

Table 4: Distribution of firm-count.

Entry and exit:

- Occur in 10% of county-years.
- Between 1 and 5.

Structural model: Demand

The utility of consumer i for hospice j in period t is given by:

$$u_{ijt} = \alpha_{m(j)} + X'_{jt}\beta + \psi_{jt} + \xi_{jt} + \zeta_i + (1-\sigma)\tilde{\varepsilon}_{ijt}$$

$$\xi_{jt} = \rho\xi_{jt-1} + \epsilon_{jt}$$

where ϵ_{jt} is distributed independently with mean zero.

Reputation follows a stock transition equation:

$$\psi_{jt} = (1-\tau)\psi_{jt-1} + \eta a_{jt}$$

where a_{jt} is the average-visits-per-patient made by hospice j in period t.

Assuming $\psi_{j0} = 0$ (i.e. a new entrant has a reputation of zero):

$$\psi_{jt} = \eta[a_{jt} + (1-\tau)a_{jt-1} + (1-\tau)^2 a_{jt-2} + \ldots]$$

Structural model: Demand

$$u_{ijt} = \alpha_{m(j)} + X'_{jt}\beta + \xi_{jt} + \zeta_i + (1-\sigma_n)\tilde{\varepsilon}_{ijt} + \eta[a_{jt} + (1-\tau)a_{jt-1} + (1-\tau)^2 a_{jt-2} + \ldots]$$

$$\xi_{jt} = \rho\xi_{jt-1} + \epsilon_{jt}$$

Key parameters:

1. $\tau =$ how fast the effect of past quality choices depreciates.
2. $\eta =$ importance of reputation for consumer choice.

Structural model: Supply

Intuition: marginal cost is increasing linearly in quality choice.

The cost of serving each patient at quality a_j is given by:

$$MC_j(a_j) = \gamma_0 + \left(\gamma_{1,k(j)} + \gamma_{fp} FP_j + \gamma_{rural} RURAL_j\right) a_j$$

where $k(j)$ denotes the type of the hospice j.

All patients of hospice j receive quality a_j.

Structural model: Supply

$$\bar{\pi}(a_j, \mathrm{a}_{-j}, \mathrm{x}_m; \theta) = M_m s_j(a_j, \mathrm{a}_{-j}, \mathrm{x}_m)[P_m^{MCAR} - MC_j(a_j; \theta)]$$

where:

- θ = cost parameters.
- x_m = state variable in market m.
- a_{-j} = actions of rivals.
- M_m = market size.
- P^{MCAR} = Medicare per-day rate times 60 days.

Structural model: Supply

Combine to form dynamic model of quality choice under competition.

Incumbent's value function:

$$V_j(x_m, \epsilon_j^a; \theta) = \max_{a_j \in \mathcal{A}} \mathbb{E}\left[\bar{\pi}(a_j, x_m; \theta) + \epsilon_j^a(a_j) + \beta V_j(x'_m, \epsilon_j'^a; \theta) \middle| a_j, x_m\right]$$

where

- $\epsilon_j^a(a_j)$ = choice-specific errors for hospice j choosing action a_j ($i.i.d$ T1EV)

Structural model: Timing

For period t and market m:

1. Incumbents observe x_{mt} and structural errors, and make quality choices.
2. Reputation stock of each incumbent evolves.
3. Consumers observe x_{mt}, reputation stocks, and structural errors, then choose a hospice.
4. Incumbents stay/exit.
5. Potential entrants enter/stay out.
6. All state variables evolve.

Structural model: Equilibrium

Firm's strategy is a mapping from states and choice-specific shocks to actions:

$$\sigma_j : \left(\mathrm{x}_m, \epsilon_j^a\right) \rightarrow \mathcal{A}$$

Restrict attention to:

- Pure, symmetric and anonymous strategies.
- Markov Perfect Equilibrium: Strategy depends on only current period payoff-relevant state variables and choice-specific shocks.

Estimation: Demand

Using Berry (1994):

$$ln(s_{jt}) - ln(s_{0t}) = \alpha_m + X'_{jt}\beta + \sigma_n ln(s_{j|gt}) + \xi_{jt} + \eta[a_{jt} + (1-\tau)a_{jt-1} + (1-\tau)^2 a_{jt-2} + \ldots]$$

where

- s_{jt} = market share of hospice j.
- s_{0t} = market share of outside option.
- $s_{j|gt}$ = hospice j's within-hospice market share.

Recall that unobserved demand shocks are persistent:

$$\xi_{jt} = \rho\xi_{jt-1} + \epsilon_{jt}$$

Estimation: Demand

$$ln(s_{jt}) - ln(s_{0t}) = \alpha_m + X'_{jt}\beta + \sigma_n ln(s_{j|gt}) + \xi_{jt} + \eta[a_{jt} + (1-\tau)a_{jt-1} + (1-\tau)^2 a_{jt-2} + \ldots]$$

$$\xi_{jt} = \rho\xi_{jt-1} + \epsilon_{jt}$$

Estimated simultaneously with two-step GMM.

- Moment conditions built around ϵ_{jt}.
- Standard IO instruments: BLP IVs (sum of rivals and rival characteristics), fuel prices.

Estimation: Supply

Two-stage estimator from Bajari, Benkard and Levin (2007) used to estimate the cost parameters.

First stage:

- Reduced-form estimates of firms' policy functions.
- Transition probabilities for state variables.

Second stage:

- First-stage results used to conduct forward simulation and generate model-predicted CCPs for a given guess of cost parameters.
- Find parameter values that match model-predicted and observed probabilities.

Estimation: Supply, First stage

Exogenous entry and exit rates based on empirical patterns.

Obtain empirical estimate of the policy function by projecting visit choice on state variables.

Infer cost-types using from FE regression on visit choices.

I discretize visit choice into six tiers and estimate an ordered logit with county FEs.

Inferring type Entry and exit simulation

Estimation: Supply, First stage

	No types	With cost-types
ξ_{jt}	-0.843	-0.996
	(0.114)	(0.117)
$X_{jt}'\beta$	0.355	-1.285
	(0.566)	(0.589)
Own reputation	2.902	2.997
	(0.203)	(0.209)
Count of rivals in first reputation tier	0.214	0.207
	(0.057)	(0.058)
Count of rivals in second reputation tier	0.244	0.245
	(0.042)	(0.042)
Count of rivals in third reputation tier	0.081	0.084
	(0.028)	(0.029)
For-profit	1.315	0.521
	(0.215)	(0.226)
Share of patients with 180+ days stay	0.167	0.178
	(0.012)	(0.012)
Share of patients with home residence	-0.020	-0.016
	(0.003)	(0.003)
Type 2		1.649
		(0.128)

Estimation: Supply, Second stage

The dynamic oligopoly model is estimated using GMM.

The model-predicted error term for observation n is given by:

$$\Xi_n(\theta) = a_n^{data} - \sum_{a_n \in \mathcal{A}} a_n \hat{\Psi}(a_n | x_{mt(n)}^{data}, \theta)$$

where $\hat{\Psi}(a_n | x_{mt(n)}^{data}, \theta)$ is the predicted choice probability for a_n.

Instruments used in GMM are the variables in the first-stage empirical policy functions.

The objective function is:

$$\min_{\theta} \left[\frac{1}{N} \sum_n Z_n' \Xi_n(\theta) \right]' \hat{W} \left[\frac{1}{N} \sum_n Z_n' \Xi_n(\theta) \right]$$

Results: Demand

$$u_{ijt} = \alpha_{m(j)} + X'_{jt}\beta + \psi_{jt} + \xi_{jt} + \zeta_i + (1 - \sigma_n)\tilde{\varepsilon}_{ijt}$$

$$\xi_{jt} = \rho\xi_{jt-1} + \epsilon_{jt}$$

$$\psi_{jt} = (1 - \tau)\psi_{jt-1} + \eta a_{jt}$$

	Demand
τ	0.530
	(0.156)
ρ	0.756
	(0.072)
σ_n	0.597
	(0.034)
η	0.012
	(0.003)

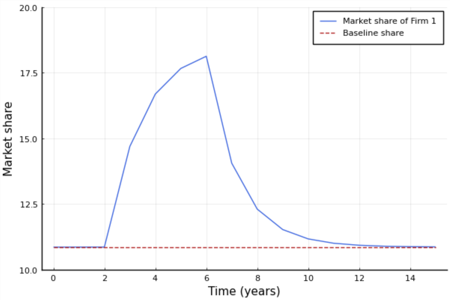
Results: Demand

	Demand
Hospice inpatient unit	0.011
	(0.112)
Pediatric program	0.223
	(0.071)
Bereavement services	0.008
	(0.037)
Day care for adults	0.038
	(0.169)
For-profit	-0.291
	(0.081)
Agency type: free-standing	-0.168
	(0.133)
Agency type: home health based	-0.287
	(0.152)
Agency type: hospital-based	-0.259
	(0.159)

Results: Estimation

$$\text{Quality by Firm 1} = \begin{cases} 22, & \text{if } t \leq 2 \\ 39, & \text{if } 2 < t \leq 6 \\ 22, & t > 6 \end{cases}$$

$$\text{Quality by Firm 2} = 22$$



Results: Supply

$$MC_j(a_j) = \gamma_0 + \Big(\gamma_1 + \gamma_{fp} FP_j + \gamma_{rural} RURAL_j\Big) a_j$$

$$MC_j(a_j) = \gamma_0 + \Big(\gamma_1 + 1(type_j = 2)\gamma_{12} + \gamma_{fp} FP_j + \gamma_{rural} RURAL_j\Big) a_j$$

	No types	With cost-types
γ_1	1343.728	1541.100
	(32.311)	(48.872)
γ_{fp}	-740.676	-532.156
	(93.892)	(116.642)
γ_{rural}	125.534	206.063
	(54.289)	(74.825)
γ_{12}		-594.847
		(111.097)

Counterfactuals

To evaluate different policy measures, I solve the model for 3 firms with no entry or exit.

Also test if differentiated hospices react differently based on their characteristics and unobserved demand shocks.

$$\begin{aligned} u_{ijt} &= \alpha_{m(j)} + X'_{jt}\beta + \psi_{jt} + \xi_{jt} + \zeta_i + (1-\sigma)\tilde{\varepsilon}_{ijt} \\ &= \Pi_{jt} + \psi_{jt} + \zeta_i + (1-\sigma)\tilde{\varepsilon}_{ijt} \end{aligned}$$

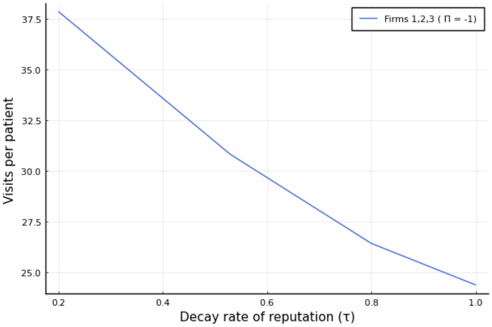
where $\Pi_{jt} = \alpha_{m(j)} + X'_{jt}\beta + \xi_{jt}$ reflects how much hospice j differentiates along non-reputation dimensions.

Impose that a hospice's Π_j remains constant over time for clarity.

Counterfactuals: reputation persistence

First set of counterfactuals involves the persistence of reputation.

Mimics policies like online review sites that make quality information widely available and easier to find.



Counterfactuals: Medicare prices

Medical providers have frequently complained that Medicare reimbursement rates are too low.

Study how hospice quality changes as prices increase:

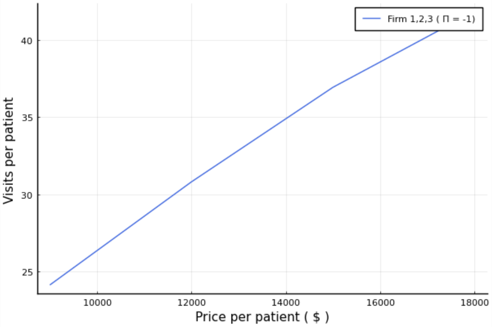
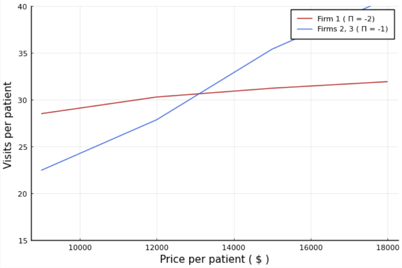


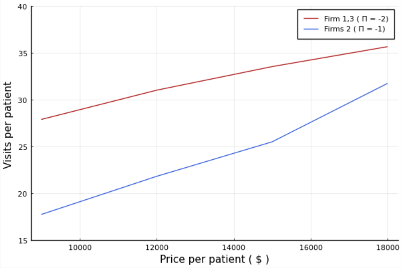
Figure 1: $\Pi_1 = \Pi_2 = \Pi_3 = -1.$

Counterfactuals: Medicare prices

With heterogeneous hospices:



(a) $\Pi_1 = -2,\ \Pi_2 = \Pi_3 = -1$



(b) $\Pi_1 = \Pi_3 = -2,\ \Pi_2 = -1$

Counterfactuals: Medicare prices

Comparison between static vs reputation setting:

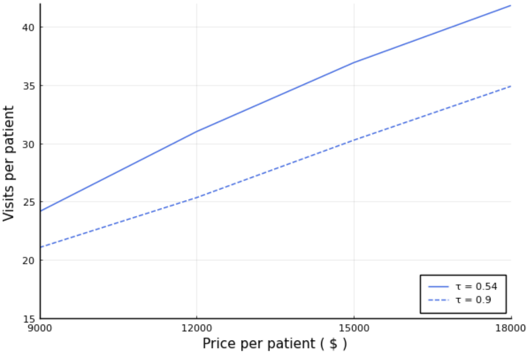


Figure 3: Average quality choice by hospice against increasing Medicare rates. $\Pi_1 = \Pi_2 = \Pi_3 = -1$.

Counterfactuals: contract design

Marginal cost per visit = \$200

The following contract structures all achieve 29 average visits-per-patient:

Per-day rate	Per-visit rate	Medicare cost
186.7	0.0	1.0
150.0	50.0	0.93
100.0	110.0	0.82
50.0	170.0	0.71

Counterfactuals: contract design

Takeaway: potential cost savings by shifting weight from per-day to per-visit reimbursement.

Caveats:

1. Silent on quality target.
   (can be set by CMS)
2. Spurious visits:
   - Can hurt firm reputation.
   - Can be discouraged by finer contract structures.
   - Govt monitoring.

Conclusion

1. Demonstrate importance of reputation for patients choosing hospices and hospices choosing quality.
2. Estimate a structural model of reputation accumulation to estimate hospice cost function.
3. Counterfactuals show:
    - Persistence of reputation $\uparrow$ and Medicare prices $\uparrow \implies$ hospice quality $\uparrow$.
    - A hybrid per-day and per-visit reimbursement scheme achieves the same quality as the current per-day scheme at lower cost.

Estimation: Inferring types

One specification accounts for cost "type":

- Regress visit choices on hospice fixed effects, hospice characteristics and market characteristics.
- Hospices with FEs above median = Type 2
- Intuition: Type 2 hospices consistently choose higher quality than expected $\implies$ more **efficient/altruistic**.
  - Consumers may use reputation to infer cost type of hospices.
- In estimation, marginal cost can vary by hospice type.
  - *a priori* a hospice of a higher type has lower marginal cost.

BBL first stage

Estimation: Entry and exit

Exit: Firms exogenously exit the market with probability 4.1% (derived from data).

Entry: Potential entrants enter a market at the rate predicted by the following ordered logit.

	Entry count
Firm count	-0.300
	(0.117)
Market size	0.001
	(3.461e-04)
Medicare price	-3.846e-04
	(2.423e-04)
County FE	Yes

Structural model: Equilibrium

Let the vector $\sigma = \{\sigma_j\}_{\forall j}$ denote the strategy profile of all firms in a market.

$W_j(a, \mathrm{x}_m)$, is the net payoff to the hospice j from choosing action a before choice-specific shocks ϵ_j^a are observed.

The ex-ante value functions $V_j(\mathrm{x}_m; \theta)$ can thus be written in terms of choice-specific value functions:

$$
\begin{aligned}
V_j^{\sigma}(\mathrm{x}_m) &= \int V_j^{\sigma}\left(\mathrm{x}_m, \epsilon_j^a\right) dG\left(\epsilon_j^a\right) \\
&= \int \max_{a_j \in \mathcal{A}} \left\{ W_j^{\sigma}(a_j, \mathrm{x}_m) + \epsilon_j^a(a_j) \right\} dG\left(\epsilon_j^a\right),
\end{aligned}
$$

Structural model: Equilibrium

The MPE is the strategy profile σ^* such that every firm is choosing the optimal strategy given the strategies of their rivals:

$$\sigma_j^* \left(x_m, \epsilon_j^a\right) = \arg\max_{a_j \in \mathcal{A}} \left\{ W_j^{\sigma^*} \left(a_j, x_\mathrm{m}\right) + \epsilon_j^a \left(a_j\right) \right\}$$

where the superscript σ^* indicates that the choice-specific value function is conditional on the optimal strategies of all its rivals.

Assuming ϵ_j^a is distributed *i.i.d* Type-1 Extreme Value, the CCP of an action a_j taken by firm j can be written as:

$$\Psi\left(a_j \mid x_m, \sigma^*\right) = \frac{\exp\left\{W_j^{\sigma^*}\left(a_j, x_m\right)\right\}}{\sum_{a \in \mathcal{A}} \exp\left\{W_j^{\sigma^*}\left(a, x_m\right)\right\}}$$

Counterfactuals

$$\Psi(a_j|\mathrm{x}) = \frac{e^{\hat{v}(a_j,\mathrm{x})/\sigma_e}}{\sum_{a\in\mathcal{A}} e^{\hat{v}(a,\mathrm{x})/\sigma_e}}$$

$$\hat{v}(a_j,\mathrm{x}) = \sum_{\mathbf{a}_{-j}\in\mathcal{A}_{-j}} \Bigg\{ \Bigg[\bar{\pi}(a_j,\mathbf{a}_{-j},\mathrm{x}') + \beta V(\mathrm{x}')\Bigg]$$

$$F(\mathrm{x}'|\mathrm{x},a_j,\mathbf{a}_{-j}) \prod_n \Psi(\mathbf{a}_{-j}[n]|\mathrm{x}) \Bigg\}$$

$$V(\mathrm{x}) \quad = \quad \sigma_e \Bigg[0.577216 + \ln\big(\sum_{a_j\in\mathcal{A}} e^{\hat{v}(a_j,\mathrm{x})/\sigma_e}\big)\Bigg]$$

Examples of hospice care

Examples of hospice care:

- Pain medication
- Medical supplies
- Dressing bedsores
- Giving physical and speech therapy
- Bathing and feeding
- Respite for primary caregiver.

Back

Choosing a hospice

- AmericanHospice.org: "**What do others say about this hospice?** Get references both from people you know and from people in the field – e.g., local hospitals, nursing homes, clinicians. Ask anyone that you have connections to if they have had experience with the hospice and what their impressions are. Geriatric care managers can be a particularly good resource, **as they often make referrals to hospices and hear from families about the care that was provided**. Anecdote and word of mouth won't paint a full picture but they are still valuable data points...
  How long has the hospice been in operation? If it has been around for a while, that's an indication of stability."

Choosing a hospice

- HospiceFoundation.org: "Seek professional opinions. Ask clinicians, professional caregivers at nursing homes, geriatric care managers, or end-of-life doulas about their experience with a hospice. Talk to friends, family, and neighbors **who have used hospice services and get their opinions about the experience with a provider**."
- Vitas.com: "Evaluate the hospice provider's **history and reputation** before you decide. How long has it been in business? ... What do other patients or families say about their experiences?"

Choosing a hospice

- Caringinfo.org: "Most hospice programs use family satisfaction surveys to obtain feedback about their services so they can make improvements. Ask the hospice to share a summary of their **family satisfaction scores for the last several months with you**. You can also ask to see their latest state or Medicare inspection report to see if there are care provision problems. Finally, you could ask to see the hospice provider's list of complaints from the past 12 months."

Back