Medicare Program Expenditures Associated with Hospice Use

Diane E. Campbell, PhD; Joanne Lynn, MD; Tom A. Louis, PhD; and Lisa R. Shugarman, PhD

Background: Hospice providers contend that enrollment reduces the cost of the Medicare programs, but estimates of effects are dated, methodologically limited, and focused on persons with cancer.

Objective: To estimate the effects of hospice care on Medicare program payments during the last year of life from 1996 to 1999 within cohorts defined by age and diagnosis.

Design: Retrospective cohort.

Setting: Deceased Medicare enrollees.

Participants: Elderly Medicare fee-for-service beneficiaries who received 36 months of continuous Part A and B coverage before death during 1996 to 1999 (n = 245 326). Age- and condition-specific (cancer or noncancer and principal condition) cohorts were defined.

Measurements: Medicare expenditures in the last year of life, as a total figure and by service type. The cost effects of hospice were estimated by using linear regression within the cohorts for hospice enrollees compared with nonenrollees after adjustment for propensity to use hospice, gender, race, enrollment in Medicaid, urban setting, duration of illness, comorbid conditions, low use of Medicare, nursing home residence, and year of death.

Results: Adjusted mean expenditures were 4.0% higher overall among hospice enrollees than among nonenrollees. Adjusted mean expenditures were 1% lower for hospice enrollees with cancer than for patients with cancer who did not use hospice. Savings were highest (7% to 17%) among enrollees with lung cancer and other very aggressive types of cancer diagnosed in the last year of life. Expenditures for hospice enrollees without cancer were 11% higher than for nonenrollees, ranging from 20% to 44% for patients with dementia and 0% to 16% for those with chronic heart failure or failure of most other organ systems. Hospice-related savings decreased and relative costs increased with age.

Conclusion: Hospice enrollment correlates with reduced Medicare expenditures among younger decedents with cancer but increased expenditures among decedents without cancer and those older than 84 years of age. Future studies should assess the effects of hospice on quality and on expenditures from all payment sources.

Ann Intern Med. 2004;140:269-277. www.annals.org

For author affiliations, see end of text.

The hospice benefit in Medicare aimed to enhance beneficiaries' options for less aggressive end-of-life medical care and for death at home by providing comprehensive services that were not otherwise covered (for example, outpatient drugs, homemaker services, and bereavement counseling) to patients who agree to forgo "curative treatment for their terminal illness" and who have a physician-certified life expectancy of 6 months or less (1). Previous research on patients with cancer who died between 1981 and 1992 (2–8) indicated, and opinion leaders have often claimed, that hospice enrollment reduces Medicare program costs compared with conventional care during the last month but not the last year of life (2–4, 9, 10). Earlier evaluations cautioned that changes in pricing, benefit design, and case mix could affect their findings (3).

Those elements have certainly changed. Enrollment in the Medicare hospice benefit increased from 9% in 1992 to 23% in 2000 (11). Between those years, the percentage of hospice enrollees without cancer increased from 24% to 49%, the percentage of enrollees in nursing homes increased from 11% to 36%, and the percentage of those older than 79 years of age increased from 35% to 47% (11, 12). The Balanced Budget Act of 1997 made the Medicare hospice benefit more flexible and long lasting, instituted prospective payments for after-hospital home and skilled-nursing facility care, and decreased hospital payments for unusually short stays before postacute care. These policies increase the desirability of hospice enrollment, especially for patients without cancer.

We estimated the effects of hospice enrollment on national Medicare expenditures during the last year of life among persons who died of conditions other than cancer and made more recent estimates of effects for persons who died of cancer. Examination of expenditures in the last year of life directly addresses the influence of hospice on Medicare program costs at the end of life and avoids serious limitations of previous studies that involved matching enrollees and nonenrollees by duration of hospice enrollment (8). Our design, analytical methods, and measures address selection bias, matching, and generalizability limitations of previous studies (2–4, 8, 13, 14).

METHODS

Design

In this retrospective cohort study, we used linear regression models to estimate adjusted mean Medicare payments in the last year of life that were associated with hospice enrollment. Hospice enrollees were matched to nonenrollees by using poststratification (15) with strata

Improving Patient Care is a special section within *Annals* supported in part by the U.S. Department of Health and Human Services (HHS) Agency for Healthcare Research and Quality (AHRQ). The opinions expressed in this article are those of the authors and do not represent the position or endorsement of AHRQ or HHS.

Table 1. **Sample Characteristics by Condition Cohort and Age Stratum**

Characteristic	Total Sample	Noncancer Decedents				Cancer Decedents			
		All	68–79 Years	80–84 Years	≥85 Years	All	68–79 Years	80–84 Years	≥85 Years
Decedents, *n* (%)	245 365 (100)	180 190 (73)	59 761 (24)	39 509 (16)	80 920 (33)	65 175 (27)	34 067 (14)	14 115 (6)	16 993 (7)
Hospice use, %	18	10	9	11	11	38	42	38	32
Descriptors									
Mean age at death, y	83	84	75	83	91	80	74	82	90
Women, %	57	61	48	57	72	48	45	48	55
Nonwhite, %	10	10	12	9	9	10	11	9	10
Medicaid use, %	24	27	23	24	32	16	14	15	21
Duration of illness, %									
Diagnosed last mo before death	11	11	12	11	10	11	10	12	12
Diagnosed 2nd mo before death	4	3	3	3	4	6	7	7	6
Diagnosed 3–6 mo before death	11	10	9	9	10	16	17	15	13
Diagnosed 7–12 mo before death	14	14	14	14	14	15	17	14	14
Comorbid conditions, %									
0 or 1	20	20	21	18	21	18	20	17	15
≥5	18	19	22	22	16	15	13	16	16
Nursing home residence, %	45	50	34	49	63	32	23	34	48
Area of residence, %									
Metropolitan	72	72	71	72	72	73	72	73	73
Urbanized	13	13	14	13	13	13	13	13	13
Rural	15	15	15	15	15	14	14	14	14
Low Medicare use, %	8	9	10	8	9	4	3	3	5

formed by age and diagnosis group (cancer or noncancer, or principal condition). Within strata, we adjusted for propensity to use hospice, gender, race, enrollment in Medicaid, urban setting, illness duration, comorbid conditions, consistently low use of Medicare, nursing home residence, and year of death. Data sources include denominator and claims files from Medicare.

Setting and Participants

The sample (n = 245 326) comprises all decedents from the Medicare standard national 5% sample who had fee-for-service coverage, were older than 67 years of age, died between 1 January 1996 and 31 December 1999, and had at least 36 months of continuous Part A and B Medicare coverage before death. We excluded decedents who were eligible for Medicare on the basis of end-stage renal disease or disability and those who resided outside the United States.

Outcome Measures

Our primary outcome measure was Medicare payments to providers, adjusted for inflation to 1999 and summed overall and by type of service (hospital inpatient, skilled-nursing facility, home health, hospice, outpatient facility, and physician or supplier). We exclude co-insurance, copayments, and deductibles because our focus was

Table 2. **Unadjusted Mean Medicare Program Expenditures in the Last Year of Life by Hospice Enrollment, with Ratios of Hospice to Non-Hospice Expenditures within Condition Cohort and Age Stratum***

Condition Cohort	Expenditures by Age Stratum			
	All Ages	68–79 Years	80–84 Years	≥85 Years
	← $ →			
All enrollees	24 830	30 015	25 498	19 495
Hospice enrollees	27 426	30 910	26 794	23 094
Non-hospice enrollees	24 273	29 781	25 214	18 882
Ratio	1.13	1.04	1.06	1.22
Noncancer cohort				
All	23 271	28 429	24 634	18 797
Hospice enrollees	26 751	31 856	27 461	23 328
Non-hospice enrollees	22 879	28 096	24 296	18 247
Ratio	1.17	1.13	1.13	1.28
Cancer cohort				
All	29 140	32 799	27 917	22 820
Hospice enrollees	27 917	30 558	26 274	22 721
Non-hospice enrollees	29 905	34 396	28 937	22 868
Ratio	0.93	0.89	0.91	0.99

* A ratio less than 1.0 indicates that use of hospice is associated with savings to the Medicare program, whereas a ratio greater than 1.0 indicates increased costs.

Medicare program expenditures. Measures of volume and intensity of service use in the last year of life were mean days in hospital, mean days in the intensive care unit, and mean hospice payments per diem. Timing of hospice entry was defined by days in hospice.

Covariate Measures

Hospice enrollees comprised decedents with any hospice claim, including the 10% of those discharged before death or who had gaps in hospice enrollment. Information on age at death, gender, race, and Medicaid enrollment was obtained from the denominator file. Race was categorized as white or nonwhite. Any state buy-in during the last year of life indicated Medicaid enrollment. Urban setting was categorized as metropolitan, urbanized, or rural (16). Categories for unusually many (≥5) or few (1 or none) comorbid conditions (based on the number of Charlson comorbid conditions) (17, 18) were used to control for the variation in illness burden among decedents.

Low use of Medicare (within the 25th percentile of total expenditures consistently for 24 months before death) was used to control for selection and data sampling biases. Consistently low use may indicate selection bias related to patient preference for less aggressive care. If hospice enrollees generally wanted less aggressive care, the associated costs would be less even without hospice. Consequently, hospice savings would be overstated without controls for consistently low use (3). Consistently low use of Medicare may also reflect data sampling bias for patients with coverage from other insurance programs (for example, veterans) or care from non-Medicare providers and may imply a lower chance of referral to hospice under Medicare.

Categories of illness duration (Table 1) were used to control for variations in opportunity to enroll in hospice, because some time is needed to arrive at a prognosis and enroll in hospice. Duration of illness was calculated as number of days between the date of death and earliest diagnosis of a principal condition.

Principal conditions in the last year of life were derived from expenditures and principal diagnoses recorded on claims. We adapted a plurality of physician expenditures method that places patients in leading cause-of-death categories as defined by the National Center for Health Statistics (19). Adaptation was necessary for 3 reasons. First, among causes of death derived by using the expenditure plurality method, 3 (pneumonia or influenza, accidents or adverse effects, and septicemia) are often secondary to underlying serious and chronic illnesses, and 6% of cases could not be classified. Second, we aimed for consistency with previous research that selected patients with cancer on the basis of having any cancer diagnosis in claims (3, 4). Finally, for decedents with cancer, we identified subgroups that were homogeneous in terms of survival and disease course to control for confounders associated with those factors and to allow comparison of estimated cost effects of hospice in the cancer cohort.

Consequently, after we classified decedents into condition groups by using the expenditure plurality method, we reclassified those who died of pneumonia or influenza, accidents or adverse effects, septicemia, or unclassified causes by using the plurality of principal diagnoses among all last-year-of-life claims. We then assigned decedents with a cancer classification from the expenditure plurality or the diagnosis plurality method to the cancer cohort. Finally, we divided decedents with cancer into 7 subgroups by plurality of cancer diagnosis (lung, other aggressive types of cancer with median survival <1 year [20], all other types of cancer with metastases, and all other types of cancer without metastases) and timing of diagnoses (incident [first diagnosed in the last year] or prevalent [first diagnosed before the last year]). Because nonaggressive, nonmetastatic types of cancer are fairly indolent, making incident cases uncommon, we combined patients with incident and prevalent cancer. The validity of this method is supported by consistency between the distribution of decedents among principal conditions and distributions by cause of death reported by the National Center for Health Statistics and National Mortality Follow Back Survey (19, 21).

We derived and validated an indicator of nursing home residence from physician claims in which place-of-service or evaluation and management codes indicated encounters that took place at a nursing home or skilled nursing facility. Application of these classification rules to Medicare Current Beneficiary Survey claims resulted in a κ value of 0.78 (95% CI, 0.76 to 0.80) between our measure and Medicare Current Beneficiary Survey facility residence status (22).

To mitigate potential selection bias, we calculated hospice use propensity scores within each cohort by using logistic regression (23, 24). The propensity score for a decedent is the predicted likelihood of hospice use conditioned on factors that are known to correlate with hospice use (3, 4, 11, 25, 26) (gender, race, Medicaid enrollment, primary condition, comorbid conditions, and urban setting) and an indicator for residence in states with high or low rates of hospice use (20% to 29% and ≥30% greater or less than the norm among the sample) to account for combined influences of health service supply, provider practice patterns, selection bias, and geopolitical variations that affect service supply or health coverage (for example, Medicaid hospice and home health payments, charismatic leaders, and innovative non–hospice-based end-of-life care programs).

Statistical Analysis

Interaction effects observed among age, principal condition, race, and gender prompted us to perform stratified analyses to avoid masking true effects. Within each stratum of age and cancer or noncancer status, or age and principal condition, linear regression was used to further control for propensity to use hospice, gender, race, Medicaid enrollment, urban setting, comorbid conditions, low use of

Table 3. **Ratios (Hospice/Non–Hospice Enrollees) of Adjusted Mean Medicare Expenditures in the Last Year of Life by Condition Cohort and Age Stratum***

Condition Cohort	Total Sample, *n*	Age Stratum			
		All Ages	68–79 Years	80–84 Years	≥85 Years
All conditions	245 365	1.04	0.98	1.04	1.16
Noncancer conditions	180 190	1.11	1.05	1.09	1.22
Kidney disease	10 748	0.93	0.86	0.90	1.02
Diabetes	9535	1.09	1.12	1.04	1.10
Cerebrovascular disease	31 344	1.11	1.02	1.11	1.14
Chronic obstructive pulmonary disease	22 636	1.04	0.99	1.07	1.15
Chronic heart failure	40 258	1.08	1.00	1.05	1.16
Other heart disease	23 081	1.24	1.16	1.18	1.41
Dementia	18 633	1.34	1.30	1.20	1.44
All other disease	23 955	1.53	1.50	1.40	1.59
Cancer conditions†	65 175	0.99	0.95	0.99	1.06
Incident aggressive cancer	5293	0.83	0.83	0.87	0.86
Incident lung cancer	7135	0.85	0.84	0.87	0.93
Incident other metastatic cancer	5104	0.91	0.89	0.93	0.84
Prevalent aggressive cancer	4998	0.93	0.91	0.94	1.04
Prevalent lung cancer	6629	0.96	0.96	0.95	1.03
Prevalent other metastatic cancer	10 617	0.98	0.96	1.00	1.05
All other cancer with no metastases	25 399	1.08	1.06	1.08	1.13

* A ratio less than 1.0 indicates that use of hospice is associated with savings to the Medicare program, whereas a ratio greater than 1.0 indicates increased costs.
† "Incident" means that the cancer was diagnosed in the last year of life. "Prevalent" means that the cancer was diagnosed before the last year of life. Aggressive types of cancer are those other than lung cancer with a median survival of 1 year or less.

Medicare, duration of illness, nursing home residence, and year of death.

We estimated the effects of hospice enrollment on Medicare program expenditures in the last year of life, overall and by service type (hospital inpatient, skilled-nursing facility, home health, outpatient facility, and physician or supplier). We modeled untransformed expenditures, expenditures truncated at the 5th and 95th percentile of the strata-specific distributions (that is, more extreme values set to those percentiles), and log-transformed expenditures and present effects from the truncated models because they moderate the disproportionate influence of very high and low use decedents while estimating mean effects in the original dollar scale. Adjusted mean ratios for Medicare program expenditures in the last year of life (hospice enrollees or nonenrollees) less than 1.0 indicated savings, and those greater than 1.0 indicated added costs for hospice enrollees compared with nonenrollees. Adjusted differences between mean expenditures incurred by hospice enrollees and nonenrollees, by service type within age and cancer or noncancer stratum, show the relation of hospice enrollment to patterns of service use and expenditures. Variations in service use and timing of entry to hospice between condition cohort and age strata inform interpretation of results.

Role of the Funding Sources

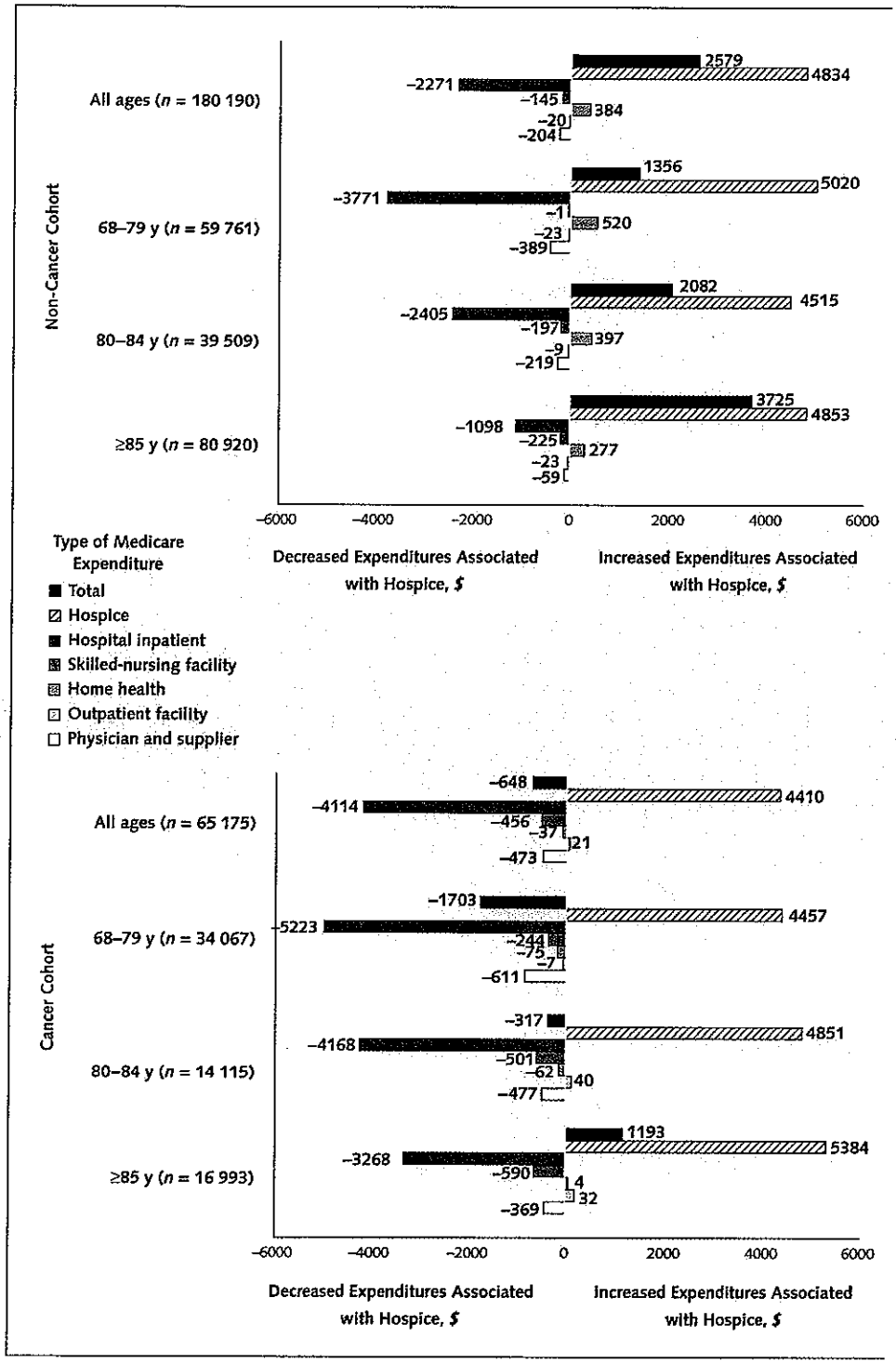
The funding sources had no role in the analyses or interpretation of the study findings. The manuscript was reviewed by the Centers for Medicare & Medicaid Services (formerly Health Care Financing Administration) to ensure the confidentiality of patients and providers.

RESULTS

The sample was 57% female, 10% nonwhite, 72% metropolitan, 13% urbanized, and 15% rural; 24% were Medicaid enrollees (**Table 1**). Characteristics varied by condition cohort and age. The noncancer cohort comprised 73% of all decedents and had an overall rate of hospice use of 10%, compared with 38% for cancer decedents. Hospice use increased with age in the noncancer cohort and decreased with age in the cancer cohort. Compared with the cancer cohort, the noncancer cohort was older and more likely to be female, use Medicaid, have a longer duration of illness, have more coexisting conditions, live in a nursing home, and have consistently low use of Medicare services in the 24 months before death. In both cohorts, the percentage of women, those using Medicaid, nursing home residents, and those with consistently low use of Medicare increased with age.

Unadjusted Medicare program expenditures and associated expenditure ratios (hospice enrollees to nonenrollees) also varied by age and condition cohort (**Table 2**). Expenditures decreased with age in every category. Total expenditures were higher at every age for the cancer cohort than the noncancer cohort. Ratios increased with age from 1.04 to 1.22; the average was 1.13 for all ages and all conditions. These unadjusted ratios suggest that use of hospice is associated with additional costs to the Medicare program and that added costs increase with age. Comparison of ratios between the noncancer cohort (1.13 to 1.28) and cancer cohort (0.89 to 0.99) suggests that additional Medicare program costs associated with hospice are a function of hospice use in the noncancer cohort.

Figure. Estimated effect of hospice on adjusted mean Medicare program expenditures in the last year of life by type of Medicare expenditure within condition cohort and age stratum.



Similar findings were derived from estimated Medicare program expenditures that were adjusted for propensity to use hospice, gender, race, use of Medicaid, urban setting, duration of illness, comorbid conditions, consistently low use of Medicare, nursing home residence, and year of death (Table 3). Overall adjusted ratios increased with age from 0.98 to 1.16 and averaged 1.04 for all ages and conditions, suggesting that hospice incurs additional costs to the Medicare program. Comparison of ratios in the noncancer cohort (1.05 to 1.22 [average, 1.11 for all ages]) with those in

Table 4. **Differences between Adjusted Mean Medicare Program Expenditures in the Last Year of Life for Hospice Enrollees Compared with Non–Hospice Enrollees by Type of Expenditure within Condition Cohort and Age Stratum**

Type of Expenditure	Difference in Noncancer Cohort (95% CI)			
	All (n = 180 190)*	68–79 Years (n = 59 761)	80–84 Years (n = 39 509)	≥85 Years (n = 80 920)
	← $ →			
Total differences in means	2579 (1934 to 3224)	1356 (509 to 2203)	2082 (1300 to 2864)	3725 (3296 to 4153)
Hospital inpatient	−2271 (−2723 to −1819)	−3771 (−4425 to −3116)	−2405 (−2944 to −1866)	−1098 (−1358 to −839)
Skilled-nursing facility	−145 (−280 to −8)	−1 (−123 to 122)†	−197 (−372 to −21)	−225 (−352 to −97)
Home health care	384 (271 to 497)	520 (398 to 642)	397 (253 to 541)	277 (187 to 368)
Outpatient facility	−20 (−52 to 12)†	−23 (−58 to 13)†	−9 (−48 to 29)†	−23 (−49 to 4)†
Physician or supplier	−204 (−275 to −132)	−389 (−484 to −293)	−219 (−308 to −130)	−59 (−104 to −14)
Hospice‡	4834 (4673 to 4992)	5020 (4835 to 5201)	4515 (4311 to 4719)	4853 (4731 to 4972)

* Values for all ages are the weighted average of stratum-specific estimates.
† Not significant ($P < 0.05$).
‡ Hospice values are calculated as [total − (hospital inpatient + skilled-nursing facility + home health care + outpatient facility + physician or supplier)].

the cancer cohort (0.95 to 1.06 [average, 0.99 for all ages]) suggests that additional costs are a function of hospice use by the noncancer cohort and the oldest old within the cancer cohort.

Adjusted expenditure ratios by principal condition imply that conditions indicative of multiple organ system failure (kidney disease, diabetes, cerebrovascular disease, chronic obstructive pulmonary disease, and heart disease) have less effect on added costs associated with hospice than do conditions indicative of dementia or frailty (dementia and all other noncancer diseases). In the cancer cohort, savings associated with hospice were higher for incident and more aggressive cancers. Ratios increased with age for all conditions, indicating that hospice savings decrease and added costs increase with age.

To illustrate pattern variations in use of services by condition cohort and age stratum (**Figure**), we examined differences between estimates for adjusted mean expenditures among hospice enrollees and nonenrollees by type of expenditure (total, hospital inpatient, skilled-nursing facility, home health, outpatient facility, or physician or supplier). The 95% CIs imply that estimated differences are relatively precise, and most are statistically significant (**Table 4**). The average hospice enrollee without cancer incurs Medicare costs that are about $2579 more in the last year than those of the average nonenrollee, and their additional costs increase with age from $1356 at 68 to 79 years of age to $3725 at 85 years of age or older. The average hospice enrollee with cancer appears to save Medicare $648 in the last year of life compared with the average nonenrollee. The estimated savings of $1703 among enrollees with cancer who are 68 to 79 years of age more than offset the additional cost of $1193 among those 85 years of age or older. For decedents in the cancer cohort who were younger than 85 years of age, the cost of hospice is offset by savings in all other expenditures except outpatient facility use. In contrast, the estimated savings among the noncancer cohort for hospital inpatient, skilled-nursing facility, outpatient facility, and physician or supplier services do not offset the costs of hospice and increased spending for home health care among hospice enrollees.

Examination of volume, intensity, and timing of service use indicates that the noncancer cohort tended to use fewer but more intensive hospital and hospice services in the last year of life. On average, patients in the noncancer cohort spent 4 fewer days as a hospital inpatient than did those in the cancer cohort (16 vs. 20 days), yet patients in both cohorts spent an average of 3 days in a hospital intensive care unit. Hospice enrollment accounted for an average decrease of 6 days in hospital and 2 days in the intensive care unit among the cancer cohort but had little effect among the noncancer cohort. Mean per diem hospice expenditures were higher among enrollees without cancer ($155) than those with cancer ($136). Finally, entry to hospice in the last week of life was more prevalent among enrollees without cancer than those with cancer (36% vs. 23%). Because of higher hospice costs and lower expenditures for other services among the noncancer cohort (**Table 2**), hospice has reduced opportunities to show savings.

The results reported above persisted even after we varied our methods, although these alternative strategies affected the exact estimates. Specifically, population charac-

Table 5. **Key Conclusions and Implications for Policy and Future Research**

- Hospice use appears to reduce Medicare expenditures for patients with cancer who are younger than 85 years of age, but to increase costs for patients without cancer and all patients older than 85 years of age.
- Hospice use in the Medicare program probably conserves more than 10% of the costs for patients with aggressive cancer and probably adds more than 30% to the costs for patients with dementia. Costs for other conditions fall in between these extremes.
- The variation in the effects of use of hospice on costs probably arises from different trajectories of service needs and prognostic certainty that are associated with patients' diagnoses and ages.
- From 1996 to 1999, use of hospice probably added about 4% to Medicare payments for the last year of life in the typical patient. This study does not estimate effects on other payment sources.
- Policy judgments on the merits of hospice use and expansion require understanding of the benefits, as well as the costs of hospice care.

Table 4—**Continued**

Difference in Cancer Cohort (95% CI)			
All (n = 65 175)*	68–79 Years (n = 34 067)	80–84 Years (n = 14 115)	≥85 Years (n = 16 993)
←	$		→
−648 (−1425 to 11)†	−1703 (−2293 to −1113)	−317 (−1117 to 483)	1193 (515 to 1870)
−4485 (−5398 to −4385)	−5223 (−5665 to −4781)	−4168 (−4727 to −3609)	−3268 (−3699 to −2838)
−390 (−549 to −301)	−244 (−310 to −177)	−501 (−651 to −352)	−590 (−768 to −411)
−52 (−163 to 51)†	−75 (−138 to −11)	−62 (−189 to 64)†	4 (−139 to 148)
13 (−55 to 85)†	−7 (−73 to 60)†	40 (−34 to 115)†	32 (−20 to 84)
−519 (−709 to −423)	−611 (−745 to −476)	−477 (−631 to −324)	−369 (−474 to −264)
4784 (4984 to 5449)	4457 (4272 to 4638)	4851 (4589 to 5115)	5384 (5151 to 5615)

teristics would not change substantially if the continuous enrollment requirement were 12 rather than 36 months. The model presented has the same overall implications as do models with untransformed or log-transformed expenditures. Overall implications are also consistent with those of models that exclude hospice enrollees with discontinuous stays and models that do not correct for consistently low Medicare use.

Discussion

Hospice is cost-neutral to cost-saving for persons who die of cancer and generally yields added costs for those who do not die of cancer. The latter is the fastest growing group of hospice enrollees (11). Overall, hospice users incur an estimated 4% greater costs than do similar patients who do not use hospice. Savings decrease and relative costs increase with age at death. Medicare expenditures near death decrease with age (27–30), whereas hospice expenditures remain relatively constant. Medicare expenditures were lower at every age and mean per diem hospice costs were higher in the noncancer cohort than the cancer cohort. Consequently, the potential for hospice savings was lower for the noncancer cohort.

Our findings confirm and update those of other studies. Studies in patients with cancer in the late 1980s to early 1990s indicate that hospice may have only small effects in the last year of life (2–4). More recent descriptive studies suggest that hospice may increase costs in the last year of life for persons who do not die of cancer (14, 31).

The relative costs of hospice are highest among patients with dementia and relatively nonspecific diagnoses and intermediate among patients with organ system failures. Hospice-related savings are often realized among patients with cancer. This pattern probably reflects differences in service needs (31–37) and certainty of prognosis (38–42) that are associated with 3 major trajectories to death: a short period of obvious decline at the end of life, which is typical of cancer; long-term disability with exacerbations and unpredictable timing of death, which is typical of chronic organ system failure; or persistent decline and deficits in self-care associated with frailty or dementia (37, 43, 44). Effective and reliable care for persons approaching death may require organization and financing of care that match these trajectories (4, 37, 43, 45–60).

Earlier entry to hospice in the noncancer cohort may appear to be a way to reduce added costs associated with hospice care. However, earlier entry may not reduce costs or be achievable. The costs of hospice may exceed the costs of services avoided by earlier entry. Because prognoses in the noncancer cohort are typically uncertain (38–42), patients and their physicians may be unable or unwilling to determine or accept a 6-month prognosis or to forgo "curative treatment for their terminal illness," as required for hospice eligibility.

Our study has some limitations. First, although our methods offer improved control for selection bias and other confounders that limited previous research, some selection bias and confounding inevitably remain. Second, findings pertain to the Medicare program only and do not consider the effect of Medicare's hospice benefit on expenditures in the last year of life by patients and their families, Medicare for caregivers (61, 62), Medicaid, or other public or private payers. Finally, judging the merits of the hospice benefit requires understanding of the effect of hospice on quality of life, the impact of the Medicare hospice benefit on expenditures from all sources, and alternatives for organization and financing of end-of-life care. **Table 5** shows key conclusions and implications for policy and future research.

Most Americans are seriously and chronically ill in the years before death. Sustainable comprehensive services are required that ensure comfort, advance planning, closure, and family support, in addition to treatment for medical conditions. Even if hospice care costs somewhat more than conventional care, its comprehensiveness and continuity may merit those costs.

From Medical Outcomes Research and Evaluation Services, Thetford, Vermont; RAND, Santa Monica, California; The Washington Home Center for Palliative Care Studies, Washington, DC; and Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.

Disclaimer: The findings, statements, and views expressed are those of the authors and do not necessarily reflect the opinions and policies of the sponsors.

Grant Support: By the Agency for Healthcare Research and Quality, The National Institute on Aging, The Fan Fox-Leslie Samuels Foundation, and The Washington Home Center for Palliative Care Studies. The work was performed under a cooperative agreement with MedPAC, the Medicare Payment Advisory Commission.

Potential Financial Conflicts of Interest: None disclosed.

Requests for Single Reprints: Joanne Lynn, MD, Washington Home Center for Palliative Care Studies and RAND, 4200 Wisconsin Avenue, 4th Floor, Washington, DC 20016; e-mail, jlynn@rand.org.

Current author addresses are available at www.annals.org.

References

1. Gage B, Miller SC, Mor V, Jackson B, Harvell J. Synthesis and analysis of Medicare's hospice benefit: executive summary and recommendations. March 2000. Report to U.S. Department of Health and Human Services. Available at http://aspe.os.dhhs.gov/daltcp/reports/samhbes.htm. Accessed November 2003.

2. Mor V, Kidder D. Cost savings in hospice: final results of the National Hospice Study. Health Serv Res. 1985;20:407-22. [PMID: 4055382]

3. Kidder D. The effects of hospice coverage on Medicare expenditures. Health Serv Res. 1992;27:195-217. [PMID: 1592605]

4. National Hospice Organization. An Analysis of the Cost Savings of the Medicare Hospice Benefit. Miami, FL: Lewin-VHI, Inc; 1995.

5. Brooks CH, Smyth-Staruch K. Hospice home care cost savings to third-party insurers. Med Care. 1984;22:691-703. [PMID: 6381920]

6. Spector WD, Mor V. Utilization and charges for terminal cancer patients in Rhode Island. Inquiry. 1984;21:328-37. [PMID: 6240464]

7. Kane RL, Wales J, Bernstein L, Leibowitz A, Kaplan S. A randomised controlled trial of hospice care. Lancet. 1984;1:890-4. [PMID: 6143195]

8. Emanuel EJ. Cost savings at the end of life. What do the data show? JAMA. 1996;275:1907-14. [PMID: 8648872]

9. Miller GW, Williams JR, English DJ, Keyserling J. Delivering Quality Care and Cost-Effectiveness at the End of Life: Building on the 20-Year Success of the Medicare Hospice Benefit. Alexandria, VA: National Hospice and Palliative Care Organization; 2002.

10. Community-State Partnerships to Improve End-of-Life Care. Hospice Care Part I: A Policymaker's Primer on Hospice Care. State Initiatives in End-of-Life Care. 2001;11. Available at www.midbio.org/npopolicybrief.htm. Accessed 14 November 2003.

11. General Accounting Office. September 2000. Medicare: More Beneficiaries Use Hospice but for Fewer Days of Care. Publication no. GAO:HEHS-00-182 Washington, DC: General Accounting Office; 2000.

12. Medicare Payment Advisory Commission. Report to Congress: Medicare Beneficiaries' Access to Hospice. Washington, DC: MedPAC; 2002.

13. Emanuel EJ, Emanuel LL. The economics of dying. The illusion of cost savings at the end of life. N Engl J Med. 1994;330:540-4. [PMID: 8302321]

14. Emanuel EJ, Ash A, Yu W, Gazelle G, Levinsky NG, Saynina O, et al. Managed care, hospice use, site of death, and medical expenditures in the last year of life. Arch Intern Med. 2002;162:1722-8. [PMID: 12153375]

15. Schlesselman JL. Case-Control Studies: Design, Conduct, Analysis. New York: Oxford Univ Pr; 1982.

16. Ghelfi LM, Parker TS. A county-level measure of urban influence, rural development. Perspectives. 1997:12:32-41.

17. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992;45:613-9. [PMID: 1607900]

18. Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J Clin Epidemiol. 1993;46:1075-9. [PMID: 8410092]

19. Hogan C, Lynn J, Gabel J, Lunney J, O'Mara A, Wilkinson A. Medicare Beneficiaries' Costs and Use of Care in the Last Year of Life. Washington, DC: MedPAC; ; 2000. Publication no. 00-1.

20. Reis LA, Kosary CL, Hankey BF, Miller BA, Clegg L, Edwards BK, eds. SEER Statistics Review 1973-1999. Bethesda, MD: National Cancer Institute; 2000.

21. Hoyert DL, Kochanek KD, Murphy SL. Deaths: Final Data for 1997. National Vital Statistics Reports, Volume 47, June 30, 1999. Hyattsville, MD: National Center for Health Statistics; 1999.

22. Medicare Current Beneficiary Survey Cost and Use files 1992-1996. Available at www.cms.hhs.gov/MCBS/default.asp. Accessed November 2003.

23. Rubin DB. Estimating causal effects from large data sets using propensity scores. Ann Intern Med. 1997;127:757-63. [PMID: 9382394]

24. Joffe MM, Rosenbaum PR. Invited commentary: propensity scores. Am J Epidemiol. 1999;150:327-33. [PMID: 10453808]

25. Gage B, Dao T. Medicare's Hospice Benefit: Use and Expenditures. March 2000 Report to U.S. Department of Health and Human Services. Available at http://aspe.os.dhhs.gov/daltcp/reports/96useexp.htm. Accessed 14 November 2003.

26. Banaszak-Holl J, Mor V. Differences in patient demographics and expenditures among Medicare hospice providers. Hosp J. 1996;11:1-19. [PMID: 8920312]

27. Lubitz JD, Riley GF. Trends in Medicare payments in the last year of life. N Engl J Med. 1993;328:1092-6.

28. Lubitz J, Prihoda R. The use and costs of Medicare services in the last 2 years of life. Health Care Financ Rev. 1984;5:117-31. [PMID: 10310597]

29. Levinsky NG, Ash AS, Yu W, Moskowitz MA. Patterns of use of common major procedures in medical care of older adults. J Am Geriatr Soc. 1999;47:553-8. [PMID: 10323648]

30. Levinsky NG, Yu W, Ash A, Moskowitz M, Gazelle G, Saynina O, et al. Influence of age on Medicare expenditures and medical care in the last year of life. JAMA. 2001;286:1349-55. [PMID: 11560540]

31. Moon M, Boccuti C. Medicare and End-of-Life Care. 2003. Available at www.lastacts.org/files/publications/medicare.pdf. Accessed 14 November 2003.

32. Lynn J, Ely EW, Zhong Z, McNiff KL, Dawson NV, Connors A, et al. Living and dying with chronic obstructive pulmonary disease. J Am Geriatr Soc. 2000;48:S91-100. [PMID: 10809462]

33. Levenson JW, McCarthy EP, Lynn J, Davis RB, Phillips RS. The last six months of life for patients with congestive heart failure. J Am Geriatr Soc. 2000;48:S101-9. [PMID: 10809463]

34. McCarthy EP, Phillips RS, Zhong Z, Drews RE, Lynn J. Dying with cancer: patients' function, symptoms, and care preferences as death approaches. J Am Geriatr Soc. 2000;48:S110-21. [PMID: 10809464]

35. Somogyi-Zalud E, Zhong Z, Lynn J, Dawson NV, Hamel MB, Desbiens NA. Dying with acute respiratory failure or multiple organ system failure with sepsis. J Am Geriatr Soc. 2000;48:S140-5. [PMID: 10809467]

36. Lynn J, Arkes HR, Stevens M, Cohn F, Koenig B, Fox E, et al. Rethinking fundamental assumptions. SUPPORT's implications for future reform. J Am Geriatric Soc. 2000;48:S91-S100.

37. Field MJ, Cassel CK, eds. Approaching Death: Improving Care at the End of Life. Washington, DC: National Academy Pr; 1997.

38. Lynn J, Harrell F Jr, Cohn F, Wagner D, Connors AF Jr. Prognoses of seriously ill hospitalized patients on the days before death: implications for patient care and public policy. New Horiz. 1997;5:56-61. [PMID: 9017679]

39. Lynn J, Harrell FE, Cohn F, Hamel M, Dawson N, Wu AW. Defining the "terminally ill": insights from SUPPORT. Duquesne Law Rev. 1996;35:311-36. [PMID: 12385311]

40. Christakis NA. Predicting patient survival before and after hospice enrollment. Hosp J. 1998;13:71-87. [PMID: 9644394]

41. Fox E, Landrum-McNiff K, Zhong Z, Dawson NV, Wu AW, Lynn J. Evaluation of prognostic criteria for determining hospice eligibility in patients with advanced lung, heart, or liver disease. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments. JAMA. 1999;282:1638-45. [PMID: 10553790]

42. Christakis NA. Death Foretold: Prophecy and Prognosis in Medical Care.

Chicago: Univ of Chicago Pr; 1999.

43. **Lynn J.** Perspectives on care at the close of life. Serving patients who may die soon and their families: the role of hospice and other services. JAMA. 2001;285: 925-32. [PMID: 11180736]

44. **Lunney JR, Lynn J, Hogan C.** Profiles of older Medicare decedents. J Am Geriatr Soc. 2002;50:1108-12. [PMID: 12110073]

45. **Medicare Payment Advisory Commission.** Report to Congress: Assessing Medicare Benefits. Washington, DC: MedPAC; 2002.

46. **Miller SC, Gozalo P, Mor V.** Use of Medicare's Hospice Benefit by Nursing Facility Residents. In: Synthesis and Analysis of Medicare's Hospice Benefit. Washington, DC: Office of Disability, Ageing, and Long Term Care Policy in the Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services; March 2000. Available at http://aspe.hhs.gov/dalcp/reports/nufares.htm. Accessed 14 November 2003.

47. **Committee on the Quality of Health Care in America, The Institute of Medicine.** Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, DC: National Academy Pr; 2001.

48. **Lunney JR, Lynn J, Foley DJ, Lipson S, Guralnik JM.** Patterns of functional decline at the end of life. JAMA. 2003;289:2387-92. [PMID: 12746362]

49. **National Hospice and Palliative Care Organization, Center to Advance Palliative Care In Hospitals and Health Systems.**Hospital-Hospice Partnerships in Palliative Care: Creating a Continuum of Service. Project Report. Alexandria, VA: National Hospice and Palliative Care Organization; 2001.

50. **Kane RL, Kane RA.** Emerging issues in chronic care. In: Binstock RH, George LC, eds. Handbook of Aging and the Social Sciences, 5th ed. San Diego: Academic Pr; 2001.

51. **Harrington C, Lynch M, Newcomer RJ.** Medical services in social health maintenance organizations. Gerontologist. 1993;33:790-800. [PMID: 8314106]

52. **National PACE Association.**PACE profile. Program of All-Inclusive Care for the Elderly, 2000: integrated acute and long-term care service delivery and financing. Available at www.natlpaceassn.org/includes/content_profile_main.asp. Accessed 14 November 2003.

53. **Branch LG, Coulam RF, Zimmerman YA.** The PACE evaluation: initial findings. Gerontologist. 1995;35:349-59. [PMID: 7622088]

54. **Eng C, Pedulla J, Eleazer GP, McCann R, Fox N.** Program of All-inclusive Care for the Elderly (PACE): an innovative model of integrated geriatric care and financing. J Am Geriatr Soc. 1997;45:223-32. [PMID: 9033525]

55. **White AJ, Abel Y, Kidder D.** Evaluation of the Program of All-Inclusive Care for the Elderly Demonstration. A Comparison of the PACE capitation rates to projected costs in the first year of enrollment. Final report, October 27, 2000. Available at www.cms.hhs.gov/researchers/reports/1998/chatterji.pdf. Accessed 14 November 2003.

56. **Kane RL, Chen Q, Blewett LA, Sangl J.** Do rehabilitative nursing homes improve the outcomes of care? J Am Geriatr Soc. 1996;44:545-54. [PMID: 8617903]

57. **Bock I.** Completing the continuum of cancer care: integrating life-prolongation and palliation. CA Cancer J Clin. 2000;50:123-32.

58. **Lynn J, Wilkinson AM.** Quality end of life care: the case for a MediCaring demonstration. Hosp J. 1998;13:151-63. [PMID: 9644400]

59. **Foley DM, Gelband H.** Improving Palliative Care in Cancer (Report to the National Cancer Policy Board of the Institute of Medicine and the National Research Council). Washington DC: National Academy Pr; 2001.

60. **Covinsky KE, Eng C, Lui LY, Sands LP, Yaffe K.** The last 2 years of life: functional trajectories of frail older people. J Am Geriatr Soc. 2003;51:492-8. [PMID: 12657068]

61. **Schulz R, Beach SR.** Caregiving as a risk factor for mortality: the Caregiver Health Effects Study. JAMA. 1999;282:2215-9. [PMID: 10605972]

62. **Connor SR, McMaster JK.** Hospice, bereavement intervention and use of health care services by surviving spouses. HMO Pract. 1996;10:20-3. [PMID: 10155754]

Current Author Addresses: Dr. Campbell: Medical Outcomes Research and Evaluation Services, PO Box 303, Thetford, VT 05074.
Dr. Lynn: The Washington Home Center for Palliative Care Studies, 4200 Wisconsin Avenue, NW, 4th Floor, Washington, DC 20016.
Dr. Louis: Johns Hopkins Bloomberg School of Public Health, 615 North Wolfe Street, Baltimore, MD 21205.
Dr. Shugarman: RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138.

Note: This letter was written on behalf of the Japan Diabetes Complications Study Group.

References

1. Howard AA, Arnsten JH, Gourevitch MN. Effect of alcohol consumption on diabetes mellitus: a systematic review. Ann Intern Med. 2004;140:211-9. [PMID: 14757619]
2. Sone H, Katagiri A, Ishibashi S, Abe R, Saito Y, Murase T, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDCS) study design, baseline analysis and three year-interim report. Horm Metab Res. 2002;34:509-15. [PMID: 12384828]
3. Sone H, Yoshimura Y, Ito H, Ohashi Y, Yamada N. Energy intake and obesity in Japanese patients with type 2 diabetes [Letter]. Lancet. 2004;363:248-9. [PMID: 14738815]
4. Sone H, Ito H, Ohashi Y, Akanuma Y, Yamada N. Obesity and type 2 diabetes in Japanese patients [Letter]. Lancet. 2003;361:85. [PMID: 12517507]
5. Bosron WF, Li TK. Genetic polymorphism of human liver alcohol and aldehyde dehydrogenases, and their relationship to alcohol metabolism and alcoholism. Hepatology. 1986;6:502-10. [PMID: 3519419]

TO THE EDITOR: In their review, Howard and colleagues (1) found that moderate alcohol consumption was inversely associated with risk for diabetes mellitus and with incidence of CHD in persons with diabetes. However, among the mechanisms underlying this beneficial effect, they did not mention the anti-inflammatory action of alcohol. There is mounting evidence that low-grade systemic inflammation is associated with an increased risk for diabetes (2). Furthermore, an ongoing inflammatory response may be contributing to the accelerated atherogenesis in diabetic patients (3). Since light to moderate alcohol consumption has been shown to be associated with lower levels of inflammatory markers (4, 5), this anti-inflammatory action may help explain the beneficial activity of alcohol in diabetes mellitus.

Luca Mascitelli, MD
Casa di Cura Città di Udine
33100 Udine, Italy

Francesca Pezzetta, MD
Ospedale di Tolmezzo
33028 Tolmezzo, Italy

References

1. Howard AA, Arnsten JH, Gourevitch MN. Effect of alcohol consumption on diabetes mellitus: a systematic review. Ann Intern Med. 2004;140:211-9. [PMID: 14757619]
2. Pradhan AD, Cook NR, Buring JE, Manson JE, Ridker PM. C-reactive protein is independently associated with fasting insulin in nondiabetic women. Arterioscler Thromb Vasc Biol. 2003;23:650-5. [PMID: 12692007]
3. Mooradian AD. Cardiovascular disease in type 2 diabetes mellitus: current management guidelines. Arch Intern Med. 2003;163:33-40. [PMID: 12523914]
4. Albert MA, Glynn RJ, Ridker PM. Alcohol consumption and plasma concentration of C-reactive protein. Circulation. 2003;107:443-7. [PMID: 12551869]
5. Volpato S, Pahor M, Ferrucci L, Simonsick EM, Guralnik JM, Kritchevsky SB, et al. Relationship of alcohol intake with inflammatory markers and plasminogen activator inhibitor-1 in well-functioning older adults: the Health, Aging, and Body Composition study. Circulation. 2004;109:607-12. [PMID: 14769682]

IN RESPONSE: Sone and colleagues report a lack of association between baseline alcohol consumption and CHD incidence among a cohort of Japanese patients with diabetes. These preliminary findings may suggest that racial or ethnic differences are playing an unmeasured role in CHD incidence. However, because nearly half of Sone and colleagues' patients were randomly assigned to a lifestyle modification program that included abstinence from alcohol (1), it is difficult to have confidence in their conclusions without data on alcohol consumption during follow-up.

Drs. Mascitelli and Pezzetta correctly point out that we did not discuss anti-inflammatory effects of alcohol as a mechanism for the association between moderate alcohol consumption and decreased incidence of diabetes and of CHD in persons with diabetes. Instead, we focused on more established risk factors, including insulin resistance and high-density lipoprotein cholesterol levels. Emerging data suggest that inflammation may play a role in the pathogenesis of type 2 diabetes mellitus and cardiovascular disease (2). While the cross-sectional studies cited by Mascitelli and Pezzetta show an association between light to moderate alcohol consumption and lower levels of inflammatory markers, other studies have not found an association (3), and a causal relationship has not been established. Further research is warranted to determine whether alcohol affects systemic inflammation and whether this partially explains the association between moderate alcohol consumption and decreased risk for both diabetes and diabetes-related cardiovascular disease.

Andrea A. Howard, MD, MS
Julia H. Arnsten, MD, MPH
Montefiore Medical Center
Bronx, NY 10467

Marc N. Gourevitch, MD, MPH
New York University School of Medicine
New York, NY 10016

References

1. Sone H, Katagiri A, Ishibashi S, Abe R, Saito Y, Murase T, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDCS) study design, baseline analysis and three year-interim report. Horm Metab Res. 2002;34:509-15. [PMID: 12384828]
2. Pradhan AD, Ridker PM. Do atherosclerosis and type 2 diabetes share a common inflammatory basis? [Editorial] Eur Heart J. 2002;23:831-4. [PMID: 12042000]
3. Woodward M, Rumley A, Lowe GD, Tunstall-Pedoe H. C-reactive protein: associations with haematological variables, cardiovascular risk factors and prevalent cardiovascular disease. Br J Haematol. 2003;122:135-41. [PMID: 12823355]

Hospice Effect on Medicare Expenditures

TO THE EDITOR: The interesting study by Campbell and colleagues (1) confirmed much previous research on the cost of hospice versus nonhospice care to the Medicare program. It also documented the decade-long shift in the mix of hospice beneficiaries from cancer to noncancer diagnoses and from the younger elderly to the oldest old, particularly those residing in nursing homes. The authors found that the savings hospice achieves by avoiding terminal hospitalizations among patients with cancer are offset by additional hospice services provided to older patients and patients without cancer who use fewer hospital resources. Aggregate added costs due to hospice depend heavily on the distribution of patient types in the population, suggesting that the statistical adjustment models comparing hospice and

nonhospice patients are very sensitive to how these types of patients are accounted for in the models.

Using expenditure data from a study (2) of the effect of hospice on expenditures in dying nursing home residents, we found that even in this more homogeneous sample a propensity score model similar to that used by Campbell and colleagues did little to control for selection bias compared with group-specific propensity score models incorporating a larger set of confounders. Underlying heterogeneity will be even larger if nursing home and non–nursing home populations are combined, as they were in Campbell and colleagues' study. The authors' use of propensity score by cohort with a modest list of confounders is unlikely to satisfactorily control for selection among such heterogeneous hospice samples. In addition, Campbell and colleagues' operational definition of low use may be confounded with hospice choice, biasing results toward no hospice effect (defined as a hospice-to-nonhospice expenditure ratio of 1) (compare ratios in Campbell and colleagues' Tables 2 and 3). Low use is less likely to differentiate patient preferences for aggressive care among the long-stay nursing home residents who contribute substantially to the increased cost associated with hospice (2).

Pedro Gozalo, PhD, MSc
Vince Mor, PhD
Susan Miller, PhD, MBA
Brown University
Providence, RI 02912

References

1. Campbell DE, Lynn J, Louis TA, Shugarman LR. Medicare program expenditures associated with hospice use. Ann Intern Med. 2004;140:269-77. [PMID: 14970150]
2. Miller SC, Intrator O, Gozalo P, Roy J, Barber J, Mor V. Government expenditures at the end of life for short- and long-stay nursing home residents: differences by hospice enrollment status. J Am Geriatr Soc. 2004;52:1284-92. [PMID: 15271115]

IN RESPONSE: The letter from Drs. Gozalo, Mor, and Miller appears to raise 2 issues. One concerns potential bias in our hospice effect estimation related to controlling for consistently low service use for 24 months before death. We did test for the effect of this variable and stated that the results persisted among all sensitivity analyses, including "models that do not correct for consistently low Medicare use."

The other issue turns on the effectiveness of propensity scores to control for selection bias, particularly in study samples, such as ours, in which nursing home residents are combined with community dwellers. Our analyses, including calculation of propensity score, were stratified by age group and condition cohort. Within each of these relatively homogeneous strata, models estimating hospice effects controlled not only for propensity score and for nursing home residence but also for an array of measures previously shown to correlate with hospice use: duration of illness, disease burden, gender, race, Medicaid enrollment, and urban or rural influences. Our discussion of limitations acknowledged that even if poststratification is used to match decedents by age and condition and propensity scores are used to control for other hospice selection effects, some selection bias will inevitably remain in an observational study design.

We sought methods that improved upon those applied in previous research concerning hospice effects on Medicare expenditures. We welcome future studies that offer additional methodologic improvements. Our study mainly shows that the quality and costs of various strategies to serve patients coming to the end of life deserve careful study.

Diane Campbell, PhD
Medical Outcomes Research and Evaluation Services
Thetford, VT 05074

Joanne Lynn, MD, MA, MS
Washington Home Center for Palliative Care Studies
Washington, DC 20016

Lisa R. Shugarman, PhD
RAND Corp.
Santa Monica, CA 90407

CLINICAL OBSERVATION

Editor's Note: The second author of the following Clinical Observation was one of a dozen Associates of the American College of Physicians selected to present a clinical vignette at the 2003 Annual Session in Philadelphia. We are proud to present this case report through a special arrangement with the Council of Associates of the College.

Silo-Filler's Disease, the Acute Respiratory Distress Syndrome, and Oxides of Nitrogen

TO THE EDITOR: *Background:* Oxides of nitrogen can both harm and help human health. For example, silo-filler disease is a form of acute lung injury caused by exposure to nitrogen dioxide (NO_2), but inhaled nitric oxide can improve oxygenation in patients with the acute respiratory distress syndrome (ARDS).

Objective: To describe a case of ARDS due to silo-filler's disease that was treated with inhaled nitric oxide, demonstrating how oxides of nitrogen can both harm and help human health.

Case Report: A 29-year-old male farmer was admitted to Fletcher Allen Health Care at The University of Vermont for management of respiratory failure. The patient had been in good health until 1 day before admission, when he opened the door to a corn silo and was engulfed in a yellow-orange gas that smelled like rotten eggs. He immediately developed severe dyspnea, lightheadedness, and diaphoresis. On presentation to the hospital he was hypoxemic, and chest radiographs showed bilateral pulmonary infiltrates. He was intubated and mechanically ventilated for respiratory support.

The patient was given a diagnosis of ARDS secondary to NO_2 inhalation from silo gas. He was maintained on mechanical ventilation using the low tidal volume, high positive end-expiratory pressure strategy, but he remained difficult to oxygenate. Despite inverse ratio ventilation, his oxygenation deteriorated and he required fluids and pressors for hemodynamic support. Steroids were administered for the possibility of bronchiolitis as a sequela of silo-filler's disease (1). As a last resort, inhaled nitric oxide was considered as therapy to improve oxygenation (2) and was subsequently started at 40 parts per million (ppm). Minutes after the inhaled nitric oxide was started, oxygen saturation increased by ten percentage points. Inhaled nitric oxide was continued at 20 ppm and was then gradually weaned over the next 3 days as the patient continued to improve. The remainder of his hospital course was uneventful, and he fully recovered.