Social determinants, multimorbidity, and patterns of end-of-life care in older adults dying from cancer[*]

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Abstract

Objective—Most prior studies on aggressive end-of-life care in older patients with cancer have accounted for social determinants of health (e.g., race, income, and education), but rarely for multimoribidity (MM). In this study, we examine the association between end-of-life care and each of the social determinants of health and MM, hypothesizing that higher MM is associated with less aggressive care.

Methods—From the linked 1991–2008 Health and Retirement Study, Medicare data, and the National Death Index, we identified fee-for-service patients age 66 years who died from cancer (*n* = 835). MM was defined as the occurrence or co-occurrence of chronic conditions, functional limitations, and/or geriatric syndromes. Aggressive care was based on claims-derived measures of receipt of cancer-directed treatment in the last two weeks of life; admission to the hospital and/or emergency department (ED) within the last month; and in-hospital death. We also identified

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patients enrolled in hospice. In multivariable logistic regression models, we analyzed the associations of interest, adjusting for potential confounders.

Results—While 61.2% of the patients enrolled in hospice, 24.6% underwent cancer-directed treatment; 55.1% were admitted to the hospital and/or ED; and 21.7% died in the hospital. We observed a U-shaped distribution between income and in-hospital death. Chronic conditions and geriatric syndromes were associated with some outcomes, but not with others.

Conclusions—To improve quality end-of-life care and curtail costs incurred by dying patients, relevant interventions need to account for social determinants of health and MM in a nuanced fashion.

Keywords

1. Introduction

In patients dying from cancer, receipt of aggressive care, including receipt of cancer-directed treatment, admission to an inpatient hospital and/or to the emergency department (ED), and in-hospital death, is considered an important indicator of poor-quality end-of-life care [1,2]. In addition, aggressive care is an important driver of health care costs [3], though it does not always yield benefits relative to cure or extension of life [4]. Conversely, palliative and hospice care provide a venue for pain management and symptom relief, as well as emotional and spiritual support, which may be beneficial to the patient and his/her family [5–7].

Variations in quality markers of end-of-life care have been observed across physicians [8,9], health centers [10], geographical regions [11–14], and various subgroups of the population [9,15–18]. In particular, racial/ethnic disparities both in receipt of aggressive care and hospice use have been documented extensively. Indeed, compared to others, minority patients are more likely to choose aggressive care [19] or to be hospitalized after being enrolled in hospice [20], and less likely to enroll in hospice care [17,21–24]. However, seldom have previous studies examined disparities in the specific context of geriatric patients with cancer presenting with multimorbidity (MM), defined here as the co-occurrence of not only chronic conditions but also functional limitations and geriatric syndromes [25]. Functional limitations include limitations in strength and mobility, as well in activities of daily living and instrumental activities of daily living. Geriatric syndromes include such conditions as cognitive impairment, depressive symptoms, incontinence, and sensory impairment.

MM is (a) highly prevalent in older adults with cancer [26], and (b) more prevalent in minority than in non-minority patients [25]. Given that "do not resuscitate" orders are associated with chronic conditions and/or cognitive impairment [27], patients with higher burden of MM may be less likely to receive aggressive end-of-life care, and more likely to enroll in hospice.

Using a unique data resource, developed by linking data from the Health and Retirement Study, Medicare enrollment and claims files, and the National Death Index, this study aims at gaining a better understanding of the correlates of aggressive end-of-life care and hospice use in older adults dying from cancer, by accounting for both social determinants of health and MM. We hypothesized that aggressive end-of-life care is independently associated with each of social determinants of health and MM.

Elucidating these associations could establish the need for and provide the basis to relevant interventions tailored to patients' sociodemographics and the level of complexity of their clinical presentation. Such interventions may help to curtail use of aggressive care and costs incurred by terminally ill patients with cancer.

2. Methods

We used the 1992–2008 linked Health and Retirement Study (HRS), National Death Index (NDI), and Medicare data. The study was approved by the University of Michigan, which maintains the HRS, the privacy board of the Centers for Medicare and Medicaid Services (CMS), and the Institutional Review Board, University Hospitals of Cleveland.

3. Data Sources

3.1. The Health and Retirement Study (HRS)

Funded by the National Institute on Aging, the HRS includes longitudinal data on a nationally representative sample of over 30,000 non-institutionalized older adults born in 1953 and earlier. At each interview, which is conducted every two years, self-reported data are collected on a number of domains, including (but not limited to) health and functional status, chronic medical conditions, cognitive status, depressive symptoms, and sociodemographic characteristics.

We used data from the last HRS interview prior to death to obtain our measures of interest, including multimorbidity.

3.2. The National Death Index (NDI)

The NDI consists of a compilation of death certificate data that are obtained from all states, thus making it possible to ascertain HRS participants' vital status regardless of their state of residence.

The key variables that were retrieved from the NDI were date of death (in month and year), and the underlying cause of death, documented in International Coding of Diseases (ICD)— in the 9th edition for deaths that occurred in 1999 or before, and in the 10th edition for deaths that occurred thereafter.

3.3. Medicare Enrollment and Claims Data

The enrollment file, which is organized at the individual level, carries the beneficiary's demographic variables (age, race, sex), as well as monthly variables indicating their

enrollment in managed care programs, making it possible for us to identify and exclude managed care enrollees.

The claims data include the Medicare Provider, Analysis, and Review (MedPAR) file, the Inpatient Standard Analytic File (SAF), the Outpatient SAF, the Carrier SAF, and Hospice SAF. Records in these files carry the service dates, as well as diagnosis and procedure codes. Diagnosis codes are documented in ICD-9; procedure codes are recorded in ICD-9, Common Procedural Terminology, 4th Edition (CPT-4), or Healthcare Common Procedural Coding System (HCPCS).

We used the Hospice SAF to identify study participants who used hospice at the end of life.

3.4. File Linkage

The above data sources (HRS, NDI, and Medicare data) were linked by HRS and Medicare. The files sent to us included dummy identifiers that do not carry any string of name, date of birth, or social security number, thus making it virtually impossible to identify a given participant. The same dummy identifier was used over time to be able to follow an individual longitudinally. A cross-reference file was provided to identify the same individual across the three different sources.

4. Study Population

Our study population consisted of HRS participants who died from cancer, as identified from the cause of death documented in the NDI ($n = 2403$). In order to ensure complete Medicare claims history, we limited our study subjects to those 66 years of age or older, and receiving their care exclusively through the traditional fee-for-service system ($n = 835$).

5. Variables of Interest

5.1. Dependent Variables

Following were our dependent variables: (1) receipt of cancer-directed treatment with 14 days of death, including diagnostic and therapeutic procedures (for certain cancers only), chemotherapy, and radiation therapy (see relevant codes in the Appendix A); (2) multiple acute care visits within 30 days of death, including hospitalization and visits to the emergency department (ED), or at least one hospitalization with a stay of 14 days or longer. Inpatient admissions were identified from MedPAR files, and ED visits were identified from the Inpatient, Outpatient, and Carrier SAF, using procedure codes (99281–99285); (3) inhospital death; and (4) use of hospice care, as identified from the hospice SAF.

Each of the above measures were binary (0/1) variables for receipt of cancer-directed treatment, hospitalizations and/or ED visits, in-hospital death, and hospice use, respectively.

5.2. Main Independent Variables

Our main independent variables included race, defined as non-Hispanic Blacks (NHBs) vs all others, and multimorbidity (MM). Consistent with our previous study [25], we defined MM as the co-occurrence of chronic conditions (CC), functional limitations (FL), and/or

geriatric syndromes (GS). These measures were identified from the last HRS wave preceding death.

MM was constructed in two steps: first, we identified the presence of absence of each of CC, FL, and GS, as three different dichotomous variables. The presence or CC was determined based on whether the respondent "was ever told by a doctor that" s/he had one of seven chronic conditions: high blood pressure, heart disease, lung disease, stroke, arthritis, or psychiatric illness. The presence of FL based on whether "[b]ecause of a health [or memory] problem" the respondent had any difficulty performing four or more standard mobility, strength, activities of daily living, or instrumental activities of daily living (out of 21 possible). Respondents were instructed to exclude any difficulties expected to last less than three months. GS are conditions commonly experienced by older adults that fall outside of the chronic disease paradigm [28]. We determined the presence of GS based on whether the respondent had one or more of the following: vision impairment (eyesight rated as poor or fair even when wearing "corrective lenses as usual" or was legally blind); hearing impairment (hearing rated as fair or poor even when "using a hearing aid as usual"); moderate or severe depressive symptoms (4 or more modified 8-item Center for Epidemiologic Studies Depression Scale [CES-D] [29]); urinary incontinence; low cognitive performance (bottom third of a 35-point scale, designed to measure working memory, mental processing speed, knowledge and language, and orientation [30]); persistent dizziness or lightheadedness; or severe pain ("often troubled") [31].

Next, we summed the binary indicators of CC, FL, and GS to create the ordinal measure of MM, ranging from 0 to 3. Thus, MM0–MM3 were defined as follows: *MM0*: no chronic conditions, functional limitations, or geriatric syndromes (reference category); *MM1*: presence of any one of chronic conditions, functional limitations, or geriatric syndromes; *MM2*: co-occurrence of any two of chronic conditions, functional limitations, or geriatric syndromes; and *MM3*: co-occurrence of all three of chronic conditions, functional limitations, and geriatric syndromes. Because of the small number of respondents with MM0, we combined the MM0 and MM1 categories as MM0/1.

5.3. Other Independent Variables

5.3.1. Sociodemographic Variables—They included age (in 5-year increments 66–69, 70–74, 75–79, 80–84, 85+); sex (male and female); marital status (married, divorced, widowed, never married); education (<9 years, 9–11 years, 12 years, 13–15 years, 16 years, 17+ years); and income (in quartiles).

The anatomic tumor site was identified from the underlying cause of death documented in the NDI. Based on the distribution shown in Table 1, we further grouped them in the following categories: trachea, bronchus, and lung; pancreas; colorectal; breast (female); hematologic cancers; and all others.

6. Analytic Approach

In addition to descriptive analysis, we conducted multivariable logistic regression analysis to analyze the association of each of the social determinants of health and MM (or components

thereof) in relation to hospice use, after adjusting for other patient characteristics. We also tested the significance of interaction terms. Since none of these terms proved to be statistically significant, we present the findings from the models that did not include interaction terms. Our multivariable models accounted for income, but not for education, given that the two variables are highly correlated. In addition, while our composite measure for MM did not prove to be significantly associated with the outcomes, the components of MM did—at least with some of the outcomes.

For parsimony, we present findings from the final models only.

We used SAS version 9.2 for all of our analyses.

7. Results

The distribution of our study population ($n = 835$) by sociodemographic variables and MM is presented in Table 1. Nearly 12% were non-Hispanic Black; 51.3% were women; 44.2% were 80 years of age or older; 53.5% were married; and 27.2% had at least some college. Nearly 60% presented with MM3, i.e., with co-occurring chronic conditions, functional limitations, and geriatric syndromes. A total of 25% died from trachea, bronchus, or lung cancer; 10.5% from hematopoietic cancers; 9.7% from colorectal cancer; and 5.6% from (female) breast cancer.

Fig. 1 presents results from the bivariate association between each of the social determinants of health and our outcomes of interest. The percentage of patients receiving cancer-directed treatment declined significantly with older age, but increased significantly with higher education and income, in a "J-shaped" distribution. There was no significant difference by race/ethnicity. Admission to the ED and/or acute care hospital was significantly lower in older patients, but higher among non-Hispanic Blacks than in others; no significant differences were observed by income or education. Enrollment in hospice was significantly lower in non-Hispanic Blacks than in others, but generally higher with higher levels of income or education; it was not associated with age. In-hospital death was significantly higher in non-Hispanic Blacks than in others. More interestingly, we observed a "U-shaped" distribution between in-hospital death and each of income and education. Older age was not associated with in-hospital death.

We note that both sex and marital status, important social determinants of health, were not associated with any of our outcomes. For parsimony, we opted not to present these variables in our figures.

Fig. 2 shows variations in the measures of interest by anatomic cancer site. Except for cancer-directed treatment, all other variations were statistically significant. Receipt of cancer-directed treatment was lowest among breast patients with cancer (8.5%) and highest among those with trachea, bronchus, and lung cancer (27.8%). Both admission to hospital and/or ED and in-hospital death were highest in patients with hematopoietic cancers (70.5% and 45.5%, respectively). Enrollment in hospice was highest in patients with breast cancer (76.6%), and lowest in patients with hematopoietic cancers (39.8%).

Fig. 3 presents results from the bivariate association between our outcomes of interest, the composite measure of MM, and each of its components. Receipt of cancer-directed treatment was significantly lower among patients with high MM. Among its components, higher counts for each of functional limitations and geriatric syndromes—but not for chronic conditions—were negatively associated with receipt of treatment. MM or its components were not associated with any of the other outcomes.

Table 2 presents the results from the multivariable analysis. With the following exceptions, the findings are consistent with that of the bivariate associations described above: First, non-Hispanic Blacks were more likely than others to receive cancer-directed treatment but the association was borderline significant (adjusted odds ratio (AOR): 1.71, 95% confidence interval (1.02, 2.86), $p = 0.04$). Second, the composite measure of MM was not associated with any of our outcomes; we therefore present findings from the models incorporating the MM components. Here, we note that a higher count of functional limitations was no longer associated with receipt of cancer-directed treatment; however, presenting with 3 or more geriatric syndromes was significantly associated with a lower likelihood of undergoing treatment for cancer (AOR: 0.54 (0.32, 0.98)). In addition, presenting with 3 or more chronic conditions was associated with a greater likelihood to be admitted to acute care hospital or to the ED, but at borderline significance (AOR: 1.77 (1.05, 2.99)).

8. Discussion

This study, analyzing end-of-life care in a representative sample of older adults dying from cancer, investigated correlates of aggressive care and hospice use in the weeks preceding death. In addition to social determinants of health, we also accounted for MM, which is a measure that has seldom been accounted for in previous studies. We hypothesized that aggressive end-of-life care was independently associated with each of social determinants of health and MM.

Our findings indicated that the association between patterns of end-of-life care and each of social determinants of health and MM was highly complex, and that these associations varied greatly across the outcomes being studied. Findings of particular interest include the J-shaped and U-shaped distribution between income and each of receipt of cancer-directed treatment and in- hospital death, respectively, reflecting a non-linear association that has not been described previously. In addition, with the exception of cancer-directed treatment, we observed marked and statistically significant variations in our outcomes by anatomic cancer site. On the other hand, similar to prior studies, we also report that being non-Hispanic Black and having low incomes was associated with significantly lower likelihood to enroll in hospice [17, 32]. Surprisingly, patient sex and marital status were not associated with our outcomes of interest.

With regard to MM, our composite measure of MM was not associated with our outcomes. Similarly, limitations in functional status were not significantly associated with our outcomes in multivariable models. On the other hand, we noted that a higher count of geriatric syndromes was associated with a significantly lower likelihood to receive cancer-directed treatment, and a higher count of chronic conditions was associated with a greater

likelihood to have ED visits or hospital admissions. Our small sample size precluded us from being able to include individual clinical conditions in our multivariable model; however, a recent study [32] failed to show any association between use of hospice care and cognitive decline, one of the conditions that we accounted for among geriatric syndromes.

These findings call for the development of tailored interventions to educate patients and their families on the benefits of palliative care and hospice, based on the above-noted variations by age, race/ethnicity, income, anatomic cancer site, and MM. Such interventions would not only affect quality of life, but they would also result in substantial savings to the health care system. A recent study from Canada reported that patients with cancer receiving aggressive end-of-life care incur 43% higher costs in their final month of life compared to their counterparts who are not managed aggressively [3]. Furthermore, to achieve the desired reductions in the cost of care, palliative care should be offered to patients with metastatic cancer earlier (more than 90 days prior to death), rather than later [33].

An important new development is the Medicare Care Choices program, which was launched by the Centers for Medicare & Medicaid Services (CMS) on January 1, 2016 [34]. Through this 5-year program, patients with terminal illness will be able to receive hospice care while also receiving chemotherapy. Although the effect of this program on patterns of end-of-life care remains to be seen, it is possible that when cancer treatment is no longer withheld, it may be easier for patients and families to decide to enroll in hospice, and possibly even gradually decrease chemotherapy.

Our study's main strength lies in our use of a unique database, which combines self-reported data from the HRS, claims-based measures from Medicare administrative data, as well as death data on a U.S. representative sample of older adults dying from cancer. In addition, by incorporating functional limitations and geriatric syndromes in our measure of MM, our study expands beyond the simple count of chronic conditions that are derived from claims data, to more comprehensively capture the complex clinical presentation of older patients with cancer. Findings from our recent work in this area support drawing a clear distinction between multiple chronic conditions and MM. Indeed, in a recent study using predictive analytic techniques to identify predictors of health outcomes [35], including self-reported health status, self-reported worse health in two years, and two-year mortality, we demonstrated that the drivers of health outcomes are not necessarily chronic conditions, but functional limitations and geriatric syndromes. This highlights the importance of accounting for the latter conditions and the nuance that they add to the interpretation of our findings when we include them in our studies, compared to when we limit ourselves to chronic conditions.

Our study also presents limitations. First, we were unable to account for the patient-centered measures (e.g., knowledge, preference) and/or providers' attitudes regarding end-of-life care. Second, rather than care in real-time, our end-of-life care measures are retrospective, and the patients in our cohort may not have seemed to be nearing death at the time care was rendered [36]. However, since our study population was identified based on the cause of death in the NDI, and our outcomes reflect care received in the weeks preceding death, we believe that our results accurately capture patterns of end-of-life care in older patients with cancer. Third,

some of the treatment modalities (e.g., radiation therapy) may have been administered as part of palliative care. Fourth, since we were unable to access Part D data and account for oral agents, our measure of cancer-directed treatment may have been underestimated. Fifth, to be consistent with how we identified functional limitations and geriatric syndromes, we retrieved chronic conditions from the HRS as well, thus limiting them to the seven self-reported chronic conditions (in addition to cancer). Findings from studies identifying comorbid chronic conditions based on claims-based algorithms may differ from that of this study [37]. Lastly, we note that there may be inaccuracies and miscoding in the cause of death documented in death certificates, with over-representation of coronary heart disease as a cause of death, especially in older persons [38]. Furthermore, inaccuracies and miscoding may vary across anatomic cancer sites, as documented by Polednak [39–42]. These inaccuracies may be due to insufficient knowledge of the decedent's medical history by the certifier [42]. Others, however, have reported high-level agreement between the underlying cause of death and medical records, as was the case in studies in prostate patients with cancer [43,44]. Also, in contrast to our use of the underlying cause of death to identify patients dying from cancer, future studies should explore the utility of using multiple causes of death, as documented in a study on deaths from myelodysplastic syndromes [45].

In conclusion, our findings underscore the significant and complex role that social determinants of health and MM play in the patterns of end-of-life care, and that interventions to curtail aggressive care and high costs incurred by dying patients should be tailored to the social and clinical contexts in which patients with terminal cancer present. Future studies should focus on identifying specific combinations of conditions with and across the rubrics of social determinants and MM that are associated with patterns of end-of-life care to aid with the development of interventions targeting subgroups of geriatric patients with cancer who are at high risk to receive aggressive end-of-life care.

Acknowledgments

Appendix A. Procedure codes to capture cancer-directed treatment

Cancer-directed surgery for common cancers [1]:

Procedure type	ICD-9 procedure codes	CPT/HCPCS codes
Lung cancer		

Procedure type	ICD-9 procedure codes	CPT/HCPCS codes
Biopsy	33.24-33.38, 34.02-34.27, 34.10-34.19, 34.21, 40.11	31625, 31628, 31629, 32095, 32405, 32602, 32606, 39000, 39010, 39400, 76360
Local excision	32.28	31640, 31641
Resection	32.29, 32.3-32.99	32440-32525, 32657, 32663
Breast cancer		
Biopsy	85.11, 85.12	19100, 19101
Local excision	85.20-85.22	19125, 19126, 19160, 19162
Resection	85.23, 85.41-85.48	19180-19240
Prostate cancer		
Biopsy	60.11, 60.12	55700, 55705, 76360
Local excision	60.2-60.49	52601, 52612-52650, 55801, 55831
Resection	60.5-60.59, 62.4-62.42	54520, 54530, 55810-55815, 55840-55845
Endometrial cancer		
Biopsy	68.13, 68.16, 69.09	58100-58120
Local excision	68.3-68.59, 68.9-68.99, 65.3-65.69	58150, 58180-58200, 58260-58262
Resection	68.6, 68.7, 68.8-68.89	58210, 58240, 58285
Colorectal cancer		
Biopsy	45.25, 45.26, 48.24, 48.25	44389, 45305, 45331, 45390, 76360
Local excision	45.41-45.49, 48.31-48.35	44110, 44392-44394, 45160-45180, 45308, 45309, 45315, 45320, 45333, 45338, 45339, 45383-45385
Bypass surgery	46.01, 46.03, 46.10-46.24	44310, 44320
Resection	45.71-45.76, 45.79-45.89, 48.41, 48.49-48.69	44140-44160, 45110-45121
Pancreatic cancer		
Biopsy	52.11, 52.12, 52.14	43261, 48100, 48102, 76360
Local excision	52.2-52.22	48120, 48145, 48148
Bypass surgery	44.39, 51.36, 51.39, 51.42	43820, 43825, 47720-47780
Resection	52.5-52.79	48140-48144, 48146, 48147, 48149-48155

Chemotherapy (Adapted from Earle et al. 2008) [2]: ICD-9 Diagnosis V58.1, V66.2, V67.2; ICD-9 procedure code: 99.25; HCPCS codes: 964XX, 965XX Q0083-Q0085; J7150, J85XX, J86XX, J87XX, J8999, J9XXX, Q0083, Q0084, Q0085.

Radiation therapy (Adapted from Earle et al. 2008) [2]: ICD-9 diagnosis codes: V58.0, V66.1, V67.1; ICD-9 procedure codes: 92.21-92.29; HCPCS codes: 77401-77499, 77750-77799; Revenue center codes: 0330, 0333.

References

1. Cooper GS, Yuan Z, Stange KC, Dennis LK, Amini SB, Rimm AA. Agreement of Medicare claims and tumor registry data for assessment of cancer-related treatment. Med Care. Apr; 2000 38(4):411–421. [PubMed: 10752973]
2. Earle CC, Landrum MB, Souza JM, Neville BA, Weeks JC, Ayanian JZ. Aggressiveness of cancer care near the end of life: is it a quality-of-care issue? J Clin Oncol. Aug 10; 2008 26(23):3860–3866. [PubMed: 18688053]

References

1. Earle CC, Neville BA, Landrum MB, Ayanian JZ, Block SD, Weeks JC. Trends in the aggressiveness of cancer care near the end of life. J Clin Oncol. Jan 15; 2004 22(2):315–21. [PubMed: 14722041]

2. Toole M, Lutz S, Johnstone PA. Radiation oncology quality: aggressiveness of cancer care near the end of life. J Am Coll Radiol. Mar; 2012 9(3):199–202. [PubMed: 22386167]

3. Cheung MC, Earle CC, Rangrej J, et al. Impact of aggressive management and palliative care on cancer costs in the final month of life. Cancer. Sep 15; 2015 121(18):3307–15. [PubMed: 26031241]

4. Saito AM, Landrum MB, Neville BA, Ayanian JZ, Earle CC. The effect on survival of continuing chemotherapy to near death. BMC Palliat Care. 2011; 10:14. [PubMed: 21936940]

5. Kirolos I, Tamariz L, Schultz EA, Diaz Y, Wood BA, Palacio A. Interventions to improve hospice and palliative care referral: a systematic review. J Palliat Med. Aug; 2014 17(8):957–64. [PubMed: 25000384]

6. Prince-Paul M. When hospice is the best option: an opportunity to redefine goals. Oncology (Williston Park). Apr; 2009 23(4 Suppl. Nurse Ed):13–7.

7. Lopez-Acevedo M, Lowery WJ, Lowery AW, Lee PS, Havrilesky LJ. Palliative and hospice care in gynecologic cancer: a review. Gynecol Oncol. Oct; 2013 131(1):215–21. [PubMed: 23774302]

8. Keating NL, Landrum MB, Rogers SO Jr, et al. Physician factors associated with discussions about end-of-life care. Cancer. Feb 15; 2010 116(4):998–1006. [PubMed: 20066693]

9. Huskamp HA, Keating NL, Malin JL, et al. Discussions with physicians about hospice among patients with metastatic lung cancer. Arch Intern Med. May 25; 2009 169(10):954–62. [PubMed: 19468089]

10. Keating NL, Herrinton LJ, Zaslavsky AM, Liu L, Ayanian JZ. Variations in hospice use among cancer patients. J Natl Cancer Inst. Aug 2; 2006 98(15):1053–9. [PubMed: 16882942]

11. Waldrop D, Kirkendall AM. Rural–urban differences in end-of-life care: implications for practice. Soc Work Health Care. 2010; 49(3):263–89. [PubMed: 20229397]

12. Virnig BA, Moscovice IS, Durham SB, Casey MM. Do rural elders have limited access to Medicare hospice services? J Am Geriatr Soc. May; 2004 52(5):731–5. [PubMed: 15086653]

13. Casey MM, Moscovice IS, Virnig BA, Durham SB. Providing hospice care in rural areas: challenges and strategies. Am J Hosp Palliat Care. Sep-Oct;2005 22(5):363–8. [PubMed: 16225358]

14. Virnig BA, Kind S, McBean M, Fisher E. Geographic variation in hospice use prior to death. J Am Geriatr Soc. Sep; 2000 48(9):1117–25. [PubMed: 10983913]

15. Cohen LL. Racial/ethnic disparities in hospice care: a systematic review. J Palliat Med. Jun; 2008 11(5):763–8. [PubMed: 18588409]

16. Virnig BA, Morgan RO, Persily NA, DeVito CA. Racial and income differences in use of the hospice benefit between the Medicare managed care and Medicare fee-for-service. J Palliat Med. 1999; 2(1):23–31. Spring. [PubMed: 15859795]

17. Fairfield KM, Murray KM, Wierman HR, et al. Disparities in hospice care among older women dying with ovarian cancer. Gynecol Oncol. Apr; 2012 125(1):14–8. [PubMed: 22138230]

18. Sharma RK, Prigerson HG, Penedo FJ, Maciejewski PK. Male–female patient differences in the association between end-of-life discussions and receipt of intensive care near death. Cancer. Aug 15; 2015 121(16):2814–20. [PubMed: 25975179]

19. Benton K, Stephens J, Vogel R, et al. The influence of race on end-of-life choices following a counselor-based palliative consultation. Am J Hosp Palliat Care. Feb; 2015 32(1):84–9. [PubMed: 24085311]

20. Cintron A, Hamel MB, Davis RB, Burns RB, Phillips RS, McCarthy EP. Hospitalization of hospice patients with cancer. J Palliat Med. Oct; 2003 6(5):757–68. [PubMed: 14622455]

21. Ramey SJ, Chin SH. Disparity in hospice utilization by African American patients with cancer. Am J Hosp Palliat Care. Aug; 2012 29(5):346–54. [PubMed: 22025746]

22. Drisdom S. Barriers to using palliative care: insight into African American culture. Clin J Oncol Nurs. Aug 1; 2013 17(4):376–80. [PubMed: 23899976]

23. Ngo-Metzger Q, Phillips RS, McCarthy EP. Ethnic disparities in hospice use among Asian-American and Pacific Islander patients dying with cancer. J Am Geriatr Soc. Jan; 2008 56(1):139–44. [PubMed: 18047496]

24. LoPresti MA, Dement F, Gold HT. End-of-life care for people with cancer from ethnic minority groups: a systematic review. Am J Hosp Palliat Care. Apr; 2016 33(3):291–305. [PubMed: 25550406]

25. Koroukian SM, Warner DF, Owusu C, Given CW. Multimorbidity redefined: prospective health outcomes and the cumulative effect of co-occurring conditions. Prev Chronic Dis. 2015; 12:E55. [PubMed: 25906436]

26. Koroukian SM, Murray P, Madigan E. Comorbidity, disability, and geriatric syndromes in elderly cancer patients receiving home health care. J Clin Oncol. May 20; 2006 24(15):2304–10. [PubMed: 16710028]

27. de Decker L, Annweiler C, Launay C, Fantino B, Beauchet O. Do not resuscitate orders and aging: impact of multimorbidity on the decision-making process. J Nutr Health Aging. Mar; 2014 18(3): 330–5. [PubMed: 24626763]

28. Inouye SK, Studenski S, Tinetti ME, Kuchel GA. Geriatric syndromes: clinical, research, and policy implications of a core geriatric concept. J Am Geriatr Soc. May; 2007 55(5):780–91. [PubMed: 17493201]

29. Cigolle CT, Ofstedal MB, Tian Z, Blaum CS. Comparing models of frailty: the Health and Retirement Study. J Am Geriatr Soc. May; 2009 57(5):830–9. [PubMed: 19453306]

30. Langa KM, Larson EB, Karlawish JH, et al. Trends in the prevalence and mortality of cognitive impairment in the United States: is there evidence of a compression of cognitive morbidity? Alzheimers Dement. Mar; 2008 4(2):134–44. [PubMed: 18631957]

31. Andrews JS, Cenzer IS, Yelin E, Covinsky KE. Pain as a risk factor for disability or death. J Am Geriatr Soc. Apr; 2013 61(4):583–9. [PubMed: 23521614]

32. Karikari-Martin P, McCann JJ, Farran CJ, Hebert LE, Haffer SC, Phillips M. Race, any cancer, income, or cognitive function: what influences hospice or aggressive services use at the end of life among community-dwelling Medicare beneficiaries? Am J Hosp Palliat Care. Jul; 2016 33(6): 537–45. [PubMed: 25753184]

33. Scibetta C, Kerr K, McGuire J, Rabow MW. The costs of waiting: implications of the timing of palliative care consultation among a cohort of decedents at a comprehensive cancer center. J Palliat Med. Jan; 2016 19(1):69–75. [PubMed: 26618636]

34. Butcher L. New Medicare program set to expend access to hospice. Oncol Times. 2015; 37(12):1.

35. Koroukian SM, Schiltz N, Warner DF, et al. Combinations of chronic conditions, functional limitations, and geriatric syndromes that predict health outcomes. J Gen Intern Med. Jun; 2016 31(6):630–7. [PubMed: 26902246]

36. Earle CC, Ayanian JZ. Looking back from death: the value of retrospective studies of end-of-life care. J Clin Oncol. Feb 20; 2006 24(6):838–40. [PubMed: 16484691]

37. Ferraro KF, Farmer MM. Utility of health data from social surveys: is there a gold standard for measuring morbidity? Am Sociol Rev. Apr; 1999 64(2):303–15.

38. Lloyd-Jones DM, Martin DO, Larson MG, Levy D. Accuracy of death certificates for coding coronary heart disease as the cause of death. Ann Intern Med. Dec 15; 1998 129(12):1020–6. [PubMed: 9867756]

39. Polednak AP. Using cancer registries to assess the accuracy of primary liver or intrahepatic bile duct cancer as the underlying cause of death, 1999–2010. J Registry Manag. 2013; 40(4):168–75. Winter. [PubMed: 24625770]

40. Polednak AP. US death rates from myeloproliferative neoplasms, and implications for cancer surveillance. J Registry Manag. 2011; 38(2):87–92. Summer. [PubMed: 22096879]

41. Polednak AP, Phillips C. Cancers coded as tongue not otherwise specified: relevance to surveillance of human papillomavirus-related cancers. J Registry Manag. 2014; 41(4):190–5. Winter. [PubMed: 25803632]

42. Polednak AP. Inaccuracies in oral cavity-pharynx cancer coded as the underlying cause of death on U.S. death certificates, and trends in mortality rates (1999–2010). Oral Oncol. Aug; 2014 50(8): 732–9. [PubMed: 24862544]

43. Penson DF, Albertsen PC, Nelson PS, Barry M, Stanford JL. Determining cause of death in prostate cancer: are death certificates valid? J Natl Cancer Inst. Dec 5; 2001 93(23):1822–3. [PubMed: 11734600]

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44. Albertsen PC, Walters S, Hanley JA. A comparison of cause of death determination in men previously diagnosed with prostate cancer who died in 1985 or 1995. J Urol. Feb; 2000 163(2): 519–23. [PubMed: 10647669]

45. Polednak AP. Trend (1999–2009) in U.S. death rates from myelodysplastic syndromes: utility of multiple causes of death in surveillance. Cancer Epidemiol. Oct; 2013 37(5):569–74. [PubMed: 23773300]
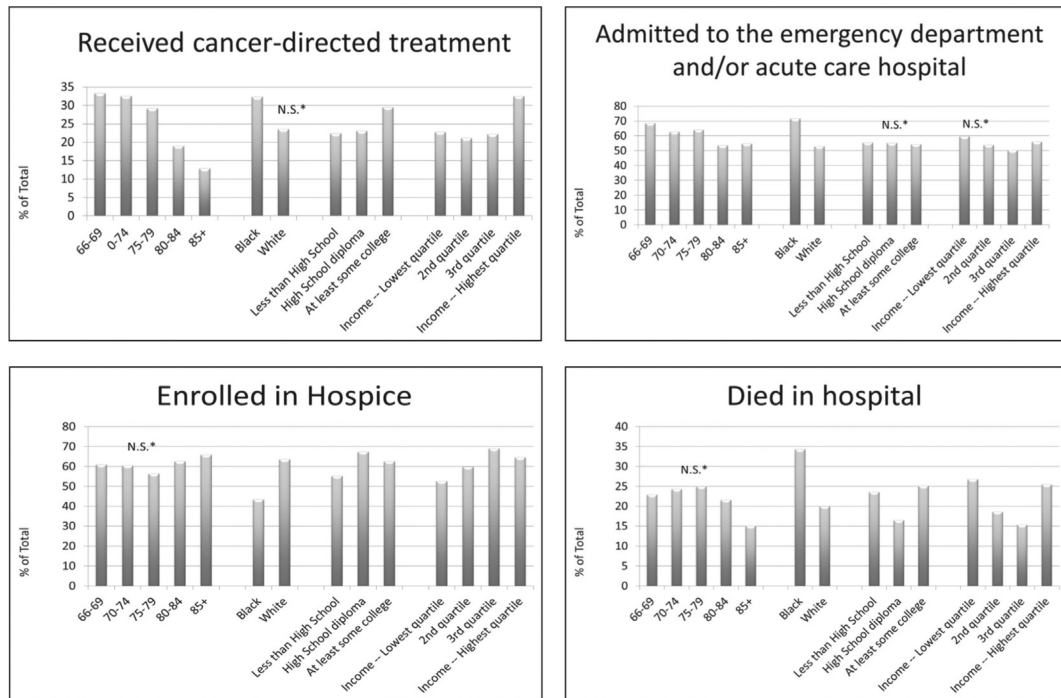
Fig. 1.
Social determinants of health and patterns of end-of-life care.

* N.S.=Not Significant; all other comparisons significant at p < 0.05
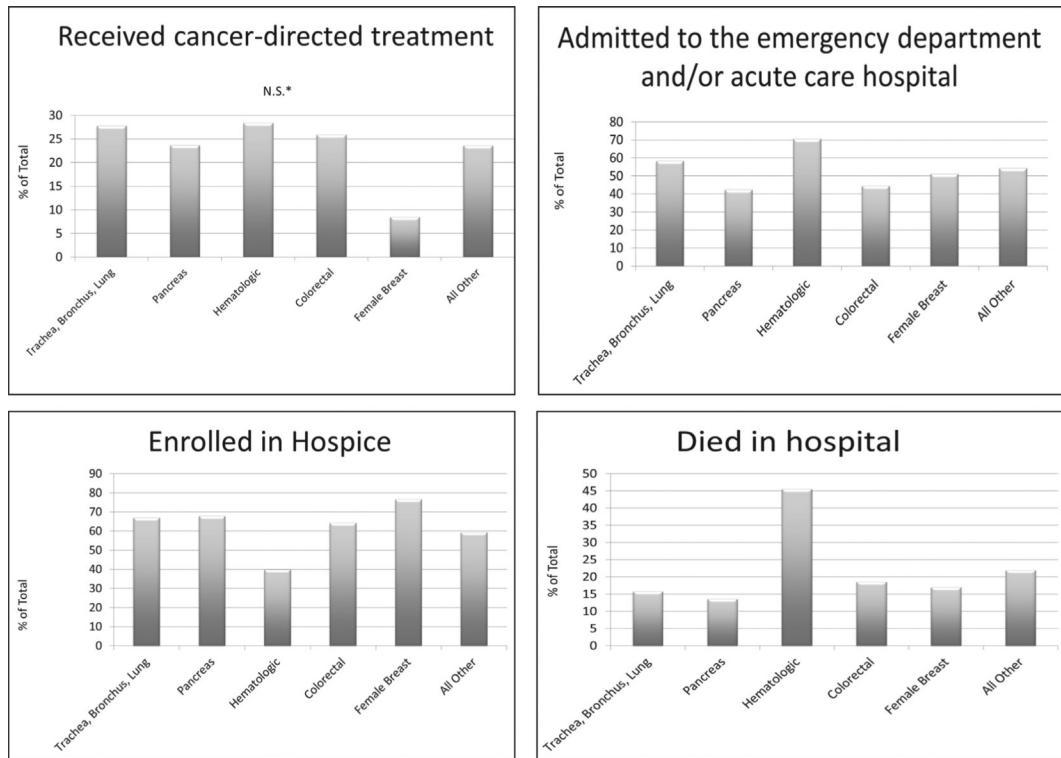
* N.S.=Not Significant; all other comparisons significant at p < 0.05
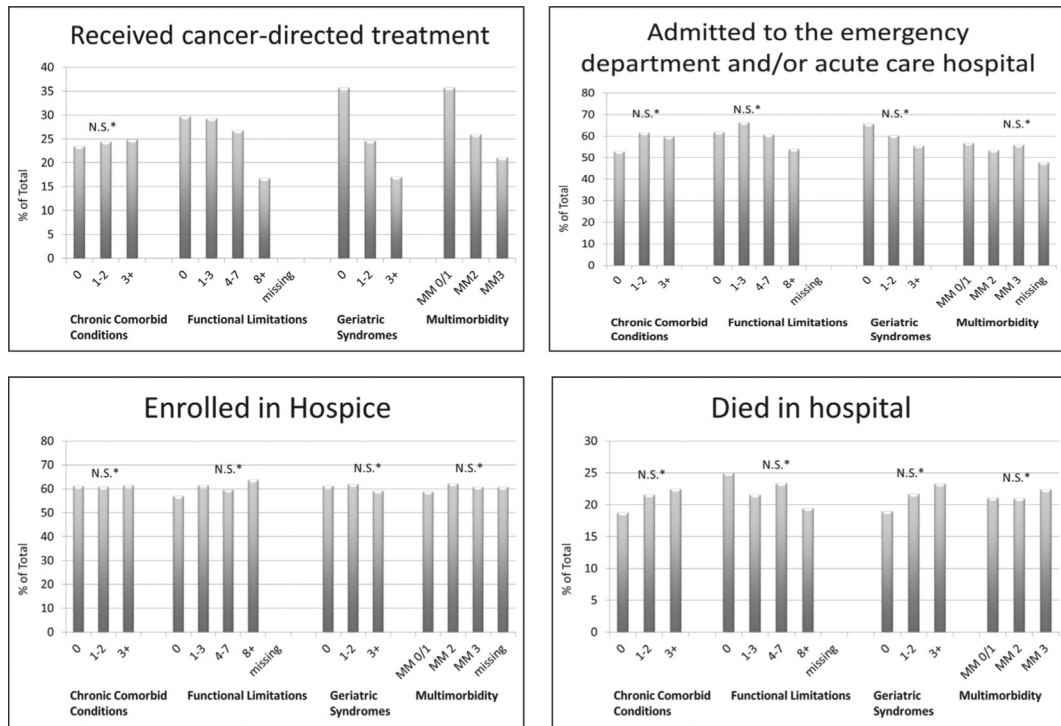
Fig. 2.
Anatomic cancer sites and patterns of end-of-life care.

* N.S.=Not Significant; all other comparisons significant at p < 0.05

Fig. 3.
Chronic conditions, functional limitations, and geriatric syndromes in relation to patterns of end-of-life care.

Table 1

Distribution of the study population by social determinants of health and multimorbidity.

Variables of interest	Total study population *N* (% of total)
Number with outcome	835 (100.0)
Race	
Black	99 (11.9)
All other	736 (88.1)
Age	
66-69	105 (12.6)
70-74	169 (20.2)
75-79	192 (23.0)
80-84	190 (22.8)
85 +	179 (21.4)
Sex	
Male	407 (48.7)
Female	428 (51.3)
Marital status	
Married	447 (53.5)
Single/widowed/divorced	*
Missing	*(< 2.0)
Education	
At least some college	227 (27.2)
High school graduate	273 (32.7)
High school dropout	335 (40.1)
Household income	
Lowest quartile	228 (27.3)
2nd quartile	204 (24.4)
3rd quartile	203 (24.3)
Highest quartile	200 (24.0)
Count of chronic conditions	
0	85 (10.2)
1-2	417 (49.9)
3 or more	333 (39.9)
Count of functional limitations	
0	84 (10.1)
1-3	208 (24.9)
4-7	273 (32.7)
8 or more	257 (30.8)
Missing	13 (1.6)
Count of geriatric syndromes	
0	*(<17.0)

Variables of interest	Total study population N (% of total)
1-2	474 (56.8)
3 or more	223 (26.7)
Missing	*
Composite multimorbidity measure (MM)	
MM0/1	109 (13.1)
MM2	262 (31.4)
MM3	441 (52.8)
Missing	23 (2.8)
Tumor site	
Oro-pharyngeal	*
Esophagus	17 (2.0)
Stomach	23 (2.8)
Colorectal	81 (9.7)
Pancreas	59 (7.1)
Larynx	*
Trachea, bronchus, lung	209 (25.0)
Skin	*
Breast (female)	47 (5.6)
Uterus	12 (1.4)
Ovary	26 (3.1)
Prostate	15 (1.8)
Bladder	24 (2.9)
Brain	15 (1.8)
Blood	88 (10.5)
Secondary	*
All other	190 (22.8)

*
Cell contents suppressed if $n < 11$. A corresponding cell in the column was suppressed to prevent the reader from deducing the masked number.

Table 2

Multivariate adjusted outcome models.

Variables of interest	Cancer-directed treatment	Acute care	Hospice	Died in-hospital
Number of decedents with outcome	204	457	509	180
Age				
66-69	1.0	1.0	1.0	1.0
70-74	1.08 (0.62, 1.86)	1.06 (0.63, 1.77)	0.91 (0.54, 1.56)	1.27 (0.69, 2.37)
75-79	0.99 (0.58, 1.69)	1.17 (0.70, 1.94)	0.78 (0.47, 1.32)	1.20 (0.65, 2.19)
80-84	0.61 (0.34, 1.10)	0.88 (0.52, 1.48)	1.01 (0.59, 1.74)	1.00 (0.53, 1.91)
85 +	0.45 (0.23, 0.86)[c]	1.08 (0.63, 1.86)	1.15 (0.65, 2.02)	0.62 (0.31, 1.23)
Sex				
Male	1.0	1.0	1.0	1.0
Female	0.99 (0.68, 1.44)	0.84 (0.61, 1.16)	1.21 (0.86, 1.69)	0.81 (0.54, 1.20)
Race				
Black	1.71 (1.02, 2.86)[a]	2.05 (1.24, 3.38)[c]	0.48 (0.30, 0.77)[c]	1.88 (1.13, 3.16)[a]
All other	1.0	1.0	1.0	1.0
Marital status				
Married	1.0	1.0	1.0	1.0
Divorced	1.38 (0.75, 2.55)	1.03 (0.58, 1.82)	1.05 (0.59, 1.88)	1.38 (0.73, 2.61)
Widowed	1.12 (0.73, 1.70)	0.96 (0.67, 1.37)	1.13 (0.78, 1.64)	1.03 (0.66, 1.59)
Never married	0.68 (0.18, 2.59)	0.99 (0.35, 2.79)	0.70, 0.25, 1.98)	0.51 (0.11, 2.41)
Household income				
Lowest quartile	1.12 (0.67, 1.88)	1.59 (1.04, 2.45)	0.44 (0.28, 0.70)[c]	2.17 (1.25, 3.76)[a]
2nd quartile	1.03 (0.63, 1.69)	1.25 (0.83, 1.88)	0.61 (0.40, 0.94)	1.40 (0.81, 2.42)
3rd quartile	1.0	1.0	1.0	1.0
Highest quartile	1.77 (1.11, 2.83)[a]	1.27 (0.84, 1.91)	0.84 (0.54, 1.30)	1.91 (1.13, 3.22)[c]
Count of chronic conditions				
0 (ref)	1.0	1.0	1.0	1.0
1-2	1.22 (0.86, 3.01)	1.61 (0.98, 2.64)	1.06 (0.63, 1.77)	1.17 (0.62, 2.20)
3 or more	1.61 (0.86, 3.01)	1.77 (1.05, 2.99)[a]	1.09 (0.63, 1.88)	1.21 (0.62, 2.37)
Count of functional limitations				
0 (ref)	1.0	1.0	1.0	1.0
1-3	0.99 (0.55, 1.80)	1.04 (0.61, 1.79)	1.16 (0.67, 2.02)	0.84 (0.44, 1.61)
4-7	0.96 (0.53, 1.72)	1.00 (0.58, 1.70)	1.07 (0.62, 1.86)	0.94 (0.50, 1.77)
8 or more	0.57 (0.30, 1.10)	0.77 (0.44, 1.36)	1.27 (0.71, 2.28)	0.74 (0.37, 1.48)
Count of geriatric syndromes				
0 (ref)	1.0	1.0	1.0	1.0
1-2	0.70 (0.45, 1.08)	1.04 (0.69, 1.57)	1.13 (0.74, 1.73)	1.16 (0.69, 1.95)
3 or more	0.54 (0.31, 0.94)[a]	0.93 (0.57, 1.50)	0.92 (0.56, 1.52)	1.38 (0.75, 2.54)
Tumor site				
Trachea, bronchus, lung	1.14 (0.75, 1.73)	1.19 (0.83, 1.71)	1.56 (1.07, 2.29)[a]	0.59 (0.37, 0.95)[a]
Pancreas	1.02 (0.51, 2.05)	0.61 (0.34, 1.11)	1.65 (0.87, 3.13)	0.56 (0.25 (1.27)

Variables of interest	Cancer-directed treatment	Acute care	Hospice	Died in-hospital
Blood	1.12 (0.65, 1.95)	2.06 (1.23, 3.46)[c]	0.41 (0.25, 0.68)[b]	3.05 (1.82, 5.10)[c]
Colorectal	1.09 (0.61, 1.96)	0.62 (0.38, 1.03)	1.41 (0.83, 2.38)	0.75 (0.39, 1.41)
Breast (female)	0.36 (0.12, 1.07)	0.96 (0.50, 1.85)	2.23 (1.05, 4.71)[a]	0.80 (0.34, 1.87)
All other	1.0	1.0	1.0	1.0

P-values are denoted as superscripts (a) $0.01 \leq p \leq 0.05$; (b) $0.0001 \leq p < 0.01$; (c) $p < 0.0001$.