BRIEF REPORT

Rural disparities in end-of-life care for patients with heart failure: Are they due to geography or socioeconomic disparity?

Rebecca N. Hutchinson MD, MPH1,2 | Paul K. J. Han MD, MA, MPH2 | F. Lee Lucas PhD2 | Adam Black MS2 | Douglas Sawyer MD, PhD3 | Kathleen Fairfield MD, DrPH4

1 Division of Palliative Medicine, Maine Medical Center, Portland, Maine, USA
2 Center for Outcomes Research and Evaluation, Maine Medical Center Research Institute, Portland, Maine, USA
3 Division of Academic Affairs, Maine Medical Center, Portland, Maine, USA
4 Department of Internal Medicine, Maine Medical Center, Portland, Maine, USA

Correspondence
Rebecca N. Hutchinson, MD, MPH, Center for Outcomes Research and Evaluation, Maine Medical Center Research Institute, 509 Forest Ave, Suite 200, Portland, ME 04101, USA. Email: rhutchins@mmc.org

Abstract

Purpose: The impact of rurality and socioeconomic deprivation on end-of-life (EOL) care for patients with heart failure (HF) is unknown. We analyzed claims to describe the prevalence and predictors of EOL health care utilization for patients dying with HF in a predominantly rural state.

Methods: We used the MaineHealth Data Organization’s All-Payer Claims Data to identify 15,168 patients ≥35 who died with HF between 2012 and 2017. The primary outcome was health care utilization during the last 180 days of life (EOL definition for this analysis), including emergency department (ED) visits, hospitalizations, intensive care unit (ICU) admissions, and hospice utilization. Patient characteristics analyzed included age, gender, comorbidities, area deprivation index (ADI), and rurality.

Findings: Among 15,168 patients ≥35 who died with HF, 48% had ≥2 hospitalizations, 72% had ≥2 ED visit, 29% had an ICU stay, 2% initiated dialysis during EOL, and 64% received hospice. Rural patients were more likely to have an ICU admission and have ≥2 hospitalizations. Patients residing in areas with higher ADI were more likely to be hospitalized, admitted to the ICU, and started on dialysis. Both rural patients and those living in higher ADI areas were less likely to receive hospice. After multivariable adjustment, rurality and ADI were independently associated with a decreased likelihood of receiving hospice (OR 0.62 [95% CI: 0.53-0.72] for the most rural patients and OR 0.64 [95% CI: 0.57-0.72] for the highest ADI).

Conclusion: Both rurality and local area deprivation drive disparities in EOL care for patients dying with heart failure.

KEYWORDS
end-of-life, heart failure, rurality

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Heart failure (HF) is a contributing cause of death for more than 10% of all US decedents, and it has a mortality rate similar to, or worse than, many cancers.1,2 Although there are no accepted quality metrics specific to HF, bereaved caregivers rate quality of care higher with hospice3 and lower when ICU care occurs close to end-of-life (EOL).4–6 Furthermore, aggressive care close to EOL does not prolong survival with HF.7 Despite this, patients with HF are less likely to enroll in hospice and more likely to receive ICU care during EOL compared with patients dying from cancer.8,9

The burden of HF is disproportionately high in rural areas,10 yet little is known about EOL care received by rural-dwelling patients with HF. Rural patients dying from cancer are more likely to receive aggressive EOL care and less likely to be enrolled in hospice.11–14 Patients from lower socioeconomic backgrounds also have poorer quality EOL care.14 Rural areas are more often socioeconomically deprived than urban areas. As a result, we do not know if observed care differences for rural-dwelling patients are due to geographic factors or socioeconomic deprivation.

The objective of this study was to describe the relationships between rurality, socioeconomic deprivation, and EOL care for patients dying with HF. We used an all-payer claims dataset, which includes patients with multiple payer sources and provides unique opportunities to understand care patterns regardless of type of health insurance.15 We also included the area deprivation index (ADI), a composite measure of regional socioeconomic deprivation.16–20 The ADI encompasses 4 domains of disadvantage: poverty, education level, housing, and employment and is available at the ZIP Code level. This composite measure facilitates our ability to understand the independent effects of socioeconomic deprivation and rurality in relation to EOL care. To our knowledge, this study is the first to examine these inter-relationships, and it is an important first step toward improving EOL care for rural patients with HF.

METHODS

Data source

We used the MaineHealth Data Organization’s all-payer claims data to identify patients (N = 15,168) who died with HF from 8/15/2012 to 12/31/2017. This data set includes insurance claims for nearly all beneficiaries in Maine insured by Medicare, Medicaid, and commercial insurers. The Maine Medical Center IRB approved this study.

Cohort identification

We identified patients with ≥ one inpatient hospitalization or 3 outpatient claims within 2 years with a primary diagnosis of HF using previously defined ICD9 and ICD10 codes.8 We identified decedents if they expired in a health care facility (hospital, skilled nursing facility, and long-term care) or while receiving hospice. We excluded patients under the age of 35 (n = 54), since younger adults often have different preferences regarding EOL. There are variable definitions of young adults ranging from under 30 to under 40; we chose the midpoint.21–23 We excluded patients without a ZIP Code (n = 56) and those who died prior to 8/15/2012 (n = 876) in order to have complete data during EOL and to identify patients with newly initiated dialysis.

Patient characteristics

We categorized age at death (35–54, 55–64, 65–74, 75–84, and 85+) and calculated the Charlson Comorbidity Index (CCI) using claims during the last 6 months of life with previously validated methods.24–25 All patients in our study had a CCI ≥ 1 since all patients had HF; we categorized CCI into 1, 2, and ≥3.

Rurality was categorized using federal Rural-Urban Commuting Area (RUCA) codes. These codes are derived from a combination of urbanicity, population density, and commuting patterns.26 We assigned an RUCA code for each patient by using an RUCA ZIP Code approximation file to crosswalk RUCA census tracts to ZIP Codes.26–27 The 10-level RUCA codes were categorized into 4 groups: metropolitan, large rural, small rural, and isolated rural.27

Socioeconomic deprivation was measured using the ADI, which is calculated at the census block group level based on 17 measures of poverty, education, housing, and employment.28 We assigned ADI to ZIP Code and collapsed ADI into quintiles.

Outcomes

Health care utilization during EOL was identified using claims data. We defined EOL as the last 180 days of life, consistent with prior analyses.29 EOL care measures were selected based on quality metrics for cancer.30–32 We identified patients who had ≥2 hospitalizations, ≥2 ED visits, or any ICU admission during EOL. Patients with a CPT code for dialysis during EOL and without a prior claim for dialysis during the preceding 45 days were considered to have initiated dialysis. We defined receipt of hospice based on a claim with an HCPS/CPT code for hospice.

Statistical analysis

All data were analyzed using SAS 9.3 (SAS Institute Inc., Cary, NC). We used chi-square tests and Student’s t-tests as appropriate to compare proportions and continuous variables. We fit logistic regression models for each outcome to obtain effect estimates; models included age, sex, insurance status, CCI, rurality, and ADI.

RESULTS

Patient characteristics

Most patients in our cohort were 75 or older (78%, Table 1), and approximately half were women. Most (82%) had a high comorbidity burden with a diagnosis of 1 serious disease or 2 minor diseases in
**TABLE 1**  Characteristics of patients dying with heart failure (n = 15,168)

| Characteristic               | Number | Percent |
|-----------------------------|--------|---------|
| **Age group**               |        |         |
| 35-54 years                 | 236    | 2       |
| 55-64 years                 | 768    | 5       |
| 65-74 years                 | 2,422  | 16      |
| 75-84 years                 | 4,647  | 31      |
| 85+ years                   | 7,095  | 47      |
| **Sex**                     |        |         |
| Female                      | 8,147  | 54      |
| Male                        | 7,021  | 46      |
| **Charlson Comorbidity Index** |  |        |
| 1                           | 978    | 7       |
| 2                           | 1,752  | 12      |
| 3+                          | 12,438 | 82      |
| **Urban/rural residence**   |        |         |
| Metropolitan                | 5,203  | 34      |
| Large rural                 | 4,686  | 31      |
| Small rural                 | 4,205  | 28      |
| Isolated rural              | 1,074  | 7       |
| **Insurance type**          |        |         |
| Private                     | 935    | 6       |
| Medicaid                    | 397    | 3       |
| Medicare                    | 8,200  | 54      |
| Dual Medicaid/Medicare      | 5,636  | 37      |
| **Area deprivation index**  |        |         |
| 1                           | 2,765  | 18      |
| 2                           | 2,791  | 19      |
| 3                           | 2,586  | 17      |
| 4                           | 3,256  | 22      |
| 5                           | 3,629  | 24      |

addition to HF. Over a third (35%) of the patients lived in isolated rural or small rural communities. Most patients were insured by Medicare (54% with Medicare and 37% dually eligible for Medicaid). Twenty-four percent lived within a top-quintile ADI ZIP Code.

**Health care utilization at EOL**

There were variable rates of health care utilization during EOL. Almost half of patients (n = 7,202, 48%) were hospitalized at least twice, nearly 3-quarters (n = 10,971, 72%) had ≥2 ED visits, and almost a third (n = 4,456, 29%) had an ICU admission during EOL. Few patients initiated dialysis (n = 326, 2%), and 64% of patients received hospice (Table 2).

**Utilization based on patient characteristics**

Older patients received fewer aggressive interventions and more hospice care, while men utilized more care, but less hospice. Those with more comorbidities also had higher EOL health care utilization. Patients in isolated rural areas were less likely to have ED visits but more likely to be hospitalized, admitted to the ICU, or initiate dialysis. Residing in a region with higher ADI was associated with a higher percentage of ICU admissions, hospitalization, and dialysis initiation. Both rurality and residence in a higher ADI region were associated with lower hospice utilization.

**Multivariable analysis**

Multivariable models, including age, gender, CCI, rurality, insurance, and ADI, revealed persistent differences based on patient characteristics (Table 3). After adjustment, younger patients and male patients had higher health care utilization and lower rates of hospice. Patients with higher comorbidity burden were more likely to be hospitalized, visit the ED, and receive ICU care. Patients insured by Medicaid were less likely to have ED visits, hospitalizations, or enroll in hospice. Several rurality-based differences in EOL care utilization persisted after adjustment. Patients from isolated rural areas were less likely to have ≥2 ED visits and more likely to be admitted to the ICU. Rural patients were also less likely to receive hospice care. The only difference in EOL care utilization according to ADI that persisted after multivariable adjustment was a decreased likelihood of receiving hospice.

**DISCUSSION**

This study revealed variable levels of EOL health care utilization for patients with HF in a predominantly rural state. Younger age, male sex, and higher comorbidity were associated with higher EOL health care utilization. Furthermore, ADI and rurality were each associated with important differences in EOL care. Living in a rural area or a more socioeconomically deprived area were each independently associated with a decreased likelihood of hospice care. Patients living in rural areas were more likely to receive ICU care.

Our findings are similar to a prior study using Medicare claims. Unroe et al found over 80% of patients with HF had 1 hospitalization during EOL, while we found nearly half of patients had ≥2 hospitalizations. Higher rates of hospitalization may be due to a variety of factors. Patients with HF typically receive treatments during hospitalization, such as intravenous diuretics, which improve symptoms. Symptom benefit may contribute to a greater acceptance of hospitalization during EOL. There is also evidence that patients with HF may be more willing to accept hospitalization in order to live longer.

Although patients’ preferences are an important factor, a recent study showed that patients with HF were more likely than cancer patients to receive care inconsistent with stated wishes. In addition, increased
TABLE 2  ED visits, hospitalizations, ICU stays, initiation of dialysis, and hospice in the last 6 months of life (n = 15,168)

|                          | ≥2 hospitalizations | P-value | ≥2 ED visits | P-value | ICU admission | P-value | Initiation of dialysis | P-value | Hospice admission | P-value |
|--------------------------|---------------------|---------|--------------|---------|---------------|---------|------------------------|---------|------------------|---------|
| Overall                  | 7,202 (48%)         |         | 10,971 (72%) |         | 4,456 (29%)   |         | 326 (2%)               |         | 9,677 (64%)       |         |
| Age group                |                     |         |              |         |               |         |                        |         |                  |         |
| 35-54 years              | 133 (56%)           | <.0001  | 188 (80%)    | <.0001  | 123 (52%)     | <.0001  | 20 (8.5%)              | <.0001  | 104 (44%)         | <.0001  |
| 55-64 years              | 449 (59%)           |         | 613 (80%)    |         | 390 (51%)     |         | 53 (6.9%)              |         | 347 (45%)         |         |
| 65-74 years              | 1,352 (56%)         |         | 1,924 (79%)  |         | 1,040 (43%)   |         | 126 (5.2%)             |         | 1,362 (56%)       |         |
| 75-84 years              | 2,372 (51%)         |         | 3,541 (76%)  |         | 1,565 (34%)   |         | 100 (2.2%)             |         | 2,948 (63%)       |         |
| 85+ years                | 2,896 (41%)         |         | 4,705 (66%)  |         | 1,338 (19%)   |         | 27 (0.4%)              |         | 4,916 (69%)       |         |
| Sex                      |                     | .01     |              | <.0001  |               | <.0001  |                        |         | .0001            | <.0001  |
| Female                   | 3,791 (47%)         |         | 5,606 (69%)  |         | 2,209 (27%)   |         | 141 (1.7%)             |         | 5,323 (65%)       |         |
| Male                     | 3,411 (49%)         |         | 5,365 (76%)  |         | 2,247 (32%)   |         | 185 (2.6%)             |         | 4,354 (62%)       |         |
| Charlson Index           |                     | <.0001  |              | <.0001  |               | <.0001  |                        |         |                  | .0002   |
| 1                        | 140 (15%)           |         | 517 (53%)    |         | 171 (18%)     |         | 5 (0.5%)               |         | 637 (65%)         |         |
| 2                        | 482 (28%)           |         | 1,040 (59%)  |         | 410 (23%)     |         | 15 (0.9%)              |         | 1,040 (59%)       |         |
| 3+                       | 6,580 (53%)         |         | 9,414 (76%)  |         | 3,875 (31%)   |         | 306 (2.5%)             |         | 8,000 (64%)       |         |
| Urban/rural residence    |                     | <.0001  |              | <.0001  |               | <.0001  |                        |         | .02              | <.0001  |
| Metropolitan             | 2,359 (45%)         |         | 3,734 (72%)  |         | 1,226 (24%)   |         | 95 (1.8%)              |         | 3,588 (69%)       |         |
| Large rural              | 2,218 (47%)         |         | 3,476 (74%)  |         | 1,355 (29%)   |         | 100 (2.1%)             |         | 3,097 (66%)       |         |
| Small rural              | 2,112 (50%)         |         | 3,058 (73%)  |         | 1,531 (36%)   |         | 104 (2.5%)             |         | 2,400 (57%)       |         |
| Isolated rural           | 513 (48%)           |         | 703 (65%)    |         | 344 (32%)     |         | 27 (2.5%)              |         | 592 (55%)         |         |
| Insurance type           |                     | .6      |              | <.0001  |               | <.0001  |                        |         |                  | <.0001  |
| Commercial               | 450 (48%)           |         | 784 (84%)    |         | 374 (40%)     |         | 58 (6.2%)              |         | 206 (22%)         |         |
| Medicaid                 | 179 (45%)           |         | 249 (63%)    |         | 161 (41%)     |         | 16 (4.0%)              |         | 100 (25%)         |         |
| Medicare                 | 3,919 (48%)         |         | 6,586 (79%)  |         | 2,362 (29%)   |         | 161 (2.0%)             |         | 5,823 (71%)       |         |
| Medicare/Medicaid        | 2,654 (47%)         |         | 3,452 (61%)  |         | 1,559 (28%)   |         | 91 (1.6%)              |         | 3,548 (63%)       |         |
| Area Deprivation Index   |                     | <.0001  | .0001        | <.0001  |               | <.0001  |                        | .0037   | .0001            |         |
| 1                        | 1,249 (45%)         |         | 2,024 (73%)  |         | 749 (27%)     |         | 51 (1.8%)              |         | 1,964 (71%)       |         |
| 2                        | 1,287 (46%)         |         | 2,032 (73%)  |         | 741 (27%)     |         | 49 (1.8%)              |         | 1,927 (69%)       |         |
| 3                        | 1,257 (49%)         |         | 1,902 (74%)  |         | 767 (30%)     |         | 66 (2.6%)              |         | 1,651 (64%)       |         |
| 4                        | 1,518 (47%)         |         | 2,374 (73%)  |         | 978 (30%)     |         | 55 (1.7%)              |         | 2,054 (63%)       |         |
| 5                        | 1,834 (51%)         |         | 2,538 (70%)  |         | 1,186 (33%)   |         | 101 (2.8%)             |         | 1,994 (55%)       |         |

prognostic uncertainty in HF may create challenges in identifying when a patient is entering EOL, resulting in increased utilization.\textsuperscript{34,38}

We found important differences in EOL health care utilization according to rurality. Consistent with prior studies, we found that rural patients were less likely to receive hospice care than urban patients.\textsuperscript{13,29,39} These differences persisted after adjustment for socioeconomic deprivation. Patients residing in areas with higher ADI were also less likely to receive hospice care, which persisted after adjusting for rurality. To our knowledge, this is the first study demonstrating differences in hospice care according to both ADI and rurality. Our findings suggest that geographic isolation and socioeconomic factors are both independent drivers in poorer quality EOL care.

Patients from rural areas were also more likely to receive ICU care during EOL. This is a novel finding for HF but is consistent with findings for patients with cancer.\textsuperscript{29} Though there are no accepted quality indicators for EOL care in HF, receipt of ICU care during EOL for cancer is accepted as a marker of poor quality. Notably, patients living in rural areas were less likely to have ≥2 ED visits during EOL. Taken together, the decreased ED visits and the increased rate of ICU care suggest that rural patients may delay seeking care, resulting in a need for ICU-level care. Another explanation for the decreased access to hospice as well as the increased rate of ICU care is lack of hospice and palliative care specialists in rural areas.\textsuperscript{13,40,41} Speciality palliative care decreases ICU care at EOL and increases hospice utilization.\textsuperscript{42,43} Despite the rural and socioeconomic disparities, overall utilization of hospice for patients dying with HF in Maine is higher than described previously.\textsuperscript{6} One reason for this may be the timing of our study; hospice utilization has increased over time.\textsuperscript{44} Despite overall high rates
of hospice, we observed high rates of hospitalizations, ED visits, and ICU care. The combination of hospice care with other health care utilization is consistent with evidence showing a greater likelihood of hospitalization and ED care for patients with HF following hospice admission. The association between hospice and lower EOL care utilization depends on the particular hospice; some hospices are more effective at decreasing utilization than others.

We were not able to account for such differences as a possible contributing factor in this study. Our study has several limitations. Patients who expired at home without hospice were not included in our cohort, resulting in missing some deaths. We do not have data on regional variability in hospice availability, and thus we were not able to control for this factor in our models. Our sample came from one state, and Maine lacks racial and ethnic diversity; our data source does not include race, further limiting our ability to detect racial disparities. Our data source did not allow us to require continual insurance coverage during the study period; this may have resulted in some missed claims. However, it seems unlikely that a large number of patients would have lost coverage during EOL. Finally, this analysis was based on claims data, which does not allow us to account for patient preferences.

Despite these limitations, our study sheds light on important aspects of EOL care among patients with HF in a rural state, and it suggests that socioeconomic deprivation and rurality are both independent factors that contribute to EOL care disparities. Further research is needed to confirm these findings and test interventions to decrease these disparities—for example, by providing timely access to palliative care, which is limited in rural areas. Potential strategies include the use of telehealth to deliver palliative care services, and training programs to bolster the palliative care skills of rural primary care...
providers. Improving socioeconomic deprivation, however, will require systemic interventions that address other material needs, such as food insecurity and transportation. Our study thus highlights the challenges involved in improving EOL care for our most vulnerable patients in rural communities.

ORCID
Rebecca N. Hutchinson MD, MPH https://orcid.org/0000-0002-9121-6426

REFERENCES

1. Stewart S, Maclntyre K, Hole DJ, Capewell S, McMurray JJ. More ‘malignant’ than cancer? Five-year survival following a first admission for heart failure. Eur J Heart Fail. 2001;3(3):315-322.
2. CDC. Heart disease. Available at: https://www.cdc.gov/heartdisease/heart_failure.htm. Accessed May 12, 2020.
3. Teno JM, Clarridge BR, Casey V, et al. Family perspectives on end-of-life care at the last place of care. JAMA. 2004;291(1):88-93.
4. Teno JM, Mor V, Ward N, et al. Bereaved family member perceptions of quality of end-of-life care in US regions with high and low usage of intensive care unit care. J Am Geriatr Soc. 2005;53(11):1905-1911.
5. Wright AA, Keating NL, Balboni TA, Matulonis UA, Block SD, Prigerson HG. Place of death: correlations with quality of life of patients with cancer and predictors of bereaved caregivers’ mental health. J Clin Oncol. 2010;28(29):4457-4464.
6. Ornstein KA, Aldridge MD, Garrido MM, et al. The use of life-sustaining procedures in the last month of life is associated with more depressive symptoms in surviving spouses. J Pain Symptom Manage. 2017;53(2):178-187.
7. Gelfman LP, Barrón Y, Moore S, et al. Predictors of hospice enrollment for patients with advanced heart failure and effects on health care use. JACC: Heart Fail. 2018;6(9):780-789.
8. Unroe KT, Greiner MA, Hernandez AF, et al. Resource use in the last 6 months of life among Medicare beneficiaries with heart failure, 2000-2007. Arch Intern Med. 2011;171(3):196-203.
9. Kauf P, McAllister FA, Ezekowitz JA, et al. Resource use in the last 6 months of life among patients with heart failure in Canada. Arch Intern Med. 2011;171(3):211-217.
10. Verdejo HE, Ferreccio C, Castro PF. Heart failure in rural communities. Heart Fail Clin. 2015;11(4):515-522.
11. Du XL, Parikh RC, Lairson DR. Racial and geographic disparities in the patterns of care and costs at the end of life for patients with lung cancer in 2007-2010 after the 2006 introduction of bevacizumab. Lung Cancer. 2015;90(3):442-450.
12. Waldrop D, Kirkendall AM. Rural–urban differences in end-of-life care: implications for practice. Soc Work Health Care. 2010;49(3):263-289.
13. Rainsford S, MacLeod RD, Phillips CB, Wiles RA, Wilson DM. Rural end-of-life care from the experiences and perspectives of patients and family caregivers: a systematic literature review. Palliat Med. 2017;31(10):895-912.
14. Davies JM, Sleeman KE, Leniz J, et al. Socioeconomic position and use of healthcare in the last year of life: a systematic review and meta-analysis. PLoS Med. 2019;16(4):e1002782.
15. Freedman JD, Green L, Landon BE. All-Payer Claims Databases — uses and expanded prospects after Gobeille. N Engl J Med. 2016;375(23):2215-2217.
16. Kind AJ, Jencks S, Brock J, et al. Neighborhood socioeconomic disadvantage and 30-day readmission rate: a retrospective cohort study. Ann Intern Med. 2014;161(11):765-774.
17. Hu J, Kind AJH, Nerenz D. Area deprivation index predicts readmission risk at an urban teaching hospital. Am J Med Qual. 2018;33(5):493-501.
18. Fairfield KM, Black AW, Ziller EC, et al. Area deprivation index and rurality in relation to lung cancer prevalence and mortality in a rural state. JNCI Cancer Spect. 2020;4(4):pkaa011.
19. Kurani SS, McCoy RG, Lampman MA, et al. Association of neighborhood measures of social determinants of health with breast, cervical, and colorectal cancer screening rates in the US Midwest. JAMA Netw Open. 2020;3(3):e200618.
20. Rosenzweig MQ, Althouse AD, Sabin L, et al. The association between area deprivation index and patient-reported outcomes in patients with advanced cancer. Health Equity. 2021;5(1):8-16.
21. DeCourcey DD, Silverman M, Oladunjoye A, Wolfe J. Advance care planning and parent-reported end-of-life outcomes in children, adolescents, and young adults with complex chronic conditions”. Crit Care Med. 2019;47(1):101-108.
22. Snaman JM, Kaye EC, Lu JJ, Sykes A, Baker JN. Palliative care involvement is associated with less intensive end-of-life care in adolescent and young adult oncology patients. J Palliat Med. 2017;20(5):509-516.
23. Mack JW, Chen LH, Cannavale K, Sattayapiwat O, Cooper RM, Chao CR. End-of-life care intensity among adolescent and young adult patients with cancer in Kaiser Permanente Southern California. JAMA Oncol. 2015;1(5):592-600.
24. Quan H, Li B, Duncan Saunders L, et al. Assessing validity of ICD-9-CM and ICD-10 administrative data in recording clinical conditions in a unique dually coded database. Health Serv Res. 2008;43(4):1424-1441.
25. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005;43(11):1130-1139.
26. Hart LG, Larson EH, Lishner DM. Rural definitions for health policy and research. Am J Public Health. 2005;95(7):1149-1155.
27. Codes RuC. United States Department of Agriculture Economic Research Service. Available at: https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/. Accessed May 13, 2021.
28. University of Wisconsin School of Medicine and Public Health. Available at: https://www.neighborhoodatlases.wisc.edu/. Accessed May 29, 2020.
29. Watanabe-Galloway S, Zhang W, Watkins K, et al. Quality of end-of-life care among rural Medicare beneficiaries with colorectal cancer. J Rural Health. 2014;30(4):397-405.
30. Earle CC, Park ER, Lai B, Weeks JC, Ayanian JZ, Block S. Identifying potential indicators of the quality of end-of-life care from administrative data. J Clin Oncol. 2003;21(6):1133-1138.
31. Earle CC, Neville BA, Landrum MB, et al. Evaluating claims-based indicators of the intensity of end-of-life care. Int J Qual Health Care. 2005;17(6):505-509.
32. 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. 2008;26(23):3860.
33. Warraich HJ, Meier DE. Serious-illness care 2.0 – meeting the needs of patients with heart failure. N Engl J Med. 2019;380(26):2492-2494.
34. Hutchinson R, Gutheil C, Wessler BS, Prevatt H, Sawyer D, Han PK. What is quality end-of-life care for patients with heart failure? A Qualitative Study with Physicians. J Am Heart Assoc. 2020. In press. 9(8):e016505.
35. Brunner-La Rocca HP, Rickenbacher P, Muzzarelli S, et al. End-of-life preferences of elderly patients with chronic heart failure. Eur Heart J. 2012;33(6):752-759.
36. Warraich HJ, Taylor DH, Casarett DJ, et al. Hospice care for heart failure: challenges faced by hospice staff in a predominantly rural setting. J Palliat Med. 2019;22(1):7-8.
37. Formiga F, Chivite D, Ortega C, Casas S, Ramon JM, Pujol R. End-of-life preferences in elderly patients admitted for heart failure. QJM. 2004;97(12):803-808.
38. Lee RY, Brumback LC, Sathitratanacheewin S, et al. Association of physician orders for life-sustaining treatment with ICU admission among patients hospitalized near the end of life. *JAMA*. 2020;323(10):950-960.

39. Wang H, Qiu F, Bollesen E, et al. Rural-urban differences in costs of end-of-life care for elderly cancer patients in the United States. *J Rural Health*. 2016;32(4):353-362.

40. Worldwide Palliative Care Alliance, World Health Organization. *Global Atlas of Palliative Care at the End of Life*. London: Worldwide Palliative Care Alliance; 2014.

41. Bakitas MA, Elk R, Astin M, et al. Systematic review of palliative care in the rural setting. *Cancer Control*. 2015;22(4):450-464.

42. Jang RW, Krzyzanowska MK, Zimmermann C, Taback N, Alibhai SM. Palliative care and the aggressiveness of end-of-life care in patients with advanced pancreatic cancer. *J Natl Cancer Inst*. 2015;107(3):dju424.

43. Temel JS, Greer JA, Muzikansky A, et al. Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med*. 2010;363(8):733-742.

44. Warraich HJ, Xu H, DeVore AD, et al. Trends in hospice discharge and relative outcomes among Medicare patients in the get with the guidelines–heart failure registry. *JAMA Cardiol*. 2018;3(10):917–926.

45. Cheung WY, Schaefer K, May CW, et al. Enrollment and events of hospice patients with heart failure vs. cancer. *J Pain Sympt Manage*. 2013;45(3):552-560.

46. Aldridge MD, Epstein AJ, Brody AA, Lee EJ, Morrison RS, Bradley EH. Association between hospice spending on patient care and rates of hospitalization and Medicare expenditures of hospice enrollees. *J Palliat Med*. 2018;21(1):55-61.

47. Elk R, Emanuel L, Hauser J, Bakitas M, Levkoff S. Developing and testing the feasibility of a culturally based tele-palliative care consult based on the cultural values and preferences of southern, rural African American and White community members: a program by and for the community. *Health Equity*. 2020;4(1):52-83.

48. Cheung KL, Tamura MK, Stapleton RD, Rabinowitz T, LaMantia MA, Gramling R. Feasibility and acceptability of telemedicine-facilitated palliative care consultations in rural dialysis units. *J Palliat Med*. 2021, ahead of print. https://doi.org/10.1089/jpm.2020.0647.

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