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An individual housing-based socioeconomic status measure predicts advance care planning and nursing home utilization

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Abstract

Background: Socioeconomic status (SES) is an important determinant of disparities in healthcare and may play a role in end of life care and decision making. SES is difficult to retrospectively abstract from current electronic medical records (EMR) and datasets.

Objective: Using a validated SES measuring tool derived from home address, the HOUSing-based SocioEconomic Status index, termed HOUSES we wanted to determine whether SES is associated with differences in end-of-life care and decision making.

Design/Setting/Subjects: This cross-sectional study utilized a cohort of Olmsted County adult residents admitted to 7 ICUs at Mayo Rochester between 6/1/2011 and 5/31/2014.

Measurements: Multiple variables that reflect decision making and care at end-of-life and during critical illness were evaluated, including presence of advance directives and discharge disposition. SES was measured by individual housing-based SES index (HOUSES index; a composite index derived from real property as a standardized z-score) at the date of admission to the ICU which was then divided into four quartiles. The greater HOUSES, the higher SES, Outcomes were adjusted for age, 24 hour APACHE III score, sex, race/ethnicity and insurance.

Results: Among the eligible 4134 subjects, the addresses of 3393 (82%) were successfully geocoded and formulated into HOUSES. The adjusted odds ratios comparing HOUSES 1 versus

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2,3, and 4 demonstrated lower likelihood of advance directives -0.77 (95% CI 0.63-0.93), and lower likelihood of discharge to home -0.60 (95% CI 1.05-0.72).

Conclusion: Lower SES, derived from a composite index of housing attributes, was associated with lower rates of advance directives and lower likelihood of discharge to home.

Keywords

socioeconomic status; HOUSES index; advance directives; discharge disposition; social work referral; end of life care; decision making

Introduction

Socioeconomic status (SES) is a much discussed but poorly understood and studied demographic predictor for a broad range of health outcomes and behaviors. There is a growing body of literature that underscores the importance of ethnic, racial, religious, as well as language barriers in decision-making at the end of life.¹⁻⁷ These factors have been previously studied as predictors and moderators of various aspects of care, including advance care planning, receiving comfort care, and resuscitation preferences. While low SES has been noted to negatively affect access to care, quality of care, and potentially, healthcare outcomes, its role in end-of-life decision-making and care has not been extensively studied and there is no consensus about its role or importance.⁸

Given that SES is recognized as an important social determinant of health that impacts health through proximal and distal pathways, it is important to understand whether people in a critical care setting, who anticipate critical outcomes, equitably access end of life care and decision making across different SES groups including using advance care planning.^{9,10} The absence of advance care planning has been strongly associated with prolonged suffering at the end of life, making its presence a potential mediator of quality of death.^{11,12}

To date the evidence regarding the association between lower SES and advance care planning has been inconclusive¹³⁻¹⁷. Measures of SES have included education, income and insurance status. A study by Tripken et al¹³ demonstrated that those of low SES were likely to be less familiar with ACP and may be less likely to complete an ACP¹³. Carr et al noted that SES might mediate lower rates of ACP planning¹⁴. Khosla's longitudinal study that used income and education as predictors of ACP did not support these findings¹⁵.

This research effort is consistent with the recent National Academy of Medicine's recommendation for the vital direction for a health care system which includes "a delivery of care on a personal and social context".¹⁸ While it is relatively easy to determine disparities in end of life care by gender, age, and race/ethnic groups, it is difficult to assess disparities in access to end of life care and decision making by SES, which is frequently unavailable in a clinical care setting.

An adequate measure of SES, especially individual-level SES, has been historically difficult in health outcomes research as SES measures in commonly used data sources such as medical records, administrative datasets and disease registries are frequently unavailable. To overcome the absence of SES measures in commonly used data sources, Juhn et al

developed and validated the HOUsing-based SocioEconomic Status index *termed HOUSES* as a surrogate metric of individual-level SES derived from publicly available property assessment data of local government. Thus, HOUSES enables clinicians and researchers to directly assess SES through geocoding address information in medical records. This index provides a unique opportunity to assess disparities in end of life care by SES in a critical care setting.

Therefore, the primary aim of this study was to examine if lower socioeconomic status, as measured by the HOUSES index, was associated with lower rates of advance directive completion for patients admitted to the ICU. In addition, we sought to determine if lower socioeconomic status was associated with higher rates of life support utilization in the ICU. Based on a conceptual framework that vulnerable populations are less likely to access resources to formulate an advance directive, we hypothesized that lower SES would be associated with lower rates of advance directive completion. We also hypothesized that lower SES (and lower advance directive completion) would be associated with higher rates of life support utilization.

Methods

The study was approved by the Mayo Clinic Institutional Review Board as a minimal risk study.

Study Setting and Population:

This study focused on Olmsted County patients admitted to the 7 Intensive Care Units (ICUs) at Mayo Clinic, Rochester, Minnesota, between 6/1/2011 and 5/31/2014. Mayo Clinic is a tertiary care hospital with about 15,000 ICU admissions annually including all Olmsted County ICU admissions. Olmsted County is the 8th most populous county in Minnesota, with the 2010 census reporting 144,248 residents and 2015 census predictions estimating 151,436 residents.¹⁹ Rochester, MN is the seat of Olmsted county, comprising 74% of the county's residents as of 2010.¹⁹

Study Design:

This was a single center cross sectional study of patients admitted to the ICUs in Mayo Rochester. .

Study Subjects:

We excluded patients who were less than 18 years old and those of any age without research authorization.

Data Collection:

Primary Outcome: The Primary outcome of the study was documentation of an advance directive was in the electronic medical record (EMR) on admission to the ICU. For patients for whom the presence of advance directives was not available using an automated search query, manual chart abstraction and simple imputation strategies were utilized, proportional to the observed rate of Advance Directives in the cohort.

Secondary Outcomes: The secondary outcomes which we studied included characteristics of decision-making for life support, and aggressiveness of treatment such as: code status (full code or do not resuscitate), use of life support and implementation of a standardized institutional comfort measures only order set, documentation of a family conference, ICU and hospital length of stay and mortality, and hospital discharge location.²⁰ We selected these variables as they reflect characteristics of decision making for life support and the desire for treatment intensity at end of life. The data was abstracted using automated retrieval queries from the EMR.

The demographic variables we abstracted from the EMR were as follows: age, sex, race/ethnicity, education level and insurance type. We assessed medical complexity using the Charlson co-morbidity index, a weighted scoring system, which incorporates the number and severity of 19 comorbid conditions as identified by ICD-9 codes. Acute Physiology and Chronic Health Evaluation (APACHE) III scores were calculated at 24 hours following admission.²¹

The index date for most primary and secondary end points was defined as first admission to the ICU. For those end points relating to death in the ICU, the index date was the final admission to the ICU that resulted in death.

Measurement of Socioeconomic Status-HOUSES Index:

The HOUSES Index is an individual-level SES and was derived from address-linked real property data. The details of how to measure the individual SES were previously reported.^{22,23} Briefly, address-linked, publically available, real property data was obtained from Olmsted County governmental sources and was matched to study participant addresses in the EMR at index date after geocoding.^{22,23} The HOUSES index is a composite index derived from data points abstracted from the property data, including value and square footage of the housing unit, as well as number of bedrooms and bathrooms in the housing unit.²³ The HOUSES index has been applied to study a wide variety of health outcomes and risk factors in adults and children. These outcomes include vaccination uptake, rates of invasive pneumococcal disease, prevalence of asthma and rates of smoking among adolescents, rheumatoid arthritis and mortality, accidental falls, rates of hospitalization, , and multiple chronic conditions as well as cardiovascular outcomes and health disparities.^{4,22-31}

Statistical Analysis:

All continuous variables were reported as medians with interquartile range (IQR). Wilcoxon rank-sum tests were used to compare continuous variables between groups, to minimize the effects of outliers and variables with non-normal distributions. We performed multivariate linear regression for continuous outcomes including time to code status change, time on mechanical and non-invasive mechanical ventilation, hospital and ICU lengths of stay, and time to comfort measures only order, adjusting for APACHE III score, sex, education, and insurance. Parameter estimates with 95% confidence intervals were reported. All categorical variables were reported as counts with percentages and compared between groups using chi-square tests. Binary outcomes were also analyzed using multivariate logistic regression to adjust for age, 24 hour APACHE III score, sex, race/ethnicity, and insurance. The adjusted

odds ratios with 95% confidence intervals were reported. Leverage plots were assessed to check for outliers in the models. A two-sided p value of less than 0.05 was considered statistically significant. All analyses were done using SAS version 9 in a Linux environment.

Cochrane-Armitage trend tests and logistic models were used to assess the impact of SES on all binary variables including discharge disposition, social work referrals, and frequency of advance care planning among other outcomes. HOUSES was categorized based on quartiles using the 3393 patients with non-missing data as follows: (1) less than -2.49 (HOUSES 1: lowest) (2) greater than or equal to -2.49 but less than -0.325 (HOUSES 2); (3) greater than or equal to -0.325 but less than 1.595 (HOUSES 3); and (4) greater than or equal to 1.595 (HOUSES 4: highest).²⁴

Results

Baseline Characteristics of study subjects:

4134 unique patients were identified as being Olmsted County residents. Of those 250 had either an address that was not retrievable or were subsequently found to not live in Olmsted County. 468 residents had an address that could not be formulated into a HOUSES index, either because the residents lived in a nursing home without prior residential addresses available or a P.O. Box address was the only available address recorded in the EMR. The final cohort included 3393 Olmsted county residents whose addresses were geocoded and formulated into HOUSES successfully. This was 82% of the eligible patients. Patients with HOUSES data tended to be slightly older, have higher Charlson scores, were more frequently single, and were less likely to have private insurance than patients without HOUSES data. Patients in the highest HOUSES quartile (HOUSES 4) compared to HOUSES 1, 2, and 3 were older, male, white non-Hispanic, married and have private health insurance and more education Age ($p<0.001$), sex ($p<0.001$), race (<0.001), ethnicity (0.003), and marital status (<0.001) differed between the quartile groups.(Table 1).

Advance directives:

Patients in HOUSES 1 (lowest SES quartile) were less likely to have an advance directive than those in HOUSES 2, 3 and 4. (28.5% v.40%, 40.5%, 42.8%, $p<0.001$) (Table 2). When these results were adjusted for age, sex, race/ethnicity, insurance and APACHE score the results remained significant ($p<0.001$) as shown in Table 3. Odds ratios comparing HOUSES 1 versus 2,3 and 4 demonstrated lower likelihood of advance directive-0.77(95% CI. 0.63-0.93). Trend tests confirmed the linear association between socioeconomic status as measured by the HOUSES index and likelihood of having an Advance Directive. ($p<0.001$) (Table 3).

Healthcare Utilization:

There were no differences in code status on admission among the HOUSES quartiles groups (2.7%–3.2%, $p=0.93$). No differences were noted in mechanical ventilation use, non-invasive mechanical ventilation use, dialysis vasopressor use or CPR. Length of stay, hospital, and ICU mortality did not differ. No significant differences were found in comfort measures prior to death. Following adjustment all outcomes listed above remained

insignificant between the HOUSES quartiles as demonstrated in Table 2. Unadjusted and adjusted ICU and hospital mortality did not differ across the HOUSES quartiles ($p=0.97$, $p=0.90$ respectively). Unadjusted and adjusted median ICU and Hospital length of stay did not differ across the HOUSES quartiles ($p=0.45$, $p=0.07$ respectively). (Table 2).

Hospital Disposition:

Rates of social work consultation among the first quartile (Q1, lowest SES), second, third and fourth quartile were 20.9%, 19.1%, 16.8% and 11% respectively p value <0.001) (Table 2). Table 3 shows results following adjustment. The difference in social work consultation remained following adjustment with age, sex, race/ethnicity, APACHE III score, and insurance status ($p<0.001$) Adjusted odds ratios comparing HOUSES 1 versus 2,3,and 4 demonstrated higher likelihood of social work referral-01.46(95% CI.1.18-1.79) More patients from the lowest HOUSES quartile were discharged to places other than home. Rates of discharge to home among the first, second, third and fourth quartile were 22.6%,25.1%, 25.0% and 27.4% respectively (p value <0.001). These results remained significant following adjustment with age, sex, race/ethnicity, APACHE III score, and insurance status ($p<0.001$) Adjusted odds ratios comparing HOUSES 1 versus 2,3,and 4 demonstrated lower likelihood of discharge to home following ICU admission -0.60 (0.50,0.72)(Table 3).

Discussion

Lower socioeconomic status, as derived from a composite index of housing attributes, was associated with lower rates of advance directives on admission to the ICU and higher rates of discharge to nursing home, but was not associated with differences in code status or life support utilization in the ICU. The HOUSES index predicts presence of advance directives, nursing home utilization, and social work consultation in the hospital. No differences were noted in measures of end-of-life care and aggressiveness for life-sustaining treatment. We successfully measured a HOUSES score for 82 % of the eligible patients using retrospective data (i.e., address information) without patient contact.

Previous work has shown that differences in familiarity with advance care planning terminology, knowledge of advance care planning, and non-completion of advance directives were potentially mediated by socioeconomic factors.¹³ There is evidence to show that SES may play a role in lower levels of advance care planning potentially reflecting a multitude of factors including income, education, assets and home ownership.¹⁴ However other work that used education and income as proxies for SES and examined the trends over time demonstrated that SES had a limited role in advance care planning although those with a higher SES were more likely to have a designated power of attorney.¹⁵ Deborah Carr's work examined assets, occupation and education and found that although all of these SES measures were associated with rates of advance care planning (as SES increased, ACP increased), assets were the most powerful predictor. Assets also demonstrated a graded association with increased ACP as assets increased, a relationship not seen with education and occupation.³² Some qualitative research has noted that communication barriers may contribute to ineffective advance care planning among vulnerable populations.^{16,17}

Since lack of advance care planning has been associated with costly, poor quality care the association of low SES with lower rates of advance care completion and documentation is troubling.⁵ Although there may be limitations with the effectiveness of advance care planning it remains a cornerstone of end of life decision making in the United States.^{11,12} Advance Care Planning has been associated with improved outcomes including fewer intensive treatments and less hospitalization at the end of life, fewer communication concerns, and increased likelihood that a person will die in their preferred place.^{33,34} Studies have shown that those who have completed advance directives are more likely to receive medical care that reflected their stated preferences than patients who did not have an advance directive.^{35,36} Thus it is possible that lower rates of advance directive completion for those in the lowest socioeconomic group (HOUSE 1) as demonstrated in our study may lead to care that is not value-concordant care and may not fully honor patients' wishes. These findings represent a disparity, bearing in mind that some people even with resources may elect not to formulate an advance directive.³⁷

The association between increased social work referral rates and lower SES has face validity although it has not been explicitly measured or reported in the literature. The relationship between SES and discharge disposition has been previously explored including among those receiving rehabilitation after stroke.³⁸ Socioeconomic status was not found to be correlated with discharge to home in that study. However a study by Inneh et al conducted in a population of patients post lower extremity arthroplasty did demonstrate that lower SES was correlated with lower likelihood of discharge to home.³⁹ Evidence exists that supports the notion that those of lower SES face multiple challenges and do worse after discharge for a number of reasons, including lack of the necessary financial and social supports when they leave the hospital.⁴⁰ The factors influencing discharge destination are complicated and beyond the scope of this discussion. We believe our results reflect the fact that patients perceived to have low SES will receive more social work referrals because issues about insurance and financing nursing home placements will concern providers as they plan for discharge. Conversely families and patients that have financial and other resources to arrange and subsidize nursing home arrangements or support within the home may not require a social worker to assist with this. However our findings may suggest that lower likelihood of discharge to home reflects a disparity in care quality and an issue that deserves further exploration. Of note there were no differences noted in mortality, length of stay, life support, healthcare utilization, or code status orders. Our findings suggest that socioeconomic status may be an important predictor in certain specific domains of end of life care and decision making in the ICU, beyond the often cited demographic predictors of age, illness, and race/ethnicity. Building on this finding, having an easily accessible tool to highlight this social determinant of a patient's health that would benefit from social work engagement, might be useful for healthcare systems when planning for patient discharge.

We measured secondary end points for several reasons. We wanted to examine whether the rates of ACP correlated with treatment intensity at the end of life. We did not find any correlation in our cohort. Those without advance care plans might be expected to receive more aggressive end of life care since surrogate decision makers will have no guidance about what a patient would want and therefore may be hesitant when making decisions about withdrawal of care and thus continue aggressive care.

Furthermore since those in the lowest SES quartile may have less education and therefore understanding of options at end of life or a strongly held belief that aggressive treatment has a higher likelihood of success than can reasonably be expected, they may opt for aggressive care. Thirdly those who experience poverty and poor medical care throughout life may seek to compensate for this pattern with intensive interventions and aggressive care to prolong life. We did not find any differences in life support utilization between the SES quartiles, despite differences in presence of AD. This might be for several reasons. Possible reasons for no relation between HOUSES quartiles and health care utilization include: 1) low rates of health care utilization across all quartiles (for example average length of stay of ICU is 1 day in all quartiles, reflecting a quick turnaround for all subjects 2) narrower SES spectrum in Olmsted County when compared to other locations and 3) in-ICU communication practices that emphasize sound decision making for patients across all spectrums of SES. It is also possible that the presence of the advance directive did not change the treatment of healthcare utilization for several reasons. The reasons might include the fact that it did not stipulate anything specific that would guide clinicians and family during decision making or it was not used to guide decision making. We think the fact that no differences were shown may be due to the narrower SES spectrum seen in Olmsted County when compared to other places with areas of vast wealth and extreme poverty. For example, proportion of people with bachelor degree or higher are 34% for US and 42% for Olmsted County, and proportion of people with income below poverty level are 15% for US and 9% for Olmsted County, respectfully (US Census, American Community Survey 2016 5-year estimate; <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>).

Measuring SES poses many challenges for clinicians and researchers alike. These include a lack of consensus about what is considered an appropriate measure of SES, poorly systematized ways of recording and updating an appropriate measure of SES and self-reporting bias.²³ While SES has been previously approximated from data about zip code, health insurance, income education and occupational characteristics⁴¹, these measures are often neither recorded in the EMR nor maintained up to date, resulting in unreliable metrics that fail to capture social mobility.⁴¹ The lack of individual-level SES measures has led to frequent use of census-level or area level SES as proxy measures, which are not always accurate (ie, misclassification biases).^{42,43} The Housing-based SocioEconomic Status (HOUSEs) index was developed and validated as a surrogate metric of individual-level SES, deriving housing characteristics from patient address data to construct a reliable estimate of SES. While the HOUSEs index has been used to evaluate health outcomes in multiple outpatient and inpatient settings in both adults and children, it has never been used in the critical care setting.^{4,22,24–26,28,29,31,44,45} Using the HOUSEs index, we measured patient's SES in quartiles within our ICU cohort and studied several primary and secondary endpoints and whether differences in quality of death and dying existed among four socioeconomic groups, using previously established measures.^{46,47} We were able to abstract education data from the EMR, however, education data is still self-reported data, and we could not verify the date when this variable was last updated, unlike the address which would be updated on each admission to the hospital.

This study has several limitations. It is a single center study based in a tertiary care academic medical center in the Midwest United States. Olmsted County has a predominantly white

population potentially making our findings less generalizable in other settings. Given the retrospective and observational nature of the data, we were unable to prospectively measure individual authentic patient and family preferences, quality of decision making or satisfaction. We were reliant on documented evidence in the EMR and assumed it was an accurate representation of preferences. Some studies have suggested that documented code status preferences may not accurately reflect patient preferences in some cases.⁴⁸ We were therefore not able to completely determine whether what we abstracted from the EMR was truly the authentic values of the patients whose charts we analyzed.

Strengths of this study include the fact that it is the first to utilize the HOUSES index for examining the role of SES in end of life care in an ICU setting. It examined multiple variables reflecting quality of end of life care and decision making. The HOUSES index is an objective SES measures which has been derived from assessment data (real property data). The index was validated externally in Lincoln County, South Dakota and Jackson County Missouri.^{23,25,30} It can be formulated relatively easily by directly linking address in the EMR to assessment data and captures changes in patient's socioeconomic status over time and can be a static measure at the time of event of interest (example, ICU admission, or discharge in this study). All patients requiring admission to the ICU that present to a hospital in Olmsted County are admitted to Mayo Clinic ICU, and therefore although this was a retrospective single-center cohort study conducted in Mayo Clinic, Rochester, MN, it is an appropriate setting for a population-based study.²⁶

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References

1. Quill CM, Ratcliffe SJ, Harhay MO, Halpern SD. Variation in decisions to forgo life-sustaining therapies in US ICUs. *Chest*. 2014;146(3):573–582. [PubMed: 24522751]
2. Barnato AE, Anthony DL, Skinner J, Gallagher PM, Fisher ES. Racial and ethnic differences in preferences for end-of-life treatment. *Journal of general internal medicine*. 2009;24(6):695–701. [PubMed: 19387750]
3. Soto GJ, Martin GS, Gong MN. Healthcare disparities in critical illness. *Critical care medicine*. 2013;41(12):2784–2793. [PubMed: 24121467]
4. Johnson M, Urm S, Jung J, et al. Housing data-based socioeconomic index and risk of invasive pneumococcal disease: an exploratory study. *Epidemiology and infection*. 2013;141(04):880–887. [PubMed: 22874665]
5. Huang IA, Neuhaus JM, Chiong W. Racial and Ethnic Differences in Advance Directive Possession: Role of Demographic Factors, Religious Affiliation, and Personal Health Values in a National Survey of Older Adults. *J Palliat Med*. 2016;19(2):149–156. [PubMed: 26840850]
6. Searight HR, Gafford J. Cultural diversity at the end of life: issues and guidelines for family physicians. *Am Fam Physician*. 2005;71(3):515–522. [PubMed: 15712625]
7. Barwise A, Jaramillo C, Novotny P, et al. Differences in Code Status and End-of-Life Decision Making in Patients With Limited English Proficiency in the Intensive Care Unit. Paper presented at: Mayo Clinic Proceedings 2018.
8. Volandes AE, Paasche-Orlow M, Gillick MR, et al. Health literacy not race predicts end-of-life care preferences. *Journal of palliative medicine*. 2008;11(5):754–762. [PubMed: 18588408]

9. Sills MR, Hall M, Colvin JD, et al. Association of social determinants with children's hospitals' preventable readmissions performance. *JAMA pediatrics*. 2016;170(4):350–358. [PubMed: 26881387]
10. Warnecke RB, Oh A, Breen N, et al. Approaching health disparities from a population perspective: the National Institutes of Health Centers for Population Health and Health Disparities. *American journal of public health*. 2008;98(9):1608–1615. [PubMed: 18633099]
11. Gillick MR. Advance care planning. *The New England journal of medicine*. 2004;350(1):7–8. [PubMed: 14702421]
12. Sudore RL, Fried TR. Redefining the “planning” in advance care planning: preparing for end-of-life decision making. *Ann Intern Med*. 2010;153(4):256–261. [PubMed: 20713793]
13. Tripken JL, Elrod C, Bills S. Factors Influencing Advance Care Planning Among Older Adults in Two Socioeconomically Diverse Living Communities. *American Journal of Hospice and Palliative Medicine®*. 2016;1049909116679140.
14. Carr D, Luth EA. Advance Care Planning: Contemporary Issues and Future Directions. *Innovation in Aging*. 2017;1(1):igx012–igx012. [PubMed: 30480109]
15. Khosla N, Curl AL, Washington KT. Trends in Engagement in Advance Care Planning Behaviors and the Role of Socioeconomic Status. *American Journal of Hospice and Palliative Medicine®*. 2016;33(7):651–657. [PubMed: 25900854]
16. Cohen MJ, McCannon JB, Edgman-Levitan S, Kormos WA. Exploring attitudes toward advance care directives in two diverse settings. *J Palliat Med*. 2010;13(12):1427–1432. [PubMed: 21091225]
17. Born W, Greiner KA, Sylvia E, Butler J, Ahluwalia JS. Knowledge, attitudes, and beliefs about end-of-life care among inner-city African Americans and Latinos. *J Palliat Med*. 2004;7(2):247–256. [PubMed: 15130202]
18. Dzau VJ, McClellan MB, McGinnis JM, et al. Vital directions for health and health care: priorities from a National Academy of Medicine initiative. *Jama*. 2017;317(14):1461–1470. [PubMed: 28324029]
19. Bureau USC. American Community Survey, Detailed Languages Spoken at Home and Ability to Speak English for the Population 5 Years and Over: 2009-2013. 2009-2013.
20. Mularski RA, Curtis JR, Billings JA, et al. Proposed quality measures for palliative care in the critically ill: a consensus from the Robert Wood Johnson Foundation Critical Care Workgroup. *Crit Care Med*. 2006;34(11 Suppl):S404–411. [PubMed: 17057606]
21. Knaus WA, Wagner DP, Draper EA, et al. The apache iii prognostic system. risk prediction of hospital mortality for critically ill hospitalized adults. *Chest*. 1991;100(6):1619–1636. [PubMed: 1959406]
22. Juhn Y, Krusemark E, Rand-Weaver J, et al. A novel measure of socioeconomic status using individual housing data in health disparities research for asthma in adults. *Allergy: European Journal of Allergy and Clinical Immunology*. 2014;69:327.
23. Juhn YJ, Beebe TJ, Finnie DM, et al. Development and initial testing of a new socioeconomic status measure based on housing data. *Journal of Urban Health*. 2011;88(5):933–944. [PubMed: 21499815]
24. Bang DW, Manemann SM, Gerber Y, et al. A novel socioeconomic measure using individual housing data in cardiovascular outcome research. *International journal of environmental research and public health*. 2014;11(11):11597–11615. [PubMed: 25396769]
25. Butterfield MC, Williams AR, Beebe T, et al. A two-county comparison of the HOUSES index on predicting self-rated health. *Journal of Epidemiology and Community Health*. 2010;jech.2008.084723.
26. Ghawi H, Crowson CS, Rand-Weaver J, Krusemark E, Gabriel SE, Juhn YJ. A novel measure of socioeconomic status using individual housing data to assess the association of SES with rheumatoid arthritis and its mortality: a population-based case-control study. *BMJ open*. 2015;5(4):e006469.
27. Ryu E, Juhn YJ, Wheeler PH, et al. Individual housing-based socioeconomic status predicts risk of accidental falls among adults. *Ann Epidemiol*. 2017;27(7):415–420.e412. [PubMed: 28648550]

28. Takahashi PY, Ryu E, Hathcock MA, et al. A novel housing-based socioeconomic measure predicts hospitalisation and multiple chronic conditions in a community population. *J Epidemiol Community Health*. 2016;70(3):286–291. [PubMed: 26458399]
29. Wi C-I, Gauger J, Bachman M, et al. Role of individual-housing-based socioeconomic status measure in relation to smoking status among late adolescents with asthma. *Annals of epidemiology*. 2016;26(7):455–460. [PubMed: 27266369]
30. Harris MN, Lundien MC, Finnie DM, et al. Application of a novel socioeconomic measure using individual housing data in asthma research: an exploratory study. *NPJ primary care respiratory medicine*. 2014;24:14018.
31. Hammer R, Capili C, Wi C-I, Ryu E, Rand-Weaver J, Juhn YJ. A new socioeconomic status measure for vaccine research in children using individual housing data: a population-based case-control study. *BMC public health*. 2016;16(1):1000. [PubMed: 27655468]
32. Carr D The social stratification of older adults' preparations for end-of-life health care. *Journal of Health and Social Behavior*. 2012;53(3):297–312. [PubMed: 22940813]
33. Molloy DW, Guyatt GH, Russo R, et al. Systematic implementation of an advance directive program in nursing homes: a randomized controlled trial. *Jama*. 2000;283(11):1437–1444. [PubMed: 10732933]
34. Teno JM, Gruneir A, Schwartz Z, Nanda A, Wetle T. Association between advance directives and quality of end-of-life care: A national study. *Journal of the American Geriatrics Society*. 2007;55(2):189–194. [PubMed: 17302654]
35. Brinkman-Stoppelenburg A, Rietjens JA, van der Heide A. The effects of advance care planning on end-of-life care: a systematic review. *Palliative medicine*. 2014;28(8):1000–1025. [PubMed: 24651708]
36. Silveira MJ, Kim SY, Langa KM. Advance directives and outcomes of surrogate decision making before death. *The New England journal of medicine*. 2010;362(13):1211–1218. [PubMed: 20357283]
37. Braveman P What are health disparities and health equity? We need to be clear. *Public Health Reports*. 2014;129(Suppl 2):5.
38. Nguyen T-A, Page A, Aggarwal A, Henke P. Social determinants of discharge destination for patients after stroke with low admission FIM instrument scores. *Archives of physical medicine and rehabilitation*. 2007;88(6):740–744. [PubMed: 17532895]
39. Inneh IA, Clair AJ, Slover JD, Iorio R. Disparities in Discharge Destination After Lower Extremity Joint Arthroplasty: Analysis of 7924 Patients in an Urban Setting. *The Journal of Arthroplasty*. 2016;31(12):2700–2704. [PubMed: 27378643]
40. Kangovi S, Barg FK, Carter T, et al. Challenges Faced by Patients with Low Socioeconomic Status During the Post-Hospital Transition. *Journal of General Internal Medicine*. 2014;29(2):283–289. [PubMed: 23918162]
41. Braveman P Health disparities and health equity: concepts and measurement. *Annu Rev Public Health*. 2006;27:167–194. [PubMed: 16533114]
42. Narla NP, Pardo-Crespo MR, Beebe TJ, et al. Concordance between individual vs. Area-level socioeconomic measures in an Urban setting. *Journal of health care for the poor and underserved*. 2015;26(4):1157–1172. [PubMed: 26548670]
43. Pardo-Crespo MR, Narla NP, Williams AR, et al. Comparison of individual-level versus area-level socioeconomic measures in assessing health outcomes of children in Olmsted County, Minnesota. *J Epidemiol Community Health*. 2013;jech-2012-201742.
44. Wi C-I, Sauver JLS, Jacobson DJ, et al. Ethnicity, Socioeconomic Status, and Health Disparities in a Mixed Rural-Urban US Community—Olmsted County, Minnesota. Paper presented at: Mayo Clinic Proceedings 2016.
45. Ryu E, Wi C-I, Crow SS, et al. Assessing health disparities in children using a modified housing-related socioeconomic status measure: a cross-sectional study. *BMJ open*. 2016;6(7):e011564.
46. Glavan BJ, Engelberg RA, Downey L, Curtis JR. Using the medical record to evaluate the quality of end-of-life care in the intensive care unit. *Critical care medicine*. 2008;36(4):1138. [PubMed: 18379239]

47. Mularski RA, Curtis JR, Billings JA, et al. Proposed quality measures for palliative care in the critically ill: a consensus from the Robert Wood Johnson Foundation Critical Care Workgroup. *Critical care medicine*. 2006;34(11):S404–S411. [PubMed: 17057606]
48. Jesus JE, Allen MB, Michael GE, et al. Preferences for resuscitation and intubation among patients with do-not-resuscitate/do-not-intubate orders. *Mayo Clinic proceedings*. 2013;88(7):658–665. [PubMed: 23809316]

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Table 1:

Baseline Characteristics

Characteristic	HOUSES 1 N=846 (lowest SES)	HOUSES 2 N=845	HOUSES 3 N=850	HOUSES 4 N=852 (highest SES)	p value
Age, years, n (%)					<0.001
<40	148 (17.5%)	81 (9.6%)	112 (13.2%)	102 (12.0%)	
40-49	96 (11.3%)	63 (7.5%)	66 (7.8%)	77 (9.0%)	
50-59	159 (18.8%)	113 (13.4%)	106 (12.5%)	151 (17.7%)	
60-69	154 (18.2%)	143 (16.9%)	142 (16.7%)	173 (20.3%)	
70-79	138 (16.3%)	211 (25.0%)	170 (20.0%)	180 (21.1%)	
80	151 (17.8%)	234 (27.7%)	254 (29.9%)	169 (19.8%)	
Female sex, n (%)	437 (51.7%)	380 (45.0%)	373 (43.9%)	364 (42.7%)	<0.001
Race, n (%)					
White	694 (82.0%)	783 (92.7%)	773 (90.9%)	795 (93.3%)	<0.001
Black or African American	69 (8.2%)	10 (1.2%)	21 (2.5%)	9 (1.1%)	
Asian	28 (3.3%)	21 (2.5%)	32 (3.8%)	20 (2.3%)	
American Indian or Alaska Native	4 (0.5%)	3 (0.4%)	1 (0.1%)	2 (0.2%)	
Other	42 (5.0%)	26 (3.1%)	19 (2.2%)	21 (2.5%)	
Unknown	9 (1.1%)	2 (0.2%)	4 (0.5%)	5 (0.6%)	
Ethnicity, n (%)					0.003
Hispanic	26 (3.1%)	13 (1.5%)	8 (0.9%)	8 (0.9%)	
Non-Hispanic	807 (95.4%)	815 (96.4%)	821 (96.6%)	820 (96.2%)	
Unknown	13 (1.5%)	17 (2.0%)	21 (2.5%)	24 (2.8%)	
White Non-Hispanic, n (%)	677 (81.7%)	769 (92.5%)	756 (90.9%)	772 (93.1%)	<0.001
Insurance, n (%)					<0.001
Medicaid only	238 (28.1%)	98 (11.6%)	74 (8.7%)	51 (6.0%)	
Medicare only	144 (17.0%)	187 (22.1%)	152 (17.9%)	135 (15.8%)	
Medicare plus private	237 (28.0%)	299 (35.4%)	299 (35.2%)	276 (32.4%)	
Private insurance only	211 (24.9%)	255 (30.2%)	318 (37.4%)	386 (45.3%)	
Uninsured	16 (1.9%)	6 (0.7%)	7 (0.8%)	4 (0.5%)	
Marital status, n (%)					<0.001
Single	577 (68.2%)	362 (42.8%)	337 (39.6%)	266 (31.2%)	
Married or long term partner	265 (31.3%)	482 (57.0%)	513 (60.4%)	585 (68.7%)	
Unknown	4 (0.5%)	1 (0.1%)	0 (0.0%)	1 (0.1%)	
Education, n (%)					<0.001
Some high school or less	132 (15.6%)	106 (12.5%)	66 (7.8%)	64 (7.5%)	
High school graduate	241 (28.5%)	325 (38.5%)	250 (29.4%)	194 (22.8%)	
Any college	229 (27.1%)	213 (25.2%)	228 (26.8%)	212 (24.9%)	
College graduate	110 (13.0%)	121 (14.3%)	232 (27.3%)	303 (35.6%)	
Unknown	134 (15.8%)	80 (9.5%)	74 (8.7%)	79 (9.3%)	

Characteristic	HOUSES 1 N=846 (lowest SES)	HOUSES 2 N=845	HOUSES 3 N=850	HOUSES 4 N=852 (highest SES)	p value
Charlson comorbidity index, median (IQR)	2.0 (1-5)	2.0 (1-4)	2.0 (0-4)	1.0 (0-4)	<0.001
APACHE III score, median (IQR) 24 hours	54 (39-74)	60 (46-79)	60 (44-78)	57 (42-74)	<0.001
Primary language spoken, n (%)					<0.001
English	766 (91.0%)	815 (96.8%)	801 (94.6%)	829 (98.0%)	
Non English	76 (9.0%)	27 (3.2%)	46 (5.4%)	17 (2.0%)	

APACHE=Acute Physiology and Chronic Health Evaluation; IQR=interquartile range

AA-African American AI-American Indian

Table 2:

Unadjusted outcomes across HOUSES quartiles

Outcome	HOUSES 1 N=846 (lowest SES)	HOUSES 2 N=845	HOUSES 3 N=850	HOUSES 4 N=852 (highest SES)	p value
Code status and advance directives					
DNR on ICU admission, n (%)	27 (3.2%)	24 (2.8%)	26 (3.1%)	23 (2.7%)	0.93
Advance directives present at ICU admission, n (%)	241 (28.5%)	338 (40.0%)	344 (40.5%)	365 (42.8%)	<0.001
Documentation of a family conference, n (%)	32 (3.8%)	41 (4.9%)	32 (3.8%)	24 (2.8%)	0.19
Life support and other treatment utilization					
Mechanical ventilation use, n (%)	206 (24.3%)	204 (24.1%)	222 (26.1%)	210 (24.6%)	0.78
Noninvasive ventilation use, n (%)	118 (13.9%)	137 (16.2%)	111 (13.1%)	131 (15.4%)	0.26
Dialysis use, n (%)	39 (4.6%)	36 (4.3%)	34 (4.0%)	28 (3.3%)	0.56
Vasopressor use, n (%)	132 (15.6%)	154 (18.2%)	149 (17.5%)	156 (18.3%)	0.42
CPR performed, n (%)	2 (0.2%)	5 (0.6%)	3 (0.4%)	2 (0.2%)	0.57
Length of stay and disposition					
ICU length of stay, days, median (IQR)	1.1 (0.8-2.1)	1.2 (0.8-2.3)	1.2 (0.8-2.3)	1.1 (0.9-2.1)	0.45
Hospital length of stay, days, median (IQR)	4.4 (2.2-7.9)	4.8 (2.7-8.3)	4.7 (2.7-8.1)	4.3 (2.7-7.3)	0.07
Hospital discharge to nursing home, n (%)	283 (34.7%)	248 (29.8%)	251 (30.3%)	202 (24.1%)	<0.001
ICU mortality, n (%)	30 (3.5%)	31 (3.7%)	31 (3.6%)	28 (3.3%)	0.98
Hospital mortality, n (%)	59 (7.0%)	59 (7.0%)	55 (6.5%)	63 (7.4%)	0.91
Social work consultation, n (%)	177 (20.9%)	161 (19.1%)	143 (16.8%)	94 (11.0%)	<0.001
Deaths in the ICU	N=30	N=31	N=31	N=28	
Comfort measures only order placed, n (%)	19 (63.3%)	22 (71.0%)	21 (67.7%)	19 (67.9%)	0.94
Chaplain visitation, n (%)	2 (6.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.11
Palliative Care consultation, n (%)	7 (23.3%)	3 (9.7%)	8 (25.8%)	6 (21.4%)	0.40
Delirium within 24 hours of death, n (%)	6 (20.0%)	3 (9.7%)	6 (19.4%)	6 (21.4%)	0.61
Pain within 24 hours of death, n (%)	4 (13.3%)	3 (9.7%)	7 (22.6%)	1 (3.6%)	0.16
Agitation within 24 hours of death, n (%)	7 (23.3%)	2 (6.5%)	4 (12.9%)	3 (10.7%)	0.26

DNR=do not resuscitate; ICU=intensive care unit; IQR=interquartile range; IV=intravenous; CPR=cardiopulmonary resuscitation

Table 3:

Adjusted outcomes across HOUSES quartiles 1 versus 2,3,4.

Outcome	Odds Ratio(95% CI)	Adjusted p value	P value for trend test
Advance directives present at ICU admission	0.77 (0.63,0.93)	<0.001	<0.001
Hospital discharge to nursing home	0.60 (0.50,0.72)	<0.001	<0.001
Social work consultation	1.46 (1.18,1.79)	<0.001	<0.001

Adjusted for age, 24 hour APACHE III score, sex, race/ethnicity and insurance

CI=confidence interval