Sensivity Analysis: Patterns and Predictors of Palliative Care Use in Acute Heart Failure Hospitalizations

NIS Analysis for the RCOP Match Mentorship Program

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## Preamble:

* **Reference Studies:**
  + [Kavalieratos et al., 2017](https://doi.org/10.1016/j.jacc.2017.08.036)
  + [Webb et al., 2025](https://doi.org/10.1016/j.cardfail.2024.06.005)
* **Study Objective:** To characterize the demographic, clinical, and hospital-level factors associated with receipt of palliative care consultation among patients hospitalized with acute decompensated heart failure, using a nationally representative U.S. inpatient database.
* **Data Source:** Retrospective cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020. The NIS is part of the Healthcare Cost and Utilization Project (HCUP) and provides a stratified sample of inpatient discharges from U.S. community hospitals across all payers.
* **Cohort Definition:** Patients were included if they met the following criteria
  + Age ≥18 years
  + Hospitalization flagged as involving acute decompensated heart failure, identified using ICD-10-CM diagnosis codes (principal diagnosis)
  + Non-missing data for palliative care consultation status
* **Outcome of Interest:** Receipt of palliative care consultation, defined by the presence of ICD-10-CM code Z51.5 (“Encounter for palliative care”) in any diagnosis position.
* **ICD-10 Code Definitions:**
  + **Heart Failure (inclusion diagnosis):**
    - ICD-10-CM:
      * I50.\* (Heart failure)
      * I0981, I110, I130, I132 (Hypertensive and rheumatic HF-related conditions)
      * I97130, I97131 (Postprocedural cardiac dysfunction)
      * O29121, O29122, O29123, O29129 (Pregnancy-related cardiac disease)
      * Z95811, Z95812 (Presence of heart assist devices or heart transplant status)
  + **Sensivity Analysis:** Our primary exposure was palliative care consultation identified by any-listed ICD-10-CM Z51.5. As Z51.5 may undercapture palliative/hospice involvement, we conducted a sensitivity analysis that broadened the exposure to include discharges to home health care. Specifically, for the sensitivity definition we considered patients exposed if they had Z51.5 or were live discharges to home health care (i.e., excluding those who died in hospital before discharge).
    - ICD-10-CM:
      * Z51.5\* (“Encounter for palliative care”)
    - Discharge Disposition:
      * Home health care
      * DIED ≠ Yes
* **Covariates for Adjustment:** All models adjusted for
  + **Demographic Factors:** Age, sex, race/ethnicity
  + **Socioeconomic Factors:** Primary payer, ZIP code–level income quartile
  + **Clinical Factors:** Elixhauser comorbidity index (aggregate score), APR-DRG risk of mortality
  + **Hospital-Level Factors:** Hospital region, bed size, teaching status, and urban/rural location
* **Statistical Methods:**
  + **Descriptive Analysis:**
    - Patient and hospital characteristics were compared between those who did and did not receive palliative care consultation.
    - Categorical variables: Compared using Pearson’s chi-square test with Rao & Scott adjustment
    - Continuous variables: Analyzed using the design-based Kruskal–Wallis test, a non-parametric alternative suitable for survey-weighted data
  + **Multivariable Analysis:**
    - Predictors of palliative care consultation were assessed using survey-weighted logistic regression with the quasibinomial family.
    - Results were reported as adjusted odds ratios (aORs) with 95% confidence intervals.
* **Software:** All statistical analyses were performed using the R Statistical Language (Version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria), incorporating survey-weighted procedures via the *survey* package to account for the complex sampling design of NIS.

## Baseline table:

| **Characteristic** | **Overall** N = 3,655,265*1* | **No** N = 2,601,555*1* | **Yes** N = 1,053,710*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 71 (14) | 69 (15) | 76 (12) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 1,727,015 (47%) | 1,168,155 (45%) | 558,860 (53%) |  |
| Male | 1,928,105 (53%) | 1,433,290 (55%) | 494,815 (47%) |  |
| Race |  |  |  | <0.001 |
| White | 2,324,455 (65%) | 1,611,075 (63%) | 713,380 (69%) |  |
| Asian or Pacific Islander | 78,725 (2.2%) | 55,910 (2.2%) | 22,815 (2.2%) |  |
| Black | 775,265 (22%) | 582,330 (23%) | 192,935 (19%) |  |
| Hispanic | 305,485 (8.5%) | 224,975 (8.8%) | 80,510 (7.8%) |  |
| Other | 101,805 (2.8%) | 75,540 (3.0%) | 26,265 (2.5%) |  |
| Insurance payer |  |  |  | <0.001 |
| Medicaid | 410,265 (11%) | 340,990 (13%) | 69,275 (6.6%) |  |
| Medicare | 2,639,675 (72%) | 1,769,225 (68%) | 870,450 (83%) |  |
| Other | 186,690 (5.1%) | 160,410 (6.2%) | 26,280 (2.5%) |  |
| Private | 415,065 (11%) | 328,030 (13%) | 87,035 (8.3%) |  |
| Income quartile |  |  |  | <0.001 |
| $1 - $51,999 | 1,215,355 (34%) | 898,790 (35%) | 316,565 (30%) |  |
| $52,000 - $65,999 | 966,405 (27%) | 690,365 (27%) | 276,040 (27%) |  |
| $66,000 - $87,999 | 802,395 (22%) | 557,670 (22%) | 244,725 (24%) |  |
| $88,000 or more | 604,945 (17%) | 401,385 (16%) | 203,560 (20%) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 840,355 (23%) | 615,885 (24%) | 224,470 (21%) |  |
| Northeast | 666,465 (18%) | 425,195 (16%) | 241,270 (23%) |  |
| South | 1,512,105 (41%) | 1,094,870 (42%) | 417,235 (40%) |  |
| West | 636,340 (17%) | 465,605 (18%) | 170,735 (16%) |  |
| Hospital bedsize |  |  |  | <0.001 |
| Large | 1,721,030 (47%) | 1,214,280 (47%) | 506,750 (48%) |  |
| Medium | 1,080,100 (30%) | 769,105 (30%) | 310,995 (30%) |  |
| Small | 854,135 (23%) | 618,170 (24%) | 235,965 (22%) |  |
| Hospital location/teaching status |  |  |  | <0.001 |
| Rural | 378,755 (10%) | 287,030 (11%) | 91,725 (8.7%) |  |
| Urban, non-teaching | 739,455 (20%) | 531,215 (20%) | 208,240 (20%) |  |
| Urban, teaching | 2,537,055 (69%) | 1,783,310 (69%) | 753,745 (72%) |  |
| APR-DRG risk of mortality |  |  |  | <0.001 |
| Extreme | 729,665 (20%) | 471,440 (18%) | 258,225 (25%) |  |
| Major | 1,629,075 (45%) | 1,121,230 (43%) | 507,845 (48%) |  |
| Minor | 256,475 (7.0%) | 226,235 (8.7%) | 30,240 (2.9%) |  |
| Moderate | 1,040,050 (28%) | 782,650 (30%) | 257,400 (24%) |  |
| No. of comorbidities |  |  |  | <0.001 |
| No comorbidities | 10 (<0.1%) | 5 (<0.1%) | 5 (<0.1%) |  |
| One comorbidity | 319,740 (8.7%) | 252,345 (9.7%) | 67,395 (6.4%) |  |
| Two or more comorbidities | 3,335,515 (91%) | 2,349,205 (90%) | 986,310 (94%) |  |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Multivariable logistic regression:

### Palliative care consultation:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Age, y | 1.03 | 1.03, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.84 | 0.83, 0.85 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.99 | 0.95, 1.04 | 0.8 |
| Black | 1.06 | 1.04, 1.09 | <0.001 |
| Hispanic | 1.00 | 0.96, 1.03 | 0.9 |
| Other | 0.93 | 0.89, 0.97 | <0.001 |
| Insurance payer |  |  |  |
| Medicaid | — | — |  |
| Medicare | 1.19 | 1.16, 1.23 | <0.001 |
| Other | 0.72 | 0.69, 0.76 | <0.001 |
| Private | 0.99 | 0.96, 1.03 | 0.6 |
| Income quartile |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.03 | 1.01, 1.05 | 0.003 |
| $66,000 - $87,999 | 1.04 | 1.01, 1.06 | 0.003 |
| $88,000 or more | 1.07 | 1.04, 1.10 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.58 | 1.52, 1.65 | <0.001 |
| South | 1.18 | 1.15, 1.22 | <0.001 |
| West | 1.07 | 1.02, 1.12 | 0.002 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 0.88 | 0.85, 0.91 | <0.001 |
| Small | 0.83 | 0.81, 0.86 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.19 | 1.14, 1.24 | <0.001 |
| Urban, teaching | 1.30 | 1.25, 1.35 | <0.001 |
| APR-DRG risk of mortality |  |  |  |
| Extreme | — | — |  |
| Major | 0.89 | 0.88, 0.90 | <0.001 |
| Minor | 0.48 | 0.46, 0.49 | <0.001 |
| Moderate | 0.71 | 0.70, 0.72 | <0.001 |
| Elixhauser comorbidity index | 1.10 | 1.09, 1.10 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |