Outcomes in Heart Failure with Preserved vs. Reduced Ejection Fraction in Patients with Iron Deficiency Anemia (with propensity score matching)

Eliza Aisha

## Preamble:

* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with Iron deficiency anemia.
* **HF Categories**:
  + Heart failure with reduced ejection fraction
  + Heart failure with preserved ejection fraction
* **ICD Codes**:
  + HFrEF = I50.2 and I50.4
  + HFpEF = I50.3
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **Heart failure with preserved ejection fraction** N = 4,756,715*1* | **Heart failure with reduced ejection fraction** N = 4,756,715*1* | **p-value***2* |
| --- | --- | --- | --- |
| Age, y | 72 (13) | 72 (13) | <0.001 |
| Sex |  |  | <0.001 |
| Female | 2,442,390 (51%) | 2,171,440 (46%) |  |
| Male | 2,314,325 (49%) | 2,585,275 (54%) |  |
| Race |  |  | <0.001 |
| White | 3,344,800 (70%) | 3,319,335 (70%) |  |
| Asian or Pacific Islander | 101,455 (2.1%) | 102,460 (2.2%) |  |
| Black | 819,515 (17%) | 840,980 (18%) |  |
| Hispanic | 360,440 (7.6%) | 361,855 (7.6%) |  |
| Native American | 25,280 (0.5%) | 26,435 (0.6%) |  |
| Other | 105,225 (2.2%) | 105,650 (2.2%) |  |
| Elixhauser comorbidity index | 6.68 (2.01) | 6.59 (2.07) | <0.001 |
| Residential income |  |  | 0.001 |
| $1 - $51,999 | 1,496,525 (31%) | 1,515,615 (32%) |  |
| $52,000 - $65,999 | 1,286,830 (27%) | 1,286,290 (27%) |  |
| $66,000 - $87,999 | 1,118,680 (24%) | 1,106,925 (23%) |  |
| $88,000 or more | 854,680 (18%) | 847,885 (18%) |  |
| Expected primary payer |  |  | <0.001 |
| Private | 613,260 (13%) | 658,035 (14%) |  |
| Medicaid | 402,115 (8.5%) | 429,145 (9.0%) |  |
| Medicare | 3,654,795 (77%) | 3,574,360 (75%) |  |
| Other | 86,545 (1.8%) | 95,175 (2.0%) |  |
| Hospital region |  |  | >0.9 |
| Midwest | 1,156,755 (24%) | 1,156,755 (24%) |  |
| Northeast | 890,230 (19%) | 890,230 (19%) |  |
| South | 1,897,245 (40%) | 1,897,245 (40%) |  |
| West | 812,485 (17%) | 812,485 (17%) |  |
| Hypertension | 402,335 (8.5%) | 377,765 (7.9%) | <0.001 |
| Hyperlipidemia | 2,649,390 (56%) | 2,638,400 (55%) | 0.011 |
| Peripheral vascular disease | 668,450 (14%) | 688,295 (14%) | <0.001 |
| Chronic obstructive pulmonary disease | 1,998,760 (42%) | 1,873,735 (39%) | <0.001 |
| Coronary artery disease | 2,201,465 (46%) | 2,392,615 (50%) | <0.001 |
| Dementia | 492,145 (10%) | 468,275 (9.8%) | <0.001 |
| Fluid and electrolyte imbalance | 2,141,595 (45%) | 2,129,180 (45%) | 0.002 |
| Valvular heart disease | 609,675 (13%) | 618,055 (13%) | 0.005 |
| Atrial fibrillation | 1,732,860 (36%) | 1,799,210 (38%) | <0.001 |
| Obesity | 1,260,700 (27%) | 1,115,595 (23%) | <0.001 |
| Presence of pacemaker | 517,560 (11%) | 534,450 (11%) | <0.001 |
| previous MI | 562,475 (12%) | 807,630 (17%) | <0.001 |
| Pior cardiac surgery | 675,155 (14%) | 730,805 (15%) | <0.001 |
| Malnutrition | 408,180 (8.6%) | 424,460 (8.9%) | <0.001 |
| Cancer | 236,205 (5.0%) | 236,690 (5.0%) | 0.8 |
| *1*Mean (SD); n (%) | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | |

## Outcomes Table:

| **Characteristic** | **Heart failure with preserved ejection fraction** N = 4,756,715*1* | **Heart failure with reduced ejection fraction** N = 4,756,715*1* | **p-value***2* |
| --- | --- | --- | --- |
| Died during hospitalization | 199,540 (4.2%) | 278,470 (5.9%) | <0.001 |
| Length of stay (days) | 6.4 (7.3) | 6.7 (7.8) | <0.001 |
| Inflation-adjusted total charge ($) | 78,960 (123,104) | 89,454 (157,003) | <0.001 |
| *1*n (%); Mean (SD) | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | |

### Multivariable Logistic Regression:

#### All-Cause Mortality:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Heart failure categories |  |  |  |
| Heart failure with preserved ejection fraction | — | — |  |
| Heart failure with reduced ejection fraction | 1.44 | 1.42, 1.46 | <0.001 |
| Age, y | 1.02 | 1.02, 1.02 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.15 | 1.13, 1.16 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.10 | 1.06, 1.16 | <0.001 |
| Black | 0.87 | 0.85, 0.89 | <0.001 |
| Hispanic | 0.96 | 0.93, 0.99 | 0.010 |
| Native American | 1.21 | 1.11, 1.32 | <0.001 |
| Other | 1.06 | 1.01, 1.11 | 0.018 |
| Elixhauser comorbidity index | 1.19 | 1.19, 1.20 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.96 | 0.94, 0.98 | <0.001 |
| $66,000 - $87,999 | 0.93 | 0.91, 0.95 | <0.001 |
| $88,000 or more | 0.93 | 0.91, 0.96 | <0.001 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.76 | 0.73, 0.78 | <0.001 |
| Medicare | 0.79 | 0.76, 0.81 | <0.001 |
| Other | 1.59 | 1.48, 1.70 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.23 | 1.19, 1.27 | <0.001 |
| South | 1.01 | 0.98, 1.04 | 0.4 |
| West | 1.05 | 1.01, 1.08 | 0.004 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.61 | 0.59, 0.63 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.61 | 0.60, 0.62 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 0.95 | 0.93, 0.97 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 0.88 | 0.87, 0.90 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 0.80 | 0.79, 0.81 | <0.001 |
| Valvular heart disease |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.74, 0.77 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.05 | 1.03, 1.07 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.22 | 1.19, 1.25 | <0.001 |
| Fluid and electrolyte imbalance |  |  |  |
| No | — | — |  |
| Yes | 2.18 | 2.14, 2.23 | <0.001 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | 0.97 | 0.96, 0.99 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.60 | 0.59, 0.62 | <0.001 |
| Presence of pacemaker |  |  |  |
| No | — | — |  |
| Yes | 0.65 | 0.63, 0.67 | <0.001 |
| previous MI |  |  |  |
| No | — | — |  |
| Yes | 0.84 | 0.82, 0.86 | <0.001 |
| Malnutrition |  |  |  |
| No | — | — |  |
| Yes | 1.54 | 1.50, 1.57 | <0.001 |
| Pior cardiac surgery |  |  |  |
| No | — | — |  |
| Yes | 0.81 | 0.80, 0.83 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |

### Multivariable Linear Regression:

#### Length of Stay:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Heart failure categories |  |  |  |
| Heart failure with preserved ejection fraction | — | — |  |
| Heart failure with reduced ejection fraction | 0.28 | 0.25, 0.30 | <0.001 |
| Age, y | -0.03 | -0.03, -0.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.30 | 0.28, 0.33 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.35 | 0.21, 0.48 | <0.001 |
| Black | 0.03 | -0.02, 0.08 | 0.3 |
| Hispanic | 0.07 | 0.00, 0.15 | 0.064 |
| Native American | -0.02 | -0.23, 0.19 | 0.9 |
| Other | 0.48 | 0.36, 0.61 | <0.001 |
| Elixhauser comorbidity index | 0.46 | 0.45, 0.48 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.02 | -0.06, 0.02 | 0.4 |
| $66,000 - $87,999 | 0.05 | 0.00, 0.10 | 0.042 |
| $88,000 or more | 0.11 | 0.04, 0.18 | <0.001 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | 0.13 | 0.05, 0.20 | <0.001 |
| Medicare | -0.06 | -0.11, -0.01 | 0.014 |
| Other | -0.07 | -0.19, 0.04 | 0.2 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.0 | 0.93, 1.1 | <0.001 |
| South | 0.36 | 0.28, 0.45 | <0.001 |
| West | -0.20 | -0.30, -0.10 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -0.52 | -0.57, -0.48 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -0.86 | -0.90, -0.83 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -0.03 | -0.07, 0.01 | 0.094 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -0.12 | -0.15, -0.10 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -0.62 | -0.65, -0.59 | <0.001 |
| Valvular heart disease |  |  |  |
| No | — | — |  |
| Yes | -0.47 | -0.50, -0.43 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.23 | 0.18, 0.27 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.01 | -0.04, 0.07 | 0.6 |
| Fluid and electrolyte imbalance |  |  |  |
| No | — | — |  |
| Yes | 1.8 | 1.8, 1.9 | <0.001 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | -0.06 | -0.09, -0.04 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | -0.21 | -0.25, -0.17 | <0.001 |
| Presence of pacemaker |  |  |  |
| No | — | — |  |
| Yes | -0.99 | -1.0, -0.96 | <0.001 |
| previous MI |  |  |  |
| No | — | — |  |
| Yes | -0.60 | -0.62, -0.57 | <0.001 |
| Malnutrition |  |  |  |
| No | — | — |  |
| Yes | 4.1 | 4.0, 4.2 | <0.001 |
| Pior cardiac surgery |  |  |  |
| No | — | — |  |
| Yes | -0.65 | -0.68, -0.62 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |

#### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Heart failure categories |  |  |  |
| Heart failure with preserved ejection fraction | — | — |  |
| Heart failure with reduced ejection fraction | 9,784 | 9,046, 10,523 | <0.001 |
| Age, y | -943 | -1,000, -887 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 7,782 | 7,302, 8,261 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 16,010 | 11,765, 20,256 | <0.001 |
| Black | -3,288 | -4,709, -1,867 | <0.001 |
| Hispanic | 17,755 | 15,022, 20,488 | <0.001 |
| Native American | -14,116 | -18,270, -9,963 | <0.001 |
| Other | 25,228 | 20,550, 29,906 | <0.001 |
| Elixhauser comorbidity index | 5,833 | 5,330, 6,336 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1,270 | 113, 2,427 | 0.031 |
| $66,000 - $87,999 | 4,346 | 2,962, 5,730 | <0.001 |
| $88,000 or more | 12,385 | 9,951, 14,820 | <0.001 |
| Expected primary payer |  |  |  |
| Private | — | — |  |
| Medicaid | -11,979 | -13,939, -10,019 | <0.001 |
| Medicare | -4,360 | -5,540, -3,180 | <0.001 |
| Other | -2,442 | -4,967, 83 | 0.058 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 24,137 | 20,185, 28,089 | <0.001 |
| South | 14,347 | 12,115, 16,579 | <0.001 |
| West | 41,695 | 36,381, 47,009 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -6,327 | -7,481, -5,174 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -7,967 | -8,755, -7,179 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 5,146 | 4,200, 6,092 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 9,071 | 8,416, 9,725 | <0.001 |
| Chronic obstructive pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | -13,015 | -13,970, -12,059 | <0.001 |
| Valvular heart disease |  |  |  |
| No | — | — |  |
| Yes | 17,595 | 16,238, 18,952 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | -12,866 | -13,733, -11,999 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | -2,513 | -3,676, -1,350 | <0.001 |
| Fluid and electrolyte imbalance |  |  |  |
| No | — | — |  |
| Yes | 24,068 | 23,152, 24,984 | <0.001 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | -445 | -1,051, 161 | 0.15 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | -5,237 | -6,235, -4,239 | <0.001 |
| Presence of pacemaker |  |  |  |
| No | — | — |  |
| Yes | -18,098 | -18,821, -17,376 | <0.001 |
| previous MI |  |  |  |
| No | — | — |  |
| Yes | -13,488 | -14,124, -12,852 | <0.001 |
| Malnutrition |  |  |  |
| No | — | — |  |
| Yes | 56,685 | 53,215, 60,156 | <0.001 |
| Pior cardiac surgery |  |  |  |
| No | — | — |  |
| Yes | -15,059 | -15,753, -14,364 | <0.001 |
| Abbreviation: CI = Confidence Interval | | | |