Contemporary 30-Day Readmissions Following ICD Implantation in Ischemic vs Non-Ischemic Cardiomyopathy

2025\_June\_NRD\_A4

Eliza Aisha

Mariam Shahabi

## Preamble:

* **Reference Studies:**
  + [Gharbin et al., 2023](https://www.sciencedirect.com/science/article/abs/pii/S0146280623000269)
* **Study Objective:**
* To identify patient- and hospital-level predictors of 30-day all-cause hospital readmission among adults patients hospitalized with ischemic or non-ischemic cardiomyopathy undergoing ICD implantation using a nationally representative dataset. This study also evaluates the clinical and economic burden of readmission in this high-risk population, including its association with in-hospital mortality.
* **Data Source:**
* A retrospective cohort study using the 2016–2017 Nationwide Readmissions Database (NRD), developed by the Healthcare Cost and Utilization Project (HCUP). The NRD enables tracking of individual patients across hospitalizations within a given year via synthetic identifiers, capturing discharges from U.S. community hospitals and supporting survey-weighted national estimates through complex sampling design.
* **Cohort Definition:**
* Index hospitalizations were included if they met all of the following criteria:
  + Patients aged ≥ 18 years
  + Principal diagnosis of ischemic cardiomyopathy (ICD code I255) or non-ischemic cardiomyopathy (ICD code I42) undergoing ICD implantation.
  + Index discharge by the end of November to allow for a complete 30-day follow-up period
  + Complete data on LOS and NRD\_DAYSTOEVENT, required to compute discharge dates
  + Trauma-related hospitalizations were excluded only from the readmission pool to avoid injury-related returns
* **Outcomes of Interest:**
  + Primary Outcome:
    - All-cause 30-day readmission
  + Secondary Outcomes (index admission):
    - In-hospital mortality (DIED)
    - Length of stay (LOS, in days)
    - Total hospitalization charges (TOTCHG), inflation-adjusted to 2017 USD
    - Non-home discharge
  + Readmission Characteristics:
    - In-hospital mortality
    - Length of stay (LOS, in days)
    - Total hospitalization charges (inflation-adjusted to 2017 USD)
* **Outcome Definitions:**
  + Readmission:
    - Defined using HCUP NRD’s methodology. Readmissions were identified only among patients with qualifying index events.
    - Trauma-related hospitalizations were excluded only from the readmission pool to avoid unrelated admissions.
  + Mortality:
    - In-hospital death recorded during index or readmission (DIED = 1)
  + LOS:
    - Reported in days; modeled as count outcome
  + Charge:
    - Derived from HCUP’s TOTCHG variable and adjusted to 2017 dollars using Consumer Price Index (CPI) data
  + Non-Home Discharge:
    - Defined as any disposition other than home/self-care, specifically:
      * Transfer to another short-term hospital
      * Transfer to skilled nursing facility (SNF), intermediate, or other facility
      * Left against medical advice
      * Died in hospital
      * Alive, destination unknown
* **Covariates and Variable Construction:**
  + Demographic & Socioeconomic Factors:
    - Age (continuous)
    - Sex (FEMALE; ref = Male)
    - Primary expected payer (Insurance; Medicare, Medicaid, Private, Other)
    - Income quartile based on ZIP code (ZIPINC\_QRTL)
  + Comorbidities and Clinical Covariates:
    - Diabetes
    - Hypertension
    - Congestive heart failure
    - Chronic pulmonary disease
    - Anemia
    - Liver disease
    - Obesity
    - Renal Failure
    - Cardiac Arrhythmia
    - History of undergoing PCI
    - History of undergoing CABG
    - History of myocardial infarction
  + Hospital Characteristics:
    - Hospital bed size (Small, Medium, Large)
    - Urban/rural teaching status (Metropolitan, teaching vs non-teaching, etc.)
  + Disposition and Severity:
    - Non-home discharge (e.g., SNF, hospice, other facilities, or death)
    - Length of stay
* **Statistical Methods:**
  + Survey Design and Weighting:
    - All analyses accounted for NRD’s complex survey design using weights (DISCWT), strata (NRD\_STRATUM), and clustering (HOSP\_NRD). Survey-adjusted methods were implemented via survey and srvyr packages.
  + Descriptive Analyses:
    - Baseline characteristics were summarized across ischemic vs. non-ischemic cardiomyopathy groups using survey-weighted means/proportions.
    - P-values from design-based statistical tests (Rao–Scott adjusted chi-square for categorical variables; design-based Kruskal–Wallis test for continuous variables).
  + Multivariable Regression:
    - A survey-weighted logistic regression modeled predictors of 30-day readmission.
    - The model included demographic, clinical, hospital-level, and index-stay factors.
    - Results were exponentiated to yield odds ratios (ORs) with 95% confidence intervals.
  + Readmission Characteristics:
    - A sub-analysis among patients with 30-day readmissions summarized readmission hospitalization characteristics descriptively using weighted survey statistics.
* **Software:** All analyses were conducted in R Statistical Language (Version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria).

## Descriptive Analyses

### Baseline Characteristics

| **Characteristic** | **Overall** N = 10,382*1* | **Ischemic Cardiomyopathy** N = 4,151*1* | **Non-Ischemic Cardiomyopathy** N = 6,231*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age (years) | 64 (14) | 68 (11) | 61 (15) | <0.001 |
| Sex |  |  |  | <0.001 |
| Male | 7,065 (68%) | 3,242 (78%) | 3,823 (61%) |  |
| Female | 3,316 (32%) | 909 (22%) | 2,408 (39%) |  |
| Primary Expected Payer |  |  |  | <0.001 |
| Private | 2,524 (24%) | 667 (16%) | 1,858 (30%) |  |
| Medicaid | 1,466 (14%) | 459 (11%) | 1,008 (16%) |  |
| Medicare | 5,818 (56%) | 2,834 (68%) | 2,984 (48%) |  |
| Other | 564 (5.4%) | 189 (4.6%) | 375 (6.0%) |  |
| Median Household Income Quartile |  |  |  | 0.035 |
| 0-25th percentile | 3,260 (32%) | 1,260 (31%) | 2,000 (33%) |  |
| 26th to 50th percentile | 2,693 (26%) | 1,160 (28%) | 1,533 (25%) |  |
| 51st to 75th percentile | 2,408 (24%) | 971 (24%) | 1,437 (23%) |  |
| 76th to 100th percentile | 1,876 (18%) | 704 (17%) | 1,173 (19%) |  |
| Hospital Bed Size |  |  |  | 0.020 |
| Small | 837 (8.1%) | 378 (9.1%) | 458 (7.4%) |  |
| Large | 6,736 (65%) | 2,588 (62%) | 4,148 (67%) |  |
| Medium | 2,809 (27%) | 1,184 (29%) | 1,625 (26%) |  |
| Hospital Location and Teaching Status |  |  |  | 0.14 |
| Metropolitan, non-teaching | 2,162 (21%) | 930 (22%) | 1,232 (20%) |  |
| Metropolitan, teaching | 7,971 (77%) | 3,121 (75%) | 4,850 (78%) |  |
| Non-metropolitan | 249 (2.4%) | 100 (2.4%) | 149 (2.4%) |  |
| Non home discharge | 858 (8.3%) | 388 (9.4%) | 470 (7.5%) | 0.034 |
| Number of comorbidities |  |  |  | <0.001 |
| No comorbidities | 331 (3.2%) | 0 (0%) | 331 (5.3%) |  |
| One comorbidity | 2,595 (25%) | 505 (12%) | 2,090 (34%) |  |
| Two or more comorbidities | 7,456 (72%) | 3,646 (88%) | 3,810 (61%) |  |
| Congestive heart failure | 9,784 (94%) | 4,151 (100%) | 5,632 (90%) | <0.001 |
| Chronic pulmonary disease | 2,396 (23%) | 1,063 (26%) | 1,333 (21%) | 0.001 |
| Liver disease | 359 (3.5%) | 105 (2.5%) | 253 (4.1%) | 0.003 |
| Obesity | 1,990 (19%) | 620 (15%) | 1,369 (22%) | <0.001 |
| Hypertension | 8,005 (77%) | 3,452 (83%) | 4,553 (73%) | <0.001 |
| Diabetes | 3,815 (37%) | 1,916 (46%) | 1,899 (30%) | <0.001 |
| Arrhythmia | 6,140 (59%) | 2,396 (58%) | 3,744 (60%) | 0.10 |
| Renal\_disease | 2,572 (25%) | 1,289 (31%) | 1,283 (21%) | <0.001 |
| Anemia | 1,671 (16%) | 717 (17%) | 954 (15%) | 0.071 |
| Previous PCI | 1,960 (19%) | 1,533 (37%) | 427 (6.9%) | <0.001 |
| Previous CABG | 1,786 (17%) | 1,508 (36%) | 278 (4.5%) | <0.001 |
| Prior myocardial infarction | 2,562 (25%) | 1,987 (48%) | 575 (9.2%) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

### Outcomes of Index Hospitalizations

| **Characteristic** | **Overall** N = 10,382*1* | **Ischemic Cardiomyopathy** N = 4,151*1* | **Non-Ischemic Cardiomyopathy** N = 6,231*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| In-Hospital Mortality | 63 (0.6%) | 22 (0.5%) | 41 (0.7%) | 0.6 |
| Length of Stay (days) | 3.0 (1.0, 6.0) | 3.0 (1.0, 5.0) | 3.0 (1.0, 6.0) | <0.001 |
| Inflation-Adjusted Total Charges ($) | 146,797 (97,045, 214,807) | 142,535 (93,483, 205,157) | 148,974 (98,793, 220,723) | 0.003 |
| Discharged to Non-Home Setting | 858 (8.3%) | 388 (9.4%) | 470 (7.5%) | 0.034 |
| *1*n (%); Median (Q1, Q3) | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | |

## Multivariable Analyses

### 30-Day Readmission:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Cardiomyopathy Categories |  |  |  |
| Ischemic Cardiomyopathy | — | — |  |
| Non-Ischemic Cardiomyopathy | 0.76 | 0.59, 0.97 | 0.025 |
| Age (years) | 0.99 | 0.98, 1.00 | 0.033 |
| Sex |  |  |  |
| Male | — | — |  |
| Female | 0.98 | 0.80, 1.21 | 0.9 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.95 | 1.37, 2.77 | <0.001 |
| Medicare | 1.96 | 1.46, 2.64 | <0.001 |
| Other | 1.07 | 0.63, 1.83 | 0.8 |
| Median Household Income Quartile |  |  |  |
| 0-25th percentile | — | — |  |
| 26th to 50th percentile | 0.87 | 0.67, 1.12 | 0.3 |
| 51st to 75th percentile | 0.88 | 0.68, 1.13 | 0.3 |
| 76th to 100th percentile | 0.81 | 0.61, 1.07 | 0.14 |
| Hospital Bed Size |  |  |  |
| Small | — | — |  |
| Large | 0.97 | 0.66, 1.41 | 0.9 |
| Medium | 0.76 | 0.50, 1.15 | 0.2 |
| Hospital Location and Teaching Status |  |  |  |
| Metropolitan, non-teaching | — | — |  |
| Metropolitan, teaching | 0.94 | 0.75, 1.18 | 0.6 |
| Non-metropolitan | 0.67 | 0.31, 1.48 | 0.3 |
| Non home discharge |  |  |  |
| No | — | — |  |
| Yes | 1.33 | 0.96, 1.84 | 0.081 |
| Number of comorbidities |  |  |  |
| No comorbidities | — | — |  |
| One comorbidity | 1.59 | 0.51, 4.94 | 0.4 |
| Two or more comorbidities | 1.41 | 0.45, 4.44 | 0.6 |
| Congestive heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.21 | 0.62, 2.37 | 0.6 |
| Chronic pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 0.81, 1.32 | 0.8 |
| Liver\_disease |  |  |  |
| No | — | — |  |
| Yes | 1.50 | 0.97, 2.31 | 0.070 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.89 | 0.68, 1.16 | 0.4 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.73, 1.22 | 0.7 |
| Diabetes |  |  |  |
| No | — | — |  |
| Yes | 1.12 | 0.88, 1.42 | 0.3 |
| Arrhythmia |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.76, 1.18 | 0.6 |
| Renal\_disease |  |  |  |
| No | — | — |  |
| Yes | 1.42 | 1.12, 1.80 | 0.004 |
| Anemia |  |  |  |
| No | — | — |  |
| Yes | 1.73 | 1.37, 2.19 | <0.001 |
| Previous PCI |  |  |  |
| No | — | — |  |
| Yes | 1.18 | 0.91, 1.53 | 0.2 |
| Previous CABG |  |  |  |
| No | — | — |  |
| Yes | 0.85 | 0.65, 1.13 | 0.3 |
| Prior myocardial infarction |  |  |  |
| No | — | — |  |
| Yes | 0.81 | 0.62, 1.05 | 0.11 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |