Prevalence, Causes, and Predictors of 30-Day Readmissions Following Hospitalization With Acute Myocardial Infarction Complicated By Cardiogenic Shock

2025\_June\_NRD\_A1

Eliza Aisha

Jawad Ahmed

## Preamble:

* **Reference Studies:**
  + [Mahmoud et al., 2018](https://www.ahajournals.org/doi/10.1161/JAHA.117.008235)
* **Study Objective:**
* To identify patient- and hospital-level predictors of 30-day all-cause hospital readmission among adults patients hospitalized with acute myocardial infarction complicated by cardiogenic shock 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 acute myocardial infarction using ICD code I21 and secondary diagnosis of cardiogenic shock using ICD code R570
  + Non-elective admission
  + 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 unrelated to MI care
* **Outcomes of Interest:**
  + Binary indicator of 30-day readmission (Yes/No)
  + Top causes of 30-day readmission
  + Mortality
* **Covariates:**
  + Demographic & Socioeconomic Factors:
    - Age
    - Sex
    - Primary expected payer (Insurance; Medicare, Medicaid, Private, Other)
    - ZIP-based median income quartile
  + Clinical Characteristics:
    - Number of comorbidities
  + Hospital Characteristics:
    - Hospital bed size (Small, Medium, Large)
    - Urban/rural teaching status (Metropolitan, teaching vs non-teaching, etc.)
  + Disposition and Severity:
    - Discharge disposition
* **Statistical Methods:**
  + Survey Design and Weighting:
    - All analyses incorporated NRD’s complex sampling design via the survey and srvyr packages.
  + Descriptive Statistics:
    - Weighted baseline characteristics of index hospitalizations were summarized and stratified by 30-day readmission status to compare patients who were readmitted versus those who were not.
    - Stratification was performed using a derived binary variable, which categorized patients as:
      * With 30-day readmission
      * Without readmission
    - P-values from statistical tests (Rao–Scott adjusted chi-square for categorical variables; 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.
* **Software:** All analyses were conducted in R Statistical Language (Version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria).

## Baseline Characteristics

| **Characteristic** | **Overall** N = 22,779*1* | **Without Readmission** N = 21,675*1* | **With 30-day readmission** N = 1,104*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age (years) | 69 (12) | 69 (12) | 69 (12) | 0.5 |
| Sex |  |  |  | 0.10 |
| Male | 14,712 (65%) | 14,039 (65%) | 673 (61%) |  |
| Female | 8,067 (35%) | 7,636 (35%) | 431 (39%) |  |
| Median Income Quartile |  |  |  | 0.3 |
| 0-25th percentile | 6,549 (29%) | 6,205 (29%) | 344 (32%) |  |
| 26th to 50th percentile | 6,597 (29%) | 6,272 (29%) | 324 (30%) |  |
| 51st to 75th percentile | 5,444 (24%) | 5,218 (24%) | 226 (21%) |  |
| 76th to 100th percentile | 3,818 (17%) | 3,626 (17%) | 192 (18%) |  |
| Hospital Bed Size |  |  |  | 0.6 |
| Small | 2,285 (10%) | 2,162 (10.0%) | 123 (11%) |  |
| Large | 14,531 (64%) | 13,848 (64%) | 682 (62%) |  |
| Medium | 5,963 (26%) | 5,664 (26%) | 299 (27%) |  |
| Hospital Teaching Status |  |  |  | 0.8 |
| Metropolitan, non-teaching | 4,717 (21%) | 4,479 (21%) | 238 (22%) |  |
| Metropolitan, teaching | 16,918 (74%) | 16,110 (74%) | 808 (73%) |  |
| Non-metropolitan | 1,143 (5.0%) | 1,086 (5.0%) | 57 (5.2%) |  |
| Insurance |  |  |  | 0.019 |
| Private | 4,896 (22%) | 4,694 (22%) | 202 (18%) |  |
| Medicaid | 1,963 (8.6%) | 1,868 (8.6%) | 95 (8.6%) |  |
| Medicare | 14,287 (63%) | 13,531 (63%) | 756 (68%) |  |
| Other | 1,600 (7.0%) | 1,550 (7.2%) | 50 (4.6%) |  |
| No. of comorbidities |  |  |  | <0.001 |
| One comorbidity | 2,402 (11%) | 2,349 (11%) | 53 (4.8%) |  |
| Two or more comorbidities | 20,377 (89%) | 19,326 (89%) | 1,051 (95%) |  |
| Hypertension | 10,463 (46%) | 10,015 (46%) | 448 (41%) | 0.014 |
| Diabetes | 7,335 (32%) | 6,940 (32%) | 395 (36%) | 0.10 |
| Hyperlipidemia | 12,917 (57%) | 12,251 (57%) | 666 (60%) | 0.10 |
| Chronic kidney disease | 6,788 (30%) | 6,373 (29%) | 415 (38%) | <0.001 |
| Heart failure | 13,759 (60%) | 12,970 (60%) | 789 (71%) | <0.001 |
| Depression | 1,741 (7.6%) | 1,612 (7.4%) | 129 (12%) | <0.001 |
| Valvular Disease | 4,673 (21%) | 4,398 (20%) | 275 (25%) | 0.019 |
| Chronic pulmonary disease | 5,370 (24%) | 5,066 (23%) | 304 (28%) | 0.040 |
| Rheumatic Disease | 443 (1.9%) | 406 (1.9%) | 36 (3.3%) | 0.033 |
| Metastatic Cancer | 238 (1.0%) | 232 (1.1%) | 6 (0.6%) | 0.2 |
| Obesity | 3,643 (16%) | 3,450 (16%) | 192 (17%) | 0.4 |
| Fluid and electrolyte disorders | 13,024 (57%) | 12,384 (57%) | 640 (58%) | 0.7 |
| Cerebrovascular Disease | 2,057 (9.0%) | 1,946 (9.0%) | 111 (10%) | 0.4 |
| Peripheral vascular disease | 3,950 (17%) | 3,727 (17%) | 223 (20%) | 0.073 |
| Drug abuse | 830 (3.6%) | 782 (3.6%) | 48 (4.3%) | 0.4 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Unadjusted Outcomes

### Outcomes of Index Hospitalizations

| **Characteristic** | **Without Readmission** N = 21,675*1* | **With 30-day readmission** N = 1,104*1* | **p-value***2* |
| --- | --- | --- | --- |
| In-Hospital Mortality | 7,789 (36%) | 0 (0%) | <0.001 |
| Length of Stay (days) | 6 (3, 12) | 10 (6, 18) | <0.001 |
| Inflation-Adjusted Total Charges ($) | 147,394 (79,607, 273,624) | 198,365 (110,143, 370,149) | <0.001 |
| Discharged to Non-Home Setting | 12,355 (57%) | 460 (42%) | <0.001 |
| *1*n (%); Median (Q1, Q3) | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | |

### In-Hospital Mortality by Readmission Status:

Index hospitalizations resulted in:

1. Deaths (n): 7788
2. Death Rate (%): 34.21%
3. Death Rate (95% CI): 33.14% to 35.28%

Readmission hospitalizations resulted in:

1. Deaths (n): 96
2. Death Rate (%): 8.78%
3. Death Rate (95% CI): 6.1% to 11.46%

## Top Causes of Readmission

| Diagnosis Code | ICD-10 Description | Proportion |
| --- | --- | --- |
| I13 | Hypertensive heart and chronic kidney disease | 0.0945 |
| I50 | Heart failure | 0.0795 |
| I11 | Hypertensive heart disease | 0.0790 |
| A41 | Other sepsis | 0.0745 |
| I21 | Acute myocardial infarction | 0.0664 |
| I25 | Chronic ischemic heart disease | 0.0448 |
| K92 | Other diseases of digestive system | 0.0308 |
| T82 | Complications of cardiac and vascular prosthetic devices, implants and grafts | 0.0265 |
| I95 | Hypotension | 0.0236 |
| J18 | Pneumonia, unspecified organism | 0.0215 |

## Multivariable Analyses

### 30-Day Readmission:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Age (years) | 1.00 | 0.99, 1.01 | 0.8 |
| Sex |  |  |  |
| Male | — | — |  |
| Female | 1.14 | 0.93, 1.40 | 0.2 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.05 | 0.72, 1.55 | 0.8 |
| Medicare | 1.36 | 1.01, 1.82 | 0.041 |
| Other | 0.80 | 0.50, 1.27 | 0.3 |
| Median Income Quartile |  |  |  |
| 0-25th percentile | — | — |  |
| 26th to 50th percentile | 0.91 | 0.70, 1.18 | 0.5 |
| 51st to 75th percentile | 0.79 | 0.61, 1.03 | 0.078 |
| 76th to 100th percentile | 0.97 | 0.75, 1.27 | 0.8 |
| AWEEKEND |  |  |  |
| Monday-Friday | — | — |  |
| Saturday-Sunday | 0.94 | 0.76, 1.15 | 0.5 |
| Hospital Bed Size |  |  |  |
| Small | — | — |  |
| Large | 0.85 | 0.62, 1.16 | 0.3 |
| Medium | 0.90 | 0.65, 1.24 | 0.5 |
| Hospital Teaching Status |  |  |  |
| Metropolitan, non-teaching | — | — |  |
| Metropolitan, teaching | 0.87 | 0.70, 1.08 | 0.2 |
| Non-metropolitan | 0.98 | 0.62, 1.56 | >0.9 |
| Discharged to Non-Home Setting |  |  |  |
| No | — | — |  |
| Yes | 0.46 | 0.38, 0.56 | <0.001 |
| No. of comorbidities |  |  |  |
| One comorbidity | — | — |  |
| Two or more comorbidities | 1.57 | 0.99, 2.50 | 0.057 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.83 | 0.68, 1.01 | 0.061 |
| Diabetes |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 0.92, 1.40 | 0.2 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 0.84, 1.26 | 0.8 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 1.30 | 1.07, 1.59 | 0.009 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.33 | 1.05, 1.69 | 0.017 |
| Depression |  |  |  |
| No | — | — |  |
| Yes | 1.35 | 0.99, 1.84 | 0.056 |
| Valvular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.10 | 0.88, 1.38 | 0.4 |
| Chronic pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 1.08 | 0.86, 1.35 | 0.5 |
| Rheumatic Disease |  |  |  |
| No | — | — |  |
| Yes | 1.62 | 0.93, 2.84 | 0.091 |
| Metastatic Cancer |  |  |  |
| No | — | — |  |
| Yes | 0.56 | 0.21, 1.51 | 0.3 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 0.83, 1.36 | 0.6 |
| Fluid and electrolyte disorders |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 0.85, 1.24 | 0.8 |
| Cerebrovascular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.15 | 0.85, 1.56 | 0.4 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.11 | 0.89, 1.38 | 0.4 |
| Drug abuse |  |  |  |
| No | — | — |  |
| Yes | 1.18 | 0.74, 1.86 | 0.5 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |