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).

## Descriptive Statistics:

### Readmission Rate:

Index hospitalizations resulted in:

1. Readmission (n): 8144
2. Readmission Rate (%): 12.04%
3. Readmission Rate (95% CI): 11.66% to 12.43%

### In-Hospital Mortality by Readmission Status:

Index hospitalizations resulted in:

1. Deaths (n): 23560
2. Death Rate (%): 34.85%
3. Death Rate (95% CI): 34.16% to 35.55%

Readmission hospitalizations resulted in:

1. Deaths (n): 654
2. Death Rate (%): 8.04%
3. Death Rate (95% CI): 7.14% to 8.94%

### LOS and Cost by Readmission Status:

Index hospitalizations resulted in:

1. Mean Length of Stay (days): 9.34
2. Mean Length of Stay (95% CI): 9.13 to 9.55
3. Mean Charge ($): 221712
4. Mean Charge (95% CI): 213800 to 229624

Readmission hospitalizations resulted in:

1. Mean Length of Stay (days): 6.73
2. Mean Length of Stay (95% CI): 6.47 to 7
3. Mean Charge ($): 84515
4. Mean Charge (95% CI): 78498 to 90533

## Baseline Characteristics

| **Characteristic** | **Overall** N = 67,625*1* | **Without Readmission** N = 59,481*1* | **With 30-day readmission** N = 8,144*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age (years) | 69 (12) | 69 (13) | 68 (12) | <0.001 |
| Sex |  |  |  | 0.13 |
| Male | 43,713 (65%) | 38,540 (65%) | 5,173 (64%) |  |
| Female | 23,912 (35%) | 20,940 (35%) | 2,972 (36%) |  |
| Median Income Quartile |  |  |  | 0.4 |
| 0-25th percentile | 19,811 (30%) | 17,322 (30%) | 2,489 (31%) |  |
| 26th to 50th percentile | 19,281 (29%) | 17,011 (29%) | 2,270 (28%) |  |
| 51st to 75th percentile | 16,015 (24%) | 14,086 (24%) | 1,929 (24%) |  |
| 76th to 100th percentile | 11,422 (17%) | 10,078 (17%) | 1,344 (17%) |  |
| Hospital Bed Size |  |  |  | 0.2 |
| Small | 6,856 (10%) | 6,067 (10%) | 789 (9.7%) |  |
| Large | 43,599 (64%) | 38,246 (64%) | 5,353 (66%) |  |
| Medium | 17,170 (25%) | 15,168 (26%) | 2,002 (25%) |  |
| Hospital Teaching Status |  |  |  | 0.014 |
| Metropolitan, non-teaching | 14,823 (22%) | 13,136 (22%) | 1,687 (21%) |  |
| Metropolitan, teaching | 49,406 (73%) | 43,299 (73%) | 6,107 (75%) |  |
| Non-metropolitan | 3,396 (5.0%) | 3,046 (5.1%) | 350 (4.3%) |  |
| Insurance |  |  |  | <0.001 |
| Private | 14,174 (21%) | 12,672 (21%) | 1,501 (18%) |  |
| Medicaid | 5,746 (8.5%) | 4,819 (8.1%) | 927 (11%) |  |
| Medicare | 42,779 (63%) | 37,484 (63%) | 5,296 (65%) |  |
| Other | 4,822 (7.1%) | 4,415 (7.4%) | 407 (5.0%) |  |
| No. of comorbidities |  |  |  | <0.001 |
| One comorbidity | 7,457 (11%) | 7,021 (12%) | 436 (5.4%) |  |
| Two or more comorbidities | 60,168 (89%) | 52,460 (88%) | 7,708 (95%) |  |
| Hypertension | 34,029 (50%) | 29,950 (50%) | 4,079 (50%) | 0.8 |
| Diabetes | 22,167 (33%) | 19,121 (32%) | 3,046 (37%) | <0.001 |
| Hyperlipidemia | 38,348 (57%) | 33,397 (56%) | 4,951 (61%) | <0.001 |
| Chronic kidney disease | 20,257 (30%) | 17,319 (29%) | 2,939 (36%) | <0.001 |
| Heart failure | 40,792 (60%) | 34,892 (59%) | 5,899 (72%) | <0.001 |
| Depression | 5,245 (7.8%) | 4,360 (7.3%) | 885 (11%) | <0.001 |
| Valvular Disease | 13,856 (20%) | 11,875 (20%) | 1,981 (24%) | <0.001 |
| Chronic pulmonary disease | 15,544 (23%) | 13,288 (22%) | 2,255 (28%) | <0.001 |
| Rheumatic Disease | 1,443 (2.1%) | 1,205 (2.0%) | 238 (2.9%) | <0.001 |
| Metastatic Cancer | 720 (1.1%) | 635 (1.1%) | 84 (1.0%) | 0.9 |
| Obesity | 11,151 (16%) | 9,616 (16%) | 1,535 (19%) | <0.001 |
| Fluid and electrolyte disorders | 38,590 (57%) | 33,864 (57%) | 4,725 (58%) | 0.2 |
| Cerebrovascular Disease | 5,916 (8.7%) | 5,071 (8.5%) | 845 (10%) | <0.001 |
| Peripheral vascular disease | 11,449 (17%) | 9,850 (17%) | 1,599 (20%) | <0.001 |
| Drug abuse | 2,248 (3.3%) | 1,902 (3.2%) | 346 (4.3%) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## 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) | 0.99 | 0.99, 1.00 | <0.001 |
| Sex |  |  |  |
| Male | — | — |  |
| Female | 1.05 | 0.98, 1.14 | 0.2 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.46 | 1.27, 1.67 | <0.001 |
| Medicare | 1.39 | 1.24, 1.55 | <0.001 |
| Other | 0.80 | 0.66, 0.96 | 0.020 |
| Median Income Quartile |  |  |  |
| 0-25th percentile | — | — |  |
| 26th to 50th percentile | 0.95 | 0.86, 1.05 | 0.3 |
| 51st to 75th percentile | 0.99 | 0.89, 1.09 | 0.8 |
| 76th to 100th percentile | 0.98 | 0.87, 1.09 | 0.7 |
| AWEEKEND |  |  |  |
| Monday-Friday | — | — |  |
| Saturday-Sunday | 0.99 | 0.92, 1.07 | 0.9 |
| Hospital Bed Size |  |  |  |
| Small | — | — |  |
| Large | 1.04 | 0.92, 1.18 | 0.6 |
| Medium | 1.01 | 0.88, 1.16 | 0.8 |
| Hospital Teaching Status |  |  |  |
| Metropolitan, non-teaching | — | — |  |
| Metropolitan, teaching | 1.04 | 0.95, 1.13 | 0.4 |
| Non-metropolitan | 0.92 | 0.75, 1.13 | 0.4 |
| Discharged to Non-Home Setting |  |  |  |
| No | — | — |  |
| Yes | 0.45 | 0.41, 0.49 | <0.001 |
| No. of comorbidities |  |  |  |
| One comorbidity | — | — |  |
| Two or more comorbidities | 1.39 | 1.18, 1.64 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 1.08 | 1.00, 1.16 | 0.058 |
| Diabetes |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 1.05, 1.23 | 0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 1.01 | 0.93, 1.09 | 0.9 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 1.27 | 1.17, 1.37 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.62 | 1.48, 1.78 | <0.001 |
| Depression |  |  |  |
| No | — | — |  |
| Yes | 1.35 | 1.17, 1.56 | <0.001 |
| Valvular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.14 | 1.04, 1.24 | 0.005 |
| Chronic pulmonary disease |  |  |  |
| No | — | — |  |
| Yes | 1.17 | 1.08, 1.28 | <0.001 |
| Rheumatic Disease |  |  |  |
| No | — | — |  |
| Yes | 1.36 | 1.09, 1.70 | 0.006 |
| Metastatic Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 0.73, 1.47 | 0.8 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 1.05 | 0.96, 1.15 | 0.3 |
| Fluid and electrolyte disorders |  |  |  |
| No | — | — |  |
| Yes | 1.05 | 0.98, 1.14 | 0.2 |
| Cerebrovascular Disease |  |  |  |
| No | — | — |  |
| Yes | 1.23 | 1.09, 1.38 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.08 | 0.99, 1.18 | 0.10 |
| Drug abuse |  |  |  |
| No | — | — |  |
| Yes | 1.13 | 0.94, 1.36 | 0.2 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |