**Trends in Hospitalization Among Patients with Cardiovascular,** **Immunological, and neurological Illnesses: Findings from HowOften**

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**Background**

Cardiovascular, immunological, and neurological disorders represent the most significant disease burden both in the United States and worldwide. These conditions are primarily chronic, requiring continuous medical care and often leading to frequent hospitalizations, significantly increasing healthcare costs1,2. To enhance our understanding of the conditions associated with substantial morbidity, we analyzed hospitalization rates and trends for specific diseases in the United States from January 1, 2012, to December 31, 2022. Specifically, we utilized real-world data to determine the incidence rates of hospitalizations across 14 conditions, stratified by age and gender. Additionally, we investigated changes in these rates over the past decade.

**Methods**

This retrospective observational cohort study leveraged routinely collected healthcare data from five US administrative claims databases and one electronic health record database. We utilized IBM Health MarketScan® Commercial Claims and Encounters Database (IBM CCAE), IBM Health MarketScan® Multi-State Medicaid Database (IBM MDCD), IBM Health MarketScan® Medicare Supplemental and Coordination of Benefits Database (IBM MDCR), PharMetrics Plus (PharMetrics), Optum’s Clinformatics® Extended Data Mart – Socio-Economic Status (OPTUM Extended SES), and Optum EHR, representing clinical data standardized to the Observational Medical Outcomes Partnership (OMOP-CDM) format.

HowOften was conducted in October 2023 as part of Observational Health DataSciences and Informatics (OHDSI) community 2023 Global symposium <https://forums.ohdsi.org/t/howoften-community-contributions-wanted/19666> . This analysis focused on cardiovascular, immunological, and neurological conditions. We included four cardiovascular diseases: hemorrhagic stroke, heart failure, myocardial infarction (MI), and atrial fibrillation or flutter (AF). Immunological conditions examined were psoriatic arthritis, plaque psoriasis, systemic lupus erythematosus, ulcerative colitis, rheumatoid arthritis, and Crohn’s disease. For neurological disorders, we selected major depressive disorder, epilepsy, multiple sclerosis, and Alzheimer's disease. All conditions were defined using phenotype algorithms from the OHDSI Phenotype Library. We limited this analysis to patients aged 30 to 79 years.

Hospitalization was defined as any inpatient visit during the time at risk. We calculated the incidence rate of hospitalization for each disease, defined as the ratio of the number of cases to the total time at risk within each target cohort. The time-at-risk period started one day after the index date and ended 365 days later, irrespective of the cohort's end date. We stratified each cohort by age (deciles) and sex and reported on the incidence rate and proportion in each calendar year. All analyses were conducted using code from the OHDSI Methods library, accessible at https://ohdsi.github.io/CohortIncidence/ and https://github.com/ohdsi-studies/HowOften.

**Results**

We calculated a total of 23,760 incidence rates in 6 data sources, with a full set of results available publicly at https://results.ohdsi.org/. For cardiovascular conditions, we identified 3,540,662 patients with acute myocardial infarction, 12,119,266 patients with atrial fibrillation or flutter, 6,682,227 patients with heart failure, and 819,177 patients with hemorrhagic stroke across all 6 data sources. For immunological conditions, there were 268,361 patients with psoriatic arthritis, 747,071 with plaque psoriasis, 377,033 with systemic lupus erythematosus, 523,315 with ulcerative colitis, 1,181,277 with rheumatoid arthritis, and 393,575 with Crohn’s disease. For neurological disorders, we identified 8,827,388 patients with major depressive disorder, 1,805,943 with epilepsy, 248,178 with multiple sclerosis and 962,235 with Alzheimer's disease.

Across all data sources, hospitalization was notable with the overall incidence proportion ranging from 6.7% for plaque psoriasis in PharMetrics to 60.3% for heart failure (HF) in Medicaid (Table 1). Patients with cardiovascular conditions exhibited the highest hospitalization rates (36.97% to 60.39%), followed by patients with epilepsy and Alzheimer's disease (22.71% to 43.07%). Patients with common immunological conditions, such as Crohn's disease, systemic lupus erythematosus, and ulcerative colitis, had similar hospitalization trends, ranging from 16.26% to 40.00%. Patients with rheumatoid arthritis and multiple sclerosis had slightly lower hospitalization rates, ranging from 14.06% to 39.39%, followed by patients with major depressive disorder and psoriatic arthritis (9.84% to 30.33%). Finally, patients with plaque psoriasis had the lowest hospitalization rates, ranging from 6.72% to 24.44%.

Figure 1 illustrates the age- and gender-stratified incidence rates (IR) by calendar year, starting at age 30, in the OPTUM Extended SES. For most conditions, age and gender variations are observed. In myocardial infarction and atrial fibrillation, females are at higher risk, whereas for heart failure and hemorrhagic stroke, males are at higher risk, particularly in the 60+ age groups. Across all cardiovascular conditions, an inverted U-shaped pattern with age is observed, where the risk increases with age until 50-59 years, then decreases. For immunological conditions, hospitalization rates increase with age. Older males have a higher risk compared to females, except in the 30-39 age group where females have higher rates. Among patients with neurological disorders, there is a clear increasing pattern of hospitalization with age, except for Alzheimer’s disease. Among patients with major depressive disorder and multiple sclerosis, males are at higher risk of hospitalization.

Figure 3 illustrates the overall incidence rates (IR) by calendar year for each condition across data sources. Across all conditions, a dip in 2020 due to COVID-19 is apparent. Aside from the 2020 dip, hospitalization rates have been stable over the last 10 years, with some clear patterns of fluctuation specific to each data source. These fluctuations are similar for all conditions within one data source, suggesting that such variations are a function of the data source rather than the condition.

**Conclusion**

We found that incidence rates of hospitalization within one year following the diagnosis of cardiovascular conditions such as heart failure, myocardial infarction, or atrial fibrillation or flutter are significant. Similarly, common neurological and immunological conditions such as epilepsy, Alzheimer’s disease, Crohn's disease, systemic lupus erythematosus, and ulcerative colitis also pose a considerable hospitalization risk post-diagnosis. Hospitalization following the diagnosis of skin-related immunological diseases such as psoriatic arthritis and plaque psoriasis was the lowest among all 14 conditions. Consistent with prior findings, incidence rates varied by age, gender, and data source4. For most conditions, the incidence rates remained relatively stable over the last 10 years, imposing a persistent burden on the healthcare system. ￼

**Tables and figures:**

Table 1 Heat map of Incidence proportion (%) of hospitalization among all conditions by data source

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Disease group | Condition | IBM CCAE | IBM MDCD | IBM MDCR | OPTUM Extended SES | Optum EHR | PharMetrics | Range |
| Cardiovascular | Heart failure | 42.93 | 60.39 | 54.42 | 46.7 | 52.88 | 42.92 | 42.92-60.39 |
| Acute Myocardial Infarction | 38.92 | 59.81 | 51.74 | 45.44 | 54.1 | 32.45 | 32.45-59.81 |
| Atrial Fibrillation or Flutter | 29.43 | 56.68 | 46.34 | 42.25 | 39.82 | 33.37 | 29.43-56.68 |
| Hemorrhagic Stroke | 39.56 | 54.69 | 47.35 | 40.92 | 55.45 | 36.97 | 36.97-54.69 |
| Neuroscience | Epilepsy | 26.1 | 41.69 | 43.07 | 34.07 | 31.67 | 24.61 | 24.61-43.07 |
| Alzheimer's | 22.71 | 40.9 | 34.71 | 28.64 | 27.34 | 26.77 | 22.71-40.90 |
| Multiple Sclerosis | 19.1 | 39.39 | 35.33 | 25.46 | 16.91 | 14.06 | 14.06-39.39 |
| Major depressive disorder | 12.06 | 25.52 | 29.5 | 17.16 | 18.66 | 10.42 | 10.42-29.5 |
| Immunology | Crohns disease | 18.62 | 40 | 33.66 | 24.88 | 23.12 | 17.18 | 18.62-40.0 |
| Systemic lupus erythematosus | 18.55 | 38.64 | 32.2 | 24.07 | 22.61 | 17.65 | 17.65-38.64 |
| Ulcerative colitis | 16.96 | 43.84 | 33.3 | 25.25 | 22.67 | 16.26 | 16.26-43.84 |
| Rheumatoid Arthritis | 14.46 | 34.99 | 29.1 | 21.83 | 20.37 | 13.66 | 13.66-34.99 |
| Psoriatic arthritis | 12.37 | 30.33 | 25.82 | 18.52 | 15.33 | 9.84 | 9.84-30.33 |
| Plaque Psoriasis | 7.71 | 24.44 | 19.78 | 12.11 | 12.53 | 6.72 | 6.72-24.44 |

Figure 1Age and gender stratified Incidence rate by calendar year among patients aged 30-79 in OPTUM Extended SES

|  |  |
| --- | --- |
| Cardiovascular conditions |  |
| Immunological conditions |  |
| Neurological conditions |  |

Figure 2 Overall incidence rates (IR) per 100-person year (100 PY) by calendar year for each condition across data sources.

|  |  |
| --- | --- |
| Cardiovascular conditions |  |
| Immunological conditions |  |
| Neurological conditions |  |

**References**

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