Clinical Outcomes of MS in CVD

Analysis for RCOP NIS Neuro2

Eliza Aisha

## Preamble:

* **Reference Papers:**
  + [Sidhu et al. 2022](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9207776/pdf/main.pdf)
* **Study Objective**: Examine the impact of MS on in-hospital mortality and length of stay among inpatient admissions with a principal diagnosis of CVD.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a principal diagnosis of Stroke.
* **CVD + MS Categories**:
  + CVD with MS
  + CVD without MS
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Statistical Analysis**: Multiple logistic and linear regression to determine the independent association of atrial fibrillation with in-hospital mortality, stroke mortality, length of stay and total charges (inflation adjusted), respectively, adjusted for:
  + Demographics: Age, sex, race, residential income, insurance, hospital region, hospital bedsize, hospital location, and teaching status.
  + Medical History: Hypertension, diabetes mellitus, hyperlipidemia, coronary artery disease, peripheral vascular disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, dementia, liver disease, obstructive sleep apnea, anemia, obesity, alochol use disorder, prior stroke, prior cardiac surgery, presence of pacemaker/defibrillator, tobacco use disorder, use of tissue plasminogen activator and use of thrombectomy.
  + Comorbidities: Charlson comorbidity index.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **Overall** N = 2,697,285*1* | **CVD with MS** N = 652,515*1* | **CVD without MS** N = 2,044,770*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 69 (14) | 73 (11) | 68 (15) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 1,316,685 (49) | 257,160 (39) | 1,059,525 (52) |  |
| Male | 1,380,475 (51) | 395,330 (61) | 985,145 (48) |  |
| Race |  |  |  | <0.001 |
| White | 1,786,970 (68) | 480,350 (76) | 1,306,620 (66) |  |
| Asian or Pacific Islander | 86,710 (3.3) | 14,890 (2.3) | 71,820 (3.6) |  |
| Black | 434,350 (17) | 79,275 (12) | 355,075 (18) |  |
| Hispanic | 228,465 (8.7) | 43,925 (6.9) | 184,540 (9.3) |  |
| Native American | 13,260 (0.5) | 2,710 (0.4) | 10,550 (0.5) |  |
| Other | 72,975 (2.8) | 14,780 (2.3) | 58,195 (2.9) |  |
| Charlson comorbidity index | 3.44 (2.08) | 4.24 (2.18) | 3.19 (1.98) | <0.001 |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 801,675 (30) | 194,780 (30) | 606,895 (30) |  |
| $52,000 - $65,999 | 712,045 (27) | 180,040 (28) | 532,005 (26) |  |
| $66,000 - $87,999 | 632,865 (24) | 152,690 (24) | 480,175 (24) |  |
| $88,000 or more | 507,880 (19) | 115,580 (18) | 392,300 (20) |  |
| Expected primary payer |  |  |  | <0.001 |
| Private | 645,795 (24) | 98,830 (15) | 546,965 (27) |  |
| Medicaid | 264,665 (9.8) | 40,030 (6.1) | 224,635 (11) |  |
| Medicare | 1,719,965 (64) | 499,525 (77) | 1,220,440 (60) |  |
| Other | 63,210 (2.3) | 13,405 (2.1) | 49,805 (2.4) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 593,715 (22) | 160,090 (25) | 433,625 (21) |  |
| Northeast | 461,440 (17) | 110,115 (17) | 351,325 (17) |  |
| South | 1,127,510 (42) | 280,790 (43) | 846,720 (41) |  |
| West | 514,620 (19) | 101,520 (16) | 413,100 (20) |  |
| Hospital bedsize |  |  |  | <0.001 |
| Large | 1,493,355 (55) | 355,970 (55) | 1,137,385 (56) |  |
| Medium | 750,485 (28) | 184,780 (28) | 565,705 (28) |  |
| Small | 453,445 (17) | 111,765 (17) | 341,680 (17) |  |
| Hospital location and teaching status |  |  |  | <0.001 |
| Rural | 169,170 (6.3) | 44,060 (6.8) | 125,110 (6.1) |  |
| Urban, non-teaching | 442,825 (16) | 112,145 (17) | 330,680 (16) |  |
| Urban, teaching | 2,085,290 (77) | 496,310 (76) | 1,588,980 (78) |  |
| Hypertension | 2,261,495 (84) | 601,915 (92) | 1,659,580 (81) | <0.001 |
| Diabetes mellitus | 1,001,335 (37) | 315,125 (48) | 686,210 (34) | <0.001 |
| Peripheral vascular disease | 261,900 (9.7) | 113,480 (17) | 148,420 (7.3) | <0.001 |
| Heart failure | 464,830 (17) | 215,165 (33) | 249,665 (12) | <0.001 |
| COPD | 453,720 (17) | 154,715 (24) | 299,005 (15) | <0.001 |
| Chronic kidney disease | 493,095 (18) | 176,790 (27) | 316,305 (15) | <0.001 |
| *1*Mean (SD); n (%) | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | |

## Outcomes Table:

| **Characteristic** | **Overall** N = 2,697,285*1* | **CVD with MS** N = 652,515*1* | **CVD without MS** N = 2,044,770*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 137,625 (5.1) | 29,390 (4.5) | 108,235 (5.3) | <0.001 |
| Length of stay (days) | 6 (9) | 6 (7) | 6 (9) | <0.001 |
| Inflation-adjusted total charge ($) | 84,342 (125,922) | 74,256 (91,597) | 87,559 (134,891) | <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)***1* | **p-value** |
| --- | --- | --- |
| CVD categories |  |  |
| CVD with MS | — |  |
| CVD without MS | 1.28 (1.24 to 1.32) | <0.001 |
| Age, y | 1.02 (1.02 to 1.02) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 0.99 (0.96 to 1.01) | 0.34 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 1.33 (1.25 to 1.43) | <0.001 |
| Black | 0.92 (0.88 to 0.96) | <0.001 |
| Hispanic | 1.07 (1.01 to 1.13) | 0.017 |
| Native American | 1.01 (0.83 to 1.23) | 0.90 |
| Other | 1.33 (1.23 to 1.44) | <0.001 |
| Charlson comorbidity index | 1.14 (1.13 to 1.14) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.92 (0.89 to 0.96) | <0.001 |
| $66,000 - $87,999 | 0.87 (0.83 to 0.90) | <0.001 |
| $88,000 or more | 0.86 (0.82 to 0.90) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 1.10 (1.04 to 1.16) | <0.001 |
| Medicare | 0.85 (0.81 to 0.89) | <0.001 |
| Other | 1.68 (1.51 to 1.86) | <0.001 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 1.18 (1.11 to 1.26) | <0.001 |
| South | 1.08 (1.03 to 1.14) | 0.002 |
| West | 1.26 (1.19 to 1.34) | <0.001 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.78 (0.74 to 0.81) | <0.001 |
| Small | 0.61 (0.57 to 0.65) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 0.96 (0.88 to 1.04) | 0.29 |
| Urban, teaching | 1.45 (1.35 to 1.56) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.59 (0.57 to 0.61) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.66 (0.64 to 0.68) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.66 (0.63 to 0.69) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 1.35 (1.31 to 1.40) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.87 (0.83 to 0.90) | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **exp(Beta)** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| CVD categories |  |  |
| CVD with MS | — |  |
| CVD without MS | 2.24 (2.12 to 2.37) | <0.001 |
| Age, y | 0.98 (0.98 to 0.98) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 1.23 (1.17 to 1.29) | <0.001 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 4.05 (3.32 to 4.94) | <0.001 |
| Black | 3.77 (3.40 to 4.17) | <0.001 |
| Hispanic | 2.25 (1.98 to 2.55) | <0.001 |
| Native American | 1.32 (0.93 to 1.89) | 0.12 |
| Other | 4.46 (3.60 to 5.52) | <0.001 |
| Charlson comorbidity index | 1.22 (1.19 to 1.25) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.95 (0.88 to 1.02) | 0.17 |
| $66,000 - $87,999 | 0.91 (0.83 to 0.99) | 0.037 |
| $88,000 or more | 0.95 (0.84 to 1.06) | 0.36 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 9.31 (7.95 to 10.9) | <0.001 |
| Medicare | 1.01 (0.94 to 1.09) | 0.79 |
| Other | 0.83 (0.70 to 0.99) | 0.040 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 1.52 (1.27 to 1.82) | <0.001 |
| South | 1.32 (1.16 to 1.50) | <0.001 |
| West | 1.08 (0.92 to 1.26) | 0.34 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.48 (0.42 to 0.54) | <0.001 |
| Small | 0.37 (0.31 to 0.43) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 0.94 (0.77 to 1.14) | 0.51 |
| Urban, teaching | 2.20 (1.86 to 2.59) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.95 (0.86 to 1.05) | 0.34 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.75 (0.70 to 0.80) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.49 (0.45 to 0.53) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 3.77 (3.49 to 4.09) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 1.13 (1.04 to 1.23) | 0.004 |
| *1*CI = Confidence Interval | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| CVD categories |  |  |
| CVD with MS | — |  |
| CVD without MS | 5,905 (5,124 to 6,687) | <0.001 |
| Age, y | -964 (-1,017 to -910) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | -1,525 (-2,260 to -790) | <0.001 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 22,512 (17,850 to 27,174) | <0.001 |
| Black | 7,686 (5,687 to 9,684) | <0.001 |
| Hispanic | 27,404 (23,813 to 30,994) | <0.001 |
| Native American | -10,291 (-15,544 to -5,039) | <0.001 |
| Other | 32,251 (27,641 to 36,861) | <0.001 |
| Charlson comorbidity index | 4,947 (4,651 to 5,242) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 429 (-1,060 to 1,918) | 0.57 |
| $66,000 - $87,999 | -13 (-1,920 to 1,894) | 0.99 |
| $88,000 or more | 6,424 (3,580 to 9,268) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 15,751 (13,448 to 18,054) | <0.001 |
| Medicare | 1,378 (74 to 2,681) | 0.038 |
| Other | 105 (-3,116 to 3,326) | 0.95 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 22,693 (17,962 to 27,423) | <0.001 |
| South | 15,449 (12,809 to 18,089) | <0.001 |
| West | 41,476 (37,024 to 45,928) | <0.001 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -15,494 (-18,778 to -12,210) | <0.001 |
| Small | -26,189 (-29,678 to -22,701) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 26,978 (23,795 to 30,160) | <0.001 |
| Urban, teaching | 43,908 (41,741 to 46,075) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | -8,319 (-9,945 to -6,693) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | -13,708 (-14,702 to -12,714) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | -7,685 (-8,860 to -6,511) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 11,555 (10,410 to 12,700) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | -9,073 (-10,268 to -7,878) | <0.001 |
| *1*CI = Confidence Interval | | |