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 Multiple Sclerosis (MS) on in-hospital mortality and length of stay among inpatient admissions with a principal diagnosis of cerebrovascular (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 cerebrovascular disease.
* **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 ($)
* **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 = 9,535*1* | **CVD without MS** N = 2,687,750*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Age, y | 69 (14) | 63 (13) | 69 (14) | <0.001 |
| Sex |  |  |  | <0.001 |
| Female | 1,316,685 (49) | 6,815 (71) | 1,309,870 (49) |  |
| Male | 1,380,475 (51) | 2,720 (29) | 1,377,755 (51) |  |
| Race |  |  |  | <0.001 |
| White | 1,786,970 (68) | 7,000 (76) | 1,779,970 (68) |  |
| Asian or Pacific Islander | 86,710 (3.3) | 75 (0.8) | 86,635 (3.3) |  |
| Black | 434,350 (17) | 1,400 (15) | 432,950 (17) |  |
| Hispanic | 228,465 (8.7) | 510 (5.5) | 227,955 (8.7) |  |
| Native American | 13,260 (0.5) | 35 (0.4) | 13,225 (0.5) |  |
| Other | 72,975 (2.8) | 220 (2.4) | 72,755 (2.8) |  |
| Charlson comorbidity index | 3.44 (2.08) | 3.16 (1.93) | 3.44 (2.08) | <0.001 |
| Residential income |  |  |  | <0.001 |
| $1 - $51,999 | 801,675 (30) | 2,390 (25) | 799,285 (30) |  |
| $52,000 - $65,999 | 712,045 (27) | 2,605 (28) | 709,440 (27) |  |
| $66,000 - $87,999 | 632,865 (24) | 2,480 (26) | 630,385 (24) |  |
| $88,000 or more | 507,880 (19) | 1,980 (21) | 505,900 (19) |  |
| Expected primary payer |  |  |  | 0.052 |
| Private | 645,795 (24) | 2,515 (26) | 643,280 (24) |  |
| Medicaid | 264,665 (9.8) | 985 (10) | 263,680 (9.8) |  |
| Medicare | 1,719,965 (64) | 5,795 (61) | 1,714,170 (64) |  |
| Other | 63,210 (2.3) | 210 (2.2) | 63,000 (2.3) |  |
| Hospital region |  |  |  | <0.001 |
| Midwest | 593,715 (22) | 2,535 (27) | 591,180 (22) |  |
| Northeast | 461,440 (17) | 1,770 (19) | 459,670 (17) |  |
| South | 1,127,510 (42) | 3,460 (36) | 1,124,050 (42) |  |
| West | 514,620 (19) | 1,770 (19) | 512,850 (19) |  |
| Hospital bedsize |  |  |  | 0.91 |
| Large | 1,493,355 (55) | 5,305 (56) | 1,488,050 (55) |  |
| Medium | 750,485 (28) | 2,610 (27) | 747,875 (28) |  |
| Small | 453,445 (17) | 1,620 (17) | 451,825 (17) |  |
| Hospital location and teaching status |  |  |  | 0.47 |
| Rural | 169,170 (6.3) | 545 (5.7) | 168,625 (6.3) |  |
| Urban, non-teaching | 442,825 (16) | 1,510 (16) | 441,315 (16) |  |
| Urban, teaching | 2,085,290 (77) | 7,480 (78) | 2,077,810 (77) |  |
| Hypertension | 2,261,495 (84) | 7,310 (77) | 2,254,185 (84) | <0.001 |
| Diabetes mellitus | 1,001,335 (37) | 3,000 (31) | 998,335 (37) | <0.001 |
| Peripheral vascular disease | 261,900 (9.7) | 725 (7.6) | 261,175 (9.7) | 0.003 |
| Heart failure | 464,830 (17) | 1,045 (11) | 463,785 (17) | <0.001 |
| COPD | 453,720 (17) | 1,710 (18) | 452,010 (17) | 0.19 |
| Chronic kidney disease | 493,095 (18) | 1,115 (12) | 491,980 (18) | <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 = 9,535*1* | **CVD without MS** N = 2,687,750*1* | **p-value***2* |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 137,625 (5.1) | 305 (3.2) | 137,320 (5.1) | <0.001 |
| Length of stay (days) | 6 (9) | 6 (8) | 6 (9) | 0.018 |
| Inflation-adjusted total charge ($) | 84,342 (125,922) | 79,802 (103,303) | 84,358 (125,995) | 0.72 |
| *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 | 1.46 (1.12 to 1.90) | 0.005 |
| Age, y | 1.02 (1.02 to 1.02) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 0.96 (0.94 to 0.99) | 0.005 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 1.35 (1.26 to 1.45) | <0.001 |
| Black | 0.94 (0.90 to 0.98) | 0.002 |
| Hispanic | 1.08 (1.02 to 1.14) | 0.005 |
| Native American | 1.02 (0.84 to 1.24) | 0.82 |
| Other | 1.35 (1.25 to 1.45) | <0.001 |
| Charlson comorbidity index | 1.13 (1.12 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 0.91) | <0.001 |
| $88,000 or more | 0.87 (0.83 to 0.91) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 1.10 (1.04 to 1.16) | <0.001 |
| Medicare | 0.84 (0.80 to 0.88) | <0.001 |
| Other | 1.68 (1.51 to 1.86) | <0.001 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 1.19 (1.11 to 1.26) | <0.001 |
| South | 1.08 (1.03 to 1.14) | 0.002 |
| West | 1.28 (1.20 to 1.35) | <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 | 0.95 (0.88 to 1.04) | 0.26 |
| Urban, teaching | 1.45 (1.35 to 1.55) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.58 (0.56 to 0.60) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.64 (0.62 to 0.66) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.64 (0.61 to 0.67) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 1.29 (1.25 to 1.34) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 0.86 (0.83 to 0.89) | <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 | 0.87 (0.61 to 1.22) | 0.42 |
| Age, y | 0.98 (0.98 to 0.98) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 1.14 (1.09 to 1.20) | <0.001 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 4.25 (3.48 to 5.19) | <0.001 |
| Black | 4.06 (3.66 to 4.49) | <0.001 |
| Hispanic | 2.35 (2.07 to 2.66) | <0.001 |
| Native American | 1.37 (0.96 to 1.95) | 0.084 |
| Other | 4.62 (3.73 to 5.72) | <0.001 |
| Charlson comorbidity index | 1.20 (1.18 to 1.23) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.95 (0.88 to 1.03) | 0.19 |
| $66,000 - $87,999 | 0.92 (0.84 to 1.00) | 0.056 |
| $88,000 or more | 0.96 (0.86 to 1.08) | 0.50 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 9.22 (7.87 to 10.8) | <0.001 |
| Medicare | 0.97 (0.90 to 1.04) | 0.39 |
| Other | 0.82 (0.69 to 0.98) | 0.031 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 1.53 (1.29 to 1.83) | <0.001 |
| South | 1.32 (1.16 to 1.50) | <0.001 |
| West | 1.13 (0.96 to 1.32) | 0.14 |
| 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 | 0.93 (0.76 to 1.12) | 0.43 |
| Urban, teaching | 2.18 (1.85 to 2.57) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.90 (0.82 to 0.99) | 0.037 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | 0.71 (0.66 to 0.75) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.44 (0.41 to 0.47) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 3.23 (2.99 to 3.50) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 1.12 (1.03 to 1.22) | 0.008 |
| *1*CI = Confidence Interval | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| CVD categories |  |  |
| CVD with MS | — |  |
| CVD without MS | 8,655 (3,917 to 13,394) | <0.001 |
| Age, y | -979 (-1,033 to -925) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | -2,097 (-2,823 to -1,371) | <0.001 |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 22,830 (18,167 to 27,494) | <0.001 |
| Black | 8,224 (6,223 to 10,226) | <0.001 |
| Hispanic | 27,699 (24,104 to 31,294) | <0.001 |
| Native American | -10,061 (-15,315 to -4,807) | <0.001 |
| Other | 32,494 (27,882 to 37,105) | <0.001 |
| Charlson comorbidity index | 4,866 (4,573 to 5,159) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 451 (-1,038 to 1,941) | 0.55 |
| $66,000 - $87,999 | 54 (-1,855 to 1,963) | 0.96 |
| $88,000 or more | 6,532 (3,688 to 9,376) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 15,674 (13,372 to 17,977) | <0.001 |
| Medicare | 1,088 (-216 to 2,391) | 0.10 |
| Other | 49 (-3,171 to 3,269) | 0.98 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 22,755 (18,024 to 27,486) | <0.001 |
| South | 15,445 (12,804 to 18,085) | <0.001 |
| West | 41,776 (37,321 to 46,231) | <0.001 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -15,492 (-18,776 to -12,209) | <0.001 |
| Small | -26,168 (-29,656 to -22,680) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 26,881 (23,701 to 30,062) | <0.001 |
| Urban, teaching | 43,840 (41,678 to 46,003) | <0.001 |
| Hypertension |  |  |
| No | — |  |
| Yes | -8,743 (-10,377 to -7,108) | <0.001 |
| Diabetes mellitus |  |  |
| No | — |  |
| Yes | -14,146 (-15,149 to -13,142) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | -8,535 (-9,714 to -7,355) | <0.001 |
| Heart failure |  |  |
| No | — |  |
| Yes | 10,417 (9,290 to 11,543) | <0.001 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | -9,164 (-10,359 to -7,969) | <0.001 |
| *1*CI = Confidence Interval | | |