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Original Paper

Readmissions for Depression and Suicide Attempt following Stroke and Myocardial Infarction

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Keywords
Stroke · Myocardial infarction · Depression · Suicide attempt

Abstract
Background and Purpose: Rates of depression after ischemic stroke (IS) and myocardial infarction (MI) are significantly higher than in the general population and associated with morbidity and mortality. There is a lack of nationally representative data comparing depression and suicide attempt (SA) after these distinct ischemic vascular events. ***Methods:*** The 2013 Nationwide Readmissions Database contains >14 million US admissions for all payers and the uninsured. Using International Classification of Disease, 9th Revision, Clinical Modification Codes, we identified index admission with IS (n = 434,495) or MI (n = 539,550) and readmission for depression or SA. We calculated weighted frequencies of readmission. We performed adjusted Cox regression to calculate hazard ratio (HR) for readmission for depression and SA up to 1 year following IS versus MI. Analyses were stratified by discharge home versus elsewhere. ***Results:*** Weighted depression readmission rates were higher at 30, 60, and 90 days in patients with IS versus MI (0.04%, 0.09%, 0.12% vs. 0.03%, 0.05%, 0.07%, respectively). There was no significant difference in SA readmissions between groups. The adjusted HR for readmission due to depression was 1.49 for IS versus MI (95% CI 1.25–1.79, p < 0.0001). History of depression (HR 3.70 [3.07–4.46]), alcoholism (2.04 [1.34–3.09]), and smoking (1.38 [1.15–1.64]) were associated with increased risk of depression readmission. Age >70 years (0.46 [0.37–0.56]) and discharge home (0.69 [0.57–0.83]) were associated with reduced hazards of readmission due to depression. ***Conclusions:*** IS was associated with greater hazard of readmission due to depres-

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sion compared to MI. Patients with a history of depression, smoking, and alcoholism were more likely to be readmitted with depression, while advanced age and discharge home were protective. It is unclear to what extent differences in type of ischemic tissue damage and disability contribute, and further investigation is warranted.

Introduction

Depression occurs in approximately 30% of stroke and 20% of myocardial infarction (MI) patients and can cause increased morbidity and mortality [1–5]. In 2014, The American Heart Association (AHA) elevated depression to a risk factor for adverse prognosis in acute coronary syndrome [6], and in 2017 The AHA/American Stroke Association published its first guideline statement on poststroke depression (PSD) [7].

Despite extensive literature on PSD and post-MI depression (PMD), few studies directly compare these distinct ischemic vascular events [8–11]. We used nationally representative data to compare risk of readmission for PSD, PMD, and suicide attempt (SA) up to 1 year following stroke or MI. We hypothesized that there would be more admissions for depression and SA following stroke, and those with psychiatric comorbidities and substance use disorders would be at highest risk for readmission.

Methods

We analyzed the 2013 Nationwide Readmissions Database (NRD), a Healthcare Cost and Utilization Project (HCUP) database containing >14 million US hospitalizations. Each patient has an anonymized, verified linkage identifier allowing for analysis of readmissions. Because data are publicly available, and to comply with the data use agreement, the data, analytic methods, and study materials will not be made available. Mount Sinai Hospital's IRB approved this project and waived need for patient consent (IRB-16-00378).

We used International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes to identify index ischemic stroke (IS) or MI admission and readmission for a primary diagnosis of depression or SA. We report HCUP-defined characteristics of index hospitalization. The All Patient Refined Diagnosis Related Groups (APR-DRGs) divides patients into 25 diagnostic categories, and patients are further subdivided into 4 separate APR-DRG severity of illness and risk of mortality subclasses. The APR-DRG system mortality scores are correlated with mortality rates [12, 13].

Figure 1 depicts the inclusion criteria and outcomes. We identified IS in the primary diagnosis position by validated ICD-9-CM codes 433.x1, 434.x1, and 436 (sensitivity 74%, specificity 95%, and positive predictive value 88%) [14, 15]. We identified MI in the primary diagnosis position by the validated ICD-9-CM codes 410.x (sensitivity and specificity ≥84%) [16]. Primary outcomes included weighted frequencies of readmissions with primary diagnosis of depression or SA. There are no ICD-9-CM codes for PSD or PMD. Previous studies have used ICD-9-CM codes 296.2x, 296.3x, and 300.4 to identify depression [17–19]. The ICD-9-CM definition used in this study fell well within these validated definitions (296.2x, 296.3x, 296.82, 300.4, 309.0, 309.1, 311). Because precise psychiatric diagnosis requires time, we were more inclusive and used codes 300.9 "Adjustment Disorder with Depressed Mood," 309.1 "Prolonged Depressive Reaction," and 311 "Depressive Disorder, not elsewhere classified."

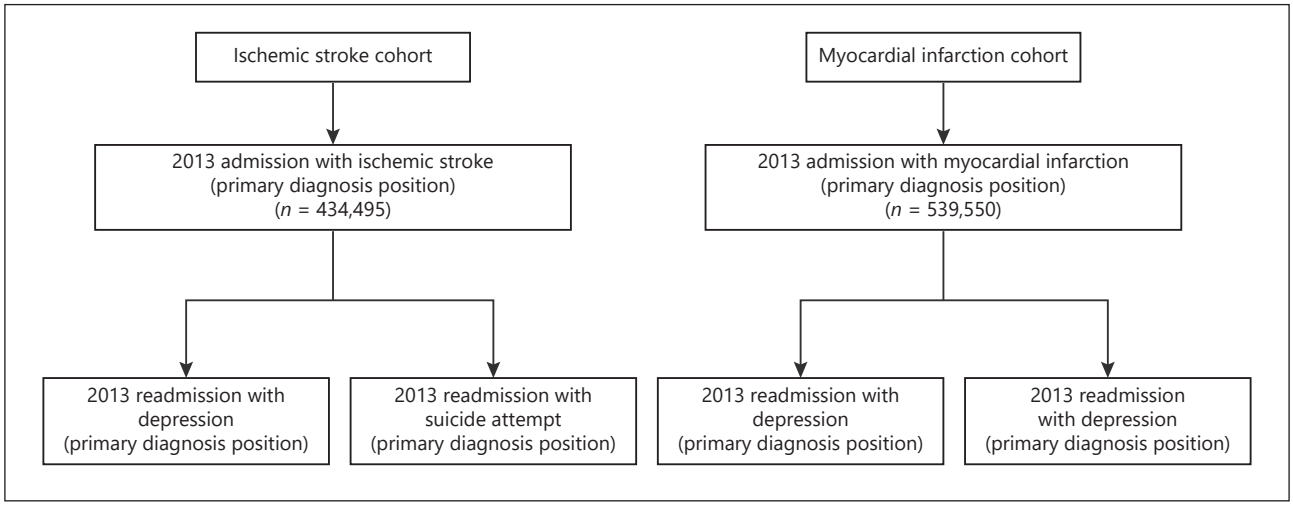

Fig. 1. Ischemic stroke and myocardial infarction cohorts. All patients with 2013 admission with ischemic stroke and myocardial infarction in the primary diagnosis position were included. Primary outcome was 2013 readmission with depression or suicide attempt in the primary diagnosis position.

Statistical Analysis

We calculated baseline characteristics of index IS and MI cohorts. We used population weights provided by HCUP to determine nationally representative estimates of medical comorbidities and index hospitalization characteristics.

We calculated weighted 30-, 60-, and 90-day readmission rates for primary diagnosis of depression or SA. We did not exclude index admissions with depression and SA and acknowledge that some of those readmitted with depression were depressed at the time of their IS or MI. To calculate 30-day, 60-day, and 90-day readmission rates, we excluded index hospitalizations in the months falling within the respective time intervals.

We created Kaplan-Meier curves stratified by index admission (IS vs. MI) of cumulative risk of depression and SA readmission up to 1 year following index admission and tested for differences using the log-rank test. Because only the month of admission is available in the NRD, for those without the event of interest, we calculated the maximum observed follow-up period as the number of days from the midpoint of the month of index admission to December 31, 2013. We assumed full capturing of mortality and no loss to follow-up.

We performed Cox regression, reporting hazard ratio (HR) and 95% confidence intervals (CI) separately for readmission for depression and SA. Main independent variable was index admission type, IS (= 1) versus MI (= 0). Considering variables previously identified in the literature as associated with a history of depression, we adjusted for potential confounders including history of depression, alcoholism, smoking, sex, age >70 versus <70 years, length of stay, income quartile of patient's zip code, discharge home versus other discharge destination, and APR-DRG estimated severity [7, 20–23]. In secondary analysis, we stratified by discharge home versus elsewhere. Analyses were performed in SAS version 9.4 and R version 3.4.2.

Results

Table 1 lists baseline demographics, comorbidities, and hospital characteristics at index event. There were 434,495 patients in the IS and 539,550 in the MI cohorts (Fig. 1). At baseline, depression was more common in the IS cohort (11.86%, 95% CI 11.54–12.18 vs. 8.44%, 95%

Table 1. Baseline characteristics at the time of index ischemic stroke and myocardial infarction

	Index ischemic stroke admission		Index myocardial infarction admission	
	weighted frequency[a]	percent (95% CI of percent)	weighted frequency[a]	percent (95% CI of percent)
Total	434,495	100.0	539,550	100.0
Variables at index admission				
Mean age, years	–	70.90 (70.67–71.13)	–	67.25 (67.05–67.44)
Female	223,126	51.35 (51.02–51.69)	204,823	37.96 (37.63–38.30)
Tobacco use	133,204	30.66 (29.86–31.46)	223,649	41.45 (40.61–42.29)
Diabetes	156,740	36.07 (35.66–36.49)	197,010	36.51 (36.10–36.93)
Hypertension	293,258	67.49 (67.02–67.96)	300,775	55.75 (55.28–56.21)
Hyperlipidemia	251,554	57.90 (57.15–58.64)	347,582	64.42 (63.69–65.16)
Atrial fibrillation/flutter	108,313	24.93 (24.53–25.33)	99,133	18.37 (18.04–18.71)
Intracerebral hemorrhage	12,039	2.77 (2.57–2.98)	424	0.08 (0.07–0.09)
Ischemic stroke	–	–	6,628	1.23 (1.18–1.28)
Myocardial infarction	10,752	2.48 (2.34–2.61)	–	–
Renal failure	42,228	9.72 (9.41–10.03)	87,039	16.13 (15.69–16.57)
Peripheral vascular disease	23,102	5.32 (5.14–5.49)	40,680	7.54 (7.32–7.76)
Depression	51,530	11.86 (11.54–12.18)	45,515	8.44 (8.16–8.71)
Suicide attempt	66	0.02 (0.01–0.02)	118	0.02 (0.02–0.03)
Alcoholism	7,794	1.79 (1.70–1.89)	6,349	1.18 (1.11–1.24)
Drug abuse	1,887	0.43 (0.39–0.48)	2,237	0.41 (0.37–0.46)
Length of stay, days	–	6.86 (6.70–7.02)	–	4.94 (4.84–5.03)
Total charges, USD	–	53,205 (51,398–55,012)	–	82,806 (80,177–85,435)
Patient zip code income quartile				
0–25th percentile	126,946	29.70 (28.05–31.34)	153,334	28.89 (27.10–30.69)
26th to 50th percentile	117,090	27.39 (26.27–28.51)	150,559	28.37 (27.16–29.58)
51st to 75th percentile	101,477	23.74 (22.75–24.72)	127,211	23.97 (22.89–25.06)
76th to 100th percentile	81,983	19.18 (17.73–20.63)	99,564	18.76 (17.16–20.36)
APR-DRG mortality				
1 = Minor likelihood of dying	132,990	30.61 (30.15–31.07)	155,411	28.80 (28.33–29.28)
2 = Moderate likelihood of dying	186,951	43.03 (42.60–43.45)	159,427	29.55 (29.23–29.87)
3 = Major likelihood of dying	79,496	18.30 (17.97–18.63)	153,418	28.43 (27.99–28.88)
4 = Extreme likelihood of dying	35,030	8.06 (7.75–8.37)	71,268	13.21 (12.90–13.52)
APR-DRG severity				
1 = Minor (or no) loss of function	60,267	13.87 (13.52–14.22)	116,286	21.55 (21.08–22.02)
2 = Moderate loss of function	214,874	49.45 (49.02–49.89)	216,262	40.08 (39.75–40.42)
3 = Major loss of function	124,681	28.70 (28.24–29.15)	140,983	26.13 (25.70–26.56)
4 = Extreme loss of function	34,645	7.97 (7.67–8.28)	65,994	12.23 (11.94–12.53)
Disposition				
Routine - home or self-care	174,777	40.24 (39.63–40.85)	360,579	66.85 (66.11–67.59)
Transfer to short-term hospital	6,945	1.60 (1.39–1.81)	15,501	2.87 (2.64–3.11)
Transfer to SNF, ICF, or other facility	146,591	33.75 (33.04–34.46)	60,916	11.29 (10.97–11.62)
Home Health Care	80,923	18.63 (18.07–19.19)	68,037	12.61 (12.09–13.14)
Against medical advice	3,499	0.81 (0.75–0.86)	4,954	0.92 (0.86–0.98)
Died	21,137	4.87 (4.70–5.04)	29,199	5.41 (5.27–5.56)
Discharged alive, destination unknown	500	0.12 (0.08–0.15)	232	0.04 (0.03–0.05)
Hospital bed size				
Small	45,181	10.40 (9.33–11.47)	44,102	8.17 (6.97–9.38)
Medium	103,328	23.78 (22.29–25.28)	121,370	22.49 (20.57–24.42)
Large	285,986	65.82 (64.07–67.58)	374,078	69.33 (67.18–71.48)
Hospital urban-rural designation				
Large metro area >1 million residents	223,143	51.36 (48.59–54.12)	264,990	49.11 (46.13–52.10)
Small metro areas <1 million residents	160,826	37.01 (34.38–39.65)	225,725	41.84 (38.89–44.78)
Micropolitan areas	37,571	8.65 (7.71–9.58)	41,015	7.60 (6.33–8.88)
Not metropolitan or micropolitan	12,955	2.98 (2.63–3.33)	7,821	1.45 (1.09–1.81)

Table 1 (continued)

	Index ischemic stroke admission		Index myocardial infarction admission	
	weighted frequency[a]	percent (95% CI of percent)	weighted frequency[a]	percent (95% CI of percent)
Teaching status of hospital				
Metropolitan teaching	217,641	50.09 (48.21–51.97)	274,866	50.94 (48.67–53.21)
Metropolitan non-teaching	50,526	11.63 (10.64–12.62)	48,835	9.05 (7.74–10.36)
Primary expected payer				
Medicare	295,425	68.05 (67.33–68.76)	315,074	58.47 (57.83–59.10)
Medicaid	29,708	6.84 (6.47–7.22)	33,354	6.19 (5.83–6.55)
Private insurance	72,944	16.80 (16.33–17.28)	132,547	24.60 (24.01–25.18)
Self-pay	21,128	4.87 (4.52–5.21)	34,370	6.38 (6.06–6.69)
No charge	2,650	0.61 (0.47–0.75)	4,560	0.85 (0.65–1.04)
Other	12,279	2.83 (2.52–3.13)	18,988	3.52 (3.18–3.87)

[a] Unless otherwise indicated. APDRG, all patient refined-diagnosis related group; SNF, skilled nursing facility; ICF, intermediate care facility.

Table 2. Weighted depression and suicide attempt readmission rates

	Index ischemic stroke admission		Index myocardial infarction admission	
	weighted frequency	number per 10,000 (95% CI)	weighted frequency	number per 10,000 (95% CI)
Depression readmission rates				
30 days	172.3	4.37 (3.19–5.55)	141.2	2.91 (2.11–3.71)
60 days	310.5	8.64 (6.92–10.36)	221.5	5.00 (3.88–6.12)
90 days	391.5	12.12 (9.92–14.32)	271.9	6.83 (5.46–8.20)
Suicide attempt readmission rates				
30 days	58.5	1.48 (0.811–2.15)	82.0	1.69 (1.06–2.32)
60 days	88.9	2.47 (1.52–3.42)	132.4	2.99 (2.10–3.88)
90 days	94.8	2.94 (1.82–4.06)	183.2	4.60 (3.45–5.75)

CI 8.16–8.71). There was no significant difference in history of SA, alcoholism, or drug abuse. According to APR-DRG mortality and severity, patients in the MI group had higher likelihood of dying and extreme loss of function. More MI patients were discharged home or with self-care (66.85%, 95% CI 66.11–67.59 vs. 40.24%, 95% CI 39.63–40.85), while more IS patients were discharged to skilled nursing facility, intermediate care facility, other facility, or home with home health care.

Although weighted depression readmission rates were low (Table 2), they were higher at 60 and 90 days in IS versus MI patients. Weighted SA readmission rates were not significantly different (Table 2).

Kaplan-Meier curves of cumulative risk of depression and SA readmission are shown in Figure 2a and b. Risk of depression readmission was higher in IS patients throughout 1 year of follow-up, with greater separation of the curves after 100 days (log-rank $p < 0.0001$). There was no difference in risk of SA between IS and MI patients (log-rank $p = 0.13$).

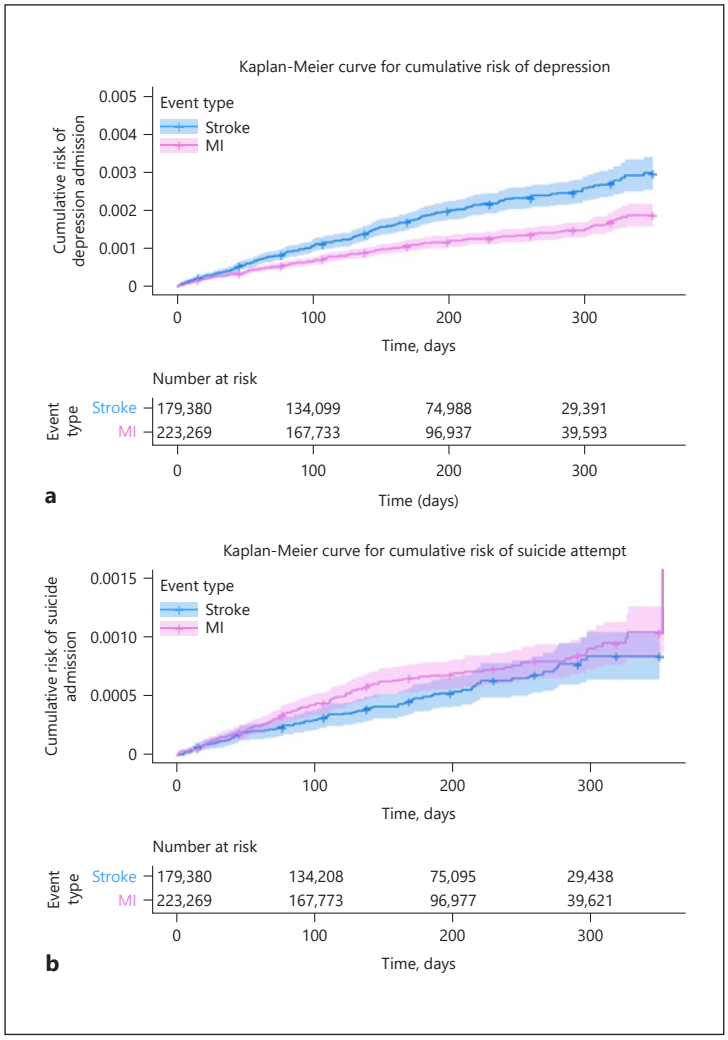

Fig. 2. a Kaplan-Meier cumulative risk of depression. Kaplan-Meier curves of cumulative risk of the outcome of depression readmission following index admission for stroke and myocardial infarction (MI) are shown. The *x* axis depicts the time in days and corresponding number of index stroke and MI patients at risk and the *y* axis the cumulative risk of readmission for depression. log-rank $p < 0.0001$. **b** Kaplan-Meier cumulative risk of suicide attempt (SA). Kaplan-Meier curves of cumulative risk of the outcome of SA following index admission for stroke and MI are shown. The *x* axis depicts the time in days and corresponding number of index stroke and MI patients at risk and the *y* axis the cumulative risk of readmission for SA. log-rank $p = 0.13$.

Table 3 shows Cox regression models comparing index IS versus MI. There was no difference in SA readmission. In an unadjusted model, the HR for depression readmission was 1.62 (95% CI 1.37–1.92, $p < 0.0001$), comparing index IS to index MI. In an adjusted model, this magnitude of effect did not change substantially (HR 1.49, 95% CI 1.25–1.79). History of depression was associated with a HR of 3.70 (95% CI 3.07–4.46, $p < 0.0001$) for depression readmission. History of smoking (HR 2.04, 95% CI 1.34–3.09, $p < 0.0001$) and alcoholism (1.38, 95% CI 1.15–1.64, $p < 0.0001$) were associated with increased hazards of depression readmission. Age >70 years (HR 0.46, 95% CI 0.37–0.55, $p < 0.0001$) and discharge home (HR 0.69, 95% CI 0.57–0.83, $p < 0.0001$) were associated with a lower risk of depression readmission. Stratified by discharge destination (Table 4), associations between history of depression, history of alcoholism, and age >70 years and depression readmission remained significant in patients discharged home. In patients not discharged home, history of depression and smoking were associated with greater odds of depression readmission, and age >70 years was protective against depression readmission.

Table 3. Multivariable Cox regression models testing depression outcome, comparing index stroke vs. myocardial infarction

	Depression readmission		
	hazard ratio	95% CI	*p* value
Index ischemic stroke vs. index myocardial infarction	1.49	1.25–1.79	<0.0001
Depression history	3.70	3.07–4.46	<0.0001
Alcoholism history	2.04	1.34–3.09	<0.0001
Smoking history	1.38	1.15–1.64	<0.0001
Age >70	0.46	0.37–0.55	<0.0001
Female sex	0.88	0.74–1.05	0.16
Length of stay	1.00	0.99–1.01	0.73
Patient zip code income quartile			
26th to 50th percentile	0.92	0.74–1.13	0.42
51st to 75th percentile	0.78	0.62–0.98	0.03
76th to 100th percentile	0.69	0.53–0.89	<0.0001
Discharge home	0.69	0.57–0.83	<0.0001
APR-DRG severity			
2 = moderate loss of function	1.29	1.01–1.65	0.04
3 = major loss of function	1.11	0.83–1.47	0.47
4 = extreme loss of function	0.93	0.60–1.44	0.74

An adjusted model was not run for suicide attempt because the main independent variable was not significant in univariate testing. APR-DRG, all patient refined-diagnosis related group.

Table 4. Cox regression models comparing index stroke vs. myocardial infarction and risk for readmission with depression, stratified by discharge home

	Discharge home			Discharge not to home		
	hazard ratio	95% CI	*p* value	hazard ratio	95% CI	*p* value
Multivariable model						
Depression history	4.14	3.17–5.41	<0.0001	3.32	2.55–4.31	<0.0001
Alcoholism history	2.58	1.49–4.46	<0.0001	1.54	0.81–2.93	0.19
Smoking history	1.25	0.98–1.60	0.07	1.52	1.18–1.97	0.00
Age >70	0.53	0.39–0.71	<0.0001	0.41	0.31–0.53	<0.0001
Female sex	0.79	0.61–1.01	0.07	0.98	0.76–1.26	0.88
Length of stay (days)	1.00	0.99–1.02	0.27	0.99	0.98–1.01	0.37
Patient zip code income quartile						
26th to 50th percentile	0.95	0.99–1.02	0.72	0.88	0.64–1.21	0.43
51st to 75th percentile	0.65	0.47–0.91	0.12	.93	0.67–1.28	0.64
76th to 100th percentile	0.61	0.42–0.88	0.01	0.93	0.67–1.28	0.20
APR-DRG severity						
2 = moderate loss of function	1.43	1.05–1.93	0.02	0.93	0.61–1.41	0.73
3 = major loss of function	0.83	0.37–1.87	0.14	0.76	0.49–1.19	0.23
4 = extreme loss of function	1.25	0.98–1.60	0.66	0.73	0.41–1.30	0.28

APR-DRG, all patient refined-diagnosis related group.

Discussion

This study compares the risk of readmission for depression and SA up to 1 year after hospitalization for index IS and MI. Weighted depression readmission rates were higher at 30, 60, and 90 days in patients with IS versus MI, but there was no difference in SA readmis-

sions. IS patients with history of depression, alcohol use, or substance use were at even greater risk for readmission with depression. Discharge home and older age were associated with lower risk of readmission for depression. This study is unique because we were able to directly compare the mental health sequelae of vascular events in the brain and the heart in a large US population.

Our findings conflict with limited existing literature comparing post-stroke and PMD. A 2001 study compared active SI, but not SA, in 496 patients from Baltimore admitted with stroke, traumatic brain injury, MI, or spinal cord injury [8]. Authors found no significant difference between the 4 injury types in their rates of SI. In addition to comparing SI rather than SA, this study was limited by poor follow-up, as 40% of the initial patients did not have follow-up evaluations.

Much of existing post-stroke versus MI depression research has been conducted outside of the US. A prospective cohort study from the Netherlands compared cumulative 1-year incidence of depression in 190 first-time stroke and 200 first-time MI patients [10]. Authors report a cumulative 1-year incidence of depression of 37.8% in stroke and 25% in MI patients, but this difference disappeared after controlling for sex, age, and level of handicap. Another prospective cohort study from the Netherlands also failed to demonstrate a significant difference in depressive syndromes following stroke and MI [11].

A study of 100 patients from the UK compared depression following index stroke with carotid stenosis resulting in transient ischemic attack, peripheral vascular disease, and a non-vascular control group. Authors found higher average depression scores in stroke and TIA groups than in PVD and non-vascular control groups. They also found that a "wish to die" had significantly higher prevalence in the stroke group [9]. This study is again limited by small sample size and lack of generalizability to a US population.

Most psychiatric illness, including depression, results from a combination of biological, psychological, and social factors [24, 25], and reasons for SA are varied. However, the greater hazard of depression readmission following stroke may suggest a distinct pathophysiology of ischemia in the brain compared to other organs. The biological basis of PSD is not well understood but is likely multifactorial [26–31]. While cytotoxic cell death and altered brain circuitry likely impact the biology of PSD, the life-altering nature of acute stroke likely also impacts PSD. The increasing difference in cumulative risk of depression following stroke versus MI over 1 year may partially reflect psychological and social difficulties of disability from stroke. With time, hope for improvement may fade.

Previous research has demonstrated that patients without close social contacts had increased odds of depressive symptoms after heart attack or stroke, while those with close social contacts only had increased odds of depressive symptoms after stroke [32]. Individuals discharged home may have better social contacts. Additionally, older age may be protective because disability due may not have the same impact on an older person.

Our analysis of large, nationally representative IS and MI cohorts likely reflects real-world associations. However, we acknowledge several limitations. First, there may have been misclassification and incomplete assessment of comorbidities based on ICD-9-CM codes. Validated ICD-9-CM definitions of depression and SA are not well-defined in the literature. Several things likely explain this, including no objective gold standard for psychiatric diagnoses, frequently changing classifications of mood disorders in the Diagnostic and Statistical Manual of Mental Disorders, and diagnostic uncertainty. However, ICD 7-CM through ICD-10-CM psychiatric have been demonstrated to have a PPV around 75% for affective disorders [33]. A recent systematic review and validation study reported a PPV between 89.7 and 92.0% for 3 different ICD-9-CM definitions of depression [34]. SA admissions were identified using validated ICD-9-CM suicide and intentional self-injury codes (E950.x through E959). Prior studies have validated SA using ICD-9-CM suicide and intentional self-injury codes with a PPV and

sensitivity and specificity of 86 and 65%, respectively [35]. Such codes have been demonstrated to be predictive of higher future suicide death rates (HR = 10.45) [36].

Second, the data only enabled us to look at depression and SA resulting in hospitalization; the data likely underestimate the true prevalence of more minor forms of post-stroke and PMD as well as out-of-hospital mortality. Since stroke patients were more likely to be discharged to nursing or other care facilities, they interact more frequently with the healthcare system and could therefore have higher rates of detection of depression. We cannot fully know whether depression and SA readmissions are related to the PSD or comorbid psychiatric conditions. We were also unable to control for potentially confounding variables not found in ICD-9-CM codes, including the presence of a close social contact. Lastly, we could not assess severity of post-stroke disability and its impact on rates of readmission with depression and SA or the impact of treatment with an antidepressant on outcomes.

In the 90 days following index hospitalization, as well as at 1 year after, risk of depression readmission was higher in patients with IS, especially in those with preexisting depression or substance use disorders. These findings emphasize the importance of screening for depression and suicidal ideation in both IS and MI patients. Further research may elucidate how type of ischemic tissue damage and disability contribute, as well as impact of treatment of depression on outcomes.

Statement of Ethics

The Mount Sinai Hospital's IRB approved this project and waived the need for patient consent.

Conflict of Interest Statement

The authors have no conflicts of interest to disclose.

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There are no funding sources to declare.

Author Contributions

L.K.S. study design, interpretation of data, drafting the work. A.K. and J.E. interpretation of data, drafting the work. M.S.D. study design, analysis and interpretation of the data, critical revision for important intellectual content.

References

1 Frasure-Smith N, Lespérance F, Talajic M. Depression following myocardial infarction. Impact on 6-month survival. JAMA. 1993 Oct;270(15):1819–25.
2 Thombs BD, Bass EB, Ford DE, Stewart KJ, Tsilidis KK, Patel U, et al. Prevalence of depression in survivors of acute myocardial infarction. J Gen Intern Med. 2006 Jan;21(1):30–8.
3 Larsen KK. Depression following myocardial infarction–an overseen complication with prognostic importance. Dan Med J. 2013 Aug;60(8):B4689.

4 Hackett ML, Pickles K. Part I: frequency of depression after stroke: an updated systematic review and meta-analysis of observational studies. Int J Stroke. 2014 Dec;9(8):1017–25.
5 de Miranda Azevedo R, Roest AM, Carney RM, Denollet J, Freedland KE, Grace SL, et al. A bifactor model of the Beck Depression Inventory and its association with medical prognosis after myocardial infarction. Health Psychol. 2016 Jun;35(6):614–2.
6 Lichtman JH, Froelicher ES, Blumenthal JA, Carney RM, Doering LV, Frasure-Smith N, et al.; American Heart Association Statistics Committee of the Council on Epidemiology and Prevention and the Council on Cardiovascular and Stroke Nursing. Depression as a risk factor for poor prognosis among patients with acute coronary syndrome: systematic review and recommendations: a scientific statement from the American Heart Association. Circulation. 2014 Mar;129(12):1350–69.
7 Towfighi A, Ovbiagele B, El Husseini N, Hackett ML, Jorge RE, Kissela BM, et al.; American Heart Association Stroke Council; Council on Cardiovascular and Stroke Nursing; and Council on Quality of Care and Outcomes Research. Poststroke Depression: A Scientific Statement for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2017 Feb;48(2):e30–43.
8 Kishi Y, Robinson RG, Kosier JT. Suicidal ideation among patients with acute life-threatening physical illness: patients with stroke, traumatic brain injury, myocardial infarction, and spinal cord injury. Psychosomatics. 2001 Sep-Oct;42(5):382–90.
9 Rao R, Jackson S, Howard R. Depression in older people with mild stroke, carotid stenosis and peripheral vascular disease: a comparison with healthy controls. Int J Geriatr Psychiatry. 2001 Feb;16(2):175–83.
10 Aben I, Verhey F, Strik J, Lousberg R, Lodder J, Honig A. A comparative study into the one year cumulative incidence of depression after stroke and myocardial infarction. J Neurol Neurosurg Psychiatry. 2003 May;74(5):581–5.
11 Bour A, Rasquin S, Aben I, Strik J, Boreas A, Crijns H, et al. The symptomatology of post-stroke depression: comparison of stroke and myocardial infarction patients. Int J Geriatr Psychiatry. 2009 Oct;24(10):1134–42.
12 Shen Y. Applying the 3M All Patient Refined Diagnosis Related Groups Grouper to measure inpatient severity in the VA. Med Care. 2003 Jun;41(6 Suppl):II103–10.
13 Baram D, Daroowalla F, Garcia R, Zhang G, Chen JJ, Healy E, et al. Use of the All Patient Refined-Diagnosis Related Group (APR-DRG) Risk of Mortality Score as a Severity Adjustor in the Medical ICU. Clin Med Circ Respirat Pulm Med. 2008 Apr;2:19–25.
14 Tirschwell DL, Longstreth WT Jr. Validating administrative data in stroke research. Stroke. 2002 Oct;33(10):2465–70.
15 Roumie CL, Mitchel E, Gideon PS, Varas-Lorenzo C, Castellsague J, Griffin MR. Validation of ICD-9 codes with a high positive predictive value for incident strokes resulting in hospitalization using Medicaid health data. Pharmacoepidemiol Drug Saf. 2008 Jan;17(1):20–6.
16 McCormick N, Lacaille D, Bhole V, Avina-Zubieta JA. Validity of myocardial infarction diagnoses in administrative databases: a systematic review. PLoS One. 2014 Mar;9(3):e92286.
17 Cipriani A, Reid K, Young AH, Macritchie K, Geddes J. Valproic acid, valproate and divalproex in the maintenance treatment of bipolar disorder. Cochrane Database Syst Rev. 2013 Oct;(10):CD003196.
18 Garrison GM, Angstman KB, O'Connor SS, Williams MD, Lineberry TW. Time to Remission for Depression with Collaborative Care Management (CCM) in Primary Care. J Am Board Fam Med. 2016 Jan-Feb;29(1):10–7.
19 Khambaty T, Stewart JC, Gupta SK, Chang CH, Bedimo RJ, Budoff MJ, et al. Association Between Depressive Disorders and Incident Acute Myocardial Infarction in Human Immunodeficiency Virus-Infected Adults: Veterans Aging Cohort Study. JAMA Cardiol. 2016 Nov;1(8):929–37.
20 Burvill P, Johnson G, Jamrozik K, Anderson C, Stewart-Wynne E. Risk factors for post-stroke depression. Int J Geriatr Psychiatry. 1997 Feb;12(2):219–26.
21 Kutlubaev MA, Hackett ML. Part II: predictors of depression after stroke and impact of depression on stroke outcome: an updated systematic review of observational studies. Int J Stroke. 2014 Dec;9(8):1026–36.
22 Guiraud V, Gallarda T, Calvet D, Turc G, Oppenheim C, Rouillon F, et al. Depression predictors within six months of ischemic stroke: the DEPRESS Study. Int J Stroke. 2016 Jul;11(5):519–25.
23 Volz M, Ladwig S, Werheid K. Gender differences in post-stroke depression: A longitudinal analysis of prevalence, persistence and predictive value of known risk factors. Neuropsychol Rehabil. 2019 Aug:1–17.
24 De Ryck A, Brouns R, Geurden M, Elseviers M, De Deyn PP, Engelborghs S. Risk factors for poststroke depression: identification of inconsistencies based on a systematic review. J Geriatr Psychiatry Neurol. 2014 Sep;27(3):147–58.
25 Robinson RG, Jorge RE. Post-Stroke Depression: A Review. Am J Psychiatry. 2016 Mar;173(3):221–31.
26 Gold PW, Charney DS. Diseases of the mind and brain: depression: a disease of the mind, brain, and body. Am J Psychiatry. 2002 Nov;159(11):1826.
27 Fang J, Cheng Q. Etiological mechanisms of post-stroke depression: a review. Neurol Res. 2009 Nov;31(9):904–9.
28 Kim JM, Stewart R, Kang HJ, Kim SW, Shin IS, Kim HR, et al. A longitudinal study of SLC6A4 DNA promoter methylation and poststroke depression. J Psychiatr Res. 2013 Sep;47(9):1222–7.
29 Kim JM, Stewart R, Kang HJ, Kim SY, Kim SW, Shin IS, et al. A longitudinal study of BDNF promoter methylation and genotype with poststroke depression. J Affect Disord. 2013 Jul;149(1-3):93–9.

30 Noonan K, Carey LM, Crewther SG. Meta-analyses indicate associations between neuroendocrine activation, deactivation in neurotrophic and neuroimaging markers in depression after stroke. J Stroke Cerebrovasc Dis. 2013 Oct;22(7):e124–35.
31 Li W, Ling S, Yang Y, Hu Z, Davies H, Fang M. Systematic hypothesis for post-stroke depression caused inflammation and neurotransmission and resultant on possible treatments. Neuro Endocrinol Lett. 2014;35(2):104–9.
32 Simning A, Seplaki CL, Conwell Y. The association of a heart attack or stroke with depressive symptoms stratified by the presence of a close social contact: findings from the National Health and Aging Trends Study Cohort. Int J Geriatr Psychiatry. 2018 Jan;33(1):96–103.
33 Davis KA, Sudlow CL, Hotopf M. Can mental health diagnoses in administrative data be used for research? A systematic review of the accuracy of routinely collected diagnoses. BMC Psychiatry. 2016;16:263.
34 Fiest KM, Jette N, Quan H, St Germaine-Smith C, Metcalfe A, Patten SB, et al. Systematic review and assessment of validated case definitions for depression in administrative data. BMC Psychiatry. 2014 Oct;14:289.
35 Walkup JT, Townsend L, Crystal S, Olfson M. A systematic review of validated methods for identifying suicide or suicidal ideation using administrative or claims data. Pharmacoepidemiol Drug Saf. 2012 Jan;21(Suppl 1):174–82.
36 Crandall C, Fullerton-Gleason L, Aguero R, LaValley J. Subsequent suicide mortality among emergency department patients seen for suicidal behavior. Acad Emerg Med. 2006 Apr;13(4):435–42.