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Racial differences in utilization of life-sustaining versus curative inpatient procedures after stroke

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Inpatient procedures are integral to routine stroke care. Common non-diagnostic procedures after stroke include intravenous thrombolysis (IVT), mechanical ventilation, hemicraniectomy, carotid revascularization (endarterectomy/stenting), gastrostomy, and tracheostomy. While some of these procedures are considered curative, aiming at improving functional status (IVT) or preventing further stroke (carotid revascularization), others are considered life-sustaining by preventing death in the short-term (mechanical ventilation, hemicraniectomy) or long-term (gastrostomy, tracheostomy). Race disparities among some stroke-related procedures have been described¹, but a comprehensive comparison of procedure utilization by patients from different racial groups after stroke is lacking. In the present study we compared racial differences in the use of six common non-diagnostic inpatient procedures after stroke; we hypothesized that curative procedures are underutilized, while life-sustaining procedures are overutilized in minorities.

Methods

Data were obtained from the Nationwide Inpatient Sample². We identified cases with the primary diagnosis of ischemic stroke by using *International Classification of Diseases* version 9 Clinical Modification (ICD9-CM) codes 433.01/433.11/433.21/433.31/433.81/433.91/434.01/434.11/434.91/436 between 2007 and 2011³. For hemicraniectomy analysis we excluded posterior circulation strokes (ICD9-CM codes 433.01/433.21). In order to determine carotid revascularization only among strokes associated with carotid disease, we restricted the analysis to cases with ICD9-CM codes 433.11/433.31/433.91. Procedures were identified with the following ICD9-CM codes: 43.11 (gastrostomy), 96.70/96.71/96.72/96.04 (mechanical ventilation), 31.1/31.21/31.29 (tracheostomy), 99.10 (IVT), 01.24/01.25 (hemicraniectomy), and 38.12/00.63 (carotid revascularization). End-of-life care was identified by ICD9-CM code V66.7.

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Patients with and without each procedure were compared using Chi-squared and Wilcoxon rank-sum tests for categorical and continuous variables (Stata version 13; College Station, TX), respectively. Logistic regression was used to assess the association between race and the respective procedure. A p-value of <0.05 was considered statistically significant.

Results

Patients undergoing life-sustaining procedures were more likely to be of a minority race than those not undergoing such procedures (38.4% versus 29.5% for gastrostomy; 48.0% versus 29.8% for tracheostomy; 36.5% versus 29.6% for mechanical ventilation; 46.9% versus 29.8% for hemicraniectomy; $p<0.001$ for all; table). In contrast, 27.4% of patients who underwent IVT were minorities, while 30.3% of cases who did not receive IVT were of a race other than white ($p<0.001$). Similarly, minorities constituted only 17.4% of those who underwent carotid revascularization, while representing 24.6% of patients who were not revascularized ($p<0.001$).

In fully adjusted multivariable models, minorities had significantly higher odds of gastrostomy (OR 1.56, 95% CI 1.48–1.65), tracheostomy (OR 1.44, 95% CI 1.30–1.61), mechanical ventilation (OR 1.16, 95% CI 1.09–1.24), and hemicraniectomy (OR 1.36, 95% CI 1.11–1.66) when compared to whites (Figure). In contrast, the adjusted odds of IVT (OR 0.80, 95% CI 0.75–0.86) and carotid revascularization (OR 0.57, 95% CI 0.50–0.66) were significantly lower in minorities compared to whites.

Discussion

We report underutilization of procedures with curative intent (IVT and carotid revascularization), and overutilization of life-sustaining procedures (gastrostomy, tracheostomy, mechanical ventilation, and hemicraniectomy) in ethnic minority stroke patients. These results persisted after accounting for severity of medical comorbidities, end-of-life care, and in-hospital mortality, but we acknowledge that clinical characteristics not captured in NIS, such as stroke severity, stroke location, and time-to-presentation, may partially explain our results.

Of note, both procedure groups differ in their strength of supporting evidence. While IVT and carotid revascularization have a long-standing track-record of efficacy, convincing evidence supporting the use of gastrostomies and tracheostomies after stroke is lacking^{4,5}. Hemicraniectomy after hemispheric stroke has been demonstrated to reduce mortality predominantly at the expense of increasing the proportion of patients with moderate/moderately severe disability, particularly in patients above the age of 60 years⁶; therefore, we considered hemicraniectomy a life-sustaining procedure.

Contrasting differences among procedure groups may allow for a bird's-eye view on stroke-related procedure utilization. A better understanding of commonalities within and differences between curative and life-sustaining procedures may facilitate the development of effective strategies aimed at eliminating racial disparities in delivery of stroke care.

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Figure.

Forest plot; graphic representation of odds ratios and 95% confidence intervals of six common stroke-related inpatient procedure in minorities compared to whites (reference). All models we adjusted for sociodemographic factors (age, sex, insurance status, median household income per patient's ZIP code), hospital characteristics (teaching status, bed size, location, region, and annual volume of stroke cases, discharge quarter, weekend admission status), as well as medical comorbidities and disease severity measures (hypertension, diabetes mellitus, dyslipidemia, coronary artery disease, peripheral vascular disease, congestive heart failure, atrial fibrillation, valvular disease, chronic kidney disease, anemia, thrombocytopenia, alcohol abuse, drug abuse, modified Charlson Comorbidity Index, APR-DRG severity subclass). With the exception of analysis of IVT as the outcome of interest, all models were also adjusted for end-of-life care, in-hospital mortality, and the use of IVT. Some models were additionally adjusted for common complications such as pneumonia, urinary tract infection, sepsis, gastrointestinal bleeding, deep vein thrombosis, pulmonary embolism, and hemicraniectomy (for analysis of tracheostomy, gastrostomy, mechanical ventilation, and carotid revascularization).

Table

Baseline characteristics of the study population by procedure type. PI: Pacific Islander. Numbers given are n (%) unless stated otherwise.

Characteristic	Gastrostomy (n=340,463)		Tracheostomy (n=340,463)		Mechanical Ventilation (n=340,463)		Hemi- craniectomy (n=337,111)		IV Thrombolysis (n=337,214)		Carotid revascularization (n=20,553)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
N	15,490	324,973	2,218	338,245	14,107	326,356	731	336,380	15,838	321,376	3,592	16,961
Age – years: median (IQR)	77 (66–85)	73 (61–83)	66 (55–76)	73 (61–83)	71 (59–81)	73 (61–83)	55 (46–63)	73 (61–83)	72 (59–82)	73 (61–83)	70 (62–78)	72 (61–81)
Female	8,451 (54.6)	172,763 (53.2)	982 (44.3)	180,232 (53.3)	6,817 (48.3)	174,397 (53.4)	307 (42.0)	179,691 (53.4)	7,969 (50.3)	171,695 (53.4)	1,348 (37.5)	7,781 (45.9)
Race												
White	9,546 (61.6)	229,188 (70.5)	1,154 (52.0)	237,580 (70.2)	8,961 (63.5)	229,773 (70.4)	388 (53.1)	236,105 (70.2)	11,506 (72.6)	223,881 (69.7)	2,967 (82.6)	12,783 (75.4)
Black	3,387 (21.9)	53,938 (16.6)	614 (27.7)	56,711 (16.8)	2,813 (19.9)	54,512 (16.7)	175 (23.9)	56,551 (16.8)	2,294 (14.5)	55,244 (17.2)	242 (6.7)	2,190 (12.9)
Hispanic	1,399 (9.0)	23,354 (7.2)	242 (10.9)	24,511 (7.3)	1,276 (9.1)	23,477 (7.2)	91 (12.5)	24,397 (7.3)	1,073 (6.8)	23,780 (7.4)	212 (5.9)	1,135 (6.7)
Asian/PI	571 (3.7)	8,515 (2.6)	89 (4.0)	8,997 (2.7)	483 (3.4)	8,603 (2.6)	39 (5.3)	8,933 (2.7)	428 (2.7)	8,693 (2.7)	59 (1.6)	364 (2.2)
Other	587 (3.8)	9,978 (3.10)	119 (5.4)	10,446 (3.1)	574 (4.1)	9,991 (3.1)	38 (5.2)	10,394 (3.1)	537 (3.4)	9,778 (3.0)	112 (3.1)	489 (2.9)
All minorities	5,944 (38.4)	95,785 (29.5)	1,064 (48.0)	100,665 (29.8)	5,146 (36.5)	96,583 (29.6)	343 (46.9)	100,275 (29.8)	4,332 (27.4)	97,495 (30.3)	625 (17.4)	4,178 (24.6)
Health Insurance												
Private	1,989 (12.8)	63,857 (19.7)	481 (21.7)	65,365 (19.3)	2,763 (19.6)	63,083 (19.3)	290 (39.7)	64,535 (19.2)	3,853 (24.3)	61,180 (19.0)	837 (23.3)	3,481 (20.5)
Medicaid	1,338 (8.6)	21,722 (6.7)	383 (17.3)	22,677 (6.7)	1,464 (10.4)	21,596 (6.6)	160 (21.9)	22,612 (6.7)	1,106 (7.0)	21,619 (6.7)	193 (5.4)	1,202 (7.1)
Medicare	11,454 (73.9)	213,482 (65.7)	1,196 (53.9)	223,740 (66.2)	8,752 (62.0)	216,184 (66.2)	191 (26.1)	223,079 (66.3)	9,640 (60.9)	213,539 (66.5)	2,179 (63.5)	10,922 (64.4)
Self-pay	430 (2.8)	8,957 (5.0)	86 (3.9)	16,645 (4.9)	711 (5.0)	16,020 (4.9)	50 (6.8)	16,434 (4.9)	788 (5.0)	15,681 (4.9)	187 (5.2)	815 (4.8)
Median household income per ZIP code												
Quartile 1	5,080 (32.8)	92,030 (28.3)	765 (34.5)	96,345 (28.5)	4,329 (30.7)	92,781 (28.4)	224 (30.6)	96,038 (28.6)	3,708 (23.4)	91,921 (28.6)	915 (25.5)	4,726 (27.9)

Characteristic	Gastrostomy (n=340,463)		Tracheostomy (n=340,463)		Mechanical Ventilation (n=340,463)		Hemi- craniectomy (n=337,111)		IV Thrombolysis (n=337,214)		Carotid revascularization (n=20,553)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Quartile 2	3,692 (23.8)	81,075 (25.0)	541 (24.4)	84,226 (24.9)	3,371 (23.9)	81,396 (24.9)	171 (23.4)	83,741 (24.9)	3,626 (22.9)	79,775 (24.8)	970 (27.0)	4,232 (25.0)
Quartile 3	3,390 (21.9)	75,235 (23.2)	434 (19.6)	78,191 (23.1)	3,138 (22.2)	75,487 (23.1)	169 (23.1)	77,672 (23.1)	3,945 (24.9)	74,195 (23.1)	896 (24.9)	4,037 (23.8)
Quartile 4	2,976 (19.2)	69,701 (21.5)	411 (18.5)	72,266 (21.4)	2,914 (20.7)	69,763 (21.4)	146 (20.0)	71,729 (21.3)	4,208 (26.6)	68,636 (21.4)	729 (20.3)	3,564 (21.0)
Teaching Hospital	7,570 (48.9)	143,290 (44.1)	1,451 (65.4)	149,409 (44.2)	8,480 (60.1)	142,380 (43.6)	577 (78.9)	148,200 (44.1)	8,857 (55.9)	134,689 (41.9)	1,981 (55.2)	7,735 (45.6)
Hospital stroke case volume/year												
Quartile 1	2,897 (18.7)	83,064 (25.6)	260 (11.7)	85,701 (25.3)	1,881 (13.3)	84,080 (25.8)	34 (4.7)	84,806 (25.2)	1,618 (10.2)	83,061 (25.8)	786 (21.9)	4,851 (28.6)
Quartile 2	3,909 (25.2)	80,542 (24.8)	476 (21.5)	83,975 (24.8)	3,222 (22.9)	81,229 (24.9)	120 (16.4)	83,709 (24.9)	3,668 (23.2)	81,783 (25.5)	769 (21.4)	4,082 (24.1)
Quartile 3	4,173 (26.9)	81,211 (25.0)	630 (28.4)	84,754 (25.1)	3,994 (28.3)	81,390 (24.9)	236 (32.3)	84,540 (25.1)	4,723 (29.8)	78,547 (24.4)	933 (26.0)	4,146 (24.4)
Quartile 4	4,511 (29.1)	80,156 (24.7)	852 (38.4)	83,815 (24.8)	5,010 (35.5)	79,657 (24.4)	341 (46.7)	83,325 (24.8)	5,829 (36.8)	77,985 (24.3)	1,104 (30.7)	3,882 (22.9)
Charlson Comorbidity Index												
1	2,070 (13.4)	92,295 (28.4)	403 (18.2)	93,962 (27.8)	2,630 (18.6)	91,735 (28.1)	141 (19.3)	92,973 (27.6)	3,192 (20.2)	90,248 (28.1)	945 (26.3)	3,898 (23.0)
2	2,268 (14.6)	75,373 (23.2)	395 (17.8)	77,246 (22.8)	2,435 (17.3)	75,206 (23.0)	78 (10.7)	76,681 (22.8)	2,153 (13.6)	75,025 (23.3)	893 (24.9)	3,467 (20.4)
3	4,172 (26.9)	67,591 (20.8)	582 (26.2)	71,181 (21.0)	3,634 (25.8)	68,129 (20.9)	297 (40.6)	70,878 (21.1)	4,819 (30.4)	66,236 (20.6)	774 (21.6)	4,101 (24.2)
4	6,980 (45.1)	89,714 (27.6)	838 (37.8)	95,856 (28.3)	5,408 (38.3)	91,286 (28.0)	215 (29.4)	95,848 (28.5)	5,674 (35.8)	89,867 (28.0)	980 (27.3)	5,495 (32.4)