



The importance and challenge of comparing stroke care, utilization and outcomes in Medicare Advantage and Fee-for-Service Medicare: a narrative review and vision for the future

Emily J. Bian¹, Priyanka Menon² , Kathleen A. McManus³ , Timothy J. Layton⁴ ,
Bradford B. Worrall⁵  & Jonathan R. Crowe^{*,5,6,7} 

¹University of Virginia School of Medicine, Charlottesville, VA 22903, USA

²Medical College of Georgia, Augusta University, Augusta, GA 30912, USA

³Division of Infectious Diseases & International Health, University of Virginia School of Medicine, Charlottesville, VA 22903, USA

⁴Frank Batten School of Leadership & Public Policy, University of Virginia, Charlottesville, VA 22903, USA

⁵Department of Neurology, University of Virginia School of Medicine, Charlottesville, VA 22903, USA

⁶Department of Public Health Sciences, University of Virginia School of Medicine, Charlottesville, VA 22903, USA

⁷Miller Center for Public Affairs, University of Virginia, Charlottesville, VA 22904, USA

*Author for correspondence: jrc8z@uvahealth.org

Stroke prevalence is highest in adults ≥ 65 years, the majority of whom are Medicare beneficiaries. Fee-for-Service Medicare (FFS) incentivizes utilization by paying for each service. Medicare Advantage (MA) uses capitated payments to reduce overutilization. It is not clear if stroke patients with FFS or MA receive different stroke preventive care and whether those differences are associated with differences in post-acute care utilization, cost and clinical outcomes. We performed an empirical narrative review of published peer-reviewed studies in the PubMed, EMBASE and Web of Science databases comparing stroke preventive care between FFS and MA using the American Heart Association's Life's Essential 8 and American Heart Association/American Stroke Association national guidelines. We added atrial fibrillation (AF), post-acute care utilization and outcomes, including mortality. 7/1356 studies met inclusion criteria. Studies were heterogeneous in their design and settings. There was limited availability of clinical data. Within those limitations, published studies suggest that MA appears to allow for guideline-directed stroke preventive care for hyperlipidemia, smoking cessation and AF in specific study populations. Post-acute care utilization was generally lower in MA. Functional outcomes improvements were similar but occurred in fewer days in MA, though the absence of acute stroke treatment data is notable. Mortality data were mixed. Given the importance of stroke in Medicare and the growth in MA enrollment, comparing the effectiveness of MA and FFS warrants further study among appropriately matched MA and FFS beneficiaries with stroke.

Plain language summary

What is this article about? Stroke is a leading cause of long-term disability and mortality in the US. Most US stroke patients are Medicare beneficiaries, and Medicare pays for most US stroke care. However, little is known about whether growing enrollment in Medicare Advantage (MA) impacts stroke patients' access to preventive care, access to post-acute care, or their outcomes. In this narrative review, we examine peer reviewed studies that compare stroke care in MA and Fee-for-Service Medicare.

What was found? Heterogeneity in study design, study settings and reporting of patient characteristics limit broad comparisons. Within those limits, published studies suggest that MA allows for access to stroke preventive care in specific guideline-directed categories. Post-acute care utilization is lower in MA than Fee-for-Service, but functional gains appear similar. Hospital readmission rates are lower in MA, while rates of community living are higher.

Why is this important? Further research is needed to clarify these dynamics, including the degrees to which differences in prestroke health status, level of social support, access to acute stroke treatment and insurance networks may influence differences in outcomes.

First draft submitted: 30 September 2025; Accepted for publication: 18 December 2025; Published online: 12 January 2026

Keywords: American Heart Association • health policy • hyperlipidemias • Medicare Part C • metabolic diseases • prevalence • smoking cessation • stroke • United States

Stroke is a common and expensive condition that requires preventive care, acute treatment and rehabilitation to avoid recurrence, disability and death. Insurance status impacts stroke preventive care, acute treatment, in-hospital mortality and access to rehabilitation [1,2]. Stroke prevalence notably increases with age, and two-thirds of those hospitalized with stroke are 65 years and older [3,4]. The vast majority of people in the US who are 65 years and older are Medicare beneficiaries [5]. Medicare is the largest payer in the US health system, and stroke is a major driver of Medicare spending [4,6,7]. More than 70% of all US stroke patients are Medicare beneficiaries, and Medicare pays for approximately 75% of all US stroke care [8]. Stroke's impact on patients who are Medicare beneficiaries and its contribution to Medicare costs have led to recent increasing interest in preventing strokes and improving stroke outcomes in Medicare, especially for beneficiaries in traditional Fee-for-Service (FFS) Medicare [4,7,9–12].

Amidst this growing interest, Medicare is changing significantly. As of 2024, more than 54% of Medicare beneficiaries are enrolled in Medicare Advantage (MA), a private health insurance option that offers beneficiaries an alternative to FFS [13,14]. MA and FFS operate under different structures. FFS pays providers for each service rendered with no limit in the amount paid per year, which could potentially create financial incentives for overutilization [11]. In MA, private health insurance plans receive fixed or capitated prospective payments to cover Medicare beneficiaries. Since these private plans are effectively the residual claimant on any savings generated by keeping spending below that payment, this creates incentives to contain costs through a variety of methods – including narrowed networks, utilization control measures like prior authorization, and coordinated care models – that are not typically used in FFS [15–18]. Further, competition for enrollees among MA and between MA and FFS potentially ensures that MA plans do not cut ‘too much’, as doing so would cause them to lose market share and earn fewer profits.

The differences between MA and FFS have led to growing interest in how those differences impact quality of care and utilization [17–21]. Researchers and policymakers also have raised historical concerns about favorable selection in MA, where healthier and relatively lower-cost beneficiaries disproportionately enroll in MA, and have questioned whether MA's screening practices for vascular risk factors are more aggressive than FFS [14,22]. More recently, the American Heart Association/American Stroke Association (AHA/ASA) released a policy statement highlighting concerns about the growing impact of MA on post-acute care utilization in stroke and emphasizing the need for more research in this area [23]. While prior research has examined the impact of insurance status on stroke care and post-acute utilization – including differences between the uninsured, privately insured, Medicare and Medicaid – the degree to which these evolving dynamics within Medicare may impact stroke care and outcomes has not been well characterized [1,2].

In this review, we sought to address this gap by examining published peer-reviewed research comparing AHA/ASA guideline-directed stroke care, utilization and outcomes for beneficiaries enrolled in FFS and MA. We aimed to determine whether there are clear clinical differences between stroke patients in MA and FFS, whether guideline-directed preventive stroke care differs between MA and FFS in published studies, and whether differences in preventive care and post-acute care in MA and FFS appear to influence outcomes for Medicare beneficiaries with stroke. Comparing the effectiveness of MA and FFS for Medicare beneficiaries with stroke is essential to informing strategies for improving stroke care delivery and better understanding the role of health policy within stroke systems of care [24].

Materials & methods

To review differences in stroke prevention, utilization and outcomes in MA and FFS, we conducted an empirical narrative review using Boolean search terms in PubMed, Embase and Web of Science to identify articles comparing MA and FFS with a focus on preselected, specific categories relevant to stroke [25]. To reinforce a methodology structure that addresses potential selection bias, we followed guidance from the Agency for Healthcare Research and Quality (AHRQ) on conductive comparative effectiveness reviews [26]. The Population, Intervention, Comparator, and Outcomes framework was used as a guide for a systematic approach by focusing on stroke patients in Medicare (population), MA coverage (intervention), comparisons to FFS (comparator) and Outcomes mentioned

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Compares MA and FFS on Life's Essential 8, AF, post-acute care utilization, spending, or outcome	Study uses pre-2003 data
≥20% study population with stroke	
Stroke patients in Medicare	
AF: Atrial fibrillation; FFS: Fee-for-Service Medicare; MA: Medicare Advantage.	

Table 2. Search strategies.

Database	PubMed
Date searched	25 November 2024
Search terms	(stroke OR cholesterol OR statin OR diabetes OR metformin OR sulfonylurea OR "blood pressure" OR hypertension OR "atrial fibrillation" OR "postacute care" OR "post acute care" OR "diet" OR "dietary counseling" OR "smoking cessation" OR "topamax" OR "nicotine replacement therapy" OR "varenicline" OR "tobacco cessation counseling" OR "sleep apnea" OR "bipap" OR "cpap" OR ("stroke" AND ("specialist" OR "cardiologist" OR "stroke specialist")) AND ("medicare advantage" OR "medicare part C" OR "medicare plus" OR "medicare plus choice")
Results returned	461
Database	EMBASE
Date searched	28 September 2024
Search terms	('stroke'/exp OR stroke OR 'cholesterol'/exp OR cholesterol OR 'diabetes'/exp OR diabetes OR 'blood pressure'/exp OR 'blood pressure' OR 'hypertension'/exp OR hypertension OR 'atrial fibrillation'/exp OR 'atrial fibrillation' OR 'post acute care'/exp OR 'post acute care' OR 'diet' OR 'diet'/exp OR 'dietary counseling' OR 'dietary counseling'/exp OR 'smoking cessation' OR 'smoking cessation'/exp OR 'topamax' OR 'topomax'/exp OR 'nicotine replacement therapy' OR 'varenicline' OR 'tobacco cessation counseling' OR 'sleep apnea' OR 'sleep apnea'/exp OR 'bipap' OR 'bipap'/exp OR 'cpap' OR 'cpap'/exp OR ('stroke' AND ('specialist' OR 'specialist'/exp OR 'cardiologist' OR 'cardiologist'/exp OR 'stroke specialist') AND ('medicare advantage'/exp OR 'medicare advantage' OR 'medicare part c'/exp OR 'medicare part c' OR 'medicare plus' OR 'medicare plus choice') AND ('traditional medicare'/exp OR 'traditional medicare' OR 'fee for service medicare') OR 'prescription drug plans')
Results returned	439
Database	Web of Science
Date searched	10 November 2024
Search terms	(stroke OR cholesterol OR statin OR diabetes OR metformin OR sulfonylurea OR "blood pressure" OR hypertension OR "atrial fibrillation" OR "postacute care" OR "post-acute care" OR "diet" OR "dietary counseling" OR "smoking cessation" OR "topamax" OR "nicotine replacement therapy" OR "varenicline" OR "tobacco cessation counseling" OR "sleep apnea" OR "bipap" OR "cpap" OR ("stroke" AND ("specialist" OR "cardiologist" OR "stroke specialist")) AND ("medicare advantage" OR "medicare part C" OR "medicare plus" OR "medicare plus choice")
Results returned	456

in AHA/ASA guidelines, including evidence-based care, utilization related to evidence-based care, and outcomes, such as mortality [25,27,28]. To select appropriate frameworks for Outcomes, we chose categories of stroke preventive care based on the American Heart Association's Life's Essential 8, which provides an evidence-based approach to stroke and cardiovascular prevention and management [29]. We used the AHA/ASA secondary risk reduction guideline to assess risk factor control and the AHA/ASA stroke rehabilitation and recovery guideline to assess post-acute care utilization [28,30].

We further followed AHRQ guidance by choosing Timing relevant to our specific study. To ensure that the results of our review are relevant to current policy, we mirrored an approach used by other researchers and excluded studies performed with data prior to 2003, when the Medicare Modernization Act created the modern MA program ([Supplementary Material](#)) [31]. Because our review is intended to study both stroke prevention in the outpatient setting and stroke rehabilitation in multiple post-acute care settings (i.e., inpatient rehabilitation facility and skilled nursing facility), we chose not to restrict our review to one specific Setting. This approach standardized the selection process using the comparative effectiveness methodology that AHRQ recommends while also helping to ensure adherence to our inclusion and exclusion criteria. We selected clear, precise inclusion criteria to limit ambiguity while also allowing for reproducibility (Table 1) [26]. Search terms were individually tailored to each category, then compiled and adapted for each search modality (Table 2). Search results were uploaded to Covidence, an online review platform available through our institution. Studies were sorted and tracked using that platform.

Decisions to include or exclude studies were made by authors, not the online platform. For our study selection process, we followed AHRQ guidance and used dual review to create a methodological structure to guard against

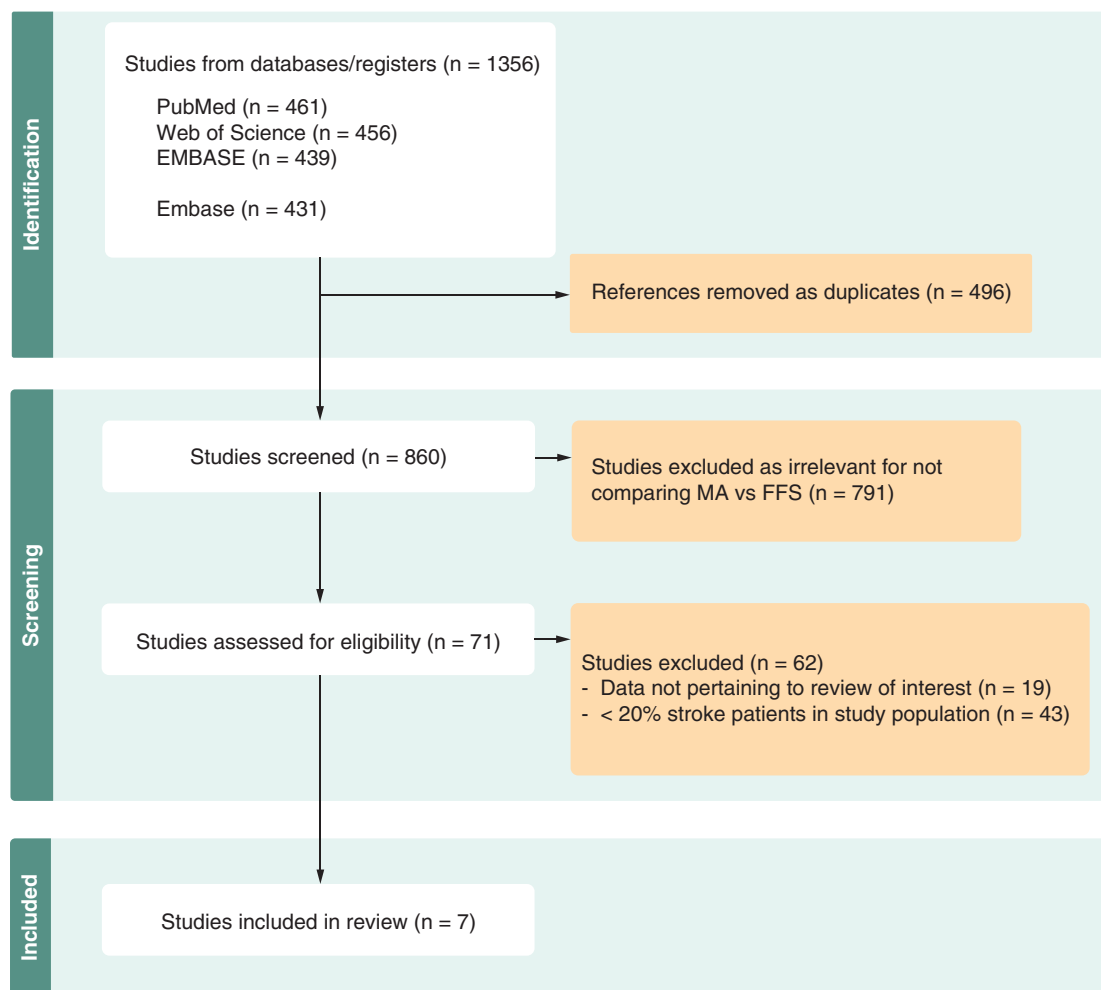


Figure 1. Study selection flowchart and results.

Data taken from [32–38].

FFS: Fee-for-Service Medicare; MA: Medicare Advantage.

selection bias. Two authors (EJ Bian and P Menon) independently assessed studies at each stage, including for inclusion and exclusion [26]. The first step was a screening the title and abstracts for possible eligibility. Studies were excluded during the initial screening of title and abstract if they did not compare MA to FFS. If studies were considered candidates for inclusion, then the full text was reviewed. Studies were excluded on full text review if the study metrics were irrelevant to our inquiry or did not specify a stroke population. Decisions to include and exclude studies were compared, and the senior author resolved differences that could not be resolved through discussion [26]. Two authors (EJ Bian and P Menon) performed dual review of the full-text articles which were deemed eligible for inclusion in the comparative review. These two authors then presented these studies to the senior author for final review. The flowchart and final results are presented in [Figure 1](#).

An initial dual review found that few studies existed that directly compared MA and FFS in stroke exclusively. We iteratively sought to increase the search yield by including study populations with known stroke risk factors, such as diabetes, if the study population included $\geq 20\%$ stroke patients. We reported on data related to Life's Essential 8. We added atrial fibrillation (AF) given its contribution to stroke risk and its presence in AHA/ASA national guidelines [28,39].

We also sought to increase our search yield by examining studies with different data sources. Notably, Medicare beneficiaries can enroll in standalone prescription drug plans (PDP) to supplement FFS or in MA plans that include prescription drug coverage (Medicare Advantage Prescription Drug Plans, i.e., MAPD) [40]. We thus searched for studies examining differences in prescription drug practices between PDP and MAPD as a proxy for comparing

Table 3. Articles from systematic search included in empirical narrative review.

Author (year)	Study type	Data source	Total	Stroke patients	Relevant categories
Cao Y <i>et al.</i> (2023)	Multiyear retrospective cross-sectional study	Inpatient Rehabilitation Facility-Patient Assessment Instrument	266,558	50.89%	Post-acute care utilization, cost
Cao Y <i>et al.</i> (2020)	Multiyear retrospective cross-sectional study	Uniform Data System for Medical Rehabilitation	1,028,470	45.99%	Post-acute care utilization
Essien UR <i>et al.</i> (2022)	Retrospective cohort study	Diabetes Collaborative Registry linked to CMS claims data via Medicare Beneficiary Summary File	345,911	20.14%	Quit tobacco, cholesterol control, blood glucose management, blood pressure management
Huckfeldt PJ <i>et al.</i> (2017)	Retrospective cross-sectional study	Medicare Provider Analysis and Review File, Master Beneficiary Summary File, Minimum dataset (SNF), Inpatient Rehabilitation Facility Patient Assessment Instrument (IRF), Provider of Services File, Hospital Compare, and Hospital Cost Reports	2,212,238	21.75%	Blood glucose management, blood pressure management, manage weight, post-acute care utilization, post-stroke outcomes, cost, mortality
Luo D <i>et al.</i> (2024)	Retrospective multiyear cross-sectional study	Inpatient Rehabilitation Facility-Patient Assessment Instrument data provided by Uniform Data System for Medical Rehabilitation	72,794	100%	Post-acute care utilization
Newman TV <i>et al.</i> (2022)	Retrospective cohort study	CMS Medicare claims data for standalone prescription drug plan, Medicare Advantage Prescription Drug Plan for large, regional health plan in Pennsylvania	7053 (unmatched) 5074 (propensity-score matched)	23.15% (unadjusted) 23.02% (adjusted)	Anticoagulation for AF
Skopec L. <i>et al.</i> (2020)	Retrospective cross-sectional study	Medicare Provider Analysis and Review file, Minimum dataset, Inpatient Rehabilitation Facility Patient Assessment Instrument, Home Health Outcome and Assessment Information Set, Master Beneficiary Summary File	1,188,030	21.32%	Blood glucose management, blood pressure management, manage weight, post-acute care utilization, post-stroke outcomes, mortality

AF: Atrial fibrillation; CMS: Centers for Medicare and Medicaid Services

prescription drug practice for beneficiaries likely enrolled in FFS (i.e., PDP) and beneficiaries enrolled in MA (i.e., MAPD). In addition, we searched for studies comparing post-acute care utilization, gains in functional independence and mortality between FFS and MA.

In the iterative process, we continued to use dual review with oversight of a senior reviewer. We did not identify published studies that distinguished consistently between transient ischemic attack, ischemic stroke and hemorrhagic stroke. We thus chose to focus on published studies with stroke patients in Medicare and to note data on subtypes of strokes patients if it was feasible and relevant to our study. We did not perform any statistical tests and only report primary articles' pertinent statistical tests.

Results

Our search yielded 1356 publications, with 71 publications (5.2%) assessed in full. Seven publications (0.5%) met our inclusion and exclusion criteria (Figure 1). Five Life's Essential 8 categories – tobacco cessation, cholesterol management, blood glucose control, blood pressure management and weight control – were identified in the literature. Among Life's Essential 8 areas, we did not find any studies comparing physical activity, sleep and diet in Medicare beneficiaries with stroke. We included one study comparing prescription drug differences between PDP and MAPD as a proxy for comparing beneficiaries' experience in FFS (i.e., PDP) and MA (i.e., MAPD). Study populations ranged from 5074 beneficiaries to 2,212,238 beneficiaries with 20.6 to 100% stroke patients (Table 3). Only one article directly compared FFS and MA for stroke patients exclusively. Data sources varied, but Inpatient Rehabilitation Facility-Patient Assessment Instrument, Centers for Medicare and Medicaid Services (CMS) data, disease registry data linked to CMS data and regional health plan data were noted as important sources (Table 3).

Study design

All studies were retrospective, but important study characteristics were notably heterogeneous. Two studies were retrospective cohort studies [32,33]. Five were retrospective cross-sectional studies [34–38]. Clinical contexts also differed. All five retrospective cohort studies examined post-acute care utilization [34–38]. One retrospective cohort study focused exclusively on quality of outpatient care for diabetic patients [32]. Another retrospective cohort study compared oral anticoagulation use and adherence in patients with AF [33]. Of the studies meeting our criteria, only one study focused exclusively on stroke patients [36].

Clinical characteristics

There were notable differences in terms of the reporting of clinical characteristics between MA and FFS across studies. The two retrospective cohort studies provided the most complete reporting of patient characteristics, which likely reflects the data sources. One linked a diabetes quality improvement registry to Medicare claims data using the Medicare Beneficiary Summary File [32]. This allowed identification of patients' Medicare status (FFS vs MA), demographics (age, race/ethnicity, income), and more detailed clinical information, such as medical history including stroke and vascular risk factors for stroke, medications, vital signs (including BMI) and laboratory values. Both MA and FFS patients were predominantly in their mid-70s and White, though MA patients were less likely to be White. Patients in MA were more likely to be enrolled in Medicaid, live in an area with a lower median income and receive care from a cardiologist or endocrinologist. Most MA and FFS patients had hypertension and dyslipidemia, but there were no significant differences between MA and FFS in the prevalence of hypertension, dyslipidemia, heart failure, coronary artery disease, AF, peripheral artery disease, stroke or transient ischemic attack, myocardial infarction, atherosclerotic cardiovascular disease, tobacco use or other medical comorbidities. Forthcoming sections discuss reporting of important values for stroke risk reduction, such as BMI, LDL-C and HgbA1C.

The second retrospective cohort study compared a regional health plan's data on MAPD beneficiaries to Medicare data on beneficiaries in standalone PDPs in the same region [33]. This study used claims data to look for AF and the co-morbidities necessary to calculate patients' CHA₂DS₂-VASc score (congestive heart failure, hypertension, age, diabetes and prior history of stroke). This was done to compare oral anticoagulation use and adherence in patients with AF and a CHA₂DS₂-VASc score ≥ 2 . Due to the reliance of claims data, important clinical values such as laboratory data and vital signs were notably absent. This study identified 2551 patients meeting their study criteria in standalone Part D PDPs and 4502 patients meeting their study criteria in the MAPD. This study then used demographics and clinical characteristics to create covariates. Covariates included a history of congestive heart failure, hypertension, acute myocardial infarction, renal disease, liver disease, diabetes, stroke or transient ischemic attack, intracranial hemorrhage or major bleeding. Prior use of nonsteroidal inflammatory drugs, antiplatelet drugs or anticoagulants was used to calculate patients' HAS-BLED scores, but labile INR was excluded due to the absence of laboratory values in Medicare claims data. The authors used these demographics and clinical characteristics to create an MAPD cohort and a standalone PDP cohort, which were then matched using propensity scoring. Before matching, MAPD patients tended to be younger, male, and to have more 0–1 HAS-BLED scores. MAPD patients also had lower prevalence of congestive heart failure, hypertension and renal disease. Prevalence of stroke or transient ischemic attack and intracranial bleeding were the same in the MAPD cohort and the standalone PDP cohort. Propensity scoring eliminated those differences in the study, and analyses in the study primarily relied on comparing the matched cohorts.

Retrospective cross-sectional studies meeting our criteria provided less detailed clinical information. One study used nationally representative data from the Inpatient Rehabilitation Facility-Patient Assessment Instrument (IRF-PAI) from 2007 to 2016 found that stroke patients in MA were slightly younger and more likely to be black or Hispanic [34]. However, clinical data were limited. Patients were characterized into minor, moderate and major comorbidity tiers without any detailed description of vascular risk factor prevalence or control [34]. Two nationally representative studies of post-acute care in the COVID-19 pandemic used 2019–2020 IRF-PAI data to similarly assign patients into minor, moderate and major comorbidity tiers, but they did not provide more descriptive clinical data or compare comorbidity tiers between MA and FFS or provide more detailed comorbidity data [35,36].

Two other studies linked IRF-PAI to nationally representative Medicare data from 2011–2013 and 2015–2016, respectively [37,38]. In terms of MA and FFS cohort characteristics, the 2011–2013 study found that a higher percentage of MA than FFS patients were male, younger and non-Hispanic black. A lower percentage of MA patients were non-Hispanic white. Dual eligibility was similar between groups, but more MA patients were eligible

for a Part D Low-Income Subsidy. The total number of comorbidities did not differ between MA and FFS. The percentage of hemorrhagic stroke was slightly lower in MA. The 2015–2016 cohort study found that MA patients were younger, less likely to be female, less likely to be non-Hispanic white, more likely to be non-Hispanic black, and more likely to be eligible for a Part D Low-Income Subsidy. Similar rates of hemorrhagic stroke were reported between MA and FFS. There were slightly more total comorbidities reported in MA compared with FFS. In both studies, authors notably compared percentages of MA and FFS patients with diabetes, diabetes with complication, hypertension and obesity. While differences in those specific comorbidities will be discussed in upcoming sections, there notably was no reporting of how well controlled any of those comorbidities were at the time of the study.

Life's essential 8 categories (Table 4)

Tobacco cessation

One study linking a US-based quality improvement registry to a national Medicare file with FFS and MA beneficiaries compared tobacco use and tobacco cessation practices in MA and FFS. Current tobacco use was higher among MA beneficiaries than FFS beneficiaries (31.0 vs 26.7%, standardized difference 10.2%) [32]. In patients with a stroke or Transient Ischemic Attack (TIA) who smoke tobacco, national guidelines give a Level IA recommendation to recommend counseling to assist in quitting smoking [28]. MA beneficiaries were more likely to undergo tobacco cessation counseling (20.0 vs 16.9%; adjusted odds ratio 1.05, 95% CI: 1.02–1.09) [32].

Cholesterol control

The same study reported higher LDL cholesterol levels (LDL-C) among MA beneficiaries compared with FFS (81.5 vs 78.9 mg/dl, $p < 0.001$) [32]. Noting that greater than 60% of both MA and FFS beneficiaries in this study have atherosclerotic cardiovascular disease, both groups have LDL-C levels above the Level IA recommendation, and both would be recommended for a statin and ezetimibe if necessary to achieve an LDL-C ≤ 70 mg/dl [28,32]. Statin prescription rates were statistically significantly higher in MA than FFS (72.0 vs 70.6%, standardized difference = 32%) [32]. PCSK9 inhibitor and ezetimibe prescription rates were similar in MA and FFS.

Blood glucose management

One study used a series of nationally representative CMS data sources to study patients in inpatient rehabilitation facilities (IRF) and skilled nursing facilities (SNF) [37]. It found a modestly higher percentage of MA beneficiaries than FFS beneficiaries had diabetes (28.7 vs 28.2%, adjusted difference 2.2%, $p < 0.05$) and diabetes with complications (7.0 vs 4.8%, adjusted difference 0.8%, $p < 0.05$) [37]. A follow-up study using more recent nationally representative CMS data to study utilization of IRFs, SNFs and Home HealthCare also found a higher percentage of MA beneficiaries with stroke had diabetes without complications (23.1 vs 22.3%, $p < 0.01$) and diabetes with complications (17.5 vs 14.5%, $p < 0.01$) compared with FFS beneficiaries with stroke [38].

A third study that linked a US diabetes quality improvement registry to national Medicare data found MA beneficiaries had an independently higher mean HgbA1C levels compared with FFS (7.1 vs 7.0%, $p < 0.001$) [32]. While difference was mild, the MA beneficiaries HgbA1C level is slightly higher than the Level IA stroke guideline recommendations [28]. MA beneficiaries had relatively higher use of metformin and sulfonylureas (i.e., older antihyperglycemic medications) compared with FFS beneficiaries, and FFS beneficiaries had relatively higher uses of dipeptidyl peptidase-4 (DPP-4) inhibitors, glucagon-like peptide 1 receptor agonists (GLP-1RA) and sodium-glucose cotransporter 2 (SGLT2) inhibitors (i.e., newer antihyperglycemic medicines). MA beneficiaries remained less likely to receive GLP-1RAs and SGLT2s after accounting for variable risk profiles, and differences in prescription rates of newer blood glucose lowering therapies persisted over time and across clinical subgroups, including atherosclerotic cardiovascular disease [32].

Blood pressure management

One study using multiple nationally representative CMS data sources to study patients in IRFs and SNFs found that a higher percentage of MA beneficiaries than FFS beneficiaries had hypertension (86.7 vs 85.8%, adjusted difference 0.9%, $p < 0.05$) [37]. The follow-up study of patients utilizing IRFs, SNFs and Home HealthCare using nationally representative CMS data also found a modestly higher percentage of MA beneficiaries with hypertension compared with FFS (89.5 vs 88.6%, $p < 0.01$) [38].

AHA/ASA national guidelines currently recommend treating patients with a prior stroke or TIA to achieve a blood pressure of less than 130/80 mmHg and tailoring therapy based on their comorbidities [28]. One study found

Categories	Measures	Results			Refs.
		MA	FFS	Comparison	
Quit tobacco	Current tobacco users	31.0%	26.7%	SD = 10.2%	[40]
	Tobacco cessation counseling	20.0%	16.9%	aOR: 1.05 95% CI: 1.02–1.09 p < 0.001	
Cholesterol control	LDL cholesterol level	81.5 mg/dl	78.9 mg/dl	p-value < 0.001	[40]
	Total cholesterol	154.5 mg/dl	151.0 mg/dl	SD = 8.1%	
	HDL cholesterol level	45.0 mg/dl	44.0 mg/dl	SD = 5.0%	
	Triglyceride level	133.0 mg/dl	134.0 mg/dl	SD = 1.6%	
	Statin prescription rate	72.0%	70.6%	SD = 32.0%	
	PCSK9 inhibitor prescription rate	0.3%	0.4%	SD = 1.0%	
	Ezetimibe prescription rate	7.0%	8.6%	SD = 6.8%	
Blood glucose management	HgbA1C	7.1%	7.0%	p-value < 0.0001	[36,37,40]
	Diabetes (mean)	28.7%	28.2%	AD = 2.2% p-value < 0.05	
	Diabetes with complications (mean)	7.0%	4.8%	AD = 0.8% p-value < 0.05	
	Diabetes without complications	23.1%	22.3%	p < 0.01	
	Diabetes with complications	17.5%	15.5%	p < 0.01	
	Metformin use, prescription rate (2014–2019)	69%–76%	65%–74%	NR	
	Sulfonylurea use, prescription rate (2014–2019)	50%–50%	43%–43%	NR	
	DPP-4i use, prescription rate (2014–2019)	17–25%	23–27%	NR	
	GLP-1 receptor agonist prescription rate	6.9%	9.0%	aOR: 0.80 95% CI: 0.77–0.84	
	SGLT2 inhibitor prescription rate	5.4%	6.7%	aOR: 0.91 95% CI: 0.87–0.95	
Blood pressure management	Hypertension	86.7%	85.8%	AD = 0.9% p < 0.05	[36,37,40]
	Hypertension	89.5%	88.6%	p-value < 0.01	
	Systolic blood pressure (median)	130.0 mmHg	130.0 mmHg	p-value 0.009	
	Diastolic blood pressure (median)	72.0 mmHg	71.0 mmHg	p-value < 0.0001	
	Receipt of ACE-I/ARB with DM and CAD	39.2%	38.7%	aOR: 1.06 95% CI: 1.04–1.09 p-value < 0.0001	
	Calcium channel blocker	52.4%	49.8%	SD = 5.5%	
	Thiazide Diuretic	2.4%	2.1%	SD = 2.3%	
	Beta-blocker	63.8%	64.6%	SD = 3.0%	
	Blood pressure control	70.3%	71.5%	aOR: 0.98 95% CI: 0.96–1.00 p-value 0.07	
Manage weight/BMI	BMI (kg/m ²)	30.5	30.6	SD = 0.5%	[37,40]
	Obesity (mean)	7.5%	6.5%	AD = 0.9% p < 0.05	
	Obesity	10.8%	9.5%	p < 0.01	

Statistically significant results in bold.
AD: Adjusted difference; aOR: Adjusted odds ratio; CAD: Coronary artery disease; DM: Diabetes mellitus; FFS: Fee for Service; MA: Medicare Advantage; NR: Not reported; SD: Standardized difference.

that MA beneficiaries had independently higher systolic blood pressure (+0.2 mmHg, $p < 0.01$), though both MA and FFS appear to be at or near 130 mmHg [32]. The same study found that diastolic blood pressure was less than 80 mmHg but was slightly higher in MA. Blood pressure control was slightly lower in MA but did not reach statistical significance (70.3 vs 71.5%; adjusted odds ratio 0.98, 95% CI: 0.96–1.00) [32]. ACE-I/ARB utilization in diabetic patients with coexisting coronary artery disease was higher in MA (51.7 vs 46.5%; adjusted odds ratio 1.06, 95% CI: 1.04–1.09) [32]. Other classes of antihypertensive therapy and the number of antihypertensive agents did not differ between MA and FFS.

Table 5. Anticoagulation for atrial fibrillation [32].

	Adjusted odds ratio (FFS with PDP vs MA with MAPD)
Oral anticoagulant use	0.67 (95% CI: 0.56–0.81)
Oral anticoagulation adherence	0.68 (95% CI: 0.59–0.78)
Use of warfarin	0.88 (95% CI: 0.77–1.00)
Warfarin adherence	0.72 (95% CI: 0.61–0.84)
Direct oral anticoagulant use	0.79 (95% CI: 0.69–0.90)
Direct oral anticoagulant adherence	0.88 (95% CI: 0.74–1.04)
Oral anticoagulation use, first time users	0.73 (95% CI: 0.60–0.89)
Oral anticoagulation adherence, first time users	0.69 (95% CI: 0.51–0.92)
Subgroup analysis of warfarin users (adherence)	0.59 (95% CI: 0.49–0.70)
Subgroup analysis of DOAC users (adherence)	1.02 (95% CI: 0.82–1.28)

Statistically significant results in bold.
FFS: Fee for Service; DOAC: Direct oral anticoagulants; MA: Medicare Advantage; MAPD: Medicare Advantage Prescription Drug Plans; PDP: Prescription drug plan.

Manage weight

In patients with ischemic stroke or atherosclerotic cardiovascular disease (ASCVD), calculation of BMI is recommended to screen for and classify obesity (Level IC-EO) [28]. One study that linked a national quality improvement registry to a national Medicare file with FFS and MA beneficiaries did not find a difference in Body Mass Index between MA and FFS [32]. A second study using nationally representative CMS data sources to study patients in IRFs and SNFs found that a higher percentage of MA beneficiaries were obese compared with FFS beneficiaries (7.5 vs 6.5%, adjusted difference 0.9%, $p < 0.05$) [37]. A third study of patients utilizing IRFs, SNFs and Home HealthCare (HHC) using nationally representative CMS data also found a higher percentage of MA beneficiaries with obesity compared with FFS (10.8 vs 9.5%, $p < 0.01$) [38].

Atrial fibrillation (Table 5)

In patients with nonvalvular AF and stroke or TIA, oral anticoagulation is recommended to reduce the risk of recurrent stroke (Level IA) [28]. One study using deidentified CMS claims data for FFS beneficiaries in Pennsylvania and regional health plan data for MA beneficiaries in Pennsylvania compared oral anticoagulation prescription rates and adherence for patients with newly diagnosed nonvalvular AF for those in MAPD to those in standalone PDPs, which supplement FFS [40]. Notably, the authors defined adherence as 80% of days or greater in a 360-day period covered with a particular drug, which is similar to other studies [33,41,42]. They also excluded individuals who died within 12 months of the index event, which was defined as a new diagnosis of AF.

Using propensity score matching and adjusting for clinical covariates that included a prior history of stroke or transient ischemic attack, Medicare beneficiaries with AF in PDPs had 33% lower odds of oral anticoagulant use and 32% lower odds of oral anticoagulation adherence compared with beneficiaries in a MAPD [33]. Use of direct oral anticoagulants (DOAC) was 21% lower in PDPs compared with MAPD [33]. DOAC adherence was lower in PDP compared with MAPD but did not reach statistical significance (adjusted odds ratio 0.88, 95% CI: 0.74–1.04), and a subgroup analysis of DOAC users produced similar findings [33]. Another subgroup analysis found that patients in PDPs without a history of oral anticoagulation use in the 6 months before their AF diagnosis had lower odds of oral anticoagulant use (OR: 0.73, 95% CI: 0.60–0.89) and adherence (OR: 0.69, 95% CI: 0.51–0.92) compared with MAPDs [33]. In an adjusted subgroup analysis, PDP enrollment was associated with lower warfarin adherence (OR: 0.59, 95% CI: 0.49–0.70) [33].

Post-acute care utilization (Table 6)

National guidelines recommend that stroke patients who are candidates for post-acute rehabilitation receive organized coordinated, interprofessional care (Level IA) and that stroke survivors who qualify for and have access IRF care receive treatment in an IRF in preference to a SNF (Level IB) [30]. Three studies compared post-acute care utilization between MA and FFS before the COVID-19 pandemic. These studies each generally suggest lower intensive post-acute care utilization among MA beneficiaries. One study FFS using nationally representative CMS data to compare IRF and SNF utilization in MA and FFS found lower IRF use among MA beneficiaries compared

Table 6. Post-acute care utilization.

	MA	FFS	Comparison	Ref.
Share of 90-day episodes with no institutional or Home HealthCare	39.9%	34.1%	AD = 5.1%, p < 0.01	[37]
Skilled nursing facility or inpatient rehabilitation facility, any use	44.7%	49.8%	AD = -3.7%, p < 0.05	[36]
Inpatient rehabilitation facility, any use	17.4%	24.8%	AD = -7.2%, p < 0.05	[36]
Share of 90-day episodes with inpatient rehabilitation facility stay	17.0%	25.7%	AD = -8.2%, p < 0.01	[37]
Inpatient rehabilitation facility, length of stay (days)	16.2	16.2	AD = 0.1	[36]
Inpatient rehabilitation facility, length of stay (days)	14.84	15.13	AR = -0.17, $\alpha = 0.01$	[33]
FIM score gain (Mean)	26.65	26.5	AR = -0.01	[33]
Length of stay efficiency (i.e., FIM score gain relative to length of stay)	2.12	2.08	AR = 0.02, $\alpha = 0.01$	[33]
Share of 90-day episodes with Home HealthCare use	36.4%	40.2%	AD = -4.1%, p < 0.01	[37]
Skilled nursing facility, any use	32.6%	33.6%	AD = 0.6%	[36]
Skilled nursing facility, length of stay (days)	11.8	13.7	AD = -1.0%, p < 0.05	[36]
Skilled nursing facility days	20.5	24.4	AD = -3.1, p < 0.01	[37]
Statistically significant results in bold.				
AD: Adjusted difference; AR: Adjusted regression (i.e., Regression on care outcomes on insurance type and control variables); FFS: Fee-for-Service; FIM: Functional Independence Measure; MA: Medicare Advantage.				

with FFS beneficiaries (17.4 vs 24.8%, adjusted difference -7.2%, $p < 0.05$) but no significant difference in the number of days for those admitted to IRF [37]. There were not differences in the mean percentages of any SNF use between MA and FFS, but MA beneficiaries admitted to SNF had fewer days (36.1 vs 40.7, adjusted difference -3.5 days, $p < 0.05$) [37].

A follow-up study also using nationally representative CMS data included Home HealthCare in addition to IRF and SNF [38]. Compared with FFS beneficiaries, MA beneficiaries had a higher share of 90-day episodes involving a SNF. MA beneficiaries were admitted to a SNF for fewer days compared with FFS beneficiaries (34.8 v 42.9, adjusted difference -7.4, $p < 0.01$), had a lower share of 90-day episodes with IRF stay for MA beneficiaries (17.0% vs 24.7%, adjusted difference -8.2%, $p < 0.01$), had a lower share of 90-day episodes of IRF followed by Home HealthCare (36.4% vs 40.2%, adjusted difference -4.1%, $p < 0.01$), and had a higher share of 90-day episodes without IRF, SNF or Home HealthCare (39.9 vs 34.1%, adjusted difference 5.1%, $p < 0.01$) [38]. MA beneficiaries were also less likely to receive institutional care in an IRF or SNF without Home HealthCare.

Interestingly, lower use of intensive post-acute care, including IRF, did not suggest worse recovery in MA. A third study using nationally representative IRF data included recovery measures. Three findings were notable. Mean length of stay in IRF among MA beneficiaries with stroke was shorter by 0.17 days (95% CI: -0.21 to -0.13 day), but the mean Functional Independence Measure (FIM) score improvement was not statistically different between MA and FFS (difference, -0.01 units) [34]. MA beneficiaries had a 3.0% (95% CI: 2.6%–3.4%) greater likelihood of returning to community [34]. Notably, shorter lengths of stay and similar functional improvements for MA beneficiaries with stroke were more likely to be observed in freestanding IRFs, which suggests the importance of care coordination within MA's networks [34]. Notably, patients receiving post-acute stroke rehabilitation care in an IRF could be receiving guideline-directed care regardless of MA or FFS status [30]. Thus, the differences in results could reflect patient selection into MA or FFS coverage before their stroke rather than a treatment effect of a stroke patient's MA insurance coverage. This could present an opportunity for a future prospective study.

Two more recent studies assessed changes within MA and FFS during the first year of the COVID-19 pandemic. One using nationally representative IRF data found that IRF length of stay decreased by 0.7 days ($p < 0.01$) for both insurances during the first year of the pandemic and that differences in length of stay were no longer statistically significant by the end of 2020 [35]. Both MA and FFS saw decreases in adjusted self-care and adjusted mobility improvements. Discharges from IRF to SNF and home decreased for MA and FFS, and both groups increased Home HealthCare utilization.

Another study using the same nationally representative IRF data compared regional variation in IRF length of stay for stroke patients in MA and FFS during the COVID-19 pandemic in 2020 relative to 2019. In this study, MA plans on average across regions had longer lengths of stay relative to FFS by 0.19 days (95% CI: 0.11, 0.27) before the pandemic, and it similarly found that average length of stay decreased in both groups during 2020 [36]. However, this study notably highlighted variation in average length of stay within MA by region before

Table 7. Outcomes and mortality.

	MA	FFS	Comparison	Ref.
Hospital readmissions, within 30 days	11.9%	12.8%	AD = -0.9%, p < 0.05	[36]
Hospital readmission, within 30 days	11.4%	12.6%	AD = -1.2%, p < 0.01	[37]
Hospital readmissions, within 90 days	21.5%	23.6%	AD = -1.9%, p < 0.05	[36]
Hospital readmission, within 90 days	21.2%	23.5%	AD = -2.4%, p < 0.01	[37]
Living in community for 90 days post discharge	40.6%	34.6%	AD = 3.9%, p < 0.05	[36]
Living in community at end of 90-day episode	76.9%	71.5%	AD = 2.9%, p < 0.05	[36]
Return to community	72.0%	67.5%	AR = 0.03, $\alpha = 0.01$	[33]
Mortality	13.6%	15.0%	AD = 0.3%	[36]
Mortality	13.2%	14.0%	AD = 0.5%, p < 0.05	[37]

Statistically significant result in bold.

AD: Adjusted Difference; AR: Adjusted regression (i.e., regression on care outcomes on insurance type and control variables); FFS: Fee-for-Service; MA: Medicare Advantage.

the pandemic and an increase in that variation during 2020 (SD: 0.271 vs 0.261; $p = 0.04$), which led to larger across-region differences between MA and FFS (SD: 0.271 vs 0.238; $p = 0.02$) [36]. In MA, regions with longer or shorter lengths of stay became more polarized over time, which underscores heterogeneity within MA itself [36]. Variation in lengths of stay across regions may partially reflect differences in market concentration among IRFs, but the authors acknowledge that the underlying difference in centrally administered FFS and individually managed MA plans operating in different regulated regions may also be important.

Cost

According to one study using nationally representative CMS data sources from 2011 to 2013 (notably a pre-COVID-19 pandemic study), FFS would achieve \$2397 per care episode if it had the same patterns of post-acute care and readmissions as MA [37]. Another study using nationally representative IRF data tracked IRF cost early in the pandemic and found that risk-adjusted predicted payment per episode of IRF care was lower in MA before the pandemic (-\$361, 95% CI: -\$573 to -\$149) but not statistically different by the end of 2020 (-\$194, 95% CI: -\$721 to \$333) [35]. We did not identify studies that assessed costs after the COVID-19 pandemic.

Post-stroke outcomes (Table 7)

Coordinated care models are a key feature of some MA plans [18]. One study of nationally representative CMS data found lower percentages of hospital readmissions for MA beneficiaries at 30 days (11.9 vs 12.8%, adjusted difference -0.9%, $p < 0.05$) and 90 days (21.5 vs 23.6%, adjusted difference -1.9%, $p < 0.05$) [37]. MA also had statistically significantly higher percentages of patients living in the community for 90 days after hospital discharge, continuously living in the community following discharge from IRF or SNF, and living in the community at the end of a 90-day episode [37]. A second study using similar nationally representative CMS data also found that MA beneficiaries were less likely to be readmitted within 30 days of hospital discharge (11.4 vs 12.6%, adjusted difference -1.2%, $p < 0.01$) or within 90 days (13.2 vs 14.0%, adjusted difference 0.5%, $p < 0.05$) [38].

Mortality (Table 7)

One study on post-acute care using nationally representative CMS data found a lower mean mortality in MA compared with FFS that did not reach statistical significance (13.6 vs 15.0%, adjusted difference 0.3%) [37]. A second study using CMS data found slightly higher mortality rates within 90 days in MA versus FFS (13.2 vs 14.0%, adjusted difference 0.5%, $p < 0.05$) [38]. In the second study, the authors notably posited that the mortality rate difference may be the result of endogenous controls stemming from coding differences due to changes in coding incentives in FFS and decreasing significance of their findings when omitting comorbidity controls.

Discussion

In this empirical narrative review, we examine the available peer-reviewed literature comparing secondary stroke preventive measures, post-acute care utilization, cost and outcomes between MA and FFS within the context of AHA/ASA guidelines. Studies were notably heterogenous in their design and outcomes of interest. In addition, detailed descriptions of patient's clinical characteristics were limited in most studies. Taken together, this limits the

comparisons that can be made between studies and the degree to which observed differences might be attributable to actual differences in care patterns and outcomes caused by a beneficiary enrolling in MA versus FFS or other confounding factors that could not be controlled in retrospective analyses.

Within those limitations, several findings were notable. Our study did identify several categories across Life's Essential 8 that could be compared. While these data sources are limited, one study meeting our criteria found that LDL-C levels, HgbA1C levels and systolic blood pressures were all higher in MA. Similarly, the prevalence of tobacco use (one study), a diagnosis of diabetes (two studies) and a diagnosis of hypertension (two studies) were also higher in MA. Two studies also identified higher percentages of obesity in MA. While these differences are notable for studies in our review, these findings should be interpreted with appropriate context. The most detailed clinical data available relied on a study linking a nationally representative diabetes quality improvement registry to Medicare data [32]. While this study methodology provides the most detailed clinical data available, it should be noted that slightly less than 30% of stroke patients are estimated to have diabetes [43]. This limits the generalizability of findings from this particularly registry but does suggest a need for additional research for stroke patients in Medicare. For example, more recent research using nationally representative data has not found a difference in the prevalence or control of vascular risk factors across MA and FFS [14,44]. Thus, while certain studies in our review may suggest a higher comorbidity burden among stroke patients with MA insurance, current national evidence suggests that a significantly higher comorbidity burden among stroke patients in MA is more likely to be artifact. Further research with more robust clinical data can explore this more deeply for stroke patients in Medicare.

Study design and setting also may play an important role in explaining these findings. Two studies that met our inclusion criteria compared MA and FFS beneficiaries in post-acute care settings and reported data relevant for blood pressure control, blood glucose control and weight management [37,38]. Given MA's utilization control measures limiting post-acute care, it is possible that MA beneficiaries with a higher burden of comorbidities are more likely to obtain approval for more intensive post-acute care. In addition, MA plans receive higher risk-adjusted payments for higher diagnosis-based risk scores, which also may contribute to the higher percentage of MA beneficiaries with diabetes with complications [45]. For studies that lack clinical data but simply rely on coding of conditions, differences in coding practices between MA and FFS thus may be a mechanism for producing an artificially higher prevalence of comorbidities among all stroke patients in MA.

Obtaining clinical data, including in a stroke registry linked to Medicare data, could clarify these dynamics in future studies for stroke patients. In addition, research using national and regional data sources can better characterize the burden of vascular risk factors among stroke patients in Medicare, particularly in MA. Notably, none of the studies used a quasi-experimental design, making it difficult to establish the extent to which differences in outcomes (or even differences in patients' clinical characteristics and co-morbidities due to coding differences) between MA and FFS patients are due to causal effects of MA on stroke care or due to underlying differences between MA and FFS patients.

When applying AHA/ASA guideline recommendations to studies comparing MA and FFS, preventive care trends are notable from the two retrospective cohort studies. In a study of diabetic patients on at least one medication for blood glucose control, more MA beneficiaries received smoking cessation counseling, statin therapy for hyperlipidemia, and ACE-I/ARB therapy for blood pressure control in a subgroup of diabetic patients with CAD. Newer antihyperglycemic medications were less common in MA. This could reflect MA's utilization control practices like prior authorization, but future research could explore the degree to which these differences reflect patient and provider preferences in MA and FFS. Notably, this did not apply to all newer medications which might require a prior authorization given a similar prescription rate of PCSK9 inhibitors in MA and FFS. Given that this data is derived from a quality improvement registry, it is difficult to know the degree to which differences reflect efforts related to the registry or whether they are reflective of broader differences across the FFS and MA populations. In a second study of patients with AF in a single region, oral anticoagulation use and adherence were generally higher in a MAPD compared with a PDP. This dynamic should be further explored, especially given the inclusion of two direct oral anticoagulant medications in Medicare's forthcoming Drug Price Negotiation Program [46]. Future studies can explore how the preventive care trends in these studies compare to other patient groups and to nationally representative data.

Despite AHA/ASA guideline recommendations for intensive post-acute care for stroke recovery, intensive post-acute care utilization – including IRF utilization – was generally lower in MA. This likely reflects MA's use of prior authorization to limit more expensive utilization. The AHA and the US Senate have both expressed concern that MA's prior authorization practices limit stroke survivors' access to guideline-directed stroke rehabilitation [23]. One

study averaging lengths of stay across regions found longer lengths of stay in IRFs in MA driven largely by regional variability. This underscores that MA can vary by region and market and merits further investigation, including comparisons of stroke care between different MA regions [23]. More research is needed to assess the relationship between MA's prior authorization practices that limit guideline-endorsed IRF care after stroke and the longer-term clinical impacts on stroke survivors' recovery. Qualitative research among stroke survivors could clarify how stroke survivors in MA and their caregivers experience prior authorization and what impact they feel it has on their stroke recovery. It also raises a question of whether a group of stroke survivors in MA switch into FFS because of their experiences with prior authorization and its impact on their stroke rehabilitation and recovery.

Despite lower IRF utilization in MA, functional improvements in MA were similar to FFS, and similar functional gains in fewer days was especially notable in freestanding IRFs. Since it seems less likely that MA and FFS patients are receiving different rehabilitative care programs in the same IRF after a stroke, one potential explanation for this difference could be selection bias. Stroke patients in MA have been in better overall health before their stroke and thus responded to IRF care differently. Future research could assess this by comparing comorbidity burden and vascular risk factor control among newly diagnosed stroke patients with MA and FFS.

A second explanation could be differences in acute stroke treatments, such as thrombolysis, between stroke patients in MA and FFS. Stroke patients with private insurance have better access to thrombolysis for acute ischemic stroke than Medicare patients even when adjusting for age [2]. Since MA is private insurance, it is possible that differences exist in the rates of acute stroke treatments between MA and FFS stroke patients. Those differences could potentially manifest in different responses to IRF care, especially since acute stroke treatments reduce disability in the months after an ischemic stroke. Future research using stroke registries could compare the rates of thrombolysis and mechanical thrombectomy for ischemic stroke patients in MA and FFS.

Along with lower readmission rates in MA, these findings warrant further investigation. Specifically, it would be helpful to know more about patients' comorbidities and health status before their stroke, acute stroke treatments during the acute hospitalization, and control of their modifiable vascular risk factors. This would allow for greater characterization of the intersection of their prestroke clinical status, access to acute stroke treatments, insurance networks, post-acute care utilization and outcomes. This is likely an important direction for future research in stroke rehabilitation and recovery. This would allow for better understanding of how MA's coordinated care between stroke survivors, their caregivers and their physicians affects stroke rehabilitation and recovery. Qualitative research, such as semi-structured interviews among stroke survivors in MA and FFS and their caregivers, could be useful in clarifying how stroke survivors and their caregivers experience the presence or absence of coordinated care.

In addition to lower IRF utilization in MA, other coordinated care mechanisms could be important in stroke rehabilitation and recovery. Since stroke patients have modifiable vascular risk factors that lower the risk for future stroke, future research can clarify if stroke patients with MA insurance receive extra benefits or care to lower their risk of hospital readmission. Future research can also clarify how lower rates of guideline-endorsed IRF care after hospital discharge in MA impacts MA stroke survivors' functional status over time, which studies in this review did not address. This is particularly important because transitions in care between the different providers and settings (i.e., acute hospitalization, inpatient rehabilitation, nursing facility and home) are critical for stroke patients [47]. Alternatively, quasi-experimental evidence could also shed light on actual treatment differences in MA versus FFS, without the need for rich data on confounders like comorbidities.

While research has compared quality of care between MA and FFS in other fields, this is the first study to our knowledge that compares MA and FFS in stroke specifically [17,20,21]. Since stroke has guideline-directed preventive care intended to prevent stroke recurrence, it offers a unique context for clinicians and policymakers to understand differences in preventive care, utilization and outcomes in MA and FFS. This comparison may be important if differences in between these segments of the Medicare program result in differences in care that modify stroke outcomes. This could have implications for Medicare patients with stroke across the continuum of stroke care. Studies in our review suggest similar FIM score gains in fewer days in freestanding IRFs in MA, lower rates of hospital readmissions in MA, and higher rates of living in the community in MA. Future research should investigate the extent to which these findings reflect causal effects of MA and the relationship between these findings, prestroke clinical status and acute stroke treatment (i.e., thrombolysis and mechanical thrombectomy).

No study compared the risk of recurrent stroke in MA to FFS, though the risk of recurrent stroke has been an area of interest in FFS [9]. In our review, mortality data was mixed with one study suggesting a possible trend toward lower mortality in MA and another potentially influenced by changes in coding incentives within FFS. Mortality is perhaps the most important clinical outcome, especially over a defined period after a stroke (i.e., 12 months).

Given the mixed mortality findings in our review and the growth in MA enrollment, we believe this warrants closer study among appropriately matched MA and FFS beneficiaries with stroke.

Our work differs from prior work examining the impact of insurance status on stroke care by focusing on differences within Medicare [1]. This distinction is critical the fact that Medicare covers more than 70% of all US patients with stroke [8]. In addition to our review's focus on stroke prevention, stroke rehabilitation and stroke recovery, recent work suggests that acute stroke care also could be another important area of study. While the use of intravenous thrombolysis has been increasing for Medicare beneficiaries, Medicare beneficiaries remain less likely to receive thrombolysis than those in private insurance even when adjusting for age [2]. Since MA utilizes private insurance to administer Medicare benefits, this warrants closer study in cohorts of matched MA and FFS beneficiaries or, even better, quasi-experimental analyses to look for causal differences in rates of intravenous thrombolysis as well as mechanical thrombectomy among Medicare beneficiaries. Ideally, these approaches could be used to compare MA and FFS across stroke subtypes, such as transient ischemic attack, ischemic stroke and hemorrhagic stroke. We did not find published studies that effectively compared these important stroke subtypes in conducting our review.

From a policy standpoint, our study comes amidst high-level interest in MA's coding practices. Studies have debated whether MA's higher diagnosis-based risk scores accurately reflect MA beneficiaries' medical complexity, and policymakers have been concerned about favorable selection in MA and MA 'upcoding' chronic conditions to increase risk-adjusted payments from the federal government [14,48–51]. This may reflect differences in incentives since private insurance plans in MA receive higher prospective payments if beneficiaries have higher diagnosis-based risk scores, which does not occur in FFS [45]. Our study did find a higher prevalence of certain vascular risk factors for stroke between MA and FFS. Differences in incentives and utilization control measures among Medicare plans may partially explain this in post-acute settings. This is an area of active debate. Recent work raised the possibility that MA encourages more aggressive screening and/or diagnosis practices than FFS [14]. Since stroke patients are screened for vascular risk factors as part of the stroke workup, they could offer an important study population to explore whether risk factor identification and management differ over time [28]. Stroke patients may also offer a study population for assessing the degree to which MA and FFS coding differences reflect actual clinical differences and how coding differences relate to clinical outcomes.

As policymakers become increasingly interested in chronic disease diagnosis, management and associated utilization, stroke also may offer a useful context for studying chronic diseases [52]. Stroke guidelines offer measurable biomarkers indicating chronic disease control, and stroke's time course means that this could be studied within months after a stroke occurs. To accomplish this, future studies need to better incorporate guideline-directed clinical data to compare the effectiveness of stroke care in MA and FFS. This approach could offer advantages over other conditions which require years of data to understand an association between chronic diseases and health outcomes. Stroke and vascular risk factors notably contribute to cognitive impairment and dementia, and stroke shares preventable chronic disease risk factors with dementia [53,54]. As the US population ages, clinicians and policymakers both want to address chronic diseases and healthcare spending in Medicare and across the US health system. Comparing the effectiveness of MA and FFS in administering preventive stroke care, assessing how differences in chronic disease management mediate important clinical outcomes, and understanding utilization and spending differences between MA and FFS may offer important insights for both clinicians and policymakers.

Strengths & limitations

This review offers a timely synthesis of evidence comparing MA and FFS in secondary stroke prevention with a focus on AHA/ASA national guidelines. By excluding studies performed before the Medicare Modernization Act (2003), we ensured the relevance of our findings to current policy. Our review also clarifies areas for future investigation.

Our study has several limitations. As a review, our study relies on published studies, which can introduce publication bias. While we sought to guard against selection bias by using dual review with oversight from a senior investigator as recommended by AHRQ, random error and systemic bias remain a possibility as with all reviews [26]. All studies were retrospective studies, which may increase confounding. There are notable differences in the reporting of patient characteristics, which limits the ability to compare patient populations within and between studies. The heterogeneity of study designs and data sources, including PDP data, also may have introduced residual confounding factors and limited the generalizability of our results. Several studies were excluded from our review

for not reporting the number of stroke patients, but there may have been appropriate numbers of stroke patients in those studies.

Conclusion

Our review of recent published peer-reviewed studies suggests available studies comparing stroke preventive care, post-acute care utilization and outcomes are heterogenous in their study design, study setting and reporting of patient characteristics. The limited clinical data available limits the ability to identify the degree to which favorable selection is present and the ability to differentiate between causal effects of MA versus underlying differences between MA and FFS patients. Within those limitations, published studies in our review suggest that MA appears to allow for stroke preventive care for hyperlipidemia, smoking cessation and AF. Post-acute care utilization was generally lower in MA. FIM score improvements were similar but occurred in fewer days in MA, though the absence of acute stroke treatment data is notable. Mortality data were mixed. Given the growing importance of stroke in Medicare and the growth in MA enrollment, this area warrants further study among appropriately matched MA and FFS beneficiaries with stroke, especially for important outcomes such as mortality.

Summary points

- Medicare pays for approximately 75% of all US stroke care, but changes in Medicare raise important questions for stroke patients, clinicians, researchers and policymakers.
- As of 2024, 54% of Medicare beneficiaries are enrolled in Medicare Advantage (MA), a private insurance option that offers an alternative to traditional Fee-for-Service (FFS) Medicare.
- It is not clear how stroke care compares between MA and FFS Medicare.
- This empirical narrative review compares stroke care in MA and FFS Medicare using the following as guides for important metrics: American Heart Association/American Stroke Association's Life's Essential 8 categories, American Heart Association/American Stroke Association Guideline for the prevention of stroke in patients with stroke and transient ischemic attack, and American Heart Association/American Stroke Association Guidelines for Adult Stroke Rehabilitation and Recovery.
- 7/1356 studies from PubMed, Embase and Web of Science meet our inclusion and exclusion criteria.
- The seven studies were notably heterogenous in their design and outcomes of interest. Detailed descriptions of patient's clinical characteristics were limited in most studies.
- In one study, patients in MA appeared to have higher levels of LDL-C, HgbA1C and systolic blood pressure.
- Two studies suggest that certain groups of MA patients have receive equal or greater preventive care for smoking cessation, statin therapy for hyperlipidemia and oral anticoagulation for atrial fibrillation compared with FFS Medicare patients.
- Similar functional improvement gains at inpatient rehabilitation facilities appear to occur in fewer days in MA compared with FFS Medicare following a stroke. The degree to which this reflects patient differences or treatment differences in care is unclear.
- Future research with more clinical detail or using quasi-experimental methodology can clarify the degree to which these differences reflect confounders such as patient selection into MA or FFS Medicare versus true differences in stroke care and outcomes.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at: <https://becarispublishing.com/doi/epdf/10.57264/cer-2025-0157>

Author contributions

Study conception and design (EJ Bian, BB Worrall, JR Crowe); acquisition of data (EJ Bian, P Menon, JR Crowe); data analysis (EJ Bian, P Menon, JR Crowe); drafting and revision of manuscript (EJ Bian, P Menon, KA McManus, TJ Layton, BB Worrall, JR Crowe)

Acknowledgments

This work was originally presented at the 2025 American Heart Association/American Stroke Association International Stroke Conference by the first author (EJ Bian). Her participation in the project was made possible by the University of Virginia Medical Student Summer Research Program.

Financial disclosure

The author(s) received no financial and/or material support for this research or the creation of this work.

Competing interests disclosure

The authors have no competing interests or relevant affiliations with any organization or entity with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

Writing disclosure

No funded writing assistance was utilized in the production of this manuscript.

Open access

This work is licensed under the Attribution-NonCommercial-NoDerivatives 4.0 Unported License. To view a copy of this license, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/>

References

Papers of special note have been highlighted as: ● of interest; ●● of considerable interest

1. Medford-Davis LN, Fonarow GC, Bhatt DL *et al*. Impact of insurance status on outcomes and use of rehabilitation services in acute ischemic stroke: findings from Get With The Guidelines – Stroke. *J. Am. Heart Assoc.* 5(11), e004282 (2016).
2. Sun P, Zheng L, Lin M *et al*. Persistent inequities in intravenous thrombolysis for acute ischemic stroke in the United States: results from the Nationwide Inpatient Sample. *J. Am. Heart Assoc.* 13(9), e033316 (2024).
3. Tsao CW, Aday AW, Almarazooq ZI *et al*. Heart disease and stroke statistics-2023 update: a report from the American Heart Association. *Circulation* 147(8), e93–e621 (2023).
4. Lichtman JH, Leifheit-Limson EC, Goldstein LB. Centers for Medicare and Medicaid services medicare data and stroke research: goldmine or landmine? *Stroke* 46(2), 598–604 (2015).
5. United States Census Bureau. Percentage of older adults with both private health insurance and Medicare decreased from 2017 to 2022 (2024). Available from: <https://www.census.gov/library/stories/2024/04/older-adults-health-coverage.html>
6. *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Agency for Healthcare Research and Quality, MD, USA (2006).
7. de Havenon A, Skolarus LE, Mac Grory B *et al*. National- and State-level trends in Medicare hospice beneficiaries for stroke during 2013 to 2019 in the United States. *Stroke* 55(1), 131–138 (2024).
8. Trogon JG, Finkelstein EA, Nwaise IA, Tangka FK, Orenstein D. The economic burden of chronic cardiovascular disease for major insurers. *Health Promot. Pract.* 8(3), 234–242 (2007).
9. Leifheit EC, Wang Y, Goldstein LB, Lichtman JH. Trends in 1-year recurrent ischemic stroke in the US Medicare Fee-for-Service population. *Stroke* 53(11), 3338–3347 (2022).
10. Allen NB, Holford TR, Bracken MB *et al*. Trends in one-year recurrent ischemic stroke among the elderly in the USA: 1994–2002. *Cerebrovasc. Dis.* 30(5), 525–532 (2010).
11. Brown K, El Hussein N, Grimley R *et al*. Alternative payment models and associations with stroke outcomes, spending, and service utilization: a systematic review. *Stroke* 53(1), 268–278 (2022).
12. Bushnell CD, Kucharska-Newton AM, Jones SB *et al*. Hospital readmissions and mortality among Fee-for-Service Medicare patients with minor stroke or transient ischemic attack: findings from the COMPASS Cluster-Randomized Pragmatic Trial. *J. Am. Heart Assoc.* 10(23), e023394 (2021).
13. McWilliams JM. The future of Medicare and the role of traditional Medicare as competitor. *N. Engl. J. Med.* 391(8), 763–769 (2024).
14. Oseran AS, Aggarwal R, Figueroa J, Joynt Maddox KE, Landon BE, Wadhwa RK. Prevalence of chronic medical conditions among Medicare Advantage and traditional Medicare beneficiaries. *Ann. Intern. Med.* 178(3), 327–335 (2025).
15. Jacobson G, Blumenthal D. The predominance of Medicare Advantage. *N. Engl. J. Med.* 389(24), 2291–2298 (2023).
16. Ankuda CK, Aldridge MD, Braun RT *et al*. Addressing serious illness care in Medicare Advantage. *N. Engl. J. Med.* 388(19), 1729–1732 (2023).
17. Aggarwal R, Gondi S, Wadhwa RK. Comparison of Medicare Advantage vs traditional Medicare for health care access, affordability, and use of preventive services among adults with low income. *JAMA Netw. Open* 5(6), e2215227 (2022).
18. DuGoff E, Tabak R, Diduch T, Garth V. Quality, health, and spending in Medicare Advantage and traditional Medicare. *Am. J. Manag. Care* 27(9), 395–400 (2021).
19. Agarwal R, Connolly J, Gupta S, Navathe AS. Comparing Medicare Advantage and traditional Medicare: a systematic review. *Health Aff. (Millwood)* 40(6), 937–944 (2021).
20. Park S, Figueroa JF, Fishman P, Coe NB. Primary care utilization and expenditures in traditional Medicare and Medicare Advantage, 2007–2016. *J. Gen. Intern. Med.* 35(8), 2480–2481 (2020).

21. Landon BE, Anderson TS, Curto VE *et al.* Association of Medicare Advantage vs traditional Medicare with 30-day mortality among patients with acute myocardial infarction. *JAMA* 328(21), 2126–2135 (2022).
22. Newhouse JP, Price M, Huang J, McWilliams JM, Hsu J. Steps to reduce favorable risk selection in Medicare Advantage largely succeeded, boding well for health insurance exchanges. *Health Aff. (Millwood)* 31(12), 2618–2628 (2012).
23. Ifejika NL, Awosika OO, Black T *et al.* Improving access to stroke rehabilitation and recovery: a policy statement from the American Heart Association/American Stroke Association. *Stroke* 56(9), e218–e233 (2025).
24. Adeoye O, Nyström KV, Yavagal DR *et al.* Recommendations for the establishment of stroke systems of care: a 2019 update. *Stroke* 50(7), e187–e210 (2019).
25. Sukhera J. Narrative reviews: flexible, rigorous, and practical. *J. Grad. Med. Educ.* 14(4), 414–417 (2022).
26. *Methods Guide for Effectiveness and Comparative Effectiveness Reviews.* Agency for Healthcare Research and Quality, MD, USA (2008).
27. Amir-Behghadami M, Janati A. Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. *Emerg. Med. J.* 37(6), 387 (2020).
28. Kleindorfer DO, Towfighi A, Chaturvedi S *et al.* 2021 guideline for the prevention of stroke in patients with stroke and transient ischemic attack: a guideline from the American Heart Association/American Stroke Association. *Stroke* 52(7), e364–e467 (2021).
29. Lloyd-Jones DM, Allen NB, Anderson CAM *et al.* Life's Essential 8: updating and enhancing the American Heart Association's construct of cardiovascular health: a Presidential Advisory from the American Heart Association. *Circulation* 146(5), e18–e43 (2022).
30. Winstein CJ, Stein J, Arena R *et al.* Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 47(6), e98–e169 (2016).
31. Landon BE, Zaslavsky AM, Saunders RC, Pawlson LG, Newhouse JP, Ayanian JZ. Analysis of Medicare Advantage HMOs compared with traditional Medicare shows lower use of many services during 2003–09. *Health Aff. (Millwood)* 31(12), 2609–2617 (2012).
32. Essien UR, Tang Y, Figueroa JF *et al.* Diabetes care among older adults enrolled in Medicare Advantage versus traditional Medicare Fee-for-Service plans: the Diabetes Collaborative Registry. *Diabetes Care* 45(7), 1549–1557 (2022).
- **This retrospective cohort study provides our review's most detailed clinical information by linking a diabetes quality improvement registry to Medicare data in order to compare the quality of care in Medicare Advantage (MA) and Fee-for-Service (FFS) Medicare.**
33. Newman TV, Gabriel N, Liang Q *et al.* Comparison of oral anticoagulation use and adherence among Medicare beneficiaries enrolled in stand-alone prescription drug plans vs Medicare Advantage prescription drug plans. *J. Manag. Care Spec. Pharm.* 28(2), 266–274 (2022).
- **This retrospective cohort study uses claims data to compare oral anticoagulation patterns for Medicare beneficiaries in a standalone prescription drug plan to those in a Medicare Advantage Prescription Drug Plan, but it does not provide clinical data on stroke risk factor control.**
34. Cao Y, Nie J, Sisto SA, Niewczyk P, Noyes K. Assessment of differences in inpatient rehabilitation services for length of stay and health outcomes between US Medicare Advantage and traditional Medicare beneficiaries. *JAMA Netw. Open* 3(3), e201204 (2020).
- **This retrospective cross-sectional study used nationally representative data to show that MA patients with stroke appear to make similar Functional Improvement Measure gains compared to FFS Medicare patients with stroke but have shorter lengths-of-stay in inpatient rehabilitation facilities.**
35. Cao YJ, Luo D. Post-acute care in inpatient rehabilitation facilities between traditional Medicare and Medicare Advantage plans before and during the COVID-19 pandemic. *J. Am. Med. Dir. Assoc.* 24(6), 868–875.e5 (2023).
- **This nationally representative retrospective cross-sectional study compared post-acute care for MA and FFS Medicare patients with stroke and other conditions before and during the first year of the COVID-19 pandemic.**
36. Luo D, Ouayogodé MH, Mullahy J, Cao YJ. Regional variation in length of stay for stroke inpatient rehabilitation in traditional Medicare and Medicare Advantage. *Health Aff. Sch.* 2(7), qxae089 (2024).
- **This nationally representative retrospective cross sectional study found increasing regional variation in inpatient rehabilitation facility length of stay for stroke patients in Medicare Advantage but not those in FFS Medicare in the first year of the COVID-19 pandemic, which highlights that stroke rehabilitation and recovery practices may vary in MA across regions.**
37. Huckfeldt PJ, Escarce JJ, Rabideau B, Baraca-Mandic P, Sood N. Less intense postacute care, better outcomes for enrollees in Medicare Advantage than those in Fee-for-Service. *Health Aff. (Millwood)* 36(1), 91–100 (2017).
- **This nationally representative retrospective cross-sectional study found that stroke patients with MA in inpatient rehabilitation facilities (IRFs) and skilled nursing facilities (SNFs) had different levels of certain comorbidities and lower utilization of post-acute care than stroke patients with FFS Medicare, which may represent differences in coding practices and utilization control measures.**
38. Skopec L, Huckfeldt PJ, Wissoker D *et al.* Home health and postacute care use in Medicare Advantage and traditional Medicare. *Health Aff. (Millwood)* 39(5), 837–842 (2020).
- **This nationally representative retrospective cross-sectional study found higher levels of stroke comorbidities and lower Home Health Care, IRF and SNF utilization for stroke patients in MA compared with FFS Medicare, which could also represent more intense coding practice differences and utilization control measures in MA.**

39. Friberg L, Rosenqvist M, Lip GY. Evaluation of risk stratification schemes for ischaemic stroke and bleeding in 182 678 patients with atrial fibrillation: the Swedish Atrial Fibrillation cohort study. *Eur. Heart J.* 33(12), 1500–1510 (2012).
40. Cubanski J. A current snapshot of the Medicare Part D prescription drug benefit. Kaiser Family Foundation. Available from: <https://www.kff.org/medicare/issue-brief/a-current-snapshot-of-the-medicare-part-d-prescription-drug-benefit/>
41. Hernandez I, He M, Chen N, Brooks MM, Saba S, Gellad WF. Trajectories of oral anticoagulation adherence among Medicare beneficiaries newly diagnosed with atrial fibrillation. *J. Am. Heart Assoc.* 8(12), e011427 (2019).
42. Hernandez I, He M, Brooks MM, Saba S, Gellad WF. Adherence to anticoagulation and risk of stroke among Medicare beneficiaries newly diagnosed with atrial fibrillation. *Am. J. Cardiovasc. Drugs* 20(2), 199–207 (2020).
43. Kernan WN, Viscoli CM, Inzucchi SE *et al.* Prevalence of abnormal glucose tolerance following a transient ischemic attack or ischemic stroke. *Arch. Intern. Med.* 165(2), 227–233 (2005).
44. Oseran AS, Aggarwal R, Wadhera RK. Cardiovascular risk factor management in Medicare Advantage and traditional Medicare. *Circ. Cardiovasc. Qual. Outcomes* 18(11), e012143 (2025).
45. Geruso M, Layton T. Upcoding: evidence from medicare on squishy risk adjustment. *J. Polit. Econ.* 12(3), 984–1026 (2020).
46. Medicare Drug Price Negotiation Program: selected drugs for initial price applicability year 2026 (2023). Available from: <https://www.cms.gov/files/document/fact-sheet-medicare-selected-drug-negotiation-list-ipay-2026.pdf>
47. Reeves MJ, Boden-Albala B, Cadilhac DA. Care transition interventions to improve stroke outcomes: evidence gaps in underserved and minority populations. *Stroke* 54(2), 386–395 (2023).
48. Cohen K, Ameli O, Chaisson CE *et al.* Comparison of care quality metrics in 2-sided risk Medicare Advantage vs Fee-for-Service Medicare programs. *JAMA Netw. Open* 5(12), e2246064 (2022).
49. Medicare Payment Advisory Commission. Report to the Congress: Medicare Payment Policy (2023). <https://www.medpac.gov/document/march-2023-report-to-the-congress-medicare-payment-policy/>
50. Medicare Payment Policy (2024). https://www.medpac.gov/wp-content/uploads/2024/03/Mar24_MedPAC_Report_To_Congress_SEC.pdf
51. Jacobs PD, Layton TJ. Identifying coding intensity in Medicare Advantage through switchers. *Health Serv. Res.* 60(5), e14628 (2025).
52. The White House. Establishing the President's Make America Healthy Again Commission. (2025). <https://www.whitehouse.gov/presidential-actions/2025/02/establishing-the-presidents-make-america-healthy-again-commission/>
53. Livingston G, Huntley J, Liu KY *et al.* Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. *Lancet* 404(10452), 572–628 (2024).
54. El Hussein N, Katzan IL, Rost NS *et al.* Cognitive impairment after ischemic and hemorrhagic stroke: a scientific statement from the American Heart Association/American Stroke Association. *Stroke* 54(6), e272–e291 (2023).