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Stroke. published online May 22, 2013;

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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AHA/ASA Policy Statement

Forecasting the Future of Stroke in the United States A Policy Statement From the American Heart Association and American Stroke Association

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Background and Purpose—Stroke is a leading cause of disability, cognitive impairment, and death in the United States and accounts for 1.7% of national health expenditures. Because the population is aging and the risk of stroke more than doubles for each successive decade after the age of 55 years, these costs are anticipated to rise dramatically. The objective of this report was to project future annual costs of care for stroke from 2012 to 2030 and discuss potential cost reduction strategies.

Methods and Results—The American Heart Association/American Stroke Association developed methodology to project the future costs of stroke-related care. Estimates excluded costs associated with other cardiovascular diseases (hypertension, coronary heart disease, and congestive heart failure). By 2030, 3.88% of the US population >18 years of age is projected to have had a stroke. Between 2012 and 2030, real (2010\$) total direct annual stroke-related medical costs are expected to increase from \$71.55 billion to \$183.13 billion. Real indirect annual costs (attributable to lost productivity) are projected to rise from \$33.65 billion to \$56.54 billion over the same period. Overall, total annual costs of stroke are projected to increase to \$240.67 billion by 2030, an increase of 129%.

Conclusions—These projections suggest that the annual costs of stroke will increase substantially over the next 2 decades. Greater emphasis on implementing effective preventive, acute care, and rehabilitative services will have both medical and societal benefits. (*Stroke*. 2013;44:00-00.)

Key Words: AHA Scientific Statements ■ burden of illness ■ cost of illness ■ early medical intervention ■ epidemiology ■ ethnicity ■ healthcare reform ■ projections and predictions ■ race ■ sex ■ thrombolysis, therapeutic ■ treatment

In the United States, stroke exacts a tragic personal toll on patients and families and a tremendous financial cost on the economy. For health policy planning, it is imperative to understand projected future prevalence and cost of stroke in the country and to identify potential actions that might reduce this burden. Currently, stroke is the fourth-leading cause of death in the United States and a leading

cause of disability.¹ Direct spending on non-nursing home stroke care constitutes >10.7% of the Medicare budget and >1.7% of overall national health expenditures.¹⁻³ Long-term direct costs including nursing home care are even higher, and indirect costs attributable to premature mortality and lost productivity for stroke survivors are greater than all direct costs combined.⁴ In the decade from 1995 to 2005,

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This statement was approved by the American Heart Association Advocacy Coordinating Committee on March 31, 2013. A copy of the document is available at <http://my.americanheart.org/statements> by selecting either the "By Topic" link or the "By Publication Date" link. To purchase additional reprints, call 843-216-2533 or e-mail kelle.ramsay@wolterskluwer.com.

The American Heart Association requests that this document be cited as follows: Ovbiagele B, Goldstein LB, Higashida RT, Howard VJ, Johnston SC, Khavjou OA, Lackland DT, Lichtman JH, Mohl S, Sacco RL, Saver JL, Trogon JG; on behalf of the American Heart Association Advocacy Coordinating Committee and Stroke Council. Forecasting the future of stroke in the United States: a policy statement from the American Heart Association and American Stroke Association. *Stroke*. 2013;44:00-00.

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DOI: 10.1161/STR.0b013e31829734f2

the medical costs of stroke grew at an average of only 2%⁵; however, the aging of the US population in coming decades has the potential to increase stroke costs substantially, because the risk of stroke is higher at older ages. To face this demographic reality, it is essential to understand and pursue available opportunities to further improve cerebrovascular disease prevention and treatment and control stroke-related costs.^{6,7}

To address these opportunities, a critical first step is to understand the future of stroke prevalence and costs in the United States. A multidisciplinary writing group of the American Heart Association/American Stroke Association (AHA/ASA) conducted analysis to project the prevalence and medical costs from 2010 to 2030 for all cardiovascular diseases, including hypertension, coronary heart disease, heart failure, diverse additional cardiac conditions, and stroke.⁸ To obtain more detailed projections regarding stroke, the AHA/ASA convened a multidisciplinary panel of experts in cerebrovascular disease. The methodology used to generate cost estimates reduces the bias associated with double counting disease costs across categories. These forecasts of future stroke prevalence and costs assume no change to current policy is made and no further actions are taken to reduce the clinical and economic burden of cerebrovascular disease, but they do reflect changing demographics. The projections also provide a baseline to gauge the success of current and future stroke policy initiatives.

Data and Methods

Overview

Stroke prevalence and per person cost (direct and indirect) projections were developed by age group (18–44 years, 45–64 years, 65–79 years, ≥80 years), sex (men, women), and race/ethnicity (white non-Hispanic, black non-Hispanic, Hispanic, other), similar to prior methods used to estimate future costs of cardiovascular disease.⁸ Stroke prevalence was assumed to remain constant for each of the 32 age, sex, and race/ethnicity groups. Initial average per person stroke cost was estimated for each group and increased in real dollars based on the historical rate of growth of overall medical spending (direct) and real wages (indirect), which assumed that drivers of medical spending such as rising prices and technological innovation will continue at the same rate for the next 18 years. We generated projections of the total stroke population and costs by multiplying prevalence and average costs by the census-projected population of each demographic group. The resulting projections, therefore, reflect expected changes in population demographics but assume no change in policy that would affect prevalence and average relative cost within a demographic group.

Projections of Prevalence of Stroke

Prevalence estimates for stroke were determined on the basis of data from the 1999–2008 National Health and Nutrition Examination Survey (NHANES) and US Census Bureau projected population counts for the years 2012 to 2030.^{9,10} Projected population counts for years 2012 to 2030 were obtained from the 2008 population projections of the US

resident population by age, sex, race, and Hispanic origin generated by the US Census Bureau based on Census 2000. The US Census Bureau generated these projections using a cohort-component method and assumptions about future births, deaths, and net international migration. We multiplied predicted prevalence of stroke in each sex/age/race group by the projected population counts for the corresponding group for years 2012 to 2030 to estimate the number of people with stroke in each group per year. We then aggregated the number of people with stroke by sex, age, and race and calculated the overall projected stroke prevalence by each demographic characteristic.

Projections of Direct Medical Costs of Stroke

The main source of data for generating projections of medical costs of stroke was the 2004–2008 Medical Expenditure Panel Survey (MEPS).¹¹ To project the direct medical costs of stroke, we first computed total annual medical expenditures for people with stroke calculated as the difference in predicted expenditures for a person with stroke and predicted expenditures for a similar person without stroke. We used an approach that minimizes double counting of costs related to comorbidities.¹² We then estimated total medical costs of stroke by multiplying the per person cost by the projected number of people with stroke. Costs are presented as 2010 dollars (\$2010).

Projections of Indirect Costs of Stroke

Two types of indirect costs were calculated: lost productivity from morbidity and from premature mortality. Morbidity costs represent the value of foregone earnings from lost productivity and include work loss among currently employed individuals, home productivity loss (defined as the value of household services performed by household members who do not receive pay for the services), and work loss among individuals too sick to work.^{13,14} Mortality costs represent the value of foregone earnings attributable to premature death.

Literature Search

To provide a pertinent discussion of the results, the writing group conducted a comprehensive review and synthesis of the relevant literature. Searches were limited to English-language sources and human subjects. Literature citations were generally restricted to published manuscripts appearing in journals listed in *Index Medicus* and reflected literature published as of May 31, 2012. The references selected for this document are exclusively from peer-reviewed publications that are representative but not all-inclusive, with priority given to references with higher levels of evidence. All members of the committee had frequent opportunities to review drafts of the entire document and reach a final consensus draft.

Results

Table 1 presents projected crude stroke prevalence from 2012 to 2030, overall and by age, as well as by sex/race/ethnicity. With the aging population, the prevalence of stroke

Table 1. Projections of Crude Stroke Prevalence, 2012–2030, in the United States

Demographic Group	Prevalence, %					% Relative Change (2012–2030)
	2012	2015	2020	2025	2030	
Age, y						
18–44	0.71	0.71	0.71	0.71	0.71	0.00
45–64	2.82	2.82	2.82	2.83	2.84	0.71
65–79	9.02	9.04	9.06	9.09	9.11	1.00
≥80	15.41	15.43	15.45	15.45	15.48	0.45
Race/ethnicity/sex						
White, non-Hispanic, men	2.94	3.05	3.24	3.46	3.68	25.20
White, Hispanic, men	1.49	1.56	1.68	1.80	1.92	29.07
Black, men	3.33	3.45	3.67	3.94	4.23	26.90
Other, men	2.66	2.79	3.01	3.20	3.38	27.33
White, non-Hispanic, women	3.84	3.94	4.13	4.39	4.67	21.66
White, Hispanic, women	1.99	2.06	2.18	2.30	2.44	22.55
Black, women	4.55	4.71	5.01	5.37	5.75	26.46
Other, women	3.33	3.49	3.75	4.00	4.24	27.40
Overall	3.22	3.31	3.48	3.67	3.88	20.50

is projected to increase, which translates to an additional 3.4 million people with stroke in 2030 relative to 2012. By 2030, nearly 4% of the US population is projected to have had a stroke. Because the risk of stroke increases with age, people ≥65 years of age (particularly those ≥80 years of age) have a higher prevalence of stroke, and this segment of the population will grow substantially over the next 18 years. By 2030, stroke prevalence is projected to rise the most among white Hispanic men, followed by other races/ethnicities and black men and women (Table 1).

Between 2012 and 2030, real (2010\$) total direct medical stroke-related costs are projected to triple, from \$71.55 billion to \$184.13 billion (Table 2). By 2030, total direct

medical costs of stroke are projected to rise the most among people in the 65- to 79-year-old age category. By sex/race/ethnicity, white Hispanic men and women of other races/ethnicities are expected to experience the largest rise in total direct medical costs by 2030 (Table 2). Real indirect costs for stroke are estimated to rise from \$33.65 billion in 2012 to \$56.54 billion in 2030, an increase of 68% (Table 3). The aging of the population and the growth in per capita medical spending are the primary drivers of increased stroke costs, which are expected to grow the fastest for those ≥65 years of age (Figure). The aging of the population has a lesser impact on indirect than direct costs given the lower rates of employment among the elderly.

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Table 2. Projected Direct (Medical) Costs of Stroke, 2012–2030, in the United States

Demographic Group	Cost, Billions 2010\$					% Relative Change (2012–2030)
	2012	2015	2020	2025	2030	
Age, y						
18–44	1.14	1.25	1.48	1.75	2.05	79.80
45–64	12.99	14.45	16.85	19.36	22.69	74.70
65–79	31.66	38.82	53.59	71.75	89.35	182.20
≥80	25.76	28.76	35.65	47.91	70.04	171.90
Race/ethnicity/sex						
White, non-Hispanic, men	22.39	25.92	33.00	42.44	54.20	142.03
White, Hispanic, men	1.76	2.25	3.37	4.99	7.26	311.81
Black, men	4.25	5.08	6.80	9.16	12.11	185.15
Other, men	0.91	1.14	1.65	2.34	3.34	264.71
White, non-Hispanic, women	30.89	35.17	43.92	55.66	70.13	126.99
White, Hispanic, women	2.72	3.43	5.00	7.23	10.32	279.49
Black, women	6.47	7.59	9.91	13.16	17.99	178.07
Other, women	2.15	2.70	3.93	5.79	8.80	308.33
Overall	71.55	83.28	107.57	140.77	184.13	157.30

Table 3. Projected Indirect (Lost Productivity) Stroke Costs, 2012–2030, in the United States

Demographic Group	Cost, Billions 2010\$					% Relative Change (2012–2030)
	2012	2015	2020	2025	2030	
Age, y						
18–44	4.96	5.26	5.86	6.53	7.24	46.00
45–64	16.88	18.05	19.7	21.2	23.27	38.00
65–79	9.02	10.64	13.77	17.29	20.2	123.90
≥80	2.79	2.98	3.43	4.28	5.82	108.60
Race/ethnicity/sex						
White, non-Hispanic, men	11.57	12.49	13.97	15.47	16.95	46.49
White, Hispanic, men	1.67	1.98	2.60	3.34	4.17	149.07
Black, men	4.71	5.18	6.00	6.92	8.07	71.37
Other, men	1.25	1.45	1.83	2.27	2.78	121.70
White, non-Hispanic, women	9.75	10.52	11.88	13.42	15.03	54.10
White, Hispanic, women	1.33	1.57	2.07	2.68	3.41	157.30
Black, women	2.99	3.29	3.83	4.44	5.17	72.90
Other, women	0.38	0.44	0.58	0.75	0.96	156.44
Overall	33.65	36.94	42.76	49.3	56.54	68.00

Discussion

Future Stroke Prevalence

The projected increase in stroke prevalence by 3.4 million individuals from 2012 to 2030 clearly represents a substantial rise in the nationwide burden of this disease among the US population. There are likely at least 2 major contributors to the high forecasted stroke prevalence rates. First, an increasing incidence of stroke corresponding with the aging population is anticipated on the basis of previous trends and models in which stroke risk increased with each year of age by 9% (95% confidence interval, 9%–10%) in men and by 10% (95% confidence interval, 9%–10%) in women.¹³ Second, lower case fatality rates associated with enhanced acute ischemic stroke

management approaches and secondary vascular risk reduction strategies will lead to higher stroke prevalence rates. To foster accurate assessment of these projected future trends and permit the timely implementation of effective strategies to address them, which has been advocated for >40 years,^{14–16} there is a need for strengthened ongoing surveillance, to include nationally representative data on stroke incidence, case fatality, and recurrence rates.

Types and Subtypes of Stroke

Understanding stroke subtype is critical for guiding both acute treatment and secondary prevention strategies. As described below, reperfusion therapy with a thrombolytic drug might be appropriate for selected patients with ischemic stroke but is

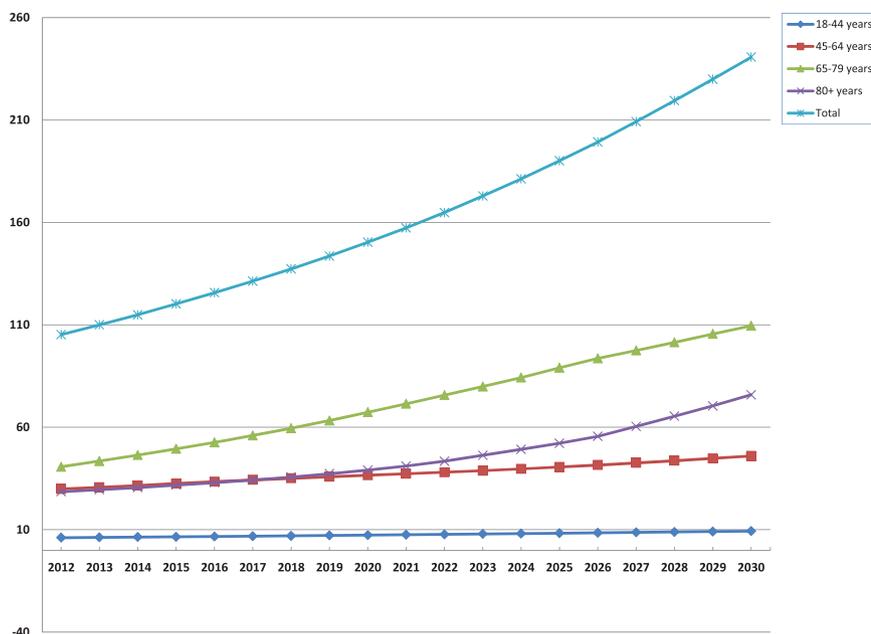


Figure. Projected total (direct and indirect) costs of all stroke by age, 2012 to 2030 (in billions 2010\$).

harmful in those with a brain hemorrhage.¹⁷ Long-term anticoagulation is warranted for secondary prevention of ischemic stroke in patients with atrial fibrillation. Carotid revascularization is considered in patients with ischemic stroke associated with a significant carotid stenosis.¹⁸ Secondary prevention in those with an ischemic stroke in the distribution of a penetrating artery and no proximal occlusive disease or source of embolism involves management of risk factors such as hypertension. Venous occlusive disease spurs an evaluation for an underlying coagulation disorder.

As the population continues to age, the likelihood of specific stroke subtypes is also anticipated to change. For example, the population-attributable stroke risk for atrial fibrillation, the most common source of cardiogenic embolism, increases from 1.5% in 50- to 59-year-olds to 23.5% in those aged 80 to 89 years.¹⁹ Understanding the changing patterns of stroke subtypes will be important for anticipating the appropriate allocation of preventive and treatment resources and their cost implications for the healthcare system.

Stroke Risk Factors

Major risk factors for stroke include age/sex, diabetes mellitus, dyslipidemia, hypertension, smoking, obesity, sedentary lifestyle, family history of cardiovascular disease at a young age, and proinflammatory and prothrombotic factors.¹⁹ There is a substantial concern regarding the rapidly growing rise in obesity, as well as the potential that an increase in risk factors associated with obesity (including hypertension and diabetes mellitus) will follow.²⁰ A recent study predicted that obesity rates in the United States will increase by 33% between 2010 and 2030.²¹ In another study, the Trust for America's Health and the Robert Wood Johnson Foundation compiled self-reported data on obesity and other risk factors from the national Behavioral Risk Factor Surveillance System (BRFSS) through 2010, the most recent period available.²² Obesity rates were >25% in 38 states, with the rates of obesity and obesity-related diseases such as diabetes mellitus and hypertension highest in the southern states; hypertension rates in every state are currently >20%, whereas only 37 states had such rates 20 years ago. Diabetes mellitus rates have doubled in 10 states over the past 15 years, and 42 states have diabetes mellitus rates >7%.²³ These data support the concern that the increased prevalence of obesity is nearly certain to be associated with corresponding increases in the prevalence of both hypertension and diabetes mellitus, 2 of the major risk factors for stroke. Another trend being watched closely is that of rising stroke rates among young adults.^{23,24} If this trend were to continue, especially given observations of poorer hypertension control in young versus older adults,²⁴ it could significantly impact the epidemiology of stroke such that the population burden of stroke among younger adults could increase dramatically. Longer-term expectations of the stroke burden underscore the importance of the AHA's goal to improve cardiovascular health, in part by preserving it from childhood through adolescence into early adulthood. Although the major impact of this strategy will be seen after 2030, absent this action now the 2030 projections will be compounded in future decades.

Disparities and Health Equity Issues

Not only does the incidence of stroke in adults increase with age,²⁵ the rate of adverse outcomes and complications associated with stroke is also greater in older individuals.²⁶ Because the US population is aging, the total number of people ≥65 years old will nearly double, increasing from 34 million (in 2000) to 90 million (in 2050).^{27–29} As measured by disability-adjusted life years, the burden of stroke relative to other diseases is anticipated to continue to increase worldwide from sixth in 1990 to fourth in 2020.³⁰

A systematic review of evidence-based acute stroke care found poorer care for older patients for 7 of 11 evidence-based process indicators, potentially contributing to poorer outcomes for older patients.³¹ Recommended therapies are underused among older stroke patients eligible for treatment,³² and research is needed to explore strategies to improve treatment for the elderly population. The relative change in projected stroke prevalence is largest (5.1%) for those aged 45 to 64 years. Those aged 45 to 64 years represent 1.3 million of the estimated 4.1 million stroke survivors, but they report poorer access to physician care and lower medication affordability than older stroke survivors.³³ Lack of health insurance explains some of the reduced access to physician care, but not the more frequent problems with medication affordability. Reduced access to care and medications for an increasing number of uninsured nonelderly Americans may lead to inadequate risk factor modification and increased recurrent events in younger stroke populations that can contribute to greater costs.

The age at stroke onset is older for women than for men (75 years compared with 71 years).¹ Overall, women have a lower age-adjusted stroke incidence than men; however, sex-related differences in stroke risk are modified by age. Data from the Framingham study demonstrate that white women 45 to 84 years of age have lower stroke risk than white men, but this association is reversed in older ages in that women >85 years of age have a higher risk.¹ The prevalence of stroke is greater for women, likely because of women's longer life expectancy. Not only is stroke prevalence higher in women, but the bulk of these strokes occur in women >70 years old, who are more likely to be socially isolated, live alone, have fiscal constraints, and have higher rates of comorbid disease. The higher rate of stroke deaths in women is predicted to be even greater in the future based on population projections; an excess of 32 000 stroke deaths in women in 2000 is anticipated to increase to nearly 68 000 excess deaths by 2050.³⁴

Women <50 years of age are generally considered to be at lower risk for stroke than men, although recent studies show that women aged 45 to 64 years are much more likely than men to report prior stroke,³⁵ which is consistent with our results showing an increasing prevalence of stroke among women aged 45 to 64 years. Studies suggest that women are protected by endogenous estrogens; however, clinical trials suggest a higher risk of stroke in postmenopausal women treated with exogenous estrogen and progesterone.³⁴

Stroke incidence varies by race/ethnicity. The risk of first ischemic stroke increases from 88 per 100 000 in whites to 149 per 100 000 in Hispanics/Latinos to 191 per 100 000 in

blacks.¹ Blacks and Hispanics/Latinos have 2 to 4 times the rate of stroke, stroke recurrence, and stroke-related deaths as whites.³⁶⁻⁴⁰ Although differences are more prominent in younger age groups, race/ethnicity differences remain among older age groups.^{36,40} The projected percentage of blacks is estimated to remain relatively stable from 2010 to 2050 (increase from 12.9% to 13%), whereas for Hispanics/Latinos, an increase from 16% to 30.2% is projected, potentially resulting in an increased stroke burden for this subgroup of the population.⁴¹ Our stroke cost projections demonstrate the greatest relative increase in both direct and indirect costs for Hispanics. Prior reports have also identified the enormous increase in the cumulative total ischemic stroke costs for blacks and Hispanics by 2050.⁴²

In the United States, over the past decade, stroke incidence has been decreasing in whites but not in blacks, which suggests a worsening of the racial disparity in stroke incidence.³⁶ An analysis of National Center for Health Statistics mortality data from 1996 to 2005 found important racial and sex disparities in stroke death rates over time. Stroke became the fourth-leading cause of death in whites and the fifth-leading cause of death in men but remained the second-leading cause of death in women and blacks.⁴³ The prevalence, odds ratio, and etiologic fraction of stroke risk factors vary by race/ethnicity.⁴⁴ Moreover, between ages 45 and 65 years, approximately half of the racial disparity in stroke risk is attributable to traditional risk factors, particularly systolic blood pressure.⁴⁵ These findings combined with socioeconomic factors identify a critical need to understand the disparities in the development of traditional risk factors.⁴⁵ Nontraditional risk factors may also play a role in the excess risk and warrant further investigation. Not only do risk factor profiles differ, the recognition of stroke symptoms is lower among blacks and Hispanics-Latinos than among whites.^{46,47} and temporal trends indicate that knowledge about stroke warning signs and treatment with tissue-type plasminogen activator (tPA) remains poor, particularly for blacks, who were far less likely to be aware of tPA treatment, even after controlling for other factors.^{48,49}

Secondary prevention treatments are underused by all race/ethnic groups, but minorities are less likely to receive medications for secondary prevention.⁴⁶ Lower health literacy, denial of disease, concern for potential or experienced side effects of medications, absence of symptoms, burden of filling prescriptions, and perceived racial bias from the healthcare system may influence receipt of and compliance with treatment.⁴⁶ Among older stroke survivors, blacks and Mexican Americans reported poorer access to medications and physician care than whites, potentially leading to inadequate risk factor modification and recurrent events in these high-risk minority groups,^{46,50-53} although differences are attenuated after adjustment for age, sex, education, and insurance status.⁵¹ Potential causes for these disparities include differences in socioeconomic status, healthcare access and use, and availability of community resources.⁴⁶ These factors explain much of the difference in access to physician care between Hispanics/Latinos and whites but explain less of the disparities between blacks and whites.⁵⁴ Mexican Americans and blacks are less likely to arrive by emergency medical

services (EMS) transportation than whites.^{55,56} Arrival by EMS transportation is associated with more urgent medical evaluation, and delays in presentation may contribute to race/ethnic disparities in the receipt of acute care.⁵⁶⁻⁵⁹ Existing racial differences in the use of inpatient rehabilitation and postacute care⁵⁷⁻⁶⁰ may contribute to differences in recovery and risk for recurrent events. Low-income black stroke patients who experience delay in the initiation of inpatient rehabilitation have a slower trajectory of functional recovery within the first year after a stroke.⁶¹ Low socioeconomic status is associated with a lower likelihood of receiving optimal acute stroke care.⁶²⁻⁶⁴ Factors related to socioeconomic status, insurance coverage, mistrust of the healthcare system, and a limited number of providers belonging to minority groups may contribute to differences in access to care.⁴⁶ Race/ethnic disparities in acute care improve when adherence to evidence-based recommendations is improved with quality improvement programs such as Get With The Guidelines-Stroke.⁶⁵

Stroke mortality has varied regionally in the United States over the past 50 years, with the highest mortality rates in the southeast United States, a region of the country termed the *Stroke Belt*.⁶⁶⁻⁷⁰ The reasons for the existence of the Stroke Belt remain uncertain. Within the Stroke Belt, a “buckle” region along the coastal plain of North Carolina, South Carolina, and Georgia has even higher stroke mortality rates than the remainder of the Stroke Belt.⁷¹ The overall average stroke mortality is $\approx 20\%$ higher in the Stroke Belt than in the rest of the nation and $\approx 40\%$ higher in the stroke buckle. Recently, higher stroke mortality rates were noted in the Pacific northwestern region of the United States.^{72,73} Geographic patterns in age-adjusted stroke hospitalization rates by county are consistent with stroke mortality patterns.⁷⁴ Stroke incidence is higher in the Southeast,^{75,76} and a recent study suggests that regional disparities in incidence may play a substantial role in mortality disparities.⁷⁶ There are also regional differences in recurrent stroke events within the year after a stroke hospitalization, after adjustment for risk factors.^{77,78}

Regional differences in access to care may contribute to acute care and outcomes.⁷⁹⁻⁸² Although the majority of the US population has access to an emergency department, there are geographic inequities in timely access, particularly in rural regions.⁷⁹⁻⁸¹ A more detailed review of risk factor profiles, barriers to achieving risk modification goals, patterns of healthcare resource use, and the development of regionalized emergency care delivery systems may provide insights into opportunities to reduce regional variations in disease rates and outcomes.

System-level Interventions

Policy changes and other forms of system-level intervention at all levels of healthcare decision making could effectively reduce stroke risk and overall burden. Such changes can also be cost saving. Specific policies can reduce stroke risk factors, enhance prevention efforts, improve acute and chronic care, and guide support for research that advances the field and produces more effective treatments. Policy changes can have a broad and dramatic impact on health but may be difficult to

institute and sustain. Recent federal healthcare reform legislation may specifically impact stroke incidence, burden, and care.

Prevention is a particularly promising area for policy change and systems intervention, with examples of prior successes. Primary prevention represents the greatest and most efficient approach for societal stroke reduction, but secondary prevention strategies are also critical. Tobacco-related policies (particularly taxation but also regulations to reduce environmental tobacco smoke exposure) have been credited with bringing about substantial decreases in smoking rates in the United States,⁸³ which could have contributed to the declines in ischemic stroke and subarachnoid hemorrhage rates seen over the past decade. Reducing salt intake has also been proposed as a strategy to reduce stroke risk.⁸⁴ Indeed, meaningful reductions in salt consumption could be achieved rapidly through policy changes.⁸⁵ Hypertension treatment with blood pressure reduction reduces stroke risk.^{86,87} Blood pressure reduction is effective in reducing risks in all populations and ages and is a major component of primary and secondary stroke prevention strategies.^{18,19} Successful implementation of evidence-based guidelines in clinical practice can result in higher control rates.⁸⁸ Some of the improvements in high blood pressure control rates are attributable to newer classes of medications and combination therapy, which are, however, associated with higher medication costs. Although many proven prevention strategies are cost-effective in reducing the burden of stroke, it is very difficult to quantify whether and how much cost savings would result from implementation of specific strategies. There is, however, limited evidence that some of the more cost-effective strategies do result in savings to the patient and the healthcare system more generally. For example, one study found that eliminating copayments for relatively inexpensive, commonly used medications for prevention of cardiovascular events resulted in improved medication adherence and reduced the rate of vascular events, while significantly reducing costs for patients and without increasing the insurer's healthcare costs.⁸⁹

More effective strategies are required to adequately educate the general and high-risk populations about stroke in a way that leads to more timely activation of the EMS system.⁸⁶ For people with suspected stroke, EMS personnel should ideally bypass hospitals that do not have resources to treat stroke and go to the closest facility capable of treating acute stroke patients.⁸⁶ Also, emergency medical dispatch personnel need to be educated to recognize that a person may be having a stroke, as well as to alert the appropriate EMS responder.⁸⁷ EMS personnel should be instructed to rapidly identify possible stroke patients using standardized assessment tools,^{88,89} evaluate stroke patients using an algorithm and predetermined protocol, and transport the patient to the nearest appropriate facility, preferably a stroke center. Prearrival emergency department notification by EMS personnel further shortens the time to evaluation and treatment.⁹⁰ Improved ways of identifying patients in the field may lead to more accurate identification of those with stroke who may be candidates for emergent reperfusion therapy, thereby optimizing resource use.⁹¹

Enhanced stroke systems of care can be one method to ensure that patients receive optimal care and experience better outcomes. Several states have introduced laws or policies mandating that acute stroke patients be taken to the nearest designated stroke center rather than to the closest emergency department for treatment. Although not dictated by legislation, the primary stroke center (PSC) certification system in the United States has also used policy initiatives to improve care. Since 2004, hospitals have been certified as PSCs by The Joint Commission using criteria established by the Brain Attack Coalition. One study found that a PSC designation increased the use of intravenous tPA from 1.5% to 10.2% in 2 years.^{90,92} Comprehensive stroke centers (CSCs) are intended to provide more advanced stroke care, including interventional management, than available in PSCs. Some states have begun to designate CSCs, and The Joint Commission recently began to certify CSCs. As with PSCs, a self-designated CSC hospital increases the use of lytic drugs in its region.⁹³ Care at CSCs may also be associated with less variation in weekend versus weekday gaps in stroke care.⁹⁴ Opportunities currently exist to allow access to adequate care for all patients with stroke across the country and to provide adequate rehabilitation and support for stroke survivors. Telemedicine systems can provide stroke expertise to underserved hospitals. The concept of a telemedicine stroke "hub-and-spoke" network can extend acute stroke treatment options to hospitals without these capabilities and facilitate transport of appropriate patients who might require higher levels of care.⁹⁵⁻¹⁰⁰

The AHA/ASA has outlined strategic policy priorities to enable attainment of the 2020 goals to improve the cardiovascular health of all Americans by 20% while reducing deaths attributable to cardiovascular diseases and stroke by 20%. These policies include increasing access to healthy and affordable foods in the community, more frequent physical education in schools, increasing access to recreational spaces for physical activity in the community, robust clean indoor air laws in public places, tobacco excise taxes, improved food labeling, reducing sodium in the food supply, promoting public funding for heart disease and stroke prevention programs, comprehensive worksite wellness programs, and ensuring the availability of essential cardiovascular disease preventive benefits in private insurance and public health insurance.¹⁰¹ The AHA/ASA also supports the Million Hearts initiative, a program of the US Department of Health and Human Services to collaborate with private sector partners to prevent 1 million heart attacks and strokes through increased public awareness and partnership engagement, science and evaluation, clinical care improvement, patient outreach, and public policy.¹⁰² For stroke, the AHA/ASA promotes efforts to create inclusive and coordinated statewide systems of care to improve the treatment of the stroke patient (Table 4). The AHA/ASA works to ensure that the recognition and the protection of PSC, CSC, and Acute Stroke Capable Facility designations are based on Joint Commission/AHA/ASA accreditation or an equivalent accreditation process offered by a guidelines-based, nationally recognized accrediting organization. Using current AHA/ASA guidelines for stroke care, the AHA/ASA

Table 4. American Heart Association Policy Strategies to Address Stroke Systems of Care

Stroke Systems of Care	Advocacy/Policy Strategies
Prevention	<p>Federal</p> <ul style="list-style-type: none"> • Incorporate measures of physical activity levels into electronic medical records and counsel in the healthcare environment • Advocate for regular revision and update of the “Physical Activity Guidelines for Americans” • Obesity counseling and treatment coverage in the healthcare environment • Robust surveillance and monitoring of obesity • Partner with US Department of Health and Human Services to promote the Million Hearts campaign • Work to eliminate food deserts and improve access to and affordability of healthy foods • Reduce sodium in the food supply • Implement the Institute of Medicine’s recommendations to reduce sodium in the food supply • Improve food labeling to increase consumer understanding of sodium levels in packaged foods • Advocate for robust sodium limits in procurement standards, nutrition standards in schools, and other government feeding programs <p>State</p> <ul style="list-style-type: none"> • Increase sports, recreational opportunities, parks, and green spaces in the community • Support efforts to design workplaces, communities, and schools around active living and integrate physical activity opportunities throughout the day • Support the use of zoning policy to increase access to safe places for recreation • Create and maintain comprehensive worksite wellness programs • Advocate for adequate prevention, diagnosis, and treatment of overweight and obesity in the healthcare environment • Advocate for continued funding for obesity prevention research and work to ensure a strong evaluation component is a part of the implementation of new laws and programs • Include sodium information through the use of warnings on the menu as allowed by federal law and support strategies that reduce sodium in the food supply • Support the elimination of food deserts through policies that increase the availability of fruits, vegetables, and water in underserved neighborhoods • Support the use of zoning policy to increase access to healthy foods and decrease access to unhealthy foods • Support the establishment of food procurement policies that meet AHA guidelines for government offices • Support policies that change relative prices of healthy vs unhealthy food items • Support policies designed to encourage retailers to increase access to healthy foods while decreasing access to unhealthy foods • Increase funding for programs that eliminate health disparities • Promote public funding for heart disease and stroke programs • Support policies that ensure the availability of evidence-based stroke preventive benefits in private insurance and public health programs that are consistent with the AHA position statement, “Recommended Model Benefits Package: Preventive Cardiovascular Services” and the US Preventive Services Task Force recommendations for preventive health services. Support policies that eliminate cost sharing (including copays and deductibles) associated with these stroke-related preventive services. Oppose policies that establish punitive measures within health plans for those with CVD risk factors such as tobacco use, being overweight or obese, hypertension, and high cholesterol.
EMS transport	<p>Federal/state</p> <ul style="list-style-type: none"> • Support public policy and sustainable appropriations initiatives and other activities that promote increased quality and timely use of 9-1-1 systems. This includes the ability of current and future generations of telecommunications technology to supply enhanced 9-1-1 (E9-1-1) capabilities to their customers. • Promote the use of sustainable funding for nationally recognized emergency medical dispatch protocols and appropriate quality improvement programs among 9-1-1 dispatch agencies to ensure that bystanders promptly receive effective coaching and support and that dispatch personnel provide prearrival medical instructions • Support public policy, sustainable appropriations, and other initiatives that promote a strong, well-trained, data-driven, quality EMS system that improves collaboration, responsiveness, and effectiveness • Strengthen EMS systems by supporting efforts that will eliminate geographic, racial, ethnic, sex, and socioeconomic disparities in EMS care • Using current AHA/ASA guidelines for stroke care, promote within EMSs statewide standardization and implementation of stroke training, assessment, treatment, and transportation protocols

AHA indicates American Heart Association; ASA, American Stroke Association; CVD, cardiovascular disease; and EMS, emergency medical services.

For AHA/ASA advocacy resources including fact sheets, policy briefs, published papers, and position statements, go to: http://www.heart.org/HEARTORG/Advocate/PolicyResources/Policy-Resources_UCM_001135_SubHomePage.jsp.

promotes within EMS the statewide standardization and implementation of stroke training, assessment, treatment, and transportation protocols. Finally, the AHA supports the removal of barriers for rehabilitation referral and treatment of stroke patients.

Research has a fundamental role in reducing stroke burden; because of the large dependence on government funding,

research depends on federal policies. Quality improvement, comparative effectiveness, health services, implementation, and dissemination are all areas of research that promote the identification of strategies that can improve care. Setting aside a portion of healthcare expenditures to study strategies to improve care is a part of the US healthcare reform legislation. Bold new initiatives such as the Million Hearts program that

Table 5. Select Provisions of the Affordable Care Act Likely to Have a Profound Impact on Stroke Mortality, Prevalence, and Costs

Provision	Implementation Date (Effective Date)	Government Agency/Level Responsible for Implementation
Principle 1: Health insurance coverage/reform		
Interim high-risk pool for Americans who are uninsured because of a preexisting condition (§1101)	6/23/2010	HHS; can contract with states
Prohibits insurance companies from putting lifetime caps on coverage (§2711)	Plan years beginning on or after 9/23/2010	HHS
Prohibits health plans from requiring prior authorization for emergency services and from charging differential cost sharing for out-of-network emergency care (§1001)	Plan years beginning on or after 9/23/2010	HHS
Prohibits insurance companies from denying coverage to children and adults with preexisting conditions (§10103 and §2704)	09/23/2010 for children; 1/1/2014 for adults	HHS/states
Prohibits higher premiums based on health status; establishes rating areas for variation based on age, tobacco use, etc (§2704)	1/1/2014	States, with review by HHS Secretary and consultation with NAIC
Defining of “essential health benefits”: statute requires inclusion of 10 categories of services, including rehabilitative care (§1302)	Before 1/1/2014	HHS Secretary (DOL conducts employer survey first)
Establishment of health insurance exchanges as new marketplace for buying coverage for those in individual and small group markets. Tax credits available on sliding income scale for those with incomes up to 400% FPL to help make coverage affordable (§1311)	1/1/2014	States (with federal fallback for states that choose not to establish an exchange)
Increased Medicaid eligibility to 133% FPL for all nonelderly individuals (§2001)	1/1/2014	States
Principle 2: Prevention and wellness		
Creation of Prevention and Public Health Trust Fund; mandatory appropriations of \$15 billion over 10 years	Enactment	HHS
Community Transformation Grants to state or local governments or nonprofit organizations to conduct evidence-based community preventive health activities (§4201)	Enactment	HHS (CDC)
Requires new private health plans to cover evidence-based preventive services with no cost sharing (§2713)	9/23/2010	HHS
Menu labeling requirements for chains with >20 restaurants and vending machines (§4205)	7/23/2010, voluntary registration; promulgation of proposed rules, 3/23/2011	HHS (FDA)
Elimination of cost sharing for preventive services under Medicare (§4104)	1/1/2011	CMS
Establishes new annual wellness visit for Medicare beneficiaries (§4103)	1/1/2011	CMS
Provides 1% Medicaid FMAP increase for states to cover evidence-based preventive services with no cost sharing. (§4106)	1/1/2013	States/HHS
Principle 3: Quality and delivery system reform		
Authorizes at least 4 competitive grants or contracts for regionalized systems for emergency care, including for stroke and cardiac emergencies. Matching funds required. Subject to appropriations. (§3504)	FY2010–2014	Assistant Secretary for Emergency Preparedness and Response
Establishment of Community Care Transitions Program for high-risk Medicare beneficiaries (§3026)	1/1/2011	CMS
Creation of Center for Medicare and Medicaid Innovation to test innovative payment and service delivery models that address a defined population for which there are deficits in care leading to poor outcomes or potentially avoidable expenditures, including specifically the use of telehealth services in treating stroke, particularly in medically underserved areas and IHS facilities (§3021)	1/1/2011	CMS
Establishment of a Medicare Shared Savings Program through ACOs (§3022)	1/1/2012	CMS

(Continued)

Table 5. Continued

Provision	Implementation Date (Effective Date)	Government Agency/Level Responsible for Implementation
Establishment of acute hospital value-based purchasing program under Medicare (§3001)	1/1/2012	CMS
Begin tracking hospital readmission rates for certain conditions (CHF, CABG, and COPD initially) and implement payment penalty for hospitals with highest readmission rates (§3025)	10/1/2012	CMS
National pilot program on payment bundling (around a hospital stay) (§3023)	1/1/2013	CMS
Creation of physician value-based payment program under Medicare (§3002 and §3007)	1/1/2015 (Begin implementing during 2013 physician fee schedule rulemaking)	CMS
Establishment of independent payment advisory board for Medicare (15 members appointed by President, with Senate confirmation), including representatives of consumers; section also provides for a 10-member consumer advisory council appointed by GAO to advise the Board (§3403)	1/15/2014	HHS
Principle 4: Addressing health disparities		
Collaboration with health professional societies, experts in prevention, etc for development of model curricula for cultural competency, prevention, training (§5307)	Enactment	HHS (HRSA)
Requires any federally conducted or supported healthcare program or survey to collect and report data by race, ethnicity, sex, primary language, and disability status (§4302)	3/23/2012	HHS
Principle 5: Research		
Establishment of Patient-Centered Outcomes Research Institute, a private, nonprofit entity to fund comparative effectiveness research (§6301)	Enactment	GAO
Principle 6: Workforce issues		
Establishment of National Health Care Workforce Commission, with 15 members appointed by GAO (§5101)	Enactment	HHS
10% Medicare bonus payment for primary care services (§5501)	1/1/2011	HHS (CMS)

ACO indicates accountable care organization; CABG, coronary artery bypass graft surgery; CDC, Centers for Disease Control and Prevention; CHF, congestive heart failure; CMS, Centers for Medicare and Medicaid Services; COPD, chronic obstructive pulmonary disease; DOL, US Department of Labor; FDA, US Food and Drug Administration; FMAP, federal medical assistance percentage; FPL, federal poverty level; FY, fiscal year; GAO, US Government Accountability Office; HHS, US Department of Health and Human Services; HRSA, Health Resources and Services Administration; IHS, Indian Health Service; and NAIC, National Association of Insurance Commissioners.

involve collaborative efforts across multiple federal agencies, in conjunction with nonprofit agencies such as the AHA/ASA, also target general primary prevention goals that can have a direct impact on stroke prevention.¹⁰²

Healthcare Reform

The US Patient Protection and Affordable Care Act (ACA) has the potential to reduce stroke mortality and incidence, as well as the cost of stroke, relative to previous projections (Table 5). Although the law was enacted in March 2010, implementation of key provisions is still in the early stages. The US Supreme Court recently upheld the law, yet it remains uncertain how fully and effectively its provisions will be carried out.

In its "Statement of Principles for Healthcare Reform"¹⁰³ published in *Circulation* in the fall of 2008, the AHA/ASA recognized that national health reform was critical to reducing death and disability attributable to cardiovascular disease. The 6 principles elucidated in the statement (access to affordable healthcare coverage, preventive benefits and incentives

built into the healthcare system, promotion of high-quality care, reduction of disparities in care, support for research, and growth and diversification of the healthcare workforce) provide a useful framework for examining the potential impact that aspects of the law may or may not have on stroke mortality, incidence, and cost.

Expanding access to affordable, adequate health insurance coverage can be expected to reduce stroke mortality in the future. Because more people will survive a stroke, disease prevalence and costs will increase. The detrimental impact of a lack of health insurance coverage for individuals experiencing a stroke is well documented. For example, those without insurance who have a stroke have a risk of death that is 24% to 56% higher than for stroke patients with insurance coverage.¹⁰⁴ When fully implemented, the ACA is projected to expand private and public insurance coverage to an additional 32 million Americans (95% of the non-elderly population) by 2019, although 23 million residents are still estimated to be uninsured.¹⁰⁵ It is not yet clear what impact the Supreme Court's recent decision curtailing the

current administration's ability to require states to expand Medicaid will have on these numbers. Table 5 summarizes select provisions of the ACA that are likely to have the greatest impact on stroke mortality, prevalence, and costs. A greater emphasis on prevention may serve to reduce stroke incidence and mortality, as well as the public health burden. There are currently many missed opportunities for stroke prevention, particularly in the area of high blood pressure, a major risk factor for stroke. In a recent national study, nearly 80% of adults >20 years of age who have hypertension were aware that they had high blood pressure, but only 48% had their hypertension under control.¹⁰⁶ It is worth noting that hypertension can be treated at a relatively low cost, even for those without adequate insurance, through the use of generic drugs, and nonpharmacological approaches (exercise, avoidance of alcohol, reduction in salt) can also improve blood pressure control.

The ACA provides an unprecedented emphasis on the provision of evidence-based clinical preventive services and calls for a substantial investment in community-based prevention strategies that may help to reduce the growing future burden of stroke. In particular, the law encourages Americans to take advantage of clinical preventive services by requiring that most private health plans and Medicare provide first-dollar coverage of evidence-based preventive services. The ACA also establishes a \$15 billion Prevention and Public Health Trust Fund to promote investment in community-based prevention activities, including Community Transformation Grants from the Centers for Disease Control and Prevention aimed at implementing successful population-level prevention strategies.

As with prevention, there are numerous missed opportunities in the treatment of stroke that, if improved, may reduce stroke morbidity and the direct and indirect costs of stroke. For example, treatment of appropriate patients with the thrombolytic drug tPA can significantly reduce the debilitating effects of stroke if administered as soon as possible within 4.5 hours of symptom onset.¹⁰⁷ tPA can provide considerable cost savings if used in just 20% of all ischemic stroke patients in the United States (nearly \$74 million for the first poststroke year alone).¹⁰⁷ Furthermore, the failure of current insurance plans to cover rehabilitation beyond a short poststroke window denies opportunities for the fullest attainable functional recovery; change in this policy is needed and would have significant cost implications.

The health reform law includes a number of provisions that hold promise in improving the quality and value of care. The ACA primarily uses Medicare and to a lesser extent Medicaid as a vehicle for testing innovative delivery system reforms that can improve health outcomes and "bend the cost curve" in medical spending. The nonpartisan Congressional Budget Office projected that annual growth in medical costs will decline from 3.6% to 2.8%, largely as a result of the delivery system and other reforms in the ACA; our projections of stroke costs reflect this change in the Congressional Budget Office's estimates.

Although the ACA does not address funding for the National Institutes of Health, the ACA does establish a

mechanism for ensuring a new and stable source of funding for comparative effectiveness research through a new private, nonprofit entity, the Patient-Centered Outcomes Research Institute. Over time, research funded by the Patient-Centered Outcomes Research Institute is intended to provide clinicians, researchers, and patients with better scientific evidence comparing ≥ 2 treatment or care options, a common issue in stroke care.

Limitations

Our projections are subject to sampling error in the underlying surveys. The combination of varied data sources prevented calculation of confidence intervals for our estimates. The human capital approach does not incorporate the psychological costs of morbidity and therefore likely undervalues the morbidity costs for those not in the labor force. Our approach assumed a continued acceleration of healthcare spending for stroke based on historical trends, which may prove to be incorrect. Similarly, although we assumed that without a change in policy, the prevalence estimates would remain stable, changes in medical treatment patterns may influence prevalence independent of policy changes. Our grouping of the population by age, race, and sex does not account for the disparities in stroke incidence for blacks compared with whites in younger age groups or for men compared with women by age. We analyzed age in 20-year age groups (eg, 45–64 years), thereby potentially obscuring subtle age distinctions. Also, our stroke prevalence estimates and costs may be underestimates if current obesity and diabetes mellitus trends continue. Lastly, some race/ethnic groups, including Asians, Pacific Islanders, and Native populations, were coded as "other" race/ethnicity rather than as a separate category. Because data are generally lacking, we did not account for the potential impact of innovations in poststroke rehabilitation on reducing stroke-related disability and morbidity or for the burden of vascular cognitive impairment, both of which are important contributors to direct and indirect costs.

Conclusions

With the aging population, stroke incidence and costs are projected to rise substantially in the future, and as such, the prevention of high risk through improvements in cardiovascular health and the reduction of risks for stroke by use of primary prevention strategies, as well as mitigation of stroke mortality and long-term disability by evidence-based acute and postdischarge treatments, are all imperative to address the anticipated rise in the human, economic, and societal burden of stroke. The issue of the projected increasing toll of all cardiovascular disease including stroke should be firmly on the agenda of policy makers in all sectors and at all levels of health care, including research institutions, healthcare systems, payers, government bodies, nongovernmental agencies, and patient support groups, directing them to begin earnest planning and decision making aimed at timely detection and optimal treatment of stroke risk factors.

Disclosures

Writing Group Disclosures

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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