Risk of Cardiovascular Events and Death—Does Insurance Matter?

Angela Fowler-Brown, MD, MPH[1,2], Giselle Corbie-Smith, MD, MSc[1,2,3], Joanne Garrett, PhD[4], and Nicole Lurie, MD, MSPH[5]

[1]Division of General Medicine and Epidemiology University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; [2]Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; [3]Department of Social Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; [4]Center for Women's Health Research, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; [5]RAND Corporation, Arlington, VA, USA.

BACKGROUND: Many Americans lack health insurance. Despite good evidence that lack of insurance compromises access to care, few prospective studies examine its relationship to health outcomes.

OBJECTIVE: To determine the relationship between insurance and cardiovascular outcomes and the relationship between insurance and selected process measures.

DESIGN AND PARTICIPANTS: We used data from 15,792 participants in the Atherosclerosis Risk in Communities Study, a prospective cohort study. Participants were enrolled in 1987–1989 and returned for follow-up visits every 3 years, for a total of 4 visits.

MAIN OUTCOME MEASURES: We estimated the hazard of myocardial infarction, stroke, and death associated with insurance status using Cox proportional hazard modeling. We used generalized estimating equations to examine the association between insurance status and risk of (1) reporting no routine physical examinations, (2) being unaware of a personal cardiovascular risk condition, and (3) inadequate control of cardiovascular risk conditions.

RESULTS: Persons without insurance had higher rates of stroke (adjusted hazard ratio, 95% CI 1.22–2.22) and death (adjusted hazard ratio 1.26, 95% CI 1.03–1.53), but not myocardial infarction, than those who were insured. The uninsured were less likely to report routine physical examinations (adjusted risk ratio 1.13, 95% CI 1.08–1.18); more likely to be unaware of hypertension (adjusted risk ratio 1.12, 95% CI 1.00–1.25) and hyperlipidemia (adjusted risk ratio 1.11, 95% CI 1.03–1.19); and more likely to have poor blood pressure control (adjusted risk ratio 1.23, 95% CI 1.08–1.39).

CONCLUSIONS: Lack of health insurance is associated with increased rates of stroke and death and with less awareness and control of cardiovascular risk conditions. Health insurance may improve cardiovascular risk factor awareness, control and outcomes.

Received May 10, 2006
Revised October 6, 2006
Accepted January 2, 2007
Published online February 16, 2007

KEY WORDS: insurance; cerebrovascular disease; cardiovascular disease; populations at risk; mortality; atherosclerosis.
DOI: 10.1007/s11606-007-0127-2
 2007;22:502–507

INTRODUCTION

The increasing number of people without health insurance is alarming. Recent reports estimate that 15.9% of the population or 46.6 million people were without health insurance coverage in 2005.[1] Although there are several studies that have examined the association of insurance with health-related outcomes, most focus on health utilization measures, rather than direct effects on health. In addition, the majority of the published studies are cross-sectional study designs, from which it is more difficult to infer the impact of insurance status on health over time. We are aware of only two other prospective studies that have examined the relationship between insurance and mortality.[2,3] We are not aware of any previous papers that have studied the possible impact of insurance status on stroke. A relative paucity of prospective studies that examine the impact of lack of health insurance on health outcomes and mortality limits our knowledge about the impact of this very prevalent issue and may hinder public policy efforts to address this issue.

Cardiovascular disease (i.e., coronary heart disease and stroke) is the leading cause of death and a major cause of morbidity for adults. Effective strategies to evaluate and reduce cardiovascular risk have been developed; but lack of insurance may reduce access to these services, and this barrier may ultimately manifest itself in detrimental effects on cardiovascular health. We hypothesized that the impact of lack of insurance could be discerned at several points in the medical care process related to cardiovascular risk reduction. As documented in previous studies, lack of insurance is associated with a lower likelihood of having routine health assessment medical visits.[4] As a consequence of fewer routine visits, the uninsured may have fewer opportunities for screening for asymptomatic risk conditions, such as diabetes and hypertension; therefore, they may have less awareness and poorer control of these conditions. Finally, poorer awareness and control of chronic risk conditions could translate into increased risk of cardiovascular disease events.

Given this framework, we examined, in a prospectively followed cohort, the relationship between lack of health insurance and the incidence of cardiovascular events and death. We also examined the relationship between lack of insurance and three aspects of care that might contribute to these negative cardiovascular

outcomes: (1) infrequent routine physical examinations, (2) lack of knowledge of personal risk factors for cardiovascular disease, and (3) poor control of cardiovascular risk factors.

METHODS

Study Population

The Atherosclerosis Risk in Communities Study (ARIC) is a longitudinal epidemiologic study of risk factors for incident cardiovascular disease and the prevalence of disease and risks for disease over time; details of the study design are described elsewhere.[5] Briefly, we used data from the ARIC cohort component, comprised of 15,792, predominantly African American and white adults in 4 U.S. communities: Forsyth County, North Carolina; Jackson, Mississippi; Minneapolis, Minnesota; and Washington County, Maryland. Participants were 45 to 64 years old at entry into the study and were enrolled during the years 1987–1989. At baseline, participants provided data on cardiovascular risk factors, personal medical histories, socioeconomic and family histories, and they underwent physical examination and cardiovascular and laboratory testing. Participants were similarly reevaluated at approximately 3-year intervals for a total of 4 visits, the last visit occurring in 1996–1998. Annual telephone surveys assessed changes in health status. Cardiovascular outcomes were ascertained through the year 2000.

Outcome Variables

Our main clinical outcome measures were: (1) incident myocardial infarction (fatal, hospitalized, or subclinical), (2) stroke, and (3) all-cause death. These events were ascertained at follow-up visits, by annual telephone surveys, and through surveillance of hospital discharge indexes, obituary notices, and death certificates. Medical records, detailing both inpatient and outpatient events, and death certificates, were reviewed to categorize the event. Events were then classified as "definite", "probable", "possible" or ineligible events using a standardized algorithm developed by the ARIC investigators. Only "definite" and "probable" events are analyzed in this study. ARIC investigators determined the dates of clinical outcomes of myocardial infarction, stroke, and death and then calculated follow-up time to these events.

Our secondary outcomes were aspects of care related to: (1) frequency of routine physical examinations, (2) awareness of the personal diagnosis of cardiovascular risk factors, and (3) adequacy of control of cardiovascular risk factors. Each outcome was assessed separately at visits 1, 2, and 3. Frequency of routine physical examination visits ("How often do you have a routine physical?") was dichotomized as "never" has routine exam versus any "other" frequency response. Awareness of personal cardiovascular risk factors, such as hypertension, was assessed using items asking whether participants had been advised by their doctors that they had particular medical conditions. For example, participants who answered "no" at a particular visit to the question, "Has a doctor ever told you that you have high blood pressure or hypertension?", yet had a systolic blood pressure (average of 2 measures) of 140 mmHg or greater or a diastolic blood pressure (average of 2 measures) of 90 mmHg or greater, were categorized as unaware of personal diagnosis of hypertension. A similar process was used for the diagnosis of diabetes to determine the proportion of participants unaware of a personal diagnosis of diabetes (using diagnostic criterion of that time—fasting blood sugar of greater than or equal to 140 mg/dL or non-fasting blood glucose of greater than or equal to 200 mg/dL) and hyperlipidemia (total cholesterol greater than or equal to 240 mg/dL). Finally, we examined adequate blood pressure control in those who were aware of a diagnosis of hypertension. We determined the percentage of persons with a known diagnosis of hypertension who had adequately controlled systolic blood pressure, defined as a systolic blood pressure (average of 2 measurements) less than or equal to 140 mmHg. Similarly, we determined the percentage of participants who reported being aware of a personal diagnosis of hyperlipidemia with adequate lipid control (defined as total cholesterol less than or equal to 200 mg/dL). Control measures for diabetes, i.e., glycosylated hemoglobin, were not obtained during all 4 visits of ARIC.

Insurance Status

At visits 1, 2, and 3, participants were asked: "Do you have health insurance, such as Medicare, or a medical plan such as an health maintenance organization (HMO) which pays part of a hospital, doctor's or surgeon's bill?" Participants with an affirmative answer to this question were coded as insured at that visit. At visit 4, participants were asked: "To help pay for your medical care, do you now have: (a) health insurance or a health plan, such as Blue Cross/Blue Shield or an HMO, (b) Medicare, (c) Medicaid, (d) other." Any participant that responded with options a, b, or c were designated insured at visit 4. To examine the relationship between insurance and our outcomes, we modeled insurance as a time-varying dichotomous variable based on whether the participant reported having insurance at a particular visit.

Covariates

All models controlled for baseline factors that we felt may affect the relationship between insurance status and each of the outcomes. Covariates included were demographic factors including age (years), gender, race (African American, Asian American, white, or other), combined family income (8 categories), education (grade school, high school—no degree, high school graduate, vocational school, college, graduate school), study site (4 study centers). Self-reported health status (excellent, good, fair, poor) and history of coronary heart disease before entry into the study (dichotomized as yes or no) were also assessed at baseline. In our models, we controlled for clinical characteristics measured at each visit, including presence of diabetes (fasting blood sugar greater than or equal to 126 mg/dL or taking medication for diabetes), smoking (current, former, never), hypertension (blood pressure greater than 140/90 or on antihypertensive medication), body mass index (kg/m^2), and total and high density cholesterol (mg/dL).

Statistical Analysis

We characterized participant's demographic and clinical characteristics at baseline using means and standard deviations for continuous variables and frequencies and percents for categorical variables. Some categories were collapsed when

Table 1. Baseline Characteristics of ARIC Participants

Characteristic	Total Sample	Participants Who Always Report Having Insurance	Participants Who Report Being Uninsured at Least Once	*P* value*
	N=15,792	*N*=13,289	*N*=2503	
Age, years mean (SD)	54.2 (5.8)	54.3 (5.8)	53.6 (5.6)	*P*<.005
Female (%)	55%	54%	60%	*P*<.005
White (%)	73%	79%	38%	*P*<.005
Yearly income per household occupant (%)				
<$5,000	5%	3%	20%	*P*<.005
$5,000–7,999	4%	3%	14%	
$8,000–11,999	6%	4%	14%	
$12,000–15,999	7%	6%	14%	
$16,000–24,999	15%	15%	17%	
$25,000–34,999	18%	19%	11%	
$35,000–49,999	19%	22%	6%	
>$50,000	25%	28%	5%	
Education level (%)				
Grade school	10%	7%	24%	*P*<.005
High school, no degree	14%	12%	26%	
High school graduate	32%	34%	25%	
Vocational school	8%	9%	7%	
College	26%	27%	15%	
Graduate school	10%	11%	4%	
Self-reported health status (%)				
Excellent	33%	35%	22%	*P*<.005
Good	47%	47%	43%	
Fair	17%	15%	28%	
Poor	3%	3%	8%	
Diabetes	12%	11%	19%	*P*<.005
Smoking (%)				
Current	26%	25%	34%	*P*<.005
Former	32%	34%	25%	
Never	42%	42%	41%	
Total Cholesterol (mg/dl) (SD)	215 (42)	214.4 (41.5)	217.7 (45.1)	*P*<.005
HDL (mg/dl) (SD)	53 (17.6)	52.9 (17.6)	54.3 (18.0)	*P*<.005
Hypertension (%)	35%	33%	47%	*P*<0.005
Body Mass Index (kg/m^2)(SD)	27.7(5.4)	27.4 (5.1)	29.2 (6.3)	*P*<.005
Previous history of CHD (%)	5%	5.1%	4.3%	*P*=.081

**P value for the comparison of those always reporting insurance and those who report being uninsured at least once*

doing so and did not alter the conclusions of the analyses. Final categorizations are shown in Table 1. This study was longitudinally designed with repeated measures obtained of insurance status at different visits. The insurance variable was modeled as time varying variable, allowing insurance status for the individual participant to change over time. Insurance status in the interim between visits is not known and cannot be accounted for in this analysis.

To analyze our primary clinical outcomes, we used Cox-proportional hazards modeling to examine how the hazard of having a clinical event is associated with lack of insurance. Time-to-event was used in the analysis with single failure-per-participant, although participants could contribute time at risk for all three of the clinical outcomes. Participants were right-censored if they were lost to follow-up, or the period of observation ended without an event. These models controlled for both baseline demographic and for clinical characteristics measured at each visit that may have been confounders of the relationship between insurance status and each outcome. We evaluated the proportional hazards assumption for the variables in each of our models by testing the nonzero slope of the scaled Schoenfeld residuals in generalized linear regression as functions of time.[6] Both covariate-specific and global tests were produced, and we saw no evidence that the proportional hazards assumption was violated for any of the models.

For the secondary outcomes related to aspects of care, we used generalized estimating equations (GEE) with a logit-binomial regression model, using an autoregressive correlation structure and robust variance estimators to assess the covariate adjusted relationship between insurance status at each visit and each outcome. A post-estimation equation:

$$RR_i = \frac{P(Y|E,\ x_{2i},\ldots,x_{ki})}{P(Y|\overline{E},\ x_{2i},\ldots,x_{ki})} = \frac{\left(1+e^{-\left(\beta_0+\beta_1\overline{E}+\beta_2 x_{2i}+\ldots+\beta_k x_{ki}\right)}\right)}{\left(1+e^{-\left(\beta_0+\beta_1 E+\beta_2 x_{2i}+\ldots+\beta_k x_{ki}\right)}\right)}$$

was used to yield risk ratios.[7]

All analyses were conducted using STATA statistical software (version 8.2, College Station, TX). The study was submitted for review and approved by the Committee on the Protection of the Rights of Human Subjects of the University of North Carolina at Chapel Hill School of Medicine.

RESULTS

Characteristics of the Sample

The 15,792 study participants were majority female and white with good to excellent reported health status at baseline (Table 1). The majority had combined family incomes greater

than $25,000 and at least a high school education. We compared baseline characteristics of those who reported always having insurance to those who reported being uninsured at least once during the time that they were followed. Those who reported being uninsured at least once were more often female and nonwhite, with lower education levels and family income. Participants who were uninsured at least once were also more likely to have cardiovascular risk factors such as diabetes, current smoking, hypertension, and higher body mass index. We had insurance status data at all 4 visits for 11,003 of the 14,560 participants who survived to visit 4. The percentage of participants who lacked health insurance was 10% at visit 1, 9% at visit 2, 6% at visit 3, and 5% at visit 4.

Association of Insurance Status with Cardiovascular Events and Death

Our Cox survival models included 444 strokes, 968 myocardial infarctions, and 1,157 deaths (Table 2). After adjusting for baseline characteristics, lack of insurance was associated with an increased relative hazard for stroke and all-cause death when compared to those who were insured (Table 2). While not statistically significant, lack of insurance was associated with an increased relative hazard of myocardial infarction.

Association of Insurance Status with Aspects of Care

Before and after adjusting for clinical and demographic characteristics, insurance status at each visit was associated with increased risk that a participant went without routine physical examinations (Table 3). Those who were not insured also had a higher adjusted risk of being unaware of a personal diagnosis of hypertension and hyperlipidemia compared to those who had insurance. In the subset of participants who reported being aware that they had hypertension, those that were uninsured had a higher adjusted risk of having inadequately controlled blood pressure compared to those that were insured. However, among participants who were told by their doctor that they had hyperlipidemia, there was no significant difference by insurance status for inadequately controlled hyperlipidemia.

Table 2. Lack of Insurance and Hazard Rate of Cardiovascular Events and Death*

Lack of isurance and hazard of	Number of outcome events	Unadjusted hazard ratio (95% CI)	Adjusted hazard ratio (95% CI)†
Stroke	444	2.32 (1.80–2.98)	1.65 (1.22–2.22)
Myocardial infarction	968	1.43 (1.17–1.74)	1.22 (0.97–1.54)
Death	1,157	1.77 (1.50–2.09)	1.26 (1.03–1.53)

*Compared to those with insurance
†Based on Cox proportional hazard models adjusted for baseline age, gender, race, study site, family income, family size, education, health status, and previous coronary heart disease, and measures at each visit of diabetes, smoking, total cholesterol, high density cholesterol, hypertension, and body mass index

Table 3. Lack of Insurance and Processes of Care

Lack of insurance and risk of	Unadjusted risk ratio (95% CI)	Adjusted risk ratio (95% CI)
Never having routine physical examination	1.40 (1.33–1.47)	1.13* (1.08–1.18)
Being unaware of a personal diagnosis of hypertension	1.01 (0.92–1.11)	1.12† (1.00–1.25)
Being unaware of a personal diagnosis of diabetes	1.10 (0.99–1.21)	1.20‡ (0.98–1.42)
Being unaware of a personal diagnosis of hyperlipidemia	1.31 (1.24–1.37)	1.11§ (1.03–1.19)
Having inadequate control of hypertension	1.26 (1.17–1.35)	1.23† (1.08–1.39)
Having inadequate control of hyperlipidemia	1.03 (0.99–1.07)	1.04§ (0.96–1.13)

*Based on generalized estimating equation models adjusted for baseline age, gender, race, education, family income, family size, health status and previous coronary heart disease, and measures at each visit of presence of hypertension, diabetes and smoking, and levels at each visit of total cholesterol, high density lipoprotein body mass index
†Adjusted for all of the above in footnote* except presence of hypertension
‡Adjusted for all of the above in footnote* except presence of diabetes
§Adjusted for all of the above in footnote* except levels of total cholesterol and high density lipoprotein

DISCUSSION

In this study of a prospectively followed cohort, we found that persons lacking health insurance had higher rates of stroke and death than those who were insured. However, the rate of myocardial infarction was not significantly associated with insurance status. Aspects of personal health, such as awareness and control of cardiovascular risk factors, were also found to be related to insurance status. This study adds to the relatively small body of literature that prospectively examines the association of insurance status with clinical outcomes.

There has been only one randomized trial of insurance in the United States. The Rand Health Insurance Experiment was a multisite trial during which over 2,000 families were randomly assigned to an insurance plan that provided free care or a plan that required some cost sharing.[8] No premiums were charged for any of the experimental plans and no family was assigned to be uninsured. Although participants randomized to free care had higher rates of health care utilization, the only significant benefit of free care on health measures in this trial was improved corrected far vision. The free care group was also found to have a lower diastolic blood pressure that approached statistical significance;[8] and within the subgroup of hypertensives, free care participants had significantly lower blood pressures than their counterparts.[9] Although participants randomized to free care did not realize significant improvement in many health status measures, such as physical and mental functioning and lipid control, better control of blood pressure significantly reduced the calculated risk of early death among a high risk subgroup.[8] Other studies have examined "natural experiments" to examine the effects of loss of insurance in populations who were insured, but precipitously lose their coverage. These quasi-experimental studies have found that those losing insurance suffered substantial declines in health, including poorer blood pressure control, when compared to their insured peers.[10–12]

Cardiovascular risk assessment and risk factor management is widely acknowledged to be a cornerstone in the prevention of adverse cardiovascular events. Satisfactory control of risk conditions is predicated upon adequate access to medical care. We hypothesized that lack of stable insurance would result in reduced health care access, inadequate risk factor identification and management, and increased risk of cardiovascular events. In fact, we found that those without health insurance had a higher risk of forgoing routine physical examinations and a higher risk of being unaware of a personal diagnosis of hypertension, diabetes, or hyperlipidemia.

While we found that blood pressure was less likely to be controlled in those who were both hypertensive and uninsured, we did not find any differences by insurance status in the degree of lipid control in those who were told that they had hyperlipidemia. These results are similar to those of the Rand Health Insurance Experiment. One possible explanation may be that the data collection for both our study and the Rand study predated the widespread, aggressive control of lipids that constitutes current practice. As lipid management has become more intensive and lipid lowering therapy used more widely, subsequent studies may yield different results.

We found that lack of health insurance was associated with an increased rate of stroke and death in our study. A previous study concluded that uninsured white women, but not white men, were at an increased risk of cardiovascular death, compared to those with employer-based insurance, when adjusted for age and income.[3] Interestingly, the authors of the study found that those with Medicaid and Medicare had the highest rates of cardiovascular and all-cause death; even higher than those without insurance. This earlier study did not control for participant health status or comorbidities, raising the possibility that unmeasured factors confounded the relationship between type of insurance and outcomes. Another study estimated that lack of health insurance was associated with an adjusted hazard ratio of 1.25 (95% CI 1.00–1.55) of death, when compared to private insurance.[2] This estimate of the hazard of death associated with lack of insurance is similar to what was found in our study.

Although we found an elevated point estimate of the hazard of myocardial infarction associated with lack of insurance, this was not statistically significant. Although it is unclear why this is so, we postulate that this finding may point to the relative importance of hypertension as a risk factor for stroke compared to myocardial infarction. Hypertension is the most powerful risk factor for stroke.[13] We observed that hypertension was significantly less likely to be well controlled in those lacking insurance. We believe that poorly controlled hypertension may be the link between lack of insurance and increased incidence of stroke. Although hypertension is an important risk factor for myocardial infarction, the relative contribution of other risk factors, such as inherited traits, lipid levels, smoking, and diabetes may be greater in the development of coronary heart disease. However, the interrelationships between multiple risk factors, demographic factors, insurance, and health outcomes are likely to be extremely complex. For example, we believe that poorer blood pressure control largely mediates the relationship between lack of insurance and increased risk of stroke. However, when we added systolic and diastolic blood pressure measurements to our model, we observed only modest attenuation of increased risk of stroke, suggesting that there are mediators, other than blood pressure, of the relationship between stroke and insurance. In addition, because we only have blood pressure levels at discrete time points, measurement issues may also affect our observations.

Our analysis has several important limitations. The estimation of the independent or distinct impact of insurance on health is very difficult, as health insurance is closely intertwined with other personal and community characteristics that are associated with health. Unlike randomized controlled trials, we could not equally distribute the other determinants of outcome to isolate a "pure" insurance exposure. Therefore, it is impossible to absolutely eliminate the possibility of residual confounding or bias in estimates derived from observational studies like this one. In our multivariable analyses, we statistically controlled for factors that we felt may be related to both insurance and the outcome, thus, reducing the potential for confounding bias and increasing the likelihood that the relationships we observed are truly causally related. In addition, elements of our study, namely, the association between lack of insurance and poorer blood pressure control, are mirrored in studies with different experimental designs, including the Rand randomized controlled trial of insurance.[9] Yet, there still could be unknown, unmeasured, or poorly measured confounding factors that could influence our assessment of the relationship between insurance and our outcomes.

Our study analyzed data initially collected for purposes other than the objectives of our study. Consequently, insurance was not measured as completely as it could have been. Insurance was asked in such a manner that insurance history before the visits was not obtained. Also, the question querying insurance status changed at the fourth visit and this may have affected data ascertainment. In our analysis, "being insured" is a heterogeneous designation, including different types of plans and payers. Future investigations of the association of insurance with health, where type and duration of insurance can be quantified, will be extremely valuable. In addition, because of the constraints of the data, we were unable to assess the degree of diabetes control by insurance status, as hemoglobin A1C values for participants were unavailable. ARIC investigators informed participants of the results of their research medical evaluation in the form of a letter to the participants and their doctors after each visit. Therefore, although we recognize that in theory, risk factors that were present at visit 1 should have been known to participants thereafter, we decided to study the lack of awareness of cardiovascular risk factors at all 4 visits because participants may not have fully understood the communications from the investigators, may not have had a doctor, or may have developed a risk condition after visit 1. Structuring the analysis this way biases the measurement of the relationship between insurance status and awareness of cardiovascular risk factors toward the null.

In summary, we found a significant relationship between lack of health insurance and lower utilization of primary care resources, decreased awareness of personal cardiovascular risk factors, poorer control of hypertension, and finally, increased rate of stroke and death. This study, along with others that have associated lack of health insurance with adverse health outcomes, underscores the importance of developing policies that ensure that all can receive sufficient access to medical care.

Acknowledgements: *This work was supported by grants from the U. S. Department of Health and Human Services, Health Resources and Services Administration [T32-HP14001]; the National Heart Lung Blood Institute at the National Institutes of Health; and the Robert Wood Johnson Harold Amos Medical Faculty Development Program and was previously presented in abstract form at the national meetings of the Society for General Internal Medicine (2004) and of the AcademyHealth (2004). The Atherosclerosis Risk in Communities Study is carried out as a collaborative study supported by National Heart, Lung, and Blood Institute contracts N01-HC-55015, N01-HC-55016, N01-HC-55018, N01-HC-55019, N01-HC-55020, N01-HC-55021, and N01-HC-55022. The National Heart, Lung, and Blood Institute approved a draft of the manuscript. Angela Fowler-Brown had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The authors thank the staff and participants of the ARIC study for their important contributions. We also pay tribute to the contributions of Dr. Paul McGovern, who helped conceptualize this study before his untimely death.*

Potential Financial Conflicts of Interest: *None disclosed.*

Corresponding Author: *Angela Fowler-Brown, MD, MPH; Division of General Medicine and Primary Care, Beth Israel Deaconess Medical Center, 1309 Beacon Street, 2nd Floor Brookline MA 02446, USA (e-mail: afowler@bidmc.harvard.edu).*

REFERENCES

1. **DeNavas-Walt C, Proctor BD, Lee CH.** Current Population Reports, Income Poverty and Health Insurance Coverage in the United States: 2005. Washington, D.C.: U.S. Census Bureau, U.S. Government Printing Office. 2006;60–231.
2. **Franks P, Clancy CM, Gold MR.** Health insurance and mortality. Evidence from a national cohort. JAMA. 1993;270(6):737–41.
3. **Sorlie PD, Johnson NJ, Backlund E, Bradham DD.** Mortality in the uninsured compared with that in persons with public and private health insurance. Arch Intern Med. 1994;154(21):2409–16.
4. **Ayanian JZ, Weissman JS, Schneider EC, Ginsburg JA, Zaslavsky AM.** Unmet health needs of uninsured adults in the United States. JAMA. 2000;284(16):2061–9.
5. The ARIC investigators. The Atherosclerosis Risk in Communities (ARIC) Study: design and objectives. Am J Epidemiol. 1989;129(4):687–702.
6. **Schoenfeld D.** Partial residuals for the proportional hazards regression model. Biometrika. 1982;69:239–41.
7. **McNutt LA, Wu C, Xue X, Hafner JP.** Estimating the relative risk in cohort studies and clinical trials of common outcomes. Am J Epidemiol. 2003;157(10):940–3.
8. **Brook RH, Ware JE Jr., Rogers WH, Keeler EB, Davies AR, Donald CA, et al.** Does free care improve adults' health? Results from a randomized controlled trial. N Engl J Med. 1983;309(23):1426–34.
9. **Keeler EB, Brook RH, Goldberg GA, Kamberg CJ, Newhouse JP.** How free care reduced hypertension in the health insurance experiment. JAMA. 1985;254(14):1926–31.
10. **Lurie N, Ward NB, Shapiro MF, Brook RH.** Termination from Medi-Cal —does it affect health? N Engl J Med. 1984;311(7):480–4.
11. **Lurie N, Ward NB, Shapiro MF, Gallego C, Vaghaiwalla R, Brook RH.** Termination of Medi-Cal benefits. A follow-up study one year later. N Engl J Med. 1986;314(19):1266–8.
12. **Fihn SD, Wicher JB.** Withdrawing routine outpatient medical services: effects on access and health. J Gen Intern Med. 1988;3(4):356–62.
13. **Bronner LL, Kanter DS, Manson JE.** Primary prevention of stroke. N Engl J Med. 1995;333(21):1392–400.