Burden of Catastrophic Health Expenditures for Acute Myocardial Infarction and Stroke Among Uninsured in the United States

Acute myocardial infarction (AMI) and stroke are unanticipated major healthcare events that require emergent and expensive care. Given the potential financial implications of AMI and stroke among uninsured patients, we sought to evaluate rates of catastrophic healthcare expenditures (CHEs), defined as expenses beyond financial means, in a period before the implementation of insurance expansion and protections in the Affordable Care Act.[1]

In a large, nationally representative database of inpatient hospitalizations, the National Inpatient Sample, we identified all AMI (*Clinical Classification Software* code 100 as the primary diagnosis) and stroke (*International Classification of Diseases, Ninth Revision* codes 430, 431, 432.x, 433.x1, 434.x1, or 436 as the primary diagnosis) hospitalizations among uninsured nonelderly adults (age,18–64 years) between 2008 and 2012. To estimate patient expenses relative to income, we obtained 2 data components from the National Inpatient Sample: hospitalization charges and an ordinal variable (value of 1–4) representing quartiles of median income based on residential ZIP code. However, patient incomes can vary widely for each income quartile, and assessing CHEs requires an estimate of patient-level income. Therefore, using a previously suggested microsimulation model for assessing patient-level income from community income quartiles,[2,3] we estimated income for each patient from a 2-parameter gamma probability distribution. We used the US Gini coefficient (a measure of income inequality) of 0.411 to define the shape parameter and the community-level income corresponding to each quartile to define the scale parameter for the income curve for each quartile (Figure, A).[4] As previously suggested, to prevent overestimation of CHE as a result of an underestimation of income, mean quartile income values were centered at the highest value of the quartile range for quartiles 1 to 3 and at 80% of the upper bound for quartile 4.[3]

Annual food expenditures were derived from US Bureau of Labor Statistics estimates of food-related expenses as a function of income.[5] Postsubsistence income was the difference between income and food-related subsistence expenses. On the basis of previous literature,[3] a hospitalization charge was classified as a CHE if charges exceeded 40% of the postsubsistence income. Bootstrapped means and 95% confidence intervals were obtained by repeating the model over 10 000 simulations. All estimates were indexed to the year 2012 on the basis of the Consumer Price Index. National estimates were obtained with survey-analysis tools in SAS 9.4 (SAS Institute Inc, Cary, NC).

We identified 39 296 AMI (81% patients ≥45 years of age, 26% women, 13% blacks, 38% in lowest income quartile, and 12% in highest quartile) and 29 182 stroke (82% patients ≥45 years of age, 39% women, 26% blacks, 41% in lowest income quartile, and 11% in highest quartile) hospitalizations among uninsured nonelderly, corresponding to 188 192 and 139 687 nationally. The uninsured represented 15% of both AMI and stroke hospitalizations among nonelderly. Median hospitalization charges

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Correspondence to: Khurram Nasir, MD, MPH, Center for Healthcare Advancement and Outcomes, Baptist Health South Florida Research Institute, Baptist Health South Florida, 1500 San Remo Avenue, Suite 340, Coral Gables, FL 33130. E-mail khurramn@baptisthealth.net or knasir1@jhmi.edu

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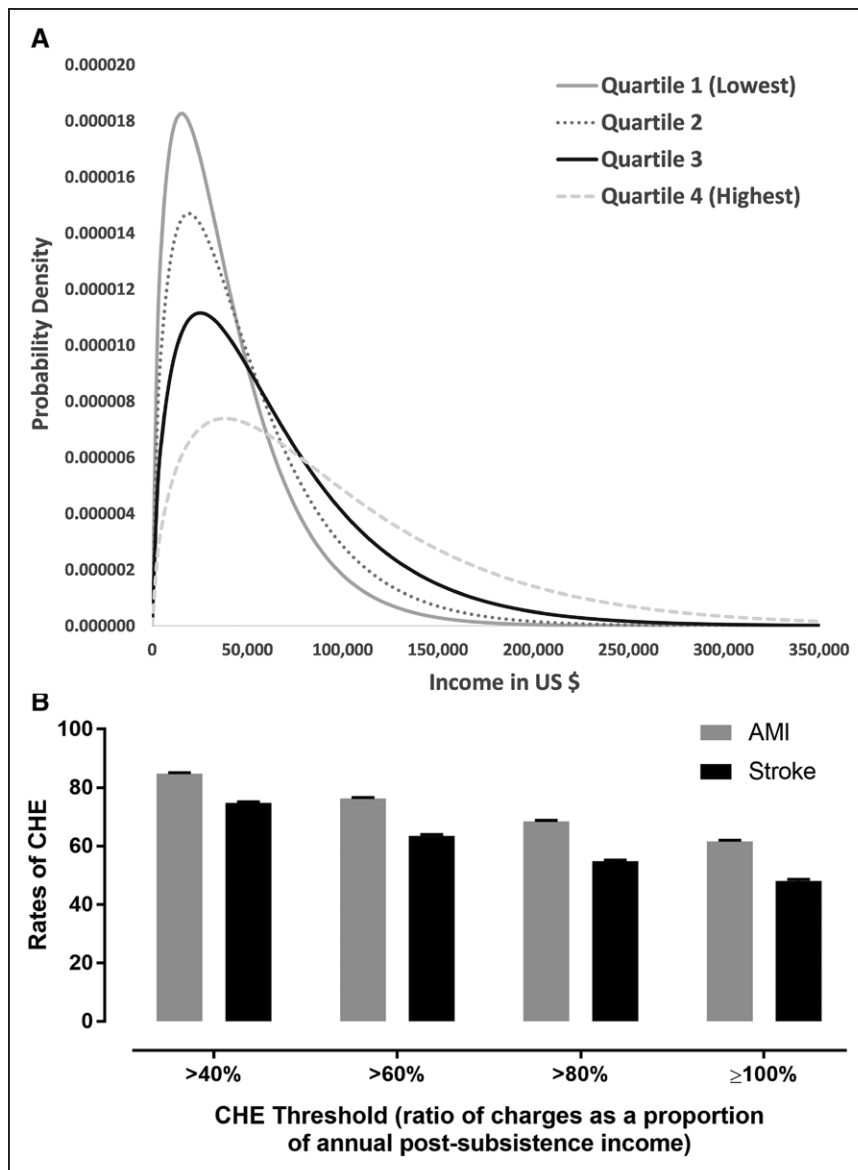**Figure.** **A**, Gamma distribution of income across the 4 income quartiles and (**B**) rates of catastrophic healthcare expenditures (CHE) with different cut points for defining the CHE based on the ratio of hospitalization charges to postsubsistence incomes. AMI indicates acute myocardial infarction.

were $53384 (interquartile range, $33282–$84551) for AMI and $31218 (interquartile range, $18805–$60009) for stroke. Among hospitalizations in the uninsured, the rate of CHE after AMI was 85% (95% confidence interval, 84–85) and after stroke was 75% (95% confidence interval, 74–75; Figure, B). In sensitivity analyses in which CHE was redefined by hospitalization charges representing higher proportions of annual postsubsistence income (charge thresholds at 60%, 80%, and ≥100% of annual postsubsistence income), a substantial proportion of uninsured nonelderly had CHEs during AMI and stroke hospitalizations (Figure, B). Furthermore, CHE rates for AMI and stroke were similar in 4 additional analyses in which patient income was assumed to be at the upper bound of respective quartiles, restricted to quartile limits, derived from income distribution for the general US population (US Census data), and distributed in a different 2-parameter distribution (Weibull).

The strengths of our study include evaluation of a nationally representative sample of the uninsured, a frequently understudied patient population. Several limitations merit comment. First, patient income in National Inpatient Sample is not reported at an individual level. Therefore, we estimated individual income on the basis of previous work suggesting the gamma distributions as an appropriate approach to model income between predefined population-specific cutoffs for income.[3] Although imputed individual incomes from the microsimulation model are expected to be imprecise, summary estimates provide meaningful estimates of CHE risk among the uninsured. Moreover, results were robust to several sensitivity analyses. Next, we cannot account for income differences among uninsured who have AMI/stroke compared with others in the same income quartile. Finally, hospitalization costs may be overestimated because some charges may be reduced/waived. How-

ever, these individuals are likely to encounter continued financial difficulties because of missed work, disability, and outpatient healthcare needs, putting them at risk for financial catastrophe, including bankruptcy.

In summary, before the Affordable Care Act, >1 in 8 AMI and stroke hospitalizations among nonelderly adults occurred among those without insurance. In this vulnerable group of patients, in-hospital expenditures alone would be expected to cross the threshold to define a catastrophic expense in the large majority. Because many of these patients will have additional hospitalizations and health expenditures, they may easily exceed their annual income while being deprived of work during the illness. The potentially devastating financial impact of these events on the uninsured is considerable.

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DISCLOSURES

Dr Nasir is a consultant for Regeneron. Dr Krumholz has research agreements with Medtronic and Johnson & Johnson through his institution, is a member of the scientific advisory board for UnitedHealth; and is founder of Hugo. The other authors report no conflicts.

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FOOTNOTES

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