

Health Insurance Expansion and Incidence of Out-of-Hospital Cardiac Arrest: A Pilot Study in a US Metropolitan Community

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Background—Health insurance has many benefits including improved financial security, greater access to preventive care, and better self-perceived health. However, the influence of health insurance on major health outcomes is unclear. Sudden cardiac arrest prevention represents one of the major potential benefits from health insurance, given the large impact of sudden cardiac arrest on premature death and its potential sensitivity to preventive care.

Methods and Results—We conducted a pre–post study with control group examining out-of-hospital cardiac arrest (OHCA) among adult residents of Multnomah County, Oregon (2015 adult population 636 000). Two time periods surrounding implementation of the Affordable Care Act were evaluated: 2011–2012 (“pre-expansion”) and 2014–2015 (“postexpansion”). The change in OHCA incidence for the middle-aged population (45–64 years old) exposed to insurance expansion was compared with the elderly population (age ≥ 65 years old) with constant near-universal coverage. Rates of OHCA among middle-aged individuals decreased from 102 per 100 000 (95% CI: 92–113 per 100 000) to 85 per 100 000 (95% CI: 76–94 per 100 000), P value 0.01. The elderly population experienced no change in OHCA incidence, with rates of 275 per 100 000 (95% CI: 250–300 per 100 000) and 269 per 100 000 (95% CI: 245–292 per 100 000), P value 0.70.

Conclusions—Health insurance expansion was associated with a significant reduction in OHCA incidence. Based on this pilot study, further investigation in larger populations is warranted and feasible. (*J Am Heart Assoc.* 2017;6:e005667. DOI: 10.1161/JAHA.117.005667.)

Key Words: health policy • healthcare access • sudden cardiac arrest

Health insurance is an important factor influencing health-care delivery and patient engagement in health care. Uninsured individuals are less likely than insured individuals to receive preventive care, be appropriately diagnosed with chronic medical conditions, receive care for serious medical conditions, and report being in good health.^{1–8} Individuals who newly acquire health insurance enjoy improved access to care, better self-reported health, and greater financial security.^{1,9–13} Nonetheless, findings have been mixed regarding the role of health insurance on reducing major adverse health outcomes.^{13–16} In this study, we sought to evaluate out-of-hospital cardiac arrest (OHCA) incidence among a middle-aged

population experiencing a rapid, community-wide expansion of health insurance coverage as part of the federal Affordable Care Act. OHCA represents an ideal health outcome to study given its large public health burden and potential rapid responsiveness to improved cardiovascular diagnosis and prevention.^{17–21}

We hypothesize that OHCA incidence among the middle-aged population (45–64 years old) has declined after rapid expansion of health insurance, while OHCA incidence among the near-universally insured elderly population (≥ 65 years old) has remained unchanged. The feasibility of testing these hypotheses was evaluated in a US metropolitan community using an emergency medical system (EMS) database.

Methods

Population

Residents of Multnomah County, Oregon (2015 adult population 636 000) were studied using US Census Bureau intercensal data to define population counts within each prespecified age stratum.

OHCA Ascertainment and Incidence

A database of all EMS dispatches within Multnomah County was queried to identify those for which EMS providers

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Received January 20, 2017; accepted April 19, 2017.

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Clinical Perspective

What Is New?

- This pilot study shows an association between insurance expansion and reduced incidence of cardiac arrest and shows the feasibility of future larger-scale research.
- These results must be verified in larger populations with information on preventive care patterns and potential confounding factors.

What Are the Clinical Implications?

- Access to health insurance may positively influence important health outcomes such as cardiac arrest, which are responsible for a substantial proportion of deaths in the United States.

recorded a primary or secondary impression of “cardiac arrest” from a prepopulated list of discrete variables. All cases with noncardiac causes recorded in either the primary or secondary impression fields were excluded (trauma, accident, suicide, overdose, gastrointestinal bleeding) using spreadsheet filtering, in a manner blinded to patient age or date of arrest. On the basis of these exclusions, we considered the selected cases to represent OHCA of primary cardiac etiology.

Two time periods were evaluated: 2011–2012 was defined as “pre-expansion” and 2014–2015 was defined as “postexpansion.” The year 2013 was excluded as a transition year because of large-scale Medicaid and direct-purchase private insurance enrollment efforts (with coverage effective January 1, 2014 as part of the Affordable Care Act), as well as large-scale changes in payment policy and care delivery infrastructure (as part of implementation of Oregon’s Medicaid waiver). Counts of OHCA cases by patient age and year of arrest formed the age-based population numerator for OHCA events in each time period of the study. US Census Bureau assessments (census table “pepagesex”) were used to estimate the age-stratified county population during each time period. Numerators were divided by respective denominators to generate the age-stratified OHCA incidences for Multnomah County during each study time period.

Socioeconomic and Insurance Characteristics

Socioeconomic and insurance characteristics for age-stratified subgroups of Multnomah County residents were determined using the US Census Bureau’s American Communities Survey online search.²² Annual characteristics were determined for 2011–2015. The following variables were evaluated: proportion with less than high-school education

(census table B1501), poverty (census table B17001), unemployment (census table B23001), and insurance characteristics (census tables S2701, B27001, and B27010).

Statistical Analysis

Power calculations were performed using age-stratified population estimates from the US Census Bureau for 2011–2015 and OHCA incidence estimates from Oregon Sudden Unexpected Death Study from 2002 to 2004. Using PASS 13 software “test of two proportions in a repeated measure design” function with autocorrelation level of 0.5 and $\alpha=0.05$, we estimated that the study would have >80% power to detect $\geq 15\%$ change in OHCA incidence among the elderly and $\geq 19\%$ change among the middle-aged. Both were considered plausible effect sizes.

All statistical analyses were performed using SAS version 9.4. Rates and their 95% CI were calculated using the function “proc genmod” with a Poisson distribution. The differences in rates and their 95% CIs were calculated using the function “proc nlmixed” with a Poisson distribution. For statistics directly reported from US Census Bureau summary tables, the standard errors were back-calculated from the reported “margin of error” (defining the 90% CI) by dividing the margin of error by 1.645 and then multiplying by 1.96 to define the 95% CI. When multiple population strata were combined from US Census Bureau data, standard errors were estimated using simulation. For these simulations, the numerator and denominator of each stratum was assumed to have a normal distribution, with the stratum-specific standard errors derived from the US Census Bureau 90% CIs as described above. The simulated standard errors for the aggregated strata were derived by sampling 100 000 iterations of aggregated numerators and denominators that were randomly generated based on stratum-specific means and their respective standard errors. In validation tests against Census-Bureau-aggregated data, the simulation standard errors were within 30% of the actual standard errors.

This study was approved by the relevant institutional review boards; informed consent was not required for analysis of de-identified data.

Results

Overall Population and OHCA Incidence

The total combined population of middle-aged and elderly in Multnomah County (age ≥ 45) increased from an average of 274 454 in 2011–2012 time period to 290 838 in 2014–2015. The number of adult OHCA cases of presumed cardiac etiology was 844 in 2011–2012 and 834 in 2014–2015 (accounting for 88% of all cases over 18 years old in the

Table 1. OHCA Incidence Before and After Health Insurance Expansion

Age Group	OHCA Incidence Pre-Expansion (2011–2012); Per 100 000 Population (95% CI)	OHCA Incidence Post-Expansion (2014–2015); Per 100 000 Population (95% CI)	OHCA Incidence Difference; Per 100 000 Population (95% CI)	P Value
Age 45 to 64	102 (92–113)	85 (76–94)	17 (3.7–31)	0.013
Age ≥65	275 (250–300)	269 (245–292)	...	0.70

OHCA indicates out-of-hospital cardiac arrest.

county). There was no significant difference in OHCA annual incidence for individuals age ≥45 between time periods (154 per 100 000 [95% CI: 143–164 per 100 000] in 2011–2012 and 143 per 100 000 [95% CI: 134–154 per 100 000] in 2014–2015; *P*=0.15).

Age-Stratified OHCA Incidence

The middle-aged population (45–64 years old) experienced a 17% reduction (95% CI: 3.7–31) in OHCA incidence after expansion of health insurance (Table 1). The elderly population (≥65 years old) did not experience a significant change in OHCA incidence across the same time periods.

Age-Stratified Population Insurance Characteristics

Multnomah County rates of uninsurance declined abruptly for the middle-aged, while the elderly remained stably, near-universally insured (Figure 1). Medicaid expansion was responsible for the greatest reduction in uninsurance among the middle-aged (Table 2). Medicaid coverage grew from 7.0% (95% CI: 5.5–8.5%) before the Affordable Care Act to 13.5% (95% CI: 11.5–15.5%) after the Affordable Care Act, a 93% relative increase. Direct-purchase insurance increased from

8.2% (95% CI: 6.9–9.5%) before the Affordable Care Act to 10.0% (95% CI: 8.5–11.5%) after the Affordable Care Act, a 22% relative increase. Employer-sponsored insurance did not change between time periods.

Age-Stratified Socioeconomic Characteristics

Changes in population socioeconomic factors between 2011 and 2015 were variable (Figure 2). Among the middle-aged, the poverty rate was not notably different between time periods (Figure 2A). Among the elderly, the poverty rate rose from 9.0% (95% CI: 7.1–10.0%) to 12.2% (95% CI: 9.9–13.3%). Education attainment was similar between time periods for both age groups (Figure 2B). Unemployment decreased among the middle-aged, consistent with national trends (Figure 2C).

Feasibility of Pilot Study Design

OHCA event rates were efficiently ascertained from EMS encounter data, with noncardiac causes of OHCA excluded based on age-stratum-blinded review of the primary or secondary impressions recorded by EMS providers. Age-stratified population denominators, required to calculate OHCA incidence, were available from publically available US Census Bureau. Standard error simulations were required to generate confidence intervals for some age-stratified insurance and socioeconomic data.

Discussion

After implementation of the Affordable Care Act in Multnomah County, Oregon, the middle-aged population experienced a 17% decrease in incidence of OHCA of primary cardiac etiology. OHCA incidence among the near-universally insured elderly did not change over the same time period. There were no large temporal changes apparent in socioeconomic indicators. Among middle-aged adults, Medicaid expansion was responsible for the greatest reduction in uninsurance, while coverage from employer-based insurance did not change.

This pilot study strengthens the rationale to study the hypothesis, “Health insurance expansion reduces the incidence of sudden cardiac death.” We demonstrated significant

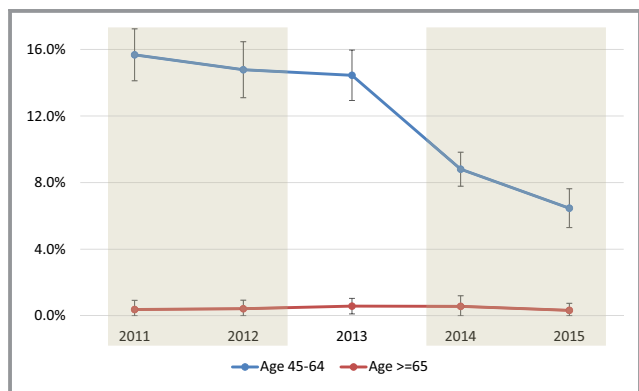


Figure 1. Uninsured. All data are for Multnomah County, Oregon. X-axis shows year of study and y-axis shows proportion of population. Data for each age-stratified group are shown with 95% CI. Time periods before and after the Affordable Care Act implementation are highlighted.

Table 2. Insurance Type by Year and Age Group*

Age Group and Insurance Type	2011	2012	2013	2014	2015
Age 35 to 64					
Medicare	2.5±0.2%	1.9±0.1%	1.8±0.1%	1.5±0.1%	2.5±0.1%
Medicaid	6.7±0.8%	7.3±0.7%	7.0±0.9%	13.4±1.1%	13.6±1.0%
Dual eligible	1.4±0.2%	1.8±0.1%	2.3±0.2%	2.1±0.2%	2.3±0.2%
Employer-based	58.6±1.3%	60.4±1.2%	60.5±1.4%	58.6±1.3%	59.6±1.3%
Direct-purchase	8.7±0.8%	7.6±0.5%	7.0±0.9%	10.4±0.8%	9.6±0.7%
Other	3.8±0.4%	4.3±0.3%	4.0±0.3%	4.2±0.5%	4.8±0.4%
Uninsured	18.3±1.3%	16.7±1.0%	17.4±1.2%	9.8±1.2%	7.7±0.9%
Age ≥65					
Medicare	64.3±2.4%	65.9±2.5%	65.9±2.4%	65.0±2.3%	64.3±2.2%
Dual eligible	7.8±1.0%	9.4±0.9%	9.4±1.0%	11.1±1.3%	10.5±1.0%
Employer-based	1.5±0.4%	1.8±0.4%	1.8±0.5%	2.4±0.5%	2.4±0.4%
Direct-purchase	0±0.2%	0.2±0.1%	0.2±0.1%	0.4±0.2%	0.8±0.3%
Other	26±1.5%	22.8±1.4%	22±1.3%	20.5±1.3%	21.7±1.2%
Uninsured	0.4±0.2%	0.6±0.2%	0.6±0.3%	0.6±0.2%	0.3±0.2%

*All data are for Multnomah County, Oregon. Proportions from stratified Census Bureau data are shown, along with simulated standard errors (see Methods section). Data were not available in a form that allowed re-stratification into a 45- to 64-year-old age group. Medicare coverage includes Medicare alone and with supplemental or other policies. Dual-eligible coverage refers to individuals qualifying for both Medicare and Medicaid. Employer-based coverage includes employer insurance or TRICARE, with or without additional direct-purchase insurance. Direct-purchase coverage includes individually purchased insurance only. Other coverage includes Veterans Health Administration insurance and all insurance categorized as "other" by the US Census Bureau.

reductions in OHCA incidence among a population exposed to abrupt expansion of Medicaid and private insurance during a period of extensive payment and delivery innovation. At the same time, a contemporaneous elderly population with near-universal insurance experienced no change in OHCA incidence. Prior studies showing notable improvements in cardiovascular care after individuals gain access to insurance support the potential for insurance expansion to improve cardiovascular outcomes.¹ A relationship between health insurance expansion and reduced OHCA rates could explain an important portion of the previously observed decreases in all-cause mortality in states that expanded Medicaid enrollment,¹⁵ since OHCA constitutes a large proportion of overall mortality.^{17,23} Finally, future studies using this methodology could be used to evaluate similarities or differences in the effects of private insurance expansion and Medicaid expansion.²⁴

There are potential confounders of these results; nonetheless, this pilot study serves the important purpose of showing both the possibility that insurance expansion may affect OHCA incidence and the feasibility of an efficient study design using standard EMS data. Future studies could allow for causal inference through the use of regression-based techniques that include an interaction term for time period and covariates that allow for identification and adjustment for confounders. One potential confounder is improvement in

socioeconomic determinates of health. We have previously shown that baseline population socioeconomic factors affect OHCA incidence.^{25,26} However, among the elderly these effects were blunted overall and were absent in the Pacific Northwest (Portland, Seattle, and Vancouver, BC)²⁶; therefore, socioeconomic determinants of health are unlikely to have significantly affected OHCA incidence among the control group of individuals ≥65 years old. Among the middle-aged, poverty and educational attainment were stable between time periods. Unemployment among the middle-aged decreased between time periods. Nonetheless, the significance of this observation is uncertain since it is unknown to what degree unemployment affects health outcomes when expanding non-employer-based health insurance. In addition, it is unknown whether short-term changes in socioeconomic factors influence OHCA. Another potential confounder is insurance-independent improvement in patient- or physician-driven sudden cardiac arrest (SCA) prevention. This could be evaluated in future studies with use of adjunctive data on overall cardiovascular preventative health care and risk factor prevalence.

A possible explanation for health insurance expansion influencing OHCA is through improvements in medical care that could promote cardiovascular prevention and prompt diagnosis and management of cardiovascular disease. However, this potential explanation was not supported by a prior

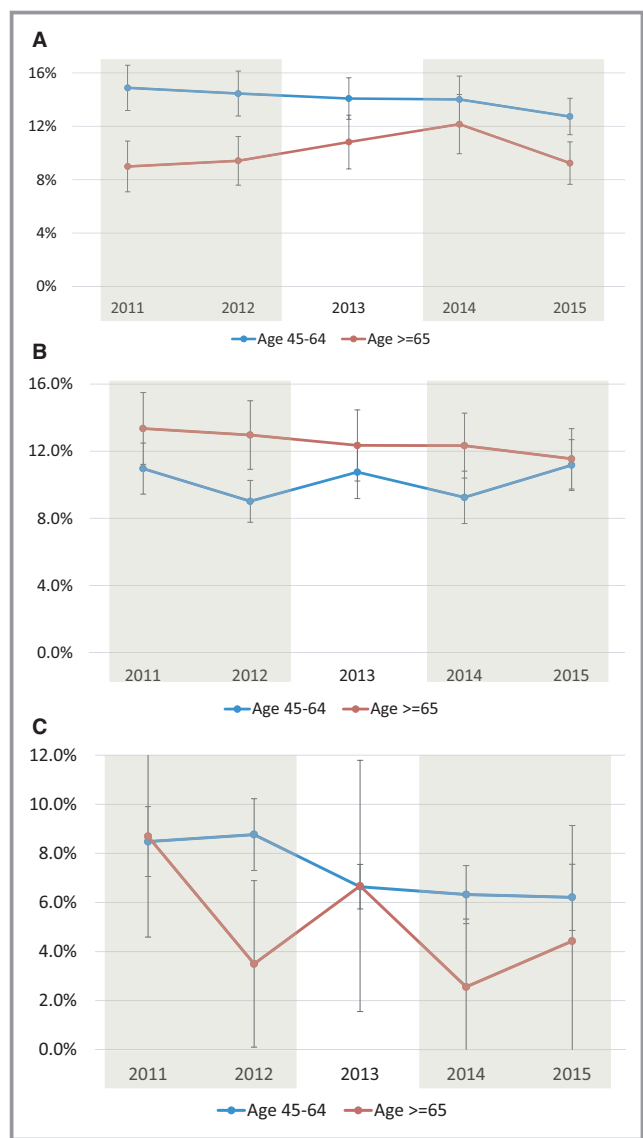


Figure 2. Socioeconomic factors. A, Poverty. B, Education less than high-school graduation. C, Unemployment. All data are for Multnomah County, Oregon. X-axis shows year of study and y-axis shows proportion of population. Data for each age-stratified group are shown with 95% CI. Time periods before and after the Affordable Care Act implementation are highlighted.

randomized study of Medicaid expansion in Oregon that showed no change in physical health indicators.¹³ While that study utilized very high-quality methodology that minimized risk of bias or confounding, the covered populations and Medicaid expansion programs were notably different from the present study. Baicker et al evaluated a small group of patients (n=12 229) throughout the state who participated in a small-scale randomized Medicaid enrollment expansion, whereas the present study evaluated the population of an entire county during a large statewide insurance expansion. The number of patients involved in the program studied by Baicker et al may have been too small for health systems to

improve access, prevention, and disease management activities for newly enrolled Medicaid recipients. In contrast, the large-scale expansion and payment reforms that were engaged in Oregon after the Affordable Care Act and Medicaid waiver implementation generated great attention and focus on how to most effectively engage and care for new enrollees.^{27–30}

Despite general agreement that expanded insurance coverage leads to positive health effects, the mechanism of this benefit and effect on health outcomes remains poorly understood. OHCA represents an ideal area in which to investigate the role of health insurance on disease outcomes, given its large public health burden, unambiguous mode of presentation, and short-term responsiveness to treatment of cardiovascular risk factors. OHCA is responsible for a greater burden of premature death than any individual disease¹⁷ and is responsive to evidence-based primary and secondary prevention measures focused on coronary artery disease and ventricular arrhythmias.

More effective outpatient preventive care is one of the major proposed mechanisms by which health insurance leads to improved health outcomes,¹ and outpatient care is uniquely important for preventing death attributable to OHCA, given the 95% mortality rate after a cardiac arrest occurs.³¹ SCA-targeted prevention with the implantable cardioverter defibrillator is a well-recognized approach to reducing arrhythmic death.^{32,33} Other important approaches for reducing arrhythmic death include improved cardiovascular risk factor modification through smoking cessation and statin use, and improving medication therapy for patients with recognized atherosclerotic cardiovascular disease or heart failure.^{19–21,32,34,35} Given evidence showing that individuals who receive health insurance engage more effectively in cardiovascular care,¹ it is plausible to consider that improved diagnosis and prevention of cardiovascular disease resulting from expanded insurance availability could explain the observed decrease in OHCA incidence among middle-aged Multnomah County residents.

Our study has important strengths. OHCA of presumed cardiac etiology is a highly relevant outcome, since it is a readily definable major adverse health outcome that constitutes a major proportion of all-cause mortality.^{17,23} The study employed consistent measurement methods that did not change with time and were made by EMS providers unaware of the study objectives. We studied a populous geographic area exposed to abrupt, large-scale expansion of Medicaid and direct-purchase private insurance; therefore, we could capture adaptive or maladaptive effects of large-scale policy changes in the context of intentional changes to the regional healthcare delivery infrastructure.

Our study also has important limitations. As outlined above, this was an observational study in a single urban

geographic area that was underpowered for regression-based techniques; as a result it should not be used to infer that health insurance was the cause of the observed decline in OHCA incidence nor that the findings would be consistently generalizable to other regions. However, as a pilot study the association observed coupled with a feasible and scalable study design provides important justification for larger scale investigations that could exclude confounders and allow more robust causal inferences. Other limitations include our assumption that OHCA of presumed primary cardiac etiology as defined by EMS information from the time of arrest was a reasonable surrogate for SCA that is defined by detailed review of arrest-related and pre-arrest medical records. This method may overestimate SCA magnitude if underlying disorders such as pneumonia, sepsis, or cancer are not known or coded by EMS personnel, while it may underestimate SCA magnitude if conditions such as respiratory arrest are incorrectly identified as the primary cause of OHCA rather than as a symptom of acute ischemia or ventricular tachycardia. While more detailed clinical information is required for etiologic and mechanistic investigations of SCA, the approach used in this study allows for efficient measurement of OHCA incidence changes over time. Any miscategorization should be consistent between time periods and therefore would not be expected to influence the OHCA incidence changes that are the focus of this investigation.

Conclusion

Community-wide health insurance expansion, primarily through Medicaid, was associated with a significant decrease in the incidence of OHCA among middle-aged individuals in Multnomah County, Oregon. These results are consistent with prior studies showing improvements in cardiovascular preventive care after the acquisition of insurance. Based on this pilot study, further investigation in larger populations using quasi-experimental analytic techniques is warranted and feasible.

Acknowledgments

The authors thank all EMS personnel (American Medical Response and Portland and Gresham fire departments) and hospitals in the Portland metropolitan area for their assistance, as well as Katherine Strellich, MD for discussions that prompted this investigation and Rochelle Fu, PhD for statistical consultations.

Sources of Funding

This work was supported by the National Heart, Lung, and Blood Institute (Stecker—K12HL108974; Chugh—R01HL122492 and R01HL126938).

Disclosures

None.

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