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Healthcare costs are substantially higher in insured older US adults with hearing loss

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Abstract

Objective—To measure the 18-month healthcare cost difference attributable to hearing loss (HL) in older adults.

Design—Matched Cohort.

Setting—Retrospective analysis of administrative health care bills of insured older Americans.

Participants—904,750 total older US adults with health insurance were examined in three cohorts and were matched based on HL diagnosis using propensity score methods.

Intervention—None.

Measurements—Comparison groups were defined as those with and without HL diagnoses using ICD-9 diagnosis codes from billing records. Outcomes measured include 18-month total healthcare payments and healthcare payments broken down by payment type (inpatient, outpatient, prescriptions, and hearing services). Three comparison cohorts were examined for these outcomes, a group that included individuals covered by Medicare plus supplemental private insurance (Cohort1), those only covered under Medicare (Cohort2) and those within the Medicare sample that were dually eligible for both Medicare and Medicaid coverage (Subcohort3). The quality of the propensity score match was examined using standardized differences in means or proportions between all matched covariates and cost outcomes were analyzed using Multiple Generalized Linear Regression models.

Results—A total of 782,216 (Cohort1), 105,296 (Cohort2), and 17,238 (Subcohort3) individuals were included. Fully adjusted models showed significantly higher 18-month healthcare payments for individuals with a diagnosis of HL, without indication of use of hearing services, compared to patients without a HL diagnosis in the three samples (Payment Differences: \$3,587 Cohort1, \$3,779 Cohort2, \$4,657 Subcohort3; all p-values <0.001). Smaller payment differences were also found between individuals with HL and indications of hearing services and those without HL.

Conclusions—We observed >20% higher total healthcare payments over 18-months for a group of insured patients with HL regardless of insurance type or hearing services use. This finding

indicates that negative health-related effects of HL may increase healthcare use unrelated to HL. Thus, clinical care to ameliorate HL may improve overall patient health.

Keywords

Healthcare costs; Hearing loss; Age-related hearing loss; Presbycusis

INTRODUCTION

Presbycusis or age-related hearing loss (HL) is a prevalent medical problem in older adults¹. HL has been found to be associated with perceived problems in access to medical care², negative life events such as incident dementia^{3,4}, higher rate of falls⁵, poorer cognitive functioning⁶, higher risk of mortality in men⁷, decreased health-related quality of life (HRQoL)^{8–10}, and social isolation¹¹.

HL is among the most common chronic conditions of aging, with 26.2 million individuals age 50 and older reporting HL.³ HL is estimated to affect 63% of the Medicare eligible population over 70 years¹. However, only approximately 17% of older US adults with hearing loss use hearing aids¹². Given these statistics, we might expect HL to be defined as an important public health problem and the target of efforts to improve population health particularly in view of the projected increases in the aging population. However, Healthy People 2020, which identifies the US nationwide health improvement priorities, reports for year 2007 that only 162.7 individuals per 1,000 people age 20–69 with HL had ever used a hearing aid¹³. The stated 2020 goal is to increase this rate to 179 per 1,000 individuals by the year 2020¹³. This is an increase of 0.8% per year, indicating that this condition is not a high priority target for the nation's health. It is possible that HL among older adults is so common that it is not perceived as a problem, or it is simply considered a normal consequence of aging that requires diagnosis and intervention only if requested by the patient. An alternative view is that there is a pervasive and persistent lack of understanding by decision makers of the potential broader health ramifications of HL.

The identification of associations between HL and medical care utilization represents an important health policy step for reclassifying HL from a “condition” to that of a “problem” in the minds of US health policy makers. This is an essential step for policy changes aimed at increasing awareness of hearing loss and the need for better patient identification, and improving access to and utilization of hearing healthcare services.

HL has been associated with social isolation in older adults¹¹ and higher levels of frustration⁹. Recent evidence indicates that patients with hearing loss have significantly higher odds of performing below the median in satisfaction with patient-physician communication (doctors explained things clearly, listened carefully, showed respect for what they had to say, and afforded them adequate time) as well as lower likelihood of rating themselves above the median for their overall quality-of-healthcare¹⁴.

Patients who feel socially isolated or dissatisfied with patient-physician communication may choose not to make medical visits because these are stressful and/or frustrating for individuals with HL. This is an important patient satisfaction issue which, in turn, may

become an access to care barrier¹⁵. Thus, patients with HL may avoid or delay healthcare visits because their HL results in a stressful experience when trying to communicate with healthcare providers^{16,17}. Less timely healthcare seeking behavior could lead to a longer time between visits making exacerbation of healthcare conditions likely¹⁸. These gaps in care may result in increases in utilization of more acute and expensive healthcare services resulting in increased healthcare costs¹⁸. However, few studies have examined healthcare cost differences by HL. In order to begin to measure the impact of HL on overall healthcare utilization, our group recently published a cost and utilization study of middle aged privately insured adults, which found a 33% increase in the average cost of healthcare services, over 18 months, in a well-matched group of individuals with HL¹⁹.

In order to examine if similar findings may be seen in an older publically insured population, the current study compared the average healthcare costs in a US sample of older adults with and without HL, while matching on all potential and available cost risk factors and chronic diseases.

METHODS

We extracted two cohorts of patients 65 years old with an International Classification of Disease, 9th revision (ICD-9) code of HL (V41.2, V72.1x, 388.00, 388.01, 388.40, 388.43, 388.44, 388.5, 389.1x, 389.2x; Supplementary Table S1) and propensity score matched²⁰ them to a comparison group based on age, sex, ethnicity, US region, insurance type, beneficiary status, Charlson comorbidity index score²¹, outpatient services use, and baseline presence of 22 chronic conditions (conductive heart failure, congestive heart failure, pulmonary heart disease, chronic obstructive pulmonary disease, asthma, diverticulitis, renal failure, rheumatoid arthritis, systemic lupus erythematosus, diabetes, HIV, hepatitis, cystic fibrosis, sickle cell anemia, senile dementia, schizophrenia, Parkinson's disease, multiple sclerosis, epilepsy, heart valve disorder, carditis or cardiomyopathy, and hypertension with complications).

The first cohort of Medicare plus privately insured individuals (Cohort1) was extracted using the 2009–2013 Market Scan® database with at least 18-months of continuous coverage. The second (Cohort2) and third cohorts (Subcohort3) were extracted from the 2012–2013 Medicare Limited Data Set standard analytic files (SAF) National 5% sample. The Medicare (Cohort2) cohort included individuals who had Medicare coverage as their primary source of insurance. The dually eligible (Subcohort3) subgroup included the patients within the Medicare group who were dually eligible for Medicaid. Exclusion criteria, variable definitions, matching and analysis methods were consistent across the three samples with the exception of race, which was unavailable in the MarketScan data (Cohort1). Each cohort was propensity score matched based on covariates likely to influence selection into a HL group or if those baseline variables that may disproportionately influence cost of care²². Matching was based on the nearest neighbor greedy matching algorithm without caliper distance limits and without replacement²³. Goodness of match was examined and confirmed for each matched cohort by statistically comparing all matching characteristics using descriptive statistics and with standardized differences in means and proportions of each matching variable being less than 0.2²⁴.

Six months of lookback period data were used for each individual to develop the baseline variables for matching. Patients with diagnoses of late effects of stroke, coma or paralysis were excluded. Healthcare bills for up to 18-months post baseline follow up were summed by patient to calculate total payments for inpatient, outpatient, prescription medication and cost of hearing services. Hearing services were defined for bills with ICD-9 procedure codes 9548, 69710, 69711, V532, V5014, V5267, V5298, V5010, V5011, or V5275 (Supplementary Table S2).

Statistical Analysis

Descriptive statistics and crude outcome estimates were compared between the HL and comparison groups by using chi-square tests for categorical variables and t-tests (normally distributed) or Mann-Whitney U/Wilcoxon tests (non-normally distributed) for continuous variables. P-values for descriptive statistics are not shown as sample sizes are so large as to result in statistically significant differences even if not clinically important. Differences between matched groups are tested using standardized differences in means or proportions.

Outcomes analysis for total payments and payment type subgroups were compared by group using Gamma distributed generalized linear log linked multivariable regression models, adjusting for baseline covariates. The use of a gamma distributed generalized linear model with a log transformed link function has been shown to be a good method to estimate healthcare cost distributions that are generally right-skewed, especially when the log transformed dependent variables do not have heavy tails or excessive heteroscedasticity²⁵. Adjustors considered for inclusion in each outcome model includes demographic characteristics, chronic conditions, Charlson comorbidity index score, number of days in the follow-up period, and use of hearing services. Variables removed from the final models included only those with little to no predictive/confounding effect and no influence on model fit (AIC) or primary estimate (beta), which resulted in final models including all covariates but the more rare chronic conditions (MS, Schizophrenia, HIV, CF, SCA)²⁶. Sensitivity analyses to assess the impact of hidden bias for each outcome were performed using the methods defined by Vanderweele and Arah²⁷. This method provides a means to quantify the robustness of the results under conditions where potential selection bias due to unmeasured confounders is simulated. SAS version 9.4 (SAS Institute Inc., Cary, NC) was used for analysis with p-values considered statistically significant for $\alpha < 0.05$. The study protocol was reviewed by the university's Institutional Review Board and deemed to constitute non-human research.

RESULTS

In the first matched Cohort1, patients averaged 76 (SD 7.8) years of age, had low comorbidity, and were split evenly between men and women for both the HL and no HL groups (Table 1). Just over 28% of the HL Cohort1 received hearing services (Table 1). This cohort had the lowest proportion of chronic illnesses when compared to the two other groups (Cohort2, Subcohort3). The matched Cohort2 had an average age of 77 years and was comprised of 61.1% female and 89% white individuals (Table 1). The HL group in this cohort comprised only 3.8% of the population with indication of hearing services.

When the matched Cohort2 is descriptively compared with the matched Cohort1, there is a marked increase in the proportion of the sample with chronic conditions; with 63% of Cohort2 having a hypertension diagnosis while only 13% of Cohort1 had this diagnosis (Table 1).

Subcohort3, a subgroup of the Medicare matched cohort who are slightly older (mean 79 years), predominately female (73%), and more racially diverse with just over 63% white and 37% non-white minority. This subgroup has the highest proportion of chronic conditions with particularly high dementia diagnoses (>13%) (Table 1). The propensity score matching within Cohort1 and Cohort2 produced very similar groups at baseline. Subcohort3, while not formally matched, are also similar at baseline between the HL diagnosed and not diagnosed comparison groups.

Total unadjusted mean hospital payments are consistently highest in the HL group and lowest in the no HL group within each of the three cohorts, with the HL group having hearing services falling between the two (Table 2). When qualitatively comparing the total healthcare payments between the three cohorts, Cohort1 are the highest at \$21,164 on average per person, followed by Subcohort3 (\$18,193), with the lowest average total 18-month cost of healthcare (\$13,129) in Cohort2 (Table 2).

Adjusted models of matched cohorts showed significantly higher healthcare payments for individuals with a diagnosis of HL during follow-up compared with patients having no diagnosis of HL (Table 3). The subgroup of patients with a diagnosis of HL who received hearing services had significantly lower (by \$1,431 Cohort1; \$1,648 Cohort2; \$3,431 Subcohort3, all p-values <0.001) overall mean costs than did patients who did not receive hearing services after adjusting for the cost of hearing services in each of the three cohorts. Payment differences were substantially higher in patients with HL compared to those with no diagnosis of HL (by \$3,587 Cohort1; \$3,779 Cohort2; \$4,657 Subcohort3, all p-values <0.001) for all three cohorts, after propensity score matching and covariate adjustment (Table 3, Figure 1). These differences may be driven both by higher hospital costs and outpatient costs (Table 2).

DISCUSSION

The objective of this study was to compare average healthcare costs in US older adults with and without HL. We used data from two sources, 1) Medicare billing data from patients age 65 and older who have supplementary private health insurance, and 2) a 5% random sample of Medicare data selected by Centers for Medicare and Medicaid (CMS) as a representative limited sample of all US Medicare patients. The use of these two data sources enables us to examine healthcare costs for Medicare patients who have substantially different levels of financial resources. In addition, the two data sets have different benefits and limitations. The Medicare plus supplemental private insurance (Cohort1) data set contains all Medicare bills, including bills for prescription payments, but does not include race. The Medicare 5% (Cohort2) sample does not include prescription payments but does include race, and allows us to examine the dual Medicare and Medicaid eligibility (Subcohort3), a subgroup of patients who meet Medicaid income eligibility criteria. Within the three data sets defined by

patients' insurance type, we observed similar differences in mean cost for the 18-month observation period: patients with untreated HL had the highest cost, followed by patients with treated HL, with patients without HL having the lowest cost. We also observed a consistent cost pattern across the three patient comparison groups in all three insurance cohorts. Cohort1 had the highest means cost, in part because this data set included the cost of all prescription medications, and Cohort2 had the lowest cost.

The primary findings of this study of a 21.5% increase (Cohort1) in 18-month costs in older adults with Medicare and supplemental insurance having an HL diagnosis when compared to those without an HL diagnosis are similar to the findings of our recently published study in a sample of working-age adults aged 55–64 years old where we found a 33% increase in costs between a matched group of individuals with HL ¹⁹. While the cost difference in the older group reported here is less than observed in the younger sample, the trends between those with HL (highest costs) versus those with HL and hearing services (middle costs) compared to those with no indication of HL (lowest costs) remain consistent. Foley and colleagues reported an \$392 (CI \$277–\$513) in excess annual medical expenditures for patients with HL in their analysis of Medical Expenditure Panel Survey data from 2000–2012 ²⁸. Our annualized expenditure differences associated with HL were \$2,391. However, their analysis depended on the combination of 12 years of data and a much smaller sample which could not be matched at baseline, thus it is possibly that unmeasured differences in comorbid conditions and age is obscuring expenditure differences due to reported HL. In a systematic review of the economic effects of HL, Huddle and colleagues (2017) report consistently higher costs and expenditure for patients with HL, with very high cost of foregone earnings and lifetime expenditures ²⁹. Most studies focus on total cost to society, and lifetime effects of HL on earnings. However, a study by Stucky (2010) reports mean expenditures of \$1,012 for hearing services in the first year of reported HL, which is similar our finding of \$1,296 of the added cost of hearing services ³⁰.

Although these new findings are an important early step in providing evidence needed to raise awareness of HL from an annoyance or a normal consequence of aging to a public health concern, there are inherent limitations to the use of retrospective billing data. The use of administrative claims to ascertain diagnoses and identify resource use and costs with complete accuracy is difficult, because these data are not purposely collected for clinical research but are collected for the distinct purpose of eliciting healthcare payments ³¹. In addition, there are known variations in coding practices ³¹. They are likely to change over time and differ between institutional settings. Perhaps most importantly in this study, these data lacked clinical information including confirmatory diagnosis of HL and use of hearing services. Because hearing testing and hearing services are governed by limited reimbursement rules by insurers, including Medicare and private insurance, there is likely to be significant undercoding of diagnoses and services billed ³¹. So we might expect to only find a certain patient group who have hearing services in their Medicare bills. These patients may differ in systematic ways from others who are receiving hearing healthcare but are doing so by paying out of pocket or compared to the larger number of individuals who have hearing deficits but do not seek care. However, examination of marginal cost differences between two populations using the same data, and while using propensity methods, reduces the likelihood of significant confounding impact to internal validity as many of these

limitations related to administrative data will be equal in both groups resulting in valid differences.

Propensity score methods in combination with well specified controlled outcomes modeling help to reduce selection bias and confounding due to imbalances in measured baseline covariates between the comparison groups. However, these methods cannot control for bias that might occur due to unmeasured confounders, except if unmeasured confounders are correlated with those that were measured³². The degree to which unmeasured factors may influence the results of the study can be estimated using sensitivity analyses^{27,33}.

The results of this study appear to be insensitive to unmeasured confounders when we examine the case of the primary difference in cost between individuals with and without HL in Cohort1 (\$3,587; the smallest difference among the three comparators). If an unmeasured confounder increased average cost by a magnitude of \$4,396, which is equal to the largest predictor in the outcome model, having chronic renal failure; and if the prevalence of an unmeasured confounder, such as high level of treatment seeking behavior, is 10% higher in the HL group compared to those without HL, then the estimated unbiased difference between these groups would be \$3,147 (95% CI \$3,118–\$3,306). Even if we were to change the prevalence assumption to an unlikely 60% difference between groups, the estimated unbiased difference in cost between individuals with HL and those without would be \$949 (95% CI \$920–\$1,108). Thus, it seems unlikely that an unmeasured confounding variable could have an effect on the outcome to be sufficiently large to invalidate the qualitative conclusion that 18-month healthcare costs are substantially higher in individuals with HL compared with those without HL.

CONCLUSION

Older adults with a diagnosis of HL have substantially higher healthcare costs than a matched comparison group of patients without a HL diagnosis regardless of type of insurance or indication of the use of hearing healthcare services. This study is limited by the lack of audiometry confirmation of HL, and our inability to differentiate between successful and unsuccessful HL interventions. However, after propensity score matching and covariate adjustment, we observed >20% higher payments over an 18-month time period for a group of insured patients with HL. This finding indicates that negative health-related effects of HL may increase healthcare use unrelated to HL. There is currently no Medicare coverage for hearing aids, nor for most hearing healthcare services; private insurance coverage and Medicaid is limited and Medicaid coverage varies widely by state. Future studies are needed to determine if increased coverage for hearing healthcare and/or use of hearing aids results in cost savings for Medicare and other insurers in potentially avoidable healthcare use and improved quality of life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Impact Statement

We certify that this work is novel and sheds light on the impact of hearing loss to overall health and healthcare resource use in older age individuals.

Figure 1.
Adjusted 18-month Total Healthcare Payments by Hearing Loss

Table 1

Patient Descriptive Characteristics by Hearing Loss

Characteristic	Value ^b	Cohort1 ^a		Cohort2 ^a		Subcohort3 ^a	
		Hearing Loss (n= 391,108)	No Hearing Loss (n = 391,108)	Hearing Loss (n = 75,148)	No Hearing Loss (n = 75,148)	Hearing Loss (n = 8,729)	No Hearing Loss (n = 8,509)
Age, m(sd)	75.9 (7.8)	75.9 (7.8)	75.9 (7.8)	77.1 (8.0)	77.0 (7.9)	79.0 (8.2)	78.6 (8.1)
Charlson Score, m(sd)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.2 (0.7)	0.1 (0.7)	0.3 (1.0)	0.2 (0.9)
Follow Up Days, m(sd)	540.0 (29.3)	537.5 (33.2)	537.5 (33.2)	450.7 (91.5)	437.5 (95.0)	440.4 (97.2)	432.1 (97.7)
Sex							
Male	192,038 (49.1)	194,133(49.6)	194,133(49.6)	29,221 (38.9)	29,265 (38.9)	2,343 (26.8)	2,298 (27.0)
Female	199,070 (50.9)	196,975(50.4)	196,975(50.4)	45,927 (61.1)	45,883 (61.1)	6,386 (73.2)	6,211 (73.0)
White Race	NA	NA	NA	66,669 (88.7)	66,958 (89.1)	5,304 (60.8)	5,288 (62.2)
Hearing Services	109,968 (28.1)	0 (0.0)	0 (0.0)	2,873 (3.8)	0 (0.0)	262 (3.0)	0 (0.0)
Chronic Conditions							
Hypertension	51,411 (13.1)	48,711 (12.5)	48,711 (12.5)	47,346 (63.0)	47,647 (63.4)	6,506 (74.5)	6,339 (74.5)
Diabetes	21,520 (5.5)	20,538 (5.3)	20,538 (5.3)	20,147 (26.8)	20,222 (26.9)	3,398 (38.9)	3,238 (38.1)
CondHF	16,499 (4.2)	15,146 (3.9)	15,146 (3.9)	16,504 (22.0)	16,431 (21.9)	2,058 (23.6)	1,890 (22.2)
Heart Valve	8,802 (2.6)	7,737 (2.0)	7,737 (2.0)	8,364 (11.1)	8,051 (10.7)	1,005 (11.5)	905 (10.6)
COPD	8,522 (2.2)	7,561 (1.9)	7,561 (1.9)	7,958 (10.6)	8,016 (10.7)	1,405 (16.1)	1,335 (15.7)
CHF	4,195 (1.1)	3,518 (0.9)	3,518 (0.9)	5,545 (7.4)	5,237 (7.0)	1,229 (14.1)	1,034 (12.2)
PHD	1,024 (0.3)	845 (0.2)	845 (0.2)	1,551 (2.1)	1,366 (1.8)	178 (2.0)	153 (1.8)
Asthma	4,943 (1.3)	4,313 (1.1)	4,313 (1.1)	3,946 (5.3)	3,930 (5.2)	624 (7.2)	584 (6.9)
Diverticulitis	4,625 (1.2)	4,213 (1.1)	4,213 (1.1)	4,082 (5.4)	4,026 (5.4)	410 (4.7)	374 (4.4)
CRF	3,791 (1.0)	3,467 (0.9)	3,467 (0.9)	4,889 (6.5)	4,691 (6.2)	819 (9.4)	717 (8.4)
Dementia	2,827 (0.7)	2,473 (0.6)	2,473 (0.6)	4,428 (5.9)	4,250 (5.7)	1,254 (14.4)	1,103 (13.0)
RA	2,082 (0.5)	1,778 (0.5)	1,778 (0.5)	1,947 (2.6)	1,880 (2.5)	275 (3.2)	246 (2.9)
Carditis	1,909 (0.5)	1,550 (0.4)	1,550 (0.4)	1,829 (2.4)	1,702 (2.3)	222 (2.5)	187 (2.2)
Epilepsy	888 (0.2)	731 (0.2)	731 (0.2)	846 (1.1)	793 (1.1)	181 (2.1)	167 (2.0)
Parkinson's	833 (0.2)	700 (0.2)	700 (0.2)	902 (1.2)	897 (1.2)	167 (1.9)	148 (1.7)

Characteristic	Value ^b	Cohort1 ^a			Cohort2 ^a			Subcohort3 ^a		
		Hearing Loss (n= 391,108)	No Hearing Loss (n= 391,108)	Hearing Loss (n = 75,148)	No Hearing Loss (n = 75,148)	Hearing Loss (n = 75,148)	No Hearing Loss (n = 75,148)	Hearing Loss (n = 8,729)	No Hearing Loss (n = 8,509)	Hearing Loss (n = 8,509)
SLE		688 (0.2)	620 (0.2)	633 (0.8)	602 (0.8)	55 (0.6)	53 (0.6)	110 (1.3)	5 (0.1)	5 (0.1)
Hepatitis		382 (0.1)	334 (0.1)	490 (0.7)	390 (0.5)	156 (1.8)	110 (1.3)	93 (1.1)	13 (0.2)	13 (0.2)
MS		193 (0.1)	174 (0.0)	84 (0.1)	81 (0.1)	9 (0.1)	5 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Schizophrenia		104 (0.0)	82 (0.0)	192 (0.3)	153 (0.2)	113 (1.3)	93 (1.1)	13 (0.2)	13 (0.2)	13 (0.2)
HIV		62 (0.0)	43 (0.0)	46 (0.0)	35 (0.0)	1 (0.0)	2 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
CF		12 (0.0)	10 (0.0)	10 (0.0)	8 (0.0)	1 (0.0)	2 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
SCA		12 (0.0)	12 (0.0)	9 (0.0)	8 (0.0)	2 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

NA – Not Available

^aCohort1 is the Medicare plus privately insured cohort, Cohort2 is the Medicare Only cohort, and Subcohort3 is the subgroup among Cohort2 who is also eligible for Medicaid.

^bData are presented as number (percentage) of patients unless otherwise indicated

Chronic Conditions: Conduction=conductive heart failure, CHF=congestive heart failure, PHD=pulmonary heart disease, COPD=chronic obstructive pulmonary disease, asthma, diverticulitis, CRF=chronic renal failure, RA=rheumatoid arthritis, SLE=systemic lupus erythematosus, Diabetes=type II diabetes, HIV, hepatitis, CF=cystic fibrosis, SCA=sickle cell anemia, Dementia=senile dementia, schizophrenia, Parkinson's disease, MS=multiple sclerosis, epilepsy, Heart Valve=heart valve disorder, Carditis=carditis or cardiomyopathy, and Hypertension=hypertension with complications

Table 2

Unadjusted 18-month Healthcare Payments and Hospital Length of Stay *

	Value ^b , \$		
	Hearing Loss	Hearing Loss with Hearing Services	No Hearing Loss
Cohort1 ^a			
Total	21,164 (39,824)	20,078 (45,248)	17,569 (37,708)
Hospital [‡]	25,837 (45,079)	19,446 (37,846)	24,216 (44,267)
Length of Stay [‡] , days	6.5 (10.7)	5.8 (7.9)	7.4 (11.5)
Out Patient	10,947 (24,229)	10,551 (35,751)	8,499 (22,717)
Hearing Services	0	2,056 (1,194)	0
Cohort2 ^a			
Total	13,129 (21,983)	11,848 (19,074)	10,036 (19,789)
Hospital [‡]	18,557 (23,831)	17,268 (18,063)	17,814 (22,456)
Length of Stay [‡] , days	9.3 (12.9)	8.8 (10.5)	9.4 (12.8)
Out Patient	4,655 (5,776)	3,919 (4,544)	2,989 (1,919)
Hearing Services	0	3,414 (3,325)	0
Subcohort3 ^a			
Total	18,193 (29,070)	14,658 (20,894)	13,453 (23,376)
Hospital [‡]	21,662 (29,828)	16,380 (19,539)	19,588 (23,556)
Length of Stay [‡] , days	11.5 (15.5)	9.1 (12.4)	10.9 (13.8)
Out Patient	5,428 (6,933)	3,978 (4,259)	3,376 (5,188)
Hearing Services	0	1,296 (1,929)	0

* Cost of health care services are estimated as the sum of insurance and patient payments in real 2010–2013 US\$

^a Cohort1 is the Medicare plus privately insured cohort, Cohort2 is the Medicare Only cohort, and Subcohort3 is the subgroup among Cohort2 who is also eligible for Medicaid.

^b Data are presented as mean (standard deviation)

[‡] includes only patients with a hospital admission

Table 3 Adjusted 18-month Total Healthcare Payments by Hearing Loss[†]

	Adjusted Mean (95% Confidence Interval), \$		
	Hearing Loss	Hearing Loss with Hearing Services	No Hearing Loss
Cohort1 ^{a,b}	20,304 (20,211–20,398)	18,873 (18,735–19,012)	16,717 (16,652–16,782)
Cohort2 ^{a,c}	11,957 (11,815–12,101)	10,309 (9,713–10,942)	8,178 (8,083–8,275)
Subcohort3 ^{a,c}	16,281 (15,737–16,843)	12,850 (10,599–15,579), NS	11,624 (11,237–12,024)

^a Cohort1 is the Medicare plus privately insured cohort, Cohort2 is the Medicare Only cohort, and Subcohort3 is the subgroup among Cohort2 who is also eligible for Medicaid.

^b Includes prescription payments

^c Payments do not include prescription medication.

[†] Estimates are adjusted for age, sex, race (when available), and 17 chronic conditions.

All p-values <0.001 within cohort (No Hearing Loss is the Reference Group), except within Subcohort3 where the Hearing Loss with Hearing Services group was not significantly different p=0.26 from the No Hearing Loss group.

NS=not significant