

Letters

RESEARCH LETTER

Higher Health Care Costs in Middle-aged US Adults With Hearing Loss

Age-related hearing loss affects more than 60% of US adults older than 70 years and has been associated with increased risk of hospitalization,¹ decreased quality of life,^{2,3} and increased risk of functional and cognitive decline.⁴ The onset of hearing loss is gradual, with prevalence tripling from the age of 50 years to 60 years.³ However, the association between hearing loss in older middle-aged adults (aged 55-64 years) and the use of health care has not been studied. We compared the costs of health care for a matched cohort of privately insured individuals with and without a diagnosis of hearing loss.

Methods | Using the Truven Health MarketScan database from January 1, 2009, to December 31, 2013, of privately insured individuals with at least 18 months of coverage, we extracted data on a cohort of patients aged 55 to 64 years with an *International Classification of Diseases, Ninth Revision*, code for hearing loss (codes V41.2, V72.1x, 388.00, 388.01, 388.40, 388.43, 388.44, 388.5, 389.1x, and 389.2x). We then propensity score matched them with a comparison group based on age, sex, US region, insurance type, beneficiary status, Charlson comorbidity score,⁵ use of outpatient services, and baseline presence of 22 chronic conditions (asthma, carditis, chronic obstructive pulmonary disease, chronic renal failure, conductive heart disease, congestive heart failure, cystic fibrosis, diabetes mellitus type 2, diverticulitis, epilepsy, heart valve disease, hepatitis, human immunodeficiency virus, hypertension, multiple sclerosis, Parkinson disease, pulmonary heart disease, rheumatoid arthritis, schizophrenia, systemic lupus, senile dementia, and sickle cell disease). Owing to very small cell sizes, cystic fibrosis, diverticulitis, heart valve disease, human immunodeficiency virus, multiple sclerosis, and schizophrenia were not used in the final matching model. Six months of baseline data for each individual were used for matching. Patients with diagnoses of late effects of stroke, coma, or paralysis were excluded. Health care bills for up to 18 months of follow-up after baseline were summed by patient to calculate total payments for inpatient services, outpatient services, prescription medication, and cost of hearing services. Payments were compared by group using gamma distributed, generalized, linear log-transformed models, adjusting for baseline covariates (demographic characteristics, chronic conditions, Charlson comorbidity score, number of days in the follow-up period, and use of hearing services). Data analysis was conducted using SAS, version 9.4 (SAS Institute Inc), with $\alpha < .05$. The study protocol was approved by the Medical University of South Carolina Institutional Review Board. Patient consent was not required because data were deidentified and the Medical University of

Table 1. Baseline Characteristics of Patients With a Diagnosis of Hearing Loss and Matched Controls^a

Characteristic	Value ^b	
	Diagnosis of Hearing Loss (n = 280 882)	No Diagnosis of Hearing Loss (n = 280 882)
Age, mean (SD), y	59.0 (2.6)	59.0 (2.6)
Follow-up, mean (SD), d	539 (30)	535 (37)
Charlson Comorbidity score, mean (SD)	0.014 (0.2)	0.013 (0.2)
Any hearing services received	36 323 (12.9)	0
Male sex	146 687 (52.2)	147 189 (52.4)
US region		
North Central	65 848 (23.4)	65 887 (23.5)
Northeast	68 031 (24.2)	67 480 (24.0)
South	89 825 (32.0)	90 268 (32.1)
West	54 347 (19.3)	54 402 (19.4)
Employment		
Full time	108 950 (38.8)	108 508 (38.6)
Part time	2476 (0.9)	2510 (0.9)
Retired	67 798 (24.1)	68 108 (24.2)
Employed in an hourly wage job	49 879 (17.8)	50 125 (17.8)
Low deductible insurance	251 698 (89.6)	251 586 (89.6)
Presence of chronic conditions		
Asthma	11 050 (3.9)	10 728 (3.8)
Congestive heart failure	2089 (0.7)	1824 (0.7)
Chronic obstructive pulmonary disease	9485 (3.4)	9255 (3.3)
Chronic renal failure	2592 (0.9)	2437 (0.9)
Carditis	1903 (0.7)	1699 (0.6)
Conductive heart disease	16 251 (5.8)	15 836 (5.6)
Diabetes mellitus	39 677 (14.1)	39 851 (14.2)
Epilepsy	1808 (0.6)	1640 (0.6)
Hepatitis	1963 (0.7)	1905 (0.7)
Hypertension	84 530 (30.1)	85 014 (30.3)
Parkinson disease	359 (0.1)	317 (0.1)
Pulmonary heart disease	1020 (0.4)	881 (0.3)
Rheumatoid arthritis	4036 (1.4)	3849 (1.4)
Systemic lupus	1867 (0.7)	1708 (0.6)
Senile dementia	1029 (0.4)	872 (0.3)
Sickle cell disease	40 (0.01)	33 (0.01)

^a Patients and controls were extracted from Truven Health MarketScan research databases. Groups were propensity score matched based on bills from 6 months of the baseline period, including age, sex, high-deductible insurance, full-time or part-time employment, retired, US geographical region, Charlson comorbidity score, and presence of 16 codes for chronic comorbid condition diagnosis in outpatient files (asthma, carditis, chronic obstructive pulmonary disease, chronic renal failure, conductive heart disease, congestive heart failure, diabetes mellitus type 2, epilepsy, hepatitis, hypertension, Parkinson disease, pulmonary heart disease, rheumatoid arthritis, systemic lupus, senile dementia, and sickle cell disease).

^b Data are presented as number (percentage) of patients unless otherwise indicated.

Table 2. Adjusted Cost of Health Care Services^a

Type of Cost	Adjusted Mean (95% CI), \$		
	Patients With HL Who Received Any HS (n = 36 323)	Patients With HL With No HS Record (n = 244 559)	Patients Without HL (n = 280 882)
Total	13 797 (13 530-14 069)	14 165 (14 091-14 239)	10 629 (10 576-10 681)
Hospital ^b	32 942 (31 962-33 952)	33 116 (32 719-33 518)	33 890 (33 480-34 306)
Outpatient services, including HS	8634 (8515-8755)	7980 (7937-8023)	5473 (5446-5501)
HS	2879 (2871-2887)	NA	NA
Prescription medication	3136 (3082-3192)	2956 (2936-2976)	2348 (2333-2363)

Abbreviations: HL, hearing loss; HS, hearing services; NA, not applicable.

^a Cost of health care services are estimated as the sum of insurance and patient payments (including all payments made by health care professionals and patients as deductibles, copayments, and coinsurance) in real 2010-2013 US\$. All estimates are adjusted for baseline characteristics listed in Table 1; the total cost of care model is also adjusted for cost of HS. Hearing services were

defined by summing payments for services with *Current Procedural Terminology* or Healthcare Common Procedure Coding System⁷ codes indicating service for hearing screening; hearing assessment; ear impressions; fitting, checking, or modifying a hearing aid; conformity evaluation; or other HS except those related to implantation of devices.

^b Includes only patients with a hospital admission.

South Carolina Institutional Review Board classified this study as nonhuman research.

Results | A total of 561 764 individuals were included in the study. Groups were balanced (standardized mean differences on all covariates, <20%).⁶ Descriptive characteristics of the matched groups at baseline are shown in Table 1. Fully adjusted models showed significantly higher mean health care payments for individuals with a diagnosis of hearing loss during follow-up compared with patients without a diagnosis of hearing loss (Table 2). Patients with a diagnosis of hearing loss who received hearing services (36 323 of 280 882 patients [12.9%]) had slightly lower (by \$368) overall mean costs (\$13 797; 95% CI, \$13 530-\$14 069) than did patients who did not receive hearing services (\$14 165; 95% CI, \$14 091-\$14 239) when we adjusted for the cost of hearing services; however, payments remained significantly higher (by \$3168) than those for patients without hearing loss (\$10 629; 95% CI, \$10 576-\$10 681).

Discussion | Older middle-aged adults (aged 55-64 years) in our study with a diagnosis of hearing loss had substantially higher health care costs than a matched comparison group of patients without such a diagnosis. Our results mirror the finding by Genter et al¹ that patients with hearing loss documented by audiometry had a higher risk of hospital admission than did patients without hearing loss, indicating that hearing loss may place patients at risk for increased health care use and costs. Our study is limited by the lack of audiometry confirmation of hearing loss and our inability to differentiate between successful hearing loss interventions and failed interventions. Residual confounding may remain owing to unmeasured variables. However, we observed 33.3% higher payments during a 1.5-year time period for a relatively young group of insured patients with hearing loss (mean, \$14 165) vs patients without hearing loss (mean, \$10 629). This finding indicates that negative health-related effects of hearing loss, a condition that many consider simply an unavoidable result of aging, may manifest earlier than is generally recognized and may affect use of health care across the continuum of care. Studies are needed to identify the underlying factors that lead to the observed cost differences, as well as to ascertain

the extent to which early and successful use of hearing aids and other hearing loss interventions modify cost differences. Nevertheless, our study suggests that hearing loss is costly, even in middle-aged individuals, and is present in large numbers of adults for whom early, successful intervention may prevent future hearing-related disabilities and decreased quality of life.

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Published Online: April 7, 2016. doi:10.1001/jamaoto.2016.0188.

Author Contributions: Dr A. N. Simpson had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: All authors.

Acquisition, analysis, or interpretation of data: All authors.

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Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: A. N. Simpson, K. N. Simpson.

Obtained funding: A. N. Simpson, Dubno.

Administrative, technical, or material support: A. N. Simpson, Dubno.

Study supervision: A. N. Simpson, Dubno.

Conflict of Interest Disclosures: None reported.

Funding/Support: This work was supported by grant R21 DC014031-01 from The National Institutes of Health/National Institute on Deafness and Other Communication Disorders and by the South Carolina Clinical and Translational Research Institute, with an academic home at the Medical University of South Carolina, through grant UL1 RR029882 from the National Institutes of Health. This investigation was conducted in a facility constructed with support from National Institutes of Health Research Facilities Improvement Program grant CO6 RR14516.

Role of the Funder/Sponsor: The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

1. Genter DJ, Frick KD, Chen D, Betz J, Lin FR. Association of hearing loss with hospitalization and burden of disease in older adults. *JAMA*. 2013;309(22):2322-2324. doi:10.1001/jama.2013.5912.

2. Hawkins K, Bottone FG Jr, Ozminowski RJ, et al. The prevalence of hearing impairment and its burden on the quality of life among adults with Medicare Supplement Insurance. *Qual Life Res*. 2012;21(7):1135-1147.
3. Simpson AN, Simpson KN, Dubno JR. Health-related quality of life in older adults: effects of hearing loss and common chronic conditions. *Healthy Aging Research*. 2015;4:4. doi:10.12715/har.2015.4.4.
4. Dobie RA. The burdens of age-related and occupational noise-induced hearing loss in the United States. *Ear Hear*. 2008;29(4):565-577.
5. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992;45(6):613-619.
6. Rubin DB. Using propensity scores to help design observational studies: application to the tobacco litigation. *Health Serv Outcomes Res Methodol*. 2001;2(3):169-188. doi:10.1023/A:1020363010465.
7. Centers for Medicare & Medicaid Services. HCPCS—general information. <https://www.cms.gov/Medicare/Coding/MedHCPCSGenInfo/index.html>. Modified December 20, 2015. Accessed March 1, 2016.

OBSERVATION

Spontaneous Resolution of a Tracheoesophageal Fistula Caused by Button Battery Ingestion

This observation reports a pediatric case of spontaneous resolution of tracheoesophageal fistula caused by button battery ingestion. Button battery ingestion in children is a common problem, and it can cause clinically significant morbidity and mortality. Complications including tracheoesophageal fistula are rare but serious if the battery is not removed early. Our purpose is to emphasize the importance of the conservative management prior to surgical intervention to allow possible spontaneous closure.

Report of a Case | An 18-month-old girl, with a history of accidental button battery ingestion removed after 48 hours endoscopically, presented to an emergency department with dysphagia for solids, violent coughing bouts, tachypnea, and drooling.

The physical examination showed that her weight was 10.5 kg (in the 25th percentile) and that her temperature was 39°C. Chest auscultation revealed bronchial rales in both lung fields. The endoscopic assessment (esophagoscopy and tracheoscopy) and a computerized axial tomography (CT) scan of the chest with 3-D reconstruction (**Figure 1**) showed a large tracheoesophageal fistula (TEF) (15 mm in diameter) at the D1 level.

A gastrostomy feeding tube was then placed under endoscopic guidance. The patient was scheduled for repair of the TEF with an esophageal stent endoscopically 3 weeks later but a resolution of the TEF was found without need for any therapy.

At a 1-year follow-up, she remained asymptomatic, on a regular diet, and an esophagram (**Figure 2**) showed no evidence of stricture or residual TEF.

Discussion | Button battery ingestion can cause significant morbidity and mortality, especially when the button is stuck in the esophagus. Owing to different mechanisms, it may cause local damage and necrosis.¹ The generation of the

external electrolytic current can hydrolyze tissue fluids and produce hydroxide at the battery's negative pole. Batteries must be removed urgently to limit such potential complications as perforation, TEF, esophageal strictures, vocal cord paralysis, spondylodiscitis, and hemorrhagic complications.² The TEF is detected in most cases during esophagoscopy and CT scan. If a fistula is seen, the child should not be fed, and intravenous antibiotics should be initiated in case there is a suspicion of mediastinitis.

Various treatment modalities have been described for acquired TEF and there is no consensus.³ Conservative treatment with esophageal stents can be tried if there is no severe sepsis, pneumothorax, or a pneumomediastinum.

Figure 1. Chest Computed Tomography Scan Showing a Large Tracheoesophageal Fistula (15 mm in Diameter) at D1 Level

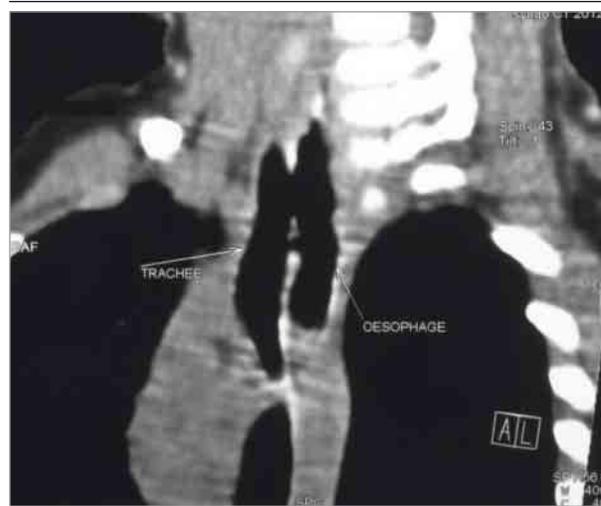


Figure 2. An Esophagram Showing No Evidence of Stricture or Residual Tracheoesophageal Fistula

