Effective Hearing Loss Screening in Primary Care: The Early Auditory Referral-Primary Care Study

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ABSTRACT

PURPOSE Hearing loss, the second most common disability in the United States, is under-diagnosed and under-treated. Identifying it in early stages could prevent its known substantial adverse outcomes.

METHODS A multiple baseline design was implemented to assess a screening paradigm for identifying and referring patients aged ≥55 years with hearing loss at 10 family medicine clinics in 2 health systems. Patients completed a consent form and the Hearing Handicap Inventory for the Elderly (HHI). An electronic alert prompted clinicians to screen for hearing loss during visits.

RESULTS The 14,877 eligible patients during the study period had 36,701 encounters. Referral rates in the family medicine clinics increased from a baseline rate of 3.2% to 14.4% in 1 health system and from a baseline rate of 0.7% to 4.7% in the other. A general medicine comparison group showed referral rate increase from the 3.0% baseline rate to 3.3%. Of the 5,883 study patients who completed the HHI 25.2% (n = 1,484) had HHI scores suggestive of hearing loss; those patients had higher referral rates, 28% vs 9.2% (P <.001). Of 1,660 patients referred for hearing testing, 717 had audiology data available for analysis: 669 (93.3%) were rated appropriately referred and 421 (58.7%) were considered hearing aid candidates. Overall, 71.5% of patients contacted felt their referral was appropriate.

CONCLUSION An electronic alert used to remind clinicians to ask patients aged ≥55 years about hearing loss significantly increased audiology referrals for at-risk patients. Audiologic and audiogram data support the effectiveness of the prompt. Clinicians should consider adopting this method to identify patients with hearing loss to reduce its known and adverse sequelae.

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INTRODUCTION

Hearing loss affects over 30% of those aged ≥55 years, with over one-half suffering morbidity that includes reduced quality of life.[1-14] Untreated hearing loss is a major risk factor for substantial health conditions (hypertension, diabetes, dementia, depression)[2-4,10,11,15-22] as well as increased health care cost and use.[23-26] Patients with hearing loss are reluctant to reveal it, and most non-otolaryngologist physicians provide inadequate hearing care to these patients. It is a condition physicians often do not suspect, are uncomfortable with, or consider unimportant despite growing recognition of its impact on health.[27,28] In fact, 75% of hearing loss remains underdiagnosed and undertreated.[27-30]

Common screening tests can effectively identify patients with hearing loss,[15,31-33] yet physicians rarely use them.[7] Primary care physicians, the vanguard for screening and prevention, juggle multiple office demands ranging from treating ill patients to addressing quality metrics;[34,35] thus implementing new interventions, regardless of importance, is hard.[35-38] Other barriers to screening are poor understanding of hearing loss, optimal screening, counseling, and referral approaches.[3,6,27,29,30,39] Despite effective treatments being available, there are multiple barriers that reduce the likelihood of screening in the primary care setting. Most patients are reluctant to reveal

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their hearing loss.[40-43] However, those with established primary care physicians, if asked, will discuss their hearing and often follow treatment recommendations that are known to be effective.[27,30,32,39,40,44]

The US Preventive Services Task Force acknowledges the adverse outcomes from untreated hearing loss.[15] They state, however, that "adequately powered studies are needed to better evaluate the effect of screening for hearing loss on health outcomes (in older persons)...particularly among adults without self-perceived or established hearing loss at baseline."[15] Thus, hearing loss screening is rated "I," ie, "…evidence is insufficient to assess the balance of benefits and harms of screening in asymptomatic adults aged 50 years or older."[15]

The Early Auditory Referral-Primary Care study was designed to address the lack of data about hearing loss screening.[15] Implemented in real-world, community-based clinics, it evaluated the effect of a tailored electronic alert appearing at all visits of patients aged ≥55, to encourage clinicians to ask the single question screener: "Do you have difficulty with your hearing?" This article summarizes the findings.

METHODS

University of Michigan and Beaumont Health Institutional Review Boards approved the research.

Study Setting

The first 2 years of the Early Auditory Referral-Primary Care study developed and tested a Best Practice Alert (BPA) in Epic (Epic Systems Corporation) to prompt clinicians to ask about hearing loss.[44] The study's implementation phase, reported here, was conducted from July 2016 through February 2019 at the University of Michigan (UM) and Beaumont Health (BH) family medicine clinics using Epic electronic health records. Patients were enrolled from 5 practices in each system, and all clinicians at the practices (faculty, residents, midlevel clinicians) were included. Audiograms performed on referred patients were obtained when available. All UM referrals went to UM audiologists plus 2 private audiologists. All BH referrals were to private medical offices.

An 11-minute in-person hearing loss educational video was presented to available clinicians at each site 1 week before activating the BPA. It reviewed general hearing loss information, brief information about hearing aids, and suggestions for counseling patients with hearing loss. Approximately 28% (n = 40) of UM and 52% (n = 33) of BH clinicians viewed the video.

All patients aged ≥55 years seen at study sites during the enrollment period were invited to participate and handed a description of the study plus a consent form. Due to high volumes, this was a self-administered, paper-based consent process. Consenting patients completed a Hearing Handicap Inventory for the Elderly (HHI)[31, 33] our gold standard to identify patients at risk for hearing loss. HHI is a 10-question patient-completed questionnaire that is a well validated standard screening instrument in primary care.[31,45,46] Clinicians were blinded to HHI results. Data from patients declining consent to individual level analysis was used in aggregated de-identified form to assess primary outcomes.

Measures

The hearing loss alert (ie, BPA in Epic)[44] appeared when clinicians saw eligible patients who did not have hearing loss on their problem list. Five possible responses to the alert existed: (1) the patient had known hearing loss, (2) the patient had suspected hearing loss (responded yes to the single question) and was referred for testing, (3) the patient had suspected hearing loss but declined referral, (4) the patient did not have hearing loss (answered no to the single question), and (5) the clinician did not address the alert. Responses to all alerts were recorded and analyzed.

For our trial, we used a multiple baseline design that is a special case of a stepped wedge trial. The multiple baseline design makes staggered starts that are synchronized with interventions offered at multiple time points, to facilitate causal inference.[47] This design offers a lower cost alternative with potentially smaller sample sizes compared to traditional designs.[48]

Sites were enrolled in a staggered format, a new site added approximately every 3 to 4 months in each health system. Once a site was enrolled, the alert triggered for every eligible patient seen and prompted the clinician to ask the patient, "Do you have difficulty with your hearing?" If clinicians did not ask about hearing loss, the alert reappeared at future visits for that patient until addressed. Once addressed, it turned off for time-lengths based on the outcome—for patients with known hearing loss it turned off permanently; for those declining testing it turned off for 1 year; and for those referred, it remained until a hearing specialist saw the patient. The same alert was used at both institutions. A separate process prompted audiologists to answer 3 questions: referral appropriateness, hearing loss severity, and if hearing aid evaluation was recommended.[44] A few audiograms collected from private offices without responses to the questions were answered by our audiologist co-investigator (P.K.). We calculated pure tone averages (average of decibel losses at 500 Hz, 1,000 Hz, 2,000 Hz, and 4,000 Hz) for each ear from each audiogram and categorized them as mild, moderate, or severe using World Health Organization criteria.[49]

Demographics, race, ethnicity, insurance, medical diagnoses on the problem list, and frequency of hearing loss on the problem list at baseline were obtained directly from the Epic electronic health records.

Follow-up telephone calls were made to approximately 20% of study participants, selected at random, who were either referred for hearing loss testing or had a positive HHI score (≥10). Responses to survey questions focusing on patient perceptions about hearing loss, discussions with their physicians, and compliance with any referrals (and why/why not) were collected.

Statistical Analysis

Participant demographic and comorbidity variables were summarized for all sites within each institution. Distributions between institutions were compared using Pearson's χ^2 tests, except for age which was compared using a *t*-test. Percentage of patients referred to audiology with hearing loss diagnosis on the problem list were compared to rates from 1 year immediately prior (baseline) to the study period using Pearson's χ^2 tests at each institution. Baseline rates were calculated from aggregate (de-identified) data on all patients seen at participating clinics who met study criteria. Study period rates were calculated using comparable aggregate data-based rates during the intervention period as well as rates from study participants. A Cochran-Mantel-Haenszel test was used to compare the change in referral rates across institutions.[50] Because the clinics were under the intervention for different lengths of time, we adjusted for months under intervention as a clinic-level covariate in our referral rates analysis. Referral rates of patients with probable hearing loss (HHI score ≥10) vs those unlikely to have hearing loss (HHI <10) were compared using Pearson's χ^2 tests. Percentages of all referred patients seen by audiology and audiologist evaluations of referral appropriateness were assessed for participants.

Associations between participant demographics (age, sex, race, smoking status, insurance), and comorbidities (obesity, high blood pressure, diabetes) with referral status were examined using a clustered logistic regression under a generalized estimating equations framework. Models were clustered by clinic using an exchangeable correlation structure and a fixed effect for institution was included in the model. An additional model on the subset of individuals who had HHI information available was fit to explore the likelihood of referral for those who had indications of hearing loss (HHI ≥10), adjusting for potential confounders.

RESULTS

There were 14,411 (11,151 UM; 3,260 BH) patients arriving at the sites for whom individual level data were obtained. HHI information was available only for the 5,893 study participants (2,641 UM; 3,252 BH). Eight BH patients did not have HHI scores. The 11,151 UM patients had 29,361 encounters and the 3,260 BH patients had 7,340 encounters during the study period.

Demographics

Patient characteristics differed between the 2 institutions (Table 1), though this was clinically significant only for insurance, where UM had significantly more private pay patients. Comorbidity prevalence was similar for both health systems.

Table 1. Demographic and Comorbidity Characteristics of All Participants[a,b]

Characteristic	UM (n = 11,151)	BH (n = 3,260)	*P* Value
Age, mean (SD)	65.0 (8.7)	65.6 (8.6)	<.001
Gender, No. (%)			<.001
Female	6,242 (56.0)	2,056 (63.1)	
Male	4,909 (44.0)	1,204 (36.9)	
Race, No. (%)			<.001
White	9,548 (85.6)	2,786 (85.5)	
Black	799 (7.2)	271 (8.3)	
Other	689 (6.2)	112 (3.4)	
Unknown	115 (1.0)	91 (2.8)	
Ethnicity, No. (%)			<.001
Hispanic	199 (1.8)	16 (0.5)	
Non-Hispanic	10,413 (93.4)	2,931 (89.9)	
Unknown	539 (4.8)	313 (9.6)	
Marital status, No. (%)			<.001
Married/significant other	7,200 (64.6)	1,951 (59.9)	
Divorced/separated	496 (4.5)	399 (12.2)	
Other	3,092 (27.7)	905 (27.8)	
Unknown	363 (3.3)	5 (0.2)	
Smoking status, No. (%)			<.001
Yes	1,189 (10.7)	442 (13.6)	
Quit	4,108 (36.8)	1,313 (40.3)	
Never	5,849 (52.5)	1,484 (45.5)	
Unknown	5 (0.04)	21 (0.6)	
Hypertension, No. (%)	4,562 (40.9)	1,247 (38.3)	.007
Diabetes, No. (%)	1,819 (16.3)	489 (15.0)	.084
Alcohol abuse, No. (%)	175 (1.6)	98 (3.0)	<.001
Insurance, No. (%)			<.001
Private	6,632 (59.5)	1,178 (36.1)	
Medicare/federal	3,905 (35.0)	1,066 (32.7)	
Medicaid	513 (4.6)	190 (5.8)	
Uninsured	101 (0.9)	11 (0.3)	
Unknown	0 (0.0)	815 (25.0)	

BH = Beaumont Health; UM = University of Michigan

[a] Includes all participants (consented at UM and BH and non-consented de-identified at UM).

[b] Unknown or missing categories were removed prior to comparison.

Best Practice Alert Response and Referral Rates

At both institutions, referrals increased significantly vs baseline rates for both consented and all patients (Table 2). Cochran-Mantel-Haenszel testing was significant ($P = .0004$) indicating that referral rate changes were different between institutions.

Table 2. Referral Rates of All Participants

Study Location	Baseline (Aggregate Data[a]) % (No./Total)	Study Period (Aggregate Data[a]) % (No./Total)	Study Period (BPA Report[b]) % (No./Total)
UM	3.2 (370/11,554)	14.4 (2,240/15,602)	13.3 (1,487/11,151)
BH	0.7 (50/7,606)	4.7 (432/9,283)	5.3 (173/3,260)
Total[c]	2.2 (420/19,160)	10.7 (2,672/24,885)	11.5 (1,660/14,411)

BH = Beaumont Health; BPA = best practice alert; UM = University of Michigan

[a] Referrals captured from all patients seen during study period at both sites.
[b] *Referrals captured through BPA report on consented patients at BH and all patients (consented and non-consented de-identified) at UM.*
[c] P <.001 for both institutions vs baseline rates.

Since Medicare wellness visits (includes hearing loss screening) for persons aged ≥65 years were implemented nationally during the study period, we evaluated UM general medicine sites referral rates. They had non–clinically significant increases in referrals vs baseline (3.3% vs 3.0%, $P = .04$).

Hearing loss was documented on the problem list for 58 (0.5%) participants at UM, not significantly different from the baseline rate of 0.5% ($P = .85$). At BH, 266 (8.2%) participants had hearing loss documented on their problem list, a significant increase from the baseline rate of 2.3% (P <.001).

Hearing Handicap Inventory Findings

HHI data from 5,893 patients (2,641 UM, 3,252 BH) showed overall 25.2% (n = 1,484) scores ≥10, suggestive of hearing loss; 29.5% (n = 778) at UM and 21.7% at BH (n = 706). Patients with HHI scores ≥10 vs scores <10 had greater overall referral rates, 28% vs 9.2% (P <.001) respectively. HHI scores ≥10 were associated with increased age, male sex, White race, and having diabetes. (Table 3)

A generalized estimating equations model, clustered by clinic, run on all participants, found White patients and patients with diabetes had higher odds of referral while smokers had lower odds of referral (Table 4). For consented patients with HHI scores, these associations disappeared after adjusting for the presence or absence of HHI scores ≥10. A strong association between high HHI scores with referral indicated that clinicians were likely to refer patients appropriately based on the single question (HHI results were blinded to clinicians). Months under intervention had a mildly significant association (OR = 0.96; 95% CI, 0.93-0.99) but the direction was counter-intuitive, with greater time under observation associated with a lower referral rate. When the results were compared to a model without time as a covariate, the findings between these models were virtually identical.

Best Practice Alert Encounter Data

The alert was addressed for 10,567 of all 14,877 eligible patients. There was an average of 1.7 (SD = 1.4) encounters before the alert was first responded to, 14% of which resulted in a referral. The alert was not addressed at any encounter for 3,812 (26.5%) patients (UM - 32.4% vs BH - 6.3%; P <.001). Patients who never had the alert addressed averaged 2.6 encounters (SD = 2.1) in which the alert prompted the physician.

Audiologic Data

Of 1,660 patients referred for hearing testing, 717 (43.2%) were seen and had data available. Audiologists deemed 669 referrals (93.3%) appropriate, 6 (0.8%) not appropriate, and 42 (5.9%) were not rated. Asymmetric hearing loss was present in 228 (31.8%) patients, and 421 (58.7%) patients were considered hearing aid candidates. Of the 717 audiograms, 540 were available to be coded using the World Health Organization criteria for pure tone average (PTA) calculations (average of decibel [dB] losses at 4 frequencies: 500 Hz, 1,000 Hz, 2,000 Hz and 4,000 Hz)[49] (Table 5).

There were 284 patients with both audiograms and HHI ratings available, split evenly between HHI scores ≥10 and <10. HHI score was associated with PTA dB loss. In the better ear, mean PTA loss was 27.5 dB (SD 11.9) for HHI ≥10 vs 19.6 dB (SD 9.3) for HHI <10 (P

Table 3. Characteristics of Participants With Low vs High HHI Scores

Characteristic	HHI <10 (n = 4,409)	HHI ≥10 (n = 1,484)	*P* Value
Age, mean (SD)	64.8 (7.9)	65.6 (8.5)	<.001
Male, No. (%)	1,604 (36.4)	717 (48.3)	<.001
White, No. (%)	3,811 (88.2)	1,328 (91.1)	.002
High blood pressure, No. (%)	1,680 (38.1)	607 (40.9)	.056
Diabetic, No. (%)	664 (15.1)	269 (18.1)	.005
Smoker, No. (%)	440 (10.7)	151 (10.7)	.973
Referred to audiology, No. (%)	401 (9.1)	415 (28.0)	<.001

HHI = hearing handicap inventory.

<.001). In the worse ear mean PTA loss was 33.6 dB (SD 15.2) for HHI ≥10 (*P* <.001) vs 23.1 dB (SD 10.3) for HHI <10. Speech reception threshold (SRT) scores were also associated with HHI scores: for HHI scores ≥10 vs <10, in the better ear mean SRT (SD) was 23.3 (11.2) dB loss vs 17.3 (7.7) dB loss, respectively (*P* <.001), and in the worse ear mean SRT (SD) was 27.6 (14.8) dB vs 19.3 (9.0) dB, (*P* <.001). Word recognition data was highly skewed; 55% of all participants had scores of 100%, and 82% had scores >90%, making analysis difficult.

Telephone Call Data

Of 557 consented patients who had 3-month follow-up telephone calls, 392 (70.4%) recalled discussing hearing loss with their clinician; 347 (62.3%) recalled being referred for hearing testing of whom 314 (56.4%) accepted the referral and 33 (5.9%) did not. Over one-half were glad the conversation occurred.

Among those recalling a referral, most (61%) were glad they received it, and when asked if it was appropriate, 71.5% said yes, 7% said no, and the remainder were unsure or had no opinion. For those accepting a referral, 85% made an appointment and 70% (219) had the testing. Of the 219 individuals tested, 60% said a recommendation was made, most commonly hearing aids (64%); 71% of those receiving recommendations found them appropriate and 70% planned to follow them. If hearing aids were recommended, one-half planned to get them; the most common reason for not doing so was cost.

Table 4. Factors Associated With Referral to Audiology (GEE Model Results)

	Full Sample (n = 13,381)		Sample With HHI (n = 4,964)	
Characteristic	**OR (95% CI)**	***P* Value**	**OR (95% CI)**	***P* Value**
Age	0.99 (0.98-1.02)	.95	1.00 (0.99-1.01)	.98
Male	1.05 (0.94-1.16)	.40	0.99 (0.87-1.14)	.98
White	1.27 (1.17-1.39)	<.001	1.01 (0.82-1.24)	.93
High blood pressure	1.06 (0.99-1.14)	.10	0.97 (0.89-1.05)	.44
Diabetic	1.17 (1.04-1.32)	.007	1.18 (0.97-1.43)	.10
Smoker	0.84 (0.74-0.94)	.003	1.14 (0.86-1.51)	.37
Insurance				
Private	Reference		Reference	
Medicare/federal	1.12 (0.96-1.31)	.13	1.12 (0.99-1.27)	.09
Medicaid	1.11 (0.83-1.48)	.46	0.94 (0.55-1.60)	.81
Uninsured	0.68 (0.36-1.29)	.22	1.23 (0.41-3.73)	.71
Institution (Ref = BH)	2.58 (1.65-4.02)	<.001	4.71 (2.89-7.68)	<.001
Clinic intervention time (Months)	0.96 (0.93-0.99)	.03	0.94 (0.90-0.99)	.04
HHI ≥10	...	...	3.67 (3.19-4.21)	<.001

BH = Beaumont Health; HHI = hearing handicap inventory; GEE = generalized estimating equations.

DISCUSSION

Our intervention, focused on getting clinicians to ask "Do you have difficulty with your hearing?" and tested in 2 family medicine health systems serving diverse patients, significantly increased identification and referral of patients at risk for hearing loss. Referrals of these patients increased almost fivefold (from 2.2% to 10.7%) vs minimal increases (3.0 to 3.3%) in the general medicine comparison group. The increased referral rate was sustained over the 2-3 years of the study as patients were referred at subsequent alert prompts, suggesting the intervention will be increasingly effective over time. Also, 28% of patients with positive HHI scores (blinded to clinicians) were referred based on the screening question vs only 9.2% of those with negative HHI scores were referred. This supports the audiologist assessments that 93% of the referrals seen were appropriate. The 72% of participants with a positive HHI who were not referred is likely due to a combination of patients not admitting their hearing loss, clinicians too busy to address the alert, and patients declining referrals. Of note, our population hearing loss rates (using HHI data) were similar to other studies[51-53] suggesting that our outcomes are applicable to typical community populations.

Audiologists stated 85% of referred patients had hearing loss, most of them mild. Mild hearing loss can negatively impact income,[51] cognitive function,[2,4,54] physical health,[55] quality of life,[2,4,9] depression,[2,6] and social interaction,[8,9] while increasing dependence on social support systems,[14] communication difficulties, hospital admissions,[26] and readmission rates.[23-25] Our average PTA findings (25 dB loss in the better ear and 30.7 dB loss in the worse ear) confirmed that hearing loss was identified at an early stage. This increases the chances that treatment (hearing aids, etc) could reduce sequelae. That is particularly true since the impact of mild hearing loss is greater in noisy real-world settings than the quiet testing environments where our PTA numbers were obtained. It should be emphasized that a 6 dB decrease in the PTA is equal to a doubling of the hearing loss impact in life.[56]

Electronic health record alerts are often difficult to use, reducing their effectiveness.[57] The Early Auditory Referral-Primary Care alert had been extensively vetted and approved by physicians and configured to support efficient cognitive processing.[57]

Table 5. Audiogram Findings, N = 540

Findings	Values
Pure tone average, dB loss	
Better ear, mean (SD)	25.0 (11.9)
Worse ear, mean (SD)	30.7 (14.5)
Speech reception threshold, dB loss (n = 537)	
Better ear, mean (SD)	21.3 (10.3)
Worse ear, mean (SD)	25.2 (13.6)
Word recognition (n = 538)	
Better ear, % correct mean (SD)	96.8 (6.3)
Worse ear, % correct mean (SD)	94.1 (12.1)
Hearing aid candidate, No. (%)	353 (65.4)
Classification of HL (based on better ear), No. (%)[a]	
No loss	306 (56.7)
Slight/mild	172 (31.9)
Moderate	57 (10.6)
Severe	5 (0.9)
Classification of HL (based on worse ear), No. (%)[a]	
No loss	229 (42.4)
Slight/mild	185 (34.3)
Moderate	103 (19.1)
Severe	21 (3.9)
Profound	2 (0.4)

dB = decibel; HL = hearing loss.

[a] Based on WHO criteria.[49]

Still, our most common alert response remained "not addressed." We believe this is both due to lack of clinician time and the mental model clinicians have about hearing loss. In short, they are uncomfortable addressing hearing loss as discussed elsewhere.[57] Physicians have little training regarding care for hearing loss, are largely unaware of its sequelae, and are uncomfortable discussing hearing care interventions. Potential interventions include improved clinician education, or greater use of other medical personnel (nurses, aides, etc) to address the alert. Moreover, our finding that cost is the most common reason for patients declining hearing aids is consistent with other studies, which also show that vanity and negative connotations of hearing aids are 2 other frequent reasons for lack of use.[58] Increasing hearing aid use will require reducing the cost of aids (whether via Medicare coverage or less expensive versions).

Although this study was not a comparison between the 2 institutions, UM had greater referral rates for hearing testing, audiology seeing referred patients, and "not-addressed" alerts. The greater UM referral rates may be due to their 2 deaf family physicians raising the level of awareness for all clinicians. Additionally, UM's Department of Family Medicine has an emphasis on improving care for patients with disabilities which may have increased referral rates. The increased audiology visits may be due to the fact that UM has all clinicians in 1 system; patients know their insurance is accepted, and audiologist have full access to patient information. Moreover, the cost to see an audiologist is less than an otolaryngologist (where Beaumont patients were referred), though we did not verify if that caused fewer hearing evaluation visits. The recent over-the-counter hearing aid act[59] of 2017 may result in many patients trying over-the-counter hearing aids vs getting official hearing testing.

BH had few best practice alerts during the study period; thus, its clinicians had less familiarity with alerts, potentially reducing their comfort using them to refer patients. Still, BH sites increased their referrals for hearing loss testing 7-fold, supporting the intervention's effectiveness. Regarding the greater "not addressed" UM alert rate, this may reflect alert fatigue because UM sites have >50 alerts, which aggravates time constraints in busy practices. Future research is needed to understand physician/staff perspectives that influence intervention effectiveness.

Limitations

Our study was conducted with family physicians and their advanced practice providers, who may have different receptivity than other primary care physicians and advanced practice providers for hearing loss interventions, alerts, and workflow changes. Our alert was uniquely designed, and the outcomes may not apply to other alerts. Study patients were predominantly middle-class, White, and aged ≥55 years; findings may not apply to other populations though we did not see a difference in referral rates between race, ethnicity, or age. It is possible that patients concerned about a hearing loss were more likely to consent to the study. The fact that the consented population hearing loss rates (using HHI data) were similar to other studies, and that the aggregate data (all patients seen in the clinics, not just consented patients) showed similar referral rates suggests this was not the case.

Our findings demonstrate that using an electronic alert to prompt primary care clinicians to ask the single question, "Do you have difficulty with your hearing?" to identify and refer appropriate at-risk patients for hearing testing is feasible and improves outcomes. This should increase the chances that hearing loss patients, who suffer substantial morbidity when untreated, will get better and earlier hearing health care with potentially fewer hospitalizations and improved quality of life.

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Key words: audiology; family practice; family medicine; hearing loss; mass screening; primary care

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