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ORIGINAL CONTRIBUTION

CME

Emergency department condition acuity, length of stay, and revisits among deaf and hard-of-hearing patients: A retrospective chart review

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Abstract

Objective: Deaf and hard-of-hearing (DHH) patients are understudied in emergency medicine health services research. Theory and limited evidence suggest that DHH patients are at higher risk of emergency department (ED) utilization and poorer quality of care. This study assessed ED condition acuity, length of stay (LOS), and acute ED revisits among DHH patients. We hypothesized that DHH patients would experience poorer ED care outcomes.

Methods: We conducted a retrospective chart review of a single health care system using data from a large academic medical center in the southeast United States. Data were received from the medical center's data office, and we sampled patients and encounters from between June 2011 and April 2020. We compared DHH American Sign Language (ASL) users ($n = 108$), DHH English speakers ($n = 358$), and non-DHH English speakers ($n = 302$). We used multilevel modeling to assess the differences among patient segments in outcomes related to ED use and care.

Results: As hypothesized, DHH ASL users had longer ED LOS than non-DHH English speakers, on average 30 min longer. Differences in ED condition acuity, measured through Emergency Severity Index and triage pain scale, were not statistically significant. DHH English speakers represented a majority (61%) of acute ED revisit encounters.

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Conclusions: Our study identified that DHH ASL users have longer ED LOS than non-DHH English speakers. Additional research is needed to further explain the association between DHH status and ED care outcomes (including ED LOS and acute revisit), which may be used to identify intervention targets to improve health equity.

KEYWORDS
condition acuity, deaf and hard-of-hearing, emergency department, health care quality, length of stay

INTRODUCTION

Deaf and hard-of-hearing (DHH) patients are a government-delineated priority population for health services research, comprising 15% to 17% of people (or between 49 and 55 million) in the United States.[1,2] Although heterogenous with respect to sociomedical characteristics of hearing loss (e.g., age of onset, etiology, language modality), this population experiences disparities in social outcomes (e.g., education and un/underemployment) and health inequities across all major domains of health.[3] These inequities in social determinants are likely due to a fundamental cause[4]: a system of oppression known as audism, which privileges being non-DHH in society.[5] Audism has been linked to poorer access to resources that promote healthier behavior and improved health care navigation (e.g., health literacy, English proficiency, general communication access),[3,6,7] likely contributing to this population's higher risk of emergency department (ED) utilization when compared to non-DHH patients.[3,8–12]

Despite evidence that DHH patients are more likely to use the ED than non-DHH patients,[3,8–12] to our knowledge, there have been no comparative studies that have primarily assessed indicators of ED care processes, including condition acuity, length of stay (LOS), and revisits among DHH patients. Further, assessing the intersection of language modality (i.e., American Sign Language [ASL] vs. spoken English) and being DHH is crucial to understanding opportunities to improve ED care for this population given the association of patient satisfaction and health care service uptake with adequate language access.[13,14] DHH English speakers are more likely to have adult-onset hearing loss (e.g., age-related hearing loss) and have better English proficiency than DHH ASL users.[3,6] ASL is a natural language distinct from English[15] and is used by at least 500,000 individuals in the United States.[16] As ASL is a distinct language and not known by most health care providers, providers require the use of an ASL interpreter to facilitate patient–provider communication.[17]

Preliminary descriptive studies, however, suggest that DHH patients who use ASL to communicate use the ED for less acute conditions than non-DHH English-speaking patients and also have higher risk of revisiting within a 36-month time frame.[8] This large time frame of ED revisits, however, does not provide information about acute ED revisits, which is of more interest to health services researchers. Other studies focused on ED care processes and quality indicators (e.g., LOS) found that patients who used an interpreter had longer LOS and more imaging studies[18]; this study, however, did not differentiate DHH ASL users and other non–English-speaking patient populations, decreasing the usability of these data to understand ED outcomes at intersection of disability and language modality. Furthermore, to our knowledge, there are no studies on the ED care outcomes analyzing DHH English-speaking patients as a distinctive patient group.

As ED utilization increases in the United States,[19,20] ED crowding remains a central concern for patient safety and patient health outcomes.[21–25] Patients who are Black, Hispanic, limited English proficient, or un/underinsured are at higher risk of experiencing the brunt of disparities in patient-centered care in the ED.[24–26] Theory and empirical evidence suggest that DHH patients experience similar disparities.[3] For example, DHH ASL users who require the use of an qualified interpreter may not receive a requested interpreter for hours, diminishing patient-centered communication and patient–provider trust and potentially increasing LOS.[3,27]

Therefore, the purpose of this study was to assess indicators of ED care-seeking and quality outcomes among DHH patients, segmenting by language modality. This study was conducted as a secondary quantitative aim of a larger explanatory sequential mixed-methods study investigating ED utilization among DHH patients.[3,12] In an explanatory sequential mixed-methods design, quantitative results inform the development of qualitative data collection procedures with the end goal of qualitative data being used to further explain quantitative findings.[28] In this current study, we hypothesized that DHH ASL users and DHH English speakers would be more likely to use the ED for conditions of lower acuity and pain and have longer ED LOS, than non-DHH English speakers. Lastly, as an exploratory aim, we assessed the prevalence of acute ED revisits (i.e., 9 days post–index ED encounter discharge) among each patient segment.

METHODS

Data source and sample

This study was designed as a retrospective chart review study, specifically comparing DHH ASL users, DHH English speakers, and non-DHH English speakers. Data are from a large academic medical center in the southeastern United States, which operates primary care clinics, specialty clinics, and hospitals in the region, including a main ED designated as a Level I trauma center and two full-service

emergency centers (all considered part of the ED). All data were provided by the office of the chief data officer of the medical center (i.e., no charts were reviewed/abstracted by the authors). The sampling frame consisted of patients who had used the medical center for any care between June 1, 2011, and April 3, 2020; these dates coincided with the beginning of the use of Epic at the medical center and the start of the study (before COVID-19 precautions were put in place in the region). DHH patients were identified using ICD-9-CM/ICD-10-CM hearing loss diagnosis codes and the associated language preference (i.e., English or ASL).

As described in previous papers,[12] the sample included 100% of DHH ASL users ($n = 277$), 1000 randomly sampled DHH English speakers, and 1000 randomly sampled non-DHH English speakers from the sample of patients served by the academic medical center. The sample size was determined based on previous studies[8,18] not formal power analysis.[29] The DHH English-speaking and non–DHH English-speaking samples were age-matched (on current age) to the age distribution of DHH ASL users to account for the confounding effect of age on hearing loss and poorer health outcomes. The analytic sample for this study included 108 DHH ASL users, 358 DHH English speakers, and 302 non-DHH English speakers who had used the ED. All study procedures were approved by the University of Florida's Institutional Review Board (201901488).

Measures

Outcome and covariate measures were selected based on the *Conceptual Model of Emergency Department Utilization among Deaf and Hard-of-Hearing Patients*[3] and resource/feasibility constraints based on structured data within the medical record. Alignment and operationalization between constructs in the conceptual model and variables used in this study are listed in Table S1.

Outcome measures

Outcome variables were measured at the encounter level and were nested within patients, as each patient may have multiple ED visits within the studied time frame. The outcome variables chosen were (1) Emergency Severity Index (ESI), (2) triage pain rating, (3) ED LOS, and (4) acute ED revisit.

ED condition acuity was conceptualized using two outcome variables: ESI classification and triage pain rating. The ESI is a five-level triage algorithm used to stratify patients based on encounter urgency and resource need.[30] The ESI classifies ESI 1 and ESI 2 as most urgent requiring lifesaving care or representing a high-risk situation, respectively. ESI 3, ESI 4, and ESI 5 are classified for encounters with lower condition acuity based on resource need, with higher resource need indicated by lower numbers. ESI scores were dichotomized to be "lower acuity" (ESI 3, ESI 4, or ESI 5) versus "high acuity" (ESI 1 or ESI 2).[30]

Triage pain ratings were measured using the Defense and Veterans Pain Rating Scale (DVPRS) 2.0. DVPRS is a pain scale that allows patients to rank their pain from 0 to 10, matched through a traffic light color-coding system, short descriptions, and illustrated facial expressions.[31] Given the use of additional visual aids,[32] this pain scale triaging system may be optimal for DHH patients.

ED LOS, in minutes, was calculated as the ED throughput time (from patient entry to disposition). Due to resource constraints, disposition (i.e., admission, treat and release) was not measured.

Lastly, we measured whether the ED encounter was a revisit to the ED within an acute time period, which may be indicative of discharge failure.[3,33] Acute ED revisit is operationalized in the literature using multiple time frames, including 48 h, 72 h, 7 days, and 30 days.[33,34] In this study, we chose a time period of 9 days. The period of 9 days is based on a study of ED discharges in Nebraska and Florida, which found that 9 days is the most appropriate cutoff for ED revisits.[35]

Covariates

Covariates were measured at both the encounter and the patient levels. As measures of ED burden, we accounted for ED census at time of encounter; we also adjusted for the encounter being in the past 36 months. The objective of including the latter was twofold: first, this variable allowed us to study ED utilization in the past 36 months (an outcome of interest in the larger study, unreported in this article), in addition to potential changes in ED policy over time. Other covariates were patient demographic characteristics, specifically age at time of encounter, gender, race, patient insured status, triage vital signs, and smoking status (combustible cigarettes).

Data analysis

This study sought to assess encounter-level outcomes that were nested within patients. We used frequencies, percentages, and means (with standard deviations) to describe the sample and outcome distributions. To test our hypotheses, we estimated multilevel (random-intercept) models in Mplus version 8.[36] Before estimating covariate adjusted models, we assessed the unconditional variance componence models to estimate within- and between-patient variance components. The intraclass correlation coefficient (ICC), calculated as the variance of between-patient differences over the sum of between- and within-patient differences, was used as a measure of between-patient variation.

To assess hypothesized differences in ESI classification between patient segments, we used multilevel logistic regression to estimate adjusted odds ratios. Encounter-level covariates were patient age, insured status, and whether the encounter was in the past 36 months; patient-level covariates were gender, race, and smoking status. Although vital signs may be helpful at triage, "an objective assessment of the patient, including the patient's chief complaint,

is often sufficient to categorize the patient as a higher acuity encounter (ESI level 1 or 2), or lower acuity encounter (ESI level 3, 4, or 5)."[30] Further, the ESI does not mandate the use of triage vital signs unless a patient is classified as ESI 3 (to determine whether the patient should move to ESI 2).[30] Therefore, triage vital signs were not included in the primary model. However, as vital signs are a helpful tool for acuity designations when communication barriers are present,[37] we conducted an additional analysis using categorical variables for triage vital signs within ESI-indicated danger zones (i.e., heart rate over 100 beats/min and respiratory rate over 20 breaths/min, respectively) and patient triage pain scores between 7 and 10.[30] (Triage blood pressure is not incorporated in the ESI vital sign algorithm, and oxygen saturation is only used if indicated.[30]) Hypothesized differences in patient pain rating (as a measure of condition acuity) were estimated by modeling DVPRS score collected at triage as a function of patient segment, patient demographic, encounter-level patient age, and insured status.

Lastly, we used multilevel negative binomial modeling to assess differences in ED LOS across the patient segments. ED LOS was modeled using a negative binomial multilevel model as a function of patient segment and patient demographic variables, and encounter-level age, insurance, ED census (based on time of encounter as a proportion of the maximum census in the study period), a binary variable indicating whether the encounter was in the past 36 months (to account for potential effects of time and changes in hospital policy), and whether the encounter was an acute revisit (within 9 days of index ED encounter). This model provides an incident rate ratio (IRR), which is a measure of LOS for a given independent variable. Estimation of the ICC of this negative binomial model was calculated as the variance of between-patient differences over the sum of between-patient differences and the dispersion parameter.[38] In all models, non–DHH English-speaker patient group was used as the referent, comparing them to DHH ASL-users and DHH English speakers.

RESULTS

Of the total sample, 39.0% of DHH ASL users ($n = 108$), 35.8% of DHH English speakers ($n = 358$), and 30.2% of non-DHH English speakers ($n = 302$) had an ED visit during the study time frame and were included in the analytic sample. These patients represented 446, 1521, and 823 ED encounters, respectively. The analytic sample was predominantly White and female and had an average age (at time of data extraction) of 48 years old (see Table 1). Encounter outcome distributions are described in Table 2 and are embedded in the results below.

Condition acuity

ESI

The majority of ED encounters were ranked as an ESI 3. The unconditional variance components model indicated that 20.7% of the total variance in ESI classification was at the patient level. Table 3 presents the results from the model explaining ESI classification, with and without danger vital signs included. When compared to non-DHH English speakers, neither DHH ASL users nor DHH English speakers had higher odds of being classified into lower-acuity ESI levels.

Triage pain

Patient triage pain scale ratings ranged from 0 to 10, with an average of 5.8 and a median of 7 (see Table 2). The unconditional model ICC was 24.4%, indicating that almost one-fourth of the variance in pain scale rating was at the patient level. The grand mean pain rating was 5.4, and there was significant patient-level and encounter-level variability. On average, patient-reported pain scores varied from the grand mean by 1.7, while encounter-level pain scores varied by 2.9. In the full model, neither of the DHH patient groups had pain scale ratings significantly different than non-DHH English speakers (see Table 4).

LOS

ED LOS ranged from 5 to 2796 min with an average LOS of 326 min (or slightly over 5 h) and a median of 262 min (or almost 4.5 h). The ICC indicated that 25.0% of the variance was at the patient level. When controlling for patient- and encounter-level characteristics, DHH ASL-using patients stayed in the ED 9% longer than non-DHH English-speaking patients (IRR 1.09, 95% CI 1.05–1.13, $p = 0.016$). On average, this equated to approximately 30 min longer ED LOS (95% CI 17–44 min). There were no significant differences between DHH English-speaking patients and non-DHH English speakers (Table 5).

Revisit

Out of 2790 ED encounters over the study period, 282 (10.1%) were acute revisits. We estimated the rate of revisit encounters by patient segment (i.e., number of revisit encounters/total encounters). Non-DHH English-speaking patients had the lowest point estimate rate of revisits (7.8%) while DHH English-speaking patients had the highest (11.3%); Clopper-Pearson 95% CIs for these estimates, however, were overlapping for all groups. Less than 10% (ICC 0.098) of the variance was at the patient level, indicating that the majority of variance in revisit outcomes were revisit encounter specific.

DISCUSSION

DHH patients experience myriad deleterious social conditions that increase risk of poor health outcomes and ED utilization. Due

TABLE 1 Descriptive statistics of patient-level characteristics, by patient segment

	DHH ASL-users (*n* = 108) Group = 2	DHH English speakers (*n* = 358) Group = 1	Non-DHH English speakers (*n* = 302) Group = 0
Gender			
Woman	58.3% (63)	58.1% (208)	52.0% (157)
Man	41.7% (45)	41.9% (150)	48.0% (145)
Age (years)			
Mean (±SD)	49.2 (15.3)	48.5 (17.1)	45.9 (15.5)
Range	21–92	18–106	19–96
Race[a]			
White	62.6% (67)	73.4% (262)	67.3% (202)
Black/African American	32.7% (35)	20.7% (74)	21.7% (65)
Asian	0.9% (1)	1.1% (4)	3.7% (11)
Pacific Islander	None	None	None
Indigenous American	None	0.3% (1)	0.7% (2)
Multiracial or other	3.7% (4)	4.5% (16)	6.7% (20)
Most recent insurance payer			
Uninsured	0.9% (1)	11.5% (41)	23.8% (72)
Private	13.0% (14)	42.2% (151)	41.7% (126)
Medicaid	27.8% (30)	18.2% (65)	15.2% (46)
Medicare	54.6% (59)	24.3% (87)	15.2% (46)
Other	3.7% (4)	3.9% (14)	4.0% (12)
Smoking status			
Unknown	0.9% (1)	0.8% (3)	10.3% (31)
Current	14.8% (16)	18.7% (67)	22.8% (69)
Prior	16.7% (18)	26.0% (93)	15.2% (46)
Never	67.6% (73)	54.5% (195)	51.7% (156)

Abbreviations: ASL, American Sign Language; DHH, Deaf and hard-of-hearing.
[a]Some cases missing. Race missing = 4.

to social and health care disenfranchisement, DHH ASL users and DHH English speakers may be at higher risk of experiencing poorer ED care outcomes.[3,12,18,27] Therefore, this study aimed to identify hypothesized disparities in ED utilization among DHH ASL users and DHH English speaking when compared to non-DHH English-speaking patients.

We used ESI and triage pain scale rating to identify differences in condition acuity among DHH patients and non-DHH English speakers. No significant differences in condition acuity were identified between DHH ASL users and DHH English speakers when compared to non-DHH English speakers. Previous research in this setting has indicated that DHH ASL users and DHH English speakers are more likely to use the ED than non-DHH English speakers.[12] Paired with the present study's findings, these results suggest that although DHH ASL users and DHH English speakers are more likely to use the ED, they are not more likely to use for conditions of lower or higher acuity.

When adjusting for relevant patient- and encounter-level characteristics, DHH ASL users were found to have longer ED LOS than non-DHH English speakers. On average, the DHH ASL users' ED encounters were approximately 30 min longer. Previous research has suggested that ED LOS may be longer for DHH ASL users due to communication inaccessibility within the ED and longer wait times to get a qualified interpreter.[3,27] For example, DHH ASL users have reported waiting hours, sometimes over 8 h, for interpreter services in the ED, if one was ever requested by health care staff.[27] Further, Rotoli and colleagues[18] found that, among Spanish speakers and DHH ASL users, patients who used interpreter services had longer ED LOS than patients who did not. Importantly, the present study's context differs from that of Rotoli and colleagues', with the latter health system employing on-staff Spanish and ASL interpreters and the former only employing on-staff Spanish interpreters. While Rotoli and colleagues' finding may be attributed to increased patient–provider communication and shared decision making, in addition to waiting for an interpreter,[18,39] it is less likely that improved patient–provider communication was a contributor of ED LOS in this study. Previous research in the present study's context

TABLE 2 Descriptive statistics of encounter-level outcome variables, by patient segment

	DHH ASL users' encounters (n_{enc} = 446)	DHH English speakers' encounters (n_{enc} = 1521)	Non-DHH English speakers' encounters (n_{enc} = 823)
ESI classification			
Missing	1.1%	0.9%	1.0%
1	0.2%	0.1%	0.4%
2	16.8%	20.3%	15.2%
3	58.5%	55.5%	54.4%
4	21.1%	22.1%	27.6%
5	2.2%	1.1%	1.5%
Triage pain scale rating			
Mean (±SD) 95% CI	6.0 (±3.3) 5.7–6.4	5.8 (±3.4) 5.6–6.0	5.8 (±3.3) 5.5–6.0
Median	7.0	7.0	7.0
Range	0–10	0–10	0–10
Missing	29.4%	24.9%	25.2%
ED LOS (min)			
Mean (±SD) 95% CI	366.4 (±257.6) 342.4–390.4	317.8 (±259.8) 304.7–330.9	317.8 (±253.0) 300.4–345.2
Median	313.0	248.000	257.000
Range	5.0–1644.0	7.0–2796.0	12.0–2727.0
Acute revisit			
Not an acute revisit	89.7% (400)	88.7% (1349)	92.2% (759)
Acute revisit	10.3% (46) (95% CI 7.7%–13.5%)	11.3% (172) (95% CI 9.8%–13.0%)	7.8% (64) (95% CI 6.6%–10.6%)

Abbreviations: ASL, American Sign Language; DHH, Deaf and hard-of-hearing; n_{enc}, sample size of encounters.

indicated a widespread lack of use of in-person ASL interpreters in the ED, technological challenges with web-based interpreting services, and patients receiving written communication that failed to meet patients' information needs.[27] More studies, accounting for the presence or absence of interpreters at each encounter and other contextual factors, are needed to better understand the relationship between DHH status and ED LOS. Other factors associated with ED LOS in this study were ED census and ESI classification; these results are similar to those of other studies that are not focused on DHH patients.[40,41]

In total, 10% of encounters during the study period were acute revisits. Acute ED revisits can indicate discharge failure, which occurs when patients do not understand their diagnosis or treatment plan or have the resources to navigate health care.[33] Based on previous studies with this population[8,27] and the conceptual model,[3] DHH ASL users seem particularly at risk for ED discharge failure. A majority of acute ED revisits, however, were among DHH English speakers. An estimated 90% of the variance in acute ED revisits in this sample were at the encounter level, which represents the medical and social conditions patients were experiencing when revisiting the ED. Due to resource constraints, we were unable to link index ED encounters to acute ED revisit encounters—this prevented the development of multilevel models that could explain variation in revisits. Additional research is needed to understand the role of patient enabling and restricting factors in ED revisits, in addition to investigating the context of discharge for DHH patients.

LIMITATIONS

There are several limitations due to the study design and selected data source. First, we could not include all the relevant covariates in the model. As identified in the *Conceptual Model of Emergency Department Utilization among Deaf and Hard-of-Hearing Patients*, there are several nonpatient factors associated with ED care outcomes.[3] Many of these variables were not available, as they are not systematically collected in the medical record. For example, the presence of an interpreter likely influences ED LOS among DHH ASL users.[18] This variable could not be included in the analysis, because the health system does not routinely collect this in a structured

TABLE 3 Estimates for multilevel logistic regression of ESI condition acuity classification as a function of patient- and encounter-level characteristics

	Model 1: Unconditional model	Model 2: Full model, without triage vitals		Model 3: Full model, with triage vitals	
Characteristic	**Est.**	**aOR Est.**	**95% CI**	**aOR Est.**	**95% CI**
Encounter level					
Encounter in past 36 months		1.32	0.96–1.82	1.35	0.97–1.87
Patient age at time of encounter—Grand mean centered, ~43 years old.		1.02	1.01–1.02	1.02	1.01–1.03
Medicaid/uninsured status, binary		0.98	0.75–1.28	0.94	0.69–1.29
Triage pain scale, dichotomized (between 7 and 10)		—	—	0.89	0.66–1.81
Triage HR, dichotomized (ref. less than 100 beats/min)		—	—	1.66	1.25–2.19
Triage RR, dichotomized (ref. less than 20 breaths/min)		—	—	1.36	1.02–1.81
Patient level					
Patient segment (ref. non-DHH English speakers)					
DHH English speakers		1.34	0.98–1.84	1.39	0.99–1.95
DHH ASL users		1.00	0.66–1.49	1.07	0.67–1.71
Gender (ref. men)					
Women		0.73	0.56–0.95	0.75	0.57–0.99
Race (ref. White)					
Black		0.96	0.72–1.29	1.03	0.77–1.39
Other		0.70	0.38–1.28	0.73	0.42–1.26
Smoking status					
Former		1.22	0.86–1.73	1.25	0.86–1.83
Current		1.14	0.81–1.61	1.20	0.77–1.86
Model fit and variance estimates					
ICC	0.21				
Patient-level variance (SE)	0.86 (0.22)				
−2LL	−1310.99	−19,337.31		−22,725.84	
AIC	2607.99	38,928.50		45,533.68	
BIC	2613.48	38,928.50		45,776.966	

Note: Model 3 estimated in Mplus using full information maximum likelihood with Monte Carlo integration to account for missing data on triage vital signs, which increases model complexity leading to a higher −2LL, AIC, and BIC.

Abbreviations: AIC, Akaike Information Criteria; aOR, adjusted odds ratio; ASL, American Sign Language; BIC, Bayesian Information Criteria; DHH, Deaf and hard-of-hearing; ESI, Emergency Severity Index; HR = heart rate; ICC = intraclass correlation; LL, log likelihood; RR, respiration rate.

format. Qualitative analysis of unstructured/free-text clinical notes may provide additional insight into ED care processes for this population, including the presence of an interpreter.

Further, due to the sampling of one academic medical center, the study was limited in sample size and potentially generalizability. Attempts to use larger, more representative patient data sets (e.g., those by the Patient-Centered Outcomes Research Network [PCORnet]) were unsuccessful: at the time of the study, PCORnet did not systematically collect language modality for DHH ASL users,[42] preventing the opportunity to segment on the equity-relevant variable of language modality. Although the sampled health system did have language modality classifications for patients, there are no data available on the accuracy or validity of these classifications (which may be entered in primary and specialty clinics, in the ED, or inpatient). As health systems start to more accurately collect patients' language and disability accommodation needs, larger studies should be conducted to attempt to replicate these findings. Furthermore, this study used diagnostic codes to identify the sample for this study. Although diagnostic codes are used routinely in DHH health care research,[9,11,43] it is possible that there is misclassification

TABLE 4 Estimates for multilevel regression of triage pain rating scores as a function of patient- and encounter-level characteristics

	Model 1: Unconditional model		Model 2: Full model	
Characteristic	**Est.**	**SE**	**Est.**	**SE**
Intercept	5.43	0.10	4.49	0.25
Encounter level				
Encounter in past 36 months			0.11	0.18
Patient age at time of encounter[a]			−0.00	0.01
Medicaid/uninsured status			0.36	0.21
Revisit			0.01	0.27
Patient level				
Patient segment (ref. non-DHH English speakers)				
DHH English speakers			−0.19	0.22
DHH ASL users			0.51	0.30
Gender (ref. men)				
Women			0.58**	0.20
Race (ref. White)				
Black			0.89***	0.24
Other			0.29	0.40
Smoking status				
Former			0.29	0.25
Current			0.61*	0.27
Model fit and variance estimates				
ICC	0.24			
Patient-level variance	2.81***	0.36	2.35***	0.30
Encounter-level variance	8.68***	0.31	8.68***	0.42
−2LL	−5375.49		−25,085.61	
AIC	10,756.98		50,683.73	
BIC	10,773.89		50,915.14	

Note: Model 2 estimated with a full information maximum likelihood estimator which is why there is a larger sample size than in Model 1.

Abbreviations: AIC, Akaike Information Criteria; ASL, American Sign Language; BIC, Bayesian Information Criteria; DHH, Deaf and hard-of-hearing; ICC = intraclass correlation; LL, log likelihood; n_{enc}, sample size of encounters; n_{pt}, sample size of patients.

[a]Patient age at time of encounter is grand mean centered, at ~43 years old.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

of the exposure (i.e., some DHH patients may not be diagnosed as DHH).

DIRECTIONS FOR FUTURE RESEARCH

The results of this study indicate that, although DHH patients are at higher risk of ED utilization,[3,8,12] when compared to non-DHH English-speaking patients they do not present to the ED for conditions of higher or lower acuity or of higher or lower pain reporting at triage. However, DHH ASL users do, on average, have longer ED LOS. These findings represent the first epidemiological evidence in the peer-reviewed literature examining hypothesized disparities in ED care and measures of patient need (e.g., condition acuity) among DHH patients segmented by language modality. Additional research should assess if there are differences in how ED providers work with DHH patients, particularly in the presence of inaccessible patient–provider communication. Furthermore, future studies may assess differences in diagnostic and treatment outcomes (e.g., imaging for abdominal pain, receipt of pain medications), which may provide specific intervention and quality improvement targets for ED care. At time of submission, the authors of this study were concluding a qualitative study with DHH patients related to ED care decision making and treatment processes, which seeks to further explain results from the present study and inform future patient-centered ED outcomes research with this population.

TABLE 5 Estimates for multilevel negative binomial regression of ED LOS as a function of patient- and encounter-level characteristics

Characteristic	Model Estimates		
	Est.	SE	IRR
Intercept	5.45***	0.04	
Encounter-level			
Encounter in past 36 months	0.16***	0.03	1.18 (1.15 to 1.21)
ED revisit	−0.04	0.04	1.18 (1.13 to 1.22)
Patient age at time of encounter[a]	0.00***	0.00	0.96 (0.96 to 0.96)
DVPRS	0.01**	0.01	1.01 (1.01 to 1.02)
Census (% of census capacity)[b]	0.02***	0.00	1.02 (1.02 to 1.02)
ESI urgent (ref. Not urgent)	0.29***	0.03	1.33 (1.29 to 1.39)
Medicaid or uninsured status	−0.02	0.03	0.99 (0.96 to 1.01)
Patient-level			
Patient segment (ref. non-DHH English speakers)			
DHH English-speakers	−0.01	0.04	0.99 (0.96 to 1.03)
DHH ASL-users	0.09*	0.04	1.09 (1.05 to 1.13)
Gender (ref. Men)			
Women	0.05	0.03	1.05 (1.02 to 1.08)
Race (ref. White)			
Black	−0.09*	0.03	0.92 (0.90 to 0.95)
Other	−0.11	0.07	0.90 (0.84 to 0.96)
Smoking status (ref. never)			
Former	0.05	0.04	1.05 (1.01 to 1.09)
Current	0.04	0.04	1.04 (1.00 to 1.08)

Note: Models estimated using a maximum likelihood estimator with robust standard errors and Monte Carlo integration to account for missing data.

Abbreviations: ASL, American Sign Language; DHH, Deaf and hard-of-hearing; DVPRS, Defense and Veterans Pain Rating Scale; ESI, Emergency Severity Index; IRR, incidence rate ratio; LL, log likelihood; LOS, length of stay.

[a]Patient age is grand mean centered at ~43 years old.

[b]Max census capacity is 114 patients; grand mean centered at ~38%.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

CONCLUSIONS

Deaf and hard-of-hearing patients are at higher risk for experiencing disparities in ED care seeking and inequities in care processes.[3,8,12,18,27] This study provides evidence from a single, large academic medical center in the southeast United States. Although disparities in triage acuity were not observed, Deaf and hard-of-hearing ASL users have, on average, 9% longer ED length of stay (~30 min) than non–Deaf and hard-of-hearing English speakers. Further, Deaf and hard-of-hearing English speakers account for a majority of acute ED revisits. Additional research is needed that continues to address ED care for Deaf and hard-of-hearing patients, segmenting on relevant sociomedical variables and, particularly, language modality.

AUTHOR CONTRIBUTIONS

Conceptualization—Tyler G. James, Michael M. McKee, JeeWon Cheong. Methodology—Tyler G. James, M. David Miller, Michael M. McKee, Thomas A. Pearson, Elham Mahmoudi, Julia R. Varnes, JeeWon Cheong. Formal analysis—Tyler G. James. Resources—Tyler G. James, JeeWon Cheong. Writing, original draft—Tyler G. James, Meagan K. Sullivan. Writing, review, and editing—Tyler G. James, M. David Miller, Michael M. McKee, Meagan K. Sullivan, Jason Rotoli, Thomas A. Pearson, Elham Mahmoudi, Julia R. Varnes, JeeWon Cheong. Supervision—M. David Miller, Michael M. McKee, Thomas A. Pearson, Julia R. Varnes, JeeWon Cheong. Funding acquisition—Tyler G. James.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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