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Title

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Permalink

<https://escholarship.org/uc/item/5kw1402w>

Journal

Medical Care, 55(3)

ISSN

0025-7079

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Publication Date

2017-03-01

DOI

10.1097/mlr.0000000000000643

Peer reviewed



HHS Public Access

Author manuscript

Med Care. Author manuscript; available in PMC 2018 March 01.

Published in final edited form as:

Med Care. 2017 March ; 55(3): 199–206. doi:10.1097/MLR.0000000000000643.

Convenient Access to Professional Interpreters in the Hospital Decreases Readmission Rates and Estimated Hospital Expenditures for Patients with Limited English Proficiency

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Abstract

Background—Twenty-five million people in the U.S. have limited English proficiency (LEP); this growing and aging population experiences worse outcomes when hospitalized. Federal requirements that hospitals provide language access services are very challenging to implement in the fast-paced, 24-hour hospital environment.

Objective—Determine if increasing access to professional interpreters improves hospital outcomes for older patients with LEP

Design—Natural experiment on a medicine floor of an academic hospital

Participants—Patients age 50 discharged between Jan 15, 2007–Jan 15, 2010.

Exposure—Dual-handset interpreter telephone at every bedside July 15, 2008–Mar 14, 2009

Outcome Measures—30-day readmission, length of stay (LOS), estimated hospital expenditures

Results—Of 8,077 discharges, 1,963 were for LEP, and 6,114 for English-proficient (EP) patients. There was a significant decrease in observed 30-day readmission rates for the LEP group during the 8-month intervention period compared to 18 months pre-intervention (17.8% vs. 13.4%); at the same time EP readmission rates increased (16.7% vs. 19.7%); results remained significant in adjusted analyses. This improved readmission outcome for the LEP group was not maintained during the subsequent post-intervention period when the telephones became less accessible. There was no significant intervention impact on LOS in either unadjusted or adjusted analyses. After accounting for interpreter services costs, the estimated 119 readmissions averted

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The authors report no conflict of interest pertaining to this manuscript.

during the intervention period were associated with estimated monthly hospital expenditure savings of \$161,404.

Conclusions—Comprehensive language access represents an important, high value service that all medical centers should provide in order to achieve equitable, quality healthcare for vulnerable LEP populations.

Keywords

language access; quality of care; aging; disparities; health care costs; health care delivery; interventions; quasi-experimental design; readmissions; underserved populations

Background

Sixty-million Americans speak a language other than English and more than 42% of them speak English less than very well – or have limited English proficiency (LEP).¹ The increase in individuals with LEP in the U.S. and their diffusion to geographic areas where few have traditionally resided presents a challenge for healthcare systems to overcome communication barriers due to language in order to provide high-quality, patient-centered care.² In addition, as the U.S. population ages, the elderly are becoming increasingly diverse, heightening the need for attention to language and cultural barriers to ensure quality health care delivery.³

In an outpatient setting, patients with LEP experience less access than English-speakers to a usual source of care as well as lower rates of physician visits and preventive services.^{4–7} Even when patients with language barriers do have access to care, they have poorer adherence to treatments, decreased comprehension of their diagnoses, lower satisfaction with care, increased medication complications, and more obstetric trauma compared to English-speakers.^{8–12}

In a 2006 national survey, 63% of hospitals reported encountering patients with LEP either daily or weekly.¹³ In the hospital, individuals with LEP experience more adverse events,¹⁴ and possibly longer hospitalizations as well as higher 30-day readmission rates compared to English speakers in settings of limited access to professional interpreters.^{15,16} Access to professional interpreters is critical to effective communication and the delivery of high quality care^{17–19} by improved communication, appropriate use of resources and better patient and clinician satisfaction.²⁰ Access to professional interpreters at admission and discharge has been shown to decrease length of stay and readmission rates in one study;²¹ however any use of professional interpretation during hospitalization was associated with increased length of stay in another study.²²

Unfortunately, access to adequate language services has been stymied by the widespread lack of reimbursement for interpreter services.^{13,23–25} While we know that the costs of professional interpreter services can be high, the cost is small relative to the total cost of hospitalization where the setting lends itself to bundled payments.²⁶ Others have outlined the theoretical savings for health systems related to avoidance of errors and liability risk;^{27,28} however, there are no published data about the degree to which interpreter costs may be offset by improved communication leading to better patient outcomes.

The challenge of providing professional interpreter services is compounded for hospitalized patients because of the frequent and brief nature of many interactions, time pressures, the need for advance scheduling for in-person interpreters, and the 24-hour nature of hospital care.²⁹ National studies have found a discrepancy between hospital policy requiring use of professional interpreters and actual practice in which professional interpreter utilization is not very robust,^{23,25,30} illustrating the widespread need for a system that will encourage time-pressured hospital staff to use professional interpreters instead of using no interpretation or untrained interpreters.

In this study we set out to evaluate the impact of increased access to professional interpreters by providing a dual-handset telephone with a direct connection to interpreter services at each hospital bedside that would facilitate use by all clinical providers. We evaluated the effect of the intervention on 30-day readmission rates, length of stay, and estimated hospital expenditures using a quasi-experimental design in a real world setting.

Methods

Setting and Participants

We included discharges from the Medicine floor of an academic medical center consisting of two separate nursing units; one a step-down unit for higher acuity patients and the other for patients with less intensive nursing needs. Discharges occurred between January 15, 2007 and January 15, 2010. This time-frame begins 18-months prior to the intervention, includes the 8-month intervention period, and continues for 10-months after the intervention.

Because in this hospital the younger adult population is predominantly English speaking we limited discharges to those for patients 50 years old. We excluded discharges with the top 1% length of stay in our dataset (those 40-days or longer) as these represented hospital stays that likely differed substantially from the majority in illness acuity and disease course. We further excluded planned admissions for chemotherapy or radiation as these often follow a set time-course in the hospital and result in planned and expected readmissions.³¹ Lastly we excluded discharges for patients with missing primary language or with primary language documented as 'unknown'.

Data Sources

We collected interpreter utilization from two interpreter databases: 1) a database kept by Interpreter Services to record in-person staff interpreter encounters that recorded the date, language, hospital floor and time of the interpretation; 2) a billing database for telephonic interpreter encounters from the vendor providing these services that recorded the date, language, vendor phone identification number and length of the call. Neither database matched an interpreted encounter to a specific patient, thus we standardized interpreter utilization (number of interpreted encounters in the database in a given month) to the number of Patients with LEP discharged from the floor.

We collected administrative data from Transition Systems Inc (TSI, Boston, MA) billing databases that included patient demographics, insurance, costs, ICD-9CM diagnostic codes, admission and discharge dates. We collected language data from a registration database.

Information on a patient's primary language was entered at the time each patient first registered at the medical center, whether for the index hospitalization or for prior clinic visits and is based on patient self-report. We have previously validated registration language against patient self-report of primary language and ability to speak English in telephone interviews and found high agreement with the majority of the errors classifying non-English speakers as English-speakers.¹⁶

Intervention

The intervention consisted of a dual-handset interpreter telephone at the bedside of every patient with LEP (Bedside Interpreter Intervention). These 66 telephones had a programmed button that allowed 24-hour access to a professional (trained and tested) medical interpreter for more than 100 languages. Immediate availability, bedside location and rapid access allowed for dual-handset interpreter phone use by any healthcare team member entering the room of any Patient with LEP, no matter how brief the interaction. This intervention began as a quality improvement effort on the Medicine floor starting July 15, 2008 and continued for 8-months. At the start of the intervention, information about the phones along with a demonstration was shared at nursing staff meetings on the floor, and morning report for Medicine resident physicians; additionally a pocket card explaining how to use the phones was mailed to Medicine attending physicians, and made available to residents when they rotated onto the inpatient service by the Medicine Chief Residents.

The intervention ended mid-March, 2009 when a floor remodel led to the removal of phones from individual bedsides. While many phones remained on the floor (ranging from 32–44 during the post-intervention period), they were no longer as easily accessible.

Prior to the intervention, usual-care communication included in-person staff interpreters who could be scheduled during usual business hours, and a slowly increasing number of dual-handset interpreter telephones (ranging from 0–5 during the pre-intervention period). The dual-handset telephones were placed on mobile carts and kept at the nursing station or in locked cabinets. Once these mobile phones were brought to a patient's room and connected, they were as easy to use as the intervention phones; however, it took additional time to locate and bring them to the patient's room, and often they were in use elsewhere. Placement of a dual-handset interpreter telephone at the bedside of each Patient with LEP was intended to eliminate these barriers for time-pressured clinicians.

Outcomes

We defined readmission as any inpatient admission to any service occurring 30-days from the time of the index discharge from the Medicine floor. All discharges from the Medicine floor during the study period were eligible to be included as index discharges which could result in a readmission; in other words, if a patient were discharged from the Medicine floor, readmitted within 30-days, and then discharged again from the Medicine floor, the second discharge was considered as an additional index discharge. However, if the patient's readmission resulted in a discharge from a different floor in the hospital, it would not be considered an index discharge. Thus an individual patient could have multiple index discharges included in the analysis. For this outcome, in keeping with standard methods, we

excluded discharges with a discharge disposition of ‘transfer to acute facility’, ‘died’, or ‘left against medical advice’.³¹

We defined length of stay (LOS) using the admission and discharge date and time from the administrative billing database. After log-transformation, the LOS outcome was approximately normally distributed (skewness and kurtosis statistics equaled -0.003 and $+0.086$, respectively), and was modeled via linear regression.

We estimated hospital expenditure savings in the following manner. First, we calculated the average cost of an admission for a patient with LEP during the intervention period from the administrative billing data. Next, we estimated the number of expected readmissions in the LEP group if the pre-intervention readmission rate were held constant during the intervention period. Taking the difference between the observed and expected readmission rates, we found the number of possible averted readmissions. We then multiplied the number of possible averted readmissions by the average cost of an admission in the LEP group during the intervention period, subtracted the cost of the intervention telephone interpretations and divided by the number of intervention months to obtain an estimate of monthly hospital expenditures savings. Similar methods were used for LOS.

Predictor and Covariates

Our primary effect of interest was the interaction between patient language (primary non-English language–LEP/English–EP) and study time-period (pre-, intervention, post-). Because there was no expectation that the bedside interpreter intervention would have an effect on the hospital outcomes of the EP group, this group was included as a non-equivalent control group. Examining the interaction between language group and study time-period allowed for evaluation of the impact of the intervention on the LEP group while accounting for potential secular trends in the outcomes. Additionally, we included the following patient-level characteristics as covariates: age (> 50 years continuous), sex (M/F), and insurance (Medicare/Medicaid/county/private/none); and the following discharge-level characteristics as covariates: severity of illness index (SOI) using the All Patient Refined DRG Classification System (minor/moderate/major/extreme),³² intensive care unit (ICU) stay (yes/no), principal diagnosis (categories according to Healthcare Cost and Utilization Project),³³ and calendar month.

Statistical Analysis

Descriptive statistics of the discharges compared LEP and EP groups using chi-square for categorical and t-tests for continuous variables. Linear (for logged LOS) and logistic (for 30-day readmission) models regressed the outcome onto a categorical indicator of the study periods, patient language group, and the period-by-language interaction, as well as covariates describing patient age, sex, insurance, discharge calendar month, principal diagnosis category, SOI index, and ICU stay. The 30-day readmission outcome model also adjusted for LOS. Subsequently, custom contrasts compared outcome response across the three study periods and whether any effects were modified by language group (LEP vs. EP; the ‘period-by-language’ interaction). All models were fit via generalized estimating

equations with exchangeable correlation structure to accommodate repeated hospital stays for individual patients.

Results

Descriptive statistics

During the study period there were 8,386 discharges from the Medicine floor; after exclusion for top 1% LOS (n=81), chemotherapy or radiation (n=186), and missing or 'unknown' primary language (n=42), there were 8,077 discharges included for patients age 50 (range 50–108), 1,963 (24.3%) for LEP and 6,114 for EP patients. For the readmission outcome, an additional 688 (8.5% in both LEP and EP groups) discharges with disposition of 'transfer to acute facility' (n=135), 'died' (n=484) or 'left against medical advice' (n=69) were excluded, resulting in 7,389 discharges eligible for readmission analysis.

Patients in the LEP group on average, were older than those in the EP group, had higher rates of Medicare insurance, were more often admitted for a respiratory illness, and more often discharged to a skilled nursing facility. There were no significant differences between groups in the distribution of SOI index, or in the proportion with an ICU stay. (Table 1) For the entire sample over the full 36 months of the study, overall 30-day readmission rate was 17.6%, and mean LOS was 5.53 days and median LOS was 3.70 days (IQR 2.01–6.64), with no significant overall differences between the LEP and EP groups for either outcome.

Intervention Fidelity: Interpreter Utilization

Pre-intervention there were low, but slowly increasing, rates of professional interpreter use over the telephone. Immediately following intervention implementation, telephonic professional interpreter use increased considerably. In the post-intervention period, some increased utilization was sustained despite decreased telephone accessibility. (Figure 1) These differences varied by patient language, with the largest rise and fall of telephone interpreter utilization for Spanish speaking patients. (Table 2) In-person professional utilization was low (<0.5 in-person interpreted encounters/LEP discharge) throughout the 36 months of the study.

Outcomes

30-Day Readmission—Observed 30-day readmission decreased during the intervention period and increased again post-intervention. (Table 3) In adjusted analyses, the effect of the intervention on readmission rates was significantly modified by patient language group; that is, the effect of the study periods on readmission rates significantly differed across the two language groups ($p = .040$ for test of interaction). The odds of readmission for the LEP compared with EP group was lower during the intervention period; while it was roughly equivalent during both the pre- and post- intervention periods. (Table 4)

Length of Stay—There was no significant impact of the bedside intervention on LOS. The unadjusted median LOS did not differ between LEP and EP groups over the three study time periods. (Table 3) In adjusted analyses, the effect of intervention intensity on LOS was not significantly modified by patient language ($p = .818$ for test of interaction). (Table 4)

Estimated hospital expenditures

The dual-handset telephones used in the intervention were provided free of cost by the vendor telephonic interpreting company. During the 8-month intervention, there were 28,284 minutes of interpreted calls billed at a cost of \$0.99/minute for an intervention cost of \$28,001. During the course of the study, the median cost of a hospital stay in the LEP group was \$11,086. If the rate of readmissions for the LEP group had stayed steady at the pre-intervention rate (17.8%) rather than falling (to 13.4%) during the high intensity intervention period, we estimate there would have been an additional 119 readmissions during the high intervention period. The projected cost of these additional readmissions would have equaled \$1,319,234. Subtracting out the cost of the interpreted calls, the estimated net savings related to the Bedside Interpreter Intervention over this 8-month time period equaled \$1,291,233, for an estimated monthly healthcare expenditure savings of \$161,404. Because there was no impact of the intervention on LOS, we did not estimate any change in hospital expenditures related to LOS.

Discussion

Providing easy access to professional interpreters via dual-handset telephones at the bedside in the acute-care hospital was associated with decreased 30-day readmission rates for patients with a language barrier. This improvement was lost once the telephones became less accessible. Having a telephone in every patient room, immediately available to clinicians at any time, was a key component to the success of the intervention. We consider this to be an effective implementation of access to professional interpretation in the hospital for a modest cost that improves the quality of care for patients with LEP.

Our results are consistent with one other study that demonstrated that professional interpreter utilization at admission and/or discharge was associated with decreased readmission rates.²¹ However, our study is the first to demonstrate that a systems intervention to increase access to those interpreters throughout the hospital stay both decreased readmission rates and estimated hospital expenditures.

The intervention had no impact on hospital LOS even after adjustment for severity of illness, ICU stay and principal diagnosis. Other studies have found mixed effects of a language barrier on length of stay.¹⁵¹⁶²¹²² These conflicting findings may be because in some cases better communication may lead to shorter LOS due to a diagnosis being made sooner, for example, but in other cases it may lead to longer LOS due to proper history taking, symptom awareness, information about needs at home on discharge, etc. In one study, the authors hypothesized that clinicians were reserving interpreter use for the sickest patients, thus interpreter utilization was associated with a longer LOS.²² It is not surprising that results for LOS differ from those for readmission because the impact on readmission likely results from avoiding clinical and communication errors and enhancing discharge preparedness; whereas, the impact of easy access to professional interpreters throughout the hospitalization likely has the effect of sometimes increasing and sometimes decreasing LOS depending on the clinical situation.

In this natural experiment the intervention ended when a remodel disrupted immediate bedside access to the telephones. We observed a concomitant drop-off in utilization of professional interpretation as access and the number of telephones decreased. However, this decrease in accessibility did not eliminate interpreter phone utilization, which still remained considerably higher than in the pre-intervention period. Interestingly, the utilization data show differential use of the dual-handset interpreter phones by language. While Spanish-speaking patients had equal utilization when the phones were most easily accessible during the high intensity intervention period, their utilization dropped off the most when the phones were less accessible. Prior studies have shown that physicians often attempt to ‘get by’ when they have even partial non-English language skills.²⁹ Our own previous survey of nurses and physicians working on the same Medicine floor demonstrated that many reported ‘getting by’ with Spanish language skills in particular.³⁴ It is likely that when the phones were easily available in every room, clinicians opted to use professional interpreters with Spanish-speaking patients, but when the phones became less available, those with partial-language skills in Spanish reverted to the ‘getting by’ behavior.

Limitations

The interpreter phone billing dataset did not record types of clinical interactions, and so we were not able to evaluate whether specific types of interpreted interactions were more important than others for preventing readmission, or whether the phones were used throughout the hospitalization course. However, our previous work surveying nurses and physicians shortly before and after implementation of the Bedside Interpreter Intervention did demonstrate that use of professional interpreters increased for all types of clinical interactions throughout the hospital course.³⁵ Furthermore, a prior study that surveyed patients with LEP on interpreter use during their hospitalization, showed very low use during hospital stay by both nurses and physicians other than at admission and discharge.²⁹

Similarly, we did not have interpreter data for individual patients, so it is possible that some patients had many interpreted encounters and others none. Without these data, we were unable to investigate whether those without interpreted encounters were readmitted more often. Thus, our findings of a positive overall impact of a systems intervention are consistent with an ‘intention to treat’ type of analysis, and a ‘per protocol’ type of analysis was not possible.

We do not know why readmission rates increased for English-speakers at the same time that LEP rates decreased. While it is possible that this was a negative unintended consequence of an intervention focused only on the LEP population, this explanation does not have much face validity as the telephones were rolled-out over a brief period, and then were simply maintained in each room and only used when an patient with LEP was housed in that room. Additionally, during the intervention period, the average interpretation time for patients with LEP was less than 20 minutes per day, which is at least what we would expect nurses and physicians combined to spend with an individual patient.

This intervention was focused largely on access provision, without a dedicated push from leadership; and, because the phones were not widely available on other floors, physicians taking care of patients on multiple floors may not always have thought to use them on this

one floor. Given this limitation, it is possible that our findings are an underestimate of the potential impact with a more supported and universal roll-out.

Our study only encompassed the experience of a single institution with limited interpreter use in the hospital before starting the intervention. However, the low level of interpreted encounters during the pre-intervention period was not unlike the expected levels in most hospitals in the country at the same time, the majority of which continue to face the challenge of providing linguistic access to patients with LEP as required by Health and Human Services interpretation of Title VI of the Civil Rights Act and Final Rule implementing the prohibition of discrimination under the Affordable Care Act.³⁶³⁷ Finally, our study included only patients 50 years and older, but because on average adult patients with LEP are 20 years older than EP patients in this hospital, we likely did not exclude many LEP adults. However, our results may not be as generalizable to hospitals serving a younger LEP population.

Finally, we did not conduct a formal cost study, but rather only were able to estimate potential expenditure savings associated with the lower rate of readmission during the intervention period.

Conclusion

We observed a decrease in readmissions for limited English proficient patients that corresponded to the increase in access to professional interpreter services, and no overall change in length of stay. Comprehensive language access for Patients with LEP represents an important service that all medical centers should provide in order to achieve equitable, high quality healthcare for vulnerable LEP populations. While there are modest costs associated with professional interpretation, this is offset by estimated hospital expenditure savings which will be increasingly meaningful in the era of population-based health and accountable care organizations, and is a small price to pay for more equitable care.

Acknowledgments

This work was funded by the National Institute on Aging, National Institutes of Health (R01 AG038684). Dr. Pérez-Stable was supported in part by the Resource Centers for Minority Aging Research program of the National Institute on Aging, National Institutes of Health (P30 AG15272).

The findings and conclusions in this article are those of the authors and do not necessarily represent the views or the official position(s) of the National Institutes of Health or any of the sponsoring organizations and agencies of the US government.

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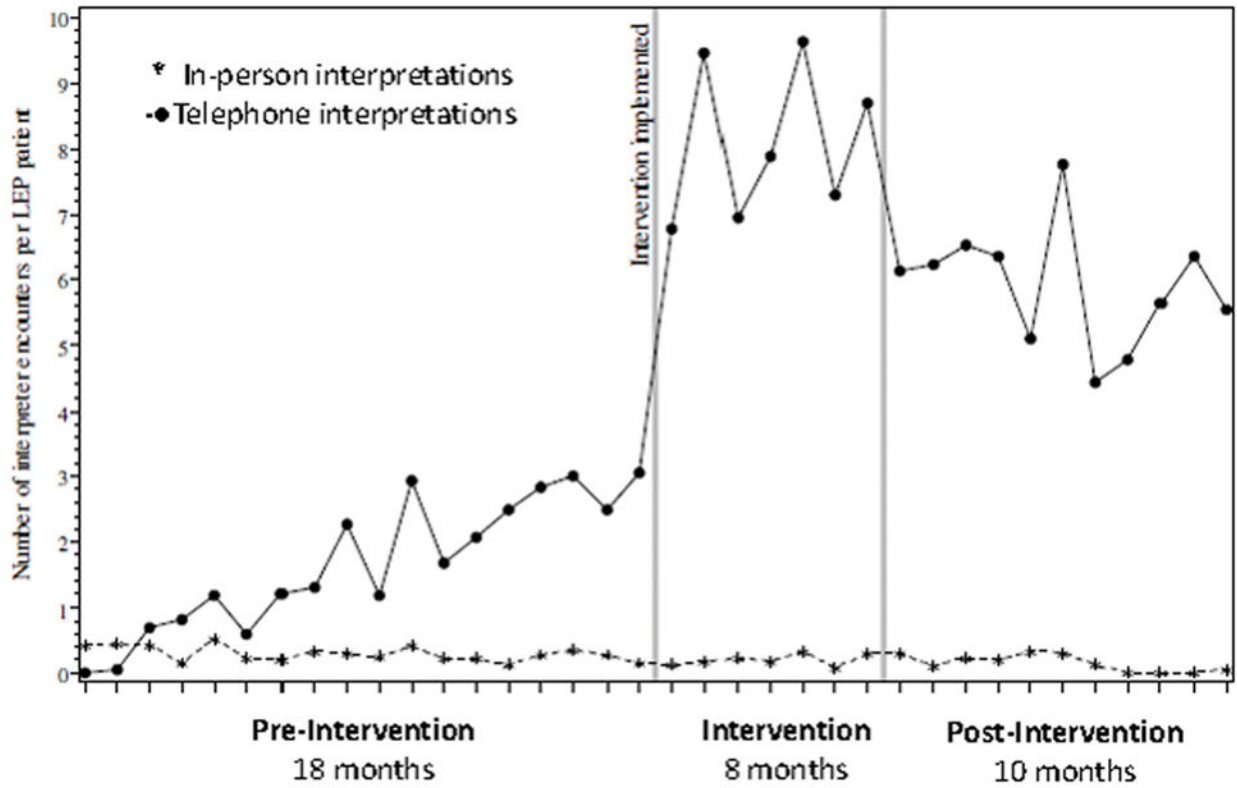


Figure 1. Average monthly number of interpreted encounters standardized to number of monthly discharges for limited English proficient (LEP) patients during the pre-intervention, intervention, and post-intervention Bedside Interpreter study periods.

Characteristics of 8077 discharges for patients 50 years old discharged from the Medicine floor of an academic medical center from January 15 2007 to January 15 2010*

Table 1

	English proficient patients		Limited English proficient patients		Total		P-value
	N	(%)	N	(%)	N	(%)	
Primary language							
English	6114	(100.0)	-	-	6114	(75.7)	
Chinese	-	-	987	(50.3)	987	(12.2)	
Russian	-	-	318	(16.2)	318	(3.9)	
Spanish	-	-	266	(13.6)	266	(3.3)	
Other Asian language	-	-	262	(13.4)	262	(3.2)	
Other	-	-	130	(6.6)	130	(1.6)	
Gender							
Women	3030	(49.6)	1099	(56.0)	4129	(51.1)	<.0001
Men	3084	(50.4)	864	(44.0)	3948	(48.9)	
Race/ethnicity							
White	3666	(60.3)	357	(18.3)	4023	(50.1)	<.0001
African American	1055	(17.4)	6	(0.3)	1061	(13.2)	
Asian	700	(11.5)	1231	(63.0)	1931	(24.0)	
Latino	334	(5.5)	243	(12.4)	577	(7.2)	
Other	322	(5.3)	117	(6.0)	439	(5.5)	
Age (mean, std dev)	68.49	(12.6)	76.32	(11.3)	70.39	(12.7)	<.0001
Insurance type							
Medicare	3257	(53.3)	1359	(69.2)	4616	(57.1)	<.0001
Private insurance	1971	(32.2)	354	(18.0)	2325	(28.8)	
Medicaid/county public insurance	791	(12.9)	232	(11.8)	1023	(12.7)	
No insurance	95	(1.6)	18	(0.9)	113	(1.4)	
Discharge disposition							
Home	3673	(60.1)	1032	(52.6)	4705	(58.3)	<.0001
Rehab/SNF	911	(14.9)	401	(20.4)	1312	(16.2)	

	English proficient patients N=6114		Limited English proficient patients N=1963		Total N=8077		P-value
	N	(%)	N	(%)	N	(%)	
Home with home health	760	(12.4)	292	(14.9)	1052	(13.0)	
Died	355	(5.8)	129	(6.6)	484	(6.0)	
Other facility	108	(1.8)	27	(1.4)	135	(1.7)	
Hospice	130	(2.1)	58	(3.0)	188	(2.3)	
Other	119	(2.0)	13	(0.7)	132	(1.6)	
Against Medical Advice	58	(1.0)	11	(0.6)	69	(0.9)	
ICU stay during hospitalization	999	(16.3)	296	(15.1)	1295	(16.0)	0.119
Severity of illness index^{**}							
Minor	556	(9.1)	150	(7.6)	706	(8.7)	0.07
Moderate	1776	(29.1)	543	(27.7)	2319	(28.7)	
Major	2620	(42.9)	864	(44.0)	3484	(43.1)	
Extreme	1162	(19.0)	406	(20.7)	1568	(19.4)	
Principal diagnosis^{***}							
Diseases of the circulatory system	921	(15.1)	279	(14.2)	1200	(14.9)	<.0001
Diseases of the respiratory system	972	(15.9)	378	(19.3)	1350	(16.7)	
Diseases of the digestive system	876	(14.3)	249	(12.7)	1125	(13.9)	
Neoplasms	752	(12.3)	263	(13.4)	1015	(12.6)	
Injury and poisoning	546	(8.9)	135	(6.9)	681	(8.4)	
Diseases of the genitourinary system	478	(7.8)	164	(8.4)	642	(7.9)	
Infectious and parasitic diseases	380	(6.2)	151	(7.7)	531	(6.6)	
Endocrine; nutritional; and metabolic diseases and immunity	295	(4.8)	130	(6.6)	425	(5.3)	
Other ^{**}	894	(14.6)	214	(10.9)	1108	(13.7)	

* Percentages may not add up to 100% due to rounding error

**

Based on the APR DRG index which calculates severity of illness categorizing each patient into one of four categories: minor/moderate/major/extreme

Principal diagnosis 'other' includes less than 5% in each of the following categories: diseases of musculoskeletal system and connective tissue; diseases of blood and blood-forming organs; mental illness; diseases of the nervous system and sense organs; symptoms, signs and ill-defined conditions; diseases of the skin and subcutaneous tissue; congenital anomalies; residual and unclassified codes. There were no diagnoses in the following categories: complications of pregnancy, childbirth and the puerperium; certain conditions originating in the perinatal period.

Table 2

Utilization of Professional Telephone Interpreters by Language: Mean number of calls per LEP patient discharged during three time periods

Language	Pre-intervention Total minutes of calls: 15,701 (mean 4.1 min/day/LEP discharge) 18- month mean; n=4231	Intervention Total minutes of calls: 28,284 (mean 18.7 min/day/LEP discharge) 8- month mean; n=1714	Post-intervention Total minutes of calls: 31,039 (mean 15.3 min/day/LEP discharge) 10- month mean; n=2132
All languages	1.7	7.9	5.9
Chinese *	2.1	8.7	7.4
Russian	2.5	8.1	7.0
Spanish	1.3	8.5	4.3
Other **	1.3	5.8	3.3

* Chinese included Cantonese and Mandarin speakers

** Other languages included: Amharic, Arabic, Armenian, Cambodian, Farsi, French German, Greek, Hebrew, Hindi, Italian, Japanese, Laotian, Polish, Portuguese, Punjabi, Serbian, Tagalog, Thai, Tigrinya, Urdu, Vietnamese

Table 3

Observed hospital outcomes for Length of Stay and Readmission during the three study periods by language proficiency in 7,389 hospitalizations, 2007–2010

	Pre-Intervention N=4231 LOS N=3869 Readmission	Intervention N=1714 LOS N=1574 Readmission	Post-intervention N=2132 LOS N=1946 Readmission
Observed LOS			
Median days (IQR) *			
LEP	3.69 (2.03–6.60) n=1035	3.86 (2.05–6.84) n=391	3.79 (2.09–6.32) n=537
EP	3.65 (1.95–6.44) n=3196	3.81 (2.19–6.98) n=1323	3.65 (1.96–6.66) n=1595
Observed 30-Day Readmission Rate (%) †			
LEP	17.8% n=938	13.4% n=365	20.3% n=493
EP	16.7% n=2931	19.7% n=1209	17.6% n=1453

* IQR: Interquartile range

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Table 4

Adjusted results for readmission and Length of Stay for Limited English Proficiency group compared to English-Proficient group during three time periods, 2007–2010*

	Readmission Odds Ratio	Length of Stay Factor Change**
Pre-intervention	1.07; 95% CI 0.85–1.35	1.02; 95% CI 0.96–1.07
Intervention	0.64; 95% CI 0.43–0.95	1.01; 95% CI 0.92–1.10
Post-intervention	1.09; 95% CI 0.80–1.48	0.99; 95% CI 0.92–1.06

* Both models adjusted for patient age, sex, insurance, discharge calendar month, principal diagnosis category, SOI index, and ICU stay; the readmission model additionally adjusted for LOS.

** Language group effect estimates are represented by ‘factor change’ coefficients, which reflect the multiplicative difference in the expected length of stay within the LEP group versus the EP group.