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FINAL RESEARCH REPORT

Testing a Program to Improve Patient-Clinician Communication for Patients Who Speak Limited English

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ABSTRACT

Background: Compared with English speakers, patients with limited English proficiency (LEP) have worse health care quality. Language concordance among patients, clinicians, and professional interpreters is an important way to reduce this disparity.

Objectives: To improve the communication and clinical outcomes of primary care patients with LEP, we aimed to (1) evaluate the impact of a systems intervention to certify the proficiency of clinicians' non-English language skills and (2) create easy access to professional interpreters through videoconferencing. Together, we called this intervention the Language Access Systems Improvement (LASI) initiative.

Methods: We conducted a natural experiment with 4 aims:

For *aim 1*, we used patient telephone interviews and electronic medical record (EMR) review to compare interpreter use and effective communication (discussions on patient awareness of diet and exercise and new medication prescriptions, and completion of laboratory tests and specialty referrals) during 3 months pre-LASI and 16 months post-LASI. Mixed logistic models incorporating inverse probability weights (IPWs) were used to compare outcomes between pre- and post-LASI groups.

For *aim 2*, we used EMRs to compare guideline-concordant care (blood pressure [BP] and glucose control, and prescription of antiplatelet and statin medications) for patients with hypertension (HTN), diabetes mellitus (DM), and coronary artery disease (CAD) over 3 periods: 2 years pre-LASI, 8 months of LASI rollout, and 2 years post-LASI. In these analyses, patients with English proficiency (EP) served as a control group that was not expected to be affected by the LASI initiative, and visit-level models were adjusted for patient-level propensity scores (propensity to have LEP vs EP).

Aim 3 complemented the first 2 aims: We used audio recordings of 151 visits to compare communication measures (visit length, number of problems addressed, and patient centeredness) across professionally interpreted visits that were English language–concordant and –discordant.

Finally, for *aim 4*, we assessed LASI implementation via semistructured interviews with clinicians and focus groups with patients.

Results:

Aim 1: We completed 1475 telephone interviews after a primary care visit (pre-LASI, n = 294; post-LASI, n = 1181). *Interpreter use:* For all discordant and partially concordant visits (n = 698), post-LASI visits had higher odds of involving a professional interpreter compared with pre-LASI visits (IPW odds ratio [OR], 2.39; 95% CI, 1.04-5.48). *Effective communication.* For patients with LEP, awareness of diet and exercise discussion was higher post-LASI than pre-LASI (diet: IPW OR, 5.94; 95% CI, 2.28-15.5; exercise: IPW OR, 5.02; 95% CI, 1.97-12.8). There were high rates

and no significant differences post-LASI compared with pre-LASI for awareness of new medication prescription, eventual laboratory test completion, and specialist referral visit completion. However, compared with pre-LASI, there was a higher rate of laboratory test completion within 30-days post-LASI (adjusted hazard ratio, 1.25; 95% CI, 1.0-1.6).

Aim 2: We included 5845 patients with a documented diagnosis of HTN, DM, CAD, or a combination of these during the study period and found a significant interaction between EP status and LASI study period only for BP control (*P* = .03). Compared with the EP group, the LEP group had worse initial BP control, greater improvement during the LASI rollout period, and near-equal control in the post-LASI period.

Aim 3: The discordant-professionally interpreted visits were, on average, 7 minutes longer and addressed fewer medical problems than the language-concordant visits. Patient centeredness (a ratio of psychosocial and socioemotional talk to biomedical talk) was highest for the English-concordant visits (0.81 [SE, 0.05]) lowest for the discordant-professionally interpreted visits (0.59 [SE, 0.05]), and intermediate in the non–English-concordant visits (0.65 [SE, 0.06]; *P* = .002). Multivariate, mixed linear models demonstrated similar significant findings.

Aim 4: Salient themes from the clinician interviews and patient focus groups were as follows: (1) Interpreter videoconferencing is convenient and well-liked by both clinicians and patients; (2) view of caregiver role during visits differs for clinicians and patients; (3) navigating the health system remains challenging for patients with LEP; and (4) clinicians noted both value and barriers to language proficiency certification.

Conclusions: LASI was associated with an increase in appropriate use of professional interpreters and an increase in patient awareness of diet and exercise discussions. We detected only a weak effect of LASI on BP control for patients with HTN. We also found that compared with language-concordant visits, professionally interpreted visits were only a bit longer, covered less territory, and had less psychosocial talk. Health systems wishing to implement LASI should make structural changes such that visits requiring interpretation are scheduled for longer to allow for more in-depth and complex communication. This should be accompanied by education regarding the importance of communication about social context during interpreted visits.

Limitations: This was a single-site study, limiting generalizability and inferences about causality. Rates of professional interpreter use and some other outcomes were high at baseline, restricting the opportunity to detect improvement.

BACKGROUND

Communicating across language barriers is a challenge for clinicians all across the United States. The most recent American Community Survey estimated that approximately 20% of the adult US population speaks a language other than English at home, with almost half of these speaking English less than very well.[1] Spanish and Chinese are the most common preferred languages of adults with limited English proficiency (LEP), but hundreds of additional languages are in use throughout the United States. The increase in the number of individuals with LEP in the United States in recent decades and their diffusion to geographic areas where few people with LEP have traditionally resided presents a significant challenge for health care systems to overcome.[2] In addition, as the LEP population ages, these individuals develop more chronic diseases, heightening the need for attention to language barriers to improve health care delivery quality and health outcomes.[3]

Patients With LEP have Poorer Health Care Quality and Outcomes

In multiple studies, LEP populations, compared with English-speaking populations, consistently receive worse health care.[4] Individuals with LEP are less likely to have a usual source of care,[5,6] have less access to preventive services,[7-10] and have worse control of diabetes.[11] In addition, language barriers make patients more vulnerable to serious adverse outcomes from medical errors,[12] misunderstandings about medications and instructions,[13-15] and medication complications.[16] Poor-quality communication between patients with LEP and clinicians leads to less adherence to medication,[15,17-20] decreased patient satisfaction with care,[21-24] less patient-centered care,[25] and more reports of negative clinical experiences.[26] Poor communication also interferes with the quality of the patient-clinician relationship, including the development of trust and follow-up.[20] This impedes patients' ability to engage in joint decision-making and self-management.[15,27,28] These challenges in communication and care delivery contribute to health disparities for this vulnerable population.

Professional Interpreters Improve Quality and Outcomes of Clinical Care for Patients With LEP

Access to professional interpreters is critical for effective communication and the delivery of high-quality care to patients with LEP.[29-31] In a comprehensive review of the literature, we found that professional interpreters improve communication, promote appropriate use of resources, and significantly increase patient and clinician satisfaction.[32] The use of professional interpreters also results in fewer errors in communication,[14] reduced disparities in use of services,[33] and improved clinical outcomes.[32] Patients with LEP who had professional interpreters present for their visits had equal quality of diabetes care compared with English-speaking patients.[34] In 1 study, the perceptions of health care experiences of uninsured patients who had access to interpreters were comparable to or better than those of insured patients who did not need interpreters.[13] In addition, professional interpreters help bridge not only linguistic but also cultural gaps that can challenge communication between patients and providers.[34,35]

Language Concordance Between Patients and Clinicians Improves Quality and Outcomes of Clinical Care

Language concordance between patients and clinicians results in improved health care quality and outcomes, including better patient satisfaction with care,[36,37] medication adherence,[38] patient understanding of diagnoses and treatment,[26,39] patient functioning for those with LEP who have diabetes,[40] patient centeredness,[41] and more health education.[37,42] Having a language-concordant clinician leads to fewer emergency department visits and fewer missed medications.[38,43] True language concordance occurs when physicians are fluent in the language their patient speaks. However, the existing studies of language concordance have not included valid measures of clinician language proficiency level, and the potential for interactions where there is only partial language concordance raises concerns for communication errors leading to lower quality of care.

Federal Law Requires Linguistic Services for Patients With LEP

Title VI of the Civil Rights Act states that people cannot be discriminated against because of their national origin, including their primary language. In addition, health care organizations receiving federal funds, which most do in the form of Medicaid or Medicare, must provide services in a language that a patient with LEP can understand.[44] In 2000, Title VI was reinforced by Executive Order 13166, which required that all recipients of federal funds provide "meaningful access" to services needed by people who with LEP. The Culturally and Linguistically Appropriate Services (CLAS) standards in Health Care, issued by the Department of Health and Human Services' Office of Minority Health, includes the statement "health care organizations must assure the competence of language assistance provided to limited English proficient. . . patients/consumers by interpreters and bilingual staff" as part of its interpretation of Title VI.[2] Thus, under federal guidance, language access in health care can take 2 main forms: professional interpreter services and language-concordant care by qualified health care professionals. Although access to professional interpreters and certification of health care professionals' language skills has been limited in many settings, there are emerging approaches to address both of these limitations.

Videoconferencing Technology Can Increase Access to Professional Interpreters

Access to adequate language services has been stymied by multiple challenges, including the complexities of needing to meet the needs of patients speaking many different languages, hiring and maintaining a highly qualified staff in the setting of widespread lack of reimbursement for interpreter services, and deploying that staff to often physically distant clinical settings with varied clinical needs.[45-48] Recently, one approach has arisen as a successful model for overcoming these access hurdles: videoconferencing, often referred to as video medical interpreting (VMI).[49,50] VMI uses videoconferencing to connect a patient and clinician with staff interpreters seated in a call center or vendor interpreters working at a distance. It allows for on-demand interpreting when the patient and clinician are in the room together. This reduces interpreter time spent in travel and waiting for clinicians to see a scheduled patient, as well as patient and clinician time waiting for interpreters, thus allowing interpreters to provide

professional, high-quality interpretation for more patients. Patients rate VMI-mediated visits as highly as in-person interpreted visits[51]; interpreters believe VMI-mediated interpreting is as good for conveying information as in-person interpreting and better than telephone-mediated interpreting for communicating substantial educational and psychosocial content[52]; and clinicians rate the overall quality of VMI-mediated and in-person interpreting as equal.[53] However, to our knowledge, no studies have evaluated the impact of increasing access to professional interpreters through VMI on patient-centered communication or clinical outcomes. There are similar data limitations in the area of language certification.

Emerging Processes for Certifying Clinician Non–English Language Skills

Although some health care organizations have instituted language proficiency testing for bilingual staff,[54] few have begun testing clinicians.[55,56] Current methods to evaluate language proficiency include self-assessments and oral proficiency tests. Dr Lisa Diamond, co-investigator on this proposal, has shown that clinician self-assessment using an adaptation of a validated tool is highly correlated with proficiency testing in the low and high self-reported proficiency ranges.[57] However, to our knowledge, these assessments have not been tested against patient reports of clinician non–English language skills, nor has a clinician assessment and certification program been evaluated for its impact on patient-centered communication and clinical outcomes.

Aims

To address these dual concerns of access to professional interpreters and proficiency of clinicians who use a non-English language to communicate directly with their patients, the University of California, San Francisco (UCSF) embarked on the Language Access Systems Improvement (LASI) initiative. The LASI initiative comprised 2 complementary improvement programs, one certifying bilingual clinicians to use their non–English language skills directly with patients, and the other simultaneously increasing easy access to professional interpreters by instituting VMI in UCSF's ambulatory practices.

We evaluated the impact of the LASI initiative via the following specific aims:

- **Aim 1.** Evaluate interpreter use and effective communication outcomes (ie, use of professional interpreters, patient awareness and completion of clinician recommendations after a primary care visit) among Chinese and Spanish speakers post-LASI compared with pre-LASI.

- **Aim 2.** Evaluate clinical outcomes—guideline-concordant care for hypertension (HTN), diabetes mellitus (DM), and coronary artery disease (CAD)—among Chinese and Spanish speakers post-LASI compared with pre-LASI vs a nonintervention comparison group of Chinese and Latino patients who have English proficiency (EP).

- **Aim 3a.** Compare observed (audio-recorded) communication factors, such as patient centeredness and visit duration, during primary care visits by language concordance (English concordant; non-English concordant; discordant-professionally interpreted).

- **Aim 3b.** Use audio recordings of primary care visits to prepare a direct observation tool to assess clinician non–English language proficiency for additional testing.

- **Aim 4.** Assess the consequences of LASI implementation via semistructured interviews with primary care clinicians and patient focus groups.

PATIENT AND STAKEHOLDER ENGAGEMENT

Developing the Research Question and Designing the Study

Patient Advisory Council

Our research team was committed to the engagement of patient partners in the planning, design, and implementation of all study-related activities throughout the project. During development of both the proposal objectives and the communication outcomes, we consulted with the Patient Advisory Council (PAC) of the Division of General Internal Medicine (DGIM) practices already in existence before the start of the project. The PAC works with the practice staff to implement changes aimed at improving the patient care experience. It is made up of a diverse group of DGIM patients and family caregiver volunteers. In the initial phase of drafting the proposal, we gave a presentation to the PAC, describing UCSF Health's LASI initiative and our desire to evaluate its impact on our patients with LEP. The PAC engaged in a lively discussion both about the LASI initiative and the possibility of an evaluation based in the DGIM. The PAC confirmed that they felt the LASI initiative had great potential for improving care for patients with LEP in the DGIM and they agreed that we should evaluate the hypothesis that LASI would improve communication and outcomes by studying its impact on DGIM patients. The PAC also voiced their thoughts on what type of outcome would be meaningful to patients. Members recommended we focus on those areas that patients need to understand well immediately after their primary care visit, regardless of their specific health concerns: in particular, understanding of medications and of the importance of the laboratory tests and specialist consultations that needed to be conducted between visits. These recommendations directly resulted in the aim 1 secondary outcome: awareness of visit recommendations and completion of next steps after the visit.

The PAC also partnered with us on the design of the patient recruitment and telephone interview protocol. PAC members were very insistent that any telephone interview be brief, no more than 10 minutes. Many stated that they would not themselves participate in anything longer on the telephone, even if the call were coming from the practice. The research team was extremely mindful of this recommendation when developing the telephone survey and

streamlined the survey until it was only 10 minutes long. The chair of the PAC, Ms Esme Seto, took the time to review survey drafts and gave the team feedback on content as well as flow and comprehensibility from the patient perspective. The PAC also felt strongly that patients needed to be informed about a potential telephone call for an interview in advance. They recommended that we develop and distribute a patient-information sheet at the time of the visit explaining in general terms the purpose of the interview as well as patient rights with respect to participation or nonparticipation and contact information for study staff. The study team took this excellent suggestion from the PAC and aligned the content with what was required during consent processes by the UCSF Committee on Human Research. This information was also repeated in the verbal consent information at the beginning of the telephone interview. We created a trilingual information sheet: 1 side in Chinese/English and the other side in Spanish/English (Appendix A). We included English on both sides because a PAC member pointed out that the sheet should be accessible to family caregivers who may not be literate in Chinese or Spanish. Again, Ms Seto reviewed the draft information sheet for content and readability in both English and Chinese (after professional translation); a study staff member reviewed the Spanish translation. We had an excellent participation rate in the interviews, in large part because of the PAC's recommendations.

Practice Stakeholders

In addition to the PAC, the research team also consulted with the practice stakeholders in the design of the recruitment and interview protocol. The principal investigator, Dr Leah Karliner, met with the DGIM Operations Committee, made up of the medical directors, administrative director, and nurse manager. She discussed the goals of the project, the PAC's endorsement of the study and contribution to the design, and asked for their support and input about how best to recruit patients. The Operations Committee was enthusiastic about the project and was eager to assist. After discussion, it was determined that the front-desk administrative staff was already overburdened and should not be asked to hand out the information sheets. The nurse manager then consulted with her medical assistant (MA) staff to get their feedback on whether they could incorporate handing out the information sheets into

the process of bringing patients into the treatment room and, as a result, the MAs became engaged in the project. Dr Karliner and the nurse manager then met separately with the MAs to discuss the project and get their input on the best workflow for distributing the information sheets to the appropriate patients. Many of the MAs themselves were bicultural and bilingual and, because they are on the front line interacting with patients with LEP, they were enthusiastic both about the LASI initiative and the study.

Implementing the Study

Because of our engagement with the PAC, the research team developed strong rapport with the chair of the PAC, Ms Seto, who is a long-standing DGIM patient. Although Ms Seto is fluent in English, her first language is Cantonese. Many of her relatives have LEP and, over time, she has developed a personal understanding of the difficulties they face in communicating with their physicians and navigating the health care system. These personal experiences have given her a deep interest in the research area. This interest, combined with her professional understanding of systems and data from her prior work in pharmaceutical quality assurance, made Ms Seto an outstanding patient stakeholder. Ms Seto served as a consultant throughout this project and contributed her insights from the perspectives of a patient and family caregiver.

In her role as patient-partner consultant, Ms Seto participated as an equal team member in the monthly LASI evaluation Steering Committee meetings. The purpose of these meetings was to discuss study progress, assess recruitment, refine planned analyses, review data integrity, and plan reports and manuscripts. In addition, Ms Seto co-chaired, along with our clinician co-chair and co-investigator, Dr Sunita Mutha, the stakeholder advisory board for the project, which the board decided early on to call the Advisory Collaboration on Language Access (ACLA). The ACLA was created to ensure that the implementation and dissemination processes were centered on the values of patient and stakeholder partners. The ACLA comprised Esme Seto (main patient stakeholder and co-chair), Sunita Mutha (clinician stakeholder and co-chair), Amanda Clarke (California Association of Public Hospitals/Safety Net Institute), Marynieves Diaz-Mendez, (patient stakeholder), Mateo Rutherford (UCSF Language

and Interpreter Services), and Cary Sanders (California Pan Ethnic Health Network). We recruited 2 additional patient partners from the DGIM practice (via invitations from their physicians); however, both ended their participation by year 3 for personal reasons, and at that point the ACLA was well established and the project far along, so we did not feel it made sense to recruit more patient stakeholders.

The ACLA was the decision-making body for this project. Major activities included annual half-day meetings with all stakeholders to review study progress; oversee data management procedures; and provide advice and input to the Steering Committee on how to solve problems with implementation and evaluation, interpret data, and plan dissemination procedures. In addition, the Steering Committee held conference calls with the ACLA 2 other times during the year to keep the ACLA members updated on study progress and to solicit feedback on current research issues. Finally, the Steering Committee reached out to individual members of the ACLA as needed to provide their expertise and input. For example, all members of the ACLA reviewed and suggested changes to the guides for the patient focus groups and clinician interviews conducted in aim 4.

During the first ACLA meeting, the team had the chance to get to know each other. All represented groups had an opportunity to make a presentation about what motivated them to join the project, what they hoped to contribute, and what they hoped to gain from participation. Dr Mutha, clinician stakeholder and co-chair of the ACLA, has considerable expertise in group facilitation in the setting of cultural competence trainings, as well as organizational systems improvement and advocacy work. Together, she and Ms Seto created a meeting environment based on active listening and respect that was conducive to discussion and sharing. This set the tone for subsequent meetings. At the second annual ACLA meeting, the research team gave an overview of the project and updates on pre- and post-LASI data. The team presented a draft of the aim 3 direct-observation assessment tool for provider language proficiency (see Aim 3b in the Methods section), and the ACLA gave feedback on how the tool might reflect experiences with communication during clinical encounters. At the third annual meeting, the team and the ACLA discussed preliminary findings from the LASI study. The ACLA

identified questions to ask patients that would enable better understanding of the results and that might provide insights to improve the use of professional interpreters at UCSF. At the final ACLA meeting, the researchers presented the findings of the aims supported by this PCORI grant, and each of the ACLA stakeholders reflected on which findings they found most impactful and why. The group then focused on brainstorming best options for reporting our findings to patients, policy makers, and Language and Interpreter Services at UCSF.

Co-learning sessions between stakeholders and the research team occurred throughout the project. Each member of the team had either experiential or scientific knowledge (or both) to contribute. Among these co-learning sessions were Ms Sanders' policy talk, Mr Rutherford's presentation on the evolution of language access at UCSF, and Ms Seto's reflection on her experience as a patient partner participating on the research team.

Disseminating the Research Results

Our 3-pronged dissemination strategy is a result of recommendations from the stakeholders at the last ACLA meeting. First, the ACLA strongly urged us to mail information about our study results to the patient-participants who agreed to be contacted in the future (N = 1301). Although the study is over, the research team is committed to acting on this ACLA recommendation and, with the help of Ms Seto, we developed, translated, and sent this mailing in 2020. Second, we are in the process of drafting and submitting for publication, multiple manuscripts related to this study to share our findings with the research community. Team members have presented results at national (Society of General Internal Medicine) and international (International Conference on Communication in Healthcare) meetings. Finally, we are preparing a policy brief in collaboration with our 2 patient-advocacy and policy partners, California Pan Ethnic Health Network and California Association of Public Hospitals/Safety Net Institute. Both organizations have committed to continued strategic guidance and hands-on assistance in disseminating the results of the project in advocacy, policy, and regulatory settings in California and nationally.

METHODS

Study Overview

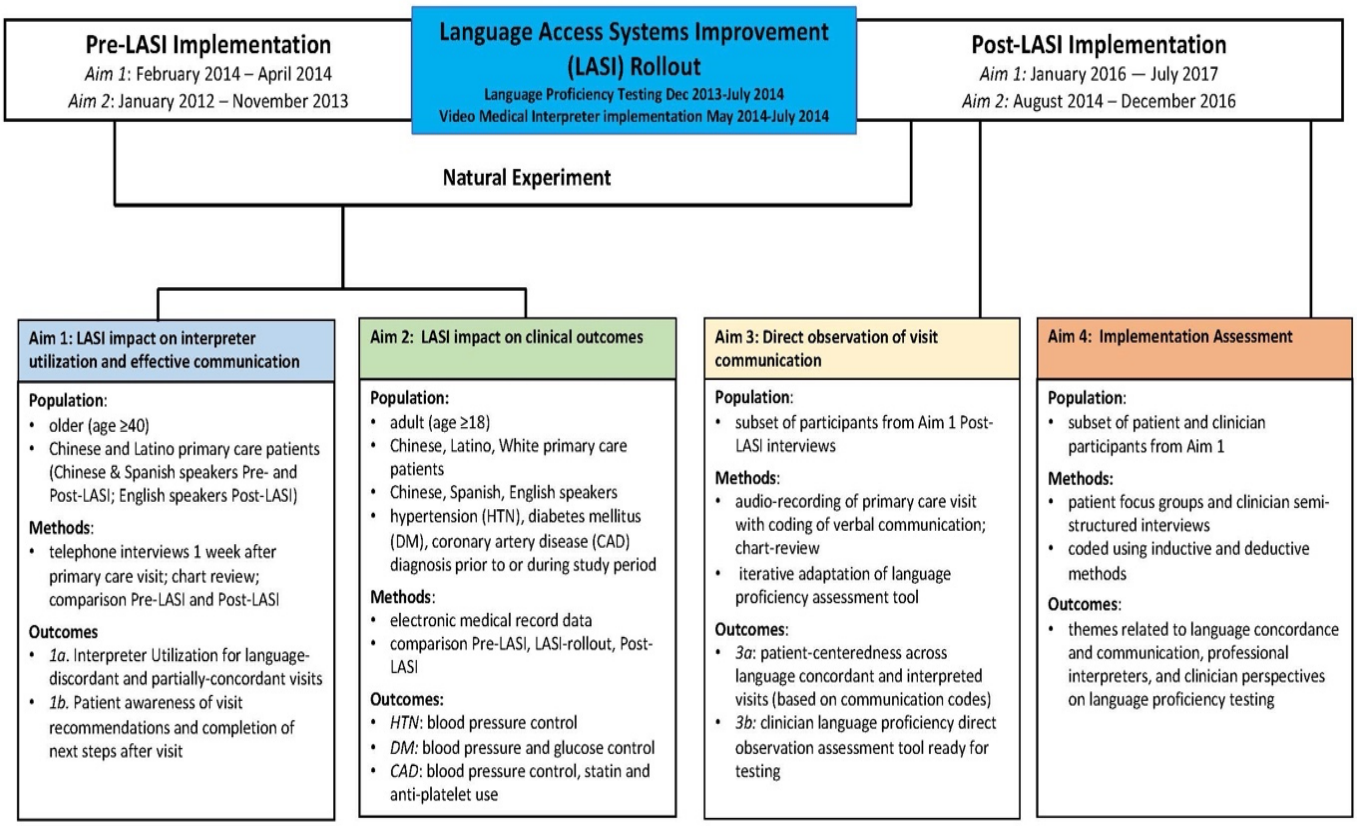
To improve the communication and clinical outcomes of primary care patients with LEP, we aimed to (1) evaluate the impact of a systems intervention to certify the proficiency of clinicians' non-English language skills and (2) create easy access to professional interpreters through videoconferencing. We hypothesized that the LASI initiative would lead to fewer partial and nonconcordant visits without professional interpreter use, better patient awareness and completion of clinician recommendations after a primary care visit, and improved clinical outcomes for patients with chronic conditions.

To test our hypotheses, we conducted a natural experiment (ie, the aim 1 patient telephone interviews and the aim 2 electronic medical record [EMR]-based analysis) comparing interpreter use and effective communication as well as clinical outcomes before and after implementation of the LASI intervention. In a natural experiment, exposure to the experimental condition is determined by forces that arguably resemble random assignment but are not under the control of the investigators. In this study, the introduction of the LASI initiative was controlled by the health system and occurred during a prespecified period. Under those circumstances, any pre- vs post-LASI initiative differences in the nature of clinical visits as well as corresponding patient outcomes may plausibly be attributed to the introduction of the LASI initiative. Of course, it is possible that other (eg, secular) changes co-occurred with the introduction of the LASI initiative, which could undermine the basis of this natural experiment for drawing causal inferences about the initiative's effects. To help mitigate that possibility, we applied statistical methods, including covariate and propensity score–based adjustments, to help statistically adjust for any measured differences in characteristics of patients and physicians across the pre- and post-LASI initiative periods. In concept, a randomized controlled trial, in which patients were randomly assigned by the investigator to receive or not receive the LASI initiative, would provide a superior basis for drawing causal inferences. However, random assignment of either patients or clinicians to the LASI initiative was not possible within this health care setting and generally would be extremely difficult to implement with sufficient

numbers of patients and clinicians. Thus, in this study, we took advantage of the natural experiment to test the effects of the LASI initiative.

We complemented the first 2 aims with comparison of communication factors across English and non–English language-concordant and discordant-professionally interpreted visits (the aim 3 audio recordings). Finally, we conducted focus groups with patients and semistructured interviews with clinicians to give context to our findings and to gain understanding of the facilitators and barriers to LASI implementation (aim 4; Figure 1).

Figure 1. LASI Study Overview



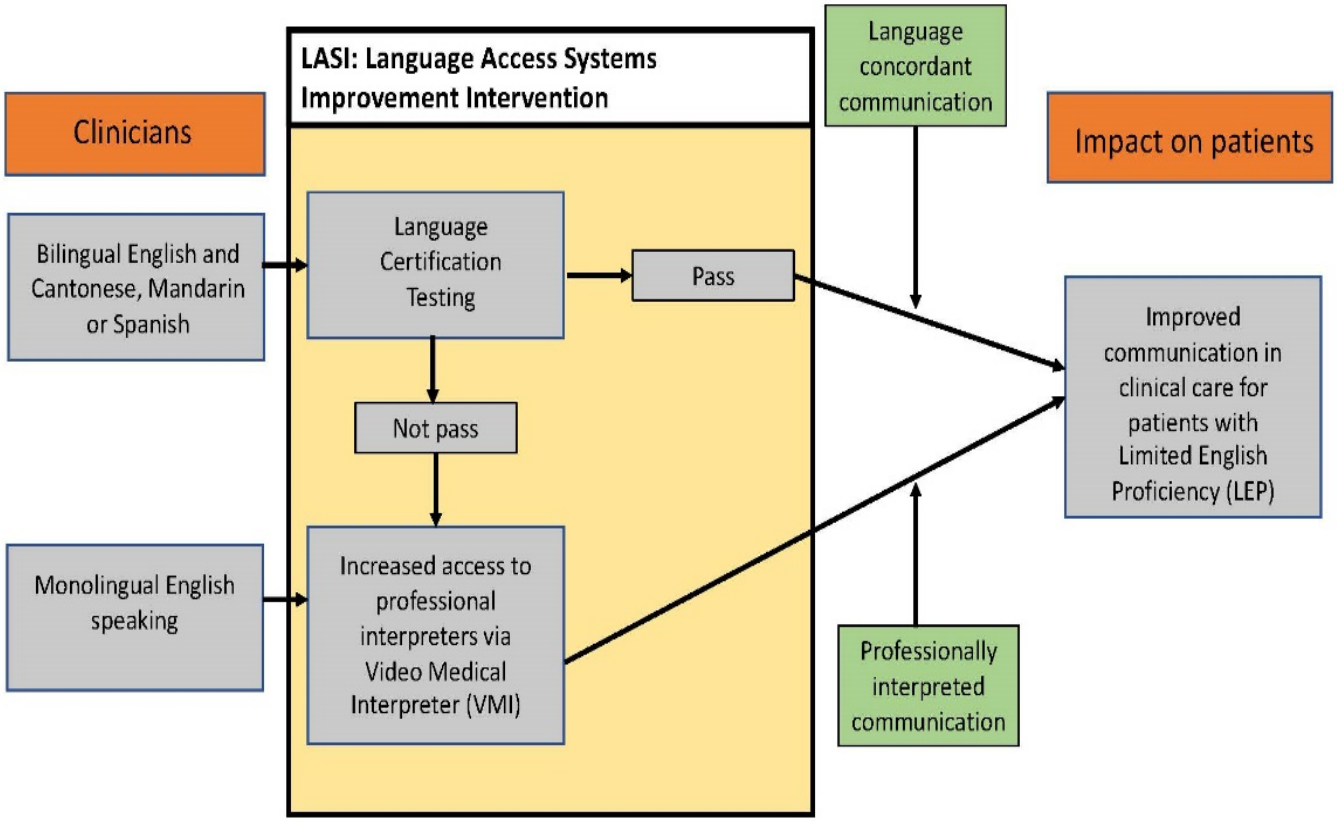
Study Setting

All study research took place in a single, large, academic general internal medicine practice at the UCSF DGIM. This practice has 3 sites and serves almost 25 000 diverse patients, approximately 12% of whom have a non-English preferred language for medical care. The top non–English-language groups served are Cantonese, Mandarin, and Spanish, which is similar to the top non–English-language groups nationally.[58] Clinicians in this practice are faculty attending physicians, resident physicians, and nurse practitioners (NPs). Although the LASI initiative took place across ambulatory practices at UCSF, focusing on this single practice allowed for a layered investigation into many aspects of communication, processes of care, and clinical outcomes while maintaining a single sampling frame for the patient and clinician population.

LASI Intervention

Our study was a natural experiment evaluating the impact of an intervention put into place by UCSF Health Medical Center. This intervention consisted of 2 simultaneous initiatives, together called LASI: (1) certifying bilingual clinicians to use their non–English language skills directly with patients (rollout, December 2013-July 2014) and (2) simultaneously increasing easy access to professional interpreters by instituting on-demand VMI services in its ambulatory practices (rollout, May 2014-July 2014) (Figure 2).

Figure 2. LASI Intervention



In December 2013, as part of the LASI initiative, the UCSF Health Medical Center sent a survey to all clinicians at the Medical Center asking about their use of non–English language skills with patients, based on the modified International Language Roundtable (Appendix B).[57] All respondents who indicated that they used a non-English language to communicate clinical information with patients and that their skills in that language were good, very good, or

excellent were then offered a standardized oral proficiency test in that language to become certified as a bilingual clinician.[55] If a clinician indicated that their skills were fair or poor, they were reminded to access a professional interpreter either in person, by video, or by telephone for communicating with patients with LEP in that language. All clinicians were reminded to access a professional interpreter for communication in any language for which they were not certified. The survey continues to be administered during new resident orientation every summer and offered to new faculty hires. For the clinicians in the DGIM who had not yet participated in the language survey, we asked the Medical Center to resend it to them. For those who were eligible for proficiency testing but had not yet completed the test, we provided a $100 restaurant gift certificate as incentive for them to complete the test.

In May 2014, the UCSF Health Medical Center began rolling out VMI access to ambulatory practices. The DGIM was in the first wave of this rollout. Before the rollout, patients and clinicians had access to in-person professional interpreter services by scheduling the interpreter in advance of the target clinic visit and to on-demand interpreter services via regular telephones in the examination rooms. When visits started or ran late, in-person interpreters often had to leave midway through the visit to travel to another appointment in the Medical Center. Telephone interpretation was difficult because of poor audio and the fixed position of the telephone on the wall in the examination room. While keeping scheduled in-person interpreter access in place, UCSF Health opted to make professional interpreters easily available via video conferencing. The VMI units are placed on carts and can be wheeled into the room, the language selected on a screen, and a visual and audio connection made to a professional interpreter working remotely. As with telephonic interpreters, these interpreters are not scheduled; rather, they are available on demand when the clinician and patient are ready to start the visit and can stay connected as long as they are needed.

Aim 1

Evaluate interpreter use and effective communication outcomes (ie, use of professional interpreters, patient awareness and completion of clinician recommendations after a primary care visit) among Chinese and Spanish speakers post-LASI compared with pre-LASI.

Aim 1 Participants

Patients. We recruited Chinese-speaking (Cantonese and Mandarin) and Spanish-speaking primary care patients from the DGIM practice during 2 periods: pre-LASI, January 2014-April 2014; and post-LASI, January 2016-July 2017. Pre-LASI recruitment took place during the initial part of the bilingual certification rollout and before VMI rollout (and before the PCORI award was granted) as part of a quality improvement evaluation and did not include English speakers. Post-LASI recruitment took place as part of this funded PCORI proposal; during the same period, we also recruited an ethnically Chinese- and Latino English-speaking comparison group from this same practice. The Chinese- and Spanish-speaking patients in this practice were, on average, 15 years older than their English-speaking counterparts. We did not want our comparison to be primarily older, non–English-speaking patients to primarily younger English speakers, so we set a lower age limit for recruitment of 40 years. We allowed any given patient to participate up to twice: once in the pre-LASI period and once in the post-LASI period. Thus, the main differences between the pre-LASI and post-LASI samples were as follows: The pre-LASI sample did not include English speakers, whereas the post-LASI sample did; and the non–English-speaking participants in the pre-LASI sample could participate a second time as part of the post-LASI sample if they met all eligibility and recruitment criteria, which are detailed in the following paragraphs.

Inclusion criteria. The inclusion criteria were age ≥40 years; preferred language was English (post-LASI only), Chinese, or Spanish; self-identification as ethnically Chinese or Latino; primary care patient at the DGIM with a primary care clinician who had taken the UCSF Health clinician language survey; and having a working telephone number and current address in the DGIM medical record.

Exclusion criteria. The exclusion criteria were age <40 years; no longer a DGIM primary care patient at time of telephone interview; no working telephone number or address; patient of 1 of the 2 co-investigators practicing in the DGIM; primary care clinician did not take the UCSF Health clinician language survey or opted out of having their language data included; hearing too impaired to participate in a telephone interview; and unable to cognitively follow and answer interviewer's questions on the telephone.

Recruitment procedures. At the beginning of each week, we pulled a list of DGIM patient appointments scheduled for the following week. An introductory letter and information sheet were then mailed to each potentially eligible participant. The letter and information sheet were written in the patient's preferred language as recorded in the EMR, although all information sheets also included English (ie, they were in Chinese and English or Spanish and English). The letter and information sheet described the study in general terms as focusing on communication, advised patients they might receive a telephone call inviting them to participate in a 10-minute voluntary telephone survey, and gave them contact information for the study coordinator in case they had questions. We also posted information sheets in Chinese and English and Spanish and English in the patient examination rooms in the practice.

We also pulled a daily report from the practice's scheduling system with all completed visits with a physician or NP in the DGIM practices on the prior day. The report indicated each patient's preferred language, race/ethnicity, primary care provider (PCP), and contact information. Bilingual-bicultural trained research assistants (RAs) then called potential participants with the goal of interviewing each participant 1 to 3 days after their primary care visit. The RAs made multiple attempts to contact the patient, leaving at least 1 message with a call-back number and, to minimize recall bias, all interviews were required to take place within 7 days of the visit. If we did not reach a patient within 7 days, they were considered unreachable. We kept track of unreachable patients and, if they had a subsequent primary care visit during the study period, we tried to reach them after that visit. However, if they were not reachable after that second visit, we categorized them as unreachable for that phase of the study (ie, pre- or post-LASI). For those patients we did reach, we received their verbal consent

to participate by telephone before the interview. The interview itself was conducted in the patient's preferred language, took approximately 10 minutes, and included questions specific to the most recent DGIM clinic visit (the index visit). Chinese- and Spanish-speaking patients' eligibility as participants with LEP was confirmed with our published, validated algorithm, which uses a combination of the participant's response to the US Census question "how well do you speak English" and the participant's preferred language for discussing their health care.[59] For all participants, we confirmed their ethnicity (Chinese or Latino) by self-report before beginning the interview.

Because ethnically Chinese patients were approximately twice as numerous as Latino patients in the practice, we set a recruitment target of 2:1 Chinese to Latino patients. Also, because non–English-speaking Chinese and Latino patients were more prevalent in the practice than their English-speaking counterparts, we targeted a recruitment ratio of 2:1 non-English to English speakers for the post-LASI sample, which included English speakers. We also targeted a recruitment ratio of 3:1 patients of attending physicians to those of resident physicians to reflect the proportion of patients in the practice cared for by each group. For attending physicians, we set a patient recruitment ceiling for any single physician's patients in direct proportion to the size of their overall patient panel (ie, the number of patients in the practice assigned to that attending clinician) to ensure a distribution of clinician representation in our patient sample. Finally, in the pre-LASI sample, without setting targets, we found that approximately half of the patients with LEP had visits with language-concordant clinicians; we targeted a similar proportion for the post-LASI LEP sample. We monitored these targets and ceilings throughout the post-LASI recruitment period.

Clinicians. We sent an email to all DGIM PCPs (attending physicians, resident physicians, and NPs) explaining the LASI study, giving them the option to opt out of having us use their language data or allowing us to recruit their patients to the telephone interview study. If they opted out of either, or if we did not have their language data, they were excluded from the study. All other clinicians were included in the study.

Aim 1 data sources.

Patient structured interview. The patient interview asked about 4 main aspects of the index visit: means of communication, medication changes, tests ordered and specialist referrals, and health-related behaviors. These topic areas were chosen as likely to be important to all visits regardless of what risk factors or chronic disease a given patient discussed with their clinician. In addition, these are patient-reported measures, focused on the patient's perspective and understanding after the visit, which is ultimately what will affect whether the patient is able to be an active participant in their care.

Visit record review and EMR data pull. The RAs hand-abstracted data from the medical record to track visit-note documentation of medication changes, diet and exercise discussion, and the number of problems discussed during the visit. A random 10% sample of records were double abstracted for quality assurance. We downloaded additional data on test and specialist visit completion from the EMR.

Aim 1 measures.

Aim 1a: Evaluate interpreter use among Chinese and Spanish speakers post-LASI compared with pre-LASI. Outcome: Interpreter use. Our primary outcome for this aim was the proportion of non–language-concordant primary care visits that were professionally interpreted at the index visit. We determined professional interpretation by using patient report of professional (VMI, in-person, telephonic) presence at the index visit.

Visit categorization. To determine whether an index visit was non–language concordant, and thus required professional interpretation, we used a combination of patient and clinician data to categorize visits.

LEP. Using our previously validated algorithm,[59] we considered patient-participants to have LEP based on a combination of their preferred language for health care and self-reported ability to speak English. These data were collected from the telephone survey. We also asked patient-participants if their clinician spoke to them at the index visit in their non-English preferred language. If they indicated "yes," then we asked how well the clinician spoke that

language. Finally, we asked patient-participants whether anyone interpreted during their visit and, if so, who did the interpreting (ie, in-person professional interpreter, professional by video, professional by telephone, family or friend, clinic staff).

We categorized clinicians as having non–English language skills based on a combination of (1) their self-reported language ability in Cantonese, Mandarin, or Spanish on the UCSF Health survey (adapted International Language Roundtable, see "LASI Intervention" section); and (2) whether they passed the clinician language-certification test (ACLA test; see "LASI Intervention" section). We considered any clinician who took and passed the Clinician Cultural and Linguistic Assessment to be bilingual in English and the tested language. We categorized all clinicians who reported no, poor, or fair ability to communicate in the target languages as monolingual English speakers. If a clinician qualified for testing in 1 of the targeted languages (self-reported ability as good, very good, or excellent) but did not take the clinician proficiency test, we used patients' reports of that clinician's language skills in Cantonese, Mandarin, or Spanish, rated on a 0 to 5 scale (excellent, 5; very good, 4; good, 3; fair, 2; poor, 1; none, 0). Among these clinicians (who self-rated their ability as good, very good, or excellent), when at least 3 unique patient reports were available from the study survey data, we used the mean of the patient-reported clinician's language skill to categorize that clinician's ability in a given language. We considered clinicians with a mean score ≥4 (very good) to be fluent in that language, those with a mean score of >2 to <4 to be partially fluent in that language; and those with a mean score of 1 to 2 to be without any fluency.

We then categorized each patient-clinician visit as follows: fully language-concordant non-English (patient has LEP and clinician is fluent in patient's language); partially concordant non-English (patient has LEP and clinician is partially fluent in patient's language); partially concordant English (patient speaks English well by self-report despite preferring medical care in a non-English language and clinician is a monolingual English speaker); or discordant (patient speaks English not well or not at all by self-report and clinician is a monolingual English speaker). All visits except those categorized as fully language concordant were included in the denominator for the professional interpreter use outcome.

Aim 1b: Evaluate effective communication outcomes among Chinese and Spanish speakers post-LASI compared with pre-LASI. Outcomes: Patient awareness and completion of clinician recommendations after a primary care visit.

Medication: new medication prescribed (yes/no); patient aware that a new medication was prescribed (yes/no). We used manual record review to determine the patient visits at which the clinician prescribed a new medication. Among those with a new medication prescription on manual record review, we considered patients aware of the new prescription if they answered "yes" to the survey question asking if they were prescribed a new medication at the visit.

Health-related behaviors: diet or exercise discussed at visit (yes/no); patient aware that diet or exercise was discussed (yes/no). Similarly, we used manual record review to determine the patient visits at which the clinician documented discussion of diet. Among those with diet discussion, we considered the patients aware of the discussion if they answered "yes" to the survey question asking if diet was discussed at the visit. This process was repeated for exercise discussion and awareness of that discussion.

Laboratory test completion. We used the EMR to determine whether a laboratory test was ordered at the clinician visit, whether that test was completed, and the date on which it was completed. We then created the following variables for patients with laboratory test(s) ordered at the index visit: completed within 30 days (yes/no), completed within 100 days (yes/no), and, for those completed within each of those time frames, time to completion.

Specialist visit after clinician referral. We used the EMR to determine whether a specialist referral was made at the clinician visit, whether the patient had a visit to that specialty department, and the date of that visit. We then created the following variables for those with specialist referrals made at the index visit: completed within 30 days (yes/no), completed within 100 days (yes/no), and, for those completed within each of those time frames, time to completion.

Systems intervention indicator: LASI time period.

Pre-LASI interviews took place between January 22, 2014, and March 25, 2014. Post-LASI interviews took place between February 1, 2016, and June 9, 2017.

Covariates included in aim 1 regression analyses.

We collected information on the following variables from the patient-participant survey: preferred language to receive medical care (Cantonese, Mandarin, Spanish, English), ability to speak English (very well, well, not well, not at all), age, sex, educational attainment (less than high school, high school diploma, associate's degree or some college, college degree or higher), health literacy (inadequate, adequate),[60,61] whether a physician or NP seen at visit was patient's usual PCP (yes/no), and whether a care partner was present at visit (yes/no). We collected information on the following variables from manual record review or the EMR: insurance status (private, Medicare, Medicaid), Elixhauser comorbidities,[62] frequency of clinic visits in prior 12 months, length of time as a patient in the practice, number of problems listed in the assessment and plan of the note, type of clinician seen at visit (physician faculty, physician resident, NP), sex of physician seen at visit.

Aim 1: Analysis plans for aims 1a and 1b.

Aim 1a: Interpreter use. We tested the aim 1a alternative hypothesis that the LASI initiative would increase the number of clinic visits attended by Chinese-speaking patients with LEP (LEP Chinese) or Spanish-speaking patients with LEP (LEP Spanish) that include appropriate professional interpretation services. In bivariate analysis, we compared the characteristics of the pre- and post-LASI samples. Bivariate analyses involved omnibus χ^2 tests for categorical variables and 1-way analysis of variance (ANOVA) for continuous variables; the significance level was set at $P < .05$. We then identified those visits eligible to have a professional interpreter present (ie, discordant, partially concordant in English, or partially concordant in Cantonese, Mandarin, or Spanish) and limited our analysis of interpreter use to those visits. We described bivariate differences in professional interpreter use between pre- and post-LASI samples separately for discordant, partially concordant English, and partially concordant non-

English visits, as well as for all of the nonconcordant visit types combined. In adjusted analysis, all nonconcordant visit types were combined, and a mixed logistic model compared professional interpretation use between pre- and post-LASI groups. All models accounted for clustering of observations within clinicians and for multiple observations per patient (ie, patients with both a pre- and a post-LASI study visit). To help bolster the basis for drawing causal inferences, the logistic model incorporated inverse probability weights (IPWs) as described on p. 31.

Aim 1b: Visit recommendations, awareness of visit recommendations, and completion of next steps after the visit. We tested the aim 1b alternative hypothesis that the LASI initiative would increase awareness of visit recommendations and completion of after-visit next steps among LEP Chinese and LEP Spanish patients. Bivariate analyses compared the following between pre- and post-LASI LEP samples: (1) prescription of new medications at the visit and patient awareness of new medication prescription; (2) discussion of diet and exercise at the visit and patient awareness of diet and exercise discussions; (3) completion of ordered laboratory tests and time to completion; and (4) completion of referral appointments and time to completion. Bivariate analyses involved omnibus χ^2 tests for categorical variables and 1-way ANOVA for continuous variables; significance was set at $P < .05$. In adjusted analyses, we fit mixed logistic models to compare each of these outcomes between pre- and post-LASI samples. To help bolster the basis for drawing causal inferences, mixed logistic models incorporated IPWs. We fit Cox proportional hazards models to compare time to completion of laboratory tests and time to completion of referral appointments between pre- and post-LASI groups. Because Cox regression models in Stata would not accommodate IPWs, these time-to-event models instead were adjusted for covariates describing patient age, sex, education, insurance, comorbidity count, frequency of visits in past 12 months, length of time as a patient, number of problems addressed at the visit, clinician type, and whether the patient saw their own PCP at the visit. All models accounted for clustering of observations within clinicians and for multiple observations per patient.

IPWs. The pre- and post-LASI samples of visits of patients with LEP might not have equivalent patient and provider characteristics. Therefore, when comparing pre- and post-LASI study outcomes, we included IPWs in analyses, which can significantly reduce bias resulting from measured confounders. The IPWs for an average treatment effect were estimated using the TWANG toolkit (SAS %PS macro; Rand Corp).[63] IPW calculation began with estimation of the propensity for a visit to be in the post-LASI sample (vs the pre-LASI sample) via generalized boosted regression specifying the average absolute standardized effect size as the model-selection criterion. Covariates included in the propensity model are listed in Appendix C. Preliminary models suggested that including all 2-way interactions between covariates (eg, patient age × sex) in the propensity score model did not improve covariate balance. IPW values were generated on the basis of the estimated propensity scores, and covariate balance across IPW pre- and post-LASI samples was assessed with the goal of obtaining all standardized effect sizes less than 0.20 in absolute value. IPWs were stabilized. In addition, overlap of estimated propensity score distributions across the pre- and post-LASI samples was assessed. When overlap was not 100%, planned analyses refit all models after removing patients from the data who were not within the estimated propensity score overlap range. IPWs were estimated within the full sample (N = 1029) as well as the subsample of 698 visits characterized by partially concordant or discordant language skills across corresponding patients and providers. After IPW within the full sample, the maximum absolute standardized difference between pre- and postintervention on any covariate equaled 0.162; all but 3 of 40 standardized effects were <0.10 in absolute value, suggesting good balance. Propensity score overlap was good but not absolute; overall, scores ranged from 0.001 to 0.993, and the range of overlapping score values across both the pre- and post-LASI samples ranged from 0.087 to 0.995. There were 60 pre- and 136 post-LASI patient visits outside of the estimated overlap range (n = 196 [19.1%]); that is, there were 1029 − 196, or 833 visits within the overlap rage. Within the sample of 698 patient visits with partially concordant or discordant patient-clinician language skills, the maximum absolute IPW standardized effect size equaled 0.18 and only 4 of 40 effect-size estimates exceeded 0.10. Overall, propensity scores ranged from 0.006 to 0.994, and the range of overlapping score values across the pre- and post-LASI samples ranged from 0.086 to 0.935.

There were 43 pre- and 156 post-LASI visits with estimated propensity scores outside of the overlap range (n = 199 [28.5%]); that is, 698 minus 199, or 499 visits within the overlap range. Therefore, in addition to analyses of the full sample set (N = 1029) and subset (n = 698), parallel sensitivity analyses were conducted on the subsamples with overlap (n = 833 and n = 499, respectively); these analyses explored the possibility that results from analysis of the full samples might be influenced by patients who had propensity score estimates outside of the range represented in both the pre- and post-LASI samples.

Secondary analyses. The mixed logistic and Cox models we have described were augmented to include an indicator of patient-preferred language and its interaction with the pre- and post-LASI indicator; this enabled us to explore whether any LASI intervention effect was modified by patient-preferred language (heterogeneous treatment effects).

Missing data. The sampling design is multi–cross-sectional, so missing data due to attrition are not an issue. However, some item missingness was expected to occur. The original analysis plan was to use multiple imputation to allow use of all available data and, relative to a complete-case analysis, invoke the assumption that item data are missing at random (MAR), conditional on modeled variables. However, missing values were rare in the sample data. Generally, the percentage of missing values for study outcomes was well below 1% and that was the case for all aim 1a and aim 1b outcomes. Therefore, we did not use multiple imputation and instead accommodated missing outcome response by fitting generalized linear mixed models (GLMMs) of study outcomes, including random intercepts for physicians and patients; GLMMs naturally invoke the MAR assumption for missing outcome response. Because of the low prevalence of missing values, no sensitivity analyses of the MAR assumption were performed.

As proposed, power analyses assumed the following: 80% power; 2-tailed $\alpha = .05$; correlation between the pre- and post-LASI indicator and propensity score quintiles equal to 0.20; binary outcomes describing inherent language barrier during most recent clinic visit (32% pre-LASI from preliminary data) and patient understanding of medication regimen (73% pre-LASI from preliminary data); 960 patients with LEP, with 1:2 sampling allocation (n = 320 pre-

LASI and n = 640 post-LASI); 96 clinicians and 10 patients sampled per clinician; and intraclinician correlations of outcome response equal to 0.15 (language barrier) and 0 (medication understanding; both from preliminary data). As explained earlier in this section, the sample represented a multi–cross-sectional design, but some patients provided both pre- and post-LASI interviews. Any longitudinal assessments will increase the power of the pre- and postintervention analyses but are conservatively treated as independent for power analyses only. The minimum detectable effect sizes were as follows: language barrier, 32.0% pre- vs 24.0% post-LASI (odds ratio [OR], 0.67); medication understanding, 73.0% vs 81.2% (OR, 1.59). Both are small to medium effect sizes, suggesting good power.

Aim 2

Evaluate clinical outcomes—guideline-concordant care for HTN, DM, and CAD—among Chinese and Spanish speakers post-LASI compared with pre-LASI vs a nonintervention comparison group of Chinese and Latino patients who have EP.

Aim 2 Participants

Inclusion. We selected patients in the EMR using the following inclusion criteria: at least 2 eligible clinic visits (ie, clinic visit with a DGIM clinician between January 1, 2012, and December 31, 2016); qualifying diagnosis made before or at the time of the visit: HTN, DM, or CAD; adult patient (aged ≥18 years); patient language preference of Cantonese, Mandarin, Spanish, or English; patient race/ethnicity of Chinese, Latino, or White. For each patient, we included their first eligible visit and all clinic visits within the study time frame that followed their first eligible visit.

Exclusion. We excluded patients with missing language or race/ethnicity data in the EMR. We also excluded those with a diagnosis of dementia, advanced-stage cancer, end-stage renal disease, heart failure, end-stage liver disease, cystic fibrosis, or severe chronic obstructive pulmonary disease, because these diagnoses may preclude patients and their clinicians from focusing on improved HTN and DM control or prevention with lipid management and

antiplatelet therapy. We additionally excluded patients who only had a single clinician visit in the study time frame, or only had visits with a registered nurse or a pharmacist.

Aim 2 Outcomes

HTN outcome: blood pressure control. For visits between January 1, 2012, and December 31, 2013, we considered patients with HTN to have controlled blood pressure (BP) based on Joint National Committee (JNC)–7 BP criteria (<140/90 mm Hg for all ages, unless <130/80 mm Hg for anyone with DM or chronic kidney disease [CKD]).[64] For visits from January 1, 2014, and after, we applied JNC–8 BP criteria (<140/90 mm/Hg for patients aged <60 years; <140/90 mm Hg for patients aged ≥60 years with comorbidity, including DM and CKD; and <150/90 mm Hg for patients aged ≥60 years with no comorbidity).[65] We also followed American Heart Association recommendations for BP control for secondary prevention for patients with CAD (<140/90 mm Hg).[66]

DM outcomes: hemoglobin A_{1c} and BP control. Given that the American Diabetes Association recommends individual tailoring of A_{1C} control[67,68] we examined 1 cutoff of good control (hemoglobin A_{1c} [HbA_{1c}] <8%) and 1 cutoff of poor control (HbA_{1c} >9%). We applied JNC–7 and –8 guidelines for BP goals in the setting of DM as described in the previous paragraph.

CAD: antiplatelet/anticoagulant use, statin use, and BP control. We followed American Heart Association guidelines for use of blood thinners, statins, and BP control for secondary prevention of CAD.[69] We considered patients with CAD to have good secondary prevention if they were taking an antiplatelet agent (eg, aspirin, clopidogrel) or an anticoagulant (eg, warfarin, enoxaparin), taking a statin, and had BP <140/90 mm Hg.

Aim 2 predictor: LASI period. We designated January 1, 2012, to November 30, 2013, as the pre-LASI period; December 1, 2013, to July 31, 2014, as the LASI rollout period; and August 1, 2014, to December 31, 2016, as the post-LASI period.

Aim 2 covariates. The following covariates were collected via the EMR. For each patient at the date of their first eligible visit, baseline covariates were age, race/ethnicity, sex, first qualifying diagnosis (ie, HTN, DM, or CAD, or combination), insurance type, clinician type (faculty physician, resident physician, NP), number of visits to the DGIM in the year prior, calendar day, and Elixhauser[62,70] comorbidities. In addition, at each visit during the study period, visit-level covariates were age, clinician type (faculty physician, resident physician, NP), an indicator for whether the patient had DM, CAD, or CKD, and comorbidities.

Aim 2 Analyses

Primary analysis. We tested the aim 2 alternative hypothesis that, among Chinese- and Spanish-speaking patients with LEP who had the targeted morbidities, the LASI initiative would increase patients' achievement of condition-appropriate national standards for quality of care (specifically, BP control, DM management, and CAD management) relative to Chinese and Latino patients with EP. Preliminary models of these data suggested that intraclinician correlation of patient outcome response was near zero. Generalized estimating equation (GEE) models with first-order autoregressive working correlation structure across repeated patient visits were fit to each outcome (ie, BP control for patients with HTN; BP control and glucose control for patients with DM; and BP control, statin use, and antiplatelet use for patients with CAD). The primary comparisons included (1) a time-averaged comparison of mean outcome response across the pre-LASI, LASI rollout, and post-LASI periods (ie, the study period main effect); (2) a comparison of responses between Chinese and Latino patients with EP vs Chinese- and Spanish-speaking patients with LEP (ie, the language proficiency main effect); and (3) a comparison of responses by study period for each language proficiency group (ie, the study period × language proficiency interaction). In these analyses, patients with EP served as a control group that was not expected to be affected by the introduction of the LASI initiative. The study period × language proficiency interactions represented tests of difference in differences; that is, they tested whether the effect of the LASI initiative among patients with LEP significantly differed from the corresponding effect among patients with EP.

We calculated patient-level propensity scores (eg, propensity to have LEP vs EP) using the *pscore* function in Stata, version 14.2 (Stata Corp). This function generates propensity-score blocks that are balanced across groups (EP and LEP) by automatically splitting the sample into blocks and performing *t* tests until the smallest number of blocks is calculated where the propensity-score means are equivalent across both groups within each block and where the observed covariates are also balanced between groups within each block. Separate propensity-score blocks were calculated for each outcome because final samples for each outcome included different subsamples of patients. The covariates included in the propensity-score calculations are available in Appendix D. Final visit-level models were adjusted for patient-level propensity-score blocks.

Secondary analysis. We expanded these analyses by including visit data for White patients with EP (EP White) and to include a 5-category measure of language group (EP White, EP Chinese, EP Latino, LEP Chinese, LEP Latino) to explore differences in outcomes for Chinese and Latino language groups relative to EP White patients. Again, GEE models were fit with first-order autoregressive working correlation structure. The primary comparisons included (1) a time-averaged comparison of mean outcome response across the pre-LASI, LASI rollout, and post-LASI periods (ie, the study period main effect); (2) a comparison of responses between the 5 language groups (ie, the language-ethnicity main effect); and (3) a comparison of responses by study period for each language-ethnicity group (ie, the study period × language group interaction). Models were also adjusted for patient age at time of visit, type of clinician seen at visit, and comorbidities at the visit: (1) an indicator for whether the patient had DM, CAD, or CKD, and a count of all other comorbidities (excluding DM, CAD, and CKD) for patients with HTN; and (2) a total count of comorbidities at the visit for patients with DM and CAD.

Missing data. As for aim 1, we initially proposed use of multiple imputation to accommodate missing responses. However, only a few EMRs had missing values on the key sample inclusion criteria of patient-preferred language (n = 6) and race/ethnicity (n = 145) values; those EMRs were excluded from the aim 2 sample. Within the selected aim 2 sample, there were no missing values for any outcomes.

As proposed, power analyses assumed the following: 80% power; 2-tailed α = .05; a binary outcome describing patient achievement of condition-appropriate national standards for quality of care (60% across the entire pre-LASI period); 1500 Chinese- or Spanish-speaking patients with LEP followed for 5 years, with primary focus on the pre-LASI (January 1, 2012, to December 31, 2013) vs post-LASI (January 2015 to December 2016) periods; 80% retention of patients in the practice over the study period (n = 1200); an average of 2 clinic visits per patient per year; 96 clinicians and an average of 12.5 patients sampled and retained per clinician; intraclinician correlation of outcome response of 0.15; and intrapatient correlation of repeated response of 0.50. The intrapatient correlation of 0.50 is considered a low estimate for this outcome; higher values would yield greater power. The minimum detectable, simultaneously estimated effects correspond to an OR of 1.37 for the time-averaged pre- vs post-LASI comparison and an OR of 1.30 for the interaction effect corresponding to each 1-year increase during the post-LASI period; both are considered small effect sizes, suggesting good power. Power was estimated by simulation via a mixed logistic model with maximum likelihood estimation.

Aim 3

Aim 3a: Compare observed (audio-recorded) communication factors, such as patient centeredness and visit duration, during primary care visits by language concordance (English concordant, non-English concordant, discordant-professionally interpreted).

Aim 3b: Use audio recordings of primary care visits to prepare a direct observation tool to assess clinician non–English language proficiency for additional testing.

Aim 3 Participants

Patients.

Inclusion and exclusion criteria. These were the same as for aim 1 participation.

Recruitment procedures. At the end of each aim 1 telephone interview during the post-LASI period, the RA asked if the participant would be willing to have a future primary care visit

audio-recorded. A weekly report was generated from the practice's scheduling system including upcoming visits in the subsequent week for all eligible participants who agreed to have a future visit audio-recorded and whose clinician consented to audio recording. The RA then called the patient during the week before the appointment to confirm interest and arranged to meet them at the clinic just before the appointment to obtain written consent. Upon consent, the RA handed a digital recorder to the participant to take into the examination room. The recorder was returned at the conclusion of the visit, at which time the RA conducted an in-person post-visit survey similar to the aim 1 interview.

Clinicians.

Inclusion. Clinicians who participated in aim 1 were included.

Exclusion. Clinicians who were no longer seeing patients in the DGIM practice and clinicians who did not agree to have their clinic visits audio-recorded were excluded.

Recruitment procedures. We mailed all clinicians participating in the aim 1 interview study a description of this audio-recording study and requested their participation and signed consent to record any of their participating patients who also consented to audio recording. Clinicians also were asked to complete a brief post-visit survey (online or on paper) regarding each audio-recorded clinic visit.

Aim 3 Data Sources

Roter Interaction Analysis System codes. All audio recordings were coded directly using Roter Interaction Analysis System (RIAS) coding.[71] This system categorizes each spoken complete thought as a single utterance (assigned to patient, clinician, care partner, or interpreter) and gives it a code classifying the type of utterance (eg, psychosocial question, biomedical information). Coding was done directly from the audio recordings by bilingual-bicultural coders; quality control was performed on a 10% sample of audio recordings in each language for each coder.

The post-visit patient-participant survey was the same as the aim 1 survey, with additional questions about patient perception of communication (Appendix E). The post-visit clinician-participant survey covered clinician perception of communication and visit processes (Appendix F). Medical record-based data collection was the same as in aim 1.

Aim 3 Measures

Aim 3a: primary outcome: RIAS patient-centeredness measure.

This measure is a ratio of psychosocial utterances to biomedical utterances. The numerator of the ratio includes utterances from the patient, care partner, or clinician coded as psychosocial questions, psychosocial and lifestyle information, emotional talk, facilitative talk, and patients' medical questions. The denominator of the ratio includes utterances from the patient, care partner, or clinician coded as procedural talk, medical talk, or clinician medical questions (Appendix G). This measure has been associated with higher patient satisfaction, higher clinician respect for the patient, and more psychosocial and emotional disclosure.[72-75]

Aim 3a: secondary outcomes.

Visit duration in minutes. We derived this measure from the audio recordings, including only the time that both the patient and clinician were in the room together.

Number of problems addressed during the visit. We derived this measure by counting discrete problems in the assessment and plan portion of the clinician visit note.

Verbal dominance of clinician. This measure is a ratio of the number of utterances of the clinician to the number of utterances of the patient plus those of a patient care partner if present at the visit.

Visit type categorization. We categorized visits as English concordant, non-English concordant, or discordant-professionally interpreted, using the same algorithm to categorize visits described for aim 1.

Aim 3a: analysis plan. We limited our primary analysis of RIAS data and communication-related outcomes to 3 groups, as defined by clinical communication modality: (1) Patient and clinician are language concordant in English (English-concordant); (2) patient and clinician are language concordant in Cantonese, Mandarin, or Spanish (non-English concordant); and (3) patient and clinician are language discordant and used a professional interpreter (discordant-professionally interpreted). Bivariate analyses compared visit characteristics across these 3 groups, including visit length, number of problems addressed, clinician verbal dominance, and the measure of RIAS patient centeredness. We also compared each component of the RIAS patient-centeredness measure across the 3 groups. Bivariate analyses involved omnibus χ^2 tests for categorical variables and 1-way ANOVAs for continuous variables; significance was set at $P < .05$. In adjusted analysis, we fit a mixed linear model, accounting for clustering of observations within clinicians, to compare patient centeredness across the 3 communication modality groups. The model was adjusted for patient age, sex, education, comorbidity count, whether care partner accompanied patients to visits, frequency of patient visits during the prior year, and the sex and faculty status of the provider. We also examined differences in RIAS patient centeredness by patient-preferred language among the non–English-concordant and discordant-professionally interpreted visits. We conducted 2 exploratory analyses. In 1 analysis, we compared the aim 1b outcome measures (new medication, discussion of diet and exercise, completion of tests and referrals) in the context of the aim 3 comparison across concordant and discordant-professionally interpreted visits. In another analysis, we compared discordant, family-interpreted visits and discordant-professionally interpreted visits.

Aim 3b: development and evaluation of a direct observation assessment of clinician non–English language skills. The Student Oral Language Observation Matrix (SOLOM) is an oral language proficiency assessment developed in 1978 by the San Jose Area Bilingual Consortium and revised by the Bilingual Education Office of the California Department of Education.[76,77] It is not a formal test but a scale that allows an assessor to use a matrix to rate a subject's oral proficiency in 5 categories: comprehension, fluency, vocabulary, pronunciation,

and grammar. Our team adapted the SOLOM for use in clinical encounters; we named our adaptation the Physician Oral Language Observation Matrix (POLOM). The POLOM is a rating scale by which an assessor can document the language proficiency of a clinician by observing them using their non–English language skills in their specific clinical setting. The POLOM codes oral language proficiency in the same 5 domains as the SOLOM.

Aim 3b: iterative adaptation of observational assessment.

Two raters independently scored 9 audio-recorded clinic visits with Spanish-speaking patients, taking notes to document their thought processes on their scores and then meeting to discuss any discrepancies in their scores and how to further modify the POLOM tool to increase inter-rater reliability in future applications. They brought their recommendations to the study team for additional adaptation. The team also identified encounter characteristics that indicated inadequacy for assessment of the clinician's language proficiency.

Aim 4

Assess the consequences of LASI implementation via semistructured interviews with primary care clinicians and patient focus groups.

Aim 4 Participants

Patients.

Inclusion criteria. We included primary care patients with LEP who took part in the telephone interview and agreed to be contacted in the future regarding similar research.

Exclusion criteria. No longer being a DGIM primary care patient at the time of the focus group and being an English-speaking patient were exclusion criteria.

Recruitment procedures. At the end of the aim 1 telephone interview, RAs asked participants if they would be willing to be contacted in the future regarding similar research. Of those who agreed, we called participants with LEP who were still active DGIM patients (visit within prior 6 months) to invite them to participate in a focus group. We recruited for 4 focus

groups: 2 in Spanish, 1 in Cantonese, and 1 in Mandarin, with a goal of 8 to 12 participants in each group. Patients who agreed by phone to participate were sent a formal letter in the mail that included important details (eg, date, time, location) about the focus group. A bilingual-bicultural researcher obtained consent from all participants at the beginning of the focus group by reviewing a written consent form and answering any questions the participants had before they signed it. The focus groups lasted 1.5 hours and were audio-recorded, translated, and transcribed for analysis.

Clinicians.

Inclusion criteria. Clinicians who participated in aim 1 were included.

Exclusion criteria. Clinicians who were no longer seeing patients in the DGIM practice were excluded.

Recruitment procedures. We conducted 16 semistructured interviews with current DGIM clinicians who participated in aim 1 of our study. We invited potential participants via email, with the goal of interviewing approximately equal numbers of clinicians from the following language groups: monolingual English; fully bilingual (in English and Cantonese, Mandarin, or Spanish); and partially bilingual (in English and Cantonese, Mandarin, or Spanish). Each interview lasted 30 to 45 minutes and was conducted in person or via video conferencing, according to the participant's preference. All participants received a written information sheet in advance by mail and then consented verbally to their participation at the beginning of the interview. All stakeholder interviews were audio-recorded and transcribed for analysis.

Aim 4 Data Sources

Focus group guide. The patient focus group guide was created with input from our patient, policy, and interpreter services stakeholders. It covered the following domains: preferred language for clinical visits, experiences with professional interpretation, role of family and care partners, use of English during visits, differences when seeing specialists, and suggestions for improvement in language access and interpreter services.

Clinician semistructured interview guide. The clinician semistructured interview guide was created with input from our clinician, policy, and interpreter services stakeholders. It covered the following domains: decisions to use or not use a professional interpreter, facilitators and barriers to professional interpreter use, and perceptions about current bilingual clinician proficiency testing as well as potential direct-observation assessment.

Aim 4 Analysis

We used inductive and deductive coding to analyze the transcribed clinician interviews and focus group meetings.[78,79] The research team created an initial codebook for the clinician interviews using 3 interviews chosen randomly to create data-driven themes and codes. Two researchers then double coded an additional 2 transcripts to confirm the definitions and reliability of the codes. If any discrepancies arose, the research team met to reconcile codes and review additional themes that may have emerged. (We used a similar process to develop the final focus group codebook.) Using an updated codebook, the 2 researchers coded the remaining transcripts, addressing any coding discrepancies and resolving them with the consensus of the research team.

Changes to Original Study Protocol

Aim 1

Recruitment. To ensure an adequate sample of patients with LEP in the post-LASI recruitment period, we changed from a 1:1 recruitment to a 2:1 LEP to EP sampling ratio. To mirror the distribution of patients in the clinic panels across attending and resident physicians, we instituted a 3:1 attending physician to resident physician sampling ratio.

We increased our target sample size (originally proposed: N = 960; n = 320 pre- and 640 post-LASI), and ultimately targeted 1280 participants in the post-LASI recruitment to accommodate the sampling of patients with LEP and those with EP described in the previous paragraph.

Analysis. Because missing values were rare, we did not use multiple imputation, as originally proposed. We limited aim 1 tests for heterogeneity of treatment effects to tests for interaction between patient-preferred language and study period (pre- vs post-LASI) because we considered this to be the most important area for possible differences.

We originally proposed propensity-score quantile adjustment but instead elected to use IPW to adjust for any potential differences across the pre- and post-LASI study periods in measured characteristics of patients and clinicians.

Aim 2

Inclusion criteria. To use all data available to us, we allowed entry into the study at any time within the study time frame, rather than creating a cohort at a somewhat arbitrary date before LASI rollout. To ensure there would be an opportunity for all study patients to have clinical improvement in their disease-specific quality measures, we required at least 2 primary care visits during the study time frame to be included in the analyses.

Analysis. Because missing values were rare, we did not use multiple imputation. The original proposal described inclusion of a nonequivalent control group with EP, including patients with EP from all racial/ethnic groups. Subsequently, we decided that a more informative comparison would be between Chinese and Latino patients with LEP vs Chinese and Latino patients with EP, and, in secondary analyses, to include an additional comparison group representing White patients with EP. In addition, the original proposal described secondary analyses that included data from all patients who preferred any non-English language (beyond Cantonese, Mandarin, and Spanish); we have not yet pursued that analysis.

With the original plan to compare Chinese and Latino patients with LEP vs patients of all racial/ethnic groups with EP (control group), we had proposed to create a ratio of 1 to many matched samples of patients with LEP vs patients with EP; the relatively large pool of patients with EP was expected to allow for matching within a narrow caliper width (ie, close matching) that also allowed for a large matched sample size after dropping nonmatching patients with EP

via the matching algorithm. Subsequently, the primary comparison shifted to one between Chinese and Latino patients with LEP vs Chinese and Latino patients with EP, plus a secondary comparison group of White patients with EP. The modified design resulted in relatively smaller samples of patients with EP (Chinese, Latino, or White; vs originally including all patients with EP); a matched sample would have reduced their numbers further because of dropped nonmatching patients and would have required specification of a wider caliper. Instead, we decided to adjust regression models using a propensity-score block covariate, which allowed for inclusion of all available Chinese, Latino, and White patients with EP in analyses.

Our original analysis plan only included the LASI rollout period in secondary analyses; however, because we allowed entry into the study at any time during the study period, we have now included the LASI rollout period in our main analyses.

Aim 3

Recruitment. We had fewer than the 200 anticipated audio recordings because of equipment malfunction in 5% of cases.

Aim 4

Recruitment. We anticipated interviewing 20 clinicians for the semistructured interviews; however, we reached saturation in themes after 16 interviews. We anticipated including the caregivers who accompanied patients to clinic visits in their own focus group; however, few patient-participants wanted us to contact their caregivers. We had 1 Spanish-language focus group with low attendance due to a storm on the day of the focus group, so we added a second Spanish-language focus group.

RESULTS

Aim 1

Evaluate interpreter use and effective communication outcomes (ie, use of professional interpreters, patient awareness and completion of clinician recommendations after a primary care visit) among Chinese and Spanish speakers post-LASI compared with pre-LASI.

PCP Clinicians' Participation and Language Skills

No clinicians opted out of allowing us to use their language data or contacting their eligible patients. However, 9 of 161 (5.6%) potentially eligible clinicians did not complete the UCSF Health language survey and so they and their patient visits were excluded.

Among the 152 unique clinicians included in the study (Table 1), 52 were eligible for the proficiency testing program in Cantonese, Mandarin, or Spanish (language ability self-reported as good, very good, or excellent), with 2 clinicians eligible for testing in >1 language. These PCPs completed 21 tests (40%) and passed 17 (81% pass rate). Testing was higher (ie, more physicians took the test) among those whose self-reported language ability was very good (n = 10 of 15 [67%]) or excellent (n = 5 of 5 [100%]), compared with those whose self-reported language ability was good (n = 6 of 33 [18%]).

Table 1. PCP Clinician Participant Characteristics Overall and Comparing Pre- and Post-LASI

	Total unique PCPs (N = 152)	Pre-LASI clinicians (n = 83)[a]	Post-LASI clinicians (n = 109)[a]	*P* value[b]
PCP sex, No. (%)				.47
Female	91 (59.9)	53 (63.9)	64 (58.7)	
Male	61 (40.1)	30 (36.1)	45 (41.3)	
Faculty status, No. (%)				1.00
Attending	49 (32.2)	33 (39.8)	43 (39.5)	
NP	7 (4.6)	4 (4.8)	5 (4.6)	
Resident	96 (63.2)	46 (55.4)	61 (55.9)	
Spanish skills (self-report), No. (%)				.44
None	102 (67.1)	54 (65.1)	72 (66.1)	
Poor	2 (1.3)	0	2 (1.8)	
Fair	13 (8.6)	8 (9.6)	10 (9.2)	
Good	22 (14.5)	13 (15.7)	16 (14.7)	
Very good	9 (5.9)	4 (4.8)	8 (7.3)	
Excellent	4 (2.6)	4 (4.8)	1 (0.9)	
Cantonese skills (self-report), No. (%)				.81
None	143 (94.1)	76 (91.6)	103 (94.5)	
Poor	2 (1.3)	1 (1.2)	1 (0.9)	
Fair	1 (0.7)	1 (1.2)	1 (0.9)	
Good	4 (2.6)	4 (4.8)	2 (1.8)	
Very good	1 (0.7)	0	1 (0.9)	
Excellent	1 (0.7)	1 (1.2)	1 (0.9)	
Mandarin skills (self-report), No. (%)				1.00
None	135 (88.8)	73 (88.0)	96 (88.1)	
Poor	2 (1.3)	1 (1.2)	1 (0.9)	
Fair	2 (1.3)	1 (1.2)	2 (1.8)	
Good	8 (5.3)	5 (6.0)	6 (5.5)	
Very good	5 (3.3)	3 (3.6)	4 (3.7)	
Excellent	0	0	0	
CCLA testing results, No. (%)				.77
Did not test	131 (86.2)	72 (86.7)	91 (83.5)	
Fail (Spanish)	2 (1.3)	0	2 (1.8)	
Fail (Cantonese)	0	0	0	
Fail (Mandarin)	2 (1.3)	1 (1.2)	2 (1.8)	
Pass (Spanish)	9 (5.9)	6 (7.2)	6 (5.5)	
Pass (Cantonese)	3 (2.0)	2 (2.4)	3 (2.8)	
Pass (Mandarin)	5 (3.3)	2 (2.4)	5 (4.6)	

	Total unique PCPs (N = 152)	Pre-LASI clinicians (n = 83)[a]	Post-LASI clinicians (n = 109)[a]	*P* value[b]
No. of patient participants per clinician				**<.001**
Mean ± SD (range)	9.6 ± 13.7 (1-122)	3.4 ± 4.0 (1-20)	10.8 ± 12.3 (1-102)	
Median (IQR)	6 (2-10.5)	2 (1-4)	7 (4-13)	

Abbreviations: CCLA, Clinician Cultural and Linguistic Assessment; IQR, interquartile range; LASI, Language Access Systems Improvement; NP, nurse practitioner; PCP, primary care provider.
[a]Forty clinicians had patients in both pre- and post-LASI periods.
[b]*P* values are from χ^2 tests (for categorical variables) or 1-way ANOVAs (for continuous variables); significance set at $P < .05$ (bold).

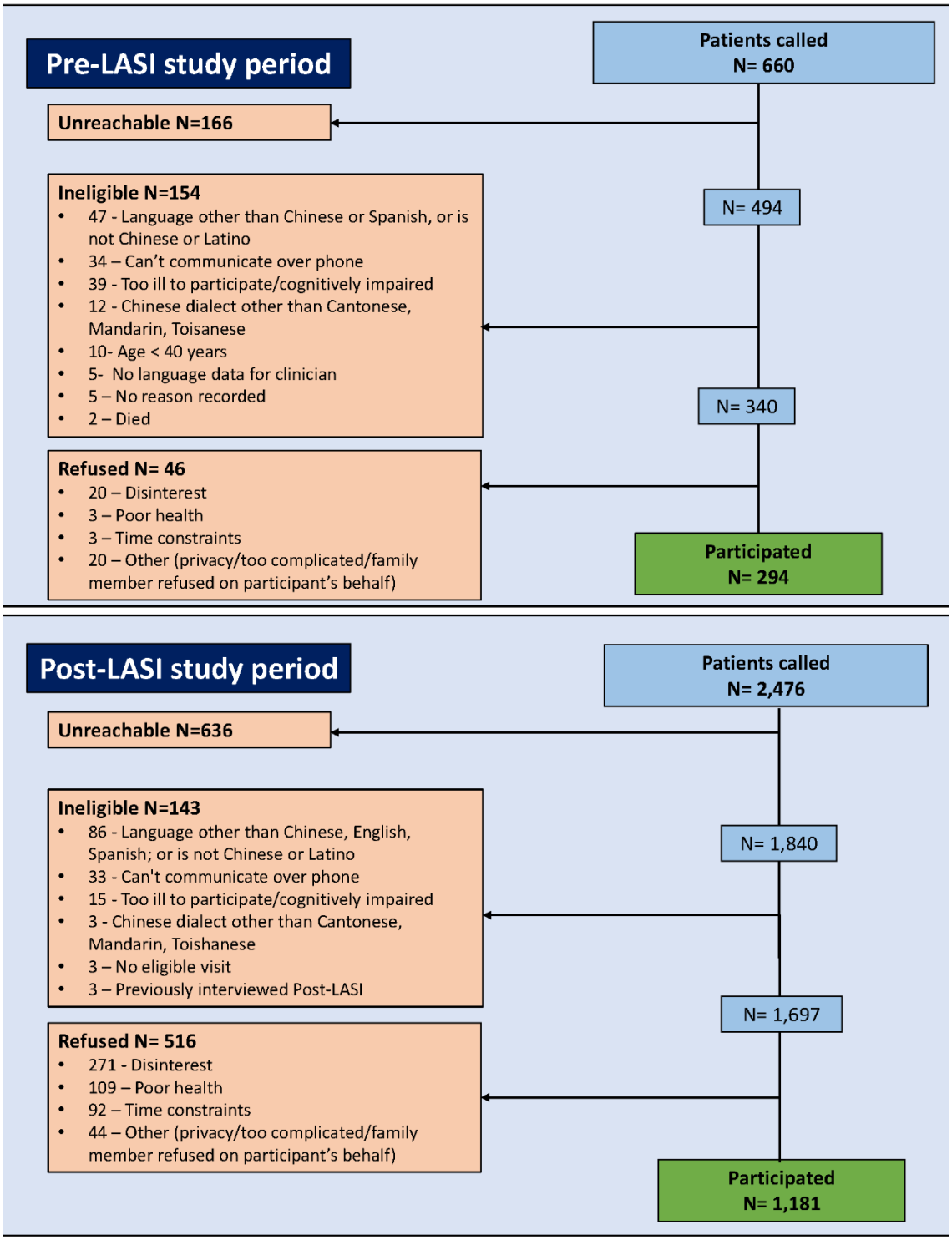
Patient Participation

In the pre-LASI study period, we called 660 patients, each within 1 week after their primary care visit: 166 were unreachable, 154 were ineligible, 46 refused participation, and 294 participated, for an overall participation rate of 58% (n = 294 of 506) and a participation rate among those we reached by phone of 87% (n = 294 of 340; Figure 3). We conducted these telephone calls and interviews as part of a quality improvement program, and they were completed before award of this PCORI proposal.

In the post-LASI study period, we called 2476 patients, each within 1 week after their primary care visit: 143 were ineligible, 636 were unreachable, 516 refused, and 1181 participated, for an overall participation rate of 51% (n = 1181 of 2333) and a participation rate among those we reached by phone of 70% (n = 1181 of 1697).

Participation rates in the post-LASI period were higher for Cantonese speakers (66% overall; 83% among those reached) and Mandarin speakers (62% overall; 76% among those reached), compared with Spanish speakers (52% overall; 71% among those reached), and lowest for English speakers (39% overall; 63% among those reached).

Figure 3. Flow Diagram of Participation for Aim 1 Telephone Interviews



Abbreviation: LASI, Language Access Systems Improvement.

Patient and Visit Characteristics Pre-LASI vs Post-LASI

We display patient and visit characteristics in the 2 study periods in Table 2. For the patients with LEP, the pre- and post-LASI samples were very similar. However, they did differ in the following ways: Compared with the pre-LASI sample, a higher proportion of sampled post-LASI patients graduated from high school and college and had adequate health literacy, and a lower proportion had private insurance. Although the mean count of comorbidities in the 2 groups was the same, those in the post-LASI sample had, on average, fewer primary care visits in the prior year.

There were marked differences between the LEP and EP groups in the post-LASI sample. Patients with LEP in the post-LASI sample were older, on average, than English speakers, had lower educational attainment, more comorbidities, and more primary care visits in the prior 12 months. Those with LEP were also less likely to have adequate health literacy, be privately insured, and see a faculty PCP at their visit.

Table 2. Characteristics of Primary Care Patients and Their Visit Clinicians: Patients With LEP by Pre-LASI and Post-LASI Periods and Patients With EP Post-LASI (N = 1475)[a]

	Patients with LEP			Patients with EP
	Pre-LASI (n = 294)	Post-LASI (n = 735)	*P* value[b]	Post-LASI (n = 446)
Preferred non-English language, No. (%)			.16	N/A
Spanish	90 (30.6)	190 (25.9)		
Cantonese	130 (44.2)	388 (52.8)		
Mandarin	74 (25.2)	157 (21.4)		
Ethnicity, No. (%)			.28	
Latino	90 (30.6)	189 (25.7)		176 (39.5)
Chinese	204 (69.4)	546 (74.3)		270 (60.5)
Age, mean ± SE (range), y	71.0 ± 0.8 (40-97)	70.2 ± 0.8 (40-97)	.37	62.8 ± 0.7 (40-95)
Sex, No. (%)			.10	
Female	208 (70.7)	483 (65.7)		255 (57.2)
Male	86 (29.3)	252 (34.3)		191 (42.8)
Education, No. (%)			<.001	
Less than high school	152 (51.7)	356 (48.4)		27 (6.1)
High school diploma	39 (13.3)	153 (20.8)		52 (11.7)
Associate's degree or some college	46 (15.6)	72 (9.8)		92 (20.6)
College degree or higher	44 (15.0)	149 (20.3)		272 (61.0)
Refused to answer/DK/missing data	13 (4.4)	5 (0.7)		3 (0.7)
Health literacy, No. (%)			<.001	
Inadequate	133 (46.3)	172 (23.4)		72 (16.1)
Adequate	140 (48.8)	555 (75.6)		369 (82.7)
Does not fill out medical forms	14 (4.9)	7 (1.0)		5 (1.1)

	Patients with LEP			Patients with EP
	Pre-LASI (n = 294)	Post-LASI (n = 735)	*P* value[b]	Post-LASI (n = 446)
Insurance status, No. (%)			.01	
Private	54 (18.4)	86 (11.7)		211 (47.3)
Medicare	193 (65.6)	501 (68.2)		193 (43.3)
Medi-Cal	47 (16.0)	148 (20.1)		42 (9.4)
Comorbidity count, mean ± SE (range)	2.6 ± 0.1 (0-9)	2.6 ± 0.1 (0-9)	.89	2.5 ± 0.1 (0-9)
No. of primary care visits in prior 12 mo, mean ± SE (range)	4.4 ± 0.2 (0-14)	3.4 ± 0.1 (0-16)	<.001	2.7 ± 0.2 (0-19)
Length of time in practice, mean ± SE (range), mo[c]	28.1 ± 1.1 (0-35.5)	30.7 ± 0.7 (0-35.5)	.01	31.4 ± 0.5 (0-35.5)
No. of problems in visit note assessment and plan, mean ± SE (range)	5.6 ± 0.3 (1-16)	5.1 ± 0.3 (1-21)	.16	4.9 ± 0.2 (1-16)
Type of clinician, No. (%)			.72	
Faculty physician	182 (61.9)	426 (57.9		313 (70.2)
Resident physician	91 (31.0)	268 (36.5)		113 (25.3)
NP	21 (7.1)	41 (5.6)		20 (4.5)
Saw own PCP at visit, No. (%)	226 (76.9)	532 (72.4)	.40	334 (75.1)
Sex of visit clinician, No. (%)			.35	
Female	193 (65.6)	440 (59.9)		288 (64.6)
Male	101 (34.4)	295 (40.1)		158 (35.4)

Abbreviations: DK, don't know; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency; N/A, not applicable; NP, nurse practitioner; PCP, primary care provider.

[a]There were 1475 visits for 1301 unique patients: 120 in pre-LASI only, 1007 in post-LASI only, and 174 patients with LEP in both the pre-LASI and post-LASI periods.

[b]*P* values are from χ^2 tests (for categorical variables) or 1-way ANOVA (for continuous variables), comparing pre- and post-LASI samples of patients with LEP and accounting for clustering of patients within clinicians; significance was set at $P < .05$.

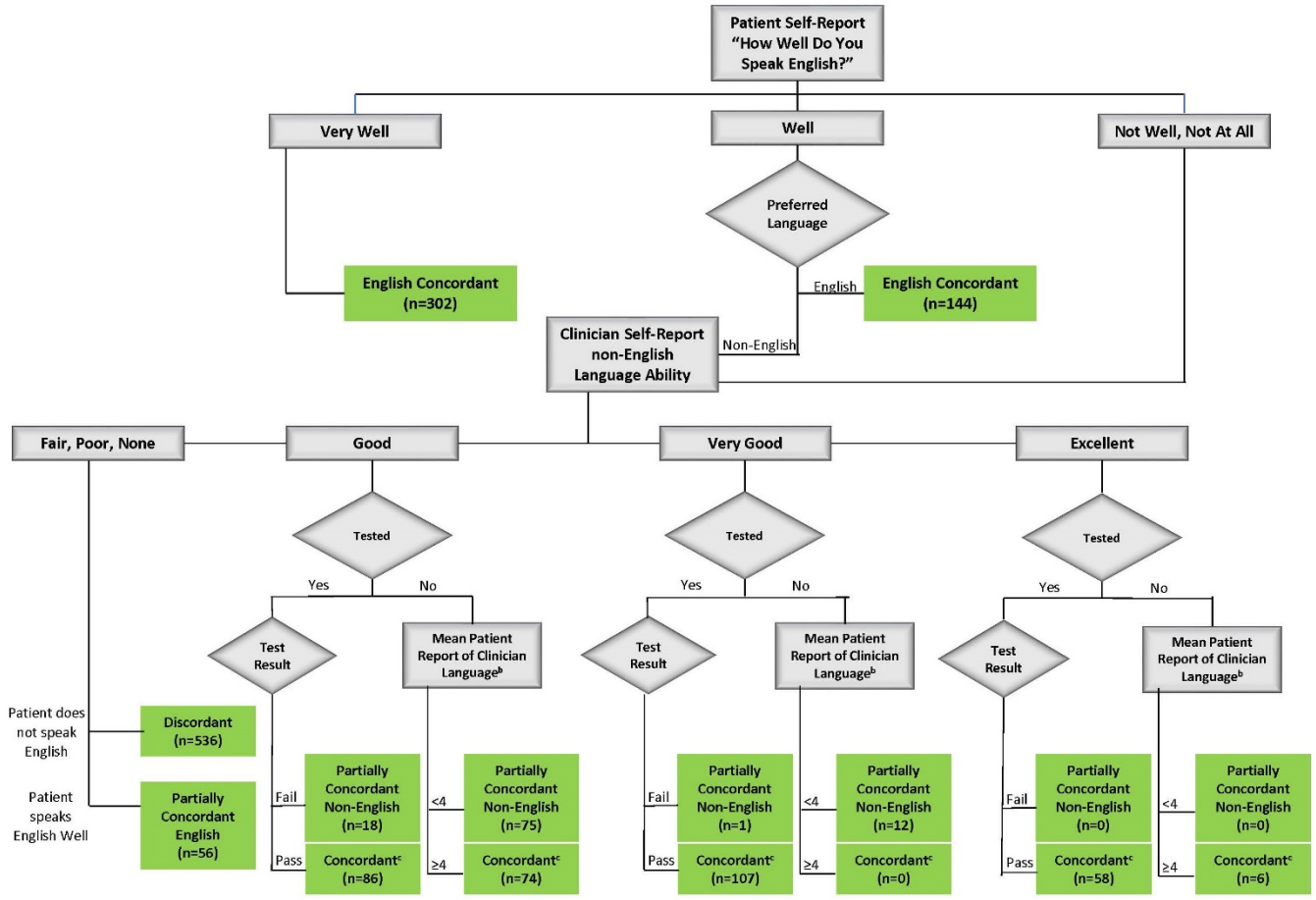
[c]The maximum amount of retrospective patient information available in the EMR for the pre-LASI patients covered 35.5 mo. Therefore, length of time as a patient in the practice was truncated at 35.5 mo for all groups.

Visit Classification by Patient and Clinician Language Skills

As described in the Methods section, to classify visits, we used a combination of patient self-reported English-speaking ability; formal testing of clinicians' fluency in Cantonese, Mandarin, or Spanish; and, for those clinicians who were eligible for testing but did not test, the mean of at least 3 patients' reports of their clinician's non–English language fluency. The 5 visit classifications included English concordant, non-English concordant, partially concordant non-English, partially concordant English, and discordant. Figure 4 presents the flow diagram and results of this visit classification in detail.

Overall in our sample, we had 446 English-concordant visits (post-LASI only), 331 non–English-concordant visits, 106 partially concordant non-English visits, 56 partially concordant English visits, and 536 discordant visits (combined pre- and post-LASI). Distribution of the LEP visit types pre- and post-LASI was similar (P = .11).

Figure 4. Visit Classification by Patient and Clinician Language Skills (N = 1475)[a]



[a]The total number of participants by group: English concordant, 446; non-English concordant, 331; partially concordant English, 56; partially concordant non-English, 106; and discordant, 536.
[b]Patient report of clinician language skill in patient's preferred language: 5 = excellent; 4 = very good; 3 = good; 2 = fair; 1 = poor/none. Ratings were used only if a given clinician had ≥3 patients reporting.
[c]There were 14 visits in which the clinician was fluent in Mandarin and the patient preferred Cantonese but reported speaking Mandarin well; these visits were categorized as non-English concordant.

Aim 1a Outcome: Use of Professional Interpreters

We included only partially concordant non-English, partially concordant English, and discordant visits as eligible for professional interpreter use (N = 698). In Table 3, we present the bivariate results of interpreter use by study period and visit classification. Overall, professional interpreter use increased after LASI implementation (pre-LASI, 57% vs post-LASI, 66%; *P* = .01). The type of professional interpreter was different post-LASI compared with pre-LASI, with a

shift away from both in-person (72% vs 15%) and telephonic interpretation (29% vs 11%) to VMI (74% vs 0%; *P* < .001).

Table 3. Comparison of Professional Interpreter Use in the Post-LASI Period Compared With the Pre-LASI Period by Visit Classification and Overall (N = 698)

	Professional interpreter use		
	Pre-LASI (n = 202) No./total (%)	**Post-LASI (n = 496) No./total (%)**	***P* value[a]**
Discordant	104/145 (71.7)	297/391 (76.0)	.09
Partially concordant English	2/11 (18.2)	11/45 (24.0)	.78
Partially concordant non-English	10/46 (21.7)	19/60 (31.7)	.15
All	116/202 (57.4)	327/496 (65.9)	.01

Abbreviation: LASI, Language Access Systems Improvement.
[a]*P* values are from χ^2 tests accounting for clustering of patients within clinicians; statistical significance was set at *P* < .05.

Although use increased for all types of eligible visits, it was already quite high for discordant visits in the pre-LASI period, and 24% (n = 94) of discordant visits in the post-LASI period remained without professional interpretation. Most (n = 59 [63%]) of the 94 nonprofessionally interpreted discordant visits had a family member or friend present who, according to the patient's report, spoke both their preferred language and English well or very well and interpreted during the visit for the patient (ad hoc interpretation). Compared with the discordant-professionally interpreted visits, these discordant ad hoc–interpreted visits were with patients who were older, on average, (ad hoc interpreted, 75.0 ± 1.3 years vs professionally interpreted, 69.3 ± 0.5 years; *P* < .001) and who had more comorbidities (ad hoc interpreted, 3.2 ± 0.2 vs professionally interpreted, 2.5 ± 0.1; *P* = .004). Other patient and visit characteristics were similar.

IPW analysis. Including all 698 interpreter-eligible visits, post-LASI visits did not have statistically significantly higher odds of using a professional interpreter compared with pre-LASI visits (OR, 2.02; 95% CI, 0.99-4.14). However, when restricted to those 499 visits with good

estimated propensity-score overlap, post-LASI visits had >2-fold higher odds of using a professional interpreter compared with pre-LASI visits (OR, 2.39; 95% CI, 1.04-5.48). There was no significant interaction between language and study period within the sample including eligible visits (N = 698) or the sample restricted based on estimated propensity-score overlap (n = 499).

Aim 1b Outcomes: Visit Recommendations, Awareness of Visit Recommendations, and Completion of Next Steps After the Visit

New medication prescription, diet and exercise discussions at the index visit, and patient-reported awareness of these recommendations. Table 4 presents the bivariate and IPW comparison of patients with LEP pre-LASI and post-LASI for frequency of visit recommendations documented in the medical record and patient-reported awareness of those recommendations.

Table 4. Unadjusted and IPW Comparison of Patients With LEP Pre- and Post-LASI: New Medication Prescription, Diet Discussion, Exercise Discussion, and Patient-Reported Awareness of These Prescriptions and Discussions Within 1 Week of a Primary Care Visit

	Patients With LEP Pre-LASI, no./total (%)	Patients With LEP Post-LASI, no./total (%)	Unweighted *P* value[a]	IPW, OR (95% CI)
New medication prescription	115/294 (39.1)	282/735 (38.4)	.823	0.99 (0.60-1.61)
Patient aware of new medication	83/115 (72.2)	235/282 (83.3)	.007	1.62 (0.73-3.60)
Diet discussion recorded	93/294 (31.6)	219/735 (29.8)	.608	0.91 (0.55-1.49)
Patient aware of diet discussion	43/93 (46.7)	179/219 (81.7)	<.001	5.94 (2.28-15.5)
Exercise discussion recorded	89/294 (30.3)	299/735 (40.7)	.002	2.04 (1.24-3.36)
Patient aware of exercise discussion	46/89 (52.3)	232/299 (77.6)	<.001	5.02 (1.97-12.8)

Abbreviations: IPW, inverse probability weighted; LASI, Language Access Systems Improvement; LEP, limited English proficiency; OR, odds ratio.

[a] *P* values are from χ^2 tests accounting for clustering of patients within clinicians; statistical significance was set at $P < .05$.

There was no difference in frequency of new medication prescription at the index visit either on bivariate analysis or after applying IPW. On bivariate analysis, compared with the pre-LASI sample, the post-LASI sample of patients with LEP had a significantly higher rate of awareness that a new medication was prescribed; however, this difference was no longer significant after applying IPW.

Similar to new medication prescriptions, there was no difference in frequency of diet discussion at the index visit on bivariate analysis or after applying IPW. However, compared with the pre-LASI sample, the post-LASI sample of patients with LEP had a significantly higher rate of awareness of the diet discussion on both bivariate analysis and after applying IPW.

Both frequency and awareness of exercise discussion were higher in the post-LASI sample of patients with LEP compared with the pre-LASI sample. This finding was robust to application of IPW.

Patient-reported awareness for the post-LASI sample of patients with LEP compared with the post-LASI sample of patients with EP. Frequency of new medication awareness (83.3% vs 79.6%; *P* = .30) and diet discussion awareness (81.7% vs 85.6%; *P* = .30) was similar when comparing the post-LASI sample of patients with LEP with the post-LASI sample of patients with EP. However, awareness of exercise discussion (77.6% vs 87.7%; *P* = .003) was lower for the post-LASI LEP sample compared with the post-LASI EP sample.

Language and LASI period interaction. There was a significant interaction effect between patient language (Cantonese, Mandarin, Spanish) and study period in the IPW model of patient awareness of diet discussion (*P* = .049). The post- vs pre-LASI effect on awareness of diet discussion was strongest for Cantonese speakers (OR, 20.8; 95% CI, 7.5-58; 22.9% pre- vs 79.0% post-LASI), weakest for Mandarin speakers (OR, 2.0; 95% CI, 0.3-12; 52.0% pre- vs 68.9% post-LASI), and in between the other 2 languages for Spanish speakers (OR, 8.0; 95% CI, 1.3-47; 68.7% pre- vs 94.2% post-LASI).

Completion of Next Steps After Visit: Ordered Laboratory Tests and Specialist Referral

Table 5 shows the bivariate comparison of the pre- and post-LASI LEP groups for clinician ordering and patient completion of laboratory tests as well as clinician referrals to a specialist and patient completion of those referrals. There was no statistically significant difference in the frequency of laboratory test ordering (52% post-LASI vs 51% pre-LASI; *P* = .94) or clinician referrals (33% post-LASI vs 34% pre-LASI; *P* = .76).

Table 5. Ordering and Completion of Laboratory Tests and Specialist Referrals After 1475 Primary Care Visits With Ethnically Chinese and Latino Patients

	Overall, No. (%)	Pre-LASI LEP, No. (%)	Post-LASI LEP, No. (%)	*P* value[a]	Post-LASI EP, No. (%)
Laboratory tests					
None ordered	689 (46.7)	143 (48.6)	355 (48.3)	.04	191 (42.8)
Ordered, never completed	58 (3.9)	8 (2.7)	31 (4.2)		19 (4.3)
Completed within 30 d	475 (32.2)	82 (27.9)	229 (31.2)		164 (36.8)
Completed within 31-100 d	130 (8.81)	43 (14.6)	59 (8.0)		28 (6.3)
Completed in >100 d	123 (8.34)	18 (6.12)	61 (8.3)		44 (9.9)
Specialist referrals					
No referral made	958 (65.0)	193 (65.7)	490 (66.7)	.58	275 (61.7)
Referral never completed	143 (9.7)	31 (10.5)	60 (8.2)		52 (11.7)
Completed within 30 d	165 (11.2)	29 (9.9)	90 (12.2)		46 (10.3)
Completed within 31-100 d	143 (9.7)	28 (9.5)	67 (9.1)		48 (10.8)
Completed in >100 d	66 (4.5)	13 (4.4)	28 (3.8)		25 (5.6)

Abbreviations: EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

[a]*P* values are from χ^2 tests accounting for clustering of patients within clinician; statistical significance set at $P < .05$.

Among those with laboratory tests ordered, ultimate completion of those tests was very high and similar between post-LASI and pre-LASI samples of patients with LEP (91.8% and 94.7%, respectively; *P* = .30). Among those with specialist referrals, completion of referral appointments was also similar between the samples (75.5% and 69.3%, respectively; *P* = .23). Laboratory test completion was similar for the post-LASI LEP sample compared with the post-LASI EP sample (91.8% vs 92.6%; *P* = .76), as was specialist referral visit completion (75.5% vs 69.6%; *P* = .16).

In IPW analyses, there was no significant difference between the post-LASI LEP and pre-LASI LEP sample in laboratory test completion (OR, 0.77; 95% CI, 0.27-2.22) or specialist referral visit completion (OR, 1.4; 95% CI, 0.7-2.7).

In a Cox model that adjusted for covariates, compared with the pre-LASI sample, there was a higher rate of laboratory test completion within 30 days for the post-LASI sample of patients with LEP (hazard ratio [HR], 1.25; 95% CI, 1.0-1.6). A significant post- vs pre-LASI effect did not remain when laboratory test completion times were censored at 100 days (HR, 1.06;

95% CI, 0.89-1.28). There was no significant interaction effect between language and study period.

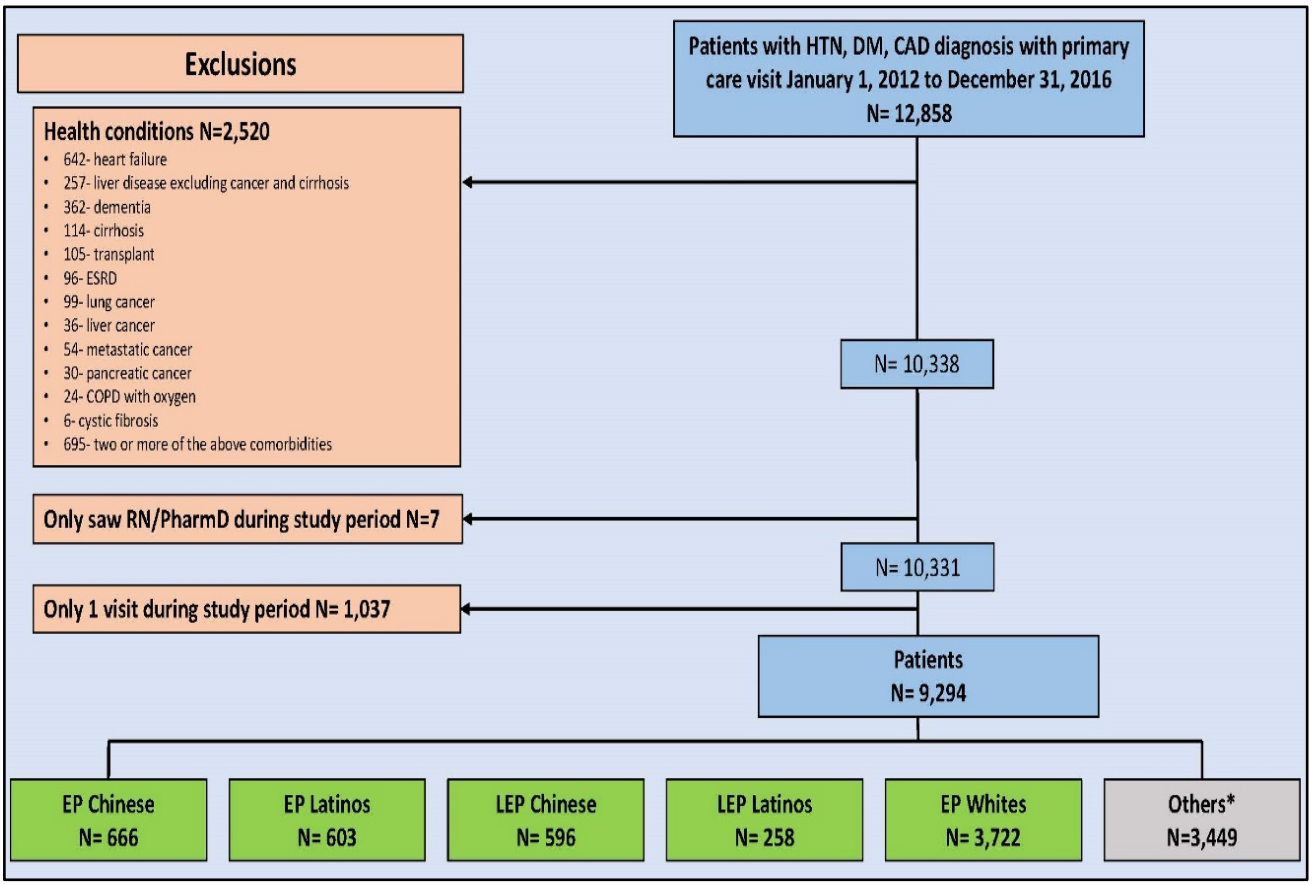
After covariate adjustment, compared with the pre-LASI sample, there was no significant difference in the rate of specialist visit completion within 30 days (HR, 1.29; 95% CI, 0.89-1.87) or within 100 days (HR, 1.11; 95% CI, 0.81-1.51) for the post-LASI sample of patients with LEP. There was no significant interaction between language and study period.

Aim 2

Evaluate clinical outcomes—guideline-concordant care for HTN, DM, and CAD—among Chinese and Spanish speakers post-LASI compared with pre-LASI vs a nonintervention comparison group of Chinese and Latino patients who have EP.

After exclusions, there were 9294 patients with a diagnosis of HTN, DM, CAD, or a combination of these and at least 2 eligible visits during the study period. Of these patients, 854 were ethnically Chinese or Latino with LEP and 1269 were ethnically Chinese or Latino with EP. These patients were included in our primary analyses comparing patients by EP status over the 3 LASI periods: pre-LASI, LASI rollout, and post-LASI. There were an additional 3722 White patients with EP who were included in our secondary analyses comparing patients by language and ethnicity group over the LASI periods. The remaining 3449 patients were not included in these analyses (Figure 5).

Figure 5. Flow Diagram for Participation in Aim 2: EMR Analyses



Abbreviations: CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; EMR, electronic medical record; EP, English proficiency; ESRD, end-stage renal disease; HTN, hypertension; LEP, limited English proficiency; PharmD, doctor of pharmacy (pharmacist); RN, registered nurse.
*Includes Black/African American, Asian (non-Chinese), Native Hawaiian/Pacific Islander, American Indian/Alaska Native, other race/ethnicity, White other languages (not English, Chinese, or Spanish).

Table 6 lists the characteristics of the 5845 included patients at their first eligible visit during the study period. Overall, compared with patients with EP, regardless of ethnicity, patients with LEP were older, less often privately insured, and had more primary care visits in the 12 months prior to study eligibility. Compared with White patients with EP, ethnically Chinese and Latino patients, regardless of EP status, were more often female, had more diagnoses of DM, and more often saw a resident physician.

Table 6. Characteristics at First Eligible Visit During the Study Period for Patients With Diagnoses of HTN, DM, and/or CAD (N = 5845)

	White patients With EP (n = 3722)	Chinese and Latino patients with EP (n = 1269)	Chinese and Latino patients with LEP (n = 854)	*P* value[a]
Race/ethnicity, No. (%)				
Chinese	—	666 (52.5)	596 (69.8)	—
Latino	—	603 (47.5)	258 (30.2)	
White	3722 (100)	—	—	
Age, y				
Mean ± SD	61.3 ± 13.3	59.1 ± 14.9	71.9 ± 12.0	<.001
Median (IQR)	62.8 (53-70)	59.6 (49-70)	73.4 (65-80)	
Sex, No. (%)				
Female	1465 (39.4)	654 (51.5)	550 (64.4)	<.001
Male	2257 (60.6)	615 (48.5)	304 (35.6)	
Participation-eligible diagnosis, No. (%)				
HTN only	2704 (72.7)	804 (63.4)	488 (57.1)	<.001
DM only	329 (8.8)	184 (14.5)	103 (12.1)	
CAD only	182 (4.9)	47 (3.7)	39 (4.6)	
HTN and DM	293 (7.9)	175 (13.8)	166 (19.4)	
HTN and CAD	162 (4.4)	41 (3.2)	35 (4.1)	
DM and CAD	14 (0.4)	4 (0.3)	5 (0.6)	
HTN, DM, and CAD	38 (1.0)	14 (1.1)	18 (2.1)	
Insurance, No. (%)				
Private	1870 (50.2)	630 (49.6)	89 (10.4)	<.001
Medicare	1359 (36.5)	361 (28.5)	523 (61.2)	
Medicare Advantage	186 (5.0)	93 (7.3)	73 (8.6)	
Medi-Cal	251 (6.7)	172 (13.6)	150 (17.6)	
None/missing	56 (1.5)	13 (1.1)	19 (2.2)	
Clinician type, No. (%)				

	White patients With EP (n = 3722)	Chinese and Latino patients with EP (n = 1269)	Chinese and Latino patients with LEP (n = 854)	*P* value[a]
Faculty physician NP Resident physician	2543 (68.3) 280 (7.5) 899 (24.2)	842 (66.3) 71 (5.6) 356 (28.1)	559 (65.5) 29 (3.4) 266 (31.1)	<.001
No. of primary care visits in 12 mo before first eligible visit Mean ± SD Median (IQR)	 1.4 ± 1.9 1.0 (0-2)	 1.6 ± 1.9 1.0 (0-3)	 2.3 ± 2.1 2.0 (0-4)	 <.001
Day of study eligibility (range, 1-1836 d)[b] Mean ± SD Median (IQR)	 330 ± 454 72 (1-564)	 346 ± 487 41 (1-636)	 286 ± 471 1 (1-416)	 .013
No. of comorbidities Mean ± SD Median (IQR)	 1.1 ± 1.1 1.0 (0-2)	 0.9 ± 1.0 1.0 (0-1)	 0.9 ± 1.0 1.0 (0-2)	 <.001[c]

Abbreviations: CAD, coronary artery disease; DM, diabetes mellitus; EP, English proficiency; HTN, hypertension; IQR, interquartile range; LEP, limited English proficiency; NP, nurse practitioner.

[a]*P* values are from χ^2 (categorical variables) or 1-way ANOVAs (continuous variables); statistical significance set at $P < .05$.

[b]Day 1 was January 1, 2012, and day 1836 was December 31, 2016; 45.6% of the 5845 patients were eligible on day 1.

[c]The *P* value comparing mean comorbidity count across the groups is significant because the standard errors are very small: patients with EP: White, .018; Chinese and Latino,.027; patients with LEP: Chinese and Spanish speakers, .033.

The following paragraphs report the results of our primary and secondary analyses for guideline-concordant care outcomes for HTN (BP control), DM (BP and glucose control), and CAD (BP control, statin use, and antiplatelet use). For all outcomes, we present figures of model-predicted percentages for the primary analyses comparing EP status (LEP vs EP) across 3 LASI study periods (pre-LASI, LASI rollout, post-LASI) as defined in the Methods section (see Figure 1). We also present figures of model-predicted percentages for the secondary analyses comparing language-ethnicity groups (EP White, EP Chinese, EP Latino, LEP Chinese, LEP Latino) across 3 LASI study periods.

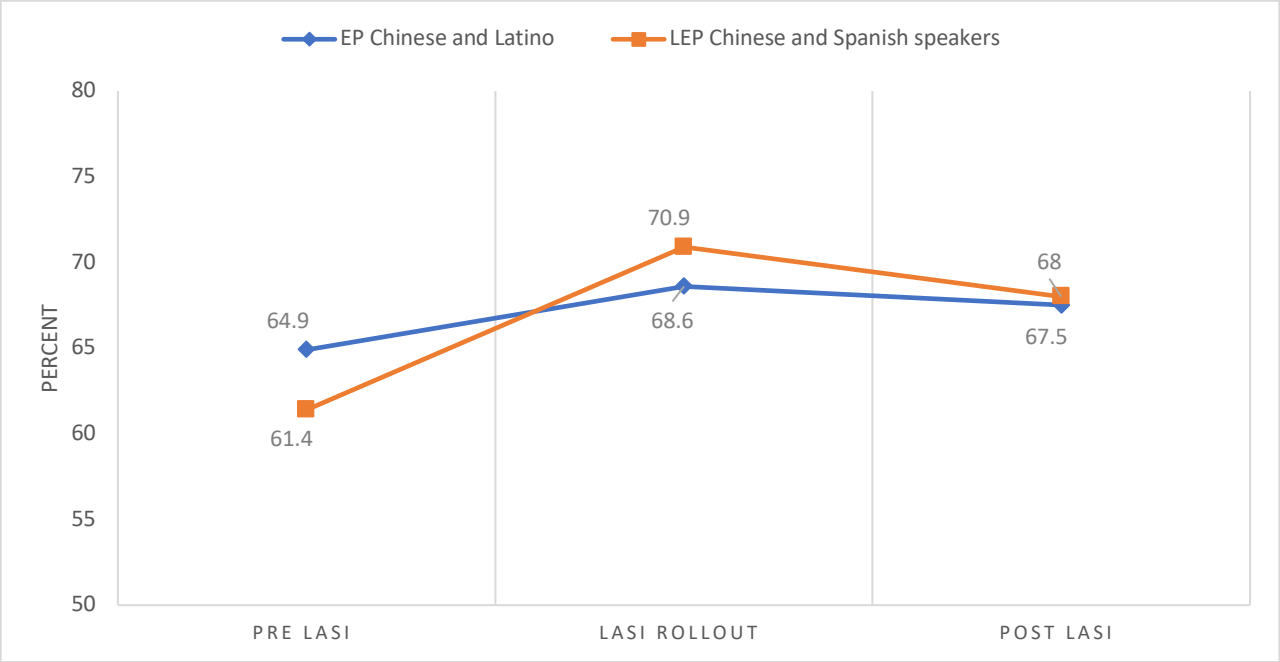
For the primary analyses, we present the propensity-score block-adjusted odds of guideline-concordant care outcomes in text and tabular form; for the secondary analyses, we present the covariate-adjusted odds of guideline-concordant care outcomes in text and tabular form. Detecting an effect of the LASI intervention on the guideline-concordant care outcomes requires a significant interaction between EP status and LASI study period for the primary analyses and, for the secondary analyses, between language-ethnicity group by LASI study period. All models tested this interaction. We found a significant interaction only for the primary analysis of BP control for patients with HTN.

HTN Outcome

BP control among all patients with HTN (n = 1792 patients in primary analysis; n = 4948 patients in secondary analysis). In analyses comparing Chinese and Latino patients with LEP with those with EP, there were differences in BP control over the course of the LASI study period. Figure 6a displays model-predicted percentages of patients with BP control in each LASI period (pre-LASI, LASI rollout, post-LASI) by EP status (LEP or EP), adjusting for propensity-score blocks. We saw overall improvement in BP control for both EP status groups coinciding with LASI rollout, which also coincided with a change in HTN management guidelines from JNC-7 to JNC-8.[65] There was a significant interaction between LASI study period and language status group (P = .03): Compared with the EP group, the LEP group had worse initial BP control, greater improvement during the LASI rollout period, and near

equal control in the post-LASI period. However, the main effect of language proficiency status (LEP vs EP) was nonsignificant within each of the LASI study periods. Both the LEP and EP groups had higher odds of at-goal BP in the post-LASI period compared with the pre-LASI period (OR, 1.18; 95% CI, 1.10-1.27; and OR, 1.07; 95% CI, 1.00-1.15, respectively), but those 2 pre- and post-LASI trends did not significantly differ from each other. Thus, despite a significant interaction effect, evidence for a LASI effect was weak.

Figure 6a. Percentage of Visits With BP Control by EP Status (Patients With HTN)

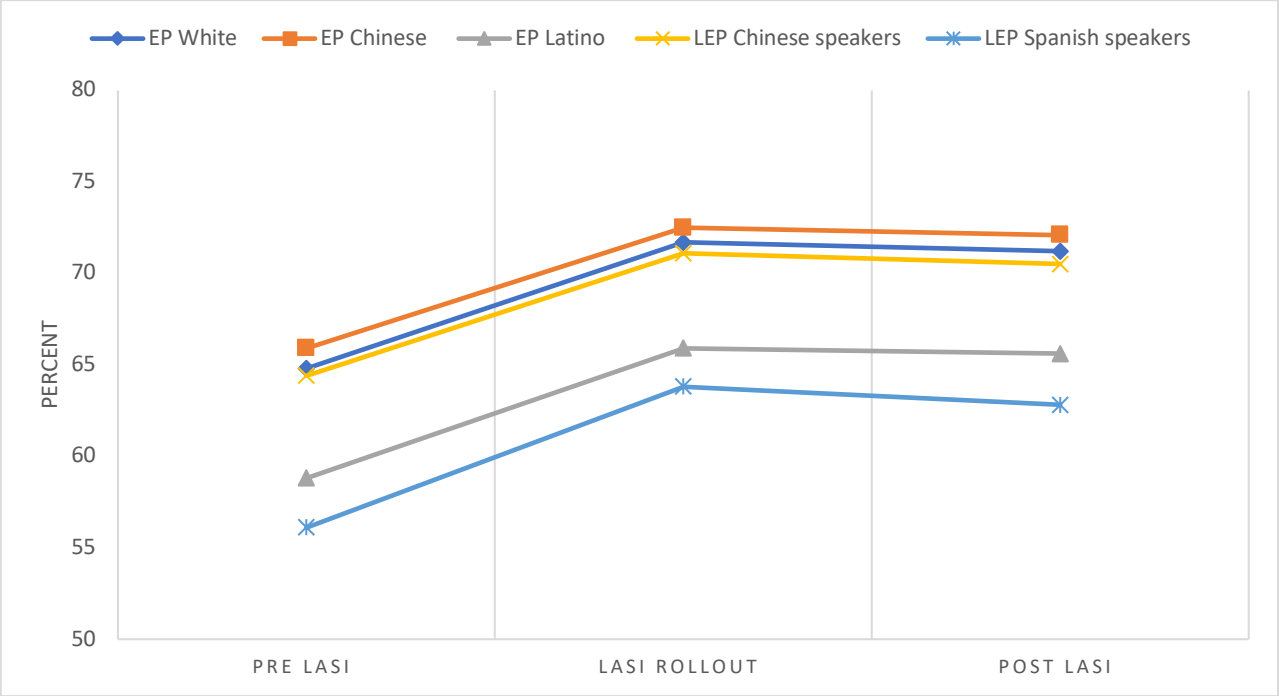


Abbreviations: BP, blood pressure; EP, English proficiency; HTN, hypertension; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

In secondary analyses, we plotted model-predicted percentages for 5 language-ethnicity groups, including English-speaking White patients (Figure 6b). Although all groups improved over the LASI study period, BP control was similar across Chinese patients with EP or LEP and White patients with EP, whereas there remained a substantial disparity for all Latino patients. Latino patients with LEP had the largest disparity in BP control. In GEE covariate-adjusted models, compared with the EP White group, averaging across study periods, the odds of BP control were similar for both the EP Chinese (OR, 1.06; 95% CI, 0.99-1.14) and the LEP Chinese groups (OR, 1.03; 95% CI, 0.96-1.11). Similar time-averaged comparisons found the odds of BP

control were significantly lower for both the EP Latino (OR, 0.89; 95% CI, 0.82-0.96) and the LEP Latino groups (OR, 0.83; 95% CI 0.75-0.91). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 6b. Percentage of Visits With BP Control by Language-Ethnicity Group (Patients With HTN)



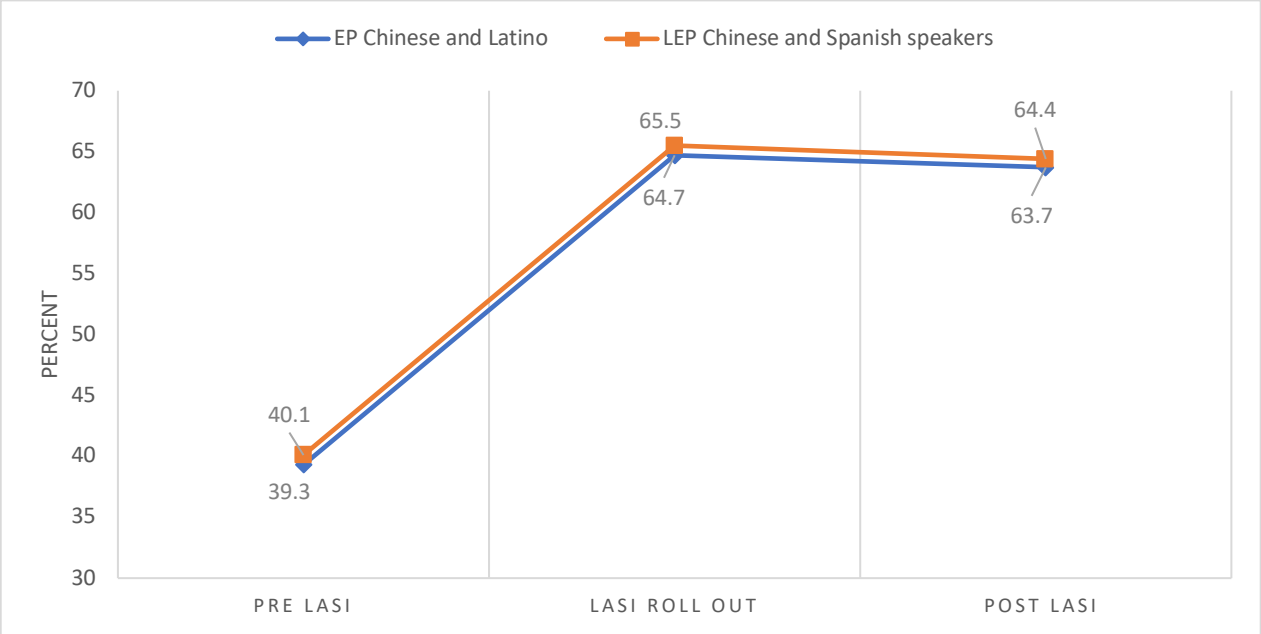
Abbreviations: BP, blood pressure; EP, English proficiency; HTN, hypertension; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

DM Outcomes: BP Control, Glucose Control

BP control among patients with DM (n = 809 patients in primary analysis; n = 1589 patients in secondary analysis). In analyses comparing Chinese and Latino patients with LEP with those with EP, there were no differences in BP control across the LASI study periods. Both groups had substantial improvement in percentage at goal at LASI rollout, which coincided with loosening of BP control guidelines for patients with DM from <130/80 mm Hg to <140/90 mm Hg.[64,65] This was largely sustained in the post-LASI period (Figure 7a). In models adjusting for propensity-score blocks, there was no time-averaged difference in the odds of BP

control for patients with LEP compared with patients with EP (Table 7). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 7a. Percentage of Visits With BP Control by EP Status (Patients With DM)



Abbreviations: BP, blood pressure; DM, diabetes mellitus; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Table 7. Guideline-Concordant BP and Glucose Control at Primary Care Visits of Patients With DM Over the LASI Study Periods, by EP Status and Language-Ethnicity Group

	Odds of BP control (95% CI)[a] (10 528 visits)	Odds of good HbA_{1c} control (95% CI)[b] (5293 measures)	Odds of poor HbA_{1c} control (95% CI)[c] (5293 measures)
Primary analysis[d]			
Study period			
Pre-LASI	Referent	Referent	Referent
LASI rollout	**1.91 (1.75-2.08)**	0.91 (0.82-1.01)	0.97 (0.83-1.13)
Post-LASI	**1.86 (1.72-2.00)**	0.92 (0.84-1.01)	1.08 (0.95-1.24)
EP status			
EP Chinese and EP Latino	Referent	Referent	Referent
LEP Chinese and LEP Latino	1.12 (0.99-1.27)	1.21 (0.98-1.48)	0.88 (0.71-1.09)
Secondary analysis[e]			
Study period			
Pre-LASI	Referent	Referent	Referent
LASI rollout	2.85 (2.55-3.18)	**0.94 (0.88-1.00)**	1.0 (0.91-1.10)
Post-LASI	**3.00 (2.72-3.31)**	**0.88 (0.83-0.93)**	**1.12 (1.04-1.21)**
Language-ethnicity group			
EP White	Referent	Referent	Referent
EP Chinese	0.94 (0.77-1.14)	0.88 (0.75-1.03)	1.02 (0.85-1.23)
EP Latino	**0.74 (0.61-0.91)**	**0.73 (0.62-0.85)**	**1.45 (1.22-1.73)**
LEP Chinese	**1.21 (1.01-1.45)**	1.08 (0.99-1.30)	0.87 (0.70-1.10)
LEP Latino	**0.77 (0.60-1.00)**	**0.64 (0.51-0.80)**	**1.58 (1.25-2.01)**

Abbreviations: BP, blood pressure; DM, diabetes mellitus; EP, English proficiency; HbA_{1c}, hemoglobin A_{1c}; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Note: Statistically significant odds ratios and their confidence intervals are indicated with bolding.

[a]For patients with coronary artery disease, between December 1, 2012, and December 31, 2013, BP control was based on Joint National Committee–7 criteria; for visits from January 1, 2014, and after, BP control was based on Joint National Committee–8 criteria.

[b]Good control is indicated by HbA_{1c} <8%.

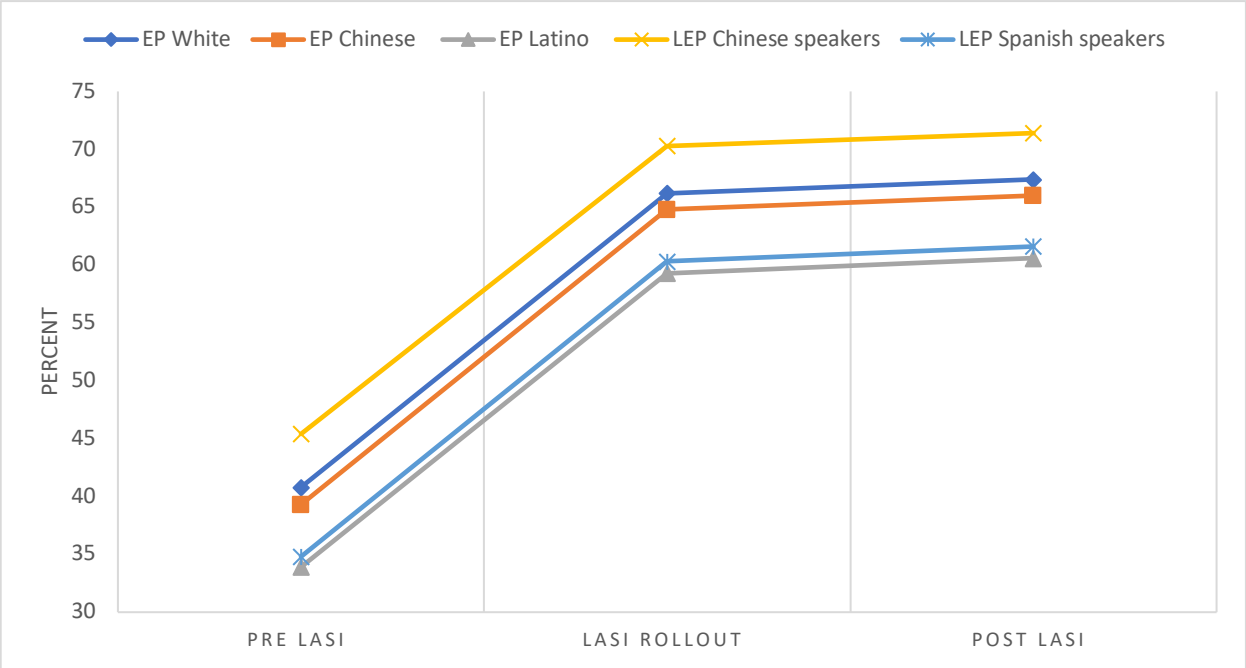
[c]Poor control is indicated by HbA_{1c} >9%.

[d]All primary models were adjusted for propensity score blocks (propensity to be LEP vs EP estimated using characteristics listed in Appendix D; each model was also tested for interaction between language-ethnicity and study period, and none were statistically significant).

[e]All secondary models were adjusted for the following visit-level covariates: patient age, sex, comorbidity count, and provider type.

In secondary analyses, we examined model-predicted percentages for the 5 language-ethnicity groups, including English-speaking White patients (Figure 7b). As with BP control for all patients with HTN, BP in patients with DM improved over the LASI study period. Compared with EP White patients, in covariate-adjusted analysis, LEP Chinese patients had higher odds of at-goal BP (OR, 1.21; 95% CI, 1.01-1.45), and EP and LEP Latino patients had lower odds of at-goal BP (OR, 0.74; 95% CI, 0.61-0.91; and OR, 0.77; 95% CI, 0.60-1.00, respectively; Table 7). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 7b. Percentage of Visits With BP Control by Language-Ethnicity Group (Patients With DM)

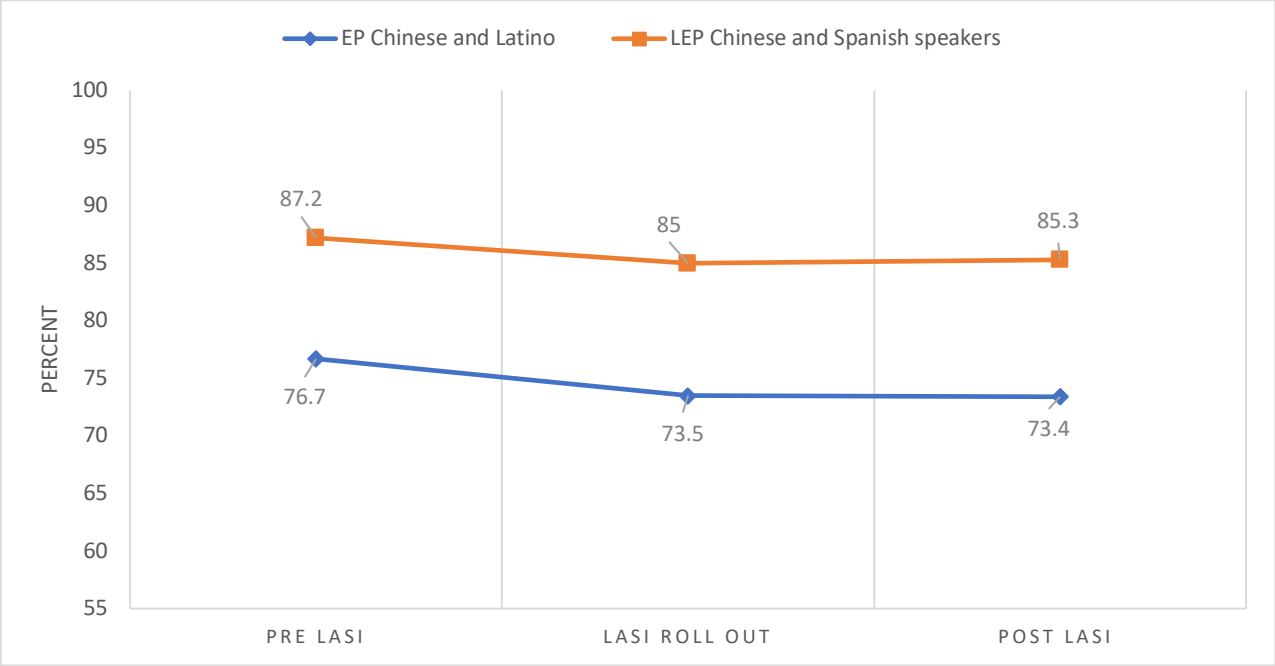


Abbreviations: BP, blood pressure; DM, diabetes mellitus; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Glucose control among patients with DM (good control, HbA_{1c} <8%; poor control, HbA_{1c} >9%; n = 704 patients in primary analysis; n = 3192 patients in secondary analysis). In analyses comparing LEP Chinese and LEP Latino patients with those with EP, there were no significant changes in glucose control over the course of the LASI study period. Patients with LEP tended to have better glucose control than did patients with EP

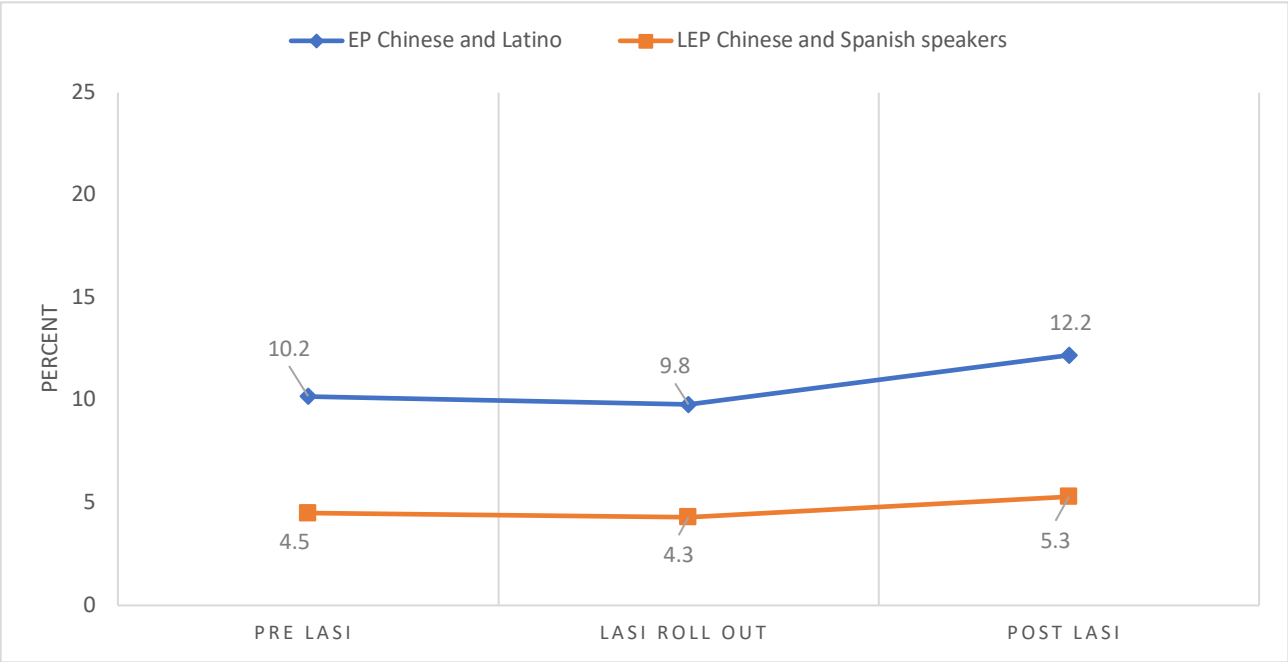
(Figure 8a and 8b). However, there was no statistically significant time-averaged difference in HbA_{1c} control (HbA_{1c} <8% or >9%) across the LEP and EP groups in the propensity-score block–adjusted model (Table 7). Finally, there was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 8a. Percentage of Measures Indicating Good Glucose Control (HbA_{1c}, <8%) by EP Status (Patients With DM)



Abbreviations: DM, diabetes mellitus; EP, English proficiency; HbA_{1c}, hemoglobin A_{1c}; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

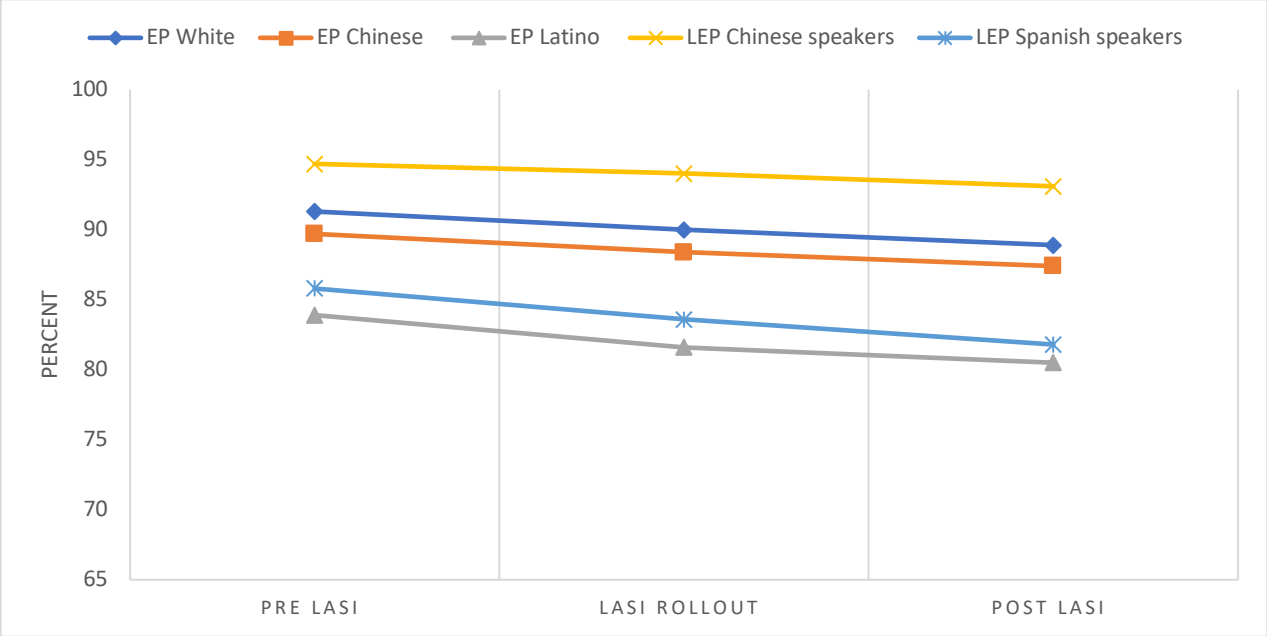
Figure 8b. Percentage of Measures Indicating Poor Glucose Control (HbA_{1c}, >9%) by EP Status (Patients With DM)



Abbreviations: DM, diabetes mellitus; EP, English proficiency; HbA_{1c}, hemoglobin A_{1c}; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

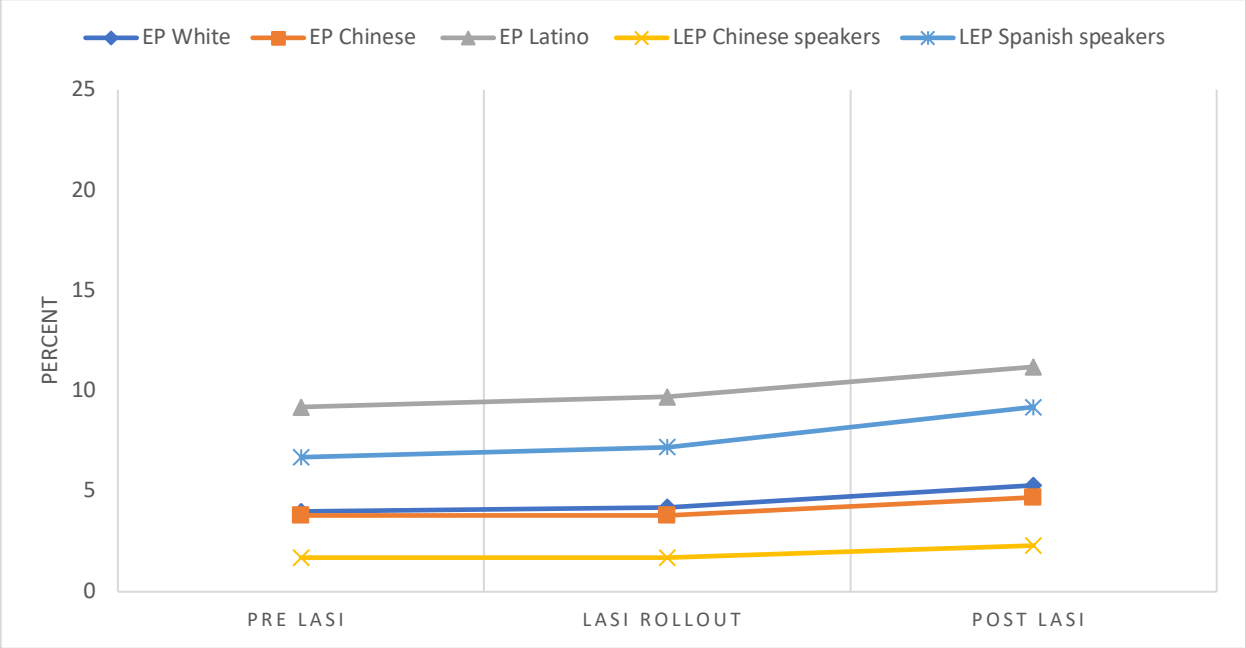
In secondary analyses, we examined model-predicted percentages across the 5 language-ethnicity groups, including English-speaking White patients (Figure 8c and 8d). Both EP and LEP Chinese patients had similar covariate-adjusted odds of good glucose control compared with EP White patients (OR, 0.88; 95% CI, 0.75-1.03; and OR, 1.08; 95% CI, 0.99-1.30, respectively). However, EP and LEP Latino patients had lower adjusted odds of good glucose control (OR, 0.73; 95% CI, 0.62-0.85; and OR, 0.64; 95% CI, 0.51-0.80, respectively) and higher adjusted odds of poor glucose control (OR, 1.45; 95% CI, 1.22-1.73; and OR, 1.58; 95% CI, 1.25-2.01, respectively; Table 7). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 8c. Percentage of Measures Indicating Good Glucose Control (HbA_{1c}, <8%) by EP Status (Patients With DM)



Abbreviations: DM, diabetes mellitus; EP, English proficiency; HbA_{1c}, hemoglobin A_{1c}; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Figure 8d. Percentage of Measures Indicating Poor Glucose Control (HbA_{1c}, >9%) by Language-Ethnicity (Patients With DM)



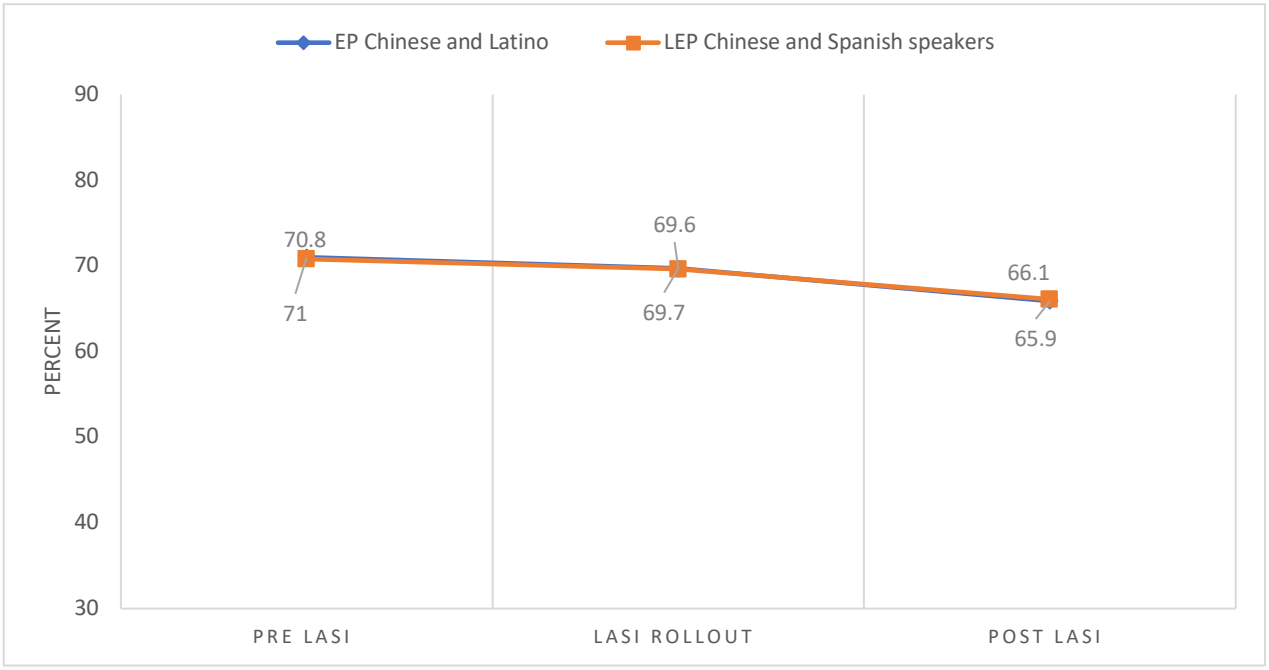
Abbreviations: DM, diabetes mellitus; EP, English proficiency; HbA_{1c}, hemoglobin A_{1c}; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

CAD: BP Control, Statin Use, and Antiplatelet Use (n = 276 Patients in Primary Analysis; n = 791 Patients in Secondary Analysis)

BP control among patients with CAD. BP control among patients with CAD declined over the study periods regardless of EP status (Figure 9a). In the propensity-score block–adjusted models, comparing the LEP group with the EP group with CAD, there was no significant difference in the odds of BP control (Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

In secondary analyses, we examined model-predicted percentages across the 5 language-ethnicity groups, including English-speaking White patients (Figure 9b). In covariate-adjusted analysis, only EP Latino patients had significantly lower odds of BP control compared with EP White patients (OR, 0.70; 95% CI, 0.56-0.88; Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 9a. Percentage of Visits With BP Control, by EP Status (Patients With CAD)



Abbreviations: BP, blood pressure; CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Table 8. Guideline-Concordant BP Control, Statin Use, and Antiplatelet Use at Primary Care Visits for Patients With CAD Over the LASI Study Periods, by EP Status and by Language-Ethnicity Group

	Odds of BP control (95% CI)[a]	Odds of statin on medication list (95% CI)	Odds of antiplatelet on medication list (95% CI)
Primary analysis (3593 visits)[b]			
Study period			
Pre-LASI	Referent	Referent	Referent
LASI rollout	0.96 (0.82-1.12)	1.06 (0.91-1.22)	1.04 (0.93-1.16)
Post-LASI	**0.87 (0.77-0.99)**	1.06 (0.92-1.22)	1.08 (0.94-1.23)
EP status			
EP Chinese and Latino	Referent	Referent	Referent
LEP Chinese and Latino	1.02 (0.82-1.26)	1.16 (0.91-1.50)	**1.55 (1.17-2.05)**
Secondary analysis (8979 visits)[c]			
Study period			
Pre-LASI	Referent	Referent	Referent
LASI rollout	0.99 (0.89-1.09)	1.02 (0.93-1.11)	0.98 (0.91-1.06)
Post-LASI	0.94 (0.86-1.01)	1.05 (0.96-1.15)	1.06 (0.97-1.15)
Language-ethnicity group			
EP White	Referent	Referent	Referent
EP Chinese	1.03 (0.84-1.27)	1.15 (0.93-1.41)	0.83 (0.64-1.08)
EP Latino	**0.70 (0.56-0.88)**	0.98 (0.76-1.27)	1.20 (0.91-1.59)
LEP Chinese	0.92 (0.77-1.11)	**1.29 (1.06-1.57)**	**1.61 (1.29-2.01)**
LEP Latino	0.85 (0.68-1.07)	1.12 (0.81-1.55)	**1.57 (1.13-2.18)**

Abbreviations: BP, blood pressure; CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

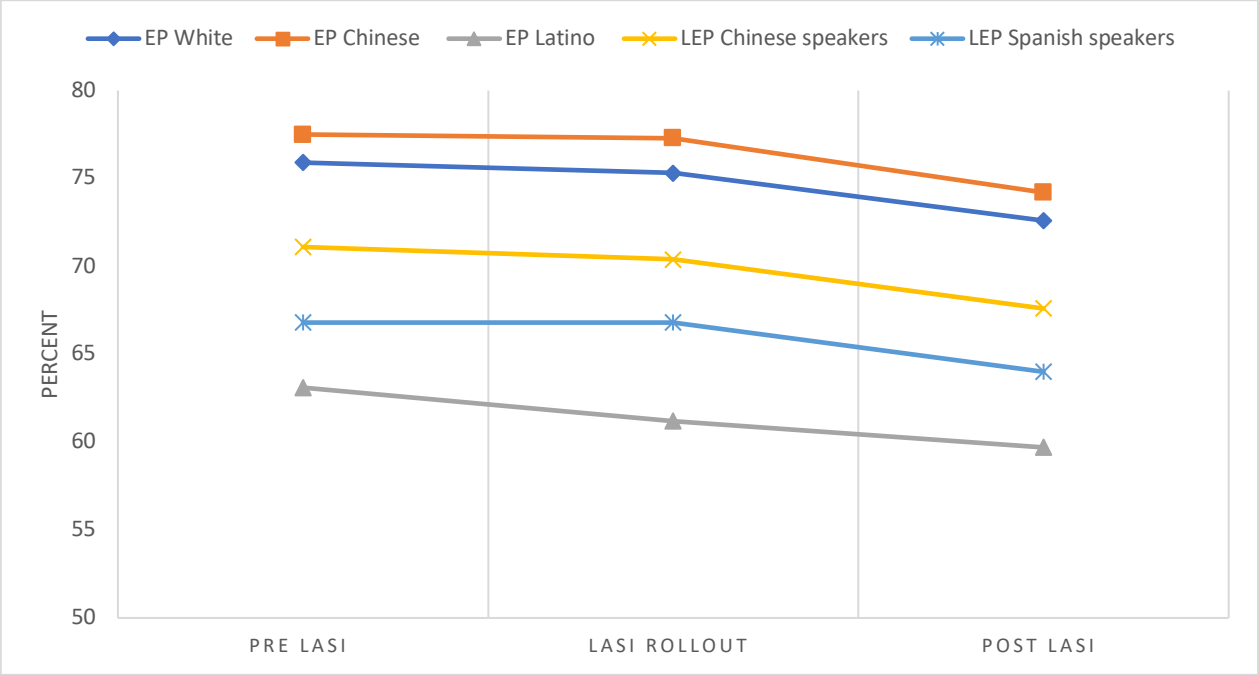
Note: Statistically significant odds ratios and their confidence intervals are indicated with bolding.

[a]BP control followed 2012-2014 American Heart Association recommendations for secondary prevention for patients with CAD.

[b]All primary models adjusted for propensity-score blocks (propensity to be LEP vs EP estimated using baseline characteristics listed in Appendix D); each model was also tested for interaction between language-ethnicity and study period, and none were statistically significant.

[c]All secondary models adjusted for the following visit level covariates: patient age, patient sex, comorbidity count, and provider type.

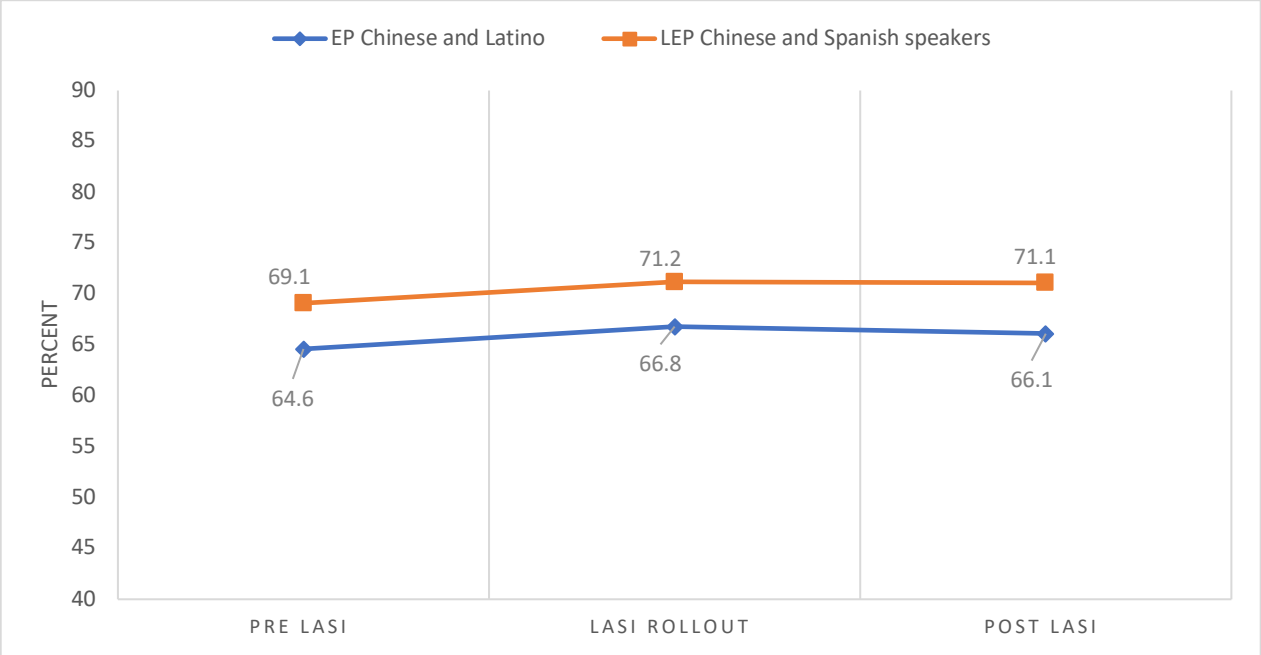
Figure 9b. Percentage of Visits With BP Control, by Language-Ethnicity (Patients With CAD)



Abbreviations: BP, blood pressure; CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Statin use among patients with CAD. Statin use among patients with CAD remained relatively stable across the LASI study periods regardless of EP status (Figure 10a). In the propensity-score block–adjusted model, comparing the LEP group and the EP group with CAD, there was no significant difference in the odds of statin use (Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

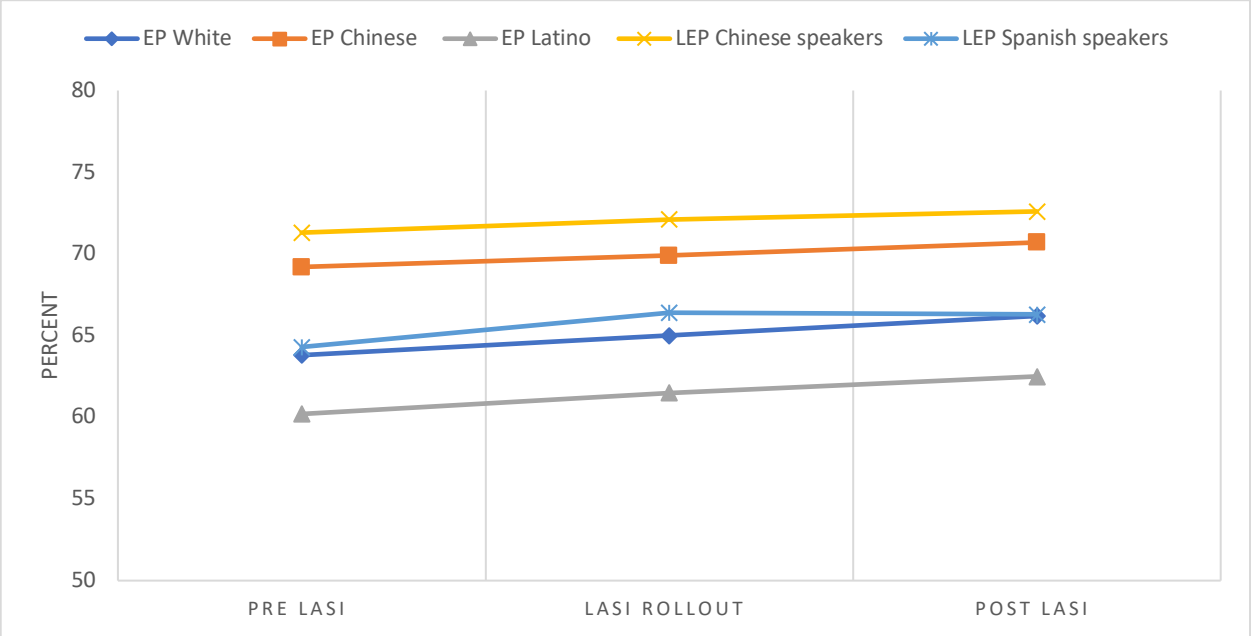
Figure 10a. Percentage of Visits With Statin Use, by EP Status (Patients With CAD)



Abbreviations: CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

In secondary analyses, we examined model-adjusted percentages across the 5 language-ethnicity groups, including English-speaking White patients (Figure 10b). In covariate-adjusted analysis, only LEP Chinese patients had a significantly higher odds of statin use compared with EP White patients (OR, 1.29; 95% CI, 1.06-1.57; Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

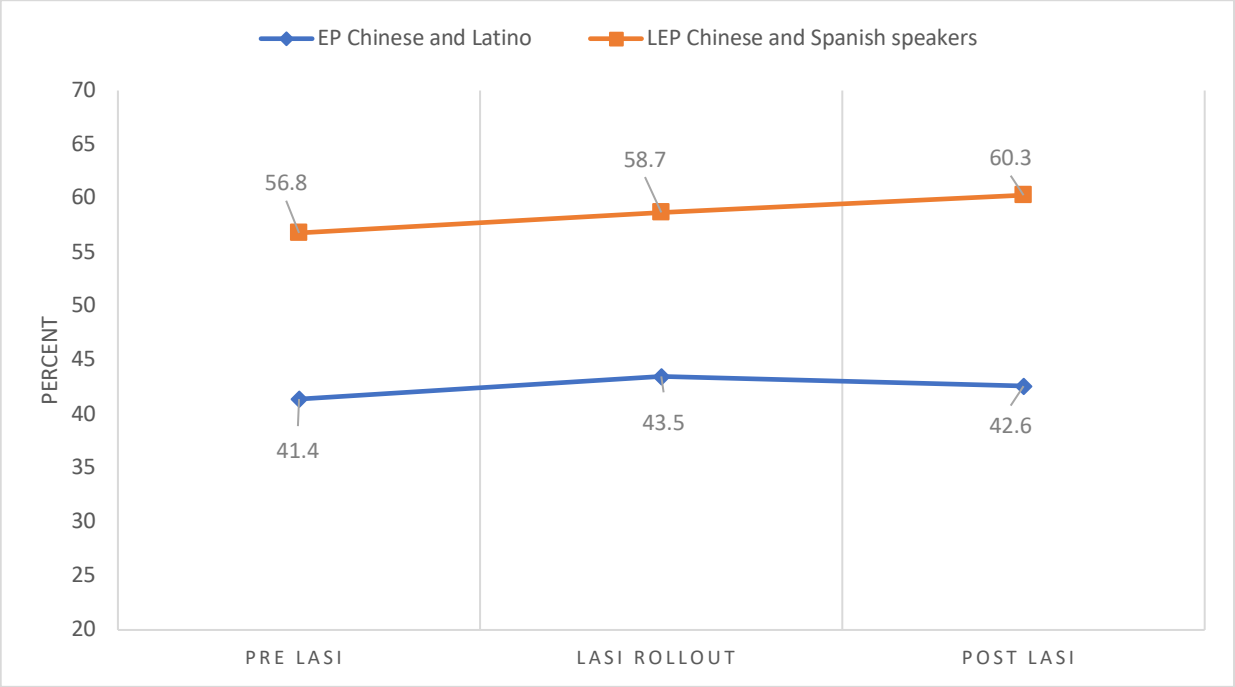
Figure 10b. Percentage of Visits With Statin Use, by Language-Ethnicity (Patients With CAD)



Abbreviations: CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Antiplatelet use among patients with CAD. Antiplatelet use among patients with CAD remained stable across the LASI study periods regardless of EP status (Figure 11a). However, in the propensity-score block–adjusted model, compared with the EP group, the LEP group with CAD had a higher odds of using antiplatelet medications (OR, 1.55; 95% CI, 1.17-2.05; Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

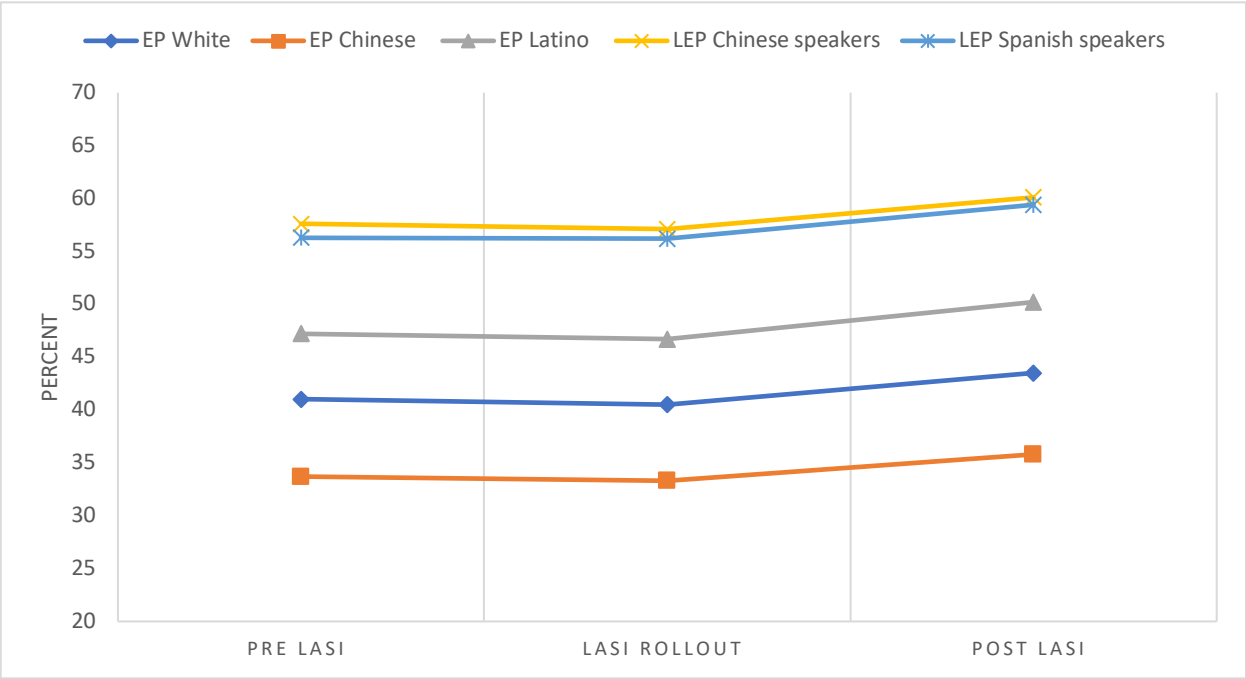
Figure 11a. Percentage of Visits With Antiplatelet Use, by EP Status (Patients With CAD)



Abbreviations: CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

In secondary analyses, we examined model-adjusted percentages for detailed language-ethnicity groups, including English-speaking White patients (Figure 11b). In covariate-adjusted analysis, LEP Chinese and LEP Latino patients had significantly higher odds of antiplatelet use compared with EP White patients (OR, 1.61; 95% CI, 1.29-2.01; and OR, 1.57; 95% CI, 1.13-2.18, respectively; Table 8). There was no significant interaction between language-ethnicity and LASI study periods, suggesting no LASI effect.

Figure 11b. Percentage of Visits With Antiplatelet Use, by Language-Ethnicity (Patients With CAD)

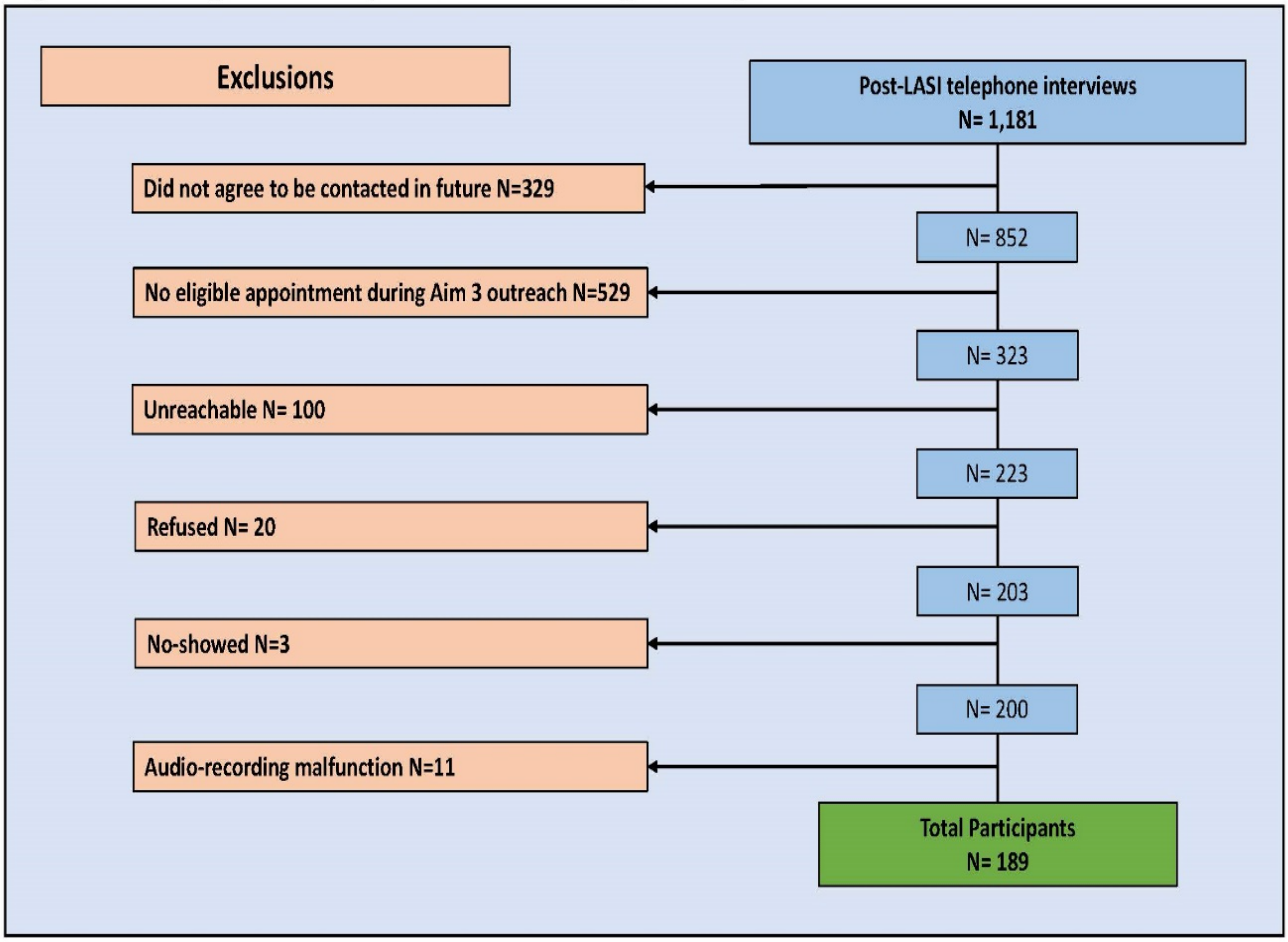


Abbreviations: CAD, coronary artery disease; EP, English proficiency; LASI, Language Access Systems Improvement; LEP, limited English proficiency.

Aim 3

Most (72%) of the aim 1 post-LASI participants agreed to be contacted in the future. Of those, we reached out to 323 who had an eligible appointment with a clinician who consented to be audio-recorded, and we successfully audio-recorded 189 primary care visits (Figure 12).

Figure 12. Flow Diagram for Participation in Audio Recording of Primary Care Visits



Abbreviation: LASI, Language Access Systems Improvement.

Comparison Across 3 Visit Types

Visit type categorization. Among the 189 visits with 50 clinicians, 58 (31%) were English concordant, 38 (20%) were non-English concordant, 55 (29%) were discordant-professionally interpreted, 12 (6%) were discordant and not professionally interpreted, 11 (6%) were partially concordant and professionally interpreted, and 15 (8%) were partially concordant

and not professionally interpreted. Among the 55 discordant-professionally interpreted visits, interpretation was via VMI for 45 (82%), in-person for 7 (13%), and by telephone for 3 (5%).

Table 9 lists the patient and clinician characteristics for the 3 visit types of interest for our RIAS analyses (English concordant, non-English concordant, discordant-professionally interpreted; N = 151). Of the 3 groups, the patients seen at discordant-professionally interpreted visits had the lowest educational attainment (less than high school education; 56% discordant-professionally interpreted vs 10% English concordant and 45% non-English concordant), were most likely to see a resident physician (58% discordant-professionally interpreted vs 17% English concordant and 29% non-English concordant), and to have a care partner accompany them (35% discordant-professionally interpreted vs 14% English concordant and 29% non-English concordant). Patients in the non-English–concordant and discordant-professionally interpreted visits were, on average, 8 years older, and more often ethnically Chinese than those in the English-concordant visits. There were, however, many similarities across visit types; these included comorbidity count, frequency of visits in the prior year, length of time in the practice (months), and percentage of patients who saw their own PCP at the recorded visit.

Table 9. Characteristics of 151 Audio-Recorded Visits by Concordance Category (N = 151 Patients With 47 Clinicians)

	English concordant (n = 58 patients; n = 34 clinicians)	**Non-English concordant** (n = 38 patients; n = 12 clinicians)	**Discordant-professionally interpreted** (n = 55 patients; n = 31 clinicians)	***P* value**[a]
Preferred language, No. (%) English Spanish Cantonese Mandarin	 58 (100) — — —	 — 10 (26.3) 21 (55.3) 7 (18.4)	 — 11 (20.0) 27 (49.1) 17 (30.9)	—
Age, mean ± SE (range), y	64.6 ± 1.4 (41-87)	72.8 ± 1.8 (47-92)	72.2 ± 1.5 (50-96)	<.001
Sex, No. (%) Female Male	 37 (63.8) 21 (36.2)	 22 (57.9) 16 (42.1)	 35 (63.6) 20 (36.4)	.80
Ethnicity, No. (%) Latino Chinese	 30 (51.7) 28 (48.3)	 10 (26.3) 28 (73.7)	 11 (20.0) 44 (80.0)	.04
Education, No. (%) Less than high school High school diploma Associate's degree or some college College degree or higher	 6 (10.3) 5 (8.6) 16 (27.6) 31 (53.5)	 17 (44.7) 6 (15.8) 5 (13.2) 10 (26.3)	 31 (56.4) 9 (16.4) 6 (10.9) 9 (16.4)	<.001
Health literacy, No. (%) Inadequate Adequate Does not fill out medical forms	 6 (10.5) 49 (86.0) 2 (3.5)	 8 (21.0) 30 (79.0) 0	 20 (37.0) 34 (63.0) 0	.10
Insurance status, No. (%) Private Medicare Medi-Cal	 14 (24.1) 38 (65.5) 6 (10.3)	 5 (13.2) 25 (65.8) 8 (21.0)	 2 (3.6) 42 (76.4) 11 (20.0)	.03
Comorbidity count, mean ± SE (range)	3.3 ± 0.3 (0-11)	3.0 ± 0.4 (0-8)	3.1 ± 0.3 (0-9)	.71
No. of primary care visits in prior 12 mo, mean ± SE (range)	4.4 ± 0.4 (0-16)	4.4 ± 0.5 (1-12)	4.9 ± 0.4 (1-13)	.66

	English concordant (n = 58 patients; n = 34 clinicians)	**Non-English concordant** (n = 38 patients; n = 12 clinicians)	**Discordant-professionally interpreted** (n = 55 patients; n = 31 clinicians)	***P* value**[a]
Patient's length of time in practice, mean ± SE (range), mo[b]	32.8 ± 1.1 (2-35.5)	32.9 ± 1.3 (2-35.5)	32.5 ± 1.1 (3-35.5)	.96
Visited clinician sex, No. (%) Female Male	 42 (72.4) 16 (27.6)	 22 (57.9) 16 (42.1)	 32 (58.2) 23 (41.8)	.45
Type of clinician, No. (%) Faculty physician Resident physician NP	 42 (72.4) 10 (17.2) 6 (10.3)	 25 (65.8) 11 (29.0) 2 (5.3)	 22 (40.0) 32 (58.2) 1 (1.8)	.02
Saw own PCP at visit, No. (%)	49 (84.5)	32 (84.2)	49 (89.1)	.73
Accompanied by care partner, No. (%)	8 (13.8)	11 (29.0)	19 (34.6)	.03

Abbreviations: NP, nurse practitioner; PCP, primary care provider.
[a]*P* values are from χ^2 tests (for categorical variables) or 1-way ANOVAs (for continuous variables), accounting for clustering of patients within clinicians; statistical significance was set at $P < .05$.
[b]The maximum amount of retrospective patient information available in the EMR covered 35.5 mo. Therefore, length of time as a patient in the practice was truncated at 35.5 mo for all groups.

Visit and communication characteristics. As shown in Table 10, the discordant-professionally interpreted visits were, on average, 7 minutes longer than the other visits and addressed fewer problems. Clinician verbal dominance did not differ across visit types. Patient centeredness (ie, the ratio of psychosocial and socioemotional talk to biomedical talk) was highest for the English-concordant visits and lowest for the discordant-professionally interpreted visits; non–English-concordant visits fell in the middle. This did not change when the talk of any accompanying care partner was included as patient-talk in calculating the patient-centeredness measure. Patient centeredness did not differ significantly by modality of interpretation (patient centeredness mean ± SE: in-person interpretation, 0.61 ± 0.04; VMI interpretation, 0.58 ± 0.04; telephone interpretation, 0.50 ± 0.14; *P* = .80). Among the non–English-concordant visits, patient centeredness was higher in visits with Spanish speakers than

with either Cantonese or Mandarin speakers; however, there was no difference in patient centeredness by language for discordant-professionally interpreted visits.

Table 10. Comparison of Visit and Communication Characteristics by Visit Type (N = 151)

	English concordant (n = 58)	Non-English concordant (n = 38)	Discordant-professionally interpreted (n = 55)	*P* value[a]
Length of visit, mean ± SE (range), min[b]	24.5 ± 1.1 (8-49)	24.2 ± 1.3 (9-52)	31.4 ± 1.4 (16-72)	<.001
No. of problems addressed during visit, mean ± SE (range)	7.1 ± 0.4 (2-16)	6.8 ± 0.5 (2-18)	5.5 ± 0.4 (1-12)	.020
Verbal dominance of clinician, mean ratio ± SE (range)	1.3 ± 0.1 (0.5-3.6)	1.3 ± 0.1 (0.8-4.6)	1.4 ± 0.1 (0.9-19)	.202
Patient centeredness, mean ratio ± SE (range)	0.81 ± 0.05 (0.2-2.5)	0.65 ± 0.06 (0.3-2.5)	0.59 ± 0.05 (0.3-1.3)	.002
Patient centeredness, including care partner talk, mean ratio ± SE (range)	0.81 ± 0.05 (0.2-2.5)	0.65 ± 0.06 (0.3-2.5)	0.58 ± 0.05 (0.3-1.3)	.001

[a]*P* values are from 1-way ANOVAs, accounting for clustering of patients within physicians; statistical significance set at $P < .05$.
[b]Excludes minutes that patient or clinician was out of the room, minutes of phone calls, minutes of clinical staff interruptions.

The lower patient-centeredness measure for the discordant-professionally interpreted visits was driven by less talk in all psychosocial and socioemotional components in the numerator. Although some components of the denominator, namely sharing of medical information by both clinicians and patients, was lower for the discordant-professionally interpreted visits than for the other visit types, somewhat balancing out the ratio, there was no difference for other denominator components (ie, clinician medical questions and procedural talk; Table 11).

Table 11. Comparison of Components of Patient-Centeredness Measure by Visit Type (N = 151)

	English concordant (n = 58)	Non-English concordant (n = 38)	Discordant-professionally interpreted (n = 55)	*P* value[a]
Clinician and patient components of patient centeredness: numerator				
Clinician psychosocial questions	5.1 ± 0.9	4.6 ± 1.0	3.0 ± 0.6	.066
Clinician psychosocial and lifestyle information	12.0 ± 2.5	7.4 ± 1.9	3.2 ± 0.7	<.001
Clinician emotional talk	34.3 ± 3.2	18.0 ± 2.4	15.8 ± 1.6	<.001
Clinician facilitative talk	70.4 ± 5.2	63.3 ± 6.3	34.0 ± 2.7	<.001
Patient psychosocial and lifestyle information	35.6 ± 5.5	24.8 ± 5.0	13.2 ± 2.2	<.001
Patient psychosocial questions	1.1 ± 0.3	0.9 ± 0.3	0.3 ± 0.1	.002
Patient emotional talk	21.9 ± 2.3	15.5 ± 2.2	11.5 ± 1.3	<.001
Patient medical questions	10.3 ± 1.0	11.0 ± 1.3	5.8 ± 0.6	<.001
Clinician and patient components of patient centeredness: denominator				
Clinician medical questions	20.0 ± 1.8	30.7 ± 2.7	19.3 ± 1.4	<.001
Clinician procedural talk	33.9 ± 2.4	30.9 ± 2.7	27.7 ± 2.0	.130
Clinician medical information	86.2 ± 5.0	75.7 ± 5.4	48.6 ± 3.0	<.001
Patient medical information	97.1 ± 7.3	94.2 ± 8.7	60.0 ± 4.7	<.001

[a]*P* values are from 1-way ANOVAs, accounting for clustering of patients within clinicians; statistical significance set at $P < .05$.

Multivariate mixed linear models accounting for clustering of patients within clinicians and adjusting for visit characteristics demonstrated similar findings. Compared with English-concordant visits, non–English-concordant visits were nonsignificantly less patient centered (β = –.113; *P* = .17), and discordant-professionally interpreted visits were significantly less patient centered (β = –.158; *P* = .03).

In exploratory analysis, we found that fewer non-English visits (concordant and discordant) had diet discussion documented in the medical record; however, there were no other statistically significant differences related to patient awareness of that discussion,

exercise discussion, or completion of laboratory tests or referrals to specialists. When comparing discordant-professionally interpreted visits and discordant-not professionally interpreted visits, we found similar patient characteristics between the 2 groups, except patients with discordant-not professionally interpreted visits were, on average, older than those with professionally interpreted visits.

Secondary Outcome: Development and Evaluation of a Direct-Observation Assessment of Clinician Non–English Language Skills

Three of the 9 audio recordings were not sufficient for evaluating the clinician's Spanish-speaking ability using the POLOM, for the following reasons: The conversation was primarily in English, a family member acted as an interpreter, or there was little direct conversation with the patient in Spanish (because of impaired cognition). In their initial independent ratings, the raters experienced frequent disagreement with scores differing at times up to 2 points on the 5-point scale, often due to different interpretations of the scoring descriptions at each level. This led the group to iterative edits of the scoring descriptions to narrow their meaning. Also, the raters brought to the group what they felt were clinical communication errors that could not be addressed by the 5 domains of comprehension, fluency, vocabulary, pronunciation, and grammar. To address these clinical communication errors, the team added a global communication rating item to assess the potential impact of any language errors on successful communication. A final global communication score was added to the POLOM to categorize the providers' ability to converse into 4 different levels, from novice to native speaker.

Aim 4

Clinician Semistructured Interview Participants

We reached out to 32 post-LASI clinician participants from aim 1 to participate in semistructured qualitative interviews, with the targeted goal of interviewing an equal number of monolingual English, fully bilingual, and partially bilingual clinicians. After conducting 16 interviews, we reached thematic saturation (Table 12).

Table 12. Characteristics of Primary Care Clinician Participants in Semistructured Interviews

	Monolingual English (n = 5), No. (%)	Fully bilingual (n = 5), No. (%)	Partially bilingual (n = 6), No. (%)
Sex			
Female	2 (40)	4 (80)	5 (83)
Male	3 (60)	1 (20)	1 (17)
Type of clinician			
Physician	4 (80)	5 (100)	5(100)
NP	1 (20)	0	0
Language			
Cantonese	–	1 (20)	0
Mandarin		2 (40)	3 (50)
Spanish		2 (40)	3 (50)
Testing status			
Passed	–	5 (100)	0
Marginal		0	1 (17)
Failed		0	1 (17)
Did not test		0	4 (67)

Abbreviation: NP, nurse practitioner.

Patient focus group participants. We called 98 post-LASI participants with LEP who had participated in aim 1 to invite their participation in focus groups. We spoke with 76 potential participants. Approximately half (n = 39 [51%]) declined to participate, 6 agreed but did not attend a group, and 31 (41%) participated (Table 13).

Table 13. Characteristics of Patients With LEP Participating in Language-Specific Focus Groups

	Spanish (n = 11)	Mandarin (n = 11)	Cantonese (n = 9)
How well do you speak English?, No. (%)			
Well	3 (27.3)	2 (18.2)	4 (44.4)
Not well	8 (72.7)	7 (63.6)	3 (33.3)
Not at all	0	2 (18.2)	2 (22.2)
Sex, No. (%)			
Female	8 (72.7)	6 (54.5)	6 (66.7)
Male	3 (27.3)	5 (45.5)	3 (33.3)
Age, mean ± SD (range), y	64.8 ± 9.3 (51-81)	65.2 ± 9.1 (49-76)	59.7 ± 8.3 (46-70)
Clinician PCP type, No. (%)			
Attending physician	7 (63.6)	7 (63.6)	4 (44.4)
Resident physician	4 (36.4)	3 (27.3)	5 (55.6)
NP	0	1 (9.1)	0

Abbreviations: LEP, limited English proficiency; NP, nurse practitioner; PCP, primary care provider.

Interview and Focus Group Salient Themes (See Appendix H for Representative Quotes)

VMI is convenient and well liked by clinicians and patients. Although some preferred in-person interpreters, most clinicians and patients were happy with the access and quality of the VMI interpreters.

View of care partner role differs for clinicians and patients. Clinicians reported sometimes using family to interpret out of convenience or habit, whereas patients reported wanting their family members at the visit for support and advocacy, not to interpret.

Partially bilingual skills adds complexity to interpreter use and communication. Some partially bilingual clinicians reported frustration with patient refusal of interpreter services. Others reported using the VMI interpreters as a backup during the visit. Patients also reported this backup use of interpreters for their partial English skills. There was also acknowledgment of a certain amount of "getting by" with partial non-English and partial English skills. Still, patients with partial English skills largely stressed the importance of having a professional interpreter present to support clear and in-depth communication.

Navigating the health system remains challenging for patients with LEP.

Clinicians and patients emphasized the need for better language-access services outside the visit itself, emphasizing challenges for patients with LEP to call into the practice with clinical concerns between visits and to schedule visits.

Clinicians noted both value and barriers to language proficiency certification.

Clinicians endorsed the importance of having a standard for language proficiency and believed it conveyed that the institution placed value on communication. Some expressed that passing the test provided reassurance that they were "doing right" by their patients; others reported that failing the test empowered them to continue using professional interpreters. Clinicians cited the following as barriers to current testing: time, fear of failing, artificiality, and lack of transparency of the recorded telephone test.

Clinicians were open to direct observation as an alternative to current testing.

Clinicians felt that a direct-observation assessment tool like the POLOM could address both the time and artificiality barriers to the current test. Some emphasized the importance of opportunity for multiple observations and transparency regarding criteria for passing.

DISCUSSION

In this natural experiment study, we found that the LASI intervention successfully increased use of professional interpreters for patients with LEP. Our qualitative data demonstrate that both patients and clinicians view interpretation via video conferencing positively. However, post-LASI, there remained a substantial proportion of discordant visits in which family members interpreted rather than professional interpreters; this was often the case for older patients. In qualitative interviews, clinicians reported sometimes using family interpreters for convenience and out of habit. Clinicians may find this approach particularly convenient with older patients for whom the family interpreter is also a primary caregiver.[80] In addition, although frequency of professional interpreter use improved, it remained low for partially language-concordant visits. Our qualitative interviews and focus group data illuminate the complexity and challenges of partially concordant visits, particularly when patients speak some English or when patients decline professional interpreters in favor of speaking directly with clinicians who are partially bilingual in their language.

LASI's impact on patient awareness of visit communication and completion of post-visit instructions was mixed. We found a positive and substantial impact on patient awareness of exercise and diet discussions at a primary care visit; patient awareness of these started out low pre-LASI and then reached levels comparable to those for English speakers post-LASI. This finding is consistent with the literature demonstrating that the use of professional interpreters can result in care for patients with LEP comparable to that for English speakers.[32,33] However, there was no change in new medication-prescription awareness, which was already high before LASI implementation and remained high afterward. Similarly, the completion rates of ordered tests and specialist referral visits were high before and after LASI implementation, with no change over time. However, post-LASI, patients with LEP were more likely to complete their ordered tests within 30 days than they were pre-LASI. This was not true for specialist visit completion.

We found only a weak effect of LASI implementation on rates of BP control for patients with HTN and no effect for guideline-concordant care of patients with either DM or CAD. To add

context to our natural experiment results, we studied audio recordings of primary care visits. Here, we found that professional interpreter–mediated visits were slightly longer, covered fewer topics, and contained less psychosocial conversation than language-concordant visits. These results may help explain why LASI did not affect management of DM or CAD—both conditions that often require complex management plans that interact with social context.[81-84] The findings may also explain why patients with LEP and DM who see fully bilingual clinicians have better DM outcomes.[11,85] It appears easier for clinicians and patients to communicate more straightforward biomedical information than to discuss social context via an interpreter. In part, this may be due to systems-based time constraints. In theory, interpreted visits should take twice as long as language-concordant visits to cover the same territory, because everything is said twice. In our study, interpreted visits were scheduled for the same amount of time as language-concordant visits but actually took, on average, only 30% longer. Despite this increased visit time, it likely was not enough to cover the same amount of information with the same complexity as language-concordant visits. In addition to more time, achieving better outcomes via interpreted visits may also require reorienting all parties—clinicians, patients, and interpreters—to the importance of psychosocial talk for in-visit communication and, ultimately, outcomes.

We adapted a direct-observation language proficiency tool (ie, the POLOM) for use in a clinical context, adding a global communication score, and identifying parameters for which visit characteristics were prerequisites for adequate assessment. To gauge clinicians' willingness to have their language skills assessed via direct observation rather than by the current testing system, we asked for their perspective during our qualitative interviews. Clinicians expressed interest in direct observation as an alternative to the current assessment test. In particular, they felt it would address concerns about the current test, including the extra time it takes and its artificiality as a recorded, telephone-based test.

Subpopulation Considerations

In aim 1, we examined treatment-response heterogeneity by testing for interaction effects between patient language (Cantonese, Mandarin, Spanish) and study period for the

outcomes, as presented in the Results section. To summarize here, for professional interpreter use, there was no significant interaction between language and study period. There was a significant interaction effect between patient language and study period in the IPW model of patient awareness of diet discussion, such that the post- vs pre-LASI effect on awareness of diet discussion was strongest for Cantonese speakers, weakest for Mandarin speakers, and in the middle for Spanish speakers. The reasons for these heterogeneous effects are unclear; it is possible they are related to differences in educational attainment or cultural differences regarding diet. For completion of laboratory tests within 30 days and specialist visit completion within 30 to 100 days, there were no significant interaction effects between language and study period.

In aim 2, we examined treatment-response heterogeneity in secondary analyses considering the interaction between race/ethnic-language groups and the 3-category study-period indicators (ie, pre-LASI, LASI rollout, and post-LASI) and found no significant interaction effects. However, in main analyses, we did find persistent disparities for ethnically Latino patients, both LEP and EP, for HTN and DM outcomes. Our data cannot explain this disparity, but it could be related to social and cultural contextual factors.[81,86,87] We also found that ethnically Chinese and Latino patients with LEP and CAD had higher rates of antiplatelet use than English-speaking White patients. Again, our data cannot explain this finding directly, but it may be related to cultural beliefs about aspirin use in this older less-acculturated population.[88,89]

In aims 3 and 4, we did not explore treatment-response heterogeneity, because both of these aims involved data collection only after the LASI intervention was implemented.

Study Limitations

First, this was a single-site study in a single diverse, academic, primary care practice in an urban setting. Although this allowed for depth of study, it limits generalizability. This practice may differ from other large and smaller practices without regular access to in-person interpreters, because rates of professional interpreter use (in-person and by telephone) in this practice were high at baseline. In fact, LASI might be even more effective in a setting with lower

baseline rates. Second, this was an observational study, which, despite our best efforts at rigorous natural experiment methods, limits our ability to infer causality. Third, for methodologic and logistical reasons, we only included the most common non-English languages in the practice; it remains to be seen if LASI has similar, less, or greater impact on patients speaking less common languages. However, a remote approach such as VMI may increase access to less commonly available language services even more than to commonly available language services, and so it is possible VMI would lead to even greater increases in professional interpreter use for patients in these language groups.

In addition, some of the outcomes we chose (eg, new medication awareness, laboratory test, referral completion), while important to patient care, had a high rate at baseline, thus presenting less opportunity to detect improvement. In fact, it may be that because of their more concrete instructional nature, these measures represent the most basic information that is communicated at a visit regardless of how a language barrier is bridged. We did detect promising improvement with LASI implementation for more communication-sensitive measures (ie, diet and exercise discussion awareness); however, because we relied on medical records to identify these discussions, we do not know the depth or extent of the conversation during the visit. Similarly, although awareness that the discussion occurred at the visit is a first step to engagement with a plan, this study did not exclusively focus on diet and exercise; therefore, we did not measure either engagement or behavior change. Also, although the RIAS analysis of the audio recordings illuminated differences between interpreted and concordant visits in relative amounts of biomedical and psychosocial talk during a visit, there is no correct amount of either type of talk for any given visit.

Finally, although we were able to adapt and refine a direct-observation tool to assess a clinician's non–English language proficiency, limitations in the number of appropriate audio recordings limited our ability to establish reliability of the tool across multiple assessors and multiple clinical encounters for a given clinician. The tool will require more work to establish reliability and validity before it can be used in real-time clinical settings.

Implications for Health Systems and Patients

Taken together, our findings demonstrate that a systems intervention to improve access to professional interpreters through videoconferencing, combined with a system-wide survey and language proficiency testing program—the LASI initiative—can increase appropriate use of professional interpreters. However, such an intervention may not be sufficient to change the behavior of all clinicians with only partial fluency in a non-English language or to improve all outcomes for patients with a language barrier.

Health systems wishing to provide universal language access for patients with LEP will need to support clinicians and patients with partial bilingual skills in their efforts to use professional interpreters. This could include framing professional interpreter use as a backup to partially language-concordant communication. It may also include workflow approaches to having the VMI equipment available in the examination room for all patients with LEP so the clinician can offer interpretation even to patients who have declined at the front desk. This could increase participation of partially bilingual–clinicians in proficiency testing, as well as their use of professional interpreters. A similar approach could be taken with the VMI in the examination room regardless of whether a family member helped interpret at the front desk or with the MA. This will remind the clinician again to offer use of a professional interpreter each time and allow the family member's role to be similar to the role for family members of English-speaking patients—as a participant, caregiver, and advocate—without complicating that with a role as interpreter.

Health systems also should make structural changes such that visits requiring interpretation are scheduled for longer to allow for more in-depth and complex communication. Such a structural change should be accompanied by education for clinicians, patients, and interpreters regarding the importance of communication about social context during interpreted visits and its potential impact on outcomes. Implementing this education with medical and NP students will ensure that the next generation of practicing clinicians can provide equitable high-quality care for patients across a language barrier.

Patients should be empowered to ask for an interpreter at the front desk, with MAs, and with their doctors. They also should be encouraged to share information through an interpreter (eg, emotional changes, family stresses, diet, and exercise challenges) that may affect their health.

CONCLUSIONS

We leveraged a natural experiment design to evaluate the impact of a systems intervention to simultaneously increase access to professional interpreters and certify clinicians to use their non–English language skills directly when speaking with primary care patients with LEP (the LASI initiative). LASI did increase use of professional interpreters; however, this was least prominent for partially language-concordant visits. We detected a substantial and significant increase in patient awareness of discussions of communication-sensitive topics (ie, diet and exercise). However, we did not detect an effect on already high levels of awareness of new medication prescription or on laboratory test or referral visit completion, possibly because communication about these may be relatively straightforward. We detected a weak impact of LASI on BP control for patients with HTN but none on outcomes for DM or CAD, both of which conditions interact with social context. We also found that compared with language-concordant visits, professionally interpreted visits were only 7 minutes longer, covered less territory, and had more biomedical talk than psychosocial talk. This finding may partially explain LASI's lack of impact on DM and CAD outcomes.

Our research has several implications for health systems and patients. Health systems wishing to implement LASI will need to support clinicians and patients with partial bilingual skills in their efforts to use professional interpreters. Patients should also be encouraged to ask for these services. Health systems should also make structural changes such that visits requiring interpretation are scheduled for longer to allow for more in-depth and complex communication. More work will be required to educate clinicians, patients, and interpreters regarding the importance of communication about social context during interpreted visits.

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APPENDICES

Appendix A. Trilingual Information Sheet

Seeing a doctor in this clinic today?

We may be calling you to PARTICIPATE IN THE LASI STUDY!
(Language Access Systems Improvement Study)

Earn $30 by answering a few questions about your visit

You may be eligible to participate in a **10-minute telephone interview** about your experiences with communication during your visit, and about your medical conditions and recommendations.

If we call you, here is what will happen:

- We will determine if you are eligible to participate
- If you are, and wish to participate, you will complete a 10 minute survey over the phone at a time that's convenient for you
- In appreciation of your time, we will send you $30 in the mail

Your information will be kept confidential. This research project will help other people in the future

Questions?
Please call Ana Fernández at **(415) 502-0862.**

There is no obligation to take part.

¿Va a ver a un doctor en esta clínica hoy?

Puede que lo llamemos para que PARTICIPE EN EL ESTUDIO LASI!
(Language Access Systems Improvement Study)

Gane $ 30 por contestar algunas preguntas sobre su visita en una encuesta telefónica

Si usted ha tenido una visita reciente en esta clínica, puede ser elegible para participar en una **entrevista telefónica de 10 minutos** sobre sus experiencias con la comunicación durante su visita, y sus condiciones médicas y recomendaciones.

Si lo llamamos, esto es lo que sucederá:

- Determinaremos si usted es elegible para participar
- Si es elegible, y desea participar, completará una encuesta de 10 minutos por teléfono en un horario que sea conveniente para usted
- En apreciación por su tiempo, le enviaremos $30 por correo

Su información se mantendrá confidencial. Este proyecto de investigación ayudara a otras personas en el futuro

¿Preguntas?
Por favor llame a Ana Fernández al **(415) 502-0862.**

No hay obligación de participar.

今天來看这个诊所的医生嗎?

我們有可能給您打電話讓您參加 LASI 的研究!
(Language Access Systems Improvement Study)
（臨床傳譯服務質量改進計劃）
回答幾個關於看醫生期間的問題，您可以獲得 $ 30!

若您符合條件，我們會進行 **10 分鐘的訪問**，關於您跟醫生如何溝通，身體狀況，以及醫生建議方面的滿意度。

如果我們給您打電話，：

- 我們會判斷您是否符合條件
- 如果您符合條件，並且也原意參加，我們將在您合適的時間進行 10 分鐘的訪問
- 為了感謝您的配合，我們將寄給您$30

我們會對您的資料保密。在未來，這個研究將會幫助更多的人。

任何問題?
請給 Ana Fernández 打電話 電話：**(415) 502-0862**

完全自願參加!

Appendix B. International Language Roundtable

Category	Description
Excellent	Speaks proficiently, equivalent to that of an educated speaker, and is skilled at incorporating appropriate medical terminology and concepts into communication. Has complete fluency in the language such that speech in all levels is fully accepted by educated native speakers in all its features, including breadth of vocabulary and idioms, colloquialisms, and pertinent cultural references.
Very Good	Able to use the language fluently and accurately on all levels related to work needs in a healthcare setting. Can understand and participate in any conversation within the range of his/her experience with a high degree of fluency and precision of vocabulary. Unaffected by rate of speech. Language ability only rarely hinders him/her in performing any task requiring language; yet, the individual would seldom be perceived as a native
Good	Able to speak the language with sufficient accuracy and vocabulary to have effective formal and informal conversations on most familiar topics. Although cultural references, proverbs and the implications of nuances and idiom may not be fully understood, the individual can easily repair the conversation. May have some difficulty communicating necessary health concepts.
Fair	Meets basic conversational needs. Able to understand and respond to simple questions. Can handle casual conversation about work, school, and family. Has difficulty with vocabulary and grammar. The individual can get the gist of most everyday conversations but has difficulty communicating about healthcare concepts.
Poor	Satisfies elementary needs and minimum courtesy requirements. Able to understand and respond to 2-3 word entry level questions. May require slow speech and repetition to understand. Unable to understand or communicate most healthcare concepts.

Appendix C. Covariates Included in Aim 1 of the IPW Analysis

The following variables were included in the propensity model as part of the Aim 1 inverse probability weight analysis: patient sex; patient preferred language; patient education level; patient insurance type; binary indicators of comorbidities including diabetes, hypertension, coronary artery disease, congestive heart failure, peripheral vascular disorder, obesity, cardiac arrythmia/valvular disease, pulmonary circulation disorder/chronic pulmonary disease, neurological disorder/paralysis, chronic kidney disease/renal failure, liver disease/peptic ulcer, lymphoma/cancer, hypothyroidism/rheumatoid arthritis, coagulopathy/anemia, weight loss/fluid/electrolyte disorder, alcohol/drug abuse, and psychosis/depression; linear and quadratic effects of patient age, months the patient had been in the practice, the count of patient clinic visits during the prior 12 months, and number of medical problems in the patient's EMR 'problem list'; and the sex of the visit physician, whether the visit physician was an attending or resident, and whether the visit physician was the patient's primary care physician.

Appendix D. Covariates Included in the Aim 2 Propensity Score Calculations

The following variables were included in the propensity score calculations for Aim 2 models: age of the patient at first eligible visit, patient race/ethnicity, patient gender, patient's first qualifying diagnosis (HTN, DM, or CAD, combination), insurance type at first eligible visit, type of clinician seen at first eligible visit, number of visits to DGIM in the 12 months prior to first eligible visit, date of first eligible visit, and a count of Elixhauser comorbidities.

Appendix E. Additional Questions in Aim 3 Patient Survey After Audio-Recorded Visit

48. During your visit with Dr. _____, in general,	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) The doctor listened carefully to what I had to say.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5
b) The doctor explained my medical problem to me in a way I could easily understand.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5
c) The doctor was not very clear in describing exactly what he/she wanted me to do.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5
d) I was not comfortable asking the doctor all of my questions.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5
e) I trust this doctor to give me the best possible healthcare.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5
f) Overall I was satisfied with the visit.	❑ 1	❑ 2	❑ 3	❑ 4	❑ 5

Appendix F. Aim 3 Clinician Survey after Audio-Recorded Visit

In general,	Excellent	Very Good	Good	Fair	Poor
1. How would you rate this patient's ability to speak English?	❑1	❑2	❑3	❑4	❑5
2. How would you rate this patient's health?	❑1	❑2	❑3	❑4	❑5

3. **Without reviewing the patient's chart, please assess this patient's visit in the following areas:**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) This patient provided a clear history.	❑1	❑2	❑3	❑4	❑5
b) I understood what the patient wanted to know.	❑1	❑2	❑3	❑4	❑5
c) The patient has a good understanding of the most important information we discussed.	❑1	❑2	❑3	❑4	❑5
d) I established rapport with this patient.	❑1	❑2	❑3	❑4	❑5
e) This patient trusts me a great deal.	❑1	❑2	❑3	❑4	❑5
f) Overall I believe that the patient was satisfied with the visit.	❑1	❑2	❑3	❑4	❑5
g) Overall I was satisfied with the visit.	❑1	❑2	❑3	❑4	❑5

4. **Please rate whether the patient had the following**:

	No Symptoms	Few symptoms only	Mild Case	Moderate Case	Severe Case	Don't Know
a) Anxiety	❑1	❑2	❑3	❑4	❑5	❑6
b) Depression	❑1	❑2	❑3	❑4	❑5	❑6

For each item below, please indicate which topics you discussed during the visit, and how well the patient understood:

	a) Did you discuss…?		***If yes***, how well do you think your patient understood…?			
			Very Well	Well	Not Well	Not at all
5. Medications	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4
6. Test Results	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4
7. Specialist Referral	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4
8. Diet	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4
9. Exercise	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4
10. Habits (e.g. drinking alcohol or smoking)	❑ No	❑ Yes	→ ❑1	❑2	❑3	❑4

11. **Did you use a professional interpreter during this visit?**

❑ Yes → 11a. ***If yes***, was it via…

❑ No

- ❑ Video VMI
- ❑ Audio only via VMI
- ❑ Wall telephone
- ❑ In-Person

THANK YOU FOR COMPLETING THIS SURVEY!

Please place completed survey in envelope in precepting room marked LASI MD Survey or mail to Leah Karliner Box 0320

11b. How satisfied were you with the quality of the interpretation?

- ❑ Very satisfied
- ❑ Satisfied
- ❑ A little satisfied
- ❑ Not satisfied

Appendix G. RIAS Codes Used to Measure Patient Centeredness

Appendix G. Roter Interaction Analysis System (RIAS) Codes Used to Measure Patient Centeredness

Formula for patient centeredness of the visit (doctor and patient talk composites)[1]:

Patient centeredness =

$$\frac{\begin{array}{c}(\text{Dr psychosocial Qs} + \text{Dr psychosocial and lifestyle info} + \text{Dr emotional talk} + \text{Dr facilitative talk} + \\ \text{Pt psychosocial and lifestyle info} + \text{Pt psychosocial Qs} + \text{Pt emotional talk} + \text{Pt medical Qs})\end{array}}{(\text{Dr medical Qs} + \text{Dr procedural talk} + \text{Pt medical information} + \text{Dr medical information})}$$

Composite	Description
Numerator	
doctor psychosocial questions	open and closed psychosocial and lifestyle questions
doctor psychosocial and lifestyle information	Information about psychosocial and lifestyle topics and counseling about psychosocial and lifestyle
doctor emotional talk	concern, reassurance, empathy, legitimation
doctor facilitative talk	asking for patient opinion, ask for understanding, check understanding of patient, cues of interest
patient psychosocial and lifestyle information	Statements about psychosocial and lifestyle topics
patient psychosocial questions	all psychosocial and lifestyle questions
patient emotional talk	concern
patient medical questions	All questions about medical condition; therapeutic regimen; other questions
Denominator	
doctor medical questions	closed and open questions about medical condition; therapeutic regimen; other questions
doctor procedural talk	orientation, transitions
medical information from patient	Information about medical condition/symptoms, therapeutic regimen, other information, concern and optimism/reassurance statements
medical information from doctor	Information about medical condition/symptoms, therapeutic regimen, other, counseling about medical condition and therapy

[1]Roter D, Larson S. The Roter interaction analysis system (RIAS): utility and flexibility for analysis of medical interactions. *Patient Educ Couns.* 2002;46(4):243-251.

Appendix H. Interview and Focus Group Salient Themes and Quotes

Appendix H. Interview and Focus Group Salient Themes and Quotes

Clinician Stakeholder Interviews	
Professional Interpreter Modality	"I feel with the initiation of the VMI, I mean, interpretation services in my view has been really incredible." "I think it's become my default is just to assume I'm going to have a video interpreter. I think it's absolutely fantastic. It is so convenient and I really appreciate how the nurse has already brought in the video interpreter. It's easy to pick the different languages and you can immediately get a video or an audio interpreter, and patients actually really like it" – Monolingual English MD "I find it really helps my efficiency, to have an in person interpreter because they are able to, I feel like they're able to more culturally interpret as they translate." "The only time I do use phone interpreters now – just because it's usually set up for me, the VMI – is [if] the VMI is not working or there isn't one." – Bilingual Mandarin speaking MD "I feel actually over age 65 or 70…maybe it's actually 75, I don't know…but it is a fairly good predictor of who I think really benefits from an in-person interpreter. In addition to obviously certain services and palliative care or psychiatry or things like that where you could feel like someone really would benefit from an in-person interpreter." – Bilingual Spanish speaking MD
Change in use from no interpreter to professional interpreter	"And I finally realized that I was saying thinks in English that even though she'd say yes, she wasn't quite getting…so I finally got translators for that." – Partially bilingual Mandarin speaking MD "I wanna start fresh and say, "Okay, let's make sure everything's crystal clear. Let's have the interpreter be part of the conversation, and let's start the plan fresh. Let me simplify it as much as I can. Let's get it settled once and for all. Let's give it another go." – Monolingual English speaking NP

	"I'm worried that I'm not getting the whole story, and I'm worried that I'm not able to really understand support between the parent and the child, for example, or the relationship between the parent and the child, like adult child, not for elder abuse necessarily…I'm concerned that I'm not getting the whole story. That's pretty much it, and that I'm not able to then talk more openly with the patient herself about resources." – Partially bilingual Spanish speaking MD
Partially Bilingual Clinicians Challenges and Practices	"There have been instances with Mandarin speaking patients where, because I do speak some Mandarin…where I haven't used one when the patient and family are like, 'No, it's okay, we don't need one.' They can just do that. That being said, I'll say that I think I did that a little more often earlier on in my time here and then I think as time went on, now I'm just like, 'Yeah, but no, we need the interpreter.' And then they're okay with that." "I will sometimes say to the interpreter at the beginning, I'll tell them, 'I do speak some Mandarin, so I may speak some Mandarin to the patient during the visit, but I will definitely need your help to interpret something along the way.' I'll let them know so that they're not wondering why they're there. – Partially bilingual Mandarin speaking MD "…so, my first language is Spanish. I have not taken the medical certification test, and what I do is I tell my patients, 'I'm not certified in the language.' And I give them the option of, we can communicate, we can talk, and if at any point I'm not being clear, I will get the interpreter. We can have the interpreter here out the whole time, and they will listen in on the conversation and break in. Those are the two options I give patients…one or two patients always want the interpreter in there, and then the majority are completely fine with it, have us communicating." – Partially bilingual Spanish speaking MD "I know that I have had people ask me, even though my Mandarin isn't perfect, it they can switch, just because they feel more comfortable that I speak some Mandarin." – Partially bilingual Mandarin speaking MD "One of the things that I really struggle with is that since I do speak Spanish, some of my patients think that I don't need an interpreter and will refuse an interpreter at the front desk."

	– Partially bilingual Spanish speaking MD
Use of family to interpret	"There are a subgroup of patients who we've gotten into, I would say maybe a habit where they always come with usually the same one or two family members and they interpret. At some point I would have offered an in-person or a video interpreter and it was declined, but I don't make the practice of always offering it." – Bilingual Spanish speaking MD "[Having an in-person interpreter] eliminates also the family factor of, 'Oh, I'm just going to have my cousin interpret.' It's like, 'No, it's all right. There's someone who's here to do that for you.'" – Partially bilingual Spanish speaking MD "Yeah, but you know, things happen right? We all know we have to do things that don't meet our ideals. In that situation, you're trying to meet a patient care need, and what's available to you is his girlfriend, and he's saying it's okay. Let's at least do this option." – Monolingual English speaking NP
Need for navigation and language access outside of clinician-patient encounter	"…one line for Cantonese/Mandarin, another one for Spanish. That's all that's needed. A little call navigation center." – Bilingual Cantonese speaking MD "I think for in person interpreters, what would be better is if they were scheduled for more time. And so that would cover their check-in, the provider visit, everything that needs to be done after the visit with clinical staff or front desk." – Monolingual English speaking MD "…it wasn't a true emergent situation so I asked her, do you have a way to get to the hospital or do you want us to call an ambulance? And she said, I don't have any family around and I don't speak the language, so can you please help me navigate this." – Partially bilingual Mandarin speaking MD

	"But really, it's about the barriers that exist between visits, the number of patients who have to come into the front desk in order to set up an appointment. You know, because they can't manage the phone systems. Or come to the front desk to give a message to their provider. And that happens far too often. So, you know, I think we've focused on the physician-patient communication part. We haven't focused as much from a patient-centered perspective, what do they need?" – Monolingual English speaking MD
Recommendations for Systems Improvement	"I wonder if, at the MA station…if formally they can be asked…every single time whether or not they do want to have a video interpreter or an interpreter in general…because as I reflect on this conversation, probably even if I've known them for a long time they might have a new issue that they want to talk to me with a formal interpreter. So maybe that can be done at the very beginning of the visit so that no assumptions have been made on my part or anyone's part about interpreter or not." – Monolingual English speaking MD "I mean, a basic thing might be having more video machines…it would be great to just have them always available. I think the other thing is that, you know, there seem to be sort of Wi-Fi dead spots in our clinic that limit the usefulness of some of the machines in specific exam rooms. And so, if that could be addressed by installing additional hardware or whatever's necessary to make them work well, I think that would be a one time cost that could improve this a lot." "That just is quite disruptive for the interpreter to leave in the middle of a conversation…since using an interpreter takes basically twice as much time, for the conversation at least, if there were some way for providing an allowance for that, because it seems not equitable to have the same visit length, because it means that either we're covering half as much or we're going over, and then basically running late. And that inconveniences everyone." – Monolingual English speaking MD "I think that what we need is a much more comprehensive approach to language services for a patient who's getting care in our system. And start from the first moment of contact to not just the visit, everything. You now, everything is made accessible and easy for them so that their language is not a barrier. When they call, when they use the, you know MyChart system."

	– Monolingual English speaking MD
Bilingual Clinician Proficiency Testing	"I think most providers care about their patients and they want to do right by the patient. But in terms of the enticing, I suppose a stipend." – Bilingual Cantonese speaking MD (certified) "I think a lot of rumors went around about it initially and I guess maybe initially too I was like, 'Well, I've been doing this all along. What a bummer it would be if that privilege got taken away from me.' I definitely hesitated…to go through the certification" – Bilingual Spanish speaking MD (certified) "That's part of why I haven't wanted to really try for the certification in Spanish, in part because if I pass personally I don't feel comfortable. I don't want to lose that change to have the interpreter, because I like having them so that I can feel more confident about how I'm communicating." – Partially bilingual Spanish speaking MD (untested) "…so, I took the language test as an intern, and I got a 79% which, as a Mexican American, was kind of a hit to my ego. And I felt like a bad representative of my culture, especially with it being my first language…I think a phone test is fine, but the script where you're just answering a question and then it's recording what you're saying and there's no real back and forth…it is the back and forth in our patient interactions that's often so important in terms of understanding…" – Partially bilingual Spanish speaking MD (failed test) "I think I was actually relieved that I failed it so then I could feel more like, yeah, I really do need an interpreter with me all the time. So it kind of empowered me to still use one." – Partially bilingual Mandarin speaking MD (failed test)
Recommendations for direct observation assessment	"Maybe doing something like that were you record yourself in an encounter with the patient, so there's not that added layer of somebody watching you. Where you could get the same information without actually having another person in the room that could make it awkward." – Bilingual Spanish speaking MD (certified)

Patient Focus Groups	
Professional interpreter modality	"The video interpreter interprets quite well. He is similar to the on-site interpreter. I can see him clearly. He could even see my throat from the camera. Both of us can see each other and understand each other." – Mandarin Focus Group participant "My doctor speaks a little bit of Spanish, but I request an interpreter. If they don't have one in person, the machine…Sometimes I understand like 30% of what the doctor is explaining. With the interpreter I understand 100%." – Spanish Focus Group participant "I prefer, if at all possible, the person. Because with the person…they understand you perfectly well. And it goes fast. But I additionally have nothing against the machines." – Spanish Focus Group participant "Sometimes they get there late when they are requested in person. The appointment with the doctor hasn't started and they get there 15 minutes late. And they say, "Oh, I'm late because I have to move from one side to the other." And it's understandable, you know? And I think to myself, "What would happen if I didn't speak any English? How would it go with them arriving so late?" Generally speaking, they get there late." – Spanish Focus Group participant "For interpretation services, no matter where it is, be it the blood pressure measuring unit, the blood drawing unit or the doctors' rooms, there should be machines. Machines could be used If there are no on-site interpreters." – Cantonese Focus Group participant "For language, they can use the screen of this television for interpretation. I feel that it is sufficient for communication." – Mandarin Focus Group participant
Partial English skills and need for interpretation as a back-up, for	"They ask, 'Do you want an on-site interpreter or a video?' I say I prefer a video. When I arrive and the video is turned on, I tell

medical terminology, and for deeper understanding and clarity	the interpreter that he does not need to interpret and I just want him to be a backup and that if I need help I will let him know." – Mandarin Focus Group participant "But there are some things that I ask to be translated because I tell them, 'My health is what is most important.'" – Spanish Focus Group participant "The vocabulary that I have doesn't allow me to express myself in all the aspects and in all its magnitude about the issues that I need to talk about and that I want to talk with her about. Because I don't have that vocabulary yet. So she uses a mechanical interpreter, and we use the interpretation of the interpreter to go deeper into the issues that we are going to talk about." – Spanish Focus Group participant "Sometimes I don't need an interpreter. Depending on the situation or what I'm going there for. Sometimes I don't understand a few things, and they ask, 'Do you want me to bring an interpreter?' 'Okay, that's better.' So that everything is clear." – Spanish Focus Group participant "…even though I understand English somewhat, if I need things clear I prefer Spanish." – Spanish Focus Group participant
Self-advocacy vs getting by	"When you are making the appointment, you need to say, 'I need an interpreter'…when you go to a medical appointment and you don't know the language, they have to give you an interpreter. And it can be that because of a problem, the person who works at the other side of the desk might have a concern or is having a problem that day and forgot to say that. So it's our responsibility to say 'please, I need an interpreter.'" – Spanish Focus Group participant "…sometimes they ask, 'Do you speak Spanish?' 'Yes.' 'Can I speak to you in Spanish?' I say 'Yes.' And when they don't speak, I tell them 'No, you say it like this' and then they thank me. So, we help each other out, no?"

	– Spanish Focus Group participant
Need for navigation and language access outside of clinical encounter	"When we call the front desk here to make appointments, the system asks us to press number '3' for Cantonese, but after pressing number '3', the system returns to English" "For making appointments, it is faster for me to come here than to call…But honestly speaking, it takes us more than one hour and several bus transfers to come here for booking. It is okay if you live nearby. However, it is still inconvenient for patients." – Cantonese Focus Group participants "[referring to the written after visit summary] If the nurse or doctor is going to communicate with the patient, it has to be communicated in the patient's language. It cannot be in English if the patient does not speak English. Whatever the doctor dose should be given to the patient in English if they speak English, in Chinese if he's Chinese, in Russian if he's Russian." – Spanish Focus Group participant
Role of family as care participant and advocate, not interpreter	"I have gone with my children but not so they interpret for me but so they know the doctor." "Yes, either way I ask for the translator because I'm not always with them. They work, just sometimes I want – I say 'Do you want to meet my doctor? Let's go.'" – Cantonese Focus Group participants "…sometimes you're left thinking, 'But what do I actually have?' So my wife is the one who focuses on that. 'But what does he actually have? Are there medications for it? Cures or not?' So, she's the one to dig deep." – Spanish Focus Group participant
Recommendations for systems improvement	"Maybe the time. Because sometimes interpreters don't have enough time. Sometimes the interpreter is somewhere, and you go to the appointment and the doctor calls you in or they send you to get your vitals, and the interpreter hasn't arrived. The interpreter sometimes arrives late, and sometimes he leaves you there because the doctor takes a little longer and the interpreter has to go."

	– Spanish Focus Group participant “Sometimes signal gets lost. That has happened to me, that we lose signal [on video].” – Spanish Focus Group participant “I think that the fundamental link that we need to guarantee, that never fails, is that the person that is going to give you the appointment asks you the question. “Do you need an interpreter?” That is where everything lays. Because many people don’t remember at that moment that they are going to need the interpreter. They don’t ask, and that’s where the mechanism fails. I think that if they do a job directed to training the people who are working in the front desk, giving the appointments, that’s where an 80 or 90 percent of the guaranteeing having the interpreter during the appointment.” – Spanish Focus Group participant

Appendix I. List of Abbreviations

ACLA	Advisory Collaboration on Language Access
ANOVA	analysis of variance
AR1	first-order autoregressive
ATE	average treatment effect
BP	blood pressure
CAD	coronary artery disease
CCLA	**Clinician Cultural and Linguistic Assessment**
CKD	chronic kidney disease
CLAS	Culturally and Linguistically Appropriate Services
DGIM	Division of General Internal Medicine
DM	diabetes mellitus
EMR	electronic medical record
EP	English proficient
GEE	generalized estimating equations
GLMM	generalized linear mixed model
HR	hazard ratio
HTN	hypertension
ILR	International Language Roundtable
IPW	inverse probability weight
IQR	Interquartile Range
JNC	Joint National Committee
LASI	Language Access Systems Improvement
LEP	limited English proficiency
MA	Medical Assistant
MAR	missing at random
NP	nurse practitioner
OR	odds ratio
PAC	Patient Advisory Committee
PCP	primary care provider
POLOM	Physician Oral Language Observation Matrix
RA	research assistant

RIAS	Roter Interaction Analysis System
SOLOM	Student Oral Language Observation Matrix
UCSF	University of California, San Francisco
U.S.	United States
VMI	Video Medical Interpreting

Disclaimer:
The [views, statements, opinions] presented in this report are solely the responsibility of the author(s) and do not necessarily represent the views of the Patient-Centered Outcomes Research Institute® (PCORI®), its Board of Governors or Methodology Committee.

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