Vietnamese-American Healthcare Access: The Importance of Investing in Machine Translation for Under-Resourced Languages

Casey Nguyen

Stanford University

Abstract

Language barriers persist and continually challenge Limited English Proficient (LEP) immigrants in the United States, especially in healthcare. LEP Vietnamese-Americans remain particularly vulnerable to language barriers as most of the population continues to learn English. The lack of access to language-concordant physicians and professional interpreters exacerbates their challenges. The U.S. government and many health institutions recognize the value of accessible interpreter services, but many medical practices struggle to offer them, and few insurers pay for them. The U.S. healthcare system can address language barriers in medicine by investing in machine translation (MT) technology and literacy. MT can potentially fill in gaps where interpreters are unavailable but currently fails to meet healthcare translation standards, particularly for English-Vietnamese translation. This paper will discuss the issues LEP Vietnamese-American patients and the development of MT face and propose strategies for government and health institutions to provide better health education access. Suggested steps include increasing MT literacy for healthcare providers in addition to offering more research grants and promoting international collaboration to improve MT.

Introduction

On social media platforms such as Twitter, posts about Google Translate fails can be hilarious because of how demonstrably bad translations are in some languages. MT gaffs have also inspired absurd, nonsensical song covers from YouTube channels such as “Twisted Translations” using back-translated English lyrics. While MT mistakes in these contexts are harmless and even funny, poor translation quality for various language pairs can be consequential for LEP immigrants, especially for Vietnamese-Americans navigating healthcare systems.

English-Vietnamese translation is one of the worst-performing language pairs for MT (Das et al., 2019) and this has substantial implications in healthcare for Vietnamese-Americans. With fifty-three percent of Vietnamese-Americans not speaking English "very well"—the highest among all Asian-American groups (Le & Nguyen, 2012)—they have a substantial need for translation services. Additionally, Vietnamese-Americans who arrived as political refugees or family-sponsored immigrants after the Vietnam war tend to be less educated and less affluent. Their challenges in adapting to American life still affect them today, with linguistic and cultural barriers remaining critical issues in healthcare access. As language barriers already pose challenges, a lack of reliable MT services complicates access to health information for LEP Vietnamese-American patients. Furthermore, the U.S. federal government and healthcare system currently does not offer sufficient MT or interpreter services for LEP patients. Even as MT offers a partial solution to insufficient interpreter access, some researchers, such as Das et al. (2019), argue that health institutions should not use MT to translate health resources; they should hire reliable, professional translators instead as it is more realistically and financially feasible. Others, such as Vieira et al. (2020) suggest that lack of user awareness and unequal MT development poses a fundamental risk for underserved communities, not the inaccuracy of MT itself. Meanwhile, researchers such as Le and Nguyen (2013) establish the socioeconomic context of Vietnamese-American health disparities and highlight the need for translated written resources.

To mitigate the consequences of language-discordant healthcare interactions for Vietnamese-Americans, the U.S. government should promote investment in English-Vietnamese translation systems and improve how healthcare workers use them. Steps to accomplish this include offering more research grants for Natural-Language Processing projects, promoting

open-source international collaboration in developing translation systems, and increasing MT literacy for healthcare workers.

Literature Review

Das et al. (2019), researchers at the Steven and Alexandra Cohen Children's Medical Center of New York, share many experts' stances on MT, in its current state, to translate health resources. They argue against using translation systems for health information, specifically online anticipatory guidance resources published by the American Academy of Pediatrics (AAP), in favor of professional translation. Das et al. state that translations are likely to have obscured meanings because of the poor quality of MT services such as Google Translate for many languages, especially Vietnamese. Because of inaccurate translation of health resources, LEP caretakers can inadvertently harm children by following "incorrect and potentially harmful suggestions." Additionally, given the availability of text translation agencies, Das et al. claim that publishing professionally translated written resources is more practical and economical than using MT. They cite that thousands of LEP families can benefit from increased access to health information with a one-time fee of seventy to five hundred dollars for a medical-grade translation of an A4-length document.

While Das et al. assert that neither health organizations nor caretakers should rely on MT to translate guidance resources, they also recognize the lack of written materials available to LEP caretakers and patients. As AAP anticipatory guidance handouts are only available in English and Spanish and only a third of pediatricians provide written materials in an LEP patient's primary language, Das et al. call upon the AAP to provide professionally translated materials in multiple languages. Das et al. argue for these changes by explaining that even when LEP caretakers visit language-concordant doctors, they may struggle to accurately recall medical

information as many caretakers only receive medical information verbally. Even though Das et al. do not support using MT for health resources in its present state, their recognition of the importance of translated written materials allows room for the potential of MT applications in healthcare if it becomes viable in the future. With further development and investment, MT could facilitate document translation and reduce translation costs. As medical-grade translation becomes more affordable with the help of MT, health institutions can make health information accessible in more languages.

Vieira et al.(2020), computer scientists and translation researchers, recognize the risks of MT but provide a different perspective on its application in healthcare. Vieira et al. argue that from a user-centered standpoint, MT itself is not inherently dangerous. Instead, it is peoples' lack of awareness of the capabilities and limitations of MT that is problematic. They identify uninformed MT usage by providers not as isolated behavioral incidents but as an institutional problem, citing budget pressures and a lack of sophisticated official guidelines as contributing causes. To address these issues, they call for promoting MT literacy in intercultural patient-physician communication and for health institutions to establish clear, robust guidelines on when MT use is appropriate. In addition to increasing MT literacy, Vieira et al. also advocate for the democratization of MT development across languages, such as for Asian and African languages that suffer most from poor translation quality. As MT can exacerbate social inequalities for minority communities because of unequal MT development, they push for data and resources to become available for more languages. Vieira et al. assert that unequal MT development is a persistent, urgent issue that requires attention from both researchers and policymakers. While computer scientists continue to improve MT's efficacy for more languages,

Vieira et al. advise health institutions to increase awareness of the technology's capabilities and limitations among providers.

Le and Nguyen (2013), professors of Asian-American studies at San Francisco State University and California State University, Fullerton, respectively, urge for more healthcare documents to be translated to Vietnamese and presented with visual aids to promote health education. Their holistic overview of social and cultural influences that affect Vietnamese-American health notes that socioeconomic and systemic barriers affect outcomes for major health concerns. Le and Nguyen explain that because of the language barriers Vietnamese-Americans face, they are uninformed or have misconceptions about many health conditions, including diabetes, hypertension, cardiovascular disease, tuberculosis, hepatitis B, and cancer. As these misconceptions contribute to health disparities, such as Vietnamese-American women having the highest incidence of and mortality from cervical cancer among all Asian ethnic groups (Le & Nguyen, 2012), Le and Nguyen emphasize the need for health education campaigns and translated resources.

Discussion

As Vieira et al. (2020) point out, the risks of MT are not in the technology itself but how people—particularly healthcare providers in high-risk environments—use it without fully understanding its potential and limitations. The unequal development of MT for language pairs like English-Vietnamese exacerbates miscommunication in these settings and predisposes Vietnamese-Americans to the consequences of poor MT quality. To ignore the state of English-Vietnamese MT and MT literacy is to ignore the translation needs of Vietnamese-Americans, a group who already faces major health disparities. As a result of insufficient language assistance services, Vietnamese-Americans face challenges in receiving

health information (Green et al., 2005). Even those with access to language-concordant physicians and professional interpreters receive less than ideal health education (Ngo-Metzger et al., 2007). To address Vietnamese-American disparities in health education and literacy, the U.S. government should promote the development of MT technology for English-Vietnamese and other under-resourced language pairs.

Vietnamese-American Health Disparities

Vietnamese-Americans have significant health disparities compared to other Asian groups and the general population, which need to be addressed with increased health education and translated resources. These disparities include but are not limited to health concerns such as cancer and mental health. According to Le and Nguyen (2012), Vietnamese-Americans have among the highest rates of incidence and death for many cancers, including liver, nasopharynx, stomach, lung, cervical, and thyroid cancer. In fact, they note that Vietnamese-American women are five times more likely than white women to suffer from cervical cancer and Vietnamese-American men are over ten times more likely than white men to be diagnosed with liver cancer. Le and Nguyen attribute these disparities to low rates of Pap and hepatitis B virus (HBV) testing and, more generally, a lack of accessible health education for Vietnamese-Americans.

In addition to cancer, the lack of translated health information also leads Vietnamese-Americans to have misconceptions about chronic health concerns such as diabetes and cardiovascular disease. For example, in one survey, sixty percent of Vietnamese-Americans did not recognize the symptoms of diabetes, such as frequent urination (Le & Nguyen, 2012). According to Le and Nguyen, because type-2 diabetes is an uncommon health concern in Vietnam, many Vietnamese immigrants are unfamiliar with its clinical symptoms. However,

living longer in the U.S. is correlated with less fruit and vegetable consumption, decreased physical activity, and increased tobacco use for Vietnamese-Americans (Le & Nguyen, 2012). These changes in diet and exercise associated with adapting to American life increase the prevalence of diabetes and cardiovascular disease in Vietnamese-American communities. With healthcare providers inadequately educating Vietnamese-Americans about diabetes and cardiovascular disease, more translated resources on the diseases' symptoms and risks are necessary.

Inaccessible health information has implications not only for Vietnamese-Americans with chronic diseases but also for their families and communities through infectious diseases. Like chronic conditions such as cancer and diabetes, Vietnamese-Americans also have misconceptions about the nature and symptoms of contagious diseases such as tuberculosis (TB). In a survey of newly-arrived Vietnamese immigrants in the U.S., many respondents incorrectly believed that TB infections always lead to disease and that a person cannot have an asymptomatic latent TB infection (Le & Nguyen, 2012). This misguided notion of TB is problematic as a five-to-ten percent of infected individuals develop TB disease later in their life according to the Centers for Disease Control and Prevention (2014). If they develop the disease, Vietnamese-Americans who have latent TB and are misinformed could inadvertently infect their family, friends, and community. As TB disease is a severe condition that can adversely affect work, relationships, and activities and even cause death if untreated, more health education is needed to reduce its prevalence and mortality rate in Vietnamese-American communities.

Regarding mental health, more accessible translation services are also necessary to help treat trauma linked with the Vietnam war that still affects many Vietnamese-American immigrants. As a matter of fact, Le and Nguyen cite that Vietnamese-American survivors of

Communist "re-education camps" have a ninety percent and forty-nine percent prevalence rate for post-traumatic stress disorder and major depression, respectively. Having faced post-traumatic stress, culture shock, the loss of loved ones, adaptation and discrimination challenges, and economic hardship, Vietnamese-Americans have dire mental health needs yet underutilize services and terminate treatment prematurely (Le & Nguyen, 2012). More translated resources are needed to support education and outreach campaigns in Vietnamese-American communities to alleviate these health disparities. By making translated information more accessible for Vietnamese-Americans, the effect of perceived linguistic discrimination can be reduced, encouraging people to seek care.

Limited access to Language Assistance in Healthcare

The consequences of language-discordant clinical visits are clear. Language discordance is associated with less health education, worse interpersonal care, and lower patient satisfaction for LEP patients (Ngo-Metzger, 2007). Language discordance is a critical issue as, according to Ngo-Metzger et al. (2007), most LEP patients lack access to language-concordant physicians, nonetheless, professional interpreters. The U.S. Department of Health and Human Services identifies inadequate interpreter services as a form of discrimination and establishes standards requiring healthcare organizations to provide language assistance services. Furthermore, Article VI of the U.S. Civil Rights Act of 1964 establishes that recipients of federally-funded health services are legally entitled to interpreters in the absence of language-concordant clinicians (Green et al., 2005). Despite the legislative, executive, and judicial branches of government supporting LEP patients' legal entitlement for interpreter services, Green et al. (2005) note that many practices—especially smaller, non-hospital based ones—fail to offer either language-concordant physicians or interpreters.

Furthermore, insurers typically do not cover language assistance services such as written translations and telephone language lines, even if providers have available interpreters (Ku & Flores, 2005). Health policy researchers Ku and Flores (2005) cite that under Medicaid, only a few states pay for interpreters, while under Medicare, interpretation is not a covered service at all. They observe the same lack of coverage from private insurers, who usually do not pay for interpretation. Even though providers are obligated to provide these services to LEP patients, the lack of coverage for interpreters under health insurance creates another barrier to accessibility.

When LEP patients find themselves without access to professional interpreters, they often rely on ad hoc interpreters—such as family members, friends, other patients, and untrained staff—who are generally unqualified. In fact, in a study conducted in California, only nine percent of LEP patients had access to a professional interpreter while most of them depended on family members or friends for translation (Ngo-Metzger, 2007). This occurrence is concerning as even though using ad hoc interpreters is better than having no translation, they still are insufficient and inadequate in healthcare settings (Green et al., 2005). Some patients are also hesitant to use family members for interpretation as it affects their family dynamics. In an interview of Vietnamese-American patients, one man explained: “When you go see the doctor, and your children go with you as your translators, this changes… [the relationship] in your family” (Ngo-Metzger et al., 2003, para. 17). Furthermore, on top of their inexperience with medical terminology, like professional interpreters, ad hoc interpreters are not always available. As another Vietnamese man in the same study notes, “relatives have to take time to go with [them]… Sometimes [they] do not want to go” (para. 17). Given that many LEP patients depend on unreliable ad hoc interpreters, using MT to translate medical documents could help ensure patients receive essential health information.

Limitations of Interpreters

Even when professional interpreters are available, they may compromise patient-physician rapport and inhibit questions about sensitive topics. Green et al. (2005) note that Vietnamese-American patients with interpreters, compared to those with language-concordant physicians, are more likely to have questions about their care or mental health they want to ask but do not. According to Green et al., this difference may be due to patients feeling uncomfortable in the presence of interpreters or having insufficient time to ask questions because of the time-consuming nature of interpreting. He explains that while interpreter use does not result in longer clinical visits, time pressures associated with interpretation reduce opportunities for patients to ask questions.

Additionally, while professional interpreters successfully relay health information in most cases, they do not mitigate disparities in interpersonal care and patient satisfaction, according to Ngo-Metzger et al. (2007). Improving interpersonal care and patient satisfaction is dependent on training for both interpreters and clinicians, but training is currently inadequate and not widespread. For medical interpreter training, there are only recommendations, not minimum requirements for training content and duration, which can make the quality of interpreter services variable (Ngo-Metzger et al., 2007). For example, in a study where researchers interviewed Chinese- and Vietnamese-American patients, one Vietnamese-American man expressed his concerns about using an interpreter: “I did not know if the translator translated my whole story to the doctor or not” (Ngo-Metzger et al., 2003, para. 18). Another Chinese-American patient had similar concerns about interpreter services: “The doctor speaks so much, but the translator says only a few words” (para. 18). Inconsistent interpreter training can also have consequences beyond incomplete translations. In the same study, another Vietnamese man complained about

poor treatment from his interpreter: “That [translator] just yelled at me and he did not care...He treated me as if I am stupid because I cannot speak English” (para. 18). In addition to inconsistent interpreter training and quality assurance, clinicians do not receive enough training on using interpreters appropriately. As such, most providers who care for LEP patients struggle to elicit exact symptoms, explain treatment, and understand patient preferences even with an interpreter (Green et al., 2005).

The limitations of interpreters, even when they are accessible, demonstrate how interpreter services are an incomplete solution in addressing language discordance in healthcare. Although MT implementation also has limitations such as reliance on user awareness, literacy, and technological proficiency, according to Vieira et al. (2020), MT offers ways to offset inadequate interpreter-related training. They also note that currently, providers primarily use MT as a last resort measure in the absence of interpreters and language-concordant providers. However, MT can add a layer of assurance to health education when used in tandem with interpreters and physicians; if doctors and interpreters fail to communicate effectively, patients can be provided with translated written materials after a visit to cover missed health information. MT can be a valuable tool and help establish a more comprehensive approach to health communication issues despite its weaknesses with increased MT literacy.

Lack of Translated Written Health Resources

As Das et al. (2019) point out, not enough health organizations and physicians provide LEP patients with written materials in their primary language, which is problematic given the established limitations of interpreters. They add that even when patients visit language-concordant physicians, they primarily receive information verbally, which can be challenging to recall. Translated materials allow patients to refer to information and

recommendations in future instances. With repeated exposure to health education outside of healthcare settings, patients can reinforce their health literacy. Like Das et al., Le and Nguyen (2013) also recognize the importance of translated written materials and call for more healthcare resources alongside visual aids to be available in Vietnamese.

One study on lay health worker outreach and media-based education for promoting cervical cancer screening among Vietnamese-American women demonstrates the effectiveness of written materials (Mock et al., 2007). In the study, Pap test rates increased significantly for both Vietnamese-American women exposed to media campaigns and those exposed to the combined intervention (lay health worker outreach plus media-based education). Within the media campaign group, women who read a newspaper article on cervical cancer were twice as likely to become up-to-date or obtain a Pap test than those exposed to other media (television and radio). The researchers suggest that newspaper articles are particularly effective in increasing health education as they provide detailed information in a form people can keep for future reference. Additionally, lay health workers in the study used Vietnamese flip charts and booklets in their outreach. Flip charts, booklets, and written materials, in general, establish another potential application for MT. With proper investment and vetting, MT could help automate the creation of educational materials in multiple languages and allow lay health workers to focus on community outreach.

Furthermore, in another study on linguistic and cultural barriers to care for Vietnamese immigrants, many patients expressed a need for proper communication about test results, health education materials, and medication instructions in their native language (Ngo-Metzger et al., 2003). As LEP patients are more likely to have problems understanding medication instructions and have medication-related health concerns (Ngo-Metzger et al., 2007), MT can help mitigate

consequences by providing written instructions in a patient's primary language. Beyond medication instructions, MT technology can translate clinical summaries, screening reports, and handouts. These documents can be made available in print or online patient portals, providing LEP patients with lasting access to information and reassurance about their health.

Developments in Machine Translation Technology

While MT is unacceptable for healthcare use in its current state, there are promising developments in machine learning and AI that could make the technology a viable tool for under-resourced languages like Vietnamese. For example, Nguyen and Huynh (2018), computer science professors at the University of Da Nang in Vietnam, created an English-Vietnamese translation system for legal documents using a neural network (AI) approach. Their system outperformed Google and Microsoft translation systems, especially for specialized terms and long sentences. Nguyen's and Huynh's accomplishments are significant as they demonstrate the feasibility of creating a high-quality translation system for healthcare materials. If computer scientists can create a specialized English-Vietnamese translation system for legal documents, another system can be created for health information and medical terminology. Developing a specialized English-Vietnamese MT system for health documents could be a highly-funded National Science Foundation project for researchers and deserves support from the government.

While their AI approach outperforms statistical translation methods used in many current English-Vietnamese translation systems, obtaining large and high-quality datasets remains a persistent obstacle. As their system relies on parallel bilingual data—texts available in both English and Vietnamese— to train their translation model, it is limited by the size and quality of their corpora.

Despite this restraint, there are various ways to create a larger corpus: extracting data from trusted sources, unifying existing corpora, and integrating post-editing functions (Nguyen & Huynh, 2018). Nguyen and Huynh explain how data can be extracted from numerous sources such as bilingual websites, language-learning materials, translation documents, technical translations, and film scripts. However, it is worth noting that curation and documentation during data collection are crucial to avoid issues with bias that other large language models face (Bender et al., 2021). Additionally, instead of creating a corpus from scratch, Nguyen and Huynh (2018) point out that existing corpora created by individuals, research groups, and organizations can be consolidated if a unified standard for data structures and format is created. They also identify implementing post-editing processes done by translation users or experts can help refine MT quality and reduce errors.

While Nguyen's and Huynh's work validates the feasibility of creating a viable English-Vietnamese translation system for health information, it is an effort that will require extensive collaboration from numerous parties. As such, the U.S. government should increase funding for research projects related to Natural Language Processing and sponsor university partnerships with research groups from other countries. To consolidate existing bilingual datasets from various sources, domestic and international research groups need to collaborate and agree on a unified structural standard for corpora. Furthermore, connections with research groups abroad can enable translation systems to receive feedback from a larger userbase.

An example of how international collaboration and unified standards increase technological development is the Python coding language. Because Python is an inclusive, open-source language that uses the Unicode Standard with characters from many human languages, computer scientists can contribute to Python updates regardless of nationality and

primary language. Similar to how a unified standard encourages international collaboration and improves Python, a unified standard for structuring MT corpora can advance translation technology.

International collaboration is necessary to form a consensus on a unified standard for MT corpora and revise translation systems through widely-used post-editing processes. With advancements in neural network translation (NNT) alongside a large, high-quality corpus, improving English-Vietnamese MT to become applicable in healthcare is entirely feasible. However, these goals can not easily be accomplished alone, and the U.S. government should promote international cooperation and the development of collaborative platforms for MT research. While many Vietnamese-speaking computer scientists in the U.S. can work on English-Vietnamese translation systems, there are challenges in obtaining enough high-quality corpora and post-editors. With MT researchers in the U.S. and Vietnam consolidating their corpora, they can access more data to train translation models. Additionally, post-editing, which involves humans revising machine-generated translations to improve them, requires many editors and users. The U.S. freelance market is limited in its supply of workers experienced with MT and post-editing (Stevens, 2021), let alone Vietnamese. Partnering with researchers in Vietnam is beneficial because they can tap into Vietnamese freelance markets and expand the number of editors for MT systems. Furthermore, Vietnamese researchers can promote translation systems in their communities to gain more user feedback and detect issues such as gender bias in translation.

It is also worthwhile for the government to invest in making MT systems less dependent on parallel bilingual data to serve under-resourced languages better and in data documentation to minimize bias in language models (LMs). Research in using monolingual data—texts available

only in the target language of a language pair—and LMs to create synthetic training datasets is currently underway (Vieira et al., 2020). The federal government should also fund these projects to make data collection easier for under-resourced languages. Without relying on bilingual texts, MT development can be democratized for languages with less data and fewer resources like Vietnamese. However, it is noteworthy that as datasets grow larger, they incorporate more harmful hegemonic viewpoints that can introduce biases into LMs (Bender et al., 2021). When the government funds MT projects, a portion of the budget should also be dedicated to data curation and documentation. According to Bender et al. (2021), many English LMs are already large and have substantial documentation debt, with datasets being both undocumented and too large to document afterward. They remark that without understanding the training data, post-hoc filtration of sexist, racist, ableist, etc. reference texts is difficult. As a solution to documentation debt, Bender et al. advise only collecting as much data as can be thoroughly documented within a project's budget.

In the unfortunate, under-resourced state of Vietnamese LMs, its small datasets present an opportunity for researchers to address the pitfalls of large LMs early on. While biases in English LMs are challenging to correct because of the massive size of existing undocumented datasets, proper curation and documentation while creating Vietnamese LMs can mitigate issues. Additionally, while developing specialized MT systems for medical terminology, LMs can grow sustainably by selectively drawing from reliable healthcare documents instead of broadly scraping the internet. Researchers can minimize problematic biases by curating training datasets and determining what data to include at the beginning of a project instead of filtering out dangerous reference texts afterward. To invest in reducing LM biases, the National Science Foundation should increase funding for curating and documenting training data.

Conclusion

Language barriers are an evident fact of life for many Vietnamese-Americans. LEP Vietnamese-Americans navigating the healthcare system suffer from inadequate governmental and institutional response to language discordance. While the government mandates that healthcare providers support LEP patients with language-concordant physicians or interpreters, many providers fall short of their responsibilities. Even if healthcare institutions successfully provide the language assistance services mentioned above, they are still incomplete, insufficient responses to the core issue.

The U.S. government and healthcare system have a moral and legal obligation (through the Civil Rights Act of 1964) to make their programs and services accessible to Vietnamese-Americans and LEP individuals at large. Additionally, from a historical perspective, many Vietnamese-Americans are political refugees who supported the U.S. during the Vietnam war or their relatives. With the United States' role in destabilizing Vietnam during the 1960s and 1970s, it has an ethical duty to care for Vietnamese-Americans. For their support of the U.S., they had no choice but to face retribution from their Communist government or flee and face language barriers in another country. By investing in MT technology to improve English-Vietnamese translation, the U.S. government can fill gaps in health education where providers and interpreters fail. While improving MT is no easy feat, it is achievable with steps such as offering more translation-related research grants, encouraging international collaboration in developing translation technology, and establishing robust directives on MT use in healthcare.

Accomplishing these goals requires institutional change and collaborative effort from both researchers and policymakers. While these changes can be costly—both financially and environmentally with data centers contributing to carbon emissions—investment in

English-Vietnamese MT is worthwhile as it paves the way for other under-resourced languages to be represented in MT development. Until the government and institutions address the shortcomings of language assistance services in healthcare, LEP Vietnamese-Americans and other immigrant groups will continue to suffer from ineffective health communication.

References

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*. https://doi.org/10.1145/3442188.3445922

Centers for Disease Control and Prevention. (2014, October 20). *Fact sheets*. Centers for Disease Control and Prevention. https://www.cdc.gov/tb/publications/factsheets/general/ltbiandactivetb.htm.

Das, P., Kuznetsova, A., Zhu, M., & Milanaik, R. (2019, February). *Dangers of Machine Translation: The Need for Professionally Translated Anticipatory Guidance Resources for Limited English Proficiency Caregivers.* Clinical Pediatrics, 58(2), 247–249. https://doi.org/10.1177/0009922818809494

Green, A. R., Ngo-Metzger, Q., Legedza, A. T., Massagli, M. P., Phillips, R. S., & Iezzoni, L. I. (2005). Interpreter services, language concordance, and health care quality. *Journal of General Internal Medicine*, *20*(11), 1050–1056. https://doi.org/10.1111/j.1525-1497.2005.0223.x

Ku, L., & Flores, G. (2005). Pay now or pay later: Providing interpreter services in health care. *Health Affairs*, *24*(2), 435–444. https://doi.org/10.1377/hlthaff.24.2.435

Le, M.-N., & Nguyen, T.-U. (2013). Social and cultural influences on the health of the Vietnamese American population. Handbook of Asian American Health, 87–101. https://doi.org/10.1007/978-1-4614-2227-3_7

Mock, J., McPhee, S. J., Nguyen, T., Wong, C., Doan, H., Lai, K. Q., Nguyen, K. H., Nguyen, T. T., & Bui-Tong, N. (2007). Effective Lay Health Worker Outreach and Media-Based Education for Promoting Cervical Cancer Screening Among Vietnamese American Women. *American Journal of Public Health*, *97*(9), 1693–1700. https://doi.org/10.2105/ajph.2006.086470

Ngo-Metzger, Q., Massagli, M. P., Clarridge, B. R., Manocchia, M., Davis, R. B., Iezzoni, L. I., & Phillips, R. S. (2003). Linguistic and cultural barriers to care. *Journal of General Internal Medicine*, *18*(1), 44–52. https://doi.org/10.1046/j.1525-1497.2003.20205.x

Ngo-Metzger, Q., Sorkin, D. H., Phillips, R. S., Greenfield, S., Massagli, M. P., Clarridge, B., & Kaplan, S. H. (2007). Providing high-quality care for limited english proficient patients: The importance of language concordance and interpreter use. *Journal of General Internal Medicine*, *22*(S2), 324–330. https://doi.org/10.1007/s11606-007-0340-z

Nguyen, B. V., & Huynh, P. C. (2018). An English-Vietnamese translation system using artificial intelligence approach. *Intelligent Information and Database Systems*, 211–220. https://doi.org/10.1007/978-3-319-75417-8_20

Stevens, A. (2021, March 17). *Overcoming the challenges of machine translation for long-tail languages*. RWS. https://www.rws.com/blog/machine-translation-long-tail/.

Vieira, L. N., O'Hagan, M., & O'Sullivan, C. (2020). Understanding the societal impacts of machine translation: A critical review of the literature on medical and legal use cases. *Information, Communication & Society*, 1–18. https://doi.org/10.1080/1369118x.2020.1776370