Video Medical Interpretation over 3G Cellular Networks: A Feasibility Study

Craig Locatis, Ph.D.,[1] Deborah Williamson, D.H.A., M.S.N., C.N.M.,[2] James Sterrett, Pharm.D.,[3] Isabel Detzler, B.A.,[4] and Michael Ackerman, Ph.D.[1]

[1]Office of High Performance Computing and Communications, National Library of Medicine, Bethesda, Maryland.
[2]College of Nursing, [3]College of Pharmacy, and [4]Interpreter Services, Medical University of South Carolina, Charleston, South Carolina.

Abstract

Objective: *To test the feasibility of using cell phone technology to provide video medical interpretation services at a distance.* ***Materials and Methods:*** *Alternative cell phone services were researched and videoconferencing technologies were tried out to identify video products and telecommunication services needed to meet video medical interpretation requirements. The video and telecommunication technologies were tried out in a pharmacy setting and compared with use of the telephone.* ***Results:*** *Outcomes were similar to findings in previous research involving video medical interpretation with higher bandwidth and video quality. Patients appreciated the interpretation service no matter how it is provided, while health providers and interpreters preferred video.* ***Conclusion:*** *It is possible to provide video medical interpretation services via cellular communication using lower bandwidth videoconferencing technology that provides sufficient quality, at least in pharmacy settings. However, a number of issues need to be addressed to ensure quality of service.*

Key words: *pharmacy, technology, telecommunication, telemedicine*

Introduction

Professional medical interpretation services have usually been provided in-person or by phone. Protocols have been developed enabling transmission of voice and video data over computer networks and increasing Internet bandwidth has improved the prospects of offering services by video. Bandwidth improvements have extended to cell phone networks, making it theoretically possible to increase accessibility to video medical interpretation in areas that have been underserved.

Medical interpretation has been provided by trained interpreters or on an *ad hoc* basis by friends, relatives, or anyone conveniently available. The advantages of using trained interpreters have been documented in three research reviews.[1–3] Trained interpreters outperform *ad hoc* ones and can raise the level of clinical care for patients with limited English proficiency (LEP) to that given with language concordance.[1] Communication quality is rated higher with trained interpreters and there are fewer errors that affect diagnosis and treatment.[2] *Ad hoc* interpretation is more error prone because interpreters may not understand technical information health providers give and may omit or distort it out of embarrassment. Moreover, patients may be less forthcoming because of lack of privacy and confidentiality if interpretation is provided by friends or relatives. Use of trained interpreters is associated with increased use of healthcare services, higher preventative screening levels, improved compliance, and greater patient satisfaction.[1,2] Consequently, providing professional language assistance services has become a standard for healthcare organizations receiving federal funding.[4]

There are few studies of remote medical interpretation; one systematic review identified only nine,[3] most involving the phone and comparing remote simultaneous medical interpretation (RSMI) to proximate consecutive medical interpretation (PCMI). In RSMI, the interpreter is not physically present; the doctor and the patient usually wear headsets and technology directs their speech to the interpreter, not to each other. The interpreter's speech is directed back to the doctor and patient allowing interpretation while they talk. In PCMI, the interpreter is usually physically present and responds after each person speaks, although PCMI also can be done remotely.

One of the two videoconferencing studies in the systematic review found similar patient satisfaction with video, phone, and in-person interpretation,[5] while the other found that interpreters preferred face-to-face service most, but favored using video more than the phone.[6] The results of the latter study were similar to an earlier one of telephonic and in-person interpretation where interpreters preferred contact in-person.[7] Both video studies that were reviewed had limitations. One used older Integrated Services Digital Network (ISDN) technology at a bit rate of 128 kilobits per second (Kbps) that was too low for full motion video, involved a single provider and interpreter, had too few encounters for statistical comparison, and only used data from patients.[5] The other had only qualitative data[6] but its results were similar to a subsequent qualitative study where providers and interpreters preferred in-person and then video interpretation to telephonic.[8]

A quantitative and qualitative study of video medical interpretation conducted by some of the authors had results similar to the two prior qualitative studies.[9] Patients, providers, and interpreters rated the quality of 80 in-person, 80 telephonic, and 81 video encounters provided by the PCMI. Seven interpreters and 24 providers participated. Ratings for in-person interpretation were significantly higher than those for remote methods and the difference was due to providers and interpreters who experienced all three methods and were more critical. Patients only experienced the type of interpretation service provided

DOI: 10.1089/tmj.2011.0084

and were pleased no matter how it was given. There were no significant rating differences between remote methods, but interpreter ratings of video encounters approached significance ($p=0.08$) and, in interviews, providers and interpreters overwhelmingly preferred video. Most encounters involved postpartum consultations where providers moved about the room and demonstrated procedures. Video was valued because interpreters could see patient's body language and what was happening. Providers liked the video more than dual handset phones because their hands were free and preferred it to speaker phones because it had superior microphone range.

H.323 standard definition videoconferencing appliances were used in the previous study with a data rate of 384 Kbps, sufficient for full screen, full motion video. The videoconferencing appliances were on carts that could be moved to different hospital rooms as needed and had pan, tilt, and zoom (PTZ) cameras that could be controlled remotely. Communication in the hospital was over its wireless network, using 802.11 routers, while that in the interpretation office was over a wired network. It took time to set up equipment and it used up space, even though communication was wireless and the carts were not large. The question arose whether it would be possible to provide the video service on laptops using cell phone transmission to provide greater mobility and extend service accessibility.

A pharmacy setting was targeted for testing cellular video service because pharmacies are numerous and geographically dispersed and because of a survey conducted by some of the authors identified a need.[10] The Hispanic population in South Carolina is growing and the study showed that few pharmacies had Spanish-speaking pharmacists, that there were few mechanisms other than printing bilingual labels for communicating medication information or verifying a patient's understanding, that most pharmacists felt they had limited ability to counsel LEP patients, and that most pharmacies had access to the Internet and to cell phone service.

Materials and Methods

Alternative technologies were identified and initially tested at the pharmacy and interpretation office sites and then tried out with patients. The initial evaluation involved determining cell phone service and bandwidth requirements and a videoconferencing mechanism. Video requires a certain level of cell phone service. Older G2 service is insufficient because, although G2 cell towers provide digital transmission, average data rates can be as low as 56 Kbps and peak rates are about 150 Kbps. While G3 services can transfer data at rates accommodating Web access and related Internet services such as one-way video streaming (Webcasts) and videoconferencing, the bandwidth problem is compounded because different cell phone carriers employ different underlying technologies with varying transfer rates depending on the version. The fastest versions may not be deployed in all areas carriers serve and available bandwidth can still fluctuate depending on how traffic is routed. Some may route voice and data over the same cell tower antenna while others may divide the spectrum amongst different antennas to distribute load. These 3G bandwidth issues, which had to be addressed in the feasibility study, have persisted with the introduction of 4G technologies increasing transfer rates by another order of magnitude.

Video tests were done using code division multiple access (CDMA) cell technology. Evolution Data Optimized (EV-DO) Rev A was determined to be the appropriate version because EV-DO Rev A has downlink rates of 600 to 1,400 Kbps with burst up to 3.1 megabits per second (Mbps) and uplink rates of 500 to 800 Kbps with burst up to 1.8 Mbps. Prior to Rev A, CDMA service provided downlink transfer rates of 400 to 1,000 Kbps, but uplink rates were only 50 to 100 Kbps. These extreme asymmetrical transfer rates were suitable for one-way video streaming and movies on demand, but more symmetrical bandwidth is needed for bidirectional videoconferencing. Importantly, the EV-DO Rev A level of service was provided by a CDMA carrier throughout the Charleston, South Carolina, region where the study was conducted. The carrier's Web site, aimed at consumers, only referred to the availability of "mobile broadband," however, and additional inquiries had to be made to determine the exact technology.

The video and audio available on most cell phones at the time had inadequate quality and the phones were cumbersome to control. Positioning the cell phone to frame both the pharmacists and patient and hold it in a stable position would be difficult and panning, tilting, and zooming the cameras remotely was not possible. Consequently, Peripheral Component Interconnect (PCI) or Universal Serial Bus (USB) cell modems connected to laptops for Internet access via cell networks were used instead (*Fig. 1*). Varied cameras and videoconferencing software could be installed to provide video interpretation services. H.323 standard videoconferencing software was tested initially but its data rate of 384 Kbps for full motion video and even lower rates (e.g., 128 Kbps) proved unworkable, with unacceptable latency and jitter even when tested on CDMA by different carriers. VSee was selected for videoconferencing because its data rates, while variable, could go as low as 50 Kbps for video and 16 Kbps for audio, it could support remote

Fig. 1. Laptop with Peripheral Component Interconnect (PCI) cell phone modem at interpretation office.

control of PTZ cameras, it provided secure Federal Information Processing Standards (FIPS) 140-2 256 bit Advanced Encryption Standard (AES)-encrypted video transmission, and its video looked superior to other low-bandwidth products. The VSee default video window size was 240×320 pixels, but could be expanded.

The pharmacy at the Harvest Free Clinic in the city of North Charleston, South Carolina, agreed to participate. Although located in a concrete building originally used for ordinance research in World War II at a somewhat remote shipyard, the pharmacy occupied an area where glass windows and doors were installed. Its cell signal was good and preliminary tests were successful, as were those at the interpretation office at the Medical University of South Carolina (MUSC). Almost a year passed after the study received funding and Institutional Review Board (IRB) approval. A laptop with a Sony standard definition D-70 PTZ camera was installed in the pharmacy while one with a Logitec HD 9000 camera was placed in the interpretation office.

Twenty-six patients, two pharmacists, five interpreters, and one nurse participated. The nurse was bilingual, consented patients, and assisted with the technology. Half of the consultations were done by phone and half by videoconference. Patients were asked to comment on the interpretation service after each consultation. The pharmacists, interpreters, and the nurse were interviewed at the end of the 3-month tryout period. The same interview protocol was used (*Fig. 2*), but only the interpreters answered the question about how the laptop videoconferencing compared with H.323 technology, since they were the only participants who used H.323 in the prior study. Although the pilot study involved providing Spanish interpretation, follow-up tests were done to judge the suitability of the video for sign language.

Results

There were two types of outcomes: technical ones associated with implementing the technology and people ones concerning their perceptions of the technology and its use. The pilot implementation varied from the preliminary test in several significant respects. First, the videoconferencing equipment had to be moved to a room toward the interior of the building away from the windows in the pharmacy lobby because of privacy. The room's concrete pillars and walls blocked cell phone communication and a repeater amplifying the cell signal had to be installed. Connectivity proved to be more of a problem at the MUSC interpretation office. Cell service was considerably worse than when initially tested and a wired network was used instead.

Patients' perceptions were like those in the previous hospital clinic study. They were exposed to only one method and were pleased to have the service. The eight participating providers and interpreters were exposed to both methods and were more critical, as in the earlier study. When they were asked about encounter quality, five indicated that in-person interpretation was superior, two did not mention in-person but only the superiority of video to phone, and one felt that all methods impacted encounter quality the same. When they were asked to directly compare the two remote methods, six felt that video was better and two felt that they were about the same. None indicated phone superiority. Provider and interpreter responses to the question about rank ordering interpretation methods were more definitive. Everyone's first preference was for in-person interpretation, seven indicated video as their second preference, and only one indicated the phone. The ability to see what was happening and to have more personable communication were the most cited reasons. The pharmacy was a new venue for the interpreters who had to become familiar with a host of medications. Interestingly, both pharmacists indicated that the video helped them detect when an interpreter might be having a problem with the information provided.

Six of the eight providers and interpreters felt that the smaller video window provided sufficient quality for interpretation in pharmacy settings. One pharmacist felt that the video window size was too small, possibly because of not knowing how to increase the default setting, and one interpreter preferred the full size, full screen H.323 video used in the previous study. However, the five interpreters who used the full screen videoconferencing appliance and the sub-full screen laptop were equally divided, when asked to compare the two video technologies. Two felt that the H.323 appliance was better because of image quality, two felt that the laptop software was better because of its ease of use, and one felt that they were the same. Everyone mentioned technical problems, albeit different ones. Some mentioned connection problems while others mentioned difficulties hearing or seeing (lighting). Medication names and how to communicate them were a special problem. The PTZ camera, considered essential for interpreters to control their view, proved unessential because the pharmacist and patient were stationary and the built-in laptop camera at the pharmacy was used instead. Follow-up tests showed that the video quality was suitable for sign language.

1. Tell what you think of the research study and technology implementation. What went well and not so well?
2. How do you think the quality of the patient-provider encounter compares between in-person, video, and phone interpretation?
3. How do the two remote technologies compare – video versus the phone?
4. If you could provide interpretation services in-person, by video, or by phone, which would you use first, second, and third? Why?
5. Have you done video medical interpretation before? If so, how does the video used in this study compare to what you used previously?
6. Do you think the video technology used in this study was sufficient for providing interpretation services? Why or why not?

Fig. 2. Interview protocol.

Discussion

Participants were pleased with video. When asked to comment generally about the study, several mentioned they were impressed that videoconferencing could work on cellular networks and that there were few problems or ones easy to troubleshoot once the cell signal was amplified at the pharmacy. The cell phone connectivity problem at the interpretation office was unexpected, given the university's more central location, but was attributable to higher volume traffic at its cell tower. In retrospect, the problem should have been anticipated, even though the carrier separates spectrum, given the high degree of cellular device usage among students, faculty, and staff.

The discontinued use of the PTZ camera was unforeseen, but one provider and one interpreter felt that not only the camera but also the video itself may not be as essential in pharmacy settings. There was little movement, unlike the previous postpartum study where providers demonstrated aspects of baby care. In retrospect, the initial pharmacy videoconferencing platform was over engineered, adding complexity and costs. The use of built-in cell phone cameras maybe possible in the future, given the generally fixed positioning of subjects at pharmacy sites and improvements in cell phone camera quality, although initially positioning and stabilizing phones remains a problem. Laptop and tablet computer displays make it easier for participants to see the signals they send and receive and to reposition the computer and its camera appropriately.

Insufficient time and exposure were also identified as a problem in working with the technology and pharmacy content. The study lasted only 3 months and the interpretation service was only provided one morning per week at the time the clinic scheduled non-English–speaking patients. It was assumed that interpretation services in one context (a hospital ward) could transfer to another (a pharmacy), but medication names and dosage requirements were problems. Issues arose over whether the name should be pronounced as it would in English or Spanish. Interpreters were provided a list of more common medications, but inevitably there were prescriptions not on the list. The use of VSee's chat feature to type the name for the interpreter to see was considered but it was not used, and subsequent test showed that the name of the medication on the prescription was generally large enough that it could be read when held to the camera, although other information was not. Several interpreters mentioned needing a copy of the prescription prior to consultation. Having electronic medical records systems interpreters could access would alleviate the problem. Interpreters would have become more knowledgeable and comfortable with medication terminology over time. Follow-up tests using sign language showed that the video was large and smooth enough.

Conclusion

The use of 3G cellular networks can potentially increase accessibility to video medical interpretation services. The pilot feasibility study proved that it was possible to do video medical interpretation with adequate image quality for language and sign language interpretation over cell phone networks, at least in pharmacy settings, but only under certain conditions.

- Appropriate 3G network connectivity must be available. Only 3G (or 4G) networks have sufficient bandwidth and only the more recent ones allocate enough uplink bandwidth to accommodate bidirectional video.
- Efficient video CoDecs should be employed that can economically use available bandwidth while providing sufficient quality. While the latest cell technology has adequate bandwidth, it is lower than what can practically be realized with landlines and more susceptible to network congestion and other factors affecting network performance.
- Tests need to be done in the exact locations where video conferencing will occur, since cell phone signals are susceptible to interference by building materials and the volume of traffic at the cell towers serving a site.
- Use of cell signal repeater antennas should be considered when signals are weak or variable. If a site already has good existing network capability by landlines, there is no need to use cellular wireless. If it does not and signals are weak, modest investments can be made in amplifying equipment.
- Performance must be continually monitored. Cell towers having sufficient bandwidth may become congested if use of cellular services increases. This is not only a function of more individual users but of the number of devices becoming cellular capable.
- Use of peripherals (e.g., PTZ cameras) or complimentary technology (e.g., chat) should be weighed in relation to the activities occurring and content provided at the remote healthcare site. Some may prove necessary while others may not, and some can add complexity and costs. Built-in computer (and possibly cell phone) cameras may suffice for some applications.
- Policies for dealing with special terminology need to be established, depending on the healthcare service being provided. For pharmacies, they include providing prescriptions to interpreters in advance or using chat technology or video to display product names as well as determining how names will be pronounced (in English, Spanish, or both).

Disclosure Statement

No competing financial interests exist.

REFERENCES

1. Karliner L, Jacobs E, Chen A, Mutha S. Do professional interpreters improve clinical care for patients with limited English proficiency? A systematic review of the literature. *Health Serv Res* **2007;**42:727–754.
2. Flores G. The impact of medical interpreter services on the quality of health care: A systematic review. *Med Care Res Rev* **2005;**62:255–299.
3. Azarmina P, Wallace P. Remote interpretation in medical encounters: A systematic review. *J Telemed Telecare* **2005;**11:140–145.
4. Office of Minority Health. National standards for culturally and linguistically appropriate services in health care: Final Report. Washington: U.S. Department of Health & Human Services. Available at www.omhrc.gov/assets/pdf/checked/finalreport.pdf (last accessed September 28, 2011).
5. Jones D, Gill P, Harrison R, Meakin R, Wallace P. An exploratory study of language interpretation services provided by videoconferencing. *J Telemed Telecare* **2003;**9:51–56.

6. Paras M, Leyva O, Berthold T, Otake R. Videoconferencing medical interpretation: The results of clinical trials. Oakland, California: Health Access Foundation, **2002**.

7. Hornberger J, Gibson C, Wood W, Dequeldre C, Corso I, Palla B, Bloch D. Eliminating language barriers for non-English-speaking patients. *Med Care* **1996;**34:845–856.

8. Saint-Louis L, Friedman E, Chiasson E, Quessa A, Novaes F. Testing new technologies in medical interpreting. Somerville, Massachusetts: Cambridge Health Alliance, **2003**.

9. Locatis C, Williamson D, Gould-Kabler C, Zone-Smith L, Detzler I, Roberson J, Maisiak R, Ackerman MJ. Comparing in-person, video, and telephonic medical interpretation. *J Gen Intern Med* **2010;**25:345–350.

10. Sterrett J, Williamson D, Pope C, Dumas B. The Hispanic health initiative. Grant Appropriation 5395-SP, The Duke Endowment.

Address correspondence to:
Craig Locatis, Ph.D.
Office of High Performance Computing and Communications
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20854

E-mail: locatis@nlm.nih.gov

Received: April 27, 2011
Revised: May 20, 2011
Accepted: May 23, 2011