High Definition Live Interactive and Store and Forward Teledermatology:

Initial Qualitative Observations

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POSTER PAPER

***Abstract*— Initial qualitative findings from a study of uncompressed and compressed high definition live interactive video, and store and forward teledermatology (photographs and written histories for later review) are presented. Quantitative data collected in the study are still being compiled and analyzed comparing diagnostic concordance and confidence with in-person exams. The early qualitative findings suggest bifurcated patient and physician preferences for the different remote exam methods.**

Keywords-*collaboration enabling technologies; information infrastructure for collaboration; tele and collaboration technologies in healthcare.*

I. INTRODUCTION

Telemedicine involves collaboration, especially when physicians share information about patients with each other to get assistance in making diagnoses or prescribing treatments. But telemedicine interventions where physicians work directly with patients are collaborative as well. Patients seek expert assistance in solving health problems and physicians and patients work together through history taking, examinations, and tests, to identify solutions. Telemedicine applications involving patients are generally categorized as "live interactive" or "store and forward". Live interactive applications usually employ videoconferencing technology for direct real time interaction and examination of patients, while store and forward applications are indirect, involving a third party collecting patient information that is subsequently sent to physicians for review. The third party may be a general practitioner, nurse, or other person trained in using telemedicine technology and data collection protocols. The consulting physician in store and forward telemedicine can be a general practitioner, but most often is a specialist that is unavailable locally. Consulting physicians in live interactive telemedicine can be general practitioners if there are no local primary care givers, but physicians in live interactive telemedicine applications are often specialists also.

A research study is discussed in this poster paper that is currently underway in the domain of teledermatology comparing in-person, live interactive and store and forward methods. A rationale for the study is presented and relevant literature is reviewed. Advanced, cutting edge videoconferencing technology used as part of the study's live interactive intervention and the research design are described. Data are still being collected and analyzed, but early qualitative results concerning patients' and dermatologists' preferences for different methods is reported.

II. BACKGROUND

There are several reviews of teledermatology research and teledermatology has been featured in reviews of telemedicine studies generally [1-9]. While there is substantial research on telemedicine, much of the research literature is about case studies or studies having few subjects. There are far fewer Randomized control trials (RCTs) than descriptive studies or studies of a single telemedicine method of providing care. Teledermatology research has been criticized particularly because studies comparing remote methods to seeing patients in-person, usually have a single remote and in-person dermatologist doing exams [2]. Individual expertise becomes confounded with method. Without at least two dermatologist independently examining patients and recording their concordance, there is no "gold standard" for comparing remote exams to those conducted face to face.

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Teledermatology was chosen as the research domain because this study includes testing very high resolution uncompressed high definition video and more standardized, compressed high definition video. The former are just emerging from laboratories and need testing in telemedicine domains where high resolution images are needed [10, 11]. Dermatological diagnoses rely on visual examination to a great extent and resolution more be more of an issue than in other medical domains, such as telepsychiatry.

The gold standard for assessing all telemedicine interventions is parity with, not superiority to, exams done in-person [2]. In addition to concordance with in-person diagnoses and treatments, patient and health care provider satisfaction, time and cost savings, and accessibility to health care are other telemedicine assessment metrics [1]. There are few satisfaction studies, especially of health care provider satisfaction [4]. Time and cost savings often are demonstrated because patient or provider travel is averted. Accessibility also increases because in many areas where telemedicine services are offered, there was no prior care [1].
Although improved accessibility and time and cost savings can be expected, these benefits are marginalized if telemedicine diagnoses are discordant with those in-person or reduce provider confidence in their diagnostic and treatment decisions. Lower confidence may result in increased use biopsy and other tests or decisions to still see patients in-person [12].

Three factors have been identified affecting concordance and confidence in telemedicine [13]. One is congruence or the degree to which the procedures and technologies used in telemedicine comply with those used in face to face clinical encounters. For example, when otolaryngologists do endoscopic exams locally, they view the images on television monitors. If the endoscope is manipulated at a distance under an otolaryngologist's direction, the only difference between the local and remote exam is distance. A second factor is fidelity or the degree to which information can be collected in remote exams to compensate for any deficits they may have from in-person exams. For example, ophthalmologists reposition their ophthalmoscopes to get different views of the eye when doing exams in-person, while eye exams in telemedicine typically involve taking photographs. Extra photographs are taken from a range of angles to make up for this difference. A third factor is reliability or the consistency with which data are acquired or transmitted. Reliability depends on the technology and those who use it. If the communication is unstable or latencies and artifacts are introduced when information is transmitted or if the person taking pictures or manipulating remote instrumentation lacks training in the kinds of information needed, reliability suffers.

The research questions in this study are:

Are there diagnostic concordance differences with in-person exams for live interactive and store and forward telemedicine?

Are there diagnostic concordance differences with in-person exams for high resolution, uncompressed video and compressed video?

Are there diagnostic confidence differences among in-person, live interactive high resolution uncompressed video, live interactive compressed video, and store and forward methods?

Are there differences in decisions to biopsy and confidence in decisions to biopsy among in-person, live interactive high resolution uncompressed video, live interactive compressed video, and store and forward methods?

Are there differences in patient and physician satisfaction with and preferences for in-person, live interactive, and store and forward methods?

III. Methods

This study addresses deficits in previous research and, indirectly, the three factors affecting concordance and confidence in telemedicine. Diagnosis from live interactive exams and from stored and forwarded histories and photographs are compared to those made in-person. In-person exams were made independently by two dermatologists to determine degree of in-person exam agreement and their consensus diagnosis was used to judge concordance of the two remote methods. One attending board certified dermatologist and ten second and third year dermatology residents participated in the study. The residents rotated among the three examination methods to control for variations in individual expertise. The attending, however, performed all in-person exams and the attending's diagnostic decisions were used to manage patients.

Each patient was examined by each method. The patients, the live interactive dermatologists, and the in-person dermatologists complete a Likert scale rating the quality of each exam encounter. Patients also rate the quality of the store and forward work up and data collection and residents assigned store and forward evaluation rate the quality of the information provided. The order in which patients experience the three types of exams is rotated, since they have no basis for comparing their first exam method to alternatives. Patients are interviewed after completing all exams and asked to rank order their preferences for the three methods and provide a rationale for their rankings. The attending and residents have been similarly interviewed at the conclusion of the study's data collection phase.

A dermatology resident used a structured form to capture history and took a minimum of three pictures (long shot, medium shot, and close up) of each patient's lesion using a 10 megapixel Canon PowerShot G12 camera. A ruler and standard color wheel were included for reference in each shot. The photographs taken were 3648 x 2736 pixel 24 bit color

JPEGs. Uncompressed and compressed videoconferencing technologies were used for remote live interactive examinations. The use of each was alternated every other clinic. The uncompressed high definition video was 1920 x 1080 pixels captured from the camera as interleaved video but displayed on 1920 x 1080 progressive monitor. The compressed video uses the H.264 standard for high definition at a resolution of 1280 x 720 pixels also captured as interleaved and displayed progressively. The data transfer rate for the uncompressed video is 1.5 gigabits per second and 2 megabits per second for compressed. The video cameras on the uncompressed and compressed videoconferencing systems have pan, tilt, and zoom capability and can be remotely controlled by the examining physician. Omni-directional microphones with echo cancellation are used with both video technologies so the physician and patient could converse in real time, even if the patient has to turn sideways or backward during exams.

IV. Results

The goal of examining over 200 patients has been reached. Diagnoses are currently being scored for concordance with the consensus in-person diagnosis for each patient. Likert scale data have been entered into a spreadsheet. When scoring is complete, statistical analyses will be performed to determine if there were differences between the various exam methods in diagnostic concordance and confidence, biopsy concordance and confidence, and exam encounter satisfaction.

Qualitative data based on patient and dermatologist comments on forms used in the study and patient and dermatologist rankings of the methods show almost unanimous preference for in-person exams, but a fifty-fifty split between the remote methods. Patients preferring store and forward valued the continuous presence of a human during the work up. In contrast, patients were left alone in the video exam room after being shown the examination chair and being introduced to remote dermatologist on the television monitor. Moreover, many of the patients favoring store and forward were concerned about whether the doctor was viewing the appropriate area of the skin during video exams. There was no picture-in-picture capability showing where the exam room camera was pointing. Those preferring video, valued the ability to interact with the physician in real time.

All the dermatologists made a distinction between uncompressed and compressed video and rated compressed video least preferable of the three methods. Even though the compressed data rate allowed for video at thirty frames per second for full motion, the 1280 by 720 pixel images lacked sufficient clarity and color information. Those rating store and forward higher than uncompressed video did so on the basis of practicality and efficiency, noting the photographs were high resolution and "good enough" and that diagnoses could be done faster, while also recognizing the images were taken by someone with dermatologic expertise. In most store and forward contexts, photographs will be taken by someone with less domain expertise and image quality and usefulness may be inferior. Those ranking video higher valued the very high image quality, the ability to see more context (the entire patient, skin around the lesion of concern) and the lesion itself, and the ability to interact. Whether diagnostic and confidence data will show similar rankings will depend on planned statistical analyses.

Patients' issues with live interactive video could be resolved by providing a picture-in-picture feature so they can see where the examination camera is pointing and by having a person physically present in the exam room (if privacy rules allow). Dermatologists' preferences for store and forward or high definition uncompressed live interactive video are harder to resolve because they are based on different criteria. Whether one method should be preferred over the other will depend on whether there are any quantitative differences in diagnostic concordance, decisions to biopsy, and confidence. Hybrid approaches have been suggested to compensate for the limitations of both store and forward and live interactive methods. Video, even at low resolution, could allow the specialists to continue quarrying patients until they are sure they have sufficient information while also directing someone on site to take appropriate high resolution photographs [14].

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