A Scenario-based Study of Doctors and Patients on Video Conferencing Appointments from Home

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Telemedicine systems that involve the use of video conferencing technologies have been available for more than three decades. Yet, they have primarily been used for specialist appointments or within healthcare facilities. We are now seeing a shift with the proliferation of commercial technologies such as smartphone apps that allow people to have appointments with a general practitioner from nearly any location for various reasons. Telemedicine has also seen an uptake due to the COVID-19 pandemic. However, little is known about how doctors and patients perceive smartphone-based telemedicine systems, what types of medical ailments are best suited for these systems, what socio-technical challenges might emerge through their usage, and how systems should be designed to best meet the needs of both doctors and patients. Thus, we applied a scenario-based design method by presenting a set of medical situations to both general practitioners and patients, and conducted contextual interviews with them to investigate their thoughts on video-based appointments for a range of medical situations. Results show that video consultations using smartphone apps could raise challenges in delivering appropriate care and utilization, conducting camera work to assist different types of examinations, supporting doctor-patient relationship creation and maintenance, allowing doctors to maintain control over the appointment, as well as protecting patients' and doctors' privacy. This suggests the need to create designs that can support particular workflows, relationship building, safety and privacy protection, and camera work for varying contexts.

CCS CONCEPTS • Human-centered computing~Human-computer interaction (HCI)~Empirical studies in HCI

KEYWORDS: Mobile video communication, video doctor appointment, domestic setting, video-mediated communication, primary healthcare

1 INTRODUCTION

Telemedicine refers to the use of telecommunication technologies to distribute healthcare services over distance without patients and healthcare providers being physically present in the same space [43]. The aim was originally to support patients who might face difficulties seeing a doctor in person, such as those with chronic illnesses or mobility issues [42]. Telemedicine can be traced back to more than a century ago when the telephone was used to convey inquiries and diagnoses. Nowadays, telemedicine has been widely applied within a variety of subspecialties, including but not limited to teleradiology, telepsychiatry, and teledermatology, incorporating synchronous communication like the telephone or video conferencing, or asynchronous communication like transmitting health data to doctors. With the prevalence of video communication technologies, telemedicine systems are now aimed at supporting a more extensive range of video appointments that move beyond just specialist consultations [14,72].

Video-mediated doctor consultations have been studied substantially in the fields of medicine and human-computer interaction (e.g., [4,38,64,77]). As early as the 1970s, video communication was introduced into medical practice and referred to as 'interactive television' where doctors, nurses and patients from different places worldwide used video communication via satellite transmissions for consultations, medical data exchange, and education [27]. At present, video communication supports services for a wide range of medical fields such as dermatology, psychiatry, and family medicine [76]. In addition, we also see changes in the use of video conferencing medical appointments due to the COVID-

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19 pandemic. Prior to it, some countries reserved video appointments for chronic or seriously ill patients only [4]. Yet the temporary closure of general practitioners' clinics and people's apprehension to visit medical offices (for fear of contracting the highly contagious virus) has led people to seek video appointments when facing common ailments during the COVID-19 pandemic (e.g., colds, sore throats) [3].

The evaluation of video appointments has commonly focused on medical outcomes, for example, coordination and administration of online appointments [16,65], patients' acceptance and satisfaction [64], as well as the performance compared with face-to-face consultations [72]. Explorations of telemedicine technologies in human-computer interaction and related fields have involved studies of the quality of light, image resolution, sound and video lag [40]. Studies of video consultations for supporting primary healthcare have looked at similar outcomes with respect to acceptance, feasibility, coordination, satisfaction, or accessibility [7,59]. However, these investigations have not included detailed explorations of how technology could change the outcomes of consultations from both technical and social perspectives, or how doctors and patients would feel about using video conferencing for various types of situations with concerns such as privacy in mind. Instead, studies have mostly looked at telemedicine usage both generally (e.g., [56]) and specifically (e.g., [23]), often glossing over more common aspects of everyday life that may affect this area (e.g., reason for the appointment, patient and doctor location). Further, research has yet to focus on how general practitioners and their patients might want to use video conferencing for different types of doctor's visits [73]. Studies have mainly focused on doctors' opinions and preferences for virtual appointments (e.g., [20,31]) and have mostly ignored the patient's point of view. In this paper, we explore doctors' and patients' thoughts and feelings about using telehealth for a diverse set of medical appointments with a focus on uncovering design and user experience knowledge to inform the creation of future applications.

We conducted an exploratory study with twenty-one patients and twelve general practitioners in Vancouver, Canada. We used a scenario-based design method [13] to interview patient and doctor participants about appointments, where one could use a smartphone to call a doctor using software akin to present-day video appointment apps. This contrasts with observing live appointments, which would be ethically challenging, especially for studying sensitive and possibly privacy-intrusive appointments. Then, we used a scenario-based interview method where participants were shown pre-recorded scenarios of mock app-based video appointments covering various common conditions and were interviewed about the scenarios. Our study explored the following research questions: What appointment types would be appropriate for smartphone app-based video calls from home, and what challenges would emerge? How would video-based appointments using a smartphone change the workflow of an appointment, in comparison to an in-person appointment, if at all? What challenges and concerns would doctors and patients have with the design and interaction needed for such video-based appointments? How should new designs address the social and technical challenges that concern patients and doctors? Across all of the questions, we focused on user interface design aspects such as camera work (capturing the right view in the camera), relationship building over video, privacy and control, and video recording.

Our results show that patients find video-based doctor appointments more accessible than in-person appointments. In addition, themes from patients and doctors emerged in relation to social concerns (e.g., difficultly establishing and maintaining doctor-patient relationships), technical concerns (e.g., suboptimal physical examinations due to poor camera work), and safety and privacy (e.g., loss of control by doctors, sensitive videos being transmitted). Our work suggests design implications for supporting video-based doctor appointments, including ideas around the design of virtual waiting rooms for patients; supporting camera work for capturing the entire body, different body parts, or actions; enhancing the physical

embodiment of both patients and doctors to help build relationships; expanding the camera view to make both parties aware of the environment; and, designing better camera control to protect patients' privacy. In the following sections, we first present related work on video communication and healthcare over distance. Then, we introduce our exploratory scenario-based design method, data collection and analysis. Afterwards, we present our results with four main sections. Lastly, we discuss our findings whilst proposing corresponding design implications.

2 RELATED WORK

2.1 Healthcare over Distance

Telemedicine systems were initially designed to support the distribution of healthcare services to less developed and remote areas [80]. Now, they also support patients who face difficulties in seeing a doctor in-person such as older adults, or those with disabilities or recurrent diseases [42]. These systems have also been instrumental during the COVID-19 pandemic, enabling patients to virtually attend doctor's appointments [3]. Generally speaking, there exist two approaches to virtual healthcare: a patient and doctor can communicate asynchronously or synchronously.

First, asynchronous communication means doctors and patients do not have to communicate in real-time, and it usually involves transmitting medical data to the doctor for diagnosis or health monitoring. Dermatology is believed to be one of the most suitable specialties for asynchronous telemedicine as visual inspections are heavily involved. For example, patients can take photos of their skin and send them to a dermatologist who is in another geographical area for their review [39]. Landow et al. [39] conducted a literature review and found four factors that helped to improve access to teledermatology, including preselection, high-quality and effective images, usage of dermoscopy, and infrastructure adaptation. However, the research did not focus on the process of taking photos. To foreshadow, our research revealed challenges with capturing different body parts on camera when a patient has to do it on their own. Another limitation of asynchronous online consultations is that there tend to be fewer interactions with doctors, which could limit doctors' abilities to gather sufficient information from patients in an efficient way. For example, Carter et al. [14] studied the use of online general practitioner services and found that a majority of asynchronous "e-consults" require subsequent face-to-face or telephone consultations because doctors need more information from patients in order to make diagnoses.

Second, synchronous communication involves doctors connecting with patients in real-time. Approaches can include instant messaging [17], phone calls [68] and video calls [48,60,66,74]—the latter being the focus of this paper. First, video consultations have been used to support a broad spectrum of scenarios such as physiotherapy [74], dermatology [60], psychiatry [66], and continuous care to patients with chronic diseases [48]. Findings show that video-based consultations increase patients' access to healthcare when face-to-face visits are unavailable. Yet, there are limits in delivering the level of quality care found with in-person appointments. For example, Turolla et al. [74] provided an opinion piece on the feasibility of tele-physiotherapy. They concluded that consults which did not require intensive care, palpation, or specific instruments could be conducted remotely; however, a lack of doctor-patient interactions could still cause patients to have a poor experience. Roman et al. [60] believed that only stable dermatological conditions were suitable for teledermatology, despite remaining challenges such as missed lesions or poor image quality due to lighting, color or pixilation. Shore [66] described protocols for conducting video psychiatry, such as how to set up a room or camera so that patients could feel calm and comfortable during video consultations. A study on chronic disease management [48] focused on equity issues when accessing healthcare during the Covid-19 pandemic, where minorities may not have access to the necessary devices or the Internet. As seen, the aforementioned studies focused on clinical

outcomes (e.g., if patients were treated in a manner similar to when in person) from the perspective of health professionals where they utilized existing video conferencing systems without a focus on improving them. In comparison, we focus on user interaction challenges that emerge in video appointments and how interactions can be improved to create usable interfaces and better user experiences.

There have been studies specifically on our paper's focus of synchronous video doctor appointments, which rather than focus on user interface design issues or user experience, have emphasized user acceptance, satisfaction, accessibility, time and expenditure saving [7,56,59,73]. For example, Bashshur et al. [7] conducted a literature review about telemedicine in primary healthcare and found that younger people, women, or people with higher income or educational levels had a higher preference for using video appointments; however, they were considered less acceptable by health professionals because they were concerned that patients would not get the same level of high-quality care as in-person visits. Similar studies also showed that patients or physicians were typically comfortable and satisfied with video appointments as they were convenient to conduct and more accessible; meanwhile, concerns were raised such as connection issues, or overhearing conversations by patients' colleagues in their workplaces [56,73]. While valuable, they did not elaborate on the details of these concerns in a way that can guide design, nor explain what contexts were seen as being appropriate or not. Therefore, our work is motivated by these studies to understand the detailed perceptions of patients and doctors in specific scenarios and explore what design challenges may exist for the design of systems to support video-based doctor appointments. Research has also shown that doctor-patient communication is a vital component of healthcare [23,54,67]. Face-to-face communication between doctors and patients involves using verbal and non-verbal behaviors to convey care and empathy to patients, to build mutual trust, respect and understanding, as well as to protect patients' physical and psychological privacy [26,50]. However, research shows that doctor-patient relationships could be difficult to establish over video as patients perceive doctors to pay less attention to them, and there might be barriers to speaking up and asking questions [23]. That said, patients also feel less engaged and rushed by providers in video appointments [23]. We further explore the topic of doctor-patient relationships to understand what design factors should be considered for future design and development efforts in order to help improve the situation.

A very limited number of explorations have looked at physical examinations in home-based video consultations. For example, Seuren et al. [63] explored video visits between doctors and older adults with heart failure, where patients were asked to examine fluid retention in their legs. Challenges emerged around the patients showing their legs to remote health professionals over the video link, but the researchers did not deeply explore the camera work or user interaction challenges with the technology. We explore such aspects and more to have a better understanding of the usage of cameras for varying types of exams in a home environment. Research within the field of human-computer interaction has looked at augmenting video feeds with visuals (via a Kinect camera) of body motions during video-based physiotherapy sessions [71]. While beneficial, the work was limited to pre-defined physiotherapy exercises, and the technology setup lacked mobility to examine patients from different angles. We therefore expand the knowledge on the topic of physical video examinations. The past decade has brought change given the proliferation and ubiquity of commercial video conferencing systems like Skype and FaceTime. Doctors have been using these systems [4,5] to conduct remote consultations. There also exists a proliferation of custom-designed video conferencing applications in North America, which are marketed as ways for patients to meet with family physicians, e.g., TELUS Babylon, Medeo, Doctors on Demand. While the availability of these technologies continues to expand, research on how these types of systems might be used from varying locations, incorporating user needs and concerns, does not yet exist. Our research differs in that our work is not limited to a specific video communication

system and looks into how various types of situations, involving different usage of camera work and varying levels of sensitivity, could affect patients' and doctors' reactions to video consultations. We focus on specific contexts, as opposed to one's general feelings on video appointments. The goal is to have a deeper understanding of doctors' and patients' needs during varying medical situations. Our work also differs from prior work in that we investigate a broader set of appointments, including those that may not exist in actual practice yet, for example, including situations with large privacy concerns. These appointment types are representative of those commonly witnessed with general practitioners during in-person appointments (e.g., [62]). The goal of our work is to test the boundaries of video appointments and understand why certain types of appointments may not be good candidates for video; to date, appointments that might be considered more 'risky' in nature have not been explored. We also explore how software and hardware designs might need to be improved beyond commercial app-based designs to best support a range of appointment types, including the camera work (the orienting of the smartphone camera to capture a preferred view) that is needed to properly have the appointment.

2.2 Video Communication

Outside of the health domain, there is a large volume of literature on video communication in the fields of human-computer interaction and computer-supported cooperative work. Video communication has been studied for personal, work, and educational contexts [2,8,12,33,37,45]. The technology is designed to overcome the obstacle of geographical separation, and it has been shown to create strong feelings of connection over distance, a strong sense of interpersonal awareness and engagement with remote family members, couples or friends through virtual presence and interactions over time [6,22,35,58,70]. Video conferencing has been used to support casual conversations and collaborative activities [35,44], as well as formal meetings amongst multiple business executives [12], in which communication is mainly task-oriented. There are notable limitations when it comes to video conferencing [33]. These include narrow fields of view (close-up shots) where only a person's head might be visible, a lack of mobility when trying to capture specific objects, or difficulty in paying full attention or coordinating collaborative activities [41,55]. As such, people are typically aware of the physical distance between them and other parties when watching via screens during video calls [37,47]. Furthermore, people often feel like they must always show their face, whether situationally appropriate or not, during video calls [25].

Design work has explored ways to improve feelings of connection over distance in video calls. For example, designs have looked at providing a larger field of view to improve engagement where the user could see the remote environment without reorienting the camera from the other end [69]; employing virtual interactions to support activity sharing over distance [21,58], and enabling first-person views to augment perceptions of co-presence [53]. Camera work is the continual reorienting of a mobile phone's camera in order to capture a view that is sufficient for remote parties to know what is happening [32,44,49]. This can be challenging to do, and research has found that it can be useful for local users to have hands-free cameras (e.g., via tripods, setting cameras down) that they can use so they can also focus on watching the event [29], while remote users value the ability to gesture at things in remote scenes [32]. Despite the benefits, video conferencing systems have often been fraught with privacy concerns for work and family use. Online privacy typically relates to how a user's data is disclosed and how one's identity becomes different online [52]. In the context of video conferencing, managing and maintaining control over these aspects can be challenging [45,57]. People may inadvertently reveal the background of their environment during video calls; they may also worry about how their appearance in video calls compares with their actual appearance [11]. Furthermore, autonomy, control over who participates in a video call and who has access to seeing or hearing a video call, can easily be infringed upon [9,11]. For example, it is entirely possible for an unauthorized third party to be outside of the camera's view, yet still see the video screen or overhear a video call [9,11]. We explore these privacy challenges and more in our

work with respect to video-based doctor appointments, which builds on prior literature on privacy concerns in work and family communication contexts.

Overall, we see video-based doctor appointments as being quite different from the aforementioned work and family settings. Video calls are between a doctor and a patient, whom patients likely have a different a type of relationship with and unbalanced power dynamics, as opposed to work colleagues or family/friends. They also involve highly focused conversations and, in many situations, showing part of the patient's body to the remote doctor. Camera work is likely to be highly important in video-based doctor appointments where a doctor may need to examine the patients in different ways. And, in return, patients may have varying expectations on how they would like to see their doctor. As such, it's not clear if the design lessons that have emerged from studies of work and family settings for video conferencing are applicable to video-based doctor appointments. For these reasons, our study examines the camera work needed for home-based video appointments in varying scenarios from both doctors' and patients' perspectives.

3 EXPLORATORY STUDY METHOD

We conducted a study to explore 1) doctors' and patients' views on what appointment types would be appropriate for app-based video calls from home and what user interface challenges would emerge; 2) how video-based appointments might change the workflow of an appointment, in comparison to an in-person appointment given the nature of camera work during video calls; 3) what concerns doctors and patients have with the technologies used for video-based appointments; and, 4) how new designs can address the social and technical challenges that concern patients and doctors.

3.1 Participants

We recruited a total of thirty-three participants into this study, including twelve family physicians (seven females, five males) and twenty-one patient participants (sixteen females, five males) who had visited doctors. The gender imbalance was unintentional and based solely on who responded to our participant call and was willing to participate. Recruitment methods included posting advertisements in clinics, on local doctor community newsletters, on university mailing lists, social networks (e.g., Facebook, Twitter), and snowball sampling. Participants resided in the Metro Vancouver area in British Columbia, Canada. The doctor participants were within the age range of 31-58 (M=41.92, SD=9.34), with years of practice from 2-32 (M=13.00, SD=10.43). Patient participants were within the age range of 19-71 (M=36.73, SD=15.57).

All general practitioners saw patients for a range of health concerns, as opposed to specialist appointments. Four doctor participants used video conferencing with their patients, and five of them used telephone appointments some of the time. We included doctors who already used video appointments with some of their patients, doctors who had the intention to use video appointments at some point in the future, and doctors who were generally opposed to video appointments. This was so that we could get a broad perspective on the technology. Six of our patient participants visited doctors regularly for long-term disease control such as high blood pressure, gout, anxiety, arthritis, depression and digestive issues, and the rest for occasional situations when sick. None of the patient participants had experience with doctor video appointments; we were not restrictive on this regard, given that our goal was to assess perceptions of different types of appointments, as opposed to prior experiences with video appointments. Patient participants had a range of occupations, including student, salesman, researcher, designer, administrative, clinic and pharmacy staff, etc., and ethnic backgrounds including European, Asian and Middle Eastern descent. Again, we wanted to explore a broad range of perspectives on the topic, which is consistent with the recruitment of our doctor participants.

3.2 Method

Semi-structured and scenario-based interviews were conducted to acquire an in-depth understanding of doctors' and patients' previous experiences and their perceptions about video-based appointments. Participants participated from a location that was convenient for them, or one that they were comfortable participating from:

- Nine doctors participated in person either at their clinic or home.
- Three doctors participated over Skype.
- Seventeen patients participated in person either on our university campus or at their homes.
- Four patients participated over Skype.

The study lasted between 50 and 90 minutes. The interview contained two sections. In the first section, participants were asked about appointment experiences in-person, over telephone or video. In the second section, six video scenarios depicting varying video-based appointments were shown to participants to inquire about their reactions. We detail each section next.

3.2.1 Interviews on Previous Experiences With In-Person and Video-Based Appointments.

A total of nine doctor participants had used phone or video appointments in the past. They were asked about what medical situations they handled using these technologies. Then we asked these doctor participants about patients' demographics and reasons for using phone or video for appointments. We also asked if there were situations that were eligible for phone or video visits, but the technology was not used and why. For doctor or patient participants who had not used video appointments, we asked whether and why they would be interested in using the technology or not. We grounded the questions in specific appointments rather than general opinions to obtain detailed data. That is, we had participants describe specific past appointments to us where they could comment on the use of video or how it may have been applicable. For example, we asked, "Which appointments do you think are (not) eligible for video visits?", "How did you (the patient) describe the situation to the doctor (you)?", "How was the patient (were you) examined?" The goal was to understand what benefits and challenges video conferencing technology could bring to the appointments if used and how systems would need to be designed to support the appointments, if done over a video call. This section lasted around twenty minutes.

3.2.2 Scenario-Based Interview Preparation and Planning.

Next, a scenario-based interview was conducted to learn how participants would react to video-based appointments with varying medical situations. We decided to show participants pre-recorded scripted videos to discuss video conferencing usage for certain situations that participants may not have experienced or those that might not exist yet in current practice. We utilized this scenario-based methodology to not infringe on participants' privacy, as some topics that we wanted to explore were private or sensitive in nature. The method resembled scenario-based design [13,18] which is usually applied in early design phases where people and design artifacts are presented in videos as a conversation piece to explore future technology usage. Previous research has taken a similar approach, by providing vignettes of video appointment patients for doctors to diagnose [31]. In our research, we provided doctor and patient participants with role-played videos (as opposed to vignettes) and asked for their thoughts on partaking in such types of appointments. Thus, we illustrated to participants what various scenarios could actually look like during video-based appointments, including aspects such as the environment (e.g., calling from home with others around or not), people's facial expressions, body language, how they used mobile devices to communicate or do examinations, and obtain feedback on perceptions of video-based appointment for such medical concerns.

Alternative study methods might include exploring video visits in person or role-playing different scenarios as opposed to presenting them with pre-recorded videos. However, there could be critical

ethical challenges. First, observing actual appointments could be extremely intrusive for patients if appointments are about sensitive topics such as drug usage, domestic abuse, or private body parts. Second, role-playing such scenarios could be awkward and intrusive as well. In contrast, pre-recorded videos would avoid risking participants' privacy. It also allowed us to gauge all participants' reactions to the same situations as they all watched the same video clips. Lastly, we were able to explore multiple scenarios with each participant rather than a subset of them, which might be the case if participants were observed in an actual appointment about a single ailment.

Figure 1. Screenshots from video scenarios. Each video depicts a medical situation. There are three views in each video, from left to right: third-person view in the patient's home, camera view of the patient, and camera view of the doctor. (Confidential details have been masked in the image.)

Thus, we designed and recorded six sample scenarios prior to conducting the study, where a patient used a mobile phone from a home setting to video call a doctor. We first brainstormed a large list of

appointments and speculated the potential benefits and challenges involved. Next, a set of six scenarios were selected to ensure that a range of situations could be represented. These scenarios were reviewed by a doctor who was not a participant in the study. We then iterated the storyboards for each scenario. Our six scenarios were chosen based on the following criteria. First, we wanted common medical inspection methods [54,78] to be covered in the scenarios, including inquiry, observation, and palpation (touching the body during an exam). Second, we wanted a variety of camera work to be presented in the videos, e.g., capturing different body parts by orienting the camera to different directions. Third, we wanted the scenarios to cover topics with potential privacy concerns at varying levels. Several scenarios contained no such concerns, such as seeing a doctor for a common cold, while others could be sensitive in terms of conversation or what would be shown on camera. While the resulting scenarios are not a representative sample of patient appointment types across the medical literature, they provide a sample of situations that help to push the envelope of remote doctor-patient appointments. The resulting scenarios are briefly described as follows (using a female doctor and a female patient):

- ***Cold***: The patient has a cold and sore throat. During the video call, the patient explains her symptoms, and the doctor asks the patient to hold the phone up so the doctor can see in her mouth. The doctor asks the patient to shift the camera to an appropriate angle and say 'Ahhh' to expose the tonsils. The patient follows the directions.
- ***Fell while jogging***: The patient fell down while jogging, which hurt her knee and abdomen. During the appointment, when showing the doctor her knees, she switches to using the back camera. Then, the doctor asks the patient to lift up her shirt to uncover her abdomen. The patient switches the phone back to using the front camera. She holds the phone in one hand and follows the doctor's instructions to press on different areas of her abdomen with her other hand.
- ***Sleeplessness***: The patient has been struggling with stress at work and sleeplessness. As part of the appointment, the doctor asks about her lifestyle, alcohol usage, and medication. The patient describes challenges with excessive alcohol consumption.
- ***Drugs***: The patient's arm was itchy. In the appointment, the doctor asks the patient about what food and medication she recently had and whether she was exposed to sunlight or something unusual. The patient feels awkward but still honestly tells the doctor that she had smoked cannabis. The doctor prescribes the patient medication.
- ***Domestic abuse***: The patient experienced domestic abuse, which bruised her arm and forehead. The patient scheduled a video appointment in their home. At the beginning of the appointment, she describes to the doctor that she accidentally fell down and showed her bruises to the doctor. The doctor continues asking for more explanations, and the patient confides that there was partner abuse.
- ***Private parts***: The patient scheduled a video call for an annual exam follow-up. During the video call, she describes concerns regarding her genital area. The doctor asks to visually examine the area. The patient takes off her clothes and shows her genital area to the doctor with the mobile phone camera. The doctor then asks about the patient's history.

Each scenario was recorded twice, once with male actors for the patient and doctor, and once with female actresses for the patient and doctor. The patients were filmed in a home setting in our lab and the doctors were in an office setting. They all used the same scripts, and any sensitive video clips were blurred for privacy.

Figure 1 shows images of the scenarios from both the male and female versions. In each video scenario, participants were shown three clips at the same time. On the left side was a third-person view where participants could have a general understanding of the context on the patient's side. The other two clips were the camera views of the patient and the doctor respectively. Thus, we included the types of camera views that are present in smartphone apps designed specifically to support video appointments, though none show both first-person and third-person views at the same time like we did. This could be considered to be more futuristic. We blurred the patient actor's partially covered or exposed body parts

in the videos to protect their privacy. We blocked the video instead of actually recording the video of the private part viewing in the sixth scenario. Each video was around two minutes.

Since none of our participants had ever had a video-based appointment before, the types of video appointments being presented to them were completely new. Our doctor participants with video-appointment experience had only ever done a subset of these appointment types, focused heavily on simple situations which involved slight or no camera work like Scenario 1: *Cold*, Scenario 3: *Sleepless*, and Scenario 4: *Drugs*. Looking across the literature, the studies we are aware of have only ever looked at appointment types generally consistent with what our doctor participants encountered, and little has looked at the detailed types of camera work (including three different camera views) and privacy as we have presented.

3.2.3 Scenario-Based Interview Method.

Participants were shown videos one at a time and asked questions based on each scenario after watching each video. Participants chose which video they wanted to watch, either male or female, as we felt that it might promote stronger empathy from participants and help better imagine how they would react to the situations in the videos if they selected their gender of choice. For each video, the interviewer briefly described the situation and then played the sample video-based appointment. We did not counterbalance the ordering of scenario videos as we wanted to gradually increase the potential for privacy risk and show somewhat commonplace situations first. Our work was also intended to be exploratory as opposed to a controlled experiment. This does generate the limitation of possibly biasing how participants felt about the scenarios given their ordering.

Participants were asked after each scenario if they had experienced similar situations in-person or over video and how they felt about these situations being conducted over video conferencing. As examples, we asked "How would you feel if you were the patient in the video?", and "How would you compare an in-person appointment with that in the video call?" The purpose was to encourage participants to provide more detailed insights on the potential benefits and challenges of using video conferencing in contrast to in-person visits. For example, for Scenario 1 and showing the throat, participants were asked to think about similar cases where patients might need to show other body parts using their mobile phone camera. For example, "Can you think of similar situations where you need to show body parts to your doctor? And how would the video appointment be different from in-person?" For Scenario 3 and the sleepless issue, participants were asked to recall other mental health issues and think about what aspects would be essential during the appointment, and how video conferencing might affect the appointment. In this way, the questions would help us to investigate a larger array of situations. After all of the scenarios were shown and discussed, we asked participants if there were any scenarios that were not covered that they wanted to talk about. The goal was to avoid missing important information. The scenario-based interview lasted about 50 minutes.

3.3 Data Collection and Analysis

We audio-recorded all the interviews with permission from participants. All interview data was fully transcribed. Three authors were involved in data analysis. The patients' and doctors' data were analyzed independently. The patients' data was coded by the first and second author. The doctors' data was coded by the first and fourth author. Open, axial and selective coding methods were used to code the data. For example, open codes such as "video recording" or "malicious patients" were created and represented participants' privacy concerns to particular scenarios conducted over video. Each coder read through and coded transcriptions independently. Then, axial codes were discussed by the coders and merged. Next, these codes were categorized into high-level descriptive themes and corresponding sub-themes after a few rounds of discussion. In this paper, the first author reorganized sub-themes and framed them to

represent patients' and doctors' reflections in a comparative way. These four themes included the *accessibility of appointments*, *camera work and examination*, *relationship building* over video, as well as *privacy and control* during video appointments. They are described in the following sections. Doctor participants' quotes are listed as D#, and patient participants' quotes are listed as P#, followed by their gender identity and age.

4 Accessibility of Appointments

Video-based appointments change the way in which people make appointments and see a doctor over distance. They connect doctors and patients in a convenient way without requiring travel. Yet we learned that such appointments also raise concerns related to scheduling and accessibility. In this section, we present patients' and doctors' opinions in relation to the accessibility of appointments.

4.1 Saving Time vs. Missing Information

First, patient participants believed that waiting time for an appointment could drop sharply from days or even weeks to within hours or less if video-based appointments were used compared to in-person appointments. This was also found in a previous study that showed physicians were more accessible because of telemedicine systems [16]. Patient participants explained to us that they were often frustrated when they had to spend time in a waiting room for an in-person appointment, even after booking a specific time. Doctors were often 'running behind' and patients said they would often sit in the waiting room performing idle activities. In comparison, they perceived that video-based visits would provide them with a means to reduce waiting time. They could be more flexible with their time while at home and perform other activities while waiting for their appointment. Even if the doctor was running behind, it still meant they could do things that were considered to be productive. For example, participants said they could continue any existing work or do housework while waiting for their appointment and the doctor to video call.

Unlike patients, however, doctors believed that time spent in a waiting room, or transitioning into and out of it, was sometimes valuable. This need has not been described in prior literature. Doctor participants worried about potentially missing some essential information that they might normally see in the waiting room for in-person appointments. This concern was brought up when talking about the *Sleeplessness* scenario, during which doctor participants referred to general neurological and mental health issues with their responses. Our doctor participants suggested that one important facet of an appointment was the ability to identify other aspects that were affecting a patient rather than just what the patient was telling the doctor. They told us that their inspection of a patient happened not only in the exam room, but also outside of the appointment in the waiting room. They would often glimpse at how patients looked when waiting, how patients interacted with staff, and how patients walked into the office. This kind of auxiliary information was able to provide doctors with important clues about patients' overall status. They believed that their clinical gestalt, which was built with years of experience, was helpful in providing additional insights. Our doctor participants felt this kind of information could easily be lost over video.

> Like Parkinson's… how long you were to kind of stand up, their gates, a little bit shuffled or you're noticing a little tremor…Sometimes I'll hear them checking in with the front staff and they just seemed a bit more confused or something…So you're seeing kind of this interaction with other people … –D5, Female, 43
>
> Walking is important, especially if they have pain, joint pains and things like that, you see how they walk. Some people with neurological issues, you need to see how they walk…if the camera is far away, you may be able to see it. –D2, Male, 31

This suggests design needs for particular populations, for example, individuals with neurological or kinesiological conditions, where designs might provide multiple angles of video or track patients' activity

and movements (inside the application and within their environment) to gain additional insight. Yet, such video information could be very challenging to get since a common video consultation usually starts with the call ringing and a patient's face shown on camera and ends with the call hanging up. There is no auxiliary information shown before or after the call. Thus, the types of information that our doctor participants described could be easily missed over a traditional video call. Moreover, this type of information could be challenging for doctors to collect through other means. For example, interactions with other people besides the doctor would be non-existent and not possible to see. A doctor could ask to see a patient's normal movement by placing the camera some distance away from them and then moving around. Such placement could easily be challenging to perform though to ensure the patient is in view; we explore this point further when discussing camera work in subsequent sections.

4.2 Ease of Booking Appointments

Second, we learned that, because video-based appointments offer greater accessibility, patients might be motivated to request appointments more often than if they were just available in person. Our patient participants said that they relied on their own judgement to decide whether to visit their doctor when it was an in-person appointment. They assessed the level of severity of their situation based on subjective feelings, past experiences, or medical knowledge, albeit limited. Although they said they would not bother to see a doctor for minor things, for example, a general cold, they reported that a lot of times they were not sure whether they should visit a doctor. Sometimes this decision was aided by web searches for medical information.

> Instead of you waiting for a week to visit the doctor you can use this system to have primary comfort to know how serious or not the problem is until you find an appointment time. -P12, Female, 32

Some patient participants felt that a lower barrier to scheduling an appointment with a doctor over video might make it easier for them to meet about more minor situations where they were unsure as to whether an appointment was necessary. This could have implications for the health and technology communities; more video visits could lead to lowered population illness and disease (as patients do not have to wait until the condition is serious enough for an in-person visit), but current systems may not be able to handle an increase of video-based appointments and their replacement of in-person visits (due to technological and design constraints).

Three out of four doctor participants who already had video-based appointments with patients reported that their patients usually brought up fewer issues during a video visit compared to an in-person one, and it took less time than a general visit in the clinic. The specific reasons were unknown, however, they thought that it could relate to a cost-benefit ratio. That is, patients who had to spend a lot of time getting to the doctor may want to ensure they talked about as much as possible in a single appointment to create large benefits. On the other hand, video appointments were seen as easy to do and requiring less effort. Thus, patients may be okay talking about fewer issues.

> I find patients just tend to be much more direct and they just want whatever they wanted…versus often in person they have a list…or they'll chitchat a bit more. –D7, Female, 44

Doctor participants were concerned that patients may book appointments that were not good candidates for video calls, e.g., those where a diagnosis is hard to give using a camera only such as the *Fell while Jogging* scenario. In these situations, doctors thought that appointments may have to be rescheduled in order to be handled in person. This could waste time.

> I would be frustrated if I'm doing video conference and then realizing, oh geez, this doesn't work because I need to do an exam on you now. –D5, Female, 43

Thus, doctor participants suggested it was important to have appropriate screening mechanisms in place so that a doctor or staff member could determine if the appointment could be video based when it

was being booked. However, doctors also commented that staff were often not yet fully aware of what made an appointment appropriate for video versus in-person only. On the other hand, it could be helpful to further equip existing and new telehealth systems with innovative technologies to enable doctors to perform virtual examinations that are not yet possible (e.g., palpitation).

Further, doctor participants pointed out that a patient may see many different doctors, which could raise issues with the continuity of care over time and create challenges for doctors to understand a patient's history. This was also found in [19]. Doctor participants all felt that video appointments should be used for ongoing relationships rather than patients who are willing to see any doctor who was presently available.

> If the continuity is disrupted and they're getting prescriptions for conditions and being diagnosed with things that were never even notified, then that becomes a problem in terms of continuity in quality of care … It's harder to take the best care possible to the patient. –D4, Male, 45
>
> I care about your blood pressure today, but over the whole year, am I actually managing it in a larger sense…It's not fair to family doctors if they're keeping the record and they're spending the intense time of making sure the blood pressure is controlled. –D1, Female, 51

Other research has pointed to the value of thorough recordkeeping over time [14]. For example, systems could potentially make up for discontinuities across doctors by providing thorough records of past appointments. With respect to video appointments, this could possibly include recordings of the video call itself; we return to this topic in subsequent sections on privacy and video calls.

In addition, doctor participants wanted to ensure that video-based appointments were booked ahead of time and not something where a patient could call them at any moment. Doctor participants did not want their personal life to be disturbed by getting random teleconference requests. While this is a feature of current telehealth applications, several of our doctor participants were using Skype to see their patients, which meant these doctors could be contacted by patients anytime if they wanted. Hence, they were worried that video conferencing could be easily abused by patients who were unaware of interpersonal boundaries, if patients were able to get in touch with their doctor at off-work times. This suggests video appointment systems need to be designed with particular types of call settings in place, e.g., one-way calling.

5 CAMERA WORK AND EXAMINATION

In this section, we explore the camera work that is needed for video-based appointments and examination techniques like palpation. Participants also talked about how various types of appointments would or would not be suitable for video conferencing given the types of camera work that would be required.

5.1 Visual Inspections via the Camera

Both doctor and patient participants recognized the importance of seeing a patient's whole body. Doctor participants who already did video-based appointments said they most often did psychiatric consultations over video as they did not usually require physical exams via palpation or a large amount of camera work to see the participants. Most often it was good enough to just see the patient's face, which was generally easy to do over video; for example, a phone could simply be set down on a table and leaned up against an object to show the patient's face. If using a laptop, it was generally easy for patients and doctors to show their faces during conversation since the camera was in a fixed location. For these reasons, most of our doctor participants thought that psychiatry was the most appropriate type of appointment to be conducted over video; prior research has found similar results [66]. Beyond these

findings, we found that seeing a patient's entire body during a video appointment was seen as being valuable, even if for psychiatry-focused appointments or consultations mostly focused on verbal exchanges. Participants said that they would like to see patients' body conduct, such as fidgeting with one's hands or feet. However, the challenge is that such information could be lost as patients generally held their phones close to them so that the entire body was not shown. Patient participants also thought that showing their whole body could help the doctor to discover subtle symptoms which patients could consider irrelevant. They said that such an aspect normally would not be practical because patients would likely hold the phone in front and solely show their face.

> For this one (sleeplessness), you just need to see their face. But a lot of times you can see that they're anxious, they're fidgeting with their hands. And if they're holding their phone you can't really see this. –D2, Male, 31

Providing doctors with a larger field of view during video-based appointments could help with this concern, yet it was seen to be difficult to achieve in practice as it could require a patient to place the camera far away from them in order to capture their entire body. At such a distance though, seeing what was in a frame on the camera would be challenging given the small size of phone screens and the patient's distance from the camera. Additionally, developing a set of etiquette guidelines for use during telehealth appointments might also be beneficial, such as holding the phone at a certain distance or angle, or placing the phone on a surface to make more of the patient visible.

Like prior research [39], we were told by doctor participants that dermatology was another specialty that could possibly be suitable for video-based appointments; our work extends this with knowledge related to camera work. Here both doctor and patient participants felt that seeing the skin clearly over video could be quite challenging because doctors need to see the nuances of the skin area, including, for example, the texture, and how the skin may be raised.

> If you see someone, you can feel the texture. But you need to sort of move it around, how far raised it is, if it's rough, or smooth. I don't think you need to necessarily touch it, but the resolution needs to be well enough that you can see a good picture…You need to like move it around to see how light goes off of it. –D2, Male, 31

Poor resolution or lagging video was seen to make a diagnosis of skin conditions difficult and unreliable. Moreover, a patient's inability to hold the camera steady and at the correct distance from the skin to allow the camera to properly focus could be an issue. Issues around a lack of focus could be difficult to detect, especially if showing close-up views of a person's body where the entire image is of a similar colour and shade. Alternatively, it might be possible to envision the incorporation of augmented reality into telemedicine applications, which is able to demonstrate nuances that cannot be captured by the naked eye through video. Some participants also suggested that taking a clear picture would be better than using video for such instances. For example, some common video calling systems (e.g., FaceTime) now allow still photos to be captured and shared in the middle of a video call. Yet, one doctor participant added that three-dimensional information would not be known from a still image.

Our video scenarios depicted actors capturing various parts of their body with mobile phone cameras, e.g., leg, throat and arm. Both our doctor and patient participants felt that some areas would be difficult to capture even though the phone is highly mobile compared to a stationary camera on a laptop. It could be hard to see what the camera was capturing due to its orientation. For example, when holding the camera in front of one's mouth for the *Cold* scenario, the patient cannot really see what is being captured by the camera since the phone has to be held so close to the patient's face. Similarly, when holding the camera to capture the back of one's leg, it was very difficult to see what was on the screen and whether the correct part of one's leg was being captured by the camera since the phone display was at an awkward angle.

> Well, [phones] might not be the best devices and they might not be able to [show the area], for example, a person coming in on a rash on the back thigh. –D6, Male, 32

This suggests alternative solutions that utilize different types of cameras. For example, systems could be adapted to share video data from other additional camera sources (e.g., an external USB or Bluetooth webcam) that allow a person to capture camera footage while seeing what is being captured on a separate display. Other solutions might allow patients to place their phones on a desk or table and "scan" their bodies by taking video that is transmitted to the doctor.

Doctor participants also hoped that examining patients' body parts via the phone camera would not occupy extra time. They explained that they may need to guide patients to shift their phones to get the best view if the body parts were difficult to capture. Yet this was seen to possibly require a lot of dialogue back and forth between the doctor and patient, e.g., Doctor: "Move the camera to the left." Patient: "Which way is left?" D: "Ok, now move it closer…. Oh, too close, now further." While systems could be augmented to guide patient users to capture good video through techniques such as overlays on the screen (e.g., showing arrows that direct the patient which way to move the camera), the screen may not always be seen by the patient when moving the camera around. Given such complexities, doctors thought it could save time if patients took images ahead of the consultation. That way, they could capture one or more images, inspect them for quality, and re-take them if needed. Even still, doctors raised concerns about quality because they thought that patients may not recognize how 'good' an image had to be in order to be useful or what should be included within it. They also thought that a patient may accidentally capture the wrong thing, and they may have to redo images during the appointment. This would take up valuable time.

> If they did it in advance and it wasn't good enough, there'd have to be a way for them to retake the picture and upload it quickly. So you're not just waiting a long time until they get a proper picture uploaded and sent to you. –D4, Male, 45

When it came to showing specific body parts, patient participants thought it would be difficult to conduct actions with both hands occupied, e.g., lifting a pant leg and showing the injured area. They could set down the phone, but it could be challenging to find an object to easily lean it against in order to still capture the right view for the doctor. Patients also felt that it could be hard to hold a phone for a prolonged period of time during an appointment, especially if the phone had to be held at awkward angles, e.g., trying to show one's back.

> I can see that given a long consultation, the patient probably gets tired that she has to hold the phone and it's not comfortable anyway…The patient only has two hands to set and hit the body. With the mobile phone, she really needs one hand. – P17, Female, 42

5.2 Palpation

Palpation is a process where doctors physically check a patients' body using their hands. For example, when in person for an appointment like our *Fell while Jogging* scenario, the doctor would inspect the patient's abdomen by pushing on it. Some patient participants thought that they could be coached by a doctor in the remote location to perform palpation on themselves. Others felt that it would be difficult to follow the doctor's instructions via video. This was especially the case because not only would they have to perform the palpation themselves, but they would have to do so while also simultaneously holding their phone and directing its camera at the right location. Both tasks were seen to be quite complex on their own and the combination of doing them together was even more problematic.

> The patient could probably apply less pressure than needed to feel versus a doctor. A doctor can physically tell if it's serious or not instead of having patients to let him know. Because this is not a common cold or a sickness. –P6, Male, 24"

Unsurprisingly, most doctor participants believed that palpation was the most challenging exam to perform over a video call because doctors were trained for years in how to properly perform palpation. They thought it would be extremely difficult for patients or their family to perform such actions themselves as part of a video appointment. For these reasons, they felt that appointments that might involve palpation would not be suitable for a video visit. This validated a previous study that showed doctors were reluctant to use video consultations because of one's inability to perform physical examinations [38].

> You might have pain, or you might feel the edge of the organ come down like the liver, spleen…if you're pressing lightly, even if they take a deep breath, you may miss the spleen or gallbladder cause you're too superficial. –D4, Male, 45

Several doctors thought that basic palpation could be done by patients themselves if the doctor knew the patients' history well and could reasonably predict the problem based on the currently described symptoms and past issues. One participant thought that palpation could possibly be replaced in the future with new techniques that might better map to the affordances and capabilities found in video appointments.

These results suggest that, if designs do attempt to support some form of patient palpation in the future, much guidance is needed. For example, systems would need to support patient users by providing visual and audio guidance on how to conduct such techniques, potentially before the appointment to save time. Systems could also be designed to better support camera work with respect to the aforementioned challenges around holding or placing a phone in a specific location so as to both touch one's body and capture the appropriate video on camera.

6 RELATIONSHIP-BUILDING OVER VIDEO

Both our patient and doctor participants recognized the importance of combining verbal and non-verbal communication behaviors to show care during appointments. Doctor participants said that proper verbal and body language could convey empathy and help establish rapport. Verbal language involved active listening or changing the tone of one's voice. Body language involved gaze contact, nodding or adjusting physical distance when listening or explaining things to patients. This was consistent with Heath's work in the 1980s [26]. The doctor's body posture and gaze can be easily perceived by the patient during face-to-face interactions. Yet, as suggested by previous research [23] and our doctor participants, such behaviors could be affected in a video-based appointment. Non-verbal behaviours could be difficult to convey and, in turn, understand.

> Often, I'll be sitting here (in front of the table) typing … If they get to a certain point, I'll stop typing, put down my pen, I presume like a distance of about three feet, to show to them, not that I wasn't listening before, but to emphasize that I am really listening to what they're saying. – D8, Male, 36

As was described by D8, doctors would not be able to perform certain actions over video in a natural way such as turning their body toward the patient or shifting their gaze to the patient. This could be because the interactions are seen through a computer display and there is no need to turn one's body. Physical distance can also be challenging to determine. While it is possible to be a certain distance from a patient in person in order to be considered socially acceptable, such physical distances are very difficult to judge in a video call. As a result, a doctor might be considered too far or too close to the camera, making it seem as though they are disinterested or socially awkward.

Patient participants described similar concerns about eye contact and the attention of the doctor. They said they might not be able to tell if the doctor was looking at them. This could be caused by the disparity between the camera and one's gaze orientation to the display [24].

> I think over video call it's hard to know if the person's attention is only on you because they might have other tabs open and stuff…Whereas if you're in person, you know through their body language and through their eye contact that they're actually focusing on you. – P1, Female, 19

Research has tried to remedy this issue, by correcting eye gaze during video calls to create eye contact [28]. This feature could be incorporated into telehealth applications to aid rapport-building. However, the problem of eye contact is not only present in virtual visits, but patients also feel disengaged during in-person visits when doctors look at medical records [15,61]. Given that during video-based appointments doctors are already looking at their computer screen (to interact with the patient), doctors might be able to look through a patient's medical records while still looking in the direction of the patient, potentially removing this issue.

With the aforementioned challenges in mind, participants felt that video-based appointments could be more appropriate for those who have pre-established relationships, or who are used to using video conferencing. Our doctor participants felt that an initial visit with a patient should be in-person and not over video. This was also found in a previous study in 2019 [16]. Often initial visits with patients involve full examinations which doctor participants said could not always be done over video. They also believed that a sense of rapport and emotional connection could be built better in a face-to-face setting, where it was very easy to see one's body language and facial expressions. This was valued by doctor participants, especially for sensitive situations like the *Domestic Abuse* or *Drugs* scenarios.

> I think establishing that trust and rapport with somebody, maybe with the first time that they've had a bout of depression, then they come in. Giving you advice over the phone, maybe it's not received very well the very first time. –D8, Male, 36

We were told by both patient and doctor participants that patients with mental health concerns would need a stronger emotional connection with their doctor. Previous research has attempted to do this by providing real-time feedback to doctors and patients about their rapport-building behaviors [20]. Our doctor participants also added that such a connection could still be conveyed over video, but only if they had already built a relationship and patients had developed the perception that their doctor was empathetic to their situation. The familiarity of the doctor's voice and workflow could also create a sense of connection.

> They know how you manage, they know the way you talk, they know your tone of voice, and when you talk quiet, you talk loud, how your voice changes... So when you actually talk to them on video conference, even if they don't have you there, they can hear those and they know that's what he does with his voice when he cares. –D6, Male, 32

Doctor participants were also worried that patients might be less engaged during video-based appointments due to distractions around them. Some had experienced this in their past video appointments, e.g., children coming into the room and distracting the patient. Another participant recalled a situation where a patient answered the video call for an appointment while driving, which was clearly unsafe. Such challenges could make it hard for doctors to build relationships with their patients since good relationship-building relies on attentive communication.

> There's a mutual shared environment [in face-to-face appointments]… There is an undeniable difference in your communication and connection with another person when it's via video conferencing… I have kids in the back background, so that, that element of, yeah, you just can't totally know what the environment is like. –D7, Female, 44
>
> Many of these people might be parents, many of these people might be calling from somewhere where they might be distracted. So I think the engagement level could be slightly diminished. So many distractions can be present, whereas when you're in a doctor's office, it's quiet. There's nowhere else to look. There's nothing else to see. –D8, Male, 36

Video appointment systems might therefore include reminders or cues to ensure that the patients are treating the visit similarly to how they would an in-person appointment, and to discourage multitasking or unsafe behaviors.

7 PRIVACY AND CONTROL DURING VIDEO APPOINTMENTS

Doctor participants talked about being able to control the space and context of a face-to-face appointment. They were able to manage, for instance, who would have access to their conversation, how to control the workflow to protect patients' physical privacy, and how the consultation in the office setting could protect patients from being harmed. Yet, video appointments could undermine their control abilities. For these reasons, we explored ideas around anonymity and video recording with participants to see how they would react to them and whether these design ideas would help to mitigate their concerns. We describe these ideas in detail in this section.

7.1 Control of Access to Conversations and Misinformation

First, we were told by doctor participants who had used video-based appointments that their patients connected to them from a variety of locations such as their bedroom, office, or, even in their car, which were far more diverse than shown in our video scenarios as a private space. They said that patients appeared to show little concern for their privacy when selecting a location. Thus, doctor participants felt that they would not be able to control the appointment in the same way that they might be able to in the office in terms of who else would have access to their conversations with patients. Sometimes video calls were done with other people around, which the doctors were not always aware of. Such varied locations for video appointments were seen as being problematic because it took control away from the doctors. This meant they may not know who could see or hear the call, which might introduce additional liability concerns.

> The man is driving, and the wife is doing telemedicine with me. Obviously, the privacy is gone at that point because whatever you say that man's going to hear, the kids are going to hear, but that's what they chose. –D6, Male, 32
>
> I'd ideally always be in a secure environment where I'm not worried about my end of the conversation, but from their perspective where are they? Who's sitting there? Who's observing? How do I know? So they'd have to feel comfortable with that. –D8, Male, 36

Doctor participants also talked about the varied locations in which they were able to conduct a video call. This might be in their clinic office; however, given the flexibility of video calls, it could also be in their home. They believed that it was important to notify their patients of the risks of possibly being exposed to their surrounding environment as well as risks of cyber security. For example, one participant listed these risks on her appointment web page; such a warning could be added to telehealth applications as well. She held video-based appointments from her home office in the late evening and this posed a possible risk for patients since others occupied her home too. She said that she made patients aware of the situation and they could accept the risk.

> My daughter wakes up in the middle of the night and comes hopping on by, they see in the video camera there's this little kid. But the thing is they know me, they know I'm doing it my home. They know that she is going to sleep in the next room. They accept that risk. –D1, Female, 51

Patient participants brought up concerns with the *Domestic Abuse* scenario. Several patient participants believed that privacy and control issues could occur if the patient met other people on the way to the clinic or in the waiting room. In comparison, attending a video appointment from home would be a wise choice such that bruises could only be seen by the doctor over video. Yet, some other patient participants said that staying at home could bring the victim additional risk of being discovered

by the perpetrator during the consultation. That said, participants were speculating and had not been in such situations before to fully understand the risk posed.

> Because you don't want neighbours to see anything or a random stranger to think, 'Oh my god, she got beat up. She's in a bad situation.' – P21, Female, 68
> Consulting with a doctor at home will increase the risk of abuse again. – P3, Female, 21

To help alleviate such concerns, telemedicine systems could incorporate non-verbal information channels, such as 'reactions' to let the doctor know that the patient is in danger, not alone, or are concerned about privacy. This could enable patients to provide non-verbal feedback to the doctor when their surroundings may not allow for them to do so verbally.

Doctor participants told us that it would be easier to discover physical abuse during in-person appointments as doctors are able to observe patients' whole body rather than only their face. The camera view during a video appointment could easily limit this ability. Further, doctor participants said that if patients did a physical exam in the office where their clothes needed to be removed, there would be an opportunity to notice bruises, which could be a sign of abuse. In contrast, if the appointment was conducted over video, such areas may not be shown on camera or might be concealed.

> Cause the abusers of kids, they will abuse them in places where the clothes are covered… So when you're doing an exam where you lift up their shirt to listen to their lungs…wait, a big hand mark here on the back… But obviously if the person on the video is the abuser, they're not going to show them. –D2, Male, 31

Doctor participants also talked about not being able to easily see other people such as parents during a video appointment. Parents could, for example, easily be off-camera and directing children in particular ways during a video appointment. This could be helped by having multiple camera views, or a wider image altogether. Nonetheless, doctors felt like they could lose control over how they were able to conduct the appointment.

> When I ask a question, is child always looking at mom, or is mom changing the answer or the story or shaking her head and these kinds of things…I don't think teleconferencing would be something appropriate for that. –D8, Male, 36

Another doctor participant explained that people with varying cultures had different perceptions around what was considered appropriate regarding privacy. When in person for an appointment, he could ask family members to leave the examination room, yet during a video call this was seen as being more difficult.

> On a telemedicine, that becomes very difficult because I have to manoeuvre in the office. I end up manoeuvring around to find a way to ask the question…I've done is that … "I really can't hear you because your kids are on, can you just take the phone and go into…a different room so I can hear?" But that is not always possible cause sometimes there's no kids. –D6, Male, 32

Once again, systems could implement a method of sharing this information with doctors through non-verbal channels, to protect the patient's privacy and discretion.

Similarly, patient participants shared concerns about not knowing the environment on the doctor's side. They did not know if there was someone else watching outside of the camera's view, although they were aware that doctors should obey confidentiality. A similar finding was found in prior work, though in that case, it related to work colleagues possibly overhearing a patient's video call [56], which presents a different context than our finding.

7.2 Protecting Physical Privacy

Control was seen as being especially problematic by doctor participants for situations like the *Private Parts* scenario that they watched in our video scenarios where the patient was asked to show their genital area to the doctor via the phone's camera. When appointments were in-person, there was a standard protocol to protect patients' physical privacy as was told to us by our doctor participants. First, the patient would have a private space to change their clothes. Then, the doctor would let the patient cover their body with a sheet. In this way, the doctor would only see what was necessary to expose to them. The doctor would inform the patient of what they needed to examine in advance. Sometimes, there was also a chaperone that accompanied the patient, requested either by the doctor or the patient, if they believed it was necessary. The procedure ensured that the physical privacy of the patient could be well protected during in-person consultations.

> You do a lot of things like covering them up with a sheet, even though the patient goes, well, this is stupid. … And you're just going to remove the sheet and have a look at it. But it's the kind of thing where you know, you leave the room for them to get changed and they'd put on the gown and then you remove the gown just to the piece that is going to be exposed and … you always give that privacy aspect. –D1, Female, 51

In comparison, such protection could be challenging if the doctor wanted to examine the patient over video. Doctor participants were concerned about how such an examination could be done over video. They generally felt it was not appropriate to have a patient expose their private parts without a similar procedure as in an in-person visit. Such procedures had not been established in their practices though.

Some doctor participants suggested solutions that could help mitigate the aforementioned concerns. Here they felt that patients could easily control the visual inspection by simply turning off the camera, redirecting it, or even terminating the consultation if they felt uncomfortable with their doctor's instructions. This might even give patients more control over such sensitive exams when compared to the same types when in-person.

> I think there'd be a limit to the harm that could be inflicted. Cause if a patient felt uncomfortable, they could just terminate the visit … no one would ever of course be touched inappropriately. If they could control what was viewed by the person on the other end before it went live and if it was destroyed... –D4, Male, 45

When reacting to the *Private Parts* scenario, doctor participants talked about the possibility of encountering malicious patients who may exploit an appointment for sexual gratification and thereby infringe on the doctor's privacy and control over what they were seeing. Some had felt suspect of certain situations in their past appointment history. They said usually there would be a chaperone when doing sensitive exams in the office. On one hand, this ensured patients received an appropriate exam, and on the other hand, it was to protect doctors from being harassed. Doctor participants felt that in a video appointment they could become vulnerable in instances involving examining sensitive or private areas of a patient's body.

> There are also some patients who are, who want to show you their stuff…Creepy, right? And it just feels like this could go wrong. – D1, Female, 51

On the other hand, the patient participants in our study were uncomfortable to show their private parts to the doctor over video. Most patient participants raised issues such as cyber security or the unknown environment on the doctor's side and not knowing if someone was standing outside the doctor's camera view but still able to see the screen.

> If I'm a patient, I'm thinking what the doctor's thinking now after seeing my area. She must be thinking about your parts… I couldn't trust this person and what she might be thinking. So that's running in my head… –P13, Female, 34

Moreover, there was a gender difference in relation to topics such as one's private parts. All of the male patient participants felt comfortable talking about sexual issues with their doctor regardless of the doctor's gender. Yet, most female patient participants felt differently when encountering sensitive topics. Some female participants preferred to talk with a female doctor.

> Especially if it's not my regular family doctor, I would not want a male there. Actually, even if it was my family doctor, I usually try to find the public nurses, like female. – P9, Female, 32

Thus, our results show that using video-based appointments for situations like the *Private Parts* scenario would not be appropriate for everyone. Those patients who are comfortable with it would need to rely on app-based controls to easily turn on/off the camera at varying points when revealing one's body, akin to how doctors leave the room when a patient is undressing. To help protect doctors from visual harassment by patients, they too could have controls to easily turn on/off or mask the camera view.

7.3 Control of Patients' Safety and Privacy Related to Sensitive Topics

Control in relation to providing support was also limited for situations like the *Sleeplessness* scenario. Doctor participants said they were able to protect patients from being harmed or suicidal when in the office by calling their office staff for direct intervention. In contrast, it would be difficult to give instant assistance during video-based appointments as doctors did not even know the patient's specific location.

> If there's any concern about the patient being psychotic, aggressive or suicidal, where you can't act right now to provide them with support. –D9, Female, 58

To help alleviate such concerns, video appointment systems could incorporate some sort of panic button, to be used by doctors when they believe a patient is in danger, and which could trigger specialized personnel to go to their location. This would be similar to several safety applications that exist, which track GPS coordinates and alert designated individuals or local authorities when the device is activated [30].

Video consultation could also benefit patients in certain situations. For example, doctor and patient participants felt that patients with psychiatric issues or those who might be hesitant to go to the clinic, such as teenagers or victims in the *Domestic Abuse* scenario might be more apt to have an appointment via video. Both doctor and patient participants felt that video conferencing would provide an alternative choice to receive healthcare and maintain a connection. However, doctor participants were concerned that they may lose track of such patients if they did not come in person, and this challenge would need to be rectified.

> I have one patient with a very severe agoraphobia, so she is having significant difficulties getting out of her house. … all her follow-up has been through telehealth, that's been invaluable. –D7, Female, 44
>
> The last thing the teenager wants to do is to be dragged into the office once a week or every two weeks just to tell you what's happening… They have no problem going on the Skype and touching base because it hasn't interfered in their life. –D1, Female, 51

Sometimes the video visit was believed to be a good way to protect patients' privacy related to disclosing sensitive information. One doctor participant said that it was common to see walk-in patients in-person with sexual health issues similar to the *Showing Private Parts* scenario. The participant speculated that it could be because patients were sometimes embarrassed to talk about such issues with their 'regular' general practitioner. This was also confirmed by ten of our patient participants. They felt that presenting such issues over video to one's doctor would be less embarrassing than doing so in person. It could be explained that the use of video communication increased their social distance, which might make it easier for patients to disclose their situations.

7.4 Patient Anonymity

We asked patient and doctor participants about how they would feel if the patient could have a choice to blur their face to hide their identity in situations like the *Domestic Abuse* or *Private Parts* scenarios, in which patients might feel embarrassed or uncomfortable. This could be a way to make patients feel more comfortable but might involve giving up some level of control. Such video obfuscation techniques came up in other studies on video conferencing and media spaces [10]; thus, we asked questions in relation to it. Anonymity through blurring was valued by some of our patient participants, while several patient participants worried that blurring faces would make it difficult for doctors to understand patients' facial expressions and assess their psychological status.

> I think [blurring faces] is very good. For example, when you want to go there and talk about drinking or marijuana or private parts, these kinds of things. I know people that don't go to doctor at all just because they don't want to talk about it with another person. – P12, Female, 33
>
> You can read the expressions of the people's face, eyes. 'Okay, this lady is really scared ... or she knows it's a minor thing, so she's not really worried about it'. – P21, Female, 68

In comparison, many doctor participants did not fully comprehend patient participants' concerns and felt this would be strange and undesirable. First, they said that doctors would maintain the confidentiality of patients' medical records, so anonymity was likely not necessary. They also felt it was their duty to not be judgmental about patients' situations and patients only needed to disclose what was necessary for diagnosis. Furthermore, they believed that observing patients' facial expressions was essential to avoiding misinformation and misdiagnosis.

> Often someone comes in, "oh I think I have a UTI," but really then you dig more and more and I can tell them in their face, maybe there's something more going on, but that's because I can tell their reaction to some of the questions I ask. –D8, Male, 36

Thus, it appears that providing masking options may not be necessary or helpful for medical purposes.

7.5 Video Recording

Doctor participants and patient participants raised serious concerns about malicious video recording during video consultations. They felt that video recording could be done surreptitiously without the other party knowing. This would create privacy and control issues. Patient participants were worried that doctors could have access to video from previous appointments without their knowledge or permission. In contrast, doctor participants generally felt that it was acceptable for patients to record video appointments with the doctor's permission such that they could playback the doctor's instructions or diagnosis as needed. Yet, they also had concerns about being exposed to lawsuits if there were malicious patients who recorded the video without asking for permission. One doctor participant said that doctors might also face the risk of being accused of illegitimate video recording of the patient.

> Could anything ever come back to me in the future that you know? 'Well, I think the doctor recorded my private exam.' How do I prove that I didn't? Right? If they were in my exam room, like Duh, I didn't record it cause there's no equipment. –D1, Female, 51

Telehealth systems might therefore be equipped with sensors to monitor the recording of appointments, and alert the other party when activated.

8 DISCUSSION AND CONCLUSIONS

We now discuss our findings and design implications for video-mediated doctor consultations in the home setting. In order to better understand how our study results are applicable to present day and future technology designs for video-based appointments, we comment on an analysis of four representative commercial video consultation applications throughout the Discussion section. The systems are listed in Table 1 and include TELUS Babylon, VSee, Medeo, and Doctor on Demand.

Table 1: Features of Commercial Video Consultation Applications

	Design Features	TELUS Babylon	VSee	Medeo	Doctor on Demand
1	Type of Devices Supported	Smartphone	Smartphone or computer	Smartphone or computer	Smartphone
2	Number of Cameras	One	One or two with a peripheral device	One	One
3	Same Doctor Each Time	Generally no	Yes	No	No
4	Video Recording	Audio only	No	No	No
5	Supports Peripheral Devices	Medical alert pendant for older adults	Stethoscope, otoscope, ultrasound, ECG, etc.	No	No
6	Provides Features to Screen Appointment Types	No	No	No	No
7	Virtual Waiting Room	No	A list of waiting patients is only shown to doctors	No	No

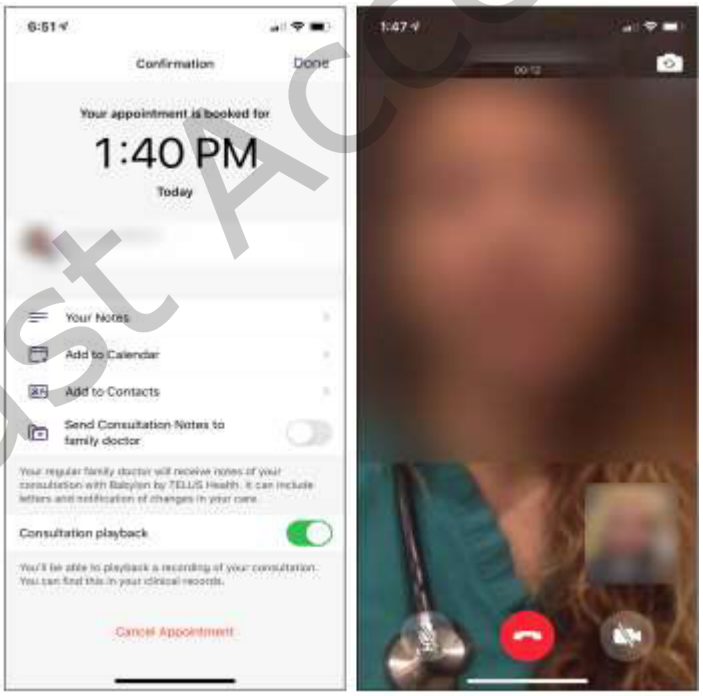

Figure 2. TELUS Babylon provides a doctor appointment via a smartphone app. (Confidential details have been masked in the image.)

For example, TELUS Babylon (Figure 2) provides nationwide video appointment services in Canada (the location of our studies). As such, we focus on it more prevalently in our descriptions. With TELUS Babylon, patients can select a time slot at the appropriate time, like how they make appointments in person. A doctor will initiate a video call with the patient on their smartphone (Table 1, Row 1). If

patients want to see the same doctor, they have to call a 'TELUS assistant' to check when the doctor would be available (Row 3). Only one phone camera can be used at a time, though users can toggle between front and rear-facing cameras on their smartphone (Row 2). Appointments are audio recorded for records and the safety of the patient. Patients can request audio recordings by contacting customer service (Row 4). The app supports a few additional peripheral devices (Row 5). Users can enter their symptoms when booking an appointment, but the system does not appear to screen appointment types on its own (Row 6). Babylon is marketed for appointments about infectious, psychiatric, digestive, dermatologic, and traumatic situations as well as for providing medical advice in relation to sexual health, lifestyles, or medications. As seen in Table 1, multiple similar services exist and have comparable device and camera features, possibly leading to interaction design challenges and opportunities for research. Other applications typically have either the same or subset of the features found within these applications. Of course, there are many other applications that have been created for video-based doctor appointments. The set we have chosen to present and explore is similar in design to many others. Overall, we found that the four systems we analyzed do not include many of the design features that our results point to as being important; we elaborate on these points throughout the Discussion section.

8.1 Virtual Clinic and Appropriate Utilization

First, our study results illustrate that there is strong value in considering video calling software for doctor appointments as a mechanism to help create a better balance between a patient's and doctor's time and availability. In-person appointments are typically arranged to benefit the doctor's time and schedule, where patients must often wait on doctors. In fact, our patient participants' main perceived benefit of video-based appointments was saving travel and wait time. They also recognized the benefit of utilizing idle time for other activities as opposed to solely waiting in a clinic. When shifting to video appointments, it is critical then to **consider what design features can be created to support better use of time for patients.** For example, designs could inform patients about their likely appointment start time (even if scheduled for a specific time) and how much of an approximate wait they have. This might be similar to phone calling systems that provide callers with 'wait time' information, e.g., messages such as "An operator will be with you in approximately 15 minutes." This idea could be extended to video appointment systems to provide more detailed awareness information such as how many patients are ahead of them and the expected wait times for each appointment, thus providing similar information to in-person appointment waiting while also extending it in useful ways. Patients could then engage in other activities at their home while they wait for their appointment to begin. Some commercial video consultation applications, such as VSee (Table 1, Column 3), support a 'virtual waiting room' in which doctors or coordinators are able to see the list of patients who are in a queue. However, such features are not available on the patients' side. More broadly, we do not see such features in other video appointment applications nor in the related literature. Overall then, the applications we analyzed in Table 1 do not consider this design recommendation deeply, if at all.

Our study results also point to the strong value that doctors can gain from seeing patients waiting, interacting, or walking between locations in a clinic. Video appointment systems take away this opportunity since they focus on just streaming the appointment itself. For this reason, there is an important opportunity for designers to **consider how to capture and share types of supplementary information about patients before an appointment begins**. For example, one possibility might involve applications that are designed to walk patients through scripted video capture such that particular types of video footage can be recorded prior to an appointment, e.g., on-screen instructions might say, "Position your camera approximately 10 feet from you. Now capture a video of yourself walking across the room." This type of feature is akin to watching a patient walking through a medical clinic and was not in the applications we analyzed. Here it would be important to illustrate the rationale

for this type of footage to patients, so it is understood as valuable. Computer vision algorithms could also be incorporated into systems to track whether the necessary patient movements were performed correctly and done within the camera's frame in order to better support the necessary camera work. In turn, it would also be important to not overburden doctors with video footage that they have to view prior to an appointment; this suggests carefully curated video clips, which could possibly be done algorithmically or through user interfaces designed to help patients cut and trim video clips prior to being shared. Data from other sources, such as health apps that track walking, might be useful for providing more holistic information to doctors. Across all of these solutions, designers would need to consider the users and their abilities. When analyzing the systems in Table 1, we found that none of them include these types of design features.

8.2 Camera Work in Video Appointments

Our study results show that it is critical to think of video calls for doctor appointments as being much different from a typical video call that one might have using systems like Skype or FaceTime. Video calls for work or home life most often focus on seeing faces and conversing [34]. On the other hand, video calls for doctor appointments include conversations, but, often more importantly, showing various parts of one's body to a doctor, which is not always easy with a mobile phone. For these reasons, we feel **it is critical to think about *both* software and hardware when designing video calling systems for doctor appointments**. When looking at the commercial systems we analyzed from Table 1, we see a focus nearly exclusively on software, e.g., an app running on a standard mobile phone with an embedded camera. Hardware is typically only considered in the form of peripheral devices that can connect with a mobile phone, such as a smartwatch that provides health data via a step count.

First, designers must **consider the type of camera being used and what it is able to capture.** Both doctors and patients recognized the importance of seeing patients' whole bodies, similar to how doctors see them in the office. It is essential for doctors to obtain patients' general status by observing their facial expressions and body language. The issue has also been mentioned in [1] where doctors desire high-quality video cameras so that they can notice nuances in patients and their behaviours. This means that mobile phones alone on the patient's side may not be ideal for video-based appointments because the front camera of most smartphones at the present time is not able to capture video of a person's entire upper body while being close enough to the user so that they can see the doctor on the phone's display. These findings suggest that cameras need to have large fields of view, or it should be possible to place them at a distance away from the patient to capture a broader area on camera. Of the applications listed in Table 1, only VSee supports an external camera, which would allow the application to meet this design suggestion if an external camera had a wide field of view.

Second, and related to the previous point, it is critical that designers **consider decoupling the camera from the video call display (the mobile phone's display).** If a camera is placed far away in order to capture a patient's entire body, they may easily not be able to see the display to see the doctor or what is being captured by their camera, which would impede camera work. Doctors also sometimes need to see particular body parts that might be difficult for patients to capture with a mobile phone camera alone. For example, a patient may need to capture an image of their back and not be sure that it is in view on their phone because the display is behind them and out of sight when holding the phone behind their back. A possible design solution could involve a stand-alone camera that can be separated from the display so that the patient can capture the video footage while looking at a display to see what the camera is pointed at. In this case, it could be useful for a camera to be able to be easily held or adhered to a surface, e.g., a wall or a desk, to facilitate image capture. This also illustrates the importance of hardware that can allow a camera or mobile phone to be easily set down in a given location where it does not fall over. Another idea could involve using a smartwatch to display what the phone's camera sees

when holding the camera behind one's back. Of the applications listed in Table 1, again, only VSee supports an external camera, which would help support this design suggestion, if the user interface made it easy to manage the external camera and decouple the camera from the display. While our results showed that palpation by patients themselves may not be possible at the present time, if palpation is possible in the future, it will need to involve hands-free capture of a patient so that they can use their hands or peripheral devices to press their own body. In this way, special-purpose mobile phone stands would help patients set down their phone and direct its camera at their body while they perform their own palpation.

These camera work challenges all suggest design opportunities for apps and devices that allow doctors to observe patients in different ways. Hands-free video conferencing systems such as Facebook Portal or similar systems designed in previous studies of family communication that are similar to portable picture frames [35], as well as telepresence robots [46,79], could be candidates for video-based appointments. Such systems are generally equipped with large camera view angles and mobility such that patients can be in a private space in their home without having to hold a phone or tablet all the time. Yet many people may not have specific devices such as a Facebook Portal or more expensive telepresence robots. This suggests that, instead, camera work might best be supported by smaller stand-alone cameras (e.g., akin to a GoPro camera) that could be placed in certain locations and paired to a mobile phone. Such cameras are popular for capturing first-person views of sports activities, e.g., skateboarding, skiing. The appointment apps that we analyzed (Table 1) only contained the most basic of camera features, focusing on the use of a single camera, and did not have features found in these other types of devices.

The idea of multiple cameras for video conferencing is not new in non-health situations and could be highly valuable for doctor appointments given our study results. Previous studies use multiple cameras to present multiple views of the same context [41,75], which have shown to be able to better support shared views and experiences during video conferencing in non-health situations. Yet, the camera work for doctor appointments would be different in that it will often require intensive and effective collaboration between the doctor and patient to position and orient the camera in different ways. For example, doctors usually need to explicitly ask patients to show body parts or perform certain actions over video. Doctors prefer not to spend valuable appointment time on such 'setup' coordination. Thus, designers should **consider opportunities for systems to be able to help patients configure their camera and video conferencing setup in advance or mechanisms to support the pre-recording of things that doctors are likely to need to see**. For example, systems could be designed with on-screen feedback that helps patients align themselves in the camera view. Or, systems could ask patients questions about their symptoms, and have them record certain video clips before the appointment that are likely to be needed by the doctor. Of course, this may not always get the correct footage, but it could help reduce time in some cases.

8.3 Relationships, Control, and Privacy

Relationship building and rapport can be important for many doctor-patient relationships. Both doctors and patients believed it would be difficult to build rapport when meeting for the first time over video without a pre-established relationship. Challenges exist in terms of seeing body language on a small display, maintaining eye contact, and seeing gestures, all of which are common issues with video calls in general when using a smartphone. While eye contact is notoriously hard to 'get right' in a video system, there are likely more straightforward opportunities to address what one can see of a doctor or patient's body in a video call. As such, designers should **consider opportunities to enhance the physical embodiment of both patients and doctors.** This could involve coupling larger displays with mobile phones so that the remote person can be shown on the large display at life-size or near life-size. For

example, a mobile phone could be connected wirelessly to a television within the home to show a doctor's video on a larger scale so that it is easier to see body language and gestures. Similarly, applications could support the use of different types of devices on the doctor's side, such as laptops or computers, if they do not already. While we do not know what the experience is like for doctors with the applications we analyzed from Table 1, we do know that none of the applications focused on making it easy to couple the app with a large display for viewing aside from using a mobile phone's built-in features, which may be difficult for many people to understand. Prior research for video communications, in general, has explored projecting people in real size [55] as a form of telepresence, or capturing people's 3D models [51] and presenting them virtually in the same virtual space. Such approaches of remote presence may make the interactions more natural but are quite forward-thinking and not presently accessible for video calls with doctors in home environments.

Most of our patient participants and many doctor participants were hesitant about privacy-intrusive scenarios, such as exposing one's private body parts over video. Nevertheless, some doctor participants were open to such exams as long as patients behaved appropriately. Yet, the challenge was that patients were unlikely to drape themselves properly and, thereby, exposing parts of their bodies that are otherwise draped during in-person appointments. This may create issues around risking patients' dignity. As such, designers should **consider features that allow patients to selectively expose portions of their body over a video call.** Here, lessons could be applied from in-person visits where patients are generally left alone to get changed before an exam and are given a cover sheet to guarantee that only a specific body part is seen by the doctor when examining the patient. For example, applications could allow patients to pause the video stream on their side while still allowing them to see what is being captured by the camera. They could orient the camera and perform the necessary camera work to get the right area of their body in view. They could also use a form of 'virtual drape' to cover up the rest of their body digitally. Here the patient could assign an area on their body to be shown, and an algorithm could recognize the area and ensure that the patient's body outside of it would be hidden from the doctor regardless of how patients hold the camera or move their body relative to the camera. In this way, only the uncovered area of their body would be transmitted once they turn the video stream on again. None of the applications we analyzed in Table 1 had such features. While promising, further patient-centred studies are needed to evaluate the effectiveness of such approaches.

Video recording was concerning to both patient and doctor participants in terms of knowing who had permission to access the video records and how one would acknowledge the use of video recordings. TELUS Babylon only audio-records consultations with the patient's consent. None of the other applications we assessed provided such a feature. This continues to be an open design space where video recording could be valuable to keep accurate records of patients' appointments and help to build trust with new doctors where they can learn more about a patient's history. Yet, the privacy concerns are very real from the patient perspective in terms of unauthorized recording or sharing. Providing notice that an appointment being recorded or accessed by doctors in follow-up appointments might help patients be more aware of any potential issues with recordings.

8.4 Conclusion

Our research contributes a study of doctors and patients that explores their thoughts on remote doctor-patient appointments using app-based video calls from home and the user interface challenges that emerge.

First, we found that social concerns exist for both doctors and patients in relation to the establishment and maintenance of long-term doctor-patient relationships. Unlike other contexts involving video communications such as family life or work situations, video-based doctor appointment systems tend to be designed for 'strangers' to connect over distance. This is far different from using a video calling

system to connect a grandparent with a grandchild in home settings, or connecting two office colleagues from work, where a prior relationship has been established. Yet, the systems are typically designed in a very similar manner with similar features (e.g., Skype-like). Second, we learned of the value of a pre-location for video calling systems to place participants in, such as a virtual waiting room, prior to the start of a video appointment call. Such spaces do not come up in the related literature on domestic or workplace video calling, given the very different nature of calling in these contexts. Instead, the literature on both contexts speaks to the idea more generally of providing an awareness of whether remote parties are free/busy for interactions [9,10,12,33,35–37], but no indications of when other parties are in-calls with someone and when they will be done. Thus, our work extends the field's understanding of designing video communication systems to provide awareness information prior to video calls. Third, our work directly explores camera work with respect to video-based appointments. Here we see challenges around patients showing parts of their body, as well as showing their entire body to the remote doctor. These problems often stem from the camera being coupled with the display, making it hard to see what is shown on camera. Such problems do not typically arise in family-to-family, and work colleague-to-work colleague calls since the video is typically focused on a person's face in these situations. We also know that people often like to show activities in domestic settings, such as a child playing, but it is usually of another person and not oneself [33,35–37]. This means that the types of camera work needed are different for doctor appointments that might only include a single patient in the call on their side. Possible design solutions presented in the related literature for video conferencing in general may work to help solve these problems, including 360-degree videos (e.g., [69]). Our work extends the literature on video communication systems to open up the design space with new opportunities for technologies to be designed for video calls focused on doctor-patient appointments, including an emphasis on both software and hardware design features. Fourth, our work uncovers challenges related to privacy and video calls for doctor-patient appointments. Privacy is a highly studied area of research when it comes to video communication systems. We extend the field's understanding of this space by showing that video appointments for doctors and patients create unique situations with highly sensitive audio and video conversations. The challenges are similar to domestic, and workplace video calls where bystanders may overhear or see things not intended for them [10,33,36]. In the case of video-based doctor appointments though, the privacy risks are potentially increased given the sensitive nature of some appointments, which means it is all the more critical to design systems in order to appease the privacy concerns of both doctors and patients.

Our study is limited in that we only interviewed participants from a certain metropolitan region and patient participants had no experience of using video appointments. This means that portions of our data involve speculations about the nature of video appointments. We overcame this by utilizing video scenarios and grounding conversations in actual appointments described by the participants. Nevertheless, our results should be understood with this limitation in mind. Additional concerns may arise in actual practice if video appointments are used, or some problems may turn out to not actually be issues with real usage. Our participants have varied ethnic origins, which might create divergent socio-technical understandings due to cultural differences, though our intention is to reveal as many challenges as possible. Future studies could include a larger sample size, multiple populations, and a larger range of ethnicities. Lastly, the primary healthcare system in Canada could work differently from other countries in terms of policy and infrastructure, e.g., publicly funded and hierarchical medical system. Related research should consider the possible difference in outcomes for countries with different health care systems.

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