

Caller Needs and Reactions to 9-1-1 Video Calling for Emergencies

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ABSTRACT

Emergency services in North America have relied on the use of audio calls to the phone number, 9-1-1, since the late 1960s. In the coming years, 9-1-1 services will move to integrate media-rich calling capabilities such as video-based calling. We explore how video calling services should be designed through an interview study with people who have called 9-1-1 in the past. Our results show the potential for video calling to help people who are calling 9-1-1 describe their location to call takers, show the situation at hand, receive video-based instructions, and assist in cases with language barriers. Yet video calling raises issues around anonymity, consent, culture and gender-based biases, and camera work. 9-1-1 video calling is best thought of as a collaborative act where camera work is negotiated between callers and call takers where callers are willing to hand over control of the call if their privacy concerns can be met.

Author Keywords

Mobile video calling; emergency calling; callers;

ACM Classification Keywords

H.5.3 [*Computer-supported cooperative work*]: Group and Organization Interfaces

INTRODUCTION

In North America, when an emergency situation arises that requires police officers, ambulance services, or firefighters, citizens are able to dial the number 9-1-1 and speak to a call taker who will dispatch the appropriate responder. Since the late 1960s, these services have focused on the use of audio calls for information sharing between the caller and call taker [14,15]. In the next few years within Canada, such services will begin moving to Next Generation 9-1-1 (NG911), which will allow citizens to use more advanced technologies such as text messaging, video calling, or the sharing of photos or videos [14,15,40]. The challenge is that there has been little investigation into how such

services should be designed and how they should fit within typical situations involving calls to 9-1-1. We explore this topic through an exploration of video calling from the perspective of everyday people who might call 9-1-1 to report an emergency and seek help. Video calling is a technology that is now readily used by many people for communicating between family and friends [3,12,29,31], yet it has not been explored to understand how it should be designed for use in emergency situations.

Our work focuses on answering several primary research questions. How do people experience audio calls to 9-1-1 and what challenges do they face? What benefits and challenges would video calling introduce if it were available for people calling 9-1-1? Our overarching goal is to understand how to design video calling systems as a part of NG911 from the perspective of 9-1-1 callers, with an emphasis on matching the technology with caller needs. While there are clearly other stakeholders in such designs, including emergency call takers and dispatchers, we focus on callers as a stepping-stone to more broadly exploring the topic and design space. Future work should explore the perspectives of other stakeholders, such as call takers, dispatchers, and emergency responders.

We conducted interviews with 17 people who had previously called 9-1-1 in urban areas where we probed them about their 9-1-1 call(s), the emergency that they needed help with, the workflow involved to make the call and receive help, the ways in which they imagined 9-1-1 video calling would have worked in their situations, and the perceived benefits and challenges of video calling during an emergency situation. We focused on covering a range of call types, including police, ambulance, and fire situations.

Our results illustrate that video calling for emergency situations can provide a number of benefits to callers, including the ability to show rather than tell call takers about a situation. 9-1-1 video calling is best thought of as a collaborative act between callers and call takers where callers want to largely give up decision-making control of what information to share. Instead, they want camera work—the continual efforts needed to properly orient a mobile device’s camera to share a certain view [25,28,30]—to be controlled by the call taker. Yet callers are actively concerned about what may be shown on camera and how this will affect emergency response. Video calling raises issues around anonymity of the caller, consent of the people being captured, and biases that might emerge around

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ethnicity or gender if a caller or victim can be seen. There is also the potential for self-censorship of what is captured by the caller. These issues illustrate that designing 9-1-1 video calling systems requires careful design considerations to balance the needs of callers and information acquisition.

RELATED WORK

Video calling is now a common practice amongst many family and friends [3,12,29,31]. This includes calls from mobile devices when out and about [28,41]. Video calling typically focuses on either conversation [29,31,41] or sharing details of one's environment in a visual form [12,13,29]. Common challenges with video calls include connectivity issues [3,31], concerns about being shown on camera [10,18,37], and properly orienting the camera as a part of 'camera work' [25,28,30,35,44]. When mobile phones are used in public settings for mobile video calls, privacy and autonomy becomes an issue [10] because bystanders may not be comfortable being captured on camera [38,43,47]. Design solutions have explored ways of obfuscating video (e.g., blurring or pixelating it) during calls to alleviate such privacy concerns [10,11,23], linking together multiple camera views [17,38], and using 360-degree cameras to shift the focus of the camera work to the recipient of the video feed [50]. While there is clearly a wealth of literature around video calling as a part of domestic life, we do not see any research around how video calling could be used as a part of emergency situations.

Emergency call centres receive calls from people in distress where they are in need of emergency services in the form of police, ambulance, or fire. Call takers receive calls, ask the caller questions to help understand the situation, and then dispatch the appropriate responder [19,33,42,54]. Information is recorded textually in a Computer-Aided Dispatch (CAD) system by the call taker [53]. Call taking is by no means easy and call takers often face challenges in knowing where a caller is located, especially if using a mobile phone since GPS coordinates may not be very accurate [19,42]. Call takers focus on taking control of a call when it comes in, such that they ask the caller a series of predetermined questions in a sequenced order [49]. Yet sometimes it can be hard to achieve a high level of control to ensure information is collected in a timely manner because callers can be frantic or desperate [4,55]. They can even become hostile if they want to share information in their own sequence [49].

Most emergency call centres contain a number of call takers and dispatchers who triage and answer calls as a team [9]. Call takers actively monitor the broader set of calls coming into their centre so they can detect multiple calls about the same situation [4,33,42]. This involves situation awareness, a moment-to-moment understanding of what is happening and how this information should be acted upon [2,16]. Situation awareness can be gained by looking around one's environment or noticing information in one's peripheral vision [7,9,22,24,52]. Call takers gain this

information by looking around the call center, as well as by monitoring an incident list in their CAD system [33,42].

Emergency call centre work is known to be stressful since call takers must deal with a large number of traumatic situations [1,34,46]. This is especially the case for calls that are focused on life or death situations [6], or traumatic events happening to children [21]. Call takers sometimes imagine the situations that people are calling about and have been known to form personal connections with callers [1]. It can be difficult to acquire information in a timely manner because call details might be ambiguous, such as the nature of the incident or the caller's specific location [1,21]. Callers may also face communication barriers with language issues, accents, or people who are unable to clearly speak (e.g., young children) [1,21]. This can make it difficult for call takers to understand a call situation [1,21].

A small amount of research has focused on the experiences of callers who call 9-1-1 to request help. Yet this research has primarily focused on those who are deaf or hard of hearing. In these cases, we know that people with hearing impairments try to rely on family or friends to call 9-1-1 operators on their behalf [48]. Teletypewriters exist, but tend to be used very rarely because they are not available on mobile phones [48]. Text-to-911 is in existence in some areas of North America though it requires special permission and sign-up to use [15,51].

Video calling has been studied as part of 9-1-1 calls with a focus on call centres. This research shows the value in call takers being able to direct the caller into capturing specific video footage [39]. Research on the use of video calls between ambulances and hospitals shows that video can be valuable to alert hospitals as to the types of situations they are about to have to deal with [5]. Studies of hospitals not currently using video from ambulances have shown that they would value additional information about patients during transportation to the hospital [56]. More generally, there is a large body of research on the use of images as a part of social media posts during natural disasters like earthquakes, floods, etc. [8,32,45]. In these cases, it can be difficult to know what information is credible [45].

Our research expands on the related work to explore the experiences of people who have called 9-1-1 and how they see video calling being designed and used in such situations. As can be seen, there is little research in this area from the perspective of technology design, with an emphasis on the future usage of video calling for 9-1-1.

STUDY METHOD

We conducted a study with people who have called 9-1-1 to understand their calling experiences, needs, and challenges. We also explored the potential of how mobile-video calling might have been used, if it was available, what benefits it would have created (if any), and what challenges could have arisen. Our study was approved by our ethics board.

Participants

We interviewed everyday people who had previously called 9-1-1 to report emergency situations. We recruited 17 participants through snowball sampling (word-of-mouth), social media (posts on Twitter and Facebook) and posters placed in our university. 16 participants used 9-1-1 services in major metropolitan cities in Canada, and 1 participant called 9-1-1 in the USA. Our participants included 10 females and 7 males with an age range of early 20s to late 70s. The occupations of the participants covered a range of jobs and professions (university students, advisors, administrators, secretary, assistants, engineers, retired professors, crisis-center volunteer). All participants were from the middle class. All participants owned smartphones and were familiar with video calling technologies (e.g., Skype, Facetime) and had used them before in their personal lives. We recruited a diverse mix of participants by sampling them for their nature of emergency call (police, fire, or ambulance), number of times they had previously called 9-1-1), their location when calling (indoor or outdoor), nature of call (reporting an incident or calling for help) and, lastly, whether they required services for themselves or someone else.

Our participants pool had called 9-1-1 an average of 3.41 times (median=1, range 1 to 24). Out of our 17 participants, 7 called for medical, 8 for police, and 2 for fire-related emergencies. Medical emergencies involved situations such as person not feeling well, strokes, seizures, injuries, and a heart attack. Six of these participants were calling for their family members while one participant was alone at the time of the emergency and was calling for himself. All the medical calls were made from the home by using a corded phone/landline except one where they used a smartphone. The seven police emergencies involved people reporting crimes such as breaking into homes, rash driving, street fights, road accidents, suicidal attempts, and verbal and physical assaults. These calls were made by people who were reporting incidents in their neighborhood or their vicinity for safety reasons. These calls were made from indoor and outdoor locations such as homes, parks, malls, side-walks, and transit (cars, trains) using a smartphone. The two fire-related emergencies involved people reporting fires in their homes or their neighborhood. These cases involved fires in home appliances and vehicles.

We found when recruiting and conducting our study that calls to 9-1-1 by an individual tended to be infrequent. As such, participants in our study reported on calls across a range of time periods. On average, participants were talking about their situations that occurred about two and half years prior to the study (median=12 months, range=1 month to 13 years). While people tend to reconstruct rather than remember events over time, participants talked about their calls as being traumatic experiences that they vividly remembered as a result. Thus, it is likely that their reflections of the event are mostly accurate, yet our results should be considered with this caveat in mind.

Method

We conducted semi-structured interviews with each participant. We structured the interview in two phases. The first phase of the interview focused on understanding their experiences with calling 9-1-1, asking them to give us a play-by-play of their situation and conversation with 9-1-1 call takers. For example, we asked questions such as, “Why did you decide to call 9-1-1?”, “What did you tell the 9-1-1 operator? How did you describe it?”, “What questions were you asked by the 9-1-1 call operator?” and “Did the call taker provide you with any further information/instructions? If yes, how did s/he explain that information? Were you able to understand and perform those instructions?” This was followed by asking them about the challenges they faced before and after the call, what worked well or not well about the call, and, lastly, about their learning experiences. With participants who had called 9-1-1 more than one time, we asked them to pick the 9-1-1 call that they were most comfortable talking about as a focal point.

The second phase of the interview focused specifically on the future use of 9-1-1 video calling for emergency situations. We gave them a very generic description of how a 9-1-1 call might take place using video (e.g., somewhat akin to a typical Skype call). To ground participants’ responses and reduce the need for them to speculate about general situations, we asked them to think specifically about their previous 9-1-1 call. We asked participants about the benefits they thought that video calling would have brought to the call, the challenges that might have arisen, the camera work and views they would have shown, and their privacy and safety concerns with using such technology. For example, we asked, “If the call was done over video chat, what do you think would have worked well? and what do you think would have not worked well?”, “What would you have shown and how?”, “What would you have not been able to show? Or wouldn’t want to show?” Later we also asked them about their preference for three different kinds of mediums (images, recorded video, and live video) and why they preferred one medium over another. We also asked for reactions to 9-1-1 video calling more generally. To summarize our participants’ evolving responses we ended our interview by asking them “What would you have done differently in your previous 9-1-1 call(s) if video calling was available? Why?”

Data Collection and Analysis

Interviews were conducted in-person with local candidates living close to our university. Distant participants were interviewed through a video communication system (e.g., FaceTime, Skype). We audio-recorded and took detailed notes of all our interviews. Interviews lasted between 25 and 45 minutes. All interview data was transcribed and then analyzed using thematic analysis to draw out main themes. This involved initial coding and then explorations for categories and central themes. We found main themes related to decision-making as to who and how the call should be placed, the acquisition of contextual information

about an emergency, communication and language barriers, camera work during video calls, and concerns around privacy, safety, control, and consent. We detail these next in our findings. For participant quotes, we refer to each participant by P#[gender], [age or age range].

CONVERSATIONS WITH 9-1-1 CALL TAKERS

Participants said that calls started with the call taker asking them what service they were calling for—fire, police, or ambulance—followed by their identification, contact number, and location. Next based on the service, they were asked a series of questions about the emergency they were calling for. In the case of medical emergencies, they were asked a series of questions to rule out certain symptoms by going through different medical criteria to diagnose the situation. In severe cases, 9-1-1 operators asked the callers to perform first-aid such as CPR or chest compressions by asking them if a family member was trained for it. Most of the 9-1-1 call takers stayed on the call until the first responders arrived on the scene.

“They asked a bunch of different questions to rule out a heart attack, and to rule out a stroke ... they went through all of the different criteria they have to determine what's wrong.” –P1F,40-45

In police or fire related emergencies, questions were directed at obtaining contextual information about the situation by asking the callers for a play-by-play of what had happened. They asked for specific details such as the exact location of the incident, number of people involved or injured, or the appearance of the assailant or any objects used (weapons, vehicles). Most of the calls ended by advising the caller to stay safe until the situation was resolved. In all cases, participants reported that call operators helped them calm down during the call by assuring them that help was on the way.

“They did try to stop the situation from getting worse before coming, and they're telling you that someone will be there shortly. Just pretty much calming the situation, telling you everything's gonna be okay.”-P17M, 22

Participants told us that there were certain factors and decisions that determined who should call 9-1-1 in the home such as a person with a medical background or recent first-aid training, person with a calm demeanor, or someone with a good spoken English. Participants told us family members who had never witnessed emergencies such as teenagers were in a state of panic or new parents found themselves under stress while talking to the operators. One person reported being calm because she worked as a call operator in a crisis center. Participants reported that being in a frantic zone and surrounded by frantic people made it hard for them to clearly think and act while sharing and receiving information from the operators.

“I definitely was screaming while [the operator] kept saying, ‘You have to calm down.’ And I'm trying to remain calm and listen to what she's saying and then I've never

done mouth-to-mouth before. I mean, if I had been in a normal state of mind, it would not have been that bad, but my husband was freaking out. I was freaking out and it was much harder given the situation.”- P5F, 31-41

Participants told us in order to reduce the stress level of certain family members, they were asked to give them tasks to distract them and keep them busy. Tasks included watching for the first responders or playing with kids.

Participants reported teamwork among members in the home to manage the situation. This included family members assisting the caller during first-aid instructions, providing information on the patient's background, or adding a calming presence to the environment through moral support. For example, one parent reported about the teamwork with his 11-year-old child where the child was talking to the operator while the parent performed cardiopulmonary resuscitation (CPR) on the victim.

“I think they were totally talking to my son throughout all of this, not to me, and I was asking questions, which my son would then ask the operator...It was pretty amazing, what I needed from [my son] and what he was able to do at that moment, and that we worked through this and got through.”- P3F, 54

CHALLENGES AND CALLERS' PERCEPTIONS

We now describe a series of challenges that our participants described about their 9-1-1 calls, if and how participants felt that video calling might help to solve some of these challenges and perceptions about the way 9-1-1 calls work.

Inaccurate Assessment

First, participants were faced with the challenge of describing the specific details of the situation to the call operators. They mentioned moments of misunderstanding and worries about providing incorrect or subjective opinions to the call operators. These challenges arose when call operators asked them for descriptive information such as the symptoms of the victim, appearance of the assailants, descriptions of objects (e.g., vehicle make and model), the size of a fire, or the direction of a moving train.

“I wanted to give accurate information not opinion-influenced information. Because they wanted to know his height, his age, you can't tell that when you're looking out the window across the street to someone.” –P2F, 35-40

“During the call there was some confusion initially, you know, in relaying the situation to them. I told them the guy was going into the water, and they assumed pretty soon that we were actually at the stage of CPR.”-P10M, 41

Participants thought with the use of video calls for their 9-1-1 situations that the operators would have been able to see the exact situation they were facing and the information conveyed through the video would be more accurate. They felt that video calls would have augmented their verbal description and eliminated any inaccuracies. They also

thought video could have conveyed the salient details that they might not have thought about sharing.

“Having the actual imagery, the actual video would definitely be beneficial because then you can see things that the reporter doesn't think to report.”-P2F, 35-40

Participants felt with video calls that communication would be much faster and it could possibly eliminate follow-up questions that the operators might have.

“I think maybe it could eliminate questions that they would have to ask you ... if they see something ... they can just enter it.”-P9F, 27

There were cases where participants found themselves to be puzzled when the operator asked them for the service they required as they did not know about the specifics of the situation or were not sure whether to call police or ambulance for suicidal cases. With video calling, participants felt in complex cases where the caller is not sure which service they require, the operator could simply assess the situation themselves and dispatch the services.

“I feel like they should make that assessment. Like, that's why I thought, ‘Hi, okay tell me what happened.’ I'll tell and show you what happened, and then you should tell me, or you should make the assessment.”-P9F, 27

Overall participants felt with video calls that the operators would have a better understanding since they could better assess the severity and criticality of the emergency rather than the caller's subjective opinions and assessments.

“I guess they would have just seen the level of the emergency a little bit differently, they would have seen the color of my husband, that it was not good.”-P3F, 54

“What I consider severe bleeding versus what somebody else considers severe bleeding may be very different, and a 911 operator would have a better sense.”-P1F, 40-45

Location Information

The call operators usually asked the callers for the nearest intersection or their exact address if available. This was challenging for participants who were outdoors in a park, the woods, or remote areas.

“I had to call an ambulance to my parents' house but they live on 20 acres. Their driveway is two thirds of a mile long and it's gravel, the ambulance had difficulties finding it.”-P2F, 35-40

Participants calling from areas where there were no nearby intersections were faced with the challenge of finding or locating a nearby intersection when instructed by the operators. This, in turn, added delay. Participants felt that video calls would have provided operators with well-known landmarks and visuals that could have helped locate them.

“I've got no clue, it's a long park, there's no streets crossing it. I know the name of the park, and I know the bridge right above me, but I cannot give you an intersection, and they

just kept asking me for that...it would've been a lot easier to show them around the spot and say, ‘Okay, this is where I am, that's the bridge...’-P10M, 41

Overall participants felt that providing location information through visuals (i.e. landmarks, buildings, signs) would have taken away the burden from them to find or locate the nearest intersection and save time. Naturally, such items would need to be visually noticeable and recognized.

Anxiety, Stress, and Clear-Headedness

Participants admitted not being able to think properly or being clear-headed during their emergency situations. Due to the stress and anxiety, they were sometimes either unable to answer basic questions or think logically. For example, two participants felt that they could have simply switched to the speaker phone during their emergency call to allow others to listen to the operator. They felt this would have helped, yet their state of mind in the moment made them not think of this idea. Participants thought that video calling would allow them to communicate more efficiently by showing relevant visuals if they were unable to verbally describe details because of anxiety or stress.

“I think when you're panicked ... I think the most problem is thinking, right? So not thinking properly what to say, but when you're showing something, that could be a different medium of communication.”-P13M, 24

We probed participants to understand if seeing the call taker over a video link would help alleviate anxiety or stress. This was generally seen as a positive feature as they felt it would help to calm them down and make it more “human” to see a person rather than just listening to a voice. Moreover, participants felt that the call operators were a person of authority. Seeing their face would provide them with an authoritative and calming presence.

“People sometimes listen to like, people with authority in uniforms and so on. So if they're in like a medical uniform, or like a police uniform. Some kind of authority, I think people would listen especially in a situation where there's a crisis.”-P6F, 36

Seeing the face of the operators was also seen as a psychological help for participants who were alone at the time of the emergency.

“If you are alone and you have the comfort of seeing another human being that you are talking with who's trying to help you. I think that would be of some psychological value.”-P4M, 70-80

Language and Articulation

Participants said that there were difficulties in effectively communicating information to call takers because of language issues. For example, one participant told us that she called 9-1-1 on behalf of a person who was going in and out of consciousness. It was difficult for her to understand what he was saying to her to describe his symptoms and she should could not easily relay this information to the call

taker. Other participants speculated that there might be situations where it might be hard to understand callers under the influence of drugs or suffering through intense pain. Secondly there were factors related to language such as proficiency in spoken English or accents. For example, a participant talked about calling 9-1-1 on behalf of the family when he was 10 years old because his parents felt they might not be able to communicate properly in English with the operator since their native language was Mandarin. Other participants speculated about language barriers given the multi-cultural community they lived in.

"I come from a Chinese family, my parents weren't that great with English, so they immediately told me 'Okay, you better talk to 911.'" -P17M, 22

Across these concerns, participants felt video calling would be helpful to alleviate language concerns by shifting the call to focus on visuals.

Instructions and Awareness

When dealing with medical emergencies such as strokes, heart-attacks, or injuries, participants were asked to perform certain first-aid instructions by the operator until the first responder arrived at the scene. Participants said it was hard for them to understand certain instructions over audio calls such as explaining mouth-to-mouth resuscitation, CPR, or instructions to clean and seal wounds. Many participants felt that video demonstrations from the operators would help in these situations to understand the intricacies of the instructions to be performed. Participants suggested pre-recorded stock videos that could be shown to them to demonstrate steps and the order of instructions.

"I've never done mouth-to-mouth before and so, having like a video thing where she could have just, I'm sure would have been much better." -P5F, 31-41

"In one of 911 calls that I made the instructions that they had to give me were on how to save a severed finger for them...It would have been very useful to know exactly what they meant, if they could've ... If there was some stock video they could've sent to show me exactly what they meant with the double bagging the finger." -P2F, 35-40

Secondly, participants faced a problem with receiving feedback on the instructions they were performing. It was hard to know if they were following instructions correctly and could only rely on verbal feedback based on what they described themselves doing to the call taker. These issues were more prominent when performing intricate instructions such as CPR that required them to use both of their hands to perform an action. In these cases, the phone was usually handed over to the nearest family member who channeled communication to the person performing the act.

"I was asking, 'How many compressions to breaths?' I could not remember the number and I just wanted that number....because [my son] was holding the phone, so I was counting very loudly so that [the operator] could hear

what I was doing... it was hard to interact with her because I was going through an 11 year old child." -P3F, 54

In these situations, video calls were seen as a possible medium for the callers to receive feedback and for the operators to monitor instructions. Of course, using video calling in this way would rely on the caller being able to provide a good camera view of the situation so that the caller could visually monitor his or her activities. This could easily be difficult if a person was alone and unable to hold a mobile device while performing actions.

Tone of the Caller

We asked participants to reflect on their 9-1-1 call and talk about what they learned from the experience. Participants explained that they thought their tone and clarity of speech was what determined the level of emergency. In reality, this is not the case as criticality is determined based on the caller's answers to questions (e.g., the content and not the tone of communication) [19]. Yet participants thought that if they had a panicked voice, it would influence the operator to dispatch services faster compared to a calmer voice.

"Maybe somebody such as myself who reacts and speaks to them in more of a calm manner, I don't get panicked so they probably don't register the level of the emergency as critical as it was because I'm not freaking out on the end of the phone, and maybe that's where something got lost in the translation." -P3F, 54

One participant felt the assessment would have been different with a panicked family member calling for help.

"I honestly think that if my step-dad had been there by himself and had phoned, he would've been so panicked in answering things and explaining things that it would've been considered an emergency even though it really wasn't." -P01F, 40-45

Participants felt with a video call the operator would be able to see the situation and assess it better without relying on the tone of the caller. This would help the operators to assess the criticality by looking at the scene and not based on the tone and description of the callers.

"To have things assessed by seeing it, not just by how people are describing things I think would be more beneficial to the 911 because everybody uses language differently." -P1F, 40-45

CAMERA WORK BY CALLERS

In this section, we describe participants' thoughts and reactions to different types of video/image capture for a 9-1-1 call and how they thought they would perform the camera work to have video calls with call takers.

Capturing Modes

We talked with participants about three different forms of visual media that could be used as part of a 9-1-1 call: 1) static images; 2) recorded video; and, 3) live video streaming. Here we were interested in knowing what

information they felt would be most important to share if they could only share certain visual media with the call taker. We received similar responses for static images and recorded video where participants said they would capture several types of information if a call used visual media. This included media of a descriptive information to show the basic problem (e.g., symptoms of a victim, identity of an assailant, nature of fire), before and after media to show the changing state of the situation, and media of the broader context of the scene (e.g., bystander, other victims). In the latter, participants said they would zoom in and out to capture specifics and, in the case of video, simply pan the camera to provide call takers with contextual awareness.

Most of the participants preferred the option of live video calling with the operators. This was because they thought that live video could help them relay the current situation with real-time updates depicting the evolving nature of the emergency. They talked about sharing the same information as with still images or recorded video only with live video they would need to think less about what to capture since the video feed would likely capture everything somewhat automatically by simply panning the camera around.

"Yeah, I think it would be a matter of showing them, keeping them apprised of the situation, this is how it's evolving so they know what's changing without my having to describe it ...So you could just leave that running and let them see what's going on while they ask you the extra information they need". -P10M, 41

Participants realized with images and recorded video that they would need to perform additional steps such as capturing, saving, and sharing the media with the operators. Their assumptions were that live video would be easier and faster to use: They would just turn on the camera and share the view without additional steps to share content.

"In images, then how would I send it, I don't understand, That's just too much work. If I'm already on the phone with them I could just easily show them versus like, I'm on the phone, and I gotta take a picture, and I have to send it to a number."-P9F, 24

Participants felt that live video would enable the operator to direct the caller for additional information to help them better understand the scene.

"I would like the live video because then they could even direct me and saying, "Oh, could you move closer to this thing?"-P8F, 27

Controlling the Call

When discussing the various ways that video calling could be designed, participants talked about a desire to control when and if video was used. That is, they wanted to be able to turn their video feed on and off while calling from their smartphones. They related this to features present in modern video calling apps (i.e. Skype, Facetime).

Participants felt that the act of capturing the scene should be collaborative work between the caller and the call taker. The call taker would be acting as a guide, requesting the caller for specific views. Callers would then perform certain actions such as zooming in or out, providing different perspectives of the scene.

"They're the ones who need to decide what to do, who to send, and what to include in the report. So, I feel like I would let them take it. Like, what do you need from me? Tell me, and I'll do it."-P9F, 27

"It would be like, 'This is what I want to see. Can you show me this? What does the scene look like right now? Can you just do a little sweep of it from left to right,' and you just go left to right. Or it's like, 'Is there anything like this?' If you say yes, they say, 'Could you show me?' I think that's how it would work."-P15M, 24

Yet participants recognized that even with a video call, there might be aspects related to the scene that might not be visible in the video feed (e.g., off-screen) and call takers would not know to direct the caller to show them. In such cases, participants thought it would be their responsibility to inform the call taker of such changes by talking to the call taker and helping decide what to show on camera.

"I would focus on what they need, but you would also want to maybe sometimes, like say, 'This is happening over there now that you need to be aware of.'" - P10M, 41

Lastly, participants felt that video calling brought the added advantage of safety where the call taker could see what the caller was doing and advise them of what not to do. For example, one participant told us that he went too close to a truck on fire to check for anyone inside the truck, which he realized was not a smart move. He felt if he was using a video call, the operator might have warned him not to go near the fire because s/he would have seen him approach it.

Training and Safety

Participants talked about possible safety and mental health risks with using video calling. First, many participants expressed uncertainty about whether they would want operators to be exposed to challenging or difficult visuals that they would capture in a 9-1-1 video call. They feared for the call taker's mental health. This suggests that callers may hesitate or not show particular things in fear of how the visuals might affect call takers.

"What if she(operator) saw the dead body? What if she didn't want to see that? The things that you'll expose might be like, you know, pretty dark."-P9F, 27

Participants also reported safety concerns about using video calling in cases where they would need to be surreptitiously streaming video of an assailant. They felt that typical camera actions like using the camera flash, turning on lights for better video quality at night, or trying to capture the face of the assailant might create additional risk for them.

“Say like if you're passing them by and you got your phone out and then they see that you got their face. And then if maybe they get mad, like if they try to slam into your car or something like that. It could maybe escalate the situation, depending.”-P11F, 26

“I've made phone calls in the middle of the night when I've seen an altercation going on outside and I don't turn on the lights to be obvious so that I can see through the window, and maybe the level of light is too low for video.”-P3F, 54

SOCIO-TECHNICAL BARRIERS AND CHALLENGES

Despite the likely benefits of using 9-1-1 video calling, our participants felt there were certain socio-technical challenges and open questions that they would encounter with video-based emergency calling systems.

Consent, Access and Liability

Participants talked with us about consent and how video would be turned on or off as part of a 9-1-1 call. In the simplest case, if a participant called 9-1-1 using video, participants felt they would be consenting to have that video be recorded as part of normal 9-1-1 procedures. They recognized that all 9-1-1 calls were recorded as a part of policy. If they called using audio-only and the call taker wanted to initiate a video link, they felt that they would need to agree and provide consent to do so by accepting it in the video calling software. What complicated matters more was capturing and sharing video of other people. Participants felt that when calling for help for someone else it might be hard to obtain their consent before the video call, yet they felt such consent was still important. For example, a person might be unconscious and unable to give consent to being video streamed.

“There are some sort of privacy issues because I'm making that decision for them, perhaps with, perhaps without their permission, depending on whether they're conscious or not.”-P4M, 70-80

Participants thought when calling for emergencies related to family members that they could make this decision for their family. They said that medical emergencies would trump any privacy related issues.

“My husband was not properly dressed at that point but ... modesty when you're going through a medical emergency like that, that's not part of the scenario.”-P3F, 54

Some participants said that obtaining consent would not be needed in possibly fatal situations where there might be harm or danger to the life of others.

“That's when yeah, you have to make a decision. Especially like, for suicide, it's like, confidentiality goes out the window once they're harming themselves or others.”-P8F, 27 Participants said that video might be captured when individuals might be partially naked or not properly dressed, and preferred the files deleted after a certain time.

“She was on camera when she wasn't feeling well, and would want to make sure, that footage wasn't kept forever, that it was destroyed after a specific amount of time I think would be important.” P1F, 40-45

Participants also had open questions regarding where the files would be saved, who would have access to these video recordings, and what purposes they would be used for later.

“People might think like is it going to be recorded? Where are they going to store it? Who has access? Will the police be able to use this data to identify suspects later.”-P11F, 26

One participant felt that video recording the entire incident, including the full travel to the hospital, could provide first responders and paramedics with a means to protect their liability and serve as evidence.

“I think it also gives them like, both liability and security, you know It didn't happen to me, but if the paramedics done something incorrectly, then they're liable.” -P7M, 40-45

Identity Disclosure

Participants said they wanted to remain anonymous on calls when they were calling ‘to report’ incidents but not necessarily when calling to ‘ask for help.’ Reporting an incident meant calling about something happening to someone else (e.g., a stranger in a car accident). Asking for help meant calling to obtain services for themselves or a close family member or friend (e.g., requiring medical aid). Participants referred to anonymity with video calls as not showing their faces to the call takers and not providing information such as their name and address. They felt their were additional risks because video was now being captured and saved.

“Maybe I want a little more anonymity when I'm reporting versus when I'm trying to get help for somebody.”-P11F, 26

“Because they're recorded, and I don't know if I would want [my face] on their file forever.”-P11F, 26

“I know that they won't use it for outside sources, but still, I feel like they have my footage. That's kind of worry me.”-P14F, 25

Participants felt that showing themselves would indicate to the operator that they might be involved in the situation they were reporting on.

“I didn't see any reason for ourselves to show, for example, ourselves that were calling to report the situation to 911 because we didn't want to feel like we were involved in.”-P12F, 28

Participants talked about calls where they might call for help but did not necessarily want to reveal their identity due to involvement in illegal activities or infringement of the law (e.g., consumption of drugs, reporting for overdose). Here they felt people would not want video shown of themselves.

“Many times people [who] report an overdose are the ones who are taking drugs with the person who's having an overdose, so they would need to show themselves when doing that and that would be a deterrent for video calling.”-P10M, 41

Some participants were concerned that showing their faces might create a bias in the call taker based on their gender, ethnicity, or personal appearance.

“When I think about that I probably wouldn't want them to see my face just because there are implicit biases into just seeing somebody's face. And it's not like people mean to have these biases, but they happen, so I wouldn't want somebody to not help me as much because I'm female for example, or I'm a certain ethnicity.”-P8F, 27

Ease of use and Technological Barriers

Participants said that video calling should be as easy as calling 9-1-1 with a smartphone or a landline. They said that anything that requires more mental effort compared to dialing 9-1-1 from their phones would not work under stressful and painful situations. Participants who mentioned this were usually older people above the age of 50 who found it hard to use Skype on their smartphones.

“As long as it was something that was simple to use, I mean when you pick up the phone... and you just hit 911. If it's anything more complicated, that would probably not work because you're so wrapped up in your emergency at that point in time that I don't think a lot of people would be terribly able to go through what we have to do today to fire up Skype.”-P3F, 54

Some participants were concerned with technical challenges such as the camera quality of the videos, consumption of battery with video calling, or connectivity issues such as no Wi-Fi or areas with bad signal reception.

DISCUSSION AND CONCLUSIONS

We now outline the implications of our results for the design and future use of 9-1-1 video calling systems. Our results show the possible benefits that video calling could bring to 9-1-1 calls from the perspective of the caller. For example, video calls could help callers share contextual information, overcome language barriers, and reduce uncertainty and decision making as to what and how to share information. However, with the introduction of video calling, there are clearly many design challenges that need to be carefully thought through. The current design paradigm for video communication technologies and apps (e.g., Skype, FaceTime) will not naturally translate to 9-1-1 video calls given the complexities of callers' needs.

Shift in Roles and Responsibility

First, we see a fundamental shift in terms of 'control' and how callers perceive 9-1-1 video calls. In the existing model of 9-1-1 voice calls, the callers are assessing their own situation and then reporting to the operator, and the operator further takes control of the situation by asking a

series of questions to understand their situation. Yet when it came to video calls for emergency situations, participants wanted to largely give up control of the decision making process in terms of acquiring and sharing information. There was a strong sense that they lacked expertise in emergencies and assessing what the problem was and it was often hard to convey information via audio descriptions. With video, they wanted to shift the burden of knowledge acquisition and decision making almost entirely to the call takers. This was exacerbated by the fact that most callers were facing a great deal of stress and anxiety and felt that their ability to make decisions and provide information was severely compromised. Past research on mobile video calling for sharing activities over distance between family and friends has shown that a camera handler often curates what is shown to a remote party [25,28,35]. Here people often take great pride in performing such camera work [35]. Yet with video calls for emergency situations, we see a very different situation where the camera work is seen as being too complex and a large burden on the caller.

Of course, it would be very difficult for a call taker to fully perform camera work on behalf of the caller since it would be difficult to gain complete control over a person's mobile device. A natural solution is to explore system designs that might permit call takers to suggest what camera work should be performed by the caller. This maps to call takers' desires for directing 9-1-1 video calls [39]. For example, one could imagine instructions being placed on a caller's mobile device screen to show them where to move their camera while streaming video. An arrow, for example, might indicate that they should move the camera left to capture a different part of the scene. Other more advanced augmented reality techniques might similarly be used. Image or video clips could be recorded of specific things, yet participants cautioned that this could be too challenging to do and they preferred live video. 360-degree video has been shown to help shift camera work to the remote viewer since s/he can look around a scene independently of the video capturer [50]. This could present a design opportunity for 9-1-1 video calls, especially if mobile devices move to include 360-degree cameras as a part of hardware advancements in coming years.

With all of these ideas in mind, we also know that call takers are already burdened with a great deal of work in order to keep records of the information they are receiving verbally from callers [53]. Thus, any additional efforts around camera work would need to be very lightweight to perform. Call takers would also now have the additional task of trying to assess the video footage on-the-fly to figure out the emergency needs of the caller. This could easily introduce larger volumes of information to be processed leading to information overload and more cognitive processing by the call taker. To help call takers handle the additional video information, significant changes would need to be made to CAD systems used for logging, viewing, and sharing information. Operators would likely

benefit from systems that allow them to tag or save images or video clips from within video feeds when they show certain objects, people, or other relevant information. They would also need to be able to easily review video on-the-fly in case they missed pertinent information. Additional computational techniques to automatically tag relevant information could also be useful.

We also see a likely shift in terms of who will make video calls to 9-1-1 as opposed to audio calls. Participants talked about deciding who should place a 9-1-1 call based on their proficiency in English or knowledge of emergency situations and what to do. Here they often picked the ‘most experienced’ person. With 9-1-1 video calling it is likely that technological abilities will play a key role in terms of who makes a video call to 9-1-1. Thus, unless 9-1-1 video calling systems can be made highly accessible and easy-to-use for those with limited technical abilities, usage of such systems will likely be limited to only experienced video call users. Other users will need to continue to use existing audio-based calling systems. For this reason, future 9-1-1 call systems should be thought of as hybrid systems that allow people to easily use either audio or video, and transition seamlessly between the two modalities. People will also require literacy around best practices for using 9-1-1 video calls such that they can more easily adopt the technology.

Social and Cultural Challenges

While callers want to give up control of their 9-1-1 video calls to the call taker, they are actively concerned about what may be shown on camera and how this will affect emergency response. Participants raised issues around staying anonymous when reporting incidents involving others (e.g., trying to not be considered a part of a problem situation), gaining consent of the people being captured, and biases that might emerge around ethnicity or gender if a caller or victim can be seen. Participants also considered censoring what was shown on camera because they were afraid of causing mental distress to the call taker (e.g., by showing a gory scene). These concerns raise issues around what should be shown and when.

It was fairly clear that consent to see and record a video call was considered to be given when participants directly called 9-1-1 services using video. Yet consent to stream others over video was more complex. This issue as well as challenges around showing distressing situations and problems related to gender and ethnicity suggest that designs require a means to share information about a situation while still obscuring potential details. This might include obscuring details of a person’s face (which could reveal gender or identity) or a severely injured person. Video obfuscation techniques have been used in workplace contexts to blur out sensitive details while still revealing enough information to understand a situation [10,11,23,36]. Similar techniques could be explored for 9-1-1 video

calling designs. Yet obscuring details raises questions around if information will be adequately conveyed.

Participants felt that they would like to see a video of the call taker to help comfort them, though call takers do not always want to share their video given that they are very busy and may not always be paying direct attention to the caller [39]. This suggests that 9-1-1 video calling systems should consider ways to allow call takers to be able to choose if and when to show their own video.

Conclusion

Our study provides details of how 9-1-1 callers experienced calls during emergency situations and their perceived benefits and challenges of video calling for similar situations. These results point to a wealth of design opportunities to explore for the creation of video-based 9-1-1 calling solutions. This relates to systems for both callers and call takers of 9-1-1 calls where our results shed light on design implications for these systems.

Our work was specifically scoped to explore the experiences and needs of 9-1-1 callers. As such, other work that explores the needs of 9-1-1 call takers and dispatchers should be considered in conjunction with it [39]. Our results are predominantly tied to emergency calling within urban areas of Canada where 9-1-1 calling is likely relatively homogeneous. Practices in urban areas of other Western countries such as the United States and the UK are likely similar given that call centre practices are somewhat homogenous across these countries [4,35,46,57]. Future work should explore rural regions of such countries to understand how the benefits and challenges of video calling may change when locations are perhaps more ambiguous than urban centres and response times might be longer for first responders. Participants were of a middle socio-economic class and none faced accessibility challenges. Future work should consider exploring more diverse demographics. We also recognize that participants in our study had to remember their past 9-1-1 calls that had sometimes occurred years ago. This is a limitation of our work, however, because the experiences were often traumatic, participants tended to remember them in great detail. Our study had a low number of people who had called 9-1-1 for fire-related emergencies. Future work should continue to explore such emergencies to understand them in more detail.

Lastly, we feel our work helps to open up a rich design space that is vastly untapped and of critical importance. With countries like Canada already creating policies around next generation emergency calling services, it is critical that we continue to understand how these services should be designed and what the likely user experience will be.

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