12-2022

Investigating 9-1-1 Call Experience for Medical Emergencies for Future Design

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Presentation: December 14, 2022

Graduation: December 22, 2022

Abstract

Emergency calling services have continued to use the 9-1-1 phone number to share information about a medical emergency for around 60 years. However, there are limitations to the current emergency call services that can have improved communication, speed, and accuracy with the implementation of advancing technology. By examining the experience and opinions of 9-1-1 medical emergency callers, we are able to investigate the design of 9-1-1 services to enhance the call experience. The major challenges found in the study are difficulty in verbally explaining the emergency situation and difficulty in describing the location of the emergency. Technologies such as location sharing, text chat, and video calling were suggested and favored to mitigate the challenges. Such features should be considered in the design of future 9-1-1 emergency calling services.

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Introduction

Since the late 1960s, medical emergency services have used phones to share information between the caller (e.g., a patient or a caregiver) and call taker (e.g., 9-1-1 dispatcher) to dispatch the appropriate first responders. However, there are many limitations to these emergency call services. Precious time can be lost due to the amount of time required to communicate with the call taker, explain the emergency situation, and clarify information. Other concerning situations are where someone cannot speak English. The exchange between the caller and call taker comes down to whether there is an accurate understanding of the incident so that proper help can be readily provided. Advancements in medical emergency call systems can lead to a better understanding of the emergency, faster action, and most importantly, a smaller number of preventable deaths.

There have been some recent research efforts attempting to develop the next generation of 9-1-1 services in North America. The challenge is that there has been little exploration into how such services and technologies should be designed and how they can fit within the workflow of current 9-1-1 call services. To design the next generation of 9-1-1 call experiences for medical emergencies, the current state of 9-1-1 call experiences must be investigated. This research examines how patients, or those calling for a patient, experienced phone calls to 9-1-1, what challenges they faced, how technology experts can design novel technologies to support their needs when encountering a medical emergency, and what the enablers and hindrances of incorporating technologies into current 9-1-1 systems are. As technology advances, we can evolve the services for medical emergencies. This research can inform the design of the next 9-1-1 calling system for medical emergencies to provide faster and more accurate care through improved communication.

Literature Review

Medical emergency responses can adopt technological developments that are implemented in many other fields. However, there has been little investigation into how these advanced technologies should be designed and how they can fit within the workflow of current 9-1-1 call-taking. Without an accurate understanding of the incident during a call, 9-1-1 dispatchers may be unable to dispatch proper emergency services. Current medical emergency calls may be lacking in communication, speed, and accuracy.

Language Barrier Present in Emergency Calls

In terms of communication, English language proficiency for medical emergency callers is an important factor. A non-English speaking caller would cause miscommunication with the call taker and lost time that may be necessary for survival.

Pew Research Center conducted a 2018 survey on English language proficiency among foreign-born adults (18 years and older) in the United States by years living in the country. About 43.17% of foreign-born adults living in the U.S. for 20 years or more speak English, but less than “very well” [1]. To have a better understanding of the number of foreign-born adults in the United States, the US Census Bureau analyzed the percentage of the foreign-born population in the United States in 2020 by state. As of 2020, California had the highest percentage of foreign-born population, with about 26.6%. About 13.5% of the United States population was born in a foreign country [2]. With roughly 43% of the 13.5% foreign-born population speaking English less than “very well,” there is a possibility that proper communication during 9-1-1 calls can be a challenge when experiencing a medical emergency.

Not only can the medical situation not be clearly understood by the call taker, but utilizing language interpreters on a call may delay necessary care. Learning the significance of

language barriers as a challenge in 9-1-1 communication would promote the implementation of technology to help offset this issue. It is difficult to obtain existing data on the percentage of medical emergency callers who are of the foreign-born population speaking English less than "very well." Therefore, our study can provide information on how significant language barriers are to a sample population with medical emergency call experience.

A qualitative study by [3] explored the topic of English language proficiency within medical emergency calls. To explore intentions to use 9-1-1 services in a Chinese-speaking community in the U.S. and to study the barriers and facilitators to accessing emergency medical services (EMS), the researchers conducted focus groups with Chinese adults who self-reported limited English proficiency [3]. It was concluded that "language difficulties, negative perceptions of EMS, perceived costs of using emergency services, and no previous experience with 9-1-1 were commonly described as barriers to calling EMS during emergencies" [3, p. 307]. Also, people commonly call 9-1-1 because they feel that the emergency is too great to solve alone and that they had previous positive encounters with EMS [3]. The results of this study regarding the Chinese population can reflect the greater population of non-English speakers or those with little English proficiency. Additionally, insight into language barriers can lead to discovering ways in which technology can be incorporated to reduce these challenges when calling medical emergency services.

Consideration of Age with Technology Use

When understanding 9-1-1 call experiences in medical emergencies and designing technology and applications to mitigate challenges, we must consider that the advancements must enhance the experiences of all subsets in a population. This would include different age groups. An analysis by [4] finds that the elderly population uses EMS at a higher rate, as

observed by EMS transport data from 105 Emergency Departments (EDs) in North Carolina. The results of the study showed that the "proportion of patients using EMS to reach NC EDs increases steadily with age," with estimates of half of EMS transports to NC EDs being patients 65 years and older by 2030 [4, p. 329]. These results are essential to consider as they are likely to reflect national trends of EMS service by age. This also makes the elderly population a significant age group to consider when investigating what challenges exist in the 9-1-1 call experience and how to approach designing applications to alleviate the challenges.

According to [5], 23.6% of the country's population was aged 60 years or older in 2021. With the considerable percentage of older adults in the country who have a greater likelihood of using EMS, it is important to factor in what advancements in 9-1-1 call services would enhance the call experience of this population. When considering technology use and acceptance by older adults, the elderly are shown to accept information and communication technologies in a similar way to younger adults [6]. This, however, must be accompanied by "assistance, encouragement and friendlier interface designs" [6, p. 311]. Understanding the expectations and needs of the elderly is necessary when designing technology and applications to be integrated into the 9-1-1 call service, which this population is more likely to use.

Technological Applications Integrated into Emergency Calling Systems

[7] explored the idea of integrating more media-rich calling capabilities, such as video-based calling, into 9-1-1 services. They conducted an interview with people who have called 9-1-1 in the past to explore how video calling services should be designed. [7] state that their "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" [7, p. 985]. However, technology such as video calling can

raise problems concerning “anonymity, consent, culture and gender-based biases, and camera work” [7, p. 985]. While [7] question and test the functionality of video calling in 9-1-1 services, our study looks into the 9-1-1 caller’s comfort and opinion on integrating such applications. Although, the results from the study give more reason as to why there must be more investigation on the integration of technology since there are unexplored enhancements and hindrances to the 9-1-1 medical emergency calling system.

One of the major components of enhancing communication, speed, and accuracy during a medical emergency situation is to have a successful outcome in regard to the patient’s health and survival. [8] review the effectiveness and value of electronic health records (EHRs), medical devices connected through the Internet, and health informatics in reducing medical errors in hospital Emergency Departments (ED). In regards to EHR systems, their “computerized order entry and clinical decision support” reduce medical errors that would otherwise place patients at risk in the ED environment [8, p. 160]. [8] find that “open and interoperable health information exchange of standardized patient data between departments, organizations, and EHR vendor software provides faster access to more complete patient records and reduces risks of medical errors” [8, p. 160]. The exchange of correct patient data is vital when assisting in a medical emergency where time is limited, and the transfer of information is currently only verbal through a 9-1-1 calling system. Automation of data exchange in which accurate patient records are transferred can further reduce medical and dispatch errors.

A patient’s updated health records are crucial for EMS during an emergency situation, especially when the patient is unconscious and cannot verbally provide their most current health information. Without access to accurate patient records, proper treatment may not be provided during transportation to the hospital. [9] created a project where a cloud platform was used to

store and manage medical data, and "a collaborative model for connecting and facilitating community members in updating personal health records, especially for the five most common conditions, namely heart disease, hypertension, diabetes mellitus, chronic renal failure, and pregnancy" [9, p. 188]. Having a way to exchange real-time information would aid in the speed and accuracy of communication and the survival of the patient. However, the researchers faced challenges with privacy laws, technical issues from differing data standards, and the quality of the data when collecting and integrating health information [9]. The above challenges provide direction for designing new technology and applications to enhance the 9-1-1 call experience.

[8] also report that an estimated 40,000 medical apps were using underlying EHR data in 2014 and that "emergency department physicians who utilize Health Information Exchange data will be able to quickly view patient's historical data and provide increased [quality of care]" [8, p. 160]. When considering medical devices, mobile devices were observed to "speed up emergency room processes by beginning to treat a critical injury or illness prior to the arrival of the patient to the emergency department" [8, p. 160]. Having access to medical services, including patient record transfer, from a mobile device in your hands would allow for faster communication and care. According to [10], 80% or more of the estimated 240 million calls made to 9-1-1 in the U.S. each year are from wireless devices. With the majority of 9-1-1 calls coming from wireless devices, it would be valuable to further research the incorporation of mobile devices within the 9-1-1 calling system. Further integration and advancements with EHRs, health informatics, and medical devices within 9-1-1 calling systems have the potential to advance the communication, speed, and accuracy of dispatched care.

Current 9-1-1 Services

Having an understanding of what the current 9-1-1 emergency calling system consists of gives developers a foundation for advancements. Basic 9-1-1 is where a call that dialed the three-digit number 9-1-1 is "delivered across dedicated circuits to a call taker/dispatcher in a local public safety answering point (PSAP), or 9-1-1 center, who answers the call" [11, Sec. I]. In this case, the caller and the call taker communicate verbally to transmit information about the emergency and location. Where Enhanced 9-1-1 (E9-1-1) is serviced, emergency calls are routed to select locations in which the local 9-1-1 center can provide the call taker information of the caller's phone number and address from its database information and equipment [10]. This is a powerful resource that allows emergency help to be dispatched faster. It also helps in terms of getting necessary information, such as location, when the caller is unable to speak with the call taker.

However, problems may arise from wireless phones. The call may not be routed to the most appropriate 9-1-1 center, and the call taker doesn't receive the callback phone number or the location of the caller [10]. This may cause appropriate medical help to take longer to reach the patient, especially if the caller cannot communicate or describe the location, or if the call drops when the call taker isn't able to get the caller's callback number. These situations can hinder the critical care a caller would be able to receive and result in life-threatening problems. Even so, the National Emergency Number Association (NENA) discusses that "in most areas, phone number and location information is available for 9-1-1 calls made from a cellular/wireless phone" [12, Sec. II].

As of now, NENA explains that texting is not available in most areas for 9-1-1 [10]. Nonetheless, there is a recent movement towards implementing texting to 9-1-1 with the support

of wireless carriers and the Federal Communications Commission (FCC). NENA describes that "text location information is not as robust as current location technology," therefore, emergency care may not arrive to the caller quickly and cause risks to survival [12, Sec. X]. Also, text messages take longer to receive than audio on a call, and messages can get out of order or fail to be received [10]. The early stages of 9-1-1 texting show obstacles to communication, speed, and accuracy, especially in regard to critical information like location. With the attempt to implement 9-1-1 texting throughout the country, NENA points out that emergency services should only be contacted by text if the caller is unable to make a voice call, using the tagline "Call when you can, text when you can't" [12, Sec. X].

The current emergency calling system must be further explored for future design, including the experiences and opinions of 9-1-1 callers on the incorporation of advanced technology.

Methodology

Before designing the next generation of 9-1-1 call experiences for medical emergencies, the current state must be investigated. This research examines how patients and/or their caregivers experience phone calls to 9-1-1 and what challenges they face, how technology experts can design novel technologies to support their needs when encountering a medical emergency, and what the enablers and hindrances of incorporating technologies such as video calling into current 9-1-1 systems are. This research can inform the design of the next 9-1-1 calling system for medical emergencies and, ultimately, improve health outcomes for these patients.

Data Collection

To research current 9-1-1 medical emergency call services and how technology could impact them, those who have experienced these emergency calls must be involved. This includes patients, their caregivers, or others making the call. Primary data was collected through a survey consisting of quantitative and qualitative measurements through multiple choice and short-response questions. The survey was created using Qualtrics with structured questions on the efficiency of current 9-1-1 medical emergency calls, opinions on potential added technology, and ideas for potential enhancements. Questions also consisted of the communication between the caller and call taker, speed from answering the call to the arrival of the proper ambulance services, accuracy regarding location and ambulance services dispatched, and quality of the patient's outcome regarding health. Since human subjects are involved in the research study through a survey, Institutional Review Board approval was obtained.

The survey was distributed through Amazon Mechanical Turk where about 200 participants voluntarily responded. Using a monetary incentive with this platform to distribute the survey increased the likelihood of having a larger sample size. After the survey was distributed, the data from 181 participants were collected and organized to be analyzed. The survey results come from a sample of medical emergency callers whose experiences could help determine where to focus when enhancing emergency calls with technology.

Data Analysis

We aimed to analyze the data collected from the survey responses and discover associations between their demographics, knowledge of health and technology, and opinions on suggested technological features. The data was gathered by Qualtrics, and the themes found within the responses were categorized. We analyzed the data using Excel spreadsheets and

calculated the number of responses for each option of a question as a percentage. For the open-ended questions, open coding was conducted by identifying common ideas between responses and categorizing them by themes. The results and categories were reviewed and helped conclude what the current 9-1-1 medical emergency call experiences are and in what ways 9-1-1 call challenges can be addressed with technology. Categories help in analyzing the most important aspects of the current system that will benefit from technology the most. Also, an analysis of the literature in this domain is included earlier in this study and will be compared to the results of the survey.

The research questions we are trying to answer through these responses are whether there are problems and inefficiencies with current 9-1-1 call experiences, if medical emergency calls can be improved with technology, and whether those who had a 9-1-1 call experience think that technology should be incorporated into emergency call services and will improve call experience.

Results

Upon the conclusion of gathering and organizing the data from our survey, we were able to analyze the medical emergency call experiences and opinions of 181 participants. The demographics of the sample consisted of 69% males and 31% females. Out of the total number of participants, the majority fell in the age range of 25 to 34 years old at 53%. Those 35 to 44 years of age followed at 28%, and 45 to 54 years old at 10%. The number of participants in each age range can be seen in **Figure 1.**

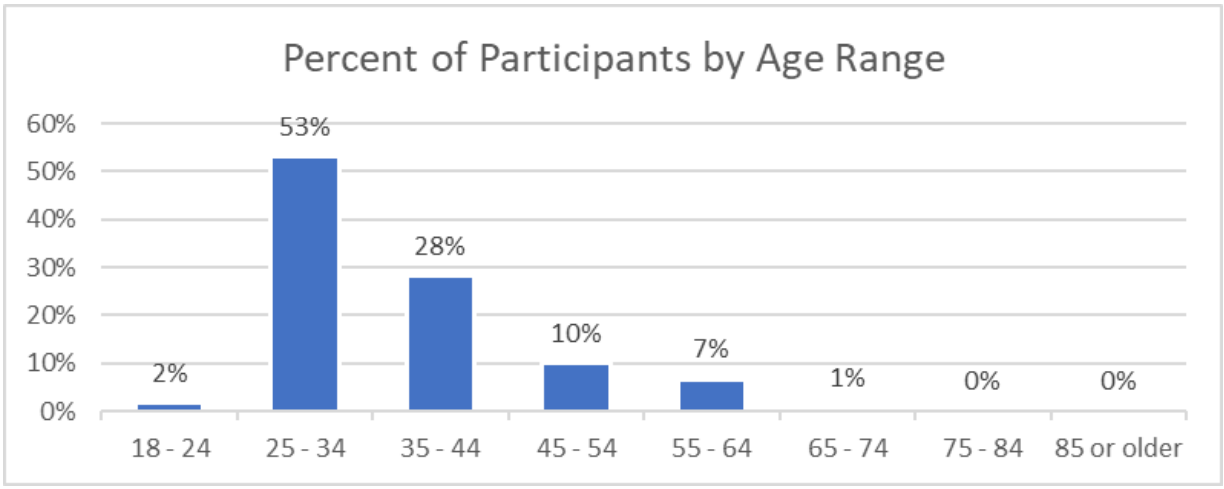

Figure 1

When looking at race and/or ethnicity, 78% of the sample was white/caucasian. The number of American Indians/Native Americans was much less at 10%, and 7% for Hispanics/Latinos. Other ethnicities such as African American, Asian, and Pacific Islander were 2% or less of the sample. All of the participants completed at least a high school education, with 57% having a Bachelor's degree and 29% having a Master's degree. At 82%, most of the participants recorded that they "can understand and speak [English] very well (Fluent)". Only one individual claimed to have no English fluency at all. Additionally, only one participant recorded a primary language other than English, which was Chinese.

When asked about health literacy, 48% of the survey respondents chose a literacy level of medium to high. Most of the other participant responses were split between "medium" and "high." Technology proficiency showed very similar results which can be seen in **Figure 2**. 39% of the survey respondents selected a proficiency level of medium to high and the other participant responses mainly were split between "medium" and "high."

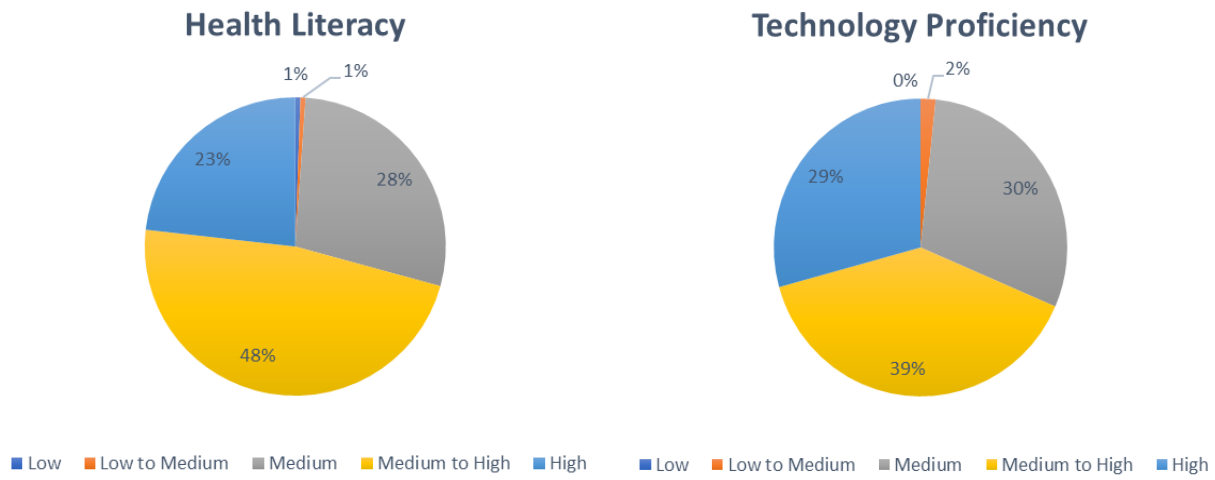

Figure 2

After the demographic questions, we gathered data about the participant's most recent 9-1-1 call experience. When asked about who the medical emergency call was for, 80% of the participants responded themselves. Out of the 20% who called for someone else, 34% called for a parent, as seen in **Figure 3** with the "Father," "Mother," and "Parent" written responses. 19% of those calling for someone else called for a friend. Calling 9-1-1 for a grandparent followed with 14% of the responses writing "Grandfather" or "Grandmother." The percentages of who the participants called for other than themselves are shown in **Figure 3**.

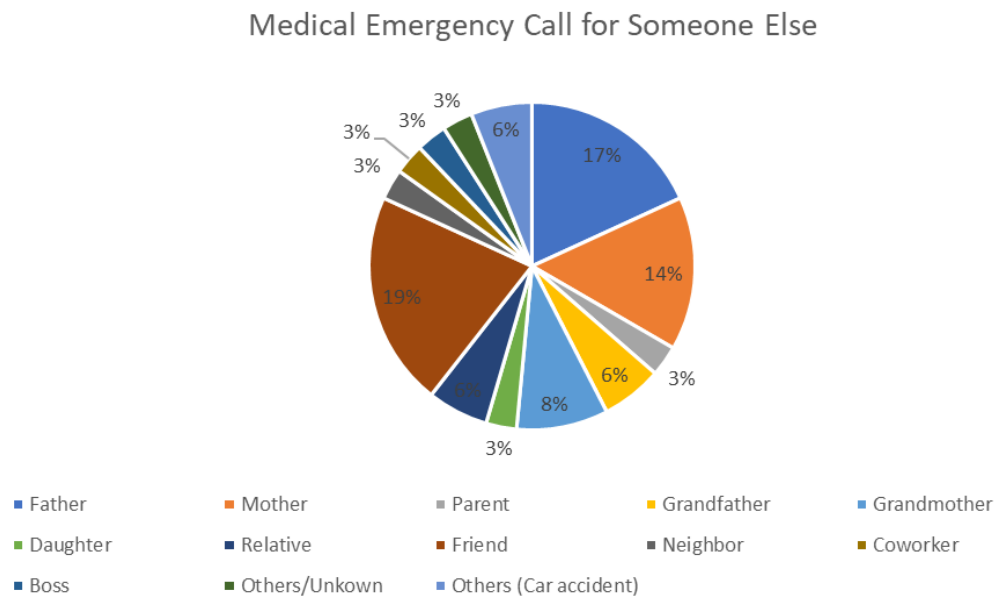

Figure 3

To get a better understanding of the most current 9-1-1 call experience the participants were referring to, we analyzed the responses of when their most recent 9-1-1 call was. For 40% of the respondents, their most recent 9-1-1 call was 1 to 5 months ago. 20% and 22% of the participants recall their most recent call to be 1 - 2 weeks ago and 6 - 11 months ago, respectively. The most recent medical emergency call for 19% of the participants was 1 or more years ago. This range of time and who the participant called for sets the context of their responses for the rest of the survey.

When asked about the severity of the situation for which the respondent called 9-1-1, 60% replied with "somewhat critical." 29% of the sample recalled their medical emergency to be very critical. The severity of the medical event is important to note because the health and survival of patients in critical emergencies rely on the speed, communication, and efficiency of the 9-1-1 service.

We asked the participants to rate the communication between themselves and the 9-1-1 call taker. Most responses fell within "excellent," "good," and "fair," with "good" making up

57% of the answers. This rating based on their 9-1-1 call experience represents the current overall feeling towards medical emergency service communication. 4% of the participants had poor or terrible communication in their experience, which will be further looked into to find reasons for the challenging experience and possible solutions. In a similar way, 62% of the participants found their call taker addressing the emergency right away, but 2% found them taking too long. 35% responded that their call taker took some time to understand and find a solution during their emergency call. Regarding the time it took for ambulance services to arrive, answers varied with 39% responding 6 - 10 minutes, 28% selecting 11 - 15 minutes, 19% choosing 16 - 20 minutes, and 11% responding less than 5 minutes. Overall, 53% of the participants reported being extremely satisfied with their 9-1-1 call experience and 36 % were somewhat satisfied. There were no survey respondents that felt extremely dissatisfied with their call experience, however, 3% were somewhat dissatisfied. Even a small number of negative experiences with calling the 9-1-1 service imply that improvements can be made.

A key part of the survey was to consider the challenges currently faced during a medical emergency call experience. Exploring the challenges faced can provide a framework of aspects that should be improved upon. Also, the effect of technology incorporated in those contexts can later be analyzed. The participants were able to select more than one challenge that they faced during their 9-1-1 call in order for us to categorize recurring challenges that may require priority when designing an improved emergency calling service. The challenge that 29% of the participants experienced was difficulty in verbally explaining the emergency situation, along with difficulty in describing the location of the emergency for 25% of the participants. Other challenges can be seen in **Figure 4**, where 13% of respondents experienced language barriers during the call and 10% reported having faced no challenges.

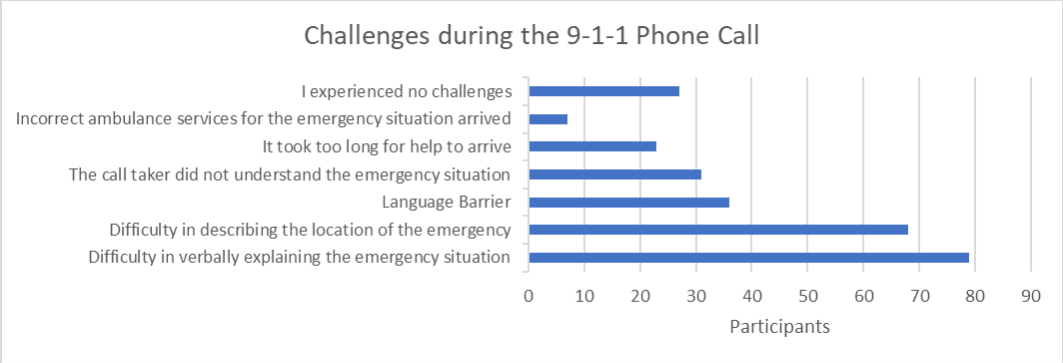

Figure 4

After gathering data on what challenges exist to be improved upon, it is necessary to get a better understanding of technology use and knowledge within the sample. It would be futile to implement technology in a medical emergency call experience if it would cause greater challenges. Speed and communication may be hindered if we do not know the user's experience with technology. Therefore, our survey helps depict our sample's knowledge of technology by reporting that 41% were extremely knowledgeable. 36% of participants were very knowledgeable about using technology, and there were no participants who were not knowledgeable about using technology at all. As opposed to using a mobile device, 3% reported not using one. Similarly, 3% of the participants do not consider using a mobile application for 9-1-1 emergency services.

Our survey also asked the participant's opinions on what technology they would like to see added to their 9-1-1 calling experience, with the option to select more than one response. The responses varied with 30% considering implementing location sharing, 26% choosing to have text chat, and 21% considering a video calling feature. Other implementations the participants selected from are shown in **Figure 5**. Only one participant suggested there be no changes with emergency calling services.

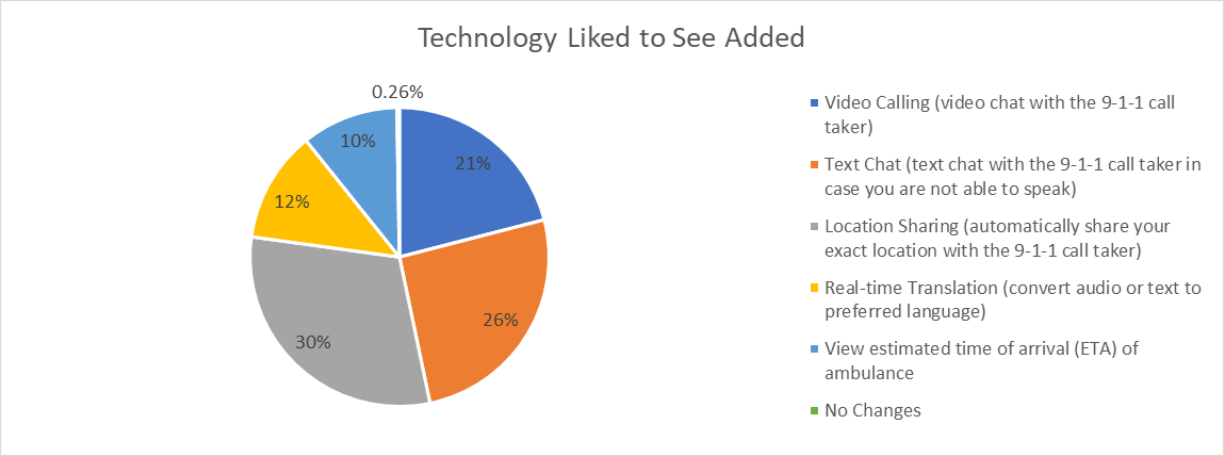

Figure 5

When considering incorporating technology within the 9-1-1 calling service, another important factor to look into is privacy and security. 82% of participants were noted to have concerns regarding privacy and security for the integration of technology, such as a mobile application. Out of those concerned, 27% may find trouble with implementing video calling, along with text chat. Also, 26% of participants would be concerned with location sharing. Many of the participants who selected a feature they would like to see implemented also were concerned about the privacy and security of that same feature.

The results of our survey explore the experiences and opinions of those who have used the 9-1-1 calling service. Participants were able to leave a final comment, which we categorized into suggestions about location sharing, estimated time of arrival (ETA), video chat, and general speed of the calling experience. A fundamental point that ties into all of the comments is the need to provide the call taker with necessary information as fast as possible. Comments suggested having a contact profile that is connected to 9-1-1 services to speed up the sharing of your information. Many also commented about integrating the service as an application where "just clicking one emergency button in our phone should help [the call taker] to track the place and should reach the destination because this method will be useful for people who are sick alone

without any supporters in the house." Participants emphasized the automation of sharing location (both the patient and ambulance) and personal health information, expressing how beneficial such features would be. A participant explained their most recent 9-1-1 call experience:

> I got through relatively quickly and I was near a mile marker on the highway. It would also have been great to know more about the arrival of the ambulance, just for peace of mind for folks. I've had experience calling 911 in the city when there is a long hold, etc. I'm not sure what can be done about it with availability of personnel or if a lot of people are calling about the same thing. AI might help with this if a bunch of folks are calling from the same location.

This was a valuable comment that gives insight into potential designs for future 9-1-1 calling services, in addition to consideration of call traffic. Another comment suggested including a way for the ambulance to know any changes to the emergency situation. The severity of an emergency may change within the time an ambulance takes to arrive at the scene, so real-time updates on the patient are important for treatment. Participants also explained that with video calling, call takers "could really see where you are and who you are," the caller can "avoid the delay explaining where and what is happening," and there can be improvement in the ability to understand the situation. Analyzing the results of this sample helps illustrate the current state of medical emergency calling services, which outlines the challenges that must be addressed and what ways the current system can benefit from advanced technology.

The major challenges found in the study are difficulty in verbally explaining the emergency situation and difficulty in describing the location of the emergency. Technologies such as location sharing, text chat, and video calling were suggested and favored to mitigate the challenges. Interestingly, many of the participants who selected one technology they preferred to

be implemented were also concerned about the privacy and security of that same feature. Additionally, a majority of our sample self-reported having medium health literacy as well as medium technology proficiency, which may reflect the population of medical emergency callers.

Discussion

The results from our survey of those who have experienced calling 9-1-1 for a medical emergency can indicate the challenges with the current state of 9-1-1 services. The analysis of our results also provides us with the general attitude on the design of technology with emergency services, which introduces new information to this field. The sample size of 181 participants can be closely representative of the population of 9-1-1 medical emergency callers in the United States and lead to more accurate results.

When analyzing the sample's self-perception of health literacy and technology proficiency, it was interesting to observe very similar results, as shown in **Figure 2**. Health literacy is described as "the degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions" [13]. In the survey, technology proficiency is defined as an individual having the ability to use tools, resources, processes, and systems responsibly to access and evaluate information and use that information to make informed decisions. The great number of "medium to high" results may be correlated to the higher education level of most of the participants, and from the younger age ranges. This means that studying those of lower educational backgrounds and older age may cause variances within the data and are key groups to further research.

In addition, a notable number of participants reported being fluent in English and using English as their primary language. As previously referenced by the survey conducted by Pew Research Center and the US Census Bureau, these results do not represent the English fluency of

the population of the United States well [1], [2]. There also was very little diversity of race/ethnicity in our survey. To have a context to base future designs of 9-1-1 calling services that are more representative of the US population of medical emergency callers, a more diverse sample of ethnicity and English proficiency should be focussed on.

In regards to the 4% of participants who had poor or terrible communication in their 9-1-1 call experience, there were differing critical levels and challenges that the participants reported. Therefore, we are unable to categorize specific features of current emergency service communication that would cause these difficult call experiences. Some of the poor and terrible experiences were very critical situations while others were not critical. Some of the terrible communication experiences were because help took too long to arrive; however, others had challenges in explaining the situation. The challenges varied too much to conclude what may cause poor or terrible communication.

On the other hand, the results from the whole sample of challenges faced, even when the communication was “fair” or better, can help identify and prioritize features that mitigate these concerns. According to the results gathered, the main challenges during a 9-1-1 call experience were difficulty in verbally explaining the emergency situation and difficulty in describing the location of the emergency. Therefore, these factors should be further researched and addressed when designing the next-generation emergency call experience. Since only 10% of the sample reported to have faced no challenges, it is shown that there does exist the opportunity to improve 9-1-1 emergency calling services.

In order to reduce these challenges, solutions involving the integration of technology and mobile applications were proposed to the participants. A few of the most notable features that the sample considered were implementing location sharing, text chat, and a video calling feature. In

other terms, participants would like to automatically share their exact location with the 9-1-1 call taker, be able to text with the call taker in case they are unable to speak, and be able to video chat with the call taker. These are significant features that are possible solutions to mitigate the challenges the participants experienced. Based on their concerns, respondents find that these features would improve communication, speed, and accuracy of medical emergency services. Along with the challenges faced, these technological features should also be considered in future designs to advance 9-1-1 emergency calls.

Yet, to begin designing mobile applications with such features for medical emergency calls, there must be an understanding of mobile application use within the US population. Based on our study, 3% of our sample reported not using mobile devices and not considering their use for 9-1-1 emergency services. It is essential to consider the group of people who do not use mobile devices because they would not have the benefits of possible features implemented in a 9-1-1 mobile application. Also, a complete transition to mobile applications would negatively impact those who do not use them. Participants who did not consider using a mobile application for medical emergency services explained how the applications would rely on network and phone life, which may cause “trouble to contact with 911." Other participants described how an app may take time to find within the rest of the apps in a cell phone and how someone may forget they have an emergency app when they are in a critical situation. These are key problems that can come up from implementing a 9-1-1 medical emergency app and must be assessed when advancing the current system.

In order to design the next generation 9-1-1 emergency calling service, we suggest the development of mobile device applications for iOS and Android to implement the major features discussed: location sharing, text chat, and video calling. Further research on storing and

managing medical data should be conducted, similarly to [9] with the cloud platform. However, challenges with privacy laws, such as the Health Insurance Portability and Accountability Act, and technical problems with varying data standards should be considered. Such apps developed can be tested with focus groups, including sample groups of older adults or the elderly, non-English speaking Americans, and other groups of people who may benefit from these added features.

The results and analysis of our study provide guidance on designing and incorporating technological features in the 9-1-1 emergency calling service. The challenges with verbal communication of the situation and location imply features such as video calling and a location tracker would increase the accuracy of dispatched help and improve communication. Speed was found to be a crucial concern, so an application must be designed in such a way that the user has quick and constant access to the features.

Study Limitations

In addition to our survey lacking ethnic diversity and few participants who are not fluent in English, our survey does not represent the age distribution of 9-1-1 medical emergency callers. The age groups of the participants in this study were limited in which we did not collect data on anyone 75 years and older. There were also a few individuals who were 55 years and older. The lack of older adults participating in this study may be due to the distribution of the study through Amazon Mechanical Turk, which is an online platform that many older adults may not know of. If there were more participants who fell in the older age ranges, then the results may be different on questions such as health literacy, technology proficiency, mobile device use, challenges during their 9-1-1 phone call, and opinions on integrating technology. Collecting data from this group is essential because they are more likely to call 9-1-1 for a medical emergency or have

someone call for them [4]. Future studies can collect data from older medical emergency callers to gain more insight into their experiences, opinions, and suggestions.

This study can also be improved by adding a question about the location the participant made the call. Options such as “rural” or “urban” may affect the time the ambulance takes to reach its destination or the amount of call traffic the 9-1-1 phone service receives, as noted by one of the comments who called from a densely populated city.

Additional questions to the survey may improve our understanding of the challenges within the current 9-1-1 call experience. Similar to the study by [3], other barriers such as perceptions of EMS, perceived costs of calling emergency services, and having no previous experience with 9-1-1 can bring new insight into what should be focussed on when advancing medical emergency services [3]. Continuous studies can be made to improve our scope of what should be implemented and how future 9-1-1 services should be designed.

Conclusion

Our study was conducted to investigate and organize the challenges in 9-1-1 medical emergency call experiences. Our study suggests that there are problems and inefficiencies with current emergency services and that 9-1-1 calls can be improved with advancing technology. Because of the lack of literature regarding the topic of advancing emergency calling services, our study provides a basis for some of the significant barriers and possible features to implement. Within our sample, we found the major challenges to be difficulty in verbally explaining the emergency situation and difficulty in describing the location of the emergency. To mitigate these challenges of communication, the implementation of location sharing, text chat, and video calling features in a mobile application must be considered. It is important to also evaluate those

who do not use mobile devices and the obstacles that come with a mobile 9-1-1 application. Examples include reliance on the network and battery life of a cellular device.

Factors such as speed, communication, and accuracy must be further investigated to enhance the current state of 9-1-1 medical emergency call services. Our study found that automation of information sharing would improve these aspects through a mobile application with technological features such as location sharing, text chat, and video calling.

While our study lays out some of the significant medical emergency service challenges and opinions from those who have experienced 9-1-1 calls, future studies should consider researching what technology could enhance communication between the caller and call taker. Surveys can also be conducted with EMS, dispatchers, and ED doctors to get their insight on enhancing medical emergencies. Mockup applications can be created where focus groups can test them and provide feedback. This would add more knowledge on how the next generation of 9-1-1 call experiences for medical emergencies may be designed.

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