Impact of Smart Devices on Telemedicine

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Abstract

The use of Telemedicine for care delivery is taking off in a big way, transforming the healthcare industry, and redefining the normal. The COVID-19 pandemic has accelerated adoption for both urgent care as well as non-urgent care. To put things in perspective, a healthcare company's telemedicine platform completed 100,000 successful video visits in 2019, whereas in 2020, it has already completed 2.5 million successful visits by October 2020. In this paper, the researcher looks into the usage statistics of a telemedicine platform, to analyze the type of devices used, and the duration of visits. An Apple iPhone or iPad makes up as much as 56% of devices used by the clinicians and about 46% by the patients. About 35% of visits are completed between 5 and 15 min. While the service is available 24 hours 7 days a week, the busiest times are still weekday business hours. This data looks at 100 visits on a busy day to see what the impact of different types of technology usage on the quality of the visit as perceived by the patient.

Keywords: Device, Healthcare, Pandemic, Quality, Telemedicine

Introduction

One of the initial challenges when the COVID-19 pandemic drove city-wide lockdowns was access to non-COVID-19-related urgent or non-urgent healthcare. Telemedicine helped address that effectively. Until recently the growth of telemedicine had been mostly incremental (Mann, Chen, Chunara, Testa & Nov, 2020). Only 8% of the US population used a telemedicine application in 2019. Before this pandemic, less than 50 telemedicine visits were conducted across non-urgent care specialties on a typical day. However, on March 19, the first day of expanded video visits to all ambulatory care, this volume increased to more than 1000 and reached over 7000 visits within 10 days with only 19.9% COVID-19-related (Mann et al., 2020).

This study analyzed a telemedicine platform. The platform has completed more than 2.5 million successful visits as of October 2020 and is now averaging about 25,000 visits on a typical weekday, about three times as much as the daily average in January 2020. That is how dramatic the shift has been.

What is Telemedicine or Telehealth?

Telemedicine, or Telehealth, as it is sometimes used interchangeably, is the use of digital information and communication technologies, such as computers and mobile smart devices, to access healthcare services remotely and manage one's healthcare. These may be technologies one uses from home or that their doctor uses to improve or support healthcare services (Telehealth: Technology meets healthcare, 2020). Telehealth is expansively defined such that even using an online portal to look up test results or using an app to keep track of a diabetes patient's glucose levels is considered that. In fact, in the midst of this COVID-19 pandemic, new telemedicine technologies have emerged such as an "Internet of Medical Things enabled wearable called

EasyBand," which helps in automatic contact tracing to help limit community spread and also encourage social distancing (Tripathy, Mohapatra, Mohanty, Kougianos, Joshi, & Das, 2020).

Telemedicine has proven to provide access to high-quality, affordable healthcare to many, and the system itself has continued to adapt healthcare services to suit its methods and technologies (Abugabah, Nizamuddin & Alzubi, 2020). Healthcare giants like Kaiser Permanente are changing their strategy to a "virtual-first" approach. Kaiser was one of the first organizations to deliver majority of care via telemedicine (Jercich, 2020).

At the same time, telemedicine is not a system without risks such as data privacy, breach, fraud, and abuse. There is still a lot to be learned. As adoption is coming up, a data breach would be costlier than before. Abugabah et al. (2020) offer a "tamper-proof Telemedicine healthcare framework," which will be interesting to watch for in the future.

This paper will be specifically focusing on the telemedicine scenario of doctor-patient visit through video-enabled devices. The purpose of this study is to take a look at the available statistics around the type of devices used, and see whether there are patterns, what impact that has on the meeting duration and the perceived quality of the teleconsultation.

Dataset and Collection Method

The telemedicine team collects vast amount of data through their platform and are at the forefront of analyzing this to provide relevant information to continuously improve patient care. The data collected here is only a small sample of all the data collected in the platform.

There are multiple methods available for a member to access the telemedicine platform to have a teleconsultation (also called video visit encounter) with their doctor. As with a regular office visit, the first stop is usually the primary care physician (PCP). However, the big difference from an office visit is that, based on the PCP's recommendation, additional clinicians or specialists can

also join the same visit at the touch of a button, instead of having to schedule another appointment for a different day. The convenience of consulting a specialist within the comfort and safety of one's own home cannot be overstated in this pandemic era.

Dataset

This research looked at 100 video visits that happened on a particularly busy weekday. The data set with sample data is given below.

Meeting ID	Meeting Time (In Minutes)	Total No. of Participants Connected	No. of Clinicians	No. of Patients / Patient Guests	Device / Access Used by Clinician 1	Device / Additional Clinician	Device Type of Access Used by Patient (Desktop / Mobile)	Android / iPhone / iPad if Patient Used Mobile, Otherwise Desktop Browser	Quality Rating
3216771	9	5	3	1	iPad	iPad	Mobile	iPad	Good
3331280	15	4	3	3	iPad	iPad	Mobile	iPad	Outstanding

1) Meeting ID – Specific ID of the Visit

2) Meeting Time – Duration of the visit in minutes

3) Total no. of participants including the clinicians, medical assistants, and the patients

4) No. of clinicians and/or medical assistants

5) No. of patients / patient guests (patients can ask to add a guest).

6) Device / type of access used by the clinician – a clinician could use a desktop or an app in their company-provided iPhone

7) Device / type of access used by the additional clinician – when available

8) Device / type of access used by the primary patient – a patient can use desktop, or a mobile app

9) Specific classification of the device type used by patient (desktop, iPad, iPhone, Android etc.)

10) Quality of the visit – perceived quality of the video visit on a 5-point scale – Poor, Good, Very Good, Excellent, Outstanding. This is based on a survey that is taken at the end of the video visit encounter.

The attached spreadsheet contains the dataset and statistical analysis that is summarized below.

Data Assumptions

Although many visits have only one clinician and one member, this research study considered 100 visits that occurred where at least two clinicians joined, and at least, one patient or member joined. Additionally, this also considered a visit that had at least 5 minutes of interaction. Finally, for the member side, the device type is captured only for the primary, and not for the guest.

Analysis of Visit Duration

Nearly 60% of the visits or encounters were in the duration of less than 25 minutes as shown in the frequency distribution table and bar chart in Figure 1. The mean duration of the visits is about 27 minutes, and the median duration is 19.5 minutes. The distribution is positively skewed as the arithmetic mean has the highest value and the mode, at 9 minutes, has the lowest value (Lind, Marchal & Wathen, 2018).

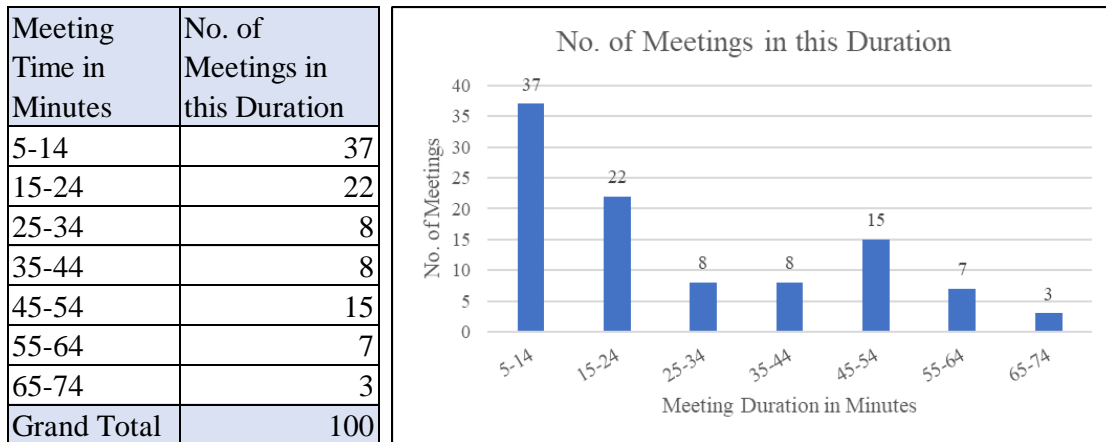| Meeting Time in Minutes	No. of Meetings in this Duration
5-14	37
15-24	22
25-34	8
35-44	8
45-54	15
55-64	7
65-74	3
Grand Total	100

Figure 1

The frequency polygon in Figure 2 gives a better view of the meeting duration. The mean is influenced by a few high values in the data and is not a good representative of the larger

population. Sometimes, the platform is used for conducting webinars or group sessions, hence the handful of meetings over 55 minutes. The median is more representative of a typical duration of video visit. More than 50% of the visits happen within the median of 19.5 minutes.

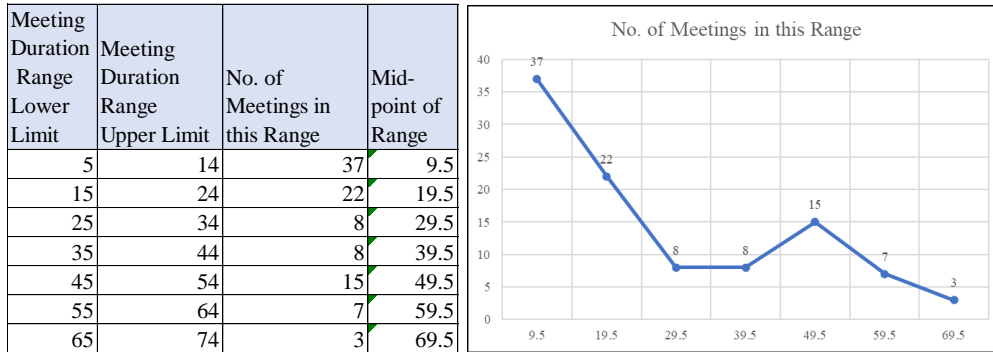| Meeting Duration Range Lower Limit	Meeting Duration Range Upper Limit	No. of Meetings in this Range	Mid-point of Range
5	14	37	9.5
15	24	22	19.5
25	34	8	29.5
35	44	8	39.5
45	54	15	49.5
55	64	7	59.5
65	74	3	69.5

Figure 2

An analysis of meeting time variations by device type in Figure 3 shows that out of the nearly 60% of visits lasted less than 25 min, majority are on the mobile device.
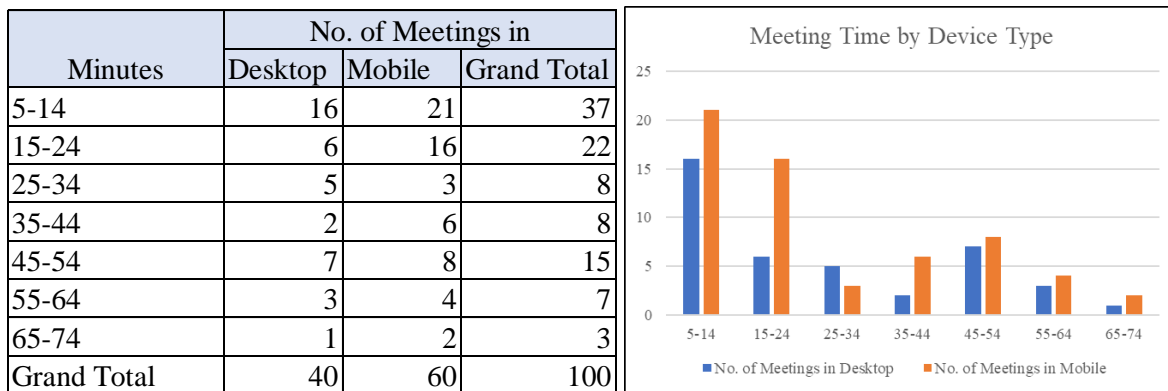
	No. of Meetings in		
Minutes	Desktop	Mobile	Grand Total
5-14	16	21	37
15-24	6	16	22
25-34	5	3	8
35-44	2	6	8
45-54	7	8	15
55-64	3	4	7
65-74	1	2	3
Grand Total	40	60	100

Figure 3

Inferences on Visit Duration

As mentioned above, a few longer duration meetings skewed the mean to a higher value. Here, a study of variation or the spread in the data can be used to compare dispersion in observations (Lind et al., 2018). The calculated variance of meeting duration for this sample is 346.43. As an example, if the variance was 112 for another day, it can be concluded that there was

less variation in the data for that day. The lower variance indicates that the duration values clustered closer to the mean. In mathematical terms, variance is the square of standard deviation. Standard deviation is also a good measure of the variation in data (Lind et al., 2018).

What do these numbers indicate for the nearly 25,000 visits a day? Is this sample reflective of that larger population? Here, the population mean and population standard deviation are not known. Considering the sample size is greater than 30, there are some statistical techniques to help us make inferences on the population (Lind et al., 2018). Assuming the population to be normal or nearly normal, the population mean can be calculated using the student's t distribution at a confidence interval of choice. For example, at 98% confidence interval, the population mean is estimated to be between 22.4 and 31.2 minutes, while at the 95%, it is estimated to be between 23.1 and 30.5 minutes. This is shown in the table in Figure 4.

Population Mean Duration for	Lower Limit (in minutes)	Upper Limit (in minutes)
98% confidence interval	22.4	31.2
95% confidence interval	23.1	30.5
90% confidence interval	23.7	29.9

Figure 4

Does the Type of Device Matter?

The study of the type of device used is indicative of the larger trend in technology. This platform supports a wide variety of devices including laptops, desktops, Apple mobile devices such as iPhone and iPad, and the multitude of devices in the Android world. As mobile devices have become more pervasive, its use in telemedicine has also changed. Whereas desktop browser used to be popular in the past, mobile devices have surpassed them now. As Mann et al., (2020) reported in their study, more than 30% of users for non-urgent care are in the 20-44 age group.

This age group is more technologically savvy, and the smartphone is well-integrated into their lifestyles.

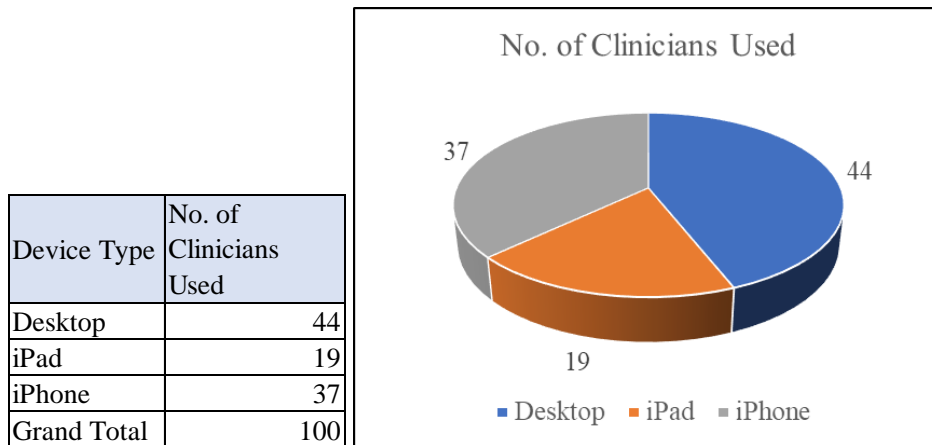| Device Type	No. of Clinicians Used
Desktop	44
iPad	19
iPhone	37
Grand Total	100

No. of Clinicians Used

Figure 5

The sample data here produced a mix of devices used by the participants. The clinicians are restricted to using only company-provided laptop or desktop or an Apple device — iPhone or iPad. 56% preferred mobile devices over desktop or laptop as shown in Figure 5. For members, the use of smart devices is even larger as shown in Figure 6, as more than 60% used some type of smart phone or tablet.

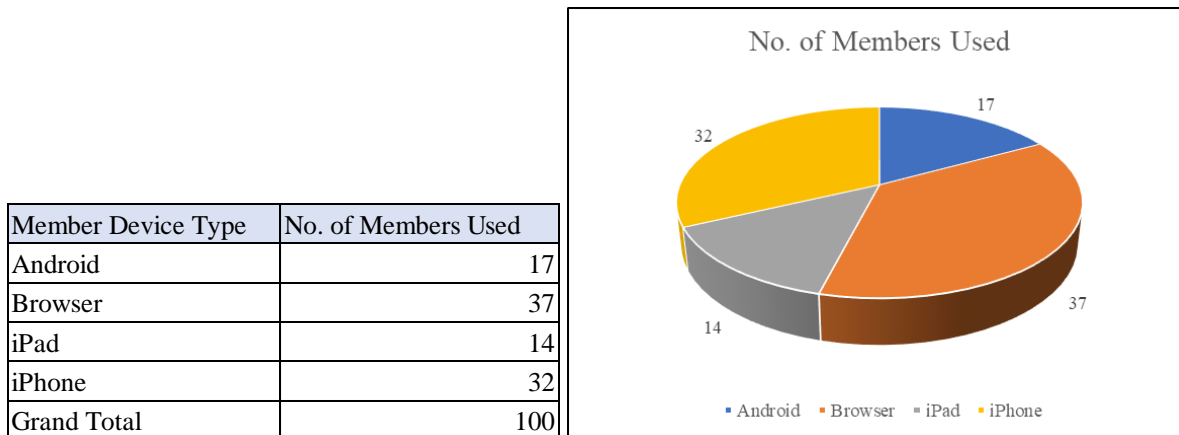| Member Device Type	No. of Members Used
Android	17
Browser	37
iPad	14
iPhone	32
Grand Total	100

No. of Members Used

Figure 6

Both members and clinicians are invited to participate in a brief survey at the end of the visit on the quality they perceived on the visit. The researchers set about finding out what impact

the member's device had on the perceived quality. The sample data was used to assemble a contingency table as featured in Figure 7.
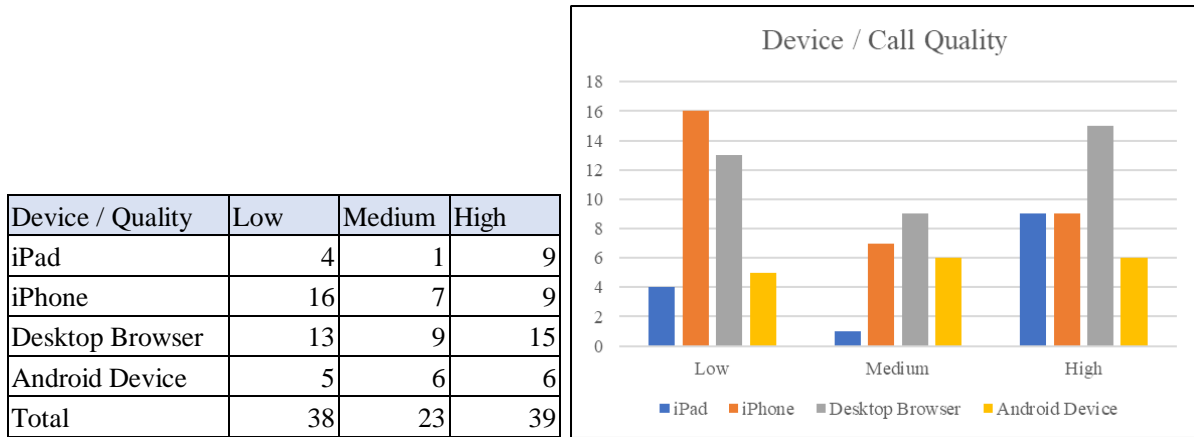
Device / Quality	Low	Medium	High
iPad	4	1	9
iPhone	16	7	9
Desktop Browser	13	9	15
Android Device	5	6	6
Total	38	23	39

Figure 7

Inferences on Devices Used

The survey is offered on a 5-point scale — Poor to Excellent. For the purposes of this study, the survey was simplified into 3-point scale by combining Poor and Good into "Low" category, Excellent and Outstanding ratings into "High" and keeping the middle rating as "Medium". The researcher used the hypothesis test for independence using the chi-square distribution (Lind et al., 2018), choosing a significance level of 0.05. Here is a quick summary of the test —

- Null Hypothesis H_0 — Perceived quality rating of a video visit is not related to the device used

- Alternate Hypothesis H_1 — Perceived quality rating of a video visit is related to the device used

- Decision Rule — Reject H_0 if the calculated value of chi-square is greater than 12.592 (found using the chi-square distribution table for 0.05 significance level)

- Calculated value of chi-square was 7.991

- Conclusion — Null hypothesis H_0 is not rejected. Perceived quality rating is not related to the type of device used by the member.

In general, even though statistically they did not make a difference in the overall perceived quality, the devices themselves matter as they progressively support more features. For example, the smart watches of today offer "Electrocardiogram at your fingertips" (Samsung Health Monitor, 2020). As the so-called Internet of Medical Things (Tripathy et al., 2020) innovation continues to build momentum, there will be more connected devices well-integrated into telemedicine.

Conclusion

The pandemic has triggered lifestyle adjustments that seemed unthinkable as recently as nine months ago. The new normal is not only working from home but doing many other tasks also from home. Fortunately, care delivery in the healthcare industry already had a system that could be mobilized. It only needed a little evangelization and the healthcare and technology industries to prioritize appropriately, which, to their credit, they did with remarkable assurance.

In this paper, the study looked at only one aspect of telemedicine, i.e., the variety of devices used for video consultation. However, this is only a tip of the iceberg. Telemedicine has other advantages too such as cost benefits for healthcare providers as well as for patients, which will also be an interesting area on which to research. The impact and importance of smart devices that helped telemedicine attain this level of popularity cannot be stressed enough. As smart devices have grown more and more smarter, their diverse features as a healthcare tool are still being discovered. Additional research is required to identify the impact of such devices too. To conclude, building more intelligence into devices and bringing continued innovation into the process are going to be crucial for the next phase of telemedicine.

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