

## Eye surgery video and audio streaming in the year 2020.

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### Abstract

**Objective:** To create an affordable set-up for the live streaming of ophthalmic microsurgery as a proof-of-concept and to review related literature.

**Methods:** Fifty surgeries, principally phacoemulsification during the SARS CoV-2 pandemic, were captured using Open Broadcaster Software and a low budget audiovisual set-up. All were assessed for video clarity and audio quality by the host. A thorough review of surgical streaming for medical education was performed.

**Results:** Fewer than 10% of streams experienced video difficulties, while the majority had unacceptable audio quality for teaching purposes. A steep learning curve for the host was noted, as adjustments to the set-up required significant trial and error. An interactive stream required the full attention of the host, who was always on site. Limited research has been published on live streaming of surgeries, and there have been none in ophthalmology space.

**Conclusion:** Live streaming of ophthalmic microsurgery is in its infancy, but it is possible with a relatively small budget. This will have the potential to complement in-person surgical training, surgical coaching, proficiency certification, and family education with reach anywhere that there is internet.

**Keywords:** Live stream, Ophthalmology, Cataract, Eye surgery, Medical education, Phacoemulsification.

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### Introduction

Video technology is becoming more advanced, more accessible, and increasingly utilized, especially for learning purposes in the medical community [1-4]. Live streaming is one video modality known to enhance anatomical and surgical knowledge in medical students and residents [1,5]. Three-dimensional live stream capabilities have even been developed to further improve the learning experience [6].

The SARS Cov-2 pandemic has created an experience vacuum, as many surgical trainees have had reduced work hours and surgical case volume. Similarly, medical students are significantly limited in their clinical and surgical access due to new hospital restrictions. It is timely to recognize that creating a surgical live stream available globally can enhance learning for surgeons everywhere.

In the present study, we discuss the advantages and disadvantages of surgery live streaming, its set-up for eye surgeries, and its potential future ramifications. To our knowledge, there are no other existing publications regarding live streaming of ophthalmic surgeries.

### Materials and Methods

After researching online how to live stream and the necessary equipment, we gained a greater appreciation for the time investment it takes to learn how to use and implement this technology into an operating room. One study to date has described the equipment used for their live stream and the set-up, however, that study was published in 2017 [1]. We will provide detailed information on the relatively inexpensive equipment and set-up to allow others to more efficiently organize their own

live stream and integrate it into their operating room.

### Equipment and software

Although live streaming can be complex, there are not many pieces of equipment required to get started. We used an Intel Core i7 Tenth Generation-enabled processor HP laptop with 16 GB of RAM and Nvidia GeForce MX250 graphics card. A free open source download, Open Broadcaster Software (OBS) Studio for Windows, was used as the streaming software. When creating an OBS account, we were able to link to Twitch, a popular streaming social media site. A number of other platforms, such as YouTube and Facebook, can also be used, but privacy must be considered. It can be relatively time intensive to learn how to use OBS for live streaming, but to describe that process in a paper is not feasible as there are many moving parts in OBS. Therefore, we encourage the use of internet tutorials to learn how to understand and use the software. We further describe what we used in our set-up and their respective costs in Table 1.

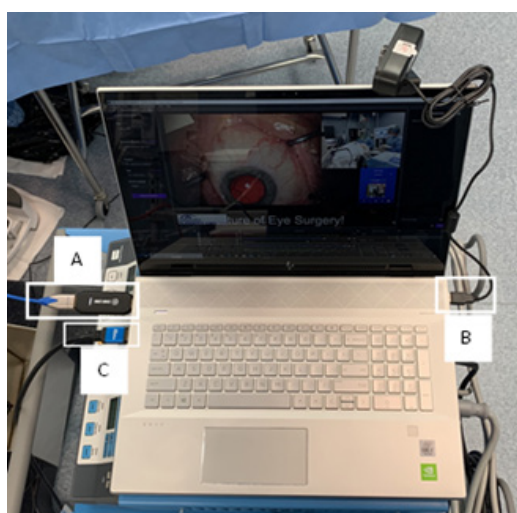
**Table 1.** Equipment used and their costs based on estimated online prices.

Equipment	Cost (\$USD)
HP Laptop	1200
Open Broadcaster Software (OBS) Studio	0
Canon T5i Digital Single-Lens Reflex (DSLR) Camera	750
Adapter with beam splitter	1400
Moukey MCM-1 Microphone	25
HDMI Cord (10 feet)	10
USB Elgato Cam Link 4K HDMI Capture Device	300
Webcam Full HD 1080P	50
Total	3,735

Starting with the HP laptop, we had OBS software running prior to connecting any cords to the computer. Next, the Moukey MCM-1 microphone was attached and plugged into the Canon T5I DSLR camera (Figure 1A). The microphone allows us to capture audio (the surgeon's voice), while the camera provides the surgeon's microscope view (Figure 1B). To send the video from the camera onto the computer for live streaming, an HDMI cord was plugged into the camera on one end and into the Elgato Cam Link 4K on the other end. The Elgato Cam Link 4K was then plugged into a USB 3.0 port on the laptop (Figure 2A). To capture the layout of the operating room, an articulating webcam was connected to the computer via USB (Figure 2B). Finally, in order to mirror the stream, a second HDMI cord was used to connect the laptop to a monitor (Figure 2C).



**Figure 1.** Camera and microphone attachments. 1A: Moukey MCM-1 microphone attached and plugged into the Canon T5I DSLR camera; 1B: Camera adapter (TTI Medical) to transmit surgeon's view.



**Figure 2.** Live stream set-up in the operating room showing connections to the laptop. 2A: Blue HDMI cord from the T5I DSLR Camera connected to the Elgato Cam Link 4K. Elgato Cam Link 4K is plugged into a USB port on the laptop; 2B: Webcam plugged into a USB port on the laptop; 3C: Optional black HDMI cord to the TV monitor.

## Results and Observations

Following the above steps, we were able to live stream cataract surgeries with audio and video. We used the HP Laptop face camera when necessary to see the host during the surgery, or

if the surgeon wanted to talk before or after the surgery. It is critical to first learn how to use OBS software prior to streaming given the steep learning curve for those not previously trained in using this technology. Trial and error was necessary to achieve the best live stream. To create an interactive stream, a dedicated host should be present to manage the stream and incoming questions while the surgeon focuses on the operation. Our greatest challenge was audio-related. The Moukey MCM-1 Microphone's location was adjacent to the microscope fan, which caused an annoying hum that degraded the surgeon's voice. After extensive research and troubleshooting, we discovered that it is very difficult for OBS to support a Bluetooth headset and microphone. Therefore, it is best for the microphone to be wired into the camera or directly into the laptop, an obvious challenge for a sterile field procedure.

Although it was difficult to capture high-quality audio, fewer than 10% (4/50) of streams experienced video interruptions. The majority of interruptions (75%, 3/4) were due to excessive tension on the HDMI cord as it was stretched by the microscope apparatus when repositioned by the surgeon. It is necessary to buy an HDMI cord that is long enough to allow for slack near both the camera and laptop connection sites to prevent or limit this complication. One (25%) video interruption was due to user inexperience at the onset of the project, which was solved by connecting the HDMI cord to the correct port.

## Discussion

Currently, there are two recent studies that have detailed the use of live streaming surgeries for medical education. Most recent is the study completed by Chaves et al. [1], which revealed how they were able to live stream at a low-cost while using a head camera that displayed onto student smartphones and tablets. Overall, students provided very positive feedback, including better visualization of the procedure and increased interest in learning about surgery. There are a few drawbacks to this study, however. The technology did not allow for simultaneous audio transmission along with the video, therefore, the surgeries could not be narrated. This means that for students to gain an adequate appreciation for the surgery, a medical professional would likely have to guide the students before or during the surgery. Another downside of their technology is lack of ability to record the live stream. As they noted, this would be beneficial for establishing a library of surgical videos that students, residents, and surgeons could review at a later time [1]. Finally, this study was completed three years ago and outside of the United States. As technology is changing rapidly, it is advantageous to address a more current approach to live streaming surgery in the United States.

The second study detailing live streaming surgeries was completed by Nagengast et al. [2], which explained how they organized their set-up. They also discussed advantages and disadvantages of live streaming, ultimately concluding that although live streaming can be beneficial for education and it cannot replace hands-on surgical training. There were a few downsides to this study as well. First, they do not provide a specific description of the equipment used, which would be beneficial for others trying to create their own set-up. Additionally, this study was completed six years ago in India, which again, reinforces that it is worthwhile to provide a more current update on live streaming surgery with the equipment used.

It is understandable to question why live streaming surgery is necessary when an over-abundance of recorded surgical videos already exist online. An advantage from the viewer's perspective is that the recorded videos are good for learning and reviewing procedures and surgeries. However, there are multiple disadvantages. Most recorded videos are edited, which is a process that, in and of itself, can take many hours. The viewer also loses the true "feel" of the operating room experience. Furthermore, viewers may lose the opportunity to learn how to manage complications as they arise, which could easily be edited out of a recorded presentation.

An overview of the advantages and disadvantages of live streaming is important to allow surgeons, other medical professionals, and families to make an educated decision on if this would be a good fit for their practice and career goals, or if they would be interested in viewing the live streams. The American Academy of Ophthalmology (AAO) also released an article in 2015 specifically discussing live surgery in Ophthalmology [7]. The primary advantage of live streaming surgery is that it makes it possible for an expert surgeon to provide surgical instruction and mass education, as the stream can be casted on many platforms, such as Facebook, Twitter, YouTube, Twitch, and Vimeo. This gives it global reach, available to anyone with internet access. In areas with limited resources, travel restrictions, or currently experiencing a pandemic, it allows medical trainee to continue learning. Family members would also be able to watch the surgery and listen to the surgeon narrate throughout the process. This could become especially important to families affected by the current coronavirus pandemic, who cannot otherwise be immediately present with their family member pre- or post-operatively.

Live audio of the physician narrating the surgery in real-time provides a more realistic experience for the viewers than a recorded, edited video. Other advantages include free access to view, interactive communication via a chat box allowing the surgeon to respond in real-time through his/her microphone, gain knowledge on how to manage complications, and it contributes to multi-modal teaching, which may improve learning and knowledge retention [8]. An ophthalmology-specific advantage is that it could provide a better educational experience given that the surgeries can be difficult to observe without the proper video monitor or observer oculars.

There are a number of disadvantages to live streaming surgery, although they number fewer than the advantages. An internet connection is necessary to view the stream, as stated previously, which creates an issue for those without the proper technology or internet access. From the host's perspective, he or she needs to have the proper equipment and understand how to create the set-up. In addition, it can take weeks to perfect the set-up, including audio and video, to be ready for live streaming. There is also a barrage of ethical considerations to make [7]. A small barrier we envision for those operating at smaller surgery centers similar to ours is that there is no dedicated "video" or technology team to assist with operating the live stream. It is difficult to have a smooth and interactive live stream with only the surgeon controlling the stream, because it takes time to set up the stream and also to interact with viewers via text or microphone. Having a "host", such as a medical student controlling the stream at the laptop during the surgery makes for a much simpler and smoother

experience for the viewers.

## Conclusion

Technological capabilities are advancing rapidly and medical education is quickly adapting by utilizing online sources for learning, such as recording lectures and surgeries. However, edited videos may not be the best virtual modality for teaching purposes. In light of the current pandemic and the general necessity for all surgeons to receive adequate training, now is a critical time to continue developing and implementing a live stream surgery education system. Live streaming allows for surgical coaching, mass education, and family observation – all of which improve medical knowledge and the overall patient-physician relationship. Furthermore, there is high potential for this technology to be used in certification programs in the future. The details provided in this paper provide a novice with information to make an informed decision regarding the use of live streaming in their operating room, the equipment required, and how to create the set-up. Live streaming is likely to play a significant role in future medical education given the aforementioned reasons and its ability to have a global impact.

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