Utilizing Virtual Reality to Teach Congenital Heart Defects to First-Year Physician Assistant Students

Yale School of Medicine Physician Assistant Online Program
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Introduction

The heart is one of the most important organs in our body. It is very complex to understand the workings of the normal heart; however, if a student is able to grasp the mechanics of the heart; they are then able to understand when the heart malfunctions, recognize the appropriate usage of pharmaceuticals, and understand cardiothoracic procedures with greater ease. Students generally have difficulty comprehending the various congenital heart defects. In our study we utilized The Stanford Heart, a virtual reality (VR) heart that offers interactions with several different congenital heart defects, as well as the normal heart. The students were able to spend time analyzing the exterior of the heart, the normal blood flow, as well as teleport inside the organ to see the oxygenated versus deoxygenated blood flow. A few of the models that students were able to delve into were congenital heart defects such as Ventral Septal Defect (VSD) and Atrial Septal Defect (ASD). All of these were in the virtual world where students were able to maneuver and see where the abnormalities lay and even perform surgery with a virtual scalpel to repair them back to normal. Virtual reality and augmented reality have been found to increase the level of knowledge for students in understanding abdominal aortic aneurism (AAA), atrial fibrillation, and supplement anatomy and neuroanatomy curriculum. VR has also been beneficial to educate patients about the aforementioned conditions. It has also helped surgeons understand and visualize complex procedures such as laparoscopic cholecystectomies.[1,2,3,4,5]

The Stanford Virtual Heart was designed by Stanford cardiologists and cardiothoracic surgeons and VR experts at Lighthaus, Inc. The virtual experience was piloted with families, patients and universities across the country. Yale PA Online is one of those pilot institutions. Typical medical trainees are given access to more than 20 of the most common and complex congenital heart defects.[6] Previous studies with VR, 3D heart models have shown that students find it a good learning tool because it is easy to use and flexible. VR has also been found to help trainees save time on learning the anatomy of the heart.[7]

Figure 1. The Stanford Heart Virtual Library

Methods and Materials

Two didactic cohorts, Class of 2020 (n=42) and Class of 2021 (n=58), at Yale School of Medicine Physician Assistant Online Program under IRB 2000022396 were given access to The Stanford Virtual Heart. The 100 students who had not yet received their formal cardiac module training were given a pre-test prior to the use of the virtual heart. The students were told to answer to the best of their ability the questions related to normal heart anatomy and congenital heart defects. The students were then individually given access to The Stanford Heart for a period of 15-minutes. Based on class feedback, the second cohort was increased to 20-minute access. This gave the second cohort more time to be immersed in the virtual heart.

The Center of Teaching and Learning (CTL) at Yale University helped to facilitate this learning workshop. CTL provided the trainers to support the technical aspects of the software, the four gaming computers and two of the four Oculus Rift headsets needed for the study. CTL was responsible for the equipment management and set up and provided detailed explanations to the students on how to use the software. The students were guided to look at several different congenital heart defects and the normal heart. If they finished looking at certain heart conditions were free to explore other heart defects in the virtual library. After the completion of this immersive experience, the students were then asked to complete a post-test of their knowledge. The results were then compared.

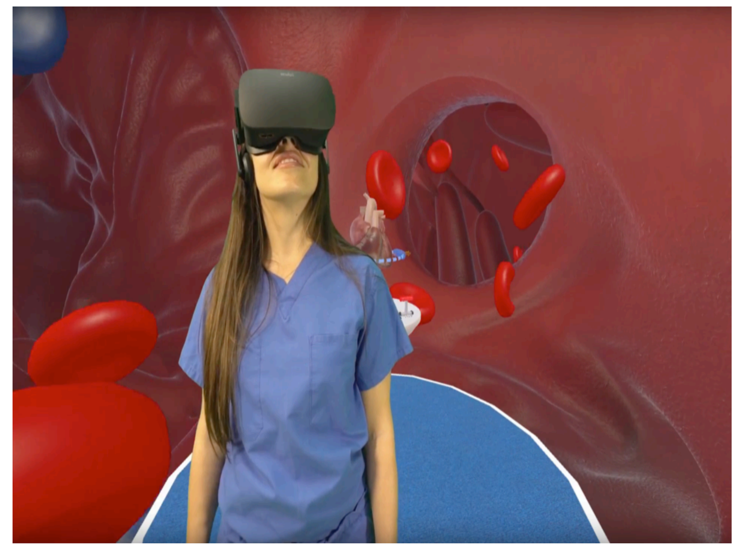

Figure 2. Inside The Stanford Virtual Heart

Figure 4. Navigating the virtual heart

Results

As noted previously, students did not have any prior formal physician assistant education in cardiology. All participants were required to complete the pre-test and post-test. Analysis of the overall data showed a slight improvement in student knowledge from pre-exposure to the VR to post-exposure. The average improvement was 1.24% from pre-test to post-test for the Class of 2020 (n=42). For the Class of 2021 the average improvement was 2.05% (n=58). Although the improvement may not be overwhelmingly significant, qualitative comments from the students indicated a stronger familiarity and depth of understanding. The intent of this pilot study was to give students a visual learning tool in preparation for their cardiology studies to help aid in their visual-spatial learning.

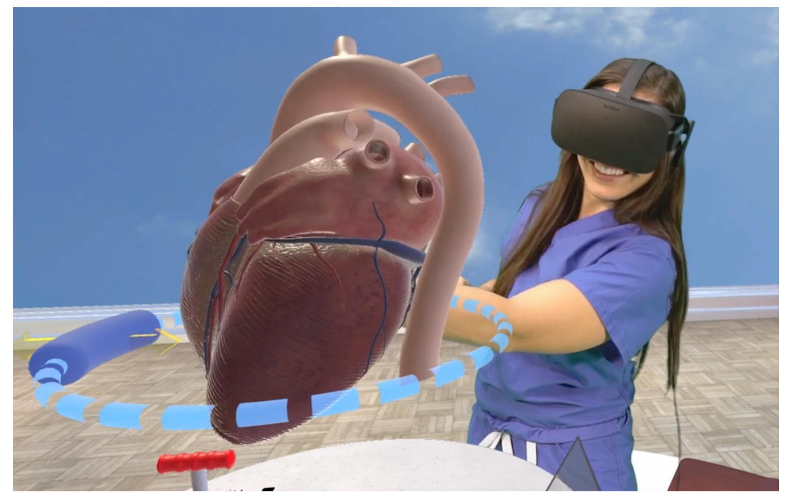

Figure 5. Example of student in Oculus headset

Figure 6. Example of the ability to dissect the heart apart

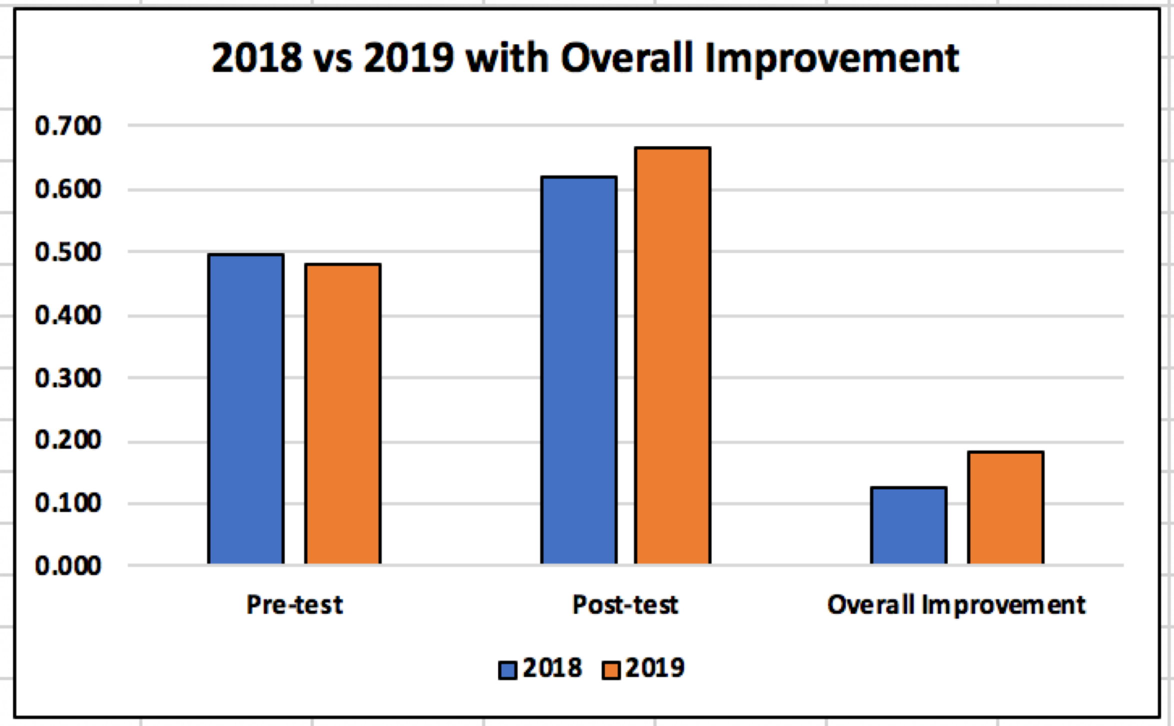

Table 1. Overall Improvement

Discussion

Virtual Reality is a conclusive way to enhance visual learning about congenital heart defects and is an effective means for teaching students. In previous years, headsets were bulky and expensive and gaming computers were also expensive and not always accessible. Today VR has become more mainstream and cost-effective to utilize in the classroom environment. For example, the Oculus purchased for this project in 2018 was $425 and included the software. We borrowed the computers to run the software from CTL. However, not all VR requires extensive investment in equipment. Students today can utilize Google cardboard for some VR programs. This is a take home VR platform that can be used with a smartphone.[8] It is light, portable, inexpensive, and easily acquired.

Some studies state that these technologies aid in the motivation and engage the students to think critically.[9] Kaiser Permanente is opening a medical school in 2020 that focuses on simulation via means of VR, AR, and 3D modeling. Schools and medical centers such as Stanford and Mayo Clinic are utilizing VR and AR to teach students neurosurgical procedures and ultrasound techniques.[10] Other institutions are utilizing computer based VR to study cardiac anatomy.[11] Programs are even using VR to train students to have increased empathy for patients with Alzheimer's, hearing and vision loss.[12]

Some studies have shown that students have learned and retained sciences with the utilization of mobile phone VR and AR technologies.[13] Virtual reality has been successful in teaching stroke patients about their condition, aiding in alcohol addiction recovery, and stress management.[3] It is also being utilized with patients to better understand their medical problems such as radiation therapy and breast cancer.[14]

VR has had a major impact in many industries outside of healthcare including entertainment, automotive and the military, immersing the user with audio and visual experiences.[3] VR has the potential for providing access to understanding medical anomalies in a cost effective manner. It allows for patient education and student training, supplementing traditional learning pedagogy. The Virtual Stanford Heart allows the user exposure to visualize often incomprehensible congenital heart defects as well as the normal heart.[15] Before VR students could spend hours trying to visualize words from a textbook. Utilizing The Virtual Stanford Heart can help expedite that learning.

Conclusions

Studies show that VR is beneficial for students and patients alike. In utilizing The Stanford Heart, we found it to be an effective resource for introducing students to congenital heart defects. Incorporating VR into the curriculum is feasible and affordable. Implementation can lead to training students in other complicated organ system thus furthering their understanding of pathologies and pharmaceutical pathways. It is easy to see how VR can have an impact on any industry even outside of healthcare. As educators our pedagogical approaches need to keep up with the changing world and the technological options we have available.

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Lighthaus
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