ISSN 2350-109X
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Indian Scholar

An International Multidisciplinary Research e-Journal

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EVOLVING HEALTHCARE SYSTEMS THROUGH DIGITALIZATION

Shllok Tahiliani
Trinity International School

Abstract

Computational modeling and simulation have time and again modified the way medicine works – from curbing the spread of pandemics to creating highly complex images of the human body. This research paper aims to analyze the effect of the above on medicine. Surveys and interviews were uniquely conducted to delve deeper into the subject. In conclusion, computational modeling and simulation can evolve medicine in ways we haven't imagined before. We rely on simulation to transform the world around us…now is the time to transform the world within us.

Keywords:*Modeling, Simulation, Technology, Medicine*

INTRODUCTION

Computational systems can be defined as the systems that are capable of solving a problem that includes calculations either mathematical or logical and can produce the result as an output.Modeling is the process of representing a model which includes its construction and working. This model is similar to a real system, which helps the analyst predict the effect of changes on the system. Simulation of a system is the operation of a model in terms of time or space, which helps analyze the performance of an existing or a proposed system.

In medical research and training, three major models are used – living, cadaver, and computer simulation. Living models are where live animals or plants are used for research, while a cadaver is a dead human body used by medical students, physicians, and otherscientists [1],[2]. Over the past years, the usage of computational models and simulation has grown exponentially in various medical fields, from microbiology to oncology, radiology to dentistry. Medicine hasn't been the same since.

However, numerous doctors haven't been able to work with the same or turn it down due to various reasons. The objective of this paper is to explore various ways in which computational models and simulation have changed medicine and the manner through which they may evolve healthcare in the future.

Theory

Computational modeling and simulation have numerous applications in medicine. I would like to list a few here:

- **Monitoring the spread of infectious diseases –** Healthcare experts can monitor infectious diseases in a specific area using computational modeling and simulation, allowing them to givea more effective response. It is possible to predict the way the disease may spread further, which may allow them to put risk individuals under

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surveillance, thus reducing the spread of the disease. This came of great help during the COVID-19 pandemic, where governments could easily identify individuals at risk and save lives. This adversely changed the way how we responded to pandemics [3].

- **Medical imaging –** Computational modeling and simulation play an important role in radiology. It is extremely useful in lung screening and diagnosis of breast cancer. Data from X-rays are used to determine a patient's exposure to viral respiratory diseases and to assist clinicians to focus on the most susceptible patient groups. Predictive models and Digital Breast Tomosynthesis (DBT) give a complete view of breast anatomy and enable the early detection of breast cancers. An important example here is the University of Montreal Hospital Centre, where AI is used to identify disease-stricken areas using X-rays. This approach also aids in the preparation of patients for surgical treatments based on predicted outcomes [4].
- **Improving glaucoma diagnosis** –Glaucoma is the primary cause of irreversible blindness in the world. The condition is associated with increased intraocular pressure (the fluid pressure within the eye), which puts pressure on the optic nerve head and destroys the nerves that connect the light-sensitive cells of the retina to the brain. Because intraocular pressure is the primary modifiable risk factor for glaucoma, precise measurement is critical for effective disease management.Until recently, the rigidity of the cornea – the front window of the eye – impacted all intra-ocular pressure measuring techniques, resulting in both false negatives and false positives in glaucoma risk assessment. According to research, inadequate measuring has also resulted in 15% of glaucoma patients losing their eyesight within 15 years of therapy.To solve this issue, researchers at the University of Liverpool employed modeling to create novel methods for estimating the biomechanical behavior of the cornea and measuring intraocular pressure. These techniques have been implemented in a widely used commercial glaucoma diagnostic gadget, benefiting hundreds of thousands of glaucoma sufferers worldwide [5].

Future Potential

Computational modeling and simulation have a long way to go in medicine. From assisting doctors in surgeries to helping in training doctors, the possibilities are endless. Cardiac surgery offers a wide scope for computational modeling and simulation. An important project integrating the two is The Living Heart Project (LHP). LHP's ultimate objective has been to build a large computer simulation model of the human heart that can subsequently be used to test various devices and drugs and educate people on how to perform various procedures. Essentially, a virtual heart on which surgeons can execute virtual experiments [6]. In the future, this project may reduce the burden on clinicians and aid them in more successful procedures.

Experimental

To find out how computational systems affect the real world and get more information directly from doctors, surveys and an interview were conducted. The following is a timeline:

Table 1 Timeline

Event	Period
First Form	2nd to 10th May

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Second Form	12th to 25th May
Interview	22nd May

1. First Form

   A form was made on the website JotForm containing 11 questions with a welcome and a thank you page. Some of the questions were general, like whether they are currently practicing medicine, and their medical field of expertise, while others were more related to the topic, such as, if they have any concerns regarding the current computational modeling and simulation technology, or how would it change in the future. The form was sent out to doctors and medical professionals. It got 11 responses in total and valuable feedback.There was a discrepancy in the responses. On further inquiry, it was found that the questions were more subjective, for which most doctors don't have the time to fill them out. Also, many doctors faced problems with the website, so they were unable to submit.The link for viewing and/or filling the form ishttps://form.jotform.com/221212911624040. The link for the responses is https://www.jotform.com/tables/221212911624040.

2. Second Form

   Based on the feedback received, a second more objective form was made on Google Forms. It contained 16 questions and garnered 13 valuable responses. Most of the questions were MCQs, so doctors could easily fill them out. Charts were made *(refer to Discussion)* and trends were noted *(refer to Results)*.The link for viewing and/or filling the form ishttps://forms.gle/v5X6fq3grdFBuUcb6. The link for the responses is https://rb.gy/nxazcv.

3. Interview

   To get more in-depth information directly from the expert, an interview was conducted. The interviewee, Dr. Omshree Shetty, took out time from her busy schedule to aid this research. She has done her Ph.D. in cancer biology from Tata Memorial Hospital and her Post Doc from ICMR NIRRH. She is currently working with Tata Memorial Hospital (which is affiliated with the Homi Bhabha National Institute) as an Assistant Professor and Scientific Officer in Molecular Pathology.

   

   Fig. 1 Interview in progress

   The questions asked were about the effectiveness and problems with computational modeling and simulation and its future potential. The answers received were extremely detailed and useful.Computational modeling and simulation have led to the development of robotic surgeries, in which doctors just have to press a few keys and the machine executes the task. They can carry out critical or delicate surgeries and increase the success rate by ruling out human error. Nevertheless, they even have a few disadvantages; unaffordability, inaccessibility, skills required, etc. In the future, as the number of people becoming aware of this technology increases it is bound to spread and develop further, leading to a reduction in cost, thus the rural areas will also have access to it.The link for the audio recording of the interview is - https://rb.gy/bhudj7.

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RESULT

The forms and the interview showed how computational modeling and simulation are currently used and trends regarding their future. It is being used to train doctors and practice surgery before performing it on humans. Nearly all the doctors believe it is mostly used in surgeries as compared to other medical fields. Also, our country is not at all behind the world in this field; even India possesses the same technology as others. Computational modeling and simulation have also reduced the burden on doctors by aiding them in complex procedures.

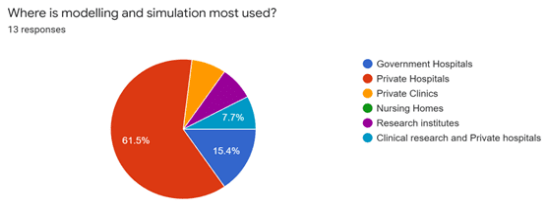

Fig. 2

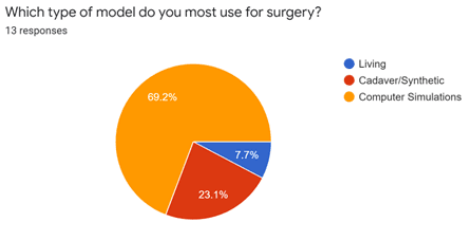

Fig. 3

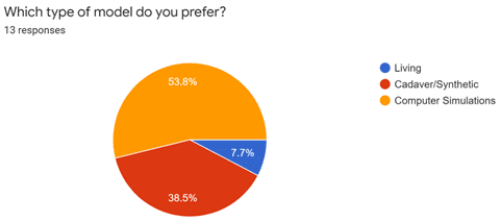

Fig. 4

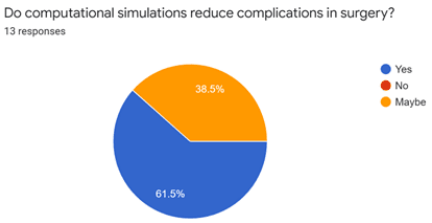

Fig. 5

DISCUSSION

Fig. 2 shows that most doctors think that modeling and simulation are most used in Private Hospitals. According to Fig. 3, 7 out of 10 doctors use computer simulations for surgery while 1 out of 4 use cadavers. On the other hand, Fig. 4 depicts that 1 out of 2 doctors prefer computer simulations, while 2 out of 5 doctors prefer cadavers. As per Fig. 5, none of the doctors believe that computer simulations do not reduce complications in surgery. Fig. 6 and 7 showwhat doctors believe to be the major advantages and disadvantages of computer simulations respectively.

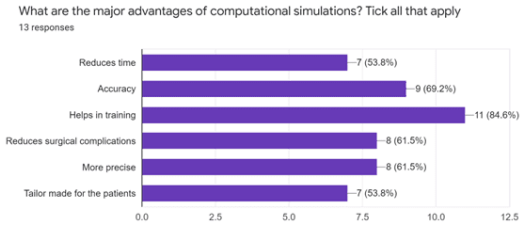

Fig. 6

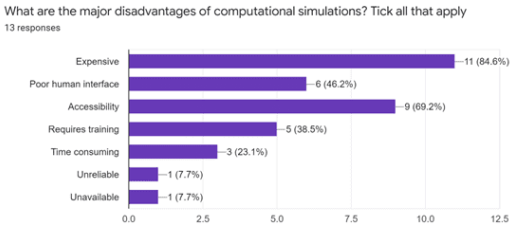

Fig. 7

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CONCLUSION

In conclusion, the scope of computational modeling and simulation in the future is endless. From practicing surgeries on living animals to identifying various blood vessels in cadavers to operating using computer simulations, medicine certainly has evolved a lot in the past years. Computational modeling and simulation can be the next major revolution in medicine. From gene editing to 3D printing body parts, we exist in a very interesting period in medicine. It is yet to be seen what wonders await us in the future. But one thing is for sure, the co-existence of humans and machines. While computational modeling and simulation can perform miracles, doing so without a human mind behind it is certainly impossible. Machines can never replace doctors, though technology can make life much easier for them while saving more patient lives at the same time. We could use machines for what they do best – simplify complex procedures and help conclude humanity's medical problems.

Acknowledgments

Dr. Gayatri Tahiliani, Dr. Omshree Shetty, Amudha Justin Manickam, Chaitrali Pramod Gurav, Clarine Avil Saldanha, Shiksha Tahiliani, Girish Tahiliani, every doctor who filled the form.

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