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Research Article

Physics tools and methods help fight covid-19

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Abstract

Physics based tools and methods play an enormous role in understanding structural features and functions of viral particles along with their impact on the body. For example, X-ray crystallography utilizes electro-magnetic radiation to produce wavelength that can help to generate 3D detailed structure of the virus. Another technique used for obtaining structure information is the Cryo- electron microscopy. Cryo-EM is the electron microscopy method applied to sample cooled to very low temperature. Computed tomography (CT) imaging technology, widely known as CT scan, use a narrow beam of X-ray quickly rotated around the patient to produce cross-sectional images or "slices" of the body. The George Washington university hospital utilized CT images to show the impact of COVID-19 on the lungs of a patient. A ventilator is required to strongly give adequate degrees of oxygen in blood. We learn about all of these physics-related methods and tools to fight SARS-CoV-2 and Covid-19 through UNO's biomedical physics concentration. Medical physicists by diagnosing and treating patients and as biomedical specialists by designing and building biomedical equipment. Artificial intelligence, nanotechnologies, synthetic biology, drones, robots, Tele health technologies, open-source technologies and gene -editing are the application used in technologies to fight covid-19

Keywords*: X –ray crystallography, Computed tomography, Ventilator, technologies.*

Introduction

This is a great deal we have barely any familiarity with the Novel corona virus, SARS-CoV-2 and the resultant disease COVID-19 what we can be sure that we are arranging our assets to get, fight and ultimately defeat it. Physics is at the forefront of this battle. Physics based tools and methods play an enormous role in understanding structural features and functions of viral particles along with their impact on the body. The Department of Physics and Astronomy at Rutgers University New Brunswick has been contributing to the battle against covid-19, creating materials for Personal Protective Equipment (PPE) and giving significant processing ability to scientists looking for a solution for this virus. The 3D printing technology to produce face mask for frontline hospital workers, which were in desperately short supply at the beginning of the pandemic. Physics based techniques assume an immense part in the field of structural biology. The vast majority of biological macromolecule structures are obtained by X-Ray Crystallography, when John Desmond Bernal and Dorothy Hodgkin recorded the main X-Ray diffraction pattern of a crystallized protein, the From that of physicists such as Wilhelm Rontgen, who discovered X-Ray. The Cryo-EM is the electron microscope with low doses of electron to limit radiation harm (1). Since single molecules or complexes are imaged directly, there is no need for crystallization. Scientists are employing X-rays, electrons, neutrons to decipher and disable the molecular machinery of the novel corona virus. Different new age technologies can be adopted by the public authority as an initial response strategy. The

uses of the Internet of Things (IOT), Internet of Medical

Things (IOMT), and other smart emerging technologies like Drones, Robots, Autonomous Vehicles (AVs), Bluetooth and Global positioning system (GPS), which can be helpful in handling this pandemic. Flow physics performs a key function in nearly every feature of the covid-19 pandemic.

This includes the generation and aerosolization of virus-laden respiratory droplets from a host, its airborne dispersion and deposition on surfaces, as well as the ensuing inward breath of these bioaerosols by unsuspecting recipients. Fluid dynamics is also key to preventative measures, for example, the uses of face masks, hand washes, ventilation of indoor environments and even social distancing. We know and more importantly, what we need to learn about the science underlying these issues so that we are better prepared to tackle the next outbreak of covid-19 or a similar disease. Thermometer, Microscope, Ophthalmoscope, Stethoscope, Laryngoscope and X-ray are among the initial inventions in medical technology. These multitudes of innovations are on the way of maturing to help us fight against the deadliest pandemics.

Methods

Physics-based tools and methods can help to fight SARS-CoV-2, and ultimately defeat it.

X-ray crystallography

X-Ray Crystallography uses electro-magnetic radiation to create wavelength that can help producing 3D detailed structures of the virus. To help during a pandemic, these methods need to give results rapidly. X-ray Crystallographic methods used to be slow, but with the use of automation, fast computing plat forms and high-quality x-rays, it is feasible to get structures rapidly. An illustration of such fast analysis is the study of SARS-CoV-2. The high-resolution structure of the virus's main protease, or an enzyme that ultimately enables replication of the virus, was transferred to the Protein Data Bank on February 5, 2020 by an exploration group at the Shanghai Synchrotron Radiation Facility (2). It

would have taken over a year to get the same results just a decade ago. The structure is helping researchers to identify targets in search for antiviral drugs that could block the activity of the proteases preventing viruses from replicating.

Fig.1: X-Ray Crystallography

Cryo-Electron Microscopy

One more method utilized for getting structural information is the Cryo-Electron Microscopy. Cryo-EM is the electron microscopy method applied to samples cooled to very low temperatures. An organization of specialists on the University of Texas at Austin used Cryo-EM to determine the structure of an outer "spike" protein of SARS-CoV-2. It took the group just 12 days from reaping the protein to obtain the results submitted to the journal "Science". The "spike" you find in portrayal of SARS-CoV-2 are used to bind to host cells and thus enable the virus to make its way into the cells. The detailed structure of the spike protein is extremely valuable for creating corona virus vaccines (3). The body can build immunity whenever presented to virus like particles with the same external features while being hollow inside.

Cryo-EM began acquiring more extensive reception around seven years prior as advances in the electron detectors, software, productivity and other significant elements permitted researchers to resolve relevant biological samples at higher resolution. In less than two months, significant progress has been made to understand the structure and behavior of the corona virus. In the past, achieving this level of progress could have taken years (4). The group that planned the spike protein utilized around 3,000 images which today can be collected within 24 hours. A decade prior, just creating these images could have taken weeks or even months. With an understanding of the structure of the corona virus spike protein, and a capacity to rapidly serialize the testing of antibodies, researchers are hopeful to develop a vaccine that can be prepared for clinical trials.

Fig. 2: Cryo-Electron Microscopy

CT scan

Computed Tomography images technology, it is otherwise known as CT scan, uses a narrow beam of X-rays quickly rotated around the patient to produce cross-sectional images or "slices" of the body. When stacked together these "slices" form 3Dimages of the patient. Normally, medical physicists use the CT imaging technology to produce images and recordings for malignant growth screenings as well as to plan surgeries simply because CT provides very detailed information showing the soft tissues, veins, and bones in various parts of the body. CT scan has turned into the "first line of defense" in diagnosing suspected infections, given the deficiency of testing units, as per Radiological Society of North America. Healthcare providers use CT outputs to look for opaque spots inside the lungs. SARS-CoV-2 assaults the lungs which fail to function properly due to extent of inflammation (5). The George Washington University Hospital (GWUH) utilized CT imaging to show the impact of covid-19 on the lungs of a patient who was otherwise healthy. Accordingly, the detailed chest CT abnormalities in Covid-19 are similar to those found in infections with SARS-CoV-1 and MERS-CoV. The prevalence of chest CT abnormalities in Covid-19 is subject to the stage and seriousness of the illness.

Diamond Light Source

Researchers across the world are using the diamond light source to comprehend the structure of the Covid-19 virus. Diamond is supporting worldwide Endeavour's to battle the Covid-19 pandemic by providing international and UK-based scientist with admittance to high-resolution synchrotron and electron-based imaging methods, which are being used to study SARS-CoV-2, the virus responsible for Covid-19. So far, researchers at the facility have effectively resolved the structure of the SARS-CoV-2 main protease in high-resolution. This has been further supported by diamond's specialist drug discovery facility–X Chem, which is being used to study the interaction between the key components of the virus and "chemical fragment" collection of the small molecules that are separated the beginning stages of drug discovery research. By quickly analyzing lots of different fragment, researchers hope to better identify and develop new drug to treat the disease. All experimental data has been made openly available in real-time to encourage worldwide collaboration and rapid progress (6). This is shown through the non-profit initiative –COVID moon shot, which crowd sources molecule designs from medicinal chemists across the world and coverts them into physical compounds and assays at the X chem facility. So far, over 500 components have been submitted and screened at the facility, with over 60 designs having been shown to effectively target a key protein associated with corona virus

In combination, these tools and datasets provide researchers with essential information to better comprehend the virus, as well as identify potential drug target and treatments to treat Covid-19.

Fig. 3: Diamond light source

Ventilator

The new corona virus behind the pandemic causes a respiratory infection called Covid-19. The virus, named SARS-CoV-2, gets into your airways and can make it difficult for you to breath. Assesses up until this point show that around 6% of individuals who have Covid-19 get critically sick. Also around 1 of every 4 of them may need a ventilator to help them breath. Yet, the image is changing rapidly as the infection continues to spread around the globe. Ventilator is a machine that assists you taking breaths if you can't do it on your own. Your physician could consider a "mechanical ventilator". People also often refer to it as a "breathing machine" or "respirator". Technically, a respirator is a mask that medical workers wear when they care for someone with a contagious illness. A ventilator is a bedside machine with tubes that connect to your airways. When your lungs inhale and exhale air normally, they take in oxygen your cells need to survive and expel carbon dioxide. Covid-19 can inflame your airways and basically suffocate your lungs in fluids. It mechanically helps pump oxygen into your body. The air flows through a tube that goes in your mouth and down your windpipe. It additionally may breath out for you, are you may do it on your own. It can be set to take a specific number of breaths for you each moment. Your specialist likewise may decide to program the ventilator to kick in when you need help. For this situation, the machine will blow air into your lungs automatically if you haven't taken a breath in a set amount of time. A ventilator helps you survive until you get better and your lungs can work on their own. When your doctor thinks you are your well enough, they will test your breathing. The ventilator stays connected but set so that you can try to breathe on your own. When you breathe normally, the tubes will be taken out and the ventilator will be switched off.

Flow Physics

Flow physics performs a key function in nearly every feature of the Covid-19 global pandemic. This includes the generation and aerosolization of virus-laden respiratory droplets from a host, its airborne dispersion and deposition on surfaces as well as the ensuing inward breath of these bioaerosols by unsuspecting recipients (7). Fluid dynamics is also key to preventative measures, for example, the uses of face masks, hand washing, ventilation of indoor environments and even social distancing. Likewise, fluid dynamic analyses helped to understand the mechanisms how the droplets are generated in the respiratory tract, and also characterize the density, size and velocity of ejected droplet (8). Now, it is possible to estimate the settling distance, evaporation time, transport of the particles, and the effect of external factor such as air current, temperature, and humidity by employing multiphase computation fluid dynamics in a fully couple Euler-Lagrange framework.

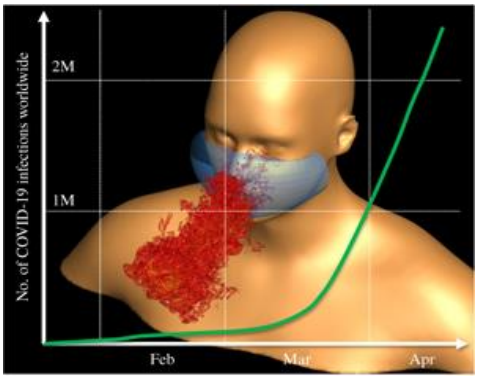

Fig. 4: Flow of physics

Conclusion

The Department of Physics at UNO is educate the current information and updates in physics, especially as they relate to Covid-19. Students learn about all of these physics-related methods and tools to fight SARS-CoV-2 and Covid-19 through UNO's biomedical physics concentration. This program intends to prepare the next generation of biophysicists, medical physicists and biomedical specialists, who will be prepared to utilize their knowledge of physics to handle the following pandemic. It is very potential they will actually want to altogether contribute as structural biophysicists to uncover the details of what causes a disease, as medical physicists by diagnosing and treating patients, and as biomedical specialists by designing and building biomedical equipment. The Covid-19 pandemic shows the necessity of a "big science" wayto deal with battling this virus. Recognizing effective solution to this pandemic is a worldwide, interdisciplinary, and multi-faceted challenge, one that demands researchers with wide-ranging ability team up to be settled. Regardless of whether through contributions to structural biology, fluid dynamics, big data, or mathematical models, physicists are active in the Covid-19 fight in numerous impactful ways.

References

Physics world. How Physics is helping the fight against the pandemic. Physics world; 2020. Availablefrom:

https://physics world.com/a/covid-19-how- physics-is-hepling-the-fight-against-the-pandemic/Creative Biostructure (2020).

Xay-crystallography platform for SARS-CoV-2, web:https://www.creativebiostructure.com/coronavirus/sars-cov-2-and-covid-19-p8.htm.

Zivanov,J., Nakane,T., Forsberg,B.O., Kimanius,K., Hagen,W.H., indahl,E., Scheres,S.H (2018). New tools for automated high-resolution cryo-EM structure determination in RELION-3. Elife 7, e42166, https://doi.org/10.7554/eLife.42166.

Klein, S., Cortese, M., Winter, S., Wachsmuth-Melm, M.,Neufeldt, C., Cerikan, B., Stanifer, M., Boulant, S., Bartenschlager, R., and Chlanda, P. (2020). SARS-CoV-2 structure and replication characterized by in situ cryo-electron tomography Nature common. 11, 5885. https://doi.org/10.1038/s41467-020-19619-7.

Ma, H., and Zhang, Y. (2020). Computed tomography of covid-19 pneumonia. BMJ 370, 1807. https://dx.doi.org/10.1136/bmj.m1807

Diamond Light Source. Visit https://www.diamond.ac.uk/covid-19/for-scientists/main-protease-structure-and-XChem.html

Stockley, P., and Twarock, R. The Physics of virus assembly Phys. Biol. 7, 040301 https://doi.org/10.1088/1478-3975/7/4/040301

The flow physics of COVID-19. Journal of Fluid Mechanics, Volume 894, 10 July 2020, F2 DOI: https://doi.org/10.1017/jfm.2020.330