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A systematic review on involvement of medicinal physics tools, techniques and effect of other parameters in diagnosis of novel corona virus, SARS-CoV-2

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Abstract
In this paper we focused Physics-based tools and methods which play an enormous role in understanding structural features and functions of viral particles as well as their effect on the body. Physics primarily based totally strategies likes X-RAY, CT Scans, Cryo-Electron Microscopy, MRI are the principle equipment which might be pretty contain in analysis of Novel corona virus. The substantial majority of biological macromolecule structures are obtained by X-ray crystallography. In this paper we centered all equipment and method at the side of impact of bodily circumstance like temperature & humidity in remedy of Covid -19. The maximum suitable method to govern this contamination is to quarantine humans and isolate symptomatic humans. Medicinal physics and structural Biology has a first rate significance in growing one of a kind fast check method and launching vaccine. Chest CT has a potential role in the diagnosis, detection of complications, and prognostication of Covid-19. Primary level analysis of COVID-19 is essential for its manage and prevention from network spread. Compared to RT-PCR, chest CT imaging may be a more reliable, practical and rapid method to diagnose and assess COVID-19, especially in the epidemic area. Computed tomography (CT) has been said as an essential device to discover and look into suspected sufferers with COVID-19 ailment at early level. AI would possibly assist radiologists to distinguish COVID-19 from different pneumonia diseases.
Keywords: - SARS-COV-2, CT Scans, M.R.I, X-ray, RT-PCR, Artificial Intelligence (AI)

1. Introduction

Physics in remedy is as various as it's far substantial. In this paper, we spotlight the position of physics thru dialogue of numerous installed and rising treatments. We in particular cope with minimum get right of entry to surgery, ultrasound, photonics, and interventional MRI, figuring out regions wherein complementarily is being exploited. We additionally speak a number of the essential bodily concepts concerned withinside the utility of every remedy to scientific practice [1, 2]. Medical physics has an essential position in scientific remedy, and in organic and scientific studies. In the context of radiation technology, scientific physics consists of subspecialties, together with radiotherapy, diagnostic radiology, nuclear remedy, and radiation protection.

From the start of the pandemic of corona virus sickness 2019 (COVID-19), there was good sized public confusion and clinical controversy over the modes of transmission and the only techniques to defend towards them, as pondered in adjustments in public fitness guidance. The clinical concepts to quantitatively check the danger of airborne transmission of COVID-19 in an indoor area primarily based totally on different factors together with the occupancy, the time spent with inside the area, the size of the room, using face masks, ventilation, air filtration, humidity, the breathing sports concerned, and so forth [3,4]. Physics is gateway to a extensive variety of organic techniques in improvement and sickness, along with most cancers tumor genesis, embryonic improvement, and now in analysis of this pandemic sickness(Covid -19). Modern remedy have been evolved through physicists who imported technology together with X rays, nuclear magnetic resonance, ultrasound, particle accelerators and radioisotope tagging and detection strategies into the scientific domain. There they have become magnetic resonance imaging (MRI), automated tomography (CT) scanning, nuclear remedy, positron emission

tomography (PET) scanning, and diverse radiotherapy remedy techniques. These contributions have revolutionized scientific strategies for imaging the human frame and treating sickness [5].
Coronavirus sickness 2019 (COVID-19), the particularly contagious infectious sickness resulting from intense acute breathing syndrome coronavirus 2. Common symptoms and symptoms of contamination encompass breathing signs and symptoms, fever, cough, shortness of breath and respiratory difficulties. In greater intense cases, contamination can reason pneumonia, intense acute breathing syndrome, kidney failure or even death. Standard guidelines to save you contamination unfold encompass everyday hand washing, overlaying mouth and nostril while coughing and sneezing, very well cooking meat and eggs. Avoid near touch with everybody displaying signs and symptoms of breathing contamination together with coughing and sneezing. There is a lot we don't understand approximately the unconventional corona virus, SARS-CoV-2, and the ensuing sickness, COVID-19. What we do understand is that we're pulling our sources collectively to apprehend, combat and in the long run defeat it. Physics is at the vanguard of this combat. When physicists say that there's physics in everything, they suggest actually everything, along with how a sickness is transmitted. From the era of virus-encumbered breathing droplets to dispersing with inside the air to inhalation or deposition on surfaces, a crew from Johns Hopkins University with inside the U.S attempted to decode the float physics of corona virus transmission. Fluid dynamic analyses helped to apprehend the mechanisms at the back of how the droplets are generated with inside the breathing tract, and additionally represent the density, length and pace of ejected droplets. The crew additionally attempted to estimate the settling distance, evaporation time and shipping of the debris. They additionally checked out the impact of outside elements together with air currents, temperature and humidity. Technologies which have enabled many to paintings remotely in the course of the pandemic have their roots in physics, substances science, data technology, and engineering.

1.1 Temperature and humidity levels as essential elements for corona virus control

Understanding how weather impacts the unfold of the corona virus is necessary, given the connection among the virus and the ambient situations supplied through temperature and humidity.
Aerosol of breathing droplet transmission is famous to be a number one car for the fast unfold and persisted move of viruses in humans. There is likewise robust assist that environmental situations will have an effect on prices of virus transmission. With the SARS-CoV-2 virus, scientific facts have continually detected the virus with inside the saliva of inflamed people.
This is especially in order iciness virus infections are normally greater common (and people of use primarily based totally with inside the northern hemisphere) will revel in cooler temperatures. To this end, physicists have studied the effect of relative humidity, environmental temperature, and wind pace when it comes to the human breathing cloud and additionally with virus viability. The most fulfilling situations to lessen the hazard of contamination from corona virus are environments with excessive temperature and coffee relative humidity. This is due to the fact such environs cause excessive evaporation prices of saliva-infected droplets, and that is vital for lowering the virus viability. Warmer temperatures, for instance, boom the strength of molecules, inflicting them to transport and vibrate greater quickly; while drier situations lower the droplet facet and affect the capacity of viruses to connect to surfaces. The virologists name this thing the saliva liquid carrier-droplet evaporation rate. However, even below those most fulfilling situations the virus can nevertheless unfold. This arises because of some other thing: wind pace. This approach the wind outside or air motion thru air adjustments while indoors. The importance of such studies will be in the direction of a higher know-how of the evaporation and the way this connects with weather effects. This ought to grow to be the premise to a version that might permit scientists to higher expect corona virus awareness and as a result to evaluate the viability of the virus or at the least the cap potential for virus survival. Such a version will be feasible thru using a computational fluid dynamics platform. [6] The researchers used a totally unique version, referred to as the three-d multiphase Eulerian–Lagrangian computational fluid dynamics solver. This calls for know-how of the steady-kingdom of warmth and mass switch when it comes to flowing round debris, as viral debris could be in a circulation of ejected saliva – together with while we talk, cough or spit. Currently it is observed that the inactivation temperature of SARS-CoV-2 must be well elucidated. It appears that this virus can be inactivated at about 27° C. Conversely, it may resist lower temperatures even below 0°C. Also, these viruses can be effectively inactivated by lipid solvents, including ether (75%), ethanol, chlorine-containing disinfectant, peroxyacetic acid, and chloroform except for chlorhexidine.

1.2 Optimizing social distancing

The only manner to keep away from corona virus transmission is to live far from a place altogether, however that isn't always honestly sensible on the subject of making medicines. Social distancing (sometimes, and greater accurately, called 'bodily distancing') is the subsequent maximum critical issue someone can exercise keeping off corona virus. This is observed via way of means of normal hand washing – the usage of warm water and cleaning soap or an alcohol-primarily based totally hand sanitizer - and ultimately via way of means of sporting a face mask.

1.3 Virus transmission and fluid dynamics

Fluid dynamics is a branch of physics that is concerned with how liquids and gases flow. Given that viruses travel through infectious droplets through the air, fluid dynamics offers a natural approach to a better understanding of how infections can spread from person to person. COVID-19 touches almost every major arena of fluid dynamics, from hydrodynamic instability to porous-media and turbulent shear flows, from droplet breakup to particle deposition, and from Newtonian gas flows to non-Newtonian liquids. The main objective of fluid dynamic analyses in this setting is to: (a) determine the mechanisms for the generation of these droplets within the respiratory tract; (b) characterize the number density, size distribution and velocity of ejected droplets; (c) determine the critical droplet size for transition between the large and small

droplet transmission routes; (d) estimate the settling distance of large droplets; (e) determine the evaporation times of small droplets; (f) characterize the transport of small droplets and droplet nuclei in the air; and (g) quantify the effect of external factors such as air currents, temperature and humidity on all of the above. The number density, velocity and size distributions of droplets ejected by expiratory events have important implications for transmission, these factors are analyzed with the help of fluid dynamics along with mathematical modeling and numerous studies have attempted to measure these characteristics. For the initial stages of modeling, the cell layer is treated as a homogeneous phase in which the viruses can diffuse (with a diffusivity D_{vc}), while the cells remain stationary [7].

The kinetics of the viral infection process can be described by the following reactions:

$$V_c + C \xrightarrow{k_1} I \xrightarrow{k_2} D + YV_c$$

Where V_c represents free virus present in the cell layer, and host cells are either non-infected (C), infected (I), or dead (D). Here, k_1 and k_2 are rate constants for the corresponding elementary reactions, and Y is an average yield or burst size of virus progeny produced by each infected host cell.
In fluid dynamics, transportation of viruses in the fluid layer can be occurs via diffusion or by the bulk flow [8, 9]. Denoting the concentration of virus in the fluid phase as $[V_f]$, the transport equation for virus in the fluid phase is given by

$$\frac{\partial [V_f]}{\partial t} + \boldsymbol{\nu} \cdot \nabla [V_f] = D_{vf} \nabla^2 [V_f]$$

Where D_{vf} is the diffusivity of virus in the fluid layer
The character of virus transport in the fluid phase can be characterized by the Peclet number Pe, a dimensionless number defined by:

$$Pe = \frac{V_{max} H}{D_{vf}}.$$

Here V_{max} is maximum fluid velocity, H diffusing distance; D_{vf} is the diffusivity of virus in the fluid layer

2. Tests, Tools and Techniques Used

2.1 Diagnostic Tests

PCR Test: PCR stands for a laboratory technique known as polymerase chain reaction. In this test, the goal is to selectively amplify trace amounts of genetic material, identifying specific parts of DNA. Just as a reminder, DNA is the genetic code that is present in every cell in the body. When a cell divides, it copies DNA, separating the two strands and then creating a new strand of DNA by copying the template. This tests for the presence of the actual virus's genetic material or its fragments as it breaks down. This is the most reliable and accurate test for detecting active infection. The nose swab PCR test for COVID-19 is the most accurate and reliable test for diagnosing COVID-19. A positive test means you likely have COVID-19. A negative test means you probably did not have COVID-19 at the time of the test. Get tested if you have symptoms of COVID-19 or have been exposed to someone who tested positive for COVID-19.

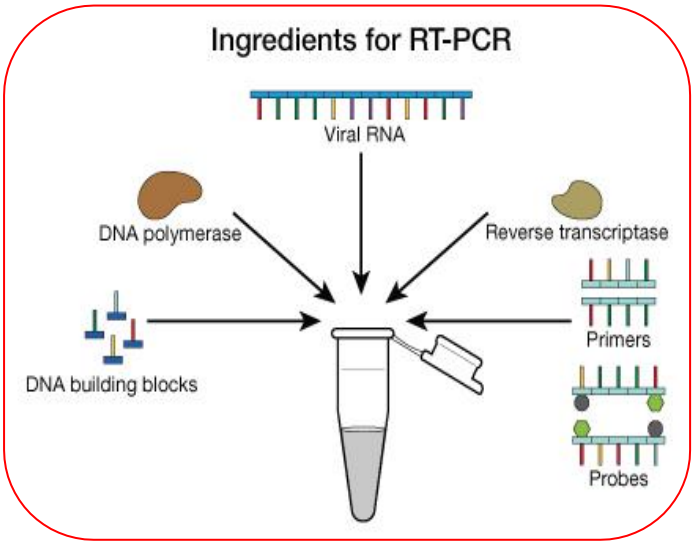

Figure-1 RT-PCR Sample

Antigen test: This test detects bits of proteins on the surface of the virus called antigens. Antigen tests are typically considered rapid, taking only 15 to 30 minutes but are less accurate than a PCR test. Rapid antigen tests are most accurate when used within a few days of the start of your symptoms, which is when the largest amount of virus is present in your body. Because this test is not as accurate as a PCR test, if an antigen test is negative, your healthcare provider may order a PCR test to confirm the negative test result

2.2 X-Ray Crystallography

Physics-based tools and methods play an enormous role in understanding structural features and functions of viral particles as well as their effect on the body. For example, X-ray crystallography utilizes electro-magnetic radiation to produce wavelengths that can help generate 3D detailed structures of the virus.
To help during a pandemic, these techniques have to provide results very quickly. X-ray crystallographic methods used to be slow, but with the use of automation, fast computing platforms and high-quality X-rays, it is possible to get structures very quickly.
An example 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 uploaded to the Protein Data Bank by a research team at the Shanghai Synchrotron Radiation Facility. 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 action of the proteases preventing viruses from replicating

2.3 MRI

MRI plays a crucial role in radiation oncology, with established applications in defining brain and spine targets for stereotactic treatments. The COVID-19 pandemic presents new challenges for many aspects of health care delivery, including diagnostic and therapeutic procedures in radiation oncology. Because the date of COVID-19 elimination is not yet known, efforts to take precautions against transmission of COVID-19, and similar viruses, will likely continue. One area that will likely be changed after the pandemic is magnetic resonance imaging (MRI) use in radiation oncology; MRI application in radiation oncology requires multidisciplinary collaboration of personnel including physicists, technologists, physicians, and nurses. Training of multidisciplinary teams can incorporate off-site and virtual simulations to reduce the number of staff in the clinic in the post pandemic world. The MRI environment imposes unique considerations regarding the safety of items that may enter the scanner room. During the COVID outbreak, an additional risk factor for the MRI environment emerged: personal protective equipment (PPE), such as face masks, respirators, face shields, goggles, and gowns. After the pandemic, continued consideration of the safety of PPE in the MRI environment will be required.

2.4 CT Scans

The role of imaging has evolved during the pandemic, with CT initially being an alternative and possibly superior testing method compared with reverse transcriptase–polymerase chain reaction (RT-PCR) testing and evolving to having a more limited role based on specific indications. CT scans have become the "first line of defense" in diagnosing suspected infections, given the shortage of testing kits. Healthcare providers use CT scans to search for opaque spots within the lungs. SARS-CoV-2 attacks the lungs which fail to function properly due to extent of inflammation. Computed Tomography imaging technology, widely 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 a 3D image of the patient. Typically, medical physicists use the CT imaging technology to produce images and videos for cancer screenings as well as to plan surgeries simply because CT provides very detailed information showing the soft tissues, blood vessels, and bones in various parts of the body.
CT has been advocated and widely applied in Covid-19 clinical management, for cases of Covid-19, CT may show signs typical of viral pneumonia, and thus help the clinical diagnose. Covid-19 suspected case should be isolated, and supportive treatments offered [7, 8].
Covid-19 patients are classified into (I) asymptomatic infection (II) acute upper respiratory tract infection (III) mild pneumonia, (IV) severe pneumonia, and (V) critical cases. The supportive treatments are primarily based on the severity of clinical symptoms/signs. For severe and critical cases, hematological and biochemical parameters are monitored.
We also expect that CT may be applied in some selected suspected cases where pathogenic tests have been negative more than once, and if CT would show findings consistent with viral pneumonia, specific measures can be taken, such as even stricter isolation according to region-specific guidelines.

Fig:Flow chart of Covid diagnosis

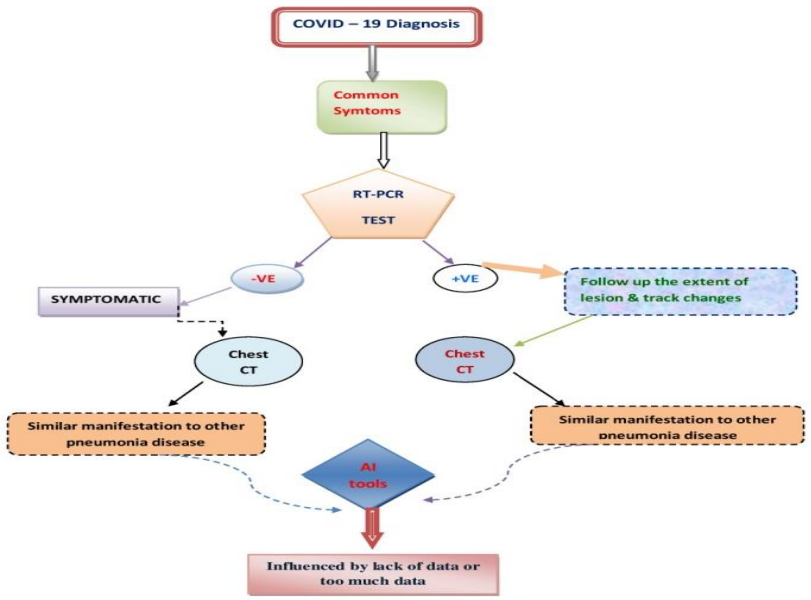

Figure-2 A flow chart of Covid-19 diagnosis

2.5 Ventilators

A mechanical ventilator is an automatic machine designed to provide all or part of the work the body must do to move gas into and out of the lungs. The act of moving air into and out of the lungs is called breathing, or, more formally, ventilation. A ventilator is required to forcefully provide sufficient levels of oxygen in blood. According to the World Health Organization (WHO), some 80% of people with Covid-19 - the disease caused by corona virus - recover without needing hospital treatment. But one person in six becomes seriously ill. In these severe cases, the virus causes damage to the lungs, causing the body's oxygen levels to drop and making it harder to breathe. To alleviate this, a ventilator is used to push air, with increased levels of oxygen, into the lungs. The ventilator also has a humidifier, which adds heat and moisture to the air supply so it matches the patient's body temperature [9, 10].

Figure-3 Hightech Ventilators

3. Conclusion

In this study we conclude that Various physical tools used in treatment of covid are very helpful to examine patient health . This paper stated modern physics can help to advance our understanding of the novel corona virus, adding an additional scientific perspective to mix and hence aiding those who manage healthcare facilities with additional guidance. Simply taking action to increase temperature and lowering humidity, for example, can go some way to reducing infectivity. The Diagnosis tools such as XRAY, CT SCANS, MRI, and Ventilators play crucial role in monitoring patient condition who is suffering from Covid -19 or its other variants. Social distancing is one of the key measures to take when seeking to minimize the risk of corona virus transmission. The generally accepted safe distance is two-meters. But is this enough? Physicists have begun to express doubts. Social distancing is about observing a set distance apart from another person and avoiding all forms of physical contact such as hugs and handshakes. As COVID-19 has similar manifestations to other pneumonia diseases, several AI systems have been proposed and developed in order to differentiate COVID-19 from other pneumonia diseases.

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