Covid-19 Diagnosis, Prognosis, and Rehabilitation: Latest Perceptions, Challenges, and Future Directions

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1 Introduction

Human coronavirus (HCoV) was the first coronavirus to be discovered in humans in 1960 [1]. It produced minor illnesses of the lower and upper respiratory tracts, which, in some cases, resulted in acute respiratory failure [2]. A severe acute respiratory syndrome (SARS-CoV) was revealed in 2003 in China, and the situation grew much more critical [3]. SARS-COV infected over one million people at the time, with a 9.5% fatality rate. The spread of the virus was halted by isolating sick individuals and identifying the source of infection. SARS-COV has been discovered in cats and bats in subsequent wild animal research [4]. As a result, the virus was thought to have moved from animals to humans, then from person to person [5]. From 2004 until the introduction of another severe virus in 2102, the situation with the Middle East respiratory syndrome coronavirus (MERS-CoV) remained unchanged. MERS-CoV was initially identified in Saudi Arabian patients with acute pneumonia [6, 7]. Despite the fact that MERS-CoV has a minor rate of dissemination than SARS, MERS-CoV patients died at a higher rate [8].

By the end of 2018, documented cases of MERS-CoV had been around 2500, with a death rate of up to 30%. In 2019, the globe was confronted with another coronavirus, SARS-COV-2, which created Covid-19, originated from an outspread in China [9]. Covid-19 is a fast transmissible virus that spreads through direct contact with an infected individual. Infections are mostly caused by respiratory droplets

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(direct contact) and aerosolized droplets (secondary contact) [10, 11]. In the absence of a Covid-19 vaccine, non-medicated treatments such as individual hygiene and communal isolation are the most effective means of preventing a Covid-19 epidemic [12]. It's important to remember that, at its highest, the disease overwhelms current medicinal facilities. As a result, intensive care and emergency units have outgrown their ability to handle the growing number of afflicted people. Covid-19 typically begins with modest indicators like temperature and cough and progresses to failure of a particular body part and demise [13]. As a result, in such pandemics, medical experts and even the patients' families must make quick and informed judgments to prevent rapid worsening of the body.

Identification and classification are the key issues of Covid-19. Nowadays post-Covid infections have drastically improved in many cases. By its association with other lung infections, this is the case. The reverse transcriptase quantitative polymerase chain reaction (RT-qPCR) is now used to identify Covid-19 [14]. Minor amounts of virus-related RNA are extracted from the nasopharyngeal culture and intensified, allowing virus identification techniques to be used. Unfortunately, the standard RT-qPCR method is laborious and needs medicinal competence, which makes it not always available. Instead, some research studies have found that RT-qPCR testing has a significant probability of false positives [15–17]. As a result, experts in the fields of virology, medicine, and artificial intelligence (AI) ought to rise to the challenge of limiting the catastrophe through novel ways.

In this context, the AI community has contributed valuable methods that could aid in the detection, forecast, and treatment of Covid-19 [18]. For a Covid-19 diagnostic, documented and emission data are deliberated as basic data kinds. Patient histories, PCR analysis, movement data, and other textual data are examples of textual data. Chest CT, X-ray, and other radiation data are examples. AI has been widely utilized to handle a variety of problems using a variety of data kinds (i.e., text, video, indicators, pictures, etc.). Machine learning (ML) algorithms train and update prototypes to resolve precise tasks based on the data supplied. This chapter's main contribution is to study diagnosis, prognosis, and rehabilitation methods for Covid-19 viral infections.

- The symptoms, behaviors, and patterns of Covid-19 are discussed in detail.
- In Covid-19 diagnosis, a different category of methods, including analytical methods, has been studied.
- Prognosis and treatment category of all methods have been studied.
- We look at the current literature on Covid-19 domain and provide deductions about how to address these problems in the future.

The following is how the entire article is structured. The diagnosis procedures used to diagnose Covid-19 are described in Sect. 2. Section 3 presents a review of the literature for the prognosis of Covid context. Section 4 discusses the rehabilitation strategies for people with post-COIVD symptoms. Section 5 covers the limitations of present solutions as well as future directions, and Sect. 5 wraps up the article.

2 Diagnosis Methods for Covid-19

Identification/analysis of Covid-19 is a critical task faced by machine learning researchers. There are many clinical methods available for Covid-19. Different category of diagnosis methods based on clinical methods is shown in Fig. 1.

2.1 Virology-Based Methods

These methods depend on the viral load in the infected patients. Throat and nasopharyngeal swabs are collected and tested based on clinical methods. These methods study the protein samples and nucleic acid samples from the swab to detect the antigens of the SARS Covid-19 from the swabs. The realization of infection isolation and detection depends on the load of the virus: samples that contained <106 copies for each ml (or copies for each sample) never produced a segregate. Viral genomic sequences are primarily used for these methods. Very common and gold standard methods based on nucleic acid and genomic sequences which are currently used are:

- *RT-PCR*: These findings serve as a guide for selecting SARS-CoV-2 trial collection spots.
- *Digital PCR*: RT-PCR is now universally accepted as the gold standard for Covid-19 diagnosis. The enormous number of inaccurate records, on the other hand, is a severe drawback. False-negative results can also be caused by little amounts of virus in infected patients. To overcome the limitations of RT-PCR, a more profound RNA discovery approach is required for more reliable Covid-19

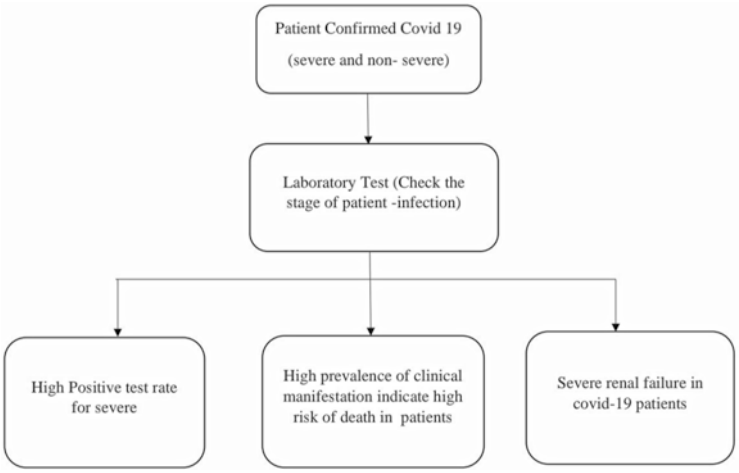

Fig. 1 Categorization of diagnostic techniques

diagnosis. To obtain absolute quantification of nucleic acids, digital PCR uses trial dilution, extreme PCR, and Poisson distribution. Researchers have compared the susceptivity and precision of droplet digital PCR (ddPCR) with RT-PCR to see if it could detect SARS-CoV-2 from medical oropharynx swab sections.

- *RT-LAMP*: Isothermal amplification mediated by a reverse transcription loop. Another possible alternative approach for the quick discovery of CoV-2 is reverse transcription loop-mediated isothermal amplification (RT-LAMP). To synthesize strand displacement DNA, the RT-LAMP uses four to six specifically designed primers, combined with chain displacement activity for DNA polymerase at a persistent temperature (60–65 °C). The improved product is continually prolonged, circularized, and re-extended, resulting in DNA with various hairpin-based topologies. Turbidity or fluorescence is used to monitor the amplification response. RT-LAMP provides a number of advantages over RT-PCR, including ease of use, quick response time, distinct apparatus is for measurement, and high sensitivity, making it ideal for on-site detection. Yang et al. [19] developed a method for the optimization of the RT-LAMP test for revealing of CoV-2 in medical sections or tissues, a set of five primers targeting the genes from orf and spike. The RT-LAMP assay detected CoV-2 in 130 clinical samples with 100% susceptivity and specificity, and the recognition time was 25.18 5.38 min, suggesting that the RT-LAMP assay is a potent device for SARS-CoV-2 identification.

2.2 Serology-Based Methods

Contrasting to the molecular approaches, blood serum-based testing procedures (known as antibody testing) can be used to detect past and present SARS-CoV-2 infection as well as track disease progression and immune response. They can identify antibodies in the blood serum and plasma of Covid-19 patients. Other genetic fluids, such as saliva and sputum, but not restricted to them, could also be used. Antibodies are created by the immune system as a resistance mechanism against Covid. Upon few days after the infection is found, IgM is created and lasts for about 14 days, shadowed by IgG creation, which lasts for some days.

2.2.1 Lateral Flow Assay

It is one of the most widely used serum-based methods in hospitals to identify antigens, neutralizers, and augmented nucleic acids in a variety of organic samples such as blood. LFA is a two-lined film strip that looks like paper. Anti-human IgG/IgM antibodies are found on the first line and anti-rabbit IgG serums are found on the second line, the control line.

Antibodies are pushed by duct action near the lines that overpass the conjugated pad where a precise compound antitoxin and rabbit-gold compounded neutralizers are blocked after a patient specimen (e.g., blood) is added to the sample collection. These neutralizers bind with gold Covid antigen compound to form a complex. Anti-human antibodies fix to the complex and immobilize at the trial line, whereas rabbit-gold compound antibodies mix with anti-rabbit neutralizer and immobilize at the regulator line. Due to the concentration of gold particles, the effect will be seen as a red line. When both the trial and regulator lines are red, the result is positive. If the regulator line alone is red, the result is negative. The result is invalid if two lines vanish or only the trial line appears.

2.2.2 Enzyme-Linked Immunosorbent Assay

Enzyme immunoassay is a different type of serological test (ELISA). In clinics and research laboratories, ELISA is a plate-based approach for identifying and measuring solvable molecules such as polypeptides and serums. It consists of both direct and indirect formats. An antigen (N protein) of interest is used in the indirect method adopting ELISA, which is more prevalent and profound than the direct method using ELISA.

In the process of discovering Covid-19 virus, both molecular and serological approaches are not flawless, and both methods have their own sets of limitations. Atomic approaches are more consistent than serological ones, but both can produce misleading results for a variety of reasons. For example, erroneous positive and negative results could be caused by faulty sampling, insufficient viral particles in the collection, inappropriate RNA removal, contradiction with other viral classes, contagion, and technological difficulties. Secondary diagnostic tools, such as a CT scan in the chest and images from X-ray, can be used to overcome these difficulties and boost the certainty of supplied results.

2.3 Imaging-Based Methods

Imaging-based methods depend on scan images from the patients. They are subjected to CT scan of chest or lungs to diagnose the viral infection. These methods rely on radiology-based scans. Currently, chest CT (computed tomography) scan and lungs CT scan are very useful in diagnosing early detection of Covid-19 infection.

Beyond these, many methods have been proposed by researchers using machine learning, artificial intelligence-based analytical methods. Another recommendation for Covid identification is to employ artificial intelligence approaches for clinical image processing, which has recently appeared in a number of coronavirus research papers. These methods mostly rely on clinical and survey data collected from the infected people or people who are undergoing treatment currently. Some of them

also rely on the medical images obtained through radiology-based X-rays and scans. These studies provide a clear picture about the fact; X-ray pictures and advanced scans are frequently employed as inputs to DL models in order to discover diseased Covid cases automatically. The scientists developed a deep convolutional neural network (CNN) algorithm for the discovery of Covid cases after discovering that infected Covid patients generally show anomalies in radiography pictures captured in the chest region. Some algorithm-based significant methods proposed by researchers are detailed in the next section.

2.4 ML Algorithms-Based Methods

In the paper proposed by Sujatha [20], a real time collection and processing of medicinal data and a modified random forest model improved using Ada boost algorithm. A boosted random forest is a two-part approach that includes the AdaBoost boosting algorithm and the random forest classifier algorithm, which is made up of many decision trees. A decision tree creates models that resemble real trees. Our data is divided into smaller subsets by the algorithm, which also adds branches to the tree. The end result is a tree with leaf nodes and decision nodes. The value of each feature (such as age, symptoms, etc.) assessed is represented by two or more branches in a decision node, and the result value on the patient's eventual condition is held by the leaf node (target value). As indicated by the information investigated in the review, passing rates were higher among Wuhan occupants, in contrast with non-locals for Covid patient condition prediction. Moreover, male patients' mortality was at a higher rate than female ones. Most of those impacted are between the ages of 20 and 70. The dataset is to forecast the intensity of the corona virus and the likely consequence of recovery or demise. This paper collects the dataset, data analysis, and data pre-processing.

Another study [21] predicted that the number of Covid tests taken by the patient and made the recommendation and the recovery of the Covid-19 exercises a gradient-boosted tree algorithm. The full WVU dataset on internal cohort was subjected to a Shapiro–Wilk test to ensure that the data was normal. It was discovered that all of the variables were found to be normally distributed; therefore, to conduct further statistical analysis, parametric approaches were employed [21]. Continuous data was given as mean and standard deviation, while categorical data was offered as counts or percentages. The Kruskal–Wallis test, with Dunn–Bonferroni adjustment test, was performed to examine the significance of continuous variables in all three groups (Covid positive, negative, and influenza). An independent sample t-test was used to establish significance between two of these three groups (Covid $+^{ve}$ vs. Covid $-^{ve}$, Covid $+^{ve}$ vs. influenza, influenza vs. Covid $-^{ve}$).

Another research by Laure [22] studied the multiple diagnostic and prognosis models for Covid-19, all of which show moderate to good discrimination. Model overfitting, incorrect model assessment (e.g., calibration neglected), use of unsuitable data sources, and imprecise reporting all put these models at high or uncertain

risk of bias. As a result, their performance approximations are likely exaggerated and unrepresentative of the target demographic. The Covid PRECISE group does not suggest any of the present prediction models for clinical usage, but both diagnostic and prognostic models each from one category from higher-quality research should be (independently) verified in additional datasets. At high risk, the reported prediction is probably optimistic and detection of Covid patients and identify the health issues of post Covid patients. Covid-related prediction models which use sharing data and proficiency for the validation and updation of the model is immediately needed. Some of the significant challenges potentially would be addressed for diagnoses are presented in the following section.

2.5 Challenges in Diagnosis Techniques

Every day, a new clinical challenge is presented by the novel coronavirus. As nations throughout the world discussion restricting the utilization of measure in friendly removing, boundless testing, and early location of the problem is exceptionally basic one. Despite multiple efforts by government agencies and international organizations, Covid-19 diagnosis remains difficult. The following is a summary of the present challenges for the identification of Covid as studied, using the above-mentioned methods:

- Though RT-PCR is the standard for Cov-2 virus detection, it is not without its drawbacks. This testing might be costly due to the equipment and lab facilities required. A certain amount of biosafety is required in the testing setting, examples are cabinets with BSL-2 for trial development or, preferably, an undesirable compression room. These facilities are not available in most regular testing locations around the world. Furthermore, these services require experts with the competence and involvement to conduct the tests in a seamless and error-free manner. As a result, most countries around the world confront primary diagnostic issues due to a lack of testing centers and trained technicians. Another important diagnostic issue with this testing is the possibility of getting false negative and positive results.
- For both clinicians and executives, asymptomatic patients have turned into a genuine concern. They are harder to identify and separate, and they imply a more serious danger of uncontrolled transmission of the infection. A most recent review found that asymptomatic patients have a comparative viral burden to suggestive patients, demonstrating that they have a similar bandwidth. Another main pressing issue about this is greater part of the patients with asymptomatic signs might decline to go to centers or offices.
- Although Covid-19 patients had apparent chest scan using CT for manifestations, despite being RT-PCR-verified Covid patients, other researchers have described normal reports for CT scan. Another issue is that it necessitates numer-

ous scans (at least two, six days apart) for maximum diagnostic accuracy, putting additional strain on already-scarce CT scan machines.

- Specific antibodies tested against Covid-19 infections are detected using serological detection methods. These tests have the benefits of being inexpensive, quick discovery, and easy accessibility, but they have low susceptibility, as demonstrated with other classes of coronavirus and other virus such as influenza antibody tests. Antibody responses, on the other hand, vary between each individual and take days to grow once infected. This might not be helpful to accurately diagnose viral infection, except for confirming delayed infection of Covid-19 cases in patients and recovered people's immunity. Despite this, they consistently expressed skepticism about the tests' ability to detect the virus early in infection. Next section elaborates on the prognosis approaches used for Covid −19 infections.

3 Prognosis Approaches for Covid-19

The prognosis is a prediction of a disease's likely conclusion or course, as well as the patient's chances of recovery. In order to reduce the burden on the healthcare system while also delivering the best care for patients, data on the prognosis is more vital for the condition than diagnosis information. Age, comorbidity, vital signs, imaging characteristics, sex, leukocyte count, and Cb1 and Cb2 proteins were the most commonly used prognostic variables for Covid-19. Prognosis techniques look at the outcome of a situation using a prediction model. Especially during pandemic times, the machine learning based on clinical, radiological, and etiological data will be able to recognize image processing and clinical affect thinking to illness severity, as well as possibly estimate prognosis (hospitalization needs, ICU admission, orotracheal intubation). The importance of prognostic approaches is depicted in Fig. 2. Here are a few essential strategies that are discussed.

In federated learning approach [23] to predict the future oxygen requirements of symptomatic patients from multiple data sources. This system predicts the X-rays of heart and lungs and is monitored. This model monitors the age and the immunity power; based on the results, the doctor prescribes the medicines and the exercises to be followed regularly. Patients undergo ventilation; it is necessary to check the pulse rate and the oxygen in the patient's body. The model called EXAM (electronic medical record [EMR] chest X-ray [CXR] AI model) uses CXR and EMR features. In total, 20 features were used and the outcome labels for oxygen requirement were set in the mentioned categories: room air (RA), low-flow oxygen (LFO), high-flow oxygen (HFO)/non-invasive ventilation (NIV), and mechanical ventilation were the oxygen therapy categories (MV). The outcome label was set to 1 if the patient died within the prediction time frame.

The approach studied by Felipe Campos Kitamura et al. (2021) studied [24] the chest CT of patients with symptoms of respiratory syndromes. Machine learning models were deployed based on clinical, radiological, and epidemiological data to

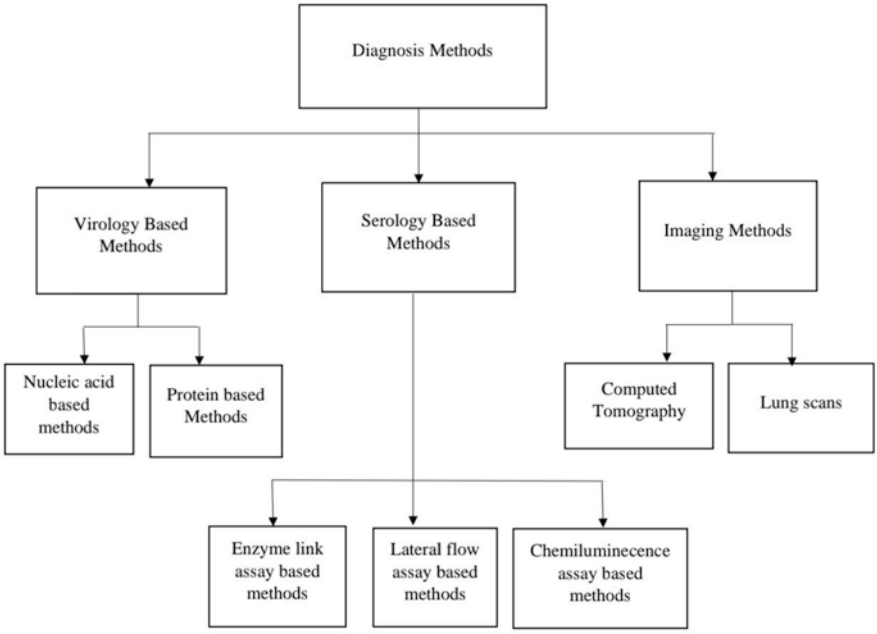

Fig. 2 Significance of prognosis

predict the severity prognosis of patients. Patient's respiratory syndrome and chest part is tested. If both are good, medicines with less dosage is prescribed and the exercise will be less. If pulse rate and respiratory strength is weak, the exercise and the medicines prescribed will be of heavy dosage.

Validation of AI algorithms enables the identification of solutions that, if allowed by regulatory agencies, have the potential to be used in a variety of situations in the future. This study is particularly relevant and promising at this time of pandemic, when the identification of prognostic markers can be critical in determining the optimal course of action and therapeutic strategy not just for patients but also for the entire health system.

4 Rehabilitation Approaches for Covid-19

Infection with the corona virus illness 2019 (Covid-19) necessitates rehabilitation. There are many techniques available for rehabilitation. Some significant methods adopted by researchers are discussed here. Because there are no English-language standards for the treatment of these people, a review of most recent reports was done. If the Covid tests are measured and identified, it shows the physical function review, measures of Heart and lungs rate, kidney if it is checked, recommendation of recovery will be based on the suggested issues and checks for the improvement.

Based on the current state of scientific knowledge and data, physiatrists and therapists [23] are expected to become more engaged in the treatment of these patients in order to enhance functional status, physical and psychological effectiveness, and restore a good quality of life for patients. Preparation ahead of time and careful planning can assist to mitigate the effects of this unexpected event.

According to the most recent estimates, 10–20% of SARS-CoV-2 patients who go through an initial symptomatic phase continue to have symptoms after 12 weeks following diagnosis. Despite the fact that researchers are beginning to look into this new ailment, there are still severe questions about diagnosis, which limits the optimal therapeutic strategy. Activity levels and exercise regimens are well-known modulation schemes of clinical symptoms and outcome in many chronic conditions. This paper predicts and suggests exercise for the patients who have recovered from Covid-19. Clinical issues must be treated, but cognitive and psychological components must be included in the evaluation, as well as the impact on society that this disorder entails, which necessitates an interdisciplinary and integrative approach that includes exercise sciences [25]. These exercises are to be maintained such as muscle strength, cardiorespiratory and other possible post-infection syndromes. There is need to have good health and a good immune system after recovery.

Coronavirus is a contamination that is brought about by a Covid that was as of late found. At the point when an infected person hacks or sniffles, the Covid-19 infection spreads dominatingly through spit beads or nasal release. The infection can enter the body through the nose, mouth, or eyes. As indicated by a few ongoing examinations, the infection can be communicated, however, through the droplets that stay suspended in air in shut and cooled conditions, for example, workplaces, AC taxis, shopping centers, and theaters because of an absence of consolidation; in any event, when you are not in touch with a contaminated individual [26].

In this study, they recommend that heart, diabetic, and hypertension patients should not meet in public places. Patients should not medicate on their own. The patients have to take their regular medicines as prescribed by the doctor every day without leaving one day. This paper suggests the patients to take heart rate and oxygen pulse, and these should be less than 80%. PROLUN, a multicenter prospective cohort research conducted at clinical sites [26]. Participants came from five of the clinics in the sub-study. Participants must be 18 years old and have been admitted for more than 8 h with a discharged indication of Covid-19 before June 1, 2020. Prior diagnosis of COPD, myocardial infarction, heart failure, or peripheral artery disease, living beyond the hospitals' catchment areas, incapacity provide the informed consent, or participation in the WHO Solidarity trial were all exclusion factors. More information about the study's design and participants has been released. This paper says that the fatigue and muscle weakness will be 63% for any post-Covid patient. Oxygen uptake, minute ventilate, heart rate, blood pressure, respiratory rate have to be checked every end of the week.

The impact of this pestilence is huge, and the best way to slow the sickness' spread is to rehearse social removing. The commanded lockdown has affected numerous components of individuals' lives, including regular work-out projects of wellness monstrosities, bringing about serious mental problems and extreme

wellness and health concerns. The writers of this article needed to get familiar with the assorted encounters of well-being cognizant individuals during the Covid-19 lockdown. The objective of the review was to perceive the way that they managed mental worries and actual medical problems at home by doing various activities and wellness exercises. Twenty-two adults who were often practicing out in the exercise room before the Covid-19 episode yet chose to remain at home during the far-reaching lockdown was consulted over the versatile in semi-organized interviews. In this paper, the creator recommends exercise to individuals who are at home during pandemic, yet we propose exercise to the post-Covid clients [27]. They recommend a minimum of 30 min of exercise during pandemic, yet here we propose more: 30–45 min. In this paper, the outcome produced will be less precise for the individual who was impacted by Covid and has presently recovered.

Covid-19 affects the immune system, physical health, and mental health, with the lung being the primary target organ of SARS-CoV-2 in the respiratory system. The rate of spread of corona disease virus infection is increasing every day and there is currently no vaccine available, making it imperative to dismiss patients with minor symptoms as quickly as possible. For the reasons stated above, it is critical to develop rehabilitation programs for such mildly affected people in order to recover physical health, pulmonary function, and reduce anxiety, all of which contribute to a better quality of life. Post-discharge patients with coronavirus illness benefit greatly from rehabilitation programs. Yoga has a significant role to play in the post-Covid-19 era, as it reduces psychological stress and strengthens the immune system, limiting infection transmission and averting consequences. Yoga is also beneficial for strengthening immunity and sustaining respiratory health. Practicing yogic breathing practices (pranayama) on a regular basis improves lung airflow, capacity, stamina, and efficiency [28]. Yoga, in combination with breathing exercises, may help individuals with chronic obstructive lung disease increase their respiratory capacity, resulting in an overall benefit of yoga training on enhanced pulmonary function. Yoga-based aasana (postures) and doing this (respiratory patterns) have been identified as beneficial workouts for Covid therapy. In this light, an example exercise regimen has also been offered.

One of these issues is post-Covid-19 syndrome, which is becoming more prevalent as the pandemic progresses. According to the most recent estimates, 10–20% of SARS-CoV-2 patients who go through an early diagnostic phase continue to have symptoms 12 weeks after being diagnosed. Although study into this new ailment has begun, there are still substantial problems about diagnosis, which limits the appropriate therapy strategy. In many chronic conditions, exercise regimens and levels of physical activity are well-known modulation schemes of clinical symptoms and prognosis [29]. This narrative review highlights the most recent research on corona disease to help people understand it better. It also describes how regular activities can improve with many of these signs and lessen the long-term impact of the disease. The paper suggests a few exercises, these exercises reduce the long-term effect of Covid-19. Exercise and physical activity level should be monitored periodically. Intake of food and immunity boosters should be monitored regularly. Rehabilitation during pandemic was suggested in the work [30]. In their paper,

patients can do their daily physical activity at their respective places with the help of social media and through online. After every session, blood rate and lungs rate is to be noted regularly. The author suggests that the improvement in body health and mood profile in elder people has to be monitored based on certain criteria.

The older people were chosen using the following criteria:

- Patients must be aged above 60 years.
- They must have engaged in physical activity for at least 2 months previous to the start of the Covid-19 epidemic.
- They should not possess any limitation for practicing physical activity.
- They should have clogged to their routine exercises and also should be under isolation for at least 3 months.

This study had two video-based phone calls. The first one had an elaborate discussion about the protocol and how to approach for answering the questions [31]. The second detailed about the remote exercise session and immediately after that they answered Brunel Mood Scale questionnaire. The exercises suggested were squat, push-up, stiff, push-up on the wall, upright row, etc.

This study suggested that remote exercises enabled them to improve total mood disorders like tension, anger, depression, and mental confusion, etc. It studied [32] a systematic review of Covid 19 patient articles from database sources like pubmed, Cochrane library, web of science, etc. They conducted randomized control studies of exercise therapy for Covid 19 disease patients. Aerobic exercise, daily exercise, endurance training, and so on are some of them.

Weight mean difference or standards mean difference were the metrics employed. This is used in studies on the therapeutic benefit of exercise to measure the efficacy of 95% CI. This informs other researchers on the prevention and treatment of Covid 19 activities, and it could be extended across language barriers.

To develop a machine learning model [19] to predict the future risk among patients diagnosed with Covid 19. Based on previous vitals, laboratory, and demographic data, a machine learning algorithm was built to predict the presence of intubation in the future. Using a sliding-window method, this model defined a supervised binary prediction classification. This is used to forecast intubation 72 h after the 24-h sampling window ends. From the time of admittance, a prediction job must be completed every 12 h.

There are various drawbacks to the proposed model. To generate a prediction, it currently requires a 24-h sampling window. As a result, fast risk evaluations for patients with less than 24 h' worth of data are impossible. It may be possible to lower this sample window in future experiments. Because different laboratory and vital sign results are updated at different times and at variable rates, we employed an indefinite feed-forward and up-sampling interpolation method to standardize feature sample frequency. Missing data was discovered following feature alignment to time because the laboratory and vital signs were updated at different times. Table 1 shows a summary of the methods discussed.

Table 1 Rehabilitation methods and activities

S.No	Method	Activities
1.	Physical activity or exercises	Squat, push-ups, etc.
2.	Yoga and breathing exercises	Pranayama, aasana (postures)
3.	Remote exercises	Improve mood disorders using Brunel Mood Scale questionnaire, aerobic exercises, endurance testing
4.	ML methods	Forecasting intubation using ML algorithms

4.1 Challenges in the Recent Studies in Rehabilitation

Some of the general challenges for patients include tiredness, sleep disorder, etc.

- Patients suffering from Covid-19 often feel tired and exhausted both physically and psychologically, as a result of modest activity; however, this will improve over time. Patients are likely to have lost immunity strength throughout their illness, and their joints may be tight. During sickness, it is projected that they have lost 2% of their muscle mass per day.
- Because everyone recovers at a different rate, it's tough to put a time frame on recovery, but patients shouldn't be concerned if it takes weeks or even months to get back to normal. Walking and exercising "little and often" is the only method to recuperate and strengthen.
- After deciding the activities that could be accomplished that day or even that week, establish a strategy to spread them out so you get enough rest. Begin with minor goals and progressively expand your workout time. Nowadays, most of the people work with their trainees or patients with physiotherapists and reading booklets with extra exercises for patients to practice at home on their own.
- After completing the Covid-19 physiotherapy exercise program, you should notice that your sleep pattern returns to normal as your activity levels increase. The most essential thing to remember is not to become concerned about lack of sleep because this will just exacerbate the situation. Before going to bed, try some relaxation techniques such as mindfulness, meditation, or even relaxing hobbies such as listening to soothing music or reading a book.
- The studies presented in this paper have a drastic lag in recommending personalized exercises for patients with post Covid syndromes. This could be an extensive area of study for researchers interested in this domain.

4.2 Limitations of Current Solutions to Covid-19

The research provided has a wide range of methods. State decision makers can assess the Covid-19 pandemic crisis in a way that prevents future crises involving other infectious illnesses. The findings of our study, which demonstrate the most

disruptive impacts of the pandemic on people, can be used to establish strategies for dealing with the crisis' repercussions so that public mental health does not deteriorate in the future. Our findings can also be utilized to influence future limits communication in order to guarantee that they are fully respected (for example, by giving rational explanations of the reasons for introducing particular restrictions). Furthermore, our findings can be utilized to provide guidance on how to deal with the limits that may arise in the event of a repeat Covid-19 pandemic, as well as other possible scenarios.

The findings revealed that the Covid-19 epidemic, particularly the lockdown periods, is posing a severe challenge for many people owing to the loss of social contact. Social contacts, on the other hand, can help people shift through crises more smoothly. This understanding should drive policymakers to design strategies to assure pandemic safety while keeping social contact to a minimum, as well as solutions that give people a sense of control (instead of depriving them). Providing such alternatives can help people manage better with a pandemic by reducing the psychological issues that come with it.

5 Conclusion

This chapter seeks to identify recent challenges in prognosis, diagnosis, and rehabilitation of corona virus-affected patients. Many methods are based on the clinical study of data and also on ML-based techniques need improvement in early diagnosis of Covid-19 infections among people. Prognosis techniques are discussed based on the stages of viral cycle. This also finds a systematic review of all the existing methods for analyzing the techniques adopted for rehabilitation of patients with post-Covid syndrome. In rehabilitation approaches, personalized recommendation of exercises could be helpful. These could be automated based on diagnosis and combined with ML-based algorithms for providing recommendations. There are many solutions still under research for Covid diagnosis, prognosis, and rehabilitation. Some general limitations to these solutions have also been addressed. This would throw light on researchers to develop solutions using clinical and machine learning-based solutions not only for detection and prognosis but to recover in an effective manner.

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