CLINICAL ASSESSMENT AND MANAGEMENT OF COVID-19 PATIENTS USING ARTIFICIAL INTELLIGENCE

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ABSTRACT

The COVID-19 infection caused by Novel Corona Virus has been declared a pandemic and a public health emergency of international concern. Infections caused by Corona Virus have been previously recognized in people and is known to cause Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Unlike the earlier infections, COVID-19 spreads alarminqly and the experience and volume of the scientific knowledge on the virus is small and lacks substantiation. To manage this crisis, Artificial intelligence (AI) promises to play a key role in understanding and addressing the COVID-19 crisis. It tends to be valuable to identify the infection, analyse it, treat it and also predict the stages of infection. Artificial intelligence algorithms can be applied to make diagnosis of COVID-19 and stepping up research and therapy. The paper explains a detailed flowchart of COVID-19 patient and discusses the use of AI at various stages. The preliminary contribution of the paper is in identifying the stages where the use of Artificial Intelligence and its allied fields can help in managing COVID-19 patient and paves a road for systematic research in future.

KEYWORDS

Artificial Intelligence, COVID-19

1. INTRODUCTION

In Wuhan, China a new corona virus was recognized in December 2019 and by 11th March 2020, a worldwide epidemic was declared by the World Health Organization (WHO). Corona virus is a group of infections and can take the form of SARS, MERS and COVID-19 that affects the respiratory tract. It has been scientifically proven that Corona Virus spreads via close contact and through respiratory droplets formed when a person sneezes or coughs. It may also be spread through fomite transmission such as infected surface and via physical contact with the body's mucous membranes like eyes, mouth, nose that might bring the pathogen into the body. The side effects of COVID-19 are vague, varying from asymptomatic to severe pneumonia and mortality. The most widely recognized clinical indications are fever and cough. Reverse transcription polymerase chain reaction (rRT-PCR) from a nasopharyngeal swab is the standard process of analysis. It can be also recognized from a grouping of chest CT scan, side effects and risk factors which show features of pneumonia [10].

Artificial intelligence (AI) programs the system to intelligent plays an important role in different domains like Natural Language Processing (NLP), robotics, biometrics, speech understanding,

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machine learning, deep learning, computer vision etc. It emphasises on reasoning action, computation and perception by use of artificial neurons that connect points in an artificial neural network. Artificial intelligence (AI) is changing our way of life, aiming to imitate human intelligence by a computer/machine in different issues. The three main considerations influencing AI algorithms are the accessibility of historical data, regular information and high computational force. The main goal of AI applications in medical field is to study relationships between precaution, treatment techniques and patient outcomes. AI technologies have been enhanced and useful in treatment protocol, drug development, diagnosis procedures, and personalised medicine.

The various roles played by AI during the pandemic are early admonition and alerts, investigation and perception of spreading patterns, prediction and identification of epidemic of diseases, study and examination of the virus, expectation of disease rate and contamination pattern, real-time disease monitoring worldwide, quick decision-making to spot the effective treatments and medication disclosure.

This paper discusses the role of AI technologies in the combat of COVID-19 infections, The primary contribution of this work is in framing a standard process followed by trained doctors to identify the COVID-19 patient and secondly to identify research areas in Artificial Intelligence. The rest of the paper is arranged as follows: the next section gives a brief background of the COVID-19 followed by literature survey, work and the conclusion.

2. Artificial Intelligence and its Importance

Artificial intelligence (AI) has contributed in all aspects of our lifestyles and its applications are changing our way of life by mimicking human intelligence to tackle everyday tasks. It permits us to mine knowledge from data by recognizing and understanding data patterns and later repeat them on new data for the required task.

AI has been applied effectively in different fields such as computer vision, medical imaging using deep learning, text mining, natural language processing, internet of things and many more. AI algorithms have been made use of in combating of COVID-19 on many fronts; from screening, identification, treating to drug improvement [13]. We give a brief description of it below, however the authors would like to point out that a systematic method of understanding of use of AI in COVID-19 infection management has not been given due attention. Most of the work has been random, leading to a haphazard overlapping work at different levels.

A brief description of the applications of AI in COVID-19 is given below:

1. Text mining and Natural Language Processing: Authors Du, S. Et.al.[3] discuss a hybrid AI model for COVID-19 infection rate forecasting is proposed with Improved Susceptible infected model. The natural language processing module, the long short-term memory networks are incorporate with ISI model to make hybrid AI model for COVID-19 forecast. NLP is utilized to extricate semantic characteristics from associated information for example citizen's avoidance awareness, outbreak control method of governments. These characteristics provide as inputs to LSTM deep learning model to modify the illness rate predictions of the SI model.

2. NLP, Text mining & network analysis are used to examine a Multilanguage Twitter dataset. In the paper titled "Understanding the perception of COVID-19 policies by mining a multilanguage Twitter dataset" by [4], they perceive the regular reactions to the pandemic and how these responses outbreak across time and countries. This dataset of 364K posts on

twitter have been extracted to give bits of knowledge on open reaction towards the pandemic over a few nations and various dialects.

3. Deep Learning for Medical Imaging: In paper "Performance of radiologists in differentiating COVID-19 from viral pneumonia on chest CT" [14] Medical Imaging assumes a significant job in the identification of COVID-19 patients those most badly affected. The overall performance of radiologists in interpreting chest CT images for discrimination of COVID-19 from viral pneumonia. AI methods mainly deep learning have been utilized to process and examine medical imaging data to help doctors and radiologists to get better diagnosis performance. Medical images such as Computed Tomography (CT), Chest X-ray (CXR) and Ultrasound (US) have been broadly used for diagnosis, follow-up, prognosis and treatment in the clinical management of COVID-19.

4. Internet of Things: Many papers have discussed how IoT is ending up being exceptionally useful in the combat against COVID-19. This technology may be useful to the epidemiologists for looking through patient and furthermore in distinguishing the people interacting with the patients. Compliance of isolate by the patients can be guaranteed. The patients who violate the isolate can be traced. Also, this innovation can be useful in giving ease to the clinical staff by remote checking of in-home patients.

5. Computer Vision: Numerous AI-based computer vision camera systems are conveyed in China and over the world to check mob for COVID-19 side effects and screen individuals throughout lockdown. Infrared cameras are utilized in china to scan mob for high temperatures at train stations and air terminal. Sometimes they used a facial recognition system to identify the person with a high temperature and whether that individual iswearing a surgical mask.It is suggested that those cameras can test 200 people in minute and could apprehend the ones whose frame temperature exceeds 37.3°

6. Robotics: The job of robotics in healthcare relating to control of the spread of the novel corona virus. Also it helps to minimizeindividual to-individual contact and to guarantee sterilization, cleaning and services like isolate. This could bring about minimizing the life threat to therapeutic workers and doctors taking an lively function in the control of the COVID-19 deadly disease.

The utilization of AI and data sharing standardization protocols is useful for better worldwide comprehension and management of health during the COVID-19 pandemic. AI methods can also demonstrate its great effectiveness in supporting managers to make better decisions for virus containment when loads of urban wellbeing information is gathered by information sharing across and between smart cities [5].

3. LITERATURE SURVEY

Initial revelations of COVID-19 with AI were made by BlueDot, a Canadian company. BlueDot recognized the spread as well as anticipated the spread of infection to different urban areas. AI can be utilized as an early epidemic warning framework. Many tools have been developed and the next section describes a few of them briefly.

Artificial intelligence (AI) technologies support the ability of imaging tools and clinical specialists. AI image acquisition can help computerize the filtering strategy and reshape the work process with insignificant contact to patients provided that efficient protection to the imaging technicians is kept in mind. AI application also developed efficiently by precise depiction of infections in X-ray and CT images which facilitate resulting measurement. Analysis strategies

used COVID-19 analysis together with segmentation, diagnosis, image acquisition. The combination of AI with X-ray and CT are used in the frontline hospitals so as to represent the most recent advancement of medical imaging and radiology combating against COVID-19 [1].

The function of CR based IoT explicit for the clinical area is called Cognitive Internet of Medical Things (CIoMT). It is investigated to handle the worldwide test. Idea of CIoT is most appropriate to present pandemic as each individual is to be associated and observed through a very big network that needs efficient spectrum management. This tool is used for quick identification, active monitoring, tracking, better triage and control without spreading the infection to others [6].

An AI analytic tool is utilized to differentiate COVID-19 from different kinds of respiratory illness within seconds by patient's chest CT scan images in China. This new model supports great potential to improve early identification, relieve the pressure off frontline physicians, isolation and treatment [8].

FluSense is a contactless syndromic examination stage which is used to figure occasional influenza and other viral respiratory epidemic like SARS. It comprises of a novel edge-computing sensor framework, models and data preparing pipelines to follow coughs, crowd behaviours and to guess daily illness. It utilizes microphone and a thermal camera to constantly distinguish speech and cough sounds in a real-time manner [9].

A deep learning model COVID-Net is planned to identify the COVID-19 positive cases from chest X-rays. It also speed up the treatment for those who require it the foremost. COVID-Net uses deep convolutional neural network to analyze corona virus from chest radiography images. Open repository data contain COVID-19 and a variety of lung conditions taken as a trained data. The author's shows it is by no means a production-ready solution and they called on the scientific community to build up its advance in specific to improve sensitivity. [12]

As discussed here, as the worldwide health crisis deepens, the medical fraternity explores and understands new technologies to monitor and controls the spread of COVID-19 pandemic. Many methods of AI and its technology are suggested to understand the phases and spread of the virus, identifies high-risk patients, as well as controlling and segregating potential high risk persons.

4. COVID-19 PATIENT MANAGEMENT PROCESS

On the basis of our detailed study of published papers and study that have come up after the COVID-19 outbreak, it is alarming to see how AI application and its use for patient management is not standardized. There is random work that comes up and some standard understanding of the flow of events in COVID-19 patient management is missing. The various roles played by AI for COVID-19 treatments and management is crucial and can range from disease identification, study and examination of the virus, expectation of disease rate and contamination pattern, real-time disease monitoring worldwide, quick decision-making to spot the effective treatments and medication disclosure.

Contagious diseases are brought by pathogenic microorganisms like virus, fungi, bacteria, parasites. When a patient is infected, he may be symptomatic or asymptomatic. Corona virus is asymptomatic disease which is transmitted by Human-to-human interaction through fomites like emitted droplets of sneezing, coughing, speaking within few meters of distance.

Based on our intensive study, Figure 1 below shows the general procedure followed by a medical fraternity to recognize COVID-19 symptoms of a suspected patient and further management of the patient till he is cured.

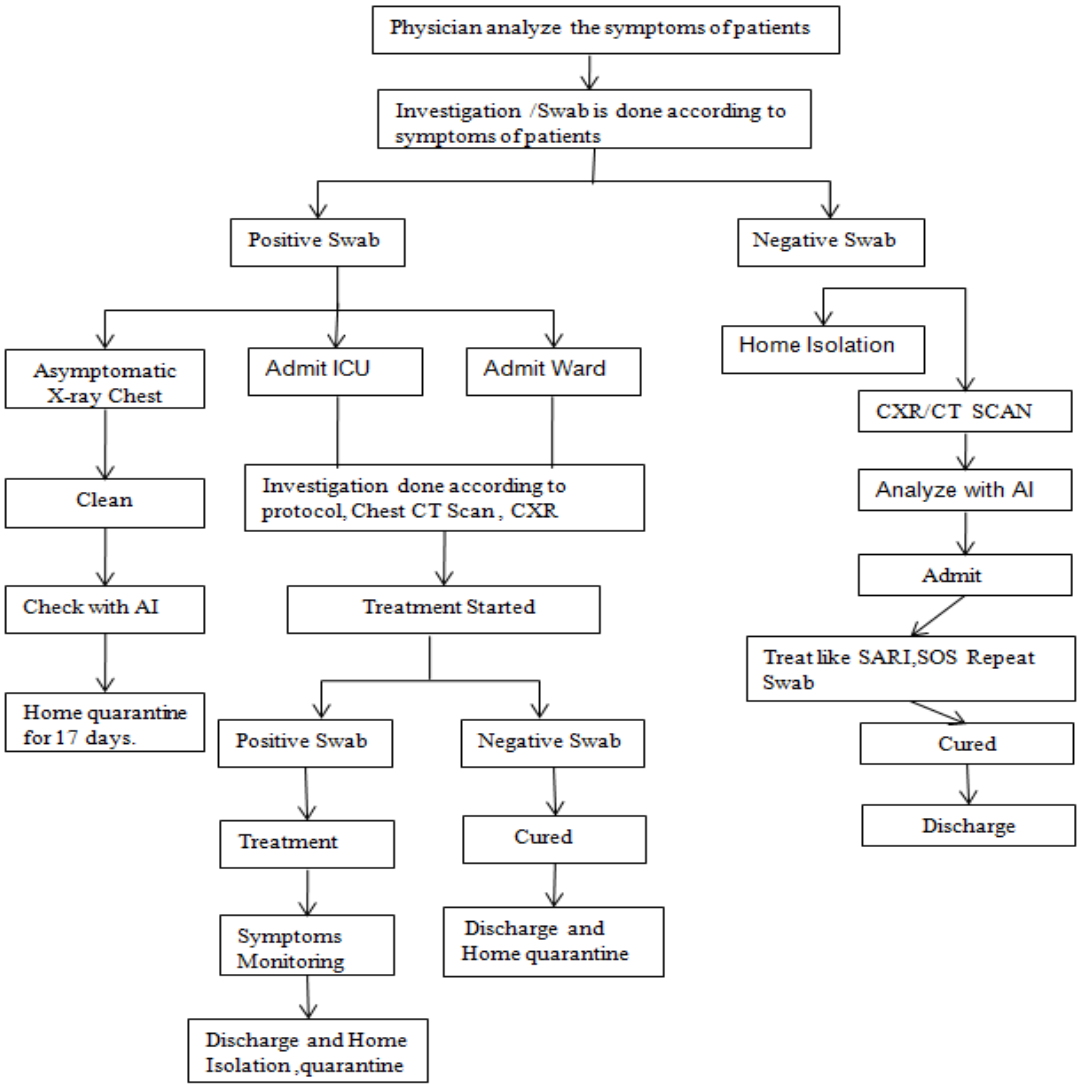

Figure 1. Process for COVID-19 Patient Management

Physician examine the symptoms of patients which include cold, fever, cough, dizziness, shortness of breath, new anosmia, diarrhoea, nausea or vomiting, headache, fatigue, muscle aches, throat pain and loss of smell and taste. These symptoms are also called are also called constitutional symptoms. Investigation of patients is done according to symptoms of patients and if these indications are strong, oral and nasal swab of patients is done. The symptoms may be categorized into mild, moderate, severe and critical.

Based on the symptoms and investigations, a inference can be drawn as to the severity of the infection. This analysis done after a detailed study and examination of hospital patients is summarized below in Table 1.

Table 1. Symptoms and Indicative Inferences of Covid-19 patients

Symptoms	**Clinical Severity**	**Indicative Inferences**
No clinical symptoms	Asymptomatic	No chest imaging findings
Mild clinical symptoms, such as fever, fatigue, cough, anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, headache	Mild	No abnormal chest imaging findings
Clinical symptoms as well as respiratory side effects of cough, shortness of breath	Moderate	Chest imaging showed mild pneumonia manifestation
Clinical symptoms and suspected respiratory infection symptoms plus any of the following: Shortness of breath, oxygen saturation	Severe	Chest imaging showed the lesions significantly progressed was a severe disease
Clinical symptoms and Cardiac injury, respiratory failure, hypertension, diabetes, cardiovascular disease, septic shock	Critical	Need mechanical ventilation and ICU monitoring treatment

Patients with mild illness may show side effects of an upper respiratory tract viral contamination. These comprise of mild fever, dry cough, sore throat, headache, nasal congestion, muscle pain. Patient with moderate sickness may show respiratory side effects of cough, shortness of breath. Severe pneumonia, acute respiratory distress syndrome present with severe symptoms of patients. A critical disease with features of cardiac injury, respiratory failure, hypertension, diabetes, cardiovascular disease may be developed in patient.

If along with these symptoms and conditions, the Swab tests are positive then admission to intensive care unit is required along with isolation or quarantine, depending on the moderate, severe or critical symptoms of patients. Under this isolation, the investigation of patients is done according to protocol. Patients can be feverish in the primary stages of infection with only respiratory and chills symptoms. In patients who are feverish without shortness of breath, a doctor would suggest estimations of complete blood count (CBC). CBC test includes haemoglobin, RBC count, WBC count. Chest CT is useful in recognizing viral pneumonia. When patient shows the symptoms of a fever, a patient needs to be taken for X-ray chest, CT and respiratory viral tests. Patients diagnosed with viral pneumonia require isolation and SARS-CoV-2 test. Further, if shortness of breath exists and oxygen immersion is seen, supplemental oxygen is prescribed and patient is admitted to an isolation ward. Special considerations are given for old people, immune compromised, pregnant patients. These patients should be treated as moderate or severe cases in the initial assessment.

If patient have any of the symptoms then test sample of nasopharyngeal specimen and Oropharyngeal specimen is taken by healthcare provider. Most tests use a cotton swab to get a sample from the inside of your nostrils and throat. If test is positive for SARS-CoV-2 then patient get treatments. After detecting positive case of patient treatment get started according to symptoms. Patients with COVID-19 require regular monitoring of vital signs like temperature pulse, respiration and SPO2. If swab is negative then patient get cured. Patient with negative swab are discharged from hospital. Patient provided with oral and written information guiding the need to stay in home quarantine.

If tests are negative then keep the patient in home isolation. Patient followed by mild symptoms may not require emergency interventions or admission to hospital if respiratory status is stable

and sanction discharge home. As per their clinical symptoms, patient management is done. Laboratory testing such as CXR, chest imaging ought to be performed in febrile patients. Chest computed tomography (CT) has been utilized to analyze COVID-19 showing that pneumonia is the most well-known appearance of the illness. So to detect the illness CT imaging is usually used.

We have described above the symptoms and indications. The goal of describing the entire process in details is to understand the future application area of Artificial Intelligence. We also expect that this flowchart will help further research work in understanding the methods used by medical fraternity to manage COVID 19 patient. During this entire process, large data may be collected at various stages and application of AI or Deep Learning on this data to discover patterns and make predictions can be very useful.

Artificial intelligence assisted with predicting which people would get the most sick and make sense of which of the side effects associate with severe acute respiratory infection(SARI). These patients have pneumonia-like symptoms. There might be a threat of contagion in these cases. So we chose to treat them like COVID 19 patients. So if required then repeat the swab of patient otherwise that patient get cured and discharged from hospital. But if these patients are tried positive for corona virus, they are moved to the COVID 19 ward and give treatment like COVID patients.

5. PATH TO FURTHER INVESTIGATIONS

Given below is a detailed analysis of the instances at which AI can play a role in further studies. Though much attempt has been made to use AI in COVID management, a systematic plan needs to be designed to understand the future of COVID analysis using AI, Deep Learning and advanced algorithms is missing. With reference to Fig. 1 as explained, the patients, who had positive tests, however do not show any signs are the ones who are asymptomatic at testing. As is logically obvious, asymptomatic people assume a major role in the transmission of SARS-CoV-2. Regardless of whether individuals have symptoms or not, they convey a similar measure of infection inside them. Symptom-based screening alone is unsuccessful to identify a high amount of contagious cases and insufficient to control transmission. In home quarantine AI is used to monitor home patients: patients can enter vital statistics like temperature, pulse, oxygen levels and this can be compared in a day to day analysis. If some alerts are detected then AI helps us to understand these alerts and the patient can be put under closer monitoring.

We can utilize Artificial Intelligence calculations to distinguish the infection using X-ray. If the patient’s X-ray is clean then patient is home quarantine for 17 days. The symptoms of such patients are check with wearable sensors.

Table 2. Analysis of COVID-19 using existing AI method

Sr. No.	Parameter	Analysis	Methods Used
1	Positive Swab	According to symptoms and history of patients admit to ICU/Ward	Decision tree, Random Forest, Neural Network, Classification and regression tree
2	Asymptomatic X-ray	Asymptomatic patients may have lung lesions on imaging so X-ray is preferred	XGBoost, Support Vector Machine
3	Investigation according to protocol	Symptoms and laboratory measurements were used to forecast the infection risk using Chest CT Scan, CXR	To predict the infection at early stage Support Vector Machine and back propagation neural network can be used. Can help in building effective predictive models to find various infections as early as possible.
4	Analyze with AI	Check respiratory status using CXR, CT scan	Support Vector Machine
5	Asymptomatic check with AI	To track heart rate variability, blood pulse wave, heart rate, blood oxygen saturation, respiration rate, activity, barometric pressure, skin temperature wearable sensors are essential to monitor asymptomatic patients.	IOT
6	Discharge & Home Isolation	Artificial Intelligence is used for remote monitoring of home-isolated patients through smart bracelets or smart phones. If the patient breaks quarantine, automatic alarm will sound and give a warning message.	Artificial Neural Networks can be trained to conclude qualitative characteristics that are depend on network inferences and intensity, which can be associated with the patient's condition

Other important methods that can prove beneficial are:

- AI has the influence to improve chest imaging beyond just screening for signs of COVID-19 in a patient's lungs.
- AI can help to improve risk classification of patients for the type of care they receive based on the predicted course of their COVID-19 infection.
- The COVID-19 database made up of medical data of real patients contains data of symptoms such as chest pain, muscle pain, chills, colds, discomfort, conjunctivitis, cough, diarrhoea, dry cough, dyspnoea, respiratory symptoms, weakness, emesis, expectoration, eye irritation, pneumonia, fatigue, dizziness, gasp, lesions on chest radiographs, little sputum, malaise and so forth. This can be useful for future predictions.

- Supervised learning algorithm such as Decision tree, random forest, neural network and support vector machine algorithms can be applied to diagnose the patient who is infected. Whether a patient is suffering from a disease or not based on symptoms is done by decision tree. SVM examine data and recognize a pattern which is used for classification and regression analysis.

- Order of treatment is important plays an important part of the procedure even on account of developing irresistible disease where endeavours must be prioritized.

- An AI system can be use where the patients having mild symptoms may be home quarantined and the patient is at higher risk, an appropriate drug is administered. A system can propose an antibiotic treatment to the patient depend on factors like the infection sites, body temperature, antibacterial spectrum, symptoms and complications. In the final step, based on the result, treatment will be given to patient.

In all the role of AI in a COVID-19 patient treatment must be given due thought and consideration.

6. CONCLUSIONS

Artificial Intelligence is powerful tool to recognize early infections due to corona virus. AI has contributed to managing the corona virus infection (COVID-19). It makes a difference in observing the condition of the infected patients. It is also helpful to facilitate the research on this disease via examining the existing data. It can make decision making and therapeutic plan by creating valuable algorithms. AI can offer assistance in creating appropriate therapeutic regime, precaution procedures and medicine and immunization innovation.

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