

Covid-19 Infected Case Estimation In India Using 5-Pl Model

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Abstract: On 11th February 2020, Corona-virus was declared as a disease, COVID-19, by the World Health Organization (WHO). In December 2019, China became the first country to report its first case of COVID-19. The novel Corona-virus started spreading at an uncontrollable pace across the world and was therefore declared as a Pandemic disease in March 2020 by the WHO. In this manuscript, the India's epidemic situation with total no. of days as 242, starting from 13th January till 10th of September 2020 is being predicted. The 5-PL model is used to predict the reported data. Nonlinear regression techniques in MATLAB to predict the parameters. In an attempt to do so, it has been observed that the prediction seems to be quite close to the actual on ground situation. This will certainly help the decision makers in implementing improved strategic decision making to counteract, and restrict the spread of the COVID -19.

Keywords: COVID-19, Immune, Cause, Prevention, Society, Health

1. INTRODUCTION:

An adverse contagious disease, Coronavirus disease 2019 (COVID-19), was identified in the capital of Hubei province of China, Wuhan, in December 2019[1]. It is mainly caused due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)[2-3]. As a result of this globally spread disease, 2019-2020 coronavirus pandemic is the outcome. On 1 December 2019, the onset of symptoms was confirmed through the study of first 41 cases of confirmed COVID-19 and this was published in January 2020 in The Lancet[4]. The symptoms can be as common as cough, shortness of breath and fever but may also include muscle pain, sore throat, abdominal pain, fatigue, diarrhea, and loss of smell as shown in Figure 1 [5]. These symptoms may begin to show their effect in two to fourteen days but generally, in around

five days. As of 10 September 2020, the confirmed cases had surged to more than 29 million in more than 185 countries and territories. More than 928,325 deaths were reported while more than 21,031,679 people had recovered.

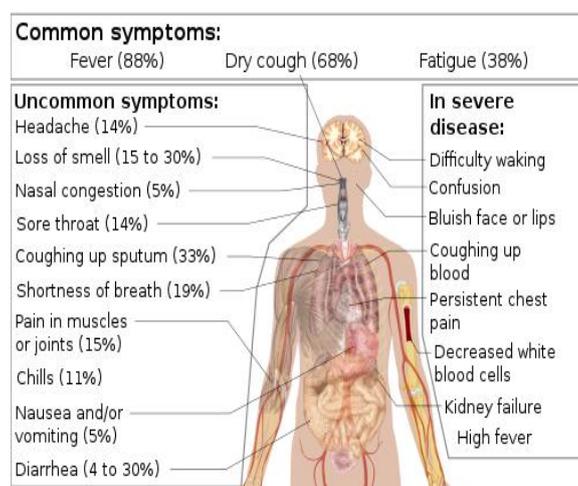


Fig.1. COVID-19 Symptoms [5]

The virus is spread mainly via small droplets which are produced when people talk, sneeze or cough[6]. These droplets, rather than being suspended in the air over long distances, fall on the ground/surface. It has the tendency to survive for up to 72 hours on the surfaces and can hence be carried by people if someone touches the contaminated surface and then touch their face[7]. A real-time reverse transcription polymerase chain reaction (rRT-PCR) from a nasopharyngeal swab is the primary method of diagnosis of the disease [8]. Further diagnosis procedures include a combination of symptoms, risk factors and a chest CT scan exhibiting features of pneumonia [9].

Preventive measures like washing hands frequently with soap, social distancing (about 6 ft), avoiding touching face, and covering coughs and sneezes with a tissue or inner elbow can be practiced [10]. To stop its spread, masks should be worn by the person affected and caregivers. Currently, there is no vaccine or specific antiviral treatment for COVID-19. Management involves the treatment of symptoms, supportive care, isolation and experimental measures[11]. The 2019–20 corona-virus outbreak was declared a Public Health Emergency of International Concern (PHEIC) on 30 January 2020 and a pandemic on 11 March 2020 by the World Health Organization (WHO)[12].

The main role of robust models is for predicting the spread of COVID-19 pandemic. Appropriate and early measures predictions of the impact of this pandemic can definitely help the government and the society to implement the effective control mechanism, and enhance its diagnostics and patient care capacities. In this paper, COVID-19 infected cases have been modeled using a nonlinear regression routine, most commonly known as logistic five parameter model. The reliability of the proposed results has been tested against the actual data for India. This type of study is particularly very important for the leadership of various countries to take prompt and effective measures to control the spread of the disease, and avoid a sense of insecurity in the minds of the general public.

2. SIGNS AND SYMPTOMS

The people who get infected with the virus may initially develop flu-like symptoms or may be asymptomatic [13]. These asymptomatic cases may also contribute to spreading of the disease [14]. The flu-like symptoms include fatigue, cough, shortness of breath, and fever. Medical attention needs to be given immediately to those with symptoms such as persistent chest pain or pressure, bluish face or lips, confusion, and difficulty in breathing and walking. Symptoms such as vomiting, nausea, and diarrhea have been observed in people [15]. In March 2020, in case of those who have mild disease, loss of sense of smell (anosmia) has also been declared as a common symptom, although it was not common in the initially reported cases [16]. Initially in China, people were seen with chest tightness and palpitations only.

The incubation period, the time between the moment when a person is infected with the virus and when symptoms are developed, ranges from two to fourteen days but is five to six days typically. 97.5% of people who develop symptoms will do so within 11.5 days of infection [17]. As of 10 April 2020, the percentage of people who did not display symptoms was unknown and was being extensively studied. It has also been reported in literature that majority of the cases are asymptomatic [18-19].

3. PREVENTIVE MEASURES

Various preventive measures have been recommended to people to reduce their chance of getting infected and spread the virus. These measures suggest staying at home, frequent hand washing and for at least 20 seconds, avoiding crowded places, avoiding touching eyes, nose or mouth, and practicing good respiratory hygiene [20]. For now, since a vaccine is not expected until 2021, COVID-19 management includes “flattening the curve”, i.e. decreasing the epidemic peak by providing good treatment to the current cases and holding back the future cases until a vaccine and effective treatment is available [20]. Although, according to WHO, the person who is coughing and sneezing the person who is treating an infected person is recommended to wear face masks. But some countries like China, Hong Kong, Austria, India, and Czech Republic recommend even healthy people to use face masks.

If the abovesaid guidelines are followed religiously, one can help the society in breaking the chain of COVID 19 spread. This also helps the governments to buy certain time to make the necessary arrangements for the treatment of the infected patients, procurement of the requisite life-saving equipment, and draft and implement the suitable policies for their country. So, if the suitable and effective predictive studies are carried out then, these can certainly help the governments to properly devise their strategies.

4. CASE STUDY OF INDIA USING 5 –PL MODEL

India reported its first case of COVID-19 on 13th January 2020 and first reported local transmission was confirmed on 30th January 2020 [20]. At the end of February, a total of 3 cases were reported. Thereafter a sharp increase in no of infected cases occurred in the mid of March 2020. The India government declared a Janta Curfew on 22nd of March 2020. Thereafter the government issued nationwide lockdown on 24th of March 2020 for 21 days in order to control the spread [21]. Figure 2 presents the date wise rise in infected cases.

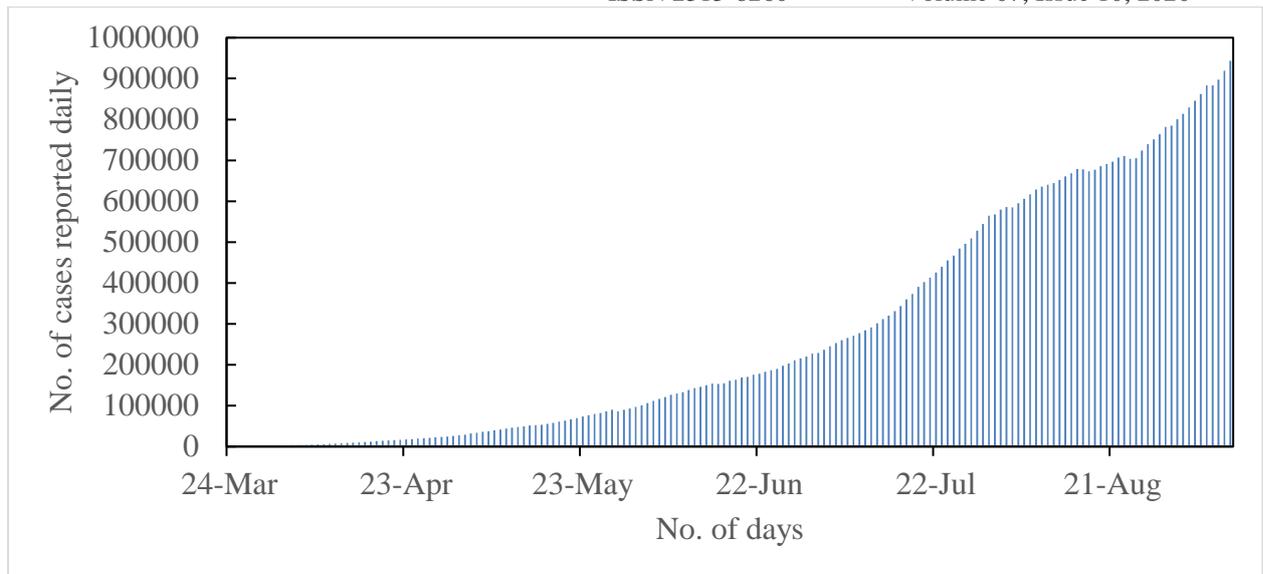


Fig. 2. India Covid-19 new confirmed cases daily [20]

The main role of robust models is for predicting the spread of COVID-19 pandemic. Appropriate and early measures predictions of the impact of this pandemic can definitely help the government and the society to implement the effective control mechanism, and enhance its diagnostics and patient care capacities.

COVID-19 infected cases can be modeled using a nonlinear regression routine, most commonly known as logistic five parameter model. This Five parameter logistic model (5-PL) is asymmetrical sigmoidal and Gaussian model best predicts the behavior of infected case, when the response curve is not symmetrical [21]. 5PL model may be expressed as follows:

$$\text{No. of infected cases}(y) = D + \frac{(A - D)}{\left[1 + \left(\frac{x}{C}\right)^B\right]^E}$$

Where:

A = estimated response at zero cases

B = slope factor

C = mid-range cases

D = estimated response at infinite cases

E = asymmetry factor

Our case scenario describing the India epidemic with total no. of days as 242, starting from 13th January till 10th of September 2020 and using nonlinear regression techniques in MATLAB, our proposed 5-PL model predicted a good fit ($R^2 = 0.9958$), to the reported data as shown in Figure 3. Comparison of the infected cases with the expected data is presented as follows, in Figure 3:

Coefficients (with 95% confidence bounds) are as follows:

A = 4195 (-1263, 9653)

B = 6.037 (5.381, 6.694)

C = 261.7 (114.3, 409)

D = 1.101e+06 (7.76e+05, 1.427e+06)

$$E = 3.371 (-7.965, 14.71)$$

From the results so obtained, it can be safely concluded that the proposed predictive model based on Gaussian form that lockdown and social distancing can help in breaking the chain of COVID 19 spread. After an exponential increase is valid and result in improved strategic decision making by limiting the spread of the COVID -19.

5. CONCLUSION

The Pandemic disease of Corona-virus is creating a serious impact on the life of individuals with everyone in the world facing its dire consequences, either directly or indirectly. Unprecedented lockdowns and emergency have been declared in many countries and have brought even the most developed countries like USA and Germany to standstill. An environment of fear, anxiety and stress prevails among the developed and developing nations. We conclude that the proposed predictive model based on Gaussian form which has been carried out for India suggests that “lockdown” can reduce contagiousness in the population after an exponential increase is valid. So, if the suitable and effective predictive studies are carried out then, these can certainly help the governments to properly devise their strategies. An attempt that has been made in the present work of using 5-PL model for predicting COVID-19 related infectious cases shows quite satisfactory results. This study helps the governments to buy certain time to make the necessary arrangements for the treatment of the infected patients, procurement of the requisite life-saving equipment, and draft and implement the suitable policies for their country. So, if the suitable and effective predictive studies are carried out then, these can certainly help the governments to properly devise their strategies.

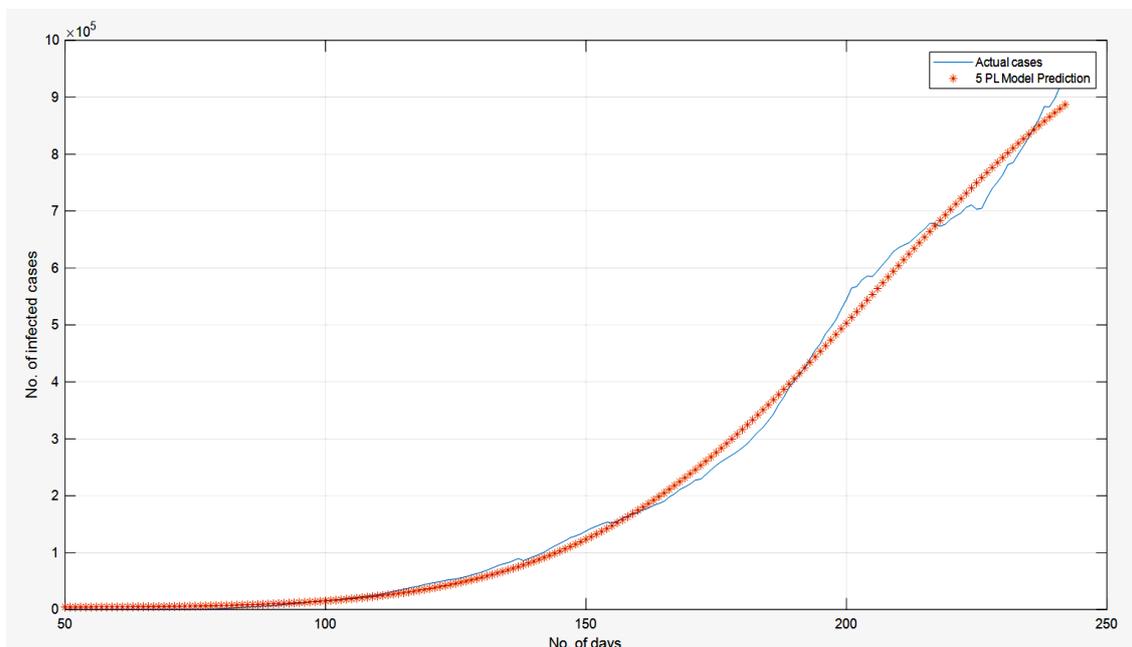


Fig. 3. India Covid-19 infected cases with our model

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