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A Mathematical Model for Infection of the Human Body by the Effects of Coronavirus

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Abstract—The effect of the coronavirus is increasing daily. The coronavirus has caught the whole world. The coronavirus has infected more than thousands of people and killed more than millions. If the coronavirus is not stopped, then the system of the population of the whole world will be shaken. We have accepted this coronavirus problem as a challenge. A guideline has been provided by Mathematical Modeling to rule out the effects of the coronavirus and to protect people from the coronavirus. We are confident that this guideline will act as a shield to protect the lives of all people from the coronavirus.

Keywords— COVID- 19, Immune system, Vaccine, Infected persons, etc.

I. INTRODUCTION

Since 2003, coronavirus has caused multiple major public health events that resulted in international epidemics, like severe acute m etabolism syndrome (SARS), geographical region metabolism syndrome (MERS), and the coronavirus sickness 2019 (COVID-19). Particularly since COVID-19 out broke in urban center, Hubei, in December 2019, the coronavirus has had a major impact on people's health and lives but so far, the pathological diagnosing of COVID-19 has been comparatively it's still confined to the pathological findings of perforated organs, and therefore the majority of medical employees have poor awareness of its pathological characteristics. The COVID-19, as same as respiratory disorder and MERS is caused by the coronavirus and might cause virus infection [3]. In Wuhan, China, a unique and alarmingly contagious primary atypical (viral) respiratory disease bust move into Dec 2019. It's since been known as an animal disease the coronavirus, kind of like severe acute respiratory syndrome the coronavirus and MERS the coronavirus and named COVID-19. As of eight Feb. 2020, 33 738 confirmed cases and 811 deaths are reported in China [8]. Surviving a COVID-19 infection means that you gain long-lived immunity and, if so, for the way long? To grasp, we predict that this study might cause a higher estimation of the unfolding of this pandemic in the future. We tend to develop a mathematical model to gift the energizing behavior of COVID-19 infection by incorporating the isolation category. First, the formulation of the model is proposed; then, the quality of the model is mentioned. The native stability and international stability of the planned model area unit conferred, that trusted the essential procreative [1]. First, we tend to gift a replacement discrete-time mathematical model describing the evolution of the COVID-19 in an exceeding population underneath quarantine. We tend to area unit intended by the growing numbers of infections and deaths in countries underneath quarantine to research potential causes. We tend to contemplate 2 new categories of individuals, those that respect the quarantine and reside home, and people United Nations agency don't respect the quarantine and leave their homes for one or another excuse. Second, we tend to use real revealed knowledge to the parameters of the model, and then, we tend to estimate these populations in Morocco [7]. We present a data-driven analysis of 4 key parameters, reducing the transmission rate, restraining the expansion rate, flattening the epidemic curve, and raising the health care system. This type of infected people from the epidemic disease was quantified by the thought of 4 different mathematical metrics, namely, replica rate, rate, doubling time, death, and infected to recovery magnitude relation. The incidence information of the epidemic disease (during the amount of 20 March 2020 to thirty-first could 2020) irruption in India has infected for the simplest suitable the epidemic curve, creating use of the growth, the most likelihood estimation, serial Bayesian methodology, and estimation of a time-dependent replica. The simplest match (based on the info considered) was for the time-dependent approach. Consequently, this approach was wont to assess the impact on the effective replica rate. The amount of pre- lockdown to the tip of internment three saw a 45% reduction within the rate of effective replica rate. Throughout an equivalent amount the expansion rate reduced from 39 % throughout the pre-lockdown to thirty third once internment three, among the common doubling time, increasing from 4-6 days to 12-14 days. Finally, the death-to-recovery magnitude relation is born from 0.28 (pre-lockdown) to 0.08 after internment three. Lastly, all the four metrics thought of to assess the effectiveness of the internment, exhibited important favorable changes, from the pre-lockdown amount to the tip of internment [2].

Rest of the paper is categorized as follows, Section I contains the introduction of the coronavirus problem in the world, Section II contains the related work of the coronavirus modeling field, Section III contain the details of the coronavirus (methodology) whose control this study, Section IV explains the coronavirus in interaction mathematical model, Section V contains the numerical solution of the model for the coronavirus study, Section VI describe results and its treatment using graphical representations and Section VII concludes research work with future directions

II. RELATED WORK

He defined the birth rate, logistic growth rate and explained immune capacity against dangerous diseases. We have to develop immune power for protection from virus attacks. [6]. He explained immune capacity and depression in this mathematical model. He has also considered depression as a responsible factor for developing immune capacity. Depression will be also increasing because it is directly proportional to the growth and loss of immune capacity [7].

III. METHODOLOGY

$$S(t)+I(t)+V(t)+C(t)+W(t)+R(t)=N(t) \quad (1)$$

where S*(t), I(t), R(t), V(t), C(t), W(t),* and *N(t)* will represent number of susceptible, a number of the infected person, number of removed person, number of vaccinated persons, number of the covered person (as Mask, proper distance), *W(t)* [*V(t) + C(t)*] and total population at time *t*. If we do not remove to infected person from the total population then

$$S(t)+I(t)+V(t)+C(t)+W(t)=n+1$$

(Total population and one infected person) (2)

$$S(0)+I(0)+V(0)+C(0)+W(0)=n$$

(Total population) (3)

$I(0)=1$ (Infected person)

Due to the coronavirus, *S(t)* decreases and *I(t)* increases every day. *V(t), C(t), and W(t)* are very little chance that they are infected. Therefore, *V(t), C(t), and W(t)* are not included in this model. Because we assume that these people will follow the guideline properly, therefore their probability of being infected will be very less. We can consider them to be a constant number (η) , considering them to be negligible. Then

$$\frac{dS}{dt}=-\alpha S I+\eta \quad (3)$$

where η is constant and it will represent sum of *V(t), C(t),* and *W(t).*

$$\frac{dI}{dt}=\alpha S I \quad (4)$$

From equations (2) and (3), we obtain

$$\frac{dS}{dt}=-\alpha S(n+1-S)+\eta \quad (5)$$

η will not include in this equation

Integrating and using (2), we obtain

$$S(t)=\frac{n(n+1)}{n+e^{(n+1)\alpha t}} \quad (6)$$

$$I(t)=\frac{(n+1)e^{(n+1)\alpha t}}{n+e^{(n+1)\alpha t}} \quad (7)$$

So that

$$\underset{t\to\infty}{Lt}\, S(t)=0, \qquad \underset{t\to\infty}{Lt}\, I(t)=n+1$$

In this way, all people will get infected from each other if they remove the infected person. If we remove the infected persons then our effective model will be

$$\frac{dS}{dt}=-\alpha S I+\beta I+\eta \quad (8)$$

$$\frac{dI}{dt}=\alpha S I-\beta I \quad (9)$$

then, from equation (1)

$$S(t)+I(t)+\eta=N(t) \quad (10)$$

From equation (9) and (10)

$$\frac{dI}{dt}=(\alpha N-\beta)I-\alpha I^2=kI-\alpha I^2 \quad (11)$$

Integrating (11), we obtain

Case *I*. *k = 0*, then

$$I(t)=\frac{\exp(kt)}{\alpha[\exp(kt)-1]/k+I_0^{-1}} \quad (12)$$

Case *II*. $k\neq 0$, then

$$I(t)=\frac{1}{\alpha t+I_0^{-1}} \quad (13)$$

As $t\to\infty$

Case *I*. $if\ N>\rho=\beta/\alpha,\ I(t)\to N-\rho$

Case *II*. $if\ N\le\rho=\beta/\alpha,\ I(t)\to 0$

Control of Coronavirus

$$\frac{dS}{dt}=\alpha S I-\gamma+\eta \quad (14)$$

$$\frac{dI}{dt}=\alpha S I-\beta I \quad (15)$$

$$\frac{dR}{dt}=\beta \quad (16)$$

$$\frac{dV}{dt}=\gamma \qquad (17)$$

where $V(t)$ will represent number of vaccinated persons at time t [8]. Initial conditions $S(0)>0,\ I(0)>0,\ R(0)=V(0)=0,$ then

$$S(t)+I(t)+R(t)+V(t)+\eta=S(0)+I(0)+\eta(0)=N$$

We can normalize equations (14), (15), (16), and (17)

$$\frac{d\bar{S}}{dt}=\bar{\alpha}\,\bar{S}\,\bar{I}-\bar{\gamma}+\bar{\eta},\quad \frac{d\bar{I}}{dt}=\bar{\alpha}\,\bar{S}\,\bar{I}-\bar{\beta}\,\bar{I},$$

$$\frac{d\bar{R}}{dt}=\bar{\beta}\,\bar{I},\quad \frac{d\bar{V}}{dt}=\bar{\gamma},\quad \bar{S}(t)=\frac{1}{N}S(t),$$

$$\bar{R}(t)=\frac{1}{N}R(t),\ \bar{V}(t)=\frac{1}{N}V(t),\ \bar{\alpha}(t)=\frac{1}{N}\alpha,$$

$$\bar{\beta}(t)=\frac{1}{N}\beta,$$

IV. Results and Discussion

$$\bar{I}(t)+R(t)\le A\,(Prescribed\ number)$$

$$\max_{[0,T]} I(t)\le B\,(Prescribed\ number)$$

The problem solved by using the technique of dynamic programming and found approximation reason for $I(t)$ increases and provide a suitable guideline with the help of mathematical model. From equations (14), (15), (16), and (17)

$$\frac{dI}{dS}=\frac{\alpha I(S-\rho)}{-(\alpha S I+\gamma)},\ \text{or}\ \frac{d\bar{I}}{d\bar{S}}=\frac{\bar{\alpha}\,\bar{I}\,(\bar{S}-\bar{\rho})}{-(\bar{\alpha}\,\bar{S}\,\bar{I}+\bar{\gamma})}$$

Case *I.* If $S>\rho$, $\frac{dI}{dt}=-ve$, for both vaccinated & non-vaccinated cases, but its magnitude will less for vaccinated and non-vaccinated cases than for non-vaccinated cases.

Case *II.* If $S<\rho$, $\frac{dI}{dt}=+ve$, for both vaccinated & non-vaccinated cases, but its magnitude will less for vaccinated and non-vaccinated cases than for non-vaccinated cases.

Case *III.* If $S=\rho$ (Maximum infection)

V. Conclusion and Future Scope

We analyzed that the coronavirus spreads very quickly when the coronavirus comes in touch with each other. Based on this mathematical model, there is some important guideline provided with the help of which we can be protected from coronavirus. Under the guideline, we have to do some of the following steps.

(i). First of all, we have to make proper distance from each other to protect ourselves, due to which the effect of coronavirus is not on another person but land or other things.

(ii). We have to increase the immune power to protect against coronavirus and other diseases. We can also increase our immune power with the help of good food and medicine. Increasing the immune power can keep the coronavirus and other diseases safe even after being infected with the coronavirus.

(iii). We do not have to touch unknown objects, using masks and sanitizer to protect ourselves which will reduce the chances of getting infected.

(iv). We should choose an online service for the purchase of goods.

(v). The temporary method of controlling the coronavirus is a lockdown. Because of which the coronavirus also gets time to control and people are not even aware. If the lockdown is applied for a longer period, people create an economic problem of eating and drinking, so the market and business can be used alternatively with the method. Due to which people will also get infected and there will not be a need to apply lockdown

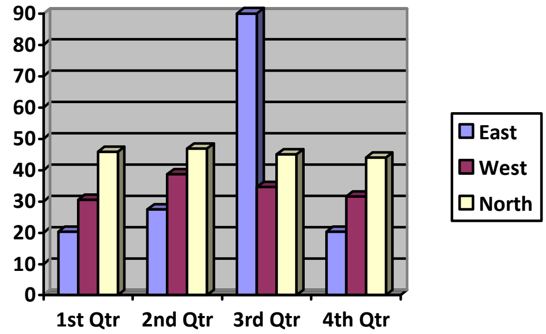

Fig. 1

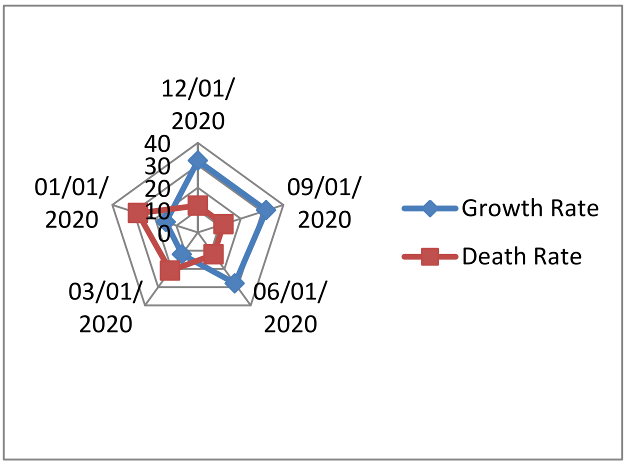

Fig. 2

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Mr. J. Singh pursed B.Sc., M.Sc. (Mathematics), M. Phil. (Fuzzy Mathematics) and B.ed from Dr. B. R. Ambedkar University, Agra in 2012, 2015, 2016 & 2019 respectively. He is currently a research scholar in mathematics from Dr. B. R. Ambedkar University, Agra. His research work focus on mathematical modeling in tumor growth and its proper treatment. He has published many research articles in peer- reviewed journal.