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Original Article

Spreading of the Novel Coronavirus (COVID-19): Mathematical Modeling in Malaysia Perspective

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ABSTRACT

A new coronavirus, SARS-CoV-2 (COVID-19), arisen towards the end of December 2019 in the city of Wuhan, province of Hubei, People's Republic of China. It has spread to the entire world very short duration and very fast. The main goal is to investigate the spreading rate of the coronavirus in Malaysia by using mathematical modeling based on the real-time data. Due to the insufficient precautions, the model shows a very fast change. Based on the estimation, this model regards that after the certain period (about time (t_1)= ~50) the number of infections will go to decrease.

Keywords: Coronavirus, COVID-19, mathematical modeling, spreading rate, Malaysia

INTRODUCTION

In human body, a novel coronavirus (2019-nCoV) has been detected, that causes the different respiratory illness such as a typical pneumonia with chest tightness, chest pain and shortness of breath [1]. This disease officially named as COVID-19. An outbreak of COVID-19 infection has been testified in the winter month of December 2019 in mainland China, Hubei Province with the city of Wuhan as the documented epicenter [2-4]. COVID-19 infection has been spread to other areas of China and whole world rapidly within a very short duration of time. The World Health Organization (WHO) declared this COVID-19 outbreak as a 'Public Health Emergency of International Concern' on 30 January 2020, precisely to increase the level of preparations for the countries that required extra support [5].

At the last week of January 2020 (24 January 2020) first patient of COVID-19 has detected in Malaysia. Until 20 April 2020, the number of COVID-19-positive cases reached 5425, while the number of related deaths increased to 94. The fatality rate is 1.64%. Currently (20 April), 60 patients are being treated at intensive care units (ICU), with 33 of them requiring the use of ventilators. Total recovered patients are 2647 and its recovery rate is 49.7% [6]. In all cities in Malaysia decreed to control the public movement with the many other measures such as tracing close contacts, quarantining infected cases, promoting social consensus on self-protection like wearing face mask in public area among others. Though, until the completing of this manuscript, the epidemic is still on going on, and the daily confirmed cases uphold to the higher side. Yet, there are no vaccine is available as antiviral treatment for this disease. Due to the

COVID-19 pandemic, the importance of the mathematical modeling is clear in terms of making medical planning and observes the future of the covid-19 pandemic in Malaysia. To contribute in addressing the challenge of predicting the spread of this novel disease and assessing the possible risks and interventions, mathematical models can be the suitable tool. The main aim of this work is to investigate the spreading rates of COVID-19 pandemic by mathematical modeling based on the previous data.

MODEL AND METHODS

As stated in the literature, for a specific country consider the population are N (time dependent spreading rate of the number of persons who have caught an infectious disease (P)). "The time-dependent spreading rate of the number of persons is proportional to the multiplication of the number of persons who have caught an infectious disease and those who have not." The following differential equation is stated the mathematical model of this current situation:

$$\frac{dP}{dt} = rP\,(N - P) \tag{1}$$

Where, r is the proportionality constant. The above stated model (1) was studied particularly for the "Novel Corona Virus Pandemic." For this model, considered variables and parameters are: t: Number of days which are independent time variables; $P(t)$: Number of patients at time t; $\frac{dP}{dt}$: Spreading rate of the disease; r: A parameter that covers all factors of effect of the spreading rate of the disease.

Therefore, at the initial time ($t = 0$), the number of patients $P(0) = P_0$ and at time ($t = t_1$), the number of patients $P(t_1) = P_1$. Furthermore, the number of persons can be affected to the disease be N. The mathematical modeling for the Covid-19 pandemic, the form is: "The spreading rate of the infection $\frac{dP}{dt}$ is directly proportional with the multiplication of the number of persons who have caught the infection and those who have not caught the infection and it is inversely proportional of the square root of the time (t)."

The main purpose of the work is, using the modified mathematical model and with the help of some actual data to obtain more consistent future data about the COVID-19 disease in the predicted time. To obtain this, using the parameter $r = r(t) = m/2\sqrt{t}$ (m is a positive proportional constant) [7] in the right hand side of the Equation 1 instead of r.

The following initial value problem (IVP) is stated the COVID-19 disease:

$$\frac{dP}{dt} = \frac{m}{2\sqrt{t}}P\,(N - P) \tag{2}$$

$$P(0) = P_0 \tag{3}$$

$$P(t_1) = P_1 \tag{4}$$

The solution of the IVP will give a formula connected to COVID-19 cases that is how many people will get infected in the very near future. First, solving the Equation 2 using separable variables, we have

$$\int \frac{dP}{P\,(N - P)} = \int \frac{m}{2\sqrt{t}}dt$$

$$lnP - ln(N - P) = Nm\sqrt{t} + lnc \tag{5}$$

$$P(t) = \frac{Nc}{e^{-Nm\sqrt{t}} + c}$$

Using the initial condition from Equation 3, we have

$$c = \frac{P_0}{N - P_0} \tag{6}$$

After that, using the initial condition from Equation 4, we have

$P(t) = \frac{N}{\left(1 + \frac{1}{c}e^{-a\sqrt{t}}\right)}$; Where, $a = \ln\left(\frac{P_0(N - P_1)}{P_1(N - P_0)}\right)/\sqrt{t_1}$.

RESULTS AND DISCUSSION

In this present situation in Malaysia, it is considered that to get the COVID-19 infected person (patients) is P=32000, using an optimum date of 20 March 2020 as $t = 0$, $P(0) = P_0 = 1030$ patients and $t_1 = 30$as 20 April 2020 with $P(30) = P_1 = 5425$ patients, let us measure the **Figure 1**, where we may observe the spreading rate of COVID-19 outbreak, meaning to predict the approximate number of infected patients by the next 25-days.

Figure 1 shows the prediction of COVID-19 patients estimated by the developed model based on the real time data for Malaysia. Prediction is estimated with the 5% deviations in **Figure 1(a)**. Prediction is estimated with the 10% deviations in **Figure 1(b)**. Because the number of infected persons depended with the various measures and steps taken into the society. In is seen that, from the starting day (t_1=0) the number of patients is increased gradually until the t_1=30. Within this time the number of infections is raised by maintaining the almost ± 5% deviations. However, after this period the model predicts a bit higher side of the

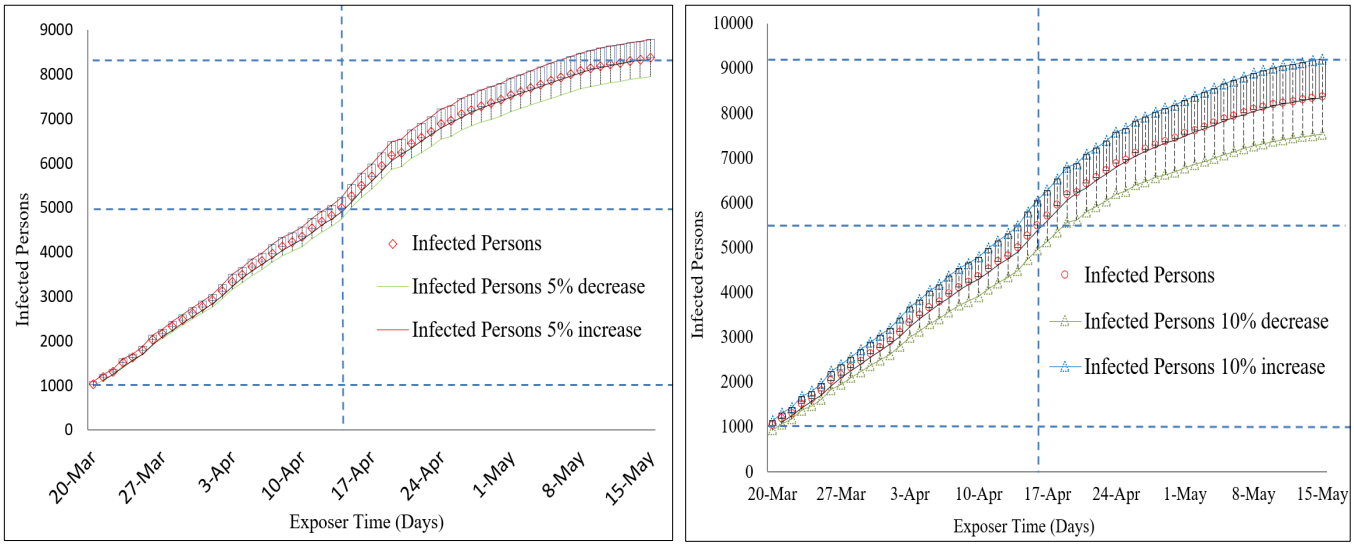

Figure 1. Estimated number of COVID-19 infected patients in Malaysia using a Mathematical model (explained above). Exponential reflections to the infected numbers based on the precaution's measures: (a) Number of patients with 5% deviation, (b) Number of patients with 10% deviation.

infection rate. Despite that mentionable, model predicted data projected likely linear increase of COVID-19 infections. Based on the estimation, this model regards that after the certain period (about t_1= ~50) the number of infections will go to decrease. As, authorities are trying to control several factors such as social distancing, cleanness, tracking of movement records of the infected persons and controlling of people intake into the country. However, it is tough to make the number to zero (P (t)=0). Because, COVID-19 diseases are declared as highly infectious [4]. Even if single or very minimal numbers are left unidentified and untreated then this might be resumed to be increased again.

CONCLUSIONS

From the results of the mathematical modeling after the certain period (about t_1= ~50) the number of infections will go to decrease due to the taken necessary measures and precautions by the relevant authorities. It can be optimistic that Malaysia is in a better situation rather than many other countries in the world. If the government take the present precaution such as lockdown, isolation, socially support, those who have symptoms of COVID-19 infection tests in hospital and finally special take care of elder people than within a reasonable period the number of COVID-19 patients will be decreased enormously.

DECLARATION OF CONFLICT OF INTEREST

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