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Mathematical Simulation Analysis of Body Temperature Observations Covid-19 Patients

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Abstract

At the end of January 2022 as many as 33 countries with new cases of 85% new variant called omicron which is the concern of the World Health Organization. Patients who have been diagnosed with COVID-19 are analyzed for temperature starting from the appearance of fever and until they experience recovery, followed by a decrease in body temperature and loss of fever. This study aims to conduct a mathematical simulation analysis of the observation of the body temperature of covid 19 patients. The research method is descriptive analysis by analyzing using mathematical simulations on the fever of covid 19 patients until the temperature changes to normal again. In February - March 2022, this research was carried out at the general practitioner clinic in Surabaya, Putat Gede, Sukomanunggal sub-district, with positive results from a PCR (Polymerase Chain Reaction) swab examination and an infrared thermometer. The study population was patients with positive Covid-19 swab results, with a large study sample of 30 Covid-19 patients. The results showed that there was a mathematical simulation with a fever variation of 38 C. – 39.5 C occurs in covid 19 patients. The temperature is decreasing day by day approaching the normal body temperature according to the fever that is gone and healing occurs in Covid 19 patients.

Keywords: math simulation, fever, covid -19

Original Research Article

Analisis Simulasi Matematika Terhadap Pengamatan Suhu Tubuh Pasien Covid-19

Abstrak

Pada akhir Januari 2022 sebanyak 33 negara dengan kasus baru 85% varian baru yang disebut omicron yang menjadi perhatian World Health Organization. Pasien yang telah terdiagnosis COVID-19 dianalisa suhunya mulai dari munculnya demam hingga sembuh, diikuti dengan penurunan suhu tubuh dan hilangnya demam. Penelitian ini bertujuan untuk melakukan analisis simulasi matematis pengamatan suhu tubuh pasien covid 19. Metode penelitian yang digunakan adalah deskriptif analisis dengan menganalisis menggunakan simulasi matematis pada pasien demam covid 19 sampai suhu berubah menjadi normal kembali. Pada bulan Februari - Maret 2022, penelitian ini dilakukan di klinik dokter umum di Surabaya, Putat Gede, Kecamatan Sukomanunggal, dengan hasil positif dari pemeriksaan swab PCR (Polymerase Chain Reaction) dan termometer inframerah. Populasi penelitian adalah pasien dengan hasil swab positif Covid-19, dengan besar sampel penelitian sebanyak 30 pasien Covid-19. Hasil penelitian menunjukkan adanya simulasi matematis dengan variasi demam 38 C – 39,5 C terjadi pada pasien covid 19. Suhu semakin hari semakin menurun mendekati suhu tubuh normal sesuai dengan demam yang hilang dan penyembuhan terjadi pada pasien Covid 19.
Kata Kunci: simulasi matematika, demam, covid-19

INTRODUCTION

The COVID-19 pandemic occurred in Indonesia and almost the entire world was affected by this virus (Unang Achlison, 2020). New variants of mutations of the SARS-CoV-2 Virus have emerged with varying variations and severities. At the end of January 2022, as many as 33 countries with new cases of 85% of the new variant were called omicron which is a concern of the World Health Organization (Amalia, 2021; Nyberg et al., 2022). The group of viruses of the Family Coronaviridae causes infection of this virus in the respiratory tract. It is necessary to carry out effective therapy to monitor the complications of death that occur in covid 19 patients. Fever is a symptom that often occurs in covid 19 patients with different severity, in general it can be monitored from a rise in body temperature (Lau et al., 2004).

According to Gul (2020) the initial symptoms that appeared to be in the form of low-grade fever were high and finally collapsed on day 10. The increase in body temperature can be one of the parameters of the presence of viral infections that occur in covid 19 patients with a normal body temperature benchmark of 36.5^{o}C - 37.5^{o}C (Chalik, 2016; Lau et al., 2004). The fever that appeared in the week that occurred in patients with COVID-19 positivity showed the entry of the virus into the body and provided an immune response to viral replication. The presence of cytokine storms, high fever indicates the occurrence of covid 19 virus infection (Gul et al., 2021). Mild moderate to severe infections can occur in covid 19 patients, symptoms that appear in the airways are marked such as getting a common cold cough, sneezing, nasal congestion, coughing to vomiting, prolonged fatigue, thick sputum and shortness of breath, x-rays photo images of pneumonia in the lungs (Karyono et al., 2020). The incubation period of covid 19 patients appears on days 5 – 14. Severe complications that occur in severe covid 19 patients have severe pneumonia to cause death (Ministry of Health RI, 2020). Patients who have been diagnosed with COVID-19 are carried out temperature analysis starting from the appearance of fever and until they experience recovery followed by a decrease in body temperature loss fever. So the importance of this research study shows that the decrease in fever in COVID-19 patients can be used as a parameter for disappearing infection and healing in patients diagnosed with COVID. The fever is gone, the infection is gone and the patient recovers well.

Mathematical model simulations have been widely used in health-related research in different parts of the world(Butland et al., 2017; Gallagher & Lago, 2019; Hennig et al., 2016; Iodice, Langella, & Amoresano, 2017; Jeanjean, Buccolieri, Eddy, Monks, & Leigh, 2017; Morakinyo, Lam, & Hao, 2016; Putut Laksminto Emanuel, 2017; Salmond et al., 2013). It is necessary to carry out a mathematical simulation analysis to ensure the observation of the body temperature of Covid 19 patients with symptoms of fever and followed day by day changes in temperature from when the fever appears until the fever disappears and an analysis of the disappearance of this fever will vary for each person and whether it can be used as a parameter The disappearance of fever is marked by the direction of recovery in patients diagnosed with Covid 19. So this study aims to carry out a mathematical simulation analysis of observing the body temperature of Covid 19 patients. The study aims to conduct a mathematical simulation analysis of the observation of the body temperature of Covid 19 patients.

MATERIAL AND METHODS

Descriptive analysis research method by analyzing using mathematical simulations in covid 19 patient fever until there is a change in temperature to normal again. February – March 2022, this study was carried out at the surabaya putat gede general practitioner practice clinic in Sukomanunggal village, On the positive results from the examination of the swab and temperature measuring device of the inftramerah thermometer. The study population was patients with covid-19 positive swab results, with a large study sample of 30 Covid-19 patients, with the inclusion criteria of patients diagnosed as positive for covid and willing to undergo all research procedures, for exclusion criteria of not being diagnosed as positive. (Jayusman & Shavab, 2020) The temperature data obtained were then mathematically modeled using SPSS version 22 to obtain simple linear regression equations as the form:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

Before we choosed the best model, we looked for the value of R. It meant that the model could be used for the temperature data or not. If the value of R is closed to 1 or -1, it means that the model can be used.

RESULTS

The results of body temperature measurements with infrared thermometers were used as research patient data (Unang Achlison, 2020b). In Table 1. parameters of body temperature are normal according to age.

Table 1. Normal Body Temperature by age

Individual	Categories		
	Normal	**Fever**	**High Fever**
Adults (>17 Years Old)	36,-37,5	37,6-39,5	>41
Teens (11-17 Years Old)	36,-37,5	37,6-39,5	>41
Children (3-10 Years Old)	36-37,5	>37,5	>37,5
Ifants (0-2 Years)	36 -37	>37	>37

Source: (Unang Achlison, 2020b)

DISCUSSION

Table 1 temperature 36.5-37.5 °C is the normal standard of body temperature, in the table temperature above is the benchmark body temperature used based on age. In covid 19 patients with fever, a mathematical simulation analysis of temperature changes was carried out until the disappearance of the fever. Infrared thermometers with a size of degrees Celsius (°C) are used as detection in the observation of temperature changes (Unang Achlison, 2020b). The results, it is known that the average body temperature of patients on the 1st to the 14th day. On day 1, the temperature of 38^0C is the minimum temperature of the patient and at 39.5°C is the maximum temperature found in patients who have postponed covid 19. The average temperature of 38.9 °C is the temperature of day 1 of Covid-19 patients. Analysis of changes in the temperature decline of covid 19 patients appears to have proven to be significant changes in temperature that occur. The 2nd to the 14th day continues to decrease the average temperature of the patient. On the 8th day, the average temperature is already below 37.5°C, at this temperature usually the patient already shows hope of recovery. The results of the T test showed that the temperature of the 9th day could not be determined because the standard deviation was 0.

The temperature of the 9th day of all patients has no difference, namely at a temperature of 37°C which means that many patients have no fever anymore and are improving their recovery.

Table 2. Test Results in the Normal Body Temperature Category

One-Sample Statistics

Temperature on day 1 to day 14	N	Mean	Std. Deviation	Std. Error Mean
TemperatureH1	30	38.9067	.35227	.06431
TemperatureH2	30	38.6067	.24202	.04419
TemperatureH3	30	38.3567	.15906	.02904
TemperatureH4	30	38.0667	.16470	.03007
TemperatureH5	30	37.6933	.07849	.01433
TemperatureH6	30	37.5067	.07397	.01350
TemperatureH7	30	37.4600	.08137	.01486
TemperatureH8	30	37.2733	.07849	.01433
TemperatureH9	30	37.0000	.00000[a]	.00000
TemperatureH10	30	37.4333	.17287	.03156
TemperatureH11	30	37.0067	.17991	.03285
TemperatureH12	30	36.8200	.23547	.04299
TemperatureH13	30	36.9733	.25587	.04672
TemperatureH14	30	36.4667	.12685	.02316

Temperature on day 1 to day 14 folded on H 1- H 14
a. t cannot be computed because the standard deviation is 0.

Table 3. One-Sample Test

Temperature on day 1 to day 14	Test Value = 0					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
TemperatureH1	604.941	29	.000	38.90667	38.7751	39.0382
TemperatureH2	873.711	29	.000	38.60667	38.5163	38.6970
TemperatureH3	1320.843	29	.000	38.35667	38.2973	38.4161
TemperatureH4	1265.928	29	.000	38.06667	38.0052	38.1282
TemperatureH5	2630.283	29	.000	37.69333	37.6640	37.7226
TemperatureH6	2777.316	29	.000	37.50667	37.4790	37.5343
TemperatureH7	2521.603	29	.000	37.46000	37.4296	37.4904
TemperatureH8	2600.974	29	.000	37.27333	37.2440	37.3026
TemperatureH9	1186.020	29	.000	37.43333	37.3688	37.4979
TemperatureH10	1126.637	29	.000	37.00667	36.9395	37.0738
TemperatureH11	856.447	29	.000	36.82000	36.7321	36.9079
TemperatureH12	791.451	29	.000	36.97333	36.8778	37.0689
TemperatureH13	1574.535	29	.000	36.46667	36.4193	36.5140

Table 4. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.577[a]	.333	-.074	9.12454	1	.577[a]	.333	-.074	9.12454

The R test result of 0.577 shows that the data obtained is quite good, meaning that it can be accounted for for its correctness and the mathematical model can be used because this value was closed to 1.

Table 5. ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	748.868	11	68.079	.818	.625[b]
	Residual	1498.632	18	83.257		
	Total	2247.500	29			

Table 6. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2248.096	2697.395		-.833	.416
	TemperatureH1	9.778	12.484	.391	.783	.444
	TemperatureH2	-.503	25.268	-.014	-.020	.984
	TemperatureH3	-22.658	29.114	-.409	-.778	.447
	TemperatureH4	31.217	41.208	.584	.758	.459
	TemperatureH5	62.222	56.092	.555	1.109	.282
	TemperatureH6	-39.494	34.318	-.332	-1.151	.265
	TemperatureH7	47.979	64.579	.443	.743	.467
	TemperatureH8	19.391	44.555	.396	.435	.669
	TemperatureH9	22.973	34.167	.614	.672	.510
	TemperatureH10	-42.840	42.261	-1.245	-1.014	.324
	TemperatureH11	-29.000	49.617	-.418	-.584	.566

The linear regression equation is determined only by the temperature variables of the 1st day, the 2nd day of temperature, the 3rd day of the 4th day of temperature, the 5th day of temperature, the 6th day of temperature, the 7th day of temperature, the 11th day of temperature, the 12th day of temperature, the 13th day of temperature, the 14th day of temperature.

The regression equations that were successfully obtained were:
Y = -2248.1 + 9.778 TemperatureH1 – 0.503 TemperatureH2 – 22.658 TemperatureH3 + 31.217 TemperatureH4 + 62.222 TemperatureH5 – 39.494 TemperatureH6 + 47.979 TemperatureH7 + 19.391 TemperatureH11 + 22.973 TemperatureH12 – 42.840 TemperatureH13 – 29 TemperatureH14.

Table 7. Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	4.0506	26.1739	15.5000	5.08164	30
Residual	-10.94943	11.37779	.00000	7.18867	30
Std. Predicted Value	-2.253	2.100	.000	1.000	30
Std. Residual	-1.200	1.247	.000	.788	30

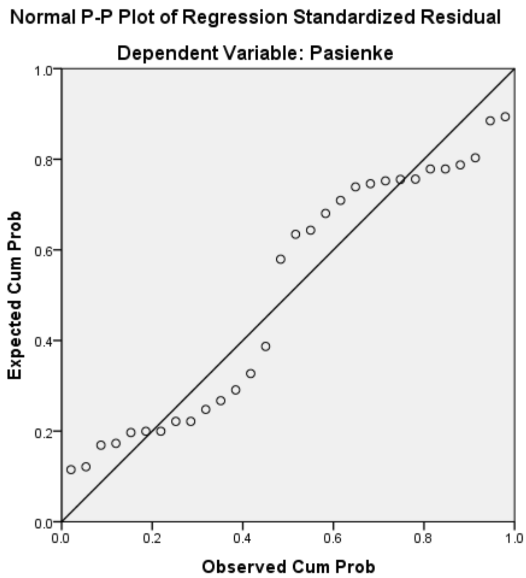

Figure 1. The results of the observation of the body temperature of patients with Covid-19

The result of the graph obtained can be said that the expectations (Expected Cum Prob) and results of observations (Observed Cum Prob) are directly proportional. The hope that the temperature possessed by patients is decreasing day by day to close to the normal temperature of the human body in accordance with the results of observations of patients with Covid 19. Fever experienced by Covid-19 sufferers is one of the beginnings that most often becomes a manifestation of disease and body temperature as an early detection (VERMA et al., 2021; Wright & MacKowiak, 2021). Covid-19 has several symptoms such as fever, weakness, muscle aches, cough, sore throat, loss of smell, shortness of breath, and respiratory distress. Fever experienced by affecting body temperature in general arises when the patient is infected with Covid- 19(Hendry et al., 2021). High body temperature in Covid-19 cases indicates the severity of the patient. Tharaka et al., (2020) explained from the results of their study that one in three patients showed temperatures above 39.5^{0}C experienced death.

The patient's fever condition during treatment has an average body temperature of 38,9067^{o} C and after the 14th day to 36.4667^{o}C. Patient temperature data results are described as obtained average body temperature with temperature starting to decrease on day five with an average temperature of 37.5 ^{o}C, and day six decreased by 37.4^{o}C, day 7 decreased again to

37.3°C and day eight decreased to 37.0°C, day eleven decreased to 36.50°C, and day fourteen decreased all to 36.0°C. The results of the patient's body temperature data obtained the minimum value a decrease in temperature is noticeable on day 5 and the maximum value decreases all to normal Back to day 14. The condition of a covid-19 positive patient with a body temperature between 37.60 ° C – 38.90° C has a fever. In hospitals, generally covid patients who seek treatment are seen from the factor that the patient has a fever, because the increase in body temperature reflects the occurrence of an immune reaction to inflammation (Tharakan et al., 2020). Fever is the body's defense mechanism in fighting microorganism infections and heat generation is a response to the body's immune warfare. Fever is the diagnostic basis for infection in the Corona-19 virus (Ding et al., 2021). The results of the study data showed that the body temperature of patients who were diagnosed positive for Covid-19 with swab results from the laboratory experienced a hot fever at a minimum body temperature of 37.60° C. Based on research conducted (Ding et al., 2021), that humans who experienced influenza strain infection had a fever with a body temperature of 38-41◦C. The results of the patient data in the study had a fever with a body temperature between 37.6° C – 38.90° C, and swab results. showing positive for Covid-19, it can be said that a patient can be said to be positive for Covid-19 will have a fever with a temperature of 37.60° C – 38.90° C. Supported by research conducted by Tharakan et al., (2020) that the marker of a potential prognosis involves body temperature resulting in fever, with a body temperature of 38.90° C °C experiencing a high mortality rate (26.5%, P = 0.003 relative to 36 °C 36 °C BT 37.5 °C body temperature normal), and conversely at low body temperatures below 36 °C is a sign of a poor prognosis in covid patients experiencing a worsening condition.

CONCLUSION

Mathematical simulation analysis of observations of body temperature of covid 19 patients, conducted in this study was fever with a body temperature between 37.60 ° C – 38.90° C. Fever begins to decrease on the fifth day with an average temperature to 37.5 °C, and day four there was no fever at all visible with the body temperature of day 14 which was 36.0°C. The disappearance of fever can be an early detection towards the occurrence of recovery in covid 19 patients. The temperature is decreasing day by day close to the normal body temperature according to the fever that disappears and there is a cure in Covid 19 patients.

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