Survival Analysis in Patients with Dengue Hemorrhagic Fever (DHF) using Weibull Parametric Model in Indonesia: Case Study at the Regional General Hospital (RSUD) Makassar

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ABSTRACT

Purpose: This research is to know the general description of the characteristics of DHF patients and to find out the factors that most influence the cure rate and the length of time for DHF patients who are hospitalized until they are declared cured.

Methodology: The data used in this study were secondary data regarding the criteria for DHF patients obtained from the medical records of the Regional General Hospital (RSUD) Makassar in 2015. This case study of DHF patients is based on 7 characteristics, starting from age, gender, hemoglobin, leucocyte, hematocrit, platelet, and body temperature.

Results: The characteristic DHF patients starting from the length of time DHF patients were hospitalized for ≤ 5 days (71.43%) and > 5 days (28.57%), the age of the patients ≤ 16 years (53.33%) and > 16 years (46.67%), the sex of the patients were male (52%) and female (48%), the hemoglobin of the patients ≤ 15 g/dl (69.52%) and > 15 g/dl (30.48%), the leukocytes of the patients ≤ $4/\mu l$ (42.86%) and > $4/\mu l$ (57.14%), the hematocrit of the patients of ≤ 42% (68.57%) and > 42% (31.43%), the platelet of the patients < normal (89.52%) and normal (10.48%), and the body temperature of the patients ≤ 38^0C (48.57%) and > 38^0C (51.43%). This research uses Weibull parametric model to calculate survival analysis. The calculation shows that the best significant model only involves platelets and body temperature where the result of the AFT model, DHF patients with normal platelets will speed up the recovery rate after treatment and give a survival time of 1.4134 times longer than DHF patients with < normal platelets and DHF patient with body temperature > 38^0C will accelerate the recovery rate after treatment and provide a survival time of 1.1266 times longer than DHF patients with body temperature ≤ 38^0C. The result of the PH model, DHF patients with normal platelets, the risk of recovery after treatment of 0.8988 times than to DHF patients with < normal platelets and DHF patients with body temperature > 38^0C will get the risk of recovery after treatment of 0.9642 times than of DHF patients with body temperature ≤ 38^0C.

Applications/Originality/Value: Data from the medical records of the Regional General Hospital (RSUD) Makassar is useful for this study because this data can provide information to the public about how the characteristics and factors that can affect the cure rate of DHF patients. In this study, a comprehensive discussion of dengue cases has been discussed.

INTRODUCTION

Bappenas (2016) states that Sustainable Development Goals (SDGs) focus on sustainable improvement in the economic welfare of the community, the sustainability of the social life of the community, the quality of the environment, ensures justice, and the implementation of governance that can maintain the improvement of the life quality. Indonesia is one of 193 countries that has been approving the SDGs Agenda in 2015. The SDGs consist of 17 goals and 169 targets related to sustainable development issues. In the SDGs, the 3rd goal is to ensure healthy lives and promote well-being for all at all ages. The development of the health sector for the SDGs is highly dependent on the active role of all stakeholders, both the central and local governments, parliament, the business world, mass media, social institutions, professional and academic organizations, development partners, and the United Nations (UN). The biggest challenge in implementing the sustainable development agenda in Indonesia is the reformulation of the concept of integrated development and the placement of health as a series of development management processes that include input, process, output, outcome, and impact of development as well as understanding together with the substance of health development

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that must be implemented together. By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases, and combat hepatitis, waterborne diseases, and other communicable diseases.

Dengue Hemorrhagic Fever (DHF) is a global virus threat that can attack human health. This virus is one of the most common viruses in tropical countries and is still a major problem in recent years. It is estimated that 390 million of these viruses occur annually worldwide (Bhatt et al., 2013). Data from 76 countries show a substantial increase in dengue cases, with the number of cases more than doubling with the highest cases reported in Asian countries (Stanaway et al., 2016). Currently, this virus has spread throughout the world, including in WHO areas such as the Pan American Health Organization (PAHO), Southeast Asia Regional Office (SEARO), and the Western Pacific Region Office (WPRO) (Brady et al., 2012). WHO (2009) states that the Asia Pacific bears 75 percent of the burden of dengue fever in the world between 2004 and 2010 and Indonesia is the country with the highest incidence of DHF in Southeast Asia since 1968-2009 and the second country in terms of cases of dengue virus spread based on Incidence Rate (IR) and Case Fatality Rate (CFR) where the IR in 2015 reached 50.75 per 100,000 population or an increase of 10.95 per 100,000 population from the previous year (Ministry of Health Indonesia, 2018).

In general, this virus is easy to develop in areas with a tropical climate, one of which is Indonesia. This is very suitable for the development of diseases, especially diseases with organisms that spread pathogenic agents from reservoirs to reservoirs. This virus is one of the viruses caused by mosquitoes with species *Aedes aegypti* and *Aedes albopictus* and is endemic in almost all regions (Kraemer et al., 2015). One of the areas affected by this virus is Makassar in South Sulawesi where there are 1735 cases of this virus and the highest case on the Sulawesi Island (Ministry of Health Indonesia, 2018). The spread of cases of this virus in Makassar occurred from 2002-2012 and tends to grow up and down. The highest number of cases of this virus occurred in 2002 with a total of 1445 cases. However, cases increased again by 5030 cases with 48 deaths in 2013 (Department of Health Makassar, 2014). This causes DHF to be one of the interesting objects to be studied and studied further. Seeing the increasing number of DHF cases with high mortality rates, a study is needed to determine the length of time DHF patients survive to recover. The application of statistical methods that can be used to analyze the case is survival analysis. Kleinbaum et al. (2012) state that survival analysis is a statistical analysis that is specifically used to analyze data or cases related to the time or length of time until a particular event occurs. This analysis is usually used in the health field. There are several models used for survival data analysis. These methods include the parametric survival model, nonparametric survival model, and semiparametric survival model. The parametric survival model assumes that the underlying distribution of survival times follows a certain distribution, such as the parametric proportional hazard model and accelerated failure time model. The nonparametric survival model is used if the data used does not follow a certain distribution that already exists, such as the Kaplan-Meier method and log-rank test. On the other hand, the semiparametric survival model is a model that is often used in research in the health sector, especially the cox proportional hazard regression method. This model is a safe model to choose when in doubt about choosing a parametric model, so there is no need to be afraid of choosing the wrong parametric survival model and more flexible for use in the health case study.

Survival analysis in this study uses a parametric survival model, namely a parametric regression model where parametric here is the number of parameters in a finite multiple regression model (Danardono, 2012). Furthermore, the parametric survival model is a model whose survival time is assumed to follow a known distribution (Harlan, 2017), while regression is a method used to determine the effect of the independent variable on the dependent variable (survival time). Parametric regression models often use the assumption of survival time following the Weibull, Exponential, and so on (Zhang, 2016). Several studies have been conducted regarding cases of the spread of DHF starting from Handayani et al. (2017) were to determine the modeling of cases of the spread of DHF using the cox proportional hazard model in a case study at the Hospital Clinic Jember, then Annas et al. (2019) which determined the modeling of cases of the spread of DHF using the cox proportional hazard model in a case study at the Regional General Hospital (RSUD) Makassar, and Prabaningrum et al. (2020) which explains and analyzes cases of the spread of DHF based on the theory of planned behavior. Meanwhile, many studies related to parametric models in survival analysis have been carried out, such as in Faruk et al. (2018) which uses the Weibull parametric proportional hazard model in the case of the first birth interval, and Saeed et al. (2020) used a Weibull parametric model for partly censored interval data in a breast cancer case study. Researches on the use of the parametric Weibull model are still not widely carried out in Indonesia, so a more in-depth study is needed. Therefore, the purpose of this study is to explain the general description of the characteristics of DHF patients who are hospitalized, to find out the factors that most influence the recovery rate of DHF patients, and to find out the length of time for DHF patients to be declared cured.

METHODOLOGY

Study Area

The object of research in this study were patients diagnosed with DHF virus in Regional General Hospital (RSUD) Makassar in 2015. Makassar is the capital of the province of South Sulawesi. It is the largest city in the region of Eastern Indonesia and the country's fifth-largest urban center after Jakarta, Surabaya, Bandung, and Medan (Ministry of Home Affairs Indonesia, 2013). The city's area is 175.77 km^2, and it had a population of around 1,424 million in 2020 (Hajramurni, 2011).

Dengue Hemorrhagic Fever (DHF)

WHO (1997) explains that DHF is the leading cause of viral hemorrhagic fever worldwide. Karyanti et al. (2014) describe that DHF was defined as having at least the first two of the following four clinical manifestations, such as sudden onset acute fever of 2 to 7 days duration; spontaneous hemorrhagic manifestations or a positive Tourniquet test; hepatomegaly; and circulatory failure, in combination with hematological criteria of thrombocytopenia (≤100,000 cells/mm^3) and an increased hematocrit over 20 percent. Li et al. (2018) state that DHF is transmitted by the bite of female *Aedes Aegyptus* mosquito or female *Aedes albopictus* mosquito by carrying dengue virus into the genus Flavivirus. Stöppler (2021) states that DHF is a syndrome due to the dengue virus that tends to affect children under 10, causing abdominal pain, hemorrhage (bleeding), and circulatory collapse (shock). DHF starts abruptly with high continuous fever and headache plus respiratory and intestinal symptoms with a sore throat, cough, nausea, vomiting, and abdominal pain.

Characteristic Data

The data used in this study were secondary data regarding the criteria for DHF patients obtained from the medical records of the Regional General Hospital (RSUD) Makassar in 2015. DHF is a disease caused by the dengue virus that is transmitted through the bites of mosquitoes *Aedes aegypti* and *Aedes albopictus.* In humans, transmission can only occur when the body is in a state of viremia which is between 3-5 days (Wang et al., 2020). To get a higher accuracy of diagnosis, laboratory tests are generally carried out, such as counting the number of antibodies against the dengue virus, and complete blood counts such as hemoglobin, leukocytes, hematocrit, and platelet (Annas et al., 2019). This case study of DHF patients is based on 7 characteristics, starting from age, gender, hemoglobin, leucocyte, hematocrit, platelet, and body temperature. The data used describe the characteristics of DHF patients who are hospitalized, the factors that most influence the recovery rate of DHF patients, and the length of time for DHF patients to be declared cured.

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Table 1. Characteristic DHF Patients

Code	Variable	Description	**Category**
(1)	**(2)**	**(3)**	**(4)**
T	Time	Time is a condition until the occurrence of the desired event. The time variable used in this study was the length of time the patient was hospitalized until he was declared cured at Regional General Hospital (RSUD) Makassar.	-
X_1	Age	Age is the span of life measured in years The age variable used in this study was the age of DHF patients at the beginning of admission to hospitalization at Regional General Hospital (RSUD) Makassar.	1 = > 16 years 0 = ≤ 16 years
X_2	Gender	The gender variable used in this study was the sex of DHF patients which is classified into two categories (male and female) and hospitalization at Regional General Hospital (RSUD) Makassar.	1 = male 0 = female
X_3	Hemoglobin	Hemoglobin is a protein found in red blood cells present in erythrocytes and plays an important role in transporting oxygen throughout the body, giving color to the blood, transporting carbon dioxide back to the lungs, and maintaining the shape of red blood cells. The hemoglobin variable used in this study was the hemoglobin level of DHF patients undergoing hospitalization at Regional General Hospital (RSUD) Makassar.	1 = > 15 g/dl 0 = ≤ 15 g/dl
X_4	Leucocyte	Leukocytes are white blood cells that are part of the immune system and function to protect themselves from infection or disease and are produced from hematopoietic stem cells in the bone marrow. The leukocytes variable used in this study was the level of the leukocytes of DHF patients undergoing hospitalization at Regional General Hospital (RSUD) Makassar.	1 = > 4 /μl 0 = ≤ 4 /μl
X_5	Hematocrit	Hematocrit is the level of red blood cells in the blood and shows the percentage ratio of red blood cells to blood volume. Red blood cells have an important role in the health of the body, namely as a carrier of oxygen and nutrients to all parts of the body and hematocrit is a number that shows the percentage of solids in the blood to blood fluids. In general, the decrease in platelets precedes the increase in the hematocrit, with an increase of 20 percent or more from baseline. The hematocrit variable used in this study was the hematocrit level of DHF patients undergoing hospitalization at Regional General Hospital (RSUD) Makassar.	1 = > 42% 0 = ≤ 42%
X_6	Platelets	Platelet is cytoplasmic fragments without a nucleus 2-4 μm in diameter biconvex disc that forms in the bone marrow and has an important role in the blood clotting process when an injury occurs so that the blood stops immediately. The platelet variable used in this study was the number of thrombocytes of DHF patients which is classified into two categories below normal and normal (150,000-400,000/mm^3) and hospitalization at Regional General Hospital (RSUD) Makassar.	1 = normal 0 = < normal
X_7	Body Temperature	Body temperature is a measure of the body's ability to produce and get rid of heat. The high or low body temperature of a person can also be an indicator of his health condition. The body temperature variable used in this study was the temperature level of DHF patients undergoing hospitalization at Regional General Hospital (RSUD) Makassar.	1 = > 38^{0}C 0 = ≤ 38^{0}C

Survival Analysis

Prentice et al. (2001) describe that survival analysis, sometimes referred to as failure-time analysis, refers to the set of statistical methods used to analyze time-to-event data. Time-to-event or failure-time data, and associated covariate data, may be collected under a variety of sampling schemes, and very commonly involve right censoring. The distribution of a failure-time variate is usefully characterized in terms of its conditional failure rate, or hazard function. Collett (2003) states that the survival analysis is a time-related data analysis, from the beginning to the occurrence of a specific event. Duration from the beginning of the observation (time origin) until the occurrence of a special event (failure event) is called the time of survival. The particular event (failure event) may be a failure, death, relapse, or recovery from an illness, a response from an experiment, or another event chosen according to the researcher's interest. Arsene et al. (2007) explain that survival analysis is an important part of medical statistics, frequently used to define prognostic indices for mortality or recurrence of a disease, and to study the outcome of treatment. Kleinbaum et al. (2010) state that survival analysis is very concerned about data censors. Data censor occurs if the object does not experience an event before the observation ends, the object disappears during observation, and the individual object is terminated due to death or due to other reasons. Jakperik et al. (2012) explain that in survival analysis, there is a term failure (even though the actual event may be successful) which is an event where the desired event is recorded. In determining the survival time, there are three factors needed, such as the start time of recording (star point) is the initial time when recording is done to analyze an event, the end-point of recording is the time when the recording ends. This time is useful for knowing the censored or uncensored status of a patient to be able to perform the analysis, and the measurement scale is the limit of the time of the incident from the beginning to the end of the event. The scale is measured in days, weeks, or years.

Parametric Survival Model

A parametric survival model is a model whose outcome (survival time) follows a certain theoretical distribution. Usually, the theoretical distributions that are widely used in survival analysis are the Exponential distribution, Weibull distribution, Lognormal distribution, Gamma distribution, and Log-Logistic distribution. The advantages of the parametric survival model include the predictable distribution of survival time; the full maximum likelihood can be used to estimate the parameters; (residuals can represent the difference between the observed and estimated time values; and the estimated parameters can provide a meaningful estimate of the effect (Zhang, 2016).

Weibull Parametric Model

One of the most useful models for analysis and modeling is the Weibull parametric model which is useful in various fields such as medicine, biology, engineering, and others (Saeed et al., 2020). This model was originally proposed by Weibull in 1939. This model is a generalization of the exponential parametric model. Lee et al. (2003) proposed that the Weibull parametric model is widely used in the study of human disease. This model does not assume a constant hazard rate and its use is wider than the exponential distribution. Let T is a random variable data length of time the patient was hospitalized until he was declared cured in Weibull distribution with the parameter is λ, then the probability density function of T is defined as follows (Kleinbaum et al., 2005).

$$f(t) = \lambda\gamma t^{\gamma-1}\exp(-\lambda t^{\gamma}) \tag{1}$$

Based on the equation, the survival function of T is obtained as follows:

$$s(t) = \exp(-\lambda t^{\gamma}) \tag{2}$$

The cumulative distribution function of the random variable T with the Weibull distribution is as follows:

$$F(t) = 1 - \exp(-\lambda t^{\gamma}) \quad (3)$$

The hazard function of the random variable T with the Weibull distribution is as follows:

$$h(t) = \lambda \gamma t^{\gamma - 1} \;\; ; \lambda > 0 \text{ dan } \gamma > 0 \quad (4)$$

Evaluation Criteria

Hosmer et al. (2008) explain that testing for the significance of parameters using simultaneous test and partial test. To test the hypothesis of β_k is zero, it can use a simultaneous test with the likelihood ratio test. This test statistic follows a chi-square distribution with a degree of freedom p. The hypothesis used in the simultaneous test is as follows:

H_0: $\beta_1 = \beta_2 = \ldots = \beta_k = 0$

H_1: at least one $\beta_k \neq 0$, with $k = 1,\ldots,7$

Rejection of H_0 if p-value < α means that there is at least one independent variable that affects survival time. Meanwhile, the partial test is then used to know the partial effect of each independent variable on the dependent variable. The hypothesis used in the partial test is as follows:

H_0: $\beta_k = 0$, with $k = 1,\ldots,7$

H_1: $\beta_k \neq 0$, with $k = 1,\ldots,7$

Rejection of H_0 if p-value < α which means that independent variable that affects survival time.

Furthermore, according to that the selection of the best models using *Akaike Information Criterion* (AIC). The best model has the smallest AIC value. The selection of the best Weibull parametric model is done by selecting the variables which can be done in many ways, such as the forward selection method is done by entering predictor variables gradually based on the largest partial correlation. In the forward selection method, the predictor variables included in the model cannot be removed again, while the backward elimination method is done by entering all predictor variables and then eliminating one by one until only significant predictor variables remain, and the stepwise method is a combination of the two methods, namely forward selection method and backward elimination method. At each stage, a variable can be included or excluded from the model. These three methods, namely forward selection, backward elimination, and stepwise, have the same goal, which is to reduce the possibility of multicollinearity in the resulting equation or model.

Data Analysis

The purpose of this study was to describe the general description of characteristics of DHF patients who were hospitalized. In knowing the general description of the characteristics of DHF patients, descriptive analysis can be done. Visualization of descriptive analysis can be in the form of histograms, pie charts, bar charts, or tables that include information on the mean, standard deviation, minimum and maximum values for each indicator. Second, knowing the factors that most influence the cure rate of DHF patients. In this case, it can be seen from the calculation results of the Weibull parametric model based on existing concepts and theories. Finally, knowing the length of time for a DHF patient to be declared cured. In this case, it can be seen from the AFT model and PH model that can accommodate factors related to survival time.

Accelerated Failure Time (AFT) and Proportional Hazard (PH)

The parametric survival model consists of 2 types of survival models, namely the Proportional Hazard (PH) Model and the Accelerated Failure Time (AFT) Model where the PH Model interprets the comparison between individual hazard values and the AFT Model interprets the comparison between individual survival times. The distribution in the parametric model is more used to form the AFT model than the PH model. Only two models can accommodate both (AFT model and

PH model), namely Exponential distribution and Weibull distribution. Meanwhile, the Lognormal distribution, Gamma distribution, and Log-Logistic distribution can only accommodate the AFT model. Wei (1992) states that the parametric AFT model provides an alternative to the PH model for statistical modeling of survival data. Orbe et al. (2002) described that the AFT model could be an interesting alternative to the PH model when the PH assumption did not hold. Implementation and interpretation of the results of AFT were simple. Saikia et al. (2017) explain that the AFT model is parametric and has the assumption that the effect of covariates act multiplicatively (proportionally) for the survival time. Though the parametric models are linear regression models, the difference between the linear regression model and the survival regression model is that in the case of the survival model the censored observations are considered.

RESULTS AND DISCUSSION

In general, the number of DHF patients has increased since 2015 and has a fairly high risk of death. This is considered worrying about the survival of patients in the future. Therefore, efforts are needed to overcome the increase in DHF patients, especially in Makassar. One of the efforts that can be done is to look at the cure rate in DHF patients, one of which is in the Regional General Hospital (RSUD) Makassar. The factors used as a reference in observing the cure rate of DHF patients, namely age, gender, body temperature, results of laboratory tests such as hemoglobin, leukocytes, hematocrit, and platelets. In general, it can be seen that the average age of DHF patients is 17 years with hospitalization for 5 days. Body temperature at the time of average 38ºC, and the laboratory results show that the leukocyte count was 5.3/µ*l*, the hemoglobin count was 14 g/dl, and the hematocrit was 39 percent.

The length of time the patients analyzed in this data was the length of time the patient was hospitalized until he was declared cured. It can be seen that the percentage of the length of time DHF patients were hospitalized for ≤ 5 days was 71.43 percent and 28.57 percent were hospitalized for more than 5 days. The age of the patients analyzed in this data is the age of life measured in years, where the age of the DHF patient when being treated. It can be seen that the percentage of DHF patients aged ≤ 16 years is 53.33 percent and 46.67 percent are over 16 years. The sex of the patients analyzed in this data were male and female patients who were registered in the medical records of DHF patients. It can be seen that the percentage of DHF patients is male by 52 percent and 48 percent is female. The hemoglobin of the patients analyzed in this data is a complex protein in erythrocytes that contains iron and the color is red. It can be seen that the percentage of DHF patients who have hemoglobin ≤ 15 g/dl is 69.52 percent and 30.48 percent have hemoglobin more than 15 g/dl. The leukocytes of the patients analyzed in this data are blood cells that are part of the immune system and function to protect themselves from infection or disease. It can be seen that the percentage of DHF patients who have leukocytes ≤ 4/µ*l* is 42.86 percent and 57.14 percent have leukocytes more than 4/µ*l*. The hematocrit of the patients analyzed in this data is a number that indicates the percentage of solids in the blood to blood fluids. It can be seen that the percentage of DHF patients who have a hematocrit of ≤ 42 percent is 68.57 percent and 31.43 percent have a hematocrit of more than 42 percent. The platelets of the patients analyzed in this data are cytoplasmic fragments without a nucleus with a diameter of 2-4 μm in the form of biconvex discs that form in the bone marrow and have an important role in the blood clotting process when an injury occurs so that the blood stops immediately. Under normal conditions, the platelet count is between 150000-400000/mm^3. A decrease in the platelet count to 100,000 mm^3, is usually found between the third and seventh day of illness. Platelet needs to be repeated until it is proven that the platelet count is within normal limits or decreasing. It can be seen that the percentage of DHF patients who have below normal platelets is 89.52 percent and 10.48 percent have normal platelets. The body temperature of the patients analyzed in this data is the temperature of the DHF patients who are hospitalized. It can be seen that the percentage of DHF patients who have a body temperature of ≤ 38^0C is 48.57 percent and 51.43 percent have a body temperature of more than 38^0C.

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In determining the distribution of survival time data, namely the length of time hospitalized until declared cured. To determine the type of distribution of the data, look at the AIC value. It can be seen that the Weibull parametric model has a lower AIC value of 400.71 than the Exponential parametric model which has an AIC value of 547.23. That means the best model of this research is the Weibull parametric model.

Table 2. AIC of the Parametric Survival Models

Scenario	**Model**	**AIC**
(1)	**(2)**	**(3)**
1	Exponential Parametric Model	547.23
2	Weibull Parametric Model	400.71

Parameter estimation in the Weibull parametric model can be calculated using by the Maximum Likelihood Estimator (MLE). In parameter testing, including simultaneous testing and partial testing. Simultaneous parameter estimation testing is carried out by looking at the output results of research data processing, namely the G test. Simultaneous parameter testing is carried out to determine the effect of the independent variables in the study on the dependent variable simultaneously, where the results obtained that the G test value is 19.96 with a p-value of 0.0056 smaller than the level significance of 0.05 which means that there is at least one significant variable or it can be interpreted that there is at least one independent variable that affects survival time in this study or it can be concluded as a whole, there is at least one variable that can contribute to the recovery rate of DHF patients.

Table 3. Partial Test Weibull Parametric Model

Code	Variable	Model AFT	p-value
(1)	(2)	(3)	(4)
	Intercept	1.5567	0.0000*
X_1	**Age** 1 = > 16 years 0 = ≤ 16 years	0.0094	0.8831
X_2	**Gender** 1 = male 0 = female	0.0578	0.3987
X_3	**Hemoglobin** 1 = > 15 g/dl 0 = ≤ 15 g/dl	0.0985	0.3070
X_4	**Leucocyte** 1 = > 4 /µl 0 = ≤ 4 /µl	-0.0019	0.9772
X_5	**Hematocrit** 1 = > 42% 0 = ≤ 42%	-0.1338	0.1826
X_6	**Platelet** 1 = normal 0 = below normal	0.2867	0.0066*

	Body Temperature		
X_7	1 = > 38^0C	0.1190	0.0650
	0 = ≤ 38^0C		

*significance of 0.05

While Table 3 shows the results of the partial test, it can be seen that the intercept and platelets have a p-value of less than 0.05, so it can be concluded that platelets can make a significant contribution to the cure rate of DHF patients. Based on the results, the researcher looks that it is necessary to select the Weibull parametric model, one of them is the backward selection method. It begins by eliminating one by one the variables according to the significance criteria and to select the best model, the smallest AIC value of the model will be considered.

Based on Table 4 shows that the selection of the best model In the first step enters all variables into the model, then for the second step and so on, removing the variables one by one, so that from output results, the process stops at the eighth step, where the model formed is a model with no variable age (X_1), gender (X_2), hemoglobin (X_3), leukocytes (X_4), and hematocrit (X_5) with the lowest AIC value of 392.84.

Table 4. Best Weibull Parametric Model

Scenario	Variable	AIC
(1)	(2)	(3)
1	All variable	400.71
2	Reduction leucocyte (X_4)	398.71
3	Reduction age (X_1) and leucocyte (X_4)	396.73
4	Reduction age (X_1), gender (X_2), and leucocyte (X_4)	395.47
5	Reduction age (X_1), gender (X_2), hemoglobin (X_3), and leucocyte (X_4)	394.62
6	Reduction age (X_1), gender (X_2), hemoglobin (X_3), leucocyte (X_4), and hematocrit (X_5)	392.84

Parameter estimation in the Weibull parametric model can be calculated using by Maximum Likelihood Estimator (MLE). In parameter testing, including simultaneous testing and partial testing. Simultaneous parameter estimation testing is carried out by looking at the output results of research data processing, namely the G test. Simultaneous parameter testing is carried out to determine the effect of the independent variables in the study on the dependent variable simultaneously, where the results obtained that the G test value is 17.83 with a p-value of 0.0001 smaller than the level significance of 0.05 which means that there is at least one significant variable or it can be interpreted that there is at least one independent variable that affects survival time in this study or it can be concluded as a whole, there is at least one variable that can contribute to the recovery rate of DHF patients.

Table 5. Partial Test Best Weibull Parametric Model

Code	Variable	Model AFT	Model PH	p-value
(1)	(2)	(3)	(4)	(5)
	Intercept	1.5842	-0.4848	0.0000*
	Platelet			
X_6	1 = normal	0.3460	-0.1056	0.0004*
	0 = < normal			

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	Body Temperature			
X_7	1 = > 38^0C	0.1192	-0.0365	0.0481*
	0 = ≤ 38^0C			

*significance of 0.05

Based on the AFT (Accelerated Failure Time) model, it can be seen that on the platelet variable, the value of exp (0.3460) = 1.4134 which means that every DHF patient with normal platelets will speed up the recovery rate after treatment and give a survival time of 1.4134 times longer than DHF patients with below-normal platelets and for the body temperature variable, the value of exp (0.1192) = 1.1266 which means that every DHF patient with body temperature > 38^0C will accelerate the recovery rate after treatment and provide a survival time of 1.1266 times longer than DHF patients with body temperature ≤ 38^0C. Meanwhile, based on the PH (Proportional Hazard) model, it can be seen that on the platelet variable, the hazard ratio of exp (-0.1056) = 0.8998, which means that every DHF patient with normal platelets, the risk of recovery after treatment is 0.8988 times compared to DHF patients with below-normal platelets and for the body temperature variable, the hazard ratio of exp (-0.0365) = 0.9642 which means that every DHF patient with body temperature > 38^0C will get the risk of recovery after treatment to be 0.9642 times that of DHF patients with body temperature ≤ 38^0C.

CONCLUSION

Dengue Hemorrhagic Fever (DHF) is a global virus threat that can attack human health. This virus is easy to develop in areas with a tropical climate, one of which is Indonesia. Indonesia is the country with the highest incidence of DHF in Southeast Asia since 1968-2009. Seeing the increasing number of DHF cases with high mortality rates, a study is needed to determine the length of time DHF patients survive to recover. The application of statistical methods that can be used to analyze the case is survival analysis. This research uses the Weibull parametric model to calculate survival analysis. The calculation shows that the best significant model only involves platelets and body temperature where the result of the AFT model, DHF patients with normal platelets will speed up the recovery rate after treatment and give a survival time of 1.4134 times longer than DHF patients with below-normal platelets and DHF patients with body temperature > 38^0C will accelerate the recovery rate after treatment and provide a survival time of 1.1266 times longer than DHF patients with body temperature ≤ 38^0C. The result of the PH model, DHF patients with normal platelets, the risk of recovery after treatment of 0.8988 times compared to DHF patients with below-normal platelets and DHF patients with body temperature > 38^0C will get the risk of recovery after treatment of 0.9642 times that of DHF patients with body temperature ≤ 38^0C.

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