Journal of Computer Science, Information Technology and Telecommunication Engineering (JCoSITTE)
Vol. 5, No. 2, September 2024, pp. 661~668
ISSN: 2721-3838, DOI: 10.30596/jcositte.v5i2.20910

Survival Analysis of Recovery Rates in Diabetes Mellitus Patients using The Kaplan-Meier Method (Case Study: Malahayati Islamic Hospital)

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ABSTRACT

Diabetes mellitus (DM) is a major global health issue characterized by insulin hormone deficiencies, leading to rising incidence rates and significant risks for society. This study analyzes survival times of DM patients at Malahayati Islamic Hospital Medan using the Kaplan-Meier method for time-to-recovery estimates and the Log-Rank test to evaluate differences in survival functions. Results indicate that survival estimates range from 0.99238 at day 0 to 0.00000 at day 13. No significant differences were found based on gender, age, disease diagnosis, or support type. However, females and older patients showed slightly longer recovery times, and patients with Type II DM recovered faster than those with Pneumonia and Type II DM. Patients receiving Nebulizer and Oxygen support showed quicker recovery compared to those with Thorax Photo, EKG, and Lab support.

Keyword : Survival analysis, DM, Kaplan-Meier, Log-Rank Test.

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Article history:
Received Aug 14, 2024
Revised Aug 18, 2024
Accepted Aug 20, 2024

1. INTRODUCTION

Diabetes Mellitus (DM) is disease abnormality induced metabolism lack insulin hormone (Kusnanto et al., 2019). The World Health Organization (WHO) and the American Diabetes Association (ADA) have set that diabetes is indicated when mark fasting plasma glucose (FGP) is more or The same with 7 mmol/L. Moment this, amount Diabetes sufferers in the US reached 23.6 million souls (7.8% of ten population). Amount diabetes sufferers worldwide are projected will increase Again from 171 million in 2000 to 336 million in 2030. Diabetes is classified disease chronic, the cause is pancreas producing insulin is not optimal/ body No capable For utilize insulin. Hyperglycemia is the consequences that occur from diabetes that is not controlled and resulted damage serious on the system in body, esp system nerves and systems vessels blood (Lestari et al., 2021).

Various triggering factors occurrence of Diabetes Mellitus ie age, excessive body weight or obesity, less activity physical, parental history (genetics), gestational diabetes, hypertension , and having history disease cardiovascular, lack knowledge, and support family (Ariyanti, 2017). From several factors described factors studied relate with incident Diabetes Militus that is, lack knowledge. Knowledge is also a the totality of ideas, thoughts, that one has man including humans and their lives as urge psychic in grow attitudes and behavior (Sanusi et al., 2018), as well as symptoms, causes, risk factors, prevention and treatment DM disease. Have six 6 levels, namely: know, understand, application, analysis, synthesis, and evaluation(Mahara et al., 2021).

So that objective from study This is For obtain estimation survival function or length of time healed patient DM sufferers with use method Kaplan-Meier as well as For know time difference healed patient based on type gender, age, diagnosis disease and its causes with using the Log-Rank test (D'Arrigo et al., 2021). Then proven with help R Studio software For prove truth with solution method Kaplan-Meier (Li et al., 2023).

For avoid the occurrence of misunderstandings in research This hence the Boundary problem is the data used from Malahayati RSI patients at a rate healing DM patients viz type gender, age, diagnosis disease and its causes. Study This focuses on estimation survival / rate healed DM patients as well look

for comparison rate healing DM patients based on type gender, age, diagnosis disease and its causes with using the Log-Rank test. Method used in apply resilience level analysis life is method Kaplan-Meier.

2. RESEARCH METHODS

This research was conducted at Malahayati Islamic Hospital, Jl. P Diponegoro No.2-4, Petisah Tengah, Kec. Medan Petisah, Medan City, North Sumatra. This research was conducted from December 2023 until with completion. Then the type of data used in study This is secondary data namely the data obtained from DM sufferers from record medical at RSI Islam Malahayati . This research uses two variables, namely the response variable jand the predictor variable. The variables used are:

1. Response variable: t = length of time for the patient's recovery rate
2. Predictor variables:
   a. $X1$ = Based on Age (age under 60 years and age over 60 years old)
   b. $X2$ = Based on gender
   c. $X3$ = Based on Diagnosis Disease
   d. Based on The support

Data analysis carried out in study This is Data analysis used the Kaplan-Meier test and the Log-Rank test for purposes For get estimation function survival (S(t)), displays chart function survival (S(t)), as well as look for difference in speed healing based on variable type gender, age, and comorbid and non-ODGJ positive comorbid. Study This use help R studio software. Function survival can stated as following (Hariadi, 2021) .

$$S(t) = P(T > t) = 1 - P(T \leq t) = 1 - F(t) \quad (1)$$

Where

S(t) = Survival function
F(t) = Cumulative function of data distribution
t = Observed time

Function survival For a time interval is proportion amount subject survive at the beginning of the reduced interval amount failure in that interval (Pradika & P, 2021) :

$$\hat{S}(t_i) = \frac{N_{i-1} - d_i}{N_{i-1}} \quad (2)$$

Method Kaplan-Meier is one methods included into the survival analysis was used For know How many big opportunity endure life a suffering patients a disease certain(Lee, 2023). Method Kaplan-Meier count continuity resilience life patient with give clear survival proportion (Liu et al., 2021). In do estimation function analysis survival with use method Kaplan-Meier data is needed. In practice, frequent data appears at the moment data retrieval is data that is not complete (censored data) (Pertiwi & Purnami, 2020). One observation resilience life usually own time beginning start observation and time final observation, so researcher only can observe all events and notes time incident during time that has been determined(Calabuig et al., 2021). The log-rank test is a frequent test used For see resilience life in a group, where the log-rank test was used For ensure whether There is significant difference between category(Yulistiani et al., 2024). The log-rank test is the statistical test used For compare two or more function survival, fine in the life table or chart the curve (McKone et al., 2021). Through the log-rank test you can known whether second group the own function the same survival Good in a way statistics or No . The log-rank test has hypothesis that is .

- $H_0 : S_1(t) = S_2(t)$ (terdapat perbedaan yang signifikan anatara 2 fungsi *survival*)
- $H_0 : S_1(t) \neq S_2(t)$ (tidak terdapat perbedaan yang signifikan antara 2 fungsi *survival*)

With area critically if P- value < level significance. Hypothesis The zero being tested is : No There is difference between function survival . Statistics the examiner including, among others following.

$$x^2 = \sum \frac{\left(\sum_{0jt} - \sum_{Ejt}\right)^2}{\sum_{Ejt}} \quad (3)$$

Which has a chi- square distribution with degrees free G – 1; Where G stated amount group comparison .

3. RESULTS AND DISCUSSION

The data that will be analyzed in this research is data on Diabetes Mellitus patients received from RSI Malahayati who are included in the recovered category and the exit category (died). However, because the registered data has a higher recovery rate than the death rate, this research was carried out using data on patients affected by DM from January 2023 to December 2023 with statements of recovery. The data consists of 394 patients suffering from DM who recovered.

3.1 Estimated Survival Analysis of DM Patients for Overall Data Using the Kaplan-Meier Method

Table 3.1. Patient Estimates

Time (Day)	Patient	Healed	$\hat{s}(t_i)$	$\hat{s}_{kumulatif}$
0	394	3	$\frac{391}{394}$	0.99238
1	391	10	$\frac{381}{391}$	$\frac{381}{391}\times 0.99238 = 0.96699$
2	301	75	$\frac{306}{381}$	$\frac{306}{381}\times 0.96699 = 0.77663$
3	306	115	$\frac{191}{306}$	$\frac{191}{306}\times 0.77663 = 0.48475$
4	191	101	$\frac{90}{191}$	$\frac{90}{191}\times 0.48475 = 0.22841$
5	90	41	$\frac{49}{90}$	$\frac{49}{90}\times 0.22841 = 0.12435$
6	49	14	$\frac{35}{49}$	$\frac{35}{49}\times 0.12435 = 0.08882$
7	35	11	$\frac{25}{35}$	$\frac{25}{35}\times 0.08882 = 0.06344$
8	24	8	$\frac{13}{25}$	$\frac{13}{25}\times 0.06344 = 0.03298$
9	13	1	$\frac{5}{13}$	$\frac{5}{13}\times 0.03298 = 0.01268$
10	5	2	$\frac{4}{5}$	$\frac{4}{5}\times 0.01268 = 0.01014$
11	4	1	$\frac{2}{4}$	$\frac{2}{4}\times 0.01014 = 0.00507$

12	2	1	$\frac{1}{2}$	$\frac{1}{2} \times 0.00507 = 0.00253$
13	1	1	()	()

In Table 3.1 it has long duration of time healed patient from duration 0 days with mark survival estimate of 0.99239 (99.23%) Up to with estimation survival of -13 days, equal to 0.00000 which shows that there is amount patient potential healed, and there is results from estimation function survival used For count estimation function survival cumulative results will used in make A curve Kaplan-Meier ¬. Following figure 1 curve estimation survival For overall data use method Kaplan-Meier in DM patients with the R Studio Program.

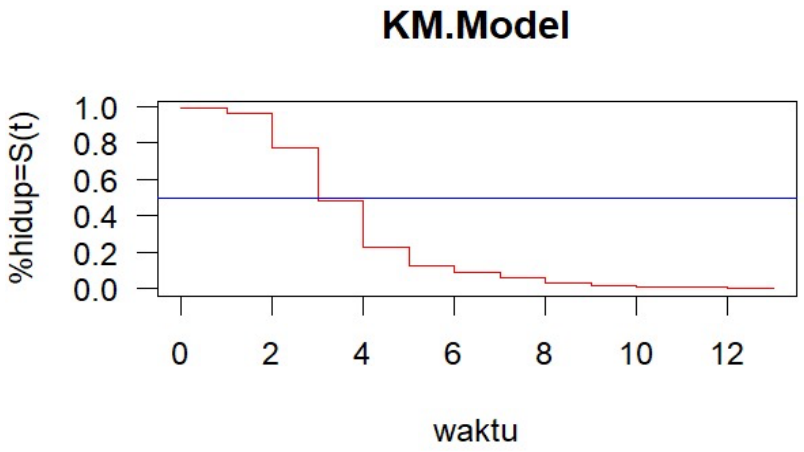

Figure 1. Estimates *Kaplan-Meier* Model on DM Patient Data

Seen in Figure 1 line curve colored red show rate healing in DM patients, namely from long duration of time recovered in 1 day up to 13 days. Curve line colored red Where show rate healing in DM patients from duration 0 days with estimation *survival* of 0.99239 (99.23%) to with duration 13 days with mark estimation *survival* 0.00000. While the lines are colored blue is the median of the length of time healed DM patients is 0.5, so DM patients at RSI Malahayati Medan will fast recovered on the day to 13 with niali of 0.00000 (0%)

The following is table 3 results estimation *survival* overall data use method *Kaplan-Meier* in DM patients with the R Studio program.

Table 2. Hasil *Survival* Pasien DM Menggunakan Software R

time	N risk	N event	survival	std.err	lower 95% CI	lower 95% CI
0	394	3	0.99239	0.00438	0.98384	1
1	391	10	0.96701	0.009	0.949527	0.9848
2	381	75	0.77665	0.02098	0.736595	0.8189
3	306	115	0.48477	0.02518	0.437852	0.5367
4	191	101	0.22843	0.02115	0.190517	0.2739

5	90	41	0.12437	0.01663	0.0957	0.1616
6	49	14	0.08883	0.01433	0.064749	0.1219
7	35	11	0.06091	0.01205	0.041337	0.0898
8	24	11	0.03299	0.009	0.019333	0.0563
9	13	8	0.01269	0.00564	0.005312	0.0303
10	5	1	0.01015	0.00505	0.003829	0.0269
11	4	2	0.00508	0.00358	0.001274	0.0202
12	2	1	0.00254	0.00253	0.000358	0.018
13	1	1	0.0000	0.0000	0.0000	0.0000

Results from purposeful R software For prove solution carried out in using R software has same result with work results manually. Can concluded the answer is made with manual method no there is error.

3.2 Analysis of DM Patient Survival for Each Factor Use Method Kaplan-Meier

In study This researcher analyze survival resilience life DM patients based on factor type gender, age, diagnosis disease and its causes.

Gender

Researcher do grouping type sex DM patients are divided into 2 parts, namely Types of DM patients sex men and women. Types of DM patients sex man as many as 176 patients and DM patients of various types sex Woman as many as 218 patients. Following chart estimation resilience life DM patients based on type sex use method Kaplan-Meier with the R Studio program.

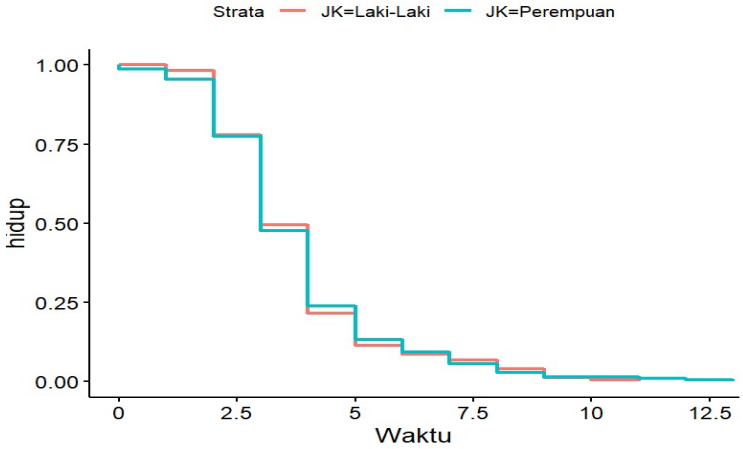

Figure 2. Estimates Cumulative Survival Based on Type Gender

Seen Figure 2 shows that the blue curve line is the line of the healing rate in patients of this type sex women and the red curve line is the line of the patient's recovery rate manifold sex man. It can be concluded from the images obtained that the healing rate in patients varies sex man more fast healed compared to patient manifold sex Woman. The more small mark probability so the more fast DM patients will healed. On the day First opportunity female survival amounting to 0.9862 (98.62%) more big compared to patient man that is amounted to 0.9829 (98.29%). However difference the in a way No statistics No meaningful, then need Log-Rank test was carried out.

Age

Researcher do grouping based on age DM patients are divided into 2 parts, namely DM patients < 60 years and > 60 years. There were 156 patients with DM < 60 and DM patients of various types sex Woman a total of 238 patients. Following chart estimation resilience life DM patients based on age use method Kaplan-Meier with the R Studio program.

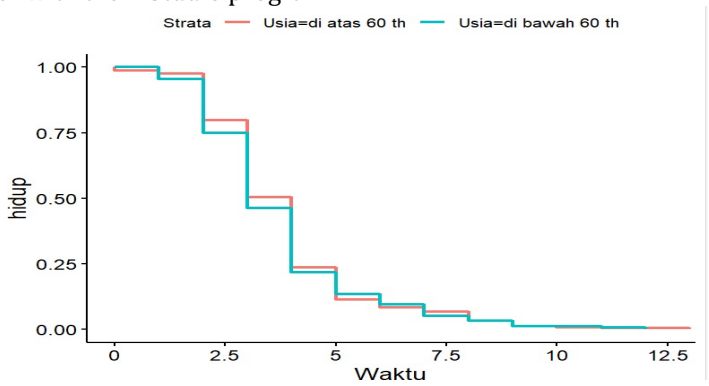

Figure 3.3. Estimates Cumulative Survival Based on Age

Seen Figure 3 shows that the red curve line is the line based on the rate of recovery for patients age > 60 years and the red curve line is the line of the patient's recovery rate based on age < 60 years . It can be concluded from the images obtained that the rate of healing in patients aged < 60 years more fast healed compared to patient > 60 years. On the day First opportunity patient survival > 60 years old amounting to 0.9874 (98.74%) more big compared to patient < 60 years old that is amounted to 0.9551 (95.51%).

3.3 DM Patients Based on Diagnosis Disease

Researcher do grouping based on diagnosis disease namely Type II DM and diagnosis of the disease Pneumonia+DM Type. Patient with a diagnosis of Type II DM as many as 267 patients more Lots compared to patient with diagnosis Pneumonia+DM Type II viz as many as 127 patients . Following chart estimation resilience life DM patients based on diagnosis disease use method Kaplan-Meier with the R Studio program.

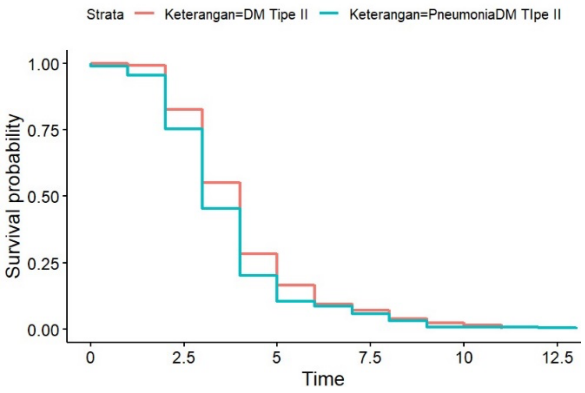

Figure 3.4. Estimates Cumulative Survival Based on Diagnosis Disease

Seen Figure 3 shows that the red curve line is the line based on the rate of recovery for patients diagnosis Type II DM disease and colored curve lines blue is the line of the patient's recovery rate based on diagnosis Pneumonia+DM Type II. It can be concluded from the images obtained that the rate of healing in patients is based on diagnosis Type II diabetes mellitus takes longer to heal compared to

patients based on diagnosis Pneumonia+DM Type II. On the day First opportunity patient survival Type II DM was more than to 0.9921 (99.21%) big compared to patient with diagnosis DM Type II viz amounted 0.98876 (98.76%).

3.4 DM Patients Based on The support

Researcher do grouping based on its support that is Thorax photo , EKG and Lab, and based on its support that is Nebules and Oxygen. Patient based on its support namely (Photo Thorax+EKG+ Lab) totaling 333 patients and based on support (Nebul+Oxygen) for 61 patients . Following chart estimation resilience life DM patients based on its support use method Kaplan-Meier with the R Studio program.

KM-Model Based on Support

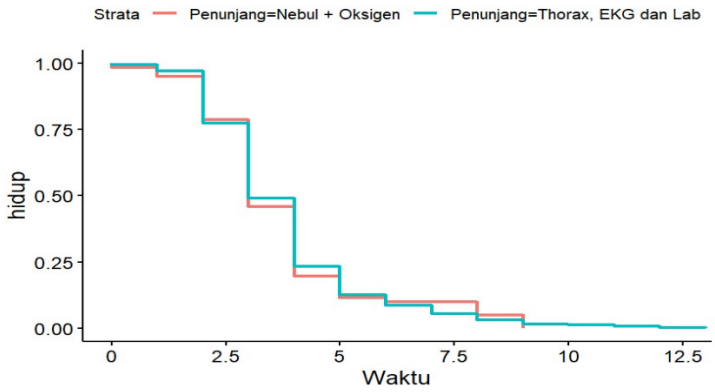

Figure 3.5. Estimates Cumulative Survival Based on The support

can see in the picture 4 colored curve lines red is the line from rate recovery in DM patients with support that is use Nebules and Oxygen and curve lines colored blue is the line from rate healing in DM patients with support that is use Thorax, Lab and EKG photos. Can concluded that rate recovery in DM patients with more support (Thorax Photo , Lab and EKG). Fast experience rate healing from the patient with support (Nebule and Oxygen). On the day First opportunity patient survival based on supporting (Thorax Photo, EKG, and Lab) amounting to 0.9939 (99.39%) more big compared to support (Nebule and Oxygen), namely value is 0.9836 (98.36%).

Log Rank Test

log-rank is used For ensure whether There is significant difference between category . The log-rank test is the statistical test used For compare two or more function survival, fine in the life table or chart the curve. Researcher observe the Log-Rank Test based on variable type gender, age, disease diagnosis and support. Log-Rank test analysis can seen in table 3.3.

Tabel 3.3. Log Rank Test Results Based on Variable

Variabel	Simbol		Kesimpulan
	P-value	sig	
Jenis Kelamin	0,0057	3,84	Gagal tolak H_0
Usia	0,272	3,84	Gagal tolak H_0
Diagnosa Penyakit	0,766	3,84	Gagal tolak H_0
Penunjang	0,174	3,84	Gagal tolak H_0

5. CONCLUSION

From the results of trials implementing mesh topology in a centralized spatial surveillance network, it can be As for the results from method Kaplan-Meier dam Lig -Rank test based on type gender, age, diagnosis disease and its

supports. Based on various types of patients sex men and women results the test is 0.0057 < 3.84, then H 0 fail reject or H 0 accepted. No there is significant difference in rate healing various types of patients sex men and women . Based on aged patients under 60 years and older patients over 60 years results the test is 0.272 < 3.84, then H 0 fail reject or H 0 accepted . No there is significant difference in rate healing aged patients under 60 years and older patients over 60 years old . Based on diagnosis disease results the test is 0,766 < 3.84, then H 0 fail reject or H 0 accepted . No there is significant difference in rate healing DM patients. Based on its support results the test is 0.174 < 3.84, then H 0 fail reject or H 0 accepted. No there is significant difference in rate healing DM patients. Test this done with distribution degrees free 1 use critical value α=0.05which is worth 3.84, which is used to show the difference between two survival curve.

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