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Research Article

Statistical Analysis Of Survival Of Brain Injury Patients

S. D. Kamble[1*], Dr. R. R. Kumbhar[2], Dr. S.V. Kakde[3]

[1*]Department of Statistics, Vivekanand College, Kolhapur, Empowered Autonomous and Affiliated to Shivaji University, Kolhapur, Email: shatawarikamble@gmail.com
[2]Department of Statistics, Vivekanand College, Kolhapur, Empowered Autonomous and Affiliated to Shivaji University, Kolhapur, Email: rrkumbhar@yahoo.co.in
[3]Krishna Institute of Medical Science, Karad, Email: satishvkakde@yahoo.co.in

***Corresponding Author:** S. D. Kamble
*Department of Statistics, Vivekanand College, Kolhapur, Empowered Autonomous and Affiliated to Shivaji University, Kolhapur, Email: shatawarikamble@gmail.com

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ABSTRACT

Background: Developing countries are facing a number of health issues and spend a huge amount of money on them. Out of the health issues, Traumatic Brain Injury (TBI) is a major global public health problem causing substantial mortality and disability among adults as well as young people. Also, people spend a lot of money to take care of TBI patients. So, this study aims at identifying how in-hospital survival differs with age of TBI patients.
Objective: To study the survival of different age groups at different levels of Traumatic Brain Injury(TBI).
Methodology: The patients having brain injury and admitted to the Intensive Care Unit (ICU) ward with an age between 18 and 55 years are included in the study. Every patient will be followed up to death or discharge or up to the 21st day after admission to the ICU. We used Kaplan Meier (KM) survival plots to compare survival rates in different age groups and different levels of brain injury.
Results: We found that 77% are male and 33% are female patients. About 85% of brain injuries are due to the Road Traffic Accidents (RTA) and 10% due to violations of traffic rules. Mild, Moderate, and severely injured patients are 46%, 25%, and 29% respectively.
Conclusion: As age increases, the in-hospital survival rate of TBI patients increases. In-hospital survival rate of TBI patients in the age groups 18–30 years and 44–55 years increases as the level of injury increases.

Keywords: Traumatic Brain Injury, Survival Analysis, Intensive Care Unit.

Introduction:

India is a developing country and is progressing in various fields like industrialization, urbanization, motorization, etc. With these developments, people are facing many health issues, of which TBI is a major one. TBI is caused by various elements, like falls, RTA, violations of traffic rules, etc. and hence TBI is the most common cause of death and disability in developing countries. In India, about 1.5 to 2 million people were injured, and out of them, 1 million people lost their lives due to TBI (G. Gururaj 2002). It is also observed that RTA constitutes a very high percentage of these deaths. By the year 2020, out of all accidents, the age group 18–45 is mostly affected due to road accidents, which contribute about 70% of total accidents (Ministry of road transport and Highways Transport Research Wing report 2020).
The data for this study was collected from the teaching hospital of Krishna Institute of Medical Sciences, Karad. The records of the TBI patients in the hospital were used, and the data was collected on demographics, injury pattern, co-morbidity, pre and in-hospital management course on ICU, and relevant laboratory findings and outcome or condition at the time of discharge. We specifically followed each and every patient enrolled in the study from their admission date to their death, discharge date, or 21st day in the hospital which was earlier.

Methodological Approach:

In this study we compared the in-hospital survival of the TBI patients according to their age groups using survival analysis technique. Survival analysis is the best technique to deal with the time to event data. For calculating time to event of TBI patients in our study, we have selected date of admission up to date of discharge from ICU or the 21st day in ICU or a death, whichever is earlier. We study the in-hospital survival of the TBI patients who directly admitted to the ICU were enrolled in the study

Study Settings:

The data for this study is collected from teaching hospital of Krishna Institute of Medical Sciences, Karad. TBI patients' hospital records were used and collected the data on demographics, injury pattern, co-morbidity, pre and in-hospital management course on ICU and relevant laboratory findings and outcome or condition at the time of discharge. We specifically followed each and every patient enrolled in the study from there admission date to the death or discharge date or 21st day in-hospital which was earlier.

Patient and population:

The present study included an individual with a brain injury reaching the hospital with vital signs and being admitted to the hospital via an emergency room with subsequent ICU/ICM (Intensive Care Medicine) care, having an age between 18 and 55 years. The study excluded those who died before reaching the hospital and were not referred by any other hospital.
A total of 115 patients who satisfied inclusion and exclusion criteria were included in the study.

Explanatory variables:

The analysis included the following variables: age at injury, gender, injury mechanism, diagnosis, date of admission to the ICU, ICU discharge date, follow-up end point, discharge status, Time of unconsciousness, edema, HB, BP, Glasgow Coma Scale (GCS), Glasgow Outcome Scale (GOS), surgery if any, CT (Computed Tomography) scan, hypoxia, seizures, focal brain contusions, pupils, hemorrhage, hematoma, vomiting, Ear/Nose/Throat Bleed, Other History (Hypertension, Diabetics, Asthma), Drowsiness. Admission date, discharge date and follow-up end point are allowed us to calculate the number of day's hospital stay of the patients.

Data Analysis:

In this research article we have compared three study groups of TBI patients formed on the basis of their age group which are 18-30 years, 31-43 years and 44-55 years. We studied every patient admitted to the ICU from admission date till in-hospital death, discharge or 21st days in ICU. The study included 24 censored cases and 91 uncensored cases. The patients who take Lama or Dama discharge or death after 21st day in-hospital were not counted as an event and hence were rightly censored. We have used R (4.0.5) software for statistical analysis.

Kaplan Meire (KM) Survival Plots:

Kaplan Meire statistical method is used to analyze time to event data. This method was used to analyze the patients that reached a certain event and those that were censored during a given period of time and also to compare between groups of participants (Manish Kumar Goel, Pardeep Khanna, Jugal Kishore 2010, Etikan İ, Abubakar S, Alkassim R 2017).
We used KM plots to compare study samples with groups according to their age. First KM curve (Figure No. 2) shows the whole study population and second set of KM curves (Figure No. 3) shows mild, moderate and severe TBI patients separately.

Log Rank Test:

The log rank test, a statistical tool for comparing the distributions of time until the occurrence of an event of interest in an independent group, is used to assess the significance of the difference. In these studies, we divided the whole of the data into three independent age groups named G1, G2, and G3. We used the log rank test to check whether a difference exists between two survival curves or if they are overlapping. For this, the test hypothesis was H0: $\overline{F_1} = \overline{F_2}$ V/s H1: $\overline{F_1} \neq \overline{F_2}$ i.e. H0: There is no difference or overlap in the curves V/s H1: there is difference or no overlap in the curves (Shayne C. Gad, Colin G., Rousseaux 2002).

Institutional Review Board:

The ethical approval for this study was obtained from the KIMS Ethics Committee.

Result:

As per the inclusion and exclusion criteria, 115 TBI patients were enrolled in the study. Out of 115 patients, 40 (35%) were 18–30 years old, 32 (28%) were 31–43 years old, and 43 (37%) were 44–55 years old. There were 27 (23%) female and 88 (77%) male patients (Table 1). RTA contributes 85% to all injury mechanisms (Fig. 1),

while 53 (46%) had mild TBI, 29 (25%) had moderate TBI, and 33 (29%) had severe TBI patients. The median duration of the hospital stay was 8 days, irrespective of the outcome status.

Figure No. 2 depicts the KM plot for the whole population in the study, comparing in-hospital survivals according to the age group. In this plot, the black curve represents G1 (Group 1, i.e., 18–30 years), the pink curve represents G2 (Group 2, i.e., 31–43 years), and the green curve represents G3 (Group 3, i.e., 44–55 years). All three Kaplan-Meier survival time curves intersected each other on the 4th hospital day, after which they separated and showed that the in-hospital survival rate increased in proportion with age. Till the 4th day in the hospital, the survival time is similar in all age groups.

Figure No. 3 presents KM plots according to the level of severity of the injury. In the case of mild TBI patients, the in-hospital survival time of the patients in the age group 31–43 years is higher as compared to the remaining two groups. For moderate TBI patients in G1, the in-hospital survival time is higher up to the 14th hospital day, and after that, it decreases compared to the other two groups. And in the case of severely injured patients, the in-hospital survival time of patients in age group 1 is higher than that of patients in age group 2, while the in-hospital survival time of patients in age group 3 is higher than that of age groups 1 and 2.

Figure No. 4 shows KM plots for different age groups according to level of injury and severity. In age groups 1 and 3, in-hospital survival time increases in proportion with the level of injury. But in age group 2, the in-hospital survival time of mild and moderate patients is higher than that of severe patients.

Table No. 2 shows the results of the log rank test for in-hospital survival rates according to age groups as G1 and G2, G1 and G3, G2 and G3. For the age groups G1 and G2, G2 and G3, G1 and G3 test p-values are 0.4, 0.1, and 0.01, respectively. This means that there is no difference in survival times for G1 and G2, G2 and G3, or they are overlapping, but there is a difference in survival times for G1 and G3, or there is no overlapping.

Table No. 3 shows the results of the log rank test for in-hospital survival rates according to the level of severity of injury, such as mild TBI and moderate TBI, mild TBI and severe TBI, moderate TBI and severe TBI. For the comparisons of mild TBI and moderate TBI, mild TBI and severe TBI, moderate TBI and severe TBI test p-values are 0.005, 5e-04, and 0.6, respectively. That means there is a difference in survival times for comparisons of mild TBI and moderate TBI, mild TBI and severe TBI, or no overlapping, but there is no difference in survival times for moderate TBI and severe TBI, or they are overlapping.

Discussion:

As India had more population in the working age group (18–60 years), people in the working age group shared 87.4%, 84.5% of total road accident fatalities.

The present study focused on TBI patients in the age group of 18–55 years. The study excluded patients 1) who died before reaching the hospital and 2) who were referred by any other hospital.

We divided the whole population into 3 age groups and in-hospital survival time of TBI patients as per the level of severity of injury is studied. It was observed that out of all causes, the TBI road traffic accidents contributed more. In-hospital survival time changes according to age and level of severity of injury are major factors affecting it.

The limitation of this study is the time period and area under study. By increasing the time period and the area, we may get more precise results.

Limitations:

This study was conducted in a single tertiary care hospital of Satara district. Hence, the patients admitting only in that hospital are included in the study. The patient having age is below 18 and greater than 55 years are not included in the study because of study design limitation. We did not follow the patient after 21st day of admission even though the patient stayed in hospital after 21st day. The patients who are transferred from other hospital are also not included in the study.

Conclusion:

This study shows that males are highly affected than females by brain injury. Out of all injury mechanisms, RTA contributes a very high percentage to brain injury. The in-hospital stay of the patients increases in proportion to their age. As the level of injury changes, each age group shows different patterns. For instance, as the level of severity increases, the in-hospital survival of patients from age group 1 increases; the in-hospital survival time of patients from age group 2 is about the same for mild and moderate cases, but it becomes minimum in severe cases; and the in-hospital survival time of patients from age group 3 increases as the level of severity increases. In age groups G1 and G2, G2 and G3, similar in-hospital survival times are observed during the study period, while for age groups G1 and G3, different in-hospital survival times are observed during the study period. For the level of injury severity, mild TBI and moderate TBI, mild TBI and severe TBI, we observed different in-hospital survival times over the study period, while for moderate TBI and severe TBI, we observed similar in-hospital survival times during the study period.

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Table No.1

Count of Age_Group	Injury_Severity			Grand Total
Age_Group	**Mild(53)**	**Moderate(29)**	**Sever(33)**	
18-30	21	7	12	40
31-43	15	10	7	32
44-55	17	12	14	43
Gender				
Female	13	7	7	27
Male	40	22	26	85
Status				
Censored	5	8	11	24
Uncensored	48	21	22	91
ICU Discharge Status				
Cured	3	2		5
Death			7	7
Improved	25	9	9	43
Improved Compliant	5	4	5	14
Improved good	20	10	5	35
Improved unstable		1		1
Poor		3	7	10
Edema				
no	31	22	11	64
Yes	22	7	22	51

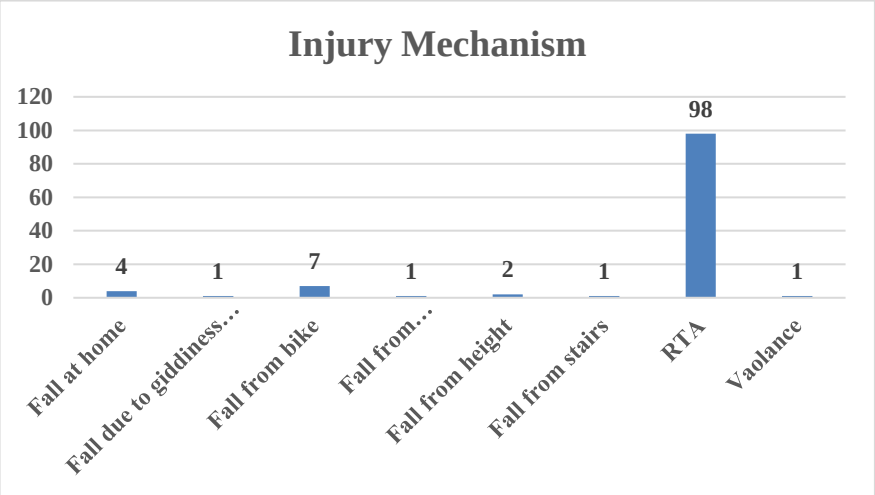
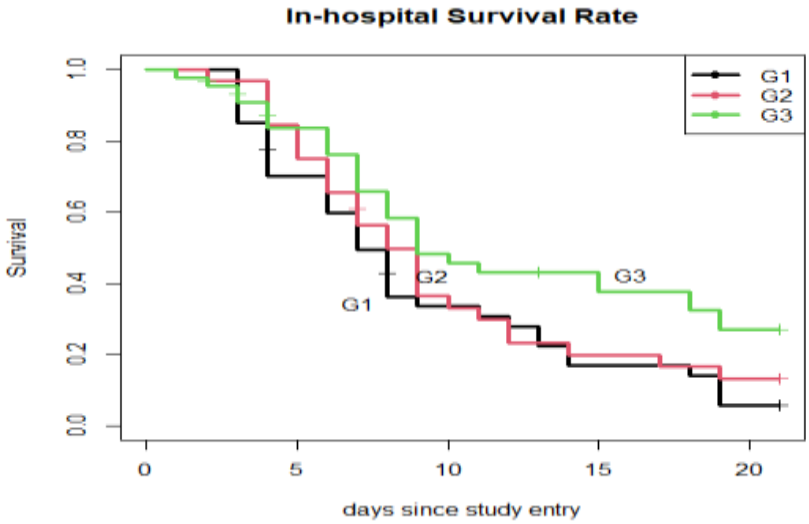


Figure No.1



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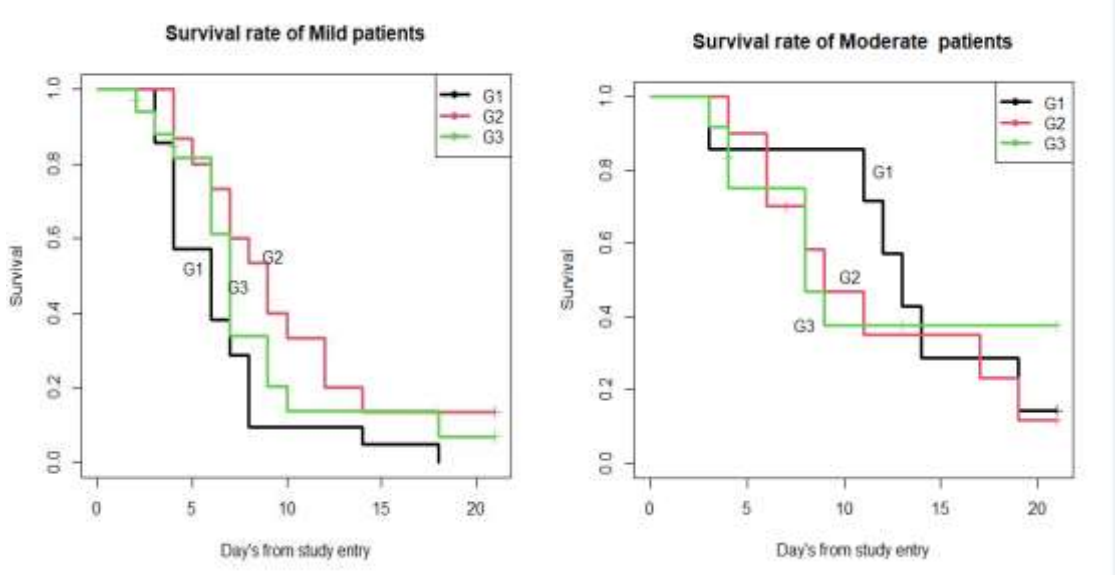

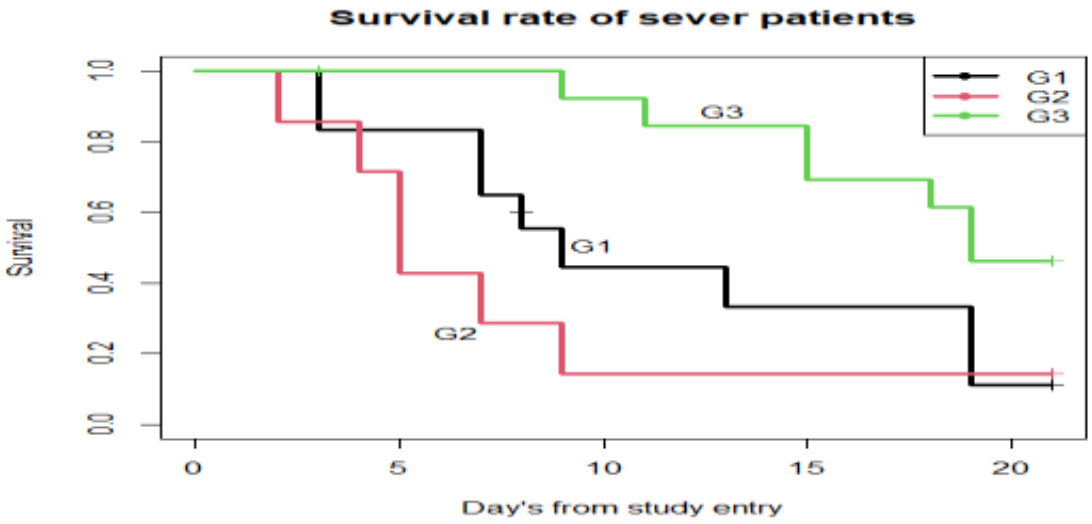

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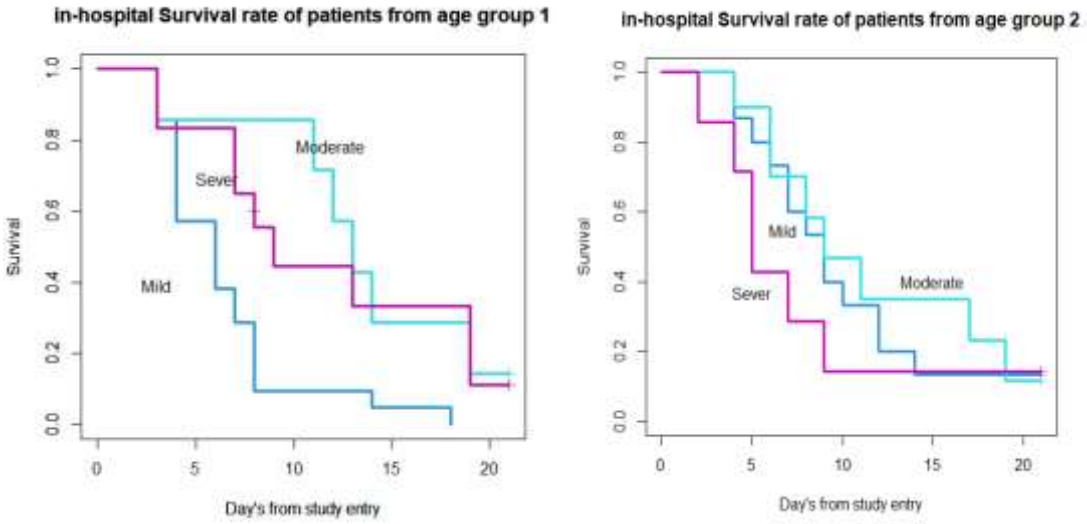

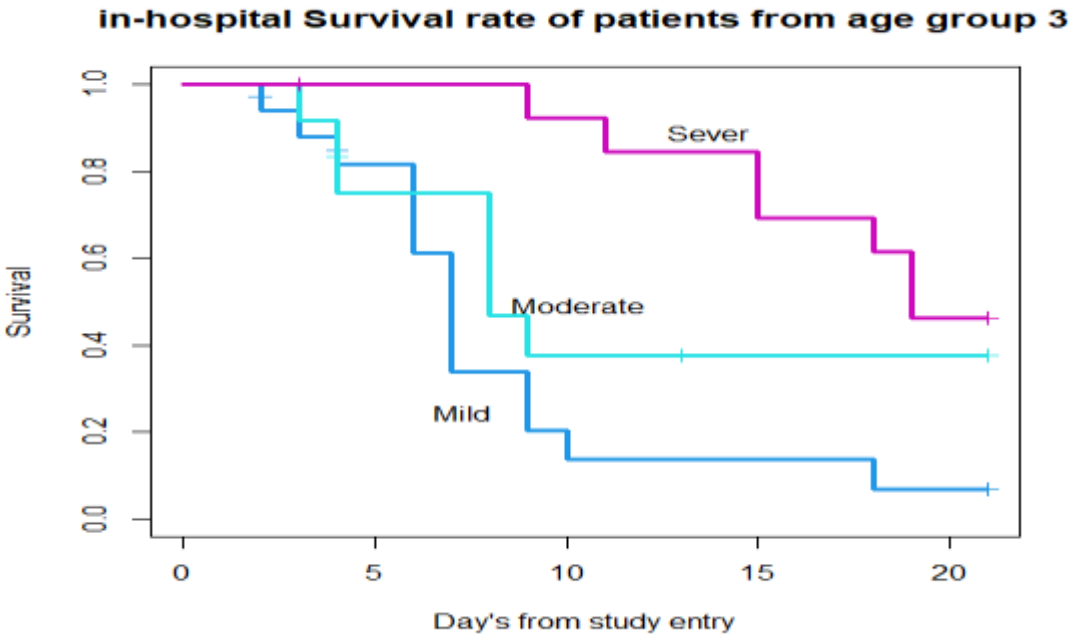

Figure No. 4

Log Rank Test Result

Table No.2

Age groups for comparison	Chi-square value	Degrees of freedom	P-Value
G1 and G2	0.6	1	0.4
G1 and G3	6.1	1	0.01
G2 and G3	2.2	1	0.1

Table No. 3

Level of Injury Severity for comparison	Chi-sq value	Degrees of freedom	P-Value
Mild and Moderate	8	1	0.005
Mild and Sever	12	1	5e-04
Moderate and Sever	03	1	0.6