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Comparison of Survival Rates Between Patients Undergoing Different Surgical Methods for Breast Cancer

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1   Introduction

Breast cancer is a significant global health concern, with millions of women diagnosed annually. The primary treatments for breast cancer include various surgical methods, among which Modified Radical Mastectomy (MRM) and Lumpectomy are the most common. These surgical approaches have distinct techniques and varying degrees of invasiveness. However, the key question that remains is whether there is a difference in the survival rates of patients who undergo these two procedures.

In this study, we aim to compare the survival rates of patients who have undergone Modified Radical Mastectomy (MRM) and Lumpectomy, assessing if the choice of surgery has a significant impact on the patients' survival. By examining data from a group of patients, we will test whether there is a statistically significant difference in survival outcomes between the two groups.

2   Research Problem

The question guiding this study is: "Does the type of surgical procedure (Modified Radical Mastectomy vs. Lumpectomy) have a statistically significant effect on the survival rates of breast cancer patients?"

3   Objectives

The objectives of this study are as follows:

1. To compare the survival rates between breast cancer patients who underwent Modified Radical Mastectomy (MRM) and those who underwent Lumpectomy.

2. To determine if there is a significant difference in survival rates between the two groups.

3. To provide evidence-based recommendations regarding the preferred surgical approach for maximizing patient survival, based on the results of the statistical tests.

4 Hypothesis Testing

To test whether the type of surgery affects patient survival, the following hypotheses will be evaluated:

Null Hypothesis (H_0):
There is no difference in the survival rates between patients undergoing Modified Radical Mastectomy (MRM) and those undergoing Lumpectomy. Given by:

$$P_1 = P_2$$

where P_1 is the survival rate for patients undergoing Lumpectomy, and P_2 is the survival rate for patients undergoing Modified Radical Mastectomy.

Alternative Hypothesis (H_a):
There is a significant difference in the survival rates between patients undergoing Modified Radical Mastectomy (MRM) and those undergoing Lumpectomy. Mathematically, this can be expressed as:

$$P_1 \neq P_2$$

This hypothesis suggests that the type of surgical method influences the survival rate, and a difference exists between the two groups.

5 Methodology

This study will use data collected from 162 breast cancer patients, split into two groups:

1. Group 1: 66 patients who underwent Lumpectomy surgery.

2. Group 2: 96 patients who underwent Modified Radical Mastectomy surgery.

For each patient, data will be recorded on whether they survived following surgery. The survival rates for both groups will be compared using a statistical hypothesis test.

6   Statistical Analysis

1. The Z-test for comparing two proportions will be used to assess whether there is a statistically significant difference between the survival rates of the two groups.

2. We will use the significance level $\alpha = 0.05$ for the hypothesis testing to investigate the possible differences in survival outcomes.

3. The confidence interval will be computed to estimate the range of possible differences in survival rates between the two groups.

7   Data Collection

The data on survival will be provided in the following format:

1. Group 1 (Lumpectomy): Total number of patients (66), number of survivors.

2. Group 2 (MRM): Total number of patients (96), number of survivors.

8   Statistical Software

Data Analysis will be performed using Minitab, which will facilitate the computation of test statistics and confidence intervals.

9   Significance of the Study

This study is significant for the medical community as it will provide evidence on whether the surgical method influences patient survival rates. The findings could guide clinical decisions, influencing recommendations on the best surgical approach for improving patient outcomes. If a significant difference is found, healthcare professionals may adjust their treatment protocols, potentially favoring one surgery over the other depending on the results.

10   Expected Results

Based on the statistical hypothesis test, one of the following outcomes is expected:

1. If the null hypothesis is rejected (H_0): It would indicate that the survival rates differ significantly between the two groups, and the choice of surgery may play a role in patient survival.

2. If the null hypothesis is not rejected (H_0): It would suggest that there is no statistically significant difference in survival between the two surgical methods, implying that other factors may be more influential in determining patient survival.

11   Conclusion

The results of this study will provide important insights into the impact of surgical methods on survival outcomes for breast cancer patients. By comparing survival rates between two commonly used surgical approaches, Modified Radical Mastectomy and Lumpectomy, this research aims to contribute valuable statistical evidence to clinical practices and assist healthcare professionals in making informed decisions regarding patient treatment.

12 Analysis

After exploring our dataset, we found the following:

Table 1: Patient Population and Surgical Outcomes

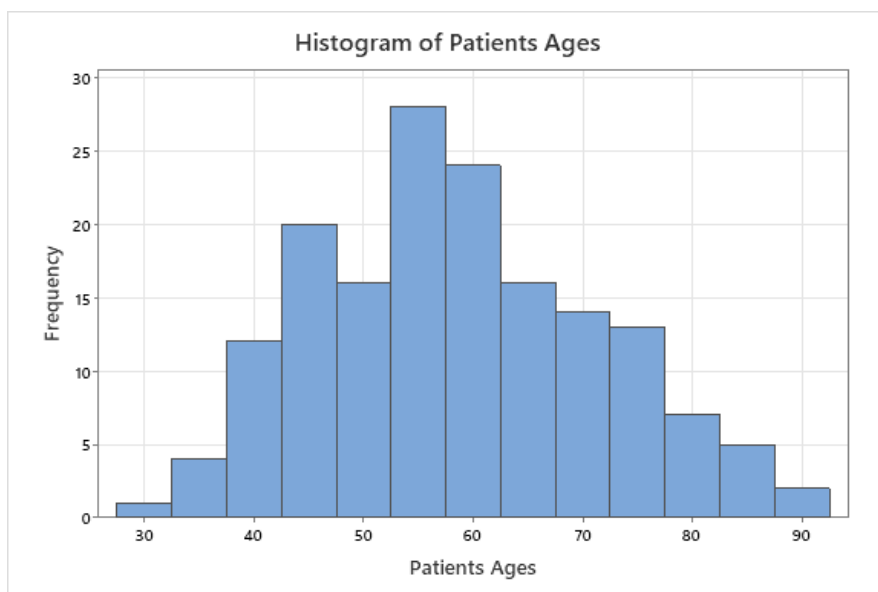| Characteristic	Value
Sample Size	166 patients (5 Males, 161 Females)
Lumpectomy Surgery	66 patients, 58 survived
Modified Radical Mastectomy Surgery	96 patients, 73 survived
Max Age	90 years
Min Age	28 years
Average Age	59 years

Figure 1: Patients Ages Distribution

Model Assumptions:

We assume that the two samples are independent. Consequently, the number of survivors under Lumpectomy surgery, denoted by X and the number of survivors under Modified Radical Mastectomy surgery, denoted by Y are also independent random variables.

Let's denote by :

$$\hat{P_1} = \frac{\text{Number of Lumpectomy survivors}}{\text{Number of patients who underwent Lumpectomy surgery}}$$

$$\hat{P_2} = \frac{\text{Number of MRM survivors}}{\text{Number of patients who underwent MRM surgery}}$$

So, we have :

$$\hat{P_1} = \frac{58}{66} = 0.88 \text{ and } \hat{P_2} = \frac{73}{96} = 0.76$$

Now, we want to estimate :

$$P_1 - P_2$$

Where P_1 and P_2 are the true population survival rates for Lumpectomy surgery and Modified Radical Mastectomy surgery respectively.

Now, since both sample sizes are large ($m = 66 > 30$ and $n = 96 > 30$), we can apply the Central Limit Theorem to conclude that :

$$Z = \frac{\hat{p_1} - \hat{p_2} - (p_1 - p_2)}{\sqrt{p_1 q_1/m + p_2 q_2/n}}$$

has approximately the standard normal distribution.
So, we are interested in testing the following hypotheses :

$$\begin{cases} H_0 : & P_1 - P_2 = 0 \\ H_A : & P_1 - P_2 \neq 0 \end{cases}$$

Under H_0, we have $p_1 = p_2 = p$, and we estimate p by :

$$\hat{p} = \frac{m}{m+n}\hat{P_1} + \frac{n}{m+n}\hat{P_2} = \frac{66}{66+96}(0.88) + \frac{96}{66+96}(0.76) = 0.808$$

So, we can use the Test Statistic value:

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}\left(\frac{1}{m} + \frac{1}{n}\right)}}$$

We estimate the Confidence Interval for $p_1 - p_2$ with a confidence level of approximately $100(1 - \alpha)\%$ by:

$$\hat{p}_1 - \hat{p}_2 \pm z_{\alpha/2}\sqrt{\hat{p}_1\hat{q}_1/m + \hat{p}_2\hat{q}_2/n}$$

For $\alpha = 0.05$ we find the following with Mintab:

Descriptive Statistics

Sample	N	Event	Sample p
Sample 1	66	58	0.878788
Sample 2	96	73	0.760417

Estimation for Difference

Difference	95% CI for Difference
0.118371	(0.002225, 0.234518)

CI based on normal approximation

Test

Null hypothesis	H_0: $p_1 - p_2 = 0$
Alternative hypothesis	H_1: $p_1 - p_2 \neq 0$

Method	Z-Value	P-Value
Normal approximation	2.00	0.046
Fisher's exact		0.069

13 Final Conclusion

Since the p-value (0.046) is less than the significance level of 0.05, we reject the null hypothesis. Moreover, the 95% confidence interval does not contain 0, which further supports the conclusion that there is a statistically significant difference between the two population proportions.

Therefore, this analysis provides evidence that the surgical method influences patient survival rates. As a result, we may recommend that healthcare professionals consider adjusting their treatment protocols, potentially favoring the *Lumpectomy* surgical approach, which appears to be associated with better survival rates, in order to improve patient outcomes.

14 Data Source

Click here to explore the Dataset

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