

INTRODUCTION

The aim of this analysis is to investigate the impact of a new surgical procedure on the length of hospital stays following heart surgery. We will address the following research questions:

1. Do the data from the new surgical procedure support the hypothesis that the new surgical procedure reduces the mean length of hospital stays?
2. Using a Matched Case-Control study, assess the size of reduction in the length of hospital stay due to the new surgical procedure.

EXPLORATORY DATA ANALYSIS

After performing an initial data analysis, the following information was obtained.

1. Summary for Current Surgeries

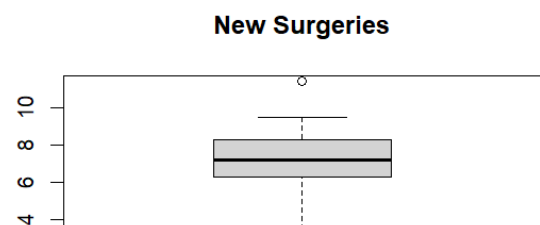
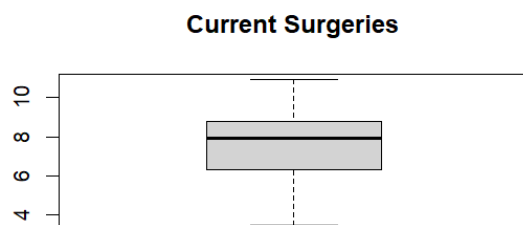
Minimum Length: 3.5
1st Quartile: 6.3
Median: 7.9
Mean: 7.6
3rd Quartile: 8.8
Maximum Length: 10.9

2. Summary for New Surgeries

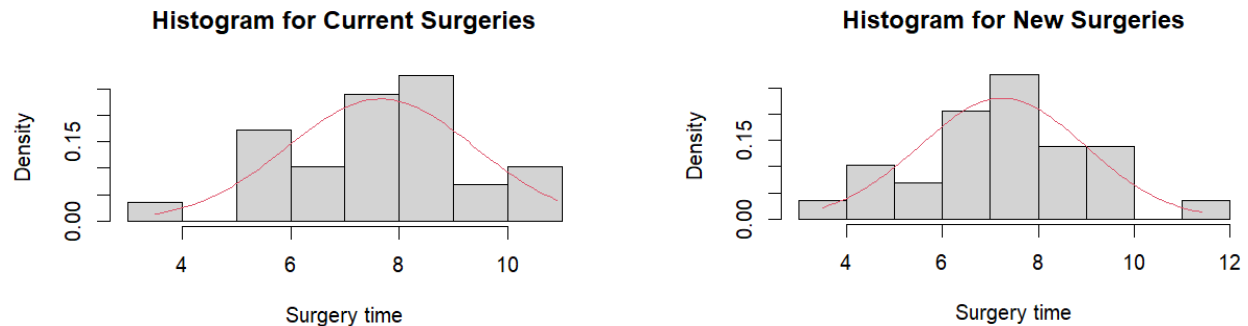
Minimum Length: 3.5
1st Quartile: 6.3
Median: 7.2
Mean: 7.255
3rd Quartile: 8.3
Maximum Length: 11.4

Here we observe that the minimum length of the surgery is the same for both the procedures. The maximum length of the surgery is greater using the new method. This is not what was expected. However, the smaller mean and median values of the new procedure suggest that generally, the length of the surgery using the new procedure is smaller than the current procedure. Therefore, it can be assumed that the greater maximum length for the new procedure is due to an outlier.

In order to confirm this assumption, a box plot was plotted for both the procedures. It can be clearly seen that the maximum value of 11.4 is an outlier for the new surgical procedure.



The following histograms show a normal distribution for the data in case of both current and new surgical procedures.



METHODS

The following statistical methods were used to answer the research questions.

1. To address the first question, a one-sided paired t-test, comparing the means of the new surgical procedure and the current surgical procedure, was performed.
2. To assess the size of the reduction in the length of hospital stay due to the new surgical procedure (research question 2), the mean difference was calculated and a confidence interval was constructed. A t-test was also performed to show that the calculated mean difference was actually correct.

RESULTS

QUESTION 1 - HYPOTHESIS TEST:

A one-sided paired t-test was performed, with the assumption of equal variances:

1. Null Hypothesis (H_0): True mean difference is equal to 0. (The new surgical procedure has no effect on the mean length of hospital stays.)
2. Alternative Hypothesis (H_1): True mean difference is greater than 0. (The new surgical procedure reduces the mean length of hospital stays.)

The t-test resulted in a t-value of 3.0616 with 28 degrees of freedom and a p-value of 0.00241.

As the p-value is smaller than 0.05 (assuming 5% significance level), we can reject the null hypothesis. Therefore, we conclude that the true mean difference is greater than 0 and the new surgical procedure has reduced the mean length.

The 95% confidence interval for the mean difference is (0.1823415, Inf). The estimated mean difference is 0.4103448, which lies within the confidence interval.

RESEARCH QUESTION 2 - SIZE OF REDUCTION:

The mean difference between the surgery lengths was calculated to assess the size of the reduction in the length of hospital stay.

The mean difference was found to be 0.4103448, and the 95% confidence interval for the mean difference is (0.1357959, 0.6848937). The mean difference lies within the confidence interval.

A two-sided paired t-test was also performed to confirm that the mean difference is equal to 0.41.

1. Null Hypothesis (H_0): True mean difference is equal to 0.41.
2. Alternative Hypothesis (H_1): True mean difference is not equal to 0.41.

A t-value of 0.0025728, a p-value of 0.998 and a confidence interval of (0.1357959, 0.6848937) was obtained.

Since, the p value is very large, we cannot reject the null hypothesis. Therefore, the true mean difference is actually equal to 0.41.

CONCLUSIONS

Based on our analysis:

1. The one-sided t-test indicates that the new surgical procedure will reduce the mean length of hospital stays. The p-value is 0.00241, which is below the conventional significance level of 0.05. This suggests that there is evidence to support the alternative hypothesis, indicating that the new procedure will lead to shorter hospital stays.
2. The mean reduction in the length of hospital stay due to the new surgical procedure is approximately 0.4103448 days (with a 95% confidence interval of 0.1357959 to 0.6848937). The two-sided t-test provides sufficient evidence to conclude that the mean difference is equal to 0.41.