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Study Title:

Cost-Effectiveness of ACL Reconstruction vs. Conservative Rehabilitation

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UNCC TEAM MEMBER	KETAKI NARENDRA GHARPURAY
UNCC TEAM MEMBER	HUYEN HUYNH
UNCC TEAM MEMBER	SYDNEY WESTFALL
UNCC TEAM MEMBER	ANYJHIA WILKINS
UNCC TEAM MEMBER	JASON ZHANG

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1 Abstract

Introduction: The Anterior Cruciate Ligament (ACL) is a crucial ligament within the knee joint, and its rupture is one of the most common injuries that impact young, athletic individuals, resulting in chronic joint instability. There are two options for treating the injury, surgical and non-surgical. The choice to go for either treatment often depends on the lifestyle of the patient. While surgical reconstruction is more expensive than non-surgical treatment, there is a huge impact on the patient's quality of life due to an unhealed ACL injury. Therefore, it is necessary to evaluate the cost-effectiveness of both treatment options in order to arrive at the right decision.

Objective: To compare the cost-effectiveness of surgical reconstruction and conservative rehabilitation in the treatment of ACL injuries.

Methods: A decision-tree model was constructed to assess and determine the most cost-effective treatment for those who experience an ACL injury; the options are limited to reconstructive surgery and conservative rehabilitation. The data utilized originated from the following published medical article: "*Reconstruction Versus Conservative Treatment After Rupture of the Anterior Cruciate Ligament: Cost Effectiveness Analysis*" by Farshad et al (2011). The data extracted from the previously mentioned published article consisted of total effectiveness measured in Quality Adjusted Life Years (QALYs), costs of treatments, and additional medical costs associated with an ACL injury. Post-treatment activity levels were considered to be indicators of treatment success or failure. The time horizon was set to 1 year. Cost-effectiveness analysis was conducted to estimate the incremental cost-effectiveness ratio (ICER) of reconstructive surgery vs. conservative rehabilitation after ACL injury.

Results: Decision tree analysis revealed a QALY of 0.854 for surgical treatment, with an incremental cost-effectiveness ratio (ICER) of 50,538.48. For conservative rehabilitation, the QALY value was 0.749, with an incremental cost-effectiveness ratio (ICER) of 10,057.15. The expected cost for surgical treatment was \$12,834.32, whereas the expected cost for conservative rehabilitation was \$7527.78.

Conclusion: Although the QALYs gained through surgical treatment are higher than those gained from conservative rehabilitation, the results of this study indicate that in the short term, conservative rehabilitation is the more cost-effective option.

2 Background

The Anterior Cruciate Ligament (ACL) is a necessary ligament within the knee joint, and its rupture is one of the most common injuries that impact young, athletic individuals, resulting in chronic instability. There are two options for treating the injury, surgical and non-surgical. The choice to go for either treatment often depends on the lifestyle of the patient. While surgical

reconstruction is more expensive than non-surgical treatment, there is a huge impact on the patient's quality of life due to an unhealed ACL injury. Therefore, it is necessary to evaluate the cost-effectiveness of both treatment options in order to arrive at the right decision.

2.1 Abbreviations

Abbreviations	Description of Abbreviations
ACL	Anterior Cruciate Ligament
MRI	Magnetic Resonance Imaging
ADL	Activities of Daily Living
QALY	Quality-Adjusted Life Years

2.2 Definitions

The Anterior Cruciate Ligament

The *Anterior Cruciate Ligament* commonly referred to as ACL, is a critical ligament within the knee. Ligaments consist of strong, fibrous material that connects to the bone for additional support (Rodriguez *et al.*, 2021). The knee is the intersection of the femur, tibia, and patella. The ACL functions as an anchor for knee stability, in addition to supporting the other ligaments within the knee to connect the tibia to the femur. Without an ACL, the knee would not be able to support aggressive landing, pivoting, and cutting (Rodriguez *et al.*, 2021). The ACL is a very important supporting ligament within the knee joint. ACL tears occur when the tibia and femur are exerted in different directions.

Reconstruction surgery

ACL reconstruction is surgery to replace a torn ACL in order to offer the patient a functional, pain-free, and stable joint.

Conservative rehabilitation

Conservative rehabilitation requires physical therapy to strengthen the muscles around the knee.

3 Methods

The objective of this study was to calculate the cost-effectiveness of each treatment option for ACL injuries. A retrospective analysis was conducted using data from published

medical literature, which included cost-effectiveness studies of patients with an ACL injury undergoing surgical or non-surgical (i.e, conservative) treatment.

In the research article by Farshad et al (2011) titled *Reconstruction Versus Conservative Treatment After Rupture of the Anterior Cruciate Ligament: Cost-Effectiveness Analysis*, (n=229) patients had reconstructive surgery for ACL repair, and (n=155) patients were treated with the conservative approach. These data consist of patients from four studies, with patients who underwent ACL reconstruction treatment from 2005 to 2009 (Farshad et al., 2011). The study included patients who had been diagnosed with grade 2 or 3 ACL injuries and undergone either surgical or non-surgical treatment. Cost data were based on the average cost of treating patients with ACL ruptures at the Department of Orthopedic Surgery, Orthopaedic University Hospital Balgrist (University of Zurich, Switzerland).

A decision tree model was created using the Rational Will software program (SpiceLogic, Inc., Ontario, Canada). It was assumed that patients included in the study had similar severity of ACL injury and had a satisfactory baseline health status. Activity level post-treatment was used as a marker for treatment success. The time horizon was set to one year.

The root of the decision tree included all patients treated for ACL tears. The child branch of the tree branches into patients who have chosen to undergo surgical repair or non-surgical repair of the ACL. Each of these branches is broken down by the success of the treatment, which is determined by activity level post-treatment. Cost-effectiveness was determined using quality-adjusted life years (QALYs) gained for each treatment type. Direct costs for the surgical and conservative treatments were used in the calculation.

4 Results

The decision tree, shown in Figure 1, utilized probabilities from the published literature. Utility values were assumed to be 1 for success and 0.5 for failure. The probability of successful surgical intervention was 70.7 percent. Unsuccessful surgical outcome probability was 29.3 percent. The probabilities for successful and unsuccessful conservative rehabilitation were 49.7 percent and 50.3 percent, respectively. Rational Will found that surgery, whether successful or unsuccessful, was the most sensitive variable within the decision tree. (Figure 2). Analysis revealed a QALY of 0.854 for surgical treatment, and 0.749 for conservative rehabilitation (Figure 3). The incremental cost-effectiveness ratios (ICERs) were \$50, 538.48 for surgical treatment and 10,057.15 for conservative treatment. The expected cost for surgical treatment was \$12,834.32, whereas the expected cost for conservative rehabilitation was \$7527.78 (Table 1).

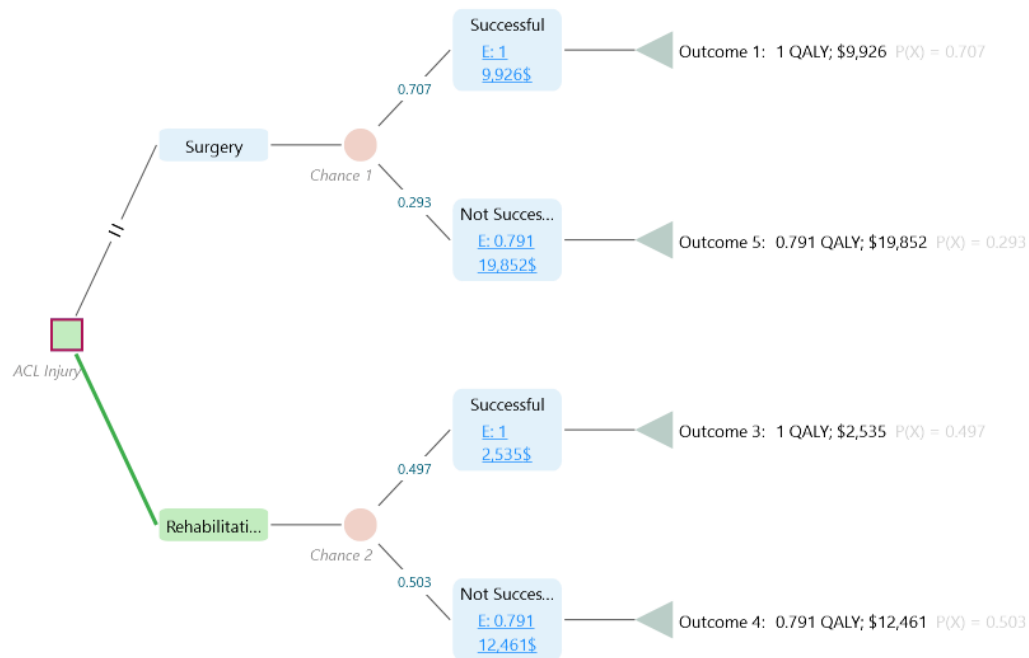


Figure 1. *Rational Will Decision Tree.* This tree was created using Rational Will to calculate QALYs for surgery versus conservative rehabilitation.

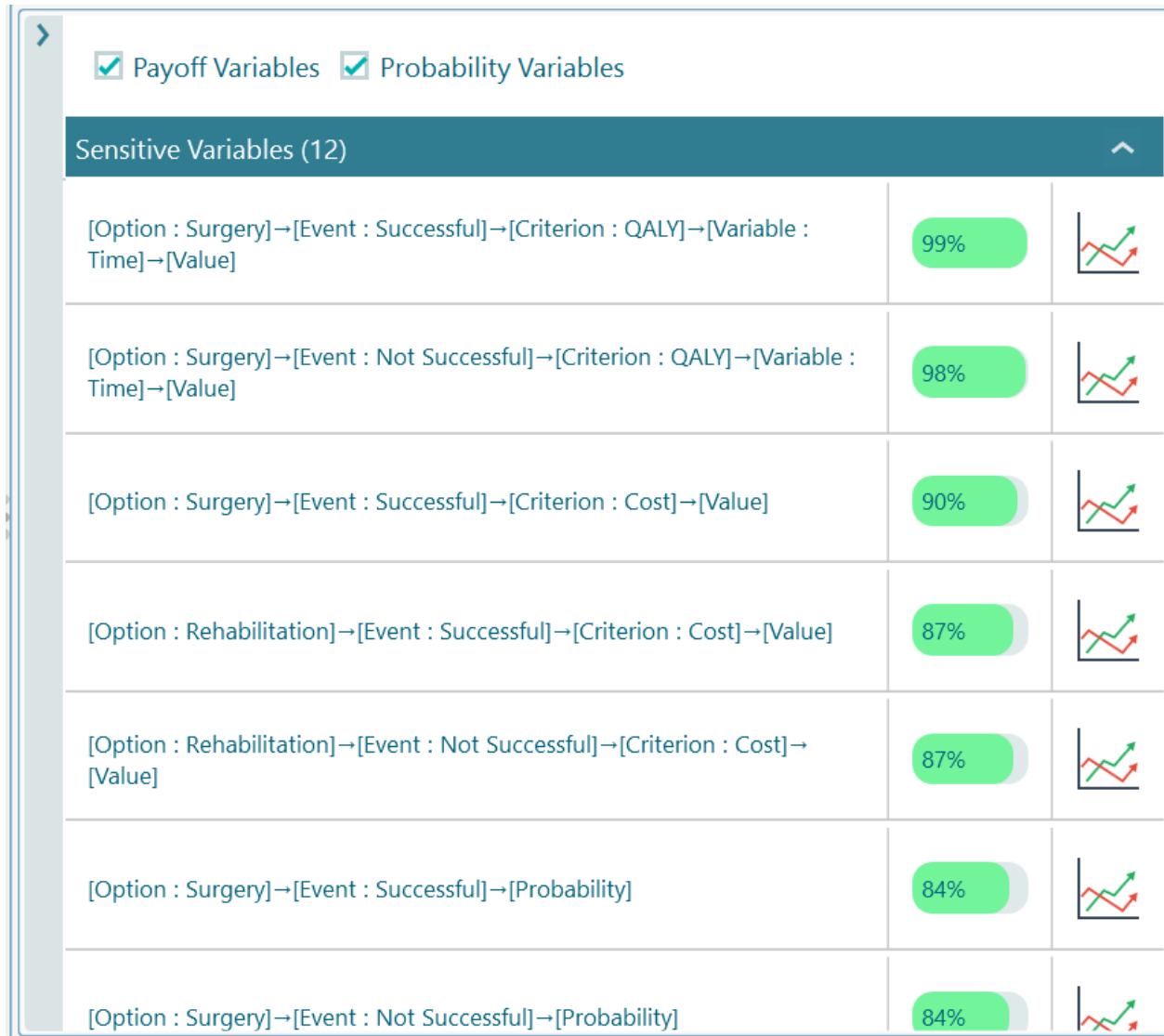


Figure 2: *Sensitivity study for the variables in the decision tree model*

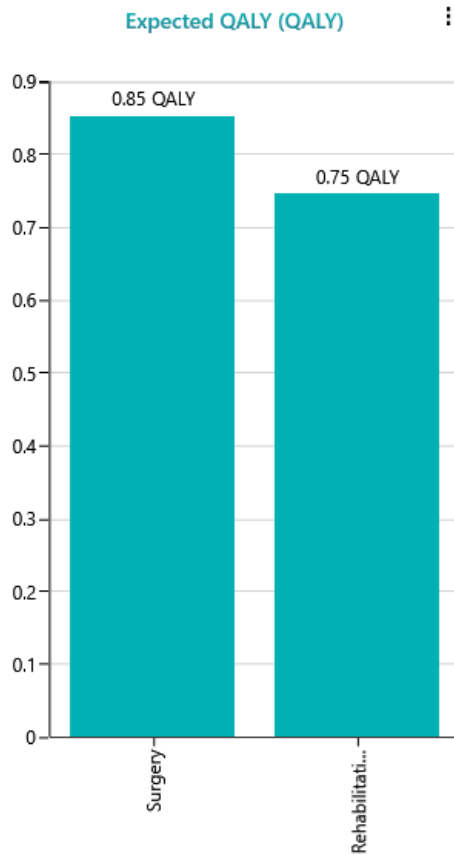


Figure 3. *QALYs gained from ACL treatments.* This study found that 0.85 and 0.75 QALYs were gained for surgical repair and conservative rehabilitation of ACL, respectively.

Treatment Type	QALY	ICER	Expected Cost
Surgery	0.854	50,538.48	\$12,834.32
Rehabilitation	0.749	10,057.15	\$7,527.78

Table 1. *Overview of Results.* Calculation of the two ICERS revealed that rehabilitation (i.e., conservative treatment) was significantly lower than surgical intervention.

5 Discussion

This study found that it may be more cost-effective for patients with ACL injury to undergo conservative rehabilitation than surgical repair. Previous studies have found varying results. For example, (Eggerding et al, 2021, Farshad et al, 2011). A limitation of this study was its retrospective nature, which used data that had been collected and compiled from other studies. Additionally, the study was simplified for analysis and potential complications and consequences occurring after ACL injury were not taken into consideration. These factors could have had an impact on our findings. Moreover, as we used published estimates of procedure cost, our cost calculations might not reflect current provider charges. The sensitivity of the surgery variable suggests that the model may also be affected by individual patient variables, such as age, sex, comorbidities, etc.

The results of this study, combined with previous research, demonstrate that the best treatment option for patients with ACL injuries may be mediated by lifestyle and patient preference in contrast to clinical efficacy. For example, there is only a slight difference between the QALY outcomes for the two treatment options, and certain patients may feel that surgical reconstruction will be more effective for their needs in the long-term. Therefore, it is important that providers inform patients of their treatment options, and make an informed decision based on the patients age, activity level, and treatment goals.

It is important to acknowledge the limitations of this study, including its retrospective nature and limited sample size, which may limit the generalizability of the results. The lack of consideration for post-injury complications and the simplified cost calculations also highlight the need for further research to refine the model's accuracy. Therefore, caution should be exercised when interpreting the results of this study and applying them to clinical practice.

6 Conclusions

In conclusion, the comparison of the cost-effectiveness of surgical and non-surgical treatments for ACL injuries highlights the importance of evaluating not only the direct medical costs but also the long-term impact on patients' quality of life. This analysis shows that surgical reconstruction is more expensive in the short term than conservative rehabilitation. Treatment types were found to have an impact on the outcome of an ACL injury, and thus should be considered when making treatment decisions. Future studies should focus on the long-term effects of the two interventions, which may alter the current balance between cost and effectiveness and lead to enhanced outcomes while assessing their impact on the healthcare system and society as a whole.

7 References

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