Improving Physician Decision-Making & Patient Outcomes Using Analytics: A Case Study with The World's Leading Knee Replacement Surgeon

Anish Pahwa (pahwaa@purdue.edu), Shikhar Jamuar (sjamuar@purdue.edu) , Varun K. Singh (singh675@purdue.edu) , Matthew A. Lanham (lanhamm@purdue.edu)

KRANNERT SCHOOL OF MANAGEMENT PURDUE UNIVERSITY

ABSTRACT

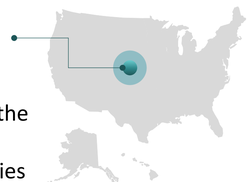
We utilize machine learning models coupled with data on patient demographics, surgery specifics and post-op patient condition to develop a recommender system for better supporting the physician in the diagnosis phase by predicting the outcome of a surgery. We also identify drivers for the success of a surgery to control the surgery process, minimise complications and mitigate risk. We believe that healthcare providers and consulting firms who are developing analytics-driven solutions for their clients in the healthcare industry will find our study novel and inspiring.

INTRODUCTION

Every year, there are thousands of cases of chronic knee pain and disability. **Knee replacement** is an effective and long-lasting course of treatment for these cases. However, there are risks and complications associated, these complications generally require revision surgeries, which adds to the problem. Therefore, it becomes crucial to understand and control the drivers of these complications, which currently is an industry-wide challenge.

1 in 5 who undergo TKA are dissatisfied with the results.

525% **expected increase** in the number of knee surgeries by 2030



PROJECT SCOPE

- What is the probability that a person who has undergone a knee surgery will develop complications in the future?
- What are the drivers for good or poor post knee surgery outcomes?

LITERATURE REVIEW

Lingard, Elizabeth A. *et al*
WOMAC Pain score, mental health scores, comorbid conditions used. Hierarchical regression model used

Brander, Victoria, A. *et al*
Pain scale, patient health data, psychological state and component reliability. Multiple regression analysis done; pain used as predictor

Sanchez-Santos, M.T., Garriga, C. *et al*
Pain score data used: Pain Score used as predictor in a General Linear model

Our Study
Probabilities of developing complications post-op. Patient demographics, comorbid conditions, BMI used. Defined new metric for failure

METHODOLOGY

REQUIREMENT GATHERING

Business Problem → **Statistical Problem**

DATA PREPARATION

Dimension Reduction

400⁺ Tables

10 Tables
6K⁺ Observations
400⁺ Parameters

Derived Variables

Age

BMI

Defining Success of a surgery

Surgery Outcome (Binary variable)

INITIAL INSIGHTS

Chances of Success/Failure for high BP vs normal BP

Chances of Success/Failure for smokers vs non-smokers

MODEL SELECTION

Decision Tree	F1 = 0.90	
Random Forrest	F1 = 0.93	
Logistic	**F1 = 0.94**	

RESULT

Effect of Significant Parameters (Logistic)

- A smoker is **34% more** likely to have a surgery failure than a non-smoker
- A BP patient is **133% more** likely to have a surgery failure than a non-BP patient
- The chances of a surgery failure decreases by 4% with 1-unit increase in Age

Metric Importance (Random Forest)

CONCLUSION

- **BMI, Age, Smoke** and **Blood Pressure** significantly contribute towards failure of a surgery according to both Logistic and Random Forest models
- **Surgeons** and **Insurance Carriers** are also significant factors impacting the outcome of a surgery
- A TKA surgery typically costs about $57000 in total. There will be approx. 550,00 TKA procedures in 2021. Our model predicts two-thirds of complications accurately, therefore factoring in two-thirds of the complications requiring a revision, more than **2.1 billion USD** could be saved in the US alone
- Our model can use patient demographics data, EHR and clinic data to predict complications before a surgery help clinics and insurance companies save up to **11 billion USD EVERY YEAR by 2030**

FUTURE SCOPE

- Data on criterions like gait and VASP to better define success
- Data on Surgery specifics like angle of cut for more realizable model
- More granular analysis for financials

ACKNOWLEDGEMENT

We would like to thank Professor Matthew A. Lanham for his support and guidance