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Clinic Data Engineering and Epidemic Prevalence of a Hospital Rehospitalization from Total Knee Replacement Surgery Patients in a Middle Taiwan Town

Cheng-Jung Chan[1], Min-Fei Liao[2] and Zih-Ping Ho[3*]
[1]*Medical Doctor,*
Department of Orthopedics,
Chang Bing Show Chwan Memorial Hospital, Lukang, Changhua county, Taiwan.
[2]*Special Assistant, Nurse,*
Department of President Office,
Chang Bing Show Chwan Memorial Hospital, Lukang, Changhua county, Taiwan.
&Show Chwan Memorial Hospital, Changhua city; Taiwan
[3]**Assistant Researcher,*
Department of Sport Technology and Information Development,
Taiwan Institute of Sports Science, Kaoshiung City, Taiwan.
Corresponding Author: Zih-Ping Ho

ABSTRACT
In orthopedics clinic, medical doctor curious that why see some patients rehospitalization after a period of time of total knee replacement (TKR) surgery. Then we make a place to study this; however, it is very difficult to do this due to data cleansing. At first, we have to exclude TKR common complication; second the common elder Three Highs disease, acute gastroenteritis and acute trauma have to be excluded, but the dislocation, etc. following TKR have to be included; the last is output each target patient record, flowing up on 0.5~2 yrs rehospitalization data. It's not a simple SQL-Like base computer language command. The software has to filter main, second, third rehospitalization ICD10 code and then decode it as general English expression. For correctness, we manually check each target patient, comparison middle Taiwan town teaching hospital's clinic data and others countries in literatures, we find new observations. The study proposed a new clinic data engineering approach, proved and found over half percent patients rehospitalization due to orthopedics related disease. The osteoarthritis is difficult in its biological path way than our known knowledge.

KEYWORDS: *Clinic data engineering, total knee replacement (TKR), osteoarthritis, orthopedics clinic, rehospitalization prediction.*

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I. INTRODUCTION

In orthopedics clinic, medical doctor curious that why see some patients rehospitalization after a period of time of total knee replacement (TKR) surgery. Then we make a place to study this; however, it is very difficult to do this due to data cleansing. At first, we have to exclude TKR common complication; second the common elder Three Highs disease, acute gastroenteritis and acute trauma have to be excluded, but the dislocation, etc. following TKR have to be included; the last is output each target patient record, flowing up on 0.5~2 yrs rehospitalization data. It's not a simple SQL-Like base computer language command. The software has to filter main, second, third rehospitalization ICD10 code and then decode it as general English expression. For correctness, we manually check each target patient (de-identification) computer output and got IRB approval in previous permission. Comparison middle Taiwan town teaching hospital's clinic data and others countries in literatures, we find it really different. It maybe nutrition condition, bacterial, medical surgery skills are so different in the world.

II. LITERATURE REVIEW

Nowadays, there were 45,087 above of TKR academic papers within PubMed database. In this section, it would divide into 7 sub categories to discuss.

2.1 Duration of Hospitalization

Prashanth et al. [1] proposed robot-assisted total knee arthroplasty using modified approach. In their research, there were 81 persons, totally 120 knees accept the Sub-vastus approach, when combined with Robot-assisted total knee arthroplasty (RATKA). It would be less blood loss, faster recovery, and shorter hospital stay. Bhanushali et al. [2] studied Revision rates after total knee arthroplasty amongst Australian orthopaedical surgeons under varying experience, finding 50,291 total knee surgeries between September 1999 and January 2023, there were no major differences among medial doctors' experience. Al-Yami et al. [3] did retrospective cohort study, observed 1046 TKR patients over ten years in a Saudi population, finding that there were no significant differences in age, sex, or BMI or medical comorbidities, including ASA score between groups. There were no differences between groups regarding length of hospital stay (LOS), no differences were found regarding gastrointestinal bleeding, pulmonary embolism, cardiovascular, and central nervous system complications. Diltz et al. [4] reviewed patients with a body mass index greater than 35have reported increased complication rates within TKR. Liu et al. [5] investigated the risk factors associated with TKR, and subsequently constructed a predictive model to reduce the incidence of postoperative blood hypercoagulation and complications. There were 490 TKR hospitalized patients at Northern Jiangsu People's Hospital in their study, found that hospital stay, hypertension, diabetes, coronary heart disease, intraoperative blood loss, platelet count, and fibrinogen were identified were independent risk factors.

Ma et al. [6] stated that 100 TKR patients were treated with electroacupuncture stimulation. The blood loss, hospitalization time and morphine equivalent consumption at 72 h postoperatively were observed condition. They found combining electroacupuncture treatment were effective improved overall recovery process. Leonard et al. [7] investigated Native Hawaiian/Pacific Islander (NHPI) vs. white TRK patients, they found there were no difference outcomes between these two groups in post surgery. Li et al. [8] reviewed TKR, UKA, THR literatures. TKR leads to periprosthetic bone mineral density (BMD) loss, it would increase risks of implant loosening and fractures. Thus, maybe patients hospitalized again due to TKR itself. Barton et al. [9] found a 55-year-old man received TKR and developed unilateral acute compartment syndrome (ACS) within 3 hours. It maybe due to bleeding from a small branch at artery, related to tourniquet.

Bond et al. [10] showed that human synovial fluid affects the electrochemical behavior of CoCrMo. In a long term, TKR patients may have implications due to implants. Coden et al. [11] presented that surgeons should consider the risks and benefits of testosterone cessation, whom undergoes TKR. It showed high rate of re-TKR if choices testosterone cessation. Ratnasamy et al. [12] stated that TKA patients taking antidepressants could have a risk facing 90-day postoperative adverse events. The antidepressants (selective serotonin reuptake inhibitors or serotonin norepinephrine reuptake inhibitors) was the main reason. Risager et al. [13] said that the periprosthetic knee fracture following TKR were hard to treat. They did a nationwide cohort study using register data from 1997 to 2022, Re-TRK within two-year was 20% (95% confidence interval (CI): 18 to 23). There is always a possibility of fracture; it is not due to the prosthesis that fractures will not occur. Ahlquist et al. [14] stated that in end-stage renal disease, the TRK would be associated with complications. They reviewed a national database from 2010 to 2018 in US, findings end-stage renal disease patients were a high-risk population. It should monitor the patients' recovery condition seriously.

Jensen et al. [15] reviewed 2303 TRK patients, 2431 knees in Danish. They found underwent further surgery within one year. The most frequent indications for reoperation were periprosthetic fracture (0.7%; 95% CI 0.4 to 1.1), periprosthetic joint infection (PJI) (0.5%; 95% CI 0.3 to 0.9), and bearing dislocation(0.4%; 95% CI 0.2 to 0.7). Those were patients return hospital's reason. Dubin et al. [16] reviewed 7767 TKR patients in Maryland State in USA between January 1, 2022 and December 31, 2022. Multivariate logistic regression analyses were performed. There were total complications following: infection, aseptic loosening, dislocation, arthrofibrosis, mechanical complication, pain, and periprosthetic fracture. Ballard et al. [17] reported that there were 0.33% from 8206 THR and TKR patients, 27 cases occurred GI bleed within 18.6 days during 2015 to 2022 in Michigan, USA. In this study, we avoid collect this type data, starting observation at 0.5 year. Turan et al. [18] studied TKR flowing medical or orthopaedic readmissions in Ohio, USA. They found 17.6% (124/704) related to orthopedic, and 82.4% belonged to others. Within dept. medical, most often pertained to gastrointestinal complaints. Why orthopedic readmissions, the reason was wound complication. Jing et al. [19] stated that using non-linear fuzzy math to describe TKR patients' attributes and made prediction.

2.2 Sports Medicine

Ge et al. [20] used Open Pose software and X-ray imaging to 50 TKR patients, they found a good correlation (R^2= 0.814), treatment error were 0.131°, maybe the patients can use software to monitor recovery

process. Ge et al. [21] stated that TRK improved knee symptoms and physical function over two years. But it is not improved patients' physical activity or mental health. In this aspect, surgery is an intervention, not the universal tool. Mazzei et al. [22] stated that exercise therapy program reduced OA and waiting for TKR. They found that funding GLA:D would cost $4.3 million, serve 12,500 people, and save $8.5 million by avoiding 1,300 TJRs in year one. Savings grow to $8.8 and $8.7 million in years two and three. Thus, they think exercise therapy program would effectively reduce OA and TKR chance. Leow et al. [23] reviewed 19 golfers and 144 non-golfers and found there was no difference in outcomes between golfers and non-golfers undergoing total ankle replacements. It showed sport or not were not direct related to surgery itself. Sever et al. [24] found kinesiophobia after TKR patients would affect recovery in the postoperative rehabilitation. There were 60 TKR patients included into their study in Acta. In PubMed, tumor in knee is very few. We found a case report in Acta.

2.3 Osteoarthritis

Kamlay et al. [25] said that Osteoarthritis (OA) of the knee is a reason of disability among the elderly people. When conservative treatments fail, TKR is a standard surgical intervention. In their study, complications were minimal, with only 9.1% (3 out of 33) reporting restricted range of motion and 3% (1 out of 33) were being infection. Nanjo et al. [26] studied psychological factors would influence activities of daily living (ADL), then its related to prognosis of TKR patients. There were 140 patients included into their observation. Five traits (agreeableness, conscientiousness, extraversion, openness, and neuroticism) were related to Knee Injury and Osteoarthritis Outcome Scores (KOOS-ADL). It showed that patients in the neuroticism group showed significantly lower KOOS-ADL scores than those without (P = 0.03). Lawford et al. [27] proceed research that risk of joint replacement after an education and exercise program for hip or knee osteoarthritis, a longitudinal cohort study of 55,059 people. They found it would reduce the number of joint replacement surgeries by 20% at 5 years post-intervention. Sport was related to reduce hip or knee osteoarthritis. Motwani et al. [28] said that metabolic syndrome was high related to OA patients. But the development of OA into TRK remains underexplored. The study involved 107 primary osteoarthritis patients and proved the above conclusion (P= 0.001). Prevot et al. [29] reviewed 7,552 knees cases; the data included demographic data, Kellgren-Lawrence (KL) grade, the presence of knee swelling, the frequency of swelling, visual analogue scale (VAS) for pain, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Knee Injury and Osteoarthritis Outcome Score (KOOS). The timeline was collected at 12, 24, 36, 48, 60, 72, 84 and 96 months, whether they underwent TKR. The OA or pain was not significant influence on progression to TKR. Schneider et al. [30] stated that it has become a problem that severe idiopathic arthrofibrosis after TKR. They reviewed 60 TKR patients, and there were 27 percent of patients return to the operating room due to severe idiopathic arthrofibrosis. They said low-dose irradiation can keep range of motion of 60° with reliable flexion. Salmons et al. [31] stated that arthrofibrosis following TKR remained unclear. They surveyed 9771 TKR patients and found arthrofibrosis rate was 4 percent, which defined as range of motion (ROM) ≤90° for ≥12 weeks postoperatively or as ROM ≤90° requiring MUA. The oral corticosteroids can reduce risk of arthrofibrosis. Sonkusale et al. [32] did a case report that anterior tibio-femoral dislocation following TKR, it was a dreaded complication. A 43-year-old lady who found above dislocation. She recovered after operation again.

Zhang and Qiu [33] stated that gut microbiota (GM) may influence the risk of OA by modulating immune cell activity. However, human know few among GM, immune cells, and OA. It has not been thoroughly investigated. Aydin et al. [34] reported that gut microbiota (GM) is a new approach to cure osteoarthritis. The study included 40 individuals, 20 of whom were knee osteoarthritis and 20 of whom were healthy controls. They said that how microorganisms, especially those identified in the knee and hip, go to the intestinal wall, each other parts of the body via the bloodstream, is still unknown; however, they found it's different outcomes.

2.4 Infection

Ghaithi et al. [35] microbial infection generated osteomyelitis, a kind of bone inflammation. They collected bone sections from TKR patients at Sultan Qaboos University Hospital, Muscat, Oman, from January 2021 to December 2022, using *Staphylococcus aureus* to simulate *in vitro* bone infection. The scanning electron microscopy (SEM) were applied into bacterial interaction with bone materials. The results showed that carbonate-to-phosphate ratio in inoculated samples (61.9%) compared to controls (47%), significant difference in microbiology growth. Liukkonen et al. [36] pointed out chronic infections from analyzing 359 TKR patients. Thus, maybe patients hospitalized again due to chronic infections. The early infections and acute hematogenous infections were easily been found. Tiwari et al. [37] stated that Methicillin-resistant Staphylococcus aureus (MRSA)significantly correlated to TKR patients. They investigated 938 TKR patients. There were 0.7% prevalence in older patients and the majority were female.

Sullivan et al. [38] pointed out a patient presented with a skin ulceration near the TKR surgical site. The knee was not infected, but had elevated serum cobalt levels. Dermatological evaluation diagnosed a friction ulcer. Thus, materials of the implant would cause *Staphylococcus* growth in some patients. Roy et al. [39] stated

human cartilage lubricated with patient-specific synovial fluid related to osteoarthritis. There were six TKR patients performed friction tests. They found friction properties of degenerated cartilage samples, explaining that osteoarthritic synovial fluid was sufficient to provide low cartilage friction. Hanus and Hladky [40] did a case report and found that a 10-Year-Old Boy, unexpected finding of a tumor in the knee joint. In our hospital, we did not find knee tumor. Sieker et al. [41] reported a case; a 74-yr-male suffering tibial loosening after TKR. They found tibial chondrosarcoma and it is a rare case. Kapoor and Tiwari [42] stated 36 patients with Campanacci Grade III giant cell tumors around the knee. After surgery, almost all recovery, only two cases received second time surgery.

2.5 Pain

Martin et al. [43] nowadays people exercise less, muscles of the knee, such as the quadriceps femoris (QF) and articularis genu (AG) would cause painful. In their study, exercise was replated to knee osteoarthritis; in a long-term aspect, it also determined how long the knee joint can last. Liu et al. [44] stated that TKR is a primary treatment for advanced knee osteoarthritis (OA). However, some patients still pain after surgery. They found optimized perioperative analgesic protocols were associated with improved pain control, and reduced complication rates in knee osteoarthritis surgery. There were 551 cases in their analysis. Patients were categorized into three groups, such as visual analogue scale (VAS) scores, knee range of motion (ROM), and Hospital for Special Surgery (HSS) scores. Tanzer et al. [45] stated that they surveyed 87 TKR patients, follow-up of 9 years studies, some of them were influenced by weather conditions after surgery, generating bad life quality. It would have worse WOMAC scores for pain (p= 0.046), stiffness (p= 0.012), and physical function (p= 0.024). Mabarak et al. [46] reviewed 13894 TKR patients in OH, USA and found chronic pain diagnosis before TKR leads to higher readmission risk, odds of 90-day readmission ($P < 0.001$), but were less likely to have a length of stay greater or equal to two days ($P = 0.004$).

2.6 Venous Thromboembolism

Yuan et al. [47] remain studied that venous thromboembolism (VTE) prophylaxis is crucial at major orthopedic surgeries. The 655 patients received either aspirin, rivaroxaban, or LMWH for VTE prophylaxis treatments. In their paper, we would know many reasons affecting patient returned in hospital. Zhang et al. [48] included 401 elderly patients (aged ≥ 65 years) who underwent hip or knee replacement surgery from 2017 to 2022 in a hospital. were They found elder people happen edlower extremity venous thrombosis (LEVT) with elderly age, body mass index (BMI) and hypertension risk factors was 13.97%.

2.7 Perioperative Sleep Disorders

Wang et al. [49] stated that patients undergoing TKR may suffer from perioperative sleep disorders (PSD). The digital cognitive behavioral therapy (dCBT) would improve the PSD.

Although a lot of literatures related to TKR, these is only small part of literatures focusing on clinic data engineering to count hospital rehospitalization due to hard data selection skills. Thus, we make a research plan to do this study.

III. PROBLEM FORMULATION

Medical doctors were not easily know what's the repeat phenomenon affecting patient returned in hospital. It depends on complex data engineering skills to isolate the minor factors or general sub problems, focusing on main purpose. Patients would not willing to be in hospital. If patients are hospitalized repeatedly, no matter what reasons is, they always think it is a very bad luck. Therefore, supposed that if we can avoid it, the precious medical resources could put into the right place. Taiwanese would face lesser the hospital space and staff insufficient supply problem.

At the beginning, let S represent all patients ever received TKR in hospital. Let R represent patients be observed within a certain 2-years after TKR, $R \in S \in N$. Let T_i be start observe time (unit: year) of the patient i.

$0.5 < T_i < 2$

Let k represent large disease classification.

Let ICD_{jki} represent rehospitalization reason j, which is belong to k category, of the patient i at T_i period.

Let P_k represent rehospitalization occurrence, which is belong to k category

$$P_k = ICD_{jki} / \sum \{k \in N\} ICD_{jki} \quad (1)$$

The formular (1) is a kind of transformation epidemic prevalence.

The analyzed approach of data engineering process was showed in Figure 1.At first, the computer search clinic database in a hospital, who received TKR during 2020 to 2021. Then program auto tracks each patient records.

If passing T_i threshold, it would identify ICD10 of main reason of rehospitalization. To review each single record manually. After that, reclassification manually and based on formular (1) outputting the estimation value and point out the most probabilities.

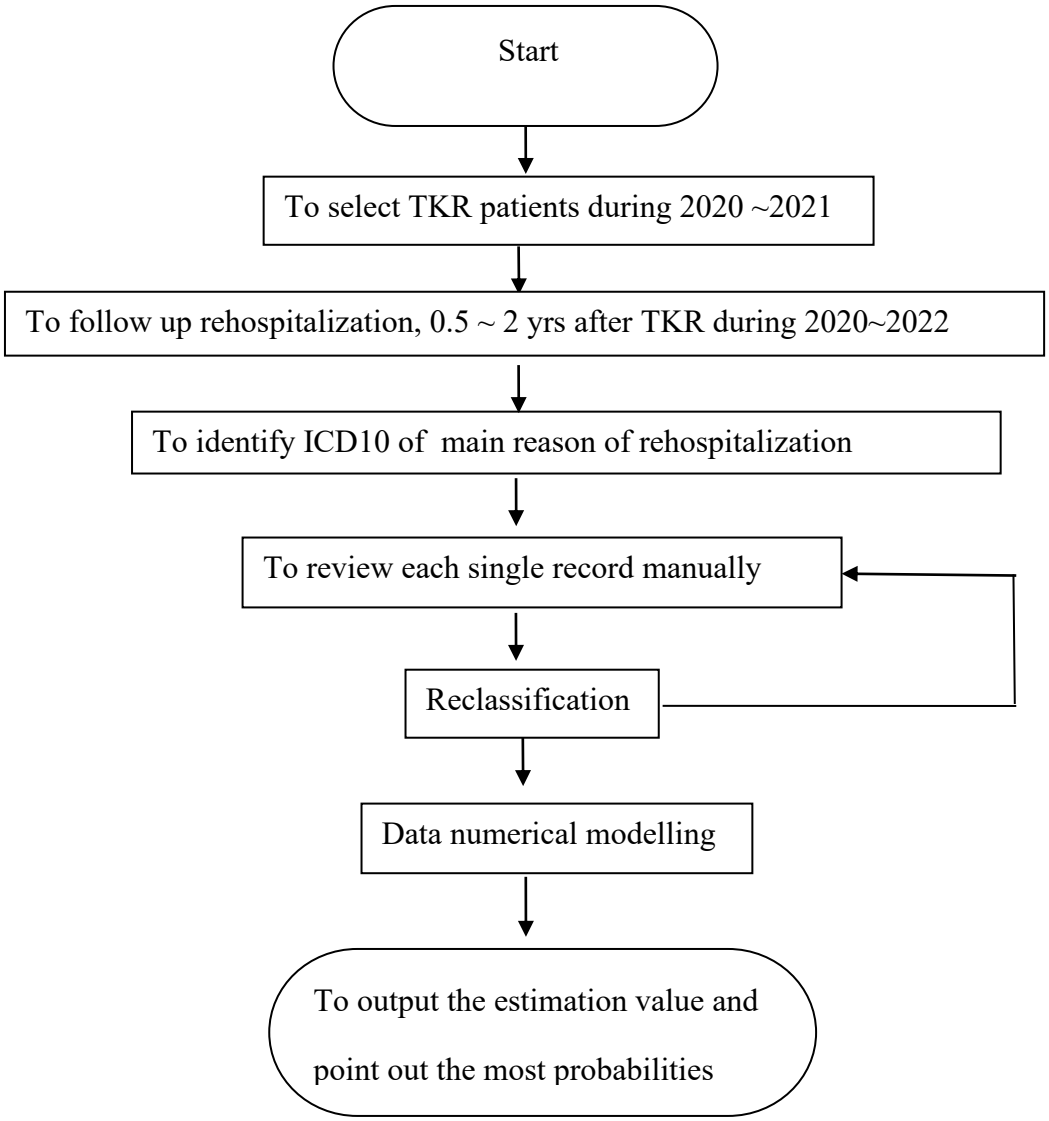

Figure 1 The Data Engineering Process

IV. RESEARCH RESULTS

The software computation was shown in Table 1. There were 698 patients received TKR. But there were 227 times (162 persons) within these patients returned and rehospitalization. In this town, most of them were elder people; however, the results showed not a general proportion of elder people problems. The osteoarthritis, fracture, pain in joint, idiopathic aseptic necrosis, and dislocation were belong to orthopedics fields; besides, it were the major part of rehospitalization reason.

In literature review, Liukkonen et al. [36] pointed out chronic infections from analyzing 359 TKR patients, it maybe patients hospitalized again due to chronic infections. The early infections and acute hematogenous infections were easily been found. In our study, we also confirmed this options. Or it should not call infection, the patients had a high probabilities rehospitalization due to other osteoarthritis disease, even the original knee place was already replaced by implant. Dubin et al. [16] mentioned in literature review. There were total complications following: infection, aseptic loosening, dislocation, arthrofibrosis, mechanical

complication, pain, and periprosthetic fracture. We also found in our study (arthrofibrosis, fracture, pain and aseptic loosening).

Table 1 Rehospitalization Types of Patients

Patient type	Proportion of patients
Osteoarthritis	38.3 %
Fracture	10.6 %
Respiratory disease	6.6%
Pain in joint	5.3 %
Heart disease	3.5%
Gastrointestinal diseases	3.5 %
Tumor	3.1 %
Idiopathic aseptic necrosis	2.6 %
Dislocation	1.8 %
Others (less than 3 cases)	24.7 %

Total: 227 times of rehospitalization

V. CONCLUSION

Before this study, we thought common diseases among the elderly would be the main proportion of the reason of rehospitalization. But it's not like that. Why TKR patients had a high probabilities rehospitalization due to other osteoarthritis disease should be more study and discuss. This research established clinic data engineering process to track the medical doctor doubts. For a patient, a very bad luck would not entirely be happened. Public health maybe be improved.

The calculation results showed that osteoarthritis disease was the main reason and should be proceeded further study.

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