Author/s:
Gould, D;Dowsey, M;Jo, I;Choong, P

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Gould Daniel (Orcid ID: 0000-0002-0423-5822)

Patient-Related Risk Factors for Unplanned 30-Day Readmission Following Total Knee Arthroplasty: A Narrative Literature Review

Running head: Patient-related readmission risk: review

Authors

Daniel Gould, BSc - University of Melbourne Department of Surgery, St Vincent's Hospital Melbourne, lvl 2 Clinical Sciences Building, 29 Regent Street, Fitzroy, 3065. Contact: daniel.gould@unimelb.edu.au, +61392313955.

- Mr Daniel Gould is the corresponding author and does not hold a research scholarship

Associate Professor Michelle Dowsey, PhD, MEpi - University of Melbourne Department of Surgery, St Vincent's Hospital Melbourne, lvl 2 Clinical Sciences Building, 29 Regent Street, Fitzroy, 3065; Department of Othopaedics, St Vincent's Hospital Melbourne, lvl 3 Daly Wing, 35 Victoria Parade, Fitzroy, 3065. Contact: mmdowsey@unimelb.edu.au.

Imkyeong Jo, B-BMED - University of Melbourne Department of Surgery, St Vincent's Hospital Melbourne, lvl 2 Clinical Sciences Building, 29 Regent Street, Fitzroy, 3065. Contact: imjo@student.unimelb.edu.au.

Professor Peter Choong, MMBS, MD, FRACS, FAOrthA, FAAHMS - University of Melbourne Department of Surgery, St Vincent's Hospital Melbourne, lvl 2 Clinical Sciences Building, 29 Regent Street, Fitzroy, 3065; Department of Othopaedics, St Vincent's Hospital Melbourne, lvl 3 Daly Wing, 35 Victoria Parade, Fitzroy, 3065. Contact: pchoong@unimelb.edu.au.

Three tables and one figure are included in Supporting Information:

- Figure S1: Modified PRISMA 2009 Flow Diagram
- Table S1: Comorbidities and risk of 30-day readmission
- Table S2: Demographic factors and risk of 30-day readmission
- Table S3: Procedure-related factors and risk of 30-day readmission

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Abstract

Osteoarthritis is a debilitating condition as well as a growing global health problem, and total knee arthroplasty is an effective treatment for advanced disease. Unplanned 30-day hospital readmission is an indicator of complications, which is a significant financial burden on healthcare systems. We reviewed the literature to better understand the patient-related factors associated with unplanned 30-day readmission following total knee arthroplasty.
MEDLINE and EMBASE were searched for studies reporting on patient-related risk factors for unplanned 30-day readmission following primary or revision total knee arthroplasty for any indication.
The impact of specific medical comorbidities on increasing the risk of 30-day readmission following TKA is quite well established. The following comorbidities are strongly associated with readmission: bleeding disorder, diabetes, CKD and dialysis, chronic immunosuppressant use, and history of cancer. Other significant comorbidities include: dementia, depression, haematological (coagulopathy, anaemia), cardiovascular (AF, CVD, CAD, CHF), respiratory (COPD), liver disease, and CVA/TIA (but only in revision TKA patients). The influence of variation in sex, age, and BMI each demonstrate a more complex pattern. A systematic review and meta-analysis is required to quantify the impact of the various patient-related factors on 30-day readmission following total knee arthroplasty. Clinicians can use this information in preoperative decision-making.

Keywords
Risk factors
30-day readmission
Hospital readmission
Unplanned readmission
Total knee replacement
Total knee arthroplasty
Patient characteristics

Introduction

Total knee arthroplasty (TKA) is a highly effective treatment for advanced knee osteoarthritis (OA) improving health-related quality of life [1] and demonstrating good long-term survivorship [2]. The number of knee arthroplasty procedures undertaken annually has increased by 123.5% in Australia since 2003 [2], and Kurtz et al. reported an expected increase in TKA demand by 673% in the 25 years leading up to 2030 in the United States alone [3].

30-day unplanned hospital readmission is an important metric closely related to post-operative complications, and hospitals are being held accountable for high 30-day readmission rates as an indicator of quality of care [4]. This particular post-operative outcome reflects a complex relationship between the general health and physiology of the patient and the morbidity of the surgery [5, 6]. Knowing the patient-related risks for readmission facilitates mitigation, and the ability to identify those patients at highest risk of readmission will improve the quality and delivery of care.

The total joint arthroplasty (TJA) literature describes discrepancies regarding some important risk factors for 30-day unplanned readmission. Some investigators reported an increased risk associated with prominent demographic factors such as older age [5, 7, 8] and increased body mass index (BMI) [5], and high American Society of Anaesthesiologists (ASA) class [7] which encompasses comorbidity burden, while other did not [9-12].

The aim of this review is to address these important differences in the available literature, and to build upon this knowledge by reviewing the findings of the literature pertaining to the impact of a broader range of demographic factors and comorbidities on 30-day readmission risk in TKA patients. This is not a statistically rigorous systematic review and meta-analysis, but a narrative review written to highlight themes and issues as they appear in the literature as it stands. This review can be read by clinicians to gain familiarity with patient risks and identify major themes in the literature, and readers can interpret these themes based on

their own knowledge, experience, and judgement, particularly where tensions exist in the available evidence. It also lays the foundation for a systematic review and meta-analysis.

Methods

Eligibility criteria and screening of articles

Titles, abstracts, and full text articles were screened according to the agreed eligibility criteria in order to answer a specific research question.

Eligibility criteria:

- Population: all TKA patients for any indication, including: primary, revision, bilateral, and unilateral TKA for osetoarthritis, inflammatory arthritis, post-traumatic arthritis, etc.
- Predictor variable: patient risk factors.
- Comparator: N/A.
- Outcome variable: unplanned 30-day readmission to any institution due to any cause, therefore including studies investigating all-cause readmission and those investigating readmission due to a specific cause.
- Study type: case series were excluded; all other types of quantitative study design were eligible for inclusion.

Research question:

- Which patient-related factors are associated with increased risk of unplanned 30-day readmission following TKA?

Figure S1 depicts the PRISMA flowchart documenting the number of titles, abstracts, and full text articles screened to arrive at the final 47 articles included in this review.

Results

The key findings of each study were presented in summary tables:

- Table S1: Comorbidities and risk of 30-day readmission
- Table S2: Demographic factors and risk of 30-day readmission
- Table S3: Procedure-related factors and risk of 30-day readmission

'Key findings' were those on which the authors focused in a given paper. Relevant non-significant findings were only included when identified by authors as being relevant to the research question of a particular study, or when concerning the impact of BMI and age on readmission risk.

The tables document whether BMI and age were analysed as categorical or continuous variables, for all studies reporting these variables. BMI is included in Table S1 for ease of reference when comparing the impact of obesity, a comorbidity, and variations in BMI on readmission risk.

In the 'Type of study' column, single-institution studies are flagged because readmissions to other hospitals may not be captured in the analysis and readers should be aware of this potential limitation.

A hierarchical approach was used to present findings. For statistically significant findings, effect size was presented when available. If effect size was not available, any available measure of statistical significance was presented. The results of multivariable analyses were similarly favored when available.

Discussion

Comorbidities with the highest effect size (OR >2)

Table S1 depicts the major findings from all studies. Listed below are those comorbidities for which a particularly large effect size was detected.

Cerebrovascular accident (CVA) and transient ischaemic attack (TIA)

Belmont et al. [13] found an OR (95% CI) of 3.47 (1.30-9.25) associated with history of CVA or TIA, which were combined as one predictor in the multivariate analysis. This was the only study included in this review to find an association between this predictor and 30-day readmission, and this study was limited to a revision-only TKA population and as such the findings cannot be generalised to primary TKA patients.

Bleeding disorder

Pugely et al. [7] reported an OR of 2.01 (1.34-3.01) for 'bleeding disorder' as a predictor of readmission. Lehtonen et al. [14] also found bleeding disorder to be a risk factor, but only on univariate analysis. They went on to combine all comorbidities into a single predictor in the multivariate analysis. Each study analysed a sample from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), so it is reasonable to expect that the definition of 'bleeding disorder' was the same for these studies and therefore the reader can be assured these studies are each analysing the same predictor variable.

Diabetes

Basques et al. [15] found that both non-insulin-dependent diabetes mellitus (NIDDM) and insulin-dependent diabetes mellitus (IDDM) were associated with readmission. The former had an OR of 3.27 (1.29-8.34) and the latter 4.02 (1.06-15.30), compared to patients without diabetes. This contrasts with the findings of another large study by Webb et al. [16], who reported an OR <2 for IDDM, and found no increase in the risk of readmission when patients with NIDDM were compared to patients without diabetes. Both studies analysed the ACS-NSQIP database for the same time period, but Basques et al. was primarily analysing the effect of same-day discharge compared to inpatient arthroplasty whereas Webb et al. were specifically investigating the effect of diabetes.

Table S1 also shows that most large studies analysing diabetes as a single predictor variable, without distinguishing between NIDDM and IDDM, also found that it increased the risk of readmission although not to the same extent as Basques et al.

Chronic kidney disease (CKD) and dialysis

Kuo et al. [17] reported an OR of 6.2 (1.98-12.18) when non-CKD patients were compared to CKD patients to determine readmission risk. The primary aim in this study was to determine the impact of CKD on readmission risk in TKA, but it comprised a small sample size of 615 patients. The larger study by Workman et al. [18] found that CKD was associated with increased readmission risk on univariate analysis but not on multivariate analysis.

However, two much larger studies by Ottesen et al. [19] and Patterson et al. [20] each found that dialysis-dependence, indicating end-stage CKD, increased the risk of readmission on multivariate analysis. Considering all of these findings, CKD does appear to increase readmission risk even though it is not a universal finding in the literature.

Chronic immunosuppressant use

Hart et al. [21] reported an OR of 2.33 (1.44-3.74) for chronic steroid use. This finding is corroborated by Curtis et al. [22] who found a smaller, but still significant, increase in risk but included a much broader range of immunosuppressants than corticosteroids alone. Further research is warranted to determine the effect of specific types of immunosuppressant on

readmission risk, and the extent to which the specific underlying condition contributes to this effect.

History of cancer

Pugely et al. [7] reported a very large OR of 11.73 (1.93-71.30) for history of cancer. This finding is corroborated by D'Apuzzo et al. who found that lymphoma and secondary tumour without metastasis each increased readmission risk, although not to the same extent. It is very important to note that Pugely et al. were unable to determine the proportion of readmissions, among those with a history of cancer, which were planned readmissions for chemotherapy. The focus of the current review is on unplanned readmissions, therefore this is an important consideration in interpreting the findings of this study. With that in mind, the more conservative estimates calculated in the much larger study by D'Apuzzo et al. are more applicable to the current review.

Comorbidities with lower effect size (OR between 1-2)

Table S1 depicts readmission risk associated with the following comorbidities:

- ASA class ≥3, indicating overall comorbidity burden
- Psychiatric: psychosis, dementia, depression
- Haematological system, and preoperative blood parameters: coagulopathy, anaemia, high serum blood urea nitrogen (BUN), low albumin, low platelets, elevated INR, fluid and electrolyte disorder
- Cardiorespiratory: hypertension, atrial fibrillation (AF), cardiovascular disease (CVD), coronary artery disease (CAD), COPD, congestive heart failure (CHF), and prior percutaneous intervention (PCI)
- Liver disease

BMI and obesity

Table S1 highlights that the literature is considerably more divided on the association between 30-day readmission and obesity or changes in BMI, due largely to differences between studies in terms of analysis of BMI as either a continuous or categorical variable. The internationally-accepted classification system for BMI (in kgm^{-2}) is that of the World Health Organization [23]: underweight (<18.5), normal weight (18.5-24.9), pre-obesity or 'overweight' (25.0-29.9), obesity class I (30.0-34.9), obesity class II (35.0-39.9), obesity class III (>40). Categorisation of continuous variables is a common practice in the literature, but one that is prone to methodological problems which increase the risk of error in the statistical analysis and make it very difficult for readers to compare findings between studies with different classification systems [24-30]. It is beyond the scope of the current review to settle the debate as to whether such a practice should always be avoided or whether it is sound practice at least in certain

circumstances, but the focus of this review is on the findings of those papers which reported BMI as a continuous predictor variable. A systematic review and meta-analysis will rigorously quantify this relationship and clarify the impact of changes in BMI on readmission risk. Due consideration will be given to the distinction between analysis of BMI as a continuous vs. categorical variable, as well as continuous data with a non-normal distribution.

BMI as a continuous variable

None of the studies included in this review found a significant difference in BMI between the readmitted and non-readmitted groups when BMI was analysed as a continuous variable.

BMI as a categorical variable

Table S1 shows considerable variability in the findings when BMI is analysed as a categorical variable. Many studies used a data-driven categorisation system or listed 'obesity' without strictly defining the term. However, it is worth noting that the majority of the papers which treated BMI as a categorical variable adhered to the WHO classification.

Age

Table S2 depicts the variability in the findings pertaining to age as a predictor of readmission. As with BMI, the focus of this review is on age as a continuous variable. A systematic review and meta-analysis will further clarify the relationship between age and risk of readmission.

Age as a continuous variable

Only two studies including age as a continuous variable, Lehtonen [14] and Sutton [12], reported a significant difference between readmitted and non-readmitted patients, with readmitted patients being significantly older. Furthermore, Sutton et al. only detected a difference on univariate analysis. Their multivariate logistic regression model did not find a significant increase in the risk of readmission due to increasing age.

Age as a categorical variable

Unlike BMI, age does not have a clearly defined and widely accepted categorisation system. The United Nations has published guidelines on the categorisation of age, and defines three levels of detail: "Highest", "Medium", and "Lowest" [31]. Some studies use a categorisation system that resembles the "Medium" level of detail (see Table S2). Others appear to take a data-driven approach to age categorisation [32], which leads to difficulty in comparing results across studies [24].

Sex

Males are frequently found to be at increased risk of readmission following TKA compared to females (Table S2), but there are important deviations from this trend in the literature. Kheir et al. [33] found no association between sex and risk of readmission, however there is a small chance of loss to follow-up in this study if patients were readmitted to a hospital which was not part of the urban academic hospital network in this study.

Focusing on revision TKA, Courtney et al. [34] found that male sex was associated with increased risk of readmission in a revision-only TKA population. However, Belmont et al. [13] also limited their study to revision TKA and reported that female sex increased readmission risk.

In summary, it is unclear whether there is a sex difference in readmission risk. Subgroup analysis in a systematic review and meta-analysis will facilitate more rigorous investigation of this issue, for example to distinguish between revision and primary TKA populations.

Other demographic factors

Table S2 shows other demographic factors that were associated with 30-day readmission, including:

Socioeconomic status

- Unsurprisingly, socioeconomic and financial disadvantage are associated with increased risk of readmission. There is no discrepancy in the available literature pertaining to this important patient-related factor, but only four studies reported it. Furthermore, each of these reported on a different metric for socioeconomic disadvantage. Future research involving multiple validated indicators of socioeconomic status could help to clarify the impact of such disadvantage on readmission risk.

Functional status

- Patients with dependent functional status were frequently found to be at higher risk of readmission. Different definitions are given in the literature, and as such it is difficult to compare the findings between studies. A clearer, more widely agreed-upon definition for levels of functional status would enable more accurate comparison between studies.

Race

- Conflicting findings are demonstrated in the literature. Some studies demonstrate increased readmission risk associated with certain ethnicities, with inconsistent findings pertaining to the specific differences, and Kheir [33] reported no association between race and readmission risk.

Procedure-related factors

Surgical indication

The limited amount of literature pertaining to the relationship between readmission risk and indication for TKA indicates that revision TKA for infection, and trauma-related TKA, are at increased risk of 30-day readmission (Table S3). Schairer et al. [35] provided the additional finding that revision TKA, regardless of the reason for revision, is associated with increased risk of readmission compared to primary TKA. Courtney et al. [34] only included revision TKA, therefore their reported finding of increased risk of readmission with revision TKA for infection was in comparison with revision TKA for non-infected indications, rather than being in comparison to primary TKA. Both studies which reported on the impact of trauma-related TKA on readmission risk found a positive correlation [36, 37], but further research is needed to strengthen the evidence for these findings and also to expand upon them by investigating different types of trauma-related TKA.

Unilateral vs. Bilateral

Most of the limited amount of literature reporting on the difference in readmission rates of unilateral vs bilateral TKA indicate that bilateral TKA does not carry increased risk of readmission compared with unilateral TKA (Table S3). These findings must be interpreted with the following information in mind – Bullock et al. [38] performed a single-institution study and as such loss to follow-up of any patients who were admitted within 30-days post-TKA to a different hospital were not included in readmission data. Furthermore, the study by Welsh et al. [37] involved a sample size of nearly one million patients, which is much larger than Bullock et al. [38] and Kheir et al. [33]. Further research could clarify the risk of readmission when simultaneous bilateral TKA is compared with staged bilateral TKA, and when each of these is compared with unilateral TKA.

Conclusion

The impact of specific medical comorbidities on increasing the risk of 30-day readmission following TKA is quite well established. The following comorbidities are strongly associated with readmission: bleeding disorder, diabetes, CKD and dialysis, chronic immunosuppressant use, and history of cancer. Other significant comorbidities include: dementia, depression, haematological (coagulopathy, anaemia), cardiovascular (AF, CVD, CAD, CHF), respiratory (COPD), liver disease, and CVA or TIA (but only in revision TKA patients). The influence of variation in sex, age, and BMI each demonstrate a more complex pattern. Further research into the difference in readmission risk when revision TKA is compared to primary TKA, and bilateral TKA compared to unilateral TKA, will clarify the impact of these factors. A systematic review and meta-analysis is needed to quantify the impact of patient-related factors on readmission risk so

clinicians can better understand their patients' likely postoperative course. This information is important for preoperative decision-making, enabling clinicians to optimise treatment plan for patients and adequately prepare for their postoperative recovery period in order to provide the most cost and clinically effective care.

Declarations

Authors' contributions

DG, MD, and PC planned and developed this review. Under MD's guidance, DG and IJ were responsible for reading titles, abstracts, and full-text articles following collation of database search results. DG wrote the review, with assistance in the editing process provided by IJ, MD and PC. PC also provided clinical insight.

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Disclosure statement

There are no conflicts of interest to declare, for any of the authors involved in this review.

References

1. Ethgen O, Bruyere O, Richy F, Dardennes C, Reginster JY. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. The Journal of bone and joint surgery American volume. 2004;86-a(5):963-74.
2. Annual Report 2018. 2018.
3. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. The Journal of bone and joint surgery American volume. 2007;89(4):780-5.
4. Axon RN, Williams MV. Hospital readmission as an accountability measure. Jama. 2011;305(5):504-5.
5. D'Apuzzo M, Westrich G, Hidaka C, Jung Pan T, Lyman S. All-Cause Versus Complication-Specific Readmission Following Total Knee Arthroplasty. Journal of Bone & Joint Surgery - American Volume. 2017;99(13):1093-103.
6. van Walraven C, Jennings A, Taljaard M, Dhalla I, English S, Mulpuru S, et al. Incidence of potentially avoidable urgent readmissions and their relation to all-cause urgent readmissions. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2011;183(14):E1067-72.
7. Pugely AJ, Callaghan JJ, Martin CT, Cram P, Gao Y. Incidence of and risk factors for 30-day readmission following elective primary total joint arthroplasty: analysis from the ACS-NSQIP. The Journal of arthroplasty. 2013;28(9):1499-504.
8. Siracuse BL, Ippolito JA, Gibson PD, Ohman-Strickland PA, Beebe KS. A Preoperative Scale for Determining Surgical Readmission Risk After Total Knee Arthroplasty. Journal of Bone & Joint Surgery - American Volume. 2017;99(21):e112.
9. Alvi HM, Mednick RE, Krishnan V, Kwasny MJ, Beal MD, Manning DW. The Effect of BMI on 30 Day Outcomes Following Total Joint Arthroplasty. Journal of Arthroplasty. 2015;30(7):1113-7.
10. Varacallo MA, Herzog L, Toossi N, Johanson NA. Ten-Year Trends and Independent Risk Factors for Unplanned Readmission Following Elective Total Joint Arthroplasty at a Large Urban Academic Hospital. Journal of Arthroplasty. 2017;32(6):1739-46.
11. Courtney PM, Boniello AJ, Berger RA. Complications Following Outpatient Total Joint Arthroplasty: An Analysis of a National Database. Journal of Arthroplasty. 2017;32(5):1426-30.
12. Sutton JC, 3rd, Antoniou J, Epure LM, Huk OL, Zukor DJ, Bergeron SG. Hospital Discharge within 2 Days Following Total Hip or Knee Arthroplasty Does Not Increase Major-Complication and Readmission Rates. Journal of Bone & Joint Surgery - American Volume. 2016;98(17):1419-28.
13. Belmont PJ, Jr., Goodman GP, Rodriguez M, Bader JO, Waterman BR, Schoenfeld AJ. Predictors of hospital readmission following revision total knee arthroplasty. Knee Surgery, Sports Traumatology, Arthroscopy. 2016;24(10):3329-38.
14. Lehtonen EJ, Hess MC, McGwin G, Jr., Shah A, Godoy-Santos AL, Naranje S. Risk Factors for Early Hospital Readmission Following Total Knee Arthroplasty. Acta ortop. 2018;26(5):309-13.
15. Basques BA, Tetreault MW, Della Valle CJ. Same-Day Discharge Compared with Inpatient Hospitalization Following Hip and Knee Arthroplasty. Journal of Bone & Joint Surgery - American Volume. 2017;99(23):1969-77.

16. Webb ML, Golinvaux NS, Ibe IK, Bovonratwet P, Ellman MS, Grauer JNJTJoa. Comparison of perioperative adverse event rates after total knee arthroplasty in patients with diabetes: insulin dependence makes a difference. 2017;32(10):2947-51.
17. Kuo FC, Lin PC, Lu YD, Lee MS, Wang JW. Chronic Kidney Disease Is an Independent Risk Factor for Transfusion, Cardiovascular Complication, and Thirty-Day Readmission in Minimally Invasive Total Knee Arthroplasty. Journal of Arthroplasty. 2017;32(5):1630-4.
18. Workman KK, Angerett N, Lippe R, Shin A, King S. Thirty-Day Unplanned Readmission after Total Knee Arthroplasty at a Teaching Community Hospital: Rates, Reasons, and Risk Factors. The journal of knee surgery. 2019;10:10.
19. Ottesen TD, Zogg CK, Haynes MS, Malpani R, Bellamkonda KS, Grauer JN. Dialysis Patients Undergoing Total Knee Arthroplasty Have Significantly Increased Odds of Perioperative Adverse Events Independent of Demographic and Comorbidity Factors. Journal of Arthroplasty. 2018;33(9):2827-34.
20. Patterson JT, Tillinghast K, Ward D. Dialysis Dependence Predicts Complications, Intensive Care Unit Care, Length of Stay, and Skilled Nursing Needs in Elective Primary Total Knee and Hip Arthroplasty. Journal of Arthroplasty. 2018;33(7):2263-7.
21. Hart A, Antoniou J, Brin YS, Huk OL, Zukor DJ, Bergeron SGJTJoa. Simultaneous bilateral versus unilateral total knee arthroplasty: a comparison of 30-day readmission rates and major complications. 2016;31(1):31-5.
22. Curtis GL, Chughtai M, Khlopas A, Newman JM, Sultan AA, Sodhi N, et al. Perioperative Outcomes and Short-Term Complications Following Total Knee Arthroplasty in Chronically, Immunosuppressed Patients. Surgical technology international. 2018;32:263-9.
23. Organization WH. Obesity: preventing and managing the global epidemic: World Health Organization; 2000.
24. Bennette C, Vickers A. Against quantiles: categorization of continuous variables in epidemiologic research, and its discontents. BMC Medical Research Methodology. 2012;12(1):21.
25. Altman DG. Categorising continuous variables. Br J Cancer. 1991;64(5):975-.
26. Buettner P, Garbe C, Guggenmoos-Holzmann I. Problems in defining cutoff points of continuous prognostic factors: Example of tumor thickness in primary cutaneous melanoma. Journal of clinical epidemiology. 1997;50(11):1201-10.
27. Frøslie KF, Røislien J, Laake P, Henriksen T, Qvigstad E, Veierød MB. Categorisation of continuous exposure variables revisited. A response to the Hyperglycaemia and Adverse Pregnancy Outcome (HAPO) Study. BMC Medical Research Methodology. 2010;10(1):103.
28. Altman DG, Royston P. The cost of dichotomising continuous variables. BMJ (Clinical research ed). 2006;332(7549):1080.
29. Altman DG, Lausen B, Sauerbrei W, Schumacher M. Dangers of using "optimal" cutpoints in the evaluation of prognostic factors. Journal of the National Cancer Institute. 1994;86(11):829-35.
30. Sauerbrei W, Royston P, editors. Continuous variables: To categorize or to model?
31. Economic DoI, Affairs S. Provisional Guidelines on Standard International Age Classifications. United Nations; New York, NY; 1982.

32. Turner EL, Dobson JE, Pocock SJ. Categorisation of continuous risk factors in epidemiological publications: a survey of current practice. Epidemiologic Perspectives & Innovations. 2010;7(1):9.
33. Kheir MM, Clement RC, Derman PB, Flynn DN, Speck RM, Levin LS, et al. Are there identifiable risk factors and causes associated with unplanned readmissions following total knee arthroplasty? Journal of Arthroplasty. 2014;29(11):2192-6.
34. Courtney PM, Boniello AJ, Della Valle CJ, Lee GC. Risk Adjustment Is Necessary in Value-based Outcomes Models for Infected TKA. Clin Orthop. 2018;476(10):1940-8.
35. Schairer WW, Vail TP, Bozic KJ. What are the rates and causes of hospital readmission after total knee arthroplasty? Knee. Clinical orthopaedics and related research. 2014;472(1):181-7.
36. Kester BS, Minhas SV, Vigdorchik JM, Schwarzkopf R. Total Knee Arthroplasty for Posttraumatic Osteoarthritis: Is it Time for a New Classification? Journal of Arthroplasty. 2016;31(8):1649-53.e1.
37. Welsh RL, Graham JE, Karmarkar AM, Leland NE, Baillargeon JG, Wild DL, et al. Effects of Postacute Settings on Readmission Rates and Reasons for Readmission Following Total Knee Arthroplasty. Journal of the American Medical Directors Association. 2017;18(4):367.e1-.e10.
38. Bullock DP, Sporer SM, Shirreffs TG, Jr. Comparison of simultaneous bilateral with unilateral total knee arthroplasty in terms of perioperative complications. Journal of Bone & Joint Surgery - American Volume. 2003;85-A(10):1981-6.

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