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Impact of co-morbidity and adverse life-style on complications in elective total knee arthroplasty

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Abstract

Background Complications related to total joint arthroplasty (TJA) have an impact on health care expenditures worldwide. The objective was to examine the influence of preoperative adverse lifestyle and co-morbidity on postoperative complications in an optimised total knee arthroplasty (TKA) programme.

Methods This study was a retrospective study conducted at the orthopaedic department of a university hospital. Information was recorded regarding adverse lifestyles, co-morbidity, adverse postoperative events and complications.

Results A total of 304 complications were recorded, of which 54 were considered to be major, and 250 were considered to be of minor significance. Of the patients included in this study, 66 were women, and 43 were men. Pain-related complications were the most frequent type of complication (n=152). A univariate analysis revealed an impact of alcohol on pain-related complications (OR 4.0, CI 1.1-14.6). Cardiovascular disease (OR 2.5, CI 1.1-23.7, OR 8.6 CI 1.0-73.8 and 12.0, CI 1.4-99.7) and diabetes (OR 3.7, CI 1.2-11.5 and OR 11.5, CI 1.7-75.9) were associated with various surgical and non-surgical complications. Male gender had an impact on infectious risk (OR 10.5, CI 1.2-91.0), while obesity increased the length of stay in the hospital (OR 3.2, CI 1.0-10.0). Diabetes (OR 3.2, CI 1.0-9.6), hypertension (OR 5.2, CI 1.1-23.7) and cardiovascular disease (OR 2.6, CI 1.1-6.1) were associated with major complications.

Conclusion Even in an optimised TKA programme, preoperative lifestyle and co-morbidity contribute significantly to the risk of postoperative complications. The data from this study indicate a new set of risk factors related to co-morbidity and lifestyle; however, larger epidemiological studies are needed.

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Introduction

The frequency of total knee-arthroplasties has doubled and the frequency of hip arthroplasties has tripled over the last two decades in the US (1). Total joint arthroplasties (TJA) are the most frequently performed surgeries worldwide. The Danish National Knee-Arthroplasty Register recorded 5228 procedures in 2005 and 7396 procedures in 2007 (2).

This surgical population is generally over 50 years of age and is characterised by preoperative co-morbidity and risk factors. Risk factors for perioperative complications include age, male gender, race, obesity and crude co-morbidity (3-5). An increased body mass index (BMI) is in itself a risk factor for osteoarthrosis of the knee, which is associated with impaired quality of life, an earlier and increased need for total knee arthroplasty (TKA), lower quality of life, wound complications and venous thromboembolism (6-9). Smoking is a risk factor for perioperative complications in this population, and smoking cessation is known to reduce the risk of these complications (10). Diabetes is a known risk factor for TJA surgery and is associated with both surgical and medical complications as well as a prolonged length of hospital stay (LOS) and higher mortality (11). Optimal perioperative treatment can suppress the endocrine stress response (12).

The use of perioperative optimisation ("fast-track surgery", "rapid recovery protocols", "care map" or "accelerated/critical/clinical pathways") to address these risk factors and thereby avoid associated complications and adverse events have achieved positive results both internationally and in Denmark (13). Although the net evidence remains inconclusive, several beneficial effects have

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been documented, including shortened LOS and convalescence due to more rapid postoperative mobilisation, better pain treatment, improved contact between the doctor and patient, more detailed patient information, and improved cost-benefit analyses (14;15).

The benefit of optimising co-morbidity by hospitalist care ("co-care" and "co-management") in the treatment of lower-extremity fractures has been demonstrated in some contexts, but it still remains controversial (16). One study has demonstrated that optimising hospitalist care benefits elective TJA patients, while studies in a mixed surgical population remain inconclusive (17). In contrast, there are many evidence-based rehabilitation programmes for chronic diseases, such as diabetes, ischemic heart disease and chronic obstructive pulmonary Disease (COPD), as well as interventions for lifestyle conditions, such as inactivity and alcohol overconsumption (18-22).

Considering the steady progress made in perioperative optimisation and the management/rehabilitation of chronic disease, older epidemiological studies may not identify current risk factors and co-morbidity within a state of the art elective TKA programme. Recent studies on preoperative optimisation of diabetes or lifestyle conditions, such as alcohol consumption and smoking, have been limited to mixed TJA populations and other surgical patient populations (23-25).

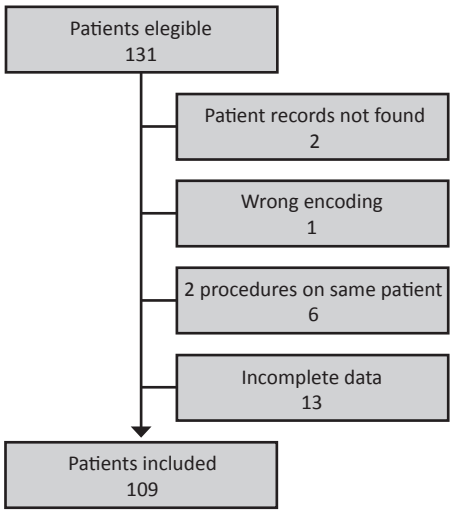
The purpose of this study was to identify a possible relationship between complications, co-morbidity and risk factors in elective TKA patients in a state of the art optimised perioperative programme.

Materials and Methods

Study population

We included 109 consecutive patients; missing information on weight and BMI was the most frequent cause of exclusion (13 out of 22) (Figure 1). All the patients underwent elective TKA at the Department of Orthopaedic Surgery at Bispebjerg Hospital in 2006 to ensure that any treatment and follow-up had been completed. All the patients were enrolled in the department's TKA programme. An initial ambulatory consultation by a specialist in orthopaedic surgery was scheduled for a short clinical assessment to determine the need for surgery. During a second consultation by an ambulatory nurse practitioner, the patient was screened for urinary infection and vital parameters (blood pressure, weight and height). The patients received oral and written information concerning the department's TKA programme with emphasis on the perioperative goals of pain-treatment, mobilisation and release on the 4th-5th postoperative day. The patients completed a questionnaire covering use of medication, general health, co-morbidities and risk factors on the day of admittance, and the patients were then clinically evaluated by a resident. Postoperative pain management consisted of epidural analgesia during the first 3 days and monitoring by a certified anaesthetic nurse. This approach was supplemented with a standard per-oral morphine analgesia regimen. Thrombosis prophylaxis with Tinzaparine 3,500 IU was started preoperatively and continued until patient discharge. Early postoperative mobilisation commenced the first day after surgery, at which point the patients were expected to leave the bed and eat their meals in a dining room and to attend scheduled physiotherapy sessions.

Figure 1 Study population



Design

This was a retrospective observational study of patient records from 2006. Permission to collect personal sensitive data was obtained by the Danish Data Protection Agency, according to the national Data Protection Act. (26) Acute and infected revision arthroplasties, as well as arthroplasties performed on children (age < 18 years), were excluded. All the patients who underwent surgery between 1st January and 31st December 2006 were included. The patient records were systematically reviewed by the main author according to predetermined criteria for any information on co-morbidity, risk factors, interventions related to co-morbidity and risk factors, or postoperative complications in 2007-2008. These criteria were defined in a catalogue that was approved by the study group prior to data collection. Co-morbidities were identified by the WHO-ICD code or during assessment, admission, bedside consultations and/or drug

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combinations. Cardiac disease and hypertension were assumed whenever common drugs combinations could be documented, and a prescription of inhalation medicine indicated pulmonary disease. To avoid underestimation of alcohol-related disease, certain drug combinations and off-label prescriptions without obvious reason (e.g., vitamins, antacids, propranolol, antidepressants and sedatives), in combination with admitted daily higher alcohol consumption, were considered to be positive for alcohol-related disease. Patient data without information on BMI and weight were excluded as this information was considered to be crucial for the analysis. Alcohol consumption was recorded according the recommendations from the National Board of Health (14 equivalents per week for men and 7 for women (1 equivalent contains 12 grams of pure alcohol)). All the postoperative complications were recorded and addressed urgently as emergencies by the department's ambulatory care unit throughout the postoperative period and prior to the first regularly scheduled ambulatory visit after 6 months. They were graded as fatal (death during admission), major (potentially lethal without immediate intervention) and minor (not life threatening). A bedside consultation was defined as whenever a consultant from another department provided non-orthopaedic specialist advice. A recorded episode of pain was defined as a complication whenever interventions and adjustments to the standard analgesia regime had to be made (Table 1).

Table 1 Postoperative major and minor complications

Major	Postoperative complications
A possible life-threatening condition, need for immediate medical attention (The same complications were considered fatal if they where cause of death.)	- Sepsis, septicaemia - Pneumonia - Wound infection – (deep, under fascia) - Bleeding (transfusion) - Thromboembolism or deep venous thrombosis - Ketoacidosis - Delirium - Apoplexy - neurological deficit with remission > 24 hours - TCI - neurological deficit with remission < 24 hours - Acute coronary syndrome - Cardiac arrhythmia - Cardiac arrest - Respiratory insufficiency pulmonary oedema - Gastroparesis, obstruction >3 days - Prosthetic luxation - Wound rupture with fascia rupture
Minor Not life-threatening, medical attention required	- Urinary infection - Wound infection – (superficial/abscess, over fascia) - Superficial venous thrombosis - Pain despite standard analgesia regime - Hypo/hyperglycaemia - Abstinences related to alcohol, tobacco or benzodiazepine - Paresis - ischiadic, femoral, peroneal nerve - Deterioration in COPD - Nausea, vomiting - Urinary retention - Prosthetic loosening - Wound rupture without fascia rupture

Data processing

Due to the observational character and the unknown outcome parameters, the sample size was not calculated. The data were collected, coded and stored in a database. Differences in continuous variables between men and women were tested using unpaired t-tests, while differences in the frequencies of categorical variables between the two groups were tested using chi-square statistics or Fisher's exact test where appropriate using Excel (Microsoft Office 2007). Odds ratios (OR) with confidence intervals (95%) > 1.0 and $p < 0.05$ for the chi square test were considered significant.

The influence of co-morbidity and risk factors on postoperative complications (all, minor and major) and many other complications were tested using univariate statistics (Table 2). In the model, one or more complications versus no complications and one or more episodes of pain requiring medical intervention versus no pain episodes constituted the outcome variables, while sex, age, BMI, smoking status, alcohol use, diabetes, hypertension, cardiovascular disease, respiratory disease and increased risk of thrombosis were evaluated as co-variates. Figure 2 depicts all the odds ratios of the model for all, major and minor complications, whereas Figure 3 only depicts the odds ratios with positive outcomes (although all the ratios were calculated) for individual risk factors.

An additional analysis was performed in which hypertension, cardiovascular disease and an increased risk of thrombosis were pooled to evaluate the total risk for vascular complications during TKA, but this analysis added nothing to the individual analyses. A multivariate analysis was also performed, but it was rejected due to the limited number of data points and the large number of covariates.

Results

In total, 66 (60.5%) patients were women. There were no significant gender differences in terms of age, BMI, length of stay or number of prescriptions (Table 3).

The co-morbidities of the study populations and the risk factors are shown in Table 4. These co-morbidities and risk factors were predominantly observed in men (smok-

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Table 2 Complications

	Women	(%)	Men	(%)	P
Number of complications (N)	181		123		NA
Fatal	0	-	0*	-	NA
Major	32	(17.7)	22	(17.9)	1.0
Minor	149	(82.3)	100	(81.3)	0.8
N per patient	2.8	-	2.9	-	NA
0 per patient	12	(18.2)	9	(20.9)	0.7
1-2 per patient	28	(42.4)	17	(39.5)	0,8
3-5 per patient	16	(24.2)	10	(23.3)	0.9
>5 per patient	10	(15.2)	5	(11.6)	0.6
>10 per patient	0	-	2	(4.7)	0.1
Medical complications (hypo-glycaemia, bedside medical consultation)	3		9		0.01
Cerebral complications (confu-sion, neurological and psychiatric bedside consultation)	1		6		0.01
Pulmonary complications (pneu-monia, respirator treatment)	1		4		0.1
Infection (sepsis, increased inflammatory parameters, uri-nary tract infection)	5		4		0.8
Complications related to anaes-thesia (nausea, dural perforation, urinary retention)	8		4		0.6
Pain (epidural catheter failure, complaints, bedside consultation by a pain specialist)	100		52		0.03
Bleeding (hematoma, blood transfusion)	10		9		0.5
Wound complications (superfi-cial infection, deep/superficial wound, secretion, rupture, pres-sure sore)	13		12		0.4
Oedema	5		0		0.1
Thromboembolic complications (Apoplexy, DVT)	0		4		0.01
Fall	1		2		0.4
Prosthesis complications (frac-ture, luxation, loosening, paresis)	1		2		0.4
Second surgery	6		2		0.4
Acute ambulatory consultation	1		1		0.8
Re-admittance	10		8		0.7
Re-admittance for rehabilitation	11		3		0.1

* renal failure (1 patient), NA: Not evaluable

ing; excessive alcohol consumption; and pulmonary, cardiac, thromboembolic and alcohol-related disease), but more women than men had diseases that demanded closer medical attention (diabetes and hypertension).

Figure 2 ORs for Postoperative Complications

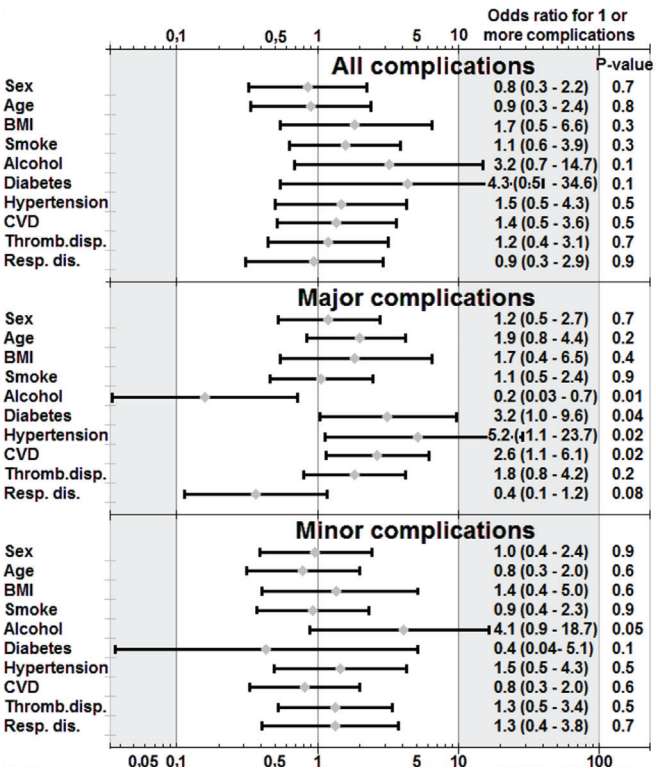
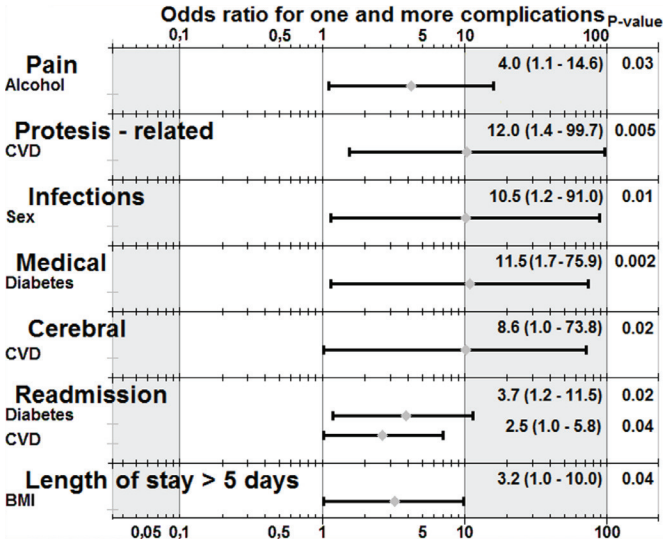


Figure 3 ORs for various complications and risk factors



We identified 304 complications, 249 (81.9 %) of which were considered minor, and 54 (17.8 %) of which were major. No fatal complications were recorded; only one male patient developed renal failure and was transferred to the intensive care unit. Overall, there were more complications among males; more females experienced pain-related complications (1.5 per female versus 1.2 per male), were re-admitted for rehabilitation (16 % versus 6 %) and reported oedema (7.6 % versus 0 %) (Table 2).

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Table 3 Patient Demographics

	Women	(SD)	Men	(SD)	P
Number of patients (N)	66		43		NA
Age at time of surgery	69.1	(11.2)	67.0	(8.8)	0.3
Height	1.64	(0.07)	1.77	(0.08)	0.0001
Weight	84.4	(19.9)	96.6	(15.8)	0.002
BMI	31.2	(6.7)	30.1	(7.29)	0.4
Number of Medications (N)	4.8	(3.2)	4.0	(2.7)	0.2
0	4	-	3	-	-
1-2	14	-	11	-	-
3-5	21	-	19	-	-
>5	27	-	10	-	-
Length of stay	9.7	(7.0)	8.5	(4.6)	0.3

NA: Not evaluable

Table 4 Co-morbidity and risk-factors

	Women	(%)	Men	(%)
Smoking	19	(28.8)	23	(53.5)
Daily	15	(22.7)	11	(25.6)
Occasionally	2	(3)	0	
Ex-smoker	2	(3)	12	(27.9)
Alcohol (no data)	3	(4,5)	0	
No recorded consumption	45	(68.2)	15	(34.9)
Recommended maximum consumption (≤ 7 units/w female, ≤ 14 units/w male)	8	(12.1)	14	(32.6)
Over recommended maximum consumption	10	(15.2)	14	(32.6)
Weight normal (BMI 20,5-24,9)	8	(12.1)	3	(6.9)
Pre-obesity (BMI 25-29,9)	18	(27.3)	20	(46.5)
Obesity class 1 (BMI 30-34,9)	20	(30.3)	10	(23.3)
Obesity class 2 (BMI 35-39,9)	10	(15.2)	4	(9.3)
Obesity class 3 (BMI >40)	7	(10.6)	5	(11.6)
Underweight (BMI <20,5)	4	(6.1)	1	(2.3)
Diabetes mellitus Type 1	1	(1.5)	0	
Diabetes mellitus Type 2	9	(13.6)	4	(9.3)
Normal blood pressure (< 140/90)	11	(16.7)	8	(18.7)
Hypertension grade 1 (140-159/90-99)	11	(16.7)	7	(16.3)
Hypertension grade 2 (160-179/100-109)	11	(16.7)	12	(27.9)
Hypertension grade 3 (>180/>110)	15	(22.7)	9	(20.9)
Systolic hypertension (>140/<90)	18	(27.3)	7	(16.3)
Cardiac disease	18	(27.3)	18	(41.9)
Earlier thromboembolic complications	23	(34.8)	19	(44.2)
Pulmonary disease (COPD, asthma)	11	(16.7)	14	(32.6)
Disease related to alcohol	6	(9.1)	10	(23.3)

BMI: Body Mass Index, COPD: Chronic Obstructive Pulmonary Disease

Figures 2 and 3 show odds ratios (OR) for risk factors in relation to postoperative complications. Odds ratios could only be calculated for all complications, major complications, minor complications and other complications due to the small number of data points. The same variables were calculated for any specific complication in Figure 3, which only shows variables with positive ORs for other complications.

Several factors were associated with major complications. Hypertension was the most important factor (OR 5.2, confidence interval 1.1 – 23.7, p = 0,02), followed by diabetes (OR 3.2, confidence interval 1.0 – 9.6, p = 0,04) and cardiovascular disease (OR 2.6, confidence interval 1.1 – 6.1, p = 0.08) (Figure 2). Alcohol had a protective effect (OR 0.2, confidence interval 0.03 – 0.7, p = 0.01) (Figure 2).

Cardiovascular disease was the single most important factor and was associated with prosthesis complications (OR 12.0, confidence interval 1.4 – 99.7, p = 0.005), cerebral complications (OR 8.6, confidence interval 1.0 – 73.8, p = 0.02) and risk of readmission (OR 2.5, confidence interval 1.0 – 5.8, p = 0.04) (Figure 3). The second most important factor was diabetes, which was related to medical complications (OR 11.5, confidence interval 1.7 – 75.9, p = 0.002) and risk of readmission (Figure 3). Alcohol consumption was the only factor related to pain-related complications (OR 4.0, confidence interval 1.1 – 14.6, p = 0,03) (Figure 3).

Two known classical risk factor were identified. Gender was associated with infection (OR 10.5, confidence interval 1.2 – 91.0, p = 0.01), while increased BMI was associated with a LOS of greater than 5 days (OR 3.2, confidence interval 1.0 – 10.0, p = 0.04). No impact was found for smoking status, thromboembolic or respiratory disease status (Figure 3).

Discussion

We reveal a novel association between preoperative co-morbidity, lifestyle and postoperative complications. Our patients were all admitted within the span of a single year to a major orthopaedic department and underwent an optimised standard of care programme for elective TKA surgery. Only two records could not be retrieved; certain records were excluded for the reasons outlined above. The near-fatal complications were similar to those documented elsewhere (> 1 %) (27).

We chose a strictly inductive approach with a single assessor to screen journal data over one year according to a predetermined set of criteria for co-morbidity and risk

factors that limit confounding. No amendment of the study protocol was needed during the review, which occurred within a 4-month period. To our surprise, we only identified one known predictors of complications: Male gender. Nonetheless, we anticipated that the study population's increased BMI, diabetes and smoking would lead to more complications. We suspect that our dataset was too limited to allow for the detection of relationships between individual complications.

Hypertension is known to be a nonspecific risk factor for perioperative complications. Anaesthesiologists have traditionally addressed the perioperative optimisation of hypertension. To the best of our knowledge, there are no studies that can confirm the effect of the preoperative optimisation of hypertension on TJA surgery. We were able to establish a more extensive relationship between hypertension and cardiovascular co-morbidity than has been previously reported. According to the American Heart Association/American College of Cardiology (ACC/AHA) guidelines, blood pressure should be optimised when grade 3 hypertension is reported (diastolic pressure > 110 mmHg and systolic pressure > 180 mmHg). Such characteristics were observed in only 1/3 of the women and men in our study. Isolated systolic hypertension is also perceived as a risk factor (28). This characteristic was observed in 27 % of the men and 16 % of the women. However, the most recent ACC/AHA guidelines state, "hypertension is common, and treatment has been shown to be associated with decreased death rates from stroke and CHD (cardiac hypertensive disease) in the nonsurgical setting. Unfortunately, all too few patients with hypertension are treated, and fewer yet have their hypertension controlled. Accordingly, the perioperative evaluation is a unique opportunity to identify patients with hypertension and initiate appropriate therapy" (28).

In our population, co-morbidity, such as cardiovascular disease and diabetes, led to several mainly non-surgical complications as suspected but was also associated with prosthesis-related complications and readmission for further treatment and rehabilitation. The lack of perioperative optimisation of both conditions may have led to a delayed healing and hampered postoperative rehabilitation during and after the hospital stay. We suspect that the increased risk for infection was associated with male gender as a result of the many contributing factors found in the male population, which could not be identified due to limited data. Obesity is known to contribute to a prolonged clinical course, which is a known complication.

Alcohol appeared to have a protective effect against major complications, which may be due to the lack of data points or the fact that this procedure is not uncommon for patients with serious alcohol issues. However, alcohol was the only important risk factor for pain-related complications. We recorded many pain-related complications in the trial, which attracted the attention of our quality management team. The pain control regimen was already considered to be inadequate. We demonstrated the association between alcohol consumption and postoperative pain by alcohol withdrawal, which in turn led to an increased perioperative stress response and a risk of delirium (29). Alcohol-associated coagulopathy can contribute to excessive bleeding and pain (30). However, we could not demonstrate associations between alcohol consumption and bleeding and complications related to the central nervous system.

Although the data were limited, our findings were consistent throughout the data sample, and our approach proved feasible and practical for the evaluation and review of the surgical activity of one year in a single field at a major orthopaedic centre in the capital of Denmark.

Conclusion

To our knowledge, this is the first study to analyse risk factors associated with lifestyle and co-morbidities in an optimised perioperative programme for elective TKA surgery.

We believe that our data identify known complications and associated risk factors, such as age, gender and obesity, but also identify a new set of risk factors in the context of surgery: diabetes, hypertension, cardiovascular co-morbidity and alcohol. The lack of well-known risk factors, such as age and smoking, in our cohort allowed us to establish a link between other less-studied complications and classical co-morbidities in the middle-aged and older surgical populations. We believe that the absence of associations between complications related to the classical risk factors proves the effectiveness of optimised surgical programmes in TKA surgery.

This new set of risk factors challenges our understanding of perioperative care in the 21st century, which has relied on making surgery more tolerable by minimising perioperative stress to improve patient outcome. The effects of anaesthesia often exacerbate this perioperative stress. We provide evidence suggesting that there is an impact of known risk factors, such as diabetes and hypertension, below the threshold currently documented and practiced according to current international guidelines. TKA patients might benefit both in the short and long term by tightly regulating their blood pressure and blood sugar levels before surgery. Smoking and drinking habits could be addressed by asking the patient to reflect

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on changing their habits at least for the preoperative period. We acknowledge that perioperative optimisation of classical co-morbidity and risk factors represents a paradigm shift in modern elective surgical care from the optimisation of the impact of surgical care to a patient-centred care model.

Although our study only presents limited data points, it provides the first evidence that known risk factors may have a far greater impact on perioperative morbidity. Thus far, no existing research or current guideline supports our findings. Our study design proved to be applicable and effective in highlighting the importance of continuous epidemiological surveillance of ever-changing demographics and health characteristics in well-defined surgical populations. An effort should be made in the future to clarify the importance of the preoperative rehabilitation of these co-morbidities and risk factors in the context of optimised elective surgical care.

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