Provider volume and other predictors of outcome after total knee arthroplasty: a population study in Ontario

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Introduction: Because of rationing of the limited pool of health care resources, access to total knee arthroplasty (TKA) is limited, but investigation of variables that predict complications, length of hospital stay, cost and outcomes of TKA may allow us to optimize the available resources. The objective of this study was to examine the effect of various factors on complication rates after TKA in patients managed in Ontario. **Methods:** Patients who had undergone an elective TKA between 1993 and 1996, as captured in the Canadian Institute for Health Information (CIHI) database, formed the study cohort. The CIHI dataset was used to obtain information regarding in-hospital complications, hospital length of stay, revision rates, infection rates and mortality. Generalized estimating linear or logistic regression equations were used to model outcomes as a function of age, gender, comorbidity, diagnosis and provider volume. **Results:** During the study period, 14 352 patients in Ontario underwent TKA. Mortality at 3 months was associated with patient age, gender and comorbidity. There was no association between provider volume and mortality or the infection rate. Higher revision rates at 1 and 3 years were significantly associated with lower patient age and low hospital volume ($p < 0.05$). Hospitals in which fewer than 48 TKA procedures were done per year (< 40th percentile) had 2.2-fold greater 1-year revision rates than hospitals performing more than 113 TKAs annually (> 80th percentile). Complications during admission were associated with increased patient age and comorbidity, and higher hospital volume. Longer hospital stay was associated with female gender, increasing patient comorbidity and age, and lower provider volume. Surgeons who performed fewer than 14 TKAs annually (< 40th percentile) kept patients in hospital an average of 1.4 days longer than surgeons performing more than 42 TKAs annually (> 80th percentile). **Conclusions:** Patient variables significantly affect the rate of complications. Age, sex and comorbidity were significant predictors of complications, length of hospital stay and mortality after TKA. Although low surgeon volume was related to longer hospital stay, there was no association between surgeon volume and complication rates. The increased early revision rate for low-volume hospitals demands further study.

Introduction : En raison du rationnement des ressources limitées destinées aux soins de santé, l'accès à l'arthroplastie totale du genou (ATG) est restreint, mais l'étude de variables prédictives des complications, de la durée de l'hospitalisation, du coût et des résultats de l'ATG peut permettre d'optimiser l'u-

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Accepted for publication Aug. 8, 2002.

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tilisation des ressources disponibles. Cette étude visait à analyser l'effet de divers facteurs sur les taux de complications après une ATG chez des patients pris en charge en Ontario. **Méthodes :** Les patients ayant subi une ATG élective entre 1993 et 1996, selon la base de données de l'Institut canadien d'information sur la santé (ICIS), ont constitué la cohorte d'étude. On a utilisé l'ensemble de données de l'ICIS pour obtenir des renseignements sur les complications à l'hôpital, la durée de l'hospitalisation, les taux de révision, les taux d'infection et la mortalité. On a utilisé des équations de régression linéaire ou logistique d'estimation généralisée pour modéliser les résultats en fonction de l'âge, du sexe, de la comorbidité, du diagnostic et du nombre d'interventions pratiquées par le prestateur de soins. **Résultats :** Au cours de la période d'étude, 14 352 patients de l'Ontario ont subi une ATG. On a établi un lien entre la mortalité à trois mois et l'âge du patient, son sexe et la présence d'une comorbidité. On n'a établi aucun lien entre le nombre des interventions pratiquées par le prestateur et les taux de mortalité ou d'infection. On a établi un lien important entre les taux de révision plus élevés à un et trois ans et l'âge moins élevé des patients, ainsi que le faible nombre des interventions pratiquées par l'hôpital ($p <$ 0,05). Les hôpitaux où l'on a effectué moins de 48 ATG par année (< 40^e percentile) présentaient des taux de révision à un an 2,2 fois plus élevés que ceux qui ont procédé à plus de 113 ATG par année (> 80^e percentile). On a établi un lien entre les complications à l'admission et l'âge plus élevé des patients, la présence d'une comorbidité et le nombre plus élevé d'interventions pratiquées par l'hôpital. On a établi un lien entre des séjours plus longs à l'hôpital et le sexe féminin, la présence d'une comorbidité croissante chez les patients et leur âge, ainsi que le nombre moins élevé d'interventions pratiquées par le prestateur. Les chirurgiens qui procédaient à moins de 14 ATG par année (< 40^e percentile) gardaient les patients à l'hôpital en moyenne 1,4 jour de plus que ceux qui en réalisaient plus de 42 par année (> 80^e percentile). **Conclusions :** Les variables des patients ont un effet important sur le taux de complications. L'âge, le sexe et la présence d'une comorbidité constituaient des prédicteurs importants de complications, de la durée de l'hospitalisation et de la mortalité après l'ATG. Même si l'on a établi un lien entre le nombre peu élevé des interventions pratiquées par les chirurgiens et une hospitalisation plus longue, on n'en a établi aucun entre le nombre des interventions pratiquées par les chirurgiens et les taux de complications. Une étude plus poussée du taux accru de révision hâtive dans les hôpitaux où l'on pratique peu d'ATG s'impose.

The frequency of total knee arthroplasty (TKA), one of the most common adult reconstructive procedures performed, continues to increase. Both short- and long-term studies have demonstrated the ability to improve pain and function in patients suffering from knee arthritis.[1–9] Advances in the last 20 years have allowed TKA to become a reliable procedure with a minimum of complications.[3,5,9] However, TKA is a resource-intensive procedure and can incur significant cost, related to the cost of the implant, of the hospital stay and of rehabilitation needs postoperatively.

Efforts to control health care costs have led to the rationing of the limited pool of health care resources. Access to TKA is limited, and the medical community must determine how to distribute these resources. Efforts to investigate variables that predict complications, length of stay, cost and outcomes may allow the medical community to optimize resources used in TKA.

Much of the literature on TKA centres on implant survival and revision rates.[3,5,9,10] These are used to compare implant and design considerations. There is a growing body of United States literature focusing on the outcomes of TKA unrelated to implant design,[1,2,4,6,7,11,12] whose goal is to define the incidence and determine factors predictive of these outcomes but little Canadian data on the subject to date.[10,13,14]

Evidence in the literature suggests that a patient's outcome after surgery is in part related to the volume of experience at the hospital and of the surgeon involved.[15–26] Some have suggested that patient complications and mortality could be minimized by assigning certain procedures, including total joint arthroplasty, to regional centres of excellence.[20,23,27] Experienced providers might make more appropriate decisions regarding the indications for surgery and other operative details as they gain expertise and learn the factors that result in better patient outcomes. Hospitals with higher volumes may have more effective procedures in place to manage these patients postoperatively, both from a nursing and a rehabilitation perspective. Moreover, rehabilitation and other important ancillary services may be more readily available to high-volume providers.

A recent study of elective total hip replacements performed in the state of Washington revealed that surgeons performing a low volume of these procedures experienced a significantly higher rate of complications, including in-hospital complications, infection, need for revision and patient death.[18] No such relationship could be established using Ontario data.[28] There is some evidence of a volume–outcome relationship for TKA in the US but, again, there is minimal data on the subject in Canada.[14,26]

The purposes of this study were to determine factors related to complication rates after elective TKA performed on patients in Ontario and to determine if surgeon and hospital volume are related to the incidence of complications after TKA.

Methods

Study cohort selection

The Ontario Health Insurance Plan (OHIP) maintains a record of

all patient encounters for which a bill is generated. Since 1992, the OHIP database has contained unique patient identifiers as well as hospital and physician identifiers. A service date, diagnostic and procedural code are also included. Although OHIP procedural codes are detailed and highly specific, diagnostic categories are quite vague and incomplete. For this study, OHIP data were supplemented with diagnostic information from another source. The Canadian Institute for Health Information (CIHI) collects information regarding inpatient admissions from all health institutions in the province including International Classification of Diseases, 9th Revision (ICD-9) diagnostic codes 81.51 and 81.59. The CIHI does collect codes for procedures using the Canadian Classification of Procedures (CCP) categories. Unfortunately, these categories are not very detailed in the area of arthroplasty. It is not possible to distinguish between primary and revision arthroplasty, for example. Combining these 2 databases allows a more accurate assessment of diagnosis and complications (CIHI) as well as the most accurate coding of the procedure (OHIP).

A cohort of patients who had undergone TKA between April 1992 and March 1996 was assembled. An algorithm was used to include only patients with inflammatory or degenerative arthritis. Surgeon and hospital volumes were computed by counting all knee replacement operations (without applying any exclusion criteria) averaged over the 4 years of study using the OHIP dataset. Surgeon and hospital providers were then divided into 5 groups based on the 20th, 40th, 60th and 80th percentiles. Because of the small number of patients treated by providers in the lower-volume groups, the bottom and middle 2 groups were combined. Thus, 3 groups were defined: a low-volume group (< 40th percentile), a medium-volume group (40th–80th percentile) and a high-volume group (> 80th percentile) based on the average number of TKAs performed during the study period.

Outcomes of interest

Each patient admission was recorded in the database. Serious postoperative complications such as accidental surgical mishaps, myocardial infarction and stroke were identified in the database. An algorithm, used in previous research, based on ICD-9 discharge diagnoses that were considered clinically significant in affecting patient's outcome and their clarity from potential misclassification,[18,28] was used to define the complications as a binary variable (no major complications v. ≥ 1 major complications). The patient cohort was followed forward in the database for a minimum of 3 years (maximum 5 yr) during which time revision knee surgery and readmissions for knee infections were sought.

The occurrence of deep venous thrombosis was also documented. Although excision arthroplasty, knee fusions and lower limb amputations could be identified, the occurrence of these complications was too infrequent to allow statistical analysis of factors related to their incidence.

The cohort of knee replacement patients was then linked to the Ontario mortality file to obtain accurate information regarding patient mortality because the CIHI dataset captures only in-hospital deaths.

Length of hospital stay was recorded for each admission, and differences in the length of stay for high- and low-volume providers were compared.

Comorbid conditions were identified from the CIHI dataset, and the modified Charlson index[29,30] was used as an indicator of comorbidity. As well, age, comorbidity, gender and surgical diagnosis (inflammatory or noninflammatory arthritis) were available in the CIHI database and were used to adjust for confounding.

Analysis of data

The presence or absence of an adverse event was treated as a binary variable. Length of stay was treated as a continuous variable. Ordinary linear or logistic regression requires that all observations be statistically independent of one another. This assumption was violated in our data, since multiple patients received care by the same hospital or surgeon provider. For this reason, generalized estimating equations suitable for correlated data were applied.[31] Interactions between covariates, surgeon volume and hospital volume were individually tested for every model. The interaction term between hospital and surgeon volume was also evaluated by entering it into the model after all main effects had been included. None of the interaction terms were found to reach statistical significance.

Results

Study cohort

Of the patient records that contained the procedural codes 81.51 or 81.59, 14 352 unique patients met all of the unique criteria. Table 1 depicts patient characteristics and the unadjusted rates of various complications in the study cohort.

Surgeon and hospital volume

Between 1992 and 1996, 262 individual surgeons performed 1 or more elective, primary TKAs in 1 of 88 different hospitals (Table 1). The volume calculations included all of the knee replacements that providers managed without any exclusion criteria. Unadjusted outcomes associated with surgeon and hospital provider volumes are shown in Table 2.

Mortality

Seventy-four patients (0.5%) died within 3 months of the index opera-

tion and 54 (0.4%) deaths occurred before the patient was discharged following the initial procedure. Patient age and comorbidity were significantly related to the probability of dying within 3 months of the initial hospital admission (Table 3). As patient age increased by 10 years, the risk of dying within 3 months increased 2.4 times. Patients with comorbid conditions (modified Charlson index ≥ 2) were 23.7 times more likely to die within 3 months than patients with no comorbid conditions. There was no significant association between surgeon or hospital volume and mortality at 3 months (Table 3).

Infection (cumulative incidence at 1 and 3 years)

Two hundred and nine patients (1.5%) were readmitted at least once for an infection involving their prosthesis during the first year after elective TKA. Patients with inflammatory arthritis were twice as likely to be readmitted for knee infection than patients with osteoarthritis. Older patients were significantly less likely to be readmitted for infection. Surgeon and hospital volumes were not significantly related to the incidence of infection at 1 year (Table 3).

At 3 years, the incidence of infection was significantly associated with male gender, decreased age and increased comorbidity. Patients with a Charlson index of 2 or more had a 2.1 times increased risk of readmission for knee infection. Surgeon and hospital volumes were not related to the incidence of readmission for knee infection at 3 years (Table 3).

Revision (cumulative incidence at 1 and 3 years)

Within 1 year of the index opera-

Table 1

Data on Provider Volumes for Total Knee Arthroplasty in Ontario

	Provider, group and volume					
	Surgeon			Hospital		
Provider data	Low	Medium	High	Low	Medium	High
Volume percentile, %	< 40	40–80	> 80	< 40	40–80	> 80
Providers, no.	108	108	51	35	36	17
Patients/year, no.	< 14	14–42	> 42	< 48	48–113	> 113
Total patients, no.	1463	5745	7144	1914	6127	6311
Average hospital volume/yr	76.9	99.4	62.8	31.9	82.5	237.4
Average surgeon volume/yr	8.9	28.0	75.0	28.3	39.2	65.8

Table 2

Unadjusted Outcomes for Providers of Total Knee Arthroplasty*

	Provider, group and volume					
	Surgeon			Hospital		
Outcome	Low (< 14)†	Medium (14–42)	High (> 42)	Low (< 48)	Medium (48–120)	High (> 120)
Average age, yr	70.1	70.0	69.2	70.1	70.0	69.1
Comorbidity						
> 0	20.4	20.3	21.4	18.1	20.8	21.7
> 1	0.5	0.6	0.4	0.7	0.5	0.5
Men	41.6	37.2	37.9	40.7	37.6	37.6
Inflammatory arthritis	8.3	8.0	9.7	5.6	9.3	9.5
Average length of hospital stay, d	11.5	10.5	10.0	10.8	10.5	10.0
Complications during index hospital admission	9.0	9.8	11.0	6.6	10.0	11.8
Death						
During index hospital admission	0.5	0.5	0.3	0.5	0.4	0.3
Within 3 mo	0.8	0.6	0.4	0.7	0.06	0.4
Infection						
Within 1 yr	1.4	1.4	1.5	1.9	1.4	1.4
Within 3 yr	2.1	2.1	2.3	2.7	2.1	2.1
Revision						
Within 1 yr	0.6	0.9	0.8	1.1	0.9	0.6
Within 3 yr	2.2	2.0	1.9	2.5	2.1	1.7
Excision						
Within 1 yr	0.4	0.2	0.4	0.3	0.4	0.3
Within 3 yr	0.8	0.6	0.8	0.6	0.8	0.7
Amputation within 3 yr	0	0.07	0.03	0.05	0.05	0.03
Deep venous thrombosis within 3 mo	1.8	2.9	2.6	1.7	3.3	2.3

*Numbers are % unless otherwise indicated.
†Patients per year.

tion, 116 patients (0.8%) were admitted for a revision procedure, and within 3 years, 282 patients (2.0%) were admitted for revision. Patient age was significantly associated with the risk of knee revision at 1 and 3 years, with older patients being less likely to undergo revision (Table 3).

Surgeon volume was not significantly associated with the incidence of revision at 1 year. Patients operated at low-volume hospitals (< 48 TKAs per yr) were 2.2 times more likely to require revision within 1 year of their index procedure than high-volume hospitals (> 113 TKAs per yr).

Complications

During the initial procedure, 1480 patients (10.3%) sustained a serious complication. Patient age and comorbidity were related to the incidence of complications (Table 3). As patient age increased by 10 years, complications increased 1.2 times. Patients with a Charlson index of 2 or more were 2.1 times more likely to have suffered an in-hospital complication. Surgeon volume was not significantly associated with increased complication rates. Patients in low-volume hospitals were half as likely to suffer an in-hospital complication than their high-volume counterparts (Table 3).

Length of hospital stay

Patients treated by the lowest-volume surgeons averaged approximately 1.4 days longer in hospital than the highest-volume surgeons after adjusting for case mix (Table 4).

Similarly, patients in hospitals in the low-volume category had significantly longer lengths of hospital stay (0.8 d) after primary TKA compared with high-volume hospitals. Increasing patient age, increasing comorbidity and female sex were also associated with increasing length of hospital stay after primary TKA.

Discussion

Surgeon volume

No association was demonstrated between surgeon experience and the rates of adverse events after primary TKA in Ontario. This is consistent with data on primary hip replacements in the province published previously.[28] It is in contrast, however, to data reported by Kreder and associates[18] on hip arthroplasty in the state of Washington. Data from Washington showed that low-volume surgeons experienced 3 times higher mortality, 1.6 times higher complication rates, 4.3 times higher infection rates and 3 times higher revision rates. It is important to note that in the Washington study, low-volume surgeons performed less than 2 knee replacements per year, and

Table 4

Adjusted Changes in Length of Hospital Stay After Total Knee Arthroplasty for Provider Volume, Patient Age, Comorbidity, Diagnosis and Gender

Variable	Stay, mean extra days (and 95% CL)*
Surgeon volume	
Low < 14 v. high > 42	**1.4 (1.2, 1.9)**
Mid 14–42 v. high > 42	0.5 (–0.1, 0.7)
Hospital volume	
Low < 48 v. high > 113	**0.8 (0.5, 1.1)**
Low 48–113 v. high > 113	**0.4 (0.2, 0.6)**
Patient age, per 10 yr	**0.7 (0.5, 0.8)**
Patient comorbidity	
1 v. 0	**0.9 (0.5, 1.2)**
> 1 v. 0	**2.8 (1.8, 3.7)**
Diagnosis, osteoarthritis v. no osteoarthritis	0.2 (–0.6, 0.2)
Patient gender, female v. male	**0.4 (0.2, 0.6)**

*Significant values appear in bold.
CL = confidence limits.

Table 3

Adjusted Complication Rates by Provider Volume, Patient Age, Comorbidity, Diagnosis and Gender

	Complication; odds ratio (and 95% confidence limits)*					
	Readmission for knee infection		Readmission for kee revision		Patient death	
Variable	1 yr	3 yr	1 yr	3 yr	< 3 mo	In-hospital complications
Surgeon volume						
Low < 14 v. high > 42	0.80 (0.4, 1.6)	0.88 (0.5, 1.3)	0.57 (0.2, 1.4)	1.00 (0.6, 1.7)	1.76 (0.80, 3.8)	0.98 (0.7, 1.3)
Mid 14–42 v. high > 42	0.84 (0.6, 1.2)	0.83 (0.6, 1.1)	0.91 (0.5, 1.6)	0.97 (0.7, 1.4)	1.61 (0.9, 2.7)	0.99 (0.76, 1.27)
Hospital volume						
Low < 48 v. high > 113	1.57 (0.9, 2.7)	1.50 (0.9, 2.3)	**2.23 (1.1, 4.5)**	**1.54 (1.0, 2.4)**	1.38 (0.7, 2.9)	0.53 (0.39, 0.71)
Low 48–113 v. high > 113	1.11 (0.8, 1.6)	1.10 (0.8, 1.5)	1.57 (0.9, 2.9)	1.25 (0.9, 1.8)	1.30 (0.8, 1.5)	0.83 (0.63, 1.07)
Patient age, per 10 yr	**0.90 (0.86, 0.97)**	**0.90 (0.85, 0.95)**	**0.77 (0.67, 0.89)**	**0.70 (0.66, 0.81)**	**2.44 (2.3, 2.6)**	**1.19 (1.1, 1.2)**
Patient comorbidity						
1 v. 0	0.67 (0.4, 1.6)	0.92 (0.6, 1.3)	1.15 (0.6, 2.1)	1.07 (0.7, 1.5)	**5.36 (3.2, 8.9)**	**1.19 (1.0, 1.4)**
> 1 v. 0	1.69 (0.9, 3.3)	**2.14 (1.3, 3.6)**	0.80 (0.2, 2.6)	0.88 (0.4, 1.8)	**23.70 (13.3, 42.1)**	**2.05 (1.6, 2.62)**
Diagnosis, osteoarthritis v. non-osteoarthritis	**0.55 (0.3, 0.9)**	0.75 (0.5, 1.2)	1.10 (0.5, 2.6)	1.26 (0.8, 2.1)	1.27 (0.7, 2.4)	0.96 (0.76, 1.22)
Patient gender, female v. male	0.80 (0.6, 1.0)	**0.78 (0.6, 0.9)**	0.91 (0.6, 1.3)	0.95 (0.7, 1.2)	0.66 (0.4, 1.0)	**0.71 (0.6, 0.8)**

*Statistically significant values appear in bold.

high-volume surgeons performed more than 10. Surgeons in the Ontario study performed higher numbers of TKAs across the board. It would appear that there is likely a minimum number of arthroplasties that a surgeon should perform annually in order to minimize adverse events. Given the data from these studies, that number lies somewhere between 2 and 14.

Low-volume surgeons in Ontario had a longer patient length of hospital stay than high-volume surgeons. This volume–length-of-stay relationship appeared to be consistent between the US and Canada. This may predict a greater cost savings per joint replacement for high-volume surgeons compared with low-volume surgeons. Cost was calculated based on US data, but not on Canadian data, and one cannot assume that shorter length of hospital stay equals lower cost. Further study is required to determine this relationship.

Hospital volume

Hospital volume was significantly associated with an increased rate of readmission for revision surgery within 1 year. Patients in low-volume hospitals also had a longer hospital stay than those in high-volume hospitals. In contrast, patients in low-volume hospitals had a significantly lower rate of in-hospital complications than their higher volume counterparts. The explanation for this observation is not known. Hospital volume was not predictive of any other adverse outcome.

Although long-term revision rates would be required to compare component design in TKA, revision at 1 year would be considered a technical error and would reflect a difference in the provider rather than the prosthesis. It is interesting that low hospital volumes, not surgeon volume, predicted higher revision rates. We have no explanation for this relationship.

Luft and associates[20] in 1979 were the first to report on the relationship between hospital volume and patient outcome. Eight operations, including total hip arthroplasty, were studied, and hospital volume was correlated to mortality. Higher mortality was found in hospitals performing less than 50 total hip arthroplasties per year. Above that number, the death rate levelled out. There are several reasons why this finding should be viewed with some skepticism in the 1990s. First, the death rate after joint replacement is much lower now than in 1979, and arthroplasty is a much more common procedure, familiar to many more providers. In addition, Luft and associates included patients operated on for fracture or malignant disease, who have a higher death rate and likely made up a higher percentage of cases from low-volume hospitals. Finally, Luft's group did not adjust for case mix, which has a significant effect on the death rate.

Studies performed in the 1990s have suggested a relationship between volume and outcome. Gutierrez and associates[14] found an inverse relationship between hospital volume and treatment cost. Norton and colleagues[24] found a rapid decline in complications in hospitals performing more than 50 TKAs per year. In contrast, Coyte and associates[32] found a lower revision rate in community hospitals compared with teaching hospitals in Ontario. Kreder and associates[18,28] found no relationship between hospital volume and adverse outcomes.

Our study also showed that patients who underwent TKA in low-volume hospitals had a longer average length of hospital stay than those in high-volume hospitals. In the US study of Kreder and associates,[18] low-volume hospitals performed hip arthroplasty at a higher cost. Length of stay may be associated with higher costs, but it cannot be proven from our study that high-volume hospitals are less expensive per procedure than low-volume hospitals.

Some have suggested that procedures such as total joint arthroplasty should be performed in regional centres of excellence to minimize adverse outcomes and cost of the procedure.[23,27] Others recommend devolution of arthroplasty in order to lower cost.[33] Our study suggests that high-volume hospitals may be associated with lower early revision rates and a shorter length of patient hospital stay but a higher complication rate. These findings cannot be used to support regionalization of TKA in Ontario.

Patient age

We found that mortality, the rate of complications, and length of hospital stay all increased as patient age increased. As patient age increased, the rates of infection and early revision decreased. Several studies have documented the beneficial effect of joint arthroplasty on well-selected, older patients. As for all surgery, consideration of TKA in the elderly requires a careful balance between the increased short-term risk of the procedure and the tremendous long-term benefit gained.

Patient comorbidity

Patient comorbidity had a profound effect of the outcome of TKA. Patients with a Charlson index of 2 or more were 24 times more likely to die within 3 months of the index procedure than patients with an index of 0. They also were twice as likely to suffer an in-hospital complication, and stayed in hospital on average 3 days longer than their healthy counterparts. Wasielewski and colleagues[34] demonstrated that patients with greater comorbidity had poorer function after TKA. It seems clear from the data presented that patient comorbidity has the most profound effect on the outcome of TKA.

Surgical diagnosis

The surgical diagnosis (rheuma-

toid arthritis v. osteoarthritis) had little effect on the incidence of adverse outcomes. Patients with inflammatory arthritis were more likely to be readmitted for infection than patients with osteoarthritis, but we found no correlation to revision, complications or mortality.

Strengths and weaknesses

The strength of this study lies in the databases used. A large number of patients were collected and followed up, and loss to follow-up was limited only to those patients who left the province. The weakness of the study also lies in its databases. Administrative databases were not designed with clinical research in mind, and important outcomes (e.g., function) cannot be recorded in the database.[35] Hawker and associates[36] compared the accuracy of the CIHI database to the hospital record in a random sample of 185 TKA recipients. They found a 63% false-negative rate for comorbid conditions and a 34% false-negative rate for in-hospital complications. No association between type of hospital and coding inaccuracy could be made. It is unclear exactly how these inaccuracies would affect the results of our study.

This study attempts to correlate various factors with adverse outcomes after TKA. Future research must focus on important patient-based outcomes, such as pain relief, return to function and health status to provide a clearer picture of outcomes after TKA.

Conclusions

There is currently no evidence to suggest that low surgeon volume is related to adverse events occurring after elective, primary TKA in Ontario. Higher hospital volume may be related to a lower revision rate and procedure cost, but further research is needed to confirm this.

Patient factors (age, comorbidity) appear to be the major determinant of adverse outcomes of elective, primary TKA.

Competing interests: None declared.

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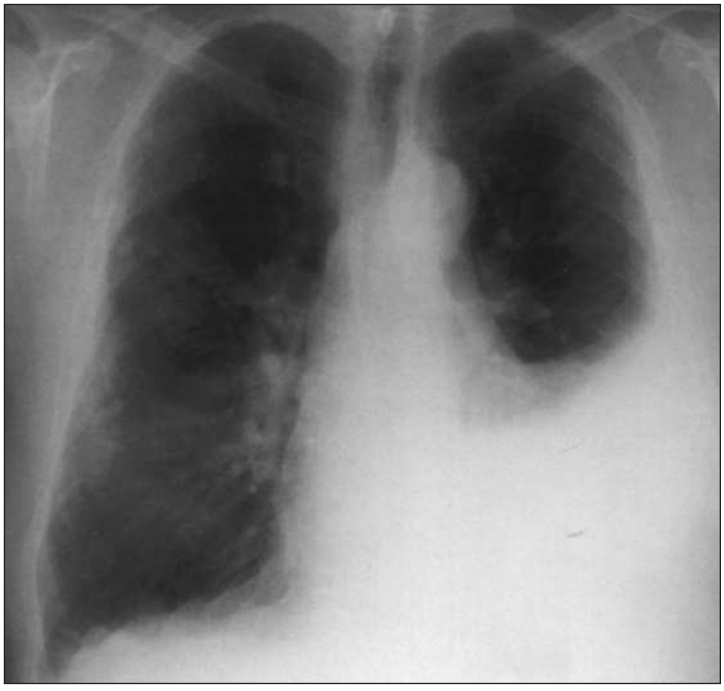
SESAP Question
Question SESAP

Category 11, Item 2



A 55-year-old man was treated for a hemothorax following rib fractures three months previously. He now has a fever of 102°F and chronic and recurrent chest pain. The chest x-ray shown is obtained. A lateral decubitus view did not show any changes.

The therapy with the LEAST chance of achieving definitive success in curing this problem would be

(A) prolonged tube thoracostomy
(B) rib resection and tube drainage
(C) thoracotomy with decortication
(D) thoracoscopic decortication
(E) marsupialization (Eloesser flap)

For the incomplete statement above, select the lettered completion that is best of the 5 given.

For the answer and a critique of item 2 see page 63.