Surgical site infections following orthopaedic surgery: Statewide surveillance using linked administrative databases

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Abstract

In many institutions prospective surveillance programmes to monitor the incidence of post-operative infection can be difficult to implement due to limited human and technical resources. In addition, prolonged patient follow up, up to one year, may be required for implant surgery. Traditional methods of surveillance can be enhanced by using administrative databases to assist in case finding and facilitate overall surveillance activities. The aim of this study was to identify the incidence of surgical site infection (SSI) in patients who had undergone total hip replacement (THR) or total knee replacement (TKR) surgery in all Western Australian (WA) hospitals in 1999 using the Western Australian Health Services Research Linked Database. The database was used to identify patients who underwent THR or TKR surgery in 1999 using ICD–9-CM and ICD–10-CM codes. Of these, patients who had been given an infection diagnosis code plus the external cause 'surgical operation with implant of artificial internal device' codes (E878.1 in ICD–9-CM, Y83.1 in ICD–10-CM) were identified. This allowed all patients to be followed for at least one year after surgery. Patients who died from other causes during the follow-up period were identified from linked mortality data. A total of 1476 THR and 1875 TKR procedures was identified from 21 WA hospitals (11 public, 10 private) during 1999. There were 169 infections identified, giving an overall cumulative incidence of 5%, (95% CI 4.3–5.7) [THR (4.86%, 95% CI 3.77–5.95) and TKR (5.15%, 95% CI 4.15–6.15)]. Only 23 infections were coded specifically as 'infection and inflammatory reaction due to hip or knee replacement'. The remainder had been given alternative infection codes, but had also been given the external cause code 'surgical operation with implant of artificial internal device'. There was a total follow-up time of 5012 person-years, giving an incidence rate of 33.72 infections per 1000 person-years. Most infections (96%) occurred within 1 year of surgery. Patients aged over 80 years experienced a significantly higher rate of infection after THR, when compared to patients aged 80 or less (z-test, z=2.56, p=0.0150), but not for TKR (z=0.35, p=0.726). Eighty-five patients (50.3%) developed a SSI during the same hospital admission as the surgical procedure, the remainder were re-admitted to hospital at a later date. For THR, 58% developed a SSI during the same admission, compared to 44% for TKR. The WA Health Services Research Linked Database provided a unique opportunity to review the incidence of SSIs in patients undergoing THR or TKR surgery in WA hospitals.

Introduction

Surgical site infection (SSI) is a major complication in patients undergoing prosthetic joint surgery, that can lead to revision or removal of the implant, prolonged antibiotic therapy and a significant increase in healthcare costs.[1] Prospective surveillance for SSIs requires prolonged follow-up, up to one year, necessitating post-discharge surveillance that is resource intensive. The overall incidence of SSI following joint replacement surgery is reportedly low, ranging from 0.6% to 4.5% depending on the surveillance method utilised.[2–4]

Sophisticated information systems with the ability to integrate clinical data are now commonplace in many health care facilities. While patient administration systems are used to store demographic data and patient event histories, these systems can be interfaced and integrated with other systems, such as laboratory and theatre systems. Data are readily available from these sources and can be utilised by Infection Control Practitioners (ICPs) to enhance conventional surveillance activities and assist in case finding methods. The use of electronic databases to assist with infectious diseases surveillance activities, in particular, the use of coded discharge diagnoses, has been suggested previously,[5] however, few investigations have looked specifically at nosocomial infections. Hirschhorn et al. demonstrated that coded discharge diagnoses combined with information on antibiotic exposure extracted from automated pharmacy records could be used to determine postoperative infections.[6]

We have previously used information obtained from the International Classification of Disease, 9th Revision, Clinical Modification (ICD–9-CM) coding in the medical record, and stored in a hospital patient administrative database, for surveillance of SSI in orthopaedic patients at a single hospital in Western Australia. ICD–9-CM coded discharge data were comparable to surveillance data obtained by ICPs (Table 1).[7] This validation enabled us to undertake the current study.

We expanded this approach to retrospectively identify SSIs in patients who underwent total hip replacement (THR) or total knee replacement (TKR) surgery in all Western Australian (WA) hospitals during 1999 using the Western Australian Data Linkage System. The WA Data Linkage System was established in 1995 and links several population-based administrative health datasets within the State, including the Hospital Morbidity Data System (HMDS) and mortality records.[8] The HMDS contains demographic information, principal and other conditions, complications, treating doctors, source and destination on discharges from all public and private acute hospitals in WA based on the International Classification of Disease codes allocated by hospital coding personnel.

Methods

Data extraction

The WA Data Linkage System was used to identify patients from the HMDS who underwent THR or TKR surgery during 1999 using the ICD–9-CM codes to June 1999 (81.51, 81.54) and the ICD–10-AM codes from July 1999 (49318.00, 49319.00, 49517.00 – 49519.00). Of these, patients who had an infection diagnosis code (ICD–9-CM 996.66, 998.5; ICD–10-AM T84.5, T81.4, T84.5) recorded as well as an external cause of 'surgical operation with implant of artificial internal device' (E878.1 in ICD–9-CM, Y83.1 in ICD–10-AM) for any admission during 1999 and 2000 were identified. This allowed all patients to be followed for at least one year after surgery. Patient outcomes were measured as those requiring revision of the prosthesis, intensive care unit (ICU) admission, and mortality associated with a SSI. Prosthetic revisions are also coded in the HMDS (ICD–9-CM 80.05, 80.06; ICD–10-CM 49312.00, 49324.00, 49527.00), and mortality associated with a SSI was determined from the mode of discharge for a SSI hospital admission. Patients who had died from other causes during the follow-up period were identified from mortality data through the linkage system.

Data analysis

The cumulative incidence of SSI after orthopaedic surgery was calculated as the number of patients identified with an infection per 100 (%) surgical procedures (THR and/or TKR) during the 2-year period. The incidence rate was defined as the number of patients with an infection per 1000 patient-years to take into account the differing times of follow-up for each patient. Ninety-five percent confidence intervals were calculated using the Normal distribution where appropriate. Hypothesis tests for differences between two proportions were undertaken using the z-test.

Results

A total of 169 SSIs from 3351 procedures was identified, giving an overall incidence of 5.0% (95% CI 4.3–5.7). This was similar for THR (4.9%, 95% CI 3.8–5.9) and TKR (5.1%, 95% CI 4.1–6.1). Only 23 infections were coded specifically as 'infection and inflammatory reaction due to hip or knee replacement'. The remainder had been given alternative infection codes, as well as the external cause code 'surgical operation with implant of artificial internal device'. There was a total follow-up time of 5012 person-years, giving an incidence rate of 33.7 infections per 1000 person-years. One hundred and sixty-three infections (96%) occurred within one year of surgery.

The incidence of SSI for TKR was similar for females and males, (5.0%, 95% CI 3.6–6.3 for females; 5.4%, 95% CI 3.9–6.9 for males), but for THR the incidence of SSI was slightly higher for females (5.6%, 95% CI 4.0–7.3) than for males (4.0%, 95% CI 2.6–5.4) but this was not statistically significant (z=1.79, p=0.073). Patients aged over 80 years experienced a significantly higher rate of infection after THR, when compared to patients 80 years or less (z=2.56, p=0.015), but not for TKR (z=0.35, p=0.73). SSI was diagnosed in 85 patients (50.3%) during the same hospital admission as the surgical procedure; the remainder were diagnosed when they were re-admitted to hospital. Fifty-eight percent of SSIs occurred in patients who had undergone the procedure in a public hospital.

Revision of a prosthesis could only be attributed to SSI for five patients, and no patients died of a SSI. Six patients with a SSI were admitted to an ICU, but all developed their SSI during the same admission as the initial procedure and it was therefore not possible to determine whether they were in an ICU because of the SSI or for some other reason.

Discussion

The WA Data Linkage System provided a unique opportunity to review the incidence of SSI in patients undergoing THR or TKR surgery in WA hospitals. The infection rate in this survey was slightly higher (5%) than previously published rates,[2–4] however, such comparisons should be made cautiously because the methods and definitions used in these studies were not consistent. Our study was based on clinical coding and ICD definitions of SSI, not the identification of infections by ICPs using the Centers for Disease Control and Prevention SSI definitions that are more commonly used in prospective surveillance. A more likely explanation for our increased rate of infection, however, is the longer period of follow-up the linked data system allowed. Approximately half of the patients with SSIs were readmitted from between two to 574 days after their initial admission. Previous studies have estimated that up to 84% of all SSIs occur after discharge.[9–10]

Our study also highlighted the significant number of patients who developed infections post discharge (49.7%) and subsequently required readmission. It is also possible that some patients may have presented to outpatient departments or their general practitioners with superficial infections and would therefore not be captured in this survey. Furthermore, patients who were diagnosed with SSI outside WA would also be missed. Therefore, although our figure of 5% appears high, it is still likely to be an under-estimation of the true infection rate. Friedman et al.[4] also found a higher infection rate when their surveillance was expanded to capture re-admissions and outpatient visits. Both our study and that of Friedman et al[4] indicate that efforts to measure post-discharge SSIs improves case ascertainment and enhances the accuracy of the data.

The quality of clinical information from administrative data has been questioned previously.[11] However, we recently showed that ICD coded information was as good as ICPs using CDC definitions for surveillance of SSI following orthopaedic surgery.[7] The ICD information recorded in the HMDS is dependent on the accuracy of the clinical coders in each health care facility, as well as the accuracy and clarity of the documentation in the medical record. Clinical coders in Australia are required to complete a nationally recognised training course, and the Department of Health in WA also provides ongoing education programmes. In addition, periodic audits of random selections of hospital assigned codes are undertaken and a quality assurance programme containing 21 different quality checks is used to identify incomplete data in the HMDS.[8] Although concordant results were achieved with orthopaedic implant surgery, further studies are required to validate this process for other types of surgical procedures and hospital acquired infections.

Prospective SSI surveillance is resource intensive due to the duration of post-discharge follow-up required. By using the WA Data Linkage System, we were able to estimate the statewide SSI rate for THR and TKR surgery. A prospective surveillance programme to achieve this, encompassing 127 healthcare facilities and covering an area of 2.5 million square km, would be logistically impossible, time consuming and financially expensive to undertake. The use of administrative databases and linkage of health records has previously been suggested as a means to enhance public health surveillance,[5,8] however, we believe this is the first time that such an approach has been used successfully to monitor SSI and support hospital infection control programmes.

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Type of surgical site infection	Surveillance method		
	ICP* -Positive Coder -Positive	ICP- Positive Coder - Negative	ICP -Negative Coder - Positive
Superficial incisional	10	3	4
Deep incisional/Organ/space	7	1	1
TOTAL	17	4	5

* Infection Control Practitioner

Using the ICP as the true positive the sensitivity of the coded discharge data was 81% with a positive predictive value of 77%.

Table 1 Surveillance method and detection of surgical site infection