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ORIGINAL ARTICLE

# SURGICAL WOUND INFECTION SURVEILLANCE: THE IMPORTANCE OF INFECTIONS THAT DEVELOP AFTER HOSPITAL DISCHARGE

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**Background**: The aim of this study was to evaluate two methods of post-discharge surgical wound surveillance and to compare the incidence and outcomes of wound infections that develop prior to patients' discharge with those that develop after hospital discharge.
**Methods**: One thousand, three hundred and sixty inpatients who underwent major elective surgery in an 800-bed teaching hospital in western Sydney between February 1996 and July 1997 were followed prospectively. Pre-discharge wound surveillance was performed by clinical assessment by an independent researcher on the fifth (or later) postoperative day. Post-discharge wound surveillance was performed by a mail out of questionnaires completed independently by patients and surgeons.
**Results**: Overall, 138 wound infections were diagnosed (incidence 10.1%), of which fewer than one-third ($n$ = 44) were diagnosed before discharge (average 10.4 days postoperatively) and the remainder ($n$ = 94) after discharge (average 20.6 days postoperatively). Seven hundred and eighty-two (57.5%) post-discharge survey forms were returned by patients and 680 (50.0%) by surgeons. When forms were returned by both surgeons and patients for the same wound (641 cases), there was substantial agreement in diagnosing infection or no infection (kappa = 0.73).
**Conclusions**: The majority of nosocomial surgical wound infections develop after the patients' discharge from hospital. A post-discharge surveillance programme including self-reporting of infections by patients and return of questionnaires by patients and surgeons is feasible in an Australian hospital setting. However, such a programme is labour and resource intensive and strategies to increase return of questionnaires are required.

**Key words: infection control, nosocomial wound infection, surgical wound infection.**

## INTRODUCTION

Post-surgical wound infections are a major cause of increased nosocomial morbidity and mortality and excess healthcare costs. There are few published Australian data, but the Australian Nosocomial Infection Prevalence Survey published in 1984 showed that surgical wound infections accounted for 34% of nosocomial infections with an estimated excess annual cost of $60 million Australia wide.[1]

Surveillance is the core component of any wound infection control programme. Comprehensive surgical wound surveillance, with reporting of infection rates to and action by individual surgeons and hospital managers, can result in sustained reductions in infection rates over time.[2] The educational aspects of surveillance also reinforce the importance of wound infections and the need for continuous maintenance of high standards of surgical care.

Despite the decision of the Australian Council on Healthcare Standards (ACHS) to include clean and contaminated surgical wound infection rates as clinical indicators for hospital accreditation,[3] it does not define a standardized method for performing surgical wound infection surveillance for use by Australian hospitals.[4] In addition, the limited surveillance that is currently being performed by Australian hospitals is usually confined to detection of infections which are diagnosed prior to the patient's discharge from hospital. The published literature, however, suggests that a significant proportion of surgical wound infection (10–80% in various studies) does not develop until after patients' discharge from hospital.[5] This proportion is likely to increase as the introduction of case-mix funding and an emphasis on the reduction of waiting lists encourage earlier discharge. There is no standardized method for conducting post-discharge surveillance.

The aims of this study were: (i) to evaluate post-discharge surgical wound surveillance methods using mailed out questionnaires completed independently by patients and surgeons; and (ii) to compare the incidence and outcomes of wound infection that develops prior to patients' discharge with those developing after hospital discharge.

## METHODS

### Location

Westmead Hospital is an 800-bed teaching hospital in western Sydney that performs about 200 major surgical procedures per week of which approximately half are classified as 'clean' procedures.

### Wound surveillance

From February 1996, a research nurse collected data on operations chosen to represent the major elective procedures performed by cardiothoracic, vascular, abdominal, orthopaedic and gynaecological surgeons at the hospital. They included clean and 'contaminated' procedures for which the expected postoperative stay exceeded 5 days, reflecting ACHS requirements current at the time.[3] Clean procedures were defined as procedures in which a hollow viscus-containing bacterial flora had not been entered,

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**Table 1.** Details of procedures performed and proportion of forms returned

| Surgical specialty | Wound class | | Patient forms returned (%) | Surgeon forms returned (%) |
|---|---|---|---|---|
| | Clean | Contaminated | | |
| Abdominal | 0 | 203 | 113 (55.7) | 86 (42.4) |
| Cardiothoracic | 642 | 0 | 370 (57.6) | 338 (52.7) |
| Gynaecology | 209 | 2 | 138 (65.4) | 121 (57.4) |
| Orthopaedics | 245 | 0 | 123 (50.2) | 99 (40.4) |
| Vascular | 59 | 0 | 38 (64.4) | 36 (61.0) |
| Total | 1155 | 205 | 782 (57.5) | 680 (50.0) |

and contaminated procedures were those in which such organs had been entered. Patients were examined by the research nurse on day 5 or later postoperatively and the status of their surgical wound(s) was determined. Infection was diagnosed and classified on the basis of clinical criteria modified (in order to simplify self-assessment by patients) from those of the Centers for Disease Control.[6] Infection was diagnosed if purulent drainage was present or obtained from the wound. Infection was classified as superficial incisional if it involved only skin or subcutaneous tissue and as deep incisional if it also involved deep soft tissues (fascial and muscle layers). Demographic, American Society of Anesthesiologists (ASA) Class,[7] wound status and outcome data were collected for each patient and entered into an MS-ACCESS v 2.0 database (Microsoft Corp, Redmond, WA, USA). Reports that detailed infection rates and other information (such as use of prophylactic antibiotics) were produced monthly and reviewed by relevant surgical, infection control and quality assurance staff.

At the time of assessment in hospital, each patient was given a mailback form and asked to complete a simple questionnaire about their wound and medical follow up and return it after day 28 of their operation. Surgeons also received a separate mailback form that requested information on the wound status of each patient obtained at their postoperative review. If any of the returned forms indicated a possible wound infection, the patient and the surgeon were contacted by the research nurse to confirm the diagnosis and obtain details.

The study proposal was approved by the Western Sydney Area Health Service Bioethics Consultative Committee and performed with the full support and cooperation of members of the Division of Surgery. The study was funded by the Westmead Hospital Charitable Trust.

### Statistical analysis

Statistical analysis was assisted by using the computer program STATA v 5.0 (Stata Corporation, Texas USA). Characteristics of those with no infection, pre-discharge wound infection and post-discharge wound infection and outcomes for those with wound infection were compared using Fisher's exact test. A significance level of less than 0.05 was used. The kappa statistic was used to assess agreement between surgeons and patients in diagnosing infections developing out of hospital. A kappa value of greater than 0.60 was considered to indicate substantial agreement.[8]

## RESULTS

### Study group characteristics and compliance with return of forms

From February 1996 to July 1997 inclusive, 1360 patients were examined by the research nurse and all agreed to participate in the post-discharge survey. The mean age of patients was 63.3 years and 53.2% were male. Their distribution into ASA Classes[7] reflected the significant proportion with underlying disease in this population: Class 1, 8.7%; Class 2, 21.9%; Class 3, 54.7%; Class 4, 14.7% (where Class 1 indicates the highest, and Class 4, the lowest, level of fitness). The operations performed and compliance with return of forms are summarized in Table 1. Seven hundred and eighty-two patient survey forms and 680 surgeon survey forms were returned, giving an overall compliance for return of forms of 57.5% and 50.0% by patients and surgeons, respectively.

**Table 2.** Wound infection rates for each surgical specialty

| Surgical specialty | No. | Wound infection Pre-discharge (%) | Wound infection Post-discharge (%) |
|---|---|---|---|
| Cardiothoracic | 642 | 18 (2.8) | 64 (10.0) |
| Orthopaedics* | 245 | 10 (4.1) | 5 (2.0) |
| Vascular | 59 | 1 (1.7) | 3 (5.1) |
| Gynaecology | 209 | 6 (2.9) | 15 (7.2) |
| All clean | 1155 | 35 (3.0) | 87 (7.5) |
| All contaminated** | 205 | 9 (4.4) | 7 (3.4) |
| All wounds | 1360 | 44 (3.2) | 94 (6.9) |

*Includes 112 prosthetic joint procedures of which one (0.9%) and four (3.6%) developed infection in hospital and post-discharge, respectively; **Includes all abdominal and two gynaecological operations.

### Agreement between patients and surgeons

Forms that related to 641 wounds were returned by both patients and surgeons. Both patients and surgeons agreed that wound infection was present in 51 and absent in 565 cases (kappa = 0.73). In eight cases, infection was diagnosed by the surgeon, but not by the patient and in 25 cases by the patient but not by the surgeon. Review of the latter 25 cases confirmed that infection had occurred in 23 patients, who had either presented to a doctor other than their surgeon or had developed infection after review by the surgeon.

Cases in which either patients or surgeons, but not both, returned forms (141 and 39 cases, respectively) were also analysed. Four additional cases of wound infection were diagnosed by surgeons and 11 were diagnosed by patients. In these latter 11 cases, eight were confirmed as true infections after review.

### Incidence of pre- and post-discharge wound infections

During the 18-month period, 44 (31.9%) of 138 infected wounds were detected prior to the patients' discharge from hospital and 94 (68.1%) after discharge. Rates of wound infection are compared for each surgical specialty in Table 2. Wound infections were more

**Table 3.** Comparison of degree and outcome of wound infections

| Outcome variable | Pre-discharge WI ($n$ = 44) | Post-discharge WI ($n$ = 94) | $P$ value* |
|---|---|---|---|
| Time of infection from surgery (mean) | 10.4 days | 20.6 days | – |
| Deep infection | 28 (63.6%) | 18 (19.1%) | < 0.001 |
| Re-admission | 5 (11.4%) | 5 (5.3%) | 0.3 |
| Re-operation | 11 (25.0%) | 0 | < 0.001 |
| Died | 6 (13.6%) | 0 | 0.001 |

*Fisher's exact test; WI, wound infection.

commonly diagnosed pre-discharge following orthopaedic procedures, unlike the situation with other clean procedures. The reason for this is not clear but it did not reflect a difference in hospital stay between orthopaedics and other specialities (data not shown). Pre-discharge infection rates were not significantly different between contaminated and clean procedures (4.4% and 3.0%, respectively; $P$ = 0.29, Fisher's exact test), but post-discharge infections occurred significantly more frequently after clean procedures (7.5% *vs* 3.4%; $P$ = 0.01, Fisher's exact test).

### Time of diagnosis and degree of wound infection and patient outcome

Ninety-seven per cent of infections were diagnosed within 28 days of operation. Comparison of outcome variables for patients with infections are shown in Table 3. Patients who developed their infection in hospital were significantly more likely to have 'deep incisional' infection than those who developed infection after discharge (63.6% *vs* 19.1%; $P$ < 0.001, Fisher's exact test). Two of the six deaths in the pre-discharge infection group were directly related to the wound infection.

### Peri-operative antibiotic prophylaxis

Patients who underwent cardiac, orthopaedic, vascular and abdominal surgery received peri-operative antibiotic prophylaxis routinely. Ninety-three (44.1%) of the women who underwent abdominal hysterectomy received antibiotic prophylaxis. Of these, five (5.4%) developed wound infection, compared with 16 (13.6%) of 118 women who did not receive antibiotic prophylaxis ($P$ = 0.06, Fisher's exact test)

## DISCUSSION

This study demonstrates both the importance and the difficulty of performing surveillance for surgical wound infections that develop after hospital discharge. Nearly 70% of the infections detected in this study developed after the patient's discharge from hospital. This is consistent with other published studies,[5] which have shown that 10–80% of surgical wound infections develop post-discharge and as in the present study, are largely unrecognized by hospital personnel. While patients with more severe infections may present as unplanned re-admissions, the majority will be managed by healthcare workers in the community and the community, not the hospital, bears the cost. Unless surgical wound surveillance includes a post-discharge component, infection rates, morbidity and costs will be grossly underestimated. The current surveillance guidelines of the ACHS do not recommend or require that post-discharge data be collected[3,4] and it has been suggested that this makes wound infection an inappropriate clinical indicator.[9]

Even if the need for post-discharge surveillance is acknowledged, the methodology is problematic. Methods used in published studies have included examination of patients in follow-up clinics or surgeons' private rooms; surveillance of re-admissions to hospital because of surgical wound infection; review of the medical records of surgical patients after a period in which most infections would be expected to have developed; postal and/or telephone follow up of surgeons; postal and/or telephone follow up of patients;[10,11] review of patients in their homes.[12] Often post-discharge data have been collected from several sources.[13] All of these methods are labour intensive and costly to implement. Each hospital needs to individualize its methodology as the pattern of patient follow up will vary for each institution. Surveillance should continue for at least 28 days postoperatively as approximately 95% of infections (97% in the present study) develop within this period.[14]

This study used a combination of simple questionnaires returned by both patients and surgeons to detect post-discharge infections. A major limitation of this approach as demonstrated in this study is the relatively poor compliance with return of forms (57% by patients and 50% by surgeons). Such compliance rates are, however, consistent with those of other published studies.[10] Compliance by surgeons could possibly be improved by sending them a form each month listing each patient operated on in the previous month and a tick box to determine wound status, rather than a separate questionnaire to return on each patient. Compliance by both patients and surgeons may also be improved by telephoning non-responders or sending a reminder form after 28 days, although this is considerably more labour intensive and time consuming.[13,15]

There are conflicting conclusions in the literature about the ability of patients to diagnose their own wound infections. In one study of sutured traumatic wounds in an emergency department,[16] the positive predictive value of a patient's diagnosis of wound infection was only 26% compared with that of medical staff. The authors concluded that patient-reported data were too unreliable to be of use. In the present study, many of the infections reported by patients had been diagnosed by the patient's surgeon or general practitioner rather than by the patient alone. Of more relevance is a post-discharge study of 5042 surgical wounds performed by a Boston hospital.[17] In this study the positive predictive value of patient-reported infections was greater than that of surgeon-reported infections (but only 36% *vs* 27%) because of the greater compliance of patients compared to surgeons in returning questionnaires. The use of patient-reported surveillance to diagnose an adverse outcome of hospital treatment raises ethical and medico-legal issues but in practice most patients apparently welcome the opportunity to be involved in their medical care.

A greater proportion of infections developed after discharge following procedures classified as clean compared with those classified as contaminated. This reflects the relatively large number of post-discharge infections in the predominately clean procedures performed by cardiac surgeons and gynaecologists. The longer incubation period may reflect the lower inoculum of bacteria contaminating the incision at the time of a clean procedure (as compared with a contaminated procedure).[13]

As would be expected, significantly more severe infections (i.e. those classified as 'deep incisional') presented early and before discharge, and a quarter of infected patients required re-operation and with a significant associated mortality. While infections that develop after hospital discharge tend to be less severe, there is still a significant cost in terms of the utilization of community health services, lost employment time etc. These costs are largely borne by the community rather than the hospital.

The important role of prophylactic peri-operative antibiotics in reducing the risk of wound infection is well established for many surgical procedures. While recommended routinely for vaginal hysterectomy, the use of prophylactic antibiotics in abdominal hysterectomy has been controversial.[18] Recent studies, however, have demonstrated a significant cost-effective reduction in infection rates following abdominal hysterectomy when a single injection of an early generation cephalosporin is given at the induction of anaesthesia.[18,19] Our data also show a trend for a protective effect of antibiotic prophylaxis for this procedure.

The majority of nosocomial post-surgical wound infections do not develop until after hospital discharge; a problem which is under-recognized in Australia. This places a significant burden on community health services. A comprehensive wound surveillance programme, including a post-discharge surveillance component, is the first step in reducing the incidence of wound infections. This study shows that a post-discharge surveillance programme including self-reporting of infections by patients and return of questionnaires by patients and surgeons is feasible in an Australian hospital setting. Such a programme is, however, labour and resource intensive and poor compliance in the return of questionnaires was found to be a major limitation.

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