A surgical wound surveillance program followed up 16,453 consecutive patients from 1983 through 1988. Patients were followed up for 30 days after operation, and 516 (35%) of the surgical wound infections first became manifest after discharge. In-hospital surveillance alone would have estimated the surgical wound infection rate to be 5.6% when the true rate was 13.6%. Infections that occurred after discharge were more likely in clean operations, in shorter operations, in obese patients, and in nonalcoholic patients. The probability that infections would begin after discharge was inversely associated with the duration of postoperative stay in the hospital. Postdischarge follow-up of patients who previously have undergone surgery is necessary to avoid underestimates of the infection rates and biases related to known risk factors. The most efficient time to survey patients appears to be at 21 days after the operation, at which time 90% of surgical wound infections have occurred.

As postoperative length of stay continues to decrease, more and more surgical wound infections (SWIs) are becoming manifest after the patient goes home. This suggests that continued surveillance of discharged patients who previously have undergone surgery will be necessary to obtain accurate, unbiased SWI rates. While few hospitals are doing this at present, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) is considering making it mandatory within the next several years to ensure accurate indicators of surgical quality.

This raises at least two questions. First, is it really necessary to do surveillance after discharge? In the past, it has been widely assumed that SWIs that occur after discharge are just like those that occur in the hospital, so that postdischarge infections can simply be ignored. But the potential for selection bias has not been studied, to our knowledge.

Second, if it is necessary to follow up patients, who previously have undergone surgery, after discharge, which postdischarge day should be selected for the follow-up contact? The prevailing practice, reflected in published studies, is to follow up patients for 30 days after the operation or after discharge, but this interval is arbitrary. Ideally, one should contact the patients as soon as possible after their infection begins but wait long enough for almost all of the infections to have occurred.

To bring empirical evidence to bear on these questions, we analyzed data on a 6-year cohort of patients who previously had undergone surgery and were followed up for at least 30 days after discharge.

MATERIALS AND METHODS

We analyzed 16,453 consecutive inpatient operations, performed from 1983 through March 1989, on the general surgery, trauma, thoracic, and transplant services at Parkland Memorial Hospital in Dallas, Tex. Surveillance of thoracic and transplant services was conducted only during certain periods, whereas general surgery and trauma services were surveyed continuously. The program was organized with a medical director (J.A.W.) and one infectious control practitioner (ICP) (D.D.). As the program grew, the number of ICPs increased to three. Surveillance was performed by the ICPs continuously on patients while they were in the hospital. Only patients who were hospitalized after their surgical procedure were included in this surveillance program.

The surgical wound surveillance program has been previously described. It consists of in-hospital follow-up by the ICPs and postdischarge follow-up by the clinic nurses who are instructed in wound evaluation by the ICPs. Wound classification is used to stratify wounds into clean, clean-contaminated, contaminated, and dirty categories. The classification is done by the operating room's circulating nurse who receives routine in-service training from the ICPs. Dirty wounds are not included in surveillance unless they represent a secondary procedure on a patient who is already being followed up.

All patients are given a clinic visit follow-up appointment unless they are scheduled to return to a private referring surgeon for care (this occurred in 2.5% of the patients). Wound infections that were detected during a follow-up visit were routinely reported to the infection control office. Between 30 and 60 days after the operation, all patients' medical records were examined by the infection control staff for evidence of SWIs that were detected during clinic visits, and 90% of the records were retrieved for review.

The ICPs were responsible for classifying wounds as infected according to the following criteria. Wounds were classified as infected if they discharged purulent drainage, if they were...
opened due to local inflammatory changes, or if antimicrobial therapy was used to treat a previously uninfected but inflamed wound postoperatively. The inclusion of the third criterion accounts for our SWI rates being substantially higher than many reported in the literature. Surgeons were not involved with the classification of wounds or determination of infection because of reported bias.

The risk factor and demographic data, including the dates of the operation and discharge for all surveyed operations, and the information on SWIs that were detected by surveillance were entered into a computer database. Obesity was defined by the clinical evaluation of the admitting physician or by a dietician’s assessment. Alcohol abuse, recorded in the surgeon’s history and physical examination findings, was used to define this risk factor. Monthly validation of data and reports were generated by the medical director. Wound infections were entered into the data if they were reported anytime postoperatively.

The data were analyzed with the FREQ Procedure of the SAS statistical software package and the LR (logistical regression) procedure of the BMDP statistical software package. The 2×2 tables were analyzed with the χ² test, and the 3×2 and 4×2 tables were also analyzed with the Mantel-Haenszel χ² test for trend which tests for a directional effect.

RESULTS

Necessity of Postdischarge Surveillance

Of the 1468 SWIs that were detected, 952 (65%) were detected while the patient was in the hospital, and 516 (35%) were first manifested after the patient’s discharge. If surveillance had been confined to inpatients, the apparent SWI rate would have been 5.8% rather than the true rate of 8.9%.

The percentage of SWIs that occurred after discharge was inversely associated with wound class (Mantel-Haenszel χ² = 91, df = 1, P < .0001) and duration of the operation (χ² = 26, df = 1, P < .0001), and it was lower in alcoholic than in nonalcoholic patients (χ² = 10, df = 1, P = .002) and higher in obese patients than in nonobese ones (χ² = 11, df = 1, P = .001) (Fig 1).

The shorter the patient’s hospital stay after the operation, the more likely the infection was to begin after discharge (χ² = 327, df = 1, P < .0001 by logistical regression) (Fig 2). For example, in patients who were staying only 1 or 2 days after surgery, 90% of the SWIs began after discharge; in those who were staying 8 to 14 days after the operation, fewer than 25% began after discharge; and in those who were staying more than 2 weeks, fewer than 5% began after discharge.

The effect of the length of postoperative stay on the percentage of SWIs that occurred after discharge only partially explained the association of the other risk factors with postdischarge occurrence. In a series of logistical regression analyses, we controlled for the length of postoperative stay and then reassessed the association between...
Each row reports the results of two separate logistic regression analyses, initially analyzing the association of the row variable alone against whether the infection occurred after discharge and then analyzing the same association after controlling for postoperative stay. SWIs indicates surgical wound infections; CI, confidence interval.

Controlling for postoperative length of stay greatly reduced the odds ratio and the \( \chi^2 \) value for the analyses wound class and duration of operation, slightly reduced them for the analysis of alcoholism, but increased them for the analysis of obesity (Table 1). These findings indicate that the greater likelihood of SWIs in cleaner operations and shorter operations occurring after discharge is due almost entirely to their shorter postoperative stay, whereas the tendency for SWIs in nonalcoholic patients to occur after discharge is only partly explained by the length of postoperative stay, and the greater likelihood for SWIs in obese patients to occur after discharge is largely unrelated to postoperative stay.

Efficiency of Postdischarge Surveillance

To determine the most efficient time to conduct follow-up surveys, we calculated the percentage of SWIs that had become manifest by varying intervals after the operation and after discharge (Fig 3). Measuring from the date of the operation, we found that 47% of SWIs had become manifest by the seventh postoperative day, 78% by the 14th day, 90% by the 21st day, 96% by the 28th day, and 98% by the 35th day. Measuring from the date of discharge, we found that 65% of SWIs had occurred by the day of discharge, 82% had begun by the seventh day after discharge, 93% by the 14th day, 97% by the 21st day, and virtually 100% by the 30th day. These findings indicate that the point of diminishing returns for detecting SWIs occurs at approximately the 21st postoperative day.

Comment

Following up patients, who previously have undergone surgery, after discharge appears to be necessary to avoid serious biases in the SWI rates that are generated through surveillance. Failure to do postdischarge wound evaluation produces two kinds of bias in the SWI rates. First, as has been reported in past studies, SWI rates derived solely from inpatient surveillance are substantially underestimated.1-12 Our finding of a 50% increase in the apparent SWI rate (8.9% vs 5.8%) when the infections that occurred after discharge were included is within the broad range reported in other published studies, where the percentage increases ranged from 39% to 360% (Table 2).

Second, contrary to the generally accepted view, the SWIs that occurred after discharge have different characteristics than those that occurred in the hospital. Those that occurred after discharge are significantly more likely to be in clean operations, in short operations, in obese patients, and in nonalcoholic patients. The propensity for cleaner and shorter operations and those in nonalcoholic patients to occur outside the hospital is predominantly explained by their shorter postoperative lengths of stay; however, the propensity for obese patients’ infections to occur after discharge is...
independent of their postoperative stay. The latter may
due to the delayed recognition of SWIs hidden by
the thick panniculus. At any rate, failure to include
postdischarge infections introduces serious selection bi-
ases into the analyses of SWI rates.

Given that postdischarge follow-up is necessary, the
most efficient timing of the follow-up contact must be de-

defined. Our findings suggest that around the 21st postop-
erative day is the optimal time for surveying patients' op-
licative wounds to detect SWIs. This is the point of
diminishing returns by which time 90% of the infections
have occurred. Edwards13 reported similar results that
showed that 7.4% of infections were detected by 4 weeks
after operation. Contacting patients on the 21st day
should detect a high percentage of SWIs with a minimal
amount of difficulty and, hopefully, a maximal degree of
reliability. This statement is based on a number of
assumptions with regard to postoperative follow-up by
surgeons. Assuming an average postoperative stay of 4 to
5 days for the types of moderate- to high-risk operations
that should be included in surveillance, the 21st postop-
erative day will often fall near the time surgeons sched-
ule their postoperative patients for follow-up appoint-
ments, i.e., 2 to 3 weeks after discharge.

From a review of the literature, we found five studies in
which patients or their surgeons were surveyed for SWI af-
der discharge. In 1975, Polk et al surveyed patients by mail
and confirmed the positives by contacting the surgeons.
They obtained a 99% response rate and found 19% of the
infections after discharge. Burns and Dippe6 contacted
the surgeons, got a 94% response rate, and found that 53% of
the infections began after discharge. Rosendorf et al8 used
a combination of contacting surgeons and following up pa-

tients in their clinic, had an 85% response rate, and found
that 44% of the infections occurred after discharge. In 1985,
Brown et al11 surveyed surgeons and patients independently
by mail. With a 59% response rate from the patients
and a 72% response from the surgeons, they detected 44% of
the infections after discharge. Reimer et al,10 able to con-
tact 97% of their patients by telephone, discovered that 77% of
their SWIs occurred after discharge. These reports sug-
suggest that postdischarge surveys are feasible and, as in our
study, are likely to detect a high percentage of SWIs after
discharge.

A potentially important logistical consideration in-
volves whether the follow-up contact should be timed

from the date of the operation or from the date of
discharge. From the different practices reported in the
published studies (Table 2), it appears that the importance
of this distinction has not been thoroughly considered. In

circumstances where uniformity is needed to allow valid
comparisons within or between hospitals, one or the
other benchmark should be adopted as the standard.

Counting from the date of the operation appears to be
preferable for several reasons. First, it provides a biologi-
cally constant benchmark, whereas using the date of dis-
charge may introduce artificial variation among sur-
egons or hospitals and spurious changes over time,
resulting from differences and changes in the length of
postoperative stay. Second, counting from the date of the
operation also obviates the need for the infection control
staft to collect and record the date of discharge on all pa-

tients under surveillance.

Given that postdischarge follow-up is necessary and
feasible, the final question is whether it is practical from

a financial point of view. In a study of the costs of follow-
up patients after discharge, Rosendorf et al found
that following 493 operations required 85 person-hours
for logistical management by a quality assurance analyst,
and another 40 hours were required for medical record
treatment by a medical records clerk, for a total of 125
person-hours. In 1983 dollars, the costs of the personnel
($1250) and postage ($50) amounted to approxi-

cantly $1300 per 493 patients who were undergoing sur-
gery, or $2.60 per patient. Assuming an average annual
inflation rate of 6% since 1983, this figure might be as high
as $4 per patient in 1990. With the use of computerization
to automate the follow-up process (not widely available
when the study of Rosendorf and colleagues was done),
the cost may actually be much lower.12

References


3. Weigelt JA. Risk of wound infections in trauma patients.

Table 2.—Published Studies in Which Patients Who Underwent Surgery Were Followed Up for Wound Infection After Discharge*

<table>
<thead>
<tr>
<th>Source, y</th>
<th>Persons Surveyed</th>
<th>Timing of Follow-up Survey, d</th>
<th>Response rate, %</th>
<th>% of SWIs Found After Discharge</th>
<th>Infection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polk et al,1980†</td>
<td>Patients (verify with surgeons)</td>
<td>6 wk†</td>
<td>99</td>
<td>19</td>
<td>12.2</td>
</tr>
<tr>
<td>Burns and Dippe,7 1982</td>
<td>Surgeons only</td>
<td>Not stated</td>
<td>94</td>
<td>53</td>
<td>1.8</td>
</tr>
<tr>
<td>Rosendorf et al,3 1983</td>
<td>Surgeons/clinic</td>
<td>30</td>
<td>85</td>
<td>44</td>
<td>2.8</td>
</tr>
<tr>
<td>Brown et al,6 1987</td>
<td>Patients, surgeons§</td>
<td>30§</td>
<td>59</td>
<td>46</td>
<td>3.5</td>
</tr>
<tr>
<td>Reimer et al,10 1987</td>
<td>Patients (telephone)</td>
<td>30</td>
<td>97</td>
<td>77</td>
<td>1.5</td>
</tr>
<tr>
<td>Present study</td>
<td>Clinic</td>
<td>30</td>
<td>88</td>
<td>35</td>
<td>5.8</td>
</tr>
</tbody>
</table>

*SWIs indicates surgical wound infections.
†This study included only abdominal and vaginal hysterectomies.
§Time measured from day of discharge; all others measured from the hospital, and three (12%) were detected by the follow-up survey.
§Patients and surgeons were surveyed independently.

Wound Surveillance—Weigelt et al


Discussion

RICHARD J. HOWARD, MD, Gainesville, Fla: Certainly with shorter postoperative stays and a larger volume of surgery being done as outpatients, more and more wound infections will present only in the postdischarge or outpatient setting. How are we to get at these postoperative wound infections when the patients aren’t in the hospital? It involves more direct surveillance, something that the Surgical Infection Society has backed, and in combination with the Society for Hospital Epidemiologists of America and the Centers for Disease Control, is writing suggested guidelines for wound surveillance. It is hoped that the JCAHO will adopt these or similar policies. This is in no small part due to our ex-president Robert Condon.

This study is significant in that it shows that a large percentage of the wound infections, 35% in this study, were found only in the postdischarge period. Yet, many hospitals without a very good surveillance techniques that your hospital does are resistant to intense surveillance largely because of cost. They maintain that looking at the laboratory for cultures of wounds will give them at least 90% or more of the wound infections that is adequate surveillance.

Did you look at the laboratory results of cultured wounds, and what would have been the recovery rate of wound infections in your own hospital if you had done that? Second, you were able to follow up a large percentage of your patient population because they returned to your hospital’s clinics. That is not true, of course, for most private hospitals in this country. And yet, you had a large number of patients—from what I can figure, about 1500 if you take 10% of the 15,000 patients you surveyed over this period—who were not followed up by chart review. Did you attempt to test your own hypothesis that either telephone call or postcard follow-up would provide a large and worthwhile response to find out what wound infection rates were?

Finally, you estimate that the cost per wound infection is about $3600. Now, that is based on other studies that are somewhat older. The numbers may be different because many wounds, it seems to me, that present only in the postdischarge setting do not require readmission to the hospital. They may have a much smaller or no cost.

Although you cited others in figuring out the cost of postoperative surveillance, why did you not make any attempt to figure out your own cost from your own hospital setting on the charges per wound infection of this kind of surveillance?

RONALD LEE NICHOLS, MD, New Orleans, La: I think your 40% rate is what everyone finds if they do posthospital surveillance. I was a little confused exactly what your surveillance includes. In other words, did you use postcards? Did you send the nurse to the house? Did you see everyone on the 21st day? In the study reported by Brown and coauthors, 11 which I think I agree with you is one of the best to date, they sent a postcard to the surgeon and to the patient as well, as including clinic visits. I think that would be the way to do it, but I was unclear exactly how you did it.

You mentioned things that are kind of surprising, including that you had more wound infections in clean surgery and that you had more wound infections in operations less than 4 hours. I assume that is because the wide majority of operations fell in these categories, or are we really doing that well today in clean surgery vs clean-contaminated, contaminated, and dirty? Do you have any data on 2 hours or less which is what people usually look at? Short operations are generally considered to be 2 hours or less. You used 4 hours or less vs 2 hours or more.

JAMES T. LEE, MD, PhD, Minneapolis, Minn: It is not true that all hospitals will find the same percentage of late wound infections, Dr Nichols. At our hospital, the Minneapolis Veterans Administration Medical Center, our fraction of wound infections discovered after discharge has steadily increased over the years, and now is about 60%. So, we, in Minneapolis, have almost the inverse situation compared with the Parkland Memorial Hospital data you have heard here this morning.

Do you have any idea why—assuming you agree that our data are accurate—the fraction of wound infections diagnosed late seems to be creeping up? We have not had changes in our distribution of cases among the clean, clean-contaminated, and contaminated classes, so that cannot explain it. Even given the gratuitous definition of wound infection as an inflamed wound for which someone gave a patient an antibiotic, an 8.9% overall infection rate is pretty high for the 1990s. Even if we cut that overall rate in half by supposing that half of your infected patients fell under the loose definition of wound infection, your overall rate is still almost twice ours. Why? I raise this point for a nonobvious reason. How can we generalize from your data if other hospitals have completely different sorts of performance within their own case distributions? In other words, maybe your work is a strong argument for the newer way of stratifying wound infection data throughout the country so that we can compare among hospitals. I mean, of course, the new risk-stratifying systems.

I like the study, and I think that anything it can do to get people doing more wound surveillance is good. I am just not sure that we can agree to the generality that only 30% of wound infections come late.

Dietmar H. Wittmann, MD, Milwaukee, Wis: You mentioned that you were able to see all patients after discharge. In Milwaukee, I am having a problem seeing all patients once they have been discharged. Actually, the problem is such that we might even have to use some of your data to calculate the true infection rates based on those assessed while they are still in the hospital. It seems that the postdischarge infection rates are procedure specific. Would you recommend publishing data with respect to procedure and the ratio of in-hospital vs out-of-hospital infections? Do you have any data that show significant differences between hospitals, or do you think we
PER-OLOF NYSTROM, MD, PhD, Linköping, Sweden: I was a little surprised in the abstract to read about the nonpurulent wound infection. I learned that a nonpurulent wound infection is half of all your wound infections that were prescribed an antibiotic for inflamed wounds. It seems to me that you could halve your wound infection rate by stopping prescribing antibiotics for slightly inflamed wounds.

DR WEIGELT: Dr Howard, most purulent wound infections detected by the surgeon are not cultured by the surgeon. If an ICP detects a wound infection, a culture will be done. Surgeons are universally not willing to culture the wound infection, at least in our hospital.

There were a couple questions about the follow-up. The follow-up is varied dependent on the patient mix. We did not visibly contact 90% of the patients but reviewed 90% of the charts. The actual contact ranges from a low of 50% in your typical trauma patient to about 95% in the transplant patients.

We do not have procedure-specific data now although people have requested that of us, and we are in the process of putting the data together. I don’t personally believe in that approach to this surveillance process, but it has been requested by a number of people.

I do not know the cost of outpatient infections. That is an interesting question. I just don’t know if these infections will reduce overall cost of infection. To be very honest with you, we didn’t think of doing our own cost of follow-up.

Dr Nichols, we did clinic follow-up headed by the ICPs and the clinic nurses. The doctors were taken out of this chain of events. Doctors’ input was not used for classification of wounds nor was it used for wound infections. They were seen by clinic staff instructed by ICPs or the ICP directly. You misunderstood my presentation. All we said about the increased cases in the clean and the short operations was that they were more common outside the hospital rather than inside the hospital. We still had a fairly low rate of clean wound infection rate. It is less than 5% in the clean cases.

Dr Lee, I have no answers for you, except to say that maybe your data are related to shorter stays in your hospital.

I guess the other issue about these data is that each hospital needs to do a similar analysis and then decide how they want to do their surveillance and see how important postdischarge surveillance is to their institution. Maybe in their institution it is going to be more important than it is even in our institution, but I think the message is clear that postdischarge surveillance is going to have to be worked out if we are going to get an accurate incidence of SWI.

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ANNOUNCEMENT

SAGES Position Statement

It is the position of the Society of American Gastrointestinal Endoscopic Surgeons that diagnostic and therapeutic laparoscopy are integral parts of general surgery and not a separate discipline. General surgery residency programs should provide adequate experience in diagnostic and therapeutic laparoscopic surgery as part of the standard surgical curriculum. (Adopted by the Board of Governors in April 1991)