Universiteit Leiden
The Netherlands

Infection control in Indonesian Hospitals
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Citation
Duerink, D. O. (2009, June 3). *Infection control in Indonesian Hospitals*. Retrieved from https://hdl.handle.net/1887/13822

Version: Corrected Publisher's Version
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Downloaded from: https://hdl.handle.net/1887/13822

Note: To cite this publication please use the final published version (if applicable).

Chapter

3

OPTIMIZING SURVEILLANCE OF SURGICAL SITE INFECTIONS IN LIMITED RESOURCES SETTINGS

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Submitted for publication

ABSTRACT

To optimize in-hospital and postdischarge surveillance of surgical site infections (SSIs) in a limited-resources setting, we developed a postoperative follow-up of patients in the Dr. Soetomo Hospital in Surabaya and the Dr. Kariadi Hospital in Semarang, Indonesia. We evaluated the use of the criteria of the Centers for Disease Control and Prevention in this setting and made a weighted comparison of our attack rates with SSI attack rates reported by PREZIES in the Netherlands.

Surveillance was performed in 2,734 patients; 2,733 during hospitalization and 161 postdischarge. Standardized wound inspections identified 92% of the SSIs that were diagnosed during hospitalization, all based on purulent discharge. No SSIs were diagnosed on microbiological culture results. Postdischarge surveillance was performed in 8% of the patients and yielded 18% of all SSIs. The attack rate was 1.6% and ranged from 0.2% after caesarean section in Semarang to 9.3% after ileocolorectal surgery in Surabaya. No significant differences were observed between superficial and deep SSIs, clean and (clean-) contaminated surgery, the two hospitals, or the departments. The attack rates in our population did not differ significantly from the weighted predicted rates based on the Dutch surveillance data, with the exception of caesarean section, which was lower in our population (0.3% versus 1.8%).

We conclude that the in-hospital surveillance of SSIs proved feasible for monitoring trends of SSI attack rates within hospitals, but that the postdischarge surveillance was unsuccessful.

INTRODUCTION

Surveillance of surgical site infections (SSIs) is common practice in Indonesian hospitals. However, point prevalence studies we performed in two Indonesian hospitals as part of the 'Antimicrobial Resistance in Indonesia' (AMRIN) study revealed several problems.[1] The inter-observer variation was considerable. Surveillance was performed by senior nurses, so-called 'infection control nurses' (ICNs), whose position is comparable to that of 'link nurses' in the European infection control system.[2] Their experience with surveillance varied, whereas experience determines sensitivity.[3] Only clinically apparent nosocomial infections could be diagnosed, because very few cultures were taken. Inspection of surgical wounds was therefore of crucial importance, but removal of dressings for wound inspection was not always allowed. The method that was used, namely screening of medical records for symptoms of infection such as fever, antibiotic use and cultures, is described to have a sensitivity of 90%.[4] However, the actual sensitivity of our surveillance was probably much lower.[1]
To remedy several of these problems, we developed a standardized postoperative follow-up of patients. Here we evaluate our method for surveillance of SSIs in limited resources settings like those in Indonesian hospitals. The applicability of the criteria of the Centers for Disease Control and Prevention (CDC)[5 6] for surveillance in this setting, and the reliability of our surveillance are assessed. The SSI attack rates we found are compared with Dutch SSI rates.[7-9] The feasibility of postdischarge surveillance is tested.

METHODS

Setting and background

The study took place in the Departments of Surgery and Obstetrics & Gynaecology of two hospitals on the Indonesian island of Java: the Dr. Soetomo Hospital in Surabaya and the Dr. Kariadi Hospital in Semarang. Both hospitals are government hospitals that provide subsidized services for lower socioeconomic classes. Up to 86% of patients have no health insurance[10] and pay cash for their medicines, laboratory tests and dressings. In Surabaya, a mean of 41,095 patients was admitted in 2003-2004 and in Semarang 21,451.
The surveillance of SSIs described in this article was linked to an intervention study to improve surgical prophylaxis (B. Wibowo et al, unpublished data). The Medical Ethical Committees of the institutions approved the intervention study. For the intervention study and the surveillance, we included all patients who underwent the most frequently performed elective general surgery or emergency caesarean section without signs of infection at the time of operation. Dirty or infected procedures and emergency surgery other than caesarean section were excluded.

Surveillance

Patients were included by Indonesian and Dutch researchers within 72 hours after surgery. The following data were collected: department, admission date, operation date, discharge date, age, sex, length, weight, American Society of Anesthesiologists (ASA) physical status classification[11] before operation, elective/emergency surgery, duration of the operation, procedure type, Mayhall wound contamination class,[12] administration of antibiotic prophylaxis, insertion of implants or drains, shaving before operation, complications and re-incisions. Surveillance was performed by local ICNs who received training about the specific methodology of the study from the researchers. ICNs from Surgery performed surveillance in Obstetrics & Gynaecology and vice versa. To improve feasibility, we adhered as much as possible to existing structures. ICNs joined the nurse who changed wound dressings. The first inspection was performed between 48 and 72 hours after surgery; consecutive visits were performed every 48 hours until discharge.

Each visit, the wound was checked for redness, swelling, pain and purulent or non-purulent discharge. The patient's temperature was checked. This information was entered in pre-printed checkboxes on the surveillance form. The ICN noted down whether there was a superficial or deep SSI. Deep incisional SSIs and organ space SSIs were both categorized as deep SSIs. For the study, no distinction was made between clean-contaminated and contaminated procedures (Mayhall-classification[12]), which are therefore presented in this article as (clean-) contaminated. In case of (suspected) SSI; microbiological tests were ordered, paid for by the study budget. Upon discharge, researchers checked medical records for re-incisions.

A single inspection was requested during the first visit to a physician after discharge. At the first in-hospital inspection, each patient received an envelope to hand to the physician who performed the checkup after discharge, either in the outpatient department or other setting. This envelope contained a letter, an SSI surveillance form and a post-paid return envelope. In the letter, the method of surveillance was explained and the physician was required to inspect the wound, complete the form and hand it back to the patient. The patient then returned the envelope to the researchers by regular mail.

Comparison of SSI attack rates with PREZIES reference data

To compare our SSI rates with international data, we calculated a predicted SSI attack rate for our population using the reference database of the Dutch national SSI surveillance system PREZIES (period 1996 - 2005, containing postdischarge surveillance data).[9] We selected the procedures that were sufficiently frequent (n > 100) and homogeneous. The attack rates from the PREZIES reference database were obtained for identical procedures and stratified according to classes of the NNIS-index (composed of ASA-classification, wound contamination class and duration of surgery). The NNIS-index for our patients was calculated using a procedure-specific 75th percentile of duration of surgery based on our data.

We calculated predicted SSI attack rates as follows:

$$P_{A1} = (P_{1\text{-}0} * N_{NNIS0}) + (P_{1\text{-}1} * N_{NNIS1}) + (P_{1\text{-}2} * N_{NNIS2}) + (P_{1\text{-}3} * N_{NNIS3}) / (N_{NNIS0} + N_{NNIS1} + N_{NNIS2} + N_{NNIS3})$$

In which:

P_{A1} = predicted AMRIN attack rate for procedure 1

$P_{1\text{-}0}$ = attack rate in PREZIES reference database for patients with procedure 1 and NNIS-index 0

N_{NNIS0} = number of NNIS-index 0 patients with procedure 1 in AMRIN database

We calculated 95% confidence intervals (95%CIs) for the observed attack rates in our database and for the predicted attack rates. When 95%CIs of actual and predicted attack rates overlapped, we assumed the attack rates were in the predicted range.

Statistical analysis

Differences in population characteristics and SSI rates between hospitals, departments and wound classes were analyzed with the chi-square test using the statistical package SPSS (version 14.0, SPSS Inc., Chicago, Illinois, USA). A significance level of .05 was used for all tests.

RESULTS

From July 2003 until October 2004, 3,236 patients were included in the surveillance programme. The population characteristics of 63 patients were not available because of missing medical records; 57 in Surabaya and six in Semarang. Five deep SSIs were diagnosed in this group of 63, all in Surabaya; one in Obstetrics & Gynaecology and four in Surgery. Because no information was available on type of operation and wound class, these cases could not be included. Wounds of 439 patients were not inspected: 131 patients were discharged within three days, 308 patients were not visited although the postoperative length of stay exceeded three days. Altogether, 502 patients could not be evaluated, leaving 2,734 patients for the calculation of SSI attack rates.

In Surabaya, postdischarge surveillance yielded no response. In Semarang, postdischarge surveillance was performed in 17% of the patients (Table 1). The median interval between the operation and the first inspection was three days (interquartile range (IQR) 3-4), between consecutive inspections two days (IQR 2-2) and from operation to postdischarge inspection 19 days (IQR 12.5-22).

Demographics and surgical procedures

All evaluable patients underwent only one of the selected surgical procedures. In Surabaya, 1,788 patients were included in fifteen months, 1,132 in Obstetrics & Gynaecology (approximately 30% of the operations in this department in the study period) and 595 in Surgery (3%). In Semarang, 946 patients were included in thirteen months, 656 in Obstetrics & Gynaecology (25%) and 351 in Surgery (8%). Relatively more Obstetrics & Gynaecology patients were included, because a limited number of subdivisions of the departments of Surgery participated in the study. The populations in both hospitals and departments differed considerably (Table 1).

Surveillance

The SSI attack rate was 1.8% in Surabaya and 1.2% in Semarang (OR 1.6, 95%CI 0.8-3.2, Table 1). The attack rate was 1.7% after clean and 1.5% after (clean-) contaminated surgery (not significant). The three reincisions because of SSIs were not diagnosed during surveillance. They were not included in the attack rate, because additional data were missing. Seven deep and one superficial SSI were diagnosed postdischarge. The overall median time between operation and diagnosis of SSI was seven days. In patients with deep SSIs time to diagnosis was 5.5 days and in patients with superficial SSIs 7.5 days (not significant).

Table 1: Population characteristics and SSI attack rates

	Obstetrics & Gynaecology					Surgery				
	Surabaya		Semarang			Surabaya		Semarang		
patients (N)	1,132		595		◊	656		351		◊
caesarean section*	680	(60)	485	(82)	◊	0	(0)	0	(0)	◊
total abdominal hysterectomy*	254	(22)	52	(9)		0	(0)	0	(0)	
adnexectomy*	103	(9)	31	(5)		4	(1)	0	(0)	
ileocolorectal surgery*	0	(0)	0	(0)		108	(17)	32	(9)	
herniotomy*	0	(0)	0	(0)		97	(15)	80	(23)	
mastectomy*	0	(0)	0	(0)		114	(17)	81	(23)	
thyroidectomy*	0	(0)	0	(0)		117	(18)	71	(20)	
other surgery*	95	(8)	27	(5)		216	(33)	87	(25)	
female sex*	1,132	(100)	595	(100)	-	376	(57)	195	(56)	
age[#]	33	(9-67)	30	(17-67)	◊	39	(0-82)	36	(0-81)	
wound class clean*	269	(24)	115	(19)	◊	424	(65)	294	(84)	◊
preoperative length of stay[##]	2, 1	(0-29)	2, 0	(0-25)	◊	8, 7	(0-50)	6, 4	(0-46)	◊
postoperative length of stay [##]	7, 6	(2-27)	7, 6	(2-30)	◊	6, 5	(1-50)	5, 4	(0-35)	
duration operation (minutes)[#]	60	(15-390)	60	(20-270)	◊	130	(15-600)	105	(20-390)	◊
antibiotic prophylaxis*	979	(87)	559	(94)	◊	553	(84)	350	(100)	◊
ASA-classification[#]	2	(1-4)	1	(1-4)	◊	2	(1-3)	1	(1-3)	◊
drains/implants *	86	(8)	1	(0)	◊	409	(62)	209	(60)	◊
shaving*	566	(50)	563	(95)	◊	441	(67)	166	(47)	◊
reincision for SSI*[†]	3	(0)	0	(0)		0	(0)	0	(0)	-
SSIs (total)*	7	(0.6)	2	(0.3)		26	(4.0)	9	(2.6)	
superficial SSIs*	5	(0.4)	2	(0.3)		4	(0.6)	7	(2.0)	◊
deep SSIs*	2	(0.2)	0	(0.0)		22	(3.4)	2	(0.6)	◊
time to diagnosis (days)[#†]	8	(5-10)	31	(21-41)	◊	6	(3-19)	6	(3-19)	
postdischarge inspection*	0	(0)	130	(22)	◊	0	(0)	31	(9)	◊
diagnosis SSI postdischarge *	0	(0)	2	(100)	◊	0	(0)	6	(67)	◊

* number (%), [#] median (range), [##] mean, median (range), [†] when applicable, ◊ significant difference ($p<0.05$)

Symptoms of SSIs

Purulent discharge was present in 39 out of 44 SSIs (89%). In all SSIs diagnosed in-hospital (n=39) purulent discharge was present, with (n=25) or without (n=14) other symptoms. The SSIs without purulent discharge (n=5) were diagnosed postdischarge.

In 80 patients in whom no SSI was diagnosed, symptoms of disturbed wound healing were present seven or more days postoperatively. One patient had purulent discharge without other symptoms, 54 patients had non-purulent discharge, with (n = 8) or without (n = 46) other symptoms. Twenty-five patients had other symptoms (pain, redness and/or swelling of the incision).

Six patients with an SSI had fever; five of them had a deep and one a superficial SSI. Other symptoms were equally often reported from superficial and deep SSIs. Microbiological cultures were obtained of five patients, four of whom were diagnosed with deep SSIs and one with a superficial SSI.

Comparison with Dutch SSI surveillance data from PREZIES

Predicted attack rates were calculated for caesarean section, total abdominal hysterectomy, adnexectomy, herniotomy, mastectomy and thyroidectomy. Although more than a 100 cases were available, ileocolorectal surgery was excluded due to much heterogeneity. Our population and the Dutch population differed in many aspects (Table 2). Table 3 shows that the observed attack rates were significantly lower than the predicted rates for caesarean section. No significant differences were observed for the other procedures.

Table 2: Comparison of population characteristics between PREZIES and AMRIN

	PREZIES		AMRIN	
	N	(%)	N	(%)
patients (N)	21,925	(100)	2,115	(100)
age 0-64	17,498	(80)	2,057	(97)
female sex	19,008	(87)	1,944	(92)
ASA-score 1-2	20,037	(96)	1,883	(89)
clean wound	16,098	(75)	783	(37)
NNIS-index 0-1	20,472	(99)	1,977	(98)
elective procedures	17,440	(80)	1,093	(52)
antibiotic prophylaxis	8,338	(39)	1,847	(87)
preoperative length of stay ≤ 1 day	20,710	(94)	1,188	(56)
P75 duration operation (minutes)	75		105	
all SSIs	543	(2.5)	15	(0.7)
SSIs diagnosed in-hospital	245	(1.1)	9	(0.4)
postdischarge inspection done	8,174	(37)	144	(7)

Table 3: Weighted comparison between observed attack rates and PREZIES surveillance data

procedure (n)	observed attack rate [a]		weighed predicted rate [b]	
	%	(95%CI)	%	(95%CI)
caesarean section (1162)	0.3	(0.0-0.6)	1.8	(1.0-2.5)
total abdominal hysterectomy (306)	0.7	(0.0-1.6)	2.1	(0.5-3.7)
adnexectomy (141)	2.1	(0.0-4.5)	4.0	(0.8-7.2)
herniotomy (153)	1.3	(0.0-3.1)	0.9	(0.6-2.3)
mastectomy (195)	1.6	(0.0-3.3)	3.9	(1.2-6.6)
thyroidectomy (158)	1.3	(0.0-3.0)	0.4	(0.0-1.3)

[a] observed SSI attack rates
[b] predicted: based on procedure-specific SSI attack rate based on NNIS-index from the Dutch SSI surveillance data from PREZIES

DISCUSSION

In the present study we applied a method of surveillance of SSIs that should remedy several of the shortcomings we experienced during an earlier study in the limited-resources setting of Indonesian hospitals.[1] We introduced standardized wound inspections to reduce inter-observer variation and linked this inspection to the regular wound care to ensure that wound inspections were allowed and dressing costs for the patient were saved. We trained ICNs who performed surveillance to better qualify them for their task, and arranged that ICNs performed surveillance in other than their own departments to assure objectivity. We made wound cultures free of charge to the patient and encouraged ICNs to order cultures when they observed (non)-purulent wound secretion. Finally, we introduced postdischarge surveillance to lengthen the postoperative observation period which is otherwise short due to the generally short length of stay.

The standardized wound inspection identified the majority (92%) of SSIs that were diagnosed during hospitalization. Three deep infections were missed because wound inspections revealed no abnormalities and one wound with purulent discharge was not classified by the ICN as infected.

So, the first CDC-criterion for diagnosing SSIs, i.e. the presence of purulent discharge, was applied in all but one of the patients with SSIs and the CDC-criterion 'signs of infection plus spontaneous dehiscence or deliberate reopening by the surgeon' could have been applied in three cases. Surveillance focused on wound inspection and, due to time restraints, ICNs were not instructed to consult medical records. The results show that limiting surveillance to wound inspection decreases sensitivity. The choice is to spend more time to surveillance or accept a somewhat lower sensitivity.

Although we encouraged taking cultures, microbiological tests were obtained in only five cases. This may have caused underreporting, as other studies report higher percentages of microbiologically documented SSIs.[7 13 14] In our population, a maximum of eight additional SSIs could have been diagnosed had cultures been taken in patients with non-purulent discharge plus other signs of inflammation. The minor input of microbiology in the diagnosis of infectious diseases in Indonesia and other low-resources settings is well-known and has to do with inadequate microbiology services and low appreciation of the possibilities of microbiology by clinicians.[15] During earlier surveillance studies we observed that cultures were only taken when empiric antibiotic therapy failed.[1] Removing the obstacle that patients have to pay for cultures is not sufficient to improve microbiological diagnostics, as was observed in the present study as well as in a study aimed at improving treatment of patients admitted to hospitals with fever.[16]

Postdischarge surveillance succeeded in only a minority (6%) of the patients, but yielded eight infections, all based on the CDC-criterion 'diagnosis of attending physician' in the absence of purulent discharge. Although our method for postdischarge surveillance did not prove successful, the results confirm the importance of postdischarge surveillance.[17] The reasons for the low response should be explored in future studies. The infections that were reported may or may not represent the majority of the infections that became manifest after discharge, as patients with well-healed wounds may have refrained from visiting a doctor after discharge.

For a limited number of procedures, we compared our attack rates with those from the Dutch PREZIES data. A comparison of PREZIES data with the German national SSI surveillance system KISS demonstrated that, even between two neighboring countries with similar healthcare facilities, differences occurred in surveillance implementation, which made the international comparison difficult.[18] Comparison of our data with those of the PREZIES network is even more complicated, because the Dutch rates include postdischarge surveillance and because our population differs more from the Dutch population than the German population does. Still, the comparison was useful, because the fact that our attack rates tended to be lower than expected confirmed our suspicions of underreporting.

In conclusion, the structured inspection of wounds as we tried out is feasible in limited resources-settings such as the Indonesian hospitals. After a short training, ICNs were well equipped to perform surveillance in departments other than their own by wound inspections during regular wound care by the nurses of the patients' departments. The yield is high for wound infections becoming manifest during hospitalization and can be optimized by combining wound inspection with inspection of medical records. It remains uncertain how many wound infections were missed due to the unsuccessful postdischarge surveillance. Results from the surveillance should not be used for comparison with SSI rates in other countries, but appear sufficient for monitoring trends in SSI rates within hospitals with limited resources over the years.

ACKNOWLEDGEMENTS

We thank the deans of the Medical Faculties of the Airlangga University, Surabaya, and the Diponegoro University, Semarang, the directors of the Dr. Soetomo Hospital and the Dr. Kariadi Hospital, the heads and members of the Infection Control Committees of both hospitals and the heads and nurses of the participating departments, who have facilitated our work. We gratefully acknowledge Dini Darmawidiarini, Chan Citra Chandoko, Sunari and Suparno from the Dr. Soetomo Hospital, Tohirun, Margiati, Helfi and Muslimah from the Dr. Kariadi Hospital and Marian Scheer from the Radboud University Medical Centre, for data collection and data-entry. We thank the infection control practitioners, medical specialists and nurses of the participating hospitals in PREZIES for the data collection, Sandra de Vries from Leiden University and Esther van der Voort and John O'Sullivan from the Leiden University Medical Centre for their help with the English language and Wim Hop from the Erasmus University Medical Centre for statistical advice. This work was supported by the Royal Netherlands Academy of Arts and Sciences (KNAW), Science Programme Indonesia-the Netherlands (SPIN, project 99-MED-03).

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