Orthopedic wound infections

182 cases after 8913 operations during an 8-year survey

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We performed a surveillance of postoperative wound infections at our department for a period of 8 years. The surveillance was based on forms completed by the surgeons at the department. Retrospectively, by scrutinizing the records of patients with recorded infections, the criteria for infections used by the surgeons were compared with the criteria recommended by the Centers for Disease Control, USA, for routine infection surveillance studies: 1) pus present in the wound, 2) bacteria isolated from the wound, 3) spontaneous wound breakdown or surgical intervention due to suspected infection; if culture is performed, it must be positive, 4) evidence of infection at reoperation or at radiologic or histopathologic examination (restricted to deep infections) or 5) diagnosis of infection by a surgeon.

182 infections were recorded; in 106 (58%) pus was present, drained either spontaneously or by surgical intervention, in 24 (13%) no pus was seen, but the culture was positive. In 116 cases, surgical intervention was performed or wounds spontaneously broke down; pus was found in 101 of these and culture of non-purulent material was positive in 13 and negative in 2. In 52 (29%) patients, only criterion 5 was fulfilled. In surveillance studies where the recordings are based on several observers, the subjective criterion 5 may, as in our study, give a falsely high number of infections, also preventing comparison between studies. We recommend that all suspected infections are cultured and that only criteria 1, 2 and 4 are used.

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When postoperative wound infection rates are used as a basis for measuring the quality of surgical procedures, the rates must be sufficiently accurate for comparison, between hospitals or within the same hospital over time. Therefore, the definition of a wound infection should be based on unequivocal criteria that can be used consistently by different observers. Unfortunately, there is no consensus on this point in the literature. To solve this problem, the Centers for Disease Control (Atlanta, USA) have proposed a definition of infection for routine surveillance studies (Horan et al. 1992).

We evaluated the usability of the definition recommended by the Centers for Disease Control (CDC) based on an 8-year prospective surveillance of postoperative wound infections at our department.

Patients and methods

After a pilot study in 1984, surveillance of postoperative wound infection has been performed at our department since 1985. Operations, with closure of an incision (including arthroscopic procedures) and postoperative wound infections, have been continuously recorded (Bremmelgaard et al. 1989). The present study is based on the 8-year period January 1, 1985 to December 31, 1992.

The surveillance was based on forms completed by surgeons at the department following each operation and each time a postoperative wound infection was diagnosed. Thus, the recorded infections represent what is supposed to be wound infections diagnosed by surgeons at the department.

The definitions of surgical wound infection recommended by CDC for use in routine surveillance are (Horan et al. 1992): 1) Purulent drainage from the incision. 2) Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision. 3) The wound spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs: a) fever (> 38 °C), b) localized pain or tenderness, c) localized swelling, redness or heat, unless culture of the incision is negative. 4) An abscess or other evidence of infection is found on direct examination, during reoperation, or at histopathologic or radiologic examination, this criterion is restricted to deep infections. 5) Diagnosis of infection by a surgeon or attending physician.

Table 1. Wounds with positive culture from a serous secretion from the incision as the first sign of infection. Distribution with regard to antibiotic treatment, bacteria cultured and progression to presentation of other criteria later (CDC 1 or 3)

Antibiotic treatment	Progression of infection	Number of wounds		
		total with positive culture	with pathogenic bacteria [a]	with only low pathogenic bacteria [b]
+	+	8	7	1
+	–	8	6	2
–	+	14	9	5
–	–	1	0	1
Total		31	22	9

[a] *S. aureus*, hemolytic streptococci, enterococci, *Enterobacteriaceae*.
[b] Coagulase negative staphylococci, non-hemolytic streptococci, coryneforme rods.
Risk of progression with antibiotic treatment (8/16) and without (14/15), p = 0.02.
Risk of progression with pathogenic bacteria cultured (16/22) and with only low pathogenic bacteria cultured (6/9), p = 1.
Correlation between antibiotic treatment and cultured bacteria, p = 0.3.

All records from infected patients were scrutinized with regard to signs and symptoms causing the wound to be recorded as infected.

The Fisher's test was used for the statistical evaluations.

Results

During the 8-year period, 8913 operations and 185 wound infections were recorded. 3 patient records were lost, leaving 182 infections to be studied. Pus was present in 106 wounds (CDC 1). Cultures of the wounds were taken in 132 patients, with positive results in 116 (CDC 2). In 48 patients, surgery was performed because of a suspected infection and 68 wounds spontaneously broke down. In 101 of these, pus was found and in 13 cultures of nonpurulent material the result was positive (CDC 3), but in 2 cultures of nonpurulent material the result was negative. In 4 patients, evidence of infection (pus) was found at reoperation for reasons other than suspected infection (CDC 4).

In 92 patients, the first sign of infection was pus in the wound. 36 of these were drained surgically because of a suspected infection and 50 spontaneously discharged pus from the incision (25 were later surgically revised). In 2 patients, the pus was found by aspiration and in 1 of these, pus was later drained surgically. In 4 patients, the pus was unexpectedly found at reoperation due to recurrent luxation of a hip prosthesis (1 patient) or redislocation of an internal fixed femoral neck fracture (3 patients).

In 38 patients, the first sign of infection was a positive culture of nonpurulent fluid from the wound. In 4 patients, the cultured fluid was discharged by spontaneous wound breakdown and in 3 patients, the fluid was obtained by aspiration. In 1 of the latter, pus was later drained surgically. In the remaining 31 patients, bacteria were found by culturing serous secretion from wounds without obvious incision defects at the time of the first culture. Later, 22 of these 31 wounds showed other signs of infection (CDC 1 or 3). In 13 cases, pus was drained surgically (9 patients) or spontaneously (4 patients) and in 9 cultures of nonpurulent material the result was positive at surgical intervention (1 patient) or at spontaneous wound breakdown (8 patients). This progression was correlated to whether or not antibiotic treatment was initiated, however, independent of the bacterial species cultured (Table 1).

CDC criteria 3 and 4 were not fulfilled in any patient as a single first sign of infection. By giving the CDC criteria priority according to the CDC number, the cumulated number of wounds accepted as infected is seen in Table 2.

For 52 of the wounds, only CDC criterion 5 was fulfilled. This group included 8 patients with serous secretion from the incision with negative culture, 2 patients having spontaneous wound breakdown with negative culture, 5 patients with redness of the wound, 5 patients with dry necrosis of the wound edges, 7 patients with positive culture of the drain site or from the drain system. For the remaining 25 patients, there was no information in the patient records indicating why the wounds were recorded as infected. However, for 10 of these patients a misunderstanding of the registration might explain the recording as we found an infection other than a wound infection.

Table 2. Number of wounds included as infected by successively adding the CDC criteria from 1 to 5

Criteria for infections	First sign	First and later signs	
	Number of wounds	Number of wounds	Cumulated number
Pus present in the wound (CDC 1)	92	106	106
Positive culture of material from the wound (CDC 2)	38	24	130
Surgical intervention because of suspected infection or spontaneous wound breakdown (CDC 3)	0	0	130
Evidence of deep infection at reoperation (CDC 4)	0	0	130
Surgeon's diagnosis of infection (CDC 5)	52	52	182

Discussion

There is little uniformity in the definitions of wound infection. However, in most studies the presence of pus in the wound is a criterion of infection and all agree that culturing of the pus is not necessary for the diagnosis (Cruse and Food 1980, Faber and Wenzel 1980, Leigh 1981, Gil-Egea et al. 1987, Olson and Lee 1990, Taylor et al. 1990). The presence of pus is also the first criterion in the definition of postoperative wound infection recommended by CDC to be used in surveillance studies. In some studies, this criterion is the only one accepted (Cruse and Food 1980, Faber and Wenzel 1980).

To avoid underestimation of the number of infections, other studies include additional criteria. The commonest are serous or nonpurulent secretions or discharge from the wound with (Gil-Egea et al. 1987, Taylor et al. 1990) or without (Leigh 1981) verification by positive culture, or in the former case accepting only growth of pathogenic organisms as evidence of an infection, excluding cases with growth of only common skin bacteria (Taylor et al. 1990). In our study, 24 wounds showed no pus, but cultures of nonpurulent fluid from the wounds were positive. By also using CDC criterion 2, these are included as infected, thereby increasing the number of infections by approximately 25%. It is not clear whether culturing serous secretion from the incision can be considered an aseptically obtained culture, as required in the second criterion of the CDC recommendations, since contamination with normal skin bacteria is, of course, possible. However, we were unable to show any pathogenic difference between type of bacteria cultured. This result is also supported by the fact that low pathogenic or normal skin bacteria, such as coagulase negative staphylococci, can be found in orthopedic infections involving implanted foreign materials (internal fixation devices or joint prostheses). The question whether serous secretion with positive culture, but no other criteria fulfilled, as was the case in 9 of the patients in our study, represent real infections was not answered by our study. However, the favorable effect of antibiotic treatment in the patients, where serous secretion with positive culture was the first sign, seems to support this assumption.

CDC criterion 3 does not require culturing. However, if culture is performed, it must be positive and in that case the use of criterion 2 would include the case as infected. In other words, if culturing of all infections or suspected infections is performed—as has been the routine at our department for years—there is no need for CDC criterion 3. We find—at least for developed countries—that surveillance of wound infections must include culturing if criteria other than pus in the wound are accepted for inclusion.

It is well known that pus does not necessarily develop in deep infections involving implanted foreign material, such as joint prostheses, and culture may be negative, although signs at reoperation or radiographic or scintigraphic and biochemical tests indicate that an infection is highly suspected. The negative culture may be caused by antibiotic treatment at the time of culturing or by difficulties in culturing low pathogenic bacteria with strong adherence to the foreign material. These infections may account for up to 20% of infected joint prostheses (Lidwell et al. 1983) and must, of course, be included in orthopedic surveillance studies, which would be the case with inclusion of CDC criterion 4. No infections of that kind were recorded in our study. 4 deep infections were unexpectedly found during reoperation for reasons other than infection, as pus was observed. In one of these cases, the primary culture was negative, but coagulase negative staphylococci were detected later when the implanted material (hip sliding screw) was removed.

In some of the published surveillance studies (Olson and Lee 1990, Taylor et al. 1990), the physician's diagnosis of infection based on clinical judgment has

been an accepted criterion and this is also the case in the CDC recommendations. In our study, 30% of the recorded infections fulfilled only this criterion, and similar figures were found in another study (Taylor et al. 1990). This might be an acceptable criterion, if the surveillance were to be based on a single person's recordings, but if the recordings are based on data from several surgeons, as in our study, this subjective criterion seems unacceptable and makes comparison between studies impossible.

We recommend the following definition of infection to be used in surveillance of postoperative wound infections in orthopedic departments: 1) pus in the wound, 2) positive culture of fluid (including serous secretion) or tissue from the wound, 3) signs of infection on reoperation or histopathologic, radiographic or scintigraphic evidence of infection. The latter is restricted to deep infections involving implanted foreign materials, such as joint prostheses or internal fixation devices.

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