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STAPHYLOCOCCAL WOUND INFECTION COMPLICATING ORTHOPAEDIC OPERATIONS

By

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INTRODUCTION

In the early nineteen fifties the hospitals became increasingly infected with antibiotic resistant staphylococci, especially the maternity and surgical wards. Epidemics of postoperative wound infections were reported where the infection rates exceeded 30 per cent. (By epidemic is generally meant that more than 6–8 per cent of operated patients become infected.) If comparable types of operations are investigated, it is, however, questionable if the increase of infection rate during the last 15–20 years is real, rather than merely apparent (1, 3, 5, 10).

Many studies concerning staphylococcal infections in general surgery have been published, including several from Scandinavia (3, 7, 8, 13). However, similar investigations in orthopaedic surgery are rare. Of 3,290 orthopaedic operations performed during 1959 at S:t Mary's Hospital, Rochester, Minnesota, 1.7 per cent were postoperatively infected (4). I have only been able to find two other investigations, both from England (11), where 208 and 131 patients were operated upon and the postoperative infection rates were 2.9 per cent and 5.4 per cent respectively.

During the last decade the use of phage typing of staphylococci has increased. Aided by this and the antibiogram, *i.e.* the antibiotic-chemotherapeutic resistance pattern of bacteria, different groups of staphylococci can be distinguished, and the routes of infection can be more thoroughly mapped.

PRESENT INVESTIGATION

Material and Methods.

Since 1959 in the Orthopaedic Department of S:t Göran's Hospital we have used Report-of-infection-cards to register all operations on in-patients. On these cards are recorded, among other things, the personnel working in the operating theatre during the operation. The ward surgeon records on the card if the wound has healed per primam or if it has become infected. In the latter case he gives a short description of the infection. This is supplemented by information regarding the organism cultured, the course of infection, and the final result of operation.

The Bacteriological Laboratory has since 1959 performed phage type and antibiogram on all cultures that have been positive for *Staphylococcus aureus*. All such cultures from the Orthopaedic Department have been registered on special lists together with the results of nose cultures regularly taken from the personnel working in the operating theatre and the wards. The laboratory-records include all kinds of staphylococcal infections but by means of the clinical charts it has been possible to select all those infections which occurred postoperatively.

I have thus had access to two different systems of registration: the report-of-infection-cards, and the records from the Bacteriological Laboratory. Because of this double registration it is unlikely that any infection of importance has been overlooked.

Frequency of Wound Infection.

In three years (from the third quarter of 1959 to the second quarter of 1962) there have been 1,925 operations on in-patients in the Orthopaedic Department. A few cases that were preoperatively infected are included in this figure. Closed reductions and various kinds of percutaneous operations are excluded. In 75 cases (3.9 per cent) wound infection due to *staphylococcus aureus* occurred postoperatively. There have only been a few cases of wound infection due to other bacteria and no cases caused by β -haemolytic streptococci. The infection rate for men was 3.6 per cent and for woman 4.2 per cent; thus, there is no significant difference. The infection rate increases markedly with age (Fig. 1).

Fig. 2 illustrates the quarterly infection rates during the three years of this investigation. The infection rate has been higher during the fourth to the eighth quarter than during other parts of the observation time. A similar increase will appear even if only those cases are in-

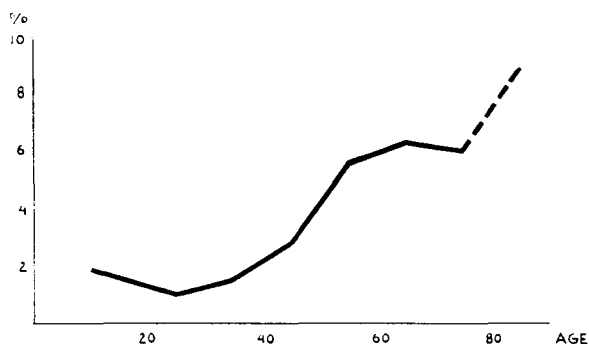


Fig. 1.

Frequency of staphylococcal wound infections in different age groups (1,925 operations).

— FREQUENCY OF INFECTIONS
 - - - " " SEVERE INFECTIONS

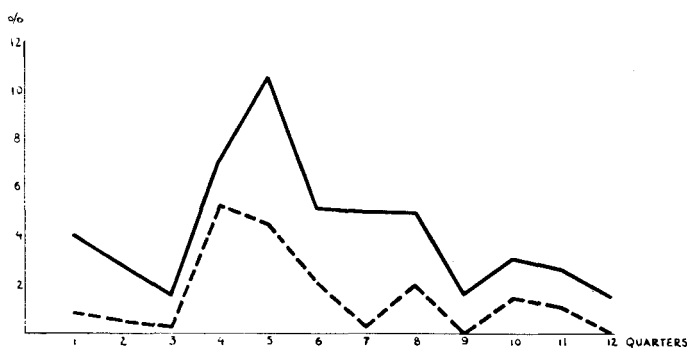


Fig. 2.

Frequency of wound infection quarterly during a three years' observation period (1,925 operations).

cluded where the final result has been affected by infection. This contradicts the supposition that the increase is due to increased care and attention and to an increased frequency of bacterial cultures during that time. In the fourth and the fifth quarters the infection rate has exceeded 6 per cent, so by the definition given above one can speak of an epidemic of wound infection during this time.

Frequency of wound infection in different body regions.

Table 1 shows the distribution in different regions. Operations in hip, spine and thigh-knee have had the highest infection rate.

TABLE 1
Frequency of wound infection in different body regions.

Region	Number of operations	Number of infections	Frequency of infection %
Hip	528	31	5.9
Spine	288	15	5.2
Thigh-knee	241	11	4.5
Calf	183	5	2.7
Foot	481	13	2.7
Arm	124	0	0
Other	80	0	0
Total	1,925	75	3.9

Time of Onset of Infection.

In 47 cases (63 per cent) deep infection appeared soon after the operation. In these cases contamination probably occurred at the time of operation. In the remaining 28 cases (37 per cent) the infection did not appear until after the first change of the dressing. In these cases contamination in the wards cannot be excluded.

Results of Wound Infection.

In Table 2 I have tried to show the consequences of the infections. In 37 per cent the infection has compromised the result of the operation.

TABLE 2
Consequences of wound infection.

	Number of cases	%
Postoperative course not affected by infection	25	33
Postoperative course but not final result affected by infection	22	30
Final result affected by infection	28	37

Staphylococcal Strains.

With reference to phage patterns and antibiograms the isolated staphylococcal strains have been divided into different groups and subgroups (Table 3).

TABLE 3

Presence of staphylococci with certain definite phage patterns and antibiograms in connection with wound infections following orthopaedic operations.

Phage group	Subgroup	Phage patterns*	S	Antibiogram Pc	Str	Te†	Number of inf.
I	I a	<i>52/52A/80/KS 6</i>	3	3	3	3	5
	I b	<i>52/52A/80/81/KS 6</i>	0	1	0	3	4
II		<i>3A/3B/3C/55/71</i>	3	3	3	3	3
III	III a	<i>6/7/42E/47/53/75/77</i>	3	1-2	3	3	26
	III b	<i>6/7/47/53/54/75/77</i>	1	1	0	1	5
Other		Varying (fewer than 3 cases of infection per phage pattern/antibiogram type) and non-typable					32

* Italic figures and letters indicate those phages most regularly causing lysis.

† S Sulphonamides. Pc Penicillin. Str Streptomycin. Te Tetracyclines.

Many staphylococcal strains especially in group III but also in other groups react with such common and uncharacteristic phage patterns that a more detailed typing of them is not possible. Such strains with similar patterns can sometimes be differentiated by the antibiogram, *e.g.* those strains in Table 3 indicated by sub-groups I a and I b and III a and III b. The figures in the antibiogram mark the degree of sensitivity of the bacteria to the antibiotics-chemotherapeutics mentioned, 3 indicating full sensitivity and 0 full resistance.

In this material one staphylococcal strain in group III, named subgroup III a, has been the most common cause of infection among these staphylococci that have been possible to phage type. The frequency of wound infections by this strain shows a heavy increase during the fourth and fifth quarter (Fig. 3).

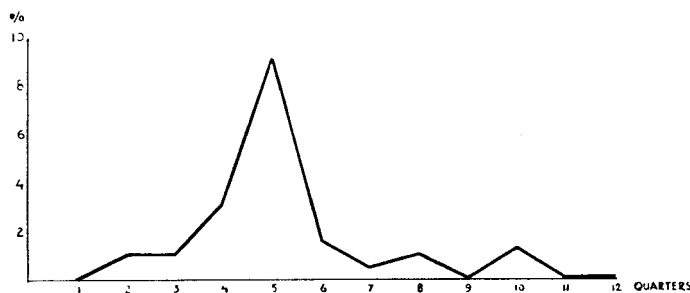


Fig. 3.

Quarterly frequency of wound infections caused by staphylococci belonging to subgroup III a.

Carriers of Staphylococci.

The nasal carrier rates for the operating room personnel are shown in Table 4.—16 of 36 persons have been practically permanent nasal carriers.

TABLE 4

*Nasal carriers of staphylococci among the operating room personnel.
36 persons examined four or more times in a period of four months or longer.
(Average 13 specimens per person.)*

Nose cultures	Number of persons
Positive in half or more of the specimens	16
Positive in less than half of the specimens	15
Negative in all specimens	5

Association of Surgeon to Wound Infection.

The incidence of wound infection for different surgeons has varied widely (Table 5).

TABLE 5

Incidence of infection for different surgeons. (Only those who have performed more than 100 operations are included.)

Surgeon	Incidence of infection %	Incidence of primary infection (see text) %
A	8.3	8.3
B	4.5	2.2
C	4.1	1.9
D	3.8	0
E	3.5	2.5
F	3.4	2.0
G	2.7	2.0

Surgeon A has had a much higher infection rate than the others. This difference becomes even more pronounced if only those infections are included where the contamination seems to have occurred during the operation (see above). In Table 5 these infections are called primary infections.

The results of the nose cultures from the personnel show that all surgeon A's nose cultures and repeated nose cultures on surgeon F showed staphylococcus III a. A worked in the department during the

above mentioned epidemic and he took part in 9 of the 10 operations which during the fifth quarter became infected by this organism. F did not work in the department during the epidemic but two patients he operated upon during the second quarter became infected by the same strain. Intermittently, surgeon G has had in his nose a strain belonging to group II. One patient operated by him became infected by staphylococci belonging to this group. I have been unable to find any other associations between staphylococci from personnel and from wounds.

DISCUSSION

I have tried to illustrate the clinical features and epidemiology of the postoperative staphylococcal infection in an orthopaedic department.

The frequency of infection has varied considerably during the three years of this investigation. Previous investigations (4, 6, 9) have shown that contamination of the wound has generally occurred during the operation. This also seems to have been the case in our material, as $\frac{2}{3}$ of the infections appeared in close connection with the operation.

Several authors have shown that the source of wound contamination often can be traced to nasal carriers among the operating theatre personnel (2, 4, 6, 9, 12). The outbreak of infections during the fourth and the fifth quarters can be assigned with great probability to a certain surgeon being a permanent nasal carrier of a strain belonging to group III. Unfortunately, no culture was made from his skin, but as he had a hand eczema during this period it is not improbable that he was also a so-called skin carrier. Such persons increase the risk of infection in the operative field because of the well-known high percentage of glove puncture (2, 11).

Among the operation personnel, 44 per cent have been almost permanent, and a further 42 per cent intermittent nasal carriers of staphylococci. Under such circumstances it is not feasible to exclude all carriers of staphylococci from work in the operating rooms. Carriers of strains frequently causing wound infection should, however, be carefully observed and should not take part in the operative work if they manifest the slightest sign of skin or respiratory infection.

I have not been able to show any clear routes of infection in the wards, but the reason for this may be paucity of data. Nor have I been able to investigate the significance of nasal carriers among the patients because cultures were not done on them. It has been stated that there

is a higher frequency of postoperative infections among staphylococcal carriers than among other patients (11).

I have found that the wound infections have been registered carefully on the report-of-infection cards, but the system has proved unnecessarily laborious and the cards difficult to survey. I therefore recommend the following simplifications:

1. The report-of-infection cards should be abandoned and instead the names of the personnel present at the operation should be noted in the patients' chart or anaesthetic record.

2. Bacterial cultures should continue to be taken from all wounds that are suspected of infection. A copy of all positive bacterial cultures from in-patients should be sent to the Infection Committee, *i.e.* a surgeon and a bacteriologist.

3. All postoperative infections should be recorded in an infection register including such facts as may subsequently lead to the establishment of routes of infection.

The number of post-operative wound infections in our department has been about two per month, and bearing in mind the serious consequences that they bring, the increased work in registering infections is certainly worth while, if it leads to the sources of infection and effective counter-measures.

S U M M A R Y

Almost 2,000 orthopaedic operations covering a three year period were studied for postoperative wound infection. The incidence of postoperative staphylococcal wound infection was 3.9 per cent. The incidence increased greatly with age but there was no significant difference in sex-incidence. Operations on the hip, spine and thigh-knee showed the highest frequency of infection. In two thirds of the cases the course of infection indicates that the bacterial contamination occurred during the operation. The final result of operation was impaired by the wound infection in more than one third of the cases. During the three years in question there was an epidemic of infections caused by staphylococci of phage type 6/47/53/75 belonging to group III. In most of these cases the contamination seems to have been transferred from a surgeon who was a chronic carrier of this strain. Finally, a suitable method of registering postoperative wound infection is discussed in order to facilitate the detection of an increased frequency and appropriate counter-action.

RESUME

2.000 opérations orthopédiques environ, s'étendant sur une période de trois ans, ont été étudiées par rapport aux infections post-opératoires de la plaie. On a constaté une fréquence d'infections staphylococques post-opératoires de la plaie de 3,9 pour cent. La fréquence augmente beaucoup avec l'âge, mais il n'y a aucune différence entre les sexes. Les opérations de la hanche, de la colonne vertébrale et de la cuisse-genou accusent la fréquence la plus élevée d'infection. Dans deux tiers des cas, l'évolution de l'infection montre que la contamination bactérienne a eu lieu pendant l'opération. Le résultat final de l'intervention a été diminué par l'infection de la plaie dans plus d'un tiers de ces cas. Durant les trois années en question, il y a eu une épidémie d'infections causées par staphylococcie du type 6/47/53/75 appartenant au groupe III. Dans la plupart des cas, la contagion semble avoir été transmise par un chirurgien porteur chronique de ce type. Il est discuté pour terminer d'une méthode permettant d'enregistrer les infections postopératoires de la plaie afin de faciliter la découverte d'une fréquence accrue et de pouvoir prendre des mesures appropriées.

ZUSAMMENFASSUNG

Fast 2000 orthopädische Operationen, die während einer dreijährigen Periode ausgeführt worden waren, wurden hinsichtlich postoperativer Wundinfektion untersucht. In 3,9 Prozent trat eine postoperative Wundinfektion mit Staphylokokken auf. Das Auftreten nahm sehr mit dem Alter zu, aber kein Unterschied hinsichtlich der Geschlechtsverteilung konnte beobachtet werden. Operationen an der Hüfte, Wirbelsäule und Oberschenkel-Knie zeigten die häufigsten Infektionen. In zwei Drittel der Fälle wies der Verlauf der Infektion darauf hin, dass die bakterielle Verunreinigung während der Operation geschah. Das Endergebnis der Operation wurde durch die Wundinfektion in mehr als einem Drittels der Fälle herabgesetzt. Während der hier in Frage kommenden drei Jahre entstand eine epidemische Infektion, die durch Staphylokokken der Phagustype 6/47/53/75 zur Gruppe III gehörig hervorgerufen worden war. In den meisten dieser Fälle scheint die Infektion von einem Chirurgen, der ein chronischer Träger dieser Abart war, übertragen worden zu sein. Am Schlusse wird eine brauchbare Methode zur Registrierung von postoperativer Wundinfektion besprochen, die es möglich machen soll die Entdeckung einer erhöhten

Häufigkeit und die Durchführung entsprechender Gegenmassnahmen zu erleichtern.

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