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Die Infektionen bei Verbrennungen
Die Wiederherstellungschirurgie nach Verbrennungen

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Mit einem Geleitwort von

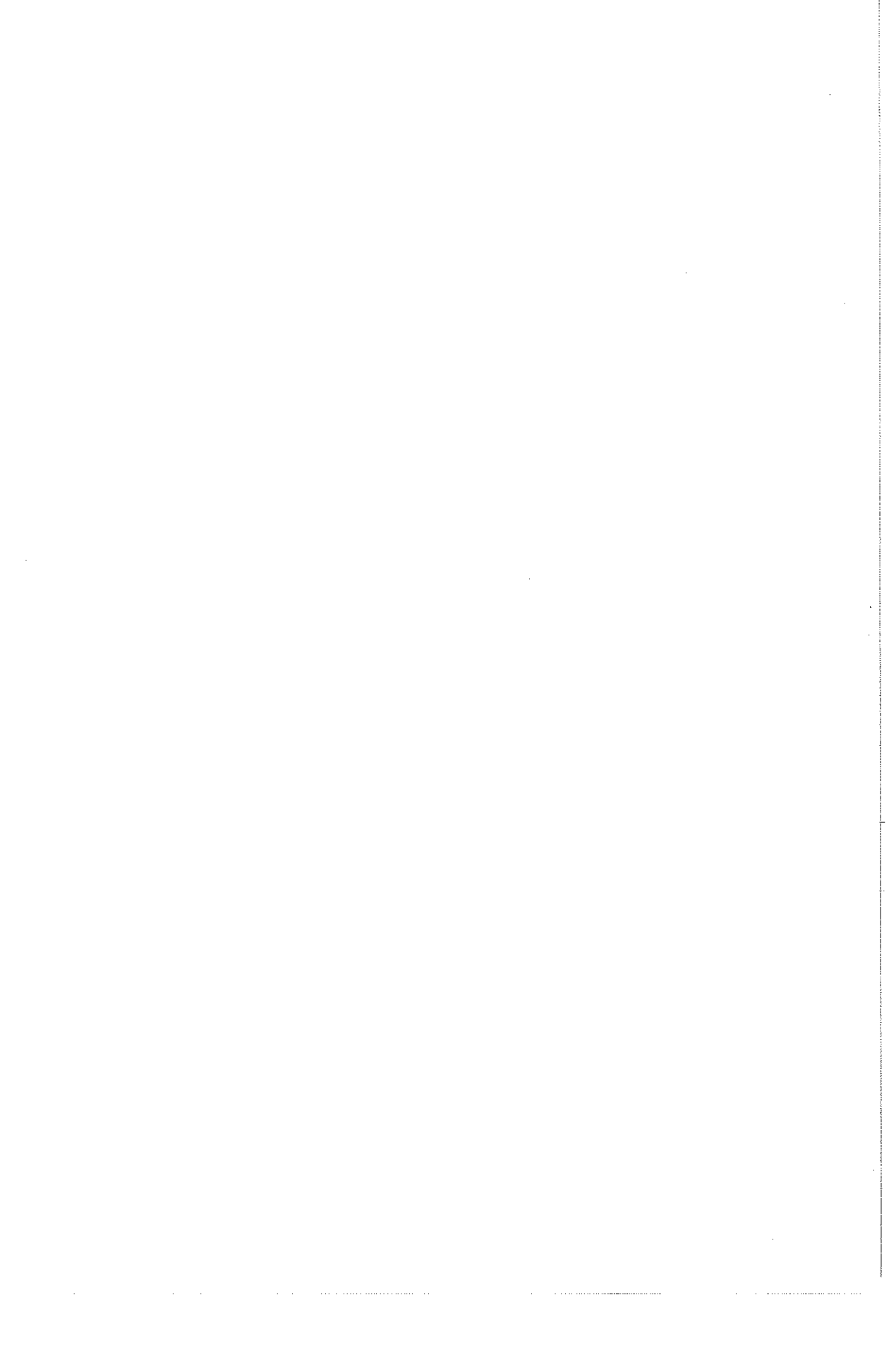
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Mit 119 Abbildungen und 36 Tabellen



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A Study of Staphylococcus Aureus Infection in Burns

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Infection is still the principal cause of death in burned patients who have survived the initial phase of shock. Many bacterial species may cause these infections, in particular *Staphylococcus aureus* which is regarded by certain authors as the germ most often isolated from burns (1).

We have made a study of *Staphylococcus aureus* infection in patients with severe burns who were admitted to the Department of Surgery of the University of Liège. Only coagulasepositive staphylococci were taken into account in this study.

Patients with extensive burns were isolated in rooms inside the resuscitation centre. They were in contact only with hospital personnel working under conditions of strict asepsis. In spite of these conditions, 6 out of 17 patients who were hospitalized in the year 1963–1964 died of septicemia (2).

Technique

I. Bacteriological material was obtained from patients with extensive burns by taking swabs at four different sites:

1. from the burn
2. from the borderline between healthy and burned skin
3. from the healthy skin 10 cm from the burn
4. from the nose.

Immediately after sampling, the swabs were placed in the refrigerator until their transport to the laboratory.

Such samples were taken twice daily during the first 2 days of the hospital stay, and thereafter once per day until the patient either dies or has improved enough to be transferred from the resuscitation centre to a less specialized ward. Swabs were also taken from the nose and hair of all persons authorized to enter the room of the burned patient (medical and nursing staff).

II. The same day, the swabs were plated on a selective solid medium (agar containing 9% sodium chloride), the Petri dishes were placed in the incubator at 37° C for 24–48 hours and the colonies then counted.

III. A pure culture isolation was carried out, using the same selective medium. The pure strains were stored on agar slopes.

IV. The strains were examined for:

- a) staphylocoagulase (3)
- b) sensitivity to antibiotics: penicillin, methicillin, erythromycin, chloramphenicol, streptomycin, tetracycline (4).

The sensitivity to antibiotics and the minimal inhibitory concentration were determined by the serial dilution technique on a solid medium; this had proved to be the most practical method for the testing of a large number of strains, and it is also highly accurate.

- c) Phage typing with 22 staphylophages (strains 29-52-52A-79-80-31-3B-3C-55-71-6-7-42E-47-53-54-75-77-42D-81-187-83A) (5).

The phagotyping was performed according to the principles laid down by the International Committee on Staphylococcus phagotyping, with the aid of a multiple-point seeder, which allows the testing of 22 different bacteriophages against a single bacterial strain.

Results

From 1000 samples, more than 400 strains have been isolated; these originated from 18 burned patients and from the hospital staff.

Of the 18 burned patients who were studied, 10 were infected with staphylococci in spite of aseptic and antiseptic precautions.

The incidence of infection of burns

The burned patients could be subdivided into 2 groups:

Group A: 15 patients who at the time of admission had sterile burns. Five of them were not carriers of staphylococci, 10 had staphylococci in the nose, or the skin or both.

Progress: 7 out of those patients developed a clinical infection.

Group B: 3 patients whose burns were infected at the time of admission.

Progress: all 3 patients developed an infection.

Table 1.

A 15 burned patients with sterile burns on admission	infection of the burn
5 not carrying staphylococci	1/5
5 nasal carriers of staphylococci	4/5
2 skin carriers of staphylococci	1/2
3 skin and nasal carriers of staphylococci	1/3
Total	7/15
B 3 patients with contamination of burns on admission	3/3

In other words, of the 13 burned patients who at the time of their admission to hospital carried staphylococci no matter where, 9 subsequently developed an infection. This high incidence suggests that the burned patients carried staphylococci that only needed a burn for rapid proliferation.

However, phagetyping and the antibiotic sensitivity patterns showed that frequently this was not the case, and that the problem was more complex.

The presence of germs in the hospital staff

All the members of the hospital staff who were examined showed the presence of staphylococci, either only in the nose (16%), or only in the hair (8%), or simultaneously in both sites (76%).

In 9 out of 10 cases, coagulase-positive staphylococci were involved. Frequently, the presence of 4 different types of staphylococci in the same subject could be demonstrated.

Out of 90 strains isolated from staff members, 16 were resistant to all the antibiotics tested, with the exception of methicillin. All these resistant staphylococci were obtained from subjects' noses.

There was no relationship to be observed between the antibiotic sensitivity pattern of the strains taken from the hair and that of strains taken from the nose.

Sensitivity to antibiotics

Eighty successive samples taken from the burns of 5 patients revealed multiple resistance to streptomycin, chloramphenicol, penicillin, erythromycin and tetracycline. All these organisms were sensitive only to methicillin. This finding is in agreement with the data from the literature which demonstrate the great efficiency of this semi-synthetic penicillin against penicillinase producing staphylococci as is usual with those staphylococci resistant to the classical penicillins.

In one single instance, a strain resistant to this antibiotic was encountered in the nose of a patient; it disappeared in the course of the hospital stay. Ten strains out of 90 isolated from 43 members of the hospital staff showed the same multiple resistance to the 5 antibiotics. No resistance to methicillin was observed.

Phage typing

In the patients, 42% of the staphylococci isolated were typable. In the hospital staff, only 3 out of 90 strains gave a lytic pattern. We cannot explain this small proportion, which contrasts with the figures of 65–75% typable strains generally reported on in the literature. Nevertheless, in certain cases phagetyping in combination with the antibiotic pattern sensitivity enabled us to determine the origin of the contamination of the burn.

The evolution of the infection

When initially sterile burns became infected, this often occurred in the same manner. The swabs taken at 24–48 hours grew a few (10–2000) organisms.

On the 3rd or 4th day, the infection reached its maximum (confluent colonies on the agar).

In every case in which the strain was of hospital origin, it persisted throughout the course of the burned wound.

If the strain was of endogenous origin, the infection could frequently be suppressed by antibiotic treatment.

Summary of the course of selected cases:

Case 1

Admission : 17/9 : Br, HS, N, M* : sterile

18/9 : idem

19/9 : Br : 2 colonies polyR/NT

20/9 : Br : 40 colonies polyR/NT, the same strain was found in N and in HS

21/9 : Br : 800 colonies polyR/83/A. N and HS : poly T/NT

until 25/9 : St. Poly R/83A in Br and M polyR/NI in N and HS in confluent colonies.

*) Br = burn, M = margin healthy skin-burn, HS = healthy skin, N = nose, PolyR = resistant to streptomycin, terramycin, penicillin, erythromycin, chloromycin, NT = not typable.

Conclusion: Exogenous infection by a polyresistant hospital strain which settled first in the burn and was subsequently also found in the nose and on the healthy skin, but in the last mentioned two localizations retained its non-typable form.

Case 2

Admission : 6/3 : Br, M, HS : sterile. N : St. R penicillin/52/52A
 7/3 : idem
 8/3 : Br, M : 20 colonies R pen./52/52A
 N : R pen./52/52A. HS: appearance of St. polyS/NT
 9/3 : idem, but 1000 colonies in Br
 10, 11 and 12/3 : idem, but 100 colonies in Br
 13/3 : sterilization of the burn. The same staphylococcus is still present in the nose.

Conclusion: Endogenous infection by relatively sensitive staphylococci, which developed from the nasal flora and had contaminated the burn.

Case 3

Admission: 13/10 : Br, M, HS markedly contaminated by St. R tetr./NT
 N : St. polyR M.P.T./NT
 severe infection until 15/10
 16/10 : Br : a few colonies polyR/7/54/47, completely analogous to the St. found in the nose of a female nurse
 N : St. polyR M.P.T./NT
 17-19/10 : increasing infection of the burn
 N : appearance of St. polyR/7/54/47
 20/10 : Br. and M : the St. assumes type 83A/7/54/47
 The N remains 7/54/47.

Conclusion: Burn infected on admission by a staphylococcus identical to, that encountered on the skin. Superinfection of the burn by the nursing staff. Secondary colonization of the nose. Phagetype 83A in the burn.

Case 4

Admission : 8/3 : Br, M, HS : highly contaminated by St. polyS/3B/3C/71
 N : St. polyS/NT
 9/3 : idem
 10, 11, 12, 13/3 : sterilization of the burn, but a few St. 3B/3C/71 still present in the marginal area
 14-16/3 : Br : still sterile
 M : 3B/3C/71
 N : appearance of 3B/3C/71

- 17-23/3 : N : appearance of St. polyR/NT
 24/3 : Br : reinfection by St. polyR/83A
 N : polyR/NT
 28/3 : Br, M : polyR/83A in confluent colonies
 N : polyR/NT
 30/3 : polyR/83A in Br, M, N, HS.

Conclusion: a) Burn infected on admission by a staphylococcus identical to that found on the healthy skin. The nose harbours a different strain. b) After sterilization of the burn, the initial strain continues to be present around the burn, but does not reinfest it. Six days later, the same strain appears in the nose. c) The first polyresistant staphylococci are found in the nose. Four days later, the burn is reinfected by polyresistant staphylococci of type 83A. Six days later, these are encountered everywhere. They have entirely replaced the 3B/3C/71 no trace of which is any longer to be found, even in the sites not treated by local chemotherapy.

Case 5

Admission : 22/10 : Burn infected by St. R. Str. and Tetr./80/81
 M and N : St. R. Str. and Tetr.80/81
 idem until 28/10.

Conclusion: Endogenous infection which remained unchanged until the end.

Summary

The bacteriological control tests regularly carried out reveal the complexity of staphylococcal infection in burned patients. It is not uncommon to find several different strains which succeed one another or coexist in the same patient in the course of his hospital stay.

In 5 of the 10 cases of infection of burns, an infection or superinfection of hospital origin was undoubtedly involved. Sometimes, the staphylococcus colonizes the burn first, and subsequently tends to settle on the skin and in the nose.

In other cases, the organism appears to be restricted initially to the nasal fossae, from which it subsequently spreads to the surface of the burn.

This exogenous infection appears to be particularly severe, because it could not be suppressed in any of the cases.

In view of the high incidence and great severity of this type of hospital infection, it must be admitted that the aseptic rules used, however strict are still inadequate.

The failure of this prophylactic policy is to be attributed to the high degree of sensitivity of burned tissue to infection; in burned tissue, the bacteria find conditions for multiplication that are as good as in the best artificial media. It is far better to prevent the staphylococcus from contaminating the burn than to attempt to combat the infection once it is fully established.

Zusammenfassung

Regelmäßig durchgeführte bakteriologische Kontrollen zeigten die Vielfältigkeit der Staphylokokkeninfektionen bei Verbrennungskranken. Es ist nicht ungewöhnlich, daß man mehrere verschiedene Stämme findet, die bei ein und demselben Patienten während des Krankenhausaufenthaltes nacheinander auftreten oder gleichzeitig vorhanden sind.

Bei 5 von 10 infizierten Verbrennungen handelte es sich zweifellos um eine Infektion oder Superinfektion mit hospitaleigenen Keimen. Manchmal siedeln sich die Staphylokokken zuerst auf der Wundfläche an und gehen erst später auf Haut und Nase über.

In anderen Fällen finden sich die Erreger anfangs nur in den Nasenhöhlen, von wo sie sich später auf die Verbrennungsfläche ausbreiten.

Diese exogene Infektion scheint besonders schwer zu sein, sie konnte jedenfalls bei keinem der Kranken unterdrückt werden.

In Anbetracht des häufigen Vorkommens und der außerordentlichen Schwere dieses Hospitalismus muß man zugeben, daß die aseptischen Maßnahmen in den Krankenhäusern, wie exakt sie auch eingehalten werden, unzureichend sind.

Das Versagen dieser prophylaktischen Maßnahmen ist auf die hohe Empfindlichkeit des verbrannten Gewebes auf eine Infektion zurückzuführen; in verbrannten Geweben finden die Bakterien Lebensbedingungen, die so gut sind wie in den besten künstlichen Nährböden. Es ist aussichtsreicher, eine Infektion der Verbrennung mit Staphylokokken zu verhindern, als eine erst einmal bestehende zu bekämpfen.

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