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Staphylococcus aureus Bacteremia in a Dutch Teaching Hospital

**Summary:** During a period of 21 months an analysis was made of bacteremia caused by *Staphylococcus aureus* in a teaching hospital for adults. During the observation period staphylococcal bacteremia was detected in 77 patients, i.e. in 1.83 cases per 1,000 admissions. Not less than 81.8% of staphylococcal bacteremia cases were hospital-acquired. The age-specific attack rate increased consistently from the sixth decade onwards. The male/female ratio was 1.96:1. If this ratio was related to the sex ratio of patients admitted to the hospital during the observation period, statistical significance was reached for the surplus of males. Staphylococcal bacteremia contributed to death in 14 of 47 patients, i.e. 18.2%. Intravascular infection was the most prevalent source of infection (25 of 77 cases, i.e. 32.5%). Serious complications were observed in 14 cases of staphylococcal bacteremia. Eight of these patients had endocarditis and four died. Tolerance was observed with nine of 77 strains and may have influenced the reaction to antimicrobial therapy in at least one case.


**Introduction**

Since the introduction of antimicrobial agents, considerable changes have taken place in the pattern of bacterial species causing bacteremia. In the fifties, bacteremias due to *Staphylococcus aureus* initially increased to one-third of all cases and thereafter declined somewhat (1). In a previous study the number of bacteremias caused by *S. aureus* observed in a Dutch University Hospital over a period of six years (1972–1977) amounted to 11.5% of all bacteremias (2). In that study patients were not classified according to the severity of their signs and symptoms. In the present study data and consecutive sera were collected at the same hospital for a period of 21 months from all patients with bacteremia due to *S. aureus*. Before analysis, patients were classified according to the clinical significance and nature of the infection. The antibody response to α-toxin, teichoic acid and peptidoglycan has been described in another paper (3).

**Materials and Methods**

Blood cultures were obtained as previously described (2). *S. aureus* was identified as a catalase-positive, gram-positive coccus that was coagulase-positive in tube tests (4). Cultures were taken from patients admitted to a 900-bed teaching hospital. This is essentially a hospital for adults, sick children being treated elsewhere.

Using a slight modification of the criteria described by Wilson et al. (5), positive blood cultures were classified as clinically significant or clinically non-significant bacteremias (CSB or CNSB). The criteria used to define CSB were the following: two or more positive blood cultures taken no more than four days apart, plus at least three of the following: temperature > 38.5°C, pulse rate ≥ 100/min, chills, leukocyte count > 10 x 10⁹/1, hypotension (systolic blood pressure ≤ 90 mmHg or a fall in pressure ≥ 30 mmHg) or oliguria (urine output ≤ 400 ml/24 h, without obstructive pathology).

According to another set of criteria (6), patients with bacteremia were considered to be suffering from complicated bacteremia if they had a known but non-removable focus of infection, and from uncomplicated bacteremia if they had a removable focus. A third group of patients was characterized by the absence of any traceable form of focus.

When analyzing the incidence and fatality rate of bacteremia, a distinction was also made between hospital-acquired and community-acquired infections. Bacteremia was assumed to be community-acquired if the first isolation of the organism occurred in
blood cultures taken within 48 h of hospitalization. Positive cultures taken after that time were considered to be hospital-acquired. For each episode of bacteremia an attempt was made to establish the portal of entry of the organism or the source of the infection. These were determined on the basis of clinical evidence or by culture. The identity of isolates from blood and other sites was established in each case by susceptibility tests and phage typing.

Antibiotic susceptibility tests were performed using standard disk diffusion (7) with isosensitest agar (Oxoid) as the medium. Methicillin resistance was detected with 5 μg methicillin disks on isosensitest agar containing 5% NaCl. Tolerance percentages were determined as described by Goessens et al. (8). Using this technique the survival of a strain is estimated 24 h after exposure to a high concentration (64 μg/l) of methicillin and is expressed as a percentage of the inoculum. The study of several collections of strains revealed that tolerance equals a survival (tolerance percentage) of 2% of the bacteria or more.

Since many patients with fatal bacteremia suffer from underlying diseases, a positive blood culture seldom constitutes the sole cause of death. Therefore, blood cultures giving rise to a fatal course of disease were considered fatal.

Serum creatinine and bilirubin levels were estimated daily in most patients. This allowed a comparison of early values with those obtained on the day of the positive cultures and on two succeeding days thereafter. The creatinine level was considered elevated when it rose to 50 μmol/l or more from a preceding level of < 250 μmol/l, or to 100 μmol/l from a preceding level of > 250 μmol/l. The bilirubin level was considered elevated when it rose to 20 μmol/l or more (normal 2-12 μmol/l) or if it rose 100% from a preceding level of 20 μmol/l or more.

**Results**

**Incidence and Acquisition**

During a period of 21 months (September 1981 to May 1983), bacteremia due to *S. aureus* was observed in 77 patients. The number of admissions to the hospital in the same period amounted to 42,049. This corresponds to an incidence of 1.83 per 1,000 admissions. A large majority of cases, i.e. 63 out of 77 (81.8%) were hospital-acquired whereas the remainder (14 out of 77) were community-acquired.

**Age and Sex Distribution**

The age distribution (per decade) of patients with bacteremia is shown in Figure 1A. Most cases occurred in the seventh and eighth decades. If the age distribution of patients admitted to the hospital is taken into account, it appears that the number of bacteremias increased rapidly from the age of 50 into the ninth decade (Figure 1B). It can also be seen from the figure that the relatively high incidence of cases in the second decade can be explained by a rather large number of community-acquired cases in that age group as compared to other age groups. No cases occurred in the first decade as this age group is not represented in the hospital population.

Of the 77 patients with bacteremia, 51 were male and 26 female. This corresponds to a male/female ratio of 1.96:1. If this ratio was related to the sex ratio of patients admitted to the hospital, the surplus of bacteremias in males differed significantly from the bacteremias in females ($X^2 = 7.07; p < 0.01$). If only hospital-acquired bacteremias are taken into account, there were 40 males and 23 females with a ratio of 1.74: 1, a difference that was no longer significant ($X^2 = 3.79; p > 0.05$).

**Distribution of Bacteremias Among Hospital Services**

Bacteremias due to *S. aureus* were observed with about the same frequency in the combined surgical services (40 cases) as in the combined medical services (37 cases).

**Fatality Rate According to Clinical Significance and the Nature of Infection**

Fourteen of 77 (18.2%) patients died. Fatality was clearly age-related as 13 of 14 patients who died were 40 years or older. In Table 1, patients are classified according to the clinical significance of their bacteremia. From the table it