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A one-year survey of nosocomial bacteraemia at a Danish university hospital

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SUMMARY

A 1-year prospective study of nosocomial bacteraemia was performed at Hvidovre Hospital with special reference to frequency, focus of infection and prognosis. All patients were examined clinically in order to confirm the bacteraemia. In total, 98 hospital-acquired bacteraemias were observed, giving an incidence rate of 0·28%. Bacteraemia due to *Escherichia coli*, *Staphylococcus aureus* and *Staphylococcus epidermidis* predominated. The overall mortality was 38%; 65% of the patients with *S. aureus* bacteraemia died, 25% due to the bacteraemia. The most common types of infection were urinary tract infections and intravenous catheter infections. Fifty-five of the bacteraemias were caused by foreign bodies, mostly urinary catheters and intravenous catheters, and in 14 cases the focus was unknown. The patient population was severely ill patients. We conclude that nosocomial bacteraemia occurs specially in severely ill patients often preceded by indwelling urinary or intravenous catheters. The patients seldom die due to the bacteraemia, but they die with concomitant bacteraemia.

INTRODUCTION

An increasing number of severely ill patients are treated in hospital as a result of newer techniques, equipment, and medications capable of prolonging life. One disadvantage of this is a considerable number of nosocomial infections. In the USA the incidence of hospital acquired bacteraemia is about 0·5% with a mortality rate at 38% (Maki, 1981).

This study was performed in a Danish university hospital in order to elucidate frequency, mortality, microbiology and focus of nosocomial bacteraemia.

MATERIALS AND METHODS

The study includes all patients with nosocomial bacteraemia at Hvidovre Hospital in a 1-year period from September 1979 until August 1980. Each patient was only included once in the study during each admission. The blood specimens were cultivated by using the two-bottle Hemobact® system (Orion, Finland). Nosocomial bacteraemia was defined as bacteraemia neither present nor incubated within 24 h of admission (Center for Disease Control, 1972).

Table 1. *Distribution of 101 bacterial isolates*

Organism	Number	Total number of deaths (%)	Death caused by bacteraemia
Escherichia coli	27	7 (26)	2
Staphylococcus aureus	20	3 (65)*	5
Staph. epidermidis	17	7 (41)	—
Klebsiella species	12	4 } (38)	—
Other enterobacteriacea	4	2 }	
Pseudomonas aeruginosa	7	2 (29)	1
Beta-haemolytic streptococci	4	0	—
Streptococcus faecalis	1	0	—
Str. pneumoniae	5	0	—
Haemophilus	1	1	
Bacillus	1	1 } (75)	—
Bacteroides	2	1 }	
Total	101	38 (38)	8

*$P < 0.005$

Discrimination between contamination of blood cultures and true infection in cases where blood cultures grew *Staphylococcus epidermidis* was as follows. Patients with blood cultures positive for *S. epidermidis* associated with an infected foreign body were included. Patients were also included when *S. epidermidis* was isolated from at least two blood cultures and 50% or more of the blood cultures were positive and no other source of fever could be identified. All other instances of positive blood cultures for *S. epidermidis* were regarded as contaminations and excluded.

When a positive blood culture was found, the patient was examined for the presence of any foreign bodies (urinary catheter, intravenous line, tracheal tube, etc.), previous surgery or other instrumentation. Time for onset of infection was confirmed clinically mostly as the time of onset of fever.

The focus of infection was determined on the background of this clinical examination and the results of additional cultures. If cultures from a foreign body revealed the same organism as found in the blood cultures, the foreign body was regarded as the focus of infection.

During hospitalization the elimination of bacteraemia and time for discharge or time for death were noted. If the patient died whilst in hospital an assessment was made whether the patient died with concomitant bacteraemia or because of the bacteraemia. Recurrence of bacteraemia was also noted.

The statistical analysis used was the chi-square test; $P < 0.05$ was regarded as significant.

RESULTS

From September 1979 until August 1980 35180 patients were admitted to the hospital. In this period 98 cases of nosocomial bacteraemia were observed giving an incidence rate of 0·28%. There were 36 woman and 62 men, age median 64·5 years (range 2–96 years) (interquartile range 53·5–72·5 years).

In total 101 bacterial strains were isolated; the distribution is listed in Table 1.

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Table 2. *Focus of bacteraemia and mortality*

Focus	Number	Foreign bodies (%)	Deaths (%)
Urinary tract	29	23 (79)	10 (34)
Intravenous catheter	18	18 (100)	10 (56)
Wound	11	0	3 (27)
Pneumonia	11	5 (45)	6 (55)
Cholangitis	5	3 (60)	0
Other†	10	6 (60)	0
Unknown	14	0	8 (57)
Total	98	55 (56)	37 (38)

* Foreign bodies causing the bacteraemia.

† Other: pancreatitis after endoscopic retrograde cholangiopancreatiocoscopy, 1; endometritis with IUD *in situ*, 1; bacteraemia caused by pleural drainage, 2; bacteraemia caused by ventricular shunt, 2; abcesses, 2; meningitis, 1; enterocolitis, 1.

Table 3. *Focus of bacteraemia*

Focus	Number	Death (%)	Death because of bacteraemia (%)
Foreign bodies	55	23 (42)	3 (5)
Not foreign bodies	29	6 (21)	3 (10)
Unknown	14	8 (57)	2 (14)
Total	98	37 (38)	8 (8)

Table 4. *Foreign bodies*

Foreign body	Total number	Focus of bacteraemia (death)
Urinary catheter	60	23 (8)
Intravenous line	68	18 (10)
Tracheal tube	16	5 (5)
*PTC, ERCP, endoprothesis	5	4 (0)
Ventricular shunt	2	2 (0)
Lung catheter	2	2 (0)
*IUD	1	1
Arterio-venous shunt	3	0
Peritoneal catheter	3	0
Aortic prothesis	1	0
Total	161	55 (23)

* PTC, percutaneous transhepatic cholangiography; ERCP, endoscopic retrograde cholangiopancreaticoscopy; IUD, intrauterine device.

More than half of the isolates were *Escherichia coli*, *S. aureus*, and *S. epidermidis*. The overall mortality was 38%. The mortality of patients with *S. aureus* bacteraemia was significantly higher (65%), and 25% died because of *S. aureus* bacteraemia. The mortality rate in patients with an unknown focus was 57% (Table 2). In Table 2 the foci of bacteraemia are listed. In addition, the number of foreign bodies causing the bacteraemia and the mortality rate are shown. About half the nosocomial bacteraemia were due to urinary tract infections or intravenous catheter infections. As illustrated in Table 3, 55 of the bacteraemias had a focus

Table 5. *Focus of bacteraemia related to bacterial species*

Focus	*E. coli*	*Staph. aureus*	*Staph. epidermidis*	Other enterobacteriacea	*Pseudomonas* species	*Strept. pneumoniae*	Other streptococci	Other	Total
Urinary tract	17 (5)	1 (1)	1 (0)	5 (2)	1 (1)	—	2 (0)	2 (1)	29 (10)
Intravenous catheter	—	7 (4)	10 (6)	—	1 (0)	—	—	—	18 (10)
Wound	—	5 (2)	1 (0)	2 (1)	2 (0)	—	2 (0)	—	12 (3)
Pneumonia	1 (1)	3 (2)	—	1 (1)	1 (1)	4 (0)	—	2 (2)	12 (7)
Cholangitis	3 (0)	—	—	2 (0)	—	—	—	—	5 (0)
Other	4 (0)	—	4 (0)	1 (0)	1 (0)	1 (0)	—	—	11 (0)
Unknown	2 (1)	4 (4)	1 (1)	5 (2)	1 (0)	—	1 (0)	—	14 (8)
Total	27 (7)	20 (13)	17 (7)	16 (6)	7 (2)	5 (0)	5 (0)	4 (3)	101 (38)

Number of deaths in parentheses.

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Table 6. *Ninety-eight patients listed according to diseases leading to hospitalization*

Diseased organ or tissue	Number	Number of deaths*
Haematologic organs	26	13 (4)
Burns	11	2
Gastrointestinal tract	10	1
Gastrointestinal tract, malignant neoplasm	8	4 (2)
Cirrhosis hepatis	7	5
Cardiovascular system	7	3
Azotaemia	6	4 (1)
Kidney and urinary tract	5	2
Kidney and urinary tract, malignant neoplasm	6	2 (1)
Central nervous system	6	0
Respiratory system	2	0
Other	4	1
Total	98	37 (8)

* Death because of nosocomial bacteraemia.

related to the foreign body, 29 had no foreign body focus, and 14 were unknown. No patient had more than one focus. Twenty-three of 55 patients with a foreign body focus died. There were 18 patients without any foreign bodies, only 1 patient died, and there were 25 patients with foreign bodies present not giving rise to the bacteraemia, 13 of whom died. The foreign bodies are listed in Table 4. In total 161 foreign bodies were observed at the day of onset of infection in 98 patients; 55 of these foreign bodies had apparently brought about a nosocomial bacteraemia. Fifty-six per cent of the patients with intravenous catheter infections died. One patient died because of the nosocomial bacteraemia, and eight died with concomitant bacteraemia. Among patients with urinary tract infection 3 died because of the bacteraemia, and 5 died with concomitant bacteraemia. None of the patients in whom a tracheal tube was the focus, died because of the bacteraemia. All were severely ill intensive care unit patients on mechanical ventilation.

The foci of bacteraemia are related to bacterial species in Table 5. Urinary tract infections were mostly caused by Gram-negative rods, and intravenous line infections were mostly caused by staphylococci.

In Table 6 the patients are listed according to the disease leading to hospitalization. About one fourth of the diseases were haematologic diseases (mostly leukaemia), and the mortality rate was 50 %. Four of these patients died because of the nosocomial bacteraemia. The patients were severely ill, 62 of 98 patients had fatal diseases.

There were 7 recurrences of bacteraemia – 4 of them due to intravenous catheter infections (Table 7). Median time to onset of bacteraemia was 6 days (range 1–37 days). Median time from onset of bacteraemia to time of elimination of bacteraemia for 58 patients was also 6 days (range 2–42 days). Thirty-seven patients died with the bacteraemia, 2 patients were discharged, and 1 was transferred to another hospital. The median overall time for stay in hospital was 23 days (range 1–212 days).

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Table 7. *Seven recurrences of bacteraemia*

Focus	*E. coli*	*Staph. aureus*	*Staph. epider-midis*	*Pseudo-monas*	*Str. pneu-moniae*
Intravenous catheter	—	1 (0)	2 (2)	14 (0)	—
Wound	—	—	1 (0)	—	—
Pneumonia	—	—	—	—	1 (0)
Unknown	1 (0)	—	—	—	—

Number of deaths in parentheses.

DISCUSSION

There was no paediatric department at Hvidovre Hospital in the study period, this explains the high median age. The high male:female ratio (1·7) is in agreement with other studies (McGowan, Barnes & Finland, 1975; Spengler, Greenough & Stolley, 1978).

The incidence of nosocomial bacteraemia in these patients was 0·28 %. Jepsen & Korner (1975) found an incidence of 0·37 % with a mortality rate at 33 %. In Boston (McGowan, Barnes & Finland, 1975) the incidence increased from 0·37 % in 1935 to 1·32 % in 1972, but the mortality decreased from 58·5 to 39·3 %. Spengler, Greenough & Stolley (1978) found an incidence of nosocomial bacteraemia of 0·41 % with a mortality of 37·1 %. A prevalance of nosocomial bacteraemia of 1·0/1000 was described in the Report on the National Survey of Infection in Hospitals (1981).

The overall mortality in this study was in agreement with other studies at 38 %, but the mortality from *S. aureus* bacteraemia was significantly higher (65 %). In 25 % *S. aureus* bacteraemia was the cause of death indicating the severity of these infections. *S. epidermidis* bacteraemias also showed a high mortality (41 %), but no patients died because of the bacteraemia. McGowan, Barnes & Finland (1975) excluded all positive blood samples with *S. epidermidis* from their material. The high incidence of *S. epidermidis* in our material all represent clinically significant bacteraemias in that 17 patients had a foreign body infected with *S. epidermidis*, and in one patient no other source of fever was likely. Friedman *et al.* (1984) reported that *S. epidermidis* septicaemia plays an important role as cause of morbidity and mortality especially in immunocompromised patients. The high incidence of *E. coli* and *S. aureus* bacteraemia is in agreement with other surveys (Jepsen & Korner, 1975; Spengler, Greenough & Stolley, 1978). *E. coli* was most frequently observed followed by *S. aureus* and *S. epidermidis*. *Klebsiella* species were most frequently observed in the Boston material (McGowan, Barnes & Finland, 1975). The frequency of *Pseudomonas* species as well as anaerobic bacteraemias was low.

In 84 out of 98 bacteraemias the focus of infection was determined and in more than half of these cases the bacteraemias were caused by foreign bodies. Urinary tract bacteraemias dominated – in 79 % caused by urinary tract catheterization, followed by bacteraemias caused by indwelling intravenous catheters. The frequency of bacteraemias caused by burns and pneumonia was high too. Urinary catheters, intravenous catheters and tracheal tubes were the only foreign bodies associated with death. Only three of these patients died due to the bacteraemia.

The tracheal intubated patients were all severely ill patients on mechanical ventilation. Spengler, Greenough & Stolley (1978) found about the same high frequencies of nosocomial bacteraemias from the urinary tract, intravenous lines, and pneumonia, but a much higher incidence of unknown sources, 38%. Harris *et al.* (1980) reported that one third of nosocomial bacteraemias were from intravenous lines. It is worth-noting that patients suffering from bacteraemia with unknown focus have a mortality rate of 57%, but that only one of 18 patients without any foreign bodies died.

Not only foreign bodies, but also the patients condition, give rise to a high mortality. Most of the patients were severely ill patients with haematologic diseases, malignant neoplasms, cirrhosis of the liver, and azotaemia – conditions with a high mortality risk. These patients probably have an increasing need for intravenous lines and urinary catheters in order to survive, as well as a high risk of being infected. The eight patients who died because of the bacteraemia were patients with malignant diseases or azotaemia. These results are in agreement with other studies (Kluge & DuPont, 1973; Rose *et al.* 1977). Britt, Schleupner & Matsumiya (1978) found a much higher incidence of nosocomial infection in patients with fatal diseases than in patients with non-fatal diseases. Wenzel *et al.* (1981) found that more than one third of all nosocomial bacteraemias occurred among intensive care unit patients, who occupied 8% of the hospital beds.

In conclusion, nosocomial bacteraemia occurs specially in severely ill patients, often preceded by indwelling urinary or intravenous catheters. The patients seldom die because of the bacteraemia, but they die with concomitant nosocomial bacteraemia.

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