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Factors influencing the occurence of nosocomial bloodstream infections observed in thoracic and cardiosurgical postoperative care units

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Abstract

Background. The aim of this study was to analyse the epidemiology and aetiology of laboratory-confirmed bloodstream infections (LC-BSI) and central line-associated bloodstream infections (CLA-BSI) after pulmonary and coronary surgery, in postoperative intensive care units in 2009.
Methods. Sources of infections were identified by the hospital Infection Control Team in cooperation with ITU personnel using the CDC definitions.
Results. A total of 37 LC-BSI and 21 CLA-BSI cases in 3.096 patients were detected. Central line device utilization ratio was 0.50. The total cumulative LC-BSI incidence rate was 1.2% and CLA-BSI rate 8.7 per 1,000 central line days. The most common causes of LC-BSI were Gram-positive cocci (*Staphylococcus aureus* – 5.9%, CNS – 50.0%, *Enterococcus faecium* – 5.9%).
Conclusions. We found that in those units in which surveillance of CLA-BSI had been conducted since 2002, BSI incidence rates were higher than those reported in the NHSN programme.

Key words: cannulation, intravenous; complications, infections, nosocomial; surgery, cardiothoracic

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Bloodstream infections (BSIs) in ITU patients belong to the most important forms of nosocomial infections and are associated with the highest costs resulting from long hospitalization and pharmacological therapy. The main factors increasing their risk include age, underlying diseases, past traumas, invasive therapy (vascular lines, central accesses, in particular, or intubation), past antimicrobial treatment and long-term immobilization. Moreover, BSIs are one of the major and most severe complications in surgical patients due to high mortality rates. The highest risk of such infections is associated with abdominal and thoracic surgeries. Despite advances in medicine, including improved interventional techniques and better understanding of bloodstream infection pathomechanisms, central lines are still serious problems in patients with such infections, which also regards Polish intensive therapy units [1, 2, 3, 4].

The objective of the study was epidemiological and microbiological analysis of primary bloodstream infections, which developed in thoracic and cardiac surgery patients in intensive therapy units.

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METHODS

The study encompassed patients requiring intensive therapy and central vascular lines in two ITUs (thoraco- and cardiosurgical) in 2009. The patients' surveillance was carried out within the Infection Surveillance System of prepared and coordinated by the Polish Society for Hospital Infections and the Department of Microbiology, Collegium Medicum, Jagiellonian University in Kraków. When BSI was suspected, the blood was sampled to isolate the aetiological factor; once confirmed, the case was qualified as laboratory-confirmed bloodstream infection (LC-BSI) [5]. The blood was cultured using the automated Bactec system; the samples signalled as positive were cultured on standard media (blood agar, McConkey agar), incubated at 37^0C for 24 h and identified using biochemical tests. Drug resistance and resistance markers (MRSA, ESBL, MLSB and HLAR) of isolated micro-organisms were determined using the disc infusion method; in the case of vancomycin and teicoplanin, the minimal inhibitory concentration (MIC) was determined applying e-tests. The results were interpreted according to the guidelines of the Clinical and Laboratory Standards Institute (CLSI) [6].

The epidemiological condition of the unit was described using the following epidemiological measures:

cumulative morbidity as the number of new LC-CSI cases in a given population in time unit per the number of admitted patients,

morbidity density index – describing the number of new bloodstream infections in patients with central lines (CLA-BSI – Central Line-Associated BSI) per time unit related to total person-time of the central line use as the method for quality management analysis recommended by the Centre for Disease Control and Prevention (CDC),

mortality – the proportion of LC-BSI cases which were directly associated with death in the total number of LC-BSI cases,

distribution of isolated aetiological factors, i.e. percentage of an isolated micro-organism in the general population and of extremely resistant isolates in the general pool of isolates of the bacterial strain or group.

The infections were recorded using a unified questionnaire – the chart of nosocomial infections. General demographic data were collected for each patient with infection symptoms (e.g. age, gender, cause of admission, date of admission, discharge, death). Moreover, information concerning the risk of infection and surgery course, diagnostic and therapeutic procedures were gathered, in particular data about microorganisms considered the aetiological factors and markers of their resistance.

The collected data, processed in agreement with the regulations for personal rights, were analysed and suitable calculations carried out. The likelihood ratio (LR) test was used to analyse LC-BSI cases; p=0.05 was considered statistically significant. The comparative analysis was based on the CLA-BSI density index [7, 8]. The distribution of the isolation incidence of microorganisms regarded as CLA-BSI aetiological factors and their drug resistance were described using the reference data of the National Healthcare Safety Network (NHSN) [9].

RESULTS

In 2009, 3 096 patients were hospitalised in both ITUs, including 2 275 after coronary or other cardiovascular procedures. The mean hospitalization time was 2.3 days.

The hospital Infection Control Team identified 202 cases of infections according to the definitions and criteria of NHSN [5]; the cumulative morbidity was 6.5/100 admissions. In the study period, central line was used with the intensity of 0.5, i.e. on average half of patients had them inserted every hospitalization day (Fig.1). In the vast majority of cases, double- or triple-lumen, non-tunnelled and without antibacterial coating catheters were placed in the internal jugular vein or subclavian vein. The number of ITU days was 8464, and the total density of morbidity was 23.9/1000 days.

The analysis involved the group of 31 patients with clinically diagnosed CLA-BSI (including 37 LC-BSI cases), mainly men (22); the mean age was 67 (48-83) years. CLA-BSL developed in 21 patients with central lines inserted at least 48 h before the first infection symptoms and in 5 cases with peripheral vascular lines. Cumulative morbidity associated with LC-BSI was 1.2%, CLA-BSI incidence density – 8.7/1 000 days of central line use (Fig. 2).

The median of CLA-BSI was 9 (2-28) days since the insertion of central line.

During hospitalisation, some patients had other infections before the first LC-BSI symptoms, most commonly pneumonia (39%), urinary infections (26%) and others (23%). The mortality rate in this group was 3.6%.

The predominating aetiological factors were Gram-positive cocci, almost 65% of all isolated microorganisms. The most abundant strains were coagulase-negative staphylococci – 51.4%. Moreover, the LC-BSI- related bacteria were Gram-negative bacilli and yeast-like fungi. The frequency of isolation of various microbial groups differed significantly from the NHSN reference data (p=7.7798 and E-43) (Table1).

MRSA strain was detected amongst Gram-positive cocci, which was resistant to macrolides, lincosamides and streptogramins (MLSB phenotype). Coagulase-negative strains showed multi-drug resistance: 84.2% – to ciprofloxacin, 63.2% –to gentamicin, and 78.9% – to erythromycin and clindamycin (MLSB phenotype); 66% of *Enterococcus fecalis spp*. were highly resistant to aminoglycoside antibiotics (HLAR phenotype).

The β-lactamase producing bacteria with a wide substrate spectrum (ESBL phenotype) constituted 37.5% of Gram-negative bacilli; 12.5% of strains were resistant to carbapenems (Table 2).

DISCUSSION

The reported data were collected in the highly specialised hospital with the departments of cardiac, vascular and thoracic surgery. The control of nosocomial infections was introduced there in 1998 and the system of active surveillance of infections in 2002. The Infection

Microorganism	OIT n (%)	NHSN [%]	Compared to NHSN data [%]
Staphylococcus aureus	2 (5.4)	9.9	3.7
Coagulase-negative staphylococci	19 (51.4)	34.1	11.6
Enterococcus spp.	3 (8.1)	8.2	2.8
Gram-negative bacteria	8 (21.6)	17.7	6.0
Yeast-like fungi	3 (8.1)	5.9	2.0
Other	2 (5.4)	24.2	8.2
Total	37 (100.0)	100.0	-

Table 1. Incidence of isolation of CLA-BSI aetiological factors in examined centre compared to NHSN data [9]

Control Team included epidemiological nurses and an infectious diseases specialist cooperating with microbiology diagnosticians and pharmacologists. According to the results published by the Team in the previous years, the incidence of surgical wound infections was about 3%, which corresponds to the expected percentages and those observed in the American or German infection control programs, i.e. is not significantly different [10].

In the present analysis the findings were different: CLA-BSI epidemiology in the study units was different from the expected/comparative data, e.g. those of the American NHSN program [9, 11]. The frequency described as CLA-BSI morbidity density in patients with central lines in American ITUs was 2.8/1000 days, on average. The median was 2.0 with central line utilisation ratio of 0.44. In our study, cannulation was performed slightly more frequently and its intensity (0.5) corresponds to the 75th percentile of NHSN results. This means that the our ITUs, compared to the reference group, belong to 50% of cardiosurgical units where central line utilisation is at the reference level (25-75th percentile). The epidemiology of CLA-BSI is different: the studied ITUs belong to the units

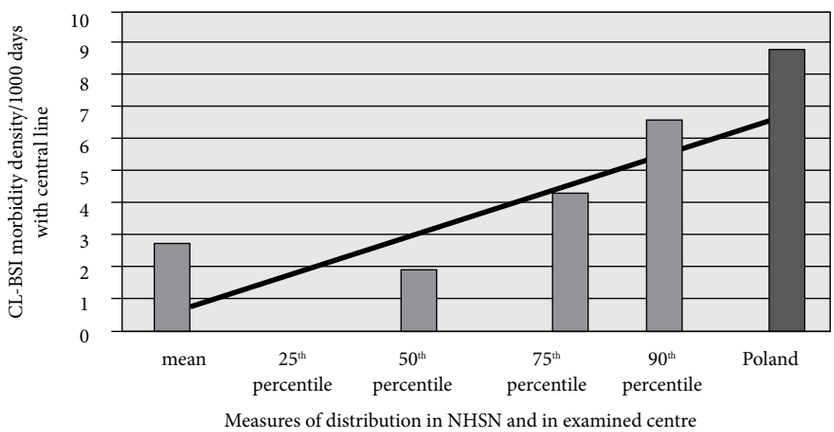

Fig.1. CLA-BSI-associated morbidity according to NHSN [11] and in examined centre

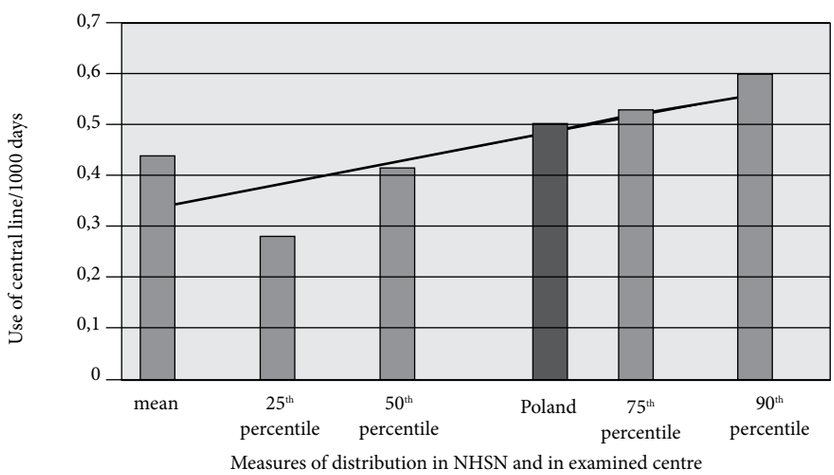

Fig. 2. The use of central lines in NHSN programme [11] and in examined centre

characterised by higher mortality rates. Unfortunately, there are no Polish studies using universal epidemiological measures; therefore, our findings cannot be referred to the entire Polish population, which might differ from the population of patients in American hospitals.

As expected, microbiological analysis of LC-BSI aetiological factors demonstrated a predominance of Gram-positive cocci; however, due to a high proportion of coagulase-negative staphylococci, our findings are again different from the NHSN reference data.

The previous multi-centre studies emphasise that the risk of nosocomial infection other than that of an surgical wound is high in severely ill surgical patients [2, 13], which particularly regards cardiac and thoracic surgery departments. Thus, our findings are not surprising; however, the number of deaths in the study population (3.6%) was not high. According to literature estimates, the crude mortality of ITU patients with LC-BSI symptoms can reach 22% [14], even 30.5% in infections with coagulase-negative staphylococci [15]. Such data strongly suggest that local infection control teams should show particular care of drug resistance surveillance of the micro-organisms listed.

Table 2. Antibiotic resistance of microorganisms isolated from CLA-BSI patients (according to NHSN programme [9])

Microorganism/antibiotic	Resistance [%]
Staphylococcus spp. (n=21)	
oxacillin or cefoxitin	94.7
fluoroquinolones	73.7
amikacin/gentamicin	47.4
vancomycin/teicoplanin	0.0
Enterococcus spp. (n=3)	
ampicillin	0.0
vancomycin	0.0
Gram-negative bacteria (n = 8)	
fluoroquinolones	37.5
piperacillin or piperacillin + tazobactam	25.0
amikacin	0.0
imipenem or meropenem	12.5
ceftazidime	50.0
cefepime	60.0

CONCLUSIONS

1. Incidence of bloodstream infections in patients with central lines hospitalised in thoracic and cardiac surgery departments is higher than expected, compared to NHSN data. Since other Polish reports are lacking, it is not possible, to conclude whether such findings are typical of other Polish ITUs.

2. The main aetiological factors of bloodstream infections in patients with central lines are Gram-positive cocci, mainly coagulase-negative staphylococci.

3. The frequency and characteristics of drug resistance of isolated micro-organisms confirm the necessity to provide epidemiological surveillance and cooperation of the infection control team with the microbiological laboratory and specialised pharmacologists.

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