

# Incidence of bacteremia in a tertiary hospital in eastern Minas Gerais

## *Incidência de bacteriemia em um hospital terciário do leste de Minas Gerais*

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### ABSTRACT

**Objectives:** To determine bacterial incidence and prevalence in a hospital in eastern Minas Gerais, as well as to verify the sensitivity of microorganisms to antibiotics available for therapy. **Methods:** This study is a retrospective analysis of medical records and blood culture results of patients from January 1st to December 31st, 2010. Infection significance was assessed based on the clinical manifestations of patients who underwent blood culture, thus avoiding sample contamination. **Results and discussion:** of 344 blood cultures studied, corresponding to 344 patients, bacterial growth was found in 64 (18.6%) cases and non-bacterial growth in 280 (81.4%) cases. *Staphylococcus epidermidis* was more prevalent as the cause of bacteriemia – 40.6% of the cases – similarly to what has been observed in other national and international studies. We found that 15.4 % of infections caused by *S. epidermidis* detected in the hospital in Caratinga were sensitive to oxacillin. **Conclusions:** *S. epidermidis* is the main agent responsible for blood infections. This is probably related to the increased use of venous catheters and to the status of immunosuppression developed by patients in prolonged hospitalizations. This species is highly resistant to oxacillin, which demands attention to prevent the indiscriminate use of antibiotics.

**Key words:** *Bacteremia; Sepsis; Staphylococcus; Oxacillin; Bacterial Drug Resistance; Epidemiology.*

### RESUMO

**Objetivos:** determinar a incidência e a prevalência bacteriana em hospital da região leste do estado de Minas Gerais, bem como verificar a sensibilidade dos microrganismos aos antibióticos disponíveis para terapia. **Métodos:** o estudo é retrospectivo, com análise de prontuários médicos e resultados das hemoculturas dos pacientes submetidos a esse exame no período de 1º de janeiro a 31 de dezembro de 2010. A avaliação da significância da infecção foi feita a partir das manifestações clínicas dos pacientes submetidos à hemocultura, evitando, assim, amostras contaminantes. **Resultados e discussão:** das 344 hemoculturas estudadas, correspondendo a 344 pacientes, evidenciaram-se crescimento e não crescimento bacteriano em 64 (18,6%) e em 280 (81,4%) casos, respectivamente. A espécie *Staphylococcus epidermidis* mostrou-se mais prevalente na causa de bacteremias – 40,6% dos casos –, como ocorre em outras descrições de estudos nacionais e internacionais. Observou-se que 15,4% das infecções por *S. epidermidis* detectadas no hospital de Caratinga eram sensíveis à oxacilina. **Conclusão:** o *S. epidermidis* é o principal agente responsável pelas infecções sanguíneas, o que está, provavelmente, relacionado ao uso crescente de cateter venoso e ao estado de imunossupressão desenvolvido pelos pacientes com internações prolongadas; e apresenta elevada resistência à oxacilina, exigindo cuidado com o uso indiscriminado de antibióticos.

**Palavras-chave:** *Bacteriemia; Sepsis; Staphylococcus; Oxacilina; Farmacorresistência Bacteriana; Epidemiologia.*

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## INTRODUCTION

The term bacteremia, also known as bloodstream infection (BSI), expresses the presence of bacteria circulating in the blood as confirmed by laboratory blood culture. It is considered pathogenic since blood is normally sterile. Bacteremia can be classified as primary and secondary. Primary bacteremia has unknown sources of infection and is usually associated with intravascular devices, especially central venous catheters.<sup>1</sup> Secondary bacteremia is due to infections in other bodily systems that migrate into the bloodstream, and the main primary foci are the lungs, urinary tract, and abdominal surgery.<sup>2</sup> The number of procedures performed in the hospital environment and during hospitalization are risk factors for BSI, and the use of intravenous catheters the main cause. Other risk factors include: hospitalization at intensive care units (ICU), surgery, diabetes mellitus, cirrhosis of the liver, burns, and immunodepression.<sup>3,4</sup>

The diagnosis of bacteremia is exclusively laboratorial and is made by bacterioscopy and blood culture. It is recommended that at least two blood samples are collected with a minimum interval of 15 minutes between them, as well as tracing of aerobic and anaerobic germs. It is fundamental that samples for culture are collected before the beginning of treatment with antibiotics to prevent false-negative results.<sup>5</sup> For patients using venous catheters, especially in case of prolonged use, culture must be performed with samples from the tip of the device and the cutaneous tissue adjacent to the orifice. Results may indicate primary BSI, if the culture is positive, or a distant focus of infection with hematogenous dissemination in case there is no bacterial growth in the catheter.<sup>6</sup> Antibiotic sensitivity testing should be performed along with the culture to test the found bacteria's sensitivity and resistance to the antibiotics available for treatment.<sup>5</sup>

The most important pathogens in the etiology of BSI, mainly due to the use of venous catheters, are Coagulase-negative Staphylococci (CoNS) – predominantly *S. epidermidis*, *Enterococcus* spp., *Staphylococcus aureus*, *Candida* spp. – and Gram-negative bacilli, especially *Pseudomonas aeruginosa* and *Enterobacter* spp.<sup>1,5</sup> The main causes of bacteremia are contamination of the venous catheter at the time of insertion, contamination of the skin near the orifice and contamination of the solutions used by professionals during patient management to maintain the venous catheter permeable as well as the existence of distant foci of infection accessed via blood.<sup>5,7</sup>

Mortality among previously hospitalized patients who received inadequate antimicrobial medication is higher than that among patients who receive correct empirical antibiotics. For this reason, it is fundamental and of great medical importance to know the predominance of the common germs in each hospital, thus allowing for the most adequate empirical treatment.<sup>3,8</sup>

The main objective of this study is to assess the incidence of laboratory-tested bacteremia at a hospital in eastern Minas Gerais, and the secondary objectives are: to determine the most prevalent microorganisms, both generally and in each of the several hospital sectors, and to assess the sensitivity and resistance of the most prevalent bacteria to the antimicrobial agents used in that institution.

## METHODS

This is a retrospective study with laboratory-tested bacteremia cultures in patients hospitalized in a tertiary hospital in eastern Minas Gerais, from January 1st to December 31st, 2010. Patients with positive blood cultures were selected based on positive blood culture results identified at the microbiology laboratory of the hospital and evaluated by a professional in the hospital infection control team.

Patients were allocated in three groups according to their hospitalization: Internal Medicine Clinic (IMC), ICU and Pediatrics. The criteria for requesting blood culture for hospitalized patients were those established by the *Centers of Disease Control*<sup>9</sup>: fever – axillary temperature  $\geq 38^{\circ}\text{C}$  – or hypothermia – axillary temperature  $< 36^{\circ}\text{C}$  – with no apparent cause; sepsis – presence of two or more of the following conditions: fever or hypothermia, heart rate  $> 90$  bpm, respiratory rate  $> 20$  ipm, WBC count  $> 12.000$  cel./mm<sup>3</sup> or  $< 4000$  cel./mm<sup>3</sup> or over 10% of band cells – with presumed infectious focus; severe sepsis – sepsis associated to organ dysfunction, arterial hypoperfusion or hypotension; septic shock – arterial hypotension with no response to adequate fluid replacement.

This study included samples from patients aged more than one year with laboratory-tested bacteremia and who were hospitalized in the hospital participating in the study from January 1 to December 31, 2010. Samples with more than two pathogens (suggesting contamination) were discarded, as well as those from children younger than one year and patients hospitalized in other institutions.

Additionally, microbial analyses of the instruments used at the ICU were made – for the emergency cart, isolation curtains, vital signs monitor, and breathing bags. Material were collected from those objects using a swab, which was then placed in a 1mL saline solution test-tube. That solution was then inoculated in the culture.

Blood for the blood culture was collected by peripheral puncture and, when available, by central venous catheter. The sample was aseptically collected and immediately sent to the laboratory to prevent contamination and colonization of bacteria from the normal flora of the human organism.

Data was collected in two distinct stages. In the first stage, blood cultures performed in the study period were quantified at the hospital laboratory and their results were analyzed. After the detection of the patients submitted to the test, analysis of the their medical history was carried out to determine the clinical status which required this propaedeutics. This second action was performed along with the hospital billing department. The evaluation of the significance of the infection was based on the clinical condition of the patients submitted to blood culture, thus avoiding contaminating samples. The research was approved by the FUNEC research ethics committee under protocol 098/11.

## RESULTS AND DISCUSSION

In the period from January 1 to December 31, 2010, 5,536 patients were hospitalized at a hospital located in eastern Minas Gerais, and 1,658 blood cultures were performed by its clinical analysis laboratory. Exams from patients from other institutions or who were younger than one year of age were excluded from this study, as well as cultures with growth of more than two pathogens. Therefore, 344 exams were analyzed, pertaining to 344 patients and corresponding to 20.7% of the total of blood cultures performed. Out of this total, 280 (81.4%) did not show any bacterial growth (negative blood culture) and 64 (18.6%) were positive for bacterial growth.

Table 1 shows the bacterial incidence in the diverse hospital sectors separated by male and female patients. The Internal Medicine sector had 36 cases of bacteremia (56.3%), adult ICU had 25 cases (39%) and Pediatrics had three cases (4.7%).

**Table 1** - Results for blood culture tests collected from patients by hospital sector from January 1 to December 31, 2010 at a hospital in Eastern Minas Gerais

	Negative Blood Culture		Positive Blood Culture	
	N <sup>o</sup> (total = 280)	%	N <sup>o</sup> (total = 64)	%
<b>Adults</b>				
Male	148	52.8	34	53.1
Female	120	42.9	27	42.2
<b>Total</b>	<b>268</b>	<b>95.7</b>	<b>61</b>	<b>95.3</b>
<b>CM</b>				
Male	109	38,9	20	31,3
Female	88	31,5	16	25,0
<b>Total</b>	<b>197</b>	<b>70,4</b>	<b>36</b>	<b>56,3</b>
<b>UTI</b>				
Male	40	14,3	14	21,8
Female	31	11,0	11	17,2
<b>Total</b>	<b>71</b>	<b>25,3</b>	<b>25</b>	<b>39,0</b>
<b>Total Ped.</b>	<b>12</b>	<b>4,3</b>	<b>3</b>	<b>4,7</b>

IM (Internal Medicine), ICU (Intensive Care Unit), Ped. (Pediatrics).

In a study conducted at a university hospital in the state of Santa Catarina, a rate of 49.4% laboratory-confirmed sepsis was registered<sup>10</sup>, showing a higher incidence of bacteremia than that found in the present study. At a university hospital in the state of Rio Grande do Sul the hospital sectors with higher prevalence of bacteremia were the adult ICU (25%), followed by the neonatal ICU (20%).<sup>11</sup> In the present study the prevalence rate was higher at the internal medicine clinic, followed by the adult ICU. We attributed this finding to the large number of beds and patients admitted to the former sector.

Table 2 shows that among the 11 strains selected the prevailing species were *Staphylococcus epidermidis* (26 out of 64/ 40.6%) at all hospital sectors, followed by *S. aureus* (11 out of 64/ 17.2%). Gram-positive bacteria corresponded to the majority of cases of bloodstream infection (51 out of 64/ 79.7%). 13 cases were caused by Gram-negative microorganisms (20.3%), mainly *Enterobacter* sp. (7.8%) and *Pseudomonas* sp. (6.3%).

Due to the increased use of intravascular devices in the hospital environment, Coagulase-negative staphylococci (CoNS), especially *S. epidermidis*, have emerged as main etiological agents of septicemia instead of Gram-negatives.<sup>12</sup> This bacterium was the main cause of bacteremia at the university hospitals in Rio Grande do Sul (67%)<sup>11</sup> and in Santa Catarina (58.5%)<sup>10</sup>.

**Table 2** - Prevalence of the main microorganisms detected by blood culture tests from January 1 to December 31, 2010 in the different sectors of a hospital in Eastern Minas Gerais

Microorganism	Hospital Sector			
	Total n° / %	IM n° / %	ICU n° / %	Ped. n° / %
<i>S. epidermidis</i>	26 / 40,6	16 / 25,0	9 / 14,0	1 / 1,6
<i>S. aureus</i>	11 / 17,2	8 / 12,5	2 / 3,1	1 / 1,6
<i>Enterococcus sp.</i>	8 / 12,5	5 / 7,8	3 / 4,7	0
<i>Enterobacter sp.</i>	5 / 7,8	3 / 4,7	2 / 3,1	0
<i>Pseudomonas sp.</i>	4 / 6,3	3 / 4,7	1 / 1,6	0
<i>S. coagulase – Negative</i> <sup>1</sup>	3 / 4,7	0	3 / 4,7	0
<i>Klebsiella sp.</i>	2 / 3,2	0	1 / 1,6	1 / 1,6
<i>Micrococcus sp.</i>	2 / 3,1	0	2 / 3,1	0
<i>Bacillus sp.</i>	1 / 1,6	0	1 / 1,6	0
<i>Salmonella sp.</i>	1 / 1,6	1 / 1,6	0	0
<i>Proteus sp.</i>	1 / 1,6	0	1 / 1,6	0

<sup>1</sup> Other species of CNS other than *S. epidermidis*.

Recent data confirm the relevance of *S. aureus* in BSI,<sup>13</sup> now ranking first position among the bacteria isolated in blood cultures not only in Brazilian hospitals but also in other urban centers in Latin America, representing 21.3% of total isolated bacteria, and nearly one third are oxacillin-resistant. In a study about the prevalence of bacteremia at a university hospital in the state of Goiás, *S. epidermidis* proved to be the second main pathogen (13.5%) and *S. aureus* the first (40%).<sup>14</sup>

Table 3 shows the antibiogram results for the most frequently isolated and identified microorganisms in the 64 blood cultures. The germ *S. epidermidis* showed low sensitivity to oxacillin (15.4% of the bacteria were sensitive to that antibiotic) and increased sensitivity to vancomycin (92.3%). The *S. aureus* species also showed low sensitivity to oxacillin (27.3%). All were sensitive to vancomycin (100%).

In the United States CoNS respond for 20.2% of BSI.<sup>15</sup> In Brazil that percentage ranges from 10-20%, with 70-90% of isolated germs being oxacillin-resistant.<sup>13</sup> These results are in agreement with the ones found in the present study (Table 3). These bacteria's low sensitivity to the antimicrobial drug is mainly due to indiscriminate use of antibiotics, common in many health institutions. CoNS are a common cause of infection, mainly those caused by the use of venous catheters, and are largely caused by oxacillin-resistant samples. Results of a study conducted by the Brazilian Health Surveillance Agency (Agência de Vigilância Sanitária – ANVISA) involving 75 Brazilian hospitals between July 2006 and June 2008 showed *Staphylococcus* (47%) as the most frequent microorganism in 5,406 isolated bacterial samples of primary bloodstream infections, with CoNS responding for 29% and *S. aureus* for 18% of those infections. In addition, 39% of the *S. aureus* samples were classified as oxacillin-sensitive. High isolation rates of oxacillin-resistant staphylococci cause a large-scale use of more expensive or more toxic antibiotics such as vancomycin.<sup>16</sup>

From an epidemiological perspective, *S. epidermidis* has developed interesting strategies to establish itself in the hospital environment and become a prominent pathogen. Its ability to colonize the inert surface of invasive medical devices forming a difficult to treat biofilm is remarkable, as is the carriage of diverse mobile genetic elements responsible for resistance to oxacillin.<sup>11</sup>

Cultures of the material collected from objects at the hospital ICU using swabs (emergency cart, isolation curtains, vital signs monitor, and breathing bags) showed growth of *S. epidermis* species. The fact that this microorganism is a part of the normal microbiota of human skin and that these materials are constantly manipulated by the ICU professionals explain the contamination.

**Table 3** - Antibiogram of the most frequent microorganisms identified in the 64 blood culture tests carried out from January 1 to December 31, 2010 in the different sectors of a hospital in Eastern Minas Gerais

Microorganism	Hospital Sector*								
	AMC	OXA	CTZ	QUI	GEN	CLI	VAN	MER	SUT
<i>S. epidermidis</i>	34,6	15,4	27	34,6	23	27	92,3	30,8	27
<i>S. aureus</i>	27,3	27,3	27,3	45,5	45,5	27,3	100	18,2	63,7
<i>Enterococcus sp.</i>	12,5	0	12,5	62,5	37,5	12,5	75	37,5	0
<i>Enterobacter sp.</i>	20	–	60	60	40	–	–	80	40
<i>Pseudomonas sp.</i>	0	0	25	50	50	0	–	50	0
<i>S. coagulase – Negative</i> <sup>1</sup>	33,3	33,3	–	66,7	33,3	33,3	66,7	66,7	33,3

Amoxicillin + Clavunilate (AMC), oxacillin (OXA), ceftazidime (CTZ), quinolones (QUI), clindamycin (CLI), vancomycin (VAN), meropenem (MER) and sulfatrim (SUT) \*Sensitiveness to the antibiotic – relative value (%).

A work developed at an ICU in the Triângulo Mineiro region showed contamination of 15.6% of the hospital beds by *Staphylococcus*, identifying a lapse in the cleaning and disinfection process in the facility.<sup>17</sup>

## CONCLUSION

The *Staphylococcus* genus is considered highly important due to its high prevalence in hospital infections. It also shows high resistance rates to oxacillin and to other antimicrobial drugs, thus complicating the treatment of patients.

The *S. epidermidis* species was the main cause of bacteremia, followed by *S. aureus*. These bacteria presented high resistance to oxacillin and high sensitivity to vancomycin. Nevertheless, reports of strains of those species with reduced susceptibility to vancomycin in many countries, including Brazil, have generated therapeutical dilemmas in the clinical practice.

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