

Bacterial species: etiologic agents of nosocomial infections

¹Stanca L. Pandrea, ¹Manuela Tompa, and ²Doina Matinca

¹Microbiology Laboratory, Third Medical Clinic Cluj-Napoca;
²"I. Hațieganu" University of Medicine and Pharmacy, Cluj-Napoca
Corresponding author: S. L. Pandrea, stanca_lucia_pandrea@yahoo.com

Abstract. Objective: evaluation of different bacterial species involved in etiology of nosocomial infections and joint analysis of nosocomial infections with multiple etiologies. Material and Methods: during January-July 2010 in the SPCIN (Prevention and Control of Nosocomial Infections Department) of Emergency Clinical Hospital "Prof. Dr. O. Fodor" Cluj-Napoca, we have investigated a number of 201 nosocomial infections. The blood cultures have been processed using the Bactec system, the rest of samples have been processed through conventional methods. The strains have been identified through classical biochemical methods and through Vitek 2 Compact (BioMerieux) system. Results: nosocomial infections were analyzed by infection site and pathogen distribution. Most frequent types were bronchopneumonia (30%), postoperative wound infections (24%), followed by urinary tract infections (17%) and septicemia (17%). Approximately 36.5% of bloodstream infections were associated with central lines, 82.4% of nosocomial pneumonia were associated with mechanical ventilation and 54.4% of urinary tract infections were associated with urinary catheters. Coagulase-negative staphylococci (18%) and *Acinetobacter baumannii* (18%) were the most common bloodstream infections isolates. The most frequent isolates from urinary tract infections were *Enterococcus spp.* (20%) and *Candida tropicalis* (20%). The most frequent isolates from postoperative wound infections were *A. baumannii* (20%) and *Klebsiella pneumoniae* (14%). From pneumonia isolates, the most frequent were Gram-negative organisms (72%). *A. baumannii* (40%) was the most frequently isolated of these, followed by *K. pneumoniae* (12%), *Staphylococcus aureus* (12%) and *Pseudomonas aeruginosa* (8%). Conclusion: the most frequent types of nosocomial infections were bronchopneumonia (30%), especially in intensive care units (45%), followed by septicemia (23%). Regarding the isolated microorganisms, it is noted an increased frequency of Gram-negative organisms (60%), both enterobacteria (30%) and nonfermenter species (30%). The most frequently isolated was *A. baumannii*, alone or in bacterial association. Approximately 8% of isolates were fungi. Certain pathogens were associated with device use: coagulase-negative staphylococci with central lines, fungal infections with urinary catheters, *A. baumannii* and *P. aeruginosa* with ventilators.

Key Words: nosocomial infections, etiology, bacterial species.

Rezumat. Obiectiv: stabilirea agenților etiologici ai infecțiilor nosocomiale precum și analiza asocierilor bacteriene în infecțiile nosocomiale cu etiologie multiplă. Material și metodă: în perioada ianuarie-iulie 2010, în cadrul activității SPCIN (Serviciul de Prevenire și Control a Infecțiilor Nosocomiale) din Spitalul Clinic de Urgență „Prof. Dr. O. Fodor” Cluj-Napoca, au fost investigate un număr de 201 infecții nosocomiale. Hemoculturile au fost lucrate în sistemul Bactec, restul probelor au fost lucrate prin metode convenționale. Identificarea tulpinilor s-a făcut prin metode biochimice clasice și pe sistemul Vitek2Compact (BioMerieux). Rezultate: infecțiile nosocomiale au fost analizate după tipul infecției și distribuția patogenilor. Cele mai frecvente tipuri de infecții nosocomiale au fost bronhopneumoniile (30%), urmate de infecțiile de plagă postoperatorie (24%), infecțiile de tract urinar (17%) și septicemiile (17%). Aproximativ 36,5% dintre septicemii au fost asociate cu prezența cateterelor venoase centrale, 82,4% dintre pacienții ventilați mecanic au dezvoltat bronhopneumonie, iar 54,4% dintre pacienții cu cateter urinar au dezvoltat infecții de tract urinar. Stafilococii coagulază-negativi (18%) și *A. baumannii* (18%) au fost cei mai frecvenți germeni izolați din septicemii. La infecțiile de tract urinar s-au izolat cel mai frecvent *Enterococcus spp.* (20%) și *Candida tropicalis* (20%). Cea mai frecventă bacterie izolată la infecțiile de plagă postoperatorie a fost *A. baumannii* (20%), urmată de *Klebsiella pneumoniae* (14%). Din bronhopneumonii, s-au izolat cel mai frecvent germeni Gram-negativi (72%), *A. baumannii* (40%) fiind cel mai frecvent dintre aceștia, urmat de *K. pneumoniae* (12%), *Staphylococcus aureus* (12%) și *Pseudomonas aeruginosa* (8%). Concluzii: cele mai frecvente tipuri de infecții nosocomiale au fost bronhopneumoniile (30%), în special pe secțiile de terapie intensivă (45%), urmate de septicemii (23%). În ceea ce privește microorganismele izolate, se remarcă frecvența crescută a germenilor Gram-negativi (60%), atât enterobacterii (30%), cât și nefermentativi (30%). *A. baumannii* a fost cel mai frecvent izolat, singur sau în asociație bacteriană. Aproximativ 8% din izolatele bacteriene au fost fungi. Anumiți patogeni au fost asociați astfel: stafilococii coagulază-negativi cu prezența cateterelor venoase centrale,

infecțiile fungice cu prezența cateterului urinar, *A. baumannii* și *P. aeruginosa* cu ventilația mecanică a pacienților.

Cuvinte cheie : infecții nosocomiale, etiologie, specii bacteriene.

Introduction. Nosocomial infection (NI) remains a current public health problem in Romania, where there is a still underreporting and undervaluation of the problem. In UE countries, the incidence of these infections is between 5% and 15%. In Romania, the recorded incidence of these infections is less than 1%. Evolution in nature is dynamic and is influenced by many factors, as it was shown (Weinstein et al 2001). The existence of the case definition, clinical and laboratory criteria are accessible, easy to use in early detection of the NI.

Commensal bacteria in the human body have a protective role by preventing colonization with other pathogens. However, some commensal bacteria may generate infections. On immunocompromised organisms, *Staphylococcus epidermidis* can become an opportunistic pathogen in infections due to venous access (catheter infection, septicemia), while *S. aureus*, that colonize the skin and nasal cavity of patients and medical staff, by pathogenicity and virulence factors that it possesses, can trigger a variety of infections. Gram-negative bacteria, which belong to the *Enterobacteriaceae* (*E. coli*, *K. pneumoniae*, *Enterobacter spp.*, *Proteus mirabilis*, *Morganella morganii*, *Serratia marcescens*, etc.) can colonize different anatomical sites, when the body's defense mechanism is low. *E. coli* can cause urinary infections, respiratory tract infections, septicemia, meningitis, etc. Nonfermentative Gram-negative bacteria: *Acinetobacter spp.*, *Pseudomonas spp.*, are often isolated from the environment and can colonize the respiratory, urinary and digestive tract, postoperative wounds. Most wound are polymicrobial, are cited association between aerobic (*S. aureus*, *P. aeruginosa*, beta-hemolytic streptococci) and anaerobic bacteria (*Bacteroides*, *Prevotella*, *Porphyromonas*). Other opportunistic organisms (*Candida albicans*) causes serious infections in immunocompromised patients (urinary and respiratory infections). After prolonged treatment with broad-spectrum antibiotics, *Candida spp.* represents a major etiologic agent of nosocomial urinary tract infections.

Material and Methods. From 201 reported NI, 194 were investigated with microbiology laboratory, remaining 7 (3.48%) being declared only on clinical criteria. The blood cultures have been processed using the Bactec system, the rest of samples have been processed through conventional methods. The strains have been identified through classical biochemical methods and through Vitek 2 Compact (BioMerieux) system. There have been isolated and identified a total of 305 bacterial and fungal strains, etiologic agents of this infections reported.

Results and Discussion. Distribution of reported infections was as a follows: 1 (0.49%) from gynecology, 15 (7.46%) from surgical wards, 17 (8.45%) from neonatology, 36 (17.49%) from orthopedic wards and the remaining 67% (133) from intensive care unit ICU.

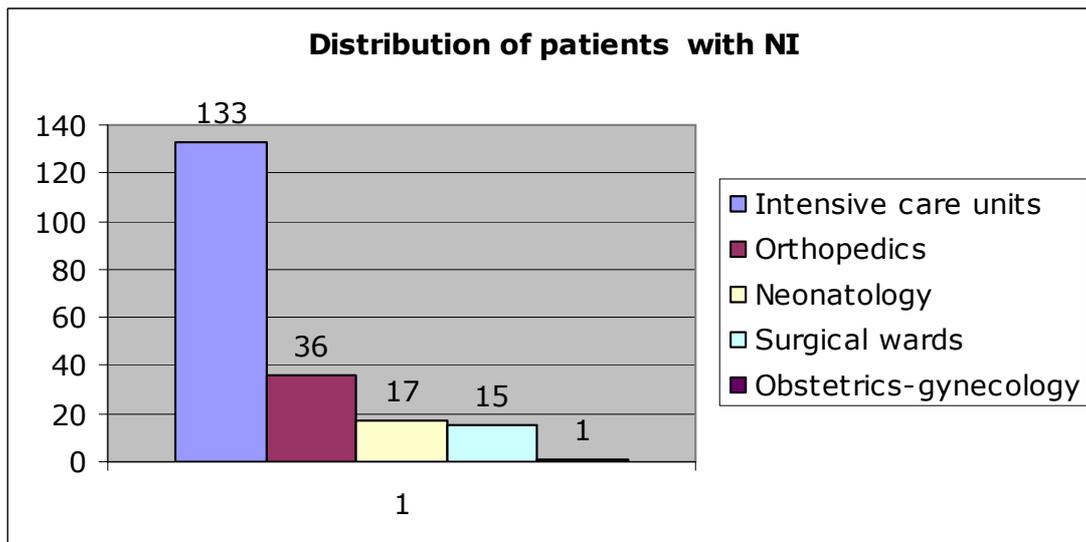


Figure 1. Distribution of patients with NI.

Type of the most frequent NI and their distribution during the period of study are represented in figure 2 (SSI=surgical sites infections, UTI=urinary tract infections, BSI=blood stream infections).

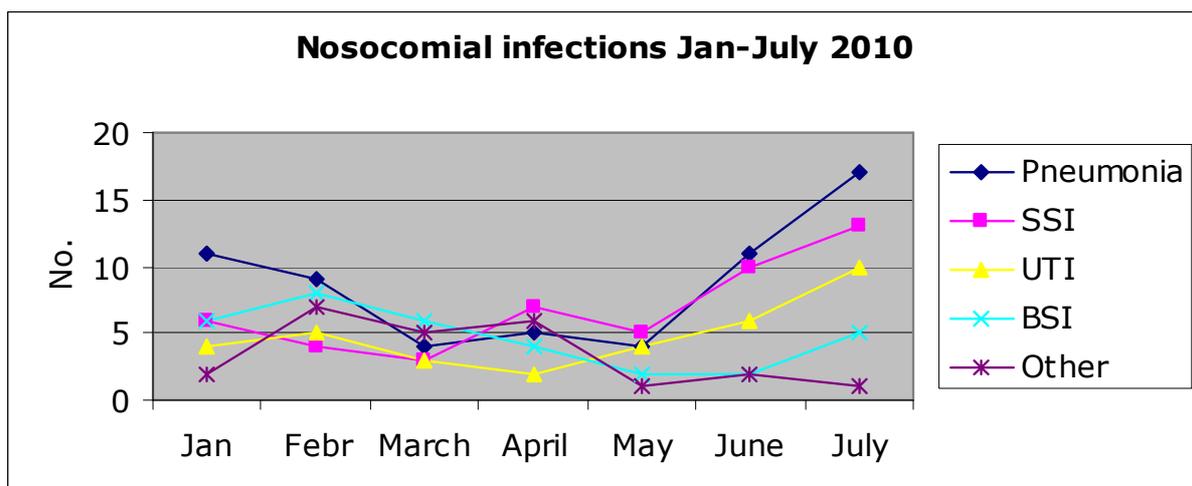


Figure 2. Types of NI during the study period.

The most common types of NI were bronchopneumonia (BP) (30%), followed by postoperative wound infection (24%), urinary tract infections (UTI) (17%) and septicemia (17%), according to the literature (Weinstein 1991; Emori and Gaynes 1993).

Other types of NI included: conjunctivitis, pharyngitis, pyoderma, sore wound infection, gastroenteritis, peritonitis, pancreatic abscess, etc., the total number being 24 (12%) during the period under study.

Among the types of prelevates, 54 (27.55%) were tracheobronchial aspirates, 35 (17.85%) were postoperative wound secretions, 21(10.71%) were blood cultures, 33 (16.83%) were urine specimens, the other taken as indicated in Table 1.

Table 1

Types of samples

<i>Samples</i>	<i>No.</i>	<i>%</i>
Respiratory specimens	60	30.61
Sputum	4	2.04
Tracheobronchial aspirates	54	27.55
Bronchoalveolar lavages	2	1.02
Wound	49	25
Postop. wound secretions	35	17.85
Bed sores	1	0.96
Drainage	13	6.63
Urine specimens	33	16.83
Catheter urine specimens	18	9.18
Midstream urine specimens	15	7.65
Blood cultures	21	10.71
Intravascular catheter tips	12	6.12
Body fluids	10	5.10
Others	11	5.61

Bacterial and fungal species isolated from nosocomial infections are shown in figures 3 and 4. It is noted an increased frequency of Gram-negative strains (60%), both enterobacteria (30%) and nonfermenter species (30%). Note approximately 8% of fungal etiology of NI (CONS=coagulase-negative staphylococci).

The most frequent was *A. baumannii* (21%), followed by *K. pneumoniae* (15%), *S. aureus* (13%) and *P. aeruginosa* (8%). This order of frequency is the same in respiratory tract infections (Figure 5).

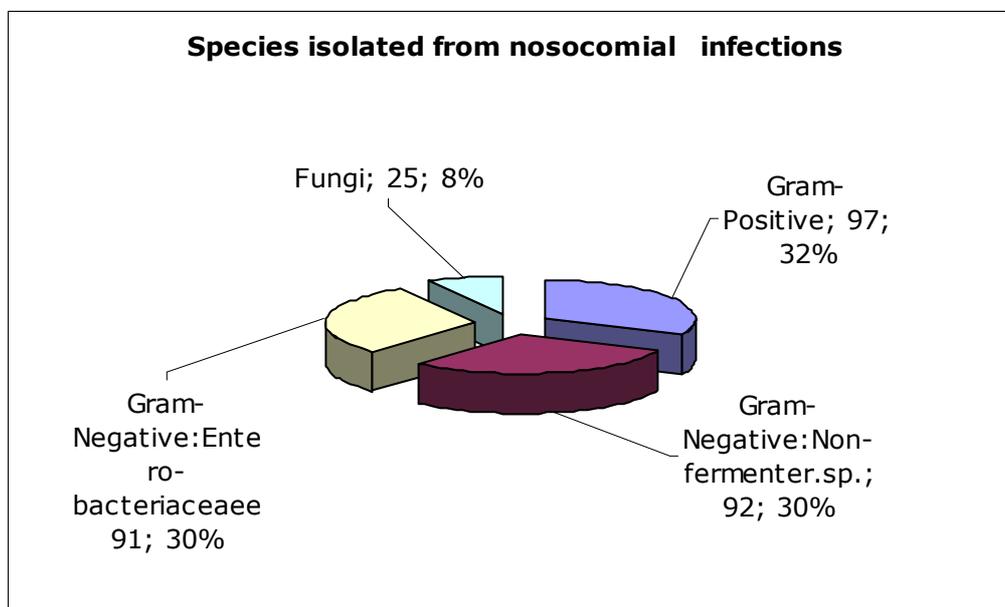


Figure 3. Species isolated from nosocomial infections.

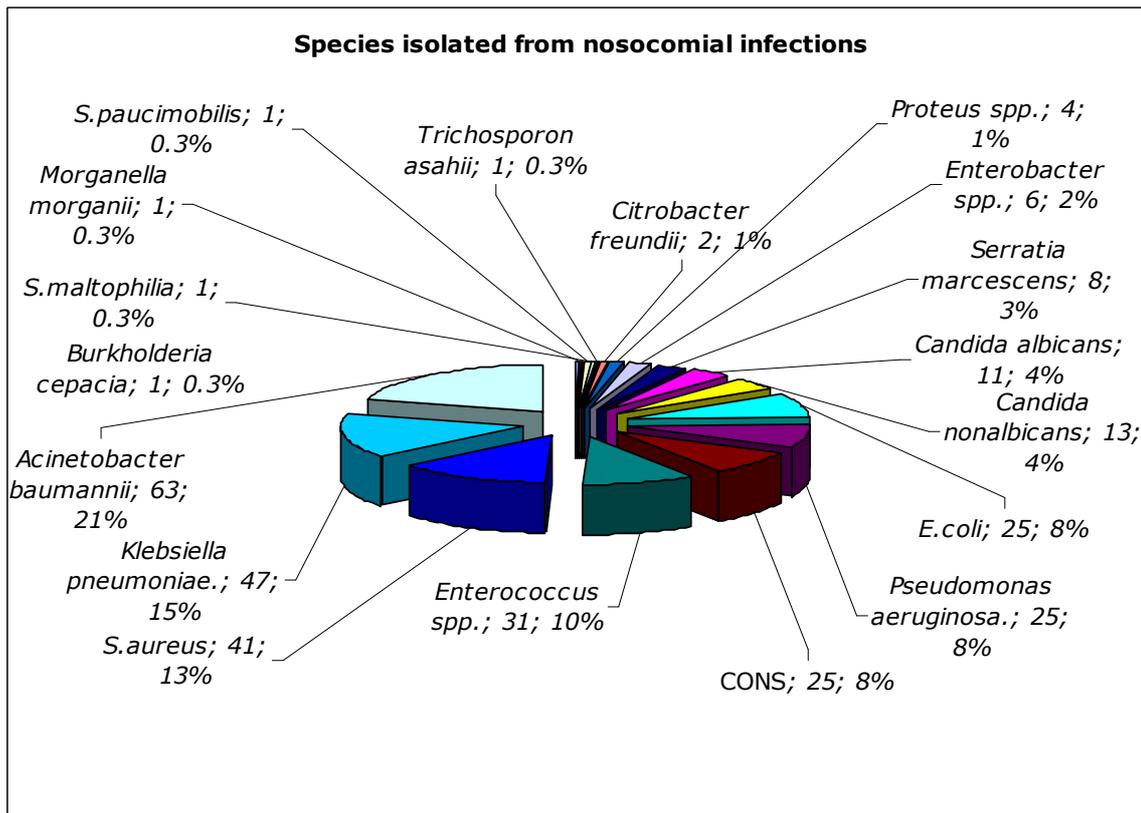


Figure 4. Bacterial and fungal strains isolated from nosocomial infections.

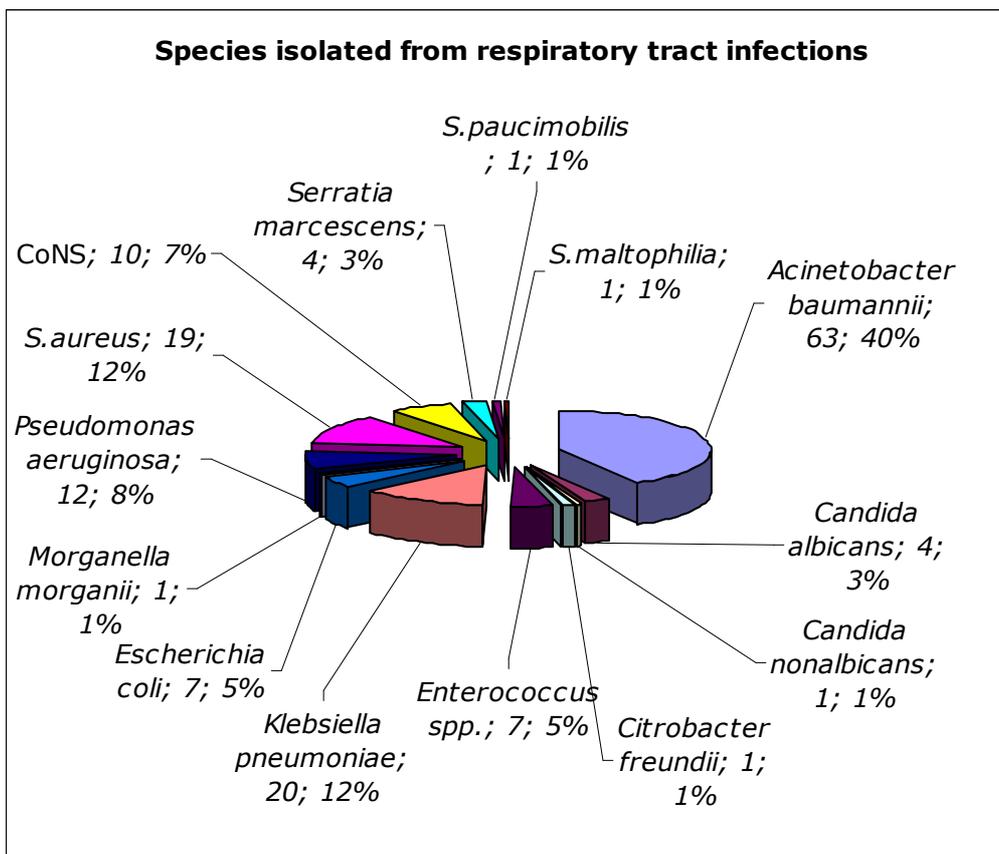


Figure 5. Species isolated from respiratory tract infections.

BP was diagnosed in 47 (of 57) patients hospitalized in ICU (76.27%) and was associated with mechanical ventilation. *A. baumannii* and *P. aeruginosa* were found in 89% cases as the etiologic agent causing BP. These data are similar to those cited in literature (Richards et al 1999).

The most frequent isolates from postoperative wound infections (surgical site infections) were *A. baumannii* (20%), followed by *S. aureus* (17%), *K. pneumoniae* (14%) and *Enterococcus spp.* (13%).

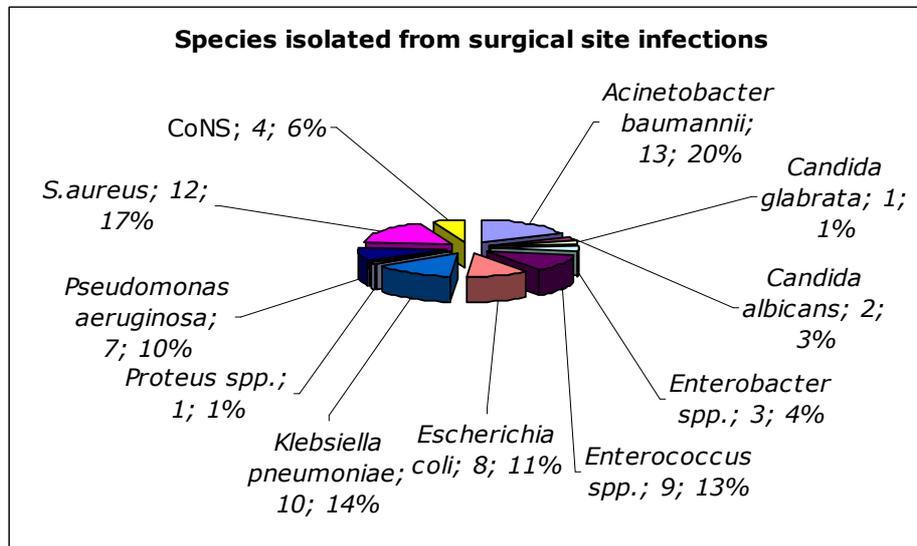


Figure 6. Species isolated from surgical site infections.

Distribution changes in UTI: *Enterococcus spp.* (20%), *Candida tropicalis* (20%) and *E. coli* (12%); fungal etiology is found at a rate of 39% (Figure 7). From UTI reported, 15 (54.5%) were associated with presence of urinary catheter, and of these, fungal etiology was recorded at rate of 87%. There is an increased presence of *nonalbicans* species (73.3%) of *Candida* and the presence of pathogens rarest but with certain implications in UTI (*Trichosporon asahii*). *E. coli* is reported as etiologic agent of UTI, with only 11% less than the literature (Richards et al 2000).

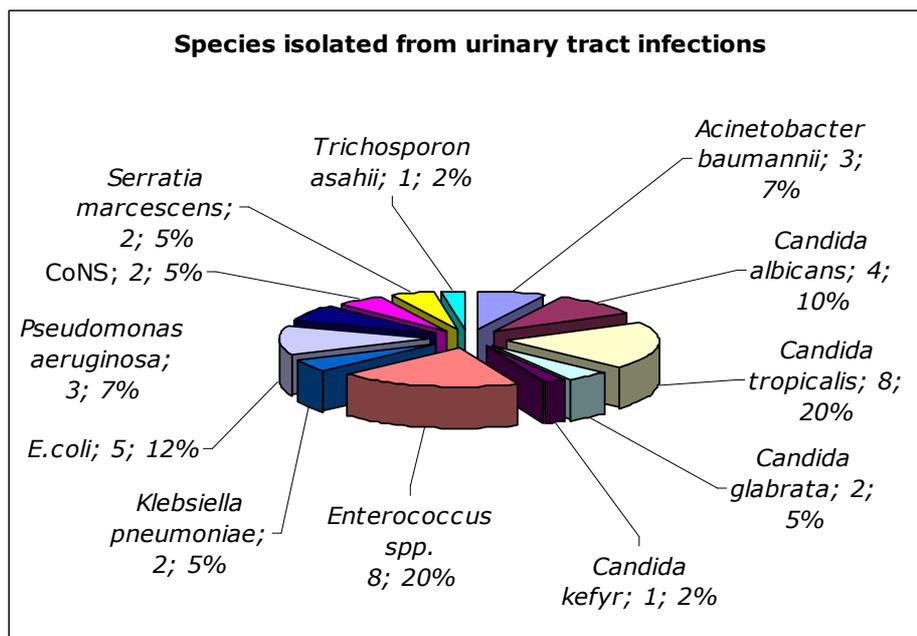


Figure 7. Species isolated from UTI.

The etiology of sepsis is dominated by the presence of CONS (18%), according to the literature (Richards et al 1999), *A. baumannii* (18%) and *S. aureus* (18%). In septicemia, in 12 (36.5%) cases, the microorganism was isolated from blood culture and central venous catheter (CVC), and of these, 7 (58.3%) were CONS.

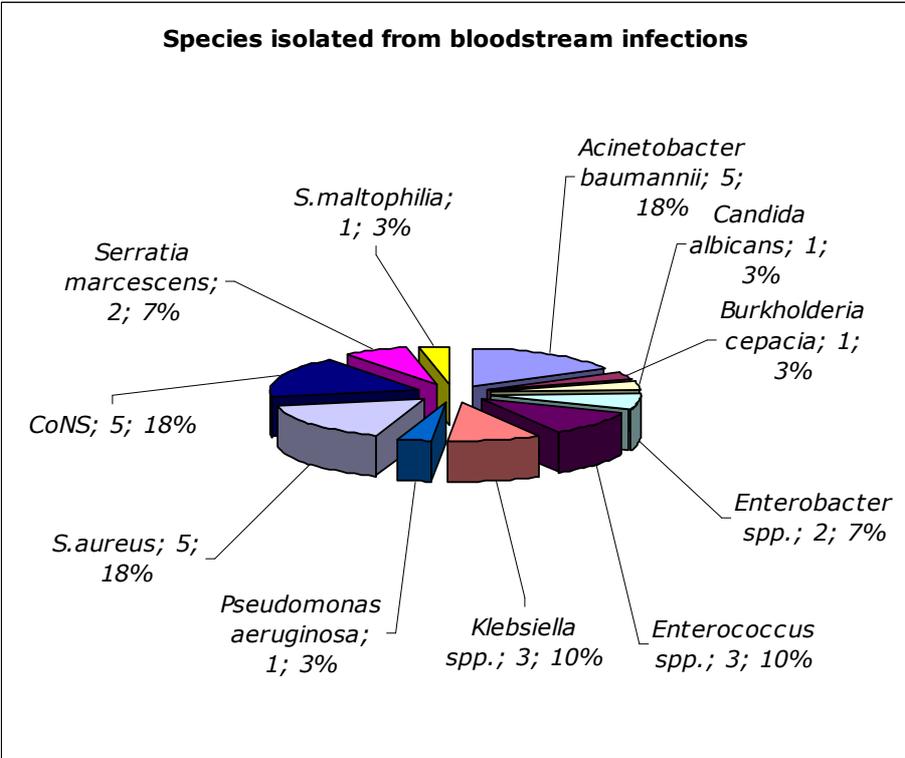


Figure 8. Species isolated from bloodstream infections.

According to established infection, we obtained the following percentages of the frequency of different bacteria involved in etiology of NI, shown in Figures 9 and 10.

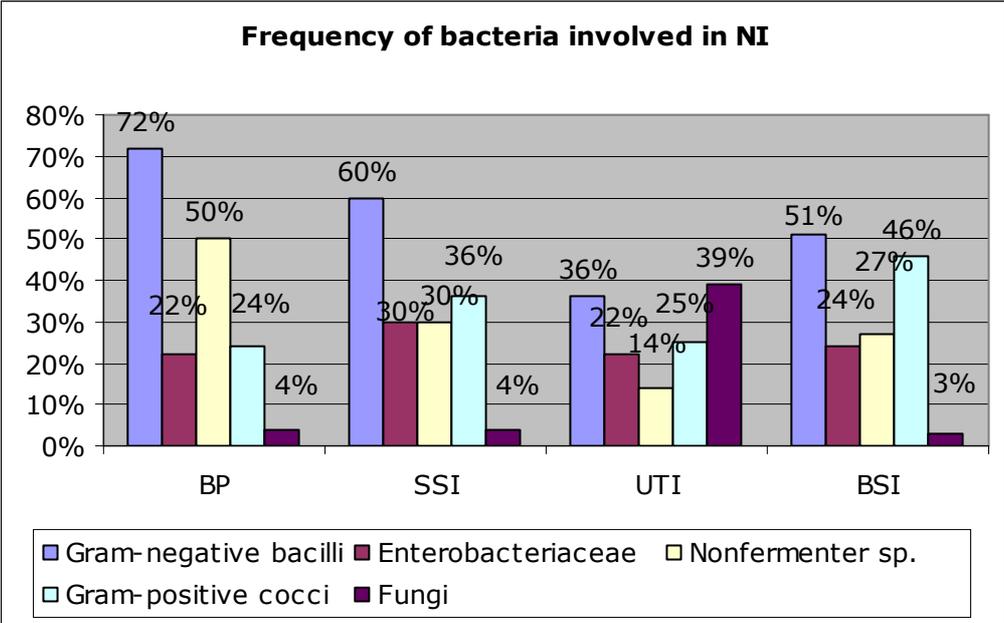


Figure 9. Frequency of different bacteria involved in etiology of NI.

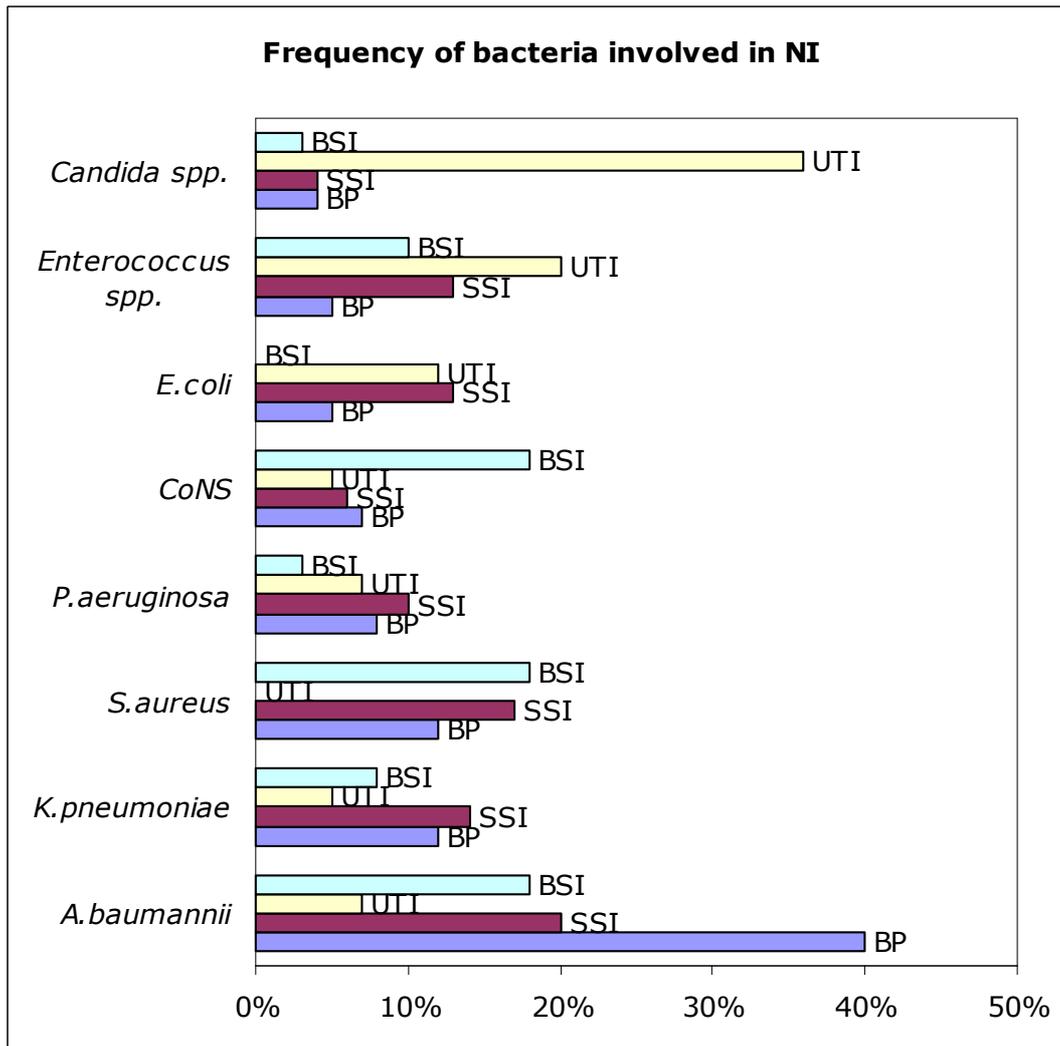


Figure 10. Frequency of different bacteria involved in etiology of NI.

The etiology of most common types of NI was dominated by Gram-negative bacilli, 72% in pneumonia, 60% in postoperative wound infections and 51% in bloodstream infections.

Gram positive cocci were found in 46% in the etiology of bloodstream infections, but also in the etiology of postoperative wound infections (36%) and UTI (25%).

Etiology of UTI was dominated by fungi (39%), while the other types of nosocomial infections had a fungal etiology in the rate of fewer than 4%.

Nonfermenter species remained in first place in the etiology of BP (50%), of postoperative wound infection (30%) and septicemia (27%).

A. baumannii remains in first place as etiologic agent of BP (40%), SSI (20%) and septicemia (18%).

The most frequent microbial associations were found in: postoperative wound secretions, tracheobronchial aspirates, peritoneal fluids, urine specimens and drainages, as shown in Table 2.

Microbial association in pluricontaminates samples

<i>Sample type</i>	<i>Microbial association</i>
Postoperative wound secretions	<i>S. aureus</i> + <i>A. baumannii</i> (3) <i>S. aureus</i> + <i>P. aeruginosa</i> (2) <i>S. aureus</i> + <i>Enterobacteriaceae</i> (1) <i>S. aureus</i> + <i>A. baumannii</i> + <i>P. aeruginosa</i> (2) <i>A. baumannii</i> + <i>P. aeruginosa</i> (3) <i>A. baumannii</i> + <i>P. aeruginosa</i> + <i>C. albicans</i> (1)
Tracheobronchial aspirates	<i>Enterobacteriaceae</i> + <i>Enterobacteriaceae</i> (2) <i>A. baumannii</i> + <i>Enterobacteriaceae</i> (2) <i>S. aureus</i> + <i>P. aeruginosa</i> + <i>C. albicans</i> (1)
Peritoneal fluids	<i>Enterobacteriaceae</i> + <i>P. aeruginosa</i> + <i>Enterococcus spp.</i> (1) <i>A. baumannii</i> + <i>Enterococcus spp.</i> (1) <i>P. aeruginosa</i> + <i>C. tropicalis</i> (2)
Urine specimens	<i>Enterobacteriaceae</i> + <i>P. aeruginosa</i> (1)
Drainages	<i>Enterobacteriaceae</i> + <i>Enterobacteriaceae</i> (3) <i>Enterobacteriaceae</i> + <i>P. aeruginosa</i> (1)

Conclusions. The most common types of NI were BP (30%), followed by postoperative wound infection (24%), UTI (17%) and septicemia (17%).

It is noted increased frequency of Gram-negative organisms (60%), both enterobacteria (30%) and nonfermenter species (30%). The most frequently isolated was *A. baumannii* (20%), alone or in bacterial association. Fungi were presented in 8% of isolates.

Approximately 36.5% of bloodstream infections were associated with central lines, 82.4% of nosocomial BP were associated with mechanical ventilation, and 54.4% of urinary tract infections were associated with urinary catheters.

Certain pathogens were associated with device use: coagulase-negative staphylococci with central lines, fungal infections with urinary catheters, *A. baumannii* and *P. aeruginosa* with ventilators.

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Authors:

Stanca Lucia Pandrea, "Iuliu Hațieganu" University of Medicine and Pharmacy Cluj-Napoca, Microbiology Laboratory, Third Medical Clinic, Cluj-Napoca, 19-23rd Croitorilor Street, 400162, Romania, EU, e-mail: stanca_lucia_pandrea@yahoo.com.

Manuela Tompa, "Iuliu Hațieganu" University of Medicine and Pharmacy Cluj-Napoca, Microbiology Laboratory, Third Medical Clinic, Cluj-Napoca, 19-23rd Croitorilor Street, 400162, Romania, EU, e-mail: tompamanuela@yahoo.com.

Doina Matinca, Department of Microbiology, "Iuliu Hațieganu" University of Medicine and Pharmacy, Cluj-Napoca, 6th Victor Babeș Street, 400012, Romania, EU, e-mail: dmatinca@yahoo.com.

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