

Corso Precongressuale A - "Diagnostica delle infezioni del torrente circolatorio  
e infezioni di devices endovascolari: percorsi, buone pratiche ed indicatori"  
*Gruppo di Lavoro per le Infezioni nel Paziente Critico (GLIPAC)*

# Interpretazione del risultato dell'emocoltura: quali criteri per dirimere le contaminazioni?

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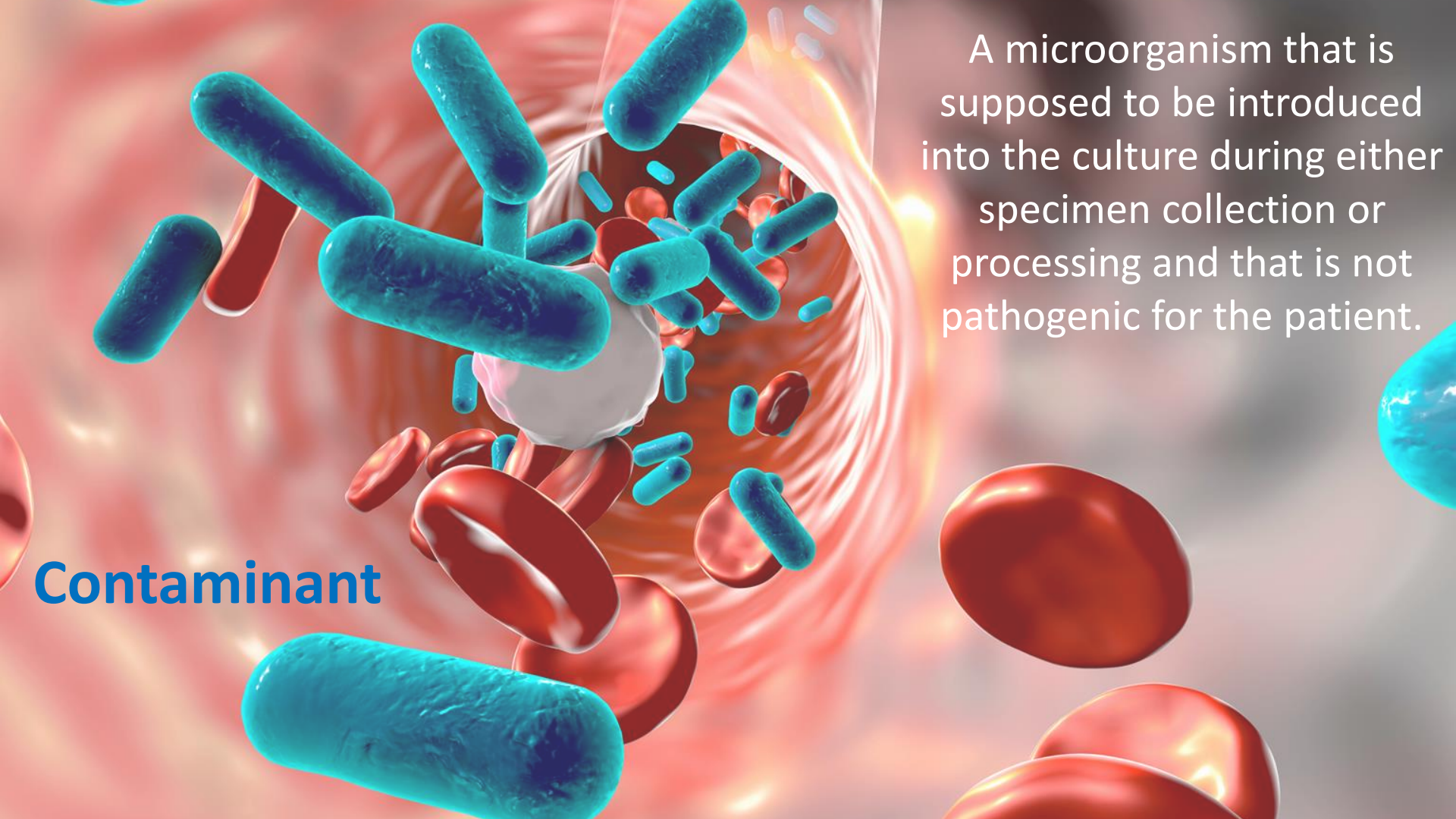


# Blood Culture, BC

- It remains the reference standard for the diagnosis of bloodstream infections (BSI)
- It's one of point of «*hour-1 bundle*» (Surviving Sepsis Campaign)
- It's recommended before starting antimicrobial therapy in patients with suspected sepsis or septic shock (if doing so results in no substantial delay in the start of antimicrobials)

Rhodes A et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. *Intensive Care Med* 2017; 43:304–377



A 3D illustration of a blood vessel, shown as a translucent red tube with a bright yellow light source at the far end. Inside the vessel, numerous red blood cells are depicted as red, biconcave discs. Scattered throughout the vessel are many blue, rod-shaped bacteria, some of which are larger and more prominent than others. The bacteria are shown in various orientations, some appearing to be moving or floating within the fluid. The overall scene suggests a medical or biological context, specifically focusing on the presence of contaminants in a blood sample.

A microorganism that is supposed to be introduced into the culture during either specimen collection or processing and that is not pathogenic for the patient.

**Contaminant**

# Bacteria associated with contaminated BC

*Coagulase-negative staphylococci (CoNS)*  
*Corynebacterium* spp.  
*Micrococcus* spp.  
*Cutibacterium acnes* and related species  
*Bacillus* spp. (other than *B. anthracis*)



most likely to represent contamination when isolated from the BC

*Enterococcus* spp.  
*Viridans group streptococci*  
*Clostridium* spp.



variable clinical significance (may be either contaminants or true pathogens)



# Microorganisms that almost always represent true bacteremia/fungemia

*S. aureus*  
*S. pneumoniae*  
*S. pyogenes*, *S. agalactiae*  
*L. monocytogenes*  
*E. coli* and other members of the Enterobacterales  
*P. aeruginosa*  
*N. meningitidis*  
*H. influenzae*  
*Bacteroides* spp., *Fusobacterium* spp.  
*Campylobacter* spp.  
*Cryptococcus neoformans/gattii*, *Candida* spp.



rarely represent contamination



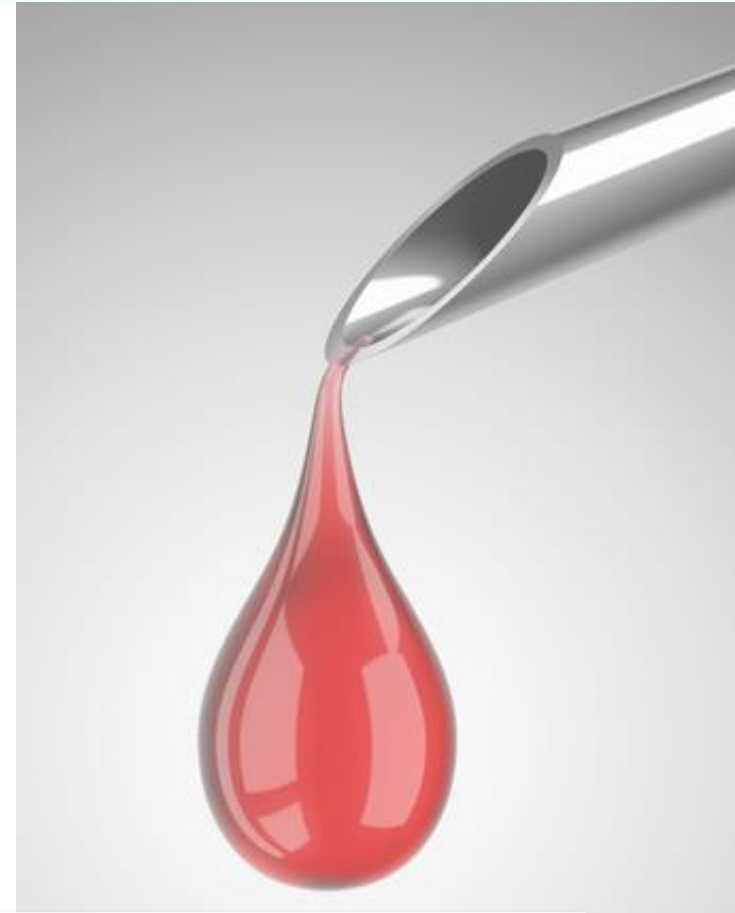


# Sources of BC contamination

- The principal source of contaminants is commensal bacteria that colonize the skin → insufficient disinfection of the skin
- Poor technique by individuals obtaining blood sample
- Collection of blood through indwelling vascular catheters → difficulty in obtaining adequate antisepsis in the port area of the intravenous device

# Magnitude of the problem

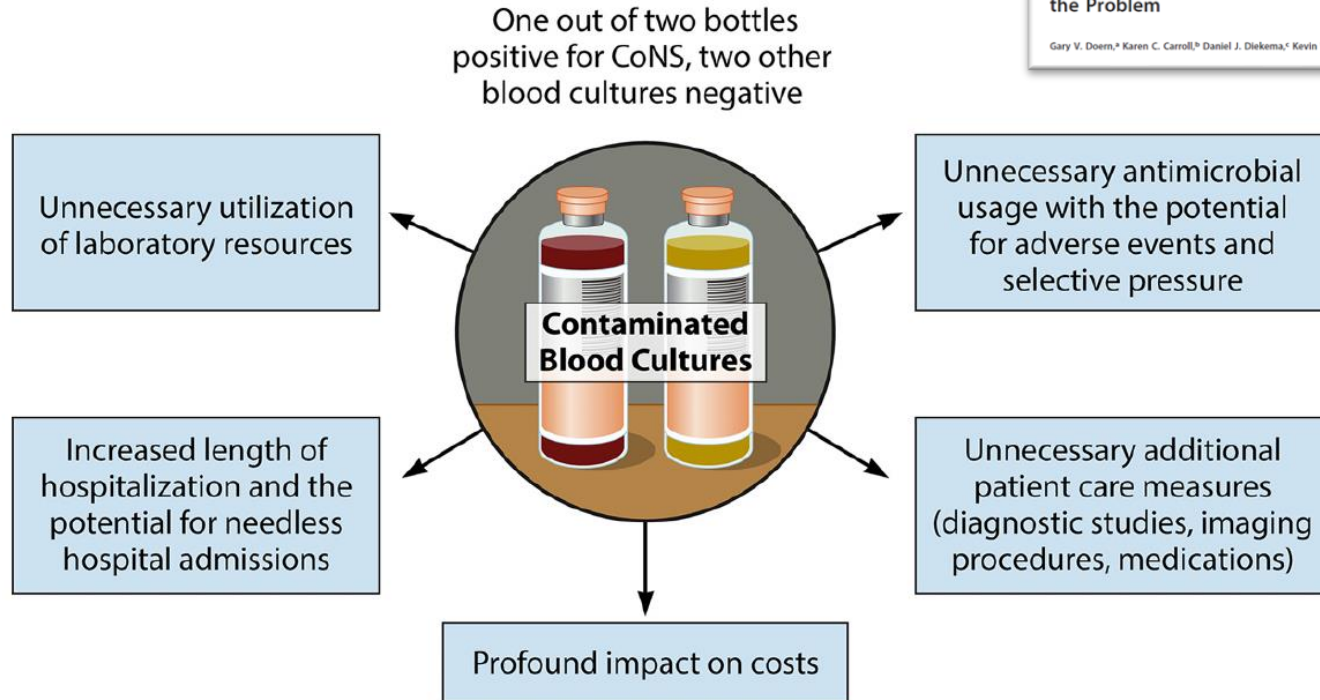
- Technological advancements that enable the detection of lesser concentrations of living bacteria in the blood
- Greater use of indwelling catheters for therapy
- Modifications in phlebotomy methods to reduce the danger of needlestick injuries



*Gunvanti R et al. Blood Culture Contamination Rate as a Quality Indicator - a Prospective Observational Study. MAEDICA – a Journal of Clinical Medicine 2022; 17(2): 311-316*



# Consequences of BC contamination





# Detection of contaminated BC

- Identity of the organism
- Number of positive culture sets
- Number of positive bottles within a set
- Time to growth (Time to Positivity)
- Clinical and laboratory data
- Source of culture

*Hall KK and Lyman JA. Updated Review of Blood Culture Contamination. Clinical Microbiology Reviews. 2006:788–802.*



# Identity of organism

*Coagulase-negative staphylococci (CoNS)*  
*Micrococcus* spp.  
Viridans group streptococci

*Corynebacterium* spp.  
*Propionibacterium acnes*  
*Bacillus* spp. (other than *B. anthracis*)

represent contamination in a  
significant proportion of cases

represent true bacteremia very rarely



# Coagulase-Negative Staphylococci (CoNS)

- Are the most common BC contaminants (70%-80% of contaminated BC)
- In the past, CoNS were usually believed to represent contamination when isolated from BC
- Recently, these organisms are an increasing source of true bacteremia in patients with prosthetic devices and central venous catheters
- In pediatric patients CoNS often cause true bacteremia

CLINICAL Microbiology Reviews, Oct. 2006, p. 788-802  
0893-8512/06/50R10-0 doi:10.1128/CMR.00062-05  
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## Updated Review of Blood Culture Contamination

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# Number of positive culture sets

The proportion of positive sets as a function of the total number of sets obtained.



Single-set blood culture (solitary BC) ranging from 10% to 30% of BC performed.



# Number of positive bottles within a set

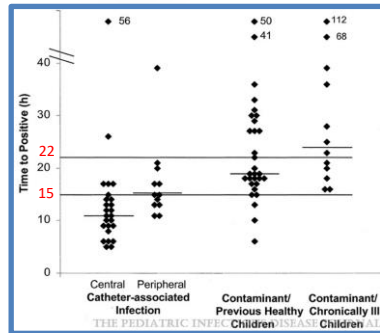
The number of BC bottles that exhibit growth within a given blood culture set.





# Time to growth (Time to Positivity, TTP)

TTP: the amount of time required for the organism to grow in the culture medium.



In pediatric population: some studies used clinical parameters to differentiate true CoNS infections from contaminants and found that values of **TTP  $\leq 15$  h** generally reflect infection and values of **TTP  $\geq 22$  h** generally reflect contamination (PPV of 84% for true infection in children).

Cohen H, et al. Use of incubation time to detection in BACTEC 9240 to distinguish coagulase-negative staphylococcal contamination from infection in pediatric blood cultures. 2003. *Pediatr. Infect. Dis. J.* 22:968–974



# Clinical and laboratory data



Clinical signs used for predict a true infection:

- hypothermia (temperature of  $<36^{\circ}\text{C}$ ) or marked fever (temperature of  $>40^{\circ}\text{C}$ )
- leukocyte counts of  $<4,000$  leukocytes/ $\mu\text{l}$  or  $>20,000$  leukocytes/ $\mu\text{l}$
- hypotension



# Source of cultures

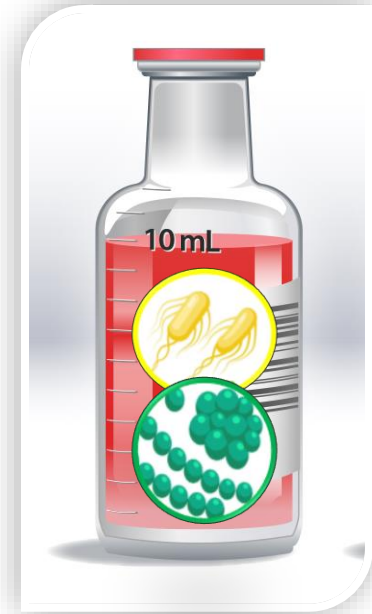
- Consensus guidelines recommend peripheral venipuncture as the preferred method for collecting BC samples
- Catheter-drawn BC has a higher risk of contamination (sterilizing catheters prior to accessing them is more difficult than sterilizing skin)
- Catheter colonization can confound catheter-drawn culture results
- 15-30% of all nosocomial bacteremia are catheter-related (*AMCLI ETS. Percorso Diagnostico "Le infezioni associate ai cateteri vascolari" - Rif. 2023-15, rev. 2023*)

Parlavecino et al. Laboratory approaches to determining blood culture contamination rates: an ASM Laboratory Practices Subcommittee report. *Clin Microbiol.* 2024 Feb 14;62(2)



# BC with multiple microorganisms

- One cannot conclude that the mere presence of multiple microorganisms in a BC always indicates contamination
- Studies have found that 6% to 21% of all true bacteremia are polymicrobial, usually in patients in high-risk groups
- Multiple CoNS species have been found to cause polymicrobial CoNS infection



# BC contamination rate



$$\frac{\text{Number of contaminated blood culture sets as determined by laboratory pre-set criteria}}{\text{Total number of all eligible blood culture sets collected}} \times 100\%$$

*Pre-set criteria are not universally defined and may depend on the individual institution's patient population and practices*

On the basis of prevalence data, it has been recommended that BC contamination rates should not exceed **3%** of BC performed, which is considered the standard benchmark.

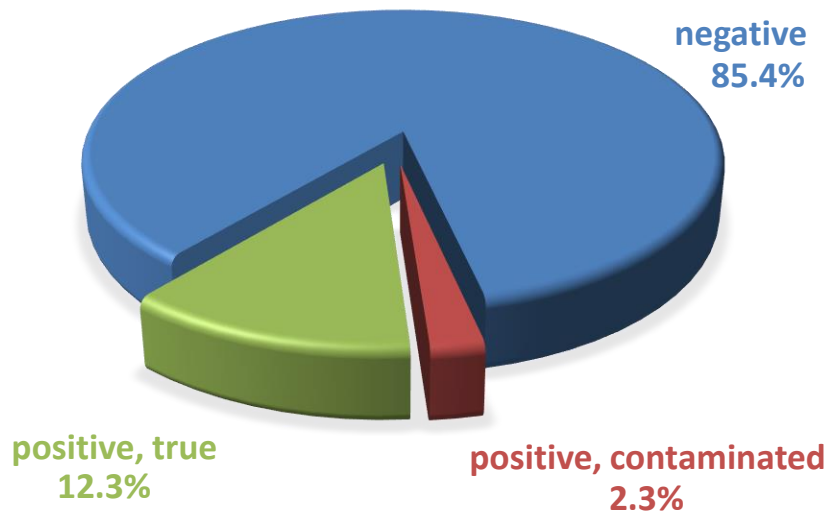
*(CLSI. Principles and Procedures for Blood Cultures. 2nd ed. CLSI guideline M47, 2022)*

*Parlavechino EL et al. Laboratory approaches to determining blood culture contamination rates: an ASM Laboratory Practices Subcommittee report. Clin Microbiol. 2024 Feb 14;62(2)*





## OPBG: Blood Culture set 2023 (N=10,976)



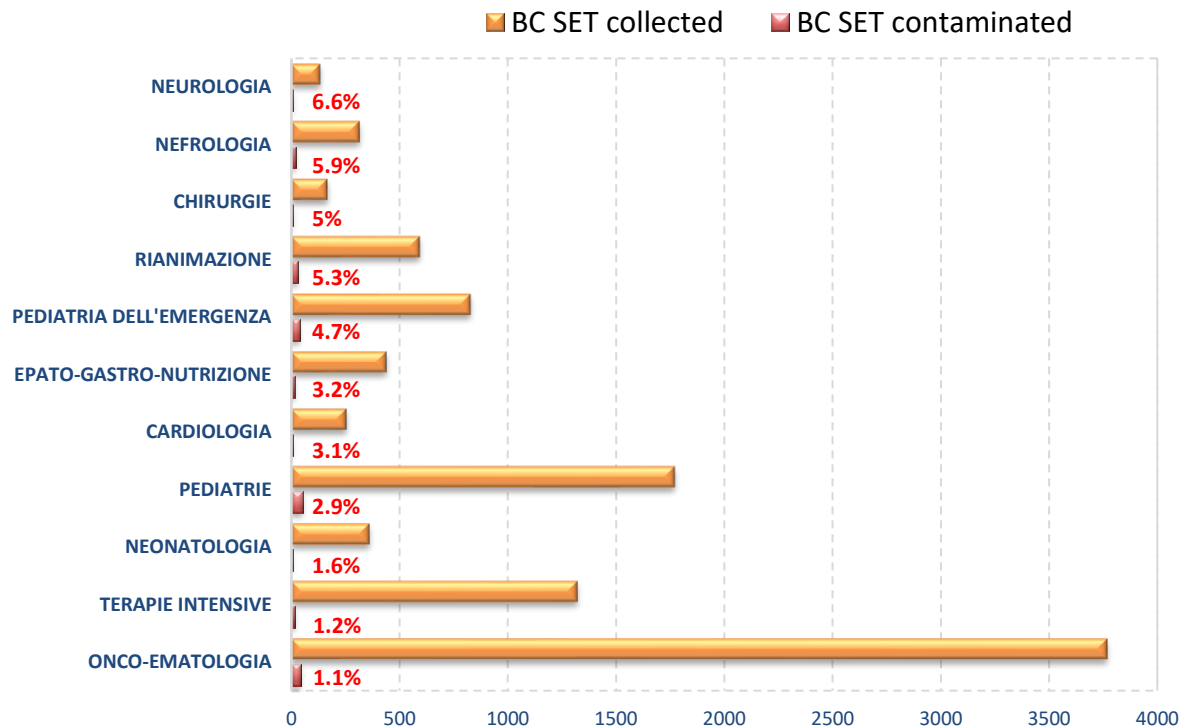
**CONTAMINATION RATE: 2.3%**

### BC SET collected

negative	9,375	85.4%
positive, true	1,350	14.6%
positive, contaminated	251	
Total	10,976	100%

<i>Bacillus</i>	<i>circulans; firmus; flexus; megaterium; mycoides</i>
<i>Brevibacterium</i>	<i>casei; luteolum; paucivorans</i>
<i>Clostridium ramosum</i>	
<i>Corynebacterium</i>	<i>afermentans; argentoratense; coyleae; falsenii; mucifaciens</i>
<i>Dermabacter hominis</i>	
<i>Kocuria</i>	<i>kristinae; rhizophila</i>
<i>Lactobacillus</i>	<i>rhannosus; sakei ssp sakei; lactis</i>
<i>Micrococcus luteus</i>	
<i>Staphylococcus</i>	<i>caprae; cohnii; gallinarum; pasteurii; pettenkoferi; saccharolyticus</i>

## OPBG: BC contamination rate for departments



contamination rates for  
departments ranging  
from 1.1% to 6.6%

## OPBG: microorganisms from BC in 2023

MICROORGANISM	N	%
Coagulase Negative Stafilococci	1,177	63.4
<i>S. aureus</i>	242	
<i>Enterococcus spp.</i>	172	
<i>S. pneumoniae</i>	16	
Streptococchi B-emolitici	14	
other Gram-positive	202	
<i>Klebsiella spp.</i>	185	24.5
<i>P. aeruginosa</i>	109	
<i>Enterobacter</i>	97	
<i>E. coli</i>	94	
<i>A. baumannii</i>	10	
other Gram-negative	183	
<i>Candida spp.</i>	212	10.1
other yeast	70	
<b>Total microorganisms</b>	<b>2,783</b>	

The highest percentage was represented by CoNS, followed by *S. aureus*

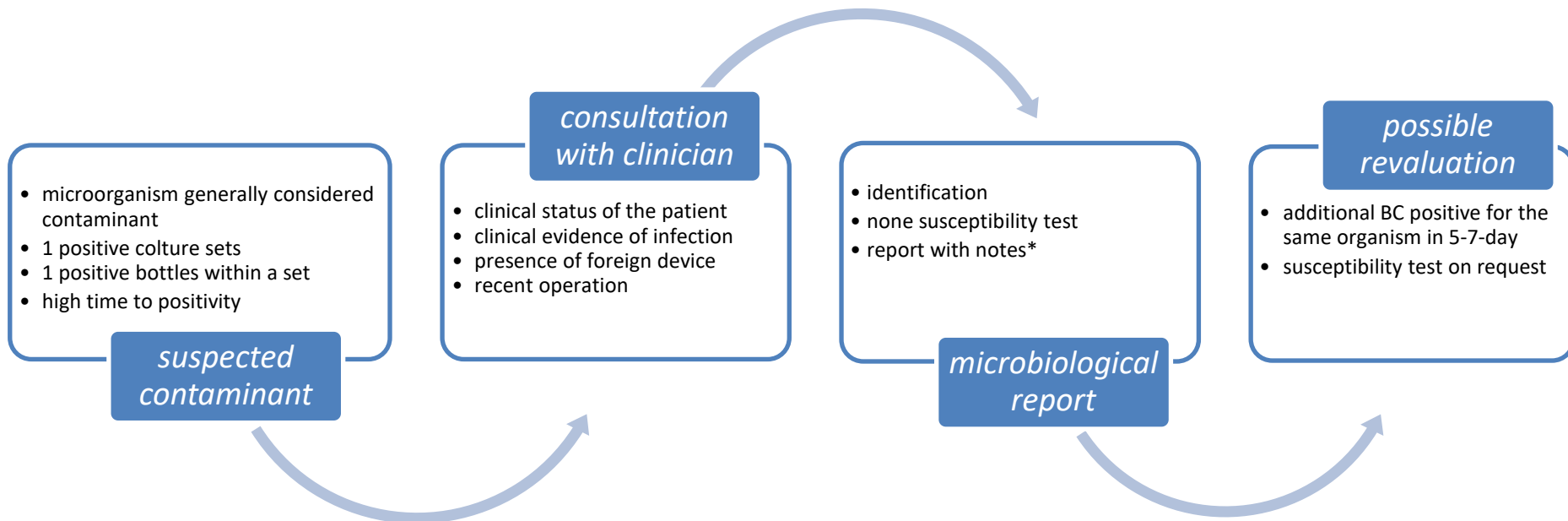
345/1,177 (29%) of CoNS were considered contaminants

The mostly isolated Gram-negative organisms were *Klebsiella spp.* and *P. aeruginosa*

# BC contamination in pediatric population

- Single blood cultures are particularly common in pediatric patients
- Pediatricians often use existing intravenous catheters for obtaining cultures to reduce unnecessary discomfort
- In the pediatric arena, additional studies are clearly needed to help physicians interpret the results of single BC that grow coagulase-negative staphylococci

# BC contamination: microbiological algorithm



\*example note: *“Microrganismo possibile contaminante; non si esegue antibiogramma. Si prega di chiamare il laboratorio entro 2 giorni se è necessario eseguire il test di sensibilità.”*

Dargere S et al. Contaminants in blood cultures: importance, implications, interpretation and prevention. *Clinical Microbiology and Infection* 2018 (24):964-969.





# Addressing the challenge of BC contamination

VOL. 19, 2006

UPDATED REVIEW OF BLOOD CULTURE CONTAMINATION 789

TABLE 1. Addressing the challenge of blood culture contamination

Approach	Rationale
Detecting contaminants.....	Given that contamination can likely never be eliminated, having reliable factors to help identify true positives vs false positives is critical for patient management and population-based surveillance
Prevention .....	Reducing contamination rates will improve the specificity of the blood culture and result in a higher PPV, resulting in a significantly more useful test
Supporting optimal use of blood cultures.....	Reducing the use of blood cultures in patients with a very low likelihood of bacteremia will result in a higher PPV and reduced costs associated with contamination; pretest probability of bacteremia can be estimated using population-based studies of disease prevalence or clinical prediction rules

CLINICAL MICROBIOLOGY REVIEWS, Oct. 2006, p. 788–802  
0893-8512/06/508.00+0 doi:10.1128/CMR.00062-05  
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# Thanks for your attention



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