



COME COMPORTARSI DI FRONTE A UNA INFEZIONE CATETERE-CORRELATA

COME FARE DIAGNOSI DI INFEZIONE BATTERIEMICA CATETERE-CORRELATA QUANDO E COME RICORRERE AL TRATTAMENTO CONSERVATIVO

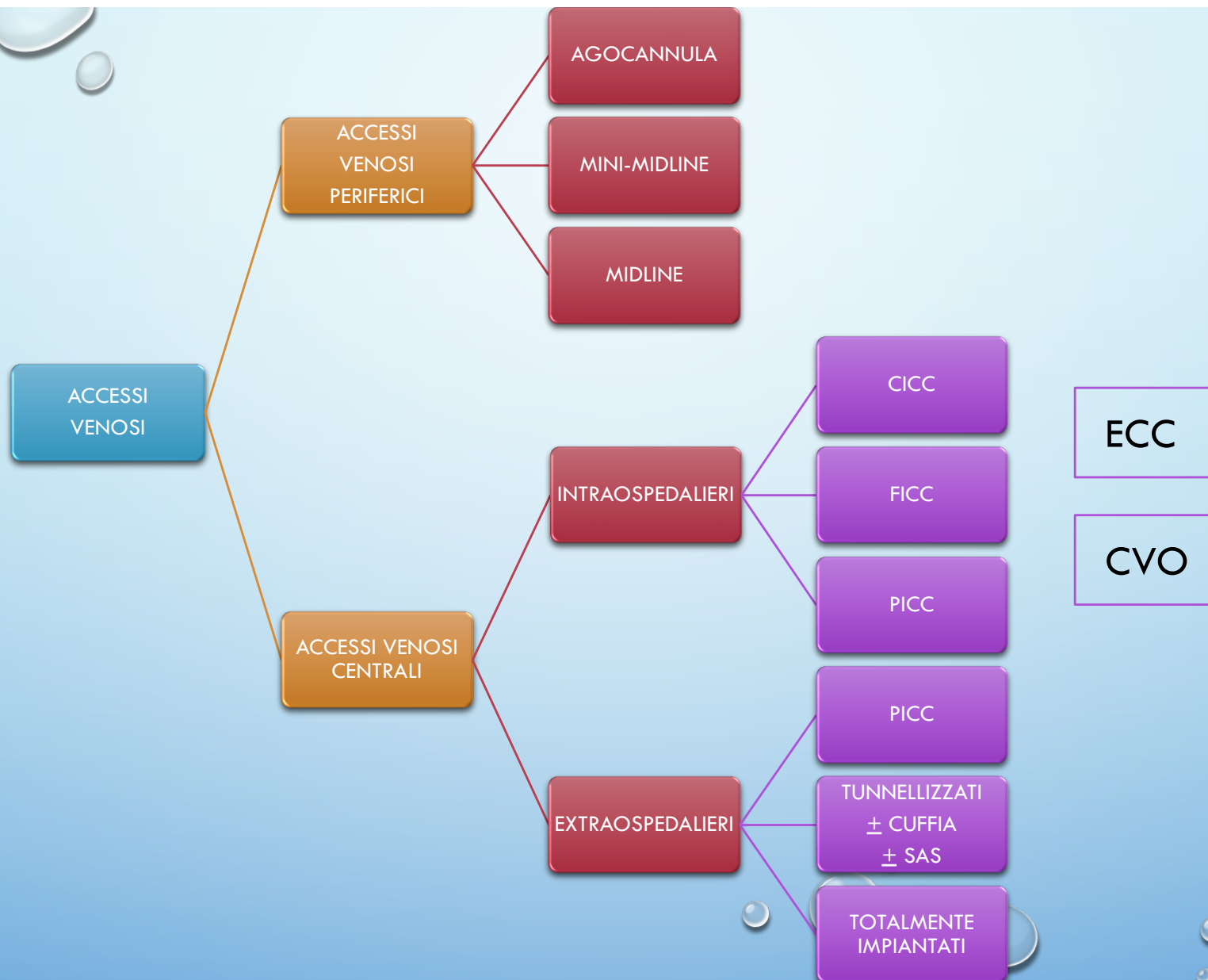
GIANCARLO SCOPPETTUOLO

DIRETTORE UOS DIAGNOSI E CURA DELLE MALATTIE INFETTIVE DI COMUNITÀ E TRASMISSIBILI

CONSULENTE INFETTIVOLOGO CENTRO INTERDIPARTIMENTALE ACCESSI VENOSI CENTRALI

COORDINATORE PERCORSO ENDOCARDITE ED ENDOCARDITIS TEAM

FONDAZIONE POLICLINICO UNIVERSITARIO A. GEMELLI – IRCCS ROMA



PRIMA TENTAZIONE DEL MEDICO....

- ATTRIBUIRE IMMEDIATAMENTE LA RESPONSABILITA' DELLA FEBBRE AL CV, ANCORA PRIMA DI AVERE ESEGUITO ALCUNA INDAGINE DIAGNOSTICA
 - SOPRATTUTTO NEL PAZIENTE OSPEDALIZZATO (MA ANCHE NEL PAZIENTE DOMICILIARE) IL CV **È SOLO UNA DELLE POSSIBILI CAUSE DI INFEZIONE**
- RIMUOVERE IL CATETERE VASCOLARE
 - IN LETTERATURA È BEN DESCRITTO CHE CIRCA IL 70% DEI CVC RIMOSI SOLO CON CRITERIO EMPIRICO NON HANNO RAGIONE DI ESSERE RIMOSI
 - CRITERI PER LA RIMOZIONE IMMEDIATA DI UN CATETERE VASCOLARE? SÌ, MA IN CASI SELEZIONATI
- RICHIEDERE SUBITO DOPO LA RIMOZIONE IL POSIZIONAMENTO DI UN NUOVO CATETERE...

Clinical Practice Guidelines for the Diagnosis and Management of Intravascular Catheter-Related Infection: 2009 Update by the Infectious Diseases Society of America

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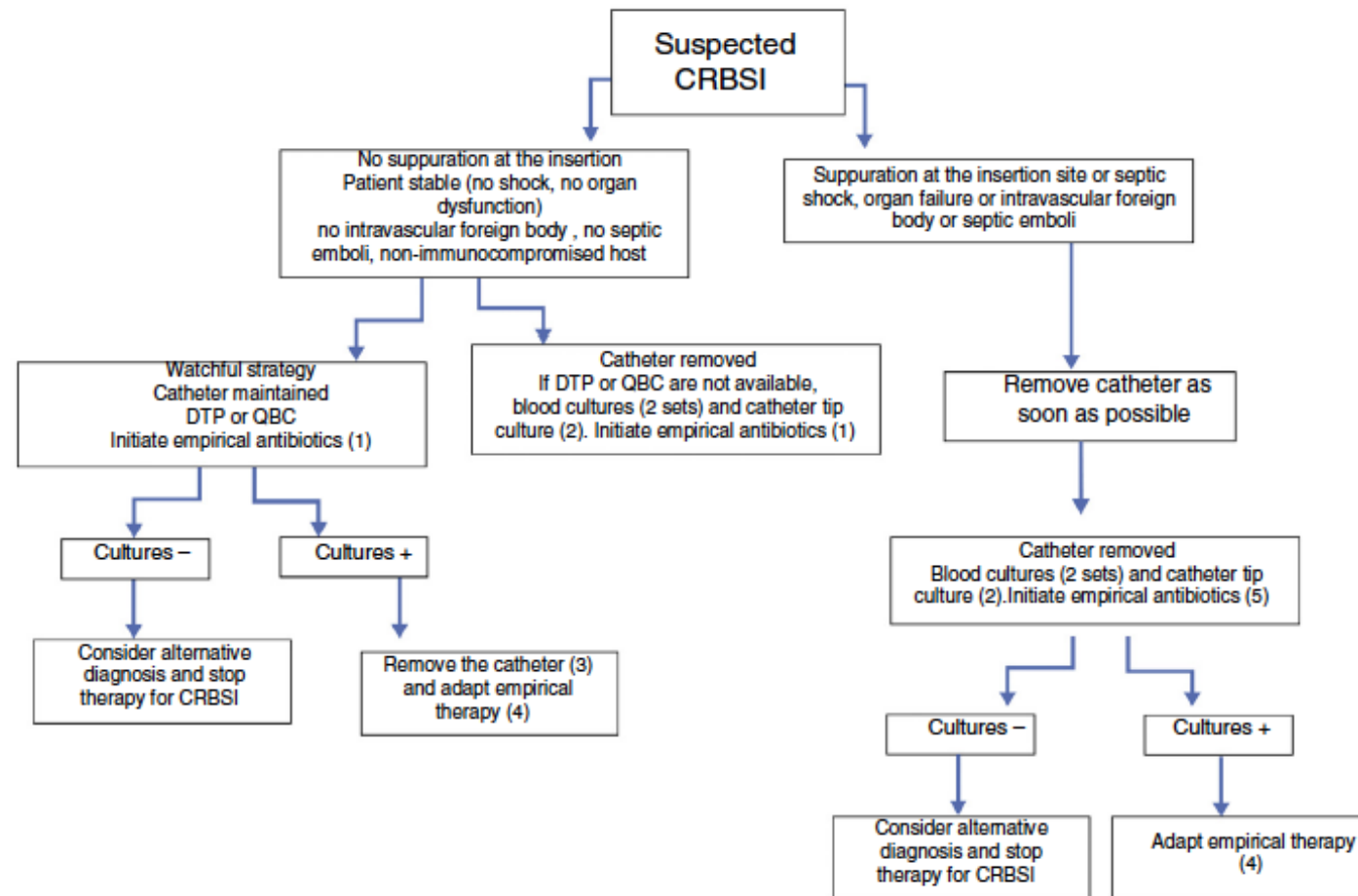


CONSENSUS STATEMENT

Diagnosis and treatment of catheter-related bloodstream infection: Clinical guidelines of the Spanish Society of Infectious Diseases and Clinical Microbiology and (SEIMC) and the Spanish Society of Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC)[☆]



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CLABSI/LCBSI E CRBSI

Table 1.

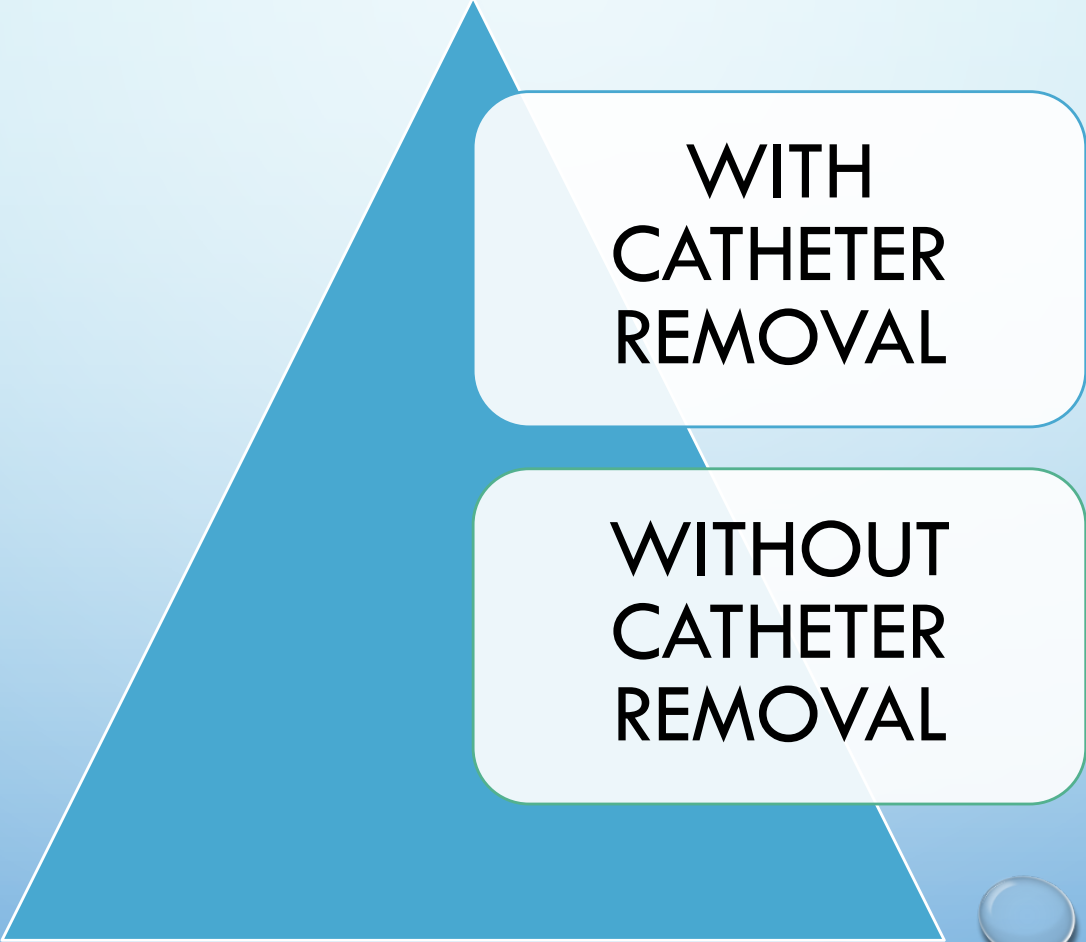
Two definitions of central venous catheter-related bloodstream infections

Bloodstream infection	Definitions
Catheter-related bloodstream infection	Clinical signs of sepsis and positive peripheral blood culture in the absence of an obvious source other than CVC with one of the following: Positive semiquantitative (>15 CFU) or quantitative ($>10^3$ CFU) culture from a part of the catheter with the same organisms isolated peripherally Simultaneous quantitative blood cultures with a ratio of $\geq 3:1$ (CVC vs. peripheral) Time difference of ≤ 2 hours leading to culture positive between CVC and peripheral cultures
Central line-associated bloodstream infection	Primary bloodstream infection in a patient who had a central line within the 48 hours period before development of infection Infection must not be related to an alternative cause

CVC, central venous catheter; CFU, colony forming unit.

Adapted from Bell T, et al. Infect Dis Clin North Am 2017;31:551-9, with permission of Elsevier. [3]

MICROBIOLOGIC DIAGNOSIS



**WITH
CATHETER
REMOVAL**

**WITHOUT
CATHETER
REMOVAL**

Table 2 Summary of main diagnostic methods for catheter-related bloodstream infections.

	Criteria for positivity	Interpretation	Comments	Recommendation
<i>Diagnosis without catheter withdrawal</i>				
Paired quantitative blood cultures	Ratio $\geq 3:1$	Both sets are positive for the same microorganism and the set obtained through the catheter has $\geq 3:1$ fold-higher colony count than the peripheral culture	Sensitivity $\approx 79\%$ Specificity $\approx 99\%$ Labor intensive and expensive	A-II
Paired blood cultures for differential time to positivity (DTP)	≥ 120 min	Both sets are positive for the same microorganism and the set obtained through the catheter becomes positive ≥ 120 min earlier	Sensitivity: 72% to 96% Specificity: 90% to 95% Less specificity for long-term catheters The interpretation of DTP should take into account adherence to the technical procedure and the type of microorganism	A-II
Endoluminal brushing	>100 CFU	Indicative of CRBSI	Sensitivity: 95% to 100% Specificity: 84% to 89% It may underestimate CRBSI in short-term catheters Risk of pathogen dissemination and thrombotic complications	C-III

Utility of Differential Time to Positivity in Diagnosing Central Line–Associated Bloodstream Infections: A Systematic Review and Meta-Analysis

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Background. Differential time to positivity (DTP), defined as pathogen growth at least 2 hours earlier from catheter versus paired peripheral blood cultures, is sometimes used to diagnose central line–associated bloodstream infections (CLABSI). Previous studies assessing DTP, however, have been small, provided conflicting results, and did not assess heterogeneity across important subgroups.

Methods. We systematically reviewed the diagnostic characteristics of DTP for CLABSI using MEDLINE, Embase, WoS, CINAHL, LILACS, AMED, and the Cochrane database. Studies were included if they reported sensitivities, specificities, predictive values, likelihood ratios, or 2 × 2 tables of DTP for diagnosing CLABSI. Extracted data were analyzed by using forest plots, bivariate model meta-analysis, and QUADAS-2 quality assessment.

Results. We identified 274 records, of which 23 met the criteria for meta-analysis. Among 2526 suspected CLABSI, DTP demonstrated a summary sensitivity of 81.3% (95% confidence interval [CI]: 72.8%–87.7%), specificity of 91.8% (95% CI: 84.5%–95.8%), positive likelihood ratio of 9.89 (95% CI: 5.14–19.00), and negative likelihood ratio of 0.20 (95% CI: .14–.30). Covariate analysis based on catheter duration, study design, and patient immune status demonstrated no significant differences. However, DTP performed worse for *Staphylococcus aureus* (low sensitivity but high specificity) and *Candida* (high sensitivity but low specificity) compared to other organisms.

Conclusions. DTP performs well in ruling CLABSI in or out. Obtaining paired catheter and peripheral blood cultures for DTP when the infectious source is unclear may prevent unnecessary line removal and diagnostic tests. However, this must be balanced against higher contamination rates from catheter cultures.

Keywords. DTP; CLABSI; sensitivity; specificity; meta-analysis.

Utility of Differential Time to Positivity in Diagnosing Central Line Associated Bloodstream Infections: A Systematic Review and Meta-Analysis

Dhaliwal et al., 2023 | *Clinical Infectious Diseases*



BACKGROUND: Differential time to positivity (DTP) supports the diagnosis of central line associated bloodstream infections (CLABSI) when blood cultures from a catheter become positive at least two hours before peripheral blood cultures. The purpose of this systematic review is to determine the diagnostic characteristics of DTP in diagnosing CLABSI



SEARCH STRATEGY AND STUDIES INCLUDED: A search was performed using MEDLINE, Embase, Web of Science, CINAHL, LILACS, AMED and the Cochrane database. Studies were eligible for inclusion if they reported sensitivities, specificities, predictive values, likelihood ratios, or 2x2 tables of DTP for diagnosing CLABSI.



METHODOLOGY: The identified studies were screened for inclusion by two independent reviewers. The extracted data were analysed by creating forest plots, performing bivariate model meta-analysis, and assessing quality using QUADAS-2.

INCLUDED STUDIES

Qualitative review: 28
Quantitative review: 23
of Suspected CLABSI: 2526



RISK OF BIAS: many of the included studies were at high risk of bias with respect to the reference standard

	[95% CI]
Sensitivity	81.3% [72.8 - 87.7]
Specificity	91.8% [84.5-95.8]
Positive Likelihood Ratio	9.89 [5.14 - 19.00]
Negative Likelihood Ratio	0.20 [0.14 - 0.30]

Additional Findings

- Covariate analysis based on catheter duration, study design, and patient immune status demonstrated no statistical significance
- DTP for *Staphylococcus aureus* and *Candida* CLABSIs performed poorly compared to other organisms.

CONCLUSION: DTP performs well in ruling CLABSIs in or out. Obtaining paired catheter and peripheral blood cultures for DTP when the infectious source is unclear may prevent unnecessary line removal and diagnostic tests, although this needs to be balanced against potentially higher contamination rates from catheter cultures.



2nd Edition

M47

Principles and Procedures for Blood Cultures

This guideline includes recommendations for collecting, transporting, and processing specimens for blood culture, as

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Gruppo di Lavoro Organizzativo dei
Percorsi Diagnostici (GLOPD)

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2. EMOCOLTURA PERCHÈ, QUANDO E COME

2.1 Perché

L'emocoltura rappresenta il *gold standard* per la diagnosi delle BSI. È anche la metodica con il miglior rapporto costo/efficacia permettendo di isolare, identificare e testare la sensibilità agli antimicrobici degli isolati batterici e/o fungini. (Singer *et al.*, 2016; Rhodes *et al.*, 2017, De Plato *et al.*, 2020)

2.2 Quando

BOX: L'emocoltura, nel sospetto di BSI, deve essere effettuata quanto prima, non appena viene formulato il sospetto clinico; soprattutto in caso di sepsi e shock settico. Non è raccomandato attendere il picco febbrile o l'insorgenza di brividi.

Una emocoltura va prescritta in risposta al sospetto clinico di batteriemia, associata non solo alla sepsi ma anche a polmonite, meningite, osteomielite e ad altre infezioni. Molti possono essere gli indicatori clinici che inducono alla prescrizione dell'esame, tra cui: la valutazione di segni di infezione localizzata con possibile coinvolgimento sistemico, la febbre o l'ipotermia, la presenza di brividi, la frequenza cardiaca elevata, la riduzione della pressione arteriosa, la variazione della frequenza respiratoria, l'alterato stato di coscienza. A corredo di una clinica suggestiva, il laboratorio fornisce degli importanti elementi che possono essere utili nella valutazione globale, come la conta dei globuli bianchi nell'emocromo, la proteina C reattiva (PCR), la procalcitonina, la proadrenomedullina, i lattati e più recentemente la presepsina (Singer *et al.*, 2016; De Plato *et al.*, 2020; Azim *et al.*, 2021).

Nonostante il timing di esecuzione delle emocolture sia uno dei principali fattori che influenza la sensibilità del metodo, ad oggi non esiste ancora un consenso a riguardo (Lamy *et al.*, 2016; De Plato *et al.*, 2020). Tuttavia, alcuni accorgimenti sono raccomandabili:

- L'esame deve essere prescritto tempestivamente a fronte del sospetto clinico;
- La batteriemia spesso non correla con segni e sintomi specifici, pertanto, non è indicato attendere la comparsa di brivido e/o del picco febbrile per eseguire il prelievo;
- L'esame deve essere eseguito prima o il più lontano possibile dall'inizio della terapia antibiotica empirica, questo tuttavia non deve causare ritardi nell'iter terapeutico (Rhodes *et al.*, 2017).

2.3 Come

BOX: La letteratura più recente indica che la "single sample strategy" presenta alcuni vantaggi rispetto allo standard corrente, basato sulla "multi sample strategy", soprattutto se si dispone di un team di personale dedicato e in generale nei reparti di terapia intensiva. In queste condizioni è consigliabile effettuare l'emocoltura tramite una singola venipuntura, utilizzando un kit con materiale pre-ordinato, secondo la tecnica "single sample strategy", prelevando circa 40 mL totali di sangue.

L'esame deve essere eseguito da personale infermieristico formato (è consigliata la presenza di due infermieri, ove praticabile) o addirittura di un *team* dedicato (es. tipo "PICC team") ed è consigliato organizzare un *kit* di prelievo che consenta di avere a disposizione del team tutti i dispositivi necessari per una corretta esecuzione (compresi i dispositivi per la disinfezione). Le modalità di prelievo, conservazione e invio dei flaconi devono essere codificate in procedure scritte da trasmettere a tutti i reparti e da esplicitare nella carta dei servizi del laboratorio.

Laddove possibile è generalmente raccomandata la "*single sample strategy*" ovvero il singolo prelievo di 30–40 mL di sangue da venipuntura periferica, da ripartire nei diversi flaconi di emocoltura (Jaimes *et al.*, 2004). La "*multi sample strategy*" viene utilizzata in specifiche circostanze, non solo legate alla tipologia di paziente, ma più spesso al sospetto di infezione: per esempio questa strategia è alla base della diagnosi di batteriemia associata ad endocardite infettiva subacuta (3 venipunture ad intervalli regolari in 24h, da ripetere in caso di negatività) (Li

et al., 1994; CLSI, 2022; Riedel *et al.*, 1975; Miller *et al.*, 2018; Dellinger *et al.*, 2013) oppure nel sospetto di infezione correlata a device (almeno 1 set dal device e 1 o più dalla vena periferica, simultaneamente).

Nel paziente con CVC, in cui si sospetti (o non si possa escludere) una sepsi catetere-correlata è indispensabile effettuare il prelievo:

- da vena periferica e dal/i catetere/i, contemporaneamente, dopo aver disinfettato il raccordo con soluzione alcolica, se compatibile con il materiale del CVC, senza scartare la prima quantità di sangue prelevato perché è quella con la più alta concentrazione di microbi. Il prelievo quando possibile dovrebbe essere effettuato scegliendo un accesso venoso posto dal lato opposto rispetto a dove è posizionato il CVC (es: CVC lato destro, accesso venoso a sinistra) (CLSI, 2022)
- Immettere rigorosamente la stessa quantità di sangue in ciascun flacone, ciò consentirà l'interpretazione dei risultati sulla base dei tempi di crescita.
- da vena periferica, (set: aerobi + anaerobi), prelevato come di consueto

Prelievo da vena periferica

Il set di prelievo a doppio ago (DA) (farfalla) per la raccolta del sangue direttamente nei flaconi corredato o meno di ISDD (*initial specimen diversion device*) è generalmente da preferirsi perché riduce i rischi di puntura accidentale per l'operatore, anche se non riduce quello di una possibile contaminazione nel prelievo. Infatti, la percentuale di contaminazione con il dispositivo a DA è del 3.7% contro il 2% dell'ago singolo (Rupp *et al.*, 2017). L'introduzione di *device* corredati da ISDD ha prodotto risultati preliminari molto soddisfacenti, riducendo, in uno studio, il tasso di contaminazione, da 1.78% allo 0.22%. Tuttavia, ulteriori studi più ampi sono necessari per accertare il reale impatto di tali *device*.

A corredo di procedure che ad oggi hanno un elevato grado di standardizzazione e con una rigorosa letteratura si vuole sottolineare che:

- È essenziale strofinare le mani per almeno 30 secondi con gel idroalcolico, prima di procedere al prelievo;
- È essenziale una corretta disinfezione della cute con una soluzione alcolica al 70% e clorexidina al 2% (30 secondi di attesa perché si asciughi);
- È essenziale una corretta disinfezione del tappo dei flaconi di emocoltura con lo stesso presidio antisettico usato per la disinfezione della cute nel rispetto delle indicazioni riportate dal produttore. Questo avviene idealmente poco prima del prelievo;
- È consigliato posizionare l'ago in vena e collegare il set di prelievo prima nel flacone per aerobi, poi nel flacone per anaerobi;
- È essenziale monitorare attentamente durante il prelievo la quantità di sangue prelevato in modo da inoculare ottimamente i flaconi, mantenendo i flaconi verticali e controllando il livello di liquido all'interno.

Non esistono in commercio flaconi sottovuoto capaci di raccogliere una quantità definita di sangue; quindi, il volume di sangue deve essere monitorato durante il prelievo dall'operatore. Se il prelievo venoso è effettuato anche per raccogliere sangue per altre determinazioni, i flaconi per emocoltura devono essere inoculati per primi al fine di evitare contaminazioni.

Il prelievo con siringa non è raccomandato.

Prelievo nel paziente con CVC, in cui si sospetti (o non si possa escludere) una batteriemia catetere-correlata

A corredo di procedure che ad oggi hanno un elevato grado di standardizzazione e con una abbondante letteratura in campo infermieristico si vuole sottolineare che:

- È essenziale che il prelievo dal/dai cateteri venga eseguito contemporaneamente con quello da vena periferica, dopo aver disinfettato il raccordo con un adeguato presidio antisettico;
- È essenziale non scartare la prima quantità di sangue prelevato dal CVC perché è quella con la più alta concentrazione microbica;
- È essenziale rispettare i volumi di inoculo cercando di immettere in ogni flacone la stessa quantità di sangue: ciò consentirà l'interpretazione dei risultati sulla base dei tempi di crescita.

3. MODALITÀ E TEMPI DI INCUBAZIONE DELLE EMOCOLTURE

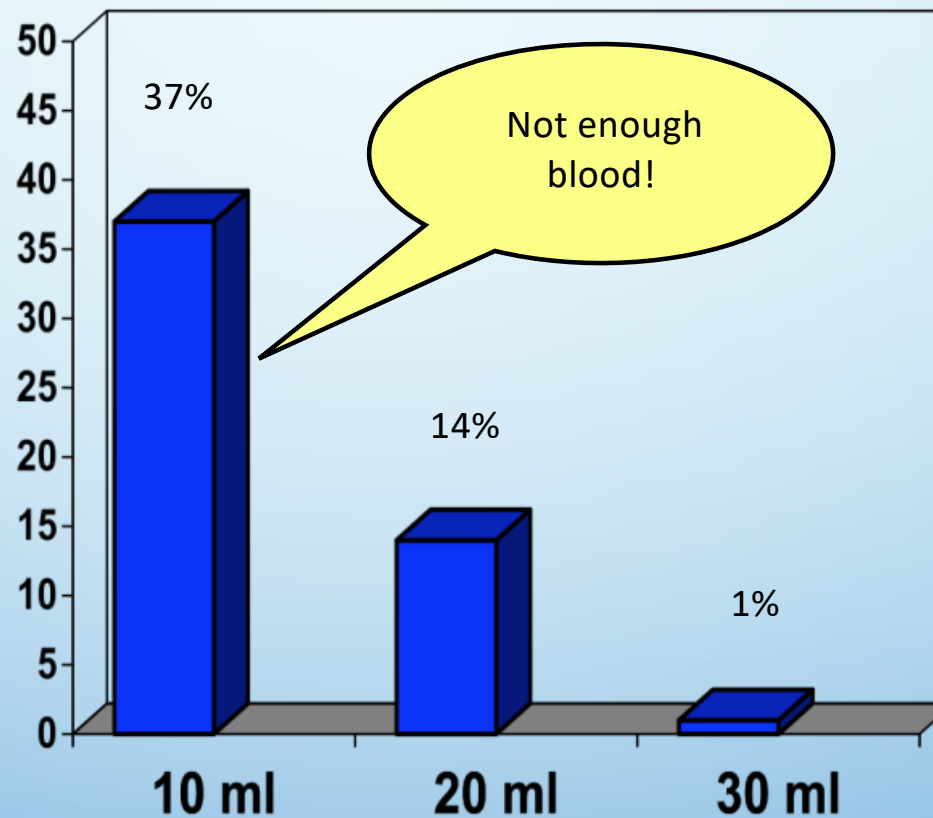
BOX: I flaconi di emocoltura devono essere incubati il più velocemente possibile, e comunque entro 2 ore dal prelievo, in sistemi di monitoraggio automatizzati che mantengano i flaconi in osservazione continua. Il tempo di incubazione raccomandato è di 5 giorni.

La maggior parte dei laboratori di microbiologia clinica sono dotati di sistemi semiautomatizzati o automatizzati per il monitoraggio continuo delle emocolture che consentono la rilevazione di emocolture positive in un tempo medio compreso fra le poche ore e 3 giorni, garantendo la rilevazione della positività in tempi più contenuti rispetto ai vecchi metodi manuali basati su ispezione visiva del flacone, colorazione di Gram e sub-coltura in cieco di flaconi per emocoltura a intervalli di tempo stabiliti *a priori* (24-48h di incubazione). Nei sistemi a monitoraggio continuo, il periodo di incubazione standard delle emocolture raccomandato è di 5 giorni ad una temperatura di 35 ± 2 °C (CLSI, 2022; Hagiya *et al.*, 2019, Lamy *et al.*, 2016, Lamy *et al.*, 2018, Lamy *et al.*, 2019, Lamy *et al.*, 2020).

Il 92-95% delle emocolture si positivizza entro le prime 24-48 ore di incubazione (Lamy *et al.*, 2019) con tempi in alcuni casi più lunghi per lieviti, batteri anaerobi e batteri particolarmente esigenti (vedi di seguito).

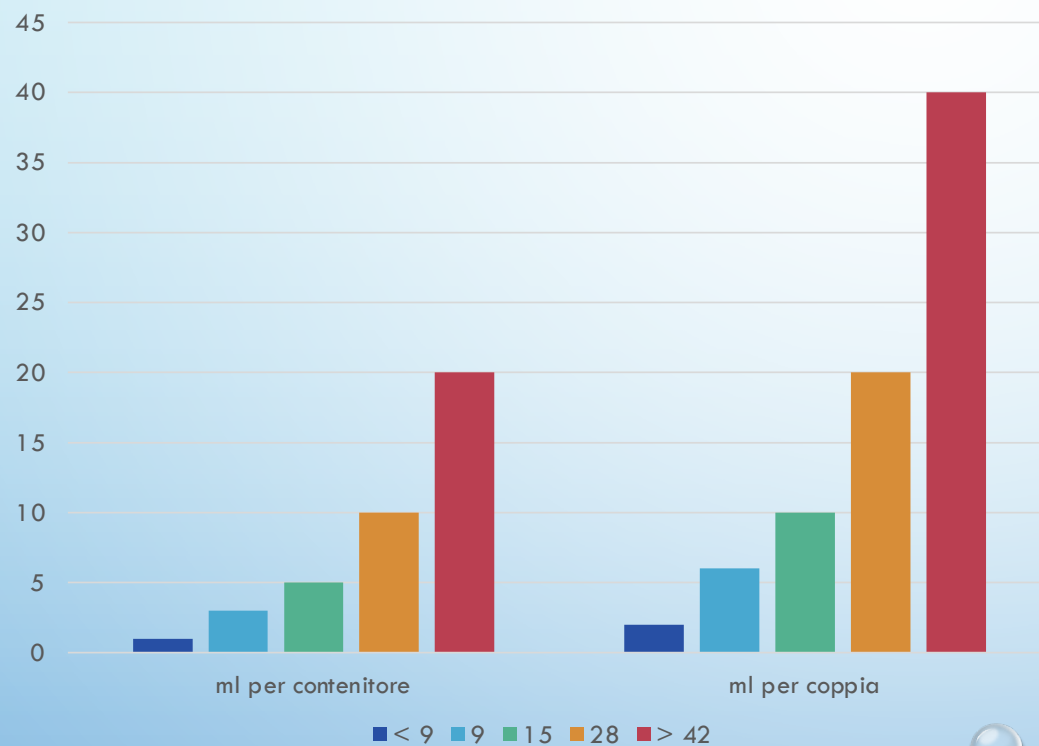
% False Negative vs. Volume of Blood

% False Negative
(blood culture is negative but patient is really septicemic)



Courtesy of E.J Baron, PhD, Dir of Microbiology Lab, Stanford Hosp

Distribuzione del peso e dei valori di ml per
contenitore e coppia



VOLUME DI SANGUE

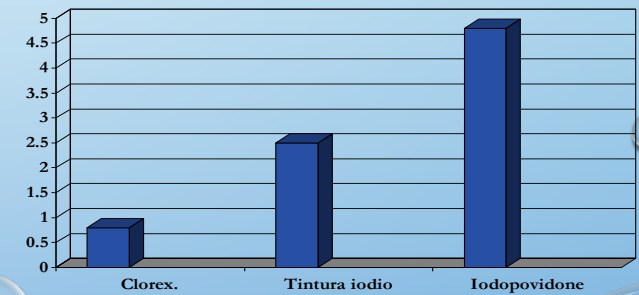
BARON, AVA 2006

IMPORTANCE OF SKIN ANTISEPSIS



Baylor, 2006

FALSE POSITIVE



CLABSI/LCBSI E CRBSI

Table 1.

Two definitions of central venous catheter-related bloodstream infections

Bloodstream infection	Definitions
Catheter-related bloodstream infection	Clinical signs of sepsis and positive peripheral blood culture in the absence of an obvious source other than CVC with one of the following: Positive semiquantitative (>15 CFU) or quantitative ($>10^3$ CFU) culture from a part of the catheter with the same organisms isolated peripherally Simultaneous quantitative blood cultures with a ratio of $\geq 3:1$ (CVC vs. peripheral) Time difference of ≤ 2 hours leading to culture positive between CVC and peripheral cultures
Central line-associated bloodstream infection	Primary bloodstream infection in a patient who had a central line within the 48 hours period before development of infection Infection must not be related to an alternative cause

CVC, central venous catheter; CFU, colony forming unit.

Adapted from Bell T, et al. Infect Dis Clin North Am 2017;31:551-9, with permission of Elsevier. [3]

Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central Line Associated Bloodstream Infection)

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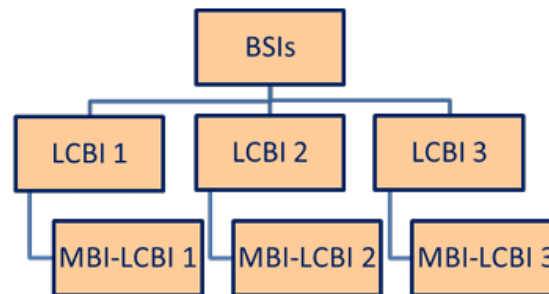
• NHSN CLABSI DEFINITION, JAN 2026

Definitions Specific to Bloodstream Infection (BSI) / Central Line Associated Bloodstream Infection (CLABSI) Surveillance:

Primary bloodstream infection (BSI): A Laboratory Confirmed Bloodstream Infection (LCBI) that is not secondary to an infection at another body site (see Appendix: Secondary BSI Guide and CDC/NHSN Surveillance Definitions for Specific Types of Infection [Ch-17], urinary tract infection (UTI) [Ch-7], pneumonia (PNEU) [Ch-6], and surgical site infection (SSI) [Ch-9]).

Laboratory Confirmed Bloodstream Infection (LCBIs) Hierarchy; Types of LCBIs

(see [Table 1](#) and [Table 2](#)):



Secondary BSI: A BSI that is thought to be seeded from a site-specific infection at another body site (see Appendix: Secondary BSI Guide and CDC/NHSN Surveillance Definitions for Specific Types of Infection, UTI, PNEU, and SSI).

Secondary BSI Attribution Period (SBAP): The period in which a blood specimen must be collected for a secondary BSI to be attributed to a primary site of infection. This period includes the Infection Window Period (IWP) combined with the Repeat Infection Timeframe (RIT). The SBAP is 14-17 days in length depending upon the date of event (See Secondary BSI Attribution period, Chapter 2).

Notes:

1. Neither the type of device nor the insertion site is used to determine if a device is considered a central line for NHSN reporting purposes. Any intravascular catheter (such as introducers, midlines, or arterial catheters) depending on the location of the tip and its use, may be considered a CL.
2. At times, a CL may migrate from its original central location after confirmation of proper placement. NHSN does not require ongoing verification of proper line placement. Therefore, once a line has been designated a CL it remains a CL, regardless of migration, until removed from the body or patient discharge, whichever comes first. CL days are included for any CLABSI surveillance conducted in that location.
3. A non-lumened intravascular catheter that terminates at or close to the heart or in a great vessel that is not used for infusion, withdrawal of blood or hemodynamic monitoring is not considered a CL for NHSN reporting purposes (for example, non-lumened pacemaker wires.)
 - There are some pacemaker wires that do have lumens, which may be considered a central line.

Types of Central Lines for NHSN reporting purposes:

1. Permanent central line: Includes:
 - a. Tunneled catheters, including tunneled dialysis catheters
 - b. Implanted catheters (including ports)
2. Temporary central line: A non-tunneled, non-implanted catheter
3. Umbilical catheter: A vascular catheter inserted through the umbilical artery or vein in a neonate. All umbilical catheters are central lines

Eligible Central Line: A CL that has been **in place for more than two consecutive calendar days** (on or after CL Day 3), following the *first access* (as defined above) of the central line, in an inpatient location, during the current admission. Such lines are eligible for CLABSI events and remain eligible for CLABSI events until the day after removal from the body or patient discharge, whichever comes first. (See [Table 3](#) for examples).

Eligible BSI Organism: Any organism that is eligible for use to meet LCBI or MBI-LCBI criteria. In other words, an organism that is not an excluded pathogen for use in meeting LCBI or MBI-LCBI criteria. All organisms may not be included in the [NHSN Terminology Browser](#). Contact NHSN for guidance regarding organisms that are not found in the browser.

January 2026

Device-associated Module
BSI

Devices **Not Considered Central Lines for NHSN Reporting Purposes:**

- Arterial catheters unless in the pulmonary artery, aorta, or umbilical artery
 - Arteriovenous fistula
 - Arteriovenous graft
 - Extracorporeal life support (ECMO)
 - Hemodialysis reliable outflow (HERO) dialysis catheter
 - Intra-aortic balloon pump (IABP) devices
 - Peripheral IV
 - Midlines unless the central line definition is met
 - Total Artificial Heart (TAH)
 - Ventricular Assist Device (VAD)
- 

Table 1: Laboratory-Confirmed Bloodstream Infection Criteria:

Must meet **one** of the following LCBI criteria:

Criterion	<i>Comments and reporting instructions that follow the site-specific criteria provide further explanation and are integral to the correct application of the criteria.</i> Once an LCBI determination is made, proceed to the MBI-LCBI definitions, and determine if the corresponding MBI-LCBI criteria are also met (for example, after meeting LCBI 2, investigate for potential MBI-LCBI 2)
LCBI 1 If LCBI 1 criterion is met, consider MBI-LCBI 1	Patient of any age has a recognized bacterial or fungal pathogen, not included on the NHSN common commensal list: 1. Identified from one or more blood specimens obtained by a culture OR 2. Identified to the genus or species level by non-culture based microbiologic testing (NCT)* methods (for example, T2 Magnetic Resonance [T2MR] or next-generation sequencing [NGS]). Note: <i>If blood is collected for culture within 2 days before, or 1 day after the NCT, disregard the result of the NCT and use only the result of the CULTURE to make an LCBI surveillance determination. If no blood is collected for culture within this time period, use the result of the NCT for LCBI surveillance determination.</i> AND Organism(s) identified in blood is not related to an infection at another site (See Appendix: Secondary BSI Guide). *For the purposes of meeting LCBI 1, NCT is defined as a methodology that identifies an organism directly from a blood specimen without inoculation of the blood specimen to any culture media.

	Notes: 1. If a patient meets both LCBI 1 and LCBI 2 or LCBI 3 criteria, report LCBI 1 with the recognized pathogen entered as pathogen #1 and the common commensal as pathogen #2. 2. An eligible organism in the blood specimen is the only element needed to meet LCBI 1 criterion; therefore, the LCBI 1 DOE <u>will always be</u> the collection date of the first positive blood specimen used to set the BSI IWP.
LCBI 2 If LCBI 2 criterion is met, consider MBI-LCBI 2	Patient of any age has at least <u>one</u> of the following signs or symptoms: fever (>38.0°C), chills, or hypotension AND Organism(s) identified in blood is not related to an infection at another site (See Appendix: Secondary BSI Guide). AND The same NHSN common commensal is identified by culture from two or more blood specimens collected on separate occasions (see Blood Specimen Collection). For common commensal organisms, refer to the NHSN Terminology Browser.

LCBI 3 If LCBI 3 criterion is met, consider MBI-LCBI 3	Patient ≤ 1 year of age has at least one of the following signs or symptoms: fever ($>38.0^{\circ}\text{C}$), hypothermia ($<36.0^{\circ}\text{C}$), apnea, or bradycardia AND Organism(s) identified in blood is not related to an infection at another site (See Appendix: Secondary BSI Guide). AND The same NHSN common commensal is identified by a culture from two or more blood specimens collected on separate occasions (see Blood Specimen Collection). For common commensal organisms, refer to the NHSN Terminology Browser.
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Table 1 The main features of currently used surveillance criteria of neonatal CLABSI summarised

From: [Sustainable neonatal CLABSI surveillance: consensus towards new criteria in the Netherlands](#)

	CDC	NEO-KISS	Dutch neonatal CLABSI criteria
Target patient population	≤ 1 year	Very low birthweight infants: birthweight < 1500 g	Neonates: postnatal age ≤ 28 days for term and up to postmenstrual age of 44 weeks for preterm infants
Description of CLABSI criteria	Laboratory-confirmed bloodstream infection (1) with a detected pathogen OR (2) with the same common commensal ^a confirmed by a second blood specimen	Laboratory-confirmed bloodstream infection (1) with a detected pathogen OR (2) with CoNS confirmed by a second blood specimen or one out of 4 laboratory elements Clinical sepsis (3) no detected pathogen	Laboratory-confirmed bloodstream infection (1) with a detected pathogen OR (2) with same common commensal ^a confirmed by a second blood specimen OR (3) with a common commensal and CRP > 10 mg/L
Clinical findings used in criteria	One out of four ^b clinical symptoms for CoNS CLABSI criteria	Two or more out of 16 ^c findings bundled in seven categories for all CLABSI criteria	Clinical symptoms of neonatal sepsis according to the treating physician for "common commensal CLABSI criteria"
Challenges for application in the Dutch setting	Two blood cultures for one event (not common practice, single blood culture policy)	Numerous clinical elements (labour intensive surveillance and possible interference with interrater agreement)	–

CDC, Centers for Disease Control; CLABSI, central line-associated bloodstream infections; CoNS, Coagulase-negative Staphylococci species; CRP, C-reactive protein; NEO-KISS, NEO-Krankenhaus Infektions Surveillance System

^aAccording to the NHSN Master Organism List

^bCDC clinical findings: fever (> 38 °C), hypothermia (< 36.5 °C), apnoea, or bradycardia

^cNEO-KISS clinical findings: (1) fever (> 38 °C) or temperature instability or hypothermia (< 36.5 °C); (2) tachycardia (> 200/min) or new increasing bradycardia (< 80/min); (3) capillary refill time > 2 s; (4) new or increasing apnoea (> 20 s); (5) otherwise unexplained metabolic acidosis (BE < – 10 mval/L); (6) new onset of hyperglycaemia (> 140 mg/dL); (7) other signs of sepsis (skin colour, biochemical signs, increasing oxygen requirement, unstable general status, apathy)

Central Line-Associated Bloodstream Infection Misclassifications—Rethinking the Centers for Disease Control and Prevention’s Central Line-Associated Bloodstream Infection Definition and Its Implications

ABSTRACT: Centers for Medicare and Medicaid Services imposes financial penalties for central line-associated bloodstream infections (CLABSIs) and other healthcare-acquired infections. Data for this purpose is obtained from the Centers for Disease Control and Prevention (CDC)’s National Health Safety Network. We present examples of misclassification of bloodstream infections into CLABSI by the CDC’s definition and present the financial implications of such misclassification and potential long-term implications.

KEYWORDS: bloodstream infections; Centers for Disease Control and Prevention; Centers for Medicare and Medicaid Services; central line-associated bloodstream infection; surveillance

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TABLE 1.**Potential Scenarios of Misclassifications of Bacteremia As Central Line-Associated Bloodstream Infections by Centers for Disease Control and Prevention/National Health Safety Network Definition**

Classification	Definition (3)	Examples of Potential Misclassifications (Not an Exhaustive List)
LCBI-1	Patient of any age has a recognized bacterial or fungal pathogen, not included on the NHSN common commensal list: 1) Identified from one or more blood specimens obtained by a culture OR 2) Identified to the genus or species level by nonculture-based microbiologic testing methods AND Organism(s) identified in blood is not related to an infection at another site	Misclassifications related to matching organism cultured from another site or lack thereof: <i>Mycobacterium avium-intracellulare</i> complex and <i>Mycobacterium tuberculosis</i> complex are not excluded from CLABSI definition by CDC though certain organisms such as <i>Histoplasma</i> species and <i>Cryptococcus</i> species are excluded. Implication: Overcounting An infected gangrenous leg about to be amputated may not need to be cultured for clinical purposes as it is being amputated well above the infected site. Bacteremia resulting from such primary site is categorized as CLABSI by CDC definition (3) because there is no matching organism cultured from another site. Implication: Overcounting
	LCBI-2 Patient of any age has at least "one" of the following signs or symptoms: fever (> 38.0°C), chills, or hypotension AND Organism(s) identified in blood is not related to an infection at another site AND The same NHSN common commensal is identified by a culture from two or more blood specimens collected on separate occasions	If antibiotics are given after obtaining blood cultures but before site specific cultures are obtained as is warranted in some clinical scenarios, for example, impending septic shock in a patient with infected joint or abscess at another site. Site-specific cultures are frequently of low yield after antibiotic administration. Implication: Overcounting Not all organisms are identified by microbiology laboratory in a polymicrobial culture. The unidentified organisms may be causing bacteremia, designated as CLABSI. Implication: Overcounting A common commensal such as coagulase negative <i>Staphylococcus</i> might grow from the blood and from a polymicrobial culture, for example from a foot wound and is classified as secondary BSI. Implication: Undercounting

TABLE 1. (Continued)

Potential Scenarios of Misclassifications of Bacteremia As Central Line-Associated Bloodstream Infections by Centers for Disease Control and Prevention/National Health Safety Network Definition

Classification	Definition (3)	Examples of Potential Misclassifications (Not an Exhaustive List)
LCBI-3	Patient ≤ 1 yr old has at least "one" of the following signs or symptoms: fever ($> 38.0^{\circ}\text{C}$), hypothermia ($< 36.0^{\circ}\text{C}$), apnea, or bradycardia AND Organism(s) identified in blood is not related to an infection at another site AND The same NHSN common commensal is identified by a culture from two or more blood specimens collected on separate occasions	Misclassifications related to special clinical circumstances: CDC's pneumonia (PNU1 and PNU2) definition refers to worsening respiratory status or bronchial breath sounds or rales (crackles). These should be present or occur within the IWP. A patient who is critically ill from before the 3 d preceding a positive blood culture may not show any more worsening of respiratory status during the IWP; they are already severely ill. In almost all these scenarios, it is difficult to hear bronchial breath sounds or rales or crackles and, therefore, cannot use that as a criterion to meet definition. So, bacteremia occurring as a result of severe pneumonia will be categorized as CLABSI. Implication: Overcounting Secondary BSI guide dictates specific criteria pertaining to IWP and secondary BSI attribution period. In some cases, especially osteomyelitis or pneumonia the imaging might fall just outside of the IWP classifying that BSI as CLABSI. Implication: Overcounting Burn infection definition requires a change in burn wound appearance or character such as rapid eschar separation, dark brown, black, or violaceous discoloration of eschar along with a positive blood culture which needs to be obtained within 3 d (before or after) these changes. A personal communication from CDC/NHSN also indicated change in color, drainage, etc., can be considered as a change in the burn wound. However, bacteremia can result from a burn wound with severe infection and the wound may not show any changes within that timeframe. Implication: Overcounting Only one blood culture is obtained because of difficult access. It is positive for a coagulase negative <i>Staphylococcus</i>. Patient has systemic signs of infection. This is not classified as CLABSI even if the line was the cause of bacteremia since only one blood culture was positive for the common commensal. Implication: Undercounting

BSI = bloodstream infection, CDC = Centers for Disease Control and Prevention, CLABSI = central line-associated bloodstream infection, IWP = infection window period, LCBI = laboratory-confirmed bloodstream infection, NHSN = National Health Safety Network.

Patient Safety

Complications of **Peripheral Venous Access Devices**: Prevention, Detection, and Recovery Strategies

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Most hospitalized patients have placement of a peripheral venous access device, either a short peripheral catheter or a peripherally inserted central catheter. Compared with central venous catheters that are not peripherally inserted, the other 2 types are generally perceived by health care providers as safer and less complicated to manage, and less emphasis is placed on the prevention and management of complications. Expertise of nurses in inserting, managing, and removing these devices may reduce the likelihood of complications, and increased recognition of complications associated with use of the devices is important to ensure continued improvements in the safety, quality, and efficiency of health care. Complications associated with short peripheral catheters and peripherally inserted central catheters include tourniquet retention, tubing and catheter misconnections, phlebitis, air embolism, device fragment embolization, and inadvertent discharge with a retained peripheral venous access device. Integration of prevention, detection, and recovery strategies into personal nursing practice promotes the quality and safety of health care delivery. (*Critical Care Nurse*. 2017;37[2]:e1-e14)

Table 1 Selected complications of peripheral venous access devices: definitions, signs, and symptoms

Complication	Definition	Potential signs and symptoms
Tourniquet retention	Tourniquet intended to temporarily promote venous distention for PVAD placement (or phlebotomy) is inadvertently left applied for an extended time	Transient pain, edema, and/or paresthesia of involved extremity and/or leaking at puncture or catheter insertion site(s) ⁹ Infusion may infiltrate or flow slowly ⁹
Tubing and catheter misconnections	Event wherein components of a medical device are attached to the connector or port of another device that performs a fundamentally different function (eg, attachment of enteral feeding tube to a PICC) ^{10,11}	May include back pain, fever, chest pain, dyspnea, anaphylaxis, cardiopulmonary arrest, seizures, altered mental status, sepsis, and/or coagulopathies ¹¹⁻¹⁵ Signs and symptoms vary widely, may be subtle or catastrophic, and onset varies widely, from insidious to abrupt
Phlebitis	Inflammation of vein wall due to chemical, mechanical, and/or particulate-induced irritation ³	Local pain, swelling, tenderness, and local and/or streaking erythema Venous cording (rigidity and firmness) may be palpable in severe cases ³
Air embolism	Inadvertent venous administration of air via intravenous access device or insertion site	Sudden dyspnea, cough, wheezing, chest and/or shoulder pain, agitation, sense of impending doom, tachypnea, tachycardia, hypotension, and/or neurological findings consistent with cerebrovascular accident ¹⁶ A harsh systolic murmur may be present
Device fragment embolization	Migration of part of a damaged vascular device (a fragment) through the vascular system ³	Palpitations, arrhythmias, chest pain, shortness of breath, cough, localized swelling and/or pain, confusion/altered mental status, and/or hypotension ^{3,17,18} Catheter dysfunction (eg, inability to flush or aspirate blood) may signal catheter damage or imminent embolization ^{3,18}
Retained PVAD at discharge	Situation in which a patient inadvertently leaves the health care setting with a PVAD in place despite the intention to remove the device before departure	No specific signs and symptoms beyond the presence of the device; secondary signs and symptoms may occur because of complications (eg, phlebitis or infection)
Catheter-associated venous thrombosis	Venous thrombosis due to the presence of a venous access device ³	Majority of patients are asymptomatic; when present, signs and symptoms include pain, edema, venous engorgement, and/or difficulty with motion of the affected extremity or shoulder, neck, or chest ³ If thromboembolism occurs, patients may show signs and symptoms of pulmonary embolism ³
Infiltration	Inadvertent administration of a nonvesicant solution into subcutaneous tissue instead of the intended vascular route ³	Persistent pain and burning at insertion site or along vascular pathway, edema, coolness or blanching of local tissue, leaking at the insertion site, and/or local paresthesias ³
Extravasation	Infiltration of a vesicant (an agent "capable of causing blistering, tissue sloughing, or necrosis") into subcutaneous tissue, instead of the intended vascular route ³	Signs may include erythema, which may progress to blistering and/or tissue necrosis
Infection associated with vascular access device	Infection (local or systemic) due to placement of a vascular access device	Local induration, erythema, tenderness, and/or site drainage (may be purulent); patients with more severe infections may show signs of systemic infection (eg, fever) ³

Abbreviations: PICC, peripherally inserted central catheter; PVAD, peripheral venous or vascular access device.

HEALTHCARE EPIDEMIOLOGY: Robert Weinstein, Section Editor

Short-term Peripheral Venous Catheter–Related Bloodstream Infections: A Systematic Review

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Short-term peripheral venous catheters (PVCs) are commonly used in healthcare settings. To determine the magnitude of bloodstream infections (BSIs) related to their use, PubMed, article bibliographies, and the authors' library were searched for pertinent articles. The incidence of PVC-related BSIs was 0.18% among 85063 PVCs. Short-term PVCs accounted for a mean of 6.3% and 23% of nosocomial BSIs and nosocomial catheter-related BSIs, respectively. Prolonged dwell time and catheter insertion under emergent conditions increased risk of PVC-related bloodstream infection (PVCR-BSI). If approximately 200 million PVCs are successfully inserted into adult patients each year in the United States, there may be many PVCR-BSIs occurring yearly. Clinicians should obtain blood cultures in patients with evidence of PVC infection and systemic symptomatology such as fever, carefully inspect the PVC insertion site in bacteremic or fungemic patients, and remove PVCs associated with localized infection with or without associated BSI.

Keywords. catheter; catheter infection; bloodstream infection; bacteremia; peripheral venous catheter.

Table 1. Risk of Peripheral Venous Catheter–Related Bloodstream Infection Compared to Central Venous Catheter–Related Bloodstream Infection

Study, First Author [Ref]	PVCR-BSI	PVCR-BSI vs CVCR-BSI	Nosocomial CR-BSI due to PVCs	Nosocomial BSI due to PVCs vs CVCs
Noble ^a [14]	0 of 203 PVCs			
Tully ^a [15]	0 of 468 PVCs			
Tager [16]	0.02% of 6286 PVCs			
Nystrom ^b [17]		0.37% of 6253 patients vs 4.5% of 424 patients		
Collignon ^c [34]		~0.1% of 23 000 PVCs vs ~1% of 2970 CVCs	43% of 61 CR-BSIs	
Cheesbrough [18]	0.2% of 519 PVCs			
Larson [19]	0 of 801 PVCs			
Gantz ^a [20]	0 of 431 PVCs			
Tomford [21]	0 of 972 PVCs			
Maki ^a [5]	0 of 2088 PVCs			
Maki [22]	0 of 878 PVCs			
Hoffmann ^a [23]	0 of 598 PVCs			
Jacquot ^a [24]	0 of 170 PVCs			
Richet ^a [25]		2.2% of 362 PVCs vs 5% of 503 CVCs (RR, 2.3; 95% CI, 1.03–4.9)		
Maki ^a [6]	0 of 1054 PVCs			
Collignon ^{b,c} [35]		~0.036% of 565 722 PVCs vs ~2.3% of 396 586 CVCs (RR, 64; 95% CI, 54–76)	47% of 491 CR-BSIs	
Fry [40]			50% of 143 CR-BSIs	
Breggenzer [10]	0 of 609 PVCs			
Soifer ^a [26]	0.3% of 875 PVCs			
Cornely [27]	0 of 412 PVCs			
Coello [41]			21% of 2377 CR-BSIs	7% due to PVCs vs 27% due to CVCs of 6956 BSIs
Bouza ^a [28]	0 of 523 PVCs			
Barbut [29]	0 of 525 PVCs			
Aygun ^d [30]	0.7% of 147 PVCs			
Collignon ^a [36]		~0.03% of 27 683 PVCs vs ~0.9% of 1238 CVCs	7% of 491 CR-BSIs	
Pujol [42]			37% of 150 CR-BSIs	
Lolom ^a [31]	1.1% of 1789 PVCs			
Rickard ^a [32]	0 of 362 PVCs			
Fakih [43]	0.02–0.04/1000 patient-days ^f		60% of 10 CR-BSIs	19% due to PVCs vs 32% due to CVCs of 31 BSIs
ECDC [44]			16% of 626 CR-BSIs	6.2% due to PVCs vs 33% due to CVCs of 1585 BSIs
Fakih [45]	0.04–0.2/1000 patient-days ^f		42% of 19 CR-BSIs	
Mestre [46]			18% of 48 CR-BSIs	
Almirante [37]		0.05/1000 patient-days for PVCs vs 0.19/1000 patient-days for CVCs vs 0.02/1000 patient-days for PICCs ^g	18.8% due to PVCs vs 76.5% due to CVCs vs 4.7% due to PICCs of 2977 CR-BSIs	
Delgado-Capel [38]		0.11/1000 admissions for PVCs vs 0.17/1000 admissions for CVCs	39.3% due to PVCs vs 57.2% due to CVCs vs 3.5% due to PICCs of 28 CR-BSIs	13% due to PVCs vs 19% due to CVCs vs 1% due to PICCs of 84 BSIs
RAISIN [2]	0.19% of 64809 PVCs	20% due to PVCs of 597 CRBSIs	8.3% due to PVCs vs 33% due to CVCs of 1456 BSIs	
Freixas [39]		0.05/1000 patient-days for PVCs vs 0.12/1000 patient-days for CVCs	29% of 396 CR-BSIs	
Marsh ^a [33]	0 of 85 PVCs			

Abbreviations: BSI, bloodstream infection; CI, confidence interval; CR-BSI, catheter-related bloodstream infection; CVCR-BSI, central venous catheter-related bloodstream infection; CVC, central venous catheter; ECDC, European Centre for Disease Prevention and Control; PICC, peripherally inserted central venous catheter; PVC, peripheral venous catheter; PVCR-BSI, peripheral venous catheter–related bloodstream infection; RR, relative risk.

^aData from prospective, randomized clinical trial.

- THE INCIDENCE OF PVCR-BSIS WAS 0.18% AMONG 85063 PVCS (RANGE, 0–2.2%)
- 0.04% OF 616 405 PVCS IN 3 AUSTRALIAN STUDIES
- THE RELATIVE RISK OF CVCR-BSI COMPARED TO PVCR-BSI VARIED FROM 1.5 TO 64
- IN 1 STUDY, THE INCIDENCE OF CATHETER-RELATED BLOODSTREAM INFECTION (CR-BSI) WAS 2.5-FOLD HIGHER FOR PVCS COMPARED TO PERIPHERALLY INSERTED CVCS
- A MEAN OF 22% (RANGE, 7%–60%) OF 7860 NOSOCOMIAL CR-BSIS WERE DUE TO PVCS
- PERIPHERAL VENOUS CATHETERS AND CVCS ACCOUNTED FOR A MEAN OF 6.3% (RANGE, 4.8%–19%) AND A MEAN OF 23% (RANGE, 13%–33%) OF 1 5936 NOSOCOMIAL BSIS, RESPECTIVELY

Infusion Therapy Standards of Practice

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47. VASCULAR ACCESS DEVICE-RELATED INFECTION

KEY DEFINITIONS

Catheter-Associated Bloodstream Infection (CABSI): Given variability in international definitions, outcome reporting, and application of the terms catheter-related bloodstream infection (CR-BSI) and central line-associated bloodstream infection (CLABSI), the INS Standards of Practice Committee is using the terminology catheter-associated bloodstream infection (CABSI) to refer to bloodstream infections (BSIs) originating from either peripheral intravenous catheters (PIVCs) and/or central vascular access devices (CVADs). Both are equally injurious and can occur from 4 possible sources:

1. During catheter insertion through transfer of microbes down the catheter tract.
2. Via the catheter hub/lumen during routine administration and manipulation at the hub/lumen.
3. Due to endogenous microorganisms within the bloodstream.
4. From contaminated infusates.

When CABSI is used within a standard, refer to the respective references in that standard to understand the terminology and definitions used in the cited studies.

Catheter-Related Bloodstream Infection (CR-BSI): The recognized diagnostic criterion that more accurately confirms the catheter as the source of the infection. It is diagnosed if the same organism is isolated from a blood culture and the tip culture and the quantity of organisms isolated from the tip is greater than 15 colony forming units (CFUs). Alternatively, differential time to positivity (DTP) requires the same organism to be isolated from a peripheral vein and a catheter lumen blood culture, with growth detected 2 hours sooner (ie, 2 hours less incubation) in the sample drawn from the catheter.

Central Line-Associated Bloodstream Infection (CLABSI): This is most commonly reported as a surveillance term; however, it is not an established diagnostic criterion. CLABSI is a primary BSI in a patient who had a central line the day of or day before infection and had more than 2 days of central access. CLABSI surveillance definition may overestimate the true incidence of CR-BSI.

47. VASCULAR ACCESS DEVICE-RELATED INFECTION

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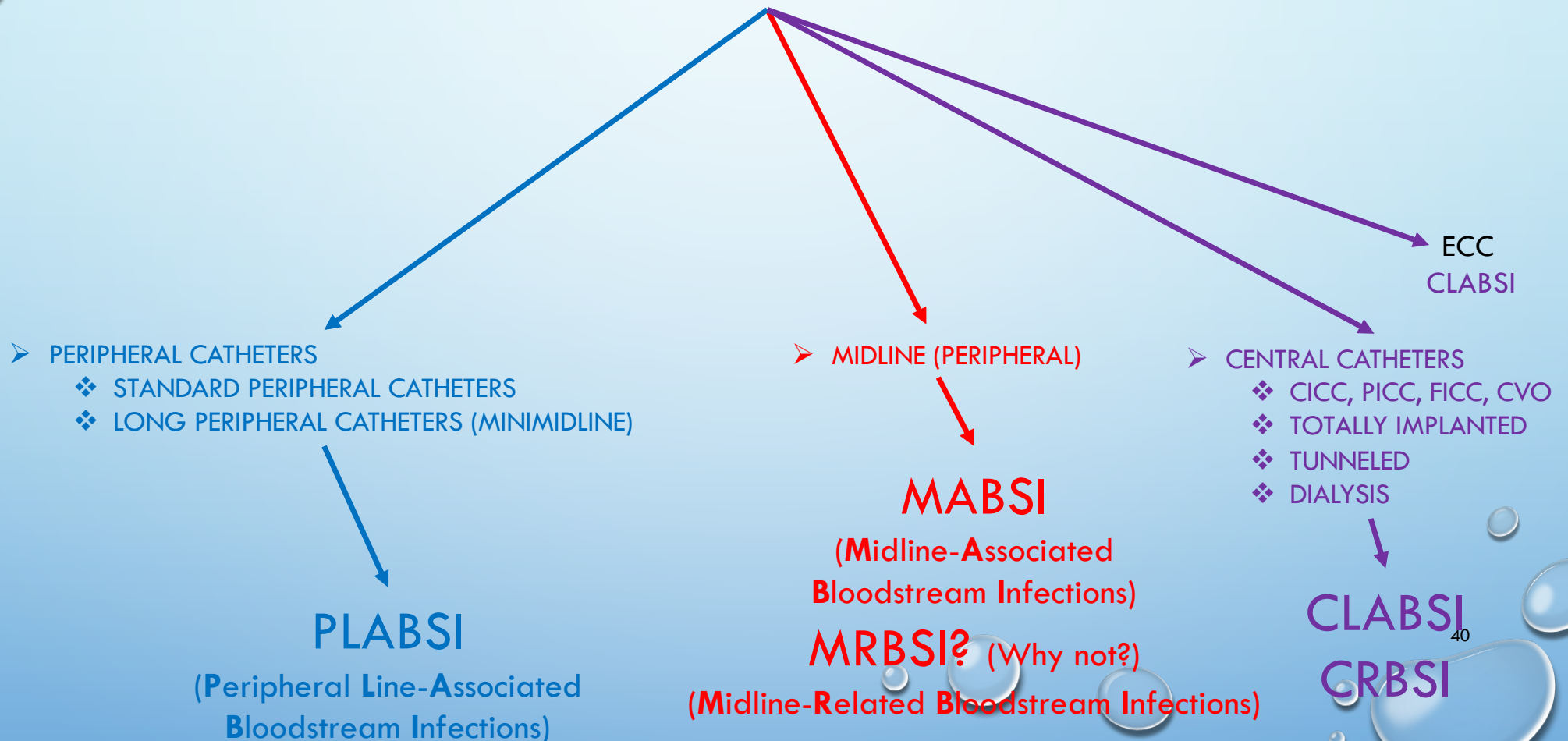
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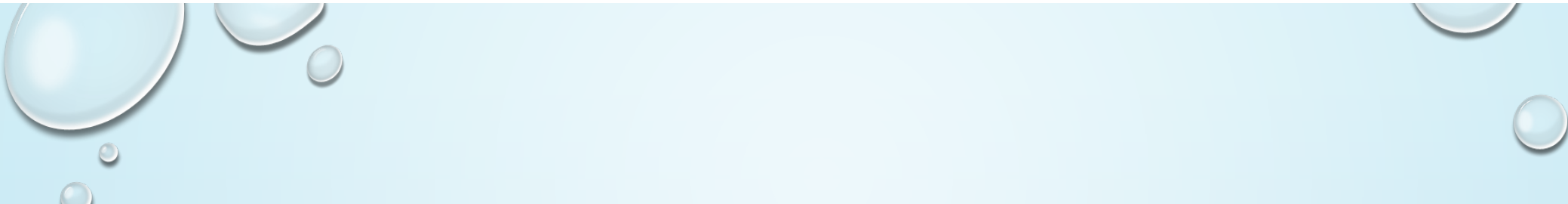
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CABSI

CATHETER ASSOCIATED BLOODSTREAM INFECTIONS





CRBSI O CLABSI

RIMOZIONE O TRATTAMENTO CONSERVATIVO?



DEVICE-RELATED INFECTIONS

- Ventricular derivations
- Contact lenses
- Endotracheal tubes
- Vascular central catheters
- Prosthetic cardiac valves, pacemakers and vascular grafts
- Peripheral vascular catheters
- Tissue fillers, breast implants
- Urinary catheters
- Orthopedic implants and prosthetic joints

TISSUE INFECTIONS

- Chronic otitis media, chronic sinusitis
- Chronic tonsillitis, dental plaque, chronic laryngitis
- Endocarditis
- Lung infection in cystic fibrosis
- Kidney stones
- Biliary tract infections
- Urinary tract infections
- Vaginosis
- Osteomyelitis
- Chronic wounds

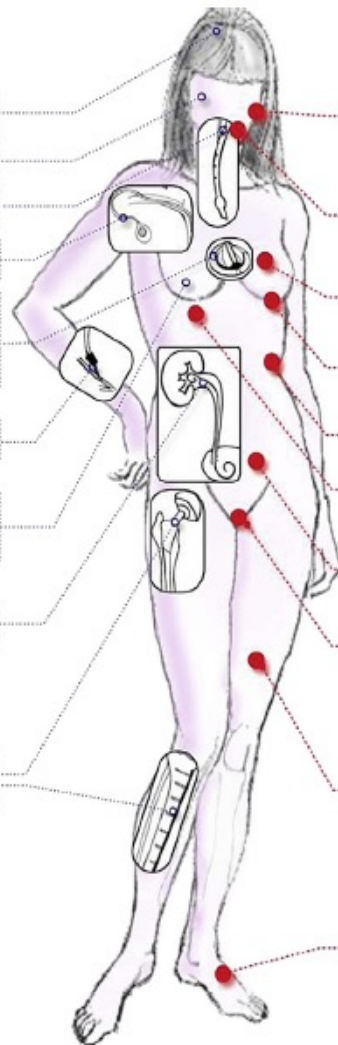
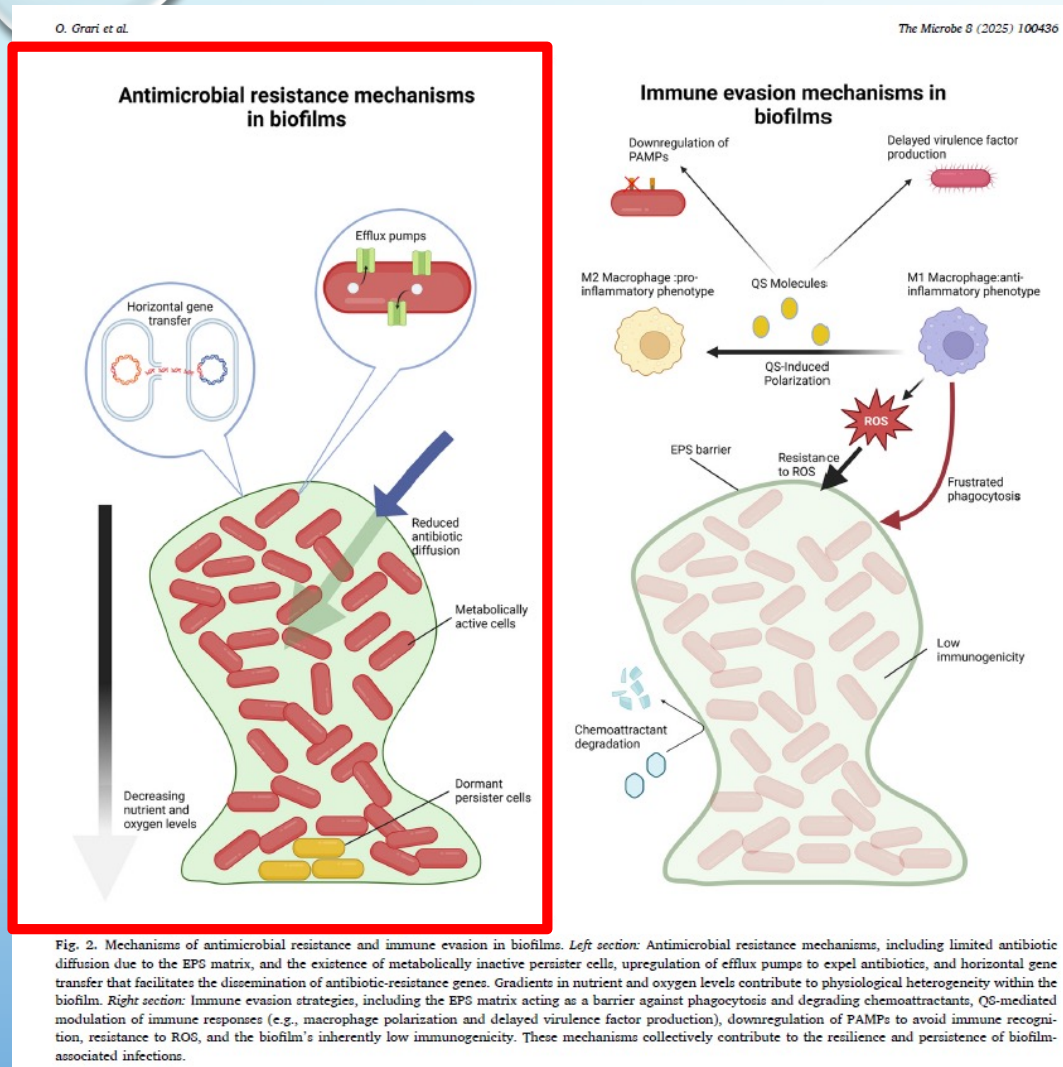


FIG. 1. Typical biofilm infections (3)
(reproduced with permission).

PATHOGENESIS OF BIOFILM-ASSOCIATED INFECTIONS



• Restricted diffusion of antimicrobial agents within the biofilm matrix

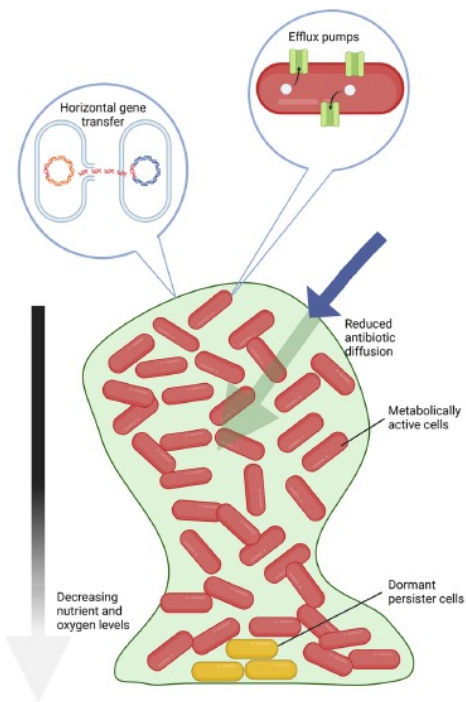
- The EPS acts as a physical barrier, slowing down the diffusion of antibiotic and other antimicrobial molecules
- Specific EPS components (polysaccharides and eDNA) can chemically interact with antibiotics
- EPS associated enzymes can inactivate antibiotics
- Significant physiological heterogeneity (gradients in nutrient and oxygen level: population of slow-growing or dormant persister cells more resistant to antibiotics)
- Upregulation of efflux pumps in biofilm associated bacteria
- Facilitation of horizontal gene transfer at higher rates than planktonic cells

PATHOGENESIS OF BIOFILM-ASSOCIATED INFECTIONS

O. Grari et al.

The Microbe 8 (2025) 100436

Antimicrobial resistance mechanisms in biofilms



Immune evasion mechanisms in biofilms

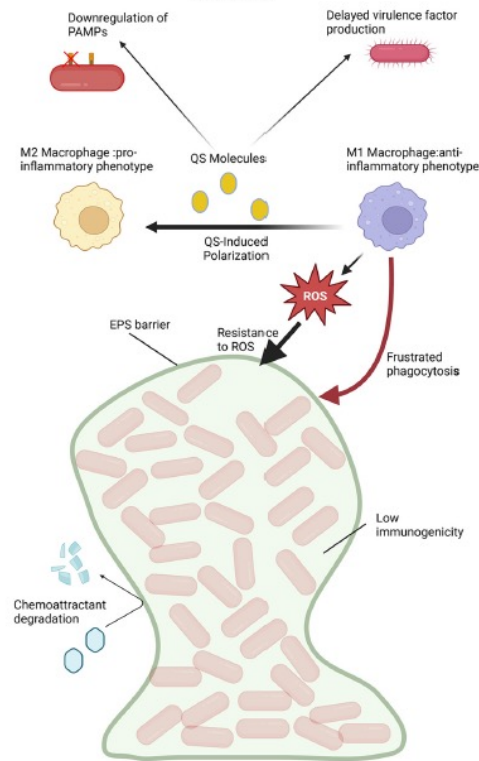


Fig. 2. Mechanisms of antimicrobial resistance and immune evasion in biofilms. *Left section:* Antimicrobial resistance mechanisms, including limited antibiotic diffusion due to the EPS matrix, and the existence of metabolically inactive persister cells, upregulation of efflux pumps to expel antibiotics, and horizontal gene transfer that facilitates the dissemination of antibiotic-resistance genes. Gradients in nutrient and oxygen levels contribute to physiological heterogeneity within the biofilm. *Right section:* Immune evasion strategies, including the EPS matrix acting as a barrier against phagocytosis and degrading chemoattractants, QS-mediated modulation of immune responses (e.g., macrophage polarization and delayed virulence factor production), downregulation of PAMPs to avoid immune recognition, resistance to ROS, and the biofilm's inherently low immunogenicity. These mechanisms collectively contribute to the resilience and persistence of biofilm-associated infections.

• Immune Evasion mechanisms

- EPS matrix physical barrier, which inhibits the recognition and engulfment of biofilm by immune cells («frustrated phagocytosis»)
- QS System
 - Control the expression of virulence factors
 - Influence the polarization of macrophages (transition from a pro-inflammatory M1 state to an anti-inflammatory M2 state)
 - Down-regulate the expression of Pathogen Associated Molecular Patterns (PAMPs)
- Resistance to reactive oxygen species (ROS) generated by immune cells

THE BIOFILM IS THE REASON FOR WHICH THE STANDARD OF CARE OF CRBSI AND CLABSI IS...



IV ANTIBIOTICS



CATHETER REMOVAL

IF CATHETER REMOVAL IS NOT FEASIBLE AND SALVAGE IS ATTEMPTED...



IV ANTIBIOTICS



LOCK THERAPY

Antibiotic-lock therapy: a clinical viewpoint

Expert Rev. Anti Infect. Ther. 12(1), 117–129 (2014)

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Antibiotic lock therapy (ALT) – instillation of high concentrations of anti-microbial agent with or without anti-coagulant into the lumen of central venous catheters – is considered a valid conservative treatment for catheter-related bloodstream infection (CRBSI) in patients highly dependent on maintaining the catheter. Results from randomized controlled studies have indicated that the effectiveness of ALT is moderate, but recent findings from experimental studies and observational case series point to considerable efficacy and safety of this therapy, which is usually associated with concomitant systemic treatment. In this article, the current knowledge about ALT for patients with CRBSI is reviewed and discussed, with emphasis on existing controversies and the results obtained according to the various uses of the catheters and the etiologies of infection.

KEYWORDS: antibiotic lock therapy • catheter-related sepsis • conservative management • permanent central venous catheter

Management of IV Access

- Infectious Disease Society of America (IDSA) recommendations on managing pediatric patients, including neonates, with a suspected or proven catheter-related infection
 - indications for catheter removal are similar to adults, however, consider the difficulty in obtaining an alternative venous access site ([IDSA Grade A, Level II](#))
 - closely monitor children treated without catheter removal with regular clinical evaluation and additional blood cultures, and remove the device if there is clinical deterioration or a recurrent catheter-related blood stream infection (CRBSI) ([IDSA Grade B, Level III](#))
 - empiric therapy is similar to adults ([IDSA Grade A, Level II](#))
 - antibiotic lock therapy is recommended when the catheter is salvaged ([IDSA Grade B, Level II](#))
 - in cases when antibiotic lock therapy cannot be used, consider systemic antibiotics through a colonized catheter ([IDSA Grade C, Level III](#))
 - Reference - [Clin Infect Dis 2009 Jul 1;49\(1\):1](#), corrections can be found in [Clin Infect Dis 2010 Feb 1;50\(3\):457](#), [Clin Infect Dis 2010 Apr 1;50\(7\):1079](#)
- no randomized trials found comparing early catheter removal vs. expectant management in neonates with central venous catheters and bloodstream infections ([Cochrane Database Syst Rev 2016 Apr 20;4\(4\):CD008436](#))

Clinical Practice Guidelines for the Diagnosis and Management of Intravascular Catheter-Related Infection: 2009 Update by the Infectious Diseases Society of America

Leonard A. Mermel,¹ Michael Allon,² Emilio Bouza,⁹ Donald E. Craven,³ Patricia Flynn,⁴ Naomi P. O'Grady,⁵ Issam I. Raad,⁶ Bart J. A. Rijnders,¹⁰ Robert J. Sherertz,⁷ and David K. Warren⁸

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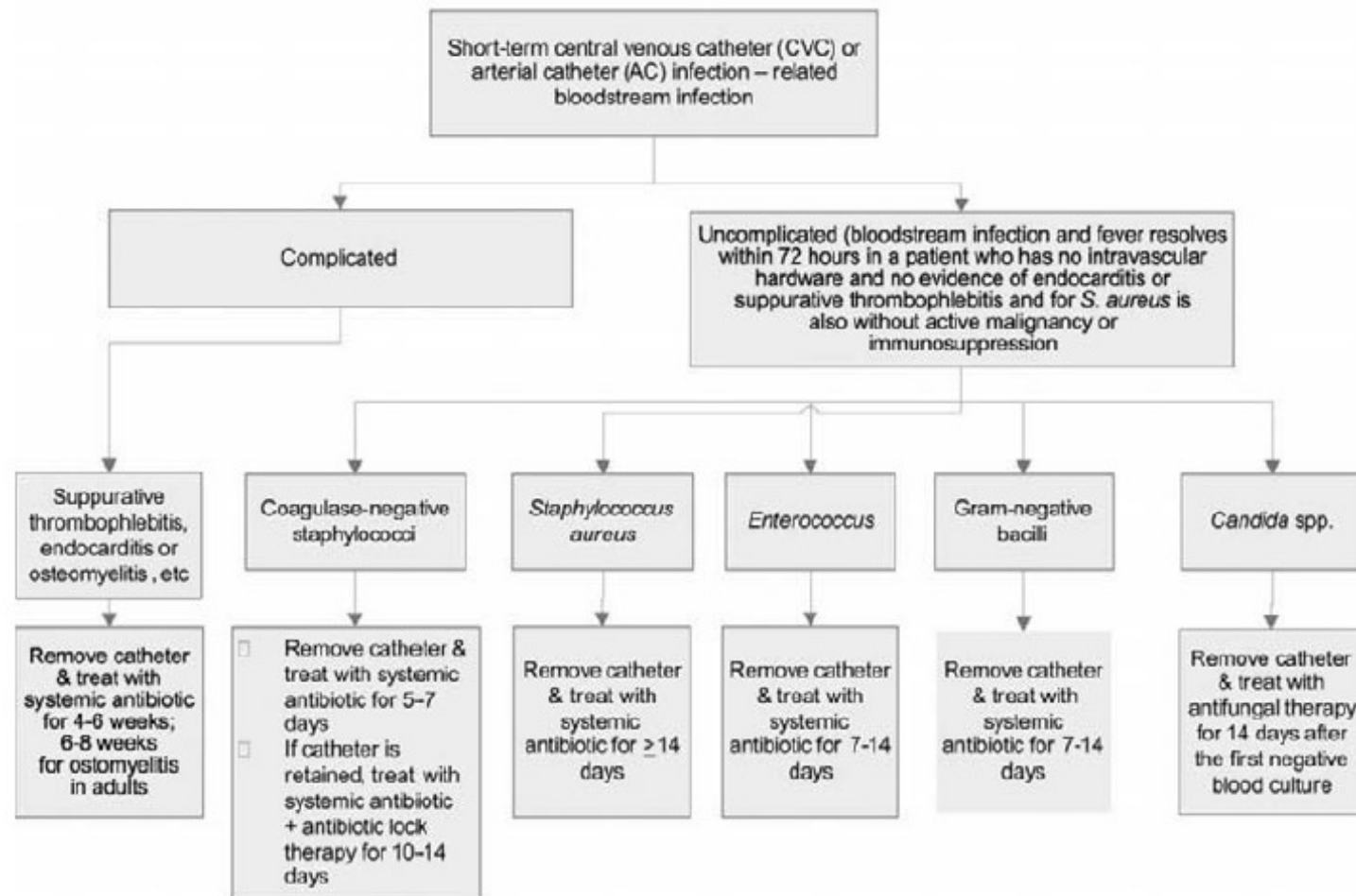


Figure 2. Approach to the management of patients with short-term central venous catheter–related or arterial catheter–related bloodstream infection. CFU, colony-forming units; *S. aureus*, *Staphylococcus aureus*.

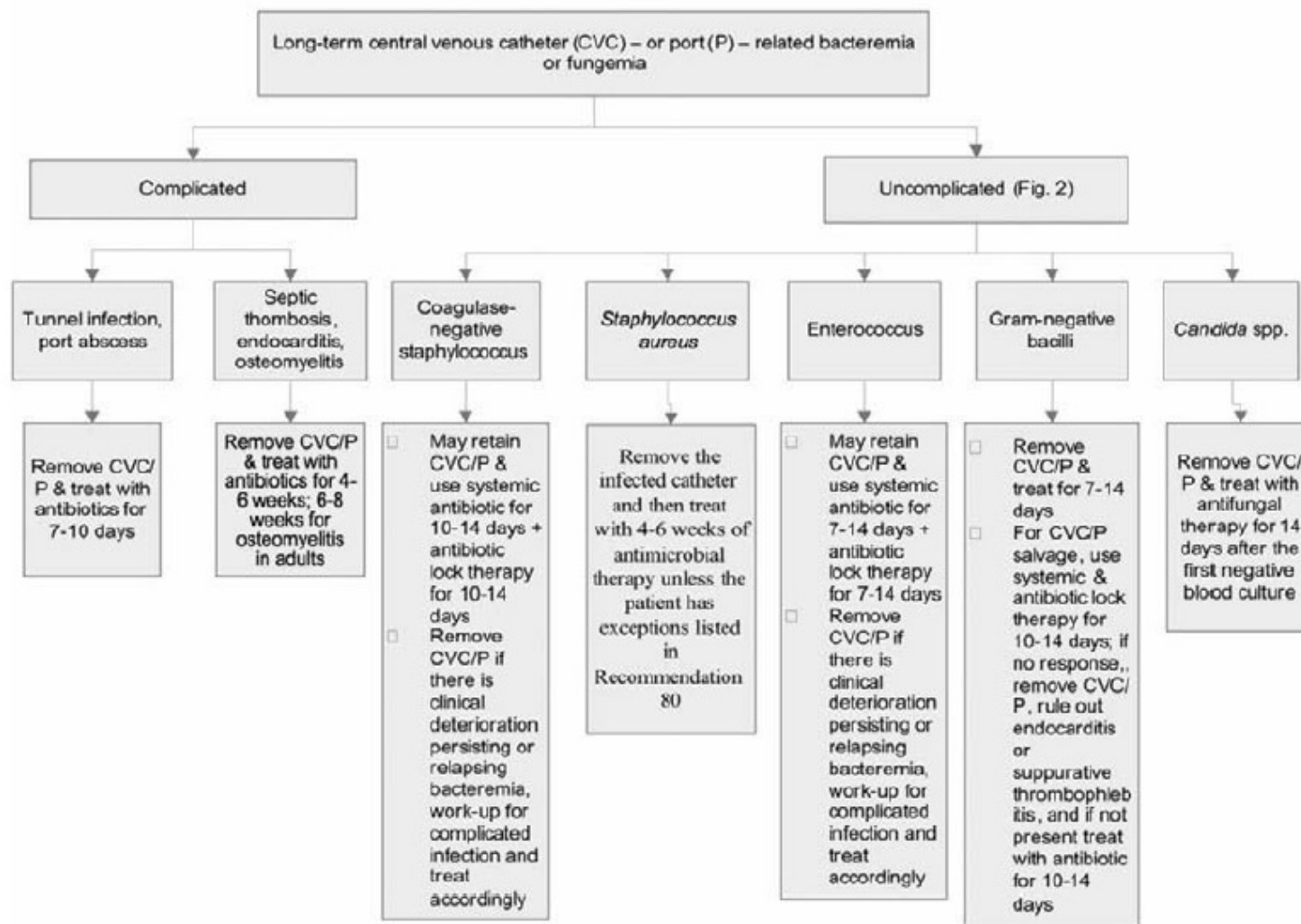


Figure 3. Approach to the treatment of a patient with a long-term central venous catheter (CVC) or a port (P)-related bloodstream infection.



Med Intensiva. 2018;42(1):5–36



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CONSENSUS STATEMENT

Diagnosis and treatment of catheter-related bloodstream infection: Clinical guidelines of the Spanish Society of Infectious Diseases and Clinical Microbiology and (SEIMC) and the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC)[☆]

F. Chaves^a, J. Garnacho-Montero^{b,*}, J.L. del Pozo (Coordinators)^c,
Authors: E. Bouza^d, J.A. Capdevila^e, M. de Cueto^f, M.Á. Domínguez^g,
J. Esteban^h, N. Fernández-Hidalgoⁱ, M. Fernández Sampedro^j, J. Fortún^k,
M. Guembe^l, L. Lorente^m, J.R. Pañoⁿ, P. Ramírez^o, M. Salavert^p,
M. Sánchez^q, J. Vallés^r



Confirmed CRBSI

Coagulase-Negative
Staphylococcus

- CoNS (1)
- Consider catheter removal (if not done) (2)
- Antimicrobial therapy for 5 days (3)
- Vancomycin is the first option (4)
- Echocardiography is not mandatory (5)
- Remove catheter if *S. lugdunensis* is isolated
- Catheter retained
 - Antimicrobial therapy for 10–14 days
 - Vancomycin in the first option (4)
 - ALT with vancomycin for 10–14 days
 - Echocardiography is not mandatory (5)

Staphylococcus aureus

- Removal of the catheter is mandatory
- Antimicrobial therapy for 14 days (6)
- Cloxacillin or cefazolin are the alternatives for MSSA
- Vancomycin or daptomycin are the alternatives for MRSA (7) (8)
- Echocardiography is mandatory

Enterococcus spp.

- Removal of the catheter is mandatory
- Antimicrobial therapy for 7–14 days
- Ampicillin is the drug of choice for susceptible strains (9)
- Vancomycin is the alternative for strains resistant to ampicillin (10)
- Echocardiography is mandatory

Gram-negative
bacilli

- Remove the catheter (if not done) (2)
- Antimicrobial therapy for at least 7 days (3)
- Antimicrobial therapy must be chosen based on the susceptibility results
- Echocardiography is not mandatory (5)
- Catheter retained (11)
 - Antimicrobial therapy for 10–14 days
 - Antimicrobial therapy must be chosen based on the susceptibility results
 - ALT for 10–14 days
 - Echocardiography is not mandatory (5)

Candida spp.

- Removal of the catheter is mandatory
- Antifungal therapy for 14 days after the first negative blood culture (12)
- Targeted antifungal therapy must be chosen based on the susceptibility results (13)
- Echocardiography is mandatory

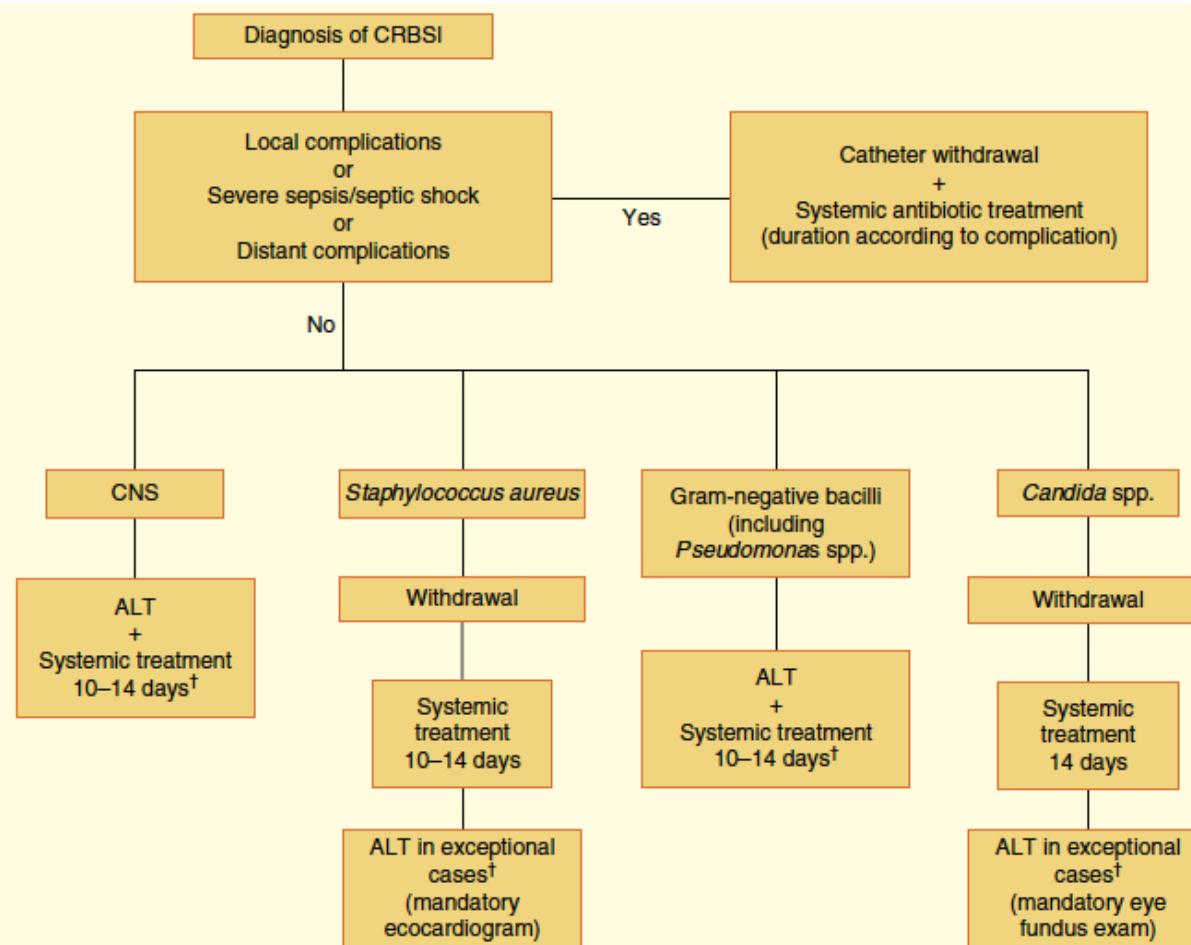


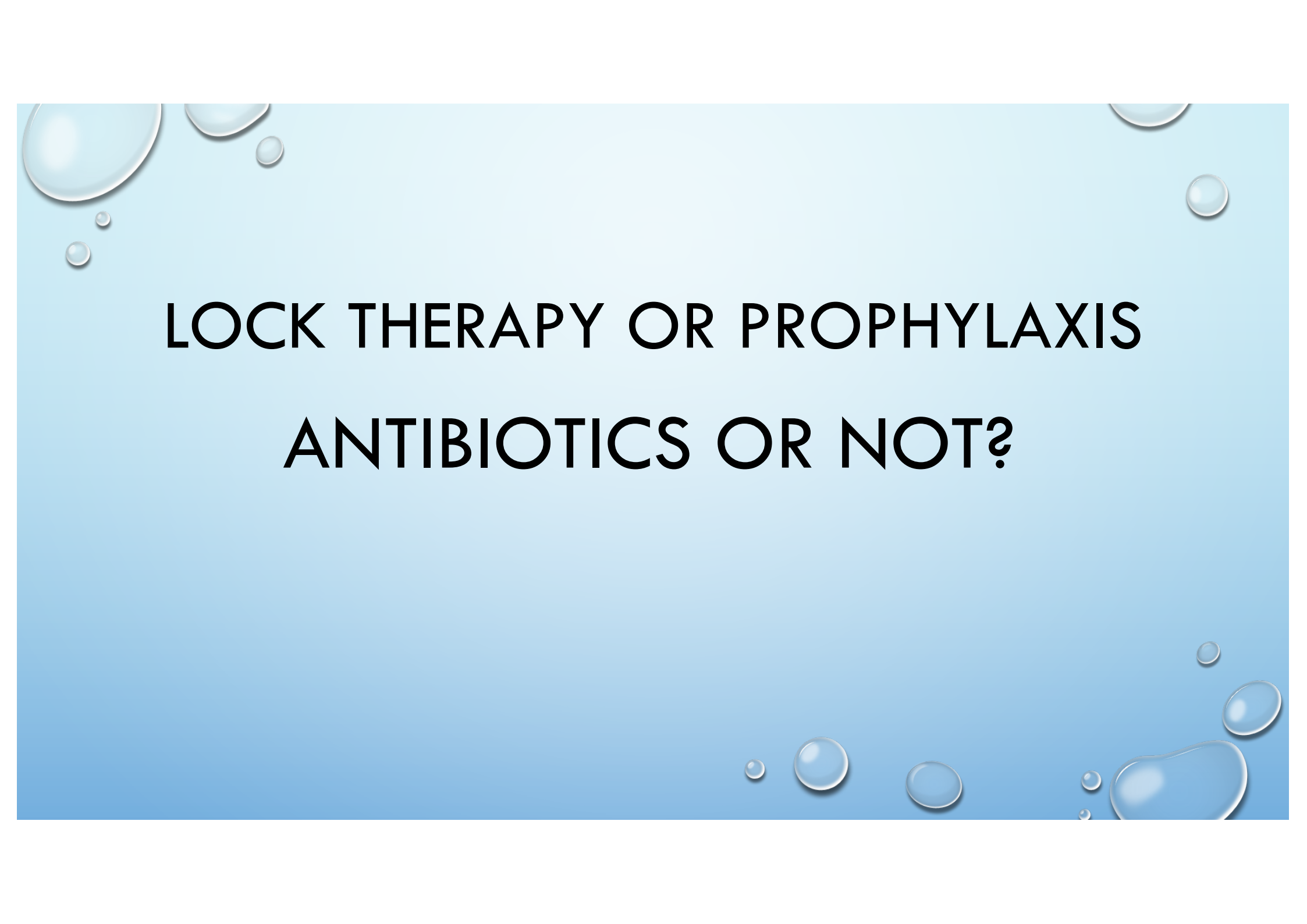
Figure 1. Therapeutic decision algorithm for catheter-related bloodstream infection. Duration of antibiotic treatment in the absence of complications. Otherwise, follow recommendations in therapeutic guidelines. When the catheter is removed in the absence of complications, antibiotic treatment duration can be reduced to 7 days in CNS infections and 7–10 days in gram-negative bacilli infections.

†Control blood culture is recommended 72 h following the start of conservative treatment. When results are positive, the catheter should be withdrawn.

ALT: Antibiotic lock therapy; CNS: Coagulase-negative staphylococci; CRBSI: Catheter-related bloodstream infection.

RULES TO ADMINISTER ANTIMICROBIAL LOCK THERAPY (ALT)

- DETERMINE THE CATHETER FILL VOLUME TO IDENTIFY THE VOLUME OF LOCK SOLUTION
 - A COMMON METHOD IS TO FLUSH THE LINE WITH NORMAL SALINE; ATTACH A NEW 5 ML SYRINGE TO THE CATHETER; ASPIRATE SLOWLY UNTIL BLOOD APPEARS AT THE SYRINGE TIP; THE AMOUNT OF SALINE IS THE «FILL VOLUME» OF LOCK SOLUTION THAT SHOULD BE ADMINISTERED
- PREPARE ANTIMICROBIAL LOCK SOLUTION USING ASEPTIC TECHNIQUE UNDER STERILE CONDITIONS IMMEDIATELY PRIOR TO INSTILLATION INTO THE CATHETER LUMEN
- THE OPTIMAL DWELL TIME IS NOT KNOWN AND MAY RANGE FROM HOURS TO DAY, DEPENDING ON STABILITY OF THE LOCK SOLUTION AND THE AMOUNT OF TIME AVAILABLE WHEN THE CATHETER IS NOT IN USE
- IN GENERAL THE DURATION OF ALT IS THE SAME AS THE DURATION OF SYSTEMIC ANTIBIOTIC THERAPY, BUT IT DEPENDS ON THE ORGANISMS AND OTHER PATIENT FACTORS.

The background is a light blue gradient with several realistic water droplets of various sizes scattered around the edges. The droplets have highlights and shadows, giving them a 3D appearance.

LOCK THERAPY OR PROPHYLAXIS ANTIBIOTICS OR NOT?

IDEAL LOCK SOLUTION

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CONSENSUS STATEMENT

Diagnosis and treatment of catheter-related bloodstream infection: Clinical guidelines of the Spanish Society of Infectious Diseases and Clinical Microbiology and (SEIMC) and the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC)☆



F. Chaves^a, J. Garnacho-Montero^{b,*}, J.L. del Pozo (Coordinators)^c,
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M. Sánchez^q, J. Vallés^r

- SPECTRUM OF ACTIVITY SHOULD INCLUDE COMMON OR TARGETED PATHOGENS
- ABILITY TO PENETRATE OR DISRUPT A BIOFILM
- COMPATIBILITY WITH ANTICOAGULANTS
- PROLONGED STABILITY
- LOW RISK OF TOXICITY OR ADVERSE EVENTS
- LOW POTENTIAL FOR RESISTANCE
- COST EFFECTIVENESS

Beta-lactams

Ampicillin	<i>K. pneumoniae</i> (beta-lactamase positive)	0%	NA	11
	<i>K. pneumoniae</i> (beta-lactamase negative)	80%–100%	Rapid	11
Oxacillin	<i>S. aureus</i> , <i>S. epidermidis</i>	<70%	NR	76
Piperacillin	<i>P. aeruginosa</i>	50%–100%	Rapid	75
	<i>P. aeruginosa</i>	0%–15%	NR	82
Cefotaxime	<i>S. aureus</i> , <i>S. epidermidis</i>	68%–70%	NR	76
Imipenem	<i>P. aeruginosa</i>	50%–100%	Rapid	75

Glycopeptides

Vancomycin	<i>S. aureus</i> , <i>S. epidermidis</i>	<70%	NR	76
	<i>S. epidermidis</i>	Adequate ^c	Slow	77,83
	<i>S. aureus</i>	Adequate ^{b,d}	Slow	9

Aminoglycosides

Streptomycin	<i>B. cereus</i> , <i>P. fluorescens</i>	0%–60%	NR	10
Tobramycin	<i>P. aeruginosa</i>	40%	Slow	74
Gentamicin	<i>P. aeruginosa</i>	<25%	Slow	75
Amikacin	<i>P. aeruginosa</i>	<25%	Slow	75
	<i>S. aureus</i> , <i>S. epidermidis</i>	79%–98%	NR	76

Notes: ^aComparable penetration compared to isolates of planktonic cells; ^bmeasured as intensity of fluorescence using confocal microscopy or other methods; ^cvancomycin concentrations reportedly exceeded the minimal inhibitory concentrations and minimal bactericidal concentrations for tested isolates; ^drepresents vancomycin concentrations from 15–45 µg/mL.

Abbreviations: NA, not applicable; NR, not reported.

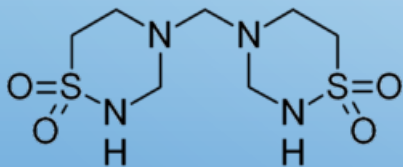


ANTIMICROBIAL (NON-ANTIBIOTIC) SOLUTIONS USED FOR LOCK THERAPY OR PROPHYLAXIS

- ETHANOL
 - **TAUROLIDINE**
 - CITRATE
 - EDTA
- 

TAUROLIDINE

- TAURINE AMINO ACID DERIVATIVE, AN ANTIMICROBIAL AGENT WITH BROAD SPECTRUM OF ANTIBACTERIAL AND ANTIFUNGAL ACTION
- THE METHYL DERIVATIVES OF TAUROLIDINE INTERACT WITH THE BACTERIAL WALL (PARTICULARLY FLAGELLA AND FIMBRIAE), CAUSING IRREVERSIBLE DAMAGE TO THE BACTERIAL WALL, WHICH CONSISTS OF AN INABILITY TO ADHERE (THUS AN INABILITY TO FORM BIOFILM!)
- UNLIKE ANTIBIOTICS, TAUROLIDINE ACTS BY A CHEMICAL REACTION AT THE LEVEL OF THE BACTERIAL WALL.
- THE OTHER MECHANISM OF ACTION IS THE INACTIVATION OF BACTERIAL EXO- AND ENDOTOXINS. THIS MAKES THE INDUCTION OF BACTERIAL RESISTANCE HIGHLY UNLIKELY.
- TAUROLIDINE HAS A BACTERICIDAL EFFECT ON GRAM-POSITIVE AND GRAM-NEGATIVE BACTERIA, INCLUDING MDR, AND FUNGI.
- THERE ARE CURRENTLY NO REPORTED RESISTANCES TO TAUROLIDINE.





In vitro activity of taurolidine against clinical *Candida auris* isolates: relevance to catheter-related bloodstream infections

Bruce E. Reidenberg,¹ Stephen G. Jenkins,^{2,3} Jared L. Crandon,⁴ Elizabeth Hurlburt,⁴ Xing Tan,⁴ Paul R. Rhomberg,⁵ S. J. Ryan Arends,⁵ Antony Pfaffle⁴

AUTHOR AFFILIATIONS See affiliation list on p. 4.

ABSTRACT *Candida auris* is an evolving and concerning global threat. Of particular concern are bloodstream infections related to central venous catheters. We evaluated the activity of taurolidine, a broad-spectrum antimicrobial in catheter lock solutions, against 106 *C. auris* isolates. Taurolidine was highly active with a MIC₅₀/MIC₉₀ of 512/512 mg/L, over 20-fold lower than lock solution concentrations of $\geq 13,500$ mg/L. Our data demonstrate a theoretical basis for taurolidine-based lock solutions for prevention of *C. auris* catheter-associated infections.

KEYWORDS taurolidine, *Candida auris*, catheter-related bloodstream infection, CLABSI

2024

TABLE 2 Cumulative distributions of MIC values for taurolidine tested against comparator-resistant *Candida auris* subsets

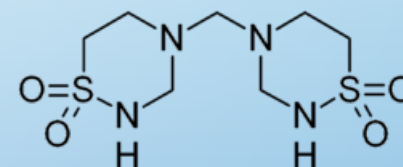
Resistant ^a subset (no. of isolates)	No. and cumulative % of isolates inhibited at MIC (mg/L) of:							MIC ₅₀	MIC ₉₀	
Antimicrobial agent	16	32	64	128	256	512	1,024	> ^b		
Amphotericin B-resistant isolates (61)										
Taurolidine 50% inhibition			0.0	1.0	37.0	23.0			256	512
			0.0	1.6	62.3	100.0				
Taurolidine 100% inhibition				0.0	1.0	57.0	3.0		512	512
				0.0	1.6	95.1	100.0			
Caspofungin-resistant isolates (3)										
Taurolidine 50% inhibition				0.0	2.0	1.0			256	–
				0.0	66.7	100.0				
Taurolidine 100% inhibition					0.0	3.0			512	–
						100.0				
Fluconazole-resistant isolates (92)										
Taurolidine 50% inhibition		0.0	1.0	11.0	48.0	32.0			256	512
		0.0	1.1	13.0	65.2	100.0				
Taurolidine 100% inhibition				0.0	12.0	77.0	3.0		512	512
				0.0	13.0	96.7	100.0			

^aCDC tentative MIC breakpoints published at https://www.cdc.gov/candida-auris/hcp/laboratories/antifungal-susceptibility-testing.html?CDC_AAref_Val=https://www.cdc.gov/fungal/candida-auris/c-auris-antifungal.html.

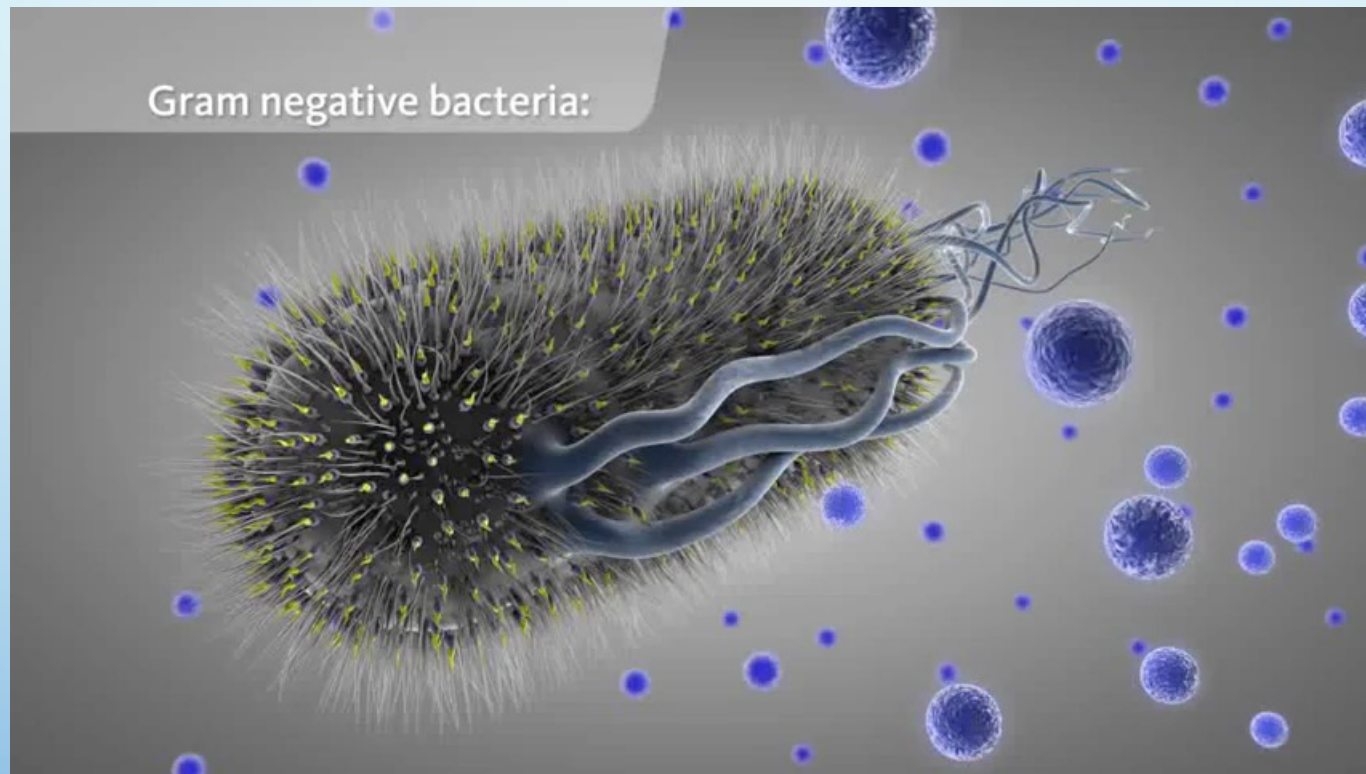
^bGreater than the highest concentration tested.

TAUROLIDINE: AVAILABLE FORMULATIONS

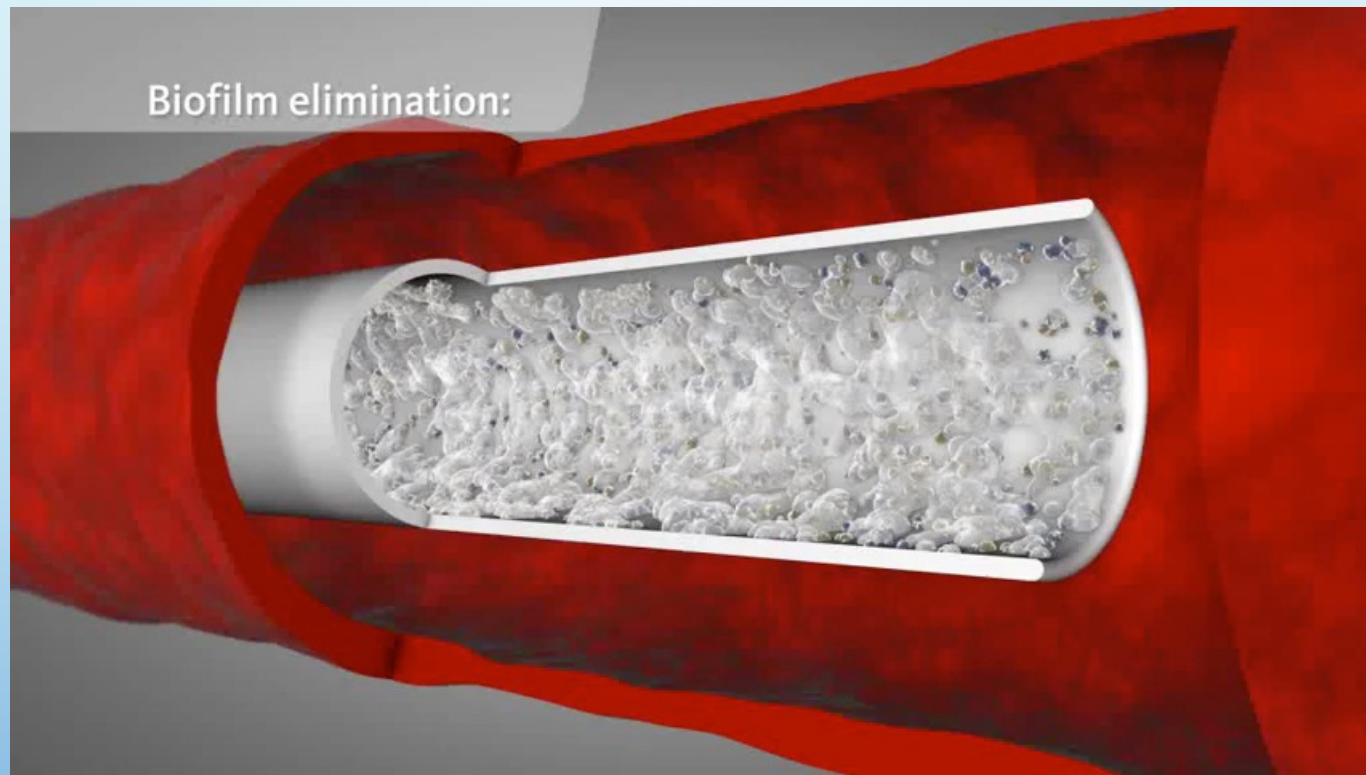
- TAUROLIDINE (1.34% OR 2%)
- TAUROLIDINE + CITRATE 4%
- TAUROLIDINE + CITRATE 4% + HEPARIN
- TAUROLIDINA + CITRATE 4% + UROKINASE



TAUROLIDINE: MECHANISM OF ACTION



TAUROLIDINE: ELIMINATION OF BIOFILM ON THE INNER WALL OF A CATHETER



Original research articles

Taurolidine lock in the treatment of colonization and infection of totally implanted venous access devices in cancer patients

Fabrizio Brescia ¹, Mauro Pittiruti ², Giancarlo Scoppettuolo³, Chiara Zanier¹, Elisa Nadalini¹, Paola Bottos¹, Chiara Moreal¹, Valentina Da Ros⁴, and Fabio Fabiani¹

Background: Taurolidine lock is known to be effective in preventing catheter-related infections in a variety of venous access devices, including long term venous access devices for chemotherapy. Though, literature about the use of taurolidine for treating catheter colonization or catheter-related blood stream infection is scarce.

Method: We have retrospectively reviewed the safety and efficacy of 2% taurolidine lock for treatment of catheter-colonization and of catheter-related bloodstream infection in cancer patients with totally implanted venous access devices. Diagnosis of colonization or catheter-related infection was based on paired peripheral and central blood cultures, according to the method of Delayed Time to Positivity.

Results: We recorded 24 cases of catheter-related infection and two cases of colonization. Taurolidine lock—associated with systemic antibiotic therapy—was successful in treating all cases of catheter-related infection, with disappearance of clinical symptoms, normalization of laboratory values, and eventually negative blood cultures. Taurolidine lock was also safe and effective in treating device colonization. No adverse effect was reported.

Conclusion: In our retrospective analysis, 2% taurolidine lock was completely safe and highly effective in the treatment of both catheter-colonization and catheter-related bloodstream infection in cancer patients with totally implanted venous access devices.

Keywords

Oncology access, techniques and procedures, catheter-related bloodstream infection, catheter-colonization, taurolidine lock

Table 1. Patients with catheter colonization or CR-BSI related to totally implantable venous devices treated with taurolidine.

Patient	Sex (M/F)	Diagnosis	Days of permanence before infection	Clinical signs				Microbial isolates				Treatment	Blood culture 48h after treatment	Days of permanence and use after taurolidine
				Fever	Chills	PCT (ng/ml)	WBC ($\times 10^9/L$)	Catheter	Time (h)	Peripheral blood	Time (h)			
1	F	Ovarian cancer	16	Yes	Yes	1.19	7.93	Staphylococcus aureus	15	Staphylococcus aureus	17	3 ml of taurolidine every 24h for 5 days	Negative	227
2	M	NHL	863	Yes	Yes	6.49	8.64	Escherichia coli	9	Escherichia coli	9		Negative	264
3	F	Uterine cancer	1323	Yes	No	0.60	8.80	Escherichia coli	2.8	Escherichia coli	15		Negative	121
4	M	NHL	895	Yes	Yes	1.2	7.48	Escherichia coli	6.8	Escherichia coli	21		Negative	232
5	M	Lung adenocarcinoma	20	Yes	Yes	0.94	28.74	Pseudomonas aeruginosa	34.4	Negative			Negative	80
6	F	Follicular NHL + breast cancer	121	Yes	Yes	0.22	6.09	Staphylococcus epidermidis	2.8	Staphylococcus epidermidis	41.9		Negative	150
7	F	Ovarian cancer	1367	Yes	No	0.24	4.22	Staphylococcus haemolyticus Staphylococcus hominis	9.3	Staphylococcus haemolyticus Staphylococcus hominis	15.6		Negative	66
8	M	Multiple myeloma	410	Yes	No	0.11	0.09	Escherichia coli Staphylococcus epidermidis	7	Escherichia coli Staphylococcus epidermidis	16.3		Negative	120
9	F	Pancreas adenocarcinoma	1155	Yes	No	16.56	7.01	Clostridium perfringens	8	Clostridium perfringens	10.6		Negative	197
10	M	NHL	1477	Yes	Yes	0.20	13.55	Escherichia coli	7.3	Escherichia coli	15.7		Negative	90
11	M	Testicular seminoma	150	Yes	Yes	0.19	0.64	Escherichia coli	1.3	Escherichia coli	15.6		Negative	136
12	M	Lung adenocarcinoma	99	Yes	No	0.69	14.35	Staphylococcus hominis ss. Hominis	6.4	Staphylococcus hominis ss. hominis	13.1		Negative	96
13	M	NHL + colon cancer	45	Yes	Yes	8.02	0.04	Staphylococcus epidermidis	18.4	Negative			Negative	43
14	F	Nasopharyngeal carcinoma	86	Yes	Yes	20.43	1.17	Enterobacter cloacae complex	1.2	Enterobacter cloacae complex	4		Negative	30
15	F	Breast cancer	1889	Yes	No	8.02	14.10	Escherichia coli	10.8	Escherichia coli	22.1		Negative	30
16	F	Colon cancer + pancreas adenocarcinoma	222	Yes	Yes	1.85	14.05	Staphylococcus epidermidis	6	Staphylococcus epidermidis	15.4		Negative	158
17	M	Multiple myeloma	1382	Yes	Yes	1.35	3.47	Staphylococcus epidermidis	5.4	Staphylococcus epidermidis	13.6		Negative	50
18	M	Colon cancer	286	Yes	No	4.03	11.2	Escherichia coli	9.4	Escherichia coli	9.0		Negative	187
19	F	Ovarian cancer	148	Yes	No	2.52	9.34	Staphylococcus aureus	5.4	Staphylococcus aureus	13.6		Negative	245
20	F	Breast cancer	57	Yes	Yes	7.31	18.23	Escherichia coli	2.2	Escherichia coli	7.2		Negative	198
21	M	Lung adenocarcinoma	124	Yes	No	3.43	6.45	Staphylococcus epidermidis	4.3	Staphylococcus epidermidis	14.2		Negative	78
22	F	Breast cancer	58	Yes	Yes	1.51	9.23	Escherichia coli	3.2	Escherichia coli	12.3		Negative	187
23	F	Rectal cancer	760	Yes	No	3.88	0.50	Staphylococcus hominis ss. Hominis	2.1	Staphylococcus hominis ss. Hominis	6.3		Negative	30
24	M	NHL	73	Yes	Yes	1.93	0.36	Staphylococcus epidermidis	6.3	Staphylococcus epidermidis	11.2		Negative	25
25	M	LLC	180	Yes	No	5.45	2.21	Escherichia coli	2.7	Escherichia coli	18.9		Negative	145
26	M	Gastric cancer	120	Yes	Yes	8.85	3.52	Staphylococcus epidermidis	9.1	Staphylococcus epidermidis	12.2		Negative	25

Catheter salvage or removal in catheter-related bloodstream infections with *Staphylococcus aureus* in children with chronic intestinal failure receiving home parenteral nutrition and the use of prophylactic taurolidine catheter lock solution: A descriptive cohort study

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Abstract

Background: Children with chronic IF require long-term home parenteral nutrition (HPN), administered through a central venous catheter. Catheter-related bloodstream infection (CRBSI) with *Staphylococcus aureus* is known to be a serious infection with a high mortality rate and risk of complications. A standardized protocol on the management of *S aureus* CRBSIs in children receiving HPN is lacking. The aim of this study is to evaluate the effectiveness and safety of the current management in an HPN expertise center in the Netherlands.

Methods: We performed a retrospective descriptive cohort study between 2013 and 2022 on children 0–18 years of age with chronic IF requiring long-term HPN. Our primary outcomes were the incidence of *S aureus* CRBSI per 1000 catheter days, catheter salvage attempt rate, and successful catheter salvage rate. Our secondary outcomes included complications and mortality.

Results: A total of 74 patients (39 male; 53%) were included, covering 327.8 catheter years. Twenty-eight patients (38%) had a total of 52 *S aureus* CRBSIs, with an incidence rate of 0.4 per 1000 catheter days. The catheter salvage attempt rate was 44% (23/52). The successful catheter salvage rate was 100%. No relapse occurred, and no removal was needed after catheter salvage. All complications that occurred were already present at admission before the decision to remove the catheter or not. No patients died because of an *S aureus* CRBSI.

Conclusion: Catheter salvage in *S aureus* CRBSIs in children receiving HPN can be attempted after careful consideration by a multidisciplinary team in an HPN expertise center.

TABLE 1 Patient characteristics.

	Total cohort (n = 74)
Age, mean (SD), years	10.2 (6.2)
Male, n (%)	39 (53)
Underlying disease, n (%)	
Short bowel syndrome	38 (51)
Motility disorder	19 (26)
Congenital enteropathy	9 (12)
Other	8 (11)
Disease leading to SBS, n (%)	
Atresia	12 (32)
Necrotizing enterocolitis	8 (21)
Gastroschisis	9 (24)
Volvulus	5 (13)
Other	4 (11)
Remaining intestinal length, median (IQR), cm	34 (22–60)
Ileocecal valve present, n (%)	
Yes	15 (39)
No	16 (42)
Unknown	7 (18)
Patients with CVC inserted before October 2013, n (%)	27 (36)
Number of CVCs, median (IQR)	3.5 (2–6)
Weight, median (IQR range), kg	26 (16.2–36.1)
Weight, mean (SD), SDS	–1.4 (1.2)
Height, mean (SD), cm	125.5 (30.1)
Height, mean (SD), SDS	–1.6 (1.5)
Weight for height, mean (SD), SDS	–0.1 (1.2)
Alive, n (%)	70 (95)
Carriage of <i>S aureus</i> , n (%)	
Yes	18 (24)
No	4 (6)
Unknown	52 (70)
Patients with <i>S aureus</i> bacteremia, n (%)	28 (38)

Abbreviations: CVC, central venous catheter; IQR, interquartile range; SBS, short bowel syndrome; SD, standard deviation; SDS, standard deviation score.

TABLE 2 *Staphylococcus aureus* CRBSI.

	Total number of <i>S aureus</i> infections (N = 52)
Patients with one or more <i>S aureus</i> CRBSI, n (%)	28 (54)
Number of infections per positive patient, mean (SD)	1.9 (1.2)
Catheter type before infection, n (%)	
Centrally inserted	34 (65)
Peripherally inserted	13 (25)
Unknown	5 (10)
Days between catheter placement and infection, median (IQR)	104 (39–323)
Primary catheter salvage attempt, n (%)	
No	29 (56)
Yes	23 (44)
Successful catheter salvage, n (%)	23 (100)
Days catheter was removed, median (IQR)	2 (1–3.5)
Complicated infections, n	5
Catheter removed	2
Catheter in situ	3

Abbreviations: CRBSI, catheter-related bloodstream infection; IQR, interquartile range; SD, standard deviation.

S aureus catheter-related bloodstream infections

A total of 28 of 74 patients (38%) were diagnosed with at least one catheter-related *S aureus* bacteremia confirmed through both central and peripheral blood cultures. No differences in positivity between central and peripheral cultures were found. These 28 patients had a total of 52 infections, with a mean number of 1.9 (SD: 1.2) infections per positive patient (see Table 2). *S aureus* CRBSI incidence was 0.4 per 1000 catheter days. Polymicrobial *S aureus* CRBSIs were not present. The catheter salvage was attempted in 44% (23/52) of all *S aureus* infections and treated with intravenous systemic antibiotics. No relapse (reinfection within 30 days) of bacteremia with *S aureus* occurred, and no removal was needed after catheter salvage in all 23 episodes. This resulted in a successful catheter salvage rate of 100% (23/23). A



Use of 2% taurolidine lock solution for treatment and prevention of catheter-related bloodstream infections in neonates: a feasibility study

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SUMMARY

Background: Taurolidine lock, a technique used to prevent or treat catheter-related bloodstream infection (CRBSI), is effective in adult and paediatric patients but has been described rarely in neonates. The aim of this descriptive retrospective study, was to determine the feasibility and direct outcomes of prophylactic and therapeutic taurolidine locks in term and preterm neonates.

Methods: We implemented the use of therapeutic taurolidine lock in addition to antibiotic treatment with the aim of catheter salvage in critical neonates with difficult vascular access (group 1). In addition, we introduced taurolidine lock as a preventive measure in neonates with a central venous catheter (CVC) at high risk of developing CRBSI (group 2). Every 24 h (in the treatment group) a 2% taurolidine solution was injected and the catheter locked for at least 120 min, until infection clearance (group 1). In the preventive group, the catheter was locked for 30 min every 48 h until CVC removal (group 2).

Findings: Thirty-seven neonates who received taurolidine were included in this study. We did not observe any major adverse events. In group 1 (21 cases), clinical symptom disappearance and bacteraemia clearance were achieved without catheter removal in 18 cases (85.7%); in the other three neonates the catheter was removed shortly after the start of the locks as it was possible to replace the CVC. In group 2 (16 neonates), no CRBSI was observed during the duration of the catheter placement.

Conclusions: In this retrospective study, taurolidine was successfully used in neonates both for prevention and treatment of CRBSI, without major undesired effects. A larger cohort and a randomized clinical trial is warranted in order to establish its efficacy and safety in neonates.

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O. Use antimicrobial locking solutions for therapeutic and prophylactic purposes in patients with long-term CVADs in the following circumstances: patients with a history of multiple CABSIs, high-risk patient populations, and in facilities with unacceptably high rates of CLABSI, despite implementation of other methods of infection prevention (see Standard 61, *Parenteral Nutrition*).^{15,39,46-53} (II)

b. Antiseptic locking solutions include solutions used alone or in numerous combinations, including, but not limited to, ethanol, sodium bicarbonate, taurolidine, citrate, concentrated sodium chloride, and ethylenediaminetetraacetic acid (EDTA).^{15,49-51,53-56} (II)

CONCLUSIONS

- CRBSI AND CLABSI: DEFINITIONS IN EVOLUTION
- CVAD INFECTIONS ARE DIFFICULT TO TREAT WITHOUT CATHETER REMOVAL
- IN SOME PARTICULAR CATEGORIES OF PATIENTS (PATIENTS HIGHLY DEPENDENT ON MAINTAINING CATHETER, MOSTLY WITH TUNNELED OR TOTALLY IMPLANTED CATHETERS) GUIDELINES, IN CASE OF INFECTION, SUGGEST ATTEMPTING RESCUE BY ADMINISTERING LOCK THERAPY IN ADDITION TO SYSTEMIC ANTIBIOTIC THERAPY.
- IN CASES OF UNCOMPLICATED INFECTIONS AND LOW-VIRULENCE MICROORGANISMS, THIS STRATEGY HAS BEEN SHOWN TO BE VERY EFFECTIVE
- THE LOCK SOLUTIONS MOST WIDELY USED TODAY ARE NOT ANTIBIOTICS, BUT OTHER SOLUTIONS WITH ANTIMICROBIAL ACTIVITY.
- AMONG THESE, A VERY EFFECTIVE, SAFE, AND COST-EFFECTIVE SOLUTION IS TAUROLIDINE AS BOTH LOCK THERAPY AND LOCK PROPHYLAXIS (ESPECIALLY IN PATIENTS WITH HEMODIALYSIS CATHETERS AND PATIENTS ON HOME PARENTERAL NUTRITION)
- TAUROLIDINE HAS ALSO BEEN SHOWN TO BE EFFECTIVE TOWARD HIGHLY VIRULENT BACTERIA SUCH AS *S. AUREUS*, CURRENTLY NOT YET CONSIDERED BY GUIDELINES AS CANDIDATES FOR ERADICATION BY LOCK THERAPY

«Cos'è più importante» chiese Grande Panda,
«il viaggio o la meta?»

«La compagnia» rispose Piccolo Drago.



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GRAZIE PER L'ATTENZIONE!

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