Standardizing Quality Metrics for Blood Culture Collection

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The presenters have no relevant disclosures to report.

Why are blood cultures important?

- Bloodstream infections can be critical, life-threatening infections with high mortality.
- Early diagnosis is critical to help direct appropriate treatment.
- Chances of survival go down drastically the longer initiation of treatment is delayed.
- Blood culture is the gold standard for diagnosis. We need it to be fast and accurate.

<u>False-positive cultures</u>

Unnecessary antibiotic treatment → resistance, adverse drug effects
Longer hospitalization → increased risk of HAIs, higher CLABSI rates
Additional testing and procedures

<u>False-negative cultures</u>

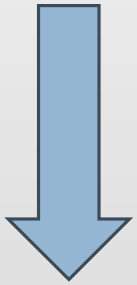
Misdiagnosis or lack of diagnosis
Delayed therapy or inadequate therapy
Longer hospitalization → increased risk of HAIs
Additional testing and procedures

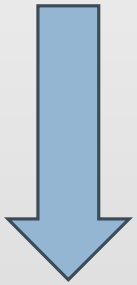
What causes false results?

Contamination of the blood specimen during collection

Pre-treatment with antibiotics

Collection of an inadequate volume of blood





<u>False-positive cultures</u>

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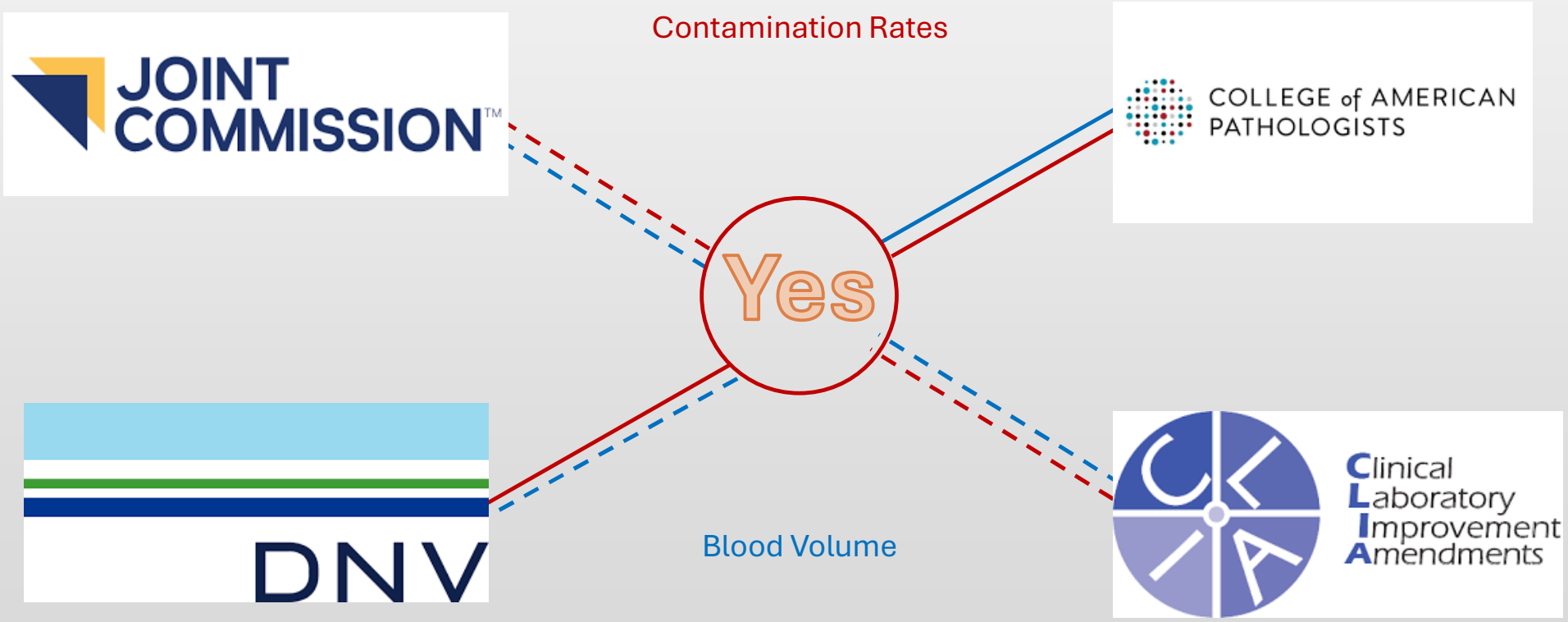
<u>False-negative cultures</u>

Misdiagnosis or lack of diagnosis
Delayed therapy or inadequate therapy
Longer hospitalization → increased risk of HAIs
Additional testing and procedures

Do we need to monitor these?



Do we need to monitor these?

MIC.22635 Blood Culture Contamination	
Requirement: The laboratory monitors blood culture contamination rates and has established an acceptable threshold.	
Phase	2
Policy/Procedure	Yes (a written policy or procedure is required to demonstrate compliance with the requirement)
Note	The laboratory must determine and regularly review the number of contaminated cultures. Tracking the contamination rate and providing feedback to units and persons drawing cultures has been shown to reduce contamination rates. Other measures for consideration in monitoring blood culture contamination include the types of skin disinfection used, line draws, and the use of diversion devices. The threshold may be established in collaboration with other relevant institutional groups (eg, infection prevention). The laboratory must perform and record corrective action if the threshold is exceeded.
Evidence of Compliance	* Records of contamination rates and corrective action if threshold is exceeded AND * Records of feedback to responsible parties

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Contamination – what's it cost?

American Journal of Infection Control 47 (2019) 963–967

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

State of the Science Review

Economic health care costs of blood culture contamination: A systematic review

Casey Dempsey PharmD [a], Erik Skoglund PharmD [a,b], Kenneth L. Muldrew MD, MPH [b,c,d], Kevin W. Garey PharmD, MS [a,b,*]

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[c] Baylor College of Medicine, Department of Pathology & Immunology and Internal Medicine, Houston, TX
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Meta-analysis of 150 different studies between 1978 and 2018

Contamination rates ranged from 0.9% to 41%

A single contaminated blood culture increased pharmacy charges between $210 and $12,611

A single contaminated blood culture increased laboratory charges between $2,397 and $11,152

Am J Inf Control 47:963-967, 2019

Blood culture contamination benchmark

- There is no official, recognized, sanctioned national benchmark.
- For decades, the fairly universally accepted goal has been <3%.
- There are recent recommendations to lower the goal.

review, it may still be impossible to categorize some positive blood cultures as either true positives or contaminants. These cultures should be excluded from the calculation. Even when optimal blood specimen collection protocols are used, completely eliminating blood culture contamination may be impossible. However, laboratories should still be able to achieve blood culture contamination rates substantially below 3%. When best practices are followed, a target contamination rate of 1% is achievable.

CLSI, M-47-ED2, Principles and Procedures for Blood Cultures, 2nd Edition, 2022

But here's the problem...

Your definition may not be the same as mine

TABLE 2 List of organisms typically considered skin contaminants according to different publications and professional organizations[a]

	Reference #2	Reference #3 (CAP)	Reference #4 (CLSI)	Reference #5 (ASM)
Standard organisms considered contaminants	CoNS	CoNS	CoNS	CoNS
	Cutibacterium acnes (and related species)	*Cutibacterium acnes*	*Cutibacterium acnes*	*Cutibacterium acnes*
	Corynebacterium spp. (and related genera)	*Corynebacterium* spp.	*Corynebacterium* spp.	*Corynebacterium* spp.
	Bacillus spp. ther than *Bacillus anthracis*	*Bacillus* spp. ther than *Bacillus anthracis*	*Bacillus* spp. ther than *Bacillus anthracis*	*Bacillus* spp. ther than *Bacillus anthracis*
Additional organisms that are considered contaminants	*Micrococcus* spp.	Viridans group streptococci	Viridans group streptococci *Micrococcus* spp. *Aerococcus* spp.	Viridans group streptococci *Micrococcus* spp. *Lactobacillus* spp. Nutritionally variant *Streptococcus* (*Abiotrophia* and *Granulicatella*)

[a]CAP, College of American Pathologists; CLSI, Clinical and Laboratory Standards Institute; ASM, American Society for Microbiology; CoNS, coagulase-negative *Staphylococcus*

Paired sets vs. single sets
Time interval to be paired
Adults vs Peds

Palavecino et al., J Clin Microbiol , published online Dec. 5, 2023

“Simple” definition

Common skin commensal isolated from a single blood culture set

AND

Other set(s) collected within +/- 24 hours (or 48 hours) did not grow this same organism

Contaminant

Not so simple

But what if there are no other sets collected in that time period?

Ignore it

OR

Look at patient record for factors associated with true sepsis:

- Fever
- Lines
- WBC count
- Inflammatory markers
- Did the physician treat for >48 hours?

Judgment

What's changing?

- New programs have been put in place to encourage hospitals to lower contamination rates
  - Reporting contamination rates to professional organizations, including KHA & HRIP
  - Comparing rates between hospitals – knowing where we stand compared to others
- To do this, we need to
  - Have a consistent, objective definition of contamination that can be applied evenly across multiple institutions (doesn't require judgment)
  - Have a definition that is simple, so that all facilities can apply it without requiring too much expertise or time

We need to standardize

AMERICAN SOCIETY FOR MICROBIOLOGY | Journal of Clinical Microbiology

Check for updates

| Bacteriology | Full-Length Text

Multicenter evaluation of blood culture contamination and blood cultures practices in US acute care hospitals: time for standardization

Valeria Fabre,[1] Yea-Jen Hsu,[2] Karen C. Carroll,[3] Aaron M. Milstone,[4] Alejandra B. Salinas,[1] Lilian M. Abbo,[5] Chris Bower,[6] Jennifer Berry,[7] Sarah Boyd,[8] Kathleen O. Degnan,[9] Pragya Dhaubhadel,[10] Daniel J. Diekema,[11] Marci Dress,[12] Baevin Feeser,[13] Mark Fisher,[14] Cynthia Flynn,[12] Bradley A. Ford,[15] Erin B. Gettler,[16] Laurel J. Glasser,[17] Jessica Howard-Anderson,[6] J. Kristie Johnson,[18] Sara M. Karaba, Justin J. Kim,[19] Alyssa Kubischta,[20] Benjamin M. Landrum,[21] Marvin Martinez,[22] Amy J. Mathers,[23] Leonard Mermel,[22,24] Rebekah W. Moehring,[16] John C. O'Horo,[25] Dana E. Pepe,[13,26] S. Sonia Qasba,[27] Barry Rittmann,[28] Evan D. Robinson,[23] Guillermo Rodríguez-Nava,[29] Rossana Rosa,[5] Jonathan H. Ryder,[30] Jorge L. Salinas,[29] Aditya Shah,[25] Gregory M. Schrank,[31] Mark Shelly,[10] Emily S. Spivak,[32] Kathleen O. Stewart,[33] Thomas R. Talbot,[34] Trevor C. Van Schooneveld,[31] Anastasia Wasylyshyn,[35] Avinash Gadala,[36] Zunaira Virk,[1] Sara E. Cosgrove[1]

Found significant differences in blood culture contamination rates depending on which definition was used.

Our Data	
Definition	**% Contamination**
Internal	1.83%
CDC/KHA	1.49%
HRIP 2026	0.95%

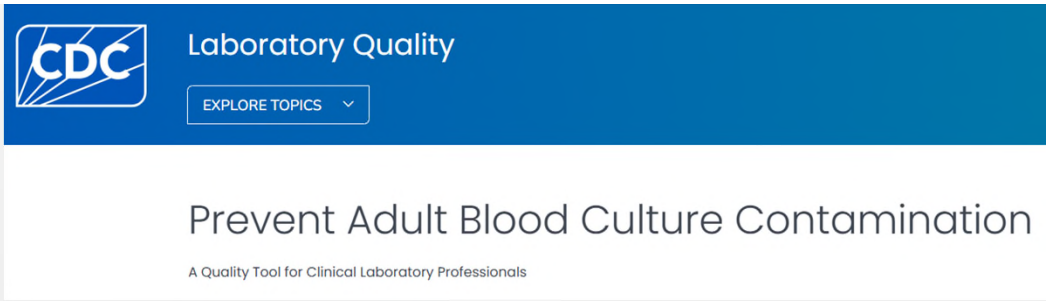
J Clin Microbiol 10.1128/jcm.00530-25, published July 11, 2025

We need to standardize

“need for standardized surveillance metrics and target thresholds within and across hospitals to help facilitate accurate benchmarking, provide feedback on existing processes, support antimicrobial and diagnostic stewardship efforts, and allocate resources to reduce BCC events.”

J Clin Microbiol 10.1128/jcm.00981-25, published September 5, 2025

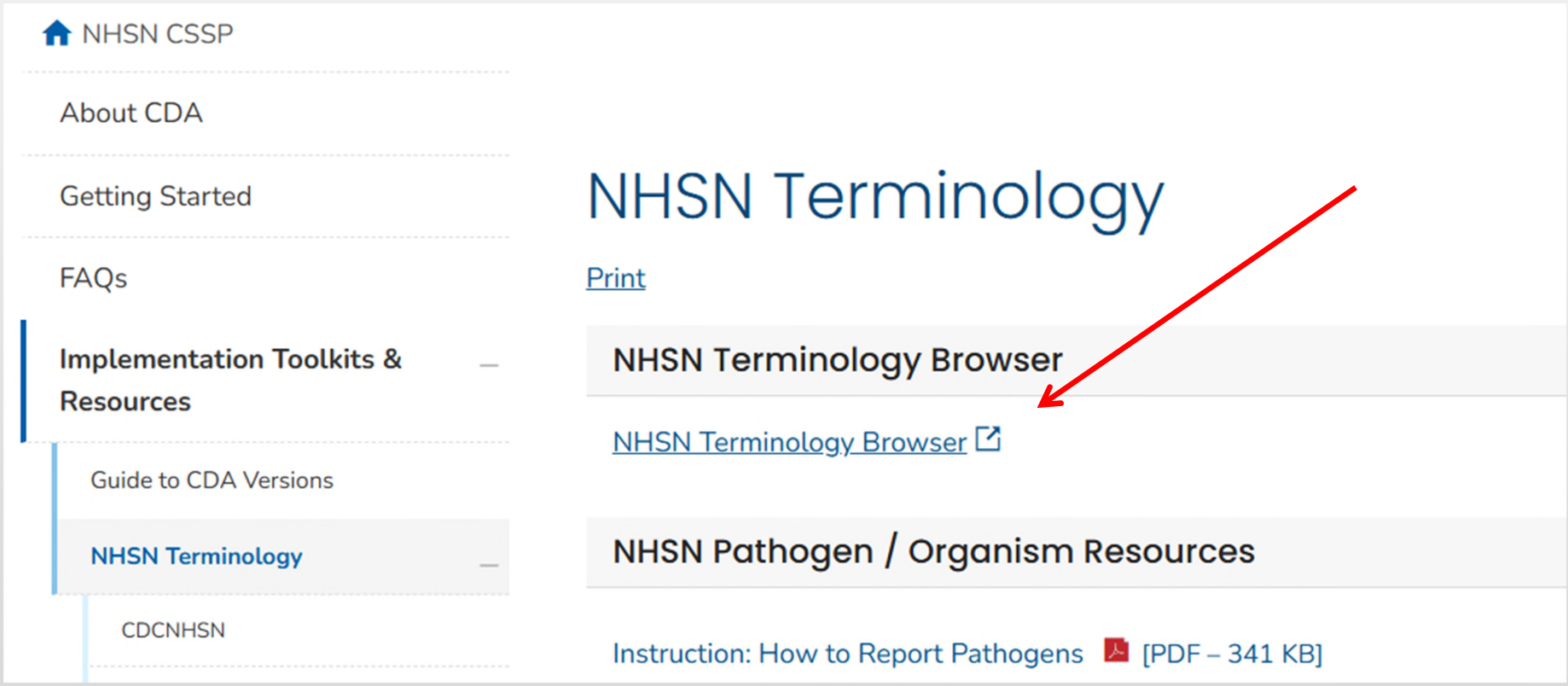
The CDC Definition



- **Organism is on NHSN's list of common commensals**
- **At least two blood culture sets are collected in a 24-hour period; single sets are ignored**
- Patient is at least 18 years old
- Patient may be present in any hospital department, such as the ICU, ED, inpatient floors, and step-down units
- Institutions may choose to include outpatients in their analysis

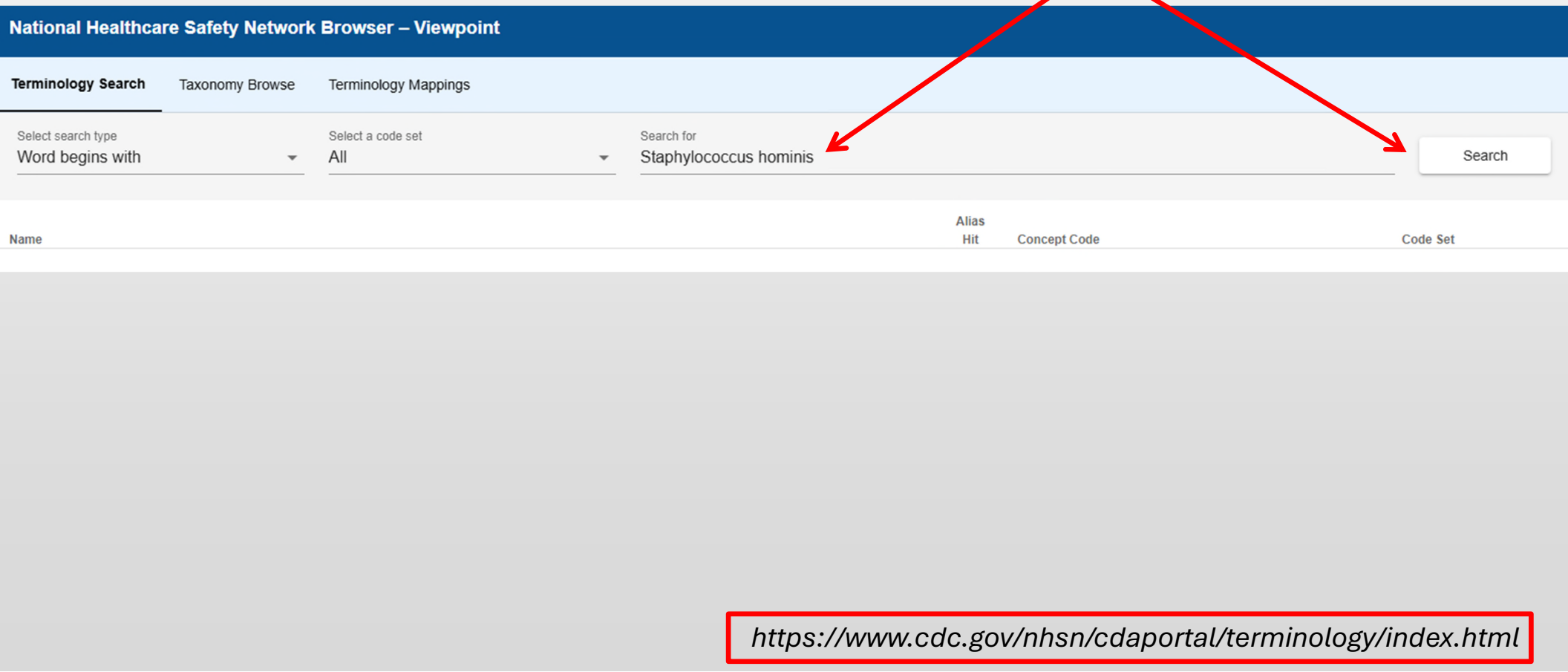
https://www.cdc.gov/lab-quality/php/prevent-adult-blood-culture-contamination/primary-measure.html

NHSN Common Commensal List



https://www.cdc.gov/nhsn/cdaportal/terminology/index.html

NHSN Common Commensal List



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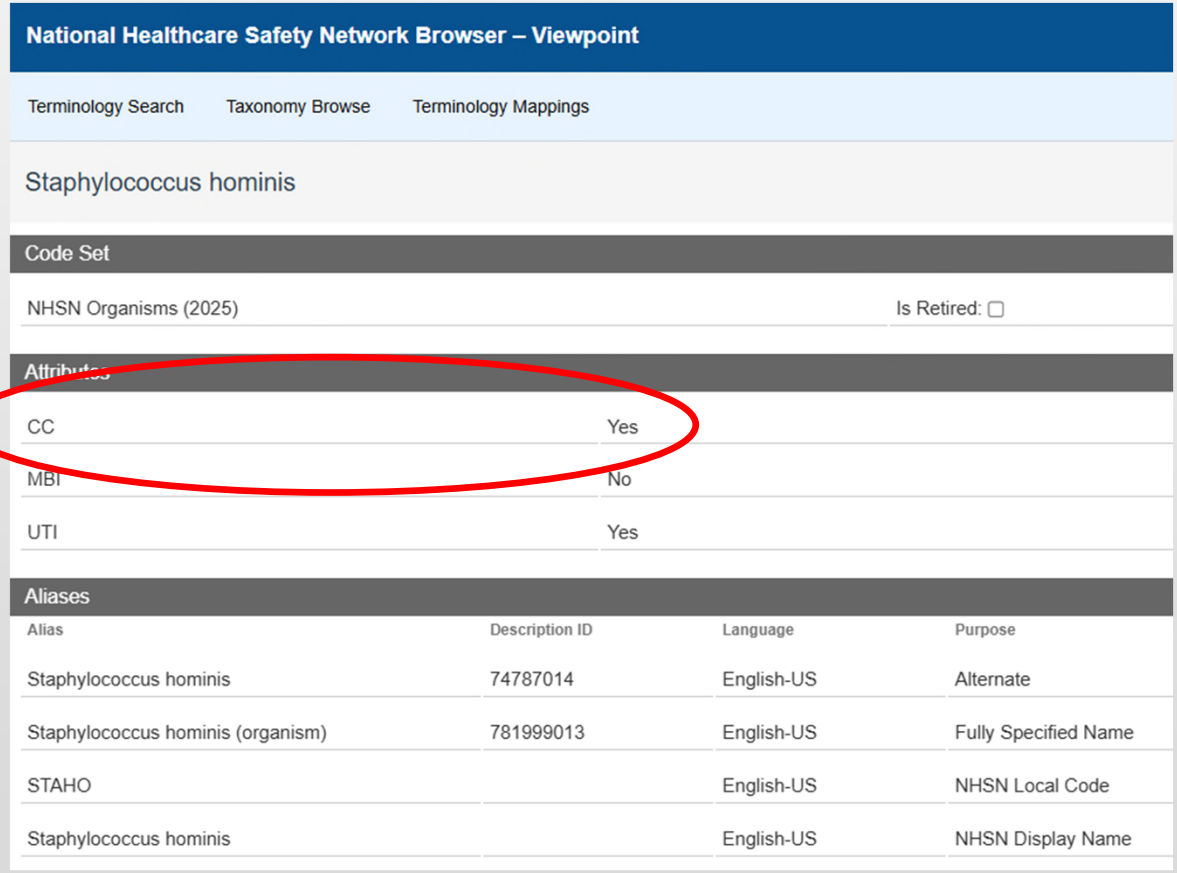
NHSN Common Commensal List



National Healthcare Safety Network Browser – Viewpoint

Terminology Search Taxonomy Browse Terminology Mappings

Staphylococcus hominis

Code Set

NHSN Organisms (2025)	Is Retired: ☐

Attributes

CC	Yes
MBI	No
UTI	Yes

Aliases

Alias	Description ID	Language	Purpose
Staphylococcus hominis	74787014	English-US	Alternate
Staphylococcus hominis (organism)	781999013	English-US	Fully Specified Name
STAHO		English-US	NHSN Local Code
Staphylococcus hominis		English-US	NHSN Display Name

https://www.cdc.gov/nhsn/cdaportal/terminology/index.html

Staphylococcus hominis is a common commensal.

It was isolated from a single set collected 10/25 at 10:00 am.

Between 10:00 am on 10/24 and 10:00 am on 10/26, two other blood culture sets were collected. Neither grow *Staphylococcus hominis*.

=

Contaminant

Notice that this definition does not require any clinical judgment.

It doesn't care if it was drawn from a line or venipuncture.

It doesn't care if *Staphylococcus hominis* was isolated from urine or a wound or a catheter tip or any other type of culture.

It doesn't care if the physician decided this was real and treated with vancomycin for 10 days.

Totally objective definition with application of set rules. Easy to apply. Straightforward enough to possibly be computerized/automated.

IMPORTANT POINT

This is a SURVEILLANCE definition, not a CLINICAL definition.

- Surveillance
  - Not intended to always denote the true clinical condition
  - Meant to be a relative measure of contamination
  - Important to be standardized and easily and objectively applied
- Clinical
  - You want this to be REAL – was this actually contamination caused by poor antisepsis at collection?
  - You want to consider other factors, other infections or markers of infection
  - This is often very difficult to determine with certainty, has to take into account lots of pretty subjective data

Contamination rate = (# of contaminated sets)/(# of eligible sets)

Patient	Time Drawn	Eligible?	Bottles	Culture Result	Common Commensal?
Albert	10/15 8:05 am	✓	Aerobic/Anaerobic	No growth	
Albert	10/15 3:45 pm	✓	Aerobic/Anaerobic	*Corynebacterium* species	✓
Beth	10/16 4:55 am	✓	Aerobic only	No growth	
Beth	10/16 5:15 am	✓	Aerobic/Anaerobic	No growth	
Candy	10/17 12:30 pm		Aerobic/Anaerobic	*Micrococcus* species	✓
Donovan	10/18 10:25 am	✓	Aerobic/Anaerobic	*Streptococcus pneumoniae*	
Donovan	10/18 10:45 am	✓	Aerobic/Anaerobic	*Streptococcus pneumoniae*	
Donovan	10/19 7:45 pm		Aerobic only	No growth	
Esther	10/19 6:30 am		Aerobic/Anaerobic	Coagulase-neg *Staphylococcus*	✓
Esther	10/20 7:30 am		Aerobic/Anaerobic	No growth	

Contamination rate = 1/6 = 16.7%

Does this count as a contaminant?

Patient	Time Drawn	Culture Result
Fitz	10/19 8:05 am	*Staphylococcus epidermidis*
Fitz	10/19 3:45 pm	*Staphylococcus epidermidis*
Fitz	10/22 4:55 am	*Staphylococcus epidermidis*
Georgia	10/20 5:15 am	No growth
Georgia	10/20 12:30 pm	*Bacillus* species
Georgia	10/20 12:40 pm	No growth

Does this count as a contaminant?

Patient	Time Drawn	Culture Result
Harold	10/21 5:30 am	*Escherichia coli*
Harold	10/21 6:00 am	*Escherichia coli* & *Cutibacterium acnes*
Inez	10/22 7:35 pm	Coagulase-neg *Staphylococcus*
Inez	10/23 1:15 pm	*Micrococcus luteus*

Does this count as a contaminant?

Patient	Time Drawn	Culture Result
Jasper	10/24 9:30 am	*Actinomyces oralis*
Kelly	10/25 8:00 am	*Staphylococcus capitis*
Kelly	10/25 8:10 am	No growth
Kelly	10/26 10:50 am	*Staphylococcus capitis*

Does this count as a contaminant?

Patient	Time Drawn	Culture Result
Linus	10/27 3:45 am	Coagulase-neg *Staphylococcus*
Linus	10/27 2:50 pm	*Staphylococcus hominis*
Margaret	10/28 8:00 am	Viridans *Streptococcus*
Margaret	10/28 8:10 am	No growth
Margaret	10/29 10:50 am	*Streptococcus mitis*
Margaret	10/29 11:15 am	No growth

How many sets is this?

Patient	Time Drawn	Bottles
Ollie	10/30 3:45 am	Aerobic only
Ollie	10/30 5:15 am	Aerobic only

This is still two sets, whether you get two bottles or one.

What's the problem with sending only a single aerobic bottle?

- Anaerobic organisms won't grow.
- Some other organisms (e.g. *Streptococcus pneumoniae*) grow better in an anaerobic bottle and may not grow at all in an aerobic bottle.
- Not enough volume of blood to have adequate sensitivity, which leads to…

False Negatives

Blood volume

M47-Ed2

3.3.4 Volume of Blood for Culture

The blood volume drawn for culture is the most important variable in detecting bacteremia or fungemia.[6,46,64,70-76]

1 Bottle
Versus
2 Bottles
Per Set

How much blood is put in a bottle?

CLSI, M-47-ED2, Principles and Procedures for Blood Cultures, 2nd Edition, 2022

Blood volume

- Underfilling (in single bottle or overall)
  - Reduced sensitivity
  - False negatives
  - Inability to get specific diagnosis → increased used of broad spectrum antibiotics
- Overfilling (in single bottle)
  - Reduced sensitivity
  - False positive alarms from the instruments
  - Additional laboratory expenses

How much blood should go in a bottle?

8-10 ml

How big of a problem is this?

Clinical Infectious Diseases

MAJOR ARTICLE

IDSA Infectious Diseases Society of America hivma hiv medicine association

Active Monitoring and Feedback to Improve Blood Culture Fill Volumes and Positivity Across a Large Integrated Health System

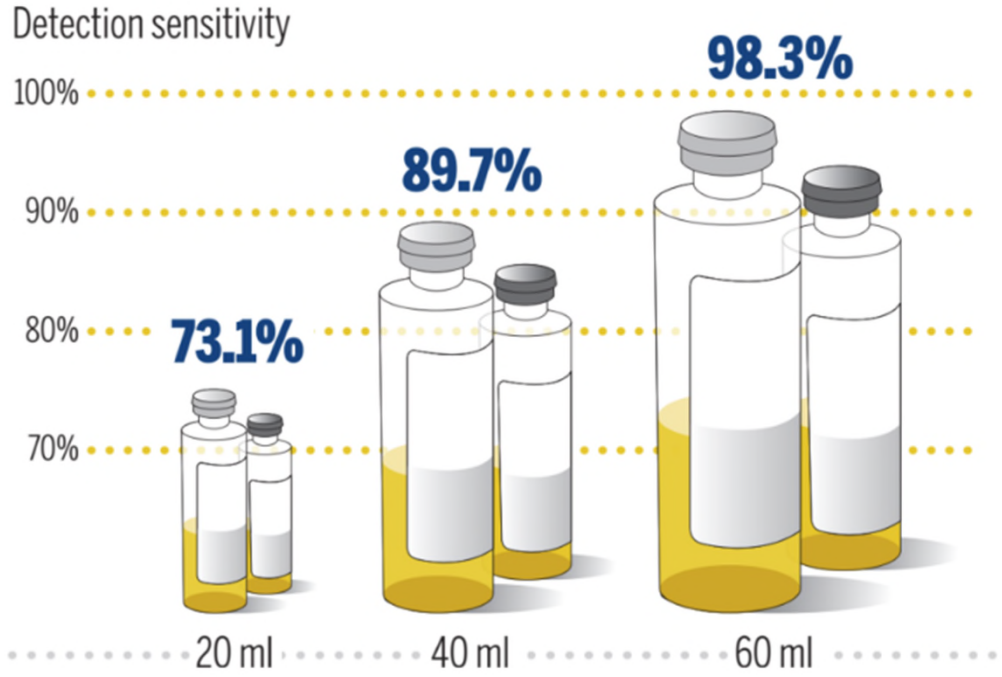
Reeti Khare,[1,2] Tarush Kothari,[2,3] Joseph Castagnaro,[3] Bryan Hemmings,[2,3] May Tso,[3] Stefan Juretschko[1,2]

[1]Infectious Disease Diagnostics, Pathology and Laboratory Medicine, Northwell Health Laboratories, Little Neck, [2]Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Hempstead, and [3]Pathology and Laboratory Medicine, Northwell Health Laboratories, Lake Success, New York

- Blood culture bottles are routinely underfilled, with as many as 40% - 85% containing inadequate volume
- Average bottle fill volume was 2.3 ml
- A bottle containing less than 80% of the recommended minimum volume (6.4 ml) is inadequate.

Khare et al., Clin Infect Dis 70:262-268, January 2020
CLSI, M-47-ED2, Principles and Procedures for Blood Cultures, 2nd Edition, 2022

How big of a problem is this?



Adapted from Lee A, Mirrett S, Reller LB, Weinstein MP. Detection of Bloodstream Infections in Adults: How Many Blood Cultures Are Needed? J Clin microbiol 2007y;45:3546-3548

For initial diagnosis of sepsis, guidelines recommend:

Two to three sets, each with an aerobic and anaerobic bottle.

Each set should have 20-30* ml of blood.

Each set from a different venipuncture.

CLSI, M-47-ED2, Principles and Procedures for Blood Cultures, 2nd Edition, 2022

What about children?

- Recommendation is to draw no more than 1% of total blood volume per culture.
- Blood volume is weight-dependent.

Weight	Total Blood Volume	Blood to Draw for Culture
1 kg (2 lbs)	78 ml	1 ml
5 kg (11 lbs)	380 ml	4 ml
20 kg (44 lbs)	1480 ml	8-10 ml
50 kg (110 lbs)	3500 ml	8-10 ml per bottle

CLSI, M-47-ED2, Principles and Procedures for Blood Cultures, 2nd Edition, 2022

Monitoring blood volume

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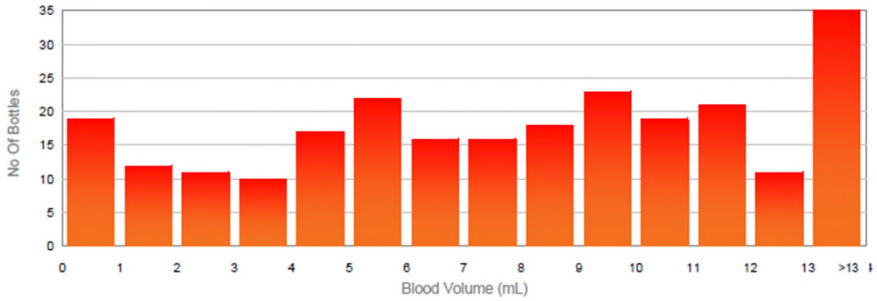
MIC.22640 Blood Culture Volume	
Requirement: The laboratory monitors blood cultures from adults for adequate volume and provides feedback on unacceptable volumes to blood collectors.	
Phase	1
Policy/Procedure	Yes (a written policy or procedure is required to demonstrate compliance with the requirement)
Note	Larger volumes of blood increase the yield of true positive cultures. The volume collected must be in accordance with manufacturer instructions (in most systems it is 20 mL, but smaller volumes may be recommended in some systems).
Evidence of Compliance	* Records of monitoring of volume at a defined frequency AND * Records of feedback to responsible parties

How to monitor blood volume

- Manual Methods
  - Visually – eyeball bottles that arrive in the lab, compare to a bottle with known amount of blood
  - By Weight – weigh bottles that arrive in the lab, compare to uninoculated bottles
  - Nursing/Phlebotomy – have nurses or phlebotomists record the volume drawn on the bottle
- Automatically
  - Most blood culture instruments can measure volume, visually or by weight
  - Can provider graphs showing congregate data
  - Some provide the volume measured so it can be reported in the laboratory report


No Of Bottles
35
30
25
20
15
10
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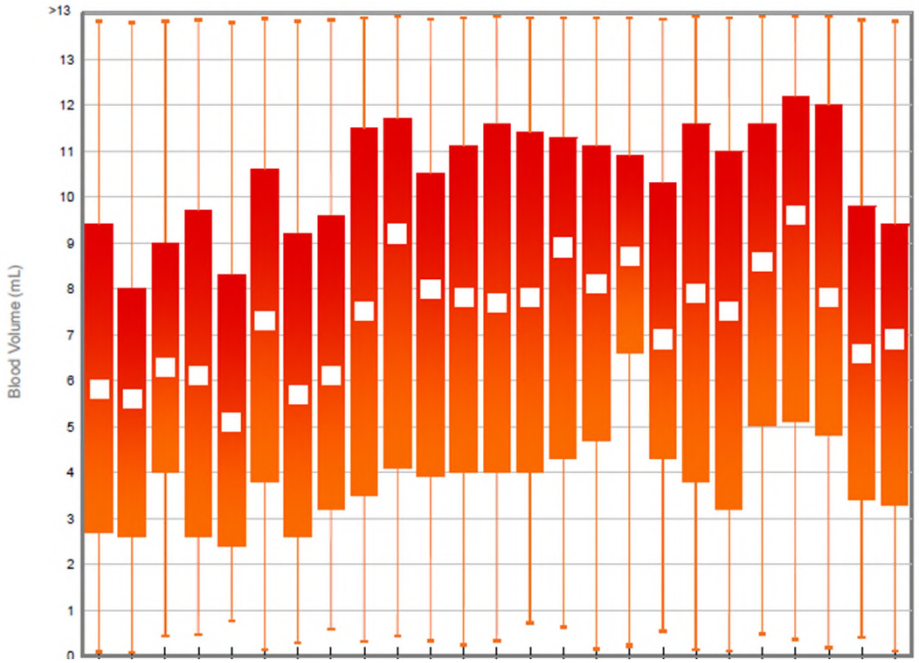
13
>13
Blood Volume (mL)


Blood Volume (mL)
>13
13
12
11
10
9
8
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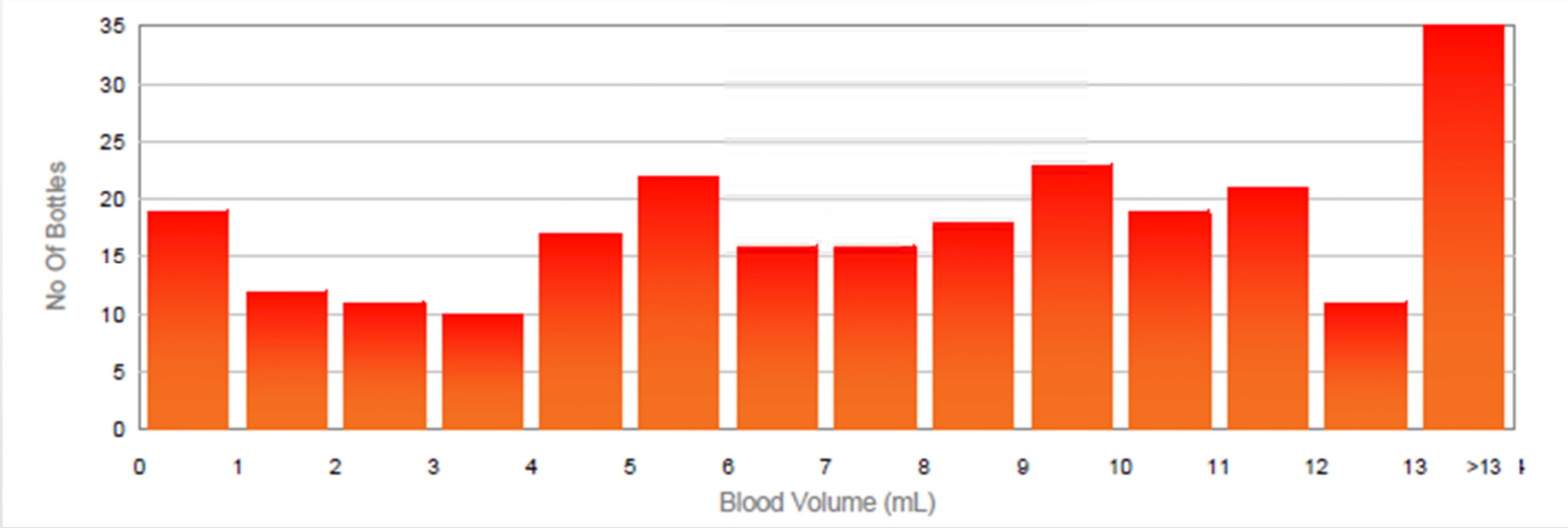
5
4
3
2
1
0

Can volume monitoring be standardized?

- That's going to be very difficult to do.
- Variability in measurements
  - Different labs have different instruments that measure different subsets of bottles by different methods.
  - Manual methods highly variable, dependent on the individual doing the measuring
- What are the standards?
  - There are none.
  - What do we care about? Median amount, percentage in an acceptable range (6-12 ml?), percentage underfilled?
  - No professional groups are asking for this information…yet.



Median = 8-9 ml
Percentage acceptable (6-12) = 45%
Percentage “perfect” (8-10) = 16%
Percentage underfilled (<6) = 36%
Percentage overfilled (>12) = 18%

Is this good?

Sub-Measure: Single-Set Blood Culture Rate

Prevent Adult Blood Culture Contamination: A Quality Tool for Clinical Laboratory Professionals

Public Health
SEPTEMBER 10, 2024

WHAT TO KNOW

- A single blood culture set collected in 24 hours lacks sufficient volume for accurate testing.
- Single-set blood cultures aren't eligible for use in blood culture contamination rate calculations but must be addressed.
- Learn to calculate your single-set blood culture rate.

https://www.cdc.gov/lab-quality/php/prevent-adult-blood-culture-contamination/sub-measure-single-set.html

Sub–Measure Eligibility Criteria

Include a blood culture set in the sub-measure calculation if it meets the following criteria:

- Patient is at least 18 years old.
- Patient may be present in any hospital department such as ICU, ED, inpatient floors, step-down units. (No outpatients)
  - Institutions may choose to include outpatients in their analysis.
- Only one blood culture set is collected in a 24-hour period.

https://www.cdc.gov/lab-quality/php/prevent-adult-blood-culture-contamination/sub-measure-single-set.html

Patient	Time Drawn	Paired or Single	Bottles	Culture Result	Common Commensal?
Albert	10/15 8:05 am	Paired	Aerobic/Anaerobic	NG	
Albert	10/15 3:45 pm	Paired	Aerobic/Anaerobic	*Corynebacterium* species	✓
Beth	10/16 4:55 am	Paired	Aerobic only	NG	
Beth	10/16 5:15 am	Paired	Aerobic/Anaerobic	NG	
Candy	10/17 12:30 pm	Single	Aerobic/Anaerobic	*Micrococcus* species	✓
Donovan	10/18 10:25 am	Paired	Aerobic/Anaerobic	*Streptococcus pneumoniae*	
Donovan	10/18 10:45 am	Paired	Aerobic/Anaerobic	*Streptococcus pneumoniae*	
Donovan	10/19 7:45 pm	Single	Aerobic only	NG	
Esther	10/19 6:30 am	Single	Aerobic/Anaerobic	Coagulase-neg *Staphylococcus*	✓
Esther	10/20 7:30 am	Single	Aerobic/Anaerobic	NG	

Single-set blood culture rate

4/10 = 40%

If a single-set is received a comment could be added to the test result as follows:

"Single-set blood culture received; at least two sets needed to achieve the optimal volume (40-60 mL) for diagnosis of bacteremia, or false negatives may occur. Recommend drawing additional blood culture sets if clinically indicated."

https://www.cdc.gov/lab-quality/php/prevent-adult-blood-culture-contamination/sub-measure-single-set.html

How can we improve contamination rates?

Minimize false positives

AMERICAN SOCIETY FOR MICROBIOLOGY | Clinical Microbiology Reviews

| Clinical Microbiology | Review

American Society for Microbiology evidence-based laboratory medicine practice guidelines to reduce blood culture contamination rates: a systematic review and meta-analysis

Robert L. Sautter,[1] James Scott Parrott,[2,3,4,5] Irving Nachamkin,[6] Christen Diel,[7] Ryan J. Tom,[8,9] April M. Bobenchik,[10] Judith Young Bradford,[11] Peter Gilligan,[12] Diane C. Halstead,[13] P. Rocco LaSala,[14] A. Brian Mochon,[15,16] Joel E. Mortensen,[17] Lindsay Boyce,[18] Vickie Baselski[19]

Clin Microbiol Rev 10.1128/cmr.00087-24, 2024

AMERICAN SOCIETY FOR MICROBIOLOGY | Clinical Microbiology Reviews

| Clinical Microbiology | Review

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#1 – Incorporate chlorhexidine with or without alcohol for skin antisepsis

Reduces blood culture contamination by 57%

#2 – Implement use of a diversion device

Reduces blood culture contamination by 64%

#3 – Have a specially trained team of phlebotomists for collecting blood cultures

Reduces blood culture contamination by 41%

#4 – Have a standardized protocol for using sterile technique for drawing blood cultures

Reduces blood culture contamination by 56%

#5 – Develop strong education programs including skills training and continuous monitoring

Reduces blood culture contamination by 56%

Clin Microbiol Rev 10.1128/cmr.00087-24, 2024

How can we improve blood volume?

Minimize false negatives

#1 – Educate collectors about need for adequate volume to improve sensitivity

#2 – Educate providers about need for at least two sets for initial diagnosis. Use order entry features in EMR to encourage or require paired sets.

#3 - Assist collectors in gauging adequate fill volume – markings, using butterfly collection, visualizing on a flat surface

#4 – Provider feedback to collectors on volume metrics via data collection and collector report cards.

#5 – Emphasize the importance of volume as an important quality metric.

Thank you for your attention.

We welcome any questions.

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