# Catheter Related Sepsis: What is it and how is it detected?

Paul Chadwick

Consultant Microbiologist

Salford Royal NHS Foundation Trust

| Infection | Definition |
|---|---|
| Catheter colonization | Significant growth of ⩾1 microorganism in a quantitative or semiquantitative culture of the catheter tip, subcutaneous catheter segment, or catheter hub |
| Phlebitis | Induration or erythema, warmth, and pain or tenderness along the tract of a catheterized or recently catheterized vein |
| Exit site infection | |
| Microbiological | Exudate at catheter exit site yields a microorganism with or without concomitant bloodstream infection |
| Clinical | Erythema, induration, and/or tenderness within 2 cm of the catheter exit site; may be associated with other signs and symptoms of infection, such as fever or purulent drainage emerging from the exit site, with or without concomitant bloodstream infection[a] |
| Tunnel infection | Tenderness, erythema, and/or induration >2 cm from the catheter exit site, along the subcutaneous tract of a tunneled catheter (e.g., Hickman or Broviac catheter), with or without concomitant bloodstream infection[a] |
| Pocket infection | Infected fluid in the subcutaneous pocket of a totally implanted intravascular device; often associated with tenderness, erythema, and/or induration over the pocket; spontaneous rupture and drainage, or necrosis of the overlying skin, with or without concomitant bloodstream infection[a] |
| Bloodstream infection | |
| Infusate related | Concordant growth of a microorganism from infusate and cultures of percutaneously obtained blood cultures with no other identifiable source of infection |
| Catheter related | Bacteremia or fungemia in a patient who has an intravascular device and >1 positive blood culture result obtained from the peripheral vein, clinical manifestations of infection (e.g., fever, chills, and/or hypotension), and no apparent source for bloodstream infection (with the exception of the catheter). One of the following should be present: a positive result of semiquantitative (>15 cfu per catheter segment) or quantitative (>$10^2$ cfu per catheter segment) catheter culture, whereby the same organism (species) is isolated from a catheter segment and a peripheral blood culture; simultaneous quantitative cultures of blood with a ratio of >3:1 cfu/mL of blood (catheter vs. peripheral blood); differential time to positivity (growth in a culture of blood obtained through a catheter hub is detected by an automated blood culture system at least 2 h earlier than a culture of simultaneously drawn peripheral blood of equal volume). Note that this definition differs from the definition of central line–associated bloodstream infection used for infection-control surveillance activities. |

**NOTE.** Adapted in part from Pearson [18]. cfu, colony forming units.

[a] For surveillance purposes, patients with positive results of blood culture would be classified as having central line–associated bloodstream infection.

From: Clinical Practice Guidelines for the Diagnosis and Management of Intravascular Catheter-Related Infection: 2009 Update by the Infectious Diseases Society of America
Clin Infect Dis. 2009;49(1):1-45. doi:10.1086/599376

# Catheter-related bloodstream infections

- Most CRBSI arise from the insertion site or hub
- For long-term catheters, particularly tunneled catheters, the **catheter hub** is a prominent source of microbes
- Organisms commonly causing CRBSI
  - coagulase-negative staphylococci
  - *Staphylococcus aureus*
  - *Candida* species
  - enteric gram-negative bacilli
  - *Pseudomonas aeruginosa*

IDSA 2009

# Salford HPN CRBSI isolates 2012-16

| Organism | Episodes |
|---|---|
| Coagulase negative staphylococci | 42 |
| *Staphylococcus aureus* | 6 |
| Other Gram positive bacteria | 14 |
| | |
| *Klebsiella* species | 16 |
| Other Gram negative bacilli | 27 |
| | |
| Fungi | 15 |
| | |
| Polymicrobial | 14 |

# The diagnostic challenge 1

- Clinical findings are unreliable for establishing the diagnosis of intravascular device-related infection because of their poor sensitivity and specificity
  - The most sensitive clinical finding, fever, has poor specificity
  - Inflammation or purulence around the insertion site has greater specificity but poor sensitivity

- Blood cultures positive for *S. aureus*, coagulase-negative staphylococci, or *Candida* sp., in the absence of other identifiable sources of infection, should increase suspicion of CRBSI. Improved symptomatology within 24 hours after catheter removal suggests, but does not prove, that the catheter is the source of infection

IDSA 2009

# The diagnostic challenge 2

- Although catheter colonization with accompanying systemic signs of infection suggests catheter-related infection, a definitive diagnosis of CRBSI requires positive percutaneous blood culture results with concordant microbial growth from the catheter tip or catheter-drawn cultures

- The accuracy of all diagnostic microbiologic methods greatly increases with increasing pretest probability

➢ Diagnostic tests for catheter-related infection should not be done unless there is a high index of suspicion

IDSA 2009

# The diagnostic challenge 3

- Laboratory criteria for diagnosing intravascular catheter-related infections are precise, but differences in definitions and methodologies among various studies have made data difficult to compare

- Culture results will be affected by prior antimicrobial use and by antimicrobial catheter coatings

# CRBSI & ESPEN 1

*When CRBSI is clinically suspected do*:

- Quantitative or semi-quantitative culture of the catheter (on removal)

  or

- Paired **quantitative blood cultures** or paired **qualitative blood cultures** from a peripheral vein and from the catheter, with continuous monitoring of the differential time to positivity…

Refers to IDSA 2009 guidelines

ESPEN parenteral nutrition guidelines 2009

# CRBSI & ESPEN 2

Is initially defined in line with CDC/HICPAC (surveillance) guidelines *in a patient with clinical symptoms of sepsis and the absence of another source of infection* by:

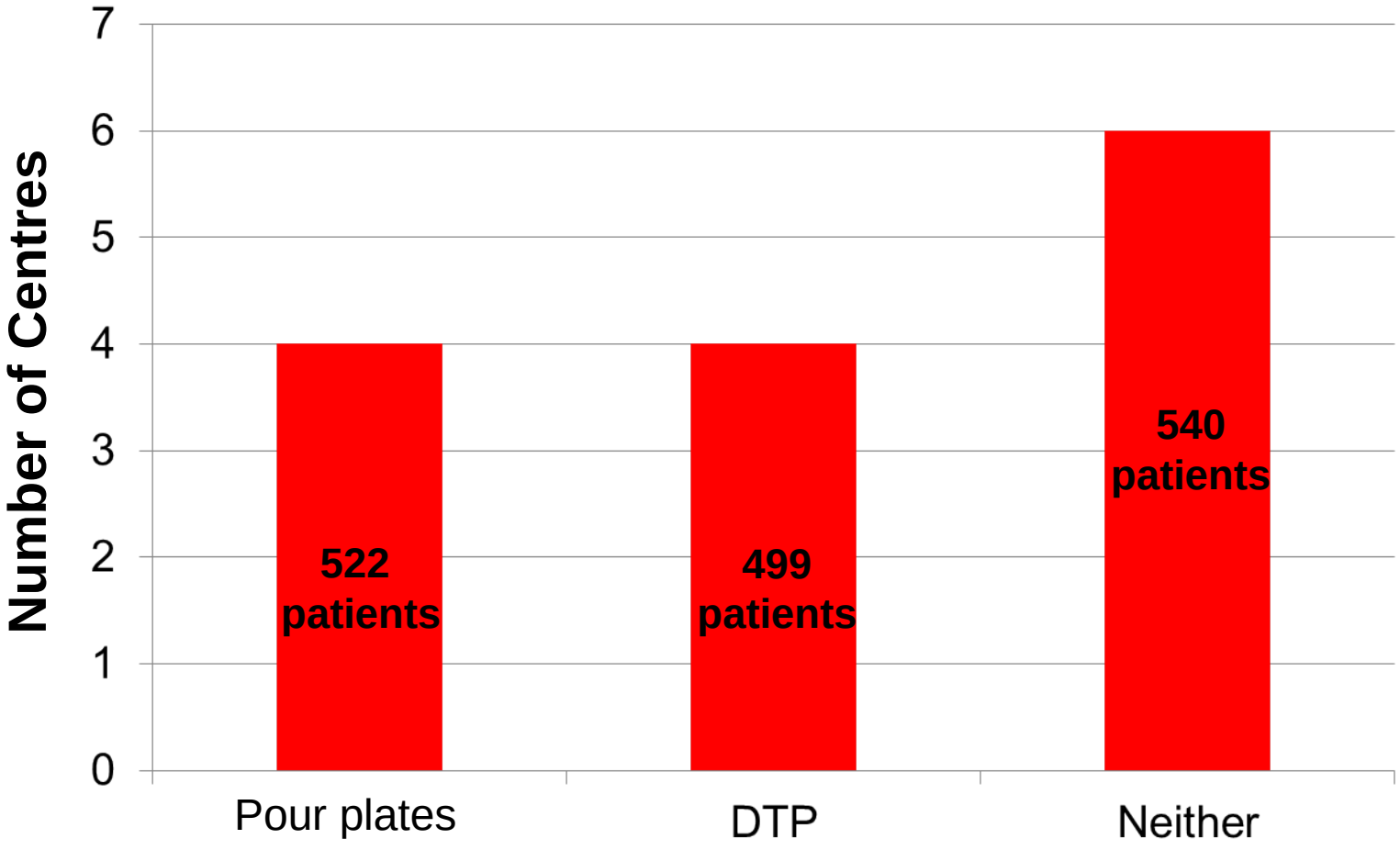
- A positive culture of the catheter (on removal) **or** by
- Isolation of identical organisms (both species and antibiograms) from cultures of catheter segments and blood drawn from a peripheral vein

Subsequently refers to IDSA 2009 guidelines

ESPEN chronic intestinal failure guidelines 2016

# UK Quick Survey May 2017:

## *CRBSI Diagnosis?*




S Lal, personal communication

# When the catheter tip is cultured:

- Culture the catheter tip, rather than the subcutaneous segment
- Growth of >15 colony-forming units (cfu) from a 5 cm segment of the catheter tip by semiquantitative (roll-plate) culture, or growth of >100 cfu from a catheter by quantitative (sonication) broth culture reflects catheter colonization
- Semiquantitative growth of <15 cfu/plate of the same microbe from both the insertion site culture and the catheter hub culture strongly suggests that the catheter is not the source of a bloodstream infection

IDSA 2009

# CRBSI: definitive diagnosis

- Same organism isolated from at least 1 percutaneous blood culture and from a culture of the catheter tip. *Requires catheter removal*

- **Or,** that 2 blood samples be drawn (one from a catheter hub and the other from a peripheral vein) that, when cultured, meet CRBSI criteria for quantitative blood cultures (QBC) or differential time to positivity (DTP)
  - QBC: colony count of organism isolated from catheter blood is ≥3x the colony count from peripheral blood
  - DTP: growth of an organism in a catheter blood sample is detected ≥2 hours before growth is detected in a peripheral blood sample

    *NB. May not be routinely reported – good liaison with laboratory required*

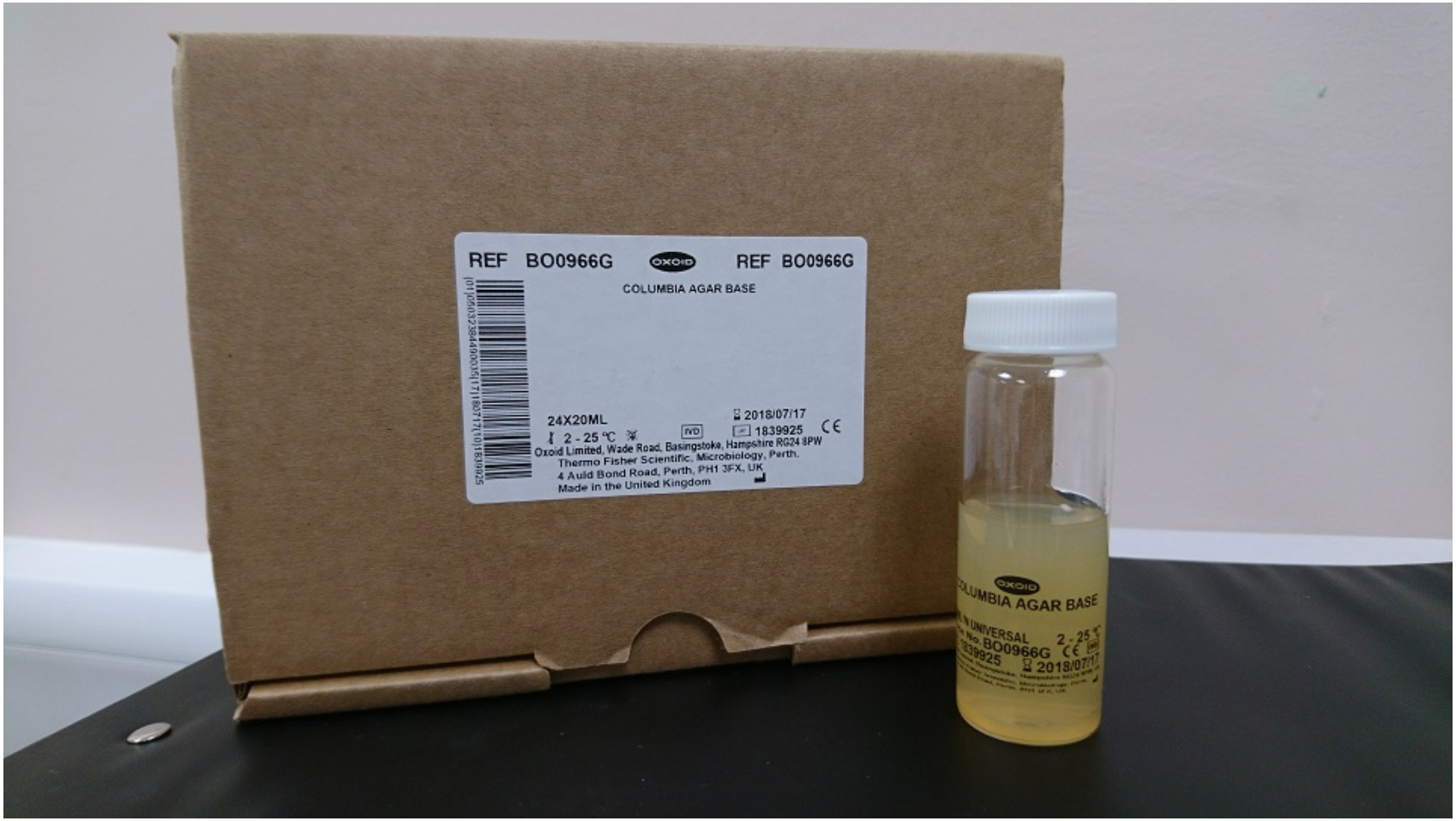
IDSA 2009

# Pour plate (QBC) sample bottles

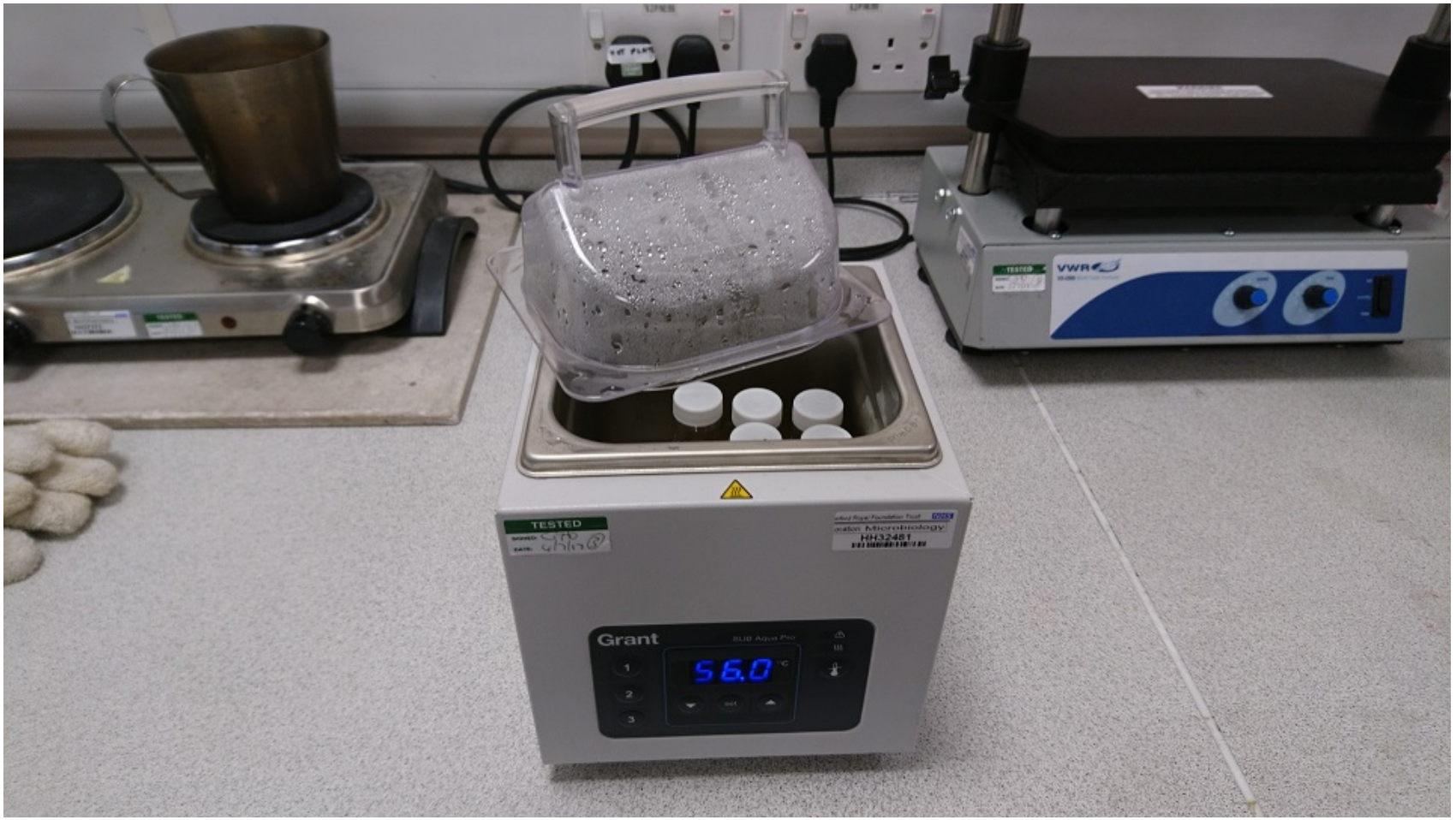

x1 via catheter
x1 peripheral

Add 1 ml blood
to each bottle

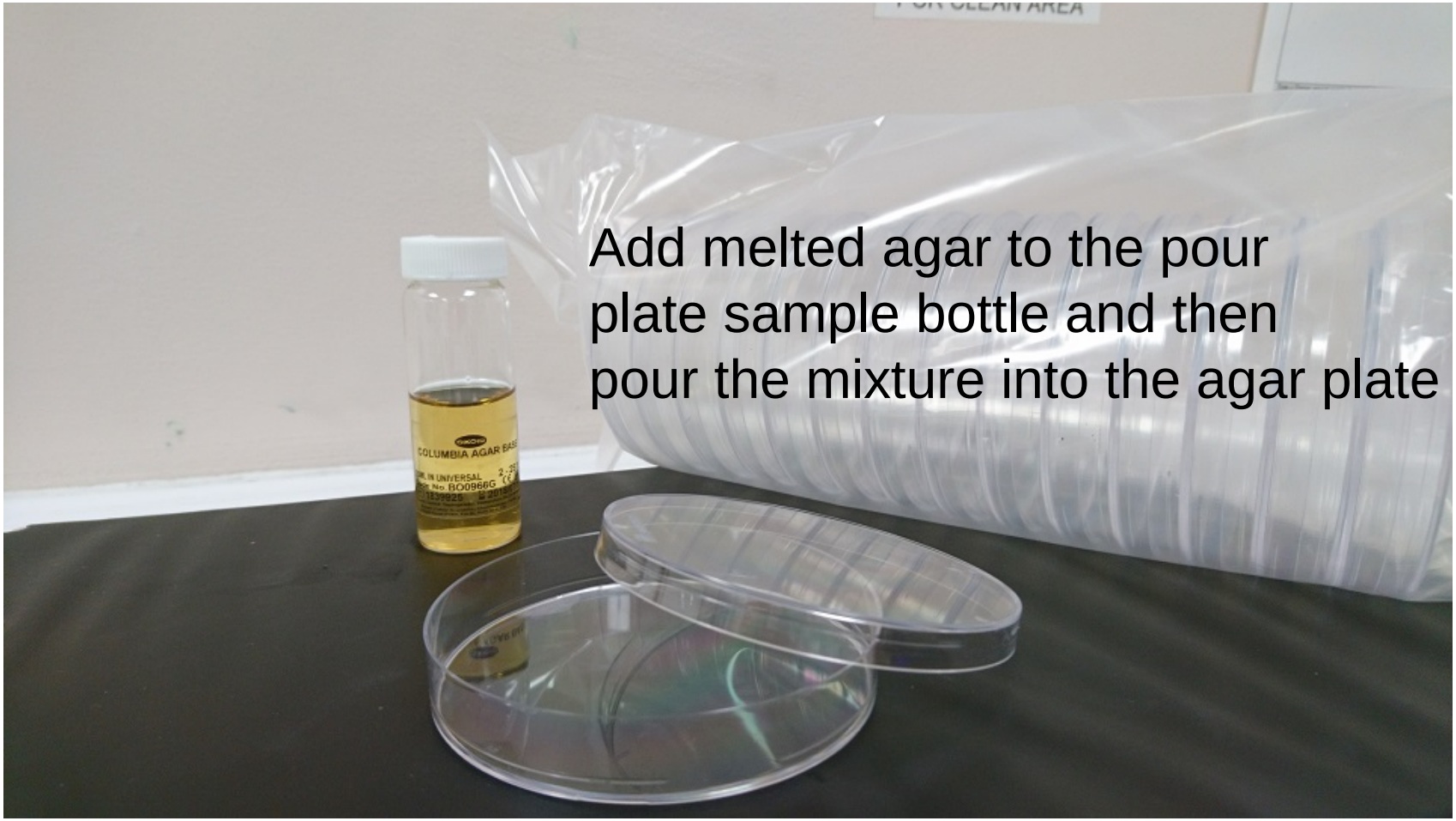
# Pour plate (QBC) agar



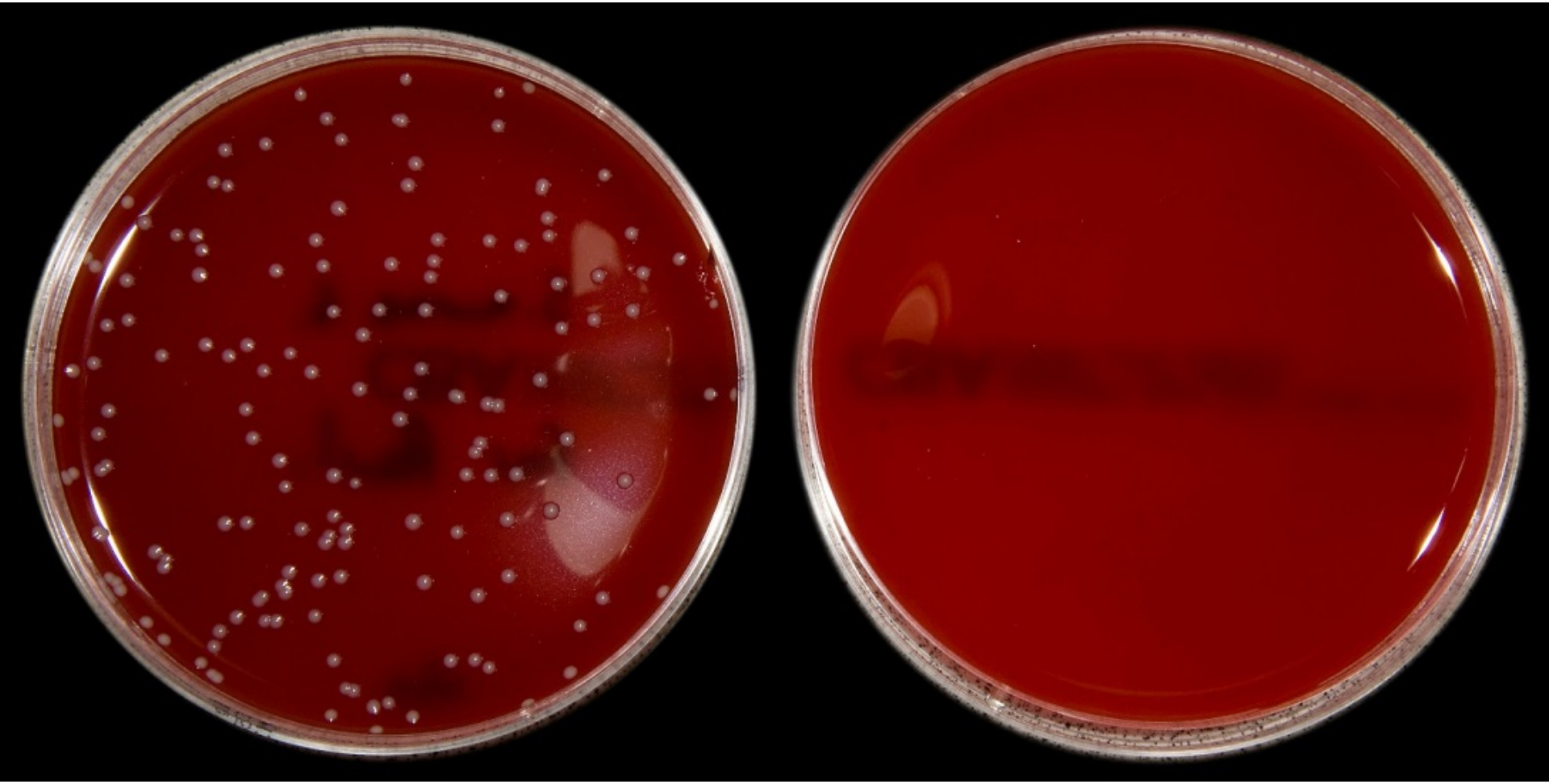
# Melting the agar



# Pour the plate



# Positive ‘pour plate’ (QBC)



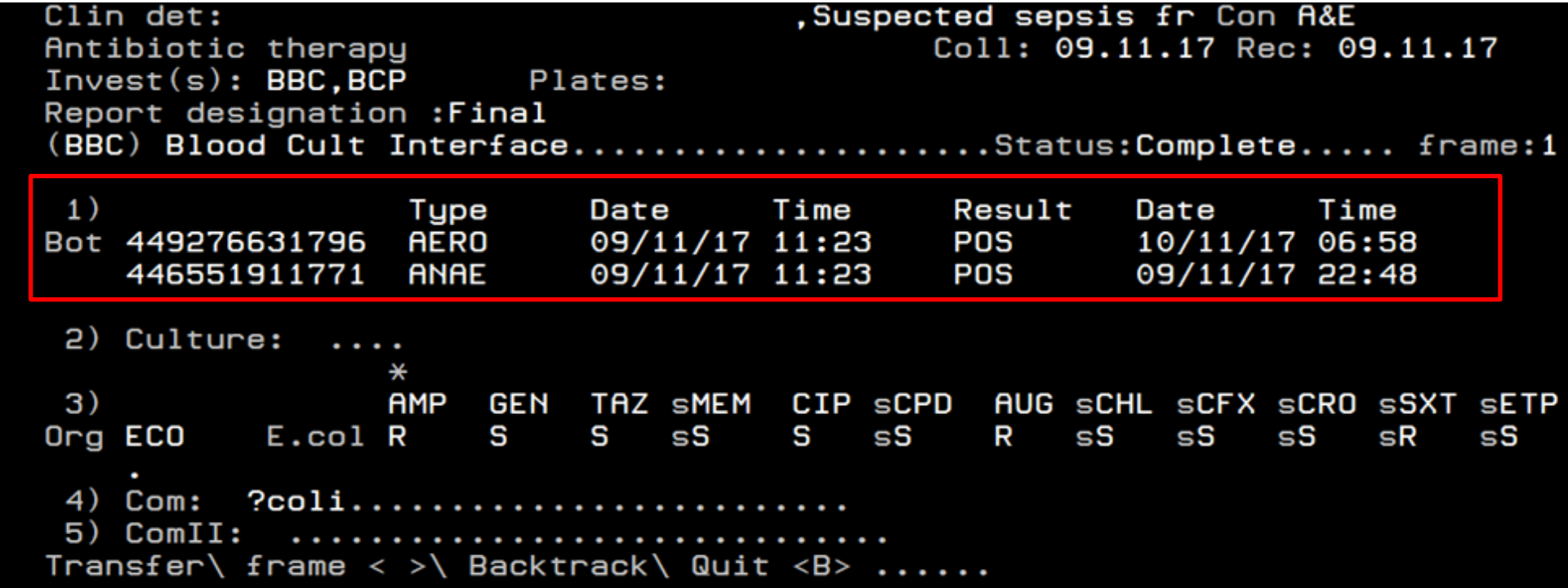
# Automated blood culture system



x1 pair via catheter, x1 pair peripheral

BD BACTEC™ FX blood culture system

# Finding DTP information




May not be routinely reported!

# QBC & DTP

- DTP uses continuous automated blood culture growth monitoring and compares DTP for central and peripheral blood cultures. The greater the inoculum of microbes inoculated into blood culture bottles, the shorter the incubation required to detect microbial growth
- DTP has been studied in cancer patients and in intensive care units who had both long-term and short-term catheters. This method has been shown to have similar accuracy to QBC and is cheaper
- QBC is technically easy, but is *time consuming*. Most microbiology laboratories do not perform QBC, but are able to determine DTP

# Some practical considerations

- Paired blood samples should be cultured before initiation of antimicrobial therapy
- Bottles should be appropriately marked to reflect the site from which the samples were obtained
- QBC and DTP should be performed with the same volume of blood per bottle
- Paired bloods must be collected *at the same time* and *transported rapidly* to the laboratory

# Why is diagnostic methodology important?

The definition of CRBSI is still debated despite clear criteria based upon QBC/DTP of paired blood cultures

A recent study noted that basing the diagnosis of a CRBSI on clinical assessment only, rather than following CDC/ESPEN guidance may lead to over diagnosis of CRBSIs by 46%:

- 1034 CRBSIs in 548 adults on HPN between 2002-13
- 1.95/1000 catheter days by clinical assessment.
- 0.96/1000 catheter days by CDC/ESPEN Criteria.

Tribler S et al. J Parenter Enteral Nutr 2017

Over diagnosis of CRBSI may lead to

- inappropriate antibiotic use
- vascular access compromise
- increased risk related to repeated catheter re-insertion

# Summary

- For diagnosis of CRBSI in patients with long-term catheters, quantitative blood cultures or differential time to positivity are recommended

But…

- Standardization is important!
  - to achieve a global quality outcome indicator
    - to support benchmarking
    - to allow translation of research into practice