One set or two?
A review of Blood Culture collection
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Consultant Medical Microbiologist, University Hospital Aintree
Hon. Senior Lecturer in Medical Microbiology, University of Liverpool
Overview

• The case for two independent blood culture sets in diagnosing sepsis

• Published guidance on number of blood culture sets needed to diagnose sepsis

• When should blood cultures be taken?

• Is blood culture collection happening less with new Trust MRSA targets?

• Routine follow up blood cultures in bacteraemia patients?

• Do antibiotic collaborative ward rounds improve the number of blood culture sets collected?
The case for two independent blood culture sets in diagnosing sepsis

• “No microbiologic test is more important for the clinician than blood culture”

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The case for two independent blood culture sets in diagnosing sepsis

• Only 5-15% of blood cultures are positive

• However, the findings of bacteraemia is highly significant and can be life-saving.

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Patterns of bacteraemia

Transient
• Minutes to hours
• Abscess, Instrumentation, onset of sepsis (pneumonia, arthritis, meningitis)

Intermittent
• Undrained abscesses

Continuous
• Endovascular lesion
• Typhoid
• Brucellosis

Very few bacteria/ml
Number of blood cultures – ‘rule of thumb’

One set
• Not advisable
• Equivocal pathogens maybe uninterpretable

Two sets
• Usually adequate
• Pre-test probability is low to moderate
• Pathogen not likely to be a contaminant

Three sets
• When suspicion of continuous bacteraemia is high
• Pre-test probability of bacteraemia is high

Four sets
• Anticipated pathogen is a likely common contaminant
• Pre-test probability of bacteraemia is high
Published guidance on number of blood culture sets needed to diagnose sepsis
Surviving Sepsis – improving using care bundles

• 44, 477 UK deaths in 2003 due to severe sepsis

• Mortality rates from sepsis similar to acute myocardial infection, lung, breast or colon cancer

• ‘Surviving Sepsis’ campaign aims to decrease mortality by 25 % by 2009
Surviving Sepsis care bundle approach

• Six hour bundle

• Blood cultures on presentation

• Antibiotics within 3 hours

• Early goal directed therapy
Surviving Sepsis Campaign

Blood Cultures

‘At least **two blood cultures** should be obtained with at least one drawn percutaneously and one drawn through each vascular access device unless the device was recently (<48hrs) inserted.’

Evidence grading D
Supported at least one level three investigation (non-randomised contemporaneous controls).
‘In patients with suspected bacteraemia, it is generally recommended that **two sets of cultures** be taken at separate times from separate sites.’  
June 2005
Two blood culture sets - key references

Weinstein MP et al

• The clinical significance of positive blood cultures. A comparative analysis of 500 episodes of bacteraemia and fungaemia in adults. Laboratory and epidemiological investigations Rev Infect Dis 1983; 5: 35-53

• ‘More than 99% of all episodes were detected when 2 samples of blood (total 30 mls) was cultured.’
University of Colorado, 1983

Rates of positivity of 1\textsuperscript{st} and 2\textsuperscript{nd} blood culture sets per septic episode

91.5%
99.3%

Rev Infect Dis 1983; 5: 35-53
Mayo Clinic USA, 1975

Rates of positivity of 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} blood cultures per septic episode (in patients without intravascular infection)

80%
90%
99%

Mayo Clinic Prac 1975; 50:91-98
‘In hospitals in which blood cultures are obtained by phlebotomy teams, these guidelines can be put into practice by obtaining a second blood culture whenever a single culture is ordered’.

Washington JA. Rev Infect Dis 1986; 8: 792 - 802
When should blood cultures be taken?
Timing

• Fever at the time of blood culture collection is neither sensitive nor specific for the presence of bacteraemia.

• There is no relationship between timing of blood culture collection and likelihood of a positive blood culture

Timing

• No difference in yield from blood cultures drawn simultaneously or spaced within a 24-hour period

• In the acutely ill, obtaining blood cultures from two separate sites within minutes of one another is appropriate

Timing Versus Blood Volume

• Blood volume far more important

• Detection rate of 92% v 63% for >5ml volume V <5ml volume

‘Bottles were immediately taken to the microbiology laboratory and placed in an automatic culture detector’.
BLOOD CULTURE SPECIMEN COLLECTION

- Only to be undertaken by staff who are trained and competent in the procedure
- Always ensure that all necessary equipment is available beforehand

Full Aseptic Procedure Required

STEP 1
- Wash and dry your hands.
- Obtain sterile pack (blood culture bottles and safety butterfly) and place on a clean stainless steel trolley. Obtain CHG wipe and SEPP skin prep.
- Place blood cultures upright on the trolley.
- Disinfect septum of blood culture bottles with CHG wipe.
- Apply tourniquet (if taking further blood samples release within 2 minutes).
- Identify vein
- Use SEPP to prepare skin and allow to air dry for 2 minutes
- Use alcohol hand gel, open pack and don sterile gloves.

STEP 2
- Perform venepuncture with butterfly needle and pre-assembled holder.
- Secure butterfly needle if necessary.
- Push holder down over blood culture bottle, (always inoculate blue aerobic bottle first).
- Fill with up to 10ml of blood per bottle - see scale on side of bottle.
- Ensure you position the holder and blood culture bottle down below puncture site to avoid possible reflux.
- Further blood samples can now be taken using the same butterfly.
- Document in patient’s notes

Removal of Butterfly Needle

Using one hand cover the puncture site and the sliding shield with sterile gauze obtained from pack. With the other hand press both sides of the safety hub.

Whilst maintaining gentle pressure on the butterfly (not needle) carefully slide the safety hub backwards.

An audible click confirns the shield is completely locked. The cannula should be fully enclosed in the protective shield.

Dispose of the butterfly set immediately into yellow sharps container.

RETURN BOTTLES TO MICROBIOLOGY DEPT. AS SOON AS POSSIBLE
- Label bottles and request form. The bottle barcode should be removed by its tag and affixed in the patient’s notes.
- Outside working hours (9am - 5pm) place blood culture bottles in overnight incubator located inside Microbiology reception area.
- DO NOT REFRIGERATE BOTTLES

Safety Blood Collection Set - Ordering Details

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>NSV code</th>
<th>Issue No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 085</td>
<td>Safety Blood Collection set + Luer Adapter + Holder (21g x 19cm tubing, green needle)</td>
<td>KFK 137</td>
<td>24</td>
</tr>
<tr>
<td>450 086</td>
<td>Safety Blood Collection set + Luer Adapter + Holder (23g x 19cm tubing, blue needle)</td>
<td>KFK 138</td>
<td>24</td>
</tr>
<tr>
<td>Safety Step 1 - Equipment</td>
<td>Signed by</td>
<td>Checked by</td>
<td></td>
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<tr>
<td>---------------------------------------------</td>
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<td>------------</td>
<td></td>
</tr>
<tr>
<td>Blood culture collection pack &amp; Sepp skin preparation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sani-Cloth CHG 2% wipe, sterile gloves &amp; apron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedure tray &amp; sharps bin</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>Safety Step 2 - Skin Preparation</th>
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<tbody>
<tr>
<td>Wash your hands with soap &amp; water then dry</td>
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<tr>
<td>Clean any visibly soiled skin on the patient</td>
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<tr>
<td>Apply a tourniquet and palpate to identify vein</td>
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<td></td>
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<tr>
<td>Clean the skin with Sepp and allow to dry for 30 seconds</td>
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<td></td>
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<tr>
<td>If blood cultures are being taken from a central venous catheter, disinfect the access port with a PDI wipe (Sani-Cloth CHG 2%)</td>
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<tr>
<th>Safety Step 3 - Kit Preparation</th>
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<tr>
<td>Check bottles and label with appropriate patient information</td>
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<tr>
<td>Flip off tops and cleanse the top of the bottles with a PDI wipe (Sani-Cloth CHG 2%) and allow to dry for 30 seconds</td>
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<tr>
<td>Open the blood culture collection kit</td>
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<tr>
<th>Safety Step 4 - Sample Collection (Using an Aseptic Procedure)</th>
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<tbody>
<tr>
<td>Clean hands with alcohol hand rub* and then apply gloves</td>
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<tr>
<td>Insert needle into prepared site then place adapter over blood collection bottle and pierce septum (fill aerobic bottle first)</td>
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<td></td>
</tr>
<tr>
<td>Hold bottles upright and fill up to 10 ml – see scale on side</td>
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<td></td>
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<tr>
<td>If other bloods are required always complete blood cultures first</td>
<td></td>
<td></td>
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<tr>
<td>Cover puncture site with an appropriate dressing</td>
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<tr>
<td>Discard blood collection equipment into a sharps bin, remove gloves and wash hands</td>
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<tr>
<td>Record the procedure with indication for culture, time, site of venepuncture and any complications in the patient’s notes</td>
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* If hands are visibly dirty, wash hands with soap & water then apply alcohol hand rub

This is to confirm that the procedure was undertaken using an aseptic technique following all actions above

Name ___________________________ Signed ___________________________ Date ___________________________
Barcode labels to be inserted into patient’s notes
Indications for blood cultures

- “Before the use of parenteral or systemic antimicrobial therapy in any hospitalised patient with fever (>38°C) combined with leucocytosis or leucopaenia”
- “Systemic or localized infections including suspected acute sepsis, menigitis, osteomyelitis, arthritis, acute untreated bacterial pneumonia or PUO”

www.uptodate.com
Subject: Guidelines for when Blood Cultures should be taken
Objective: To improve the appropriateness and timing of blood culture samples
Prepared by: Dr. Richard Cooke, Consultant Microbiologist
Dr Rob Jones, Consultant in Accident & Emergency Medicine
Approved by: Clinical Standards Group
Evidence Base: Rank: B Version 2
Date of Original Issue: January 2006 Reviewed: July 2008
Date of Issue: August 2008 Date of Review: August 2011
Key indicators for blood culture collection at UHA

- Central line sepsis
- Chronic disease patients
- Community acquired pneumonia (CAP)
- Deep seated infection
- Endocarditis
- Neutropenic fever
Septic patient\(^2\) (e.g. acute pyelonephritis, acute cholangitis, peritonitis)

Use the ‘systemic inflammatory response syndrome’ (SIRS) criteria

- **Temperature** \(> 38^0\) or \(< 36^0\)
- **Heart rate** \(> 90\) beats per minute
- **Respiratory rate** \(> 20\) breaths per minutes or \(\text{Pa O}_2 < 4.3\ \text{kPa}\)
- **WBC** \(< 4 \times 10^9/L\) or \(> 12 \times 10^9/L\)

Blood culture is required when 2 or more of these criteria are met. This is a positive diagnosis of SIRS

NB: SIRS criteria are

1. Not sensitive or specific for infection
2. Not relevant in individuals incapable of mounting an adequate host response to infection
3. Often absent in deep seated infections (e.g. endocarditis, osteomyelitis)
4. Often masked by concomitant antibiotic therapy or corticosteroids
Survey of Junior Doctors’ Attitudes to blood culture collection at UHA

- 29 Respondents

‘Do you know when blood cultures should be taken?’ 28/29

‘Do you always use the correct equipment for taking blood cultures?’ 18/29

‘Do you always follow the correct hospital policy for taking blood culture?’ 12/29
Survey of Junior Doctors’ Attitudes to blood culture collection at UHA

‘What are the major factors stopping you taking blood cultures?’

High scores (1 or 2)

- Lack of understanding of policy 5/29
- Lack of time 8/29
- Fear of MRSA 13/29
- Need for witness present 21/29
AHT: Blood Culture Sets Collected per month and Percentage Positive

Sets collected

Percentage of sets positive

Sets collected

Percentage positive

Jul-08  Jan-09  Jul-09  Jan-10  Jul-10
Is blood culture collection happening less with Trust MRSA targets?
Successful interventions to reduce MRSA bloodstream infections - Impact on Gram-negative bloodstream infection rates in a UK tertiary referral centre. Time to refocus infection prevention efforts

P.114 HPA Conference 2010

Bloodstream infection rates (% significant positives)

<table>
<thead>
<tr>
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<th>2005</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>0.57%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Gram-negative</td>
<td>2.07</td>
<td>2.19%</td>
</tr>
</tbody>
</table>
Fear and the Law of Unintended Consequences

A study to assess the impact of a blood culture collection kit on the quality of blood culture sampling


Department of Microbiology
Lancashire Teaching Hospitals (LTH)
Preston. UK
background: blood culture contamination

- “growth of bacteria in the blood culture bottle that were not present in the patients bloodstream during the process”
- can lead to mis-diagnoses, complicate patient care
- artificially raise incidence rate of e.g. MRSA infections, difficulty tracking progress towards government targets
MRSA bacteraemias at LTH by month (April 05 – Oct 08)

- 11 bacteraemia’s
- 3 contaminants
- Background rate 25%
background: blood culture contamination

- American Society for Microbiology recommended standard of no more than 3% for blood culture contamination
- Department Of Health (DOH) documents suggest actual contamination rates may be as high as 10%
- Saving Lives document recommends all trusts investigate incidence of contamination and review policies for blood culture collection and training of staff
aim of the study

- evaluate blood culture contamination problem at LTH
- assess overall impact of blood culture collection kit introduction
materials

- blood culture collection kit containing all items required to draw a blood culture
- made up by pathology directorate
  (2/3 day/wk, band 2)
- total cost of the kit was £5.15
  (including consumables and labour)
- implemented fully at LTH in Feb 08 (piloted Sept 07)
kit included

- pre-packaged antiseptic chloroprep sponge for skin preparation  
  (2% chlorhexidine, 70% alcohol)
- Safety-Lok ™ blood collection set
- guidance leaflet
Blood Culture Pack (for percutaneous use only)

USE AN ASEPTIC NON TOUCH TECHNIQUE AND FOLLOW THE CLINICAL GUIDELINE

Main Points:

- Carry out an effective hand hygiene technique
- Use the enclosed Chloraprep One-Step swab (which contains 2% chlorhexidine gluconate in 70% isopropyl alcohol) to disinfect the patient’s skin by:
  - Removing the applicator from the wrapper holding the plastic wings with the sponge facing down
  - Squeeze the two wings together to break the ampoule and release the antiseptic solution
  - Press the sponge against the patient’s skin at the proposed venepuncture site and move back and forth for 30 seconds
  - Allow the solution to dry naturally
- Remove the caps off the blood culture bottles and use the enclosed wipe to disinfect the top of each bottle for 30 seconds and allow to dry naturally
- Protect the key parts from contamination during the procedure
- Ensure that the luer adapter is connected tightly to the tubing of the butterfly needle
- Screw the blue plastic holder firmly onto the luer adapter
- Perform venepuncture and secure in place with tape
- Bottles must remain upright during collection
- Place the aerobic blood culture bottle (blue cap) into the blue plastic holder and press into place to obtain blood
- Hold the bottle and holder in place during blood collection until approximately 10mls of blood has been collected
- Remove the aerobic bottle once sample obtained and place the anaerobic (purple cap) blood culture bottle into the blue plastic holder – repeat process
- Do not remove the needle from the patients vein during this process

If additional blood is required for other tests, place the blue adapter insert into the blue plastic holder and lock in place. This makes the holder compatible with vacuum collection tubes.

Upon needle removal please activate the needle safety devise. Dress puncture site with sterile gauze or plaster. These are not included in the pack.

PLEASE DO NOT REMOVE THE BAR CODES FROM THE BLOOD CULTURE BOTTLES
kit introduction

project nurse working in conjunction with ICNs:

• training sessions (all staff)
  – DVD at trust induction
  – education re difficult venopuncture patients/documentation issues
  – remedial training for doctors responsible for MRSA contaminants

• in conjunction with
  – *Clean your Hands* campaign
  – introduction of 2% chlorhexidine and 70% alcohol use for all vascular access interventions
  – clinical audit
methods

**phase 1:** contamination problem
- analysis of all blood cultures collected between July 07 - Sept 08
- for each month
  - number of cultures isolating organisms considered contaminants
  - total number of cultures collected
  - number of significant Gram-negative organisms

**phase 2:** to evaluate the kit’s ease of use
- questionnaire to Foundation doctors 3-5 months post introduction
results: phase 1 analysis

following introduction, total number of contaminants fell significantly
(Chi $^2$ p < 0.0001)
but........

associated decline in total number of culture sets collected
however......
unintended consequence.....

decrease in genuine Gram-negative bacteraemia’s,
results: from the questionnaire (n = 34)

- 56% found the kit more difficult to use and thought it took longer
- 53% were unhappy with kit accessibility on the wards
- 26% felt training on use was inadequate
- 67% felt introduction of the kit had made them more aware of issues surrounding blood culture contamination
- 26% felt they had changed their selection criteria for collecting cultures (reasons included the possibility of senior discipline if a contaminant was detected)
findings

1. reduction in number of contaminants (9.2% to 3.8%)

2. unintended, sustained reduction in total cultures taken

➢  consequence:

3. unwanted reduction in genuine Gram-negative bacteriemies
conclusions

?? reflect increased awareness of issues surrounding blood culture contamination

?? reflect fear of consequences if a contaminant detected

so: despite significant reduction in contaminant rate, concern remains
recommendations

• continuing with the kit
• increasing kit accessibility
• target “hot-spots” where blood culture collection reducing
• continuing regular training/education in a **non-blame** manner
Routine follow up blood cultures in bacteraemia patients?
Only for S.aureus bacteraemia

ISDA Guidelines

• Repeat blood cultures on day 2 to 4 of treatment
• ECHO

Clin Infect Dis 1998;27:478-86
Do antibiotic collaborating ward rounds improve the number of blood culture sets collected?

YES!
Any Questions?