

NATIONAL STANDARD METHOD

INVESTIGATION OF INTRAVASCULAR CANNULAE AND ASSOCIATED SPECIMENS

BSOP 20

Issued by Standards Unit, Evaluations and Standards Laboratory
Centre for Infections



Association of Medical Microbiologists



INVESTIGATION OF INTRAVASCULAR CANNULAE AND ASSOCIATED SPECIMENS

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AMENDMENT PROCEDURE

Controlled document reference	BSOP 20
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Each National Standard Method has an individual record of amendments. The current amendments are listed on this page. The amendment history is available from standards@hpa.org.uk.

On issue of revised or new pages each controlled document should be updated by the copyholder in the laboratory.

Amendment Number/ Date	Issue no. Discarded	Insert Issue no.	Page	Section(s) involved	Amendment
6/ 28.05.08	4.1	5	1 11 15 All	Front page 4.5.2 References All	Redesigned Link to users manual inserted Reviewed and updated PDF links amended to title of reference document

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INVESTIGATION OF INTRAVASCULAR CANNULAE AND ASSOCIATED SPECIMENS

Types of specimens: Line tips, eg CVP or Hickman lines and swabs of cannula insertion sites.

SCOPE OF DOCUMENT

This National Standard Method (NSM) describes the processing and bacteriological investigation of intravascular cannulae and associated specimens.

INTRODUCTION

The use of indwelling cannulae/catheters for reliable intravascular access is an essential feature of modern health care for both monitoring and intervention. Insertion of intravascular cannulae and catheters allows continuous and painless access to the circulation for administration of fluids and electrolytes, medications, blood products and nutritional support. In addition the intravascular access can be used for blood sampling, haemodynamic monitoring, haemodialysis and haemofiltration.

Each year millions of intravascular devices are used in acutely or chronically ill hospitalised patients around the world. These devices come in various lengths to suit peripheral or central insertion and can have single or multiple lumens. Although the vast majority of these devices are cannulae for peripheral use, central venous or arterial catheters are also used especially in patients with difficult peripheral access or when haemodynamic monitoring is indicated.

Intravascular device related blood stream infection is a significant clinical problem. More than 50% of all outbreaks of hospital acquired (nosocomial) bacteraemia or candidaemia reported in the world literature between 1965 and 1990 originated from vascular devices^{2,3}. Evidence Based Practice for Infection Control (EPIC) guidelines have been issued by the Department of Health for the prevention of hospital acquired infections associated with the use of central venous catheters⁴. The guidelines recommend several practices and strategies for reducing the risk of catheter-related blood stream infections (CR-BSI), including catheter type, site of insertion, optimum aseptic technique, good catheter care, and the appropriate use of antimicrobial coated or impregnated central venous catheters (CVCs).

Specific examples of descriptions of cannulae, defining their siting, use or design, include:

- Peripheral eg Venflons, Abbocaths
- Central lines eg triple lumen, subclavian lines, jugular lines, femoral lines
- Monitoring lines eg central venous pressure lines, Swan Ganz lines, arterial lines
- Long term access eg Hickman lines, Broviac lines, Portacath
- Miscellaneous eg Vascath for haemofiltration, and umbilical cannulae for exchange transfusions in neonates
- Antimicrobial coated or impregnated CVCs: recent studies have demonstrated that antimicrobial coated or impregnated CVC can reduce the incidence of catheter colonisation and CR-BSI in appropriate situations⁴.

Cannula removal

When a patient with an indwelling central venous cannula (CVC) develops an unexplained fever, clinicians are faced with the decision of whether or not to remove the cannula. When the source of a fever cannot be found, the CVC is frequently removed and its tip sent for culture⁵.

Cannula tip culture gives valuable information but necessitates the removal of the cannula. This can sometimes result in the loss of venous access that can interfere seriously with the medical

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management of the patient, although sometimes catheter removal is necessary to gain control of a catheter-related infection, especially with certain organisms, such as *Candida* species.

Cannula associated swabs (eg swabs of catheter insertion sites) may be employed as alternative specimens. However, routine investigation of cannula associated swabs from asymptomatic patients is of dubious value.

Culture of the skin around insertion sites or of cannula connectors (hubs) is becoming increasingly used in confirming cannula site infection⁵⁻⁷. This is reported as having high sensitivity and specificity but is only useful where there is clinical evidence of localised infection, as positive culture results may reflect the presence of commensals and be misleading⁹. Careful interpretation of these culture results should be correlated with blood culture isolates⁸.

When skin and hub culture results concur, removal of the cannula is recommended⁹, although this may not happen in practice unless clinical sepsis unresponsive to antibiotics is present. Quantitative and semi-quantitative culture methods have been described for these sites, but are not recommended in this NSM.

An alternative method of investigating cannula-associated infection that preserves central venous access is to take samples of blood simultaneously through the cannula and from a peripheral vein. Both samples are cultured quantitatively. If the concentration of organisms in the blood from the central line is equal to or greater than 10 times the concentration of organisms in blood from the peripheral vein, then central venous cannula infection is diagnosed. This methodology has not been widely adopted.

Infections and organisms

Cannula-related infections are amongst the most important nosocomial infections. Between 5% and 25% of intravascular devices are found to be colonised by skin organisms as determined by semiquantitative culture of the removed catheters or their tips⁴. This colonisation (which is often asymptomatic) acts as a precursor of systemic or localised infection. The overall incidence of infection related to the use of intravascular is about 1%, although this figure may be as high as 4-8% for central venous catheters used for total parenteral nutrition. In high risk patients, central venous line infections carry a significant mortality rate and a high cost¹⁰.

The incidence of infection is related to the length of time the cannula remains *in situ*. The catheter tip may be infected secondarily by organisms already infecting the hub or insertion site which track down the catheter lumen or tunnel; but it may also acquire organisms from fluids passing through it or from the bloodstream itself. Colonisation of cannulae is a far commoner source of CR-BSI than contaminated infusate³. Organisms causing cannula-related infections may be acquired from¹¹:

- Patients' microflora
- Hands of staff
- Contaminated disinfectants
- Contaminated hub
- Bacteraemia due to other causes
- Contaminated intravenous fluids
- Ward air

Most central venous line-associated infections are caused by organisms from the skin near the exit site which gain access to the intravascular segment of the cannula.

Cannula-related bacteraemia

The cannula may be the source of a bacteraemia. This is likely to be so if it is infected with the same organism as that isolated from a blood culture, usually in the absence of an identifiable alternative focus of infection, and when cultures from infusions are negative¹². Infection of intravenous cannulae may lead to widespread dissemination of infection. More usually the patient develops a fever and may become generally unwell.

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Localised infection

Can occur at the insertion site and subcutaneous track of the device¹³. Clinical signs of infection include erythema, exudate formation, oedema and thrombophlebitis. The patient may complain of pain or irritation at the insertion site, and may become pyrexial.

Organisms isolated from cannula tips and swabs commonly associated with cannula sites^{3,4} include:

- Coagulase-negative staphylococci
- *Staphylococcus aureus* including MRSA
- Enterobacteriaceae
- Pseudomonads
- Enterococci
- *Corynebacterium* species
- Streptococci
- *Bacillus* species

Fungi may be isolated including:

- *Candida albicans* and other yeasts
- *Aspergillus* species
- *Fusarium* species
- *Malassezia furfur* (in patients receiving intralipid infusions)

Coagulase-negative staphylococci

Coagulase-negative staphylococci are the most frequent causes of cannula-related infections. They can produce extracellular slime that facilitates adherence and may limit the access of antibiotics, and may reduce the host's inflammatory response. If a patient has a central venous cannula and coagulase-negative staphylococci are isolated from multiple sets of blood cultures, infection with the organism must be considered seriously. However, there may be difficulty in interpretation of the significance of these isolates as coagulase-negative staphylococci are commonly isolated from contaminated blood cultures.

Any organism isolated in significant numbers should be considered as of potential significance when using methods of quantitative culture.

Culture techniques

Diagnosis of CR-BSI may be difficult due to the lack of clear clinical definitions. Definitive diagnosis can only be achieved if the catheter is removed and the tip culture yield potentially pathogenic organisms in sufficient quantity⁴. Techniques that have been used to diagnose local or systemic infection associated with cannulae include¹⁴:

- semiquantitative and quantitative culture of cannula segments
- broth culture of cannula segments, particularly the tip
- staining of cannulae
- culture of blood aspirated through an intravascular cannula
- culture of the cannula hub
- culture of the cannula insertion site
- ultrasonication of cannulae

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Semiquantitative method

Culture of the cannula surface is used to predict which catheters are truly infected and likely to cause bloodstream infections. The terminal 4cm segment of the cannula is rolled over the entire surface of the agar plate 5 times¹⁵ and the number of colonies counted.

When culturing the external surface of the cannula tip a threshold of >15 colonies¹⁶ of any organism¹⁷ is commonly accepted to predict cannula-related sepsis and is associated with bacteraemia in 10 - 14% of cases. This threshold is based on the culture of a 4cm length. In practice, varying lengths of line are often received and interpretation should be made with care, and in conjunction with blood culture results. However, in practice this threshold may be too low where stringent removal precautions are not taken or there is a delay before processing. A threshold of >100 colonies may be more appropriate¹⁵.

Multiple isolates present at >15 cfu are counted individually and their significance related to any blood culture isolate¹⁷.

Quantitative method¹⁸

This method provides information on both the inner and outer surfaces of the cannula. A cut-off of 1000 cfu/mL is used as indicating sepsis^{15,19}. The lumen result is reported to be a more reliable predictor of systemic infection where there is no evidence of localised exit site infection¹⁵. This method is labour intensive and is not recommended for routine use in this NSM. Both quantitative and semi-quantitative methods are equally effective in predicting absence of infection.

Enrichment method

The distal segment of the cannula is placed in enrichment broth. This does not distinguish among colonisation, infection or contamination of the cannula and is not recommended in this NSM.

Endoluminal brush

This has been reported as an accurate method of detecting catheter related sepsis without the need for catheter removal²⁰.

Rapid diagnostic methods

Staining the cannula (or an impression smear of the cannula) with Gram's stain²¹ or acridine orange²² have been described.

TECHNICAL INFORMATION/LIMITATIONS

N/A

1 SAFETY CONSIDERATIONS²³⁻³³

1.1 SPECIMEN COLLECTION

N/A

1.2 SPECIMEN TRANSPORT AND STORAGE

Cannulae

Sterile leakproof container in a sealed plastic bag

Swabs

Sealed plastic bag

1.3 SPECIMEN PROCESSING

Containment Level 2.

Laboratory procedures that give rise to infectious aerosols must be conducted in a microbiological safety cabinet.

Refer to current guidance on the safe handling of all organisms documented in this NSM.

The above guidance should be supplemented with local COSHH and risk assessments.

Compliance with postal and transport regulations is essential.

2 SPECIMEN COLLECTION

2.1 OPTIMAL TIME OF SPECIMEN COLLECTION

Before antimicrobial therapy where possible

2.2 CORRECT SPECIMEN TYPE AND METHOD OF COLLECTION³⁴

Cannulae

Disinfect the skin around the cannula entry site, remove cannula using aseptic technique, and cut off 4 cm of the tip into a sterile container using sterile scissors¹³.

Note 1: Skin disinfection procedures depend on local protocols and may vary.

Note 2: Cannulae should only be sent if there is evidence of infection

Swabs

Sample the inflamed area around the catheter insertion site using a swab.

2.3 ADEQUATE QUANTITY AND APPROPRIATE NUMBER OF SPECIMENS

N/A

3 SPECIMEN TRANSPORT AND STORAGE

3.1 TIME BETWEEN SPECIMEN COLLECTION AND PROCESSING

Specimens should be transported and processed as soon as possible.

3.2 SPECIAL CONSIDERATIONS TO MINIMISE DETERIORATION

Swabs should be transported in Amies transport medium with charcoal³⁵.

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4 SPECIMEN PROCESSING

4.1 TEST SELECTION

N/A

4.2 APPEARANCE

N/A

4.3 MICROSCOPY

N/A

4.4 CULTURE AND INVESTIGATION

4.4.1 PRE-TREATMENT

N/A

4.4.2 SPECIMEN PROCESSING

Cannulae

Roll specimen across the agar surface 5 times (semi quantitative technique)¹⁵ to cover as much of the agar surface and external cannula surface as possible.

If more than 4 cm is received, the distal end should be reduced to a 4 cm length, prior to culture, by cutting with sterile scissors or scalpel.

Swabs

Inoculate agar plate with swab (see [QSOP 52 – Inoculation of culture media](#)).

For the isolation of individual colonies, spread inoculum with a sterile loop.

4.4.3 CULTURE MEDIA, CONDITIONS AND ORGANISMS

Clinical details/ conditions	Standard media	Incubation			Cultures read	Target organism(s)
		Temp °C	Atmos	Time		
Cannulae: Cannula-related bacteraemia Cannula-related infection	Blood agar	35-37	5-10% CO ₂	40-48 h	daily	≥15 cfu per plate of any organism
Swabs: Local cannula site infection	Blood agar	35-37	5-10% CO ₂	40-48 h	daily	<i>Bacillus</i> species Coagulase-negative staphylococci <i>Corynebacterium</i> species Enterobacteriaceae Enterococci Pseudomonads <i>S. aureus</i> Streptococci Yeasts

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4.5 IDENTIFICATION

4.5.1 MINIMUM LEVEL IN THE LABORATORY

α-haemolytic streptococci	"α-haemolytic" level
β-haemolytic streptococci	Lancefield group level
Coagulase-negative staphylococci	"coagulase-negative" level
Coryneforms	"diphtheroids" level
Enterobacteriaceae	"coliforms" level
Enterococcus	genus level
Pseudomonads	"pseudomonads" level
S. aureus	species level
Yeasts	"yeasts" level

Organisms may be further identified if clinically or epidemiologically indicated particularly when associated with positive blood culture

It may be useful to store organisms for one week pending blood culture becoming positive

4.5.2 REFERRAL TO REFERENCE LABORATORIES

For information on the tests offered, turn around times, transport procedure and the other requirements of the reference laboratory [click here for user manuals and request forms](#).

Organisms with unusual or unexpected resistance, and whenever there is a laboratory or clinical problem, or anomaly that requires elucidation should be sent to the appropriate reference laboratory.

4.6 ANTIMICROBIAL SUSCEPTIBILITY TESTING

Refer to [BSOP 45 - Susceptibility Testing](#)

5 REPORTING PROCEDURE

5.1 MICROSCOPY

N/A

5.1.3 MICROSCOPY REPORTING TIME

N/A

5.2 CULTURE

5.2.1 CANNULAE

Report the number of cfu of organism(s) isolated with an interpretative comment, eg ≥15 cfu may be associated with systemic cannula-related infection, or may represent superficial colonisation or contamination - refer to blood culture results **or**

Report absence of growth

5.2.2 SWABS

Report the amount (eg heavy, moderate or scanty) of growth isolated with an interpretative comment relating to the presence or absence of local infection **or**

Report the absence of growth

5.2.3 CULTURE REPORTING TIME

Clinically urgent culture results to be telephoned or sent electronically

Written report: 16 - 72h stating, if appropriate, that a further report will be issued

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5.3 **ANTIMICROBIAL SUSCEPTIBILITY TESTING**

Report susceptibilities as clinically indicated

6 **REPORTING TO THE HPA³⁶ (LOCAL AND REGIONAL SERVICES AND CDSC CENTRE FOR INFECTIONS)**

Refer to the following:

Individual NSMs on organism identification

Health Protection Agency publications:

"Laboratory reporting to the Health Protection Agency: Guide for Diagnostic Laboratories"

"Hospital infection control : Guidance on the control of infection in hospitals"

Refer to local guidelines on CDSC and COSURV reporting

Local guidelines

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7 ACKNOWLEDGEMENTS AND CONTACTS

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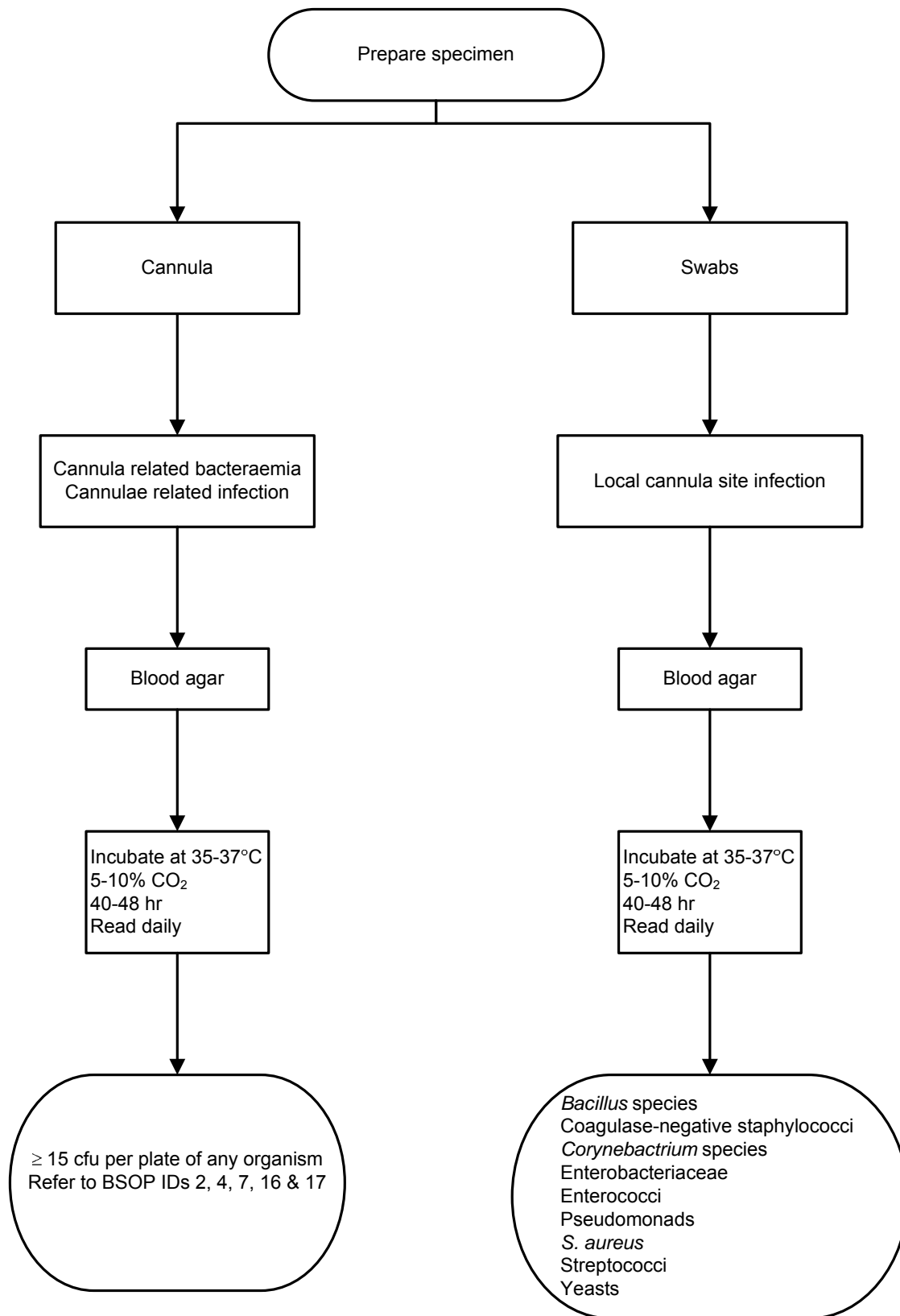
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APPENDIX



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