

NATIONAL STANDARD METHOD

INVESTIGATION OF CEREBROSPINAL FLUID SHUNTS

BSOP 22

Issued by Standards Unit, Department for Evaluations, Standards and Training
Centre for Infections



INVESTIGATION OF CEREBROSPINAL FLUID SHUNTS

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AMENDMENT PROCEDURE

Controlled document reference	BSOP 22
Controlled document title	Investigation Of Cerebrospinal Fluid Shunts

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
5/ 23.11.09	4.1	5	All	All	The term "CE Marked leak proof container" replaces "sterile leak proof container"; endnote ^a added to clarify the change; reference inserted to the IVD Directive 98/79/EC.
			5	Introduction	Restructured to improve flow
			7	Technical information	Section added
			14	Appendix	Flowchart added
			15	References	References reviewed and updated

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INVESTIGATION OF CEREBROSPINAL FLUID SHUNTS

Types of specimens: Cerebrospinal fluid shunt
Shunt tubing
Spitz-Holter valve
Ventricular catheter
Implantable reservoir (eg Ommaya)
Intraventricular portion of external ventricular drain (EVD)
Cerebrospinal fluid (CSF) (see [BSOP 27 -Investigation of cerebrospinal fluid](#))

SCOPE OF DOCUMENT

This National Standard Method (NSM) describes the processing and bacteriological investigation of cerebrospinal fluid shunts.

INTRODUCTION

Hydrocephalus

Hydrocephalus is a condition caused by the accumulation of excess cerebrospinal fluid (CSF) within the cerebral ventricular system². It occurs in both adults and children. If untreated, the prognosis is poor. It may be classified as³:

- Communicating (no block between the ventricles and subarachnoid space)
- Non-communicating (a block is present between the ventricles and subarachnoid space)

The common causes of hydrocephalus are an obstruction of the flow of CSF or a failure to absorb it, resulting from:

- Major developmental abnormalities
- Meningitis
- Overproduction of CSF
- Perinatal haemorrhage
- Trauma
- Tumours, especially in the posterior fossa

Treatment for hydrocephalus involves diverting CSF from the ventricular system to another compartment where it can be absorbed directly or indirectly into the bloodstream. This is done by means of a shunt. There is a risk of infection at the initial shunt insertion and at each subsequent insertion, and shunts may also be infected at other times.

Shunts

Shunts consist of drainage tubes incorporating one or more valves to control the direction and rate of CSF flow³. The devices may also incorporate a reservoir. There are two main types of shunt³:

- Ventriculo-atrial (VA) shunts are used to drain CSF from the ventricle to the right atrium.
- Ventriculo-peritoneal (VP) shunts are more commonly used in contemporary neurosurgical practice. In these, the route of drainage is from the ventricle to the peritoneal cavity.

Shunt replacement is necessary from time to time due to growth of the recipient or to mechanical obstruction or infection of the device.

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If a shunt has to be removed because of infection, CSF drainage has to be maintained. This can be achieved by means of an implanted reservoir (which can be tapped as required) or by an external ventricular drain. These systems allow instillation of intrathecal antibiotics to treat ventriculitis before implantation of a new shunt. They may themselves become secondarily infected. These systems are also used to relieve hydrocephalus in the short term in patients who may not require a permanent shunt.

Sources of infection, CSF shunts become infected by various routes:

- Organisms directly colonize the shunt, usually at the time of surgery
- Organisms reach the CSF and the shunt via haematogenous spread
- Organisms travel along the shunt by retrograde spread (uncommon)

Indicators of infection differ according to the type of shunt:

- Signs of shunt malfunction and/or meningitis such as headaches, vomiting, drowsiness and decreased level of consciousness, with or without fever
- Infected VA shunts discharge organisms directly into the right cardiac atrium. This gives rise to intermittent fevers and signs of septicaemia
- Infected VP shunts discharge organisms directly into the peritoneal cavity or may become distally infected without causing meningitis. Abdominal pain as a result of local inflammation may occur, as may local erythema over the shunt track. Rarely, the distal portion of the shunt may perforate the bowel, leading to peritonitis and abscess formation

Rarely, shunt nephritis may occur a long time after initial shunt surgery. It is a result of the formation of immune complexes and their deposition on the basement membranes of the glomeruli.

Peritoneal fluid may be sent for culture if there is evidence of peritoneal inflammation. Mixed infections, particularly if colonic bacteria are present, suggest bowel perforation.

Shunts which are removed should be sent for culture. Shunt infections may be confirmed by recovering the organism from blood cultures (see [BSOP 37- Investigation of blood cultures for organisms other than Mycobacterium species](#)), CSF (see [BSOP 27 - Investigation of cerebrospinal fluid](#)), shunt tubing, valves or a combination of these. It should be remembered that CSF microscopy may be unremarkable in shunt infection.

Intraventricular catheterisation (or ventriculostomy) is used to monitor intracranial pressure in a variety of neurological and neurosurgical disorders, especially trauma⁴. Catheters used for this purpose may also be sent for culture. Recently intracranial pressure 'bolts' have been introduced: this reduces the need for more invasive ventricular catheterisation in many patients.

Organisms isolated from CSF shunts and ventricular catheters include³⁻⁵:

- Coagulase-negative staphylococci
- *Staphylococcus aureus*
- Enterobacteriaceae
- Coryneforms and *Propionibacterium* species
- Enterococci
- *Haemophilus influenzae*
- *Neisseria meningitidis*
- Pseudomonads
- Streptococci

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- *Streptococcus pneumoniae*
- Yeasts
- *Mycobacterium* species

Organisms which may be isolated but less frequently include anaerobes and fungi other than yeasts⁶⁻⁹.

Coagulase-negative staphylococci are isolated most commonly. Production of extracellular slime has been reported as being important in the pathogenesis of shunt infections¹⁰.

Coryneforms also produce extracellular slime which may contribute to their pathogenesis in device-related infections^{11,12}. Many isolates are *Corynebacterium jeikeium* (formerly JK coryneforms). *C. jeikeium*, and other species, are notable for their resistance to a wide range of antimicrobials¹³.

TECHNICAL INFORMATION/LIMITATIONS

In National Standard Methods, the term “CE marked leak proof container” is used to describe containers bearing the CE marking and which are used for the collection and transport of clinical specimens. The requirements of the EU *in vitro* Diagnostic Medical Devices Directive (98/79/EC Annex 1 B 2.1)¹⁴ state that such devices must “reduce as far as possible contamination of, and leakage from, the device during use and, in the case of specimen receptacles, the risk of contamination of the specimen. The manufacturing processes must be appropriate for these purposes”.

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1 SAFETY CONSIDERATIONS¹⁵⁻²⁵

1.1 SPECIMEN COLLECTION

N/A

1.2 SPECIMEN TRANSPORT AND STORAGE

CE Marked leak proof container^a in a sealed plastic bag

1.3 SPECIMEN PROCESSING

Containment Level 2 unless infection with a Hazard group 3 organism is suspected, in which case work should be performed in a microbiological safety cabinet under containment level 3 conditions.

Although *N. meningitidis* is in Hazard group 2, local policy may dictate that suspected isolates of *N. meningitidis* should always be handled in a microbiological safety cabinet. Sometimes the nature of the work may dictate that full containment level 3 conditions should be used eg for research work using *N. meningitidis* in order to comply with COSHH 2002 Schedule 1.5 (5e).

All work on suspected *N. meningitidis* isolates which is likely to generate aerosols must be performed in a microbiological safety cabinet¹⁶.

Laboratories must take suitable safety precautions when handling CSF specimens. Laboratory policies that take into account the local risk assessments may dictate that the use of a microbiological safety cabinet should be used when dispensing the specimen. Refer to Guidance Note [QSOP 42 - Microbiological examination of CSFs, that may contain agents of spongiform encephalopathies](#).

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 FOR SPECIMEN COLLECTION

Before antimicrobial therapy where possible

2.2 CORRECT SPECIMEN TYPE AND METHOD OF COLLECTION²⁶

When a shunt is removed all three portions should be sent in separate microbiologically approved containers¹⁴ of the appropriate size. This will include the proximal catheter, a valve or reservoir, and a distal catheter²⁷. CSF is usually obtained from the shunt reservoir and sent concurrently for investigation (see [BSOP 27 - Investigation of cerebrospinal fluid](#))

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.

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3.2 SPECIAL CONSIDERATIONS TO MINIMISE DETERIORATION

N/A

4 SPECIMEN PROCESSING

4.1 TEST SELECTION

N/A

4.2 APPEARANCE

Look for pus on external surface.

4.3 MICROSCOPY

[BSOFTP 39 - Staining Procedures](#)

Standard

Fluids

Any fluid aspirated from shunt tubing or other component is treated as CSF (see [BSOP 27 - Investigation of cerebrospinal fluid](#))

Pus (from external surfaces)

Prepare a thin smear on a clean microscope slide for Gram staining

4.4 CULTURE AND INVESTIGATION

4.4.1 PRE-TREATMENT

If the whole shunt is received intact, separate and process each portion separately

If shunt tubing is received, cut a 5 cm length aseptically from each end

If CSF is visible in the shunt tubing or reservoir, aspirate it with a needle and syringe and process accordingly (see [BSOP 27 - Investigation of cerebrospinal fluid](#)). It is important to record the section from which the CSF is withdrawn to assist in deciding the aetiology of the infection and significance of isolates obtained

4.4.2 SPECIMEN PROCESSING

Pus

Swab any visible pus on the surface of the tubing²⁷

(Process separately from the flushed tubing - see below)

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

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

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Tubing

Flush the tubing with sterile saline and collect fluid in a CE Marked leak proof container^a in a sealed plastic bag.

Using a sterile pipette inoculate each agar plate with the uncentrifuged, flushed saline (see [QSOP 52 - Inoculation of culture media](#))

Note: The use of broth medium for processing shunt tubing can lead to false positive results and is not recommended²⁷

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

4.4.3 CULTURE MEDIA, CONDITIONS AND ORGANISMS FOR ALL SPECIMENS

Clinical details/ conditions	Standard media	Incubation			Cultures read	Target organism(s)
		Temp °C	Atmos	Time		
Shunt infection	Chocolate agar	35-37	5-10% CO ₂	40-48 h	daily	Any organism
	Blood agar	35-37	5-10% CO ₂	40-48 h	daily	
	Fastidious anaerobe agar	35-37	anaerobic	5 d	≥40 h and at 5 d	Anaerobes
Optional media		Incubation			Cultures read	Target organism(s)
		Temp °C	Atmos	Time		
If fungi are seen on microscopy	Sabouraud agar	35-37	air	40-48 h	≥40 h*	Yeasts Fungi
*incubation may be extended to 5 days; in such cases plates should be read at ≥40h and then left in the incubator/cabinet until day 5. Certain opportunistic pathogens will require extended incubation.						

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4.5 IDENTIFICATION

4.5.1 MINIMUM LEVEL IN THE LABORATORY

Anaerobes

"anaerobes" level

[BSOPID 14 - Identification of non-sporing, non-branching anaerobes](#)

[BSOPID 8 - Identification of Clostridium species](#)

[BSOPID 25 - Identification of anaerobic Gram-negative rods](#)

[β-haemolytic streptococci](#)

Lancefield group level

[Coagulase-negative staphylococci](#)

"coagulase-negative" level

All other organisms

species level

Note: Any organism considered to be a contaminant may not require identification to species level

It may be useful to store coagulase-negative staphylococci in case later it is necessary to distinguish re-infections from relapsed infections

Note: All work which is likely to generate aerosols must be performed in a microbiological safety cabinet¹⁶

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](#).

Isolates associated with outbreaks, where epidemiologically indicated, and 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 NSM on Susceptibility Testing ([BSOP 45 - Susceptibility Testing](#))

5 REPORTING PROCEDURE

5.1 MICROSCOPY

Report microscopy on the CSF (see [BSOP 27 - Investigation of cerebrospinal fluid](#)), or pus from external surface

5.1.1 MICROSCOPY REPORTING TIME

Urgent microscopy results to be telephoned or sent electronically

5.2 CULTURE

Report organisms isolated or

Report absence of growth

5.2.1 CULTURE REPORTING TIME

Clinically urgent culture results to be telephoned or sent electronically

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

5.3 ANTIMICROBIAL SUSCEPTIBILITY TESTING

Report susceptibilities as clinically indicated

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6 REPORTING TO THE HPA²⁸ (LOCAL AND REGIONAL SERVICES AND CENTRE FOR INFECTIONS)

Refer to the following:

Individual NSMs on organism identification

Health Protection Agency publications:

"Laboratory reporting to the HPA. A guide for diagnostic laboratories"

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

Local guidelines

In cases of suspected meningococcal disease and contacts the isolation of *N. meningitidis* should be reported urgently to the CCDC.

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7 ACKNOWLEDGEMENTS AND CONTACTS

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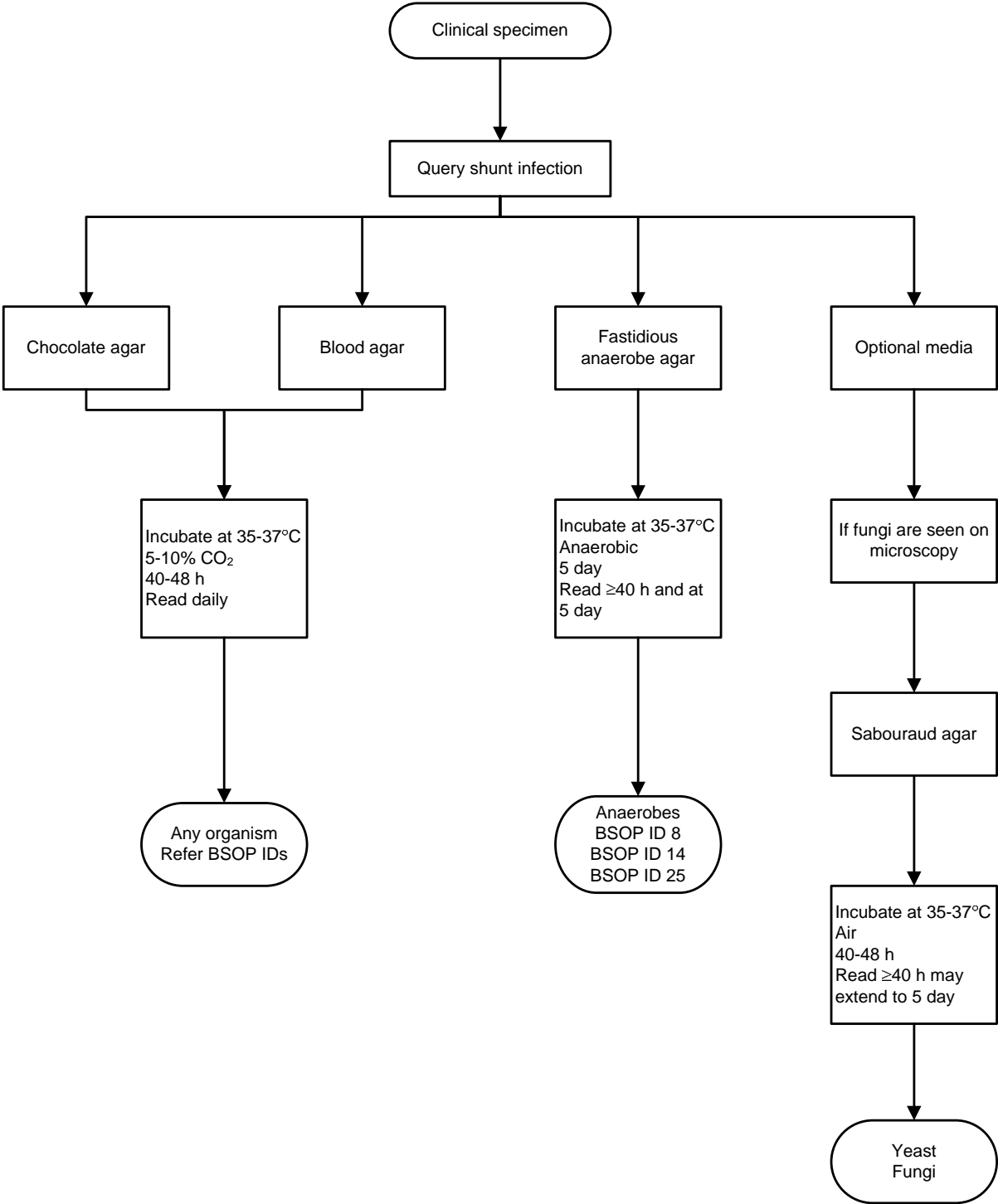
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APPENDIX



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