

Targeted literature review:

What are the key infection prevention and control recommendations to inform a neonatal peripheral venous catheter (PVC) quality improvement tool?

HPS ICT Document Information Grid	
Purpose:	To present a review of the evidence to inform the content of HAI related quality improvement tools for NHSScotland. This supports the functions of HPS in developing effective guidance, good practice and a competent workforce and translating knowledge to improve health outcomes.
Target audience:	All NHSScotland staff involved in neonatal patient care activities where interventions can lead to HAI, particularly those interventions that can cause bloodstream infections such as line insertion. Infection prevention and control teams in NHS boards and other settings. Partner organisations particularly Healthcare Improvement Scotland and National Education for Scotland to ensure consistent information across similar improvement documentation.
Description:	Literature critique summary and presentation of key recommendations to inform HAI quality improvement tools, based around a framework that evaluates these against the health impact contribution and expert opinion/practical application.
Update/ review schedule:	Every three years; however if significant new evidence or other implications for practice are published updates will be undertaken.
Cross reference:	<p>Standard Infection Control Precautions in the National Infection Prevention and Control Manual. http://www.nipcm.hps.scot.nhs.uk/</p> <p>Data on HAI incidence and prevalence and process compliance data.</p> <p>Implementation support from Healthcare Improvement Scotland and/or others, education and training support from National Education Scotland.</p> <p>http://www.nes.scot.nhs.uk/education-and-training.aspx</p> <p>The Maternity and Children Quality Improvement Collaborative (MCQIC) measurement plan is part of the Scottish Patient Safety Programme (SPSP) and contains tools for monitoring compliance with PVC insertion and maintenance bundles.</p> <p>http://www.scottishpatientsafetyprogramme.scot.nhs.uk/programmes/mcqic/neonatal-care</p>

Contents

1	Executive summary	4
2	Aim of the review.....	6
2.1	Out of scope for this review	6
2.2	Assumptions.....	6
3	Results	7
3.1	Insertion	7
3.1.1	Final recommendation - Ensure that a PVC is clinically indicated for this patient (Category 1A)	7
3.1.2	Final recommendation - Ensure that hand hygiene is performed immediately before all PVC insertion procedures (WHO Moment 2) (Category 1A)	7
3.1.3	Final recommendation - Ensure that a single-use application of an appropriate antiseptic is used to cleanse the skin and left to dry before insertion (Category 1A)	8
3.1.4	Ensure that aseptic technique is maintained throughout insertion procedure i.e. critical parts are not touched (Category 1B)	9
3.1.5	Final recommendation - Ensure that a sterile, transparent, semi-permeable dressing is used to cover the catheter site (Category 1A)	9
3.2	Maintenance.....	10
3.2.1	Final recommendation - Ensure that the clinical need for the PVC is reviewed and recorded at least every day (on a daily basis) (Category 1B)	10
3.2.2	Final recommendation - Ensure that timely removal of PVCs is considered (No recommendation)	10
3.2.3	Final recommendation - Ensure that the PVC site is assessed; removing the PVC where there is phlebitis or other inflammation at the site (Category 1B)	10
3.2.4	Final recommendation - Ensure that PVC dressings are intact (Category 1B)	11
3.2.5	Final recommendation - Ensure that hand hygiene is performed immediately before accessing the line/site (WHO Moment 2) (Category 1A)	11
3.2.6	Final recommendation - Ensure that an antiseptic containing 70% isopropyl alcohol is used to clean the access hub before accessing – rub the access hub for at least 15 seconds ('scrub the hub') (Category 1B)	11
4	Implications for research	14
5	References.....	15
	Appendix 1: Previous (Adult) recommendations for insertion and maintenance of PVCs	20
	Appendix 2: Literature review methodology.....	21
	Appendix 3: Search strategy	23

1 Executive summary

The Scottish National HAI Prevalence Survey (2011 and 2016) identified a burden of HAI in the neonatal population that requires a focus on prevention of sepsis and bloodstream infections in this population.^{1;2} The use of PVCs is necessary to provide short-term vascular access for the administration of fluids and drugs that cannot be given by another route e.g. oral. Despite the many advantages of their use, PVCs can result in complications such as phlebitis, skin and soft tissue damage in neonates due to extravasation and catheter-related blood stream infections (BSIs).³⁻⁸

A review of the extant scientific literature and available evidence based guidelines has been undertaken to develop key recommendations for preventing infection when inserting and maintaining peripheral vascular catheters in neonates. The key recommendations and their scientific grade of evidence are as follows:

Insertion

- Ensure that a PVC is clinically indicated for this patient (Category 1A)
- Ensure that hand hygiene is performed immediately before all PVC insertion procedures (WHO Moment 2) (Category 1A)
- Ensure that a single-use skin antiseptic containing 70% isopropyl alcohol is used to cleanse the skin and left to dry before insertion (Category 1A)
- Ensure that aseptic technique is maintained throughout insertion procedure i.e. critical parts are not touched (Category 1B)
- Ensure that a sterile, transparent, semi-permeable dressing is used to cover the catheter site (Category 1A)

Maintenance

- Ensure that the clinical need for the PVC is reviewed and recorded at least every day (on a daily basis) (Category 1A)
- Ensure that timely removal of PVCs is considered (No recommendation)
- Ensure that the PVC site is assessed; removing the PVC where there is phlebitis or other inflammation at the site (Category 1B)
- Ensure that PVC dressings are intact (Category 1B)

- Ensure that hand hygiene is performed immediately before accessing the line/site (WHO Moment 2) (Category 1A)
- Ensure that an antiseptic containing 70% isopropyl alcohol is used to clean the access hub before accessing – rub the access hub for at least 15 seconds ('scrub the hub') (Category 1B)

To find out more information on the categories of these recommendations see [Appendix 2](#).

It is advised that the key recommendations listed here are considered for application into practice as supported by quality improvement tools including care bundles.

Note: this review identifies the resulting key evidence based recommendations and does not aim to identify all the elements of a checklist or standard operating procedure covering PVC insertion or management.

Note

All medical and nursing staff involved in the use of all medical devices and medicinal products containing chlorhexidine should be aware of the risk of an anaphylactic reaction due to chlorhexidine allergy. The full details of the alert are available from the following web link <http://www.mhra.gov.uk/Publications/Safetywarnings/MedicalDeviceAlerts/CON197918>

2 Aim of the review

To review the extant scientific literature to ensure that the key recommendations included within a quality improvement tool are the most critical in ensuring safe insertion and maintenance of PVCs and subsequent safety of neonatal patients.

2.1 Out of scope for this review

This literature review does not address any issues specific to:

- Emergency insertion of PVCs;
- Anti-microbial impregnated catheters;
- Paediatric patients i.e. not explicitly described as neonatal;
- Prophylactic use of antimicrobials.

2.2 Assumptions

There are a number of aspects related to healthcare delivery that were not within the remit of this review as it is clear that they are the responsibility of other professionals. These include that:

Staff are appropriately trained and competent in all aspects of the insertion and management of PVCs preferably using an approved educational package.

The overall approach to the delivery of healthcare is supported by patient safety and improvement approaches and organisational readiness e.g. [MCQIC SPSP](#).

3 Results

The recommendations presented are based on review of the current evidence using the existing recommendations for insertion and maintenance of PVCs in adults in [Appendix 1](#) as a basis for the question set. The methodology for the review is described within [Appendix 2](#) and the specific search strategy in [Appendix 3](#).

3.1 Insertion

3.1.1 Final recommendation - Ensure that a PVC is clinically indicated for this patient (Category 1A)

PVCs are designed to provide vascular access, for examples for the administration of fluids and drugs that cannot be given by any other route and are able to provide access during actual or potential life-threatening situations. This recommendation is based on reports that (in adults) PVCs are often inserted unnecessarily alongside evidence that the longer the duration of catheter in use, the greater the risk of complications such as phlebitis and infection.^{4;8-14} It is therefore clear that one way to avoid PVC related infections is to only insert them when clinically required. In neonates, a small number of studies have indicated the PVCs are associated with an increased risk of phlebitis and an increased number of catheterisations compared to peripherally inserted central catheters (PICCs), their use has not however been linked to a increased risk of infection.^{15;16} Phlebitis itself may require re-siting of a PVC leading to increased catheterisations/attempt to access a vein, this could theoretically increase risk of infection as well as causing unnecessary pain; therefore when determining the necessity of venous access clinicians should also consider whether a central venous catheter (CVC) may be more appropriate, particularly if long-term access is required.

3.1.2 Final recommendation - Ensure that hand hygiene is performed immediately before all PVC insertion procedures (WHO Moment 2) (Category 1A)

The World Health Organisation (WHO) guidelines for hand hygiene in healthcare (2009) clearly describe the indications for hand hygiene and present these within the WHO 'my 5 moments for hand hygiene' approach.¹⁷ This includes emphasising the importance of performing hand hygiene before clean/aseptic procedures to prevent HAI (moment 2). The importance of hand hygiene before PVC insertion is emphasised within other evidence and guidelines.^{9;12;18}

3.1.3 Final recommendation - Ensure that a single-use application of an appropriate antiseptic is used to cleanse the skin and left to dry before insertion (Category 1A)

No evidence that was specific to PVC insertion in neonates was identified to inform this recommendation; however, relevant evidence has been identified in previous literature reviews to inform adult PVC insertion and maintenance QITs and neonatal CVC insertion and maintenance QITs. The recommendation to cleanse skin before insertion is supported by current guidelines and evidence for the adult population.^{9;12;18} It is currently recommended that for PVC insertion in adults, skin should be cleansed with a single-use application of isopropyl alcohol.¹⁹ In neonates chlorhexidine products have been associated with skin irritation such as dermatitis and chemical burns as well as a risk for systemic absorption;^{20;21} the SHEA guidelines (2014) state that the optimal choice of antiseptic agents for children under two months of age is unresolved and that the use of chlorhexidine specifically should be weighed against the risk of adverse events, particularly in preterm infants.²¹ Alternatives such as povidone iodine or alcohol alone may be used,²¹ however, the CDC guidelines state that tincture of iodine must be avoided at the umbilical site due to potential effects on the neonatal thyroid and methanol has been reported to cause chemical burns in premature neonates within a 0.5% chlorhexidine methanol solution.^{12;20}

The requirement that the skin antiseptic is allowed to dry is included as a recommendation within evidence based guidelines.^{12;18} There is no specific evidence within the literature with regards to the method of application or the time the antiseptic is allowed to dry before insertion. However, it is recommended that manufacturer's instructions should be followed.¹²

There have been multiple reports in the literature of outbreaks of HAI associated with contaminated aqueous solutions of chlorhexidine.²²⁻²⁶ Outbreaks of infection have also been associated with 70% and 95% ethanol used for skin decontamination as well as 70% isopropyl alcohol skin preparation pads, which may show a potential for this solution to become contaminated.²⁷⁻²⁹ Therefore for the purposes of skin preparation, the use of single-use sterile containers of antiseptic solutions should be considered best practise.

Note

All medical and nursing staff involved in the use of all medical devices and medicinal products containing chlorhexidine should be aware of the risk of an anaphylactic reaction due to chlorhexidine allergy. The full details of the alert are available from the following web link <http://www.mhra.gov.uk/Publications/Safetywarnings/MedicalDeviceAlerts/CON197918>

3.1.4 Ensure that aseptic technique is maintained throughout insertion procedure i.e. critical parts are not touched (Category 1B)

Aseptic technique is a broad term for a number of actions which prevent cross-transmission of microorganisms. This includes factors such as sterility of equipment combined with a non-touch technique. This is also the basis of the aseptic non-touch technique (ANTT) which is advocated for use in some parts of the UK.³⁰ However, there are a number of other activities which should be considered as part of aseptic technique.³¹ These include: preparation of a surface area which prevents 'touch' contamination of equipment; use of sterile equipment or effective decontamination of equipment prior to use; use of personal protective equipment e.g. gloves; not touching critical parts that must remain sterile throughout the procedure; and appropriate hand hygiene. Aseptic technique is also recommended in the identified guidelines.^{9;12;18}

3.1.5 Final recommendation - Ensure that a sterile, transparent, semi-permeable dressing is used to cover the catheter site (Category 1A)

No evidence that was specific to PVC insertion in neonates was identified to inform this recommendation, however, relevant evidence has been identified in previous literature reviews to inform adults PVC insertion and maintenance QITs and neonatal CVC insertion and maintenance QITs. The EPIC3 guidelines do not make neonate specific guidelines for the insertion and maintenance of vascular catheters, however, they do state that a sterile, transparent, semi-permeable polyurethane dressing should be used to cover the intravascular insertion site.¹⁸ If a patient has profuse perspiration or if the insertion site is bleeding or oozing a sterile gauze dressing is preferable.¹⁸ The current recommendation within the CDC guidelines states 'use either sterile gauze or a sterile, transparent, semi-permeable dressing to cover the catheter site'.¹² It has been reported that the rates of

colonisation found in catheters dressed with either gauze or semi-permeable transparent dressing are comparable.¹² In addition a Cochrane review of optimum dressings for CVCs (updated in 2011) concluded that the uncertainty regarding effect of different dressings no the risk of infection meant that the choice of dressing should be based on patient preference.³²

3.2 Maintenance

3.2.1 Final recommendation - Ensure that the clinical need for the PVC is reviewed and recorded at least every day (on a daily basis) (Category 1B)

The Department of Health (DH) high impact intervention recommends that the continuing clinical indication for intravascular catheters is assessed twice daily and catheters removed when no longer required.⁹ EPIC3 guidelines state that catheters should be removed as soon as no longer required but do not make a recommendation on the frequency of review of clinical need.¹⁸

3.2.2 Final recommendation - Ensure that timely removal of PVCs is considered (No recommendation)

In adults, it is currently recommended that removal of PVCs is considered after 72hrs;¹⁹ this was based on evidence that the longer a PVC remains in situ the greater the risk of complications.^{4;10;13;14} There is some evidence that this can be extended to 96hrs without an increase in complications.³³ However, a 2013 Cochrane systematic review concluded that there was insufficient evidence of benefit from routinely removing catheters every 72 to 96hrs and suggested that catheters (including PVCs) should be changed on clinical indication. This is supported by the EPIC3 guidelines which state that peripheral vascular catheters should be re-sited when clinically indicated and not routinely.¹⁸ This review identified no neonate specific guidance or evidence to guide the timely removal of PVCs, given that neonates may be difficult to catheterise and have delicate skin that can easily be injured by the removal of dressings etc. it may be more appropriate to remove PVCs only when clinically indicated rather than prescribe a timeframe for removal.

3.2.3 Final recommendation - Ensure that the PVC site is assessed; removing the PVC where there is phlebitis or other inflammation at the site (Category 1B)

EPIC3 guidelines state that the PVC insertion site should be inspected at a minimum during each shift; that a Visual Infusion Phlebitis score should be recorded and the

catheter removed if complications occur.¹⁸ There is substantial evidence to support the assessment for and removal of PVCs if complications such as phlebitis, infection or blockage occur with the aim of preventing further complications or infection and this recommendation is consistent across identified guidelines.^{9;12;14}

3.2.4 Final recommendation - Ensure that PVC dressings are intact (Category 1B)

EPIC3 guidelines state that transparent, semi-permeable dressing should be changed every 7 days or sooner if non-intact or if moisture collects under the dressing.¹⁸ However, neonatal skin, particularly in preterm infants, may be easily damaged or torn by removing adherent dressings; there is consensus that less frequent dressing changes may be more appropriate for neonatal patients and that dressings are changed if they are damp, loose, or visibly soiled as well as if there is fluid or bleeding at the insertion site.^{21;34;35}

3.2.5 Final recommendation - Ensure that hand hygiene is performed immediately before accessing the line/site (WHO Moment 2) (Category 1A)

The World Health Organisation (WHO) guidelines for hand hygiene in healthcare (2009) clearly describe the indications for hand hygiene and present these within the WHO 'my 5 moments for hand hygiene' approach.¹⁷ These 5 Moments are widely promoted within NHSScotland and hand hygiene performance is measured against these Moments. This includes emphasising the importance of performing hand hygiene before clean/aseptic procedures to prevent HAI (moment 2). In relation to the risk associated with PVC maintenance, the clearest indication for hand hygiene is before accessing the line/site which aligns to Moment 2: 'before clean/aseptic procedures'. The importance of hand hygiene before accessing the PVC line/site is emphasised within other evidence and guidelines.^{9;12;18}

3.2.6 Final recommendation - Ensure that an antiseptic containing 70% isopropyl alcohol is used to clean the access hub before accessing – rub the access hub for at least 15 seconds ('scrub the hub') (Category 1B)

It has been previously reported that hubs and connection ports are generally contaminated and must be disinfected prior to access by HCWs.^{12;14;18}

Needleless connectors were originally introduced to reduce the risk to staff from needlestick injuries.³⁶ Subsequent developments have resulted in numerous different designs of connectors which include split-septum devices, mechanical valve devices, and

devices with positive fluid displacement. However, it is possible that complex designs of connectors may make them more likely to harbour bacteria. Indeed, there have been reports of increased CRBSIs which have been observed after their introduction and subsequently a focus on the importance of adequate and thorough decontamination of these needleless ports.³⁷⁻⁴¹

The Department of Health (DH) High Impact Intervention recommends that ports or hubs are cleaned with 2% chlorhexidine gluconate in 70% isopropyl alcohol prior to catheter access.⁹ Similarly, the Center for Disease Control (CDC) guidelines recommend to 'minimize contamination risk by scrubbing the access port with an appropriate antiseptic (chlorhexidine, povidone iodine, an iodophor or 70% isopropyl alcohol) and accessing the port only with sterile devices'.¹²

The evidence for the use of 2% chlorhexidine gluconate in 70% isopropyl alcohol results mainly from studies where catheters are left in situ long term.¹⁸ There is some debate about whether it is the method of cleaning or the choice of disinfectant which is the most important factor. Two microbiological studies which examined decontamination of different designs of needleless access hubs showed that 15 seconds of a scrubbing action with 70% isopropyl alcohol was as effective as 2% chlorhexidine in 70% isopropyl alcohol.^{42;43} Despite being relatively small scale they have provided evidence that the duration of disinfectant contact along with the method of decontamination which is important. This is of particular importance when considering the different designs of the needleless connector components.

Two studies were identified which supported the use of chlorhexidine in alcohol for cleaning catheters hubs and connectors before accessing neonatal CVCs.^{44;45} No adverse effects were reported although it is unclear if these were recorded, it is possible that skin contact is minimal when chlorhexidine is used to 'scrub the hub' and so poses less risk of irritation.

Epidemiological evidence to support the inclusion of the 'scrub the hub' intervention for CVCs has been provided by a number of observational studies in adults; following introduction of this intervention within a number of ICUs, significant reductions were observed in the CRBSI rate, even within settings where the baseline rate was already low.^{39;42;43} This has also been demonstrated in neonatal patients using 5% chlorhexidine gluconate in alcohol wipes.⁴⁴

Other methods of hub decontamination, such as the use of antiseptic chambers, have also been described. However, despite some recent epidemiological and microbiological data, there is currently insufficient evidence to support routine use.^{46;47} EPIC 3 states that antimicrobial lock solutions should not be used routinely to prevent catheter related bloodstream infections.¹⁸

Note

All medical and nursing staff involved in the use of all medical devices and medicinal products containing chlorhexidine should be aware of the risk of an anaphylactic reaction due to chlorhexidine allergy. The full details of the alert are available from the following web link <http://www.mhra.gov.uk/Publications/Safetywarnings/MedicalDeviceAlerts/CON197918>

4 Implications for research

Generally, there is a lack of evidence to inform recommendations for PVC insertion and maintenance that are specific to neonates. In particular, more research is required to determine the optimum antiseptic agent and concentration for skin antisepsis in neonates (particularly preterm infants) both before insertion and during dressing changes. It is possible that there is a research or publication bias towards CVCs in this patient group, premature neonates may require longer care requiring invasive lines e.g. for parenteral nutrition, and so may be more likely to have a central vascular catheter placed than a PVC, this could lead to PVCs being seen as less of a research priority. Nevertheless it is assumed that many of the infection control recommendation for CVCs are transferable to PVCs such as hand hygiene and skin antisepsis and this review will now provide a framework for developing evidence-based guidelines for neonatal PVCs as evidence becomes available.

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Appendix 1: Previous (Adult) recommendations for insertion and maintenance of PVCs

The following are final recommendations from the adult PVC insertion and maintenance QITs produced by HPS. These were used to inform the question set for developing an equivalent neonatal QIT.

Insertion

- Ensure that a PVC is clinically indicated for this patient (Category 1A)*
- Ensure that hand hygiene is performed immediately before all PVC insertion procedures (WHO Moment 2) (Category 1A)
- Ensure that a single-use skin antiseptic containing 70% isopropyl alcohol is used to cleanse the skin and left to dry before insertion (Category 1B)
- Ensure that aseptic technique is maintained throughout insertion procedure i.e. critical parts are not touched (Category 1B)
- Ensure that a sterile, transparent, semi-permeable dressing is used to cover the catheter site (Category 1A)

Maintenance

- Ensure that the clinical need for the PVC is reviewed and recorded every day (on a daily basis) (Category 1A) *
- Ensure that medical staff review the need for intravenous (IV) therapy including antibiotics on a daily basis- switch to oral if possible (Category 1B)
- Ensure that hand hygiene is performed immediately before accessing the line/site (WHO Moment 2) (Category 1A)
- Ensure that timely removal of PVCs is considered i.e. if in longer than 72 hours (Category 1B)
- Ensure that the PVC site is assessed; removing the PVC where there is phlebitis or other inflammation at the site (Category 1B)
- Ensure that PVC dressings are intact (Category 1A)
- Ensure that an antiseptic containing 70% isopropyl alcohol is used to clean the access hub before accessing – rub the access hub for at least 15 seconds ('scrub the hub') (Category 1B)

Appendix 2: Literature review methodology

This targeted literature review was produced using a defined methodology as described below and in the [National Infection Prevention and Control Manual: Development Process](#). The grading of recommendations for HPS QITs uses the HICPAC system rather than the SIGN50 system used for the NIPCM, this is described below.

Initial rapid search and review

The initial search rapid literature search was carried out to identify mandatory guidance, or recent national or international evidence based guidance which either agrees or refutes that the current key recommendations are the most important to ensure optimal PVC care:

The main public health websites were searched to source any existing quality improvement tools

Relevant guidance and quality improvement tools e.g. Department of Health (DH), Centers for Disease Control and Prevention (CDC) etc were reviewed

Additional literature identified and sourced e.g. from the relevant Cochrane reviews.

The quality of evidence based guidance was assessed using the AGREE instrument and only guidance which achieved either a strongly recommend or recommend rating was included.

Targeted systematic review

As a result of initial rapid search and review, recommendations requiring a more in depth review were identified. This involved searching of relevant databases including OVID Medline, CINAHL, and EMBASE. All literature pertaining to recommendations where evidence was either conflicting or where new evidence was available were critically appraised using SIGN checklists and a 'considered judgement' process used to formulate recommendations based on the current evidence for presentation and discussion with the National Healthcare Associated Infection (HAI) Quality Improvement Tools Group in Scotland.

Grading of recommendations

Grading of the evidence is using the Healthcare Infection Control Practices Advisory Committee (HICPAC) method. In addition to the overall assessment of the evidence underpinning the recommendation, other factors are considered which affect the overall strength of the recommendation such as the health impact and expert opinion on the potential critical outcomes.

The HICPAC categories are as follows:

Category 1A – strong recommendation based on high to moderate quality evidence
Category 1B – strong recommendation based on low quality of evidence which suggest net clinical benefits or harms or an accepted practice (e.g. aseptic technique)
Category 1C – a mandatory recommendation
Category II – a weak recommendation which shows evidence of clinical benefit over harm
No recommendation – not sufficient evidence to recommend one way or another

Appendix 3: Search strategy

Exp neonate
Exp Catheterization/or exp Catheterization, Peripheral
Peripheral vascular catheter.mp
Peripheral venous catheter.mp
Venflon.mp
2 or 3 or 4 or 5
Phlebitis.mp
Extravasation.mp
Thrombophlebitis.mp
exp Bacteremia or exp bacteraemia/
colonisation.mp.
Blood stream infection\$.mp
Bloodstream infection\$.mp
Exp catheter-related infections
Exp sepsis
(skin adj antisepsis).mp
Infection\$
exp Infection/ or exp Cross Infection/ or exp Infection Control/
7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
(chlorhexidine adj gluconate).mp
exp alcohols/
exp 2-propanol
exp Chlorhexidine/ or exp Hand Disinfection/ or exp Povidone-Iodine/
exp Hand Hygiene/
surgical scrub*.mp
20 or 21 or 22 or 23 or 24 or 25
personal protective equipment.mp
exp Gloves, Surgical/ or exp Gloves, Protective/
exp Protective Clothing/
27 or 28 or 29
exp Asepsis/ or exp antisepsis
aseptic technique?.mp
non-touch technique?.mp
31 or 32 or 33
19 or 26 or 30 or 34
1 and 6 and 35
