Health Protection Scotland

NHS National Services Scotland

Targeted literature review:

What are the key infection prevention and control recommendations to inform a prevention of blood culture contamination quality improvement tool?

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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 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:	Standard Infection Control Precautions Policies in the National Infection Prevention and Control Manual. http://www.nipcm.hps.scot.nhs.uk/ Implementation support from Healthcare Improvement Scotland and/or others, education and training support from National Education Scotland http://www.nes.scot.nhs.uk/education-and-training.aspx

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1 Executive summary

To confirm whether a patient has bacteraemia and to guide appropriate therapy it is necessary to sample a patient's blood for 'culture'. It is important that the test is as accurate as possible. Contaminants can be introduced to a blood sample during the collection process from; the hands of the healthcare workers, the patient's skin, the environment or the equipment used (including the sample bottle itself). Contamination of the blood culture sample is a widespread problem, with rates of approximately 10% being reported.[1;2] Blood culture contamination can lead to unintended consequences which can impact on patient safety and result in avoidable increased costs. The Department of Health recommend that the incidence of blood culture contamination should be lower than 3%.[2]

The recommendations result from a review of scientific evidence and the process of assessing these within a health impact and expert opinion framework.

The key recommendations and their scientific grade of evidence for the prevention of blood culture contamination quality improvement tool are:

- Ensure that blood culture bottle tops are decontaminated by rubbing with an antiseptic containing 70% isopropyl alcohol and left to dry.(Category 1B)*
- Ensure that hand hygiene is performed immediately before the process of taking a blood culture sample (WHO Moment 2). (Category 1A)
- Ensure that a single-use skin antiseptic containing 70% isopropyl alcohol is used to cleanse the skin site and left to dry. (Category 1B)
- Ensure that aseptic technique is maintained including use of gloves; don't touch critical parts, including the skin following disinfection. (Category 1B)
- Ensure that the blood culture bottle is inoculated first (if taking blood for other samples). (Category II)

* for more information on the categories of these recommendations see appendix 2.

In Summary: It is advised that the key recommendations listed above and summarised in appendix 4 are incorporated into practice. This review did not aim to identify all the elements of taking a blood culture sample and other locally available procedures and tools should address all steps related to taking samples for blood culture. These activities are

also supported by quality improvement tools such as care bundles and national patient safety advice (as directed by Healthcare Improvement Scotland).

2 Aim of the review

To review and update the evidence base and seek expert opinion to ensure that the key recommendations included within this quality improvement tool are the most critical for consistent, optimized practice to prevent blood culture contamination. The criteria below were used to frame the review of the evidence base:

- Decontaminate blood culture bottle tops with 70% alcohol and leave to dry.
- Carry out hand hygiene before touching the patient.
- Apply a skin antiseptic containing 70% alcohol to cleanse the skin and leave to dry.
- Don't touch critical parts.
- Inoculate blood culture bottles first.

3 Background

3.1 The problem

Blood culture contamination is the 'growth of bacteria in the blood culture bottle which were not present in the patient's bloodstream'.[2] There are a number of organisms which are commonly associated with contamination of blood cultures. These include: coagulase-negative staphylococci, nonhaemolytic streptococci, *Lactococcus* and *Lactobacillus* as well as commonly known causes of HAI such as *Staphylococcus aureus*.[3;4] Contamination can arise from a number of different sources, including the hands of the healthcare worker, the patient's skin, the environment and the equipment used to transfer the sample to the culture bottles e.g. needle and syringe. Contamination of blood culture samples is considered a widespread problem with contamination rates of approximately 10% being reported.[1;2] The detrimental effects of blood culture contamination are numerous, for example false positives can result in failure to quickly and accurately diagnose a bacterial infection, cause administration of antibiotics which are not required or are inappropriate and subsequently increase the antimicrobial resistance (AMR) burden.[5] False positives artificially raise *Staphylococcus aureus* bacteraemia rates which can affect perceptions of how a hospital or NHS Board is performing against the HEAT targets as well as cause

public concern. In addition, it can have cost implications for example, due to increased length of stay.

3.2 Why taking samples for blood culture is needed

Blood culture is a used to confirm whether a patient has a bacteraemia and to guide appropriate therapy e.g. antimicrobials. It is vital that the test is able to accurately identify whether there is a blood stream infection present and the causative microorganism as soon as possible, particularly as the patient requiring this test is often critically ill.

3.3 Out of scope for this review

This literature review does not address any issues specific to:

- paediatric patients;
- sepsis;
- any other aspect related to blood culture or bacteraemia/sepsis management;
- the whole blood culture procedure.

3.4 Assumptions – to ensure successful application of recommendations into practice

Staff must be appropriately trained and competent in taking blood cultures. http://www.nes.scot.nhs.uk/education-and-training.aspx

The overall approach to the delivery of healthcare is supported by patient safety and improvement approaches and organisational readiness.

4 Results

The recommendations presented in this section are based on a review of the current evidence using the criteria set out in section 2. To further aid the process of deciding what final key recommendations were to be included, all the recommendations resulting from the review of the evidence were assessed using the 'health impact and expert opinion framework' as detailed in appendix 1. The final key recommendations were identified as a result of this evaluation and refined by the process of wider consultation.

The methodology for the review is described within appendix 2; the specific search strategy in appendix 3 and finally a summary of the resulting recommendations can be found in appendix 4.

4.1 Review of evidence base

4.1.1 Final recommendation - Ensure that blood culture bottle tops are decontaminated by rubbing with an antiseptic containing 70% isopropyl alcohol and left to dry (Category 1B)

All equipment required for collecting a blood sample should be prepared and be close at hand before commencing the procedure.[6] Blood culture bottles are clean but not sterile and therefore the rubber septum is a potential source of microbial contamination. The risk of contamination is minimised by rubbing the septum with an antiseptic containing 70% isopropyl alcohol and allowing it to dry prior to inoculation.[2] The microbiocidal activity of alcohol is well described[7] and 70% isopropyl alcohol is effective against a range of pathogens which are associated with healthcare associated infection (HAI) and common blood culture contaminants.[3;4] Therefore, despite the lack of strong evidence to specifically support this practice, it is included in many descriptions of methods in use within peer reviewed scientific publications and is considered good practice based on accepted principles of ensuring sterility and an aseptic technique.[8-10] There is a lack of evidence to inform exact rubbing times or technique.

4.1.2 Final recommendation - Ensure that hand hygiene is performed immediately before taking a blood culture sample (WHO Moment 2) (Category 1A)

This recommendation, and the importance of hand hygiene performance, is consistent with all current evidence, guidelines and the Department of Health (DH) High Impact

Intervention.[2;6] World Health Organization (WHO) Guidelines on Hand Hygiene in Health Care (2009)[6] clearly describe the indications for hand hygiene and present these within WHO 'My 5 Moments for Hand Hygiene' approach, including emphasising the importance of performing hand hygiene before clean/aseptic procedures to prevent healthcare associated infection (HAI). These '5 Moments' have been widely promoted within NHSScotland for a number of years and hand hygiene performance is measured against compliance with these 'Moments'. This tool aims to identify optimal timing for hand hygiene 'Moment 2'; this does not replace the other hand hygiene 'Moments' that should be performed before and after the procedure.

4.1.3 Final recommendation - Ensure that a single-use skin antiseptic containing 70% isopropyl alcohol is used to cleanse the skin and left to dry (Category 1B)

Decontamination of the skin prior to venous access is crucial to avoid contamination from microorganisms present on the patient's skin.[2] Department of Health (DH) high impact intervention recommends that '2% chlorhexidine gluconate in 70% alcohol is used and allowed to dry for at least 30 seconds[2] however the supporting evidence for this recommendation is not clear. Within NHSScotland, anecdotal evidence reveals that a common way of skin being prepared prior to obtaining a blood culture within the majority of clinical areas is by a single-use alcohol impregnated swab. Therefore due to the ambivalent nature of the evidence, a more detailed review was conducted to further examine the evidence on skin antisepsis.

There have been a number of studies evaluating the use of different skin antiseptics and potential effect on blood culture contamination.[3;9-15] There are some difficulties in comparing across these studies due to differences in the definition of blood culture contamination, the myriad different antiseptics studied and the lack of high quality studies e.g. randomised control trials (RCTs).

A controlled trial which compared the effect of four different antiseptics on the rate of blood culture contamination found no difference between povidone iodine, tincture of iodine, isopropyl alcohol and povidone iodine in alcohol and concluded that the use of isopropyl alcohol may be recommended due to reasons of cost and tolerability.[3] A randomized controlled trial comparing 10% povidone iodine (aqueous solution), 2% iodine tincture and 2% chlorhexidine gluconate in 70% isopropyl alcohol found no statistically significant

differences in blood culture contamination rates between the three antiseptics[16]. However, alcohol wipes were used prior to application of iodine-containing antiseptics and this was only considered as an afterthought. This was also the case for a number of recent randomised controlled trials in which the use of an alcohol swap formed the first step in both arms of the study[14;15]. There was no significant difference in rates of culture contamination following antisepsis with 2% chlorhexidine in 70% isopropyl alcohol compared to 70% isopropyl alcohol[15]. Similarly, 2% chlorhexidine in 70% isopropyl alcohol was as effective as 2% iodine tincture[14]. The role of alcohol in antiseptics is often overlooked in studies measuring the effectiveness of antiseptics, a systematic review and meta-analysis found that in many cases chlorhexidine alone had been inappropriately deemed more effective than other antiseptics by not acknowledging the role of alcohol[17]. The meta-analysis in fact showed that alcohol-containing antiseptics are always more effective at preventing blood culture contamination than those in aqueous solutions.

Taking a sample for blood culture requires a rapid effective method of disinfection, which makes 70% isopropyl alcohol suitable given its efficacy as a disinfectant combined with its rapid drying action.[10;17] In summary, given the lack of specific evidence to suggest that 2% chlorhexidine in 70% isopropyl alcohol should be used preferentially over 70% isopropyl alcohol alone for skin preparation prior to venepuncture for a blood culture sample, a skin antiseptic containing 70% isopropyl alcohol is recommended. This review identified no specific studies or evidence with respect to technique for application or specific recommendation on drying time; therefore it is recommended that manufacturers' instructions are referred to for any product used.

4.1.4 Final recommendation - Ensure that aseptic technique is maintained including use of gloves; don't touch critical parts, including the skin following disinfection (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^{TM}) which is advocated for use in some parts of the UK.[18;19] Indeed this method is promoted for use in the EPIC3 guidelines[20] on which many Department of Health (DH) high impact interventions are based. However there are a number of activities which should be considered as part of aseptic technique.[21] These include preparation of a

surface area which prevents 'touch' contamination of equipment being used, use of sterile equipment or effective decontamination of equipment prior to use, use of personal protective equipment (PPE) e.g. gloves, in addition to not touching critical parts that must remain sterile throughout the procedure and appropriate hand hygiene performed at the right times. It may be reasonable to assume therefore that this recommendation reflects the widest context of 'aseptic technique' to ensure that it is giving clear direction to all the critical actions that will result in a reduction/prevention in contamination of blood culture samples. Therefore this recommendation is based on accepted practice as described in clinical procedures and policies.[21]

4.1.5 Final recommendation - Ensure that the blood culture bottle is inoculated first (if taking blood for other samples) (Category II)

This is a good practice point designed to avoid cross contamination of additives between tubes during the procedure. World Health Organization (WHO) guidelines provide a table which details the order in which blood samples should be drawn, which is based on national standards from the USA.[22] Department of Health (DH) high impact intervention[2] also includes this key action and also it forms part of good aseptic practice to minimise the number of manipulations as far as possible to reduce potential for contamination.[21] It is concluded therefore that although this is not a strong evidence based recommendation, it is strongly embedded in good practice and should be included as one of the key recommendations.

4.2 Review of additional evidence based on initial search findings

4.2.1 Ensure that date, time and rationale for taking blood culture are documented (Category II)

Department of Health (DH) high impact intervention and World Health Organization (WHO) guidelines include recommendations to document the date, reason for sample being taken, site of venepuncture along with person undertaking the procedure and whether it is considered high risk.[2;22] This is firmly based on good practice; and is also required to enable some evidence based actions to be carried out i.e. to check that the blood culture has been clinically indicated. This step may be important for patient safety however it is not solely an infection prevention precaution; therefore it is not within the remit of this review. However the importance of accurate documentation will be included within the summary of recommendations as standard in appendix 4.

4.2.2 Consideration of blood culture collection packs

Some acute settings regularly use specially designed blood culture collection 'packs' as part of a quality improvement/patient safety approach and this has also been reported within some studies[5;8;9;23;24]. However, the current evidence base is not strong enough to make a recommendation on the use of blood culture collection 'packs'. The studies identified in the literature review gave mixed results, some studies show improvement in blood culture contamination rates associated with the introduction of collection packs and others show none. Blood culture collection 'packs' were introduced as part of a larger 'bundle' of quality improvement recommendations in all of the studies and so it is difficult to isolate any benefits specific to their use. The use of 'packs' may improve compliance with recommendation 4.1.4 "Ensure that aseptic technique is maintained including use of gloves; don't touch critical parts, including the skin following disinfection (Category 1B) ", as this includes the preparation of equipment to prevent 'touch contamination'. The use of blood culture collection 'packs' should be decided at a local level, giving consideration to potential benefits, cost implications and practicality of their implementation.

In conclusion: It is now advised that the key recommendations listed as a result of this review here and summarised in appendix 4 are incorporated into practice as supported by quality improvement tools including care bundles. These activities can also be supported by national patient safety/quality improvement work (as directed by Healthcare Improvement Scotland). http://www.hps.scot.nhs.uk/

5 References

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Note: A number of references listed above are cited within the literature review methodology which has been placed in appendix 2 for ease of reading of this document.

Appendix 1: Framework – tool to evaluate evidence based recommendations alongside the health impact contribution & expert opinion (based on target group covered by this review)

Recommendation for review	Ensure that blood culture bottle tops are decontaminated by rubbing with an antiseptic containing 70% isopropyl alcohol and left to dry.								
Grade of recommendation (based on review of evidence)	Category 1B								
Health impact contribution (based on Healthcare Quality Strategy for NHSScotland)	**Safe:** Not implementing this recommendation may increase the chance of blood culture contamination which may impact on patient care/treatment								
	Effective: This recommendation forms an essential part of the aseptic procedure required to prevent contamination of the blood culture sample								
	Efficient: This recommendation fits with the practices that should be acceptable to clinicians and allows for correct use of equipment.								
	Equitable: This recommendation promotes equitable care for all patients requiring a blood culture sample and may result in reduction in avoidable NHS costs and be beneficial to all								
	Timely: This recommendation fits with other aspects of taking a blood culture sample aseptically								
	Person Centred: This is a person centred action to reduce blood culture contamination which could lead to delays in treatment or inappropriate treatment and allows for communication with patients undergoing the procedure								
Expert opinion/consultation and practical considerations	**Measurement and feedback (Y/N/?)**	**Feasibility and sustainability (Y/N/?)**				**Applicability and reach (Y/N/?)**			**Training and informing (Y/N/?)**
	Potential for measurement through e.g. observation	Easily implemented within current culture and will improve the quality of care now	Potential for consistent delivery	Easily implemented based on reliably available resources/ products/prompts	Stealth integration into natural workflow/logical clarity of concept (also see Cause & Effect Chart)	Unambiguous	Potential for applicability to a wide range of settings	Avoids unintended consequences /perverse behaviour	Potential for congruency in design and meaning, with HCW, trainer and observer training and education
	Y	Y	Y	Y	Y	Y	?	?	Y
Is this a key recommendation?	Yes								

Recommendation for review	Ensure that hand hygiene is performed immediately before the process of taking a blood sample (WHO Moment 2).								
Grade of recommendation (based on review of evidence)	Category 1A								
Health impact contribution (based on Healthcare Quality Strategy for NHSScotland)	**Safe:** Not implementing this recommendation could put the patient at risk of harm and increase the risk of contamination of a blood culture								
	Effective: This recommendation will minimise the risk of contamination of the blood sample from healthcare workers hands during the procedure								
	Efficient: This recommendation reduces the risk of blood culture contamination occurring and therefore may result in a reduction in associated NHS costs								
	Equitable: This recommendation promotes a standard of care for all patients that may result in reduction in avoidable NHS costs and be beneficial to all								
	Timely: This recommendation should be an integral part of healthcare worker activity and patient / individual care and fits								
	Person Centred: This is a person centred action to reduce the chance of contamination occurring at the point of access and allows for engaging the patient in knowing that safe care is being practiced								
Expert opinion/consultation and practical considerations	**Measurement and feedback (Y/N/?)**	**Feasibility and sustainability (Y/N/?)**				**Applicability and reach (Y/N/?)**			**Training and informing (Y/N/?)**
	Potential for measurement through e.g. observation	Easily implemented within current culture and will improve the quality of care now	Potential for consistent delivery	Easily implemented based on reliably available resources/ products/prompts	Stealth integration into natural workflow/logical clarity of concept (also see Cause & Effect Chart)	Unambiguous	Potential for applicability to a wide range of settings	Avoids unintended consequences /perverse behaviour	Potential for congruency in design and meaning, with HCW, trainer and observer training and education
	Y	Y	Y	Y	Y	?	Y	Y	Y
Is this a key recommendation?	Yes								

Recommendation for review	Ensure that a single use skin antiseptic containing 70% isopropyl alcohol is used to cleanse the skin and left to dry								
Grade of recommendation (based on review of evidence)	Category 1B								
Health impact contribution (based on Healthcare Quality Strategy for NHSScotland)	**Safe:** Not implementing this recommendation may put the patient at risk of harm and result in contamination of the sample								
	Effective: This recommendation reduces the risk of contamination of the blood sample from the patient's skin during the procedure as well as well as patient harm								
	Efficient: This recommendation will fit with accepted clinical practice and helps prevent contamination of the sample and which could result in a reduction in the NHS cost associated with blood culture contamination								
	Equitable: This recommendation supports equitable care for all patients and may result in reduction in avoidable NHS costs, beneficial to all								
	Timely: This recommendation fits with all the other actions required to take a blood sample while minimising the risk of contamination contributing to streamlining of care								
	Person Centred: This is a person centred action aimed at reducing the potential for contamination occurring during the procedure and allows for communication with patients undergoing the procedure								
Expert opinion/consultation and practical considerations	**Measurement and feedback (Y/N/?)**	**Feasibility and sustainability (Y/N/?)**				**Applicability and reach (Y/N/?)**			**Training and informing (Y/N/?)**
	Potential for measurement through e.g. observation	Easily implemented within current culture and will improve the quality of care now	Potential for consistent delivery	Easily implemented based on reliably available resources/ products/prompts	Stealth integration into natural workflow/logical clarity of concept (also see Cause & Effect Chart)	Unambiguous	Potential for applicability to a wide range of settings	Avoids unintended consequences /perverse behaviour	Potential for congruency in design and meaning, with HCW, trainer and observer training and education
	Y	Y	Y	Y	Y	?	Y	Y	Y
Is this a key recommendation?	Yes								

Recommendation for review	Ensure that aseptic technique is maintained including use of gloves; don't touch critical parts, including the skin following disinfection.								
Grade of recommendation (based on review of evidence)	Category 1B								
Health impact contribution (based on Healthcare Quality Strategy for NHSScotland)	**Safe:** Not implementing this recommendation may put the patient at risk of harm and result in contamination of the sample								
	Effective: This recommendation should minimise the risk of contamination occurring during the procedure								
	Efficient: This recommendation will help prevent contamination of the sample and result in a reduction in the NHS cost associated with blood culture contamination								
	Equitable: This recommendation will help prevent contamination of the sample and result in a reduction in avoidable personal and NHS cost associated with blood culture contamination, beneficial to all								
	Timely: This recommendation fits with all the other actions required to take a blood sample while minimising the risk of contamination, contributing to streamlining of care								
	Person Centred: This is a person centred action to ensure safe care in all patients requiring a sample taken for blood culture and allows for communication with patients undergoing the procedure								
Expert opinion/consultation and practical considerations	**Measurement and feedback (Y/N/?)**	**Feasibility and sustainability (Y/N/?)**				**Applicability and reach (Y/N/?)**			**Training and informing (Y/N/?)**
	Potential for measurement through e.g. observation	Easily implemented within current culture and will improve the quality of care now	Potential for consistent delivery	Easily implemented based on reliably available resources/ products/prompts	Stealth integration into natural workflow/logical clarity of concept (also see Cause & Effect Chart)	Unambiguous	Potential for applicability to a wide range of settings	Avoids unintended consequences /perverse behaviour	Potential for congruency in design and meaning, with HCW, trainer and observer training and education
	Y	Y	Y	Y	Y	?	Y	Y	Y
Is this a key recommendation?	Yes								

Recommendation for review	Ensure that the blood culture bottle is inoculated first (if taking blood for other samples).								
Grade of recommendation (based on review of evidence)	Category II								
Health impact contribution (based on Healthcare Quality Strategy for NHSScotland)	**Safe:** This recommendation forms part of recognised best practice which helps avoid contamination of the blood culture sample occurring during the procedure.								
	Effective: This recommendation should contribute to preventing contamination occurring during sampling and avoid further complications.								
	Efficient: This recommendation forms part of the procedure set out to prevent contamination occurring during sampling but may not be viewed as not efficient by staff in the first instance								
	Equitable: This recommendation supports equitable care for all patients and result in reduction of avoidable NHS costs and be beneficial to all								
	Timely: This recommendation fits with all the other actions required to take a blood sample while minimising the risk of contamination, although education may be required to support the order of actions to achieve this standard								
	Person Centred: N/A								
Expert opinion/consultation and practical considerations	**Measurement and feedback (Y/N/?)**	**Feasibility and sustainability (Y/N/?)**				**Applicability and reach (Y/N/?)**			**Training and informing (Y/N/?)**
	Potential for measurement through e.g. observation	Easily implemented within current culture and will improve the quality of care now	Potential for consistent delivery	Easily implemented based on reliably available resources/ products/prompts	Stealth integration into natural workflow/logical clarity of concept (also see Cause & Effect Chart)	Unambiguous	Potential for applicability to a wide range of settings	Avoids unintended consequences /perverse behaviour	Potential for congruency in design and meaning, with HCW, trainer and observer training and education
	Y	?	Y	Y	?	Y	Y	?	Y
Is this a key recommendation?	YES (Agreed following additional consultation)								

Appendix 2: Literature review methodology

The evidence underpinning the criteria for a quality improvement tool was reviewed using a targeted systematic approach to enable input and resource to be concentrated where needed. This methodology is fully described within a separate paper '*Rapid method for development of evidence based/expert opinion key recommendations, based on health protection network guidelines'*

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 practices related to preventing contamination when taking samples for blood culture:

- 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[25] 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 Policies Guidance and Outbreaks Groups in Scotland.

Grading of recommendations

Grading of the evidence is using the Healthcare Infection Control Practices Advisory Committee (HICPAC) method.[26] 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

Framework for identifying final key recommendations

One way of improving implementation of evidence based guidance is by the identification of key recommendations which if applied will improve practice and outcome.[27-33] This is the foundation of 'care bundles' and other quality improvement tools which rely on the identification of key evidence based recommendations to ensure application in practice.[34]

A method has been developed which aims to reflect graded recommendations in line with ensuring healthcare quality, attention to cost and practical application. It combines approaches used by the Institute of Healthcare Improvement (IHI) and World Health Organization, among others, in identifying the critical factors from the evidence to ensure patient safety in a range of fields.[33;35] The method considers the current NHSScotland Quality Strategy dimensions and finally expert opinion applied within a formal framework. This framework includes a range of practical considerations under the headings

measurement and feedback, feasibility and sustainability, applicability and reach, training and informing.

Ultimately, HPS key recommendations are presented taking all of these factors into account, with the aim of improving practice and outcome.

The search strategy used is described in appendix 3.

Appendix 3: Search Strategy

Database: Embase <1974 to 2018 July 12>, Ovid MEDLINE(R) ALL <1946 to July 12, 2018>

Search Strategy:

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1 exp blood specimen collection/ (194440)

2 exp antisepsis/ (8435)

3 exp anti-infective agents/ (4372655)

4 exp alcohols/ (1047100)

5 exp disinfectants/ (284329)

6 exp chlorhexidine/ (23140)

7 contamination.mp. (354916)

8 exp bacteria/ (2781859)

9 2 or 3 or 4 or 5 or 6 (5197174)

10 7 or 8 (3066951)

11 1 and 9 and 10 (3269)

12 limit 11 to english language (3128)

13 limit 12 to yr="2014 -Current" (1000)

14 limit 13 to humans (776)

15 remove duplicates from 14 (757)

****

Key literature from e.g. the relevant Cochrane reviews were also sourced and critically appraised using SIGN methodology.

Appendix 4: Summary of key recommendations for preventing contaminations of a blood culture