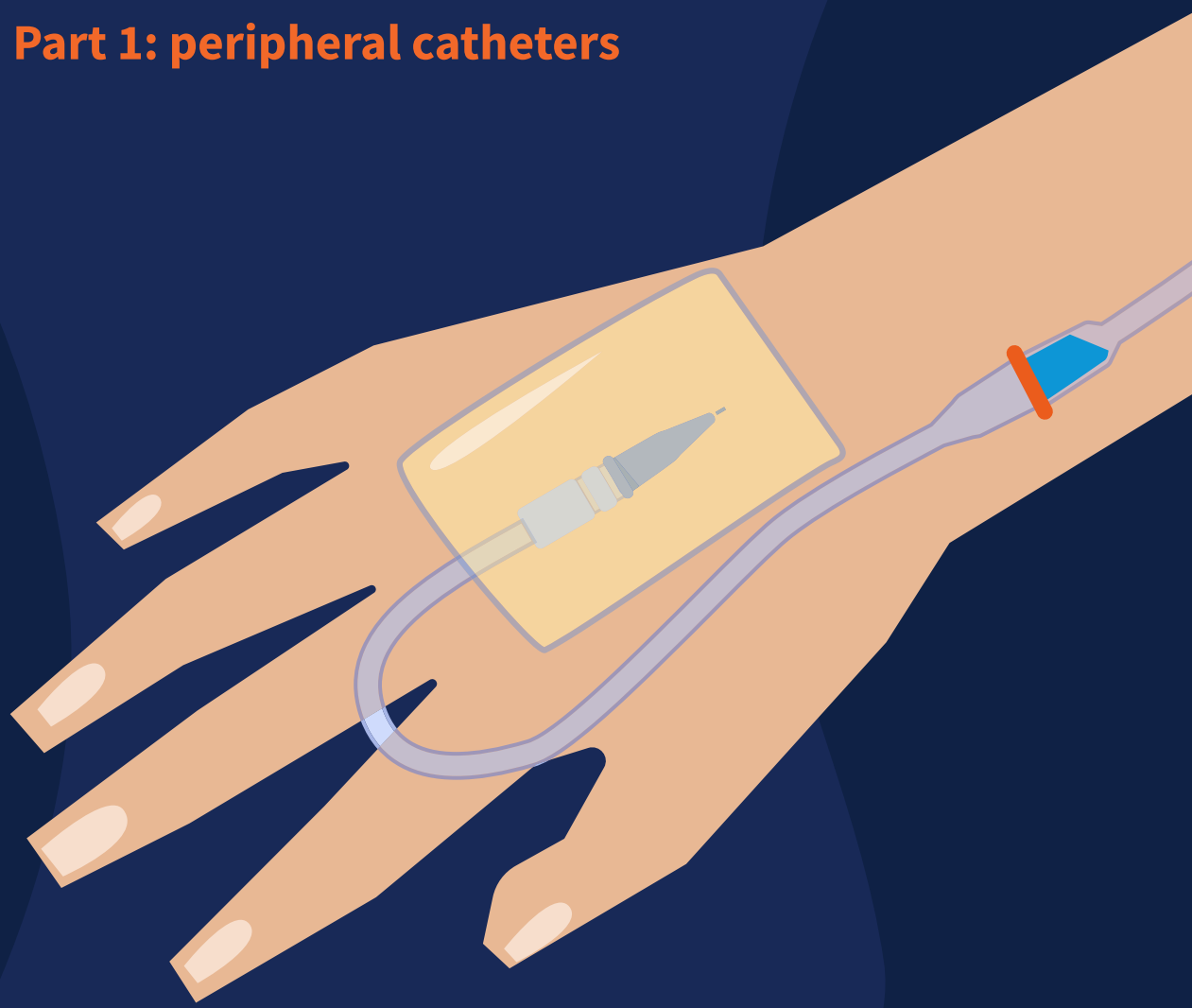
Guidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters

Part 1: peripheral catheters



World Health Organization

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Part 1: peripheral catheters

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Guidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters. Part I: peripheralcatheters

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ABBREVIATIONS AND ACRONYMS

aHR	adjusted hazard ratio
AMR	antimicrobial resistance
BSI	bloodstream infection
CABSI	catheter-associated bloodstream infection
COVID-19	coronavirus disease 2019
CRBSI	catheter-related bloodstream infection
CI	confidence interval
COE	certainty of evidence
CVC	central venous catheter
EML	Essential Medicines List
GDG	Guideline Development Group
HAI	health care-associated infection
HCW	health and care workers
HR	hazard ratio
IPC	infection prevention and control
IRR	incidence rate ratio
ITS	interrupted time-series
IV	intravenous
LMIC	low- and middle-income countries
MESH	Medical Subject Headings
MMIS	multimodal improvement strategy
MVC	midline vascular catheter
NA	not applicable
NCBA	non-controlled before-after (study)
NRSI	non-randomized studies of interventions
OECD	Organisation for Economic Co-operation and Development

OR	odds ratio
PAC	peripheral arterial catheter
PICC	peripherally-inserted central catheter
PICO	population (P), intervention (I), comparison (C), outcome (O)
PIVC	peripheral intravenous catheter
PQ	PICO question
RCT	randomized controlled trial
RR	risk ratio
SAB	*Staphylococcus aureus* bacteraemia
SDG	Sustainable Development Goals
versus	versus
USA	United States of America
WASH	water, sanitation and hygiene
WHO	World Health Organization

GLOSSARY

Age groups were defined as follows: adults: ≥18 years of age; neonates: ≤1 month of age; children and adolescents: all other participants not framed in the above groups.

Alcohol-based hand rub is an alcohol-containing preparation (liquid, gel or foam) designed for application to the hands to inactivate microorganisms and/or temporarily suppress their growth. Such preparations may contain one or more types of alcohol, other active ingredients with excipients, and humectants .

The Acute Physiology and Chronic Health Evaluation (APACHE) score is the most widely used intensive care unit mortality prediction score. The APACHE II score is made up of 12 physiological and two disease-related variables collected within the first 24 hours of intensive care unit admission. Updated APACHE scoring systems have been developed, but APACHE II remains the most used.

Aseptic "no-touch" technique for peripheral intravenous catheter (PIVC) insertion
This procedure and terminology was validated by the Guideline Development Group (GDG) members and comprises the following series of steps that must be performed by clinicians during the insertion of a PIVC.

1. Prior to commencement of the procedure, clean the workspace where you intend to place the pack and materials for PIVC insertion and wipe with an appropriate disinfectant; then gather all appropriate materials.
2. Perform appropriate hand hygiene before touching the patient (Moment 1)(*1*).
3. Position the patient for PIVC access to allow optimal visualization of the PIVC access site and ensure that the patient is comfortable. Inspect the PIVC access site to locate the vein.
4. Perform appropriate hand hygiene (Moment 4 and Moment 2)(*1*).
5. Open the sterile pack(s) containing the required components for PIVC insertion in such a way that all contents are readily accessible, but taking care not to touch the internal sterile surfaces of the insertion pack. Pour the skin disinfectant solution (for example, 2% chlorhexidine gluconate plus 70% alcohol [ethanol or isopropyl]) into the sterile container in the pack. If using a pre-soaked swab, open the swab packet and drop it onto the sterile insertion pack zone without touching the swab.
6. Open the PIVC packet and without touching the PIVC, drop it onto the sterile surface of the PIVC insertion pack zone.
7. Apply the tourniquet*.
8. Perform hand hygiene before performing the aseptic technique/procedure (Moment 2)(*1*).
9. If using gloves, then put on non-sterile gloves, being careful to not touch potentially contaminated surfaces such as the outside of the glove box or nearby surfaces.
10. Thoroughly clean the intended insertion site with a skin disinfectant and allow to dry.
11. Insert the PIVC without touching the insertion site with your fingers. If the insertion site is touched, it should be considered potentially contaminated and it will need to be disinfected

* The tourniquet should ideally be disinfected before use, but this might be impractical; alternatively, a single-use tourniquet could be used, if available.

again. If PIVC cannulation cannot be performed without touching the insertion site, then sterile gloves should be used to ensure that touching the site will not contaminate the insertion field.

12. Release the tourniquet.
13. Connect the PIVC to any required devices (for example, luer lock, injection "bung" or IV tubing/giving set) without touching any sterile components.
14. Place a suitable sterile dressing over the PIVC to anchor it appropriately and ensure that the insertion site is correctly covered. Ideally, an occlusive, semipermeable, transparent PIVC dressing should be used as this will allow a ready daily visualization of the insertion site without removing the PIVC dressing.
15. Dispose of the PIVC insertion pack waste according to local policy, place the PIVC insertion needle in a suitable sharps container (waste and sharps containers should ideally be within arm's reach of performing the procedure) and clean the insertion trolley surface with an appropriate disinfectant.
16. Remove gloves.
17. Perform hand hygiene after the aseptic procedure and after touching the patient (Moment 3 and Moment 4)(*1*).

Aseptic "no-touch" technique for PIVC access

This procedure and terminology was validated by the GDG members and comprises the following series of steps that must be performed by clinicians during access to a PIVC.

1. Prior to commencement of the procedure, clean the workspace where you intend to place the pack and materials for PIVC access and wipe with an appropriate disinfectant; then gather all appropriate materials.
2. Perform appropriate hand hygiene before touching the patient (Moment 1)(*1*).
3. Position the patient for PIVC access to allow optimal visualization of the PIVC access site and ensure that the patient is comfortable. Inspect the PIVC access site.
4. Perform appropriate hand hygiene (Moment 4 and Moment 2)(*1*).
5. Open the sterile pack(s) containing the required materials for PIVC access in such a way that all contents are readily accessible, but taking care not to touch the internal sterile surfaces of the access pack. Pour the disinfectant solution (for example, 2% chlorhexidine gluconate + 70% alcohol [ethanol or isopropyl]) into the sterile container in the pack. If using a pre-soaked swab, open the swab packet and drop it onto the sterile access pack zone without touching the swab.
6. Perform hand hygiene before performing the aseptic technique/procedure (Moment 2)(*1*).
7. If using gloves, then put on single-use gloves, being careful to not touch potentially contaminated surfaces such as the outside of the glove box or nearby surfaces.
8. Thoroughly clean the intended PIVC access site with hub disinfectant solution and allow to dry.
9. Carefully draw up the IV product intended for administration into a sterile access syringe (plus a second syringe with sterile saline, if flushing is required) and place on the open sterile access pack away from other items.
10. If using an open PIVC hub access system:
    a. remove the PIVC access cap, placing it on the open sterile access pack away from other items;
    b. promptly pick up the loaded syringe and quickly connect to the open PIVC hub device avoiding any air from entering the hub device and paying attention to not touch the PIVC hub and the tip of the syringe with the fingers;

c. slightly aspirate the syringe to withdraw any accessed air and observe that blood can be drawn back to confirm that the PIVC is patent;
d. administer the required IV product;
e. if required, flush the PIVC with a compatible sterile fluid (saline or other);
f. remove the syringe and promptly replace the PIVC access cap without touching any other items.

11. If using a closed PIVC hub access system:
    a. thoroughly clean the intended PIVC access hub with a hub disinfectant solution and allow to dry;
    b. attach the needle-less administration device to the loaded syringe and insert into the closed access hub device, according to the manufacturer's instructions;
    c. slightly aspirate the syringe to observe that blood can be drawn back to confirm that the PIVC is patent;
    d. administer the required IV product;
    e. if required, flush the PIVC with a compatible sterile fluid (saline or other);
    f. remove the syringe and needle-less device, then wipe the PIVC access hub with a hub disinfectant solution and allow to dry.
12. Dispose of all syringes, needles and other material used in an appropriate waste disposal system, including a suitable sharps container if "sharps" were used (waste and sharps containers should ideally be within arm's reach of performing the procedure).
13. Wipe the working table and any tray used with an appropriate disinfectant.
14. Remove gloves.
15. Perform hand hygiene after the aseptic procedure and after touching the patient (Moment 3 and Moment 4)(*1*).

Aseptic "no-touch" technique for PIVC maintenance and dressing change

This procedure and terminology was validated by the GDG members and comprises the following series of steps that must be performed by clinicians during PIVC maintenance dressing change.

1. Prior to commencement of the procedure, clean the workspace where you intend to place the materials for dressing change and wipe with an appropriate disinfectant; then gather all appropriate materials.
2. Perform appropriate hand hygiene** before touching the patient (Moment 1)(*1*).
3. Position the patient to allow optimal visualization of the PIVC and ensure the patient is comfortable.
4. Perform appropriate hand hygiene (Moment 4 and Moment 2)(*1*).
5. Open the sterile pack(s) containing the required components for PIVC maintenance and dressing change in such a way that all contents are readily accessible, but taking care not to touch the internal sterile surfaces of the pack. Pour the disinfectant solution (for example, 2% chlorhexidine gluconate + 70% alcohol [ethanol or isopropyl]) into the sterile container in the pack. If using a pre-soaked swab, open the swab packet and drop it onto the sterile access pack zone without touching the swab.

** Perform hand hygiene either using an alcohol-based hand rub product (preferred) or hand washing with soap, water and using single-use or clean towels to dry hands.

6. Perform hand hygiene before performing the aseptic technique/procedure (Moment 2)(*1*).
7. If using gloves, then put on single-use gloves, being careful to not touch potentially contaminated surfaces such as the outside of the glove box or nearby surfaces.
8. Carefully remove the old PIVC dressing and dispose of it immediately into an appropriate waste container/bin, which should be within arm's reach of the procedure. If gloves have become contaminated with blood or body fluid during the dressing removal, they should be changed for a new pair of gloves before proceeding to handle the new dressing.
9. Thoroughly clean the skin around the PIVC insertion site/dressing area and disinfect with a disinfectant solution. Allow to dry.
10. Carefully place the new PIVC dressing over the PIVC insertion site and PIVC base, being careful to only touch the outer edges of the dressing to avoid contamination of the PIVC site or nearby surrounding area that is under the dressing. Make sure that the dressing is well secured to the skin without any traction.
11. Dispose of all used PIVC dressing change material used in an appropriate waste disposal system (waste containers should ideally be within arm's reach of performing the procedure).
12. Wipe the workspace with an appropriate disinfectant.
13. Remove gloves.
14. Perform hand hygiene (Moment 3 and Moment 4)(*1*).

Care bundles are a set of evidence-based, patient-focused practices or interventions (generally three to five) that aim to improve patient outcomes when done collectively and reliably. They can also be a tool to guide the delivery of a specific aspect of a patient's care where the aim is to improve the care process and patient outcome in a structured manner or sequence, with the expectation that the impact will be greater than single interventions alone (*2*).

Clinicians are defined as medical, nursing and allied health staff.

Conditional recommendations are made when a WHO GDG is less certain about the balance between the benefits and harms or disadvantages of implementing a recommendation. Conditional recommendations generally include a description of the conditions under which the end-user should or should not implement the recommendation *(3)*.

Formal training programme is a structured programme that provides both theoretical and practical education, including demonstrable competency in clinical skills and adherence to appropriate clinical guidelines. Formal training programmes should include adequate specified time to undergo such training.

Good practice statement refers to a practice that is commonly accepted and unequivocally demonstrates a net benefit of the recommended action (*4*).

Grading of Recommendations Assessment, Development and Evaluation (GRADE) is an approach used to assess the quality of a body of evidence and to develop and report recommendations.

Hand hygiene is a general term referring to any action of hand cleansing. Antiseptic hand rubbing refers to applying an antiseptic hand rub to reduce or inhibit the growth of microorganisms without the need for an exogenous source of water and requiring no rinsing or drying with towels or other devices. Hand washing refers to washing hands with plain or antimicrobial soap and water (*1*).

Health and care worker is an individual who works in a community or health care facility setting and is mainly engaged in actions with the primary intent of enhancing health. This includes health

service providers, such as doctors, nursing and midwifery professionals, public health professionals, technicians (laboratory, health, medical and non-medical), personal care workers, healers and practitioners of traditional medicine. It also includes health management and support workers, such as cleaners, drivers, hospital administrators, district health managers, social workers, and other occupational groups in health-related activities. This group includes those who work in acute care facilities and long-term care, public health, community-based care and other occupations in the health and social care sectors. Health and care workers may provide direct personal care services in the home, in health care and residential settings, while assisting with the routine tasks of daily life and also performing a variety of other tasks of a simple and routine nature *(5)*.

Health care-associated infection is an infection occurring in a patient during the process of care in a hospital or other health care facility, which was not present or incubating at the time of admission. Health care-associated infections can also appear after discharge. They represent the most frequent adverse event associated with patient care.

Low- and middle-income countries: WHO Member States are grouped into income groups (low, lower-middle, upper-middle, and high) based on the World Bank list of analytical income classification of economies, calculated using the World Bank Atlas method. For the current 2024 fiscal year, low-income economies are defined as those with a gross national income per capita of US$ 1135 or less in 2022; lower middle-income economies as those with a gross national income per capita between US$ 1136 and US$ 4465; upper-middle-income economies are those with a gross national income per capita between US$ 4466 and US$ 13 845; high income economies are those with gross national income per capita of US$ 13 846 or more *(6)*.

Maximal sterile barrier precautions are defined as sterile barrier precautions that include the use of a cap, mask, sterile gown, sterile gloves, and a sterile full body drape *(7)*.

Multimodal improvement strategies (MMIS) are a means of improving the implementation of interventions to achieve the required change of system, climate and behaviour for measurable outcome improvement from the intervention(s). MMIS generally include tools, such as bundles and checklists, developed by multidisciplinary teams that consider local conditions. Multimodal thinking means that practitioners do not focus only on single strategies to change practices (for example, training and education), but consider a range of strategies that target different influencers of human behaviour. MMIS typically contain five key components: system change ("*Build it*"), training and education ("*Teach it*"), monitoring and feedback ("*Check it*"), reminders and communication ("*Sell it*") and culture change ("*Live it*"). All five elements are considered important and should be based on the local health context and situation, informed by periodic assessments *(8, 9)*.

Sterile technique is defined as a set of specific practices and procedures performed to make equipment and areas free from all microorganisms and to maintain that sterility *(10)*. See the guideline content regarding the definition of "sterile technique" for the insertion of peripheral arterial catheters (PACs) and peripherally-inserted central catheters (PICCs).

The strength of a recommendation expresses the degree to which a WHO GDG is confident in the balance between the desirable and undesirable consequences of implementing the recommendation. When a GDG is very certain about this balance (that is, the desirable consequences clearly outweigh the undesirable consequences), it issues a **strong recommendation** in favour of an intervention. When it is uncertain about this balance, however, it issues a conditional (or "weak") recommendation *(3)*.

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Executive summary

Executive summary

Numerous reports from the World Health Organization (WHO) and other organizations have identified the increasing endemic burden of health care-associated infections (HAIs) and antimicrobial-resistant infections, which harm patients every day across health care systems in all countries, regardless of income status. Key among the most preventable of these are bloodstream infections (BSIs) and other infections associated with the use of intravascular catheters.

Intravascular catheter-associated BSIs and related infections are particularly notable as they are mostly preventable if appropriate precautions and practices for safe insertion, maintenance, access and removal are followed accurately, irrespective of a country's income level.

Intravascular catheters fall broadly into two categories: those that are inserted into peripheral blood vessels (veins and arteries), and those that are inserted into central vessels.

Peripherally-inserted catheters are used far more commonly than other intravascular catheters and therefore, require special attention. In particular, peripheral intravenous catheters (PIVCs) are one of the most common invasive devices used in health care facilities, with up to 70% of all inpatients requiring a PIVC at some time during their in-hospital stay. Thus, the global burden of BSIs and other related infections associated with PIVCs is potentially huge. Peripherally-inserted central catheters (PICCs) are also notable. Although used less frequently than PIVCs, the fact that the tip of the catheter is routinely located in a large central vein means that any infection of the PICC is highly likely to quickly result in a serious systemic BSI. Peripheral arterial catheters (PACs) are primarily used in the intensive care unit setting to provide continuous blood pressure monitoring and to readily obtain arterial blood for assessment of oxygenation levels so as to guide appropriate patient ventilation management.

Purpose, scope and target audience

In the context of the prevention of infections associated with IV catheters, these guidelines (Part 1) provide guidance on best practices for the prevention of BSIs and other infections associated with peripherally-inserted IV catheters, while a subsequent WHO guideline (Part 2) to be developed in 2024 will cover centrally-inserted intravascular catheters. In particular, Part 1 of the Guidelines outlines an evidence-informed approach to the management (namely, insertion, maintenance, access and removal) of peripherally-inserted intravascular catheters, including PIVCs, PICCs and PACs, in three patient populations (adults, adolescents-children and neonates) during the provision of health care in any health care settings, including acute and long-term health care facilities and primary care settings.

The intended audience for these guidelines is clinicians (that is, doctors, nurses, IPC professionals, etc.) involved in the management of patients who require intravascular catheters. However, to ensure an appropriate, practical, clinical adherence to the guidelines, hospital administrators and other professionals involved in health care need to understand their importance and the focus of the recommendations to ensure appropriate support for clinicians. Patients are also part of the audience of these guidelines as they need to be generally informed about practices performed for their care and, in some cases, understand the choice of the intervention(s).

Guideline development methodology

The development of these recommendations was guided by standardized operating procedures in accordance with the process described in the WHO Handbook for guideline development. The recommendations were developed and updated using the following steps:

1. establishment of a WHO Guideline Steering Group and a Guideline Development Group (GDG);
2. identification of the primary critical outcomes and priority topics and formulation of a series of questions structured in a PICO (Population, Intervention, Comparison, Outcomes) format by the technical team leading the guideline development supported by the methodologist, the WHO Guideline Steering Group, and the GDG;
3. the conduct of an inventory of existing guidelines on this topic;
4. the conduct of systematic reviews for the retrieval of the evidence using a standardized methodology;
5. assessment and synthesis of the evidence;
6. development of recommendations by the GDG using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach;
7. writing of the guideline content and a process of peer review by external experts;
8. planning for its dissemination and associated implementation strategies.

These guidelines are based on a systematic review of the published, scientific, quantitative evidence related to effectiveness of preventive measures to be adopted during the insertion, maintenance, access and removal of peripherally-inserted catheters, with the aim to provide a practical template for the safe use of these devices and minimize the risk of BSI and other infections. Another scoping review was also conducted on contextual factors relevant to the priority questions addressed in these guidelines. Contextual factors included stakeholders' perceived resource implications, acceptability and feasibility of interventions employed to prevent BSIs and other infections associated with the use of PIVCs and PICCs. They also included stakeholders' valuation of outcomes relevant to these interventions. The GRADE evidence-to-decision framework that considers desirable and undesirable effects, certainty of evidence, values, balance of effects, resources required, cost effectiveness, equity, acceptability and feasibility, was used to develop these guidelines under the guidance by an independent methodologist.

The guidelines are structured under six key sections related to the management of peripherally-inserted intravascular catheters:

1. general recommendations regarding education and hand hygiene;
2. insertion;
3. maintenance;
4. access;
5. removal;
6. catheter choice.

Recommendations and good practice statements

The GDG developed a total of 14 good practice statements and 23 recommendations. It also provided guidance regarding the value of using clinical care “bundles” and the importance of using

a multimodal approach to all interventions. For all "conditional" recommendations" (based on the GRADE methodology), the GDG identified the conditions under which the recommendation would be considered as essential to adopt and implement for preventing peripheral intravascular catheter-associated BSIs and other infections.

A summary of the good practice statements and recommendations is provided below in Table 1.

Table 1. Good practice statements and recommendations for the prevention of bloodstream infections and other infections associated with the use of peripheral intravascular catheters

Recommendations and good practice statements	Type of catheter	Population	Type of statement	Certainty of evidence
General statements				
Education and training				
WHO recommends that all clinicians should be appropriately educated in the indications for intravascular catheter (PIVC, PICC, PAC) use, the proper procedures for their use, and the appropriate infection control measures to prevent catheter-related infections in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
WHO recommends that clinicians should be regularly assessed for their knowledge and adherence to guidelines related to appropriately managing intravascular catheters in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
Hand hygiene and aseptic no-touch technique				
WHO recommends that all clinicians should be appropriately trained in hand hygiene procedures in the context of the WHO multimodal improvement strategy for hand hygiene to prevent catheter-related infections in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
WHO recommends that hand hygiene should be performed at any time indicated according to the "Five moments" during catheter insertion, maintenance, access and removal practices, preferably using the WHO hand rub technique with alcohol-based hand rub products (allow hands to dry) or by hand washing with soap and water and using single-use or clean towels to dry hands.	PIVC, PICC, PAC	All	Good practice statement	NA
WHO recommends that all clinicians should be appropriately trained in the *aseptic no-touch* technique to prevent catheter-related infections in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
Insertion				
Sterile and aseptic no-touch insertion technique				
WHO recommends using a sterile technique for the insertion of a PICC and PAC in adults, adolescents, children and neonates.	PICC, PAC	All	Good practice statement	NA
WHO suggests using either a chlorhexidine-containing or a non-chlorhexidine-containing skin disinfectant before PIVC and PICC insertion in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Very low certainty evidence

Recommendations and good practice statements	Type of catheter	Population	Type of statement	Certainty of evidence
Skin disinfection preparations				
WHO recommends that adequate skin disinfection should always be used prior to the insertion of a PIVC, PICC and PAC in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
WHO suggests using either a chlorhexidine-containing or a non-chlorhexidine-containing skin disinfectant before PIVC and PICC insertion in adults, adolescents, children and neonates.	PIVC, PICC	All	Conditional recommendation	Very low certainty evidence
Formal training on catheter insertion				
WHO suggests that clinicians who insert intravascular catheters (PIVCs, PICCs, PACs) in adults, adolescents, children and neonates should undergo a formal training programme on catheter insertion.	PIVC, PICC, PAC	All	Conditional recommendation	Very low certainty evidence
Catheter insertion by a clinician wearing single-use gloves				
WHO recommends that clinicians inserting a PIVC or PICC in adults, adolescents or children, wear single-use gloves at the time of catheter insertion.	PIVC, PICC	Adults, adolescents, children	Good practice statement	NA
WHO suggests that clinicians who insert a PIVC or PICC in neonates either use single-use gloves or no gloves at the time of catheter insertion.	PIVC, PICC	Neonates	Conditional recommendation	Very low certainty evidence
Catheter insertion by a clinician wearing single-use sterile gloves				
WHO recommends that clinicians inserting a PICC or PAC use single-use sterile gloves compared to non-sterile gloves in adults, adolescents, children and neonates.	PICC, PAC	All	Good practice statement	NA
WHO suggests not using sterile gloves when inserting a PIVC in adults, adolescents, children and neonates, provided that the steps of the *aseptic no-touch* technique are carefully adhered to.	PIVC	All	Conditional recommendation	Very low certainty evidence
Catheter insertion using a standardized insertion pack/kit				
WHO recommends that clinicians use a standardized insertion pack/kit when inserting a PICC or PAC in adults, adolescents, children and neonates.	PICC, PAC	All	Good practice statement	NA
WHO suggests that clinicians who insert a PIVC use a standardized insertion pack/kit for catheter insertion in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Very low certainty evidence
Catheter insertion using ultrasound-guided assistance				
WHO suggests the use of ultrasound-guided assistance when inserting a PICC in adults, adolescents, children and neonates.	PICC	All	Conditional recommendation	Very low certainty evidence
WHO suggests not routinely using ultrasound-guided assistance when inserting a PIVC in adults, children, adolescents or neonates.	PIVC	All	Conditional recommendation	Very low certainty evidence

Recommendations and good practice statements	Type of catheter	Population	Type of statement	Certainty of evidence
Catheter insertion in the distal section of the upper limb (below the cubital fossa) compared to insertion in the proximal section of the upper limb (cubital fossa or above)				
WHO suggests the use of the distal arm veins over the proximal section of the upper limb (cubital fossa or above) for PIVC insertion in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Very low certainty evidence
Catheter insertion in the upper limb compared to insertion in the lower limb				
WHO suggests use of the upper limb over the lower limb for PIVC insertion in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Very low certainty evidence
WHO suggests use of the upper limb over the lower limb for PICC insertion in neonates.	PICC	Neonates	Conditional recommendation	Very low certainty evidence
Use of occlusive catheter dressings				
WHO suggests the use of either an occlusive dressing or a non-occlusive dressing for PIVCs in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Low certainty evidence
WHO suggests the use of an occlusive dressing for PICCs in adults, adolescents, children and neonates.	PICC	All	Conditional recommendation	Very low certainty evidence
PIVC insertion by an insertion team				
WHO suggests that PIVC insertion in adults, adolescents, children and neonates is performed by a clinician who is appropriately trained in PIVC insertion, but may not necessarily be part of a formal insertion team, compared to insertion by a formal insertion team.	PIVC	All	Conditional recommendation	Low certainty evidence
Use of local anaesthetic for insertion of a PIVC and PICC				
WHO suggests either using or not using local anaesthetic when inserting a PIVC or PICC in adolescents, children and neonates.	PIVC, PICC	Adolescents children and neonates	Conditional recommendation	Low certainty evidence
PIVC insertion in the scalp compared to catheter insertion in other sites in neonates				
WHO suggests that sites other than the scalp veins should generally be prioritized over scalp veins for insertion of a PIVC and PICC in neonates.	PIVC, PICC	Neonates	Conditional recommendation	Low certainty evidence
Maintenance				
Catheter maintenance using formal sterile dressing protocols				
WHO recommends that for all PIVCs, PICCs and PACS the insertion site should be maintained using a formal sterile dressing protocol in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
Catheter management with continuous intravenous (IV) fluid infusion				
WHO suggests that catheter management of PICCs and PIVCs be with either a schedule of continuous IV fluid infusion or no schedule of continuous IV fluid infusion (intermittent or no infusion) in adults, adolescents, children, and neonates	PICC, PIVC	All	Conditional recommendation	Low certainty of evidence

Recommendations and good practice statements	Type of catheter	Population	Type of statement	Certainty of evidence
Systematic sterile flushing after product administration				
WHO recommends that after product administration via a PIVC or PICC, the catheter should be flushed with a compatible sterile fluid (saline or other) in adults, adolescents, children and neonates.	PIVC, PICC	All	Good practice statement	NA
Saline compared to anticoagulant solutions in "lock-off" flushing of PIVCs and PICCs				
WHO suggests "lock-off" flushing using sterile saline over "lock-off" flushing using heparinized saline for PIVCs and PICCs in adults, adolescents, children, and neonates.	PIVC, PICC	All	Conditional recommendation	Very low certainty evidence
Catheter management with a schedule of regular changing of the administration (tubing/giving) set				
WHO suggests having a regular schedule of changing of administration (tubing/giving) sets for PIVC and PICC maintenance in adults, adolescents, children and neonates.	PICC, PIVC	All	Conditional recommendation	Low certainty of evidence
Access				
Catheter access using a formal sterile or aseptic protocol				
WHO recommends using a formal sterile or aseptic protocol to access PIVCs, PICCs and PACs in adults, adolescents, children and neonates.	PIVC, PICC, PAC	All	Good practice statement	NA
Catheter access using a closed-access hub system				
WHO suggests using either a closed-access hub system (for example, luer lock) or an open-access hub system to access PIVCs and PICCs in adults, adolescents, children and neonates.	PIVC, PICC	All	Conditional recommendation	Low certainty of evidence
Removal				
Catheter removal based on defined schedules				
WHO recommends inspecting PIVCs in adults, adolescents, children and neonates at least daily to assess for signs of inflammation and infection at the insertion site and vein to guide whether the catheter should be removed.	PIVC	All	Good practice statement	NA
WHO suggests either scheduled removal or clinically indicated removal of PIVCs in adults, adolescents, children, and neonates.	PIVC	All	Conditional recommendation	Moderate certainty evidence
Catheter removal/replacement within 24 hours if inserted under uncontrolled/emergency conditions				
WHO suggests the removal/replacement of PIVCs inserted in uncontrolled/emergency conditions as soon as possible in adults, adolescents, children and neonates.	PIVC	All	Conditional recommendation	Low certainty evidence
Catheter selection				
Use of single lumen PICCS compared to multi-lumen PICCS				
WHO suggests using single-lumen PICCs over using multi-lumen PICCs (unless there is a specific reason that requires multiple lumens) in adults, adolescents, children and neonates.	PICC	All	Conditional recommendation	Low certainty of evidence

Recommendations and good practice statements	Type of catheter	Population	Type of statement	Certainty of evidence
PICC versus midline vascular catheters				
WHO suggests the use of either a PICC or MVC in adults, adolescents and children requiring longer term intravenous access.	PICC, MVC	Adults, adolescents, children	Conditional recommendation	Very low certainty evidence

Abbreviations: PIVC, peripheral intravenous catheter; PICC, peripherally-inserted central catheter; PAC, peripheral arterial catheter; MVC, midline vascular catheter; NA, not applicable.

Note: Many Good practice statements and recommendations related to PICCs are likely to be equally applicable to MVCs. However, only where MVCs were specifically discussed by the GDG are they listed here.

The GDG noted that the vast majority of studies identified by the systematic review assessed "bundles" of various interventions to improve the management of PIVCs (30 studies) and PICCs (20 studies) and demonstrated superior outcomes in terms of BSI and related infections compared to when only single interventions were implemented. In addition, the use of multimodal strategies similar to the one already strongly recommended by WHO for the implementation of all infection prevention and control interventions was identified by the GDG as a critical approach to be used.

Trecia Simone Stewart, 41, has been a nurse for 12 years and has worked as an emergency nurse for the last 7 years at Spanish Town Hospital [Jamaica].
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Introduction

1. Introduction

1.1 Background

Numerous reports from the World Health Organization (WHO) and other organizations have identified the increasing endemic burden of health care-associated infections (HAIs) and antimicrobial-resistant infections, which harm patients every day across health care systems in all countries, regardless of income status *(1)*. Key among the most preventable of these are bloodstream infections (BSI) and other infections associated with the use of intravascular catheters *(2, 3)*.

A recent WHO report on infection prevention and control (IPC) highlighted the burden of HAIs and antimicrobial resistance (AMR) and the related harm to both patients and health and care workers (HCWs) in health care settings *(1)*. It presented a global situational analysis of the implementation of IPC programmes, as well as an overview of the strategies and resources available to improve the situation within countries. Data provided from several sources within this report indicate that substantial gaps in the implementation of IPC practices and a lack of programmes and infrastructures to support IPC still exist. Some gaps and important areas for improvement were also identified in high-income countries, as demonstrated by the coronavirus disease (COVID-19) pandemic and documented in a recent Organisation for Economic Co-operation and Development (OECD)-WHO Briefing Paper on IPC, which addressed the burden of HAIs and AMR associated with health care in G7 countries *(4)*. These reports well highlight how much more could and should be done across all WHO regions to ensure the reliable implementation of effective IPC strategies and to realize the potential cost and life-saving benefits that this could bring *(1)*.

BSIs associated with intravenous (IV) catheters are particularly notable for the following reasons.

a. They are mostly preventable if appropriate insertion, maintenance, access and removal protocols are followed for IV catheters. Analyses pooling together the results of systematic reviews calculated that implementing IPC interventions can achieve a significant reduction of HAI rates, in particular catheter-associated BSI (CABSI), irrespective of a country's income level *(1)*.
b. They can be caused by antimicrobial-resistant pathogens and thus difficult to treat. BSIs due to a range of resistant pathogens, mostly associated with health care, were found to be the second most frequent cause of the global burden attributable to and associated with AMR in 2019, causing almost 1.3 million deaths around the world *(5)*.
c. They have a major health impact for affected patients. In Europe, health care-associated BSIs are the second most common cause of disability and premature deaths due to HAIs *(6)*. The crude excess mortality due to catheter-related BSIs (CRBSI) in adult patients was 23.6% in a study conducted in 25 countries worldwide *(7)*.
d. They can evolve to serious, deep-seated infectious complications to major organs such as the brain and kidneys, including bacterial endocarditis, lung abscesses and infectious embolic events *(8)*. These complications are often associated with clinical sepsis and septic shock. WHO estimated that mortality among patients affected by health care-associated sepsis was 24.4%, increasing to 52.3% among patients treated in an intensive care unit *(9)*.
e. Peripheral IV catheters (PIVCs) are one of the most common invasive devices used in health care facilities, with up to 70% of all inpatients requiring a PIVC at some time during their in-hospital stay *(10)*. Thus, the global burden of BSIs and other related infections associated with PIVCs is potentially huge. However, health care-associated BSIs have also become increasingly associated

with the use of peripherally-inserted central venous catheters (PICCs), for which many of the important IPC measures for PIVCs are also important *(11)*.

f. Health care-associated BSI associated with central venous catheters (CVCs) are also a key concern. Many of these patients have complex, high-risk medical conditions that require a CVC and they are often managed in health care settings such as intensive care units where local care protocols are generally common and many confounding factors are often present *(2, 8, 11, 12)*.

Several public health agencies and medical societies have produced local guidelines regarding the prevention of BSI, in particular those associated with CVCs. Conversely, the number of guidelines for the prevention of infections associated with PIVCs is very limited. In addition, available guidelines are rarely based on a rigorous process of evidence appraisal and they often vary in their applicability and relevance to different local health systems, particularly in low- and middle-income countries (LMICs).

Thus, WHO decided to develop evidence-based guidelines with a global scope and based upon a rigorous process in accordance with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology. These guidelines also aim to cover both BSI and other infections associated with IV catheters. Notably, this project has been undertaken with the objective of implementing World Health Assembly resolutions on sepsis *(13)* and IPC *(14)*, which include the request to develop new technical IPC guidelines and implementation resources to support Member States in their improvement efforts, including for the prevention of health care-associated sepsis.

The current Part 1 of the guidelines focuses specifically on all types of peripherally-inserted intravascular catheters, including PIVCs, PICCs and peripheral arterial catheters (PACs), given that the required IPC interventions to reduce the infection risk are similar between these three catheter types; midline vascular catheters (MVCs) are also addressed in specific circumstances. The guidelines are based on a systematic review of the published scientific evidence related to preventive measures to be adopted during the insertion, maintenance, access and removal of PIVCs in order to provide a practical template for the safe use of these devices and minimize the risk of health care-associated BSI and other infections. A subsequent WHO guideline (Part 2) to be developed in 2024 will cover centrally-inserted intravascular catheters.

1.2 Purpose

The recommendations in these guidelines aim to outline an evidence-informed approach to the management (namely, insertion, maintenance, access and removal) of PIVCs in order to prevent infections associated with their use. These catheters include the following devices: PACs; PICCs; (MVCs); and PIVCs. The desired impact of these recommendations is a reduction in the rate of these infections, including those due to antimicrobial-resistant pathogens.

The need for these guidelines is emphasized by the Sustainable Development Goals (SDG) targets 3.d. “strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks”, and 3.d.2., reduction of the “percentage of bloodstream infections due to selected antimicrobial-resistant organisms” *(15, 16)*.

Furthermore, both the World Health Assembly resolution on sepsis *(13)* and the global patient safety action plan *(17)* identified the reduction in morbidity and mortality associated with health care-associated sepsis as a core indicator to be targeted by countries. The proposed guidelines aim to support Member States to achieve these targets through improved practices.

1.3 Intended audience

The intended audience for these guidelines is clinicians (that is, doctors, nurses, IPC professionals, etc.) involved in the management of patients who require PIVCs to minimize the risk of catheter-associated infections, including BSIs. However, to ensure appropriate practical clinical adherence to these guidelines, hospital administrators and other professionals involved in health care need to understand their importance and the focus of the recommendations to ensure appropriate support for clinicians. This includes helping to provide the best possible clinical health care culture and context (including adequate staffing) and availability of the various required products to allow adherence to the guidelines. Patients are also part of the audience of these guidelines because they need to be generally informed about practices performed for their care. Furthermore, they may need to be informed about the choice of the intervention regarding some recommendations. Patients may also be able to participate in ensuring safe practices (for example, hand hygiene or monitoring the status of the catheter dressing).

1.4 Scope

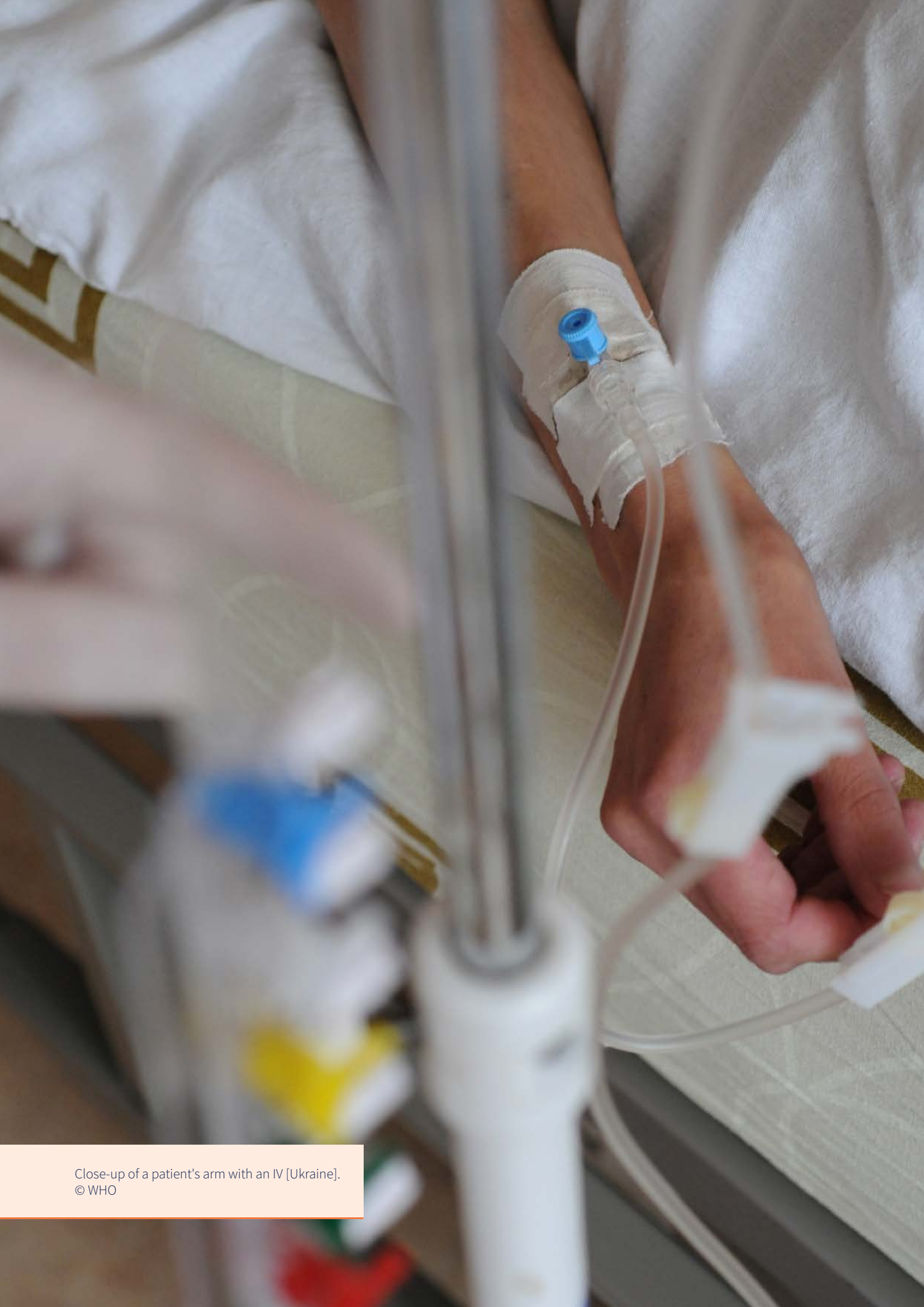
Part 1 of these guidelines will focus on the prevention of BSI and other infections associated with the use of peripherally-inserted intravascular catheters in three patient populations (adults, adolescents-children and neonates) during the provision of health care in any type of care setting, including acute and long-term health care facilities and primary care settings.

The priority research questions that guided the development of the recommendations are presented in Annex 2. These questions were structured in PICO format (Population, Intervention, Comparison, Outcomes) and guided the evidence review and synthesis.

1.5 Desired impact

The primary outcomes considered for developing the recommendations of these guidelines were the occurrence of all-cause BSI and other infections associated or related to PIVCs, including those due to antimicrobial-resistant pathogens and the related crude and attributable mortality.

The desired impact of these guidelines is the improvement of practices targeted by the recommendations and good practice statements and the reduction of the occurrence of the above-mentioned primary outcomes.



Close-up of a patient's arm with an IV [Ukraine].
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Methods for guideline development

2. Methods for guideline development

2.1 WHO guideline development process

The guidelines were developed in accordance with the approach established by the WHO Guidelines Review Committee *(18)* and a planning proposal approved by the Committee (GRC-23-01-1054). In summary, the development process included eight main stages:

1. establishment of a WHO Guideline Steering Group and a Guideline Development Group (GDG);
2. identification of the of the primary critical outcomes and priority topics and formulation of PICO questions by the technical team leading the guideline development, supported by the methodologist, the WHO Guideline Steering Group and the GDG;
3. the conduct of an inventory of existing guidelines on this topic;
4. the conduct of a systematic review for the retrieval of the evidence using a standardized methodology;
5. assessment and synthesis of the evidence;
6. development of recommendations by the GDG using the GRADE approach;
7. writing of the guidelines and a process of peer review by external experts;
8. planning for the dissemination and implementation strategies.

The development process included the participation of four main groups* that guided and contributed to the overall process: WHO Guideline Steering Group; GDG; Systematic Reviews Expert Group; and the External Review Group.

Members of the GDG, observers, and the External Review Group who participated in the discussions completed a declaration of interest form and any potential conflict of interest was discussed with the Steering Committee Group and the Ethics Office (Annex 1). Similarly, in accordance with the WHO declaration of interests' policy for experts, biographies of all GDG members were published on the WHO website for a period of two weeks prior to the guideline meeting.

The roles and functions of these groups are described below.

WHO Guideline Steering Group

The WHO Guideline Steering Group was chaired by the IPC unit head and technical lead for the IPC Taskforce and the Global IPC Network (Integrated Health Services, Universal Health Coverage/Life Course). Participating members were from the Antimicrobial Resistance Division, the Water, Sanitation and Hygiene (WASH) Unit, the Sexual and Reproductive Health and Research Department, the Access to Medicines, Vaccines and Pharmaceuticals Division, the Country Readiness Strengthening Department, and IPC focal points at the six WHO regional offices.

The Group contributed to the initial planning document for the development of the guidelines, identified the primary critical outcomes and topics, and formulated the research questions. It also identified the systematic review team, the guideline methodologist, the members of the GDG and the external peer reviewers. The GDG chair and the IPC Global Unit coordinator supervised the evidence

* Refer to the "Acknowledgements" section for the list of experts and their affiliations.

retrieval, syntheses and analysis, organized the GDG meetings, prepared or reviewed the final guideline document, managed the external peer reviewers' comments, and the guideline publication and dissemination. Members of the WHO Steering Group are presented in the Acknowledgements section.

WHO Guideline Development Group

The WHO Guideline Steering Group identified 21 external experts, country delegates and stakeholders from the six WHO regions to constitute the GDG (also referred to as "the panel"). This was a diverse group representing various professional and stakeholder groups, such as IPC experts, clinical microbiologists, epidemiologists, public health and infectious disease specialists and researchers, as well as affected communities, through the inclusion of a patient representative. Geographical representation and gender balance were also considerations when selecting GDG members. Members of this group appraised the evidence that was used to inform the recommendations, advised on the interpretation of the evidence, formulated the final recommendations while taking into consideration the 2016 WHO guidelines on core components of IPC programmes at the national and acute health care facility level *(19)*, and reviewed and approved the final guideline document. GDG members are presented in the Acknowledgements section.

The Systematic Reviews Expert Group

A Systematic Reviews Expert Group was selected by the WHO IPC Unit team in consultation with the methodologist and GDG chair through a bidding process that considered availability to conduct the systematic reviews in due time and value for money. This Group reviewed the published evidence related to effectiveness of preventive measures to be adopted during the insertion, maintenance, access and removal of peripherally-inserted catheters and assessed its quality and features according to the GRADE criteria specified by the WHO Guidelines Review Committee.

Another team of systematic reviewers led by the methodologist conducted a scoping review on contextual factors relevant to the priority questions addressed in these guidelines. Contextual factors included stakeholders' perceived resource implications, acceptability and feasibility of interventions employed to prevent BSIs and other infections associated with the use of PIVCs and PICCs. They also included stakeholders' evaluation of outcomes relevant to these interventions. This review of contextual factors included primary studies, using either quantitative methods (e.g., surveys) or qualitative methods (e.g., interviews and focus groups), as well as secondary studies such as cost-effectiveness analyses. The search strategy combined terms related to the interventions of interest and the contextual factors of interest. The findings were synthesized using both narrative and tabular formats and presented to the GDG along with the findings of the systematic review on the health effects of the interventions.

External Peer Review Group

The Group was composed of seven technical experts with high-level knowledge and experience in IPC, AMR, patient safety and health management, including field implementation, and a patient representative. The Group was geographically balanced to ensure views from both high- and LMICs; no member declared a conflict of interest. The primary focus was to review the final guideline document, identify any inaccuracies or errors and comment on technical content and evidence, clarity of language, contextual issues and implications for implementation. The Group ensured that the guideline decision-making processes incorporated the values and preferences of end-users, including health

care professionals and policy-makers. Of note, it was not within the remit of this Group to change the recommendations formulated by the GDG. All reviewers agreed with each recommendation and some suggested selected editing changes. Members of the WHO External Peer Review Group are presented in the Acknowledgements section.

These guidelines are based on the GRADE evidence-to-decision framework that considers desirable and undesirable effects, certainty of evidence, values, balance of effects, resources required, cost effectiveness, equity, acceptability and feasibility.

Based on the GRADE methodology, the GDG formulated "conditional" recommendations. The implications of "conditional" recommendations are that the majority of people to whom the recommendation applies would benefit from the suggested option and in the majority of contexts, the suggested option can be implemented as a policy *(20)*. For all "conditional" recommendations, the GDG aimed to provide the conditions under which the management strategy would be considered as essential to adopt and implement for preventing peripheral intravascular catheter-associated BSIs and related infections.

The systematic reviews on the topic of prevention of BSI and other infections associated with the use of PIVCs and its related subtopics (that is, "insertion", "maintenance", "access" and "removal") followed specific research questions in PICO format (Annex 2). More details on the systematic review methodology can be found in Annex 3.

The summary of the systematic review findings and additional evidence considered is included in each chapter of the guidelines. The systematic review findings are also summarized within the Web Annex in tables related to each PICO question and in the evidence-to-decision tables for each recommendation. All documents were shared in advance with the GDG members and the systematic review team presented the main findings. An independent methodologist facilitated the discussions and the completion of the evidence-to-decision tables.

2.2 Good practice statements

In addition to recommendations, these guidelines also include "good practice statements" (also known as "best practice statements"). The term "good (or best) practice statements" refers to a practice that is commonly accepted and unequivocally demonstrates a net benefit of the recommended action. Good practice statements are recommendations that guideline panels consider to be important but are not appropriate for formal ratings of quality of evidence in the judgment of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group *(21)*. The decision and appropriateness of developing good practice statements was discussed for each topic with the methodologist and agreed upon by the GDG.

The use of PIVCs is now such a common component of good quality, clinical health care worldwide that many of routine IPC good practices are equally applicable to these guidelines. Furthermore, the management of PIVCs is also associated with specific risks that are similar to the use of other invasive devices and procedures where good practice statements are clearly relevant. These key general good practice statements are included within this guideline in section 3.1 under "general statements", as well as in the following chapters where appropriate, based on advice from the GDG.

A local nurse prepares an IV drip for a patient at a local government funded hospital in the town of Menglong [China].
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Recommendations and good practice statements

3. Recommendations and good practice statements

3.1 General statements

3.1.1 Education and training

- **WHO recommends that all clinicians should be appropriately educated *(19)* in the indications for intravascular catheter (PIVC, PICC, PAC) use, the proper procedures for their use, and the appropriate infection control measures to prevent catheter-related infections in adults, adolescents-children and neonates.**
  (Good practice statement)

- **WHO recommends that clinicians should be regularly assessed for their knowledge and adherence to guidelines related to appropriately managing intravascular catheters in adults, adolescents-children and neonates.**
  (Good practice statement)

3.1.2 Hand hygiene and aseptic "no-touch" technique

- **WHO recommends that all clinicians should be appropriately trained in hand hygiene procedures to prevent catheter-related infections in adults, adolescents-children and neonates.**
  (Good practice statement)

- **WHO recommends that hand hygiene should be performed at any time indicated according to the "Five moments" during catheter insertion, maintenance, access and removal practices, and preferably using the WHO hand rubbing technique with alcohol-based hand rub products (allow hands to dry) or by hand washing with soap and water and using single-use or clean towels to dry hands.**
  (Good practice statement)

- **WHO recommends that all clinicians should be appropriately trained in an aseptic "no-touch" technique to prevent catheter-related infections in adults, adolescents-children and neonates.**
  (Good practice statement)

3.2 Insertion

3.2.1 Sterile and aseptic "no-touch" insertion technique

- **WHO recommends using a sterile technique for the insertion of PICCs and PACs in adults, adolescents-children and neonates.**
  (Good practice statement)

Remarks

- GDG members considered that a *sterile technique* should be used for the insertion of longer-term catheters, such as PICCs, as the tip of the catheter is located in a major central vein. Hence, any infection would likely be associated with bacteraemia. A similar consideration was made for PACs as these catheters are used almost solely in intensive care unit settings where patients are severely ill and the potential risk of health care-associated catheter-related infection is high.
- A *sterile technique* consists of *sterile barrier precautions*. The GDG decided that for the insertion of PICCs and PACs, the *sterile technique* should include the use of a medical mask, sterile gown, sterile gloves and a sterile drape that adequately covers the area around the insertion site to prevent contamination of the catheter. The GDG noted that this is different from *maximal sterile barrier precautions (22)* in which a cap is included and the drape is a full body sterile drape (similar to the sterile drapes used in the operating room).

- **WHO suggests using an aseptic "no-touch" technique for the insertion of PIVCs in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- An aseptic "no-touch" technique (refer to Glossary) is considered adequate for PIVC insertion provided that there is strict clinical adherence to all the necessary steps in the aseptic "no-touch" technique procedure.

Rationale for the recommendation

Despite the lack of identified studies for PIVCs, the GDG judged the desirable effects to be moderate for the use of the aseptic "no-touch" technique for PIVC insertion and undesirable effects to be only trivial, and that there was no important variability in what patients consider the most important outcomes. In addition, the GDG judged equity to be probably increased and that the aseptic "no-touch" technique for the insertion of PIVCs was probably acceptable and feasible.

Summary of the evidence

The systematic literature review did not identify any eligible study comparing a sterile insertion

technique to routine practice (technique without the specific requirement for sterility) in adults, adolescents-children or neonates requiring a PIVC, PICC or PAC. No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The panel considered that use of a *sterile technique* for catheter insertion was widely accepted and practised, especially for the insertion of PICCs and PACs. The use of *sterile barrier precautions* can be associated with moderate resource costs, which are justifiable for infrequently used catheters such as PICCs and PAC. These costs may be more impactful in low-resource settings where health budgets may be limited.

For the insertion of PIVCs, the panel recognized that a *sterile technique* was often practised in many settings. However, the use of an aseptic "no-touch" technique for PIVC insertion was appropriate, provided that there was strict adherence to the steps required for an aseptic "no-touch" technique. The resources required for an aseptic "no-touch" technique were considered to be moderate, but cost-effectiveness and the balance of effects were considered to favour its use for PIVC insertion.

Implementation considerations

- The procedure for the aseptic "no-touch" technique for PIVC insertion is detailed in the Glossary.
- Ensure adequate training, understanding and demonstrable competency in the application of both a sterile technique and an aseptic "no-touch" technique when inserting PICCs, PACs and PIVCs.
- In situations where PIVC insertion is likely to be difficult and strict adherence to an aseptic "no-touch" technique is unlikely**, a *sterile technique* should be followed as the use of sterile gloves (with maintenance of sterility) means that the insertion site can be re-touched just prior to insertion without contaminating the insertion site.

Research needs

- Research on lower cost alternatives to using *sterile barrier precautions* for PICC and PAC insertion in LMICs could be helpful.
- Research on the adherence to an aseptic "no-touch" technique for PIVC insertion in various clinical settings would be worthwhile as it could identify situations in which the risk of PIVC infection may be greater and require special considerations when inserting a PIVC under these circumstances.
- Research to better define the size of the drape needed and whether clinicians need to wear a mask during PIVC insertion would be useful.
- Research on the use of an aseptic "no-touch" technique for PIVC insertion, including both desirable and undesirable effects.

** Patients with insertion veins that are small or poorly filling; patients with chronic diseases who have required many PIVCs previously; patients receiving chemotherapy that may have caused substantial venous sclerosis; patients in septic shock; or patients who have previously used illicit IV drugs that have caused venous sclerosis or infection.

3.2.2 Chlorhexidine-containing skin disinfection preparations

- **WHO recommends that adequate skin disinfection should always be used prior to the insertion of PIVCs, PICCs and PACs in adults, adolescents-children and neonates.**
  (Good practice statement)

Remarks

- It is frequently observed that in the event of insertion difficulty, there is a need to re-touch the insertion site – in such situations skin disinfection should be repeated to avoid potential contamination of the insertion site.

- **WHO suggests using either a chlorhexidine-containing or a non-chlorhexidine-containing skin disinfectant before PIVC and PICC insertion in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- Consider the possibility of chlorhexidine allergy when choosing the disinfection product.
- If selecting a chlorhexidine-containing disinfection preparation, assess the concentration of chlorhexidine as efficacy studies suggest that a concentration greater than 0.5% is required.
- Avoid using chlorhexidine-containing preparations greater than 2% in neonates (particularly those with a gestational age less than 36 weeks) due to the increased risk of chemical dermatitis.
- Consider local availability, context and the cost of suitable alternative skin disinfection preparations.
- All skin disinfectants should be allowed to dry for at least 30 seconds for a maximal effect.

Rationale for the recommendation

Low certainty evidence suggested beneficial effects of chlorhexidine-containing skin disinfection preparations compared to non-chlorhexidine-containing skin disinfection products on local infection and phlebitis prevention in adults, adolescents-children and neonates, but no difference in CRBSI. GDG members therefore considered that for chlorhexidine-containing products there may be some small desirable effects, potentially moderate undesirable effects, but no important variability in what patients consider the most important outcomes. Therefore, the GDG concluded that the balance of effects favoured either chlorhexidine-containing or other comparable non-chlorhexidine-containing products.

Based on these considerations, the GDG determined that either chlorhexidine-containing skin disinfection or non-chlorhexidine-containing skin disinfection products should be used before catheter insertion in adults, adolescents-children and neonates who require insertion of a PIVC or PICC, and that there was insufficient evidence to recommend chlorhexidine-containing disinfection products over other approved non-chlorhexidine-containing skin disinfection products for use in such situations. However, it was noted by some GDG members that the use of alcohol-chlorhexidine (especially 2% chlorhexidine) is generally considered superior to either chlorhexidine alone or alcohol alone and that it may be associated with a lower risk of PIVC colonization with potential pathogens than alcohol-povidone-iodine preparations.

Summary of the evidence

The literature review identified nine studies (seven randomized controlled trials [RCTs] and two non-randomized studies of interventions [NRSIs]) comparing chlorhexidine-containing skin disinfection products to non-chlorhexidine-containing skin disinfection products in adults, adolescents-children and neonates *(23-31)*. Seven studies focused on PIVC *(23-25, 27, 29-31)* and two on PICC *(26-28)*. Overall, the studies provided data on 4491 patients from Canada, France, Iran, Japan, Thailand and the United States of America (USA). Two RCTs were rated as having a high risk of bias *(23, 24)*, four with some concerns *(26, 27, 29, 30)*, and one with a low risk of bias *(31)*. All NRSIs were rated as having some risk of bias concerns *(25, 28)*.

PIVC: adults

The evidence indicated that chlorhexidine-containing skin disinfection used before catheter insertion may result in little to no difference in local infections compared to non-chlorhexidine-containing skin disinfection (four RCTs, 1533 patients; 2.3% versus 4.5%, respectively; risk ratio [RR; 95% confidence interval (CI)]: 0.51 [0.21-1.21]; low certainty of evidence (COE) *(24, 27, 29, 31)*), and phlebitis/thrombophlebitis (four RCTs, 1389 patients; 6.4% versus 8.7%, respectively; RR [95% CI]: 0.74 [0.42-1.49]; low COE *(23, 24, 27, 31)*). The evidence was very uncertain about the effect of chlorhexidine-containing skin disinfection used before catheter insertion compared to non-chlorhexidine-containing skin disinfection on CABSI/CRBSI (one RCT, 989 patients; 0% versus 0%; very low COE *(27)*), sepsis (one RCT, 150 patients; 2.0% versus 0%, respectively; RR [95% CI]: 5.94 [0.25-143.28]; very low COE *(24)*), and all-cause mortality (one RCT, 150 patients; 16.1% versus 23.0%, respectively; RR [95% CI]: 0.70 [0.34-1.44]; very low COE *(24)*). No study reported on BSI-related mortality.

PIVC: children and adolescents

The evidence indicated that chlorhexidine-containing skin disinfection used before catheter insertion may result in little to no difference in local infections (one RCT, 150 patients; 2.3% versus 4.5%, respectively; RR [95% CI]: 5.00 [1.01-24.87]; very low COE *(24)*) compared to non-chlorhexidine-containing skin disinfection. The evidence was very uncertain about the effect of chlorhexidine-containing skin disinfection used before catheter insertion compared to non-chlorhexidine-containing skin disinfection on CABSI/CRBSI (one cohort study, 254 patients; 11.8% versus 11.9%, respectively; RR [95% CI]: 0.99 [0.50-1.94]; very low COE *(25)*), sepsis (one RCT, 150 patients; 2.0% versus 0%, respectively; RR [95% CI]: 5.94 [0.25 -143.28] *(24)*), all-cause mortality (one RCT, 150 patients; 16.1% versus 23.0%, respectively, RR [95% CI]: 0.70 [0.34.1.44]; very low COE *(24)*), and phlebitis/thrombophlebitis (one RCT, 150 patients; 2.0% versus 3.0%, respectively; RR [95% CI]: 0.67 [0.07-6.25]; very low COE *(24)*). No study reported on BSI-related mortality.

PIVC: neonates

The evidence indicated that chlorhexidine-containing skin disinfection used before catheter insertion may slightly reduce phlebitis/thrombophlebitis (one RCT, 106 patients; visual infusion phlebitis mean score [standard deviation]: chlorhexidine 0.14 [0.07]; povidone-iodine 0.68 [0.19]; p=0.003; very low COE *(30)*) compared to non-chlorhexidine disinfection. No data were available for other critical outcomes. No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence was very uncertain about the effect of chlorhexidine-containing skin disinfection used before catheter insertion compared to non-chlorhexidine-containing skin disinfection on CABSI/CRBSI (one RCT *(26)*). Another cohort study reported an increased risk of CABSI when using chlorhexidine-containing skin disinfection (less than 1% chlorhexidine) compared to 10% povidone-iodine *(28)*. When using more than 1% chlorhexidine compared to 10% povidone-iodine, the difference was not statistically significant *(28)*. No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

One limited study of contextual factors/issues suggested that chlorhexidine-containing products may be cheaper than povidone iodine-alcohol skin disinfection solutions in some settings, while other studies suggested equivalence in terms of patient acceptability *(32)*.

Evidence to recommendations: considerations

The availability of various suitable skin disinfection preparations will depend on local disinfection practices, local conditions and context. The resources required for chlorhexidine-containing products are therefore considered to vary according to local context, resulting in variable cost-effectiveness such that patient equity may be potentially reduced in some settings. Patient and HCW acceptability and feasibility of using chlorhexidine-containing skin disinfection products is considered to be good if a suitable product is available at a reasonable price.

Implementation considerations

- The concentration of chlorhexidine should be greater than 0.5% in chlorhexidine-containing skin disinfection preparations to ensure adequate disinfection efficacy. Commonly, 2% chlorhexidine-containing preparations are used.
- Patients should be asked about previous chlorhexidine skin allergy before use.
- For LMICs, development of a standard list of suitable skin disinfection products (including chlorhexidine-containing skin disinfection products) for PIVC and PICC insertion may be of benefit.

Research needs

- Since a number of the studies of chlorhexidine-containing skin disinfection products had different non-chlorhexidine-containing comparator skin disinfection products, the actual benefit (or not) of chlorhexidine-containing skin disinfection products was difficult to assess accurately. Therefore, standardization of the comparator disinfection product in future research on chlorhexidine-containing skin disinfection products would be worthwhile.

3.2.3 Formal training on catheter insertion

- **WHO suggests that clinicians who insert intravascular catheters (PIVCs, PICCs and PACs) in adults, adolescents-children and neonates should undergo a formal training programme on catheter insertion.**
  (Conditional recommendation; very low certainty evidence)

Remarks

In many settings, routine practice on the insertion of peripheral catheters typically includes some informal training. However, it is considered important that all HCWs who are inserting catheters should undergo formal insertion training. In particular:

- formal training is essential for PICCs and PACs, but also important for PIVCs in adults, adolescents and children;
- formal training is essential for inserting all catheter types (PIVCs, PICCs and PACs) in neonates where any form of catheter insertion can be difficult.

Rationale for the recommendation

GDG members judged that despite the low COE, the desirable effects were considerable and undesirable effects trivial, with no important variability in what patients consider the most important outcomes, with the balance of effects being in favour of a formal training programme on catheter insertion.

Summary of the evidence

The literature review identified nine NRSIs assessing the impact of catheter insertion by an individual with formal insertion training/certification compared to catheter insertion by an individual with no requirement for formal training/certification in adults and neonates *(33-41)*. Two studies did not report the age group *(37, 38)*. No studies were identified focusing on children and adolescents. Two studies focused on PIVC *(37, 39)*, five on PICC *(35, 36, 38, 40, 41)*, and two reported on both types of catheters *(33, 34)*. Overall, the studies reported findings on 12 812 patients from China, India, Spain, the United Kingdom of Great Britain and Northern Ireland, and the USA. Two NRSIs were rated as having some risk of bias concerns *(37, 41)* and seven with a high risk of bias *(33-36, 38-40)*.

PIVC: adults

The evidence was very uncertain about the effect of catheter insertion by an individual with formal insertion training/certification compared to catheter insertion by an individual with no requirement for formal training/certification on CABSI/CRBSI (one before–after study, 876 patients; 0% versus 0%; very low COE (*37)*), sepsis (one before–after study, 876 patients; 0% versus 0%; very low COE *(37)*), and phlebitis/thrombophlebitis (two before–after studies, 6995 patients; proportion of phlebitis ranged from 3% to 21% with training and from 5% to 34% without training; very low COE (*33, 37)*). No study reported on BSI-related mortality, local infections, all-cause mortality and complications related to insertion.

PIVC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PIVC.

PIVC: neonates

The evidence indicated that catheter insertion by an individual with formal insertion training/certification may reduce the risk of CABSI/CRBSI in neonates compared to no formal training (one before–after study, 1631 patients; CABSI/CRBSI/1000 peripheral line days: with training: 2.37 ± 3.3; without training: 10.8 ± 8.43; p=0.03; very low COE *(34)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality, phlebitis/thrombophlebitis and complications related to insertion.

PICC: adults

The evidence indicated that formal catheter insertion training may reduce the risk of CABSI/CRBSI compared to no formal training (one cohort study, 610 patients; 0.2% versus 2.7%, respectively; RR [95% CI]: 0.06 [0.00-0.98]; very low COE (*41)*). Two additional before–after studies reported similar results (226 patients, 2% versus 5%, respectively; 1276 patients, 0% versus 0.5%, respectively *(35, 40)*). Based on the findings from one cohort study, the risk of phlebitis/thrombophlebitis was reduced with formal training compared to no formal training (610 patients; 1.6% versus 6.7%, respectively; RR: 0.24 [95% CI: 0.09-0.64]; very low COE (*41)*). The results from a before–after study indicated lower proportions of phlebitis with training (3890 patients; 3% versus 5%, respectively *(33)*). The evidence was very uncertain about the effect of catheter insertion by an individual with formal insertion training/certification compared to catheter insertion by an individual with no requirement for formal training/certification on complications related to IVC insertion (three before–after studies, 681 patients; the proportion of complications related to insertion ranged from 5% to 15% with formal training, and from 14% to 36% without formal training; very low COE *(35, 36, 38)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence was very uncertain about the effect of catheter insertion by an individual with formal insertion training/certification compared to catheter insertion by an individual with no requirement for formal training/certification on CABSI/CRBSI (one before–after study, 1631 patients; CABSI/CRBSI/1000 central line days: before training: 9.11 ± 8.9; after training: 18.34 ± 27.31; p= 0.412; very low COE *(40)*) No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

A review of contextual factors/issues suggested that acceptability of training among HCWs was high as long as appropriate training time was allocated. Among patients, such training was considered to be important since it was likely to minimize the number of catheter insertion attempts *(42-44).*

Evidence to recommendations: considerations

The panel considered that the evidence suggested that formal training in insertion should always be provided for PICC and PAC insertion given the potential risks associated with these catheters, and that it should ideally also be provided for PIVC insertion.

The resources required to provide a formal training programme for catheter insertion were considered to be potentially moderate in terms of training time and need for an education programme, but cost-effectiveness, equity and acceptability factors all favoured formal training, with feasibility considered likely in all health care settings.

Implementation considerations

- A formal catheter insertion training programme should include both education and demonstrable practical competence in catheter insertion (including an understanding of the appropriate indications for a PIVC and documentation of insertion) and that this competency is demonstrably maintained.
- Establishment of a formal catheter insertion teaching programme requires the employment of qualified teaching staff and the need for hospitals to schedule appropriate training time when staff are not busy with clinical duties. In some settings, simulation tools are used, although these may be less available in some LMICs due to cost constraints.
- Ensure that catheter insertion training does not lead to a diversion of health resources.
- All stakeholders, including HCWs, hospital administrators, education staff and patients, should be engaged in catheter insertion (and maintenance) training programmes that are sustainable.
- In settings where catheter insertion may be ultrasound-assisted, appropriate skills training in ultrasound use should be provided.
- Development of a common context-appropriate (and language-flexible) educational training module from which countries and facilities can adapt training to their local conditions and needs could be useful.

Research needs

- Research into the optimal, most time-efficient method of catheter insertion training (including skill retention), particularly for low-resource settings where HCW numbers may be limited.
- Further research on the most effective methods to maintain catheter insertion competency would be useful.

3.2.4 Catheter insertion by a clinician wearing single-use gloves

- **WHO recommends that clinicians inserting a PIVC or PICC in adults, adolescents or children wear single-use gloves at the time of catheter insertion.**
  (Good practice statement)

- **WHO suggests that clinicians who insert PIVCs or PICCs in neonates use either single-use gloves or no gloves at the time of catheter insertion.**
  (Conditional recommendation; very low certainty evidence)

Remarks

In neonates, where catheter insertion is often more difficult than in older patients, the reduction in tactile agility sometimes associated with single-use glove use may make catheter insertion more challenging.

Rationale for the recommendation

GDG members considered that despite the low COE in neonates, the desirable effects of wearing single-use gloves were likely to be moderate and undesirable effects small, with no important variability in what patients consider the most important outcomes, and the balance of effects being probably in favour. Thus, clinicians who insert PIVCs and PICCs in neonates should have the option to either use single-use gloves or no gloves at the time of catheter insertion, depending on the clinical circumstances.

The reduction in tactile agility sometimes associated with single-use glove use can be important when inserting catheters in neonates, such that clinicians should have the option not to wear gloves under these circumstances, provided that appropriate hand hygiene is performed prior to catheter insertion.

Summary of the evidence

The literature review identified two studies (one RCT and one NRSI) assessing the impact of catheter insertion by an individual wearing gloves (either sterile or non-sterile) compared to insertion by an individual not specifically required to wear gloves in adults and neonates *(45, 46)*. We did not identify any study focused on children and adolescents. One study focused on PIVC *(45)* and the other on PICC *(46)*. Overall, we report findings on 1256 patients from Austria and the USA. We rated the RCT as having a low risk of bias *(46)* and the NRSI as having some risk of bias concerns *(45)*.

PIVC: adults

The evidence indicated that wearing gloves (either sterile or non-sterile) reduced the risk of insertion complications by 48% compared to no measures (one cohort study, 1132 patients; adjusted RR [aRR; 95% CI]: 0.52 [0.33-0.85]; low COE *(45)*) and by 45% compared to hand washing (one cohort study, 1132 patients; RR [95% CI]: 0.55 [0.36-0.84]; low COE *(45)*). The evidence was very uncertain about the effect of wearing gloves compared to hand disinfection on the risk of insertion complications (one cohort study,

1132 patients; RR [95% CI]: 0.86 [0.62-1.22]; very low COE *(45)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PIVC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PIVC.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence was very uncertain about the effect of catheter insertion by an individual wearing sterile or non-sterile gloves compared to insertion by an individual not specifically required to wear gloves on CABSI/CRBSI (one RCT, 120 patients; 6.7% versus 6.7%, respectively; RR [95% CI]: 1.00 [0.26-3.81]; very low COE *(46)*) and all-cause mortality (one RCT, 120 patients; 10.0% versus 3.3%, respectively RR [95% CI]: 3.00 [0.63-14.27]; very low COE *(46)*). No study reported on BSI-related mortality, sepsis, local infections, phlebitis/thrombophlebitis and complications related to IVC insertion.

A review of contextual factors/issues found that in one study of preterm neonates there was a small increased cost associated with glove use when inserting intravascular catheters, but it did not consider any potential reduction in catheter-associated infections or HCW needle-stick injuries linked to glove use *(46)*.

Evidence to recommendations: considerations

GDG members recognized that resources required for single-use glove use were potentially moderate and cost-effectiveness may favour not wearing gloves such that equity may be reduced in some circumstances and health care settings. Single-use gloves may be in short supply in some health settings, potentially posing an equity issue for patients and HCWs. However, acceptability and feasibility factors for both patients and HCWs favour wearing gloves in most health care settings.

The GDG also considered that the use of single-use gloves is likely to be associated with a substantial occupational health and safety benefit for HCWs inserting an IV catheter.

Depending on the skill and training of the HCWs inserting the catheter and the patient's clinical situation, the use of gloves may be associated with an increase in the number of IV insertion attempts.

Implementation considerations

- Appropriate hand hygiene should be performed before and after glove use.
- Single-use gloves should be changed/discarded after each patient contact to avoid cross-contamination between patients and the increased risk of HAIs.
- Clinicians who are allergic to latex should avoid using single-use gloves made of latex. For this reason, health care facilities should have non-latex gloves readily available for use.
- Ensure that the resources required and the practical issues of procurement of single-use gloves are in place so that there is consistency across all health settings, including in LMICs.

Research needs

- Research on the optimal cost-effective material from which to make single-use gloves to maximize tactile agility and reduce potential allergy risk for HCWs would be beneficial.
- Research on the impact of glove-wearing on the number of catheter insertion attempts and any subsequent impact on both infection risk and potential patient suffering should be undertaken in various types of health care settings.

3.2.5 Catheter insertion by a clinician wearing single-use sterile gloves

- **WHO recommends that clinicians inserting a PICC or PAC use single-use sterile gloves compared to non-sterile gloves in adults, adolescents-children and neonates.**
  (Good practice statement)

- **WHO suggests not using sterile gloves when inserting a PIVC in adults, adolescents-children and neonates, provided that the steps of the aseptic "no-touch" technique are carefully adhered to.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- Clinician competency and adherence to the steps involved in the aseptic "no-touch" technique is necessary to ensure that the vein is not touched immediately after skin disinfection prior to PIVC insertion.
- If the aseptic "no-touch" technique is difficult to ensure, then single-use sterile gloves should be used.

Rationale for the recommendation

GDG members noted that the published evidence in favour of sterile glove use for PIVC insertion was of very low certainty, that both the desirable and undesirable effects were small and there was no important variability in what patients consider the most important outcomes, and that the balance of effects did not favour sterile glove use over non-sterile glove use.

Summary of the evidence

The literature review identified no studies on PIVCs and PICCs in any age group regarding the use of sterile gloves and risk of infection associated with catheter insertion. The literature review did not identify any eligible study comparing catheter insertion by clinicians wearing sterile gloves to insertion by clinicians wearing non-sterile gloves in adults, adolescents-children or neonates requiring a PIVC, PICC or PAC.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

GDG members noted that the resources required to use sterile gloves are potentially moderate (especially in LMICs), such that cost-effectiveness considerations are likely to not support their use compared to non-sterile gloves; therefore, equity may be potentially reduced. It is noted that there may be a limited supply of sterile gloves in some LMICs, such that the use of sterile gloves may have negative equity impacts, especially in facilities where patients need to pay the additional cost of sterile gloves.

Patients and HCWs' acceptability is likely to vary depending on the region and health care context. Among HCWs, the acceptability of sterile gloves may be reduced in some settings due to feasibility and

logistic concerns. However, among patients, the use of sterile gloves may be more acceptable due to their perceived sense of improved sterility, but some patients could be concerned about their additional cost.

Feasibility is likely to vary by region and setting, with the use of sterile gloves not being easy to implement in LMICs due to challenges related to availability and supply, and in some health facilities it might take additional time to locate sterile gloves.

Implementation considerations

- Ensure that single-use sterile and non-sterile gloves are changed and correctly discarded after each patient contact to avoid cross-contamination between patients and thereby reduce the risk of HAIs.
- Perform hand hygiene according to the WHO “Five moments” immediately before touching the box containing single-used non-sterile gloves to avoid cross-contamination.
- Store non-sterile gloves in a manner whereby they are not likely to become contaminated with multidrug- resistant organisms.
- Use single-use sterile gloves for PIVC insertion if an aseptic “no-touch” technique cannot be ensured.
- Single-use sterile gloves are often preferred for PIVC insertion in some patient groups (for example, burns, intensive care unit, immunocompromised patients) due to the potential added risk of infection in these patient groups and the frequent difficulties associated with PIVC insertion.
- In some regions, sterile gloves are used if employing an ultrasound machine to assist with PIVC insertion as the insertion site is often touched immediately before insertion.

Research needs

- Research aiming to increase the development and availability of affordable single-use sterile gloves with good tactile agility features would be of major benefit as many of the cost concerns of currently available sterile gloves could be lessened such that equity, acceptability and feasibility concerns would be alleviated, especially in LMICs.
- Research regarding the frequency of accurate adherence to an aseptic “no-touch” technique or PIVC insertion in various clinical settings would be worthwhile as it could identify situations in which the risk of PIVC infection using single-used non-sterile gloves may be greater and the use of sterile gloves prioritized.

3.2.6 Catheter insertion using a standardized insertion pack/kit

- **WHO recommends that clinicians use a standardized insertion pack/kit when inserting a PICC or PAC in adults, adolescents-children and neonates.**
  (Good practice statement)

- **WHO suggests that clinicians who insert PIVCs use a standardized insertion pack/kit for catheter insertion in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- The packaging of most PICCs and PACs typically includes a standardized, sterile, single-use insertion pack/kit.
  Conversely, it is less common to have PIVCs in standardized packs.
- The GDG noted that it would be desirable to have the standardized pack (even locally prepared) for PIVCs because it would facilitate standardization of the procedure.

Rationale for the recommendation

GDG members noted that the evidence for the use of a standardized, sterile, single-use insertion pack/kit for PIVC insertion was of very low certainty, but that the desirable effects were likely to be moderate and the undesirable effects trivial, with no important uncertainty or variability in the values associated with the outcome of interest. Therefore, the GDG considered that the balance of effects was probably in favour of using a standardized insertion pack/kit for PIVC insertion.

The use of a standardized insertion pack/kit for the insertion of PIVCs, PICCs and PACs is likely to be associated with increased compliance with appropriate insertion technique and documentation.

Summary of the evidence

The systematic literature review identified one NRSI assessing the impact of catheter insertion by an individual using a standardized insertion pack/kit compared to insertion by an individual not using a standardized insertion pack/kit in 1345 patients requiring a PIVC; the age group was not reported *(47)*. The study was conducted in the USA and rated as having a high risk of bias.

PIVC: adults

The evidence indicated that a standardized insertion pack/kit may reduce phlebitis/thrombophlebitis in patients compared to no standardized insertion pack/kit (one before–after study, 1345 patients; 0.8% versus 3.3%, respectively; RR [95% CI]: 0.25 [0.10-0.60]; very low COE *(47)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PIVC.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

A review of contextual factors/issues suggested that the use of standardized PIVC insertion packs/kits is associated with some cost savings compared to purchasing all the required components separately and that the packs/kits are considered extremely functional, time-saving and enjoyable to use among nurses *(47)*.

Evidence to recommendations: considerations

GDG members noted that the use of a standardized insertion pack/kit for PIVC insertion may be associated with a potential reduction in insertion time for HCWs and may increase compliance with the aseptic "no-touch" technique as all the necessary components to achieve adherence are likely to be readily available in the standardized pack/kit.

In some settings, standardized insertion pack/kits may be prepared at the institutional level, thereby allowing the pack content to be customized according to the local context and needs. However, although such locally produced standardized insertion pack/kits may be associated with a saving in insertion time, the resources needed to prepare the pack/kit need to be recognized, including potential variabilities in resource availability in different settings.

Undesirable effects of using a standardized PIVC insertion pack/kit include the possibility of an increase in material wastage, especially if the clinician needs to use more than one pack for each catheter insertion. If some standardized insertion pack/kits vary in their content, then this may potentially create confusion among some clinicians.

Patient equity is likely to be improved with the use of a standardized PIVC insertion pack/kit if the time to PIVC insertion and the number of insertion attempts are reduced. However, this may be

potentially offset in some settings if patients need to pay an additional cost for the insertion packs/kits. Nevertheless, overall, the standardization achieved with the use of PIVC insertion packs/kits will generally improve equity for both patients and HCWs, including the potential freeing-up of nursing time for more patient care. Insertion packs/kits are therefore likely to be associated with HCW and patient acceptability due to their convenience and perceived safety.

Overall, feasibility is likely to vary by country and setting – recognizing that in some health care settings there may be complexities associated with the introduction of standardized insertion pack/kits due to local cost and logistic issues.

Implementation considerations

- Ensure that standardized PIVC insertion packs/kits, contain all the necessary components required to insert a PIVC safely and with adherence to the principles of the aseptic “no-touch” technique.
- Provide appropriate training to HCWs in the correct use of standardized insertion packs/kits.
- In some regions, the cost of standardized PIVC insertion packs/kits, whether produced locally or purchased from a manufacturer, may be considered prohibitive, but the potential benefits of their use should be included in any cost considerations.
- The use of standardized PIVC insertion packs/kits is likely to result in savings in HCWs’ insertion time.
- Consideration should be given to potential environmental impacts linked to additional waste if not all material included in the kit is used and requires disposal.

Research needs

- Research on the optimal standardized PIVC insertion pack/kit that is suitable for use by clinicians in a wide variety of health settings could have major benefits in streamlining mass production and, therefore, improving availability and cost-effectiveness in many health settings, especially in LMICs.

3.2.7 Catheter insertion using ultrasound-guided assistance

- **WHO suggests the use of ultrasound-guided assistance when inserting PICCs in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- The use of ultrasound guidance for PICC insertion is recognized as being routine in most health care settings as it helps to ensure that the catheter tip is directed into the appropriate central vein and the number of insertion attempts are reduced.

- **WHO suggests not to routinely use ultrasound-guided assistance when inserting PIVCs in adults, adolescents- children or neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- GDG members noted that the use of ultrasound guidance for both PICC and PIVC insertion may be associated with a reduction in the number of insertion attempts and, therefore, reduced patient suffering and insertion-related consumable costs.
- Despite the recommendation not to routinely use ultrasound for PIVC insertion, the GDG noted that the use of ultrasound for PIVC insertion may be helpful in specific patient subgroups where intravascular cannulation may be difficult (for example, intravenous drug users, patients with burns, patients who are oedematous, patients receiving chemotherapy).

Rationale for the recommendation

For PICC insertion, the GDG members considered that both the desirable and undesirable effects of ultrasound guidance are moderate, that there is no important variability in what patients consider the most important outcomes, and that the balance of effects probably favours the use of ultrasound guidance.

For PIVC insertion, the GDG members considered both the desirable and undesirable effects of ultrasound guidance to be small, that there is no important uncertainty or variability in the values associated with the outcome of interest, and that the balance of effects probably favours the non-use of ultrasound guidance in most routine clinical circumstances.

Summary of the evidence

The literature review identified 21 studies (12 RCTs and nine NRSIs) assessing the impact of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance in adults, adolescents-children and neonates *(48-68)*. One study evaluated a mixed-age group (children, adolescents, adults) *(54)*; two studies did not report the age group *(50, 64)*. Nine focused on PIVC *(48, 49, 51, 52, 54, 56, 58, 60, 61)* and the remaining 12 on PICC. Overall, the studies reported findings

on 6825 patients from Brazil, Canada, China, France, Spain, and other countries and areas. Six RCTs were rated as having a high risk of bias *(49, 58-60, 63, 68)* and six as having some risk of bias concerns *(52, 56, 57, 61, 65, 66)*.

PIVC: adults

The evidence was very uncertain about the effect of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance on BSI (one cohort study, 804 patients; 5.2 per 1000 versus 7.8 per 1000, respectively; p=0.68; very low COE *(48)*) and phlebitis/thrombophlebitis (one RCT, 60 patients; 0% versus 0% *(61)*). In addition, a cohort study focused on a mixed population reported a similar risk of phlebitis (523 patients; 5% versus 7%, respectively; very low COE) *(54)*. Another RCT reported no local inflammation (proxy for phlebitis) in both groups (n=104) *(52)*. No study reported on BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance on phlebitis/thrombophlebitis (two RCTs, 339 patients; 1.3% versus 3.9%, respectively; very low COE *(49, 56)*). In addition, a cohort study focused on a mixed population reported a similar risk for phlebitis (523 patients; 5% versus 7%, respectively) *(54)*. No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC.

PICC: adults

The evidence indicated that catheter insertion with ultrasound-guided assistance may reduce local infections (one RCT, 319 patients; 1.3% versus 7.4%, respectively; RR [95% CI]: 0.17 [0.04-0.73]; very low COE *(63)*) compared to catheter insertion without ultrasound-guided assistance. Based on a Bayesian meta-analysis of five studies, ultrasound-guided assistance may reduce phlebitis/thrombophlebitis (five RCTs, 1744 patients; 1.1% versus 5.7%, respectively; RR [95% CI]: 0.17 [0.08-0.50]; low COE *(57, 59, 63, 65, 68)*) compared to catheter insertion without ultrasound-guided assistance (Web Annex). The evidence was very uncertain about the effect of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance on CABSI/CRBSI (one RCT, 98 patients; 0% versus 2.1%, respectively; RR [95% CI]: 0.32 [0.01-7.67]; very low COE *(57)*) and all-cause mortality (one RCT, 98 patients; 0% versus 2.1%, respectively; RR [95% CI]: 0.32 [0.01- 7.67]; very low COE *(57)*). In addition, one cohort study reported little to no difference in bacteraemia in adults (43 patients; 22% versus 14%, respectively *(53)*). No study reported on BSI-related mortality, sepsis and all-cause mortality.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence was very uncertain about the effect of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance on phlebitis/thrombophlebitis (one RCT, 94 patients; 0.9% versus 4.3%, respectively; RR [95% CI]: 0.20 [0.01-4.05]; very low COE *(66)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

A review of contextual factors/issues suggested that the use of ultrasound for PIVC insertion may be associated with a higher success rate for first insertion attempts, as well as high patient satisfaction scores and strong support among HCWs. Feasibility is considered an issue among HCWs in some settings, including the need for appropriate training in ultrasound use *(51, 66, 69-71)*.

Evidence to recommendations: considerations

The GDG considered that moderate resources were needed for PICC insertion using ultrasound, both for the purchase and maintenance of the machine and for HCWs' training. However, cost-effectiveness was considered to favour ultrasound use although equity may be reduced in settings with limited ultrasound access. Nevertheless, patient and clinician acceptability probably favours ultrasound use, even though feasibility is likely to vary depending on the health care setting. Overall, the panel considered that ultrasound guidance should be used to assist with PICC insertion.

Resources for PIVC insertion are likely to be large given the high number of PIVC insertions and, therefore, cost-effectiveness favours not routinely using ultrasound guidance for PIVC insertion. Overall, equity was likely to be reduced even though patient and clinician acceptability probably favour ultrasound use unless there is an increased cost to patients. However, feasibility is likely to be generally reduced, depending on the health care setting. Additionally, it is noted that the frequency of ultrasound use may be too high to maintain cleaning quality for PIVC insertion, such that there may be an increased risk of ultrasound probe contamination and an increase in the risk of patient infections. Furthermore, many HCWs are likely to require education and training in the appropriate and accurate use of ultrasound – although this cost could be offset by a reduction in the number of IV insertion attempts and their associated costs. Overall, the panel considered that ultrasound guidance should not be routinely recommended for PIVC insertion.

The GDG noted that ultrasound use may be associated with an increased risk of infection for both PICC and PIVC insertion if the ultrasound probe is not cleaned/decontaminated appropriately or if the probe or gel used is contaminated.

In some settings, ultrasound availability might be limited and this may potentially lead to delays in catheter insertion and therefore possible delays in the administration of required therapeutics if there is no other IV access in place.

There may also be competing needs for ultrasound devices, such that their use for catheter insertion may restrict their use for other important diagnostic activities. In some resource-poor settings where ultrasound availability is extremely limited or non-existent, then this is likely to have a negative health impact on patients.

Implementation considerations

- Clinicians' education and training in the appropriate and accurate use of ultrasound is required for both PICC and PIVC insertion.

- The ease of ultrasound use may depend on device design, including the simplicity of cleaning.
- Ultrasound probes must be cleaned appropriately before and after each use.
- Potential contamination of the ultrasound gel should be considered and prevented. Only non-contaminated ultrasound gel should be used.
- Ultrasound use is likely to depend on the availability of this resource (both the device and trained staff) at the facility level.

Research needs

- Research on optimal teaching methods for ultrasound use (including standardized cleaning methods) would be useful.

3.2.8 Catheter insertion in the distal section of the upper limb (below the cubital fossa) compared to insertion in the proximal section of the upper limb (cubital fossa or above)

- **WHO suggests the use of the distal arm veins over the proximal section of the upper limb (cubital fossa or above) for PIVC insertion in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- When choosing the site of insertion consider that: 1. starting insertions distally retains the option of subsequently using more proximal veins should the initial PIVC attempt fail; and 2. cubital fossa veins are commonly required for phlebotomy to obtain blood tests, so these veins should be avoided for this reason.
- Use of the cubital fossa for PIVC insertion may be associated with an increased risk of potential infection and hence this site should be avoided.
- Flexor areas/surfaces should generally be avoided for PIVC insertion due to the excess risk of catheter movement and need for increased PIVC stabilization.
- The GDG noted that the administration of vasopressors (for example, as part of sepsis management) usually requires a PIVC inserted in the upper arm where blood flow may be greater. Furthermore, any extravasation of vasopressors in the distal arm, although uncommon, can be associated with significant soft tissue necrosis.
- Use of the cubital fossa for PIVC insertion may be appropriate in certain conditions, such as in emergency situations where IV access needs to be rapidly established.

Rationale for the recommendation

Regarding infectious outcomes, the GDG members considered both the desirable and undesirable effects of PIVC insertion in the distal arm veins to be small and that there was no important variability in what patients consider the most important outcomes. However, the GDG considered that the balance of effects probably favours the use of distal arm veins for PIVC insertion in most routine clinical circumstances. Therefore, the GDG concluded that PIVC insertion in the distal arm veins should be suggested compared to using the proximal section of the upper limb including the cubital fossa, based on both the infection-related and non-infection-related benefits.

Summary of the evidence

The literature review identified nine studies (one RCT and eight NRSIs) assessing the impact of insertion in the distal section of the upper limb (below the cubital fossa) compared to the proximal section of the upper limb (cubital fossa or above) in adults *(72-80)*. Two studies assessed a mixed population *(74, 77)*. The literature review did not identify any study focused on children and adolescents or on neonates. All studies except one *(79)* focused on PIVC. Overall, the studies reported findings on 9160 patients and/or catheters from Australia, Brazil, Japan and the USA. The RCT was rated as having some risk of bias concerns *(80)*. Six NRSIs were rated as having some risk of bias concerns *(72, 73, 75-77, 79)* and two with a high risk of bias *(74, 78)*.

PIVC: adults

The evidence indicated that catheter insertion in the distal section of the upper limb probably results in little to no difference in phlebitis/thrombophlebitis compared to the proximal section of the upper limb (one RCT, 5907 patients; incidence RR [IRR; 95% CI] upper arm versus lower arm: 1.34 [0.86-2.01]; IRR [95% CI] antecubital fossa versus lower arm: 1.05 [0.70-1.55]; moderate COE *(80)*). Four additional observational studies afforded no conclusions about whether upper or lower arm insertion is associated with an increased or reduced risk for phlebitis/thrombophlebitis in adults *(72, 73, 75, 76)*. The evidence was very uncertain about the effect of catheter insertion in the distal section of the upper limb compared to the proximal section of the upper limb on local infections (one cohort study, 67 patients; 11.1% versus 0%, respectively; RR [95% CI]: 1.17 [0.08-17.07]; very low COE *(75)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis and all-cause mortality.

PIVC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PIVC. However, it identified one cohort study focused on a mixed population (children, adolescents and neonates) *(77)*. The evidence was very uncertain about the effect of catheter insertion in the distal section of the upper limb compared to the proximal section of the upper limb on CABSI/CRBSI (433 patients; 0% versus 0%; very low COE) and local infections (433 patients; 0% versus 0%; very low COE) *(77)*.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC.

PICC: adults

The evidence was very uncertain about the effect of catheter insertion in the distal section of the upper limb compared to the proximal section of the upper limb on CABSI/CRBSI (one case-control study, 647 patients; odds ratio [OR; 95% CI]: 0.77 [0.47-1.20]; very low COE *(79)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

A review of contextual factors/issues suggested that patients reported a greater restriction of arm movement if the PIVC is located in the cubital fossa *(81, 82).*

Evidence to recommendations: considerations

GDG members considered that the resources for PIVC insertion in the distal arm were likely to be negligible with cost-effectiveness favouring neither the distal nor the proximal veins for PIVC insertion. They noted that there should probably be no impact on equity, with patient and HCW acceptability and feasibility likely to be in favour of distal vein use. Regarding patient acceptability, GDG members strongly advocated on the importance of engaging patients in these decisions, while informing them about the risks and advantages and disadvantages of the different insertion sites. Overall, the GDG considered that PIVC insertion in the distal arm veins should be recommended compared to using cubital fossa veins or those more proximal.

Implementation considerations

- Use of the proximal arm (and cubital fossa) for PIVC insertion can result in decreased patient mobility, including difficulty feeding and bathing.
- Insertion of PIVCs in the distal arm, especially the hand, may be more painful for some patients and may require more insertion attempts in some cases.
- PIVC placement in the cubital fossa may reduce the patient's ability to perform routine daily tasks and therefore require greater nursing support and time. Furthermore, patients should be informed about this potential risk.
- In some circumstances, the use of distal arm veins may require more insertion attempts, but this may be countered by the fact that the use of an initial proximal arm site may result in an increased risk of subsequently having no further arm insertion site options and therefore require the patient to have a CVC inserted – a more high-risk and costly insertion procedure than a PIVC.

Research needs

- Research on the optimal distal arm site for PIVC insertion considering key patient factors would be useful, such as the insertion risk (for example, insertion under emergency conditions) and pain, mobility and ease of self-care, need for PIVC stabilization and drug-related phlebitis risk.

3.2.9 Catheter insertion in the upper limb compared to insertion in the lower limb

- **WHO suggests use of the upper limb over the lower limb for PIVC insertion in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- PIVC insertion in the lower limb may be prioritized in some emergency situations where IV access must be established rapidly and in occasional intensive care unit patients with very poor upper limb venous access.

- **WHO suggests use of the upper limb over the lower limb for PICC insertion in neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- PICC insertion in adults, adolescents and children is almost universally in the upper limb.
- PICC insertion in the lower limb may be required in some very preterm neonates where upper limb venous access is difficult.

Rationale for the recommendation

For PIVC insertion in all age groups, GDG members considered the desirable effects of upper limb PIVC insertion to be moderate and undesirable effects trivial. They also considered that there was no important variability in what patients consider the most important outcomes, and that the balance of effects probably favoured the use of the upper limb veins over the lower limb in most clinical circumstances.

For PICC insertion in neonates, the desirable and undesirable effects of upper limb PICC insertion were considered to be small. The GDG considered that there was no important uncertainty or variability in the values associated with the outcome of interest and that the balance of effects probably favoured the use of the upper limb veins over the lower limb in most clinical circumstances.

Summary of the evidence

The literature review identified 25 NRSIs assessing the impact of insertion in the upper limb compared to insertion in the lower limb in adults and neonates *(28, 74, 76, 77, 83-102)*. Three of the studies assessed a mixed population *(74, 77, 87, 103)*. No studies were identified in children and adolescents. Eight studies focused on PIVC (*74, 76, 77, 85, 88, 99, 102, 103)* and 17 on PICCs *(28, 83, 84, 86, 87, 89-98, 100, 101)*. Overall, the studies reported findings on 16 665 patients and/or catheters from Australia, Brazil, Canada, China, India, and other countries and areas. Seventeen NRSIs were rated as having some risk of bias concerns *(28, 76, 77, 83, 84, 86, 87, 89-91, 93, 94, 96-98, 100, 102)* and eight as having a high risk of bias *(74, 85, 88, 92, 95, 99, 101, 103)*.

PIVC: adults

The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on phlebitis/thrombophlebitis (three cohort studies, 1671 patients; very low COE *(76, 85, 99)*). In two studies, phlebitis/thrombophlebitis ranged from 6%–42% in the upper limb and from 9%–72% in the lower limb *(85, 99)*. The largest study (1251 patients) was stratified by the Acute Physiology and Chronic Health Evaluation (APACHE) II score; the results indicated little to no difference between groups *(76).* The evidence was also very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on local infections (one cohort study, 3165 patients; 2.7% versus 2.3%, respectively; RR [95% CI]: 1.13 [0.43-3.14] *(103)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, all-cause mortality and complications related to catheter insertion.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on CABSI/CRBSI (one cohort study, 455 patients; 0% versus 0%; very low COE *(77)*), local infections (one cohort study, 455 patients; 0% versus 0%; very low COE *(77)*), and complications related to catheter insertion (one cohort study, 455 patients; the proportion of complications ranged from 21% to 30% in the upper limb and from 29% to 100% in the lower limb; very low COE *(77)*). No study reported on BSI-related mortality, sepsis, all-cause mortality and phlebitis/thrombophlebitis.

PIVC: neonates

The evidence indicated that catheter insertion in the upper limb compared to insertion in the lower limb probably results in little to no difference in complications related to insertion (two cohort studies, 643 patients; the proportion of complications ranged from 65% to 83% in the upper limb group and from 65% to 79% in the lower limb group; very low COE *(88, 102)*). The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on CABSI/CRBSI (one cohort study, 455 patients; 0% versus 0%; very low COE *(77)*) and local infections (one cohort study, 455 patients; 0% versus 0%; very low COE *(77)*). No study reported on BSI-related mortality, sepsis, all-cause mortality and phlebitis/thrombophlebitis.

PICC: adults

The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on phlebitis/thrombophlebitis (one cohort study, 124 patients; 20.3% versus 14.3%, respectively; RR [95% CI]: 1.42 [0.57-3.52]; very low COE *(96)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and complications related to insertion.

PICC: children and adolescents

The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on all-cause mortality (one cohort study, 620 patients; 9.5% versus 12.1%, respectively; RR [95% CI]: 0.79 [0.47-1.32]; very low COE *(87)*), phlebitis/thrombophlebitis (one cohort study, 620 patients; 0.9 versus 0.7, respectively; RR [95% CI]: 1.27 [0.14-11.23]; very low COE *(87)*), and complications related to catheter insertion (one cohort study, 620 patients; 12.6% versus 8.7%, respectively; RR [95% CI]: 1.44 [0.81-2.54]; very low COE *(87)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis and local infections.

PICC: neonates

The evidence was very uncertain about the effect of catheter insertion in the upper limb compared to insertion in the lower limb on CABSI/CRBSI (five cohort studies, 1355 patients; proportion ranged from 5% to 10% in the upper limb group and from 0% to 25% in the lower limb group; very low COE *(28, 84, 90, 92, 97)*), sepsis (four cohort studies, 2417 patients; proportion ranged from 5% to 12% in the upper limb group and from 2% to 23% in the lower limb group; very low COE *(89, 94, 100, 101)*), local infections (three cohort studies, 1388 patients; proportion ranged from 0% to 5% in the upper limb group and from 0% to 43% in the lower limb group; very low COE *(83, 95, 98)*), all-cause mortality (three cohort studies, 1172 patients; proportion ranged from 5% to 6% in the upper limb group and from 1% to 6% in the lower limb group; very low COE *(89, 100, 101)*), phlebitis/thrombophlebitis (11 cohort studies, 5837 patients; proportion ranged from 0% to 10% in the upper limb group and from 0% to 21% in the lower limb group; very low COE *(84, 89-91, 93, 95, 97, 98, 100, 101)*), and complications related to catheter insertion (five cohort studies, 2325 patients; proportion ranged from 3% to 40% in the upper limb group and from 20% to 30% in the lower limb group; very low COE *(83, 84, 86, 95, 98)*). No study reported on BSI-related mortality.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that resources needed for PIVC insertion in the upper limb were likely to be negligible, but cost-effectiveness probably favoured the upper limb over the lower limb veins for PIVC insertion due to ease of insertion. The GDG also noted that there was probably no impact on equity, with patient and HCW acceptability and feasibility in favour of upper limb vein use. Lower limb PIVC insertion was considered to be associated with an increased risk of phlebitis and a greater restriction of patient mobility compared to PIVC insertion in the upper limb, thereby affecting both patient and HCW acceptability.

The GDG considered that resources needed for PICC insertion in the upper limb in neonates were likely to be negligible, but cost-effectiveness probably favoured the upper limb over the lower limb veins for PICC insertion. There is probably no impact on equity, with patient and HCW acceptability and feasibility probably in favour of upper limb vein use, even though upper limb PICC insertion can be associated with a limitation of movement by the neonate.

Implementation considerations

- If the lower limb veins are used for PIVC insertion (for example, in an emergency), the PIVC should be removed and replaced with an upper limb catheter as soon as is practicable to avoid the risk of infection.

Research needs

- Research on the clinical situations in which lower limb PIVC insertion is more commonly required may help inform the development of new venous access devices that avoid the need for lower limb use.

3.2.10 Use of occlusive catheter dressings

- **WHO suggests the use of either an occlusive dressing or non-occlusive dressing for PIVCs in adults, adolescents-children and neonates.**
  (Conditional recommendation; low certainty evidence)

Remarks

- The use of occlusive dressings is preferred when suitable occlusive dressings are available.
- Regardless of the dressing type, it is important to ensure that the dressing allows a direct daily inspection of the PIVC insertion site for signs of possible infection.

- **WHO suggests the use of an occlusive dressing for PICCs in adults, adolescents-children and neonates.**
  (Conditional recommendation; very low certainty evidence)

Remarks

- To avoid the risk of local bacterial proliferation, occlusive semi-permeable dressings should be used with caution in patients with large amounts of serous or bloody exudate at the PICC insertion site due to the consequent need for frequent dressing changes. The use of occlusive dressings for PICCs, while suggested, is conditional on the availability of suitable occlusive dressings and the feasibility of implementation based on the local context and appropriate specific usage protocols.
- Occlusive, semi-permeable dressings have the benefits of increased ease and possibility of inspection of the insertion site, patient comfort and reduced nursing workload (due to the longevity of the dressing and ease of inspection).
- In some settings where patients can be managed at home with a PICC, occlusive dressings are a requirement for home-based IV therapy.

Rationale for the recommendation

For the use of occlusive dressings for PIVCs, GDG members considered the desirable effects to be small and undesirable effects trivial. They also considered that there was no important variability in what patients consider the most important outcomes, and that the balance of effects did not favour occlusive over non-occlusive dressings. Instead, the availability of occlusive dressings is considered a key parameter.

For the use of occlusive dressings for PICCs, GDG members considered the desirable effects to be small and undesirable effects trivial. They also considered that there was no important uncertainty or variability in these values and that the balance of effects favoured occlusive over non-occlusive dressings given their location, usual required longevity, and the seriousness of any potential infection.

Summary of the evidence

The literature review identified 17 studies (13 RCTs and four NRSIs) assessing the impact of a catheter secured with an occlusive dressing compared to one secured with a non-occlusive dressing in adults, children-adolescents and neonates *(104-120).* One NRSI focused on a mixed population (neonates and children) *(105)* and two did not report the age group *(110, 120).* Most studies focused on PIVC; one reported on both PIVC and PICC *(106)*. Overall, the studies reported findings on 4822 patients from Australia, Brazil, South Africa, Spain, Switzerland, the United Kingdom of Great Britain and Northern Ireland and the USA. Six RCTs were rated as having some risk of bias concerns *(104, 106, 112, 117-119)* and seven with a high risk of bias *(107-109, 111, 113-115)*. Two NRSIs were rated as having some risk of bias concerns (*105, 110)* and two with a high risk of bias *(116, 120)*.

PIVC: adults

The evidence indicated that an occlusive dressing may result in little to no difference in local infection compared to a non-occlusive dressing (one RCT, 2088 patients; 5.6% versus 4.7%,, respectively: RR [95% CI]: 1.20 [0.83-1.74]; low COE (*114)*). Based on a Bayesian meta-analysis of eight studies (Web Annex), an occlusive dressing may result in little to no difference in phlebitis/thrombophlebitis compared to a non-occlusive dressing (3507 patients; 35.2% versus 33.6%m respectively; RR [95% CI]: 1.05 [0.78-1.46]; low COE) *(106, 108, 109, 111, 114, 115, 118, 119)*. The evidence was very uncertain about the effect of a catheter secured with an occlusive dressing compared to one secured with a non-occlusive dressing on CABSI/CRBSI (two RCTs, 2088 patients; 0% versus 0%; low COE *(107, 114)*). Another RCT reported a similar risk of bacteraemia between groups *(107)*. No study reported on BSI-related mortality, sepsis and all-cause mortality.

PIVC: children and adolescents

The evidence was very uncertain about the effect of a catheter secured with an occlusive dressing compared to one secured with a non-occlusive dressing on phlebitis/thrombophlebitis (one RCT, 150 patients; 2.0% versus 6.0%, respectively; RR [95% CI]: 0.33 [0.04-2.69]; very low COE *(112)*). One cohort study with a focus on a mixed population of neonates and children (407 patients) showed similar proportions of phlebitis between groups at different time points *(105)*. No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PIVC: neonates

The evidence was very uncertain about the effect of a catheter secured with an occlusive dressing compared to one secured with a non-occlusive dressing on sepsis (one RCT, 52 patients; 5.4% versus 3.6%, respectively; RR [95% CI]: 1.50 [0.15-15.28]; very low COE *(104)*) and phlebitis/thrombophlebitis (one RCT, 52 patients; 0% versus 0%; very low COE *(104)*). No study reported on CABSI/CRBSI, BSI-related mortality, local infections and all-cause mortality.

PICC: adults

The evidence was very uncertain about the effect of a catheter secured with an occlusive dressing compared to one secured with a non-occlusive dressing on phlebitis/thrombophlebitis (one RCT, 25 patients; 16.7% versus 6.7%, respectively, RR [95% CI]: 2.17 [0.22-20.94]; very low COE *(106)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

A review of contextual factors/issues suggested that the use of non-occlusive dressings (usually gauze) for PIVCs was cheaper than using occlusive semi-permeable dressings. No studies of relevance were identified for PICCs *(106, 111, 121, 122)*.

Evidence to recommendations: considerations

The GDG members considered resources required for using occlusive dressings for PIVCs to be moderate but, in their opinion, cost-effectiveness probably favours their use over non-occlusive dressings. Equity was considered to vary according to the local health care setting and context, but both patient and HCW acceptability and feasibility probably favour the use of occlusive semi-permeable dressings for PIVCs. Although the use of occlusive dressings has not been shown to affect health outcomes, the ease of PIVC site inspection is considered important, as long as their use does not result in a significant diversion of health resources.

The GDG judged that the resources required for using occlusive dressings for PICCs were moderate, but cost-effectiveness favoured their use over non-occlusive dressings. In fact, in some settings, occlusive semi-permeable dressings are included as part of the PICC insertion pack/kit – hence, in this case, no additional resources are required. Equity was considered to vary according to the local health care setting and context, but patient and HCW acceptability favoured the use of occlusive semi-permeable dressings for PICCs, even though feasibility will vary according to the product used and the local context.

Implementation considerations

- Ensure that the occlusive dressing allows direct inspection of the PICC insertion site given their expected longevity.
- Dressing changes need to be done with care to avoid dislodgement or migration of the PICC.
- In some situations where the catheter insertion site is associated with excessive “ooze”/ haemoserous fluid (for example, coagulopathic patients), a non-occlusive dressing (for example, sterile gauze) may be preferred. Non-occlusive dressings require more frequent dressing changes (for example, every 1-2 days) than occlusive semipermeable dressings, such that this may affect their acceptability by patients and HCWs.
- Due to their adhesive nature, the removal of occlusive dressings may (depending on the product) be associated with more pain and possible skin irritation than non-occlusive dressings.
- Heat and humidity can affect the longevity and usability of some occlusive dressings.

Research needs

- Research on the optimal occlusive semi-permeable dressing for use in all climates would be beneficial, especially for LMICs.
- Research into a standard occlusive semi-permeable dressing product that can be mass produced at low cost would likely provide greater equity, especially for LMICs.
- Research into whether a sterile dressing for PIVCs is routinely required, especially in LMICs.
- Research on the benefits and harms on the use of chlorhexidine-containing dressings for both PICCs and PIVCs.

3.2.11 PIVC insertion by an insertion team

- **WHO suggests that PIVC insertion in adults, adolescents-children and neonates is performed by a clinician who is appropriately trained in PIVC insertion, but may not necessarily be part of a formal insertion team compared to insertion by a formal insertion team.**
  (Conditional recommendation; low certainty evidence)

Remarks

- A formal PIVC insertion team is defined as consisting of individuals specifically trained and competent in PIVC insertion who are dedicated to perform insertion, but not necessarily maintenance or removal of PIVCs.
- A formal PIVC insertion team may be of benefit for patients with difficult IV access or those who have already undergone several unsuccessful PIVC insertion attempts.

Rationale for the recommendation

GDG members considered the use of a formal PIVC insertion team to be associated with moderate desirable effects and only trivial undesirable effects, but they acknowledged that this was based on very low COE. They also considered that there is no important variability in what patients consider the most important outcomes. However, the GDG judged that the crucial factor was the adequate training of the clinician inserting the PIVC, rather than having a dedicated team itself. For this reason, the GDG considered that the balance of effects did not favour a formal PIVC insertion team over insertion by a clinician who is not part of a formal insertion team, provided that the clinician has undergone appropriate training and demonstrated competency in PIVC insertion.

A significant concern regarding the use of formal PIVC insertion teams expressed by the GDG was the potential loss of knowledge and skills in PIVC insertion among non-team staff (doctors and nurses), such that their insertion competency declines. This may be especially impactful in emergency situations where they are required to urgently insert a PIVC without the assistance of a formal PIVC insertion team.

Potential unintended effects of using a formal PIVC insertion team may include lack of accountability of non-team staff to maintain PIVC insertion competency and "ownership", such that this could affect patient outcomes and lead to a reduced focus on the overall quality of PIVC maintenance and access skills.

Summary of the evidence

The literature review identified 12 studies (three RCTs and nine NRSIs) assessing the impact of catheter insertion by an insertion team compared to insertion by an individual not part of a specific insertion team in adults, adolescents, children and neonates *(43, 80, 123-132).* Two studies did not report the age group (*124, 128)*. Nine focused on PIVC *(43, 80, 123, 124, 126, 128-131)* and the remaining three on PICC *(125, 127, 132).* Overall, the studies reported findings on 11 691 patients from Australia, Brazil, China, Italy and the USA. Two RCTs were rated as having some risk of bias concerns *(43, 80)* and one RCT with a high risk of bias *(129)*. Four NRSIs were rated as having some risk of bias concerns *(123, 124, 126, 131)* and five with a high risk of bias *(125, 127, 128, 130, 132)*.

PIVC: adults

The evidence indicated that catheter insertion by insertion teams may reduce CABSI/CRBSI compared to no insertion teams (two RCTs, 875 patients; 0.1% versus 2.2%, respectively; RR [95% CI]: 0.03 [0.00-1.52]; very low COE *(43, 129)*). A before–after study also indicated a benefit of insertion teams (BSI per 1000 patient days: 0.7/1000 with an insertion team, and 1.1/1000 with no insertion team; p <0.01 *(126)*). Also, catheter insertion by insertion teams resulted in little to no difference in phlebitis/thrombophlebitis (moderate COE) *(43, 80, 129)*. Based on a larger study by Wallis et al., the rate of phlebitis was 15.1 per 1000 days with an insertion team and 16.1 per 1000 days without an insertion team (no insertion versus insertion: IRR [95% CI]: 1.06 [0.803-1.37]) *(80)*. According to findings from one RCT (875 patients), catheter insertion by insertion teams may reduce the risk of complications related to catheter insertion (7.8 versus 21.7, respectively; RR [95% CI]: 0.36 [0.24-0.54]; very low COE *(129)*); one before–after study also reported consistent results *(130)*. The evidence was very uncertain about the effect of catheter insertion by insertion teams compared to no insertion teams on sepsis (one before–after study *(130)* 445 patients, age group not reported; 0% versus 0%; very low COE *(130)*) and local infections (one before–after study, 445 patients, age group not reported; 0% versus 0.2%, respectively; very low COE *(130)*). No study reported on BSI-related mortality and all-cause mortality.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter insertion by insertion teams compared to no insertion teams on sepsis (one before–after study, 445 patients, age group not reported; 0% versus 0%; very low COE and local infections (one before–after study, 445 patients, age group not reported; 0% versus 0.2%; very low COE) *(130)*. No study reported on CABSI/CRBSI, BSI-related mortality, all-cause mortality, phlebitis/thrombophlebitis and complications related to insertion.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The evidence indicated that catheter insertion by insertion teams may reduce the risk of CABSI/CRBSI compared to no insertion team (one before–after study, 669 patients; 2.0/1000 catheter line days versus 9.12/1000 catheter line days; very low COE (*127)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality, phlebitis/thrombophlebitis and complications related to catheter insertion.

PICC: neonates

The evidence indicated that catheter insertion by insertion teams may reduce the risk for phlebitis/ thrombophlebitis (two before–after studies; 6% versus 17%, respectively; very low COE *(125, 132)*) and

complications related to catheter insertion (one before–after study, 731 patients; RR [95% CI]: 0.43 [0.29-0.65]; very low COE *(125)*) compared to no insertion team. The evidence was very uncertain about the effect of catheter insertion by insertion teams compared to no insertion team on CABSI/CRBSI (one before–after study, 731 patients; RR [95% CI]: 0.43 [0.08-2.34]; very low COE *(125)*). No study reported on BSI-related mortality, sepsis, local infections and all-cause mortality.

A review of contextual factors/issues suggested that the use of a formal PIVC insertion team was likely to be associated with substantial additional costs, but such teams had high rates of acceptability among patients and some HCWs, depending on resource availability *(42, 126, 133, 134)*.

Evidence to recommendations: considerations

The GDG considered the resources required for a formal PIVC insertion team to be large (even in high-income countries) and that cost-effectiveness probably favoured insertion by a clinician who is not necessarily part of a formal insertion team. In some settings, the resources spent on a formal PIVC insertion team could be offset by possible savings in time by other HCWs involved in patient care.

The GDG considered that equity was probably reduced with a formal PIVC insertion team although both patient and HCWs' acceptability was probably in favour, but feasibility issues probably did not favour a formal PIVC insertion team in most settings.

Implementation considerations

- All individuals inserting PIVCs should be appropriately trained in PIVC insertion, regardless of whether they are a member of a formal PIVC insertion team.
- Insertion and management of PIVCs is primarily the responsibility of the clinicians managing the patient rather than a specific PIVC insertion team.

Research needs

- Further research regarding the potential cost-benefit of using a formal PIVC insertion team would be worthwhile since outcome data such as complication rates (including infection), number of PIVC insertion attempts and patient suffering associated with multiple PIVC insertion attempts are lacking.

3.2.12 Use of local anaesthetic for insertion of PIVCS and PICCS

- **WHO suggests either using or not using local anaesthetic when inserting a PIVC or PICC in adolescents-children and neonates.**
  (Conditional recommendation; low certainty evidence)

Remarks

- "Local anaesthetic" includes topical and injectable products. Although the use of anaesthetics has no benefit to prevent the risk of infection, GDG members suggested its use (especially topical local anaesthetic) to reduce pain and improve patient comfort, especially for children, adolescents and neonates, more so than adults.
- Consider the use of local anaesthetic use, particularly in adolescents, children, and neonates with chronic diseases who require frequent catheter insertions.
- Care should be exercised in some preterm neonates due to potential reactions associated with their fragile immature skin. Therefore, the use of topical local anaesthetic may need to be avoided in this patient population.

Rationale for the recommendation

The GDG considered the use of local anaesthetic for PIVC and PICC insertion to be associated with small desirable and undesirable effects. The GDG judged that there is no important variability in what patients consider the most important outcomes, and that the balance of effects does not favour use of local anaesthetic over non-use in terms of infection risk. However, based on their clinical experience, the GDG members favoured the use of local anaesthetic to reduce pain and improve patient comfort and, potentially, to reduce the number of catheter insertion attempts required.

Summary of the evidence

The literature review identified eight studies (six RCTs and two NRSIs) assessing the impact of catheter insertion using local anaesthetic compared to not using local anaesthetic at the insertion site in children, adolescents and neonates *(135-142)*. One NRSI evaluated a mixed population *(142)*. Six studies focused on PIVCs *(136, 138-142)* and the remaining two on PICC *(135, 137)*. Overall, the studies reported findings on 2436 patients from Australia, Canada, Italy, the United Kingdom of Great Britain and Northern Ireland and the USA. Three RCTs were rated as having a low risk of bias *(135, 137, 141)* and three with some risk of bias concerns *(136, 139, 140)*. All NRSIs were rated as having some risk of bias concerns *(138, 142)*.

PIVC: children and adolescents

Based on a Bayesian meta-analysis of four studies (Web Annex), local anaesthesia results in little to no difference in the number of first successful attempts at catheter insertion compared to no local anaesthesia (920 patients; 88.6% versus 87.7%, respectively; RR [95% CI]: 1.01 [0.81-1.29]; high COE *(136, 139-141)*). One cohort study (1019 patients, mixed population) reported consistent results *(142)*. By contrast, another cohort study (388 patients) reported a higher number of first successful attempts with local anaesthesia *(138)*. No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence indicated that local anaesthesia may result in little to no difference in the number of successful insertions compared to no local anaesthesia (one RCT, 53 participants; 72.9% versus 92.3%, respectively; RR [95% CI]: 0.79 [0.61-1.03]; low COE *(137)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

A review of contextual factors/issues suggested that the use of topical local anaesthetic may be associated with a higher rate of success for PIVC insertion in adolescents and children-and that HCWs report greater job satisfaction if local anaesthetic is available for use, but products with a slow onset of action can be associated with treatment delays and risk of vasoconstriction *(44, 143)*.

Evidence to recommendations: considerations

The GDG members considered that the resources required for local anaesthetic use varied from negligible to moderate according to the clinical setting (country income level; public versus private healthcare setting), with cost-effectiveness considerations not favouring its use over non-use, such that there is probably no impact on equity. Patient and HCWs' acceptability considerations favoured local anaesthetic use, while feasibility issues in most health care settings probably also favour its use.

Although there is no evidence regarding any impact on infection rates, the GDG considered that the use of local anaesthetic is often associated with significant positive impacts in terms of reduced patient suffering and improved patient acceptability and preferences, while its impact on reducing the number of insertion attempts is uncertain.

Implementation considerations

- The catheter insertion site should be adequately cleaned after the application of local anaesthetic and prior to catheter insertion to avoid contamination of the insertion site.
- Consider the time required for the local anaesthetic to take effect as this may potentially delay catheter insertion.
- Health care facilities should consider the feasibility and resources needed for local anaesthetic use and are therefore encouraged to evaluate which subgroups should be prioritized for the use of local anaesthetic in catheter insertions.

Research needs

- Further research to identify the optimal topical local anaesthetics in terms of absorption and drying time would be important to facilitate greater usage feasibility in emergency situations.
- Research regarding patient-related issues (for example, discomfort, pain) related to the use of local anaesthetic would be useful.

3.2.13 Catheter insertion in the scalp compared to a catheter insertion in other sites in neonates

- **WHO suggests that sites other than the scalp veins should generally be prioritized over scalp veins for the insertion of PIVCs and PICCs in neonates.**
  (Conditional recommendation; low certainty evidence)

Remarks

- The recommendation applies when the options of using either a scalp vein or non-scalp vein site for PIVC or PICC insertion are similar.
- The choice of using a scalp vein should take account of local clinical experience in catheter insertion in this site because specific skills are needed.

Rationale for the recommendation

The GDG considered that the use of scalp veins for the insertion of PIVCs and PICCs in neonates is associated with trivial desirable and small undesirable effects, there is no important uncertainty or variability in the values associated with the outcome of interest, and that the balance of effects probably favours the use of non-scalp vein sites for catheter insertion.

The GDG considered that PIVCs inserted into scalp veins were often harder to insert, generally required changing earlier due to instability in the vein, and were at a potentially higher risk of extravasation. Furthermore, the risk of thrombosis for scalp vein PIVCs was considered to be higher, and the consequences of this in a preterm neonate could be important. For PICCs, scalp vein insertion was also often more difficult than using non-scalp vein sites and correct placement of the PICC tip could be difficult due to a higher risk of the catheter entering non-central veins and becoming twisted.

Summary of the evidence

The literature search identified six NRSIs assessing the impact of catheter insertion in the scalp veins compared to catheter insertion anywhere other than the scalp in neonates *(83, 87, 93, 94, 97, 144)*. Most studies evaluated PIVC and one evaluated PICC *(144)*. Overall, the studies reported findings on 2522 patients from Canada, India, Spain and the USA. The majority of studies were rated as having some risk of bias concerns; only one study was rated with a high risk of bias *(144)*.

PIVC: neonates

The literature review did not identify any study reporting on critical outcomes in neonates requiring a PIVC. However, we identified one cohort study (200 patients) reporting on non-critical outcomes *(144).* Evidence indicated a higher incidence of oedema (55% versus 36%, respectively; RR [95% CI]: 1.53 [1.11-2.10]), and a lower incidence of occlusion/obstruction (9% versus 26%, respectively; RR [95% CI]: 0.35 [0.17-0.70]) with catheter insertion in the scalp compared to catheter insertion anywhere other than the scalp. Catheter insertion in the scalp resulted in little to no difference in fluid/blood leakage (12% versus 20%, respectively; RR [95% CI]: 0.60 [0.31-1.16]) and accidental wrenching/removal (13% versus 10% respectively RR [95% CI]: 1.30 [0.60-2.83]) compared to catheters inserted anywhere other than the scalp *(144)*.

PICC: neonates

The evidence indicated that catheter insertion in the scalp may reduce the risk of sepsis compared to catheter insertion anywhere other than the scalp (one cohort study, 123 patients; 2.4% versus 48.8%, respectively; RR [95% CI]: 0.05 [0.01-0.35]; very low COE *(97)*. The evidence was very uncertain about the effect of catheter insertion in the scalp compared to catheter insertion anywhere other than the scalp on CABSI/CRBSI (one cohort study, 140 patients; 0% versus 6.6%, respectively; RR [95% CI]: 0.38 [0.02-6.32]; very low COE *(97)*), local infection (one cohort study, 44 patients; 10.6% versus 16%, respectively; RR [95% CI]: 0.66 [0.13-3.22]; very low COE, *(83)*), all-cause mortality (one cohort study, 689 patients; 13.0% versus 10.2%, RR [95% CI] 1.28 [0.67 to 2.47]; very low COE *(87)*), and phlebitis/thrombophlebitis (four cohort studies, 2460 patients; incidence ranged from 0-16.1% for catheters inserted in the scalp and from 0.3-9.4% for catheters inserted anywhere other than the scalp; very low COE *(87, 93, 94, 97)*). No study reported on BSI-related mortality.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that in terms of resources, there were negligible costs or savings for scalp vein insertion of PIVCs and PICCs with no difference in material costs, and that cost-effectiveness therefore probably does not favour either the use of scalp veins or non-scalp veins for insertion. There is probably no impact on equity using a scalp vein, but scalp vein sites are probably less acceptable to a neonate's parents than non-scalp vein sites. The feasibility of using a scalp vein or non-scalp vein site for catheter insertion, including the number of required insertion attempts, is considered to vary according to the clinical context. It is recognized that inserting a catheter into scalp veins requires special skills and that this might vary by setting, depending on clinical experience.

Implementation considerations

- A peripheral, non-scalp vein site is preferred for the initial insertion of PIVCs and PICCs in neonates.
- Scalp veins should be considered for catheter insertion when other sites are not readily available and there is clinical expertise with placement in the scalp veins.

Research needs

- Further research on the clinical situations (including neonatal age and birth weight) in which scalp veins are used for catheter insertion would be helpful to better define the population at risk and help focus education efforts for clinicians required to insert catheters in neonates.

3.3 Maintenance

3.3.1 Catheter maintenance using formal sterile dressing protocols

- **WHO recommends that for all PIVCs, PICCs and PACS the insertion site should be maintained using a formal sterile dressing protocol in adults, adolescents-children and neonates.**
  (Good practice statement)

The procedure for the aseptic “no-touch” technique for PIVC maintenance and dressing change is detailed in the Glossary.

3.3.2 Catheter management with continuous iv fluid infusions

- **WHO suggests that catheter management of PICCs and PIVCs be with either a schedule of continuous IV fluid infusion or no schedule of continuous IV fluid infusion (intermittent or no infusion) in adults, adolescents-children and neonates.**
  (Conditional recommendation; low certainty evidence)

The procedure for the aseptic "no-touch" technique for PIVC maintenance and dressing change is detailed in the Glossary.

Remarks

- The choice of continuous versus intermittent (or no) infusion will often depend on the requirements of the treatment regimen being administered.
- While neither continuous infusion nor a schedule of intermittent (or no) infusion have been associated with the prevention of PICC or PIVC infection, continuous infusion may have an impact on reducing the risk of non-infection-related PIVC phlebitis, depending on the drugs being administered via the catheter. This factor may be considered in the choice of the intervention.
- PICCs in neonates generally require continuous infusion to maintain catheter function due to the small size of catheters used.
- PACs are always managed with a schedule of continuous fluid infusion; thus, the GDG decided not to discuss PACs in the context of this recommendation.

Rationale for the recommendation

The GDG considered that the use of continuous IV fluid infusion for PICC and PIVC maintenance is associated with trivial desirable and small undesirable effects, there is no important variability in what patients consider the most important outcomes, and the balance of effects does not favour the use of continuous IV fluid infusion over no schedule of continuous IV fluid infusion (intermittent or no infusion) for catheter maintenance.

Summary of the evidence

The literature review identified eight studies (two RCTs and nine NRSIs) assessing the impact of catheter management with continuous IV fluid infusion compared to catheter management without a schedule of continuous IV fluid infusion in adolescents-children and neonates *(88, 145-151)*. No studies were identified evaluating adults. Seven studies focused on PIVC *(88, 145-149, 151)* and one on PAC *(150)*. Overall, the studies reported findings on 1434 patients from Belgium, Brazil, Canada, and other countries and areas. Both RCTs were rated as having some risk of bias concerns *(146, 150)*. Two NRSIs were rated with a high risk of bias *(88, 145),* three as having some concerns *(148, 149, 151)*, and one with a low risk of bias *(147)*.

PIVC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PIVC.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter management with continuous IV fluid infusion compared to catheter management without a schedule of continuous IV fluid infusion on phlebitis/thrombophlebitis (one cohort study, 172 patients; 2.3% versus 3.4%, respectively; RR [95% CI]: 0.68 [0.12-3.98]; very low COE) *(151).* No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: neonates

The evidence indicated that continuous infusion may result in a reduction in sepsis compared with non-continuous infusion (one before–after study, 53 patients; 40.0% versus 67.9%, respectively; RR [95% CI]: 0.59 [0.34-1.02]; very low COE (*147)*). The evidence was very uncertain about the effect of catheter management with continuous IV fluid infusion compared to catheter management without a schedule of continuous IV fluid infusion on phlebitis/thrombophlebitis (one cohort study, 98 patients; 8.3% versus 0%, respectively; RR [95% CI]: 9.37 [0.52-168.57]; very low COE (148)). Two before–after studies reported similar results between groups *(145, 147)*. No study reported on CABSI/CRBSI, BSI-related mortality, local infections and all-cause mortality.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that the resources required for continuous IV fluid infusion maintenance for PIVCs and PICCs are associated with moderate costs, with cost-effectiveness considerations not favouring either continuous infusion or no schedule of continuous IV fluid infusion (intermittent or no infusion) for catheter maintenance. Continuous infusion often requires an electric pump and additional IV fluid, both potentially resulting in added costs. Although there is probably no impact on equity, patient and HCW acceptability and feasibility considerations do not favour continuous infusion maintenance for PICCs and PIVCs. Continuous infusion may limit patient mobility and hence they are likely to prefer intermittent infusion.

Continuous infusion may be associated with an increased risk of patient falls and injury due to entanglement in IV tubing associated with continuous infusion. Continuous infusion may also result in

increased nursing time, including annoyance from beeping of IV pumps commonly used for continuous infusion.

Implementation considerations

- Continuous infusion will generally prompt a more frequent review of IV catheters about whether they continue to be needed and whether they are safe to use.
- If the catheter is to be maintained using a continuous infusion, it should be administered according to a clearly defined protocol.
- Use caution when using a protocol of continuous fluid infusion for catheter maintenance to avoid excessive fluid being administered and resulting in potential volume overloading of the patient.

Research needs

- Further research to identify the optimal means of catheter maintenance using intermittent infusion and the ideal type of infusion fluid would be useful.

3.3.3 Systematic sterile flushing after product administration

- **WHO recommends that after product administration via a PIVC or PICC, the catheter should be flushed with a compatible sterile fluid (saline or other) in adults, adolescents-children and neonates.**
  (Good practice statement)

3.3.4 Saline compared to anticoagulant solutions in "lock-off" flushing of PIVC and PICC

- **WHO suggests 'lock-off" flushing using sterile saline over "lock-off" flushing using heparinised saline for PIVCs and PICCs in adults, adolescents-children and neonates.** (Conditional recommendation; very low certainty evidence)

Remarks

- A key concern regarding the use of heparinised saline for "lock-off" flushing is the potential risk of heparin-induced thrombocytopenia.

Rationale for the recommendation

The GDG considered that the use of sterile saline for "lock-off" flushing of PIVCs and PICCs is associated with moderate desirable effects (especially avoidance of heparin-induced thrombocytopenia) and only trivial undesirable effects, there is probably no important variability in what patients consider the most important outcomes, and the balance of effects probably favours the use of sterile saline over heparinised saline for "lock-off" flushing of catheters.

Summary of the evidence

The literature review identified 32 studies (23 RCTs and nine NRSIs) comparing saline to heparin flushing/locking after product administration in adults, adolescents-children and neonates *(152-183)*. Overall, the studies reported findings on 18 977 patients and/or catheters from Brazil, Canada, China, Hong Kong SAR, Greece, India, Italy, Japan, Lebanon, Netherlands (Kingdom of the), Spain and the USA. Six RCTs were rated as having a high risk of bias *(152, 160, 162, 165, 167, 176)*, 14 as having some risk of bias concerns *(154, 155, 159, 169-171, 173-175, 177, 179, 181-183)*, and two with a low risk of bias *(153, 164).* Six NRSIs were rated as having a high risk of bias *(158, 161, 163, 166, 172, 180)*, two with some concerns *(168, 178),* and one with a low risk of bias *(157)*.

PIVC: adults

Based on a meta-analysis of eight studies (Web Annex), saline flushing/locking likely results in little to no difference in phlebitis/thrombophlebitis in adults compared to heparin flushing/locking (2219 patients; 14.8% versus 13.0%, respectively; RR [95% CI]: 1.14 [0.78-1.66]; moderate COE *(154, 159, 169, 173, 175, 176, 181, 183)*). The evidence potentially suggested also that saline flushing/locking may result in an increase in all-cause mortality compared to heparin flushing/locking (two RCTs, 354 patients; 7.7% versus 2.9%, respectively; RR [95% CI]: 2.68 [0.98-7.27]; low COE *(175, 181)*). The evidence was very uncertain about the effect of saline flushing/locking compared to heparin flushing/locking on CABSI/CRBSI (two RCTs, 354 patients; 0.6% versus 0.0%, respectively; RR [95% CI]: 2.87 [0.12-69.93]; very low COE *(154, 175)*). Another RCT reported no BSI events in both groups, without a clear outcome definition *(181)*. No study reported on BSI-related mortality, sepsis and local infections.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter flushing/locking with saline solution compared to catheter flushing/locking with heparin solution on phlebitis/thrombophlebitis in children and adolescents (two RCTs, 150 patients; 0.5% versus 1.3%, respectively; RR [95% CI]: 0.36 [0.01-8.60]; very low COE (*160, 165)*). A prospective, blinded cohort study rated as having a high risk of bias reported a higher incidence of phlebitis/thrombophlebitis with heparin flushing/locking, but results did not reach statistical significance (21% vs 33%, respectively) (*166)*. No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: neonates

Based on a meta-analysis of three studies (Web Annex), saline flushing/locking may result in little to no difference in phlebitis/thrombophlebitis in neonates compared to heparin flushing/locking (525 patients; 8.0% versus 9.2%, respectively, RR [95% CI]: 0.88 [0.52-1.49]; low COE (*153, 156, 179)*). The evidence was very uncertain about the effect of saline flushing/locking compared to heparin flushing/locking on local infections (one RCT, 331 patients; 0.0% versus 0.0%; RR [95% CI]: not estimable; very low COE *(156)*) and all-cause mortality (one RCT, 88 patients; 0.0% versus 2.4%, respectively; RR [95% CI]: 0.30 [0.01-7.28]; very low COE *(153)*). No study reported on CABSI/CRBSI, BSI-related mortality and sepsis.

PICC: adults

The literature review did not identify any study reporting on critical outcomes in adults requiring a PIVC. However, two RCTs were identified (192 patients) *(155, 167)*, one retrospective cohort study (13 408 patients) *(178)*, and one before-after study (number of patients not reported) *(163)* reporting on non-critical outcomes (occlusion/obstruction). Evidence indicated a similar incidence of occlusion/obstruction (6% vs 0%, RR [95% CI] 7.27 [0.39 to 137.29]) between groups.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC

PICC: neonates

The evidence was very uncertain about the effect of saline flushing/locking compared to heparin flushing/locking on CABSI/CRBSI (one RCT, 133 patients; 1.4% versus 0.0%, RR [95% CI] 2.75 [0.11 to 66.21]; very low COE *(152)*), and sepsis (one RCT, 133 patients; 24.6% versus 17.2%, RR [95% CI] 1.43 [0.73 to 2.82]; very low COE *(152)*). No study reported on BSI-related mortality, local infections, all-cause mortality, and phlebitis/thrombophlebitis.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that in terms of resources, there were moderate savings associated with using sterile saline for “lock off” flushing of PIVCs and PICCs and that cost-effectiveness considerations probably favour its use over heparinised saline. Equity and acceptability are probably increased with

saline use and feasibility is also increased given that sterile saline is generally more readily available and likely to be cheaper than heparinised saline.

The GDG noted that the systematic literature review did not assess for heparin-induced thrombocytopenia as an outcome, yet it may be associated with important clinical morbidity if heparinised saline is used for "lock-off" flushing. It is also noted that among the published studies, there was significant heterogeneity regarding the concentration of heparin used in heparinised saline used for "lock-off" flushing.

Implementation considerations

- Use of multi-use vials of sterile saline and heparinised saline should be avoided due to the risk of potential contamination.

Research needs

- Further research on the rate of heparin-induced thrombocytopenia linked to heparinised saline use in "lock-off" flushing would help to quantify the clinical risk of using this product more accurately.
- Further research may be needed to investigate the comparative impact on mortality between saline and anticoagulant solutions, considering all potential adverse effects, including heparin-induced thrombocytopenia

3.3.5 Catheter management with a schedule of regular changing of administration (tubing/giving) set)

- **WHO suggests having a regular schedule of changing of administration (tubing/giving) sets for PIVC and PICC maintenance in adults, adolescents-children and neonates.**
  (Conditional recommendation; low certainty of evidence)

Remarks

- Sterile technique should be ensured when changing the administration (tubing/giving) set for a PIVC or PICC.

Rationale for the recommendation

The GDG considered that the use of a schedule of regular changing of administration (tubing/giving) sets for PICC maintenance is associated with moderate desirable and trivial undesirable effects, with no important variability in what patients consider the most important outcomes, and that the balance of effects probably favours a schedule of regular changing of an administration (tubing/giving) set over catheter maintenance with no specified schedule of regular changes of administration (tubing/giving) sets for PICC maintenance.

For PIVC, the GDG noted that maintaining the use of a schedule of regular changing of administration (tubing/giving) sets is associated with small desirable and undesirable effects, there is no important uncertainty or variability in values associated with a regular schedule of changing of administration sets, and the balance of effects probably favours a schedule of regular changing of administration (tubing/giving) sets over catheter maintenance with no specified schedule of regular changes of administration (tubing/giving) sets for PIVC maintenance.

Summary of the evidence

The literature review did not identify any eligible study comparing catheter management with a schedule of regular administration (tubing/giving) set changes to catheter maintenance with no specified schedule of regular administration (tubing/giving) set changes in adults, adolescents, children or neonates requiring a PIVC or PICC. Similarly, a review of contextual factors/issues identified no relevant studies.

Evidence to recommendations: considerations

The GDG judged that the use of a schedule of regular changing of administration (tubing/giving) sets for PICCs and PIVC is associated with moderate costs (both material costs and increased nursing time), but cost effectiveness considerations probably favour a schedule of regular changing of administration (tubing/giving) sets. Although there is probably no impact on equity, patient and HCW acceptability and feasibility considerations probably favour a schedule of regular changing of administration (tubing/giving) sets for PICCs and PIVCs. A review of contextual factors/issues identified no relevant studies.

Implementation considerations

- If the PICC or PIVC is being used to administer blood products, lipids or lipid-containing drugs such as propofol, the catheter set should be changed after product administration.
- For PICCs, the administration (tubing/giving) set should be replaced after 96 hours to 7 days' use and at the time of changing a PICC.
- For PIVCs, the administration (tubing/giving) set should be replaced at the time of changing a PIVC, but this should be no longer than after 7 days' use.

Research needs

- Further research to identify the optimal time of regular changing of administration (tubing/giving) sets when using a PIVC would be useful.

3.4 Access

3.4.1 Catheter access using a formal sterile or aseptic protocol

- **WHO recommends using a formal sterile or aseptic protocol to access PIVCs, PICCs and PACs in adults, adolescents-children and neonates.**
  (Good practice statement)

3.4.2 Catheter access using a closed-access hub system

WHO suggests using either a closed-access hub system or an open-access hub system to access PIVCs and PICCs in adults, adolescents-children and neonates.
(Conditional recommendation; low certainty evidence)

Remarks

- *"Closed-access hub systems"* are those that allow intravascular access using a needleless device and are designed to prevent blood leakage and air entry and to reduce the risk of pathogen entry into the device access site.
- *"Open-access hub systems"* are those that are directly accessible using a routine syringe. When accessed, the device is potentially open to the environment and may be associated with blood leakage or an increased risk of pathogen entry if aseptic access protocols are not strictly followed.

Rationale for the recommendation

The GDG considered that the use of a closed-access hub system for PICC and PIVC access is associated with small desirable and trivial undesirable effects, there is no important variability in what patients consider the most important outcomes, and the balance of effects probably favours the use of a closed-access hub system for catheter access. Closed-access hub systems may provide greater safety for HCWs when accessing PICCs and PIVCs as they often use needleless access systems and therefore are less associated with needlestick injuries.

Summary of the evidence

The literature review identified eight studies (five RCTs and three NRSIs) assessing the impact of catheter access using a closed-access device system compared to an open-access system in adults and neonates *(184-191)*. No studies were identified evaluating children and adolescents. Five studies focused on PIVC and three on PICC. Overall, the studies reported findings on 4550 patients and/or catheters from Australia, Indonesia, Italy, Japan, Spain and the USA. Three RCTs were rated as having some risk of bias concerns *(184, 185, 189)* and one with a high risk of bias *(190)*. One RCT was rated as having some risk of bias concerns for the subjective outcomes and a low risk for the objective outcomes *(188)*. Two NRSIs were rated as having a high risk of bias *(186, 191)* and one with some risk of bias concerns *(187)*.

PIVC: adults

The evidence indicated that closed-access device systems non-significantly reduced local infections in adults compared to open-access device systems (two RCTs, 2909 patients; RR [95% CI]: 0.80 [0.35-1.81]; moderate COE *(185, 188)*). Based on a Bayesian meta-analysis of four studies (Web Annex), closed-access device systems probably slightly reduce phlebitis/thrombophlebitis in adults compared to open-access device systems (four RCTs, 3586 patients; 12.3% versus 14.7%, respectively; RR [95% CI]: 0.84 [0.74-1.43]; moderate COE *(184, 185, 188, 190)*). The evidence was very uncertain about the effect of closed-access device systems compared to open-access device systems on CABSI/CRBSI (one RCT, 1710 patients; 0% versus 0%; very low COE *(188)*) and all-cause mortality (one RCT, 1710 patients; 0.2% versus

0.4%, respectively; RR [95% CI]: 0.66 [0.11-3.92]; very low COE *(188)*). No study reported on BSI-related mortality, sepsis and all-cause mortality.

PIVC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PIVC.

PIVC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PIVC.

PICC: adults

The evidence indicated that closed-access device systems may reduce CABSI/CRBSI compared to open-access device systems (one cohort study, 793 patients; 0.3% versus 2.9%, respectively; RR [95% CI]: 0.11 [0.02-0.7]; very low COE *(191)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The evidence indicated that closed-access device systems may reduce sepsis compared to open-access device systems (one RCT, 60 patients; 3.5% versus 26.7%, respectively; RR [95% CI]: 0.13 [0.02-0.94]; very low COE *(189)*). One cohort study reported a similar incidence of sepsis between groups (300 patients; 0.7% versus 0.8%, respectively) *(187)*. The evidence was very uncertain about the effect of closed-access device systems compared to open-access device systems on CABSI/CRBSI (one cohort study, 300 patients; 3.5% versus 26.7%, respectively; RR [95% CI]: 1.21 [0.83-1.26]; very low COE *(187)*). No study reported on BSI-related mortality, local infections, all-cause mortality and phlebitis/thrombophlebitis.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that the resources required for the use of a closed-access hub device system for PICC and PIVC access are associated with moderate costs and cost effectiveness considerations and do not favour the use of a closed-access hub device system over an open-access hub device system. Although the cost of closed-access systems is higher than open-access systems, open-access systems require more frequent replacement.

The GDG noted that although equity is probably reduced with the use of a closed-access hub device system, patient and HCW acceptability and feasibility considerations probably favour the use of a closed-access hub device system for PICCs and PIVCs.

Implementation considerations

- Open-access systems require the access caps to be replaced reliably and in an aseptic manner.
- The procedure for the aseptic "no-touch" technique for PIVC access is detailed in the Glossary.

Research needs

- Further research to identify the most cost-effective design of closed-access hub systems would assist with reducing the purchase and usage costs, especially in LMICs.
- Research on the potential for low-cost, self-disinfecting closed-access systems could be useful.

3.5 Removal

3.5.1 Catheter removal based on defined schedules

- **WHO suggests either the scheduled removal or clinically-indicated removal of PIVCs in adults, adolescents-children and neonates.**
(Conditional recommendation; moderate certainty evidence)

- **WHO recommends inspecting PIVCs in adults, adolescents-children and neonates at least daily to assess for signs of inflammation and infection at the insertion site and vein to guide whether the catheter should be removed.**
(Good practice statement)

Remarks

- The most commonly recommended PIVC removal schedule is to change the PIVC after being in situ for no longer than 72 to 96 hours.
- An assessment for the possible increased risk of PIVC-related complications should be undertaken in all patients (for example, immunocompromised patients and those with conditions known to be associated with an increased risk of staphylococcal colonization and bacteraemia). The GDG suggested that in such patients, scheduled PIVC removal is preferred.
- Signs of inflammation and infection at the catheter insertion site include cutaneous redness, swelling, tenderness and discharge (purulent or non-purulent).

Rationale for the recommendation

The GDG considered that the scheduled removal of PIVCs is associated with small desirable and small undesirable effects, there is no important variability in what patients consider the most important outcomes, and the balance of effects does not favour a scheduled removal over a clinically-indicated removal.

While the GDG noted that the available evidence was rated overall as “moderate” using the GRADE criteria, it was concerned that for the key outcome of catheter-associated bacteraemia, some of the studies were statistically underpowered to adequately measure this important outcome, and any potential bias could not be resolved by undertaking a meta-analysis. Although PIVC-associated bacteraemia is uncommon, the large number of patients worldwide who receive a PIVC as part of their medical care means that the total crude risk of PIVC-associated bacteraemia due to prolonged catheter placement may in fact be high. Thus, the GDG was concerned that many of the published studies on scheduled PIVC removal versus clinically-indicated removal may be statistically unable to accurately assess the infection risk of PIVCs that are in situ for longer than 72 to 96 hours. Some GDG members reported that PIVCs that are in situ for longer than 72-96 hours are more commonly associated with infection (especially Staphylococcus aureus), including PIVC-associated bacteraemia and, for this reason, they strongly favoured the scheduled removal of PIVCs after being in situ for no longer than 72 to 96 hours.

Summary of the evidence

The literature review identified 17 studies (13 RCTs and four NRSIs) assessing the effect of catheter removal based on a defined schedule compared to catheter removal based only on a clinical indication due to a suspected or confirmed complication in adults, adolescents-children and neonates *(192-208)*. Overall, the studies reported findings on 176 542 patients from Australia, Brazil, China, India, Sweden, Switzerland, and other countries and areas. Eight RCTs were rated as having some risk of bias concerns *(192, 194-196, 201, 204, 207, 208)* and one with a high risk of bias *(197)*. Three RCTs were rated as having some risk of bias concerns for the subjective outcomes, but with a low risk for the objective outcomes (*203, 205, 206)*. One RCT was rated as having a high risk of bias for the subjective outcomes and with some concerns for the objective outcomes *(202)*. Three NRSIs were rated as having a high risk of bias *(198-200)*, and one with low risk *(193)*.

PIVC: adults

Based on Bayesian meta-analyses (Web Annex), catheter removal based on a defined schedule likely results in little to no difference in CABSI/CRBSI (six RCTs, 9683 patients; 0% versus 0%; RR [95% CI]: 1.08 [0.31-3.75]; moderate COE *(195, 202, 203, 205, 207, 208)*), local infections (six RCTs, 5804 patients; 0.1% versus 0.1%, respectively; RR [95% CI]: 0.85 [0.28-2.61]; moderate COE *(195, 202, 203, 206-208)*), and phlebitis/thrombophlebitis (10 RCTs, 10 862 patients; 7.9% versus 10.7% respectively; RR [95% CI]: 0.74 [0.49-1.01]; high COE *(192, 195, 197, 201-203, 205-208)*) compared to catheter removal based only on a clinical indication due to a suspected or confirmed complication. Another open-label RCT reported a higher incidence of phlebitis and/or occlusion (combined outcome) for scheduled removal *(204)*. The evidence also indicated that catheter removal based on a defined schedule likely results in little to no difference in all-cause mortality compared to catheter removal based only on clinical relevance (one RCT, 3283 patients; 0.2% versus 0.3%, respectively; RR [95% CI]: 0.94 [0.243.76]; moderate COE *(203)*). No study reported on BSI-related mortality and sepsis.

PIVC: children and adolescents

The evidence was very uncertain about the effect of catheter removal based on a defined schedule compared to catheter removal based only on a clinical indication due to a suspected or confirmed complication on phlebitis/thrombophlebitis (one RCT, 280 patients; 1.4% versus 5.7%, respectively; OR [95% CI]: 0.23 [0.05-1.21]; very low COE *(196)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PIVC: neonates

The evidence was very uncertain about the effect of catheter removal based on a defined schedule compared to catheter removal based only on a clinical indication due to a suspected or confirmed complication on phlebitis/thrombophlebitis (one RCT, 113 patients; hazard ratio [HR] [95% CI]: 1.93 [0.83-4.51]; very low COE *(194)*). No study reported on CABSI/CRBSI, BSI-related mortality, sepsis, local infections and all-cause mortality.

PICC: adults

The literature review did not identify any study reporting on the outcomes of interest in adults requiring a PICC.

PICC: children and adolescents

The literature review did not identify any study reporting on the outcomes of interest in children and adolescents requiring a PICC.

PICC: neonates

The literature review did not identify any study reporting on the outcomes of interest in neonates requiring a PICC.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG discussed that resources required for scheduled PIVC removal are associated with moderate costs and cost effectiveness considerations and probably favour clinically-indicated PIVC removal over scheduled removal. The GDG also noted that scheduled PIVC removal may be associated with an increase in the number of PIVCs used and an increase in HCW time and stress to change each PIVC. Furthermore, in some LMICs, patients may be required to pay for each additional PIVC. Both scheduled PIVC removal and clinically-indicated PIVC removal require additional nursing time to monitor each PIVC regularly and carefully for signs of inflammation and infection.

Scheduled PIVC removal may theoretically result in more veins being cannulated and therefore at risk of damage (although the GDG noted that a number of large studies did not support this concern). This may be particularly important for patients with chronic diseases who may require multiple treatments and hence many PIVCs inserted. Scheduled PIVC removal prior to insertion of a new PIVC poses risks for patients temporarily being without venous access.

The GDG judged that equity is probably reduced with scheduled PIVC removal, but patient and HCW acceptability and feasibility probably favour scheduled PIVC removal. Potential acceptability issues associated with scheduled PIVC removal include the fact that patients may experience pain with each PIVC re-insertion. However, this is balanced by their likely reduced risk of infection compared with prolonged PIVC placement. Patient acceptability might therefore depend on the availability of a PIVC insertion team as PIVC re-insertion is likely to be more efficient with such teams. Potential feasibility issues include the fact that in some situations it may be difficult to obtain a new PIVC for insertion (especially in LMICs) and that in children and neonates, PIVC re-insertion may be more difficult. Some patients may require multiple PIVCs simultaneously (for example, for phlebotomy, medication administration, etc.) and hence a scheduled removal may require multiple PIVC changes in some patients, which may not be clinically feasible.

Implementation considerations

- Daily (at least) inspection of all PIVCs is required (regardless of the planned removal schedule) and patients should be involved in any decision about PIVC removal.
- The decision to use a system of scheduled removal versus clinically-indicated PIVC removal may depend on the clinical context and resources available.
- Clinically-indicated PIVC removal is more commonly utilised in children and neonates due to potentially greater difficulty in catheter insertion.
- Schedule-based PIVC removal is more commonly utilised in intensive care unit patients, especially if they are comatose and less likely to feel insertion-related pain.

- Schedule-based PIVC removal is more likely to result in a more regular HCW assessment of whether IV access is still required and whether oral drug administration could be an appropriate alternative (so-called “IV-to-oral switch”).

Research needs

- Further well-designed research trials (including cluster RCTs or large multicentre cohorts) that are statistically powered to accurately detect serious outcomes such as PIVC-related infection (including bacteraemia) that may be linked to prolonged PIVC placement would be helpful to define the optimal time to consider scheduled PIVC removal or to determine in which situations clinically-indicated removal is safe. These studies should be undertaken in various settings, including LMICs where the availability of PIVCs may be limited.
- Investigating the impact of scheduled PIVC change versus clinically-indicated PIVC change in terms of PIVC infections in LMICs would be helpful, particularly in settings where PIVCs are routinely used as the primary means of IV access.

3.5.2 Catheter removal/replacement within 24 hours if inserted under uncontrolled/emergency conditions

- **WHO suggests the removal/replacement of PIVCs inserted in uncontrolled/emergency conditions as soon as possible in adults, adolescents-children and neonates.** (Conditional recommendation; low certainty evidence)

Remarks

- PIVCs should be removed/replaced within 24 hours of uncontrolled/emergency insertion.

Rationale for the recommendation

The GDG considered that prompt removal of PIVCs inserted under uncontrolled/emergency conditions is associated with moderate desirable effects, including a potential reduction in the risk of PIVC-associated bacteraemia. There are only small undesirable effects, including potential patient pain associated with PIVC re-insertion. However, there is no important variability in what patients consider the most important outcomes, and the balance of effects probably favours early removal/replacement of PIVCs inserted under uncontrolled/emergency conditions.

Since PICCs are always inserted under controlled conditions, this issue is not relevant to PICCs.

Summary of the evidence

The literature review did not identify any eligible study comparing catheter removal within 24 hours if inserted under emergency conditions to no catheter removal within 24 hours if inserted under emergency conditions in adults, adolescents-children or neonates requiring a PIVC. Similarly, no studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that resources required for the prompt removal/replacement of PIVCs inserted under uncontrolled/emergency conditions are associated with moderate costs, including an increased number of PIVCs used and increased clinician time to change the PIVC. However, the GDG judged that cost-effectiveness considerations probably favour prompt removal/replacement. Equity is probably increased with early removal/replacement and patient and HCW acceptability and feasibility is probably in favour of prompt removal/replacement of PIVCs inserted under uncontrolled/emergency conditions.

Implementation considerations

- When removing/replacing a PIVC inserted under uncontrolled/emergency conditions, consider whether a PIVC is still required for intravenous access.
- If a PIVC is still required, ensure that the new PIVC is inserted prior to removal of the PIVC that was inserted under uncontrolled/emergency conditions to ensure that intravascular access is maintained.
- Regularly assess all PIVCs for signs of inflammation and infection at the insertion site.

Research needs

- Further research on the optimal time for removal/replacement of PIVCs inserted under uncontrolled/emergency conditions (for example, within 8, 12, 24 hours) would assist with the development of clear universal PIVC management protocols.
- Further research is needed to better define "uncontrolled/emergency conditions" (for instance, is the risk associated with a PIVC inserted in the emergency department the same as with a PIVC inserted by an ambulance officer at the site of an accident?).

3.6 Catheter selection

3.6.1 Use of single-lumen PICCS compared to multi-lumen PICCS

- **WHO suggests using single-lumen PICCs over using multi-lumen PICCs (unless there is a specific reason that requires multiple lumens) in adults, adolescents-children and neonates.**
  (Conditional recommendation; low certainty evidence)

Remarks

- Single-lumen PICCs appear to be safer in terms of catheter-associated infections and risk of lumen thrombosis; hence, the decision about whether to use a multi-lumen PICC over a single-lumen PICC should be made solely on the clinical need for multiple catheter lumens.

Rationale for the recommendation

The GDG considered that the use of a single-lumen PICC is associated with small desirable and trivial undesirable effects, there is no important uncertainty or variability in the values associated with the outcome of interest and the balance of effects probably favours the use of a single-lumen PICC over a multi-lumen PICC.

Summary of the evidence

The literature review identified nine NRSIs assessing the impact of catheter access using a single-lumen catheter compared to a multi-lumen catheter in adults and neonates *(28, 79, 209-214)*. One study did not report the age group *(209)*. We did not identify any study evaluating children and adolescents. Overall, we report findings on 15 930 patients from Brazil, Canada, China, Japan and the USA. Six studies were rated as having some risk of bias concerns *(28, 79, 209, 210, 212, 214)* and two with a high risk of bias *(211, 213)*.

PICC: adults

The evidence indicated that single-lumen catheters may reduce CABSI/CRBSI (one cohort study, 12 725 patients; 3% versus 7%, respectively; OR [95% CI]: 2.08 [1.62-2.67]; very low COE *(214)*) and local infections (one cohort study, 187 patients; 5.0% versus 14.7%, respectively; RR [95% CI]: 0.34 [0.14-0.95]; very low COE *(212)*) compared to multi-lumen catheters. One cohort study reported no events in both groups *(79)*. Another case-control study (646 patients) reported a higher incidence of CABSI/CRBSI with single-lumen catheters *(209)*. One cohort study reported a higher incidence of CABSI/CRBSI with single-lumen catheters, but did not mention the participants' age group *(209)*. No study reported on BSI-related mortality, sepsis, all-cause mortality and phlebitis/thrombophlebitis.

PICC: children and adolescents

No studies reporting on the outcomes of interest in children and adolescents requiring a PICC was identified.

PICC: neonates

The evidence indicated that single-lumen catheters may reduce CABSI/CRBSI compared to multi-lumen catheters (one cohort study, 2383 patients; adjusted HR [aHR; 95% CI]: 0.39 [0.13-1.16]; very low COE *(28)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and phlebitis/thrombophlebitis.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that the resources required for the use of a single-lumen PICC over a multi-lumen PICC are associated with moderate savings and cost effectiveness considerations and probably favour the use of single-lumen PICCs. Equity is probably increased with the use of single-lumen PICCs, patient and HCW acceptability is probably increased, and feasibility is likely to be increased with the use of single-lumen PICCs over multi-lumen PICCs.

Implementation considerations

- If a multi-lumen PICC is required, HCWs should have received training in the appropriate sterile/aseptic protocols to maintain and access a multi-lumen intravascular catheter, given their higher risk of thrombosis due to the small diameter of the lumen.

Research needs

- Further research on the situations in which multi-lumen PICCs are clinically required would assist in resource planning and the development of clinical PICC usage protocols.
- Further research on both the infectious and non-infectious complications associated with the vein, notably, the catheter diameter ratio (rather than the number of PICC lumens) would be worthwhile.
- Research on the respective advantages of multi-lumen PICCs versus multi-lumen CVCs would be helpful.

3.6.2 PICC versus MVC

● **WHO suggests the use of either a PICC or midline vascular catheter (MVC) in adults, adolescents and children requiring longer term intravenous access.**
(Conditional recommendation, very low certainty evidence)

Remarks

- The choice of a PICC versus MVC will depend on how prolonged the expected duration of IV therapy is likely to be, with MVCs usually used for periods of <14 days, whereas PICCs generally can remain in situ for much longer durations.
- The nature of the intended therapy (for example, antibiotics, chemotherapy, total parenteral nutrition), especially its likely venous toxicity/irritation, may influence the catheter choice as more vein-damaging agents generally require a PICC to allow for more central drug delivery.
- Availability of appropriately staff trained to insert the respective catheters will influence the choice, including in some cases, the availability of radiology resources for PICC insertion or the assessment of accurate catheter tip placement.

Rationale for the recommendation

The GDG considered that both the desirable and undesirable effects of using a PICC versus a MVC vary depending on what specific agent is being administered (antibiotic type, chemotherapy) and the duration of administration. There is probably no important variability in what patients consider the most important outcomes, but the balance of effects also therefore varies according to the context of the PICC versus MVC use.

Summary of the evidence

The literature review identified 11 studies (two RCTs and nine NRSIs) comparing PICCs to MVCs in adults, children and adolescents. We did not identify any study evaluating neonates *(215-225).* Overall, we report findings on 12 424 patients and/or catheters from Australia, China, Italy, the United Kingdom of Great Britain and Northern Ireland and the USA. Both RCTs were rated as having some risk of bias concerns *(217, 219)*. Four NRSIs were rated with a high risk of bias *(218, 220, 224, 225)* and five as having some concerns *(215, 216, 221-223)*.

PICC versus MVC: adults

The evidence indicated that PICCs may increase the risk of complications related to intravascular catheter insertion compared to MVCs (three cohort studies, 3971 patients; incidence ranged between 7% and 27% for PICC and between 4% and 20% for MVC; very low COE *(221, 223-225)*). The evidence was very uncertain about the effect of PICCs compared to MVCs on CABSI/CRBSI (five cohort studies, 7253 patients; incidence ranged between 0% and 3% for PICC and between 0% and 1% for MVC; very low COE *(220)*), local infections (one cohort study, 900 patients; 2.9%% versus 2.4%, respectively; RR [95% CI]: 1.23 [0.55-2.74]; very low COE *(220, 225)*), all-cause mortality (two cohort studies, 1255 patients; incidence ranged between 5% and 9% for PICC and between 9% and 13% for MVC; very low COE *(222, 224, 225)*), and phlebitis/thrombophlebitis (three cohort studies, 1331 patients; incidence ranged

between 0% and 2% for PICC and between 0.7% and 4% for MVC; very low COE *(217)*). In addition, one open-label RCT (58 patients) reported no CABSI/CRBSI events *(215)*. One observational study (691 patients) reported similar results for a composite outcome of suspected local and BSI in adults *(219)*. No study reported on BSI-related mortality and sepsis.

PICC versus MVC: children and adolescents

The evidence was very uncertain about the effect of PICCs compared to MVCs on CABSI/CRBSI (one RCT, 91 patients; 0% versus 0%; very low COE *(219)*) and phlebitis/thrombophlebitis (one RCT, 91; 0% versus 2.4%, respectively; RR [95% CI]: 0.29 [0.01-6.85]; very low COE *(219)*). No study reported on BSI-related mortality, sepsis, local infections, all-cause mortality and complications related to insertion.

PICC versus MVC: neonates

No studies reporting on the outcomes of interest in neonates requiring a PICC compared to an MVC were identified.

No studies on contextual factors were identified following a formal literature review.

Evidence to recommendations: considerations

The GDG considered that in terms of resources there may be moderate costs associated with the use of a PICC versus a MVC depending on the catheter's intended use and likely duration of use. Consequently, cost-effectiveness is likely to vary depending on the clinical context. Equity is probably reduced with PICC use, but acceptability among patients is probably greater for PICCs. Feasibility is likely to vary depending on the clinical context.

The GDG noted that the availability of PICCs versus MVCs is likely to vary and that this may impact on local costs. The insertion of PICCs is considered to potentially require more clinical training than for MVCs and this may impact on equity and feasibility in some settings. However, as PICCs generally allow for a longer duration of IV access than MVCs, this may be a clinical advantage, depending on the intended catheter use. Neither catheter type is readily available in many LMICs.

Implementation considerations

- In regions where MVCs are readily available, they are more commonly chosen over PICCs when the expected duration of required IVs access is likely not to be prolonged (typically less than 14 days), but for situations where greater than 14 days access is required, a PICC is generally used.

Research needs

- Further research on the optimal situations in which an MVC is preferred over a PICC would assist with the development of clear universal MVC and PICC management protocols.
- Research into those circumstances where MVCs may be preferred to PIVCs may be useful.
- In situations in which both catheters could be used, further evidence to determine whether MVCs vs, PICCs may reduce infectious and non-infectious complications could be worthwhile.

Precious, 10, is treated for malaria and symptoms of what appears to be yellow fever at the central hospital in Owa-Alero [Nigeria].
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4

Implementation through care bundles and the WHO multimodal improvement strategy

Implementation through care bundles and the who multimodal improvement strategy

4.1 Introduction

According to a range of WHO guidance documents *(19, 226-228)*, the use of care bundles and multimodal improvement strategies (MMIS) are effective approaches to implement IPC interventions. However, these are not synonymous and the following clear definitions have been adopted or created by WHO.

Care bundles are a set of evidence-based, patient-focused practices or interventions (generally three to five) that aim to improve patient outcomes when done collectively and reliably. They can also be a tool to guide the delivery of a specific aspect of a patient's care where the aim is to improve the care process and patient outcomes in a structured manner or sequence, with the expectation that the impact will be greater than single interventions alone *(226)*.

MMIS are a means of improving the implementation of interventions to achieve the required system, institutional climate and behavioural changes for measurable outcome improvement from the intervention(s). In general, MMIS include tools, such as bundles and checklists, developed by multidisciplinary teams that consider local conditions. Multimodal thinking means that practitioners do not focus only on single strategies to change practices (for example, training and education), but consider a range of strategies that target different influencers of human behaviour. MMIS typically contains five key components: system change ("*Build it*"); training and education (*"Teach it"*); monitoring and feedback (*"Check it"*); reminders and communication (*"Sell it"*); and culture change ("*Live it*") (*226, 228)*. All five elements are considered important and should be based on the local health context and situation, informed by periodic assessments.

4.2 Evidence on care bundles and MMIS for PIVCS and PICCS

The literature review performed for these guidelines identified 41 studies including a bundle as part of the intervention to reduce BSIs and other infections associated with PIVCs *(27, 229-268)* and 25 related to PICCs *(35, 269-292)*. These were reviewed in detail by expert members of the GDG and the WHO Secretariat for relevance and appropriateness. Based on this review, 11 PIVC studies *(27, 237, 238, 240, 251, 252, 256, 258, 260, 261, 267)* and five PICC studies *(273, 278, 284, 285, 287)* were excluded due to lack of relevance, resulting in the analyses of 30 PIVC and 20 PICC studies for specific components of the bundles and whether a MMIS was used for implementation.

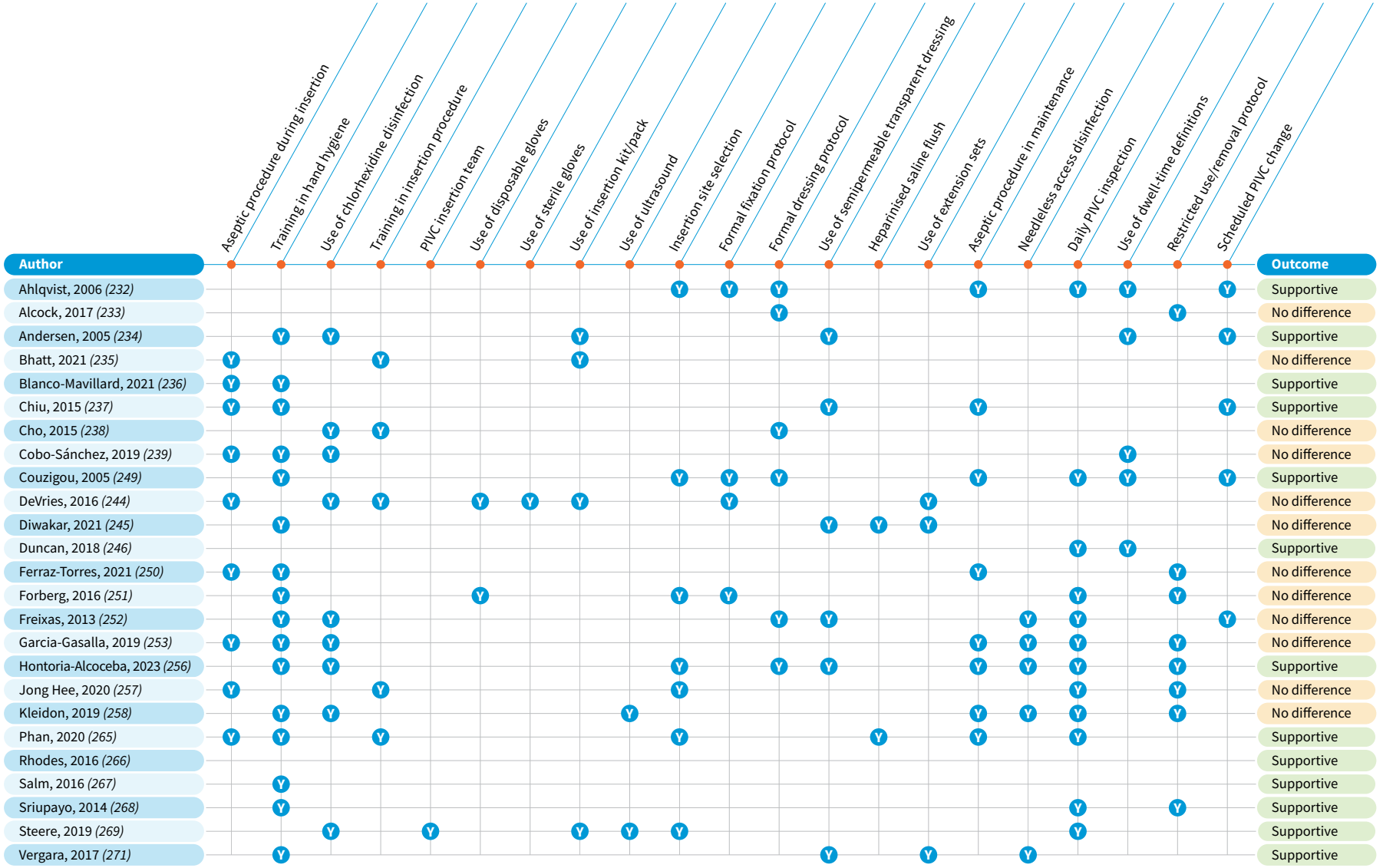
The GDG reviewed these studies and noted the following overall issues:

1. there was marked heterogeneity among the various studies, including major differences in trial design, patient populations assessed, and the interventions included (and excluded);
2. this heterogeneity meant that no specific intervention bundle could be formally recommended;
3. overall, most bundle studies supported the concept that bundle interventions were worthwhile, effective and a practical means of implementing several interventions together;
4. no conclusion could be made about whether bundle interventions were certain to be superior to individual interventions, but the GDG considered this to be likely.

For the 30 PIVC studies *(229-236, 239, 241-250, 253-255, 257, 259, 263-266, 268)*, 18 involved adults *(229, 232-234, 236, 243-247, 249, 250, 253, 254, 257, 259, 266, 268)*, five involved children *(235, 242, 248, 255, 265)*, and four involved neonates *(230, 231, 262, 264)*; in three studies, the population was not mentioned *(239, 241, 263)*. Sixteen (53%) studies *(229, 231, 233, 234, 243, 244, 246, 253, 257, 259, 262-266, 268)* reported a statistically significant benefit from using a bundle approach compared to "routine practice", while no studies suggested that a bundle intervention was inferior to single intervention implementation. All 16 studies appeared to use a multimodal strategy for implementation (see Table 4.2.1 for a summary).

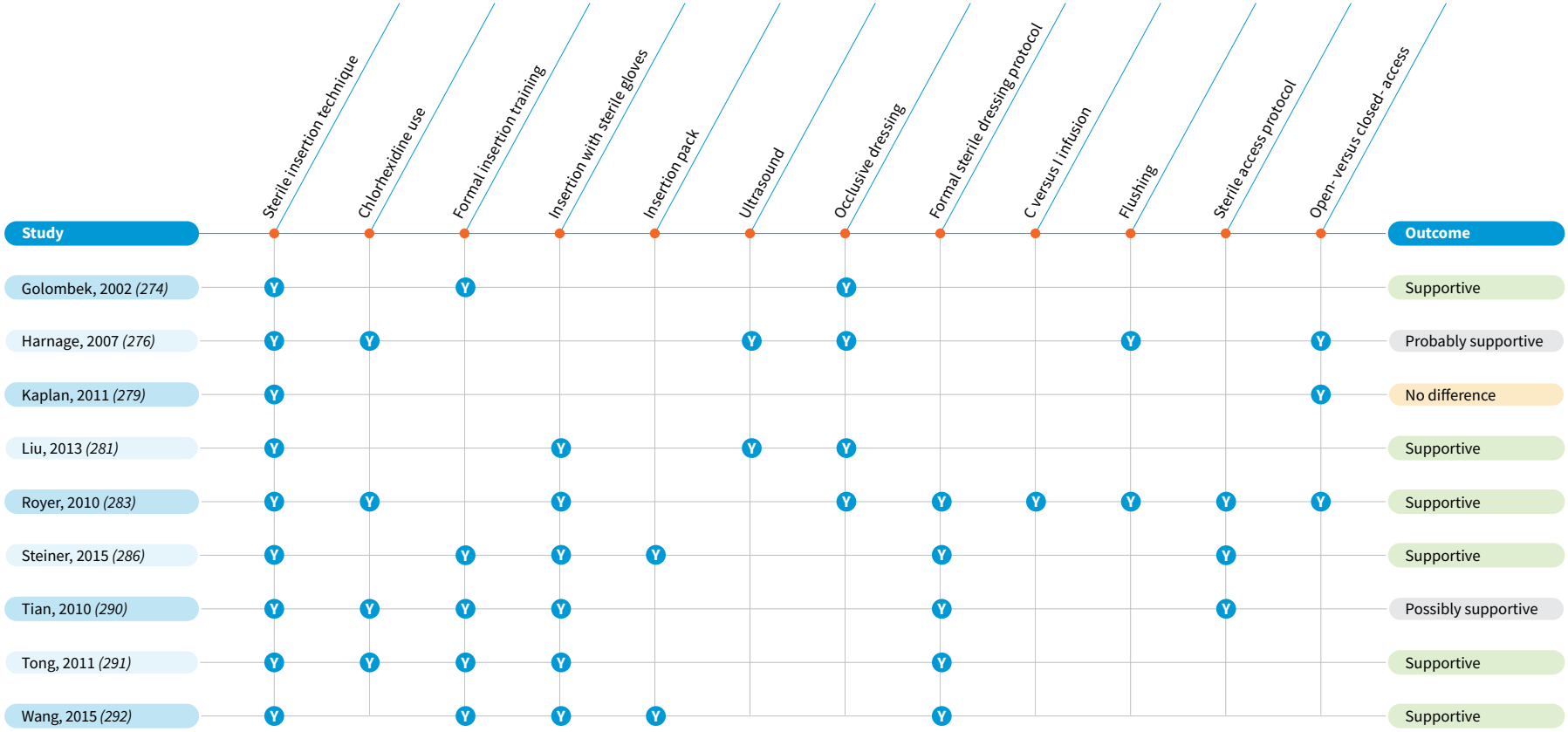
For the 20 PICC studies *(35, 269-272, 274-277, 279-283, 286, 288-292)*, seven involved adults *(275, 277, 280, 281, 289, 290, 293)*, one involved adults and children *(291),* and 10 involved neonates *(270-272, 274, 279, 282, 286, 288, 292, 294);* in two studies, the population was not stated *(276, 295)*. Fourteen (70%) studies reported that the bundle was effective *(269, 270, 272, 274, 275, 277, 281-283, 286, 288, 290, 292, 293),* three were probably supportive (but some key details were lacking) *(276, 280, 291)*, and the remaining three reported no difference between the bundle intervention and the comparator (although all three studies were statistically underpowered) *(271, 279, 289)*. Almost all studies were complicated by multiple potential confounders. Of the 20 studies, 14 appeared to use a multimodal strategy for implementation, although frequently this was not clearly stated *(269, 270, 272, 274, 275, 277, 281-283, 286, 288, 290, 292, 293).* Table 4.2.2 provides a summary of PICC bundle studies that included a sterile insertion technique as a key intervention element together with a range of other elements as an example of the significant heterogeneity in study design.

Table 4.2.1.
Summary of 25 PIVC bundle studies which included some form of aseptic technique for either insertion, access or maintenance of PIVCs, and assessed multiple interventions.



Abbreviations: PIVC, peripheral intravenous catheter; Y, yes.
Note: The table summarizes which interventions (other than the aseptic technique) were assessed in each study and whether the findings were supportive of the proposed WHO guideline recommendations for the bundle of interventions cited.

Table 4.2.2.
Summary of PICC bundle studies that included a sterile insertion technique as a key intervention element, together with a range of other elements



Abbreviations: PICC, peripherally-inserted central catheter; Y, yes; C versus I, continuous versus intermittent.

4.3 WHO recommendations on MMIS

WHO considers the use of MMIS as the most effective way to implement IPC interventions. This is based on the initial development of the WHO hand hygiene MMIS, which was shown to be highly effective in various studies *(26, 226, 296-299)*.

This concept was extended to any intervention aimed at improving IPC practices when WHO developed the guidelines on core components for IPC programmes *(19)*, among which MMIS is core component 5 *(227)*. Within these evidence-based guidelines, two strong recommendations are included (Table 4.3.1), for which the evidence represented the highest number of studies of the entire guideline.

Table 4.3.1. WHO evidence-based recommendations on MMIS for IPC interventions

CORE COMPONENT 5:	NATIONAL LEVEL	FACILITY LEVEL
CORE COMPONENT RECOMMENDATION	The panel recommends that national IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies on a nationwide or sub-national level.	The panel recommends that IPC activities using multimodal strategies should be implemented to improve practices and reduce HAI and AMR.

Core Component 5: Both at national and facility levels, IPC activities should be implemented using multimodal strategies.
Abbreviations: IPC, infection prevention and control; HAI, health care-associated infection; AMR, antimicrobial resistance.
Source: Minimum requirements for infection prevention and control programmes. Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/330080, accessed 27 December 2023).

As an example, the application of the concept of MMIS was extended by WHO to the implementation of the global guidelines for the prevention of surgical site infection *(300)*, based on evidence appraised and discussed in the document entitled "Preventing surgical site infections: implementation approaches for evidence-based recommendations" *(301)*. The "Implementation manual to support the prevention of surgical site infections at the facility level: turning recommendations into practice"*(302)* includes the application of the WHO MMIS to all WHO recommendations for surgical site infection prevention.

In 2019, WHO further issued guidance on the minimum requirements for IPC programmes at the national and facility level *(303)*, which were derived from the core components' recommendations, including the minimum requirements for core component 5 (Table 4.3.2).

Implementation of the IPC interventions should always be tackled using a stepwise approach, including a careful assessment of the status of the IPC practices and local activities related to the intervention to be improved. To undertake this process, WHO proposes a five-step cycle of implementation to support the management and planning of any IPC improvement intervention or programme, based on implementation and quality improvement science *(226, 228)*. Each step is relevant to the process of improvement and the cycle should be continuously used and refreshed for several years for each IPC intervention in order to ensure maximum impact and sustainability.

The GDG advises that the MMIS approach and five-step cycle could be used also for the implementation of this guideline. In particular, a country or a health care facility should evaluate local guidelines and/or standard operating procedures for the prevention of BSI and other infections associated with peripheral catheters and determine whether any update is needed by exploring their alignment with this WHO guideline. Furthermore, local practices should be assessed to identify the most common gaps and thus enable development of improvement plans including interventions, based upon the relevant recommendations and/or good practice statements of this guideline.

Table 4.3.2. Minimum requirements for IPC programmes at the national and facility level related to the implementation of multimodal improvement strategies

Level	Minimum requirement
National	• ***Use of multimodal strategies*** to implement IPC interventions under the coordination of the national IPC team.
Primary care facilities	• ***Use of multimodal strategies*** **– at the very least** to implement interventions to improve **hand hygiene, safe injection practices, decontamination** of medical instruments and devices and **environmental cleaning.**
Secondary care facilities	• ***Use of multimodal strategies*** **– at the very least** to implement interventions to improve **standard and transmission-based precautions and triage.**
Tertiary care facilities	• ***Use of multimodal strategies*** to implement interventions to improve **standard and transmission-based precautions, triage,** and those targeted at the **reduction of specific infections in high-risk areas/patient** groups, in line with local priorities.

Abbreviation: IPC, infection prevention and control.
Source: Minimum requirements for infection prevention and control programmes. Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/330080, accessed 27 December 2023).

Trecia Simone Stewart, 41, a certified emergency nurse assists Dr Nashoni Mitchell with a patient who is in distress at the Spanish Town Hospital [Jamaica].
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5

Research needs

5. Research needs

While PIVCs are one of the most commonly used devices in health care worldwide, there remain many issues regarding their safe use that require clarification and research. Similarly, the availability of PICCs and MVCs where they are inserted peripherally, but the tip of the catheter is located more centrally than a PIVC, has major potential advantages in terms of delivering some therapies. However, they may also be associated with a potential increased risk of bacteraemia if catheter-associated infection occurs. Thus, further research into how to insert, maintain, access and remove these intravascular catheters safely in a variety of health care settings is crucial. Following extensive discussion regarding these issues, GDG members suggested several key research areas that should be pursued to improve the practicality and safety of using PIVCs, PICCs and MCVs in health care worldwide. Table 5.1 provides a summary of gaps in the scientific evidence on the prevention of BSIs and other infections associated with peripheral catheters, which could guide future research.

Table 5.1. Summary of research gaps on the prevention of BSIs and other infections associated with peripheral catheters

Domain	Research gaps
Insertion	
Sterile and *aseptic "no-touch" insertion* technique	• Research on lower cost alternatives to using *sterile barrier precautions* for PICC and PAC insertion in LMICs could be helpful. • Research on the adherence to an *aseptic "no-touch" technique* for PIVC insertion in various clinical settings would be worthwhile as it could identify situations in which the risk of PIVC infection may be greater and require special considerations when inserting a PIVC under these circumstances. • Research to better define the size of the drape needed and whether clinicians need to wear a mask during PIVC insertion would be useful. • Research on the use of an aseptic "no-touch" technique for PIVC insertion, including both desirable and undesirable effects.
Chlorhexidine-containing skin disinfection preparations	• Several of the studies of chlorhexidine-containing skin disinfection products had different comparator non-chlorhexidine-containing skin disinfection products and the actual benefit (or not) of chlorhexidine-containing skin disinfection products was difficult to assess accurately. Therefore, standardization of the comparator disinfection product in future research on chlorhexidine-containing skin disinfection products would be worthwhile.
Formal training on catheter insertion	• Research into the optimal, most time-efficient method of catheter insertion training (including skill retention), particularly for low-resource settings where HCW numbers may be limited. • Further research on the most effective methods to maintain catheter insertion competency would be useful.
Catheter insertion by a clinician wearing single-use gloves	• Research on the optimal cost-effective material from which to make single-use gloves to maximize tactile agility and reduce a potential allergy risk for HCWs would be beneficial.
Catheter insertion by an individual wearing single-use sterile gloves	• Research aiming to increase the development and availability of affordable single-use sterile gloves with good tactile agility features would be of major benefit as many of the cost concerns of currently available sterile gloves could be lessened, such that equity, acceptability and feasibility concerns, especially in LMICs, would be alleviated. • Research regarding the frequency of accurate adherence to an *aseptic "no-touch" technique* for PIVC insertion in various clinical settings would be worthwhile as it could identify situations in which the risk of PIVC infection using non-sterile, single-use gloves may be greater and the use of sterile gloves prioritized.

Domain	Research gaps
Insertion	
	• Research on the impact of glove-wearing on the number of catheter insertion attempts and any subsequent impact on both infection risk and potential patient suffering should be undertaken in various types of health care settings.
Catheter insertion using a standardized insertion pack/kit	• Research on the optimal, standardized PIVC insertion pack/kit that is suitable for use by clinicians in a wide variety of health settings could have major benefits in streamlining mass production and therefore improving availability and cost-effectiveness in many health settings, especially in LMICs.
Catheter insertion using ultrasound-guided assistance	• Research on the optimal teaching methods for ultrasound use (including standardized cleaning methods) would be useful.
Catheter insertion in the distal section of the upper limb (below the cubital fossa) compared to insertion in the proximal section of the upper limb (cubital fossa or above)	• Research on the optimal distal arm site for PIVC insertion considering key patient factors would be useful, such as the insertion risk (for example, insertion under emergency conditions) and pain, mobility and ease of self-care, need for PIVC stabilization, and the drug-related phlebitis risk.
Catheter insertion in the upper limb compared to insertion in the lower limb	• Research on the clinical situations in which lower limb PIVC insertion is more commonly required may help inform the development of new venous access devices that avoid the need for lower limb use.
Use of occlusive catheter dressing	• Research on the optimal occlusive semi-permeable dressing for use in all climates would be beneficial, especially for LMICs. • Research into a standard occlusive semi-permeable dressing product that can be mass produced at low cost would likely provide greater equity, especially for LMICs. • Research into whether a sterile dressing for PIVCs is routinely required, especially in LMICs • Research on the benefits and harms on the use of chlorhexidine-containing dressings for both PICCs and PIVCs.
PIVC insertion by an insertion team	• Further research regarding the potential cost-benefit of using a formal PIVC insertion team would be worthwhile since outcome data such as complication rates (including infection), number of PIVC insertion attempts and patient suffering associated with multiple PIVC insertion attempts are lacking.
Use of local anaesthetic for the insertion of PIVCs and PICCs	• Further research to identify the optimal topical local anaesthetics in terms of absorption and drying time would be important to facilitate greater usage feasibility in emergency situations. • Research regarding patient-related issues (for example, discomfort, pain) related to the use of local anaesthetic would be useful.
Maintenance	
Catheter management with continuous IV fluid infusion	• Further research to identify the optimal means of catheter maintenance using intermittent infusion and the ideal type of infusion fluid would be useful.
Saline compared to anticoagulant solutions in "lock-off" flushing of PIVC and PICC	• Further research on the rate of heparin-induced thrombocytopenia linked to heparinised saline use in “lock off” flushing would help to quantify the clinical risk of using this product more accurately. • Further research may be needed to investigate the comparative impact on mortality between saline and anticoagulant solutions, considering all potential adverse effects, including heparin-induced thrombocytopenia.
Catheter management with a schedule of regular changing of administration (tubing/giving) set	• Further research to identify the optimal time of regular changing of administration (tubing/giving) sets when using a PIVC would be useful.

Domain	Research gaps
Access	
Catheter access using a closed-access hub system	• Further research to identify the most cost-effective design of closed-access hub systems would assist with reducing the purchase and usage costs, especially in LMICs. • Research on the potential for low-cost, self-disinfecting closed-access systems could be useful.
Removal	
Catheter removal based on defined schedules	• Further well-designed research trials (including cluster RCTs or large multicentre cohorts) that are statistically powered to accurately detect serious outcomes such as PIVC-related infection (including bacteraemia) that may be linked to prolonged PIVC placement would be helpful to define the optimal time to consider scheduled PIVC removal, or which situations clinically-indicated removal is safe. These studies should be undertaken in various settings, including LMICs where the availability of PIVCs may be limited. • Investigate the impact of scheduled PIVC change versus clinically-indicated PIVC change in terms of PIVC infections in LMICs where PIVCs are routinely used as the primary means of IV access.
Catheter removal/replacement within 24 hours if inserted under uncontrolled/ emergency conditions	• Further research on the optimal time for removal/replacement of PIVCs inserted under uncontrolled/emergency conditions (for example, within, 8, 12, 24 hours) would assist with the development of clear universal PIVC management protocols. • Further research needs to better define “uncontrolled/emergency” conditions (for example, does a PIVC placed in a hospital emergency department carry the same risk as one placed in the field by an ambulance staff member?).
Catheter selection	
Use of single lumen PICCS compared to multi-lumen PICCS	• Further research on the situations in which multi-lumen PICCs are clinically required would assist in resource planning and the development of clinical PICC usage protocols. • Further research on both the infectious and non-infectious complications associated with the vein:catheter diameter ratio (rather than the number of PICC lumens) would be worthwhile. • Research on the respective advantages of multi-lumen PICCS versus multi-lumen central venous catheters would be helpful.
PICC versus MCV and drug administration	• Further research on the optimal situations in which an MCV is preferred over a PICC would assist with the development of clear universal MCV and PICC management protocols. • Research into those circumstances where MCVs may be preferred to PIVCs may be useful. • In situations in which both catheters could be used, further evidence to determine whether MCVs versus PICCs may reduce infectious and non-infectious complications could be worthwhile.

Abbreviations: PICC, peripherally-inserted central catheter; PAC, peripheral arterial catheter; LMIC, low- and middle-income countries; PIVC, peripheral intravenous catheter; HCW, health and care worker, IV, intravenous; RCT, randomized controlled trial; MCV, midline vascular catheter.

Epidemiologist B. Gnoevoi cleans his hands using alcohol-based handrub in the Diagnostic Laboratory at "Dnipropetrovsk Regional Clinical Hospital Named After I.I. Mechnikov."

Gnoevoi underwent WHO training on antimicrobial resistance in late 2022. After the training he helped implement changes and organize an infection control department at Mechnikov Hospital [Ukraine].
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6

Monitoring and evaluating the impact of the guideline

6. Monitoring and evaluating the impact of the guideline

Since peripherally inserted intravascular catheters are one of the frequent invasive health care devices used worldwide, any complications potentially linked to their use should ideally be routinely monitored, recorded and the results fed back to clinicians to improve the safety of their use. Monitoring, evaluation and feedback is a key element for the success of the WHO MMIS (see chapter 4). Furthermore, WHO recommends using a stepwise cycle to implement any IPC intervention or project as assessment steps at the baseline are critical for evaluating impact and planning sustainability. Therefore, interventions aimed at improving practices related to the use of peripherally- inserted intravascular catheters should include steps focusing on this critical element *(301).*

Monitoring of the impact of these guidelines should be considered using the following approaches.

1. Measure clinician education, training and competencies in PIVC, PICC, and PAC management (insertion, maintenance, access and removal) using an ongoing system of regular assessment.
2. Monitor clinician adherence to the practices recommended in the guidelines' good practice statements and recommendations.
3. Assess any complications associated with PIVCs and PICCs and correlate these data with adherence to the guidelines in clinical practices.
4. Investigate all health care-associated BSI to determine the source of these infections and whether they are associated with intravascular catheters or another health care intervention(s). Such an approach should allow clinicians to determine the proportion of BSIs that are catheter-associated and thereby provide an indicator for the impact of these guidelines. Ideally, such data should then be correlated with a valid measure of clinical activity (for example, infections per 1000 catheter days or per 1000 inpatient bed days).

Nurse Akhter on duty in an inpatient area crowded with dengue patients at Suhrawardy Hospital in Sher-E-Bangla-Nagar, Dhaka, on 3 October 2023 [Bangladesh].
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7

Updating and dissemination of the guidelines

7. Updating and dissemination of the guidelines

These guidelines are made available as a printed document and a web-based product for dissemination and they include all evidence as presented to the GDG (within the text and in Annex 2, Annex 3, and the Web Annex).

The recommendations issued in the guidelines will remain valid for five years. The WHO Secretariat will monitor scientific evidence as they become available, as well as users' needs, to decide on the need to update the recommendations during that period. The Steering Group will continue to follow research developments in the prevention of BSI and other infections associated with PIVCs, particularly for the questions in which the systematic reviews showed that: 1) no evidence was found; 2) low-certainty evidence was identified; or 3) where additional new recommendations or further changes in published recommendations would be needed.

Following publication and dissemination of the guidelines, any concern about the validity of any recommendation will be promptly communicated to the guidelines' implementers and revisions will be made to the guidelines.

We plan to translate the guidelines in Arabic, Chinese, French, Russian and Spanish and to disseminate them on the WHO website, specifically on the IPC webpage, through the regional offices' focal points, dissemination lists, and through the Global Infection Prevention and Control Network (GIPCN), a collaborative mechanism between more than 20 organizations in the field of IPC and WHO.

The Steering Group will invite relevant WHO departments to contribute to a wider dissemination plan, as appropriate. Technical meetings will be held within WHO departments to share the products with the teams responsible for policy and programme implementation. We will also liaise with the WHO Press close to the time of publication of the guideline to agree on a publication plan. We will publish notification of the GDG process on the WHO IPC website together with the biographies of the GDG as soon as the GDG process commences. We will also publish the full report, summary report, including full details of the methodology and results of the evidence appraisal on the website as soon as the GDG process has been completed.

7.1 Derivative products

Evidence briefs will be produced to target policy-makers and programme managers. This is important to enhance interpretation and uptake of the guideline, particularly in areas where the technical expertise to fully understand the current guideline format may be limited. The evidence briefs will highlight the recommendations and related contextual issues for implementation. In addition, to increase awareness of the guideline, the recommendations will be published as a commentary in peer-reviewed scientific journals.

Finally, implementation tools to reflect the WHO multimodal strategies for the implementation of IPC interventions will be developed in collaboration with regional office, key stakeholders and field implementers.

7.2 Essential medicines list (EML)

The recommendations issued in the guidelines will not affect a priori modifications in the EML. In case changes are required, the EML Secretariat will be contacted to discuss the inclusion of new products.

7.3 Adaptation

All WHO regional offices have been invited to be observers at the GDG meetings. Immediately after the GDG meetings, we will meet with the regional offices to make detailed plans for local adaptation and implementation guidance. WHO departments and other partners will support national and subnational groups to adapt the guideline. This process may include the development or revision of existing national guidelines or protocols based on the WHO guideline.

7.4 Implementation

Implementation guidance will be developed in partnership with the regional offices. WHO departments and other partners will support national and subnational groups to implement the recommendations. In addition, in collaboration with other WHO departments, the WHO IPC team will develop a plan for research on effective implementation strategies.

A nurse attends to a patient at a primary health centre in Mutanpal village in Bastar district, Chhattisgarh [India].
© WHO / Atul Loke / Panos Pictures

8

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Trecia Simone Stewart, 41, a certified emergency nurse assists Dr Nashoni Mitchell with a patient who is in distress at the Spanish Town Hospital [Jamaica].
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Annexes

Annex 1: Guideline development group contributors and participants, with their declarations of interests

Table A1. Declarations of interest* for the Guideline Development Group

Name	1. Consulting and technical advisory boards	2. Research support	3. Investments and business interests	4. Intellectual property	5. Public statements and positions	6. Additional information	7. Tobacco products	Conflicts management plan
Ghada Abdelwahed Ismail, Supreme High Council of University Hospitals, Egypt	N	N	N	N	N	N	N	Full participation
Muna Abu Sin, Robert Koch Institute, Germany	N	N	N	N	N	N	N	Full participation
Alex Adusei, Women's Hope Foundation and Patient for Patients Safety Network, Ghana	N	N	N	N	N	N	N	Full participation
Faisal Alsheddi, Ministry of Health of the Kingdom of Saudi Arabia, Saudi Arabia	N	N	N	N	N	N	N	Full participation
Paul Anantharajah Tambyah, Yong Loo Lin School of Medicine, National University of Singapore, Singapore,	N	N	N	N	N	N	N	Full participation
Hiba Azrag, Federal Ministry of Health, Sudan	N	N	N	N	N	N	N	Full participation
Bin Gao, Tianjin 4th Central Hospital, Tianjin Medical University, China	N	N	N	N	N	N	N	Full participation
Denise Brandão de Assis, Center of Disease Control, São Paulo State Health Department, Brazil	N	N	N	N	N	N	N	Full participation
Niccolò Buetti, Geneva University Hospitals and Faculty of Medicine, WHO Collaborating Centre, Switzerland	N	N	N	N	N	N	N	Full participation
André Bulabula, Africa Centres for Disease Control and Prevention, Ethiopia	N	N	N	N	N	N	N	Full participation
Abigail Carlson, Centers for Disease Control and Prevention, USA	N	N	N	N	N	N	N	Full participation
Marilyn Cruickshank, Faculty of Health, University of Technology Sydney, Australia	N	N	N	N	N	N	N	Full participation
Aleksander Deptula, Nicolaus Copernicus University, Poland	N	N	N	N	N	N	N	Full participation
Anita Desai, National Institute of Mental Health and Neurosciences, India	N	N	N	N	N	N	N	Full participation

* Based on the Declaration of interests (WHO Experts) form, retrieved from http://intranet.who.int/homes/cre/ethics/doiexperts/, accessed 27 December 2023.

Name	1. Consulting and technical advisory boards	2. Research support	3. Investments and business interests	4. Intellectual property	5. Public statements and positions	6. Additional information	7. Tobacco products	Conflicts management plan
Susan Hopkins, United Kingdom Health Security Agency, United Kingdom of Great Britain and Northern Ireland	N	Y	N	N	N	N	N	Full participation
	2a) She declares that she received research grants on HAI, BSIs and IPC to the amount of £4.8 million over 5 years from the National Institute for Health and Care Research, United Kingdom. Current interest active.							
Shevin Jacob, Liverpool School of Tropical Medicine, Uganda	N	Y	N	N	Y	N	N	Full participation
	2a) He declares that his research unit at the Liverpool School of Tropical Medicine received a grant award of approximately £2.5 million from the National Institute for Health and Care Research, United Kingdom. The current interest ended in September 2022. **5b)** He declares that he is a member of the Board of Directors and Executive Committee for the Global Sepsis Alliance and the co-Founder, Secretary General and an Executive Committee Member for the African Sepsis Alliance.							
Kushlani Jayatilleke, Sri Jayewardenepura General Hospital, Sri Lanka	Y	N	N	N	N	N	N	Full participation
	1a) She declares that she is employed as the consultant microbiologist and IPC activities of the hospital are under her responsibility as head of the IPC unit. In this capacity, she has prepared and implemented guidelines for the prevention of line- associated BSIs and currently receives approximately Rs 400,000 (Sri Lankan rupees).							
Kalisvar Marimuthu, National Centre for Infectious Diseases and Tan Tock Seng Hospital, Singapore	N	N	N	N	N	N	N	Full participation
Leonard Mermel, Brown University, USA	N	N	N	N	N	N	N	Full participation
Sally Roberts, Health New Zealand, Te Whatu Ora, Te Toka Tumai Auckland, New Zealand	N	N	N	N	N	N	N	Full participation
Jean-François Timsit, Bichat Hospital and Université Paris Cité, France	Y	Y	N	N	N	N	N	Full participation
	1b) He declares consulting, including service as a technical or other advisor and financial support for giving a speech for BD®, participation to an advisory board in France, and one lecture in 2022 to the amount of US$ 2000.00. For BD®, he gave a lecture at the French national emergency congress in 2022 entitled “Catheter-related infection prevention in the emergency unit: what's new” (no mention of drugs or devices from the industry) (fees < €1000). For BD®: participation to a one-day advisory board meeting on " BD®'s national positioning on the prevention of catheter-related infections" (< €2000). **2b)** He declares consulting, including service as a technical or other advisor and financial support for giving a speech for BD®, participation to an advisory board in France, and one lecture in 2022, to the amount of US$ 2000.00.							

Name	1. Consulting and technical advisory boards	2. Research support	3. Investments and business interests	4. Intellectual property	5. Public statements and positions	6. Additional information	7. Tobacco products	Conflicts management plan
Walter Zingg, Zurich University Hospital, Switzerland	Y					Y		Full participation
	1b) He declares previous consulting services to 3M® related to a webinar on the proper use of peripheral venous catheters to the amount of €5000.00. In addition to that, he declares that he was not an advisor for a product. All work was done as part of an education strategy by 3M® (review and webinar). There were no restrictions and no product of the sponsor was addressed. **6d)** He declares honoraria received for a webinar on the proper use of peripheral venous catheters.							

Abbreviations: HAI, health care-associated infection; BSI, bloodstream infection; IPC, infection prevention and control; N, no declaration; Y, declaration.

Guideline Development Group Observer

Name	1. Consulting and technical advisory boards	2. Research support	3. Investments and business interests	4. Intellectual property	5. Public statements and positions	6. Additional information	7. Tobacco products	Conflicts management plan
Madonna Matar, Notre Dame de Secours University Hospital, Lebanon	N	N	N	N	N	N	N	Full participation

N, no declaration; Y, declaration.

Annex 2: Pico questions

All PICO questions (PQ) are listed below. As not all investigated preventive methods are relevant to all types of catheters and all age groups, each PQ explicitly specifies this.

Insertion

PQ 1: In participants requiring a PIVC, PICC or PAC (adults, adolescents, children, neonates), what is the impact of a sterile insertion technique compared to routine practice (technique without the specific requirement for sterility) on the rates of peripheral-inserted IV catheter-associated infection complications (BSI-PIVCAIC) and mortality?

PQ 2: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of chlorhexidine-containing skin disinfection used before catheter insertion compared to non-chlorhexidine-containing skin disinfection used before catheter insertion on rates of BSI-PIVCAIC and mortality?

PQ 3: In participants requiring a PIVC, PICC or PAC (adults, adolescents, children, neonates), what is the impact of a catheter inserted only by an individual who has undergone catheter insertion training/certification compared to insertion by an individual with no requirement for formal training/certification ("routine practice") on the rates of BSI-PIVCAIC, mortality and complications related to insertion?

P**Q 4:** In participants requiring a PIVC or PICC (adults, adolescent, children, neonates), what is the impact of catheter insertion by an individual wearing gloves (either sterile or non-sterile) compared to insertion by an individual not specifically required to wear gloves ("routine practice") on rates of BSI-PIVCAIC, mortality and complications related to insertion?

PQ 5: In participants requiring a PIVC or PICC (adults, adolescent, children, neonates), what is the impact of PIVC/PICC inserted by an individual wearing sterile gloves compared to insertion by an individual wearing non-sterile gloves on rates of BSI-PIVCAIC, and mortality?

PQ 6: In participants requiring a PIVC or PICC (adults, adolescent, children, neonates), what is the impact of catheter insertion by an individual using a standardized insertion pack/kit compared to insertion by an individual not using a standardized PIVC insertion pack/kit ("routine practice") on the rates of BSI-PIVCAIC and mortality?

PQ 7: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter insertion with ultrasound-guided assistance compared to insertion without ultrasound-guided assistance ("routine practice") on rates of BSI-PIVCAIC and mortality?

PQ 8: In participants requiring a PIVC (adults, adolescents, children, neonates), what is the impact of catheter insertion in the distal section of the upper limb (below cubital fossa) compared to insertion in the proximal section of the upper limb (cubital fossa or above) on the rates of BSI-PIVCAIC and mortality?

PQ 9: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter insertion in the upper limb (anywhere) compared to a PIVC/PICC inserted in the lower limb (anywhere) on the rate of BSI-PIVCAIC, mortality and complications related to insertion?

PQ 9a: Does the impact vary by the position in the upper limb (above or below the cubital fossa)?

PQ 10: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of a catheter (cannula section) made of silicon material compared to a catheter (cannula section) made of non-silicon material (for example, polyurethane) on the rate of BSI-PIVCAIC and mortality?

PQ 11: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of a catheter secured with an occlusive dressing (for example, semi-permeable, transparent dressing) compared to a catheter secured with a non-occlusive dressing (for example, gauze, other) on rates of BSI-PIVCAIC, mortality and complications related to the catheter dressing?

PQ 12: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of a catheter inserted by an insertion team compared to a catheter inserted by an individual not part of a specific insertion team on rates of BSI-PIVCAIC, mortality and complications related to insertion?

PQ 13: In participants requiring a PIVC or PICC (adults), what is the impact of a catheter inserted by a clinician who has used soap and water compared to a catheter inserted by a clinician who has used alcohol-based hand rub on rates of BSI-PIVCAIC and mortality?

PQ 14: In participants requiring a PIVC or PICC (adolescents, children, neonates), what is the impact of a catheter inserted using a local anaesthetic at the insertion site compared to a catheter inserted without using a local anaesthetic at the insertion site on rates of BSI-PIVCAIC, mortality and number of IV insertion attempts?

PQ 15: In participants requiring a PIVC or PICC (neonates), what is the impact of a catheter inserted in the scalp compared to a catheter inserted anywhere other than the scalp on rates of BSI-PIVCAIC and mortality?

Maintenance

PQ 16: In participants requiring a PIVC, PICC or PAC (adults, adolescents, children, neonates), what is the impact of catheter maintenance using a formal sterile dressing protocol compared to catheter maintenance where there is no specified formalized sterile dressing protocol (“routine practice”) on rates of BSI-PIVCAIC, mortality and complications related to the dressing?

PQ 17: In participants requiring a PIVC, PICC or PAC (adults, adolescents, children, neonates), what is the impact of catheter management with continuous IV fluid infusion compared to catheter management without a schedule of continuous IV fluid infusion (intermittent or no infusion) on rates of BSI-PIVCAIC, mortality and complications related to the infusion (including occlusions and dwell time)?

PQ 18: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of systematic sterile flushing (saline or other) after product administration compared to non-systematic sterile flushing after product administration on rates of BSI-PIVCAIC and mortality?

PQ 18A/27: Should saline compared to anticoagulant (that is, heparin) locking be used in patients requiring a PIVC/PICC?

PQ 19: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter maintenance with a schedule of regular changing of administration (tubing) sets compared to catheter maintenance with no specified schedule of regular changes of administration

(tubing) sets on rates of BSI-PIVCAIC, mortality, and complications related to changing tubing and change in the longevity of the catheter?

Access

PQ 20: In participants requiring a PIVC, PICC or PAC (adults, adolescents, children, neonates), what is the impact of catheter access using a defined sterile/aseptic protocol compared to catheter access using no formal sterile or aseptic protocol on rates of BSI-PIVCAIC and mortality?

PQ 21: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter access using a closed-access device system compared to catheter access using an open-access device system on rates of BSI-PIVCAIC and mortality?

PQ 22: In participants with a PICC (adults, adolescents, children -neonates), what is the impact of a single-lumen PICC compared to a multi-lumen PICC on rates of BSI-PIVCAIC and mortality?

Removal

PQ 23: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter removal based on defined schedules compared to catheter removal based only on being clinically-indicated due to a suspected or confirmed complication on rates of BSI-PIVCAIC and mortality?

PQ 23a: Does the impact vary by the time of schedule (for example, at 72-96 hours post-insertion) or activity-based (for example, 2 days post-surgery)?

PQ 24: In participants requiring a PIVC or PICC (adults, adolescents, children, neonates), what is the impact of catheter removal/replacement within 24 hours if inserted under emergency conditions compared to a catheter not removed/replaced within 24 hours if inserted under emergency conditions on rates of BSI-PIVCAIC and mortality?

PICC compared to PIVC

PQ 25: In participants (adults, adolescents, children, neonates) requiring IV access for antibiotic or chemotherapy administration, what is the impact of using a PICC compared to a PIVC on rates of BSI-PIVCAIC, mortality, complications related to IV catheter insertion, complications related to IV catheter infusion, including IV catheter occlusions and dwell time?

PICCs compared to MVCs

PQ 26: In participants (adults, adolescents, children, neonates) requiring IV access for antibiotic or chemotherapy administration, what is the impact of a PICC compared to a MVC on rates of BSI-PIVCAIC, mortality, the number of IV insertion attempts, complications related to IV catheter insertion, complications related to IV catheter infusion, including IV catheter occlusions and dwell time

Annex 3: Methods

The systematic review was conducted following the Cochrane methodology *(1)* and the Framework for Rating Evidence in Public Health *(2)*. The reporting adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist *(3)*. The review protocol is registered on the Open Science Framework website (https://osf.io/pr45x/).

A3.1 Study eligibility criteria

Table A2.1 presents the inclusion and exclusion criteria based on the PICO elements and study designs. Studies published from 1980 onwards, irrespective of publication language, country of origin and setting were included.

Table A3.1. Inclusion and exclusion criteria for studies

Criteria	
Population	
Inclusion	**Exclusion**
Adults (18 years or older), adolescents-children and neonates requiring a PIVC, PICC or PAC.	• Patients of any age requiring another type • of catheter other than a PIVC, PICC or PAC.
Comparisons (intervention versus control) with specification of relevant catheter type and age group	
Inclusion	**Exclusion**
Insertion • Sterile technique versus technique where the need for sterility is not mandated (PIVCs, PICCs and PACs; all age groups). • Chlorhexidine-containing antiseptic for skin preparation versus non-chlorhexidine-containing antiseptics. (PIVCs, PICCs; all age groups). • Inserted by a clinician who used soap and water versus inserted by a clinician who used alcohol-based hand rub for hand hygiene (PIVCs, PICCs; adults). • Ultrasound-guided insertion versus non-ultrasound-guided guided (PIVCs, PICCs; all age groups). • Silicon versus non-silicon (polyurethane) (PIVCs, PICCs; all age groups). • Non-occlusive (for example, gauze) versus occlusive dressings (PIVCs, PICCs; all age groups). • Insertion team versus no specific insertion team (PIVCs, PICCs; all age groups). • Inserted by an individual with formal PIVC/PICC/PAC training accreditation/certification versus no specified formal training accreditation/certification (PIVCs, PICCs and PACs; all age groups). • Gloves versus no gloves (PIVCs and PICCs; all age groups). • Sterile gloves versus non-sterile gloves (PIVCs, PICCs; all age groups). • Use of standard insertion set versus no specific requirement for a standard insertion pack/kit (PIVCs, PICCs; all age groups).	Any other comparison not listed as eligible.

Criteria	
Comparisons (intervention versus control) with specification of relevant catheter type and age group	
Inclusion	**Exclusion**
• Upper limb (anywhere) versus lower limb (anywhere) (PIVCs, PICCs; all age groups). • Lower arm (distal section of upper limb) versus upper arm (proximal section of the upper limb) (PIVCs; all age groups). • Local anaesthetic at insertion site versus no local anaesthetic at insertion site (PIVCs, PICCs; adolescents, children, neonates). • Scalp inserted versus anywhere other than the scalp (PIVCs only; neonates only). *Maintenance* • Formal sterile dressing versus no formal sterile dressing protocol (PIVCs, PICCs and PACs; all age groups). • Continuous-infusion versus no continuous (intermittent) infusion (PIVCs, PICCs; all age groups). • Systematic sterile flushing (saline or other) after product administration vs no systematic sterile flushing after product administration (PIVCs, PICCs; all age groups). • Regular change of tubing vs no (specified) regular change of tubing (PIVCs, PICCs; all age groups). *Access* • Sterile/aseptic protocol versus no specified formal sterile/aseptic protocol (PIVCs, PICCs, PACs; all age groups). • Use of closed-access device system (for example, luer lock) versus open-access system (PIVCs, PICCs; all age groups). • Single lumen versus multi-lumen (PICCs; adults, adolescents, children, neonates). *Removal* • Scheduled removal (defined time schedule) versus clinically-indicated (removed based on being clinically-indicated due to a suspected or confirmed complication) (PIVCs, PICCs; all age groups). • Removal within 24 hours if inserted under emergency conditions versus not removed within 24 hours if inserted under emergency conditions (PIVCs and PICCs; all age groups) • PICC versus MVC (antibiotic or chemotherapy administration) (PICCs adults, adolescents, children, neonates) • Bundle/multimodal interventions for PIVCs, PICCs and PACs	

Criteria	
Outcomes	
Inclusion	**Exclusion**
For all comparisons: • catheter-associated or -related BSI • local infections • BSI-related mortality • All-cause mortality • phlebitis/thrombophlebitis • sepsis • oedema • haematoma • sepsis • fluid/blood leaking • infiltration • accidental/wrenching removal • obstruction/occlusion • closed-system rupture. *For selected PQs:* • number of IV insertion attempts (local anaesthetic versus no local anaesthetic (PQ 14); • complications related to IV catheter insertion (training versus no training (PQ 3), upper limb versus lower limb BSIs (PQ 9), gloves versus no gloves (PQ 4), insertion team versus individual comparisons (PQ 12), PICC versus PIVC (PQ 25), PICC versus MVC (PQ 26); • complications related to IV catheter dressings (sterile dressing protocol versus no specified requirement (PQs 11, 16); • complications related to IV catheter infusion, including IV catheter occlusions and dwell time (continuous infusion versus intermittent infusion (PQ 17), PICC versus PIVC (PQ 25), PICC versus MVC (PQ 26); • Complications related to IV catheter flushing (regular flush versus none (PQ 18); • complications related to changing IV catheter tubing (regular change versus no specified regular change of tubing set) (PQ 19); • Change in longevity of PIVC (regular change versus no specified regular change of tubing set [PQ 19]) *Removal* • Scheduled removal (defined time schedule) versus clinically-indicated (removed based on being clinically-indicated due to a suspected or confirmed complication) (PIVCs, PICCs; all age groups). • Removal within 24 hours if inserted under emergency conditions versus not removed within 24 hours if inserted under emergency conditions (PIVCs and PICCs; all age groups) • PICC versus MVC (antibiotic or chemotherapy administration) (PICCs adults, adolescents, children, neonates) • Bundle/multimodal interventions for PIVCs, PICCs and PACs	

Criteria	
Publication dates	
Inclusion	**Exclusion**
1980-2023	Pre-1980
Geography	
Inclusion	**Exclusion**
No limitations	NA
Settings	
Inclusion	**Exclusion**
Any setting	NA
Publication language	
Inclusion	**Exclusion**
Any languages	NA
Publication type	
Inclusion	**Exclusion**
Full publications	Comments, letters to editor, publications without an available full text.
Study design	
Inclusion	**Exclusion**
RCTs Non-RCTs Controlled observational studies Controlled before-after studies Interrupted time-series and repeated measures studies Before-after studies	Case series, case reports. Systematic or non-systematic reviews. Studies without a comparison (or incidence/prevalence studies and surveys). Pooled data analyses.

Abbreviations: BSI, bloodstream infections; IV, intravenous; PQ, PICO question; MVC, midline vascular catheter; NA, not applicable; PIVC, peripheral intravenous catheter; PICC, peripherally-inserted central catheter; PAC, peripheral arterial catheter; RCT, randomized controlled study.

A3.2 Outcomes ranking

To identify the critical or important outcomes for this review, we asked the WHO Guideline Development Group (GDG) to rate the relative importance of the outcomes using a modified Delphi approach. A survey including the list of relevant outcomes was sent to GDG members. Participants used a 9-point Likert scale to rate the outcomes into three categories: (1) critical for decision-making; (2) important, but not critical for decision-making; and (3) of low importance for decision-making. Twenty-three of 24 (95.8%) GDG members ranked the outcomes. For average ratings, 9 would indicate the greatest importance and 1 the least. Outcomes rated as 7 or higher were considered critical for decision-making (GRADE-relevant). In addition, the GDG agreed on two additional outcomes of interest.

Table A3.2. Ratings of Importance of outcomes

Outcomes	Median
BSI	9
BSI-related mortality	9
Sepsis	9
Local infection	8
All-cause mortality	7
Thrombophlebitis	7
Complications related to IV catheter insertion	7
Phlebitis	6
Fluid/blood leaking	6
Infiltration	6
Obstruction/occlusion	6
Closed-system rupture	6
Change in catheter longevity	6
Complications related to IV catheter infusion	6
Oedema	5
Haematoma	5
Accidental/wrenching removal	5
Number of IV insertion attempts	5
Complications related to IV catheter dressings	5
Complications related to IV catheter flushing	5
Complications related to IV catheter tubing	5

Abbreviations: BSI, bloodstream infections; IV, intravenous.

A3.3 Bundle/multimodal studies

If studies assessed bundles/multimodal approaches, we included them during the study selection process, but we did not include them in the evidence synthesis as the causal pathways can be difficult to identify (which component contributed how much to an effect). However, we prepared a table including high-level information of all studies dealing with bundles/multimodal approaches in chapter 4 (Implementation through bundles and the WHO multimodal improvement strategy).

A3.4 Systematic literature search

An experienced information specialist searched in several electronic databases, taking the following steps to perform the literature searches:

1. First, a search of electronic databases was performed, such as Ovid MEDLINE, Embase.com (Elsevier), the Cochrane Library (Wiley), the WHO Global Index Medicus (https://pesquisa.bvsalud.org/gim/), and CINAHL (EBSCO) using a combination of free-text terms and subject headings (for example, Medical Subject Headings [MeSH]), limited to human-only studies. Searches covered the period from January 1, 1980, to March 16, 2023.

2. Second, to minimize retrieval bias, a manual search of the reference lists of selected systematic reviews on this topic were searched for relevant citations that electronic searches might have missed. Topic experts were also contacted for information about landmark studies.

The WHO team reviewed and approved the final search strategy.

A3.5 Study selection

Trained research team members dually and independently reviewed all titles and abstracts identified through searches for eligibility against the inclusion/exclusion criteria using DistillerSR *(4)*. To determine inclusion or exclusion for studies without adequate information at the title/abstract stage, the reviewers retrieved the full text and then made the determination. If both reviewers agreed that a study did not meet the eligibility criteria, the study was excluded. Conflicts were resolved by discussion and consensus or by consulting a third member of the review team. The reason for each excluded full-text publication that did not satisfy the eligibility criteria was recorded. If the information in the published articles was insufficient to permit the reviewers to determine inclusion or exclusion, the authors were contacted for further clarification. All results at both the title/abstract and full-text review stages were tracked in an EndNote® bibliographic database (Clarivate Analytics).

A3.6 Data extraction

We designed, pilot-tested, and used a structured data extraction form in DistillerSR to ensure consistency in data extraction. Trained reviewers initially extracted data from each study. A second reviewer then read each extracted article and evaluated the completeness and accuracy of the data extraction. Discrepancies were resolved by consensus or by involving a third senior reviewer.

The following data was extracted from the included trials: study design; eligibility criteria; intervention; additional medications allowed; study funder; outcome assessment methods; population characteristics (such as age, sex, race, ethnicity); sample size; attrition; and outcomes of interest. Intention-to-treat results (that is, all patients are analysed as randomized with missing values imputed) were recorded if available. For studies eligible for quantitative analyses, the authors were contacted if the reported data were incomplete or missing.

A3.7 Classification of study designs and assessment of the risk of bias

We applied the United States Agency for Healthcare Research and Quality, publication no. 11-EHC-007 criteria for the classification of study designs *(5)*. To assess the risk of bias in the included studies, we used the Cochrane Risk of Bias tool (2.0) for randomized controlled trials (RCTs) *(6)*, the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool *(7)* for non-randomized controlled studies of interventions (NRSIs) with concurrent controls, and the Effective Public Health Practice Project (EHHP) *(8)* tool for before–after studies. Two reviewers independently assessed the risk of bias at the study level. The reviewers also assessed on an outcome level whether different methodological aspects might impose different risks of bias (for example, lack of blinding might affect subjective outcomes, but not objective outcomes such as mortality). Therefore, we categorized the outcomes as subjective (oedema, phlebitis/thrombophlebitis, haematoma, sepsis, fluid/blood leakage, infiltration, obstruction/occlusion, number of insertion attempts, complications related to insertion/dressing/infusion/flushing/changing of tubing, change in catheter longevity) and objective outcomes (BSI, local infections, all-cause mortality, BSI-related mortality, sepsis, accidental/wrenching removal, closed-system rupture). Using the three assessments from the Cochrane Risk of Bias 2.0 *(6)*, we harmonized the ratings to three categories (low, some concerns, high) to make them comparable. For this purpose, NRSI studies rated as a “moderate” or “critical” risk of bias were listed as “some concerns” in the report. Before–after studies rated as “weak” were listed as “high” risk of bias, while “moderate” were listed as “some concerns,” and “strong” as “low” risk of bias. We assigned a high risk of bias rating to studies that had a fatal flaw regarding all or individual outcomes. For publications reporting on the same study, but with different comparisons, we assessed the risk of bias separately for each publication.

A3.8 Synthesis of the evidence

Throughout this review, we synthesized the literature qualitatively. When the data were sufficient, we augmented the findings with quantitative analyses. We structured the synthesis by PQ and within each PQ by catheter type (PIVC, PICC, PAC), age groups (adults, adolescents-children and neonates) and outcomes. In our synthesis, we focused on GRADE-relevant outcomes that were rated as critical for decision-making by the GDG (CABSI/CRBSI, BSI-related mortality, sepsis, local infections, all-cause mortality, phlebitis/thrombophlebitis, complications related to IV catheter insertion). In addition, we graded the number of insertion attempts for PQ14. This means that we considered only these outcomes for the meta-analyses, certainty of evidence (COE) ratings, and the summary of findings tables presented in the Web Annex.

A3.9 Bayesian meta-analysis

When three or more RCTs were available for a critical outcome, we conducted a Bayesian meta-analysis

using restrictive priors: μ~Normal(0,1) and τ~Half Cauchy(0,0.5). Zero events were replaced with 0.5. All calculations were performed using R (v. 4.2.2). The Markov Chain Monte Carlo procedure was employed for the calculations, utilizing the brms package and rstan *(8, 9)*. Each individual meta-analysis consisted of 16 000 iterations. Data wrangling and plot creation were executed using the tidyverse package *(10)*.

A3.10 Certainty of evidence assessment

We assessed the certainty of evidence (COE) based on the guidance established by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group *(11)*. The grades reflect the certainty of the body of evidence to answer PQs on the comparative effectiveness, efficacy, and harms of the interventions included in this review. We considered five key domains: risk of bias (includes study design and aggregate quality); inconsistency; indirectness; imprecision; and reporting bias. One reviewer assessed each domain for each selected outcome and a second reviewer verified these judgments. Conflicts were resolved by consensus discussion. We graded the COE for the seven outcomes deemed most important for decision-making. The GRADE system defines the overall certainty of a body of evidence for an outcome as high (raters are very confident that the estimate of the effect of the intervention on the outcome lies close to the true effect), moderate (raters are moderately confident in the estimate of the effect of the intervention on the outcome), low (raters have little confidence in the estimate of the effect of the intervention on the outcome), or very low (raters have no confidence in the estimate of the effect of the intervention on the outcome). RCTs and NRSIs *(12)* started at a high COE, while before–after studies started at low. We used the GRADEpro online tool (https://www.gradepro.org/) to develop the summary of findings' tables (Web Annex).

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