Clinical Practice Guideline on Intravenous Therapy with Temporary Devices in Adults

CLINICAL PRACTICE GUIDELINES IN THE SPANISH NHS
MINISTRY OF HEALTH, SOCIAL SERVICES AND EQUALITY

MINISTERIO DE SANIDAD, SERVICIOS SOCIALES E IGUALDAD

RED ESPAÑOLA DE AGENCIAS DE EVALUACIÓN DE TECNOLOGÍAS Y PRESTACIONES DEL SISTEMA NACIONAL DE SALUD

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JUNTA DE ANDALUCIA CONSEJERÍA DE IGUALDAD, SALUD Y POLÍTICAS SOCIALES

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This Clinical Practice Guideline is an aid for making decisions about healthcare. It is not mandatory, and it is not a substitute for the clinical opinion of healthcare personnel.

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Presentation

Documenting variability in clinical practice, analysing the causes thereof and adopting strategies that are targeted at eliminating that variability have proved to be initiatives that promote making effective and safe decisions by health professionals, which decisions are focused on and shared by the people. Among such strategies, the preparation of Clinical Practice Guidelines (CPGs) is at the forefront, which are a "set for recommendations based on a systematic review of the evidence and on an assessment of the risks and benefits of the various alternatives, with the objective of optimising healthcare for patients".

One of the priorities of the Ministry of Health, Social Services and Equality is to continue driving the preparation and use of health technologies assessment reports and CPGs, thereby strengthening the Network of Health Technologies Assessment Agencies and Services of the National Health System (SNS) and the GuíaSalud Project.

The Clinical Practice Guideline on Intravenous Therapy with Temporary Devices in Adults attempts to provide users with a tool that serves to systematise the most common questions that come up for health professionals and patients when facing intravenous therapy.

This guideline could be a good base for setting up a protocol that systematizes intravenous therapy at the local level, at centres and at clinical units and for assessing the effectiveness thereof.

The attempt has been made to record the intravenous therapy process by phases: before catheterization, catheterization, maintenance care and handling complications. Thus, each phase can be consulted individually, especially the collective knowledge on each phase of intravenous therapy.

The document is the result of the work of a broad group of professionals coming from various Autonomous Communities who are involved in the care of adult patients that require temporary venous accesses for administering any type of intravenous solution.

At the Directorate General of Public Health, Quality and Innovation, we are very satisfied with the work that has been performed, and we hope that this guideline allows making coordinated, safe and effective decisions on the use of intravenous therapy by professionals and allows the quality of care to be improved, thereby increasing the satisfaction of patients and of people who provide patients with home care when required.

JOSE JAVIER CASTRODEZA SANZ

Director General of Public Health, Quality and Innovation

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Collaborating Societies

This Clinical Practice Guideline has the endorsement of the following societies:

Spanish Society of Oncological Nursing (SEEO)

Association of Hospital Nurses of Andalucía (ASENHOA)

Spanish Society of Intensive Nursing and Coronary Units (SEEIUC)

Nursing Association of Intravenous Therapy Teams (ETI)

Spanish Association of Palliative Care Nursing (AECPAL)

Andalusian Society of Angiology and Vascular Surgery (SAACV)

Andalucía-Extremadura Association of Anesthesiology, Resuscitation and Pain Therapeutics (AAEAR)

Community Nursing Association of Andalucía (ASANEC)

Spanish Association of Vascular Nursing (AEEVH)

Spanish Association of Anaesthesia-Resuscitation Nursing and Pain Therapy (AEEARTD)

Declaration of interests All the members of the Development Group, as well as the people who have participated in the expert collaboration and in the external review, have made the declarations of interests that are presented in Appendix 2.

Questions to be answered

PLANNING FOR THE START OF IV THERAPY (IVT)

Aspects related to the patient

1. For hospitalised patients, what type of venous access is indicated to avoid complications and repeated punctures?
2. For outpatients, what type of venous access is indicated to avoid complications and repeated punctures?
3. For patients with a life-threatening emergency, if venous catheterization is not possible, is intraosseous access indicated to avoid complications and repeated punctures?
4. For patients in a terminal situation with palliative needs, does peripheral catheterization versus a peripherally inserted central catheter (PICC) or a central line allow avoiding repeated punctures and improving the patient's comfort?
5. For patients with poor venous access, is the blind placement of a long-term central line associated with a fewer number of complications than attempting peripheral catheterization or an ultrasound-guided PICC?
6. For patients who need to have periodic samples taken (daily/alternate days), does maintaining an access versus repeated, specific punctures decrease complications or increase patient satisfaction?

Aspects related to the type of infusion and the duration of IV therapy

7. For a patient who needs an infusion with non-physiological pH, osmolarity or particle size, does the use of a central catheter versus a peripheral one have fewer complications related to obstruction, phlebitis, irritation or thrombosis?
8. When it is necessary to administer intravenous therapy (IVT) through several lumens, is the use of a multi-lumen catheter more effective at preventing infections than the use of several lines?
9. Depending on the duration of IVT, what type of line is indicated to avoid complications?

Aspects related to the assessment of risks and patient decision-making

10. What information (duration of the line, risk of complications, availability of a caregiver, body image and financial impact) should a patient have so that they can define their preferences regarding the infusion line?
11. Is assessing the risk factors of infection or bleeding in a patient before selecting the catheter route effective at preventing infections or bleeding?

Aspects related to the prevention of occupational risks

12. Is the use of safety devices an effective clinical practice for decreasing the risk of complications due to an accidental needlestick by professionals?

PREVENTING COMPLICATIONS WHEN CATHETERIZING

Aspects related to the training of professionals

13. What specific training on the prevention of infections associated with central and peripheral catheters should a professional have who is responsible for inserting the catheter and for the care and maintenance thereof?
14. Does the does the insertion of catheters in veins, whether central or peripheral, by professionals with experience or specific training decrease the risk of complications versus the insertion of catheters by professionals without experience?

Precautions before inserting a catheter

15. Does the use of barrier precautions during the insertion of catheters, versus not using them, decrease the risk associated with a central/peripheral catheter?
16. Does shaving the skin prior to inserting a catheter decrease the risk of infectious complications?
17. What antiseptic solution (chlorhexidine versus povidone-iodine) should be used to prepare the field before puncture in order to prevent infections associated with a central/peripheral catheter?
18. Does the use of a topical anaesthetic during the insertion of a peripheral, large-calibre catheter decrease pain?

Choice of route and catheterization procedure

19. Does the central jugular access, versus the subclavian or versus peripheral insertion in the upper extremities or in the femoral vein, have a lower risk of complications?
20. What number of attempts at inserting a central venous catheter is associated with an increase in mechanical complications related to insertion of the catheter?
21. Is taking longer than 25 minutes in the process of catheterizing a central line associated with an increase in infections, traumas or bleeding related to the procedure?
22. Does the use of Doppler techniques for locating a vein decrease the risk of complications when catheterizing a central line or a peripherally accessed central line?
23. For patients in whom a central catheter or a peripherally inserted central catheter is used, does the location of the tip in the superior vena cava decrease the number of complications?
24. Are systems for locating the catheter tip effective at preventing complications related to central catheters?

Securing and locking of the access

25. Is the use of sutures to secure central venous catheters (CVCs) more effective than the use of sterile adhesive tape at preventing complications (infection, shifting, phlebitis, loss of access) related to central catheters?
26. What are the efficacy and safety of using positive pressure, Luer type threaded connectors with locking valves at the access points to the venous line versus standard mechanical caps?
27. After inserting the catheter, what locking system is most effective at preventing occlusions?

28. Regarding the cap, what types of disinfection measures decrease the risk of infections associated with central/peripheral catheters?

Covering the venous access

29. After the insertion of a catheter, what is the most effective dressing (sterile gauze versus semi-transparent membranes) for preventing complications?
30. What patient-related aspects must be taken into account when choosing the type of dressing?

Measures with the catheter for preventing infection

31. In Intensive Care Units (ICUs) with a high frequency of infections associated with CVCs, where basic prevention measures have already been implemented, does the daily cleaning of patients with a chlorhexidine solution decrease the risk of CVC-associated infections?
32. Is the use of catheters impregnated with chlorhexidine effective at preventing infections related to central catheters?
33. Does the use of dressings impregnated with chlorhexidine decrease the risk of infections associated with CVCs?

Checklists and institutional programmes

34. Does the availability of procedure protocols that include recommendations for inserting a catheter decrease the risk of complications?
35. Does the use of a checklist of the process for verifying compliance with recommendations, before inserting a catheter, decrease the risk of associated complications?
36. Is recording the condition of vascular access devices (insertion point, functionality) an effective practice for decreasing the risk of complications?
37. Are institutional programmes for the assessment of catheterization and venous access maintenance procedures effective at decreasing complications?
38. Does feedback to professionals about the number of catheter-related infections in their unit decrease the risk of infections associated with central catheters?

PREVENTING COMPLICATIONS IN ACCESS MAINTENANCE

Aspects related to the shared use of accesses

39. For maintaining a venous catheter access in a patient who has a continuous infusion of fluids and who simultaneously requires extraction for analysis or the administration of drugs, is sharing the access better than catheterizing a second access for preventing the appearance of complications?
40. In a patient who has a venous catheter and needs to share the access for taking samples for analyses or administering drugs, is using extension tubing with a three-way valve better than using y-type extensions for preventing the appearance of complications?
41. What maintenance guidelines have proved to be effective when sharing the infusion access for taking samples or for administering contrasts without the risk of complications?

Aspects related to the duration of the catheter and replacement times

42. In a patient who has a venous catheter, how often should the system and the three-way valves be replaced to prevent the appearance of complications?
43. In a patient who has a venous catheter, should the venous access be maintained if it is not being used?
44. How often should a catheter (central, peripheral) be replaced to prevent infection, thrombosis or occlusion?

Aspects related to the use of connectors

45. In a patient who has a venous catheter, is the use of a connector better than the use of conventional caps to prevent the appearance of complications?

Aspects related to the detection of complications

46. What are the sensitive warning signs for detecting infection of the access?
47. For a patient who has a venous catheter, what operations are effective for detecting the occlusion of the catheter?

ACTIONS IN THE EVENT OF COMPLICATIONS WHEN CATHETERISING OR DURING MAINTENANCE

48. For a patient who has a peripheral venous catheter and shows signs of a complication, what should be the action guideline?
49. For a patient who has a PICC and shows signs of a complication, what should be the action guideline?
50. For a patient who has a PICC and shows signs of a thrombotic complication, what should be the action guideline?
51. For a patient who has a PICC and shows signs of an access obstruction, what should be the action guideline?
52. For a patient who has a CVC and shows signs of an infectious complication, what should be the action guideline?
53. For a patient who has a CVC and shows signs of a thrombotic complication, what should be the action guideline?
54. For a patient who has a CVC and shows signs of an access obstruction, what should be the action guideline?
55. In the event of extravasation, what action minimises the adverse effects on the patient?

Levels of evidence and grades of recommendations

Classification of the quality of evidence in the GRADE system

<table>
<tr><th>Quality of the scientific evidence</th><th>Design of the study</th><th>Decrease the quality if</th><th>Increase the quality if</th></tr>
<tr><td>High</td><td>RCT</td><td rowspan="4">Limitation in the design:
Important (-1)
Very important (-2)

Inconsistency (-1)

Direct evidence:
Some (-1) uncertainty
Major (-2) uncertainty about whether or not the evidence is direct

Inaccurate data (-1)

Notification bias:
High probability of (-1)</td><td rowspan="4">Association:
• Scientific evidence of a strong association (RR > 2 or < 0.5 based on observational studies without confusion factors) (+1).
• Scientific evidence of a very strong association (RR > 5 or < 0.2 based on observational studies without the possibility of bias) (+2).

Dose-response gradient (+1)

All the possible confusion factors could have reduced the observed effect (+1)</td></tr>
<tr><td>Moderate</td><td></td></tr>
<tr><td>Low</td><td>Observational studies</td></tr>
<tr><td>Very low</td><td>Other types of design</td></tr>
</table>

Implications of the grades of recommendation of the GRADE system

<table>
<tr><th colspan="3">Implications of a strong recommendation:</th></tr>
<tr><th>Patients</th><th>Clinicians</th><th>Managers / Planners</th></tr>
<tr><td>The immense majority of people would agree with the recommended action, and only a small minority would not.</td><td>The majority of patients should receive the recommended intervention.</td><td>The recommendation can be adopted as health policy in the majority of situations.</td></tr>
<tr><th colspan="3">Implications of a weak recommendation:</th></tr>
<tr><th>Patients</th><th>Clinicians</th><th>Managers / Planners</th></tr>
<tr><td>The majority of people would agree with the recommended action, but a considerable number of people would not.</td><td>It recognises that various options will be appropriate for different patients and that the health professional has to help each patient reach a decision that is the most consistent with their values and preferences.</td><td>An important debate and participation by stakeholders are required.</td></tr>
</table>

Recommendations of the CPG

Planning for the start of IV therapy (IVT)

ASPECTS RELATED TO THE PATIENT

Weak	For hospitalised patients whose IV therapy is expected to last longer than 6 days, a PICC is suggested for use as venous access.
Weak	For outpatients who require venous access over several days, a peripherally inserted central catheter is suggested, unless parenteral nutrition is required, for which a CVC has a better risk profile.
Weak	The use of an intraosseous access is suggested in the event of a vital emergency and the impossibility of inserting a venous catheter.
Weak	For patients with palliative needs in a terminal situation and requiring venous access, peripheral catheterization is suggested.
Weak	For patients with difficult venous access, a central venous catheter is suggested, or a peripherally inserted, ultrasound-guided catheter if available and there is experience using it.
The panel does not reach a consensus about the decision between maintaining a catheter or making repeated punctures for taking samples, wherefore the decision must be made based on the circumstances and preferences of each patient.	

ASPECTS RELATED TO THE TYPE OF INFUSION AND THE DURATION OF IV THERAPY

✓	Using a central access is advisable for infusions with an osmolarity of >600 mOsm/L; a pH of less than 5 or greater than 9; or the use of irritant medication.
Weak	The use of a multi-lumen catheter with the fewest possible number of lumens is suggested instead of several catheters when IV therapy through several lumens is necessary.
Weak	Using a peripherally inserted central catheter is suggested instead of a peripheral catheter when the duration of the IVT is expected to exceed 6 days.

ASPECTS RELATED TO THE ASSESSMENT OF RISKS AND PATIENT DECISION-MAKING

Strong	When informing a patient about the venous access selection, it is recommendable to give preference to safety over the patient's freedom of movement.
CPG ADOPTED with a Weak Recommendation	In patients who are immunocompromised or have a tendency to bleed, is it suggested that avoiding the use of a central venous catheter be assessed, depending on the clinical characteristics.

ASPECTS RELATED TO THE PREVENTION OF OCCUPATIONAL RISKS

✓	It is advisable to use safety systems that prevent accidental punctures of health professionals.

Preventing complications when catheterizing

ASPECTS RELATED TO THE TRAINING OF PROFESSIONALS

Strong	Conducting accredited institutional training on subjects related to the insertion of a central venous catheter and the insertion of a peripherally inserted central catheter is recommended.
Strong	It is recommended that healthcare units have professionals available who have accredited training on handling central venous catheters and peripherally inserted central catheters.

PRECAUTIONS BEFORE INSERTING A CATHETER

Strong	Adequate hand hygiene is recommended always. For peripheral access, clean gloves will be used, and for central access catheterization and PICCs, the maximum available barriers will be used.
✓	In the event of abundant hair, removal from the puncture zone is advisable.
Strong	Cleaning the skin with an antiseptic is recommended for preparing the field before inserting a peripheral catheter. Use alcoholic chlorhexidine to clean the skin before inserting a central venous catheter. After cleaning, the skin must only be touched using antiseptic precautions.
Weak	The use of a topical anaesthetic is suggested for peripheral venous catheterization.

CHOICE OF ROUTE AND CATHETERIZATION PROCEDURE

✓	To the extent possible, it is advisable to avoid using the femoral vein for central venous access in adult patients.
Weak	It is suggested that the same professional not make more than two attempts at inserting a central venous catheter in the same healthcare event.
✓	It is advisable to take no more than 25 minutes as from the first puncture for venous catheterization.
Strong	Using Doppler is recommended for inserting a central venous catheter and/or a peripherally inserted central catheter if the technique is available and there are trained personnel.
Strong	When inserting a central line or a peripherally inserted central catheter, it is recommendable to locate the tip of the catheter in the superior vena cava.
✓	It is advisable to take a control image after central line catheterization in order to check correct placement of the catheter tip.

SECURING AND LOCKING OF THE ACCESS

Strong	Securing a catheter without sutures is recommended.
Weak	Using positive pressure, Luer-type threaded connectors with valves at the access points of the venous line is suggested, versus standard mechanical caps.
✓	It is advisable to lock venous accesses with saline solution or a solution of heparin sodium after flushing the accesses in order to decrease the risk of occlusion.
Weak	Locking with a 70% alcohol solution is suggested, according to a specific protocol, in neutropenic patients with a non-tunnelled central venous catheter for more than one month, unless the catheter is made of polyurethane, due to the risk of catheter degradation. At units where there is a high rate of catheter-related infections, despite strict compliance with aseptic techniques, locking with heparin-vancomycin is suggested.

COVERING THE VENOUS ACCESS

Strong	Covering the insertion zone with a transparent dressing is recommended.
✓	Gauze dressings are advisable for moist or exudative zones.

MEASURES WITH THE CATHETER FOR PREVENTING INFECTIONS

CPG ADOPTED with a Weak Recommendation	Cleaning patients with a 2% chlorhexidine solution is recommended in ICUs that maintain a high rate of catheter-related infections, despite correct implementation of bacteraemia reduction strategies.
CPG ADOPTED with a Strong Recommendation	The use of a central venous catheter impregnated with chlorhexidine / silver sulfadiazine or minocycline/rifampicin is recommended in patients whose catheter is expected to be maintained more than 5 days, only if in that healthcare unit the rate of catheter-related infections does not drop, despite an overall strategy of zero bacteraemia.
The panel does not reach a consensus regarding the use of dressings impregnated with chlorhexidine, wherefore the use thereof will depend on the clinical opinion regarding the individual patient.	

CHECKLISTS AND INSTITUTIONAL PROGRAMMES

Strong	Implementing protocols of IVT procedures at healthcare units is recommended.
Strong	Completing a standardised checklist during the process of inserting a central venous catheter or a PICC is recommended.
Weak	It is suggested that the status of vascular access devices after the insertion thereof be recorded in a specific sheet.
Strong	Using institutional programmes to evaluate the handling quality of venous lines is recommended.
Weak	It is suggested that in educational programmes there be feedback about the prior practice or the infection rate of the catheterization team or unit.

Preventing complications in access maintenance

ASPECTS RELATED TO THE SHARED USE OF ACCESSES

✓	The use of a Y-type shared access is advisable versus the intermittent use of another new access.
Weak	The panel finds no differences between suggesting the use of extensions with three-way valves or Y-type extensions in patients who have venous catheterization and need to share the access for taking samples for analyses or administering drugs.
✓	After taking samples, it is advisable to flush the access with an amount of saline solution that is at least double the catheter volume and a minimum of 10 ml.

ASPECTS RELATED TO THE DURATION OF THE CATHETER AND REPLACEMENT TIMES

Strong	It is recommended that the valves and systems be replaced every 4-7 days to prevent complications in venous catheterization.
Strong	It is recommended that venous accesses that are not necessary be removed.
Strong	It is recommended that a catheter not be replaced systematically in a fixed period of time, rather when it is clinically indicated.

ASPECTS RELATED TO THE USE OF CONNECTORS

Weak	For locking access ports, the use of Luer-type threaded connectors with valves is suggested, versus conventional caps, although the cost must be assessed.

ASPECTS RELATED TO THE DETECTION OF COMPLICATIONS

Strong	Monitoring for the appearance of unexplained fever or pain in the insertion zone is recommended, as well as looking for the appearance of reddening.
√	It is advisable to aspirate central catheters prior to the infusion of a fluid to check the permeability of the line.

Actions in the event of complications when catheterizing or during maintenance

Strong	In the event of complications in a peripheral access, removal of the access is recommended.
✓	In the event of an infection related to a peripherally inserted central catheter, it is advisable to remove the catheter, whether or not there is systemic involvement due to the infection.
Strong	In the event of access thrombosis with a peripherally inserted central catheter, removal of the catheter is recommended, previously assuring prevention of thromboembolic disease of the patient using low-molecular-weight heparin.

Strong	In the event of an obstruction of the central catheter that does not de-obstruct using gentle aspiration, it is recommendable to remove the peripherally inserted central catheter, subject to preventing thromboembolic disease of the patient using low-molecular-weight heparin.
Weak	In the event of a catheter-related infection, it is advisable to remove the CVC, whether or not there is systemic involvement due to the infection.
Weak	In the event of venous thrombosis secondary to a central catheter, it is suggested that the access be removed and that the attempt not be made to dissolve the thrombus.
✓	In the event of obstruction of a central catheter, it is advisable that the catheter be removed and that the attempt not be made to remove the obstruction.
✓	In the event of extravasation, it is advisable to have and act according to protocols based on standards of good practices.

1. Introduction

Intravenous therapy (hereinafter, IVT) is the administration of liquid substances (used for hydration, for administering drugs or nutrition) directly in the vein through a needle or tube (catheter), thereby allowing immediate access to the blood flow. Compared to other administration routes, the intravenous route is the quickest means for providing solutions and drugs, plus it is the only administration route for some treatments, such as transfusions. It is essential for handling hospitalised patients, especially critical, chronic and oncology patients, and increasingly for handling home care patients.

It is the invasive procedure most frequently used in hospitals, about which the US Food and Drug Administration reported the appearance of 250 different types of complications related to the administration of intravenous therapy (Mermel, 2001). The presence of such complications was fundamentally due to variability in the criteria for indicating, maintaining and replacing catheters; in hygiene measures; or in preparation of the puncture zone, among others. This variability in clinical practice also involves patient suffering, the deterioration of their venous system, the risk of suffering from local and systemic infections and inadequate use of existing resources.

In fact, information is continuously being published about inadequacy when using intravenous therapy and the repercussions of complications on survival, the increase in the number of hospitalisation days and the increase in cost that such circumstances have on the Healthcare System (Mestre, 2012).

To improve clinical practices in intravenous therapy, it is advisable for the professionals involved to proactively assess the complete healthcare loop that IVT encompasses for each patient, prior to implanting the device and according to the patient's needs. However, in our environment and up until the preparation of this guideline, professionals did not have an evidence-based document that provided them with a comprehensive approach to standardised strategies for providing intravenous therapy.

Within this context, this clinical practice guideline (CPG) has been prepared based on scientific evidence. It provides recommendations for professionals and patients to offer quality, safe, accessible and efficient health care.

The guideline originates with the desire to be a benchmark that attempts to contribute to improving the quality of health care for patients for whom intravenous therapy is indicated, preventing complications related to intravenous therapy and reducing the variability that exists among professionals.

The users of this CPG are healthcare professionals who take part directly in taking care of patients with IVT (basically doctors and nurses). Likewise, the guideline is designed for other health professionals, such as nursing assistants, laboratory technicians, image diagnostic technicians, physical therapists, etc. It is also targeted at healthcare managers and persons who are responsible for health strategies. The guideline also includes information targeted at caregivers for those situations in which intravenous therapy is administered at home.

The CPG includes recommendations for taking care of patients with intravenous therapy who are at primary care centres, hospitals and homes. Its content reflects the evidence at the time it was prepared, up to May 2012. In light of the advance in knowledge in this field, it will need to be updated in 3 years.

The guideline is presented in four formats: a complete version, with all its elements and appendixes; the summarised version; the short version or quick-help tool, which includes

indications for use, decision diagrams, clinical questions and recommendations; and finally, a version for patients, with the recommendations in which their participation is most relevant regarding shared decisions with the professionals who are providing their care.

The development process of the guideline is detailed in the corresponding section.

How to use the Guideline

It is advisable to prepare a plan for dissemination and implementation at healthcare services, where the plan should be integrated in the quality programmes of those services (Briones, 2008). To facilitate the use of this guideline, it is essential that professionals have easy access to both the quick guide and the appendixes, which illustrate the practical aspects of use. Diagrams of use are provided to schematically facilitate the decision point that a professional might want to consult within the process of IVT care.

Strategies and tools for facilitating use of the guideline are specified in the dissemination and implementation section.

2. Scope and objectives

Sphere of activity and process

This Clinical Practice Guideline on Intravenous Therapy with Non-permanent Devices in Adults is framed within the Programme of Clinical Practice Guidelines in the National Health System of GuíaSalud, within the framework of developing activities of the Spanish Network of Health Technologies Assessment Agencies and Services of the SNS, financed by the Ministry of Health, Social Services and Equality (MSSSI).

IVT is an intervention that is used extensively in healthcare, given that there are a multitude of occasions in which intravenous access is required, and not just for directly therapeutic interventions, but also diagnostic and nutritional. Even though such intravenous access is often occasional, on many others the duration is short- or medium-term, and on more than a few it is chronic. It takes place in all areas of healthcare activity, including private homes. Such a diversity of situations leads to great variability in use by healthcare professionals, with added financial considerations not only due to the individual decision of a patient, but also due to the mass accumulation represented by the extensive use of IV therapy. It is therefore necessary to prepare a clinical guideline that provides orientation for decision-making in this field.

The CPG includes recommendations for taking care of adult patients with intravenous therapy who are at primary care centres, hospitals and homes.

The clinical aspects that will not be covered in the Guideline are the following:

a. Permanent implantable ports.

b. Individuals who are not admitted to a healthcare centre and their intravenous access is for the occasional extraction (frequency of less than once per week) of a biological sample for analysis.

c. The technical procedures of venous catheterization.

d. Vascular access for dialysis.

e. The particulars of IVT in the child population, under the age of 14.

Target population

The target population of this guideline is adult patients who require non-permanent venous access for administering any type of intravenous solution.

Users

The potential users of the guideline are all healthcare professionals, specifically in the medical and nursing field, who take part in caring for patients with intravenous therapy. Other healthcare professionals involved in patient care and attention are also targets, such as nursing assistants, laboratory technicians, image diagnostic technicians, physical therapists, etc. Likewise, the guideline is targeted at persons who are responsible for health strategies and healthcare managers.

The CPG also includes relevant information for caregivers (in those situations in which intravenous therapy is administered at home), above all in those sections that refer to measures for preventing infections and extravasation and refer to warning signs of unfavourable evolution.

Objectives

The main objective of the Guideline is to provide healthcare professionals with a tool that allows them to make decisions based on evidence about aspects of adult patient care who are indicated for intravenous therapy with non-permanent devices. Moreover, we could highlight the following secondary objectives:

Increasing the quality of interventions.

Preventing complications related to intravenous therapy.

Reducing the variability that exists among healthcare professionals.

3. Methodology

The methodology used is based on the Methodological Manual for preparing clinical practice guidelines of the National Health System (2007 CPG Working Group, http://portal.guiasalud.es/web/guest/herramientas-gpc) and on the recommendations made by the GuíaSalud Scientific Committee regarding the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology. The steps below have been followed:

Establishment of the development group of the guideline

Formed by a multi-disciplinary working group composed of professionals with a clinical and methodological profile and experience on preparing evidence-based CPGs, in addition to internal and outside advisers contacted through the various scientific societies related to the subject of the Guideline, while following the criteria of diversity, amplitude of interests, qualification and availability.

The development group conducted search tasks, it critically assessed and synthesized the evidence, and it drafted the recommendations. Likewise, it prepared the clinical questions and conducted all the necessary tasks for presenting a final document proposal of the guideline before being definitively approved. The training needs of the group were covered to guarantee the uniformity of criteria and teamwork.

The development group has relied on the advising of a group of expert collaborators. This group of experts in the area of IVT (mainly formed by scientific societies, although not exclusively) should be considered as jointly responsible for and co-author of the guideline. It has participated in making suggestions and corrections to documents regarding the scope and objectives, to the list of questions, to the bibliographical review and to preparation of the recommendations that were generated by consensus. Furthermore, these expert collaborators have approved the final document of the guideline before submitting it to an external review, prior to definitive approval.

For members to join the development group, and as expert collaborators, they were required to complete a form of activities that could constitute potential conflicts of interest. This form and an assessment thereof by the coordinator constituted an essential requirement for participating in the development group. Appendix 2.

For the external review, this development group relied on a broad group of persons who have interest in the guideline, which includes reviewing the final document of the guideline in order to make suggestions, which were assessed by the development group for inclusion in the guideline.

A working timeline was established, which recorded the different phases of the guideline and the execution deadlines.

Formulation of clinical questions

After specifying the scope and objectives of the guideline, the members of the working group defined, in an initial meeting, the sequence of important decisions in this field, and they made a proposal of clinical questions in each one of the phases. Subsequently, the list of questions was restructured following the PICO format: Patient, Intervention, Comparison and Outcome.

A GRADE grid was used to identify the relevant outcome measurements in each question, as well as the measurements that were common to several questions, and the relevant importance of each measurement among members of the group was voted on (Guyatt, 2008).

The importance of the variables was classified based on the following 9-point scale:

- **1** to **3:** outcome variables that are not important for making decisions and do not play a major role in formulating the recommendations.
- **4** to **6:** outcome variables that are important but no key for making decisions.
- **7** to **9:** outcome variables that are critical and key for making decisions.

With this information, an outcomes table was prepared (Table 1) using the mean from the scores after two votes that pre-selected the outcomes, and the outcomes that were critical for making decisions in the guideline were decided on by consensus, as well as those that were important and unimportant.

Search methods for identifying studies

To produce the CPG, studies published in English, French, Portuguese, Italian and Spanish were used. The references of all the studies used for this guideline were managed using the Mendeley[1] bibliography manager.

The first search was conducted with the objective of identifying the CPGs that dealt with general or partial aspects of intravenous therapy. Therefore, query strategies were constructed in the MEDLINE and EMBASE mass reference databases to recover records of studies published between 2000 and 2011 (November). For this purpose, both databases were consulted using the OvidSP[2] interfaceTPF FPT.

The aforementioned search strategies can be consulted in Appendix 3.Of the 741 references found, after checking their correspondence to the population, pathologies and interventions specified in the scope, 23 were selected for reading of the complete text. Finally, 10 studies were considered relevant CPGs for the objective of this guideline.

With this list of relevant guidelines, a CPG adaptation process was followed according to the methodology proposed in the Osteba report (Etxebarría, 2005), using a process that consisted of the following, summarised steps:

1. Deciding if the document was or wasn't a CPG. First, each document was analysed, and they were checked to determine if they actually responded to the definition of a

1 Mendeley is a partially free reference manager located at http://www.mendeley.com/

2 Accesses to the databases were provided through:
a) Biblioteca Virtual del Sistema Sanitario Público de Andalucía (http://www.bvsspa.es/)
b) Biblioteca de la Universidad de Sevilla (http://www.us.es/)
c) *IMVS Pathology* (*Department for Health and Ageing, Government of South Australia*. [http://www.imvs.sa.gov.au])

guideline according to the criteria of the CPG Catalogue in the SNS of GuíaSalud (http://portal.guiasalud.es/ web/guest/criterios-catalogo-gpc).

- Assessing if the document includes information for helping health professionals and/or patients to make decisions about adequate care for specific clinical situations. Documents of a regulatory or administrative nature are excluded, such as therapeutic guides or work procedures.
- Assessing if the CPG has been adapted or updated following a proven methodology. The methods used to search for scientific evidence must be described, including the search terms, the consulted sources and the covered range of dates, as well as the inclusion and exclusion criteria used.
- Determining if it is based on evidence that has been prepared or updated in the last 5 years. If the search is earlier, an assessment is made to determine if updating it is worthwhile.
- The recommendations must be explicit and linked to the bibliography so that the sources and evidence on which they are based can be identified.

Those documents that do not comply with any of these criteria did not go on to the next phase. Many of them were determined to be a consultation or reference document.

2. Assessment using the Appraisal of Guidelines for Research and Evaluation (AGREE II (2011)). The 9 documents that met these criteria were independently evaluated by 4 evaluators according to the instructions in the AGREE manual regarding how to score and the final recommendations. A spreadsheet was used to score each domain individually in each guideline and to calculate the overall scores. The scores obtained in each one of the AGREE II domains and the selected guidelines are presented in Appendix 4 (http://www.juntadeandalucia.es/salud/servicios/aetsa/ pagina.asp?id=2).
3. Selection according to the overall score. The guidelines that had an overall rating of 4 or more (according to AGREE II) and that were likewise qualified as recommendable by the evaluators (recommended or highly recommended) were selected.
4. Record of the selected CPGs and description of useful data. A sheet with the following data was prepared:
   - The organisation producing the guideline.
   - Date of publication or updating.
   - Population/context of application.
   - Financing.
   - Description of methodological aspects: the search (sources, presence of search strategies, end date of the search), the scale used for classifying levels of evidence and grades of recommendation, the presence of evidence tables and the method used for formulating the recommendations.
5. The application of criteria for deciding which questions are answered by the accepted guidelines. To assess this aspect, the criteria of the Osteba report were used, thereby deciding if a new, complete or partial review were necessary or if the evidence provided by the guideline or the Cochrane review could be adopted (Etxebarria, 2005).

With these data, a table of key questions posed was prepared, which questions could be answered by each one of the guidelines, and the extent to which they completely and consistently responded to each one of the questions was checked. Likewise, a search for systematic reviews was conducted in the Cochrane Library, and those reviews that answered one or more of our questions, which were not answered by the selected clinical practice guidelines, were included.

The second search focused on the questions that could not be answered by the CPGs, and it was directed at published primary studies. They were identified using query strategies adapted to each of the research questions formulated to comply with the objectives of this guideline.

On all occasions, the MEDLINE (OvidSP), EMBASE (OvidSP or EMBASE.COM) and CINAHL (EBSCOhost) mass reference databases were queried. These strategies are described in detail in Appendix 3 (http://www.juntadeandalucia.es/ salud/servicios/aetsa/).

Initially, all the strategies had syntax elements designed to recover primary studies that used some clinical trial methodology, but when the results obtained with this approach were irrelevant or very scarce, a search strategy with greater sensitivity was used, which included other types of study design.

The lists of references of all the studies obtained, particularly CPGs, were analysed to identify additional studies that were relevant for the objectives of this guideline. From said search, 4363 references were identified, which were reviewed, by their title and summary, to assess if they could contribute empirical information to the guideline. The majority of these references were discarded, with 310 selected for complete reading. Of those, 116 original articles or reviews were finally assessed critically due to meeting the pre-selection criteria. 87 articles are included as references in the guideline, in addition to the 9 clinical guidelines.

Formulation of recommendations using the GRADE system

For each question, a summary of evidence was prepared according to the review of literature. For assessing the studies and estimating the risk of bias, the critical reading sheets included in Appendix 12 of the GuíaSalud Methodology Manual were used. In the cases in which there was a CPG of good quality or a Cochrane review, they were used to prepare the summaries of evidence. For all the other questions, new searches were conducted, likewise assessing the quality of the studies that were considered relevant.

Assessment of the quality of the scientific evidence

The GRADE system proposes a series of factors that can decrease the quality of clinical trials (considered to be of high quality) and other factors that can increase the quality of observational studies (considered to be of low quality).

The aspects that can decrease the quality of a controlled clinical trial (CCT) are the following:

- **Limitations in the design or in the execution:** such as the absence of concealment of the allocation sequence, inadequate masking, considerable losses, the absence of an intention-to-treat analysis or the end of the study before expected due to profit reasons.
- **Inconsistent outcomes:** when the estimates of the effect are very different among the available studies, it is possible that there is heterogeneity not reasonably explained, which decreases the confidence we could have in the outcomes of a study.
- **Absence of direct scientific evidence:** if there are no direct comparisons between two treatments (comparison of each treatment versus placebo, but not between treatments).

In others, the outcomes of a study with a certain intervention are extrapolated to all other studies of the same class, in the absence of a demonstrated effect. There are frequently major differences between the population where the recommendations will be applied and the population included in the assessed studies.

- **Inaccuracy:** when the available studies include relatively few events and few patients and they therefore present broad confidence intervals, which can show both positive and negative effects for the patient.
- **Notification bias:** the quality, and therefore the confidence, can decrease if there is reasonable doubt about whether or not all the studies have been included (for example, publication bias within the context of a systematic review) or whether or not the authors have included all the relevant outcome variables (notification bias).

On the other hand, the aspects that can increase the quality of observational studies are the following:

- **Important magnitude of the effect:** when the observed effect shows an association that is strong (Relative Risk [RR] > 2 or < 0.5) or very strong (RR > 5 or < 0.2) and consistent, based on studies without confusion factors, it is unlikely that it is due solely to a weaker design of the study. On these occasions, the quality can be considered to be moderate or even high.
- **The presence of a dose-response gradient.** Situations in which all the possible confusion factors could have reduced the observed association. In cases in which the patients who receive the intervention of interest have a worse prognosis, yet they show better outcomes than the control group, it is likely that the observed real effect is greater.

According to these criteria, the quality of the evidence was classified as high, moderate, low or very low for each variable and question of interest.

Preparation of the recommendations

The recommendations were prepared following the GRADE methodology, thereby considering the quality of the evidence, the balance between benefits and risks, the values and preferences of the patients involved and the use of resources. With this information, a first draft of recommendations was prepared, which was provided to the expert collaborators on the consensus panel. For final preparation, a structured consensus process was implemented based on the DELPHI methodology, therefore incorporating the best possible knowledge on the problem, even for those questions in which the evidence is very low quality according to the criteria included in Table 2 (Jaeschke, 2008). Regarding the recommendations prepared by the development group for which the group of expert collaborators did not reach a consensus, this circumstance is recorded, and the recommendations are established as standards of good practices.

For each question, it was posed to the panel whether or not the favourable effects of a recommendation exceeded the inconveniences, the adverse effects and the costs by a sufficient margin. The strength of a recommendation reflects the expert panel's degree of confidence in the assessment. The implications of a STRONG recommendation in favour or against are included in Table 3.

The expert consensus method, which incorporates the GRADE mechanisms for eliciting subjective opinions, was applied according to the following steps (Jaeschke, 2008):

1. In the initial phase, the opinion of each expert is recorded individually and anonymously using a voting sheet that records how the vote is cast and the strength

of the recommendation. The recommendations adopted from good quality guidelines were reviewed by the panel to validate them and decide if they required specific voting.

2. In a second phase, during a panel meeting, the overall distribution of the group's opinion is presented regarding each posed question.
3. Subsequently, there is a limited round of comments, thereby clarifying the scenario to which the question refers and the possible factors that could have an influence on discrepancies, together with evidence that supports the alternatives. The types of patients, the interventions to be performed, the comparators and the measurement of the outcomes are clarified.
4. After this round, a new, individual and secret vote of each expert is requested in light of the collective judgement in the preceding step. Usually, after this second round, a tendency towards convergence is observed, or clarification about whether or not it is possible to identify a point of consensus, but without forcing it.
5. After this second vote, the results are presented to the panel, thereby identifying the questions in which a consensus has not been reached. The experts are asked if there is any possibility of finding a consensus regarding those questions, based on the fact that some of them might modify their vote in view of the result of the previous vote. If no expert believes that a new collective round of discussion or voting could facilitate the identification of a consensus, those questions are categorised as "without consensus".

To assess the level of consensus, the following criteria were followed: a recommendation in favour or against a specific intervention (compared to a specific alternative) requires that at least 50% of the panellists vote in favour of one of the options, without more than 20% against. In the event that this criterion were not met, no specific recommendation is made. Likewise, to qualify a recommendation as strong, at least 70% of the panellists must have voted for it as strong. The concepts are thus clarified: if the absence of the possibility of making a recommendation is confirmed (for example, half the panel leans towards one option and the other half towards another, and the evidence in favour of each one is low quality); or if the strength of a recommendation is resolved when the balance of benefits/harm is not very clear.

Finally, the Guideline contemplates a type of recommendation for those cases in which, despite not having conclusive scientific evidence, there is an important practical aspect that the development group would like to emphasise, because it considers that the aspect concerns an action of good clinical practice, and the use thereof should be promoted. These recommendations are identified with the following mark: ✓

Therefore, the **levels of evidence** used are those recommended by GRADE:

High	⊕⊕⊕⊕
Moderate	⊕⊕⊕○
Low	⊕⊕○○
Very low	⊕○○○

The evidence that supports the **recommendations** is presented as follows:

- CPG adapted and endorsed by the panel **(CPG-panel consensus)**
- Prepared with GRADE:
    - **Strong in favour**

- **Weak in favour**
- **Strong against**
- **Weak against**

- A consensus is not reached on the panel: No recommendation
- Good practices: ✓

Table 1. Factors for decreasing complications by phases of the process

9 experts				13 experts			
1st round scores				2nd round scores			
Type of complication	**Median**	**Median Dev.**	**Dev. %**	**Type of complication**	**Median**	**Median Dev.**	**Dev. %**
Incorrect position	8	3	33.33%	Exitus	9	1	7.69%
Puncture repetition	8	2	22.22%	Catheter-related sepsis	9	0	0.00%
Major bleeding	8	0	0.00%	Surgery secondary to complication	8	1	7.69%
Major laceration	7	0	0.00%	Major bleeding	8	1	7.69%
Pain	7	1	11.11%	Quality of life related to health	7	3	23.08%
Phlebitis	7	1	11.11%	Major laceration	7	2	15.38%
Exitus	7	3	33.33%	Central venous thrombosis	7	0	0.00%
Extravasation	6	0	0.00%	Comfort/ immobilisation	6	1	7.69%
Haematomas	6	1	11.11%	Pain	6	3	23.08%
Catheter-related sepsis	6	0	0.00%	Phlebitis	6	0	0.00%
Minor laceration	5	0	0.00%	Poorly positioned tip	6	3	23.08%
Central venous thrombosis	5	2	22.22%	Prolonged stay	6	3	23.08%
Peripheral thrombosis	5	1	11.11%	Peripheral thrombosis	6	0	0.00%
Surgery secondary to complication	5	3	33.33%	Extravasation	5	1	7.69%
Quality of life related to health	4	3	33.33%	Haematomas	5	2	15.38%
Comfort	4	3	33.33%	Obstruction	5	1	7.69%
Irritation	4	1	11.11%	Loss of access sites	5	1	7.69%
Broken cannula	4	0	0.00%	Pressure ulcers	5	2	15.38%
Pressure ulcers	4	0	0.00%	Irritation	4	3	23.08%
Loss of access sites	3	2	22.22%	Puncture repetition	4	1	7.69%
Obstruction	3	3	33.33%	Broken cannula	4	2	15.38%
				Minor laceration	3	1	7.69%

Table 2. Factors that influence the strength of a recommendation

FACTOR	EXPLANATION
Balance between positive and negative effects	The greater the difference between them, the greater the possibility of a strong recommendation
Quality of the evidence	The greater the quality, the greater the possibility of a strong recommendation
Values and preferences	The greater the variability or uncertainty in values and preferences, the greater the possibility of a weak recommendation
Costs (distribution of resources)	The greater the impact, the lesser the possibility of a strong recommendation

Table 3. Examples of the implications of making a strong or weak recommendation

STRONG RECOMMENDATION
For patients – most people in this situation would opt for the recommended course of action, and only a small percentage would not.
For clinicians – most patients should receive the intervention.
For quality evaluators – adherence to the recommendation can be used as a quality criterion or a performance indicator. If clinicians choose not to follow the recommendation, they should justify it.
WEAK RECOMMENDATION
For patients – most people in this situation would opt for the recommended course of action, but many would not.
For clinicians – the evidence must be reviewed, and the subject must be prepared in the event that it has to be discussed with colleagues or with the actual patient, thereby including their values and preferences.
For quality evaluators – the discussion among clinicians and the considerations of the pros and cons, as well as documenting this debate, could be used as a quality criterion.
WITHOUT A SPECIFIC RECOMMENDATION
The advantages and disadvantages are equivalent after reviewing all the information.
There isn't sufficient evidence to make a recommendation.

4. How to use the Guideline

Diagrams of use

This guideline presents 4 clinical scenarios in its content, which correspond to the phases of the process that healthcare professionals regularly encounter in their clinical practice with respect to IV therapy.

The major scenarios are in turn divided into mini-scenarios for each of the situations that can come up during IV therapy. The major scenarios are the following:

- **Planning for the start of IV therapy (IVT**
- **Preventing complications when catheterizing**
- **Preventing complications in access maintenance**
- **Actions after complications when catheterizing or during maintenance**

The entire process has been included in 5 algorithms, one of which is general and the others are for each of the major scenarios and their mini-scenarios. They include the dynamics of patient care and the recommendations that are applicable to the patient in each clinical situation. (See Figure 1-5).

Figure 1

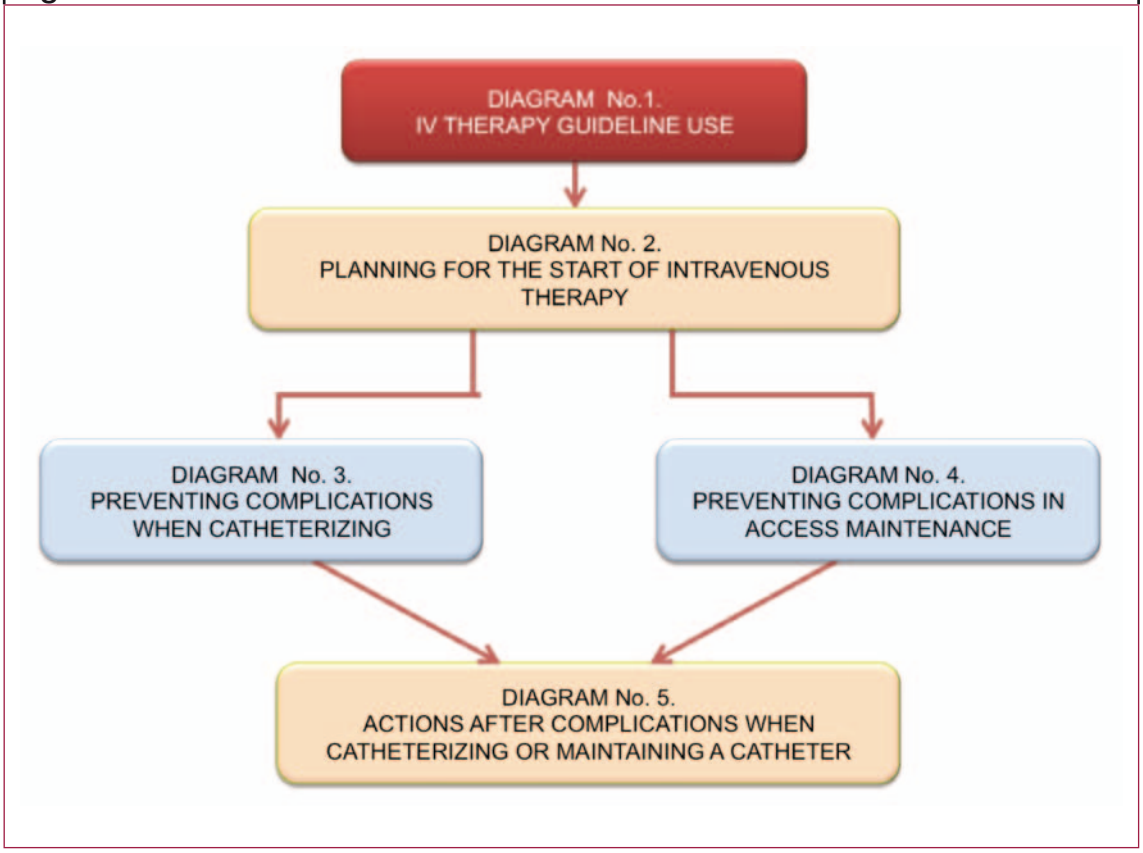


Figure 2

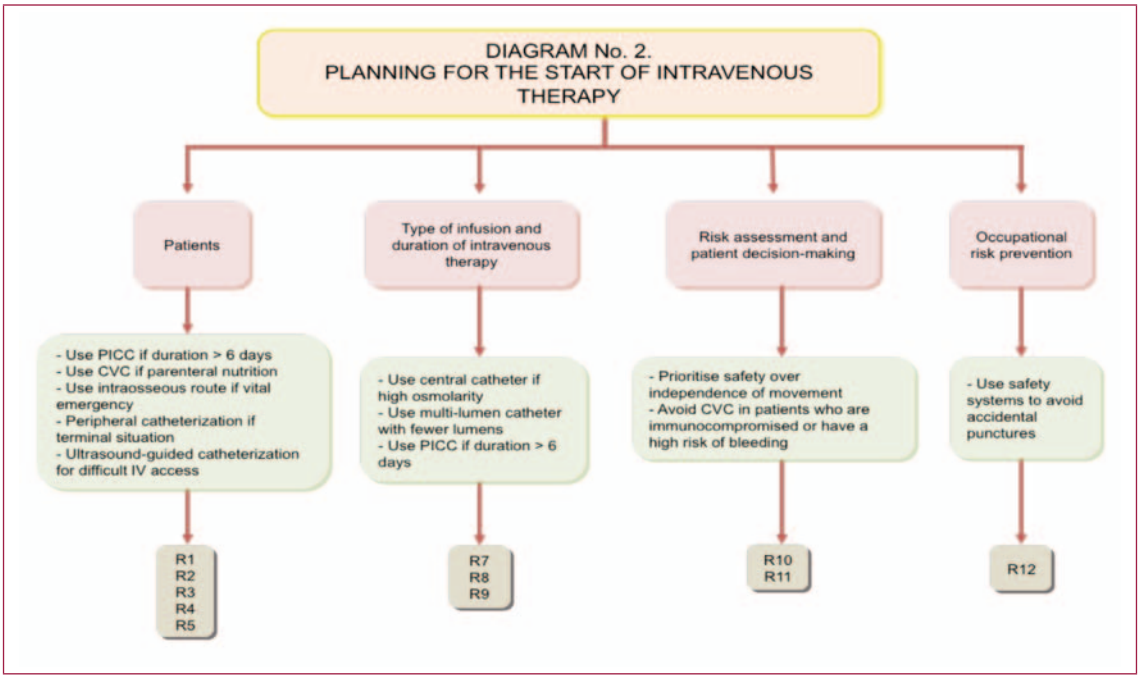


Figure 3

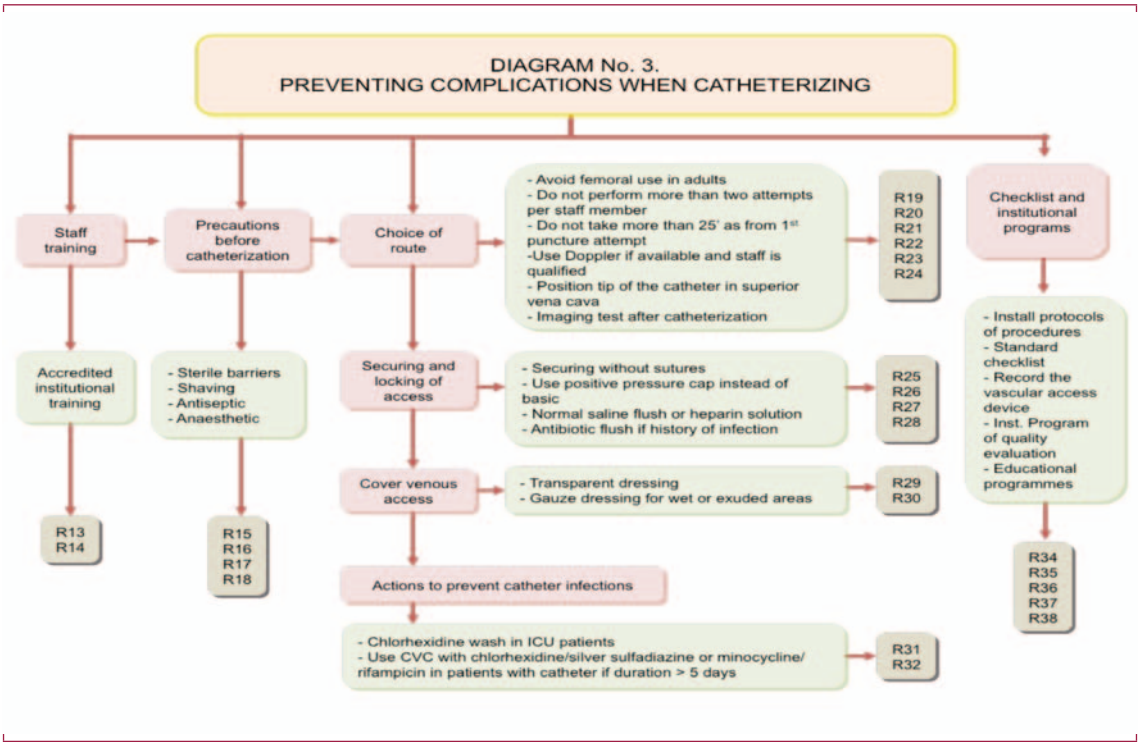


Figure 4

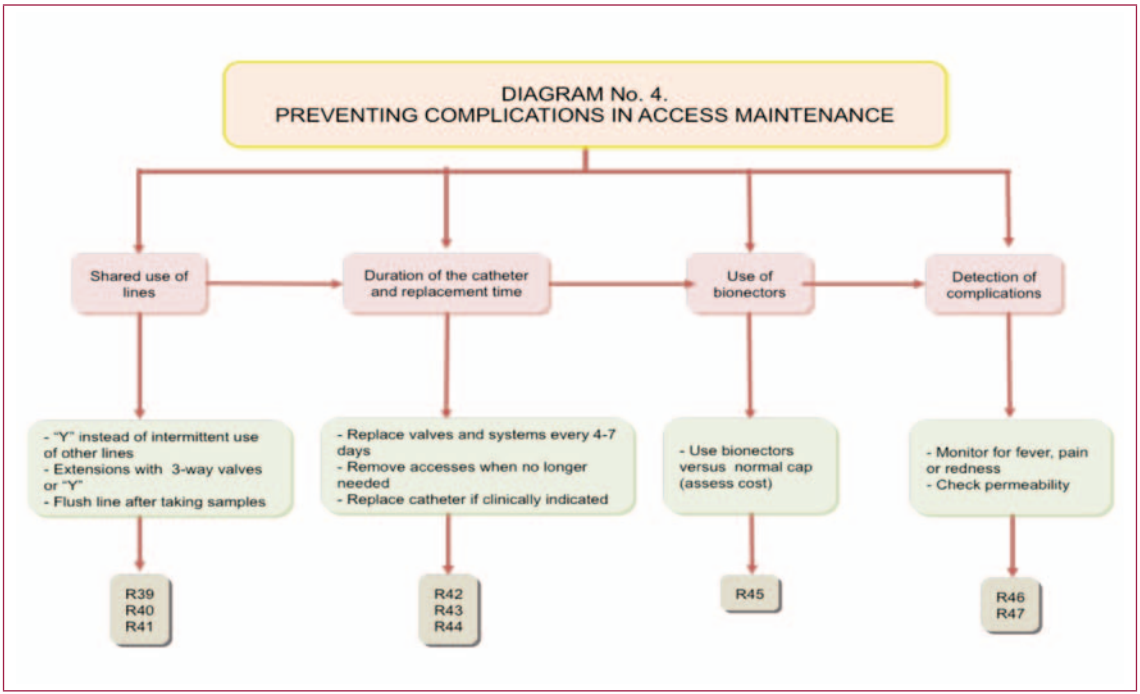
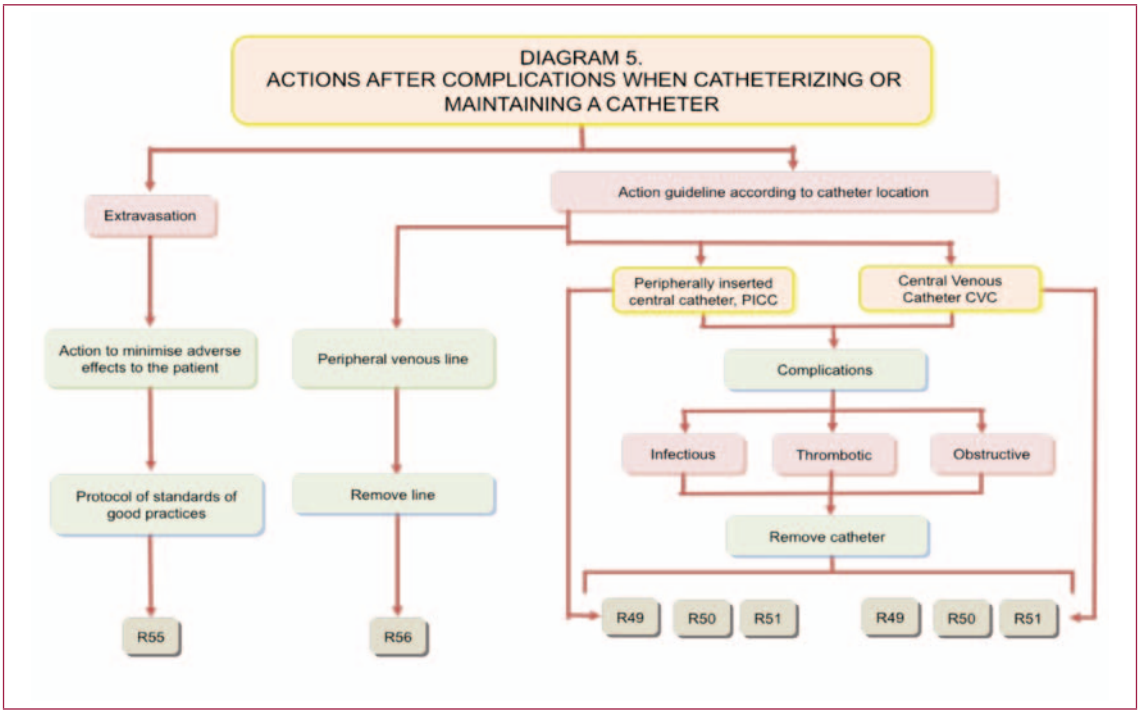


Figure 5



5. Planning for the start of IV therapy (IVT)

5.1. Aspects related to the patient

Questions to be answered

P1. For hospitalised patients, what type of venous access is indicated to avoid complications and repeated punctures?

P2. For outpatients, what type of venous access is indicated to avoid complications and repeated punctures?

P3. For patients with a life-threatening emergency, if venous catheterization is not possible, is intraosseous access indicated to avoid complications and repeated punctures?

P4. For patients in a terminal situation with palliative needs, does peripheral catheterization versus a peripherally inserted central catheter (PICC) or a central line allow avoiding repeated punctures and improving the patient's comfort?

P5. For patients with poor venous access, is the blind placement of a long-term central line associated with a fewer number of complications than attempting peripheral catheterization or an ultrasound-guided PICC?

P6. For patients who need to have periodic samples taken (daily/alternate days), does maintaining an access versus repeated, specific punctures decrease complications or increase patient satisfaction?

P1. *For hospitalised patients, what type of venous access is indicated to avoid complications and repeated punctures?*

Low quality

The CDC guideline (O'GRADY, 2011) proposes the use of a midline catheter or a PICC, instead of a short peripheral catheter, when the duration of IV therapy will likely exceed six days.

In an open CCT that included 60 patients admitted to Internal Medicine with an expected stay of greater than 5 days, peripheral access was compared to the PICC (Periard, 2008). Even though the study prematurely ended patient recruiting because the pre-established rate of adverse events was reached in one of the groups, it could be verified that the frequency of major complications, such as clinically insignificant deep vein thrombosis (DVT), was significantly greater in patients with a PICC (22.6%) than in patients with peripheral access (3.4%), but the frequency of phlebitis was lower (29% versus 37.9%). On the other hand, the mean of catheters used in each patient was lower in the PICC group (1.16) in comparison with the group with peripheral accesses (1.97), although the latter required more punctures for taking analytical controls (2.27 versus 1.16). In this regard, 96.8% of the patients were satisfied with the PICC for administering drugs and taking samples, while only 79.3% of the patients with peripheral access were satisfied. Finally, the estimated cost of using a PICC per person was 690 dollars, versus 237 dollars if peripheral accesses were used.

The authors of the study consider PICCs to be efficient and satisfactory for hospitalised patients with comorbidity who require treatment through venous access for more than 5 days.

The development group considered the phlebitis outcome less important and the high incidence of DVT more important, wherefore it was concluded that PICCs should not be considered as the first option and should be reserved for patients with peripheral catheterization difficulties who require frequent analytical controls or a more prolonged catheterization time.

P2. *For outpatients, what type of venous access is indicated to avoid complications and repeated punctures?*

In a retrospective study, the presence of catheter-related infections was evaluated in 91 patients catheterized with a PICC, in 24 of whom central venous catheters were inserted to maintain parenteral nutrition at their home. The catheter-related infection rate was 0.458 per 100 catheter days in patients with a PICC versus 0.245 per 100 catheter days in those who had other central venous accesses ($p < 0.01$). Therefore, the use of PICCs versus other central venous accesses could be associated with an increase in catheter-related infections, at least if parenteral nutrition is infused (DeLegge, 2005). **Very low quality**

P3. *For patients with a life-threatening emergency, if venous catheterization is not possible, is intraosseous access indicated to avoid complications and repeated punctures?*

In one prospective observational study conducted at a trauma hospital, which included 91 patients who arrived at the emergency-CPR room without adequate venous access, it could be verified that the success in obtaining access in the first attempt was 80.6% for intraosseous access, 73.7% for peripheral venous access and 17% for central access, with a mean time of 3.6 minutes until a good flow was obtained for the peripheral access, 15.6 minutes for the central access and 1.5 minutes for the intraosseous access. However, the perception of pain during both insertion and infusion, measured according to the visual analogue scale (VAS), was around 4 points greater for the intraosseous access that the peripheral venous access. On the other hand and without statistical significance, extravasation was more frequent in the central venous access (70.6%) than in the peripheral venous access (33.7%) or the intraosseous access (44%) (Paxton, 2009). Another CCT (Leidel, 2010), of only one centre, not blind and of moderate quality, randomised 40 adult patients with two different intraosseous access systems in emergency patients in which catheterizing a central or peripheral access had failed on three occasions. With both systems, access was attempted on the humeral head. In 85% (Confidence Interval [CI] of 95%, 73.9 – 96.1), catheterization was successful in the first intraosseous attempt, and the time as from disinfection of the puncture zone until infusion began was 2 minutes (95% CI, 1.7 – 2.3). No patient had complications, and no differences between the two intraosseous access methods were found. **Low quality**

The authors conclude that the intraosseous catheter is faster for insertion than the peripheral or central catheter, with a scarce frequency of minor complications (extravasation, infection, compartment syndrome or displacement), and the perception of pain is greater than with central venous or peripheral accesses. Wherefore the catheterization of an intraosseous access could be considered the best option in emergency situations for patients with bad peripheral venous accesses (Paxton, 2009), and therefore in the areas where it is contemplated, specific training on the technique and on handling the complications should be given.

P4. *For patients in a terminal situation with palliative needs, does peripheral catheterization versus a peripherally inserted central catheter (PICC) or central line allow avoiding repeated punctures and improving the patient's comfort?*

Very low quality

In a small cohort study with methodological limitations, which included 39 patients with cancer in a terminal situation in whom a PICC was inserted, it was verified that only 30% of the subjects related having pain at the time of catheterization, but after insertion, over 90% considered the PICC to be a convenient and comfortable alternative for them (Yamada, 2010). This idea agrees with the preferences shown by the relatives of patients in similar studies in Italy and Japan (Mercadance, 2005; Morita, 2006). On the other hand, in the Yamada study (2010), the catheter could be maintained until the time of death in 82% of the cases, and only the presence of oedemas in 8% and access obstructions in 18% (more than half reversible) were recorded as complications.

Thus, the insertion of a peripheral catheter or a peripherally inserted central catheter could be a safe, convenient and satisfactory measure for patients with cancer in a terminal situation, although the decision should be individual and considering the patient's situation, their location and possible alternatives, such as the subcutaneous route, which is suggested if the oral route is maintained.

P5. *For patients with poor venous access, is the blind placement of a long-term central line associated with a fewer number of complications than attempting peripheral catheterization or an ultrasound-guided PICC?*

Low quality

In situations that do not constitute a life-threatening emergency, the guideline of the Registered Nurses Association of Canada (RNAO, 2004) recommends (based on low-quality evidence) that the election of the best venous access option should be based on factors evaluated through physical exploration, such as (Bowers, 2008; Santolucito, 2011; Galloway, 2002): the circulatory condition (circulatory problems, lymphoedemas and swelling after surgery), the vascular situation, the integrity of the skin, obesity and hydration.

In our environment, a recent prospective observational study of low quality (Moraza-Dulanto, 2012) conducts follow-up on ultra-sound guided insertion of 165 PICCs in the basilic vein in oncological adults, thereby observing successful insertion (no complications and the tip in the superior vena cava) of 85.5% (95% CI, 80.1 – 90.8), with a median catheter presence of 92 days, at the expense of scarce complications of 0.986 per 1000 catheter days, such as accidental extraction (95% CI, 0.970 – 1.001 / 1000 days). The thrombosis rate was 0.308 / 1000 days (95% CI, 0.299 – 0.317) and catheter-related bacteraemia of 0.062 / 1000 catheter days (95% CI, 0.058 – 0.065). They support the utility of using ultrasound in PICC insertion at the bedside, with a high probability of successful insertion, which can be performed by trained nurses.

P6. *For patients who need to have periodic samples taken (daily/alternate days), does maintaining an access versus repeated, specific punctures decrease complications or increase patient satisfaction?*

In a blind prospective study conducted in Spain, which included 100 patients attended in the emergency area, the accuracy in analytical results was compared according to the extraction of samples by direct vein puncture versus sample extraction through a peripheral catheter. The values of leucocytes, erythrocytes, haemoglobin, hematocrit, platelets, prothrombin time, cephalin time, fibrinogen, glucose, urea, creatinine, sodium and potassium are compared, without finding differences in the results (Granados Gámez, 2003). **Very low quality**

Obtaining blood samples through a peripheral venous catheter can be a method as reliable and valid as a direct venous puncture (Grandados Gámez, 2003). On the other hand, a study with a cohort of cancer patients in a situation of final days verified that it is more comfortable to have a venous access rather than suffer repeated punctures. 90% of the patients preferred it. (Yamada, 2010).

Summary of the evidence

Low ⊕⊕○○	**P1.** Evidence obtained from an open clinical trial with patients hospitalised in Internal Medicine (Periard, 2008) finds that, using PICCs instead of peripheral accesses, fewer catheters per patient are used, there are a fewer number of venipunctures and greater patient satisfaction, although there is a greater incidence of clinically insignificant deep vein thrombosis. They conclude that PICCs are efficient and satisfactory for hospitalised patients with comorbidity who require treatment through venous access for more than 5 days. With PICCs, fewer catheters per patient are used, there are a fewer number of venipunctures, and there is greater patient satisfaction, although there is a greater incidence of clinically insignificant deep vein thrombosis.
Very low ⊕○○○	**P2.** The use of PICCs versus other central venous accesses could be associated with an increase in catheter-related infections, at least if parenteral nutrition is infused (DeLegge, 2005).
Low ⊕⊕○○	**P3.** Evidence obtained from an observational study (Paxton, 2009) and a CCT of moderate quality (Leidel, 2010), in which they find that in life-threatening emergency situations, the intraosseous route has a greater success rate in the first attempt and takes less time to have a good flow.
Very low ⊕○○○	**P4.** In patients in a terminal situation, the insertion of a peripheral catheter or a peripherally inserted central catheter is well tolerated and accepted by the patient and their family.
Low ⊕⊕○○	**P5.** Evidence obtained from clinical practice guidelines, in which using certain aspects of the physical exploration to choose the best venous access option is recommended. Ultrasound can be useful for PICC insertion by trained nurses.
Very low ⊕○○○	**P6.** Evidence obtained from small studies (Granados-Gámez, 2003), which do not find differences in the analytical results of samples taken by direct venous puncture versus those taken from a peripheral catheter.

Recommendations

Weak	**R1.** For hospitalised patients whose IV therapy is expected to last longer than 6 days, a PICC is suggested for use as venous access.
Weak	**R2.** For outpatients who require venous access over several days, a peripherally inserted central catheter is suggested, unless parenteral nutrition is required, for which a CVC has a better risk profile.
Weak	**R3.** The use of an intraosseous access is suggested in the event of a life-threatening emergency and the impossibility of inserting a venous catheter.
Weak	**R4.** For patients with palliative needs in a terminal situation and requiring venous access, peripheral catheterization is suggested.
Weak	**R5.** For patients with difficult venous access, a central venous catheter is suggested, or a peripherally inserted, ultrasound-guided catheter if available and there is experience using it.
R6. The panel does not reach a consensus about the decision between maintaining a catheter or making repeated punctures for taking samples, wherefore the decision must be made based on the circumstances and preferences of each patient.	

5.2. Aspects related to the type of infusion and the duration of IV therapy

Questions to be answered

P7. For a patient who needs an infusion with non-physiological pH, osmolarity or particle size, does the use of a central catheter versus a peripheral one have fewer complications related to obstruction, phlebitis, irritation or thrombosis?

P8. When it is necessary to administer IVT through several lumens, is the use of a multi-lumen catheter more effective at preventing infections than the use of several access lines?

P9. Depending on the duration of IVT, what type of line is indicated to avoid complications?

P7. *For a patient who needs an infusion with non-physiological pH, osmolarity or particle size, does the use of a central catheter versus a periphera*

Very low quality

Infusions that are different from the range of blood by osmolarity and pH can cause endothelial damage and subsequent phlebitis or thrombosis, which are the most likely complications to the extent that the difference in characteristics is greater. The flow speed at the tip of the catheter also has an influence. This means that the thicker the vein, the greater the dilution of the infusion and less vascular damage (Maki, 1991). Therefore, parenteral nutrition, chemotherapy and irritating products with characteristics outside the stated range must be infused through lines with the tip of the catheter in the superior vena cava (SVC) (INS, 2011). A low-quality, quasi-experimental study that implements an access selection algorithm according to the type of infusion suggests a decrease in complications by following the 3 stated criteria (Barton, 1998).

Despite the low quality of the evidence, the guideline of the RNAO (RNAO, 2004) recommends the following with a high grade, based on a consensus: "To determine the most adequate type of vascular access, the nurse must consider the type of prescribed therapy. The criterion for using a peripheral access should meet the following: Osmolarity < 600 mOsm/L; pH between 5 and 9; non-irritating medication".

P8. *When it is necessary to administer IVT through several lumens, is the use of a multi-lumen catheter more effective at preventing infections than the use of several lines?*

Moderate quality

One meta-analysis (MA) of good quality, which included 15 CCTs although it analysed only those of the best quality, concludes that the use of catheters with several lumens (multi-lumen) is not significantly associated with a greater risk of catheter colonisation [*Odds Ratio* (OR) 1.78; 95% CI, 0.92 – 3.47] or of catheter-related infection [OR 1.30; 95% CI, 0.50 – 3.41] versus the use of single-lumen catheters. Moreover, the utility of being able to use several lumens exceeds the slight possible disadvantage of increasing the risk of infection involved with multi-lumen catheters (Dezfulian, 2003).

However, analysing another, different outcome, one systematic review (SR) of good quality, which included 5 CCTs with 275 patients using multi-lumen catheters and 255 using catheters with a single lumen, concludes that the risk of catheter colonisation between one and three weeks is no different, but catheter-related infections are more frequent in catheters with several lumens [OR 2.58; 95% CI; 1.24 – 5.37; Necessary number to treat (NNT): 19; 95% CI; 11 – 75]. In other words, for every 20 patients in which a single-lumen catheter is used instead of a multi-lumen catheter, catheter-related bacteraemia could be avoided (Zurcher, 2004).

On the other hand, the CDC Guideline (O'Grady, 2011) recommends using a CVC with the minimum number of necessary ports or lumens for handling the patient.

P9. *Depending on the duration of IVT, what type of line is indicated to avoid complications?*

Low quality

A small CCT of low quality with 60 patients at just one centre (Periard, 2008) finds that a PICC is preferable instead of a peripheral catheter in patients who require IVT for more than 5 days. With a PICC, fewer catheters per patient are used (1.16 versus 1.97 in peripherals, p = 0.04), there are a fewer number of venipunctures (1.36 versus 8.25 in peripherals, p = 0.001) and there is greater patient satisfaction (96.8% versus 79.3 in peripherals, p = 0.001), although there is greater incidence of clinically insignificant deep vein thrombosis in PICCs (RR of 6.6 [p = 0.03]).

The CDC guideline (O'Grady, 2011) recommends using a midline catheter or a PICC, instead of a short peripheral catheter, when the duration of IV therapy will likely exceed six days. It does not provide the bibliographical references of the studies that support this recommendation.

Summary of the evidence

Very low ⊕○○○	**P7.** Infusions that have high osmolarity and extreme pHs and are administered through small calibre venous lines can have a greater risk of endothelial damage and subsequent phlebitis or thrombosis (INS, 2011).

Moderate. ⊕⊕⊕○	**P8.** There is a greater risk of infection due to catheter colonisation when a multi-lumen catheter is used with respect to the smallest possible number of lumens. In one MA (Dezfulian, 2003) without statistical significance [OR 1.78; 95% IC; 0.92 – 3.47] and in an SR (Zurcher, 2004), they find the increase in catheter-related infections to be significant [OR 2.58; 95% IC; 1.24 – 5.37; NNT 19; 95% CI, 11 – 75]. In other words, for every 20 patients in which a single-lumen catheter is used instead of a multi-lumen catheter, catheter-related bacteraemia could be avoided (Zurcher, 2004). The advantages of using a multi-lumen catheter of fewer accesses must be evaluated in comparison with the risk associated with using several catheters when IV therapy through several lumens is necessary.
Low ⊕⊕○○	**P9.** Evidence obtained from a small CCT (Periard, 2008), which finds that a PICC is preferable instead of a peripheral catheter in patients who require IVT for more than 5 days. With PICCs, fewer catheters per patient are used, there are a fewer number of venipunctures, and there is greater patient satisfaction, although there is a greater incidence of clinically insignificant deep vein thrombosis.

Recommendations

✓	**R7.** Using a central access is advisable for infusions with an osmolarity of > 600 mOsm/L; a pH of less than 5 or greater than 9; or the use of irritant medication.
Weak.	**R8.** The use of a multi-lumen catheter with the fewest possible number of lumens is suggested instead of several catheters when IV therapy through several lumens is necessary.
Weak.	**R9.** Using a peripherally inserted central catheter is suggested instead of a peripheral catheter when the duration of the IVT is expected to exceed 6 days.

5.3. Aspects related to the assessment of risks and patient decision-making

Questions to be answered

P10. What information (duration of the line, risk of complications, availability of a caregiver, body image and financial impact) should a patient have so that they can define their preferences regarding the infusion line?

P11. Is assessing the risk factors of infection or bleeding in a patient before selecting the catheter route effective at preventing infections or bleeding?

P10 *What information (duration of the line, risk of complications, availability of a caregiver, body image and financial impact) should a patient have so that they can define their preferences regarding the infusion line?*

In two studies in which focus group techniques were used to survey patients and relatives about the choice of venous lines, it was found that both groups expressed the need to participate in the decision-making and that they lacked the necessary information to have a significant impact on that decision-making. The aspects that they thought were most relevant were safety, aspects related to the treatment and independence for activities of daily life, and secondarily, comfort, the availability of a caregiver, body image and financial impact (Nugent, 2002; Macklin, 2003). **Low quality**

The RNAO Guideline (RNAO, 2004) recommends, with a consensus grade, that "Nurses will discuss the options for vascular access devices with the client and family caregivers. Device selection is a collaborative process between the nurse, client, physician and other members of the health care team, however, the nurse has a role to educate and advocate for clients in relation to the selection of appropriate devices. The involvement of the client in the decision making process supports self-care and a client-centred model of care".

P11 *Is assessing the risk factors of infection or bleeding in a patient before selecting the catheter route effective at preventing infections or bleeding?*

Two guidelines (the RNAO [RNAO, 2004] and that of the *Infusion Nurses Society* (INS) [INS, 2011]), based on expert recommendations, suggest that before selecting the most appropriate device, two aspects have to be considered: the physical examination and the patient's health history. **Very low quality**

Thus, they indicate not inserting lines on limbs that are immobilised by paresis or affected by surgery, lymphoedema, mastectomies or on limbs with fistulas for dialysis or prior scars or on the pacemaker insertion side. Likewise, inserting a central catheter should be avoided in zones with difficulty for applying compression (subclavian) if there are alterations of coagulation with the risk of bleeding.

Summary of the evidence

Low ⊕⊕◯◯	**P10.** Evidence obtained in two studies (Nugent, 2002; Macklin, 2003), in which focus group techniques were used to survey patients and relatives about their preferences regarding the choice of venous lines, it was found that both groups expressed the need to participate in the decision-making and that they lacked the necessary information to have a significant impact on that decision-making. The aspects that they thought were most relevant were safety, aspects related to the treatment and independence for activities of daily life, and secondarily, comfort, the availability of a caregiver, body image and financial impact. Despite the low quality of the evidence, due to the benefit/risk balance for the patient, the panel approves it as a strong recommendation.
Very low ⊕◯◯◯	**P11.** Evidence obtained from two clinical practice guidelines (RNAO, 2004 and INS, 2011]), which, based on expert recommendations, suggest that before selecting the most appropriate device, two aspects have to be considered: the physical examination and the patient's health history. Specifically, the condition of being immunocompromised and alterations in coagulation must be evaluated.

Recommendations

Strong	**R10.** When informing a patient about the venous access selection, it is recommendable to give preference to safety over the patient's freedom of movement.
CPG adopted with a weak	**R11.** In patients who are immunocompromised or who have a bleeding tendency, it is suggested that the central venous catheter be avoided to the extent possible.

5.4. Aspects related to the prevention of occupational risks

Questions to be answered

P12. Is the use of safety devices an effective clinical practice for decreasing the risk of complications due to an accidental needlestick by professionals?

P12. *Is the use of safety devices an effective clinical practice for decreasing the risk of complications due to an accidental needlestick by professionals?*

Moderate quality

A review of protection devices for preventing injuries from sharp instruments in the peripheral catheterization of venous lines analyses both passive devices that have a safety mechanism integrated in the puncture system, wherefore the user doesn't have to perform any operation to active it, and active devices that require action by the operator to activate the protection when inserting the catheter. It concludes that efficacy studies on needlestick protection with these devices are scarce, because samples of more than 100,000 catheterization attempts are necessary to demonstrate significant differences with cannulas without protection, given the low incidence of needlesticks that occurs with these systems. (Trim JC, 2004).

One experimental study of good quality conducted at different hospital units on the incidence of needlesticks with hollow needles before and after implementing active and passive safety devices for venous catheterizations reports a 61% reduction in the incidence of injuries due to needlesticks, from 0.785 to 0.303 needlesticks per 1000 health worker days, with an RR of 1.958 (95% CI; 1.012 – 3.790; $p = 0.046$) (Orenstein R, 1995).

A retrospective cohort study of good quality conducted in US paramedic emergency services, which compares the incidence of needlesticks after the implementation of active safety devices for peripheral venous access systems versus historical control of the incidence, describes a catheterization success rate that is similar using either of the two systems and good acceptance by professionals. The needlestick incidence was 1, versus 15 using systems without protection, with a drop in the extrapolated incidence of needlesticks from 231 (95% CI; 132, 330) to 15 (95% CI, 0, 40) per 100,000 venous catheterization attempts ($p < 0.0005$). (O'Connor RE, 1996).

In a low-quality clinical trial (Prunet B, 2008) conducted at a single centre, with 759 peripheral access catheterizations using three types of catheters (a classical catheter without protection, one with passive protection and another one with an active protection system), no differences were found between the three in the exposure to blood and therefore in the risk of contact for the professional who is catheterizing, although professionals consider the systems with protection to be more difficult for catheterizing.

In turn, the RNAO guideline (RNAO, 2004) affirms that health organisations should consider the following elements for improving performance and the management of risks, for both the patient and the professional in the use of venous lines: appropriate device selection, maintaining staff competency and the use of standardised forms to insist in implementation (Markel Poole, 1999).

Summary of the evidence

Moderate ⊕⊕⊕○	**P12.** The risk of accidental needlestick in the catheterization of peripheral venous lines can be decreased through the use of active and passive safety systems, as it is indicated in a good-quality experimental study (Orenstein R, 1995) and in a low-quality, retrospective cohort study (O'Connor RE, 1996), which analyse said incidence. The evidence obtained from a low-quality clinical trial (Prunet B, 2008) confirms that the use of active and passive safety devices does not increase the risk of accidental contamination from traces of blood versus systems without safety devices.

Recommendations

✓	**R12.** It is advisable to use safety systems that prevent accidental punctures of health professionals.

6. Preventing complications when catheterizing

6.1 Aspects related to the training of professionals

Questions to be answered

P13. What specific training on the prevention of infections associated with central and peripheral catheters should a professional have who is responsible for inserting the catheter and for the care and maintenance thereof?

P14. Does the catheterization of veins, whether central or peripheral, by professionals with experience or specific training decrease the risk of complications versus catheterization by professionals without experience?

P13. *What specific training on the prevention of infections associated with central and peripheral catheters should a professional have who is responsible for inserting the catheter and for the care and maintenance thereof?*

The guideline of the CDC (O'Grady, 2011) synthesises, as high-quality evidence, numerous studies that demonstrate a decrease in the risk of infection through the standardisation of insertion and aseptic care of the catheter. A decrease in the incidence of infections is maintained if there is periodic evaluation and if reinforcement and expanded education activities are conducted. These studies are consistent over time and in different geographic and socio-economic environments. **High quality**

Said guideline recommends having a structured training programme on IV therapy that includes indications and adequate procedures for inserting and maintaining intravascular catheters and the measures for preventing catheter-related infections. This programme must be periodically evaluated with respect to knowledge of and adherence by professionals to the standardised guidelines or procedures at the centre.

P14. *Does the catheterization of veins, whether central or peripheral, by professionals with experience or specific training decrease the risk of complications versus catheterization by professionals without experience?*

The guideline of the CDC assesses, with high quality, studies that confirm the effectiveness of specialised IVT teams at reducing the incidence of catheter-related infections (O'Grady, 2011), and it recommends that only trained professionals who demonstrate their competency at inserting and maintaining intravascular catheters be designated. It also recommends training health professionals on the indications and on the insertion and maintenance procedures of intravascular catheters and on adequate measures for controlling infection. **High quality**

Regarding the training methods of professionals on CVC catheterization, one good-quality meta-analysis concludes that education methods based on simulation create outcome benefits in patients (number of punctures and pneumothorax), although not in the incidence of infections (Ma, 2011).

Summary of the evidence

High ⊕⊕⊕⊕	**P13.** Evidence adopted from the CDC guideline (O'Grady, 2011), with the consensus of the panel of experts, based on consistent empirical studies over time and in different geographic and socio-economic environments confirms the benefit of specific training and evaluation programmes on IVT.
High ⊕⊕⊕⊕	**P14.** Evidence adopted from the CDC guideline (O'Grady, 2011) and from data of a meta-analysis confirms that training methods on CVC catheterization based on simulation improve the safety outcomes of patients with IVT.

Recommendations

CPG adopted with a Strong Recommendation	**R13.** Conducting accredited institutional training on subjects related to the insertion of a central venous catheter and to a peripherally inserted central catheter is recommended.
Strong	**R14.** It is recommended that healthcare units have professionals available who have accredited training on handling central venous catheters and peripherally inserted central catheters.

6.2. Precautions before inserting a catheter

Questions to be answered

P15. Does the use of barrier precautions during the insertion of catheters, versus not using them, decrease the risk associated with a central/peripheral catheter?

P16. Does shaving the skin prior to inserting a catheter decrease the risk of infectious complications?

P17. What antiseptic solution (chlorhexidine versus povidone-iodine) should be used to prepare the field before puncture in order to prevent infections associated with a central/peripheral catheter?

P18. Does the use of a topical anaesthetic during the insertion of a peripheral, large-calibre catheter decrease pain?

P15. *Does the use of barrier precautions during the insertion of catheters, versus not using them, decrease the risk associated with a central/peripheral catheter?*

The 2011 CDC guideline (O'Grady, 2011), with moderate-quality evidence, recommends the following regarding hand hygiene and the use of sterile barriers: **Moderate quality**

- Follow hand hygiene procedures, beginning with washing hands using conventional soap and water, if they are not clean, and always with alcohol-based solutions. Hand hygiene must be performed before and after palpation of the insertion location, as well as before and after inserting, replacing, accessing, repairing, covering or cleaning an intravascular catheter. The access must not be palpated after applying an antiseptic, unless an aseptic technique is maintained.
- Maintain aseptic techniques for the insertion and care of intravascular catheters.
- Use clean gloves, instead of sterile gloves, for inserting peripheral intravascular catheters if the insertion zone is not touched after the application of cutaneous antiseptics.
- Use the maximum sterile barriers, including the use of a cap, mask, sterile gown, sterile gloves and a sterile body field for inserting a CVC or PICC or replacement with a guide.

P16. *Does shaving the skin prior to inserting a catheter decrease the risk of infectious complications?*

No original article that studies this question was found. However, one recommendation based on a consensus of the standards of good practices of the INS (INS, 2011) recommends that "when the zone where the insertion is planned is visibly dirty, it should be washed with soap and water before applying the antiseptic solution. If there were considerable body hair, it must be removed from the insertion zone, preferably with scissors, since the micro-abrasion caused by shaving increases the risk of infection of the insertion zone". **Standard of good practices**

P17. *What antiseptic solution (chlorhexidine versus povidone-iodine) should be used to prepare the field before puncture in order to prevent infections associated with a central/peripheral catheter?*

The CDC guideline (O'Grady, 2011) recommends, based on a CCT and an MA, that the skin be cleaned with an alcohol preparation of more than 0.5% chlorhexidine before inserting a central venous catheter or a peripheral arterial catheter and during bandage changes. If there is a contra-indication for chlorhexidine, tincture of iodine, iodophors or 70% alcohol can be used as an alternative. **High quality**

P18. *Does the use of a topical anaesthetic during the insertion of a peripheral, large-calibre catheter decrease pain?*

Moderate quality

In one meta-analysis (Fetzer, 2002) of moderate quality, which includes 15 CCTs and six repeated measure studies conducted between 1980 and 2000, the effect on pain by a topical anaesthetic cream (lidocain plus prilocaine) was evaluated during puncture in 542 patients and during the intravenous insertion of a catheter in 612 patients. It concludes that the anaesthetic cream causes a significant decrease in pain in 85% of the patients, which is consistent in all the studies. The effect is independent of age, the type of scale used to evaluate the pain, the location of catheter insertion and the use of pre-medication, although the magnitude is inversely proportional to the sample size. However, the metal-analysis presents considerable limitations related to: (1) the design of the studies and the sample size (25% of the studies include fewer than 50 patients and only 10% include more than 50 patients); (2) the sources of financing (> 50% are financed by the industry, forseeably without independent evaluation committees); and (3) heterogeneity with respect to the time when the topical cream is applied (from 20 to 280 minutes before the procedure).

Summary of the evidence

Moderate. ⊕⊕⊕○	**P15** Evidence adopted form the CDC guideline (O'Grady, 2011).
Very low ⊕○○○	**P16** Evidence based on the standards of good practices of the INS (INS, 2011)
High ⊕⊕⊕⊕	**P17** Evidence based on the data of a CCT and an MA of good quality with 4143 catheters confirms that the use of a solution of alcohol and 1% chlorhexidine as a disinfectant of the skin decreases the risk of contamination and infection, versus disinfecting with povidone.
Moderate. ⊕⊕⊕○	**P18** Evidence obtained from a meta-analysis of moderate quality that includes 14 controlled clinical trials and six repeated measure studies, but it has methodological limitations.

Recommendations

CPG adopted with a Strong Recommendation	
✓	**R16:** In the event of abundant hair, removal from the puncture zone is advisable.
Strong	**R17:** Cleaning the skin with an antiseptic is recommended for preparing the field before inserting a peripheral catheter. Use alcoholic chlorhexidine to clean the skin before inserting a central venous catheter. After cleaning, the skin must only be touched using antiseptic precautions.
Weak	**R18:** The use of a topical anaesthetic is suggested for peripheral venous catheterization.

6.3. Choice of route and catheterization procedure

Questions to be answered

P19. Does central jugular access versus subclavian access or versus peripheral insertion in the upper extremities or in the femoral vein have a lower risk of complications?

P20. What number of attempts at inserting a central venous catheter is associated with an increase in mechanical complications related to insertion of the catheter?

P21. Is taking longer than 25 minutes in the process of catheterizing a central line associated with an increase in infections, traumas or bleeding related to the procedure?

P22. Does the use of Doppler techniques for locating a vein decrease the risk of complications when catheterizing a central line or a peripherally accessed central line?

P23. For patients in whom a central catheter or a peripherally inserted central catheter is used, does the location of the tip in the superior vena cava decrease the number of complications?

P24. Are systems for locating the catheter tip effective at preventing complications related to central catheters?

P19. *Does central jugular access versus subclavian access or versus peripheral insertion in the upper extremities or in the femoral vein have a lower risk of complications?*

High quality

The CDC guideline (O'Grady, 2011) recommends, when possible, avoiding the femoral vein for CVC, given its greater incidence of catheter-related infection and deep vein thrombosis in comparison with access through the jugular or subclavian vein. And it recommends avoiding subclavian insertion in patients who are undergoing hemodialysis and patients with advanced kidney disease in order to prevent stenosis of the subclavian vein. With a lower grade of evidence, it also recommends using subclavian access instead of the jugular or femoral in adult patients to minimise infection risks in the insertion of a CVC. This recommendation is based on retrospective observational studies of low quality in which the jugular route is associated with a greater risk of catheter-related infections (CRIs). It does not consider non-infectious complications. One Cochrane review (Hamilton, 2007, 2008), which only finds one good-quality CCT in which 289 patients are randomised to subclavian or femoral, finds that, for infectious complications (colonisation with or without sepsis), the RR was 4.57 (95% CI; 1.95 – 10.71) in favour of subclavian access. Thrombotic complications likewise have lower RRs of 11.53 (95% CI; 2.80 – 47.52) with central access through the subclavian. Regarding a comparison of the jugular and the subclavian, it concludes that more studies are needed to know which of the two options is preferable, regarding both infectious and non-infectious complications.

P20. *What number of attempts at inserting a central venous catheter is associated with an increase in mechanical complications related to insertion of the catheter?*

In two observational studies (Eisen, 2006; Schummer, 2007) with major methodological limitations, it was observed, with statistical significance in both, that repeated attempts at inserting a central venous catheter increase the risk of complications. In the Eisen study (2006) on CVC insertion in 385 consecutive patients, the rate of complications was 17% in the first attempt, 28% in the second attempt and 54% when there were three or more attempts ($p < 0.001$). The other study (Schummer, 2007) included 1794 patients admitted in two emergency rooms over 5 years, and the catheterization attempts were all made by expert professionals (> 200 prior insertions). The overall rate of complications was 9.4%, with a range according to the number of catheterization attempts that varied between 5.7% in the first, 15.2% in the second, 22.4% in the third and 68.8% when there were four or more attempts.

Low quality

P21. *Is taking longer than 25 minutes in the process of catheterizing a central line associated with an increase in infections, trauma or bleeding related to the procedure?*

No original publications that study this question were found. However, standards of practice (RNAO, 2004; INS, 2011), asserting the advisability of limiting catheterization attempts as well as the duration of the sterilisation effect of field, suggest that the catheterization operation be limited to a maximum of 25 minutes. The panel of experts agreed with this recommendation with a high degree of consensus.

Standard of good practice

P22. *Does the use of Doppler techniques for locating a vein decrease the risk of complications when catheterizing a central line or a peripherally accessed central line?*

In two meta-analyses assessed as high-quality evidence in the CDC guideline (O'Grady, 2011), they find that the use of Doppler for CVC insertion substantially decreases the risk of mechanical complications, the number of insertion attempts and failures in catheterization. Ultrasound devices must only be used by professionals who are fully qualified in the technique. In a recent Cochrane review (Rabindranath, 2011) of good quality, there is indirect evidence that supports the advantages of using Doppler for catheterizing central venous lines. In this work, which included seven studies with 767 patients on dialysis and 830 catheter insertions, there was evidence that catheterizing with the help of ultrasound versus the traditional blind method significantly decreases the risk of arterial puncture, OR 0.13 (95% CI; 0.04 – 0.37); haematomas, OR 0.22 (95% CI, 0.06 – 0.81); and insertion time, -1.4 minutes (95% CI, -2.17 – -0.63 min.); and increases the success in the first catheterization attempt, OR 0.40 (95% CI, 0.30 – 0.52)

High quality

A good-quality consensus of experts based on a critical evaluation of 229 articles (Lamperti, 2012) reviews evidence on the use of ultrasound in catheterizing central venous lines or PICCs, peripheral or arterial, concluding that it can be very useful for the success of catheterization, for locating the tip of the catheter, for decreasing complications, etc., but it is necessary to be trained on how to use ultrasound. One low-quality, observational study in our environment (Moraza, 2012) describes 85.5% success at inserting 165 PICCs in adult oncological patients, showing that ultrasound-guided insertion of the PICC at the bedside can be performed by trained nurses with a high probability of successful insertion..

P23. *For patients in whom a central catheter or a peripherally inserted central catheter is used, does the location of the tip in the superior vena cava decrease the number of complications?*

In one CCT (Kearns, 1996) on PICCs that included 37 patients with HIV, using catheters that are very different from those that are currently used, therefore scarcely applicable at this time, the patients were randomised into two groups: tip located peripherally (innominate vein, axillary vein or subclavian vein) and located centrally (vena cava), thereby evaluating various complications while the line remained (clinical thrombosis, phlebitis, infection). The thrombosis rate in the peripheral insertion group was significantly higher than the central insertion group (8.9 versus 1.9, RR 77%; 95% CI, 55% – 100%; $p < 0.05$), without differences in the frequency of phlebitis or infection between the two groups. In another retrospective observational study of low quality (Torres-Millan, 2010) that covers the results in 2581 adults with two types of central insertion, location of the catheter tip in either the superior vena cava (SVC) or the right aurical (RA), the conclusion is that there are no differences in the incidence of complications (arrhythmia and/or mortality) according to the location of the CVC (RA or SVC).

Low quality

P24. *Are systems for locating the catheter tip effective at preventing complications related to central catheters?*

Whenever it is necessary to ensure that the tip of the catheter is located in a high flow zone (superior vena cava or right auricle), it is essential to verify the location of the catheter tip.

Very low quality

No bibliography that specifically analyses the effectiveness of the different methods for verifying the location of the catheter tip was found, but the most accessible procedure is a simple chest X-ray. Other methods are also available, such as those that are incorporated in catheters, which, by electrocardiographic record, assure correct placement of the line at the SVC-auricle junction and can be used if they are available. The panel of experts agreed with this recommendation with a high degree of consensus.

Summary of the evidence

High ⊕⊕⊕⊕	**P19.** Evidence adopted form the CDC guideline (O'Grady, 2011) with the consensus of the panel of experts and data from a Cochrane review (Hamilton, 2007, 2008) that compares subclavian catheterization versus femoral, finds that for infectious complications, the RR was 4.57 (95% CI: 1.95 – 10.71) in favour of subclavian access. Thrombotic complications are likewise lower, with an RR of 11.53 (95% CI: 2.80 – 47.52) with subclavian central access. Regarding a comparison of the jugular and the subclavian, it concludes that more studies are needed to know which of the two options is preferable, regarding both infectious and non-infectious complications.
Low ⊕⊕○○	**P20.** Evidence obtained from two observational studies (Eisen, 2006; Schummer, 2007) with methodological limitations, even though the magnitude of the effect is large and there is a high dose-response gradient, significantly confirms that complications are multiplied by 3 between the first or more than 3 catheterization attempts, respectively in each study: 17% vs 54% or 5.7% vs 22.4%.
Very low ⊕○○○	**P21.** Evidence based on standards of good practice, with the consensus of the panel of experts.

High ⊕⊕⊕⊕	**P22.** Evidence obtained mostly from two meta-analyses included in the CDC guideline (O'Grady, 2011) and a Cochrane review (Rabindranath, 2011) that included seven studies with 767 patients. There was evidence that the use of ultrasound for catheterizing venous lines significantly decreases the risk of arterial puncture, haematomas and insertion time and increases success in the first catheterization attempt.
Low ⊕⊕○○	**P23.** Evidence based on two low-quality studies (Kearns, 1996; Torres-Millan, 2010) in which major complications are not appreciated when the catheter is located in a high-flow vein with respect to a peripheral vein.
Very low ⊕○○○	**P24.** Evidence based on standards of good practice.

Recommendations

CPG adopted with a Strong Recommendation	**R19.** To the extent possible, it is advisable to avoid using the femoral vein for central venous access in adult patients.
Weak	**R20.** It is suggested that the same professional not make more than two attempts at inserting a central venous catheter in the same healthcare event.
✓	**R21.** It is advisable to take no more than 25 minutes for venous catheterization as from the first puncture.
Strong	**R22.** Using Doppler is recommended for inserting a central venous catheter and a peripherally inserted central catheter if the technique is available and there are trained personnel.
Weak	**R23.** When inserting a central line or a peripherally inserted central catheter, it is recommendable to locate the tip of the catheter in the superior vena cava.
✓	**R24.** It is advisable to take a control image after central access catheterization in order to check correct placement of the catheter tip.

6.4. Fastening and locking of the access

Questions to be answered

P25. Is the use of sutures to fasten central venous catheters (CVCs) more effective than the use of sterile adhesive tape at preventing complications (infection, shifting, phlebitis, loss of access) related to central catheters?

P26. What are the efficacy and safety of using positive pressure, Luer type threaded connectors with locking valves at the access points to the venous line versus standard mechanical caps?

P27. After inserting the catheter, what locking system is most effective at preventing occlusions?

P28. Regarding the cap, what types of disinfection measures decrease the risk of infections associated with central/peripheral catheters?

P25. *Is the use of sutures to fasten central venous catheters (CVCs) more effective than the use of sterile adhesive tape at preventing complications (infection, shifting, phlebitis, loss of access) related to central catheters?*

Two randomised trials of low quality due to their scarce sample and due to being at only one centre (Bausone-Gazda, 2010; Wood, 1997) and another CCT of moderate quality (Yamamoto, 2002) on PICCs, in which specific types of securing methods are compared versus the classical type with adhesive tape, suggest fewer complications regarding shifting and loss of access, with greater patient and nurse satisfaction using the new fastening systems without sutures, although in the comparison there is no statistical significance. **Moderate quality**

The CDC guideline (O'Grady, 2011) recommends, with moderate-quality evidence based on the Yamamoto study (2002), using an intravascular catheter securing procedure without sutures to reduce the risk of infection.

P26. *What are the efficacy and safety of using positive pressure, Luer type threaded connectors with locking valves at the access points to the venous line versus standard mechanical caps?*

The CDC guideline (O'Grady, 2011), based on moderate-quality evidence, points out that when using needleless systems, positive pressure caps may be preferable over the caps of some mechanical valves, which have a higher risk of infection. The guideline of the *Society for Healthcare Epidemiology of America* (SHEA) (Marshal, 2008) establishes that positive pressure connectors should not be used routinely if the risk of infection is not high, and it recommends training professionals on the correct use thereof and conducting an individualised assessment of risk. **Low quality**

P27. *After inserting the catheter, what locking system is most effective at preventing occlusions?*

The standards of the *Infusion Nurses Society* (INS, 2011) establish that "venous lines must be locked after completing the flushing thereof in order to decrease the risk of occlusion", and they recommend, with different levels of evidence, the following measures with respect to the locking of catheters: **Moderate quality**

- Flushing with 0.9% saline solution, and when the prior medication is incompatible with saline solution, initial flushing with 5% glucose solution and subsequently with saline solution or a heparin solution.
- The minimum flushing volume will depend on the size of the catheter. Double the volume of the internal lumen of the catheter must be used, with a minimum quantity of 10 ml. A greater quantity is required after a transfusion or taking a blood sample.
- Short peripheral catheters will be locked with saline solution after each use.
- The nurse will evaluate possible limitations on locking with heparin in anti-coagulated patients with a risk of post-surgical bleeding or thrombocytopenia associated with heparin. Thrombocytopenia will be assessed every 2-3 days as from the 4th day after locking in patients with a risk of bleeding.
- There is insufficient data to conclude whether or not it is suitable to use saline solution to lock the sensitive valve systems that some catheters include.
- The data that compare the results of locking CVCs with heparin or 0.9% saline solution are not conclusive. While some articles show similar results, others report greater complications with saline solution. Given the risks and the high cost of CVCs, it is advisable to use a 2.5-ml solution of heparin sodium 10 U/ml after each intermittent use of the catheter.

P28. *What types of cap disinfection or access locking measures decrease the risk of infections associated with central/peripheral catheters?*

Low quality

The CDC guideline (O'Grady, 2011) recommends using a prophylactic antimicrobial lock solution in patients with long-duration catheters (more than 1 month) who may have a history of multiple, catheter-related infections, despite maximum and optimal adherence to aseptic techniques. This recommendation is based on 2 studies developed fundamentally in paediatric oncology patients and hemodialysis patients, evaluated as moderate-quality evidence.

In adult neutropenic patients with non-tunnelled CVCs, a good-quality CCT randomised 117 patients (Carratala, 1999) with an average catheter duration of 11 days and found that a 2.5-ml solution of heparin 10 U/ml plus 25 mcg/ml of vancomycin versus 10 U/ml of heparin prevents the bacteraemia associated with a CVC (15.5% in controls versus no case in the vancomycin arm). One meta-analysis (Safdar, 2006) of 7 clinical trials, 6 with oncological children and the aforementioned study on adults, found that the antimicrobial lock with a vancomycin solution reduces the risk of infection associated with CVC. This meta-analysis has limitations due to the major heterogeneity of the studies.

On the other hand, one meta-analysis of 5 CCTs that included 991 patients, both adults (2 studies) and children (3) in oncological treatment (Kethireddy, 2008), suggests that flushing of the valves with urokinase-heparin versus heparin alone, with scheduled administration using a lock, can substantially reduce the risk of bacteraemia in patients with a long-duration CVC, above all in patients with a high risk due to neutropenia. Effect of the RR on preventing bacteraemia, 0.77 (95% CI, 0.60 – 0.98; $p = 0.01$). It warns of the need for greater studies, since the quality and heterogeneity of the studies provides low-quality evidence for non-tunnelled catheters.

One CCT with a sample of 64 patients (Sanders, 2008) compares the utility of locking the valve with a 70% ethanol solution versus locking it with a heparin solution in haematological, immunocompromised patients with tunnelled CVCs. It finds that daily locking of the valve for two hours with ethanol decreases the incidence of catheter-related infection (OR of 0.18 [95% CI, 0.05 – 0.65]).

Summary of the evidence

Moderate ⊕⊕⊕○	**P25** Evidence obtained from three trials, two of low quality (Bausone-Gazda, 2010; Wood, 1997) and one of moderate quality (Yamamoto, 2002), which consistently confirm that securing catheters without sutures causes fewer complications due to infection, shifting and loss of access, with greater patient and nurse satisfaction.
Low ⊕⊕○○	**P26** Evidence obtained from the guideline of the CDC (O'Grady, 2011), which indicates that when needleless systems are used, positive pressure caps have a lower risk of infection than mechanical valves. The SHEA guideline (Marshal, 2008) does not support the routine use thereof and recommends that professionals be trained and that the risk of infection be individually assessed.

Moderate ⊕⊕⊕○	**P27.** Evidence based on the standards of the Infusion Nurses Society (INS, 2011), which recommend flushing with 0.9% saline solution (unless there is incompatibility with the administered medication), using double the volume of the catheter's internal lumen (minimum of 10 ml). There are no conclusive data with respect to locking valve systems with saline solution or locking CVCs with saline solution or heparin, although this latter solution with 2.5 ml of heparin sodium 10/ml after each intermittent use of the catheter is advisable.
Low ⊕⊕○○	**P28.** Evidence obtained from the guideline of the CDC (O'Grady, 2011), based on a CCT (Carratala, 1999) and an MA (Safdar, 2006), which fundamentally include paediatric oncology patients and hemodialysis patients, recommends flushing the cap using an antimicrobial lock solution with vancomycin in patients with catheters of more than one month's duration at units that have a history of multiple CRIs, despite using aseptic techniques. One CCT on a small sample of haematological, immunocompromised patients with tunnelled CVCs (Sanders, 2008) demonstrates that daily locking for two hours with 70% ethanol decreases the incidence of CRI. One MA (Kethireddy, 2008) of 991 patients suggests a significant decrease of 23% in the bacteraemia associated with catheters in immunocompromised patients by washing the valve with a urokinase-heparin solution. The heterogeneity of the evidence and the particulars of the samples of patients decrease the quality of the evidence provided by those studies.

Recommendations

Strong	**R25.** Securing a catheter without sutures is recommended.
Weak	**R26.** For locking access ports, the use of Luer-type threaded connectors with valves is suggested, versus conventional caps, although the cost must be assessed.
✓	**R27.** It is advisable to lock venous accesses with saline solution or a solution of heparin sodium after flushing the accesses in order to decrease the risk of occlusion.
Weak	**R28.** It is suggested that a 70% alcohol solution be used to lock according to a specific protocol in neutropenic patients with non-tunnelled central venous catheters with a duration of longer than one month. At units where there is a high rate of catheter-related infections, despite strict compliance with aseptic techniques, locking with heparin-vancomycin is suggested.

6.5. Covering the venous access

Questions to be answered

P29. After the insertion of a catheter, what is the most effective dressing (sterile gauze versus semi-transparent membranes) for preventing complications?

P30. What patient-related aspects must be taken into account when choosing the type of dressing?

P29. *After the insertion of a catheter, what is the most effective dressing (sterile gauze versus semi-transparent membranes) for preventing complications?*

The CDC guideline (O'Grady, 2011), based on high-quality evidence, recommends covering the catheter's access with a standard sterile gauze or a sterile, transparent and semi-permeable polyurethane dressing. The bibliographic review of said guideline includes a meta-analysis in which no differences in the CRI rates were observed between both systems. However, the transparent dressing allows continuous visual inspection and requires fewer changes than a standard gauze. **High quality**

One Cochrane review (MCCann, 2010) that covers the prevention of infections in patients with a CVC finds only one study of 58 patients, which finds that neither the catheter-related infection (CRI) rate nor catheter-related bacteraemia were modified when covering with polyurethane dressings was compared to the use of a dry gauze, OR 0.33 (95% CI, 0.04 – 2). The study included in this review is low quality and has an increased risk of bias, with very broad confidence intervals.

P30. *What patient-related aspects must be taken into account when choosing the type of dressing?*

The CDC guideline proposes that the choice can be based on patient characteristics, although gauze is preferred if there is a history of allergy, the patient is sweaty or the access is bleeding or there is oozing (low-quality evidence) (O'Grady, 2011). **Low quality**

Summary of the evidence

High ⊕⊕⊕⊕	**P29.** Evidence obtained from the CDC guideline (O'Grady, 2011), where it recommends covering the catheter access with a standard sterile gauze or a sterile, transparent and semi-permeable polyurethane dressing, given that no differences in the CRI rates are found between both covering systems. The polyurethane dressing allows continuous visual inspection and requires fewer changes than a standard gauze. A Cochrane review (MCCann, 2010) also finds no differences in the prevention of CRI.
Low ⊕⊕○○	**P30.** It is preferable to use standard gauzes if there are allergies or if the patient is sweaty or the access is bleeding or oozing, according to the consensus of experts (O'Grady, 2011).

Recommendations

Strong	**R29.** Covering the insertion zone with a transparent dressing is recommended.
✓	**R30.** Gauze dressings are advisable for moist or exudative zones.

6.6. Measures with the catheter for preventing infection

Questions to be answered

P31. In ICUs with a high frequency of infections associated with CVCs, where basic prevention measures have already been implemented, does the daily cleaning of patients with a chlorhexidine solution decrease the risk of CVC-associated infections?

P32. Is the use of catheters impregnated with chlorhexidine effective at preventing infections related to central catheters?

P33. Does the use of dressings impregnated with chlorhexidine decrease the risk of infections associated with CVCs?

P31. *In ICUs with a high frequency of infections associated with CVCs, where basic prevention measures have already been implemented, does the daily cleaning of patients with a chlorhexidine solution decrease the risk of CVC-associated infections?*

The CDC guideline (O'Grady, 2011), based on a CCT of only one centre with 836 ICU patients, shows that daily washing of patients with a 2% chlorhexidine solution versus washing with soap and water significantly decreased the risk of catheter-related bacteraemia (4.1 vs 10.4 infections per 1000 patients/day), with an absolute difference of incidence of 6.3 (95% CI, 1.2 – 11.0). They propose, with low-quality evidence, that the daily cleaning of the skin of ICU patients using a towelette impregnated with 2% chlorhexidine could be an effective strategy at reducing catheter-related bacteraemia. **Low quality**

P32. *Is the use of catheters impregnated with chlorhexidine effective at preventing infections related to central catheters?*

The CDC guideline (O'Grady, 2011), based on high-quality evidence, recommends using CVCs impregnated with chlorhexidine / silver sulfadiazine or minocycline/ rifampicin in patients who are expected to maintain the catheter for more than five days if, after implementing an overall strategy to reduce CRIs, the rates do not decrease below 3.3 per 1000 catheter days. It is also considered in burn patients and/or neutropenic patients, where it could be cost-effective. Before considering the use of impregnated catheters, a comprehensive strategy that includes at least these three components must have been implemented: education and appropriate training of the professionals who insert and maintain catheters, preparing the skin with chlorhexidine > 0.5% and alcohol and using the maximum sterile barriers during insertion of the CVC. **High quality**

P33. *Does the use of dressings impregnated with chlorhexidine decrease the risk of infections associated with CVCs?*

The CDC guideline (O'Grady, 2011), based on high-quality evidence, recommends using a dressing impregnated with chlorhexidine on short-duration catheters in patients over 2 months of age if the CRI rate has not decreased, despite adherence to basic prevention measures, including the education and training of professionals, the use of chlorhexidine for asepsis of the skin and using the maximum sterile barriers during CVC insertion. **High quality**

Summary of the evidence

Low ⊕⊕○○	**P31.** Evidence obtained from the CDC guideline (O'Grady, 2011), which proposes that daily cleaning of the skin of ICU patients using a towelette impregnated with 2% chlorhexidine could be an effective strategy at reducing catheter-related bacteraemia in areas with a high incidence of infection.
High ⊕⊕⊕⊕	**P32.** Evidence obtained from the CDC guideline (O'Grady, 2011), which recommends using catheters impregnated with chlorhexidine / silver sulfadiazine or minocycline/rifampicin in patients who are expected to maintain the catheter for more than five days if the CRI rate of the intake unit is not below 3.3 per 1000 catheter days after adhering to basic prevention measures and for burn and/or neutropenic patients.
High ⊕⊕⊕⊕	**P33.** Evidence obtained from the CDC guideline (O'Grady, 2011), which proposes using a dressing impregnated with chlorhexidine on short-duration catheters for adult patients and children if the CRI rate does not drop after adhering to basic prevention measures.

Recommendations

CPG ADOPTED with a Weak Recommendation	**R31.** Cleaning patients with a 2% chlorhexidine solution is recommended in ICUs that maintain a high rate of catheter-related infections, despite correct implementation of bacteraemia reduction strategies.
CPG adopted with a Strong Recommendation	**R32.** The use of a central venous catheter impregnated with chlorhexidine / silver sulfadiazine or minocycline/rifampicin is recommended in patients whose catheter is expected to be maintained more than 5 days, only if, in that healthcare unit, the rate of catheter-related infections does not drop, despite an overall strategy of zero bacteraemia.
R33. The panel does not reach a consensus regarding the use of dressings impregnated with chlorhexidine, wherefore the use thereof will depend on the clinical opinion regarding the individual patient.	

6.7. Checklists and institutional programmes

Questions to be answered

P34. Does the availability of procedure protocols that include recommendations for inserting a catheter decrease the risk of complications?

P35. Does the use of a checklist of the process for verifying compliance with recommendations, before inserting a catheter, decrease the risk of associated complications?

P36. Is recording the condition of vascular access devices (insertion point, functionality) an effective practice for decreasing the risk of complications?

P37. Are institutional programmes for the assessment of catheterization and venous access maintenance procedures effective at decreasing complications?

P38. Does feedback to professionals about the number of catheter-related infections in their unit decrease the risk of infections associated with central catheters?

P34. *Does the availability of procedure protocols that include recommendations for inserting a catheter decrease the risk of complications?*

Moderate quality

The protocols and other instruments designed to standardise clinical practice for inserting and maintaining central venous catheters must be based on guidelines or recommendations of proven efficacy, such as those included in the "Zero Bacteraemia" project, and must have a defined implementation strategy.

There is considerable heterogeneity in the definition of quality improvement instruments such as standardised protocols and procedures. Many of them include measures of the "Zero Bacteraemia" project and checklist points. To answer this question, 11 studies were reviewed, which evaluate diverse interventions such as insertion and post-insertion care protocols, decalogues, quality improvement projects with packages of specific measures and strategies for improving the implementation of measures (training, auditing and feedback, etc.). Hospitals with different levels of complexity, geographic environment and socio-economic environment are included, as well as ICUs of different specialities (**Marra, 2010; McLaws, 2012; Chua, 2010; DuBose, 2008; Duane, 2009; Charrier, 2008;** Aysegul Gozu, 2011).

They are all quasi-experimental and observational studies with limitations. The great heterogeneity in the design and in the interventions that are conducted does not allow combining the results obtained. Nevertheless, very considerable reductions in the infection rate are observed (greater than 50%), in addition to consistency in the outcomes between studies, especially those that achieve adherence to the proposed recommendations.

P35. *Does the use of a checklist of the process for verifying compliance with recommendations, before inserting a catheter, decrease the risk of associated complications?*

Moderate quality

The insertion of a CVC is considered to be a very high-risk procedure that requires the use of measures of proven efficacy and complete standardisation in the application thereof. Various initiatives have been tried to achieve this standardisation, showing a variable degree of efficacy.

The so-called Michigan Project implemented a multi-factor strategy, thereby including training on patient safety, the involvement of clinical leaders and application of the measures recommended in the CDC guideline (O'Grady, 2011) that had the greatest impact, such as: hand washing, maximum barriers during insertion, washing the skin with chlorhexidine, avoiding the femoral vein to the extent possible and removing unnecessary catheters (Pronovost, 2006).

The project incorporates the use of a central line cart and a checklist to ensure adherence to and compliance with infection control practices during insertion.

The effectiveness of the insertion was evaluated through an interrupted time series study without a control group, which compares the incidence of bacteraemia in CVC at 103 ICUs in different types of hospitals over a period of 18 months (1532 monthly measurements and 300,310 catheter days). The rates were reduced from a mean of 2.7 to 0 in 16-18 months, a reduction that remained over another 18 months in a study of part of the same ICUs (Pronovost, 2011).

This programme, called "Zero Bacteraemia", has been applied in Spain within the patient safety strategy of the Ministry of Health, Social Services and Equality and in cooperation with scientific societies. The introduction thereof was evaluated through a before-after study that compares the incidence of bacteraemia at 17 ICUs (9 intervention and 8 control) of hospitals of different characteristics in 2007 with the incidence during the three preceding years. The infection rate decreased by half, in both the intervention group and in the control group, in comparison with the historical records of each group (Palomar Martínez, 2010). Subsequent data have confirmed that these levels of incidence have been maintained, as well as the difficulties and the barriers for maintaining adherence to prevention measures.

Therefore, before the insertion of a central venous catheter, standardised checklists should be used to improve patient safety. The checklist must at least include the measures used in the "Zero Bacteraemia" project.

P36. *Is recording the condition of vascular access devices (insertion point, functionality) an effective practice for decreasing the risk of complications?*

In the bibliographic review, only one study that covers this question is identified (Guerin, 2010). It is a quasi-experimental before-after study with some limitations due to generalisation of the outcomes (single-centre and conducted on patients at intensive care units). **Low quality**

At the centre where the study was conducted, there was already an infection control programme for central venous catheters (CVCs), which included the implementation of an epidemiological monitoring system and of the handbook of six measures of the CDC (O'Grady, 2011) for inserting catheters (hand washing, sterile gloves, use of chlorhexidine, etc.). After this programme, a protocol of six post-insertion care measures was implemented, which includes: (1) Daily inspection of the insertion point; (2) care of the dressing every seven days or if it is wet; (3) documenting if the access continues to be necessary; (4) the application of a sponge impregnated with 2% chlorhexidine at the insertion site; (5) hand hygiene before the procedure; (6) flushing the connection of the infusion system with alcohol for 15 seconds before each use.

The incidence of infections due to catheters in the period before implementing the handbook of post-insertion measures was 25/4415 catheter days versus 3/2825 catheter days in the subsequent period (RR, 0.19; 95% CI, 0.006 – 0.63; $p <$ 0.004). There were no differences in adherence to the handbook of CDC measures (O'Grady, 2011) for inserting catheters between both periods (95% before vs. 93% afterwards). The authors conclude that the implementation of a handbook of post catheter insertion care measures allows a significant reduction of infections due to catheters, even in an environment in which compliance with the classic handbook of measures for inserting catheters of the CDC (O'Grady, 2011) is high

Regarding the review of CPGs, this aspect is only covered in one of them (INS, 2011). The guideline includes a consensus recommendation (very low quality) on recording the condition of vascular access devices, which indicates that at least the following aspects must be included: (1) how to prepare the skin; (2) type of line; (3) insertion date and number of attempts; (4) insertion location, total length of the catheter and length of the inserted part; (5) location of the tip; (6) covering and stabilisation system; (7) record of complications (phlebitis, irritation, extravasation), (8) type of drip used and through which lumen it is infused, if a multi-lumen catheter; (9) the date and reason for removal of the catheter, thereby indicating if the catheter tip is sent for a culture..

P37. *Are institutional programmes for the assessment of catheterization and venous access maintenance procedures effective at decreasing complications?*

The CDC guideline (O'Grady, 2011), based on the high-quality evidence of a CCT in several countries, either multi-centre or single-centre, with consistent outcomes, proposes that knowledge of and adherence to guidelines be periodically evaluated in all professionals who participate in inserting and maintaining intravascular catheters. **High quality**

P38. *Does feedback to professionals about the number of catheter-related infections in their unit decrease the risk of infections associated with central catheters?*

In the bibliographic review, three studies that cover this question were identified. The three studies are quasi-experimental and have a similar design: a prospective, non-randomised trial with pre- and post-intervention analysis. The effect of an educational initiative is evaluated in different phases, but feedback is included in all of them. In the first two (Roshental, 2003; Higuera, 2005), there is feedback on the level of compliance with measures that have proved to be effective at controlling catheter-related infections; the third (Lobo, 2005) reports monthly on the catheter-related infection rates. In all of them, a decrease in the catheter-related infection rate is documented: absolute reduction of 34/1000 catheter days (Roshental), 27/1000 catheter days (Higuera) and 9/1000 catheter days (Lobo). In the Roshental and Lobo studies, the effect of feedback is compared in isolation with the impact of other educational initiatives, and no significant reduction in the incidence of infections is observed. **Low quality**

Summary of the evidence

Moderate ⊕⊕⊕○	**P34.** Evidence obtained from 11 quasi-experimental and observational studies with limitations (Marra, 2010; McLaws, 2012; Chua, 2010; DuBose, 2008; Duane, 2009; Charrier, 2008; Aysegul Gozu, 2011), where a very heterogeneous set of interventions is assessed (insertion and post-insertion care protocols, quality improvement projects and implementation strategies) in various clinical scenarios. In all of them, a reduction in the infection rate of greater than 50% is observed, especially in those that achieve greater adherence to the proposed recommendations.
Moderate ⊕⊕⊕○	**P35.** Evidence obtained from a broad observational study of time series (103 ICUs), where a significant reduction of the infection rate was observed after applying the programme (Pronovost, 2011). In Spain, the implementation of a similar programme, called "Zero Bacteraemia", in a broad observational study (17 ICUs) with a before-after design, shows a 50% reduction in the infection rate due to CVCs, in both the control group and the intervention group (Palomar Martínez, 2010).
Low ⊕⊕○○	**P36.** Evidence obtained from a quasi-experimental, before-after study with limitations, with low quality, where a significant reduction of CRIs is observed after the implementation of a handbook of catheter post-insertion care measures (Guerin, 2010). The INS guideline (INS, 2011) recommends recording the condition of vascular access devices (consensus recommendation).

High ⊕⊕⊕⊕	**P37.** Evidence obtained from the CDC guideline (O'Grady, 2011), which proposes that knowledge of and adherence to guidelines be periodically evaluated in all professionals who participate in inserting and maintaining intravascular catheters.
Low ⊕⊕○○	**P38.** Evidence obtained from three quasi-experimental studies, which show that feedback to professionals regarding information on adherence to prevention measures (Roshental, 2003; Higuera, 2005) or CRI rates (Lobo, 2005) is associated with a reduction of CRIs, although in two of them the effect does not seem to be independent from the implementation of other educational initiatives.

Recommendations

Strong	**R34.** Implementing protocols of IVT procedures at healthcare units is recommended.
Strong	**R35.** Completing a standardised checklist during the process of inserting a central venous catheter or a PICC is recommended.
Weak	**R36.** It is suggested that the condition of vascular access devices after the insertion thereof be recorded in a specific sheet.
CPG adopted with a Strong Recommendation	**R37.** Using institutional programmes to evaluate the handling quality of venous lines is recommended.
Weak	**R38.** It is suggested that in educational programmes there be feedback about the prior practice or the infection rate of the catheterization team or unit.

7. Preventing complications in access maintenance

7.1. Aspects related to the shared use of accesses

Questions to be answered

P39. For maintaining a venous catheter access in a patient who has a continuous infusion of fluids and who simultaneously requires extraction for analysis or the administration of drugs, is sharing the access better than catheterizing a second access for preventing the appearance of complications?

P40. In a patient who has a venous catheter and needs to share the access for taking samples for analyses or administering drugs, is using extension tubing with a three-way valve better than using y-type extensions for preventing the appearance of complications?

P41. What maintenance guidelines have proved to be effective when sharing the infusion access for taking samples or for administering contrasts without the risk of complications?

***P39**. For maintaining a venous catheter access in a patient who has a continuous infusion of fluids and who simultaneously requires extraction for analysis or the administration of drugs, is sharing the access better than catheterizing a second access for preventing the appearance of complications?*

In a small study, with methodological limitations, which included 39 patients with cancer in a terminal situation in whom a PICC was inserted, it was verified that only 30% of the subjects related having pain at the time of catheterization, but after insertion, over 90% considered the PICC to be a convenient and comfortable alternative for them (Yamada, 2010).

Indirect evidence, such as a cohort study conducted on 39 patients with cancer in an advanced state verified that the patients (over 90%) considered it more comfortable to have a venous access rather than suffer repeated punctures (Yamada, 2010).

Very low quality

The RNAO guideline (RNAO, 2004) indicates that taking samples from an access used for infusion must be based on an evaluation between the risks and benefits of the action. The benefits include avoiding discomfort and anxiety due to new venipunctures in patients from whom frequent samples are required or who have puncture difficulty. Among the risks, they considered an increase in obstructions and catheter infections due to excessive handling. Although no study has demonstrated a significant increase in infections or obstructions of peripheral lines or PICCs used for taking samples.

In any event, the INS standards (INS, 2011) recommend flushing the access with saline solution before and after taking samples to prevent contamination and obstruction.

P40. *In a patient who has a venous catheter and needs to share the access for taking samples for analyses or administering drugs, is using extension tubing with a three-way valve better than using y-type extensions for preventing the appearance of complications?*

We have not found any bibliography that covers this question. However, the three-way valve should not be integrated on extension tubing, given that when it has to be replaced, it should be possible to just replace the valve, a facility provided by y-type extensions.

There is no evidence.

P41. *What maintenance guidelines have proved to be effective when sharing the infusion access for taking samples or for administering contrasts without the risk of complications?*

The standards of practice of the INS (2011), with respect to sharing the venous access for taking samples and based on a consensus of experts, recommend that blood samples be taken through venipuncture on the limb opposite that of the peripheral infusion route. If it is done on the same limb, it should be done from a distal vein to that of insertion of the infusion route.

There is no evidence.

Taking a sample from a CVC will be assessed considering the benefits and risks of the decision. The benefits include avoiding anxiety and discomfort due to a new venipuncture, and the risks include the possibility of occlusion or catheter infection, as well as the possible inaccuracy of the laboratory results. One low-quality observational study of a cohort of 100 patients does not find an increase in infections or of occlusions due to sharing a PICC for infusion and taking samples (Granados Gámez, 2003). Nevertheless, they indicate that the analytical results of the samples taken from shared peripheral lines have proved to be reliable.

Specifically, the standards of the INS (INS, 2011) indicate that "prior to taking a sample from a line, the infusion must be stopped and the catheter must be flushed with 0.9% saline solution. In multi-lumen catheters, samples will be taken from the longest lumen. If the sample is to monitor drugs, it will be taken from the lumen through which the drug is not being infused".

With respect to sharing the catheterized access for the transfusion of blood products, they affirm: "The systems used for transfusion must be changed after every transfused unit or every 4 hours, whether one or more units have passed through".

Summary of the evidence

Very low ⊕○○○	**P39.** Indirect evidence (Yamada, 2010), such as a study conducted on patients with cancer in an advanced state, verified that the patients considered it more comfortable to have a venous access rather than suffer repeated punctures.
Very low ⊕○○○	**P40.** We have not found any bibliography that covers this question. Adopted with the consensus of the panel of experts.
Standard of good practices	**P41.** We have not found any bibliography that covers this question. Standard adopted with the consensus of the panel of experts.

Recommendations

✓	**R39.** Y-type shared used is advisable versus the intermittent use of another new access.

Weak	**R40.** The panel finds no differences between suggesting the use of extensions with three-way valves or y-type extensions in patients who have venous catheterization and need to share the access for taking samples for analyses or to administer drugs.
✓	**R41.** After taking samples, it is advisable to flush the access with an amount of saline solution that is at least double the catheter volume.

7.2. Aspects related to the duration of the catheter and replacement times

Questions to be answered

P42. In a patient who has a venous catheter, how often should the system and the three-way valves be replaced to prevent the appearance of complications?

P43. In a patient who has a venous catheter, should the venous access be maintained if it is not being used?

P44. How often should a catheter (central, peripheral) be replaced to prevent infection, thrombosis or occlusion?

P42. *In a patient who has a venous catheter, how often should the system and the three-way valves be replaced to prevent the appearance of complications?*

Randomised prospective studies of good quality (Gillies, 2005; Van Donk, 2009) that compare the replacement of systems and catheters on a pre-set date versus when there is a clinical indication confirm that continuous infusion systems, both primary and secondary branches, which do not administer lipids or blood products, can be maintained for more than 96 hours (4 days) and that more frequent replacements of the systems do not decrease either the infection rates, or catheter colonisation or obstruction. Maintaining the systems for more than 7 days can be considered if systems with anti-infection protection are being used. **High quality**

Intermittent systems that are connected and disconnected have a greater risk of contamination, and even though there is an absence of evidence about various replacement guidelines, the INS standards (INS, 2011) recommend replacement every 24 hours.

When the infusion is of parenteral nutrition products with lipids, there are studies that suggest an increase in the risk of infection, therefore requiring that the systems be replaced every 24 hours. In the transfusion of blood products, systems must be changed every 4 hours.

P43. *In a patient who has a venous catheter, should the venous access be maintained if it is not being used?*

There is indirect evidence, based on an SR of good quality (Webster, 2010), regarding the duration of venous catheters, depending on their location and the type: thus, less than 1 week for peripheral lines, PICCs for up to 4 weeks and CVCs until complications advise that they be removed. But it is accepted that a venous access should not be maintained after completing the medication that justified it or if the access is not needed. **Moderate quality**

The standards of the INS (INS, 2011) indicate that PICCs or CVCs should be removed, according to the clinical condition of the patients, when the therapy for which they were required has ended, independently of the indications for removal due to complications.

P44. *How often should a catheter (central, peripheral) be replaced to prevent infection, thrombosis or occlusion?*

One SR in Cochrane (Webster, 2010) finds, in five trials (3408 patients with CVCs), an absolute, insignificant reduction of 0.2% in the incidence of bacteraemia in the group with removal if clinically indicated versus fixed-term removal. Phlebitis was evaluated in six trials (3455 patients), and there was no significant increase of phlebitis in the clinically indicated group (9% versus 7.2%). Phlebitis was also measured per 1000 days of use of the device, for which the data from five clinical trials were used (8779 days of use of the device), without finding differences in the incidence of phlebitis according to the two catheter removal guidelines. The cost was measured in two trials (961 patients). The costs of insertion were reduced significantly in the group with removal if clinically indicated. **High quality**

The authors concluded that definitive proof of a benefit from replacing catheters every 72 or 96 hours was not found. Therefore, healthcare organisations can consider the possibility of changing to a policy in which catheters are replaced only if clinically indicated. This would give rise to significant cost savings and would also be well-received by patients, who would be saved the unnecessary pain of systematic re-insertion without a clinical indication.

The CDC guideline (O'Grady, 2011) recommends removing a peripheral catheter if the patient develops signs of phlebitis or malfunction of the catheter (moderate evidence). It considers the question to be unresolved, although it is preferable, to decrease the number of CRIs, to replace the catheter systematically every 72-96 hours or when clinically indicated.

For CVCs and PICCs, it recommends not replacing them routinely as a CRI prevention measure.

Summary of the evidence

High ⊕⊕⊕⊕	**P42.** Evidence obtained from studies (Gillies, 2005; Van Donk, 2009) that confirm that continuous infusion systems, both primary and secondary branches, which do not administer lipids or blood products, can be maintained for more than 96 hours (4 days) and that more frequent replacements of the systems do not decrease the infection rates.

Moderate ⊕⊕⊕○	**P43.** There is moderate-quality evidence (Webster, 2010) regarding the duration of venous catheters, depending on their location and the type: thus, less than 1 week for peripheral lines, PICCs for up to 4 weeks and CVCs until complications advise that they be removed.
High ⊕⊕⊕⊕	**P44.** Evidence from an SR in Cochrane (Webster, 2010), which finds an absolute, insignificant reduction of 0.2% in the incidence of bacteraemia in the removal group if clinically indicated. There was an insignificant increase of phlebitis in the clinically indicated group (9% versus 7.2%). Phlebitis was also measured per 1000 days of use of the device, for which the data from five clinical trials were used, without finding differences in the incidence of phlebitis. The cost was measured in two trials, finding that costs were significantly reduced in the removal group if clinically indicated.

Recommendations

Strong	**R42.** It is recommended that the valves and systems be replaced every 4-7 days to prevent complications in venous catheterization.
Strong	**R43.** It is recommended that venous accesses that are not necessary be removed.
Strong	**R44.** It is recommended that a catheter not be replaced systematically in a fixed period, rather when it is clinically indicated.

7.3. Aspects related to the use of connectors

Questions to be answered

P45. In a patient who has a venous catheter, is the use of a connector better than the use of conventional caps to prevent the appearance of complications?

P45. *In a patient who has a venous catheter, is the use of a connector better than the use of conventional caps to prevent the appearance of complications?*

Low quality

We have not found studies that specifically assess this question. There is indirect evidence based on 4 CCTs of low quality, which find no differences in the complications of obstruction or contamination of the catheter if they are maintained with flushing versus obturators (Artioli, 2004) or due to the use of connectors with/without disinfectants (Cassey, 2012) or heparin (Bowers, 2008) or due to the use of positive pressure caps versus standard caps (Jacobs, 2004).

In turn, the standards of the INS (INS, 2011), based on a consensus, suggest that vascular accesses be locked after the completion of flushing after use to prevent occlusion of the same.

Summary of the evidence

Low ⊕⊕○○	**P45.** There is indirect evidence and through 4, low-quality CCTs (Artioli, 2004; Cassey, 2012; Jacobs, 2004; Bowers, 2008), which find no differences in complications if catheters are maintained with flushing versus obturators or due to the use of connectors with/without disinfectants or heparin or due to the use of positive pressure caps versus standard caps

Recommendations

Weak	**R45.** For locking the ports of lines, the use of connectors versus conventional caps is suggested, although the cost must be assessed.

7.4. Aspects related to the detection of complications

Questions to be answered

P46. What are the sensitive warning signs for detecting infection of the access?

P47. For a patient who has a venous catheter, what operations are effective for detecting occlusion of the catheter?

P46. *What are the sensitive warning signs for detecting infection of the access?*

The CDC guideline proposes that the catheter access be regularly monitored visually when changing the dressing or by palpation through an intact dressing, depending on the clinical situation of each individual patient. If the patient has sensitivity in the insertion zone, fever that is not from an obvious origin or other manifestations that suggest local infection or infection of the blood flow, the bandage must be removed to allow a detailed examination of the insertion zone. (O´Grady, 2011). **High quality**

It also recommends encouraging patients to notify their caregiver about any change in the catheter insertion zone or about any new discomfort.

P47. *For a patient who has a venous catheter, what operations are effective for detecting the occlusion of the catheter?*

No specific studies that cover this question have been found, although one study on the risk of catheter occlusion used the following definitions: partial occlusion of the access: if the blood cannot be aspirated from the access, but it is possible to infuse a fluid through it; total occlusion: when it is not possible to either aspirate blood or infuse fluids through the access (Jacobs, 2004). **Very low quality**

In turn, the RNA clinical practice guideline (RNAO, 2004) recommends, based on an opinion of experts, that the condition of the central line be checked by aspirating through it to confirm that blood comes out after each administration of medication or solutions. In the event that signs of obstruction are found (especially if the extraction of blood is not allowed), infusion must not be forced, given that it could involve risks for the patient (embolisms, extravasation). It likewise proposes determining the most likely cause of catheter occlusion (mechanical obstruction, non-thrombotic or thrombotic). To do so, the path of the line must be checked (systems, pumps, sutures, etc.), and treatment will be quickly initiated (the sooner it is applied, the greater the possibilities of success) to try to recover the access, depending on the cause of the obstruction, which can improve the outcomes in patients and the consumption of resources.

Summary of the evidence

High ⊕⊕⊕⊕	**P46.** Evidence obtained from the CDC guideline (O'Grady, 2011), which indicates that if the patient has sensitivity in the insertion zone, fever that is not from an obvious origin or other manifestations that suggest local infection or infection of the blood flow, the bandage must be removed to allow a detailed examination of the insertion zone.
Very low ⊕○○○	**P47.** Evidence obtained from the RNAO guideline (RNAO, 2004), based on an opinion of experts, which indicated that the condition of the central line should be checked by aspirating through it to confirm that blood comes out after each administration of medication or solutions.

Recommendations

Strong	**R46.** Monitoring for the appearance of unexplained fever or pain in the insertion zone is recommended, as well as looking for the appearance of reddening.
✓	**R47.** It is advisable to aspirate central catheters prior to the infusion of a fluid to check the permeability of the line.

8. Actions after complications when catheterizing or during maintenance

Questions to be answered

P48. For a patient who has a peripheral venous catheter and shows signs of a complication, what should be the action guideline?

P49. For a patient who has a PICC and shows signs of a complication, what should be the action guideline?

P50. For a patient who has a PICC and shows signs of a thrombotic complication, what should be the action guideline?

P51. For a patient who has a PICC and shows signs of an access obstruction, what should be the action guideline?

P52. For a patient who has a CVC and shows signs of an infectious complication, what should be the action guideline?

P53. For a patient who has a CVC and shows signs of a thrombotic complication, what should be the action guideline?

P54. For a patient who has a CVC and shows signs of an access obstruction, what should be the action guideline?

P55. In the event of extravasation, what action minimises the adverse effects on the patient?

P48. *For a patient who has a peripheral venous catheter and shows signs of a complication, what should be the action guideline?*

We have not found evidence that analyses this question. However, the recommendation made by unanimous consensus of the panel of experts, thereby considering the favourable balance between the benefits of removing the line and no risks of removing it, while there are risks for maintaining the line (discomfort, pain, phlebitis).

There is no evidence.

P49. *For a patient who has a PICC and shows signs of a complication, what should be the action guideline?*

P50. *For a patient who has a PICC and shows signs of a thrombotic complication, what should be the action guideline?*

P51. *For a patient who has a PICC and shows signs of an access obstruction, what should be the action guideline?*

P49. We have not found studies that assess action alternatives in the event of infection of a venous access catheterized by a PICC. The CDC guideline (O'Grady, 2011) indicates that short-duration catheters (less than 14 days) should be removed in the event of infection. Said guideline is not based on any empirical reference.

There is no evidence.

P50. Regarding thrombosis of the venous line, there is one SR (Yacopetti, 2008) of moderate quality that confirms the benefits of removing, without manipulating, a thrombotic catheter. The standards of the INS (INS, 2011) are based on the review and recommend, as the first step in the event of thrombosis of a peripherally inserted central catheter, that systemic anti-coagulation be guaranteed and that the catheter then be removed. They clarify, in their recommendations, that infusing the catheter or performing procedures on the valves has no effect on catheter-related venous thrombosis due to the fact that the operations performed and the solutions used are directed at the catheter lumen rather than the vein lumen. Likewise, removing the catheter without previously anti-coagulating with subcutaneous heparin of low molecular weight can leave fibrin sheaths in the vein, with negative consequences. **Moderate quality**

P51. We have not found evidence about how to act in the event of PICC occlusion. However, the panel of experts reached a unanimous consensus about the recommendation, thereby considering the balance between the benefits and risks of the decision to be favourable. **Very low quality**

Before removing a catheter, the prevention of thromboembolic disease must be assured using subcutaneous heparin of low molecular weight to prevent the pericatheter fibrin sheath from becoming detached and remaining free in the blood flow, with potentially lethal consequences.

P52. *For a patient who has a CVC and shows signs of an infectious complication, what should be the action guideline?*

P53. *For a patient who has a CVC and shows signs of a thrombotic complication, what should be the action guideline?*

P54. *For a patient who has a CVC and shows signs of an access obstruction, what should be the action guideline?*

P52. One systematic review (**Mermel, 2009)** considers that CVCs with prolonged durations (more than 14 days) can be maintained in cases of infections by coagulase-negative staphylococci or enterococcus when the general condition or suppurative phlebitis is not affected, otherwise they must be removed, or when the infection is due to candidas or staphylococcus aureus**, given the risk of sepsis**. Catheters planned for short duration must be removed in any circumstance. In all cases, specific antibiotic treatment must be given for 14 days. In cases in which the catheter is maintained, the valve must also be disinfected with chlorhexidine. (O´Grady, 2011) **Moderate quality**

P53. One SR (Yacopetti, 2008) of moderate quality finds a relevant benefit from removing the catheter, versus not doing so, and they recommend simultaneous systemic anticoagulation. This action is shared by international standards of good practices (Kearon, 2012). They clarify, in their recommendations, that infusing the catheter or performing procedures on the valves has no effect on catheter-related venous thrombosis due to the fact that the operations performed and the solutions used are directed at the catheter lumen rather than the vein lumen. **Moderate quality**

P54. The standards of the INS (INS, 2011) propose that, in the event of occlusion of a CVC, the nurse must evaluate the potential causes of the catheter's obstruction and consider the use of an adequate procedure for re-catheterizing, with the intention to maintain it if the catheterization characteristics of that patient advise it. **Standard of good practice**

The catheter must be removed if the obstruction cannot be removed. When a malfunctioning CVC is removed, it must be examined to assess possible damage and fragmentation, especially when removal of the catheter is difficult, in order to rule out catheter embolisms. If the presence of damage is observed, a chest X-ray or other techniques must be used to rule out that there are remains in the body.

In the event that removal of the obstruction is attempted, the instillation of low doses of alteplase (2 mg / 2 ml, maintained in the catheter for 30 minutes) is effective at restoring the blood flow of an occluded catheter, and it has been shown to be safe for use in both adults and children.

The instillation of hydrochloric acid 0.1 N in the lumen of an occluded catheter has been used to dissolve precipitates of low pH drugs, and the instillation of sodium bicarbonate has been used to dissolve precipitates of high pH drugs.

The instillation of ethanol, ethyl alcohol and sodium hydroxide in the lumen of an occluded catheter has been used to re-channel catheters in which obstruction is suspected due to the accumulation of fatty emulsions, such as those from parenteral nutrition. However, the instillation of alcohol solutions must be avoided in polyurethane catheters, which can become damaged.

The potential pressure exercised on an occluded central catheter must be taken into account when solutions for re-channelling are instilled. The size of the syringe used must not be less than 10 ml.

The panel of experts agreed with this recommendation with a high degree of consensus.

P55. *In the event of extravasation, what action minimises the adverse effects on the patient?*

In the event of extravasation of cytostatic agents, despite the multiple reviews that are available, we do not have studies on the effectiveness of the various measures proposed in said narrative reviews based on opinions. Among the available protocols, it is recommendable to follow the indications in the appendix, "Action measures in the event of extravasation of cytostatic agents", which is based on the latest available reviews on the subject (Conde-Estevez, 2012; Action procedure in the event of extravasation of cytostatic drugs. Virgen del Rocío Hospital Pharmacy Service, 2012; Schulmeister, 2011). **Standard of good practice**

In the event of extravasation of radiographic contrast media, there is no evidence of good quality that allows a consensus for an action guideline. It is recommendable to follow the indications in the appendix, "Actions in the event of extravasation of radiographic contrast media", which is based on the latest available reviews on the subject.

The panel of experts agreed with this recommendation with a high degree of consensus.

Summary of the evidence

Very low ⊕○○○	**P48.** Consensus of experts and standard of good practice.
Very low ⊕○○○	**P49.** Evidence adopted form the CDC guideline (O'Grady, 2011) by consensus of experts, without empirical studies.
Moderate ⊕⊕⊕○	**P50.** Evidence obtained from a systematic review of moderate quality (Yacopetti, 2008), which confirms the benefits of removing the catheter without manipulation, subject to guaranteeing systemic anticoagulant prophylaxis to prevent detachment of thrombi adhered to the catheter.
Very low ⊕○○○	**P51.** Consensus of experts without empirical studies.
Moderate ⊕⊕⊕○	**P52.** Evidence obtained from a systematic review of moderate quality (Mermel, 2009), where it was observed that the detection of coagulase-negative staphylococci or enterococcus in the catheter, if not accompanied by systemic signs, is not associated with sepsis, despite not removing the catheter for more than 2 weeks. This is not so with candidas or staphylococcus aureus. The panel of experts recalls that, in any case, infected central catheters should be removed.
Moderate ⊕⊕⊕○	**P53.** Evidence obtained from a systematic review of moderate quality (Yacopetti, 2008), which confirms the benefits of removing the catheter without manipulation, subject to guaranteeing systemic anticoagulant prophylaxis.
Very low ⊕○○○	**P54.** Standards of good practices adapted from a clinical practice guideline.
Very low ⊕○○○	**P55.** Standards of good practices adopted from action protocols.

Recommendations

Strong	**R48.** In the event of complications in a peripheral access, removal of the access is recommended.
✓	**R49.** In the event of an infection related to a peripherally inserted central catheter, it is advisable to remove the catheter, whether or not there is systemic involvement due to the infection.
Strong	**R50.** In the event of access thrombosis with a peripherally inserted central catheter, removal of the catheter is recommended, previously assuring prevention of thromboembolic disease of the patient using low-molecular-weight heparin.
Strong	**R51.** In the event of an obstruction of a central catheter, it is recommendable to remove the peripherally inserted central catheter, subject to preventing thromboembolic disease of the patient using low-molecular-weight heparin.
Weak	**R52.** In the event of a catheter-related infection, it is advisable to remove the CVC, whether or not there is systemic involvement due to the infection.
Weak	**R53.** In the event of venous thrombosis secondary to a central catheter, it is suggested that the access be removed and that the attempt not be made to dissolve the thrombus.
✓	**R54.** In the event of obstruction of a central catheter, it is advisable that the catheter be removed and that the attempt not be made to remove the obstruction.
✓	**R55.** In the event of extravasation, it is advisable to have and act according to protocols based on standards of good practices.

9. Dissemination and implementation

Prepare a plan for dissemination and implementation at healthcare services is recommended, where the plan should be integrated in the quality programmes of those services. To facilitate the use of this guideline, it is essential that professionals have easy access to both the quick guide and the appendixes, which illustrate the practical aspects of use. Strategies and tools to facilitate use of the guideline are specified below, which must contemplate an analysis of the necessary resources for compliance with the guideline (from types of dressings to training needs).

The dissemination plan must take into account the elements that can serve as facilitators at the time of implementation, such as presenting the guideline in scientific activities (workshops, congresses, meetings), the preparation of graphic documentation with more relevant information that includes action algorithms and the distribution of training material that could be handed out at the work place.

Application of the plan will be more successful if the main recommendations that discuss technical aspects are included in a pocket form for inclusion in computer programmes, distributed to nursing personnel and available at job positions. The basis for this synopsis is the quick consultation tool of the guideline. It is advisable to provide broad access to be able to consult the APPENDIXES, which complement the guideline's information with technical aspects, such as lists of incompatibilities between drugs and solutions, among other things. Based on the guideline's recommendations and the appendixes, action protocols can be easily prepared as a source of information in the event of IVT complications or for catheterization, which can be available at healthcare units for consultation if needed.

Professionals who may be interested in implementing a CPG will have to use their own judgement to decide what strategy may work best, thereby considering elements of the context and barriers to conducting adequate clinical practice, in addition to feasibility, costs and the potential benefits that the strategy could provide. There are different ways to take on the implementation of the CPG, thereby considering diverse factors, such as the type of change that is endeavoured, the place where implementation will take place and the identified barriers and facilitators.

In this regard, there are a series of interventions directed at healthcare professionals, which can serve to decrease the possible barriers:

- The appointment of a professional of reference for implementing the guideline, who will be in charge of implementing it, together with intermediate managers and executives.
- Accredited training activities and informative activities at healthcare centres: clinical sessions; workshops, speeches at conferences and congresses, etc.
- Local consensus process: Involve clinical/healthcare professionals related directly to the guideline so that "local implementation" has greater support, thereby bringing the usual practice closer to what is defined by the guideline.
- Request cooperation from professionals with specific training on the subject so that they can advise those units that are going to implement the guideline.
- Involve the so-called "informal or opinion leaders" of the units, due to their capacity to influence other professionals, thereby becoming true facilitators of implementation.

Nursing managers can organise the measures for putting into practice the recommendations that refer to the assessment of results, training and the accreditation of nurses. Likewise, the guideline provides useful material for undergraduate training in nursing.

Any publication of "standards of good practices" does not comply with its cycle of utility of it is not included in quality systems (2007 CPG implementation development group, http://portal.guiasalud.es/web/guest/herramientas-gpc). These standards require that recommendations that have a high impact on health, that are relevant at an organisation and that are based on high-quality evidence should be selected as quality indicators. In this regard, we propose a set of 4 indicators that correspond to similar recommendations, the preparation of which for auditing is included in Appendix 6, and they can be used to trace the adoption of the guideline's recommendations at healthcare units.

10. Lines of future research

During the development of the guideline, areas of knowledge were identified, in which the available scientific evidence for facilitating the decision-making process in clinical practice was discrepant, very scarce or even non-existent. In some cases, this has affected the ability to make recommendations.

In order to increase the generation and availability of knowledge on intravenous therapy, the following criteria have been used to define lines of research to be developed, although there are many other aspects to be researched:

- They should cover the main gaps in knowledge or discrepancies that have been detected during preparation of the guideline.
- They should involve improvements in patient participation and safety.
- They should deal with problems or events with a high frequency of appearance.

As a result of the process, the following lines of research have been defined:

- Patient safety with intravenous therapy, which should include preventing, identifying and handling complications.
- Controlling pain in the process of catheterizing venous accesses.
- Treating phlebitis secondary to venous catheters.
- The cost effectiveness of new types of venous catheters and catheterization systems in normal and emergency situations.
- The safety and the utility of intravenous therapy support devices, including biosafety materials.

Appendixes

Appendix 1. Glossary of terms

AGREE (*Appraisal of Guidelines, Research and Evaluation for Europe*): a structured questionnaire resulting from an international initiative to facilitate an assessment of the quality of clinical practice guidelines.

Y-type extensions: flexible, single-use devices that extend the vascular access system, thereby separating the access port to the vascular system from the puncture zone and allowing several accesses to the same venous line.

Cannula: a hollow tube made of silastic, rubber, plastic, metal or other substance used for accessing the body (INS, 2000).

CDC: centers for disease control and prevention of the US administration.

Peripherally inserted central catheter (PICC): a venous catheter of 1 or more lumens inserted in a peripheral vein and introduced until the tip is located in the vena cava.

It can be manufactured out of polyurethane, with a duration time of greater than 1 week for those made of first-generation polyurethane, and even up to 1 year or more for those made of third-generation polyurethane or of silicone.

Long-term peripherally inserted central catheter ("LT" PICC): a venous catheter of 1 or more lumens inserted in a peripheral vein and introduced until the tip is located in the superior vena cava. They are long-term (up to one year) catheters (made of third-generation polyurethane or silicone), which have been proposed by the Spanish Association of Intravenous Therapy Teams when IV therapy of more than 1 month is needed, wherefore they are mainly indicated for oncology and haematology patients and for patients who need parenteral nutrition. It is recommended that they be implanted by trained nurses using the micro Seldinger technique guided by ultrasound, which allows implantation in the basilic vein above the antecubital fossa. They are used extensively at homes, so it is necessary to instruct patients and families on the care and maintenance thereof to avoid complications. (Carrero Caballero MC (coord.) Treatise of parenteral administration. Madrid: Dissemination of Nursing Advances; 2006).

Multi-lumen catheter: a vascular access device with 2 or more lumens, which allow the simultaneous administration of several substances and/or the extraction of blood samples. They can be central venous catheters or peripherally inserted catheters.

Non-tunneled (percutaneous) catheter: a large diameter catheter, often with multiple lumens, inserted percutaneously through the subclavian, jugular or femoral vein, with the accessible tip in the vena cava (Halderman, 2000).

Tunneled catheter: A vascular access device whose proximal end is tunneled subcutaneously from the insertion site and brought out through the skin at an exit site (INS, 2000).

Compatibility of substances: the capacity of two or more substances to be mixed without causing chemical or physical changes that might modify the therapeutic action.

Contamination: the introduction or transfer of pathogens or infectious material from one source to another.

Cochrane Library: a database on the effectiveness of interventions, produced by the Cochrane Collaboration, consisting, among others, of original systematic reviews by this organisation.

Consensus: a process for facilitating decision-making and not a scientific method for creating new knowledge. In the best of cases, consensus only assures the best use of available information, whether scientific data or the knowledge of the participants (Black *et al*., 1999).

Disinfectant: an agent capable of eliminating all micro-organisms, except for spores.

Vascular Access Device (VAD): a device used to access the vascular system, and it can end in the central or peripheral vascular system or in the bone marrow.

Central Vascular Access Device (CVAD): the catheter is inserted into a centrally located vein, with the tip residing in the vena cava. It permits intermittent or continuous infusion and/or access into the venous system (INS, 2000).

Peripheral Vascular Access Device (PVAD): a peripheral catheter of 7.5 cm (3 inches) or less in length, generally inserted in the upper extremity.

CCT (Controlled Clinical Trial): it is a study design in which the subjects are randomly assigned to two groups: one (experimental group) receives the treatment being tested and the other (comparison or control group) receives a standard treatment (or sometimes placebo). The two groups are followed prospectively to observe any difference in the outcomes. The efficacy of the treatment is thus evaluated.

Erythema: reddening of the skin along the path of a vein, which results in vascular irritation or capillary congestion in response to the irritation. It could be a precursor of phlebitis.

Case-control study: a study that identifies people with a disease (cases), such as lung cancer, and compares them to a group without the disease (control). The retrospective relationship between one or several factors (such as tobacco) related to the disease is examined, thereby comparing the frequency of exposure to this factor or others between the cases and the controls.

Primary study: a study that generates original data.

Transversal descriptive study: it is a study that describes the frequency of an event or of an exposure at a given moment in time (single measurement). It allows examining the relationship between a risk factor (or exposure) and an effect (outcome) in a defined population and at a given moment in time (a cut-off). Also called prevalence studies.

Adverse event: an event that causes an injury or harm to a patient as a result of a health intervention.

Extravasation: inadvertent infiltration of vesicant solution or medication into surrounding tissue; rated by a standard scale (INS, 2000).

Phlebitis: inflammation of a vein; it may be accompanied by pain, erythema, oedema, streak formation and palpable cord; rated by a standard scale (INS, 2000).

Clinical Practice Guidelines (CPGs): systematically developed statements (based on the best available evidence) to assist practitioners and patient decisions about appropriate healthcare for specific clinical circumstances (Field & Lohr, 1990).

Catheter-related infection: bacteraemia or fungemia in a patient with a vascular access device, without another apparent focal point that explains the infection. There must be at least 1 positive blood culture (obtained from a peripheral vein), in addition to clinical manifestations of the infection (for example, fever, chills and/or hypertension).

Chemical incompatibility: a change in the molecular structure or pharmacological properties of a substance, which may or many not be observed visually.

Confidence interval: it is the range within which the true magnitude of the effect is found (never known exactly), with a pre-set degree of certainty or confidence. A "95% confidence

interval" (or "95% confidence limits") is often used. It means that the true value of the effect under study would be found within that interval in 95% of the cases that are measured.

Irritant: an agent that can cause pain, rigidity and phlebitis at the injection point or along the vein, with or without an inflammatory reaction.

Medline: a predominantly clinical database produced by the US National Library of Medicine, available on CD-Rom and the Internet (PubMed).

Meta-analysis: it is a statistical technique that allows integrating the outcomes of various studies (diagnostic test studies, clinical trials, cohort studies, etc.) in a single estimator, in which more weight is given to the outcomes of the largest studies.

Morbidity: disease or the frequency at which a disease appears in a population.

Mortality: the rate of deaths or the number of deaths due to a certain disease in a group of persons or within a certain period.

NICE (National Institute for Health and Care Excellence): it forms a part of the NHS (National Health Service of England). Its role is to provide doctors, nurses, patients and the general public with the best available evidence, fundamentally in the form of clinical guidelines.

Non-vesicant: an agent that lacks significant vesicant or irritating effects.

Osmolarity: a characteristic of a solution, determined by the concentration of the substance dissolved by one unit of solvent. Measured in millimoles/kg. This value can be calculated using sodium chloride equivalents or experimentally by osmometry (Stranz, 2002).

Panel of experts: a group of professionals who are experts in a specific area, which seeks to explore their technical opinion and reach a consensus of professional criterion with respect to the most recent scientific evidence.

Parenteral: a substance administered by any route other than the alimentary canal, such as the intravenous, subcutaneous or intramuscular route (INS, 2000).

Infusate: a parenteral solution administered into the vascular or nonvascular systems (INS, 2000).

pH: the degree of acidity or alkalinity of a substance (INS, 2000). This value denotes the number of hydrogen ions present in the solution.

Barrier precautions: the methods used to prevent the transmission of infectious agents by direct contact (person to person) or by indirect contact (environment to a susceptible person).

Prevalence: the proportion of persons with a finding or disease in a determined population at a given moment in time.

Implanted port: a catheter surgically placed into a vessel or body cavity and attached to a reservoir located under the skin (INS, 2000).

Systematic Review (RS): it is a review of scientific literature in which the evidence about a subject has been systematically identified, evaluated and summarised according to predetermined criteria. It may or may not include the meta-analysis.

Case series: analysis of groups of patients with a disease.

SIGN (Scottish Intercollegiate Guidelines Network): a Scottish multi-disciplinary agency that prepares clinical practice guidelines based on the evidence, as well as methodological documents on the design of such guidelines.

Vascular access systems with safety devices: they are central and peripheral vascular access devices that are especially designed to protect the healthcare professionals who handle them, thereby decreasing the accidents that occur with material of biological risk.

Hypertonic solution: a solution of higher osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration greater than the normal tonicity of plasma (INS, 2000). Hypertonic solutions have a concentration greater than 350 mOsm/L (CINA, 1999).

Hypotonic solution: a solution of lower osmotic concentration than that of a reference solution or of an isotonic solution; having a concentration less than the normal tonicity of plasma (INS, 2000). Hypotonic solutions have a concentration less than 250 mOsm/L (CINA, 1999).

Isotonic solution: having the same osmotic concentration as the solution with which it is compared, i.e., plasma (INS, 2000). Isotonic (or iso-osmotic) solutions have an osmolarity equivalent to plasma, 240-340 mOsm/L (CINA, 1999).

Thrombosis: the formation, development or existence of a blood clot within the vascular system (INS, 2000).

Doppler technique: it is an ultrasound technique that allows studying the flow through the different vessels by recording the pulse wave and determining the pressure thereof. The ultrasounds emitted by the transducer are reflected off the erythrocytes of the vessel and back to the transducer, with a deviation of the beam directly proportional to the speed of the erythrocytes (the flow) in the explored vessel.

Catheter-related thrombosis: venous thrombosis secondary to the presence of a vascular access device.

Infusion therapy: the parenteral administration of liquids, medication, nutritional support and blood transfusion and blood products, distributed using a vascular access device (VAD) inserted n a central or peripheral vein.

Vesicant: an agent capable of causing tissue necrosis when it escapes from the intended vascular pathway into surrounding tissue (INS, 2000).

Intraosseous route: the administration of medication and solutions in the space located in the bone marrow.

Appendix 2. Declaration of interests

The members of the guideline development group and the members of the internal and external advisory committees were asked to give an explicit declaration about possible conflicts of interest related to their participation in the IV therapy guideline.

Conflict of interest was defined as that which "occurs in those circumstances in which a professional opinion about a primary interest, such as patient safety or the validity of research, could be excessively influenced by another, secondary interest, whether it may be a financial benefit, prestige or personal or professional promotion".

Two large groups of potential collusion of interests were defined: personal interests derived from the relations of professionals with the health industry (pharmaceutical, health technology, etc.) and non-personal interests, whether of a financial type or not.

Specifically, they were given a conflict of interest form, which included current interests and interests of the last three years about the following aspects:

A. Personal

Relationship with the intravenous therapy industry.

- Support for going to meetings and congresses (registration, travel grants, etc.)
- Fees as a speaker at a meeting organised by the industry
- Financing of educational programmes or training activities
- Support and financing for research
- Employment as a consultant for a pharmaceutical company
- A shareholder of or holding financial interests in a pharmaceutical company

B. Non-personal

They included financial aid for creating a unit or department, financial support for hiring personnel in said units and financing of the research at such a unit. As well as aspects related to advantages or professional promotion.

All the members of the development group and the committees sent back those forms, signed, in which nobody declared being subject to any conflict of interest.

Appendix 3. Literature search strategies

Initial search strategies

1. Clinical practice guidelines

Database: Ovid MEDLINE(R) without Revisions <1996 to October Week 1 2011>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <October 14, 2011>

Search Strategy:

```
1    *Infusions, Intravenous/ (1217)

1    *catheterization/ or *catheterization, central venous/ or
     *catheterization, peripheral/ (12263)

2    practice guideline.pt. (13457)

3    Guideline/ or Practice Guideline/ (16749)

4    *Practice Guidelines as Topic/ (19047)

5    1 or 2 (13348)

6    3 or 4 or 5 (35495)

7    6 and 7 (136)

8    (intravenous or catheter*).m_titl. (38779)

9    (recommendation? or guidelines).m_titl. (38270)

10   9 and 10 (191)

11   8 or 11 (293)

12   limit 12 to yr="2000 -Current" (243)
```

EMBASE

Database: Embase <1996 to 2012 Week 27>

Search Strategy:

```
1    central venous catheterization/ or vein catheterization/ or blood vessel
     catheterization/ or central venous catheter/ or peripherally inserted
     central venous catheter/ or intravenous catheter/ (16469)

2    ((peripher* or central*) and catheter*).ti. (4048)

3    1 or 2 (16926)

4    practice guideline/ (196678)

5    (recommendation? or guidelines).m_titl. (55090)

6    4 or 5 (216252)

7    3 and 6 (881)

8    limit 7 to yr="2000 - Current" (770)
```

9 limit 8 to (Catalan or English or French or Italian or Portuguese or Spanish) (736)

10 limit 9 to embase (583)

RESULT: 583 DOCUMENTS

2. Prior choice of route

2.1 Peripheral central

Database: Ovid MEDLINE(R) without Revisions <1996 to February Week 1 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 10, 2012>, Ovid MEDLINE(R) Daily Update <February 10, 2012>

Search Strategy:

1 (peripher* and central* and catheter*).ti. (337)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1312876)

3 (child* or infant* or neonat* or premature?).ti. (322487)

4 (1 and 2) not 3 (40)

5 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6438)

6 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2683)

7 5 and 6 (451)

8 (co or ep or pc).fs. (1706605)

9 7 and 8 (166)

10 4 or 9 (200)

11 limit 10 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)") (50)

12 10 not 11 (150)

13 limit 12 to (clinical trial, all or comparative study or meta analysis or multicenter study) (30)

14 (prospective* or retrospective*).sh. (539232)

15 Evidence-Based Medicine/ (44425)

16 research support*.pt. (4067995)

17 12 and (14 or 15 or 16) (63)

18 13 or 17 (72)

19 4 or 18 (89)

EMBASE (Interface embase.com)

```
peripher*:ti AND central*:ti AND catheter*:ti AND (effect*:ti OR outcome*:ti
OR study:ti OR prevent*:ti OR trial:ti OR prophylaxis:ti OR assessment:ti)
OR ('central venous catheterization'/mj OR 'central venous catheter'/mj AND
('vein catheterization'/mj OR 'peripherally inserted central venous catheter'/
mj OR 'intravenous catheter'/mj)) AND ([adult]/lim OR [aged]/lim) AND
[embase]/lim AND [1996-2012]/py
```

2.2 Multi-lumen

Database: Ovid MEDLINE(R) without Revisions <1996 to March Week 1 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <March 14, 2012>, Ovid MEDLINE(R) Daily Update <March 14, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3039)
2     (effect* or outcome? or study or prevent* or trial or prophylaxis or
      assessment).ti. (1324256)
3     (child* or infant* or neonat* or premature?).ti. (324999)
4     (1 and 2) not 3 (482)
5     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (6482)
6     Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects,
      Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (2703)
7     5 or 6 (8732)
8     (co or ep or pc).fs. (1720531)
9     7 and 8 (3135)
10    4 or 9 (3352)
11    limit 10 to ("all infant (birth to 23 months)" or "all child (0 to 18
      years)") (899)
12    10 not 11 (2453)
13    limit 12 to (clinical trial, all or comparative study or meta analysis or
      multicenter study) (524)
14    (prospective* or retrospective* or cohort*).sh. (616899)
15    Evidence-Based Medicine/ (44769)
16    research support*.pt. (4105530)
17    12 and (14 or 15 or 16) (877)
18    13 or 17 (1073)
```

19 4 or 18 (1299)

20 editorial.pt. (221525)

21 19 not 20 (1287)

22 limit 21 to (English or French or Italian or Portuguese or Spanish) (1258)

23 (multilum* adj3 catheter*).mp. (54)

24 ((trilum* or tri-lum* or triplelum* or triple-lum* or multilum* or multi-lum*) adj3 catheter*).mp. (188)

25 ((four-lum* or fourlum*) adj3 catheter*).mp. (5)

26 ("3-lumen" or "3-luminal" or "4-lumen" or "4-luminal").mp. (46)

27 or/23-26 (237)

28 22 and 27 (38)

Database: Embase <1996 to 2012 Week 014>

Search Strategy:

#15 #14 AND [embase]/lim AND [1996-2012]/py 9

#14 #9 AND #13 12

#13 #11 OR #12 169

#12 (('tri lumen' OR 'tprotori luminal' OR '3 lumen' OR '3 luminal' OR 'four lumen' OR 'four luminal' OR '4 lumen' OR '4 luminal')NEAR/3 catheter*):ab,ti 36

#11 ((trilum* OR triplelum* OR multilum*) NEAR/3 catheter*):ab,ti 134

#9 #7 AND #8 1,711

#8 'clinical trial (topic)'/exp OR 'prospective study'/exp OR 'retrospective study'/exp OR 'comparative study'/exp OR 'multicenter study'/exp OR 'evidence based medicine'/exp 1,821,610

#7 #4 OR #6 7,015

#6 #5 AND ([adult]/lim OR [aged]/lim) 6,500

#5 'central venous catheterization'/exp OR 'central venous catheter'/exp OR 'vein catheterization'/exp OR 'peripherally inserted central venous catheter'/exp OR 'intravenous catheter'/exp 19,536

#4 #1 AND #2 NOT #3 784

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 867,792

#2 effect*:ti OR outcome*:ti OR study:ti OR prevent*:ti OR trial:ti OR prophylaxis:ti OR assessment:ti 3,186,666

#1 peripher*:ti OR central*:ti AND catheter*:ti 5,848

CINAHL

S17 S10 and S15 23

S16 S10 and S15 36

S15 S11 or S12 or S13 or S14 88

S14 TI (4-lumen OR 3-lumen OR 3-luminal OR 4-luminal) OR AB (4-lumen OR 3-lumen OR 3-luminal OR 4-luminal) 3

S13 TI (3-lum* or 4-lum*) OR AB (3-lum* or 4-lum*) AND (TI (catheter*) OR AB (catheter*)) 3

S12 TI ((four-lum* or fourlum*) AND catheter*) OR AB ((four-lum* or fourlum*) AND catheter*) 0

S11 TI ((trilum* or tri-lum* or triplelum* or triple-lum* or multilum* or multi-lum*) AND catheter*) OR AB ((trilum* or tri-lum* or triplelum* or triple-lum* or multilum* or multi-lum*) AND catheter*) 84

S10 PT S9 2174

S9 PT S7 NOT S8 2190

S8 PT EDITORIAL 130847

S7 (S4 OR S5) NOT S6 2196

S6 (MM "Child+") 15744

S5 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2096

S4 (S1 AND S2) NOT S3 211

S3 (child* or infant* or neonat* or premature*) 328314

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 301343

S1 TI ((peripher* or central*) and catheter*) 1372

3. Cochrane Reviews

3.1 Updating

Dababase: Ovid MEDLINE(R) without Revisions <1996 to February Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 17, 2012>, Ovid MEDLINE(R) Daily Update <February 17, 2012>

Search strategy:

1 randomized controlled trial.pt. (223929)

2 controlled clinical trial.pt. (38072)

3 randomized controlled trial.sh. (223929)

4 random allocation.sh. (38321)

5 double blind method.sh. (68419)

6 single blind method.sh. (13102)

7 or/1-6 (309059)

8 clinical trial.pt. (265847)

9 exp clinical trial/ (457418)

10 (clin$ adj25 trial$).ti,ab. (168413)

11 ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).ti,ab. (72618)

12 placebos.sh. (12291)

13 placebo$.ti,ab. (92429)

14 random$.ti,ab. (449979)

15 research design.sh. (43276)

16 or/8-15 (869215)

17 7 or 16 (894794)

18 (animals not human).sh. (2313959)

19 17 not 18 (772142)

20 thromb$.ti,ab. (160474)

21 fibrin$.ti,ab. (37854)

22 occlu$.ti,ab. (85570)

23 block$.ti,ab. (322294)

24 stenos$.ti,ab. (57151)

25 infect$.ti,ab. (656112)

26 or/20-25 (1233622)

27 (central adj5 venous).ti,ab. (10228)

28 cva$.ti,ab. (1650)

29 (jugular$ adj25 subclavian$).ti,ab. (622)

30 (jugular$ adj25 femoral$).ti,ab. (587)

31 (subclavian adj25 femoral$).ti,ab. (423)

32 or/27-31 (12703)

33 26 and 32 (5437)

32 or/27-31 (12703)

33 26 and 32 (5437)

34 19 and 33 (972)

35 limit 34 to (abstracts and yr=”2007 -Current”) (355)

Database: Embase <1996 to 2012 Week 07>

Search Strategy:

1 random$.ti,ab. (555041)

2 placebo$.ti,ab. (118195)

3 ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).mp. (120972)

4 (cross-over$ or crossover$).tw. (38868)

5 randomized controlled trial/ (249463)

6 phase-2-clinical-trial/ (26429)

7 phase-3-clinical-trial/ (11440)

8 double blind procedure/ (76569)

9 single blind procedure/ (13406)

10 crossover procedure/ (27550)

11 latin square design/ (199)

12 exp placebos/ (145279)

13 multicenter study/ (77886)

14 or/1-13 (785968)

15 limit 14 to human (614817)

16 thromb$.ti,ab. (212534)

17 fibrin$.ti,ab. (47823)

18 occlu$.ti,ab. (106407)

19 block$.ti,ab. (386003)

20 stenos$.ti,ab. (77088)

21 infect$.ti,ab. (793270)

22 or/16-21 (1509844)

23 (central adj5 venous).ti,ab. (13244)

24 cva$.ti,ab. (2603)

25 (jugular$ adj25 subclavian$).ti,ab. (871)

26 (jugular$ adj25 femoral$).ti,ab. (868)

27 (subclavian adj25 femoral$).ti,ab. (682)

28 or/23-27 (17065)

29 22 and 28 (7506)

30 15 and 29 (772)

31 limit 30 to yr="2007 -Current" (322)

32 limit 31 to embase (277)

CINAHL

S16 S7 and S8 and S14 56

S15 S7 and S8 and S14 62

S14 S9 or S10 or S11 or S12 or S13 1330

S13 TI SUBCLAVIAN* AND FEMORAL* 4

S12 TI JUGULAR* AND FEMORAL* 9

S11 TI JUGULAR* AND SUBCLAVIAN* 14

S10 TI CVA* 96

S9 TI CENTRAL AND VENOUS 1220

S8 TI THROM* OR FIBRIN* OR OCCLU* OR BLOCK* OR STENOS* OR INFECT* 57394

S7 S1 or S2 or S3 or S4 or S5 or S6 208225

S6 TI ALLOCATE* 76

S5 (MH "Meta Analysis") 11235

S4 (MH "Random Assignment") 27068

S3 (MH "Clinical Trials") OR (MH "Randomized Controlled Trials") 80737

S2 (MH "Single-Blind Studies") OR (MH "Double-Blind Studies") OR (MH "Triple-Blind Studies") 21899

S1 TI (RANDOM* OR CLIN* OR TRIAL*) OR TI (CLIN* AND TRIAL*) 124857

Specific searches by questions

Planning for the start of IV therapy

MEDLINE

1 Catheterization, Central Venous/ae (4702)

2 Catheterization, Peripheral/ae (1388)

3 catheter- related mechanical complication.mp. (0)

4 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier] (87637)

5 catheter related thrombosis.mp. (134)

6 venous thrombosis.mp. or exp Venous Thrombosis/ (26664)

7 1 or 2 (5799)

8 3 or 4 or 5 or 6 (112101)

9 Time Factors/ (459480)

10 7 and 8 and 9 (121)

11 editorial.pt. (223849)

12 10 not 11 (121)

13 editorial.pt. (223849)

14 10 not 11 (121)

15 limit 12 to (English or French or Italian or Portuguese or Spanish) (112)

EMBASE

1 1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7946)

2 catheter- related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword] (213258)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57283)

6 time factors.mp. (540)

7 time/ (199708)

8 2 or 3 or 4 or 5 (260155)

9 6 or 7 (200120)

10 1 and 8 and 9 (54)

11 editorial.pt. (312550)

12 10 not 11 (54)

13 limit 12 to (embase and (English or French or Italian or Portuguese or Spanish)) (21)

Duration of treatment

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 24, 2012>, Ovid MEDLINE(R) Daily Update <May 24, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3090)

2     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing,
      Standards, Utilization] (6608)

3     Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects,
      Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (2749)

4     editorial.pt. (225960)

5     or/1-3 (9517)

6     5 not 4 (9334)

7     limit 6 to (English or French or Italian or Portuguese or Spanish)
      (8859)

8     exp Catheters/ (9516)

9     7 and 8 (2109)

10    animals/ not human/ (1546603)

11    9 not 10 (2052)

12    ("short-term" or "long-term").m_titl. (88735)

13    Time Factors/ (463266)
```

Duration of treatment

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 24, 2012>, Ovid MEDLINE(R) Daily Update <May 24, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3090)

2     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing,
      Standards, Utilization] (6608)

3     Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects,
      Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (2749)
```

4 editorial.pt. (225960)

5 or/1-3 (9517)

6 5 not 4 (9334)

7 limit 6 to (English or French or Italian or Portuguese or Spanish) (8859)

8 exp Catheters/ (9516)

9 7 and 8 (2109)

10 animals/ not human/ (1546603)

11 9 not 10 (2052)

12 ("short-term" or "long-term").m_titl. (88735)

13 Time Factors/ (463266)

14 12 or 13 (529342)

15 11 and 14 (335)

16 exp Microbiological Techniques/ (125876)

17 15 not 16 (317)

18 limit 17 to comparative study (69)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 *central venous catheterization/ or *vein catheterization/ or *blood vessel catheterization/ or *central venous catheter/ or *peripherally inserted central venous catheter/ or *intravenous catheter/ (6613)

3 1 or 2 (7467)

4 editorial.pt. (314941)

5 3 not 4 (7366)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (6819)

7 ("short-term" or "long-term").m_titl. (114190)

8 time factors.mp. or *time/ (2305)

9 7 or 8 (116466)

10 6 and 9 (248)

11 limit 10 to (embase) (16)

pH and Osmolarity

Database: Ovid MEDLINE(R) without Revisions <1996 to March Week 4 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 09, 2012>, Ovid MEDLINE(R) Daily Update <April 09, 2012>

Search Strategy:

```
1     catheter*.ab,ti,sh. (99181)
2     (peripher* or central*).ti. (88065)
3     Hydrogen-ion concentration/ or ph.ti. (102757)
4     osmolar concentration/ or osmola*.ti. (16905)
5     1 and 2 (5217)
6     3 or 4 (116553)
7     5 and 6 (30)
8     limit 7 to (English or French or Italian or Portuguese or Spanish) (30)
```

Database: Embase <1996 to 2012 Week 14>

Search Strategy:

```
1     "catheter*".ti,sh,ab. (127529)
2     (peripher* or central*).ti. (109111)
3     ph/ or ph.ti. (127343)
4     osmolarity/ or osmola*.ti. (7012)
5     1 and 2 (6102)
6     3 or 4 (133222)
7     5 and 6 (30)
8     limit 7 to (English or French or Italian or Portuguese or Spanish) (30)
9     limit 8 to embase (27)
```

CINAHL

```
S9    S3 and S8 12
S8    S4 or S5 or S6 or S7 3320
S7    TI osmola* 100
S6    (MH "Osmolar Concentration") 696
S5    TI ph 686
S4    (MH "Hydrogen-Ion Concentration")2452
S3    (S1 or S2) 2938
S2    (MM "Catheterization, Central Venous") OR (MM "Catheterization,
      Peripheral") 2126
S1    TI ((peripher* or central*) and catheter*) 1378
```

Training

Database: Ovid MEDLINE(R) without Revisions <1996 to February Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 28, 2012>, Ovid MEDLINE(R) Daily Update <February 28, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3028)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1320755)

3 (child* or infant* or neonat* or premature?).ti. (324235)

4 (1 and 2) not 3 (479)

5 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6453)

6 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2692)

7 5 or 6 (8694)

8 (co or ep or pc).fs. (1713657)

9 7 and 8 (3114)

10 4 or 9 (3330)

11 limit 10 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)") (894)

12 10 not 11 (2436)

13 limit 12 to (clinical trial, all or comparative study or meta analysis or multicenter study) (520)

14 (prospective* or retrospective*).sh. (541799)

15 Evidence-Based Medicine/ (44599)

16 research support*.pt. (4091431)

17 12 and (14 or 15 or 16) (849)

18 13 or 17 (1051)

19 4 or 18 (1279)

20 (training or coaching or practice or practicing).m_titl. (102331)

21 19 and 20 (17)

22 *education, nursing/ or *education, nursing, continuing/ or *education, nursing, graduate/ (13704)

```
23    exp *education, medical/ or education, medical, continuing/ or
      education, medical, graduate/ or education, medical, undergraduate/ or
      "internship and residency"/ or teaching rounds/ (52803)

24    *Clinical Competence/ (20248)

25    *Health Knowledge, Attitudes, Practice/ (25770)

26    *Patient Simulation/ (1247)

27    exp *Teaching/ (20981)

28    *Inservice Training/ (3866)

29    or/22-28 (118235)

30    19 and 29 (32)

31    21 or 30 (44)
```

Database: Embase <1996 to 2012 Week 14>

Search Strategy:

```
#15 AND [embase]/lim AND [1996-2012]/py 11

#15 #10 AND #14     25

#14 #11 OR #12 OR #13            590,495

#13 'clinical competence'/exp OR 'attitude to health'/exp OR 'teaching'/exp
      153,806

#12 'nursing education'/de OR 'medical education'/exp OR 'clinical education'/
      exp OR 'residency education'/exp OR 'teaching round'/exp 290,867

#11 training:ti OR coaching:ti OR practice:ti OR practicing:ti     232,639

#10 #8 AND #9 791

#9 'clinical trial (topic)'/exp OR 'prospective study'/de OR 'retrospective
      study'/de OR 'comparative study'/exp OR 'multicenter study'/de OR
      'evidence based medicine'/exp 1,815,760

#8 #7 AND 'article'/it     2,704

#7 #4 OR #6  3,435

#6 #5 AND ([adult]/lim OR [aged]/lim)    2,881

#5 'central venous catheterization'/exp/mj OR 'central venous catheter'/exp/
      mj OR 'vein catheterization'/exp/mj OR 'peripherally inserted central
      venous catheter'/exp/mj OR 'intravenous catheter'/exp/mj     9,590

#4 #1 AND #2 NOT #3 783
```

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 866,122

#2 effect*:ti OR outcome*:ti OR study:ti OR prevent*:ti OR trial:ti OR prophylaxis:ti OR assessment:ti 3,179,313

#1 peripher*:ti OR central*:ti AND catheter*:ti 5,829

CINAHL

S16 S6 or S15 138

S15 S13 NOT S14 132

S14 (MM "Child+") 15706

S13 S11 and S12 133

S12 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2096

S11 S5 or S6 or S7 or S8 or S9 or S10 127564

S10 (MM "Professional Knowledge+") 3542

S9 (MM "Teaching") OR (MM "Teaching Methods, Clinical") OR (MM "Patient Simulation") OR (MM "Computer Simulation") OR (MM "Simulations") OR (MM "Experiential Learning") 7020

S8 (MM "Clinical Competence") OR (MM "Nursing Skills") 8044

S7 (MM "Education, Medical+") OR (MM "Education, Nursing") OR (MM "Education, Nursing, Continuing") OR (MM "Education, Nursing, Graduate") OR (MM "Education, Nursing, Practical") 30878

S6 (S4 and S5) 9

S5 TI (training or coaching or practice or practicing) 87866

S4 (S1 AND S2) NOT S3 209

S3 (child* or infant* or neonat* or premature*) 327483

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 300091

S1 TI ((peripher* or central*) and catheter*) 1367

MEDLINE

1 1 Catheterization, Central Venous/ae (4704)

2 Catheterization, Peripheral/ae (1388)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier] (87683)

4 catheter related mechanical complication.mp. (0)

5 catheter related thrombosis.mp. (134)

6 venous thrombosis.mp. or exp Venous Thrombosis/ (26670)

7 1 or 2 (5801)

8 3 or 4 or 5 or 6 (112152)

9 Education, Medical/ (16225)

10 Clinical Competence/ (44350)

11 training programs.mp. (5490)

12 9 or 10 or 11 (63296)

13 7 and 8 and 12 (15)

14 editorial.pt. (223972)

15 13 not 14 (15)

16 limit 15 to (English or French or Italian or Portuguese or Spanish) (15)

EMBASE

1 1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7946)

2 catheter related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword] (213258)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57283)

6 medical education/ (102706)

7 clinical competence/ (29905)

8 training programs.mp. (6995)

9 6 or 7 or 8 (132163)

10 2 or 3 or 4 or 5 (260155)

11 1 and 9 and 10 (29)

Database: Ovid MEDLINE(R) without Revisions <1996 to April Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 19, 2012>, Ovid MEDLINE(R) Daily Update <April 19, 2012>

Search Strategy:

1 Catheterization, Central Venous/ae (4704)

2 Catheterization, Peripheral/ae (1388)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier] (87683)

4 catheter related mechanical complication.mp. (0)

5 catheter related thrombosis.mp. (134)

6 venous thrombosis.mp. or exp Venous Thrombosis/ (26670)

7 1 or 2 (5801)

8 3 or 4 or 5 or 6 (112152)

9 Education, Medical/ (16225)

10 Clinical Competence/ (44350)

11 training programs.mp. (5490)

12 9 or 10 or 11 (63296)

13 7 and 8 and 12 (15)

14 editorial.pt. (223972)

15 13 not 14 (15)

16 limit 15 to (English or French or Italian or Portuguese or Spanish) (15)

Database: Embase <1996 to 2012 Week 15>

Search Strategy:

1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7946)

2 catheter related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword] (213258)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57283)

6 medical education/ (102706)

7 clinical competence/ (29905)

8 training programs.mp. (6995)

9 6 or 7 or 8 (132163)

10 2 or 3 or 4 or 5 (260155)

11 1 and 9 and 10 (29)

CINAHL

S12 (S7 or S8 or S9 or S10) and (S3 and S6 and S11) 9

S11 S7 or S8 or S9 or S10 61249

S10 “training programs” 2638

S9 (MH “Clinical Competence”)15581

S8 (MH “Education, Nursing, Practical”) OR (MH “Education, Nursing, Continuing”) OR (MH “Education, Nursing”)33724

S7 (MH “Education, Medical+”) OR (MH “Education, Medical, Continuing”)13160

S6 S4 or S5 17716

S5 (MH “Venous Thrombosis”) OR (MH “Thrombosis”) OR (MH “Catheter-Related Thrombosis”) 7180

S4 (bleeding or haematoma or “misplaced catheter” or “arterial puncture” or pneumothorax or “vessel injury”) OR “catheter related mechanical complication” 10902

S3 S1 or S2 2947

S2 (MM “Catheterization, Central Venous”) OR (MM “Catheterization, Peripheral”)2133

S1 TI ((peripher* or central*) and catheter*)1381

Needlestick protection / safety

MEDLINE

1 ((peripher* or central*) and catheter*).ti. (3280)

2 Catheterization, Central Venous/ (8198)

3 Catheterization, Peripheral/ (3944)

4 1 or 2 or 3 (12014)

5 limit 4 to (English or French or Italian or Portuguese or Spanish) (11397)

6 *Needlestick Injuries/pc (735)

7 *Accidents, Occupational/pc (1581)

8 6 or 7 (2190)

9 Needlestick.ti,ab. (864)

10 8 or 9 (2807)

11 4 and 10 (35)

EMBASE

1 ((peripher* or central*) and catheter*).ti. (4288)

2 *central venous catheterization/ or *vein catheterization/ or *blood vessel catheterization/ or *central venous catheter/ or *peripherally inserted central venous catheter/ or *intravenous catheter/ (7022)

3 1 or 2 (7941)

4 Needlestick.ti,ab. (971)

5 *needlestick injury/ or *occupational accident/ (6844)

6 occupational safety/ (7279)

7 4 or 5 or 6 (13769)

8 3 and 7 (20)

CINHAL

S8 (S4 OR S5 OR S6) AND (S3 AND S7) 23

S7 S4 OR S5 OR S6 13,591

S6 TI Needlestick OR AB Needlestick 890

S5 (MH "Accidents, Occupational") OR MH Boolean/Phrase Search "Occupational Safety") 12,151

S4 (MM "Needlestick Injuries") 1,857

S3 S1 OR S2 3,113

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2,226

S1 TI ((peripher* or central*) and catheter*) 1,480

Choice of venous access

Database: Ovid MEDLINE(R) without Revisions <1996 to April Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 20, 2012>, Ovid MEDLINE(R) Daily Update <April 20, 2012>

Search Strategy:

1 Catheterization, Central Venous/ae (4704)

2 Catheterization, Peripheral/ae (1388)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier] (87722)

4 catheter related mechanical complication.mp. (0)

5 catheter related thrombosis.mp. (134)

6 venous thrombosis.mp. or exp Venous Thrombosis/ (26675)

7 1 or 2 (5801)

8 3 or 4 or 5 or 6 (112196)

9 femoral vein/ or jugular veins/ or subclavian vein/ (7357)

10 (femoral or jugular or subclavian).ti. (17867)

11 9 or 10 (22427)

12 7 and 8 and 11 (277)

13 editorial.pt. (224163)

14 12 not 13 (275)

15 limit 14 to (English or French or Italian or Portuguese or Spanish) (255)

Database: Embase <1996 to 2012 Week 16>

Search Strategy:

1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7960)

2 catheter related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword] (213794)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57411)

6 2 or 3 or 4 or 5 (260794)

7 1 and 6 (1585)

8 external jugular vein/ or femoral vein/ or internal jugular vein/ or jugular vein/ or leg vein/ or peripheral vein/ or subclavian vein/ (16246)

9 (femoral or jugular or subclavian).ti. (22036)

10 8 or 9 (34947)

11 7 and 10 (533)

12 editorial.pt. (313050)

13 11 not 12 (520)

14 limit 13 to (English or French or Italian or Portuguese or Spanish) (466)

15 limit 14 to (embase and yr="1996 -Current") (403)

CINAHL

S12 S6 and S11 26

S11 S7 or S8 or S9 or S10 14108

S10 (MH "Thrombosis") OR (MH "Catheter- Related Thrombosis")3399

S9 "catheter related thrombosis" 313

S8 (bleeding or haematoma or "misplaced catheter" or "arterial puncture" or pneumothorax or "vessel injury") 10877

S7 "catheter related mechanical complication" 0

S6 (S1 or S2) and (S3 or S4) 310

S5 S1 or S2 3798

S4 TI femoral or jugular or subclavian 3008

S3 (MH "Jugular Veins") OR (MH "Femoral Vein") OR (MH "Subclavian Vein")903

S2 (MH "Catheterization, Peripheral Central Venous") OR (MH "Catheterization, Peripheral") OR (MH "Catheterization, Central Venous")3157

S1 TI ((peripher* or central*) and catheter*)1379

Information for patients

Database: Ovid MEDLINE(R) without Revisions <1996 to March Week 1 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <March 15, 2012>, Ovid MEDLINE(R) Daily Update <March 15, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3043)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1324783)

3 (child* or infant* or neonat* or premature?).ti. (325108)

4 (1 and 2) not 3 (482)

5 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6482)

6 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2703)

7 5 or 6 (8732)

8 (co or ep or pc).fs. (1720594)

9 7 and 8 (3135)

10 4 or 9 (3352)

11 limit 10 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)") (899)

12 10 not 11 (2453)

13 limit 12 to (clinical trial, all or comparative study or meta analysis or multicenter study) (524)

14 (prospective* or retrospective* or cohort*).sh. (616918)

15 Evidence-Based Medicine/ (44772)

16 research support*.pt. (4107583)

17 12 and (14 or 15 or 16) (877)

18 13 or 17 (1073)

19 4 or 18 (1299)

20 editorial.pt. (221642)

21 19 not 20 (1287)

22 limit 21 to (English or French or Italian or Portuguese or Spanish) (1258)

23 Choice Behavior/ or Cooperative Behavior/ (34171)

24 communication/ or patient compliance/ (59619)

25 Informed Consent/ (16631)

26 Patient Education as Topic/ or Physician-Patient Relations/ (110186)

27 Nurse-Patient Relations/ (15379)

28 Patient Participation/ (11206)

29 Patient Preference/ (1161)

30 Personal Autonomy/ (6881)

31 Patient-Centered Care/ (7527)

32 Socioeconomic Factors/ (56811)

33 or/23-32 (278342)

34 22 and 33 (12)

Database: Embase <1996 to 2012 Week 16>

Search Strategy:

#17 #10 AND #16 56

#16 #11 OR #12 OR #13 OR #14 OR #15 752,666

#15 'doctor patient relation'/de OR 'nurse patient relationship'/de 101,785

#14 'patient education'/de 77,242

#13 'informed consent' 62,586

#12 ‘medical information’ OR ‘patient compliance’ 145,062

#11 ‘decision making’ OR ‘cooperation’ 429,631

#10 #9 AND ([article]/lim OR [article in press]/lim OR [conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR [letter]/lim OR [note]/lim OR [review]/lim OR [short survey]/lim) AND ([english]/lim OR [french]/lim OR [italian]/lim OR [portuguese]/lim OR [spanish]/lim) AND [embase]/lim AND [19962012]/py 1,317

#9 #7 AND #8 1,720

#8 ‘clinical trial (topic)’/exp OR ‘prospective study’/exp OR ‘retrospective study’/exp OR ‘comparative study’/exp OR ‘multicenter study’/exp OR ‘evidence based medicine’/exp 1,830,329

#7 #4 OR #6 7,052

#6 #5 AND ([adult]/lim OR [aged]/lim) 6,535

#5 ‘central venous catheterization’/exp OR ‘central venous catheter’/exp OR ‘vein catheterization’/exp OR ‘peripherally inserted central venous catheter’/exp OR ‘intravenous catheter’/exp 19,646

#4 #1 AND #2 NOT #3 788

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 870,995

#2 effect*:ti OR outcome*:ti OR study:ti OR prevent*:ti OR trial:ti OR 3,199,513

prophylazis:ti OR assessment:ti

#1 peripher*:ti OR central*:ti AND catheter*:ti 5,878

CINAHL

S11 S6 and S10 42

S10 S7 or S8 or S9 74616

S9 TI patient preferences OR TI patient information OR Physician-Patient Relations OR Nurse-Patient Relations 30636

S8 MH Patient education OR MH Patient participation 35132

S7 MH Choice OR MH Patient compliance OR MH Informed consent 12998

S6 S4 or S5 2260

S5 (MM “Catheterization, Central Venous”) OR (MM “Catheterization, Peripheral”) 2126

S4 (S1 AND S2) NOT S3 235

S3 TI (child* or infant* or neonat* or premature*) 123479

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 303225

S1 TI ((peripher* or central*) and catheter*) 1378

Shaving

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 22, 2012>, Ovid MEDLINE(R) Daily Update <May 22, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3089)
2     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing,
      Standards, Utilization] (6599)
3     Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects,
      Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (2747)
4     editorial.pt. (226073)
5     or/1-3 (9511)
6     5 not 4 (9328)
7     limit 6 to (English or French or Italian or Portuguese or Spanish)
      (8853)
8     exp Hair Removal/ (836)
9     (shaving or shave or shaved or (hair adj2 removal) or depilat*).m_titl.
      (622)
10    8 or 9 (1085)
11    7 and 10 (3)
```

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3994)
2     central venous catheterization/ or vein catheterization/ or blood vessel
      catheterization/ or central venous catheter/ or peripherally inserted
      central venous catheter/ or intravenous catheter/ (16206)
3     1 or 2 (16657)
4     editorial.pt. (314941)
5     3 not 4 (16333)
6     limit 5 to (English or French or Italian or Portuguese or Spanish)
      (15347)
7     (shaving or shave or shaved or (hair adj2 removal) or depilat*).ti,ab.
      (3236)
8     6 and 7 (5)
9     limit 8 to (human and embase) (3)
```

CINAHL

S7 S3 and S6 3

S6 S4 or S5 469

S5 (MH "Hair Removal") 261

S4 TI ((shaving or shave or shaved or (hair removal) or depilat*)) OR AB ((shaving or shave or shaved or (hair removal) or depilat*)) 299

S3 S1 or S2 Display

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") Display

S1 TI ((peripher* or central*) and catheter*) Display

Local anaesthesia

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 23, 2012>, Ovid MEDLINE(R) Daily Update <May 23, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3085)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6602)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2749)

4 (co or ep or pc).fs. (1750669)

5 editorial.pt. (225841)

6 or/1-3 (9511)

7 (4 and 6) not 5 (3234)

8 limit 7 to (English or French or Italian or Portuguese or Spanish) (3121)

9 exp Anesthetics, Local/ (35291)

10 exp Anesthesia, Local/ae, cl, ct, is, mt, mo, nu, st, td, ut [Adverse Effects, Classification, Contraindications, Instrumentation, Methods, Mortality, Nursing, Standards, Trends, Utilization] (2528)

11 9 or 10 (36367)

12 8 and 11 (73)

13 pain/ (58520)

14 12 and 13 (64)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16206)

3 1 or 2 (16657)

4 editorial.pt. (314941)

5 3 not 4 (16333)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15347)

7 exp local anesthesia/ (16602)

8 exp local anesthetic agent/ (93985)

9 7 or 8 (102740)

10 6 and 9 (474)

11 pain/ (120280)

12 10 and 11 (94)

CINAHL

S9 S7 and S8 22

S8 (MH "Pain") 29665

S7 S3 and S6 97

S6 S4 or S5 7915

S5 (MH "Anesthetics, Local+") 7175

S4 (MH "Anesthesia, Local") 1109

S3 S1 or S2 2976

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2148

S1 TI ((peripher* or central*) and catheter*) 1397

Attempts

Database: Ovid MEDLINE(R) without Revisions <1996 to February Week 4 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <March 05, 2012>, Ovid MEDLINE(R) Daily Update <March 05, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3027)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1321656)

3 (child* or infant* or neonat* or premature?).ti. (324526)

4 (1 and 2) not 3 (479)

5 exp Catheterization, Central Venous/ (7647)

6 Catheterization, Peripheral/ (3670)

7 5 or 6 (10762)

8 limit 7 to "all adult (19 plus years)" (4972)

9 4 or 8 (5240)

10 attempts.ti,ab. (45661)

11 9 and 10 (158)

12 limit 11 to case reports (32)

13 11 not 12 (126)

Database: Embase <1996 to 2012 Week 10>

Search Strategy:

#13 #11 NOT #12 103

#12 #11 AND ('case report'/de OR 'case study'/de) 32

#11 #10 AND [embase]/lim AND [1996-2012]/py 135

#10 #8 AND #9 181

#9 attempts:ab,ti 87991

#8 #7 AND 'article'/it 6322

#7 #4 OR #6 7941

#6 #5 AND ([adult]/lim OR [aged]/lim) 6487

#5 'central venous catheterization'/exp OR 'central venous catheter'/exp OR 'vein catheterization'/exp OR 'peripherally inserted central venous catheter'/exp OR 'intravenous catheter'/exp 19486

#4 #1 AND #2 NOT #3 2234

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 866623

#2 effect*:ab,ti OR outcome*:ab,ti OR study:ab,ti OR prevent*:ab,ti OR trial:ab,ti OR prophylaxis:ab,ti OR assessment:ab,ti 9193172

#1 peripher*:ti OR central*:ti AND catheter*:ti 5833

CINAHL

S11 Limiters - Date when published as from: 19960101-20111231 56

S10 S9 AND S8 60

S9 TI ATTEMPTS OR AB ATTEMPTS 8231

S8 S4 or S7 2211

S7 S5 NOT S6 2074

S6 (MM "Child+") 15739

S5 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2096

S4 (S1 AND S2) NOT S3 235

S3 TI (child* or infant* or neonat* or premature*) 122707

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 300998

S1 TI ((peripher* or central*) and catheter*) 1371

Checklist

Database: Ovid MEDLINE(R) without Revisions <1996 to February Week 4 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <March 01, 2012>, Ovid MEDLINE(R) Daily Update <March 01, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3025)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1319673)

3 (child* or infant* or neonat* or premature?).ti. (324045)

4 (1 and 2) not 3 (479)

5 exp Catheterization, Central Venous/ (7641)

6 Catheterization, Peripheral/ (3667)

7 5 or 6 (10755)

8 (co or ep or pc).fs. (1715082)

9 7 and 8 (3646)

10 4 or 9 (3844)

11 limit 10 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)") (1033)

12 10 not 11 (2811)

13 Checklist/ (946)

14 check?list?.ti,ab. (12451)

15 13 or 14 (12794)

16 12 and 15 (21)

Database: Embase <1996 to 2012 Week 8>

Search Strategy:

#12 #8 AND #11 7

#11 #9 OR # 105,955

#10 'checklist'/de 4,014

#9 checklist?:ab,ti 2,548

#8 #7 AND 'article'/it 6,320

#7 #4 OR # 67,937

#6 #5 AND ([adult]/lim OR [aged]/lim) 6,484

#5 'central venous catheterization'/exp OR 'central venous catheter'/exp OR 'vein catheterization'/exp OR 'peripherally inserted central venous catheter'/exp OR 'intravenous catheter'/exp 19,470

#4 #1 AND #2 NOT # 32,233

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 866,314

#2 effect*:ab,ti OR outcome*:ab,ti OR study:ab,ti OR prevent*:ab,ti OR trial:ab,ti OR prophylaxis:ab,ti OR assessment:ab,ti 9,187,809

#1 peripher*:ti OR central*:ti AND catheter*:ti 5,830

CINAHL

S8 S4 and S7 2

S7 S5 or S6 11425

S6 TI checklist* OR AB checklist* 5337

S5 (MH "Checklists") 8184

S4 (S1 AND S2) NOT S3 233

S3 TI (child* or infant* or neonat* or premature*) 122419

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 300091

S1 TI ((peripher* or central*) and catheter*) 1367

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 21, 2012>, Ovid MEDLINE(R) Daily Update <May 21, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3085)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6594)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2746)

4 (co or ep or pc).fs. (1749130)

5 editorial.pt. (225882)

6 or/1-3 (9503)

7 (4 and 6) not 5 (3228)

8 limit 7 to (English or French or Italian or Portuguese or Spanish) (3115)

9 Checklist/ (1040)

10 (bundle or checklist).mp. (28029)

11 9 or 10 (28029)

12 8 and 11 (47)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16206)

3 1 or 2 (16657)

4 editorial.pt. (314941)

5 3 not 4 (16333)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15347)

7 checklist/ (4016)

8 (bundle or checklist).mp. (39599)

9 7 or 8 (39599)

10 6 and 9 (173)

CINAHL

S7 S3 and S6 12

S6 (“bundle”) AND (S4 or S5) 2330

S5 “bundle” 2330

S4 (MH “Checklists”) OR “checklist” 12461

S3 S1 or S2 2976

S2 (MM “Catheterization, Central Venous”) OR (MM “Catheterization, Peripheral”) 2148

S1 TI ((peripher* or central*) and catheter*) 1397

Protocols

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 18, 2012>, Ovid MEDLINE(R) Daily Update <May 18, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3080)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6592)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2746)

4 (co or ep or pc).fs. (1748734)

5 editorial.pt. (225729)

6 or/1-3 (9497)

7 (4 and 6) not 5 (3227)

8 protocols.mp. or Clinical Protocols/ (134209)

9 7 and 8 (103)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16206)

3 1 or 2 (16657)

4 editorial.pt. (314941)

5 3 not 4 (16333)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15347)

7 (co or ep or pc).fs. (1907544)

8 6 and 7 (6847)

9 protocol*.ti. or *nursing protocol/ or *clinical protocol/ (22381)

10 8 and 9 (27)

CINAHL

S6 ((MH "Protocols") OR (MH "Nursing Protocols")) AND (S3 and S4) 48

S5 ((MH "Protocols") OR (MH "Nursing Protocols")) AND (S3 and S4) 55

S4 (MH "Protocols") OR (MH "Nursing Protocols") 8218

S3 S1 or S2 2971

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2143

S1 TI ((peripher* or central*) and catheter*) 1396

Location of the tip

Database: Ovid MEDLINE(R) without Revisions <1996 to February Week 4 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <March 02, 2012>, Ovid MEDLINE(R) Daily Update <March 02, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3026)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1320712)

3 (child* or infant* or neonat* or premature?).ti. (324308)

4 (1 and 2) not 3 (479)

5 exp Catheterization, Central Venous/ (7646)

6 Catheterization, Peripheral/ (3670)

7 5 or 6 (10761)

8 4 or 7 (10826)

9 ((location or position*) and tip).m_titl. (94)

10 8 and 9 (23)

Database: Embase <1996 to 2012 Week 12>

Search Strategy:

#9 #8 AND [embase]/lim AND [1996-2012]/py 32

#8 #6 AND #7 41

#7 location:ti OR position*:ti AND tip:ti 181

#6 #4 OR #5 9803

#5 'central venous catheterization'/exp/mj OR 'central venous catheter'/exp/mj OR 'vein catheterization'/exp/mj OR 'peripherally inserted central venous catheter'/exp/mj OR'intravenous catheter'/exp/mj 9595

#4 #1 AND #2 NOT #3 783

#3 child*:ti OR infant*:ti OR neonat*:ti OR premature*:ti 866410

#2 effect*:ti OR outcome*:ti OR study:ti OR prevent*:ti OR trial:ti OR prophylaxis:ti OR assessment:ti 3180706

#1 peripher*:ti OR central*:ti AND catheter*:ti 5831

CINAHL

S8 S6 and S7 8

S7 TI ((location or position*) and tip) 36

S6 S4 or S5 2231

S5 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2096

S4 (S1 AND S2) NOT S3 233

S3 TI (child* or infant* or neonat* or premature*) 122419

S2 TI (effect* or outcome* or study or prevent* or trial or prophylaxis or assessment) 300091

S1 TI ((peripher* or central*) and catheter*) 1367

Feedback

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 25, 2012>, Ovid MEDLINE(R) Daily Update <May 25, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3090)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6609)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2749)

4 editorial.pt. (226134)

5 or/1-3 (9518)

6 5 not 4 (9335)

7 limit 6 to (English or French or Italian or Portuguese or Spanish) (8859)

8 feedback.mp. or Feedback, Physiological/ or Feedback/ (57667)

9 7 and 8 (38)

10 *Guideline Adherence/ (7475)

11 7 and 10 (29)

12 9 or 11 (63)

Database: Embase <1996 to 2012 Week 21>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3998)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16244)

3 1 or 2 (16695)

4 editorial.pt. (315394)

5 3 not 4 (16371)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15378)

7 feedback.mp. or feedback system/ (74608)

8 6 and 7 (84)

9 guideline adherence.mp. (876)

10 6 and 9 (3)

11 8 or 10 (85)

CINAHL

S8 S5 or S7 17

S7 (MM "Guideline Adherence") AND S3 2

S6 (MM "Guideline Adherence") 1036

S5 ((MH "Feedback") OR "FEEDBACK") AND S3 15

S4 (MH "Feedback") OR "FEEDBACK" 10826

S3 S1 or S2 2976

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2148

S1 TI ((peripher* or central*) and catheter*) 1397

Preventing complications when catheterizing

Institutional quality control programmes

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 25, 2012>, Ovid MEDLINE(R) Daily Update <May 25, 2012>

1 1 Catheterization, Central Venous/ae (4707)

2 Catheterization, Peripheral/ae (1391)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. [mp=title, abstract, original title, name of substance word, subject heading word, protocol

supplementary concept, rare disease supplementary concept, unique identifier] (88058)

4 catheter related mechanical complication.mp. (0)

5 catheter related thrombosis.mp. (136)

6 venous thrombosis.mp. or exp Venous Thrombosis/ (26728)

7 1 or 2 (5806)

8 3 or 4 or 5 or 6 (112581)

9 "outcome and process assessment (health care)"/ or "outcome assessment

10 (health care)"/ or "process assessment (health care)"/ (51781)

11 7 and 8 and 9 (5)

12 Medical Audit/ or Clinical Audit/ or Nursing Audit/ (11622)

13 Quality Indicators, Health Care/ or Quality Control/ or Quality Assurance, Health Care/ or Total Quality Management/ or Quality Improvement/ (71430)

14 Registries/ (33696)

15 "*outcome and process assessment (health care)"/ or "*outcome assessment (health care)"/ or *treatment outcome/ or "*process assessment (health care)"/ (3477)

16 11 or 12 or 13 or 14 (117058)

17 7 and 8 and 15 (14)

Database: Embase <1996 to 2012 Week 21>

Search Strategy:

1 1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7983)

2 catheter related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. (214629)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57537)

6 phlebitis/ or injection site phlebitis/ or thrombophlebitis/ (7357)

7 or/2-6 (264276)

8 treatment outcome/ or outcome assessment/ or outcomes research/ (766794)

9 process monitoring/ (1329)

10 total quality management/ or quality control/ (93989)

11 health care quality/ (128368)

12 medical audit/ (21896)

13 register/ (38924)

14 or/8-13 (1005798)

15 1 and 7 and 14 (228)

16 limit 15 to (embase and (English or French or Italian or Portuguese or Spanish)) (175)

CINAHL

S9 S3 and S7 Limiters - Published Date from: 19960101-20121231 151

S8 S3 and S7 160

S7 S4 or S5 or S6 81605

S6 (MH "Quality of Health Care") OR (MH "Quality Management, Organizational") OR (MH "Quality Assessment") OR (MH "Quality Improvement") OR (MH "Quality Assurance") OR (MH "Quality of Nursing Care") OR (MH "Evaluation and Quality Improvement Program") 62755

S5 (MH "Nursing Audit") OR (MH "Audit") 7909

S4 (MH "Process Assessment (Health Care)") OR (MH "Outcome Assessment") 15397

S3 S1 or S2 2954

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2133

S1 TI ((peripher* or central*) and catheter*) 1388

Securement

Database: Ovid MEDLINE(R) without Revisions <1996 to April Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 25, 2012>, Ovid MEDLINE(R) Daily Update <April 25, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3067)

2 Catheterization, Peripheral/ae (1388)

3 Catheterization, Central Venous/ae (4705)

4 1 or 2 or 3 (7092)

5 catheter related mechanical complication.mp. (0)

6 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. (87820)

7 catheter related thrombosis.mp. (135)

8 venous thrombosis.mp. or exp Venous Thrombosis/ (26695)

9 Catheter-Related Infections/pc (486)

10 Phlebitis/pc or Thrombophlebitis/pc (571)

11 or/5-10 (112877)

12 bandages/ or surgical tape/ (6589)

13 (bandages or dressing or 'surgical tape').ti,ab. (7005)

14 catheter securement devices.mp. (3)

15 catheter stabilization.mp. (0)

16 suture techniques.mp. (15777)

17 stiches.mp. (6)

18 Adhesives/ or Sutures/ (7126)

19 or/12-18 (32616)

20 4 and 11 and 19 (51)

21 editorial.pt. (224304)

22 20 not 21 (51)

23 limit 22 to (English or French or Italian or Portuguese or Spanish) (50)

Database: Embase <1996 to 2012 Week 16>

Search Strategy:

1 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7960)

2 catheter related mechanical complication.mp. (0)

3 (bleeding or haematoma or 'misplaced catheter' or 'arterial puncture' or pneumothorax or 'vessel injury').mp. (213794)

4 catheter related thrombosis.mp. (194)

5 venous thrombosis.mp. or exp vein thrombosis/ (57411)

6 catheter infection/ (7244)

7 phlebitis/ or injection site phlebitis/ or thrombophlebitis/ (7345)

8 or/2-7 (269617)

9 "bandages and dressings"/ (143)

10 (bandages or dressing or 'surgical tape').ti,ab. (8957)

11 catheter securement devices.mp. (6)

12 catheter stabilization.mp. (0)

13 suture techniques.mp. (522)

14 stiches.mp. (28)

15 adhesive agent/ (4251)

16 suture/ (11715)

17 or/10-16 (25084)

18 1 and 8 and 17 (38)

19 editorial.pt. (313050)

20 18 not 19 (38)

21 limit 20 to (English or French or Italian or Portuguese or Spanish) (36)

Sealing

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 21, 2012>, Ovid MEDLINE(R) Daily Update <May 21, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3085)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6594)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2746)

4 (co or ep or pc).fs. (1749130)

5 editorial.pt. (225882)

6 or/1-3 (9503)

7 (4 and 6) not 5 (3228)

8 limit 7 to (English or French or Italian or Portuguese or Spanish) (3115)

9 (cap or caps or plug or plugs or seal or sealed or (mechanical adj1 valve?) or "positive pressure").ti,ab. (41477)

10 8 and 9 (47)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16206)

3 1 or 2 (16657)

4 editorial.pt. (314941)

5 3 not 4 (16333)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15347)

7 (cap or caps or plug or plugs or seal or sealed or (mechanical adj1 valve?) or "positive pressure").ti,ab. (51741)

8 6 and 7 (132)

9 limit 8 to embase (118)

CINAHL

S8 (S4 or S5 or S6) AND (S3 and S7) 27

S7 S4 or S5 or S6 6218

S6 TI positive pressure OR AB positive pressure 2719

S5 TI ("mechanical valve" OR "mechanical valves") OR AB ("mechanical valve" OR "mechanical valves") 94

S4 TI (cap or caps or plug or plugs or seal or sealed) OR AB (cap or caps or plug or plugs or seal or sealed) 3442

S3 S1 or S2 2971

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2143

S1 TI ((peripher* or central*) and catheter*) 1396

Preventing complications in access maintenance

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 21, 2012>, Ovid MEDLINE(R) Daily Update <May 21, 2012>

1 1 ((peripher* or central*) and catheter*).ti. (3070)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut (6559)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut (2734)

4 1 or 2 or 3 (9456)

5 (co or ep or pc or et).fs. (2111686)

6 editorial.pt. (224682)

7 (4 and 5) not 6 (5147)

8 limit 7 to (English or French or Italian or Portuguese or Spanish) (4906)

9 exp Clinical Protocols/ (74765)

10 (maintenance or replacement? or (best adj3 practice?) or patency or occlusion or thrombophlebitis or thrombosis or phlebitis).ti,ab. (341005)

11 exp anti-infective agents, local/ or exp disinfectants/ (93123)

12 Disinfection/mt or Equipment Contamination/pc (4869)

13 skin.ti. (46971)

14 exp Bandages/ or surgical tape/ or Surgical Drapes/ (9620)

15 (bandages or dressing or 'surgical tape').ti,ab. (7016)

16 or/9-15 (562970)

17 8 and 16 (1725)

18 exp Hemorrhage/pc [Prevention & Control] (10468)

19 venous thrombosis.mp. or exp Venous Thrombosis/pc or Thrombosis/pc (26024)

20 catheter related thrombosis.mp. (136)

21 exp Catheter-Related Infections/pc [Prevention & Control] (488)

22 18 or 19 or 20 or 21 (36677)

23 17 and 22 (626)

24 limit 23 to (clinical trial, all or comparative study or meta analysis or multicenter study) (152)

25 (prospective* or retrospective* or cohort*).sh. (625619)

26 Evidence-Based Medicine/ (45315)

27 research support*.pt. (4165253)

28 or/25-27 (4617188)

29 23 and 28 (286)

30 24 or 29 (332)

Database: Embase <1996 to 2012 Week 21>

Search Strategy:

1 1 ((peripher* or central*) and catheter*).ti. (3963)

2 'central venous catheterization'/ or 'central venous catheter'/ or 'vein catheterization'/ or 'peripherally inserted central venous catheter'/ or 'intravenous catheter'/ (15600)

3 1 or 2 (16049)

4 editorial.pt. (314032)

5 3 not 4 (15743)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (14783)

7 (maintenance or replacement? or (best adj3 practice?) or patency or occlusion or thrombophlebitis or thrombosis or phlebitis).ti,ab. (444543)

8 clinical protocol/ (54965)

9 topical antiinfective agent/ or disinfectant agent/ (8481)

10 skin decontamination/ (806)

11 ((skin or equip*) and (decontamination or disinfection)).ti. (174)

12 exp "bandages and dressings"/ or surgical tape/ or surgical drape/ (18878)

13 or/7-12 (522482)

14 6 and 13 (3437)

15 limit 14 to (exclude medline journals and embase) (265)

Actions after complications when catheterizing or during maintenance

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 21, 2012>, Ovid MEDLINE(R) Daily Update <May 21, 2012>

1 1 ((peripher* or central*) and catheter*).ti. (3060)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1334959)

3 (child* or infant* or neonat* or premature?).ti. (327366)

4 (1 and 2) not 3 (487)

5 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (6526)

6 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2716)

7 extravasation.ti. (975)

8 "Extravasation of Diagnostic and Therapeutic Materials"/ (1709)

9 7 or 8 (2203)

10 Phlebitis/co, dt, nu, pc, su, th [Complications, Drug Therapy, Nursing, Prevention & Control, Surgery, Therapy] (227)

11 Thrombophlebitis/co, dt, nu, pc, su, th [Complications, Drug Therapy, Nursing, Prevention & Control, Surgery, Therapy] (1679)

12 Thrombosis/co, dt, nu, pc, su, th or Venous Thrombosis/co, dt, nu, pc, su, th (19874)

13 (phlebitis or thrombophlebitis or thrombosis).ti. (18095)

14 10 or 11 or 12 or 13 (32510)

15 occlusion.ti. (11437)

16 9 or 14 or 15 (45795)

17 5 or 6 (8788)

18 limit 17 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)") (2256)

19 17 not 18 (6532)

20 limit 19 to (clinical trial, all or comparative study or meta analysis or multicenter study) (1061)

21 (prospective* or retrospective* or cohort*).sh. or Evidence-Based Medicine/ or research support*.pt. (4588492)

22 20 or (19 and 21) (2198)

23 limit 22 to (English or French or Italian or Portuguese or Spanish) (2144)

24 editorial.pt. (223484)

25 23 not 24 (2130)

26 (4 or 25) and 16 (249)

Database: Embase <1996 to 2012 Week 21>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3915)

2 (effect* or outcome? or study or prevent* or trial or prophylaxis or assessment).ti. (1670650)

3 (child* or infant* or neonat* or premature?).ti. (416851)

4 (1 and 2) not 3 (628)

5 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ (7939)

6 extravasation.ti. (1207)

7 drug extravasation/ or contrast medium extravasation/ or injection site extravasation/ (1738)

8 6 or 7 (2569)

9 (phlebitis or thrombophlebitis or thrombosis).ti. (24086)

10 phlebitis/ or injection site phlebitis/ or superficial thrombophlebitis/ or thrombophlebitis/ (7568)

11 thrombosis/ or catheter thrombosis/ or injection site thrombosis/ or vein thrombosis/ (71287)

12 9 or 10 or 11 (89056)

13 occlusion.ti. (14465)

14 8 or 12 or 13 (105379)

15 4 or 5 (8307)

16 14 and 15 (1302)

17 limit 16 to (embase and (English or French or Italian or Portuguese or Spanish)) (896)

18 limit 17 to (evidence based medicine or consensus development or meta analysis or outcomes research or "systematic review") (58)

19 limit 17 to (clinical trial or randomized controlled trial or controlled clinical trial or multicenter study or phase 1 clinical trial or phase 2 clinical trial or phase 3 clinical trial or phase 4 clinical trial) (164)

20 18 or 19 (190)

CINAHL

S1 TI ((peripher* or central*) and catheter*)

S2 TI ((effect* or outcome* or study or prevent* or trial or prophylaxis or assessment

S3 TI(child* or infant* or neonat* or premature*)

S4 (S1 AND S2) NOT S3

S5 (MM "Catheterization central venous) or (MM "Catheterization peripheral")

S6 (MM Child*)

S7 S5 NOT S6

S8 S4 OR S7

S9 TI extravasation

S10 (MH "Extravasation of diagnostic and therapeutics materials")

S11 S9 or S10

S12 TI (phlebitis or thrombophlebitis or thrombosis)

S13 (MH "Thrombophlebitis") or (MH "Venous thrombisis")

S14 (MH "Phlebitis")

S15 (MH "Catheter occlusion") or TI occlusion

S16 S11 or S12 or S13 or S14

S17 S8 and S16 (Limiters Published Date from: 19960101-20121231 Narrow by SubjectAge:Aged, 80 and over Narrow by SubjectAge: Adolescent: 13-18 years Narrow by SubjectAge: 65+ years Narrow by SubjectAge: Middle Aged: 45-64 years Narrow by SubjectAge: Adult: 19-44 years (33)

Extravasation

Database: Ovid MEDLINE(R) without Revisions <1996 to April Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 24, 2012>, Ovid MEDLINE(R) Daily Update <April 24, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3069)

2     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing,
      Standards, Utilization] (6546)

3     Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects,
      Contraindications, Instrumentation, Methods, Nursing, Standards,
      Utilization] (2725)

4     extravasation.ti. (983)

5     "Extravasation of Diagnostic and Therapeutic Materials"/ (1715)

6     editorial.pt. (224598)

7     1 or 2 or 3 (9440)

8     4 or 5 (2216)

9     (7 and 8) not 6 (120)
```

Database: Embase <1996 to 2012 Week 16>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3927)

2     central venous catheterization/ or vein catheterization/ or blood vessel
      catheterization/ (7960)

3     extravasation.ti. (1212)

4     drug extravasation/ or contrast medium extravasation/ or injection site
      extravasation/ (1750)

5     1 or 2 (10067)

6     3 or 4 (2583)

7     5 and 6 (75)

8     limit 7 to (English or French or Italian or Portuguese or Spanish) (69)
```

Palliative care

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 3 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 24, 2012>, Ovid MEDLINE(R) Daily Update <May 24, 2012>

Search Strategy:

```
1     ((peripher* or central*) and catheter*).ti. (3090)

2     Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut [Adverse
      Effects, Contraindications, Instrumentation, Methods, Nursing,
      Standards, Utilization] (6608)
```

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut [Adverse Effects, Contraindications, Instrumentation, Methods, Nursing, Standards, Utilization] (2749)

4 editorial.pt. (225960)

5 or/1-3 (9517)

6 5 not 4 (9334)

7 limit 6 to (English or French or Italian or Portuguese or Spanish) (8859)

8 Terminal Care/ or Palliative Care/ (31781)

9 7 and 8 (8)

Database: Embase <1996 to 2012 Week 20>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3994)

2 *central venous catheterization/ or *vein catheterization/ or *blood vessel catheterization/ or *central venous catheter/ or *peripherally inserted central venous catheter/ or *intravenous catheter/ (6613)

3 1 or 2 (7467)

4 editorial.pt. (314941)

5 3 not 4 (7366)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (6819)

7 terminal care/ or terminal disease/ (15687)

8 palliative nursing/ or cancer palliative therapy/ or palliative therapy/ (43831)

9 7 or 8 (54104)

10 6 and 9 (8)

CINAHL

S7 (((MH "Palliative Care")) AND (S4 or S5)) AND (S3 and S6) 2

S6 ((MH "Palliative Care")) AND (S4 or S5) 14960

S5 (MH "Palliative Care") 14960

S4 (MH "Terminally Ill Patients+") OR (MH "Terminal Care+") 33324

S3 S1 or S2 2976

S2 (MM "Catheterization, Central Venous") OR (MM "Catheterization, Peripheral") 2148

S1 TI ((peripher* or central*) and catheter*) 1397

Blood sampling

Database: Ovid MEDLINE(R) without Revisions <1996 to May Week 2 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <May 17, 2012>, Ovid MEDLINE(R) Daily Update <May 17, 2012>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3077)

2 Catheterization, Central Venous/ae, ct, is, mt, nu, st, ut (6586)

3 Catheterization, Peripheral/ae, ct, is, mt, nu, st, ut (2743)

4 1 or 2 or 3 (9488)

5 Blood Specimen Collection/ (4171)

6 (blood adj2 (sampl* or collect*)).ti,ab. (75701)

7 5 or 6 (78106)

8 4 and 7 (255)

9 editorial.pt. (225542)

10 8 not 9 (255)

11 limit 10 to (English or French or Italian or Portuguese or Spanish) (242)

12 limit 11 to humans (211)

Database: Embase <1996 to 2012 Week 19>

Search Strategy:

1 ((peripher* or central*) and catheter*).ti. (3980)

2 central venous catheterization/ or vein catheterization/ or blood vessel catheterization/ or central venous catheter/ or peripherally inserted central venous catheter/ or intravenous catheter/ (16167)

3 1 or 2 (16612)

4 editorial.pt. (314474)

5 3 not 4 (16288)

6 limit 5 to (English or French or Italian or Portuguese or Spanish) (15303)

7 (blood adj1 (sampl* or collect*)).ti. (2454)

8 *blood sampling/ (2301)

9 7 or 8 (3801)

10 6 and 9 (95)

11 limit 10 to embase (60)

12 Appendix 4. AGREE evaluation of prior CPGs

Appendix 4. AGREE evaluation of prior CPGs

Evaluation of the quality of CPGs with the AGREE instrument									
CPG (Producer) (No. of pages)		Year/ Language	AGREE 1	AGREE 2	AGREE 3	AGREE 4	AGREE 5	AGREE 6	Overall evaluation
1	*Guidelines for the Prevention of Intravascular Catheter-related Infections (CDC) 4*	2011/I (31)	0.83	1.00	0.85	0.83	0.79	0.83	Highly recommended
2	2008 *SOR guidelines for the prevention and treatment of thrombosis associated with central venous catheters in patients with cancer: report from the working group* (ANN ONCOL)	2009/I (13)	0.50	0.44	0.69	0.56	0.04	0	Recommended
3	*National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections In NHS Hospitals in England* (EPIC2)	2007/I (64)	0.72	0.67	0.75	0.78	0.54	0.58	Highly recommended

Evaluation of the quality of CPGs with the AGREE instrument

	CPG (Producer) (No. of pages)	Year/ Language	AGREE 1	AGREE 2	AGREE 3	AGREE 4	AGREE 5	AGREE 6	Overall evaluation
4	*Infusion Nursing Standards of Practice*. (J Infus Nurs)	2011/I (110)	0.38	0.41	0.28	0.37	0.05	0	Recommended (*)
5	*Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals* (SHEA)	2008/I (8)	1	0.56	0.48	0.89	0.17	0.67	Recommended
6*	*Assessment and Device Selection for Vascular Access. Guideline supplement* (RNAO)	2008/I (74)	0.80	0.86	0.62	0.80	0.52	0.25	Recommended
7*	*Assessment and Device Selection for Vascular Access* (RNAO)	2008/I (3)	0.80	0.86	0.62	0.80	0.52	0.25	Recommended
8*	*Care and Maintenance to Reduce Vascular Access Complications. Guideline supplement* (RNAO)	2008/I (98)	0.86	0.83	0.68	0.83	0.58	0.29	Recommended

Evaluation of the quality of CPGs with the AGREE instrument									
CPG (Producer) (No. of pages)		**Year/ Language**	**AGREE 1**	**AGREE 2**	**AGREE 3**	**AGREE 4**	**AGREE 5**	**AGREE 6**	**Overall evaluation**
9*	*Care and Maintenance to Reduce Vascular Access Complications* (RNAO)	2008/I (7)	0.86	0.83	0.68	0.83	0.58	0.29	Recommended
10	*Infusion Therapy Standards of Practice* (*Intravenous Nursing New Zealand Incorporated Society*)	2012/I (62)	NOT APPLICABLE						Not recommended
11	*Guidelines on Parenteral Nutrition: Central Venous Catheters* (*access, care, diagnosis and therapy of complications*) (ESPEN)	2009/I (12)	NOT APPLICABLE						Not recommended
12	*Guidelines on the insertion and management of central venous access devices in adults* (INT-J-LAB HEMATOL)	2007/I (18)	NOT APPLICABLE						Not recommended

Evaluation of the quality of CPGs with the AGREE instrument

	CPG (Producer) (No. of pages)	Year/ Language	AGREE 1	AGREE 2	AGREE 3	AGREE 4	AGREE 5	AGREE 6	Overall evaluation
13	Guidelines for the treatment of infections related to short-term intravascular catheters in adults: consensus conference (SEIM-SEMICYUC)	2004/E (10)	NOT APPLICABLE						**Not recommended**

Note: The CPG numbered as 7 is a re-publication of number 6. The CPG numbered as 9 is a re-publication of number 8. Therefore, in evaluation terms, we have considered CPG 11, not 13.

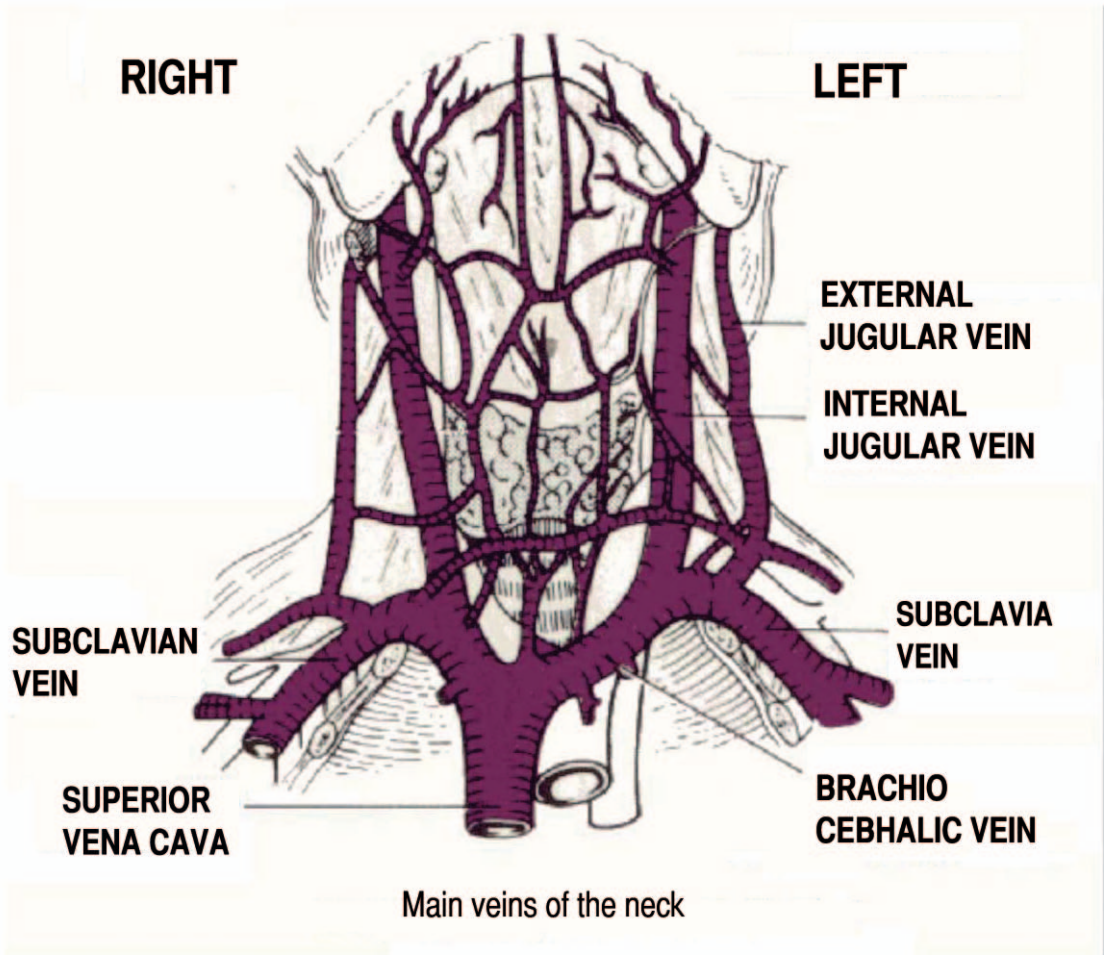
(*) It has been deemed appropriate to recommend this guideline, because it includes standards of good practices and the activities and tasks to be performed, thereby detailing them precisely and specifically.

CPG	REFERENCE	CITED IN THE TEXT
1	O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., Lipsett, P. A., et al. (2011). Guidelines for the prevention of intravascular catheter-related infections. *Clinical infectious disease*, *52*(9), e162-93.	(O'Grady, 2011)
2	Debourdeau, P., Kassab Chahmi, D., Le Gal, G., Kriegel, I., Desruennes, E., Douard, M.-C., Elalamy, I., et al. (2009). 2008 SOR guidelines for the prevention and treatment of thrombosis associated with central venous catheters in patients with cancer: report from the working group. *Annals of Oncology*, *20*(9), 1459-71.	(Debourdeau, 2009)
3	Pratt, R. J., Pellowe, C. M., Wilson, J. A., Loveday, H. P., Harper, P. J., Jones, S. R. L. J., McDougall, C., et al. (2007). epic2: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *The Journal of hospital infection*, *65 Suppl 1*, S1-64.	(Pratt, 2007)
4	Infusion Nurses Society (INS). (2011). Infusion Nursing Standards of Practice. *Journal of Infusion Nursing*, *34*(1 Suppl), S1-S110.	(INS, 2011)
5	Marschall, J., Mermel, L. A., Classen, D., Arias, K. M., Podgorny, K., Anderson, D. J., Burstin, H., et al (2008). Strategies to prevent central line-associated bloodstream infections in acute care hospitals. *Infection control and hospital epidemiology*, *29 Suppl 1*, S22-30.	(Marschall, 2008)

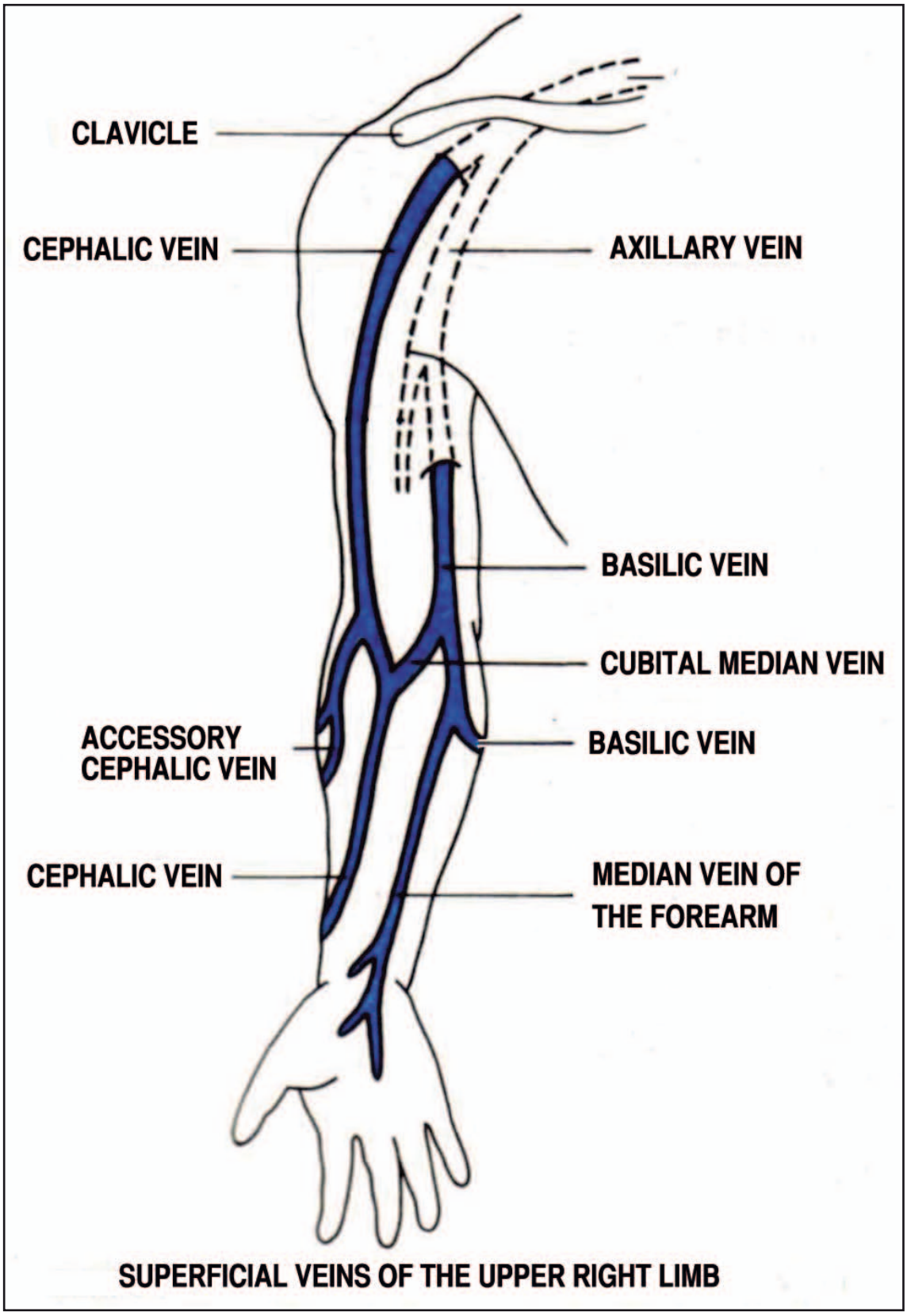
CPG	REFERENCE	CITED IN THE TEXT
6*	Registered Nurses Association of Ontario (RNAO). (2004). *Assessment and Device Selection for Vascular Access [Internet]*. (RNAO, Ed.). Toronto. URL http://www.rnao.org/Storage/39/3379_Assessment_and_Device_Selection_for_Vascular_Access._with_2008_Supplement.pdf	(RNAO, 2004)
7*	Registered Nurses Association of Ontario (RNAO). (2008a). *Assessment and Device Selection for Vascular Access. Guideline supplement [Internet]*. (RNAO, Ed.). Toronto. URL http://www.rnao.org/Storage/ 9/3378_Assessment_and_Device_Selection_for_Vascular_Access._Supplement_FINAL.pdf	(RNAO, 2008a)
8*	Registered Nurses Association of Ontario (RNAO). (2005). *Care and Maintenance to Reduce Vascular Access Complications [Internet]*. (RNAO, Ed.). Toronto. URL http://www.rnao.org/Storage/39/ 381_Care_and_Maintenance_to_Reduce_Vascular_Access_Complications._with_2008_Supplement.pdf	(RNAO, 2005)
9*	Registered Nurses Association of Ontario (RNAO). (2008b). *Care and Maintenance to Reduce Vascular Access Complications. Guideline supplement.* (RNAO, Ed.). Toronto. URL http://www.rnao.org/Storage/39/3380_Care_and_Maintenance_to_ Reduce_Vascular_Access_Complications_Supplement_FINAL.pdf	(RNAO, 2008b)
10	O'Hara, C. (Ed.). (2012). *Provisional Infusion Therapy Standards of Practice* (p. 89). Intravenous Nursing New Zealand Incorporated Society. Retrieved from http://www.ivnnz.co.nz/files/file/7672/IVNNZ_Inc_ rovisional_Infusion_Therapy_Standards_of_Practice_March_2012.pdf	(O'Hara, 2012)
11	Pittiruti, M., Hamilton, H., Biffi, R., MacFie, J., Pertkiewicz, M., & ESPEN. (2009). ESPEN Guidelines on Parenteral Nutrition: central venous catheters (access, care, diagnosis and therapy of complications). *Clinical nutrition*, 28(4), 365–377.	(Pittiruti, 2009)
12	Bishop, L., Dougherty, L., Bodenham, A., Mansi, J., Crowe, P., Kibbler, C., Shannon, M., et al. (2007). Guidelines on the insertion and management of central venous access devices in adults. *International journal of laboratory hematology*, 29(4), 261–78.	(Bishop, 2007)
13	León, C., & Ariza, J. (2004). Guidelines for the treatment of infections related to short-term intravascular catheters in adults: consensus conference (SEIMC-SEMICYUC). *Enfermedades Infecciosas y Microbiología Clínica*, 22(2), 92–101.	(León, 2004)
(*) Citations 6, 7, 8 and 9 are different versions of the same document.		

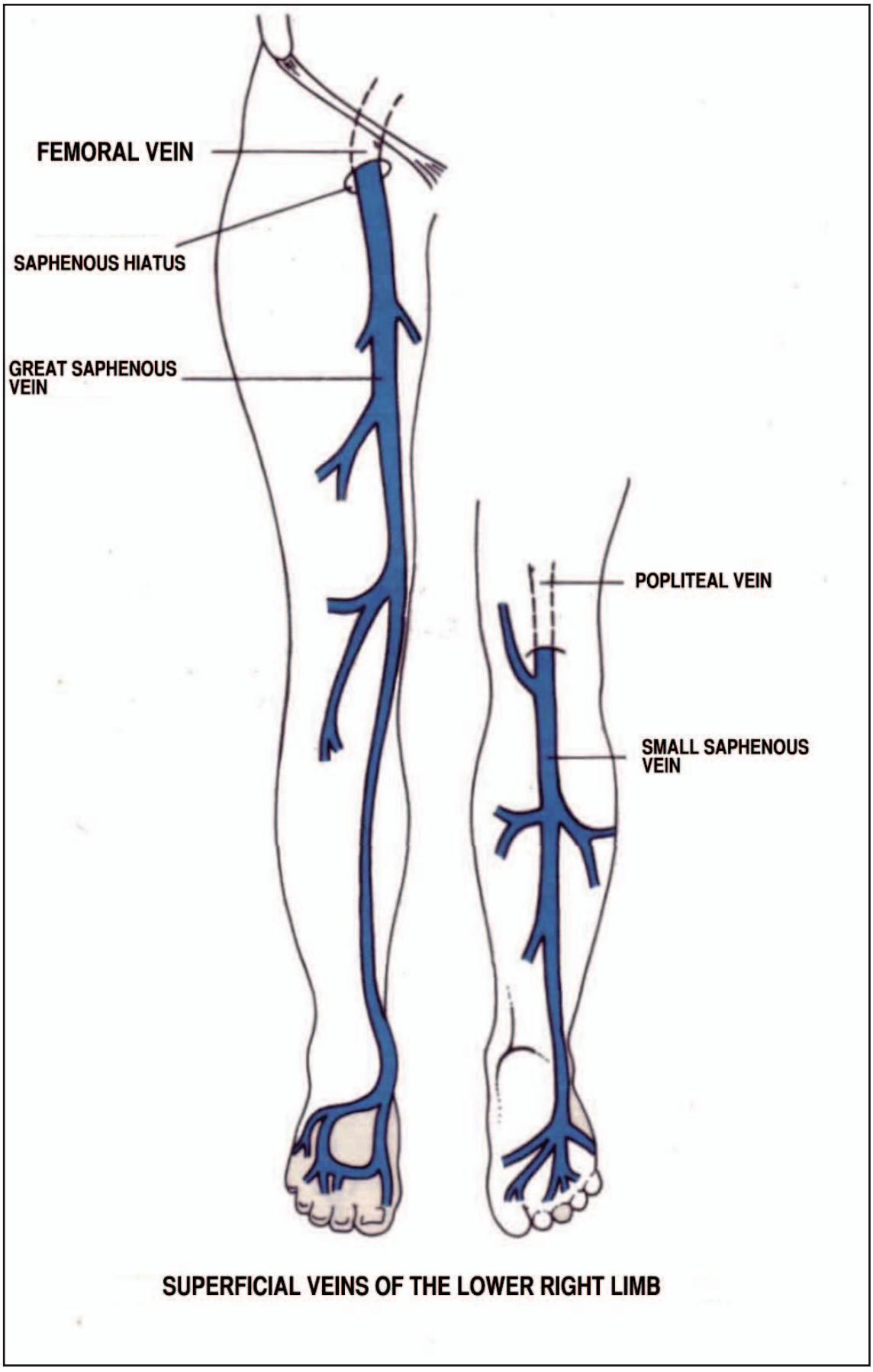
AGREE
1: Scope and objectives.
2: Stakeholder involvement
3: Rigour
4: Clarity and presentation
5: Applicability
6: Editorial independence

Appendix 5. Graphic description of the vein system



Main veins of the neck


CLAVICLE
CEPHALIC VEIN
AXILLARY VEIN
BASILIC VEIN
CUBITAL MEDIAN VEIN
ACCESSORY CEPHALIC VEIN
BASILIC VEIN
CEPHALIC VEIN
MEDIAN VEIN OF THE FOREARM
SUPERFICIAL VEINS OF THE UPPER RIGHT LIMB



SUPERFICIAL VEINS OF THE LOWER RIGHT LIMB

Indicator name	VENOUS LINES WITH NO INDICATION
Quality dimension	Risk
Justification	The indication to remove the venous access could help to decrease the risk of infectious and mechanical complications. The venous line should not be maintained after completing the medication or fluids that justified it or if the line is not needed.
Formula/format	$\frac{\text{Nº de pacientes con vía venosa periférica que no ha sido utilizada en las últimas 24h.}}{\text{Nº de pacientes con catéter periférico}} x100$
Explanation of terms	Inclusion criterion: patients who do not have IV therapy prescribed and who maintain the peripheral venous line during the last 24 hours after removal of the IV drug prescription.
Population	Total number of patients with a peripheral venous access. Patients with indications for removal due to complications are excluded.
Type	Process
Data source	Clinical documentation: record of care, pharmacy electronic prescription.
Standard	Desired level of compliance for the indicator: Less than 5%
Comments	Recommendation 43 of the IVT Guideline recommends that unnecessary venous accesses should be removed. (STRONG, Moderate evidence)

Indicator name	PHLEBITIS ASSOCIATED WITH PERIPHERAL CATHETERS OR PERIPHERALLY INSERTED CENTRAL CATHETERS
Quality dimension	Safety/Risk
Justification	An aspect of care that has to be monitored in order to identify deviations from normal for which actions have to be taken. – Post-catheterization phlebitis is an adverse effect during the course of applying hospital treatment that generates: – Patient pain. – Prolonged stay. – Increased cost of materials and personnel. – Potential risks due to the evolution of phlebitis.
Formula/format	$\frac{\text{Nº de pacientes con flebitis asociada a catéter periférico}}{\text{Nº de pacientes con catéter periférico}} x100$
Explanation of terms	Phlebitis is considered to be the inflammation of the intima wall of a vein. It is characterised by pain in the puncture zone, erythema, oedema and/or palpable venous cord, regardless of the etiology. For indicator purposes, phlebitis is considered any score of 2 or higher on the Maddox scale or 1 or higher on the scale of the Infusion Nurses Society. *(Standards of practice)*.
Population	Patients of a hospitalisation unit who have a peripheral line.
Type	Result indicator. Type of index
Data source	Medical record and direct observation of the patient.
Standard	Desired level of compliance for the indicator of less than 10%, meaning less than 10% of patients with a venous line and phlebitis.
Comments	RECOMMENDATION 46 of the IVT guideline recommends monitoring for the appearance of unexplained fever or pain in the insertion zone, as well as looking for the appearance of reddening. Which suggests complication of the venous route. (STRONG, HIGH EVIDENCE)

Indicator name	**REPLACEMENT OF THE VENOUS CATHETER WITH A CLINICAL INDICATION**
Quality dimension	Efficiency, effectiveness and satisfaction
Justification	There are no conclusive results about the benefits of replacing catheters every 72 or 96 hours according to a standard or protocol. Therefore, the possibility of replacing catheters only if it is clinically indicated should be considered. This would give rise to significant cost savings and would also be well-received by patients, who would be saved the unnecessary pain of systematic re-insertion without a clinical indication. The CDC guideline recommends removing a peripheral catheter if the patient develops signs of phlebitis, infection or malfunction of the catheter (Moderate Evidence). It considers the question to be unresolved, although it is preferable, in order to decrease the number of CRIs, to replace the catheter systematically every 72-96 hours or when clinically indicated. For CVCs and PICCs, it recommends not replacing them routinely as a CRI prevention measure (High Evidence).
Formula/format	$\frac{\text{No. of patients whose venous catheter is replaced according to clinical indication}}{\text{No. of patients with a venous catheter}} \text{ x100}$
Explanation of terms	Replacing a venous catheter should be clinically documented. In the absence of said reasons, it will be understood that replacement of the catheter is not justified. The clinical aspects that justify the replacement of a catheter will be: phlebitis, obstruction, extravasation and patient discomfort.
Population	All patients with a venous catheter.
Type	Process
Data source	Record of care.
Standard	Desired level of compliance for the indicator: I.e. 90%
Comments	RECOMMENDATION 44 of the IVT Guideline recommends that a catheter not be replaced systematically in a fixed period, rather when it is clinically indicated. (STRONG, HIGH EVIDENCE)

Indicator name	**REPLACEMENT OF THE SYSTEM AND VALVES IN A PATIENT WITH CONTINUOUS IV THERAPY**
Quality dimension	Risk, effectiveness and efficiency
Justification	Studies of good quality confirm that CONTINUOUS infusion systems, both primary and secondary branches, which do not administer lipids or blood products, can be maintained for more than 96 hours (4 days) and that more frequent replacements of the systems do not decrease the infection rates. Maintaining the systems for more than 7 days can be considered if systems with anti-infection protection are being used.
Formula/format	$\frac{\text{N}^{\underline{o}} \text{ de pacientes con terapia IV continua con cambio de sistemas y llaves antes de 4 días sin causa justificada (trasfusiones, lípidos)}}{\text{N}^{\underline{o}} \text{ total de pacientes con terapia IV continua}} x100$
Explanation of terms	The infusion system is composed of: saline solution system, connectors, bionectors and three-way valves. Therapy with lipids or blood products is excluded.
Population	All patients with continuous IV therapy for whom the administration of lipids or blood products is not necessary.
Type	Process (surveillance)
Data source	Record of care.
Standard	Desired level of compliance for the indicator: Less than 10%
Comments	RECOMMENDATION 42 of the IVT Guideline recommends that valves and systems be replaced every 4-7 days to prevent complications in venous catheterization. (STRONG, HIGH EVIDENCE)

Appendix 7. Zero Bacteraemia Checklist

Bacteriemia zero

APPENDIX 4. CHECKLIST DURING THE INSERTION OF CENTRAL LINES

Patient		Room No.
Date ___/___/___	Shift: ☐ Morning ☐ Afternoon ☐ Night	Urgency level ☐ Urgent ☐ Optional
Insertion location ☐ Subclavian ☐ Jugular ☐ Femoral ☐ Median-Basilic		Replacement with guide ☐ Yes ☐ No

A minimum of 5 supervised procedures is requires, **both thoracic and femoral** (total of 10). If a doctor succesfully inserts 5 lines in a single location, he will only be considered independently for the procedure in that location.
Assistants function: The nurse assisting with catheterization is in charge of completing the checklist.

In the event of a deviation of the basic steps, the doctor (operator) who is performing the procedure will be informed, and the procedure will be stopped until the deviation is corrected. If any correction is necessary, mark the box, "Yes with notification", and record the correction made in the "Observations" field, if applicable.

Basic steps	Yes	Yes with notification	Observations:
Before the procedure:			
Informed consent and/or patient information			
Confirmed that adequate hand hygiene has been performed			
Operator(s): cap, mask, sterile gown/glove(s), eye protection			
Assistant: cap, mask, sterile gown/glove(s), eye protection			
Disinfected the insertion location with chlorhexidine			
Used an aseptic technique to cover the patient from head to toe			
During the procedure			
Kept the field sterile			
Needed a second qualified operator after 3 punctures without sucess (except in case of an emergency)			
After the procesure:			
Used an atiseptic (chlorhexidine) to clean the remains of blood in the location and put on a sterile dressing			

Supervising nurse_____

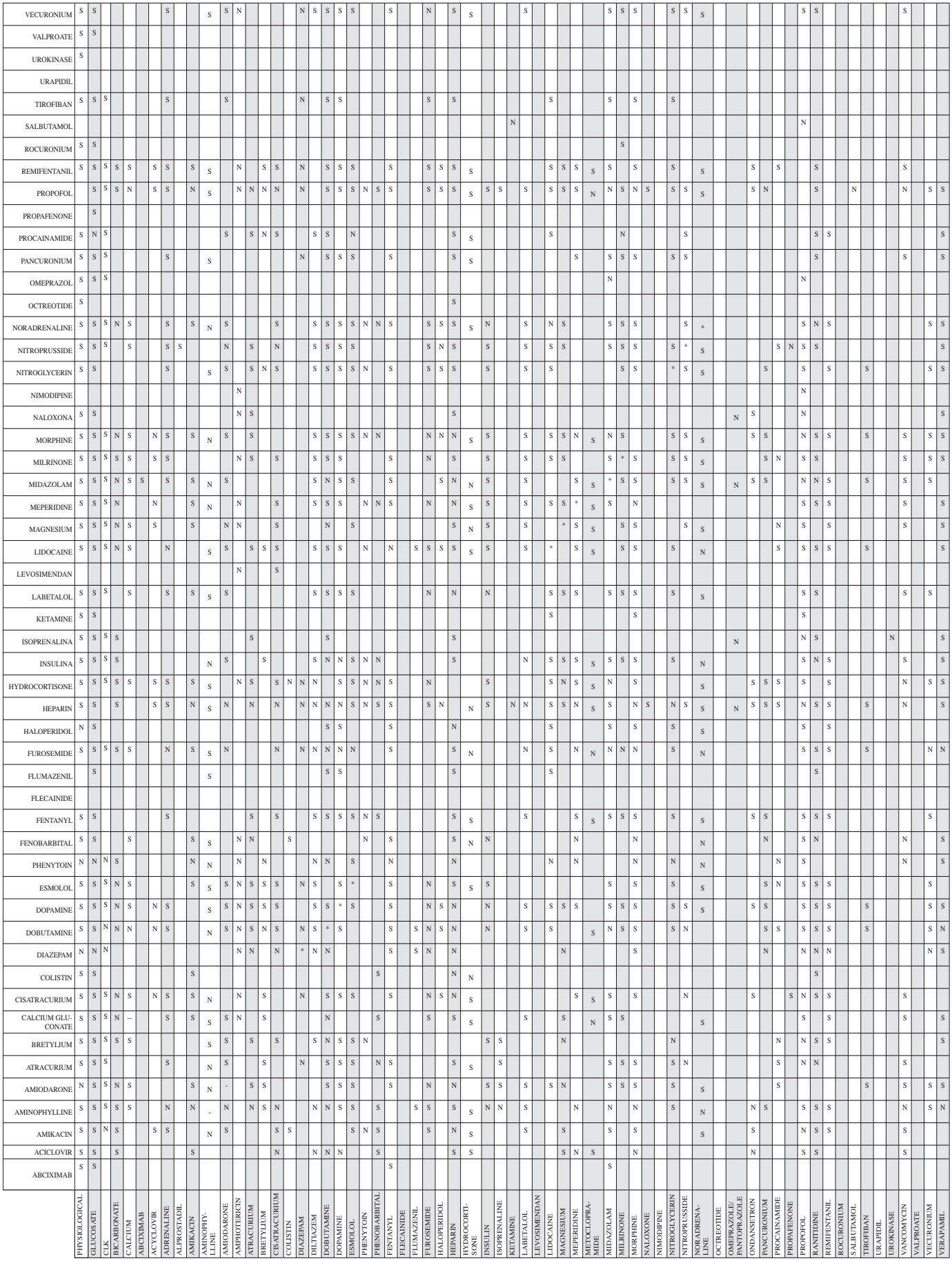
Appendix 8. PICC record

Proposal for the recording of insertion and care data on peripherally inserted central catheters in the medical record.

To guarantee adequate and safe patient care with intravenous therapy using peripherally inserted central catheters, it is recommended that a record be maintained and be included in the medical record, adapted to the particulars of each care centre or unit but including at least the following parameters:

- Patient identification data.
- Main diagnosis.
- Catheter data, including the type of catheter (models, number of lumens, etc.), implantation date, anatomical location, number of attempts.
- Administered medication and fluids, including saline solution, drugs, parenteral nutrition, blood and blood products, blood sampling, etc.
- Catheter care, including the type of treatment, frequency, type of dressing, three-way valves used, type of lock cap, extensions, locking solution and guideline of the same.
- Detected complications, including erythemas, extravasations, degree of phlebitis, thrombosis, catheter-related fever, catheter tip cultures, etc.
- Catheter removal, removal date and reason.

Appendix 9. List of incompatibilities between drugs and saline solution



Appendix 10: Phlebitis criteria and classification

Scales for identifying and assessing catheter-related phlebitis

1.- Phlebitis scale[3]

Grade 0 - No symptoms.

Grade 1 - Erythema at the access point, with or without pain.

Grade 2 - Pain at the access point, with erythema or oedema.

Grade 3 - Pain at the access point, with erythema or oedema, hardening, with palpable venous cords.

Grade 4 - Pain at the access point, with erythema or oedema, hardening, with palpable venous cords greater than 2 cm long; purulent drainage.

2.- Phlebitis scale[4]

- There is no pain, erythema, inflammation, induration or palpable venous cord.
- Pain at the puncture site, without erythema, inflammation, induration or palpable venous cord.
- Pain at the puncture site, with erythema and/or inflammation, with no palpable venous cord or induration.
- Pain at the puncture site, with erythema, inflammation, induration and a palpable venous cord < 3 cm.
- Pain at the puncture site, with erythema, inflammation, induration and a palpable venous cord > 3 cm.
- Venous thrombosis and all other symptoms present.

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[3] Infusion Nurses Society. (2011). Phlebitis. *Journal of infusion nursing*, 34 (1S),S65-S66.

[4] Maddox RR, Rush DR, Rapp RP, Foster TS, Mazella V, McKean HE. (2011) Double-blind study to investigate methods to prevent cephalothin-induced phlebitis. *American Journal of Hospital Pharmacy*. 34, 29-34

Appendix 11: Extravasation of radiographic contrast media

Recommended action in the event of extravasation of radiographic contrast media (Tonolini, 2012, ESUR, 2013).

In certain risk populations (children, unconscious patients, etc.) and above all with automatic, high-flow infusion systems of radiographic media, extravasations of large volumes of contrast media can occur, eventually even causing major damage to tissue, although fortunately the majority of these extravasations only cause minimal damage, such as erythemas or pain.

As risk factors for the occurrence of extravasations, the use of automatic injectors has been described, mainly in MMII or small distal veins, the administration of large volumes of contrast and the use of high osmolarity contrasts. Also related to the patient, special precaution must be taken with patients who are unable to communicate or who have fragile or damaged veins, who have arterial insufficiency or who have difficulty with lymphatic or venous drainage, and in obese patients.

Action in the event of extravasation of radiographic contrast media:

- Immediately stop administration of the contrast media.
- Aspirate through the cannula or venous line to remove the extravasated contrast media to the extent possible.
- Remove the venous line.
- Take to orthagonal X-rays of the affected zone to determine the scope of the subfascial or intracompartmental extravasation.
- Elevate the affected member above the level of the heart.
- Apply cool or warm compresses to the affected zone.
- When blisters occur, the use of silver sulfadiazine is recommended, despite the fact that there is no available evidence.
- Monitoring of the affected zone and assessment for surgery if the extravasated volume is high or symptoms appear.
- Record all processes, including the date, patient parentage data, the extravasated drug, the approximate extravasation volume, the location of the extravasation, signs and symptoms (including photography of the area, if possible), measures and administered treatment, results of the same, requested consultations and follow-up performed.

Appendix 12: Catheter removal procedure

Procedure for removing a peripheral venous catheter[5]

Definition:

It consists in extraction of the peripheral venous catheter after completing the intravenous therapy or in the presence of complications (infection, extravasation, occlusion, obstruction, etc.).

Objective:

Remove the catheter comfortably and safely for the patient and for the person who is performing the extraction.

Procedure:

1. Inform the patient about removal of the catheter.
2. Wash hands hygienically.
3. Shut off the infusion systems.
4. Remove dressings, endeavouring not to cause excess discomfort, so they should be moistened first if they are adhered tightly.
5. Observe the puncture zone to look for signs of infection.
6. Clean the puncture zone with a sterile gauze impregnated with an antiseptic. Allow the antiseptic to dry.
7. Remove the catheter gently, and without abrupt movements, while progressively applying pressure at the puncture point using a sterile gauze impregnated with an antiseptic.
8. Remove the catheter carefully without rubbing against the skin. Apply pressure with a sterile gauze at the puncture point for approximately 3-5 minutes. If the patient is anticoagulated or has coagulation problems, apply pressure for 10 minutes.
9. Observe the catheter to ensure it is whole. If it were not, notify the responsible doctor.
10. Cover the puncture point with sterile gauze.
11. Leave the patient in a comfortable position.
12. Gather up used material and discard the catheter in a biological container.
13. Remove gloves and wash hands.
14. If an infection is suspected (sensitivity in the insertion zone, fever of unknown origin, reddening of the zone or other manifestations that suggest a local infection), the insertion zone must be carefully examined, and the catheter tip must be sent in a sterile sample tube for a microbiological analysis.
15. After removal, assess the application of local treatment in those cases in which there are signs of inflammation, extravasation, haematomas, etc.
16. Note the care in the record: date, time and reason for removal of the catheter.

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[5] Adapted from: Hospital Universitario Virgen del Rocío. (2012). *Manual of General Nursing Procedures*. PG 3_6 *Care and maintenance of venous accesses*. Seville: Hospital Virgen del Rocío. Servicio Andaluz de Salud. http://goo.gl/0AGk07

Procedure for removing a central venous catheter [6]

Definition:

It consists in extraction of the central venous catheter after completing intravenous therapy or in the presence of complications (infection, extravasation, occlusion, obstruction, etc.).

Objective:

Remove the catheter comfortably and safely for the patient and for the person who is performing the extraction.

Procedure:

1. Wash hands.
2. Remove the dressing.
3. Surgically wash hands and put on sterile gloves.
4. Remove the catheter securement points.
5. Gently remove the cannula from the inserted vein.
6. Apply pressure to the puncture point for a few minutes using a sterile gauze impregnated with an antiseptic.
7. Cover with a sterile gauze.
8. Recommend to the patient that they not move for a period of 15-20 minutes.
9. Monitor if there is subsequent bleeding.
10. Observe the catheter to ensure it is whole. If it were not, notify the responsible doctor.
11. Gather up used material and discard the catheter in a biological container.
12. Remove gloves and wash hands.
13. If infection is suspected, send the catheter tip in a sterile sample tube for microbiological analysis.
14. Note the care in the record: date, time and reason for removal of the catheter.

[6] TP PT Adapted from: Hospital Universitario Virgen del Rocío. (2012). *Manual of General Nursing Procedures*. PG 3_7 *Removal of the Peripheral Venous Access*. Seville: Hospital Virgen del Rocío. Servicio Andaluz de Salud. http://goo.gl/0AGk07

Appendix 13: Abbreviations

AD:	Right auricle
AETSA:	Health Technologies Assessment Agency of Andalucía
AGREE:	*Appraisal of Guidelines for Research and Evaluation*
CC:	Catheter contamination
PICC:	Peripherally inserted central catheter
CDC:	*Centers for Disease Control*
CVC:	Central venous catheter
CCT:	Controlled clinical trial
VAS:	Analogue visual scale
CPG:	Clinical practice guideline
GRADE:	*Grading of Recommendations Assessment, Development and Evaluation*
CI:	Confidence interval
INS:	*Infusion Nurses Society*
CRI:	Catheter-related infections
MA:	Meta-analysis
MSSSI:	Ministry of Health, Social Services and Equality
NNT:	Number-needed-to-treat
OR:	*Odds ratio*
RNAO:	*Registered Nurses Association of Ontario*
RR:	Relative risk
SR:	Systematic review
SS:	Saline solution
SHEA:	*Society for Healthcare Epidemiology of America*
SNS:	National Health System
IVT:	Intravenous therapy
DVT:	Deep vein thrombosis
ICU:	Intensive care unit
SVC:	Superior vena cava

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