GAVeCeLT RECOMMENDATIONS 2024 FOR THE INDICATION, IMPLANTATION AND MANAGEMENT OF VENOUS ACCESS DEVICES

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PREFACE

Three years after the first edition of this document, we thought it appropriate to prepare an updated version that takes into account the latest international guidelines (SHEA 2022, INS 2024, etc.) and the many (mostly Italian) clinical studies that have recently appeared in the *Journal of Vascular Access* and other relevant journals.

As already specified for the previous edition of 2021, these recommendations have not been developed according to the methodology of guidelines or *consensus papers*, although they are firmly based on all the most important *evidence-based* documents published in recent years. They are actually meant to be an up-to-date reference for those interested in knowing the state of the art of venous access from the GAVeCeLT perspective. Indeed, next to the most important recommendations of international guidelines, our document includes many novelties validated by clinical studies recently published by our group, the results of the most recent GAVeCeLT/GAVePed consensus documents, as well aś a summary of the numerous *bundles* and protocols we have developed, published and disseminated over the last decade.

We hope that these recommendations will be useful to all those who deal with venous access devices and who want clear, reliable and documented notions (in fact, all the statements in the text are supported by the scientific literature in the extensive bibliography at the end).

Good work to all.

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Post Scriptum: Once again we would like to thank all the experts and friends who have enthusiastically and competently participated in the scientific and educational projects of GAVeCeLT and GAVePed in recent years (congresses, courses, consensus, clinical studies, etc.): Maria Giuseppina Annetta, Paolo Balsorano, Giovanni Barone, Sergio Bertoglio, Michela Bevilacqua, Daniele G. Biasucci, Roberto Biffi, Denis Bolis, Fabrizio Brescia, Maria Calabrese, Antonella Capasso, Giuseppe Capozzoli, Riccardo Carlino, Davide Celentano, Paolo Cotogni, Alessandro Crocoli, Vito D'Andrea, Sonia D'Arrigo, Antonio Dell'Anna, Elisa Deganello, Laura Dolcetti, Stefano Elli, Alessandro Emoli, Adam Fabiani, Elsa Fallani, Vincenzo Faraone, Antonio Gidaro, Davide Giustivi, Emanuele Iacobone, Massimo Lamperti, Ferdinando Longo, Aldo Mancino, Bruno Marche, Rossella Mastroianni, Andrea Musarò, Lidia Muscheri, Gloria Ortiz-Miluy, Matthew Ostroff, Maurizio Pacilli, Giovanna Passaro, Fulvio Pinelli, Alessio Pini Prato, Alessio Piredda, Stefano Romagnoli, Carmen Rodriguez-Perez, Francesca Rossetti, Valentina Selmi, Luca Sidro, Ferdinando Spagnuolo, Tim Spencer, Cristina Taraschi, Francesca Tota, Carmela Trezza, Davide Vailati, Daniele Vezzali, Ton Van Boxtel, Clelia Zanaboni, Geremia Zito Marinosci, and many others.

PART ONE - INDICATIONS FOR VENOUS ACCESS DEVICES

Venous access devices are an indispensable aid in the treatment of hospitalised and non-hospitalised patients. Like many instrumental interventions, however, they can be associated with complications of various kinds that are not always preventable, although they are often foreseeable. These complications (sometimes related to the insertion of the venous access, sometimes related to problems in its management) are clinically more relevant for central venous accesses than for peripheral venous accesses; moreover, certain types of central accesses are characterised by different types of risk than others. It follows that the first and most important strategy to minimise the risks of venous accesses is to appropriately set their indication: to place a venous access only when necessary; to correctly choose between peripheral and central venous accesses, limiting the use of the latter to situations where they are indispensable; to choose between the different available devices according to rules of maximum appropriateness.

INDICATIONS FOR VENOUS ACCESS AND CHOICE OF DEVICE

In the patient with a need for venous access, the choice of the most appropriate device is essentially based on the intended use of the access (infusion of drugs or parenteral nutrition; repeated withdrawals; haemodynamic monitoring; dialysis or aphrotic procedures; etc.), the type of drugs or solutions that will be infused intravenously, the area in which the access will be used (intra- or extra-hospital) and the duration for which it is intended.

Choice central vs. peripheral venous access

Central venous accesses are properly defined as all those intravascular devices whose tip reaches into the superior vena cava, right atrium or inferior vena cava. This position is considered appropriate to allow safe infusion of solutions of any pH and any osmolarity: in fact, even vesicant or phlebolytic drugs can be safely infused in these sites, thanks to the high blood flow (e.g.: approximately 2 litres/minute in the adult patient's superior vena cava), which dilutes the potential damage of these solutions on the endothelium. The position of the catheter tip must also be such as to allow direct infusion of the solutions directly into the blood stream, and not against the vein wall.

The central position of the tip is also considered ideal for repeated blood sampling and haemodialysis procedures, which require large inlet and outlet flows. The use of central venous access for haemodynamic monitoring (detection of central venous pressure, measurement of oxygen saturation of mixed venous blood, estimation of cardiac output by the thermo-dilution method) is only possible for central venous access devices with the tip located in the lower third of the superior vena cava or in the upper third of the atrium. The latter position (i.e. near the superior cavo-atrial junction) is also the one associated with the lowest risk of thrombosis and malfunction.

Among central venous catheters placed from the lower limb (e.g. by femoral venipuncture), two categories should be distinguished: (a) devices whose tip is positioned in the inferior vena cava (the safest position seems to be the upper part of the inferior cava, above the renal veins but below the supra-hepatic veins), which allow the infusion of any drug or solution, as well as blood samples and haemodialysis, but not haemodynamic monitoring; (b) devices whose tip is positioned in the right atrium, which also allow haemodynamic monitoring.

Examples of central venous access devices are PICCs, traditional central insertion CVCs (CICCs), central femoral insertion catheters (FICCs), thoracic ports, PICC-ports, FICC-ports, hemodialysis catheters for both short- and long-term haemodialysis, etc., and - in the neonatal setting - epicutaneous-caval catheters (ECCs) and umbilical venous catheters (CVOs).

All venous accesses whose tip is not located in the superior cava, right atrium or inferior cava should be considered peripheral venous accesses. According to national and international guidelines, neither drugs or solutions with pH <5 or >9, nor vesicant drugs, nor solutions with osmolarity> 750-850 mOsm/litre, nor drugs or solutions that by any other mechanism are associated with a high risk of phlebitis should be infused via such accesses. A recent work (Manrique-Rodriguez et al., 2012) compiled by experts from various Spanish scientific societies gives a very complete list of drugs used by the venous route, indicating those that are potentially harmful to the endothelium due to their irritant or vesicant nature. An even more recent Italian article (Borgonovo et al., 2023) similarly reports the vesicant or non-vesicant characteristics of antibiotics used . The tables in these two documents are the most up-to-date guide to defining the risks associated with the administration of certain drugs peripherally and thus to establishing the indication for central administration. The 2020 Spanish document can be downloaded free of charge from the GAVeCeLT website. For illustrative purposes, we provide in Table 1 an overview of the most commonly used intravenous antibiotics, taken from this document, distinguishing between those that can be administered peripherally, those that should preferably be administered centrally and those that absolutely require a central route.

Examples of peripheral venous accesses are agocannulas (or 'short peripheral catheters'), long peripheral catheters (*or 'mini-midline*') and midline catheters (or '*midclavicular*'). The use of such devices for the infusion of potentially endothelium-damaging drugs is to be avoided, as it is in any case associated with the risk of thrombophlebitic complications and extravasation.

It follows from the above that the correct indication for a central venous access is in the following cases:

1. need for infusion of drugs with pH <5 or >9 or vesicants or otherwise not compatible with the peripheral venous route;
2. need for parenteral nutrition (with the possible exception of brief treatments with lipid-based parenteral nutrition and in any case with osmolarity < 800 mOsm/litre)
3. need for haemodialysis;
4. need for repeated blood samples;
5. need for haemodynamic monitoring.

The first three situations can also be addressed with an inferior vena cava-tipped venous access device, which, however, will not allow haemodynamic monitoring manoeuvres. Haemodialysis will only be possible if the central venous access has specific structural features in terms of calibre, length, number of lumens and stiffness. Central venous access devices of less than 3Fr calibre (typically, ECCs in neonates) will not be appropriate for blood sampling and haemodynamic monitoring, regardless of the correct position of the tip.

Finally, it should be added that a frequent indication for central venous access is the expectation of a long duration of use (not surprisingly, all long-term accesses are central).

TABLE 1

PERIPHERALLY SAFE ANTIBIOTICS

Azithromycin
Aztreonam
Caspofungin
Cefotaxime
Ceftazidime/Avibactam
Ceftozolanol/Tazobacta
m Ceftriaxone
Clarithromycin
Clindamycin Fluconazole
Levofloxacin
Metronidazole Penicillin
Teicoplanin
Tigecycline
Voriconazole

ANTIBIOTICS THAT PREFERABLY REQUIRE A CENTRAL ROUTE

Amoxicillin/Clavulanate
Ampicillin Anidulafungin
Cefazolin
Cefepime
Ciprofloxacin
Colisitin
Cotrimoxazole
Daptomycin
Ertapenem
Fosfomycin
Gentamicin
Imipenem
Linezolid
Meropenem
Micafungin
Moxifloxacin
Oxacillin
Pentamidine
Piperacillin/Tazobactam Rifampicin

ANTIBIOTICS THAT NECESSARILY REQUIRE A CENTRAL PATHWAY

Acyclovir
Amphotericin
Ganciclovir
Vancomycin

Choice venous access for intra-hospital use

When choosing venous access, another important consideration is the context in which it will be used, i.e. whether during an in-patient admission or in situations classifiable as out-patient (patient at home, or in *hospice*, or followed on an out-patient basis, or in *day hospital*).

With regard to emergency venous access in the adult patient, the device of first choice is an agocannula-type peripheral venous access (short peripheral cannula) inserted into the veins of the upper limbs; in the presence of a relative unavailability of the superficial veins of the upper limbs (DIVA= *Difficult Intra-Venous Access*), the best choice is the placement of a long peripheral catheter (*mini-midline*) inserted by ultrasound into deep veins of the upper limbs. In particularly critical patients, such as polytrauma patients, the placement of a non-tunnelled FICC by ultrasound-guided venipuncture of the common femoral vein in the groin or a non-tunnelled CICC by venipuncture of deep veins in the supra/subclavian area is indicated. It is important to emphasise (a) that any central venous access, even in emergencies, should be inserted by means of ultrasound-guided venipuncture, (b) that central venous catheters inserted in emergencies (often inserted without being able to adopt all the correct infection prevention strategies and without appropriate intra-procedural verification of the position of the tip) should be removed within 24 to 48 hours, and (c) that the implantation of other types of central venous accesses (PICCs, tunnelled CICCs, tunnelled FICCs, etc.) should always be avoided in the patient in distress.) should always be avoided in the emergency room patient.

For the paediatric/neonatal patientvenous access in the emergency department can be particularly difficult, as this patient population presents as DIVA in a high percentage of cases. Depending on the emergency of the clinical situation and the patient's condition, different accesses may be considered: the placement of an agocannula in superficial veins of the limbs, with or without the aid of special visualisation technologies (such as NIR - *Near Infra-Red* technology); the placement of an ultrasound-guided long peripheral cannula in the veins of the upper limbs; the placement of a non-tunnelled FICC by venipuncture of the common femoral vein or a non-tunnelled CICC by venipuncture of supra/subclavian veins; the placement of an intraosseous access (especially indicated in severe emergencies requiring immediate access e.g. for cardiorespiratory resuscitation).

For intra-hospital venous access in the adult patient admitted to an intensive or non-intensive ward, short-term (agocannulas, long peripheral catheters, untunnelled CICCs and FICCs) or medium-term (midline catheters; tunnelled CICCs; mid-thigh FICCs; tunnelled or untunnelled PICCs) venous accesses are recognised as appropriate. The choice between peripheral and central will follow the above criteria. An important distinction between short-term and medium-term systems is that the former are not considered appropriate out-of-hospital use, which is why a patient may not be discharged with a short-term access at discharge, but may instead retain a medium-term access (e.g. a PICC) if they still require venous infusions at home or in *day hospital*.

In the hospitalised patient, the choice of a particular peripheral venous access (when the peripheral route is compatible with the need for use) is based on (a) the presumed duration of therapy and (b) the availability of visible or palpable superficial veins in the upper limbs. In the case of peripheral venous access in emergencies or otherwise expected to last less than 5-6 days, 'short' (i.e. less than 60mm long), preferably polyurethane, 14G to 26G gauge agocannulas are used. These needles are typically inserted after direct cannulation of superficial veins (< 7mm deep) that are visible or palpable or identifiable using *Near-Infra-Red* (NIR) technology. The use of metal needles with fins (so-called *butterflies*) for prolonged infusion is to be avoided because of the high risk of complications; they should only be used for blood sampling or bolus infusions. The choice of needle-cannula gauge depends on the diameter of the superficial vein and the type of use (26G, colour-coded purple, and 24G, colour-coded yellow, in neonates; 24G, colour-coded yellow, and 22G, colour-coded blue,

in infants and children; 22G, light blue, and 20G, pink, in non-intensive care patients; 18G, green, 16G, grey, or 14G, orange, in emergency or intensive care); in adult patients, the administration of haemotransfusions, peripheral parenteral nutrition, or contrast medium will require gauges of 20G or greater; apheresis collection will require gauges of 16G or greater. If peripheral venous access is planned for more than 24-48 hours, preference should be given to 'integrated' agocannulas (i.e. with a large flap, pre-assembled extension and pre-assembled needle-free connector (NFC). Cannulae with a second port above the cannula connector should be avoided or used only for a few hours (e.g. intraoperatively) as this additional opening carries a non-eliminable risk of bacterial contamination.

In the adult hospitalised patient, in the case of non-availability of visible/palpable/identifiable superficial veins (< 7 mm deep) with NIR technology (i.e.: DIVA patient), or in the case of peripheral intravenous therapy planned for periods longer than one week, the placement of long peripheral cannulae (so-called *mini-midline*: i.e., *power injectable* cannulae, preferably made of polyurethane or PEBA, 18G or 20G calibre, 8 or 10 cm long) is indicated.

Midline catheters (*power injectable*, polyurethane, 4Fr or 5Fr calibre, 20-25 cm long) will be preferable for planned intravenous therapy lasting more than one month or - in some cases - in apheresis manoeuvres. The use of Midline catheters may also be indicated in the hospital setting by the need daily sampling in DIVA patients; in fact, Midlines are the only peripheral venous catheters that can be used for continuous sampling, especially if the tip has correctly positioned (by ultrasound) in the widest part of the thoracic section of the axillary vein, just before clavicle. Silicone Midline catheters are strongly discouraged because of their fragility and thus the risk of rupture, while the use of valved Midline catheters is discouraged because of the high incidence of malfunction.

Both long peripheral cannulae and Midline catheters are placed by ultrasound into the deep veins of the arm (basilic, brachial, cephalic), either by the direct Seldinger method (long peripheral cannulae) or by the modified Seldinger method (Midline catheters). The predictable duration of cannulae is a couple of weeks, whereas Midlines, if used appropriately, can also be used for many months; moreover, Midlines are medium-term systems and therefore the patient can also potentially be discharged with such access. In all cases, the use of these peripheral accesses will have to be particularly monitored: their improper use (e.g. for infusion of solutions that are not compatible with the peripheral route) may lead to the occurrence of deep vein thrombosis of the arm or the axillary-subclavian tract.

Also in the hospitalised patient, the central venous access of first choice should be a **PICC**, i.e. a peripherally inserted central venous catheter inserted by ultrasound into a deep vein of the arm (basilic or brachial), rather than a CICC. In fact, the insertion of a PICC involves a less invasive and less dangerous manoeuvre than the placement of a CICC; the insertion of a CICC can in fact be associated (albeit rarely) with serious cardiorespiratory complications (pneumothorax, haemothorax, serious arrhythmias, gas embolism) that can never occur during the insertion of a PICC.

The use of PICCs made of high-strength polyurethane (*power injectable*) is recommended, as they have optimal stability characteristics and allow the infusion of high flows (up to 5 ml/sec); the use of other more fragile materials (and in particular silicone) is absolutely discouraged. The use of PICCs equipped with a valve (proximal or distal) is also absolutely inadvisable: there is no scientific evidence in favour of the advantages of the valve, and moreoveṛ the presence of the valve is associated with a greater risk of malfunction and a higher cost of the system. *Power injectable* PICCs are available in different gauges: 3Fr, 4Fr or 5Fr single lumen, 4Fr or 5Fr bilumen, 5Fr or 6Fr trilumen. The need for multiple concomitant and incompatible infusions (especially when one of these infusions is parenteral nutrition) necessitates the use of bilumen or trilumen PICCs. Trilumen PICCs are particularly indicated in the ICU patient. 3Fr single-lumen and 4Fr bilumen PICCs are particularly indicated in paediatric patients.

While it is true that the PICC is typically inserted into a basilic vein or a brachial vein, it is alsò true that if these veins are too small for the planned calibre, the PICC can be implanted in the axillary vein (in the brachial tract), in the so-called 'yellow' zone according to Dawson's *Zone Insertion Method* (ZIM). In this case, the venipuncture site wiĺl be too close to the axilla and a short tunnelling will be appropriate to move the emergence site of the catheter more distally (into Dawson's 'green' zone).

In the morbidly obese patient, it is often appropriate to place the PICC not in deep veins of the bicipital-humeral groove (basilic, brachial, axillary), but rather in the cephalic vein (a superficial vein, but one that in the morbidly obese may the only easily accessible vein), preferably in the brachial section of this vein rather than in its thoracic section.

Certain clinical situations recommend instead the placement of a **CICC**, i.e. a central venous catheter inserted by direct ultrasound-guided puncture of the deep veins of the sub/supraclavicular region and the neck (axillary, subclavian, internal jugular and anterior venae):

1. bilateral presence of contraindications to the placement of a PICC in the brachial site (previous axillary lymph node emptying, osteo-articular or cutaneous changes, chronic paresis of the arm, unavailabilitỳ of veins of sufficient calibre, venous thrombosis in the basilic-axillary-subclavian axis, etc.);
2. presence of chronic renal failure stage 3b - 4 - 5, i.e. undergoing or candidate for haemodialysis treatment;
3. need for venous access in an emergency and/or in a haemodynamically unstable patient (typically, in the emergency room or operating theatre or intensive care unit);
4. indication for the placement of a four- or five-lumen venous access.

The placement of venous access by venipuncture and ultrasound-guided cannulation of the common or superficial femoral vein (**FICC**) maỳ be indicated in the following cases:

1. emergency venous access, e.g. in a trauma patient;
2. need for short-term venous access for haemodialysis or aferetic procedures, in patients whom it is advisable to spare the upper caval district for other venous accesses;
3. patient with inabilitỳ of the upper caval district due to obstruction/compression of the superior vena cava (superior cava syndrome);
4. uncooperative patient with a high risk of dislocation/removal of the device;
5. patients with contraindications to PICC placement, in whom there is an increased risk associated with the insertion/maintenance of a CICC (e.g.: high risk of accidental puncture of the pleura, foreseeable difficulty in managing the emergency site in the supra/subclavear location, etc.).

In the first two situations an emergence site in the inguinal region will be tolerated (e.g., non-tunnelled FICC inserted into the common femoral vein); in the last two situations it will bè good to plan for a mid-thigh emergence site (common femoral venipuncture + mid-thigh tunnelling; or, superficial femoral vein venipuncture, with or without tunnelling).

It is important to emphasise - with regard to the first point - that every CVC inserted in emergency-emergency situations (not only non-tunnelled FICCs in inguinal emergencies, but also, for example, non-tunnelled CICCs in supraclavicular emergencies) shouĺd preferably be removed within 24-48 hours, to avoid infectious complications, and replaced - if necessary - with central venous access positioned according to correct asepsis techniques.

Central venous access by puncture of the supra/subclavian veins and neck (CICC) or by puncture of the femoral veins (FICC) can also be achieved by *off-label* use of commercially available central catheters such as PICCs. This strategy can be advantageous for several reasons:

- the PICC micro-introduction kit (21G echogenic needle, micro-introducer, soft-tipped, J-less metal guide - *floppy straight tip* - and small gauge, 0.018") is a guarantee of less trauma and easier and safer insertion;
- the material from which *power injectable* PICCs are made (new-generation polyurethane) is qualitatively superior - in terms of biocompatibility - to that of most CICCs and allows high-pressure use for the infusion of contrast medium;
- the length of the PICCs makes them suitable to be tunnelled (which is particularly important, for example, in femoral implantation where a mid-thigh emergence site is indicated, or when there is an indication for a non-cupped but tunnelled CICC or FICC) and allows central positioning of the tip even in situations where the emergence site is far away (e.g. FICC with superficial femoral v. insertion or CICC with left subclavian insertion).

One particular resource is the possibility of using central venous catheters treated with antimicrobial substances in the intra-hospital setting to reduce the levels of bacterial colonisation of the venous catheter and thus reduce the risk of catheter-related bacteraemic infections (CRBSI). This strategy has evidence of efficacy especially for CICCs (when treated chlorhexidine-sulfadiazine silver or rifampin-minocycline), and especially in patients at high risk of infection (see CDC, EPIC and SHEA guidelines). Currently, the following is recommended:

1. systematic use of chlorhexidine-treated CICCs (new generation: both external and internal treatment), preferably *power injectable*, in adult intensive care patients;
2. use of chlorhexidine-treated central venous catheters in selected patients at high risk of CRBSI;
3. use of chlorhexidine-treated central venous catheters in bacteraemic patients requiring central access.

In the paediatric setting, choice of intra-hospital venous access is largely similar to that described in the adult patient, but has the following peculiarities:

- different calibre of agocannulas to be used (24G, 22G and 20G); the use of 20G is reserved in children only for the need of contrast medium infusion or peripheral parenteral nutrition;
- greater incidence of situations of non-visibility/palpability of superficial veins (DIVA = *Difficult Intra-venous Access*), especially in emergency-urgency, and therefore - as already explained - greater recourse to the ultrasound-guided placement of ultrasound-guided peripheral accesses (*mini-midline*) or of ultrasound-guided central accesses or - in emergency - of intraosseous accesses;
- different calibre and length of the long peripheral cannulae to be used (preferably: 3Fr, 8 cm);
- increased frequency of the need for PICC tunnelling (in children, the veins in the middle third of the arm may be very small in calibre, requiring venipuncture in the proximal third with emergence site packing in the middle third);
- greater frequency of cervical-thoracic (CICC) rather than brachial (PICC) implantation, especially in younger children, due to the absence of veins of adequate calibre (i.e. greater than 3 mm) in the arm;
- strong indication for subcutaneous anchoring for all non-emergency central venous accesses (CICC, FICC, PICC), given the high incidence of accidental dislocation in paediatric age.

In the neonatal setting, the peripheral venous accesses used are almost exclusively small-calibre (26G and 24G) and very short (< 30 mm) cannulae, although recently the use of longer peripheral cannulae (40-60 mm) is gaining ground, which could ensure a longer device life.

There are then three types of central venous access devices in the newborn:

- single- or bilumen umbilical venous catheters (CVO), usually between 2.5 and 5Fr, also made of polyurethane, used as venous access inserted immediately after birth in high-risk infants; because of their limited duration and the position of the tip (which must be placed at the junction of the inferior cava and the right atrium), they are to all intents and purposes to be considered as short-term central venous accesses. Current evidence suggests an advantage of silver ion-treated CVOs in preventing infectious complications, but only for infants with gestational age< 30 weeks and only for CVOs that remain in place for more than two weeks; however, considering the high risk not only of infection but also of dislocation and venous thrombosis, the CVO should remain in place for as short a time as possible (preferably, no longer than 4-5 days) and be replaced quickly with a more appropriate access.
- Epicutaneous-caval (ECC) catheters, single- or double-lumen, with a calibre between 1Fr and 2.7Fr, preferably made of polyurethane, useful for infusion of fluids, parenteral nutrition and other solutions, including those not compatible with the peripheral route; however, they are not appropriate for blood or blood product administration or for haemodynamic monitoring. They are peripherally inserted central venous catheters, similar to PICCs, but differ from them because they are inserted exclusively in superficial veins and not in deep veins, not only in the upper limbs but also in the lower limbs. There are no *power injectable* ECCs, and therefore such catheters are also unsuitable for high-flow infusions, unlike PICCs. Their duration usually does not exceed 2 to 3 weeks (they are therefore short-term accesses) and are appropriate in stable preterm infants with eminently hydration and nutrition needs.
- Central venous catheters with ultrasound-guided insertion into deep veins (almost invariably: CICCs inserted into an anonymous vein and tunnelled towards the subclavian area, or FICCs inserted into a common femoral vein and then tunnelled towards the mid-thigh): 3Fr. calibre single-lumen *power injectable* polyurethane CVCs are usually used. They are indicated in severe acute neonates who are scheduled for surgery, or who require high flows, and/or frequent blood draws, and/or haemotransfusions, and/or haemodynamic monitoring. If tunnelled and fixed with subcutaneous anchorage, they can remain in situ without complications for many weeks.

It should be noted that the strategy of obtaining central venous access by surgical preparation of the vein (so-called 'venolysis') is burdened with enormous disadvantages and no longer has any indication in clinical practice, not even in the newborn.

Choice central venous access for out-of-hospital use

The out-of-hospital use of short-term venous accesses (agocannulas, long peripheral cannulae, non-tunnelled CICCs) is unanimously discouraged by national and international guidelines, due to the special surveillance required by these accesses and the high risk of complications (infectious, thrombotic, occlusive, mechanical) associated with their use at home.

The only venous accesses appropriate for out-of-hospital use (home, hospice, outpatient, day hospital) are medium-term accesses (Midline catheters; PICCs; tunnelled CICCs; FICCs with mid-thigh emergence site) and long-term (tunnelled central venous catheters; tunnelled central venous catheters not cuffed but stabilised with subcutaneous anchorage; totally implantable systems such as thoracic ports or PICC-ports or FICC-ports).

The ideal out-of-hospital central venous access for medium-term intravenous treatment, i.e. planned for weeks or months (up to 3-4 months), is the PICC, either in its classic use (insertion into a deep vein in the arm) or in its *off-label* use (insertion into an axillary, subclavian, internal jugular, anonymous or femoral vein: i.e. as a tunnelled, non-cuffed CICC, or as a FICC with an emergency site in the mid-thigh). The use of CICCs as mid-thigh accesses absolutely requires tunnelling, has a positive (direct and indirect) effect in protecting the catheter from potential bacterial contamination. The PICC will therefore be the ideal venous access - for example - for the oncology patient in palliative care; in the event of contraindication to the PICC (see above), tunnelled non-cuffed CICCs or FICCs with a mid-thigh emergency site will be used.

The use of Hohn-type medium-term central venous accesses (non-tunnelled silicone CICCs) has now been abandoned due to the high incidence of mechanical complications (dislocations and ruptures) and their low cost-effectiveness.

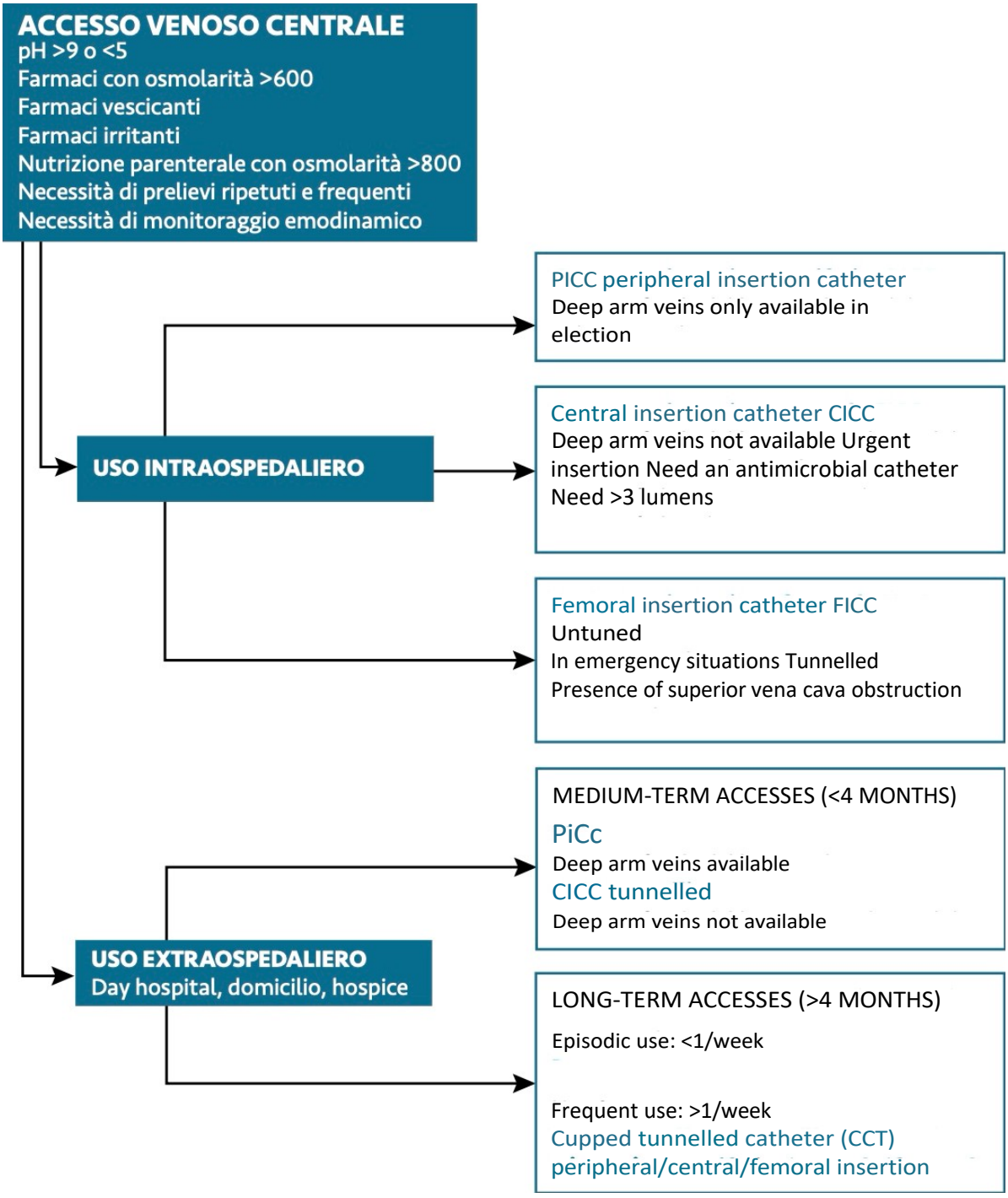
The lack of versatility in terms of use makes out-of-hospital use of Midlines as medium-term catheters (<3-4 months) rare and their use as long-term accesses (> 3-4 months) not recommended. Therefore, long-term venous accesses used at home or in day hospital will be central venous accesses.

The central venous access devices needed for months or years, and in any case for periods> 3- 4 months (i.e. long-term accesses), are (a) cuffed tunnelled catheters, (b) non-cuffed but stabilised tunnelled catheters with subcutaneous anchorage, and (c) fully implantable systems (thoracic ports, PICC-ports, femoral ports). The choice of the most appropriate long-term central venous access is based on frequency of use. In the case of a frequency of use of once a week or more, the ideal access will be a port, which can be inserted into a vein in the sub/supraclavicular region (thoracic *port* or *chest port*) or into a deep vein in the arm (brachial port or PICC-port) or - more rarely - into a femoral vein (femoral port or FICC-port). In the case of thoracic ports, the *reservoir* (usually connected with a silicone or polyurethane catheter, usually 6 - 6 gauge.5Fr) is pocked subclavian, above the pectoralis major muscle; in the case of PICC-ports, the *reservoir* is smaller, is connected with a 5Fr catheter preferably made of polyurethane, and is pocked above the biceps muscle; in the case of FICC-ports, the *reservoir* is preferably pocked above the quadriceps muscle. Typical is the use of ports for patients who are chemotherapy candidates in an outpatient or *day hospital* setting, for whom 3-4 months or more of therapy every 20 days is expected.

If the expected frequency of use is more than once a week, a tunnelled cupped catheter (CCT) should be placed, implanted by ultrasound-guided puncture of a vein in the sub/supraclavicular region (emergency site, however, subclavian), or a deep vein in the arm (emergency site in the arm) or a femoral vein (emergency site in the abdominal or - better - mid-thigh). The presence of the tunnelling directly and indirectly protects against the risk of bacterial contamination; the presence of the cuff stabilises the catheter. Typical is the use of CCTs for patients who are candidates for indefinite parenteral nutrition for benign diseases. It is advisable to use CCTs made of *power injectable* polyurethane (trade names: Pro-Line, Power-Line or Power-Hickman) rather than silicone (trade names: Groshong, Hickman or Broviac): in fact, silicone has no advantage over polyurethane in terms of the risk of infectious or thrombotic complications, but certainly presents a high risk of mechanical complications (dislocation, rupture, tip migration) due to the greater fragility of the material. Today, however, an alternative to CCTs are central tunnelled catheters that are not cuffed (CICCs, PICCs or FICCs) but stabilised with subcutaneous anchoring systems (SAS), which indeed have many advantages over the use of cuffed catheters (lower cost; easier positioning; immediate stabilisation; lower risk of catheter removal in the event of complications related to fixation; easier device removal).

Table 2 summarises the indications for different venous access devices in the adult patient.

TABLE 2


ACCESSO VENOSO CENTRALE
pH >9 o <5
Farmaci con osmolarità >600
Farmaci vescicanti
Farmaci irritanti
Nutrizione parenterale con osmolarità >800
Necessità di prelievi ripetuti e frequenti
Necessità di monitoraggio emodinamico
USO INTRAOSPEDALIERO
PICC peripheral insertion catheter
Deep arm veins only available in election
Central insertion catheter CICC
Deep arm veins not available Urgent insertion Need an antimicrobial catheter Need >3 lumens
Femoral insertion catheter FICC
Untuned
In emergency situations Tunnelled
Presence of superior vena cava obstruction
USO EXTRAOSPEDALIERO
Day hospital, domicilio, hospice
MEDIUM-TERM ACCESSES (<4 MONTHS)
PiCc
Deep arm veins available
CICC tunnelled
Deep arm veins not available
LONG-TERM ACCESSES (>4 MONTHS)
Episodic use: <1/week
Frequent use: >1/week
Cupped tunnelled catheter (CCT)
peripheral/central/femoral insertion

In paediatrics, choice of out-of-hospital venous access does not differ from adults, except for a few differences:

- As medium-term access, a higher percentagè of tunnelled CICCs and tunnelled FICCs are used than PICCs, due to the reduced availabilitỳ of veins of adequate calibre at the level of the upper limb.
- As access, external tunnelled devices are sometimes used even in situations that in adults would require totally implantable systems, due to the paediatric patient's lower tolerance of the punctures required to access the *reservoir*.

The DAV-Expert protocol

For a detailed and annotated description of the choice of venous access device in hospitalised and non-hospitalised patients, please refer to the DAV-Expert, an expert system available free of charge both as a *smartphone* application and as an *online* resource on the GAVeCeLT website.

Tables 3, 4 and 5 summarise respectively the DAV-Expert indications for choice of venous access in the adult, child and newborn patient.

TABLE 3

Figure 2

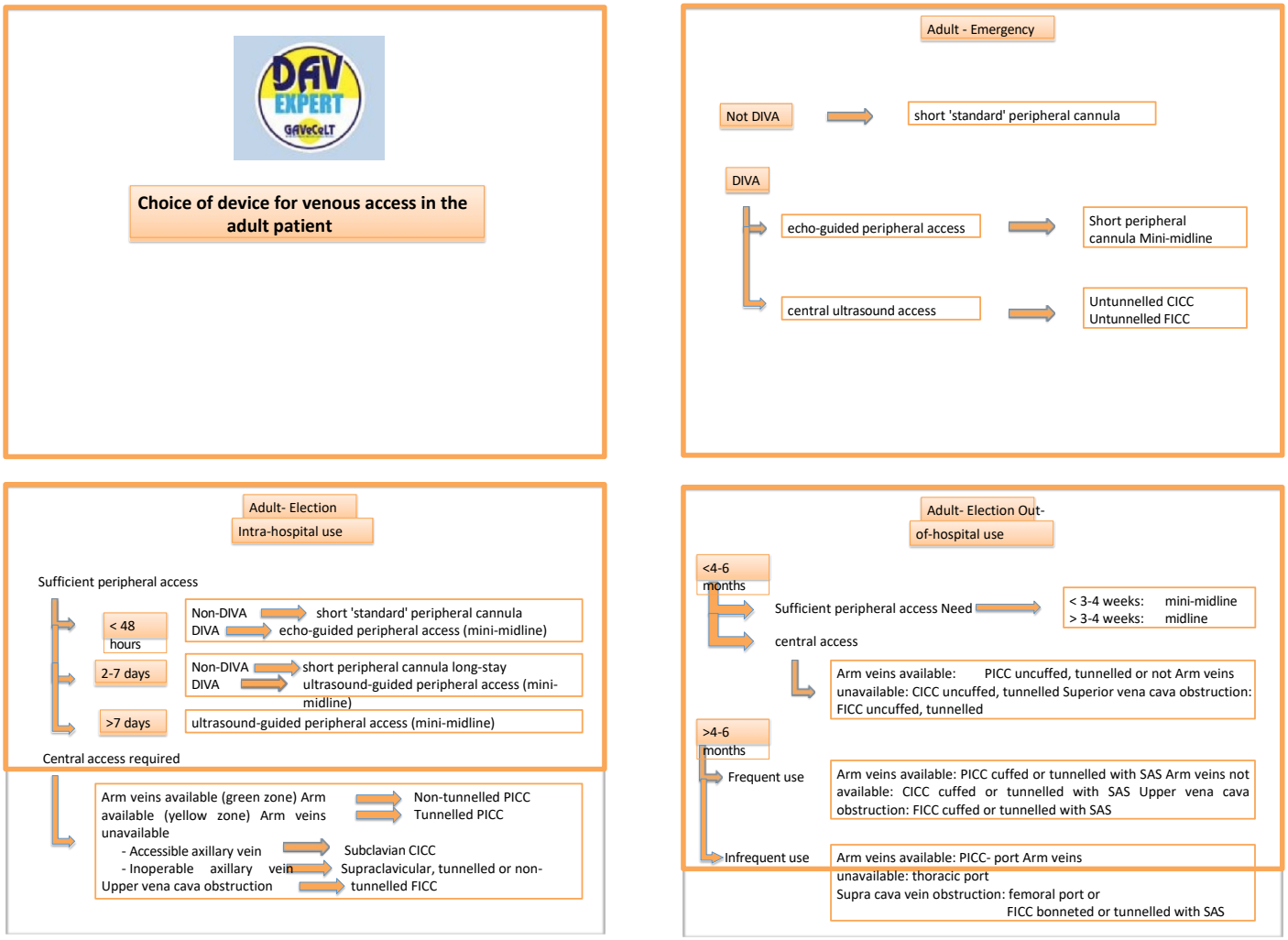


TABLE 4

Figure 3

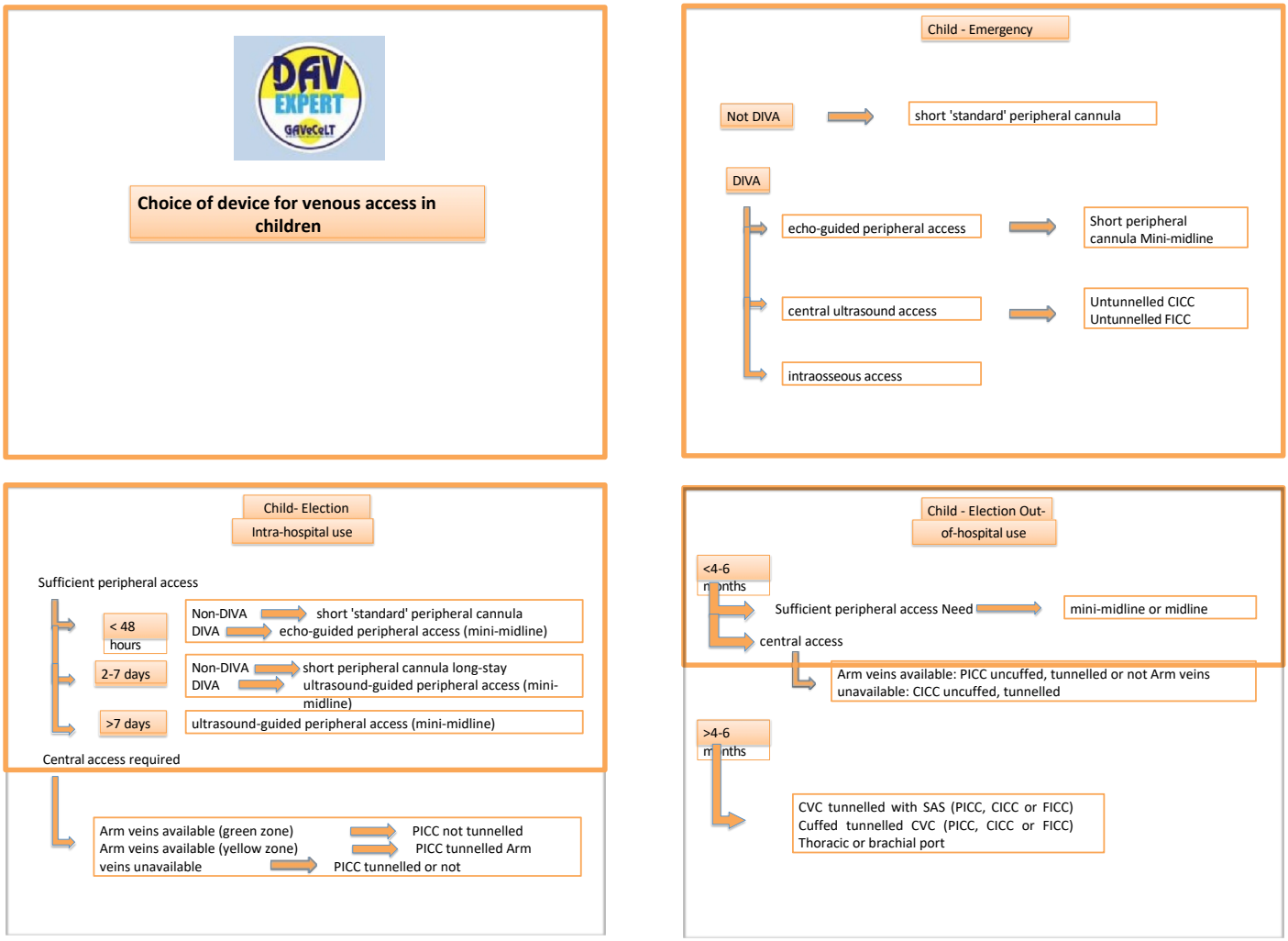
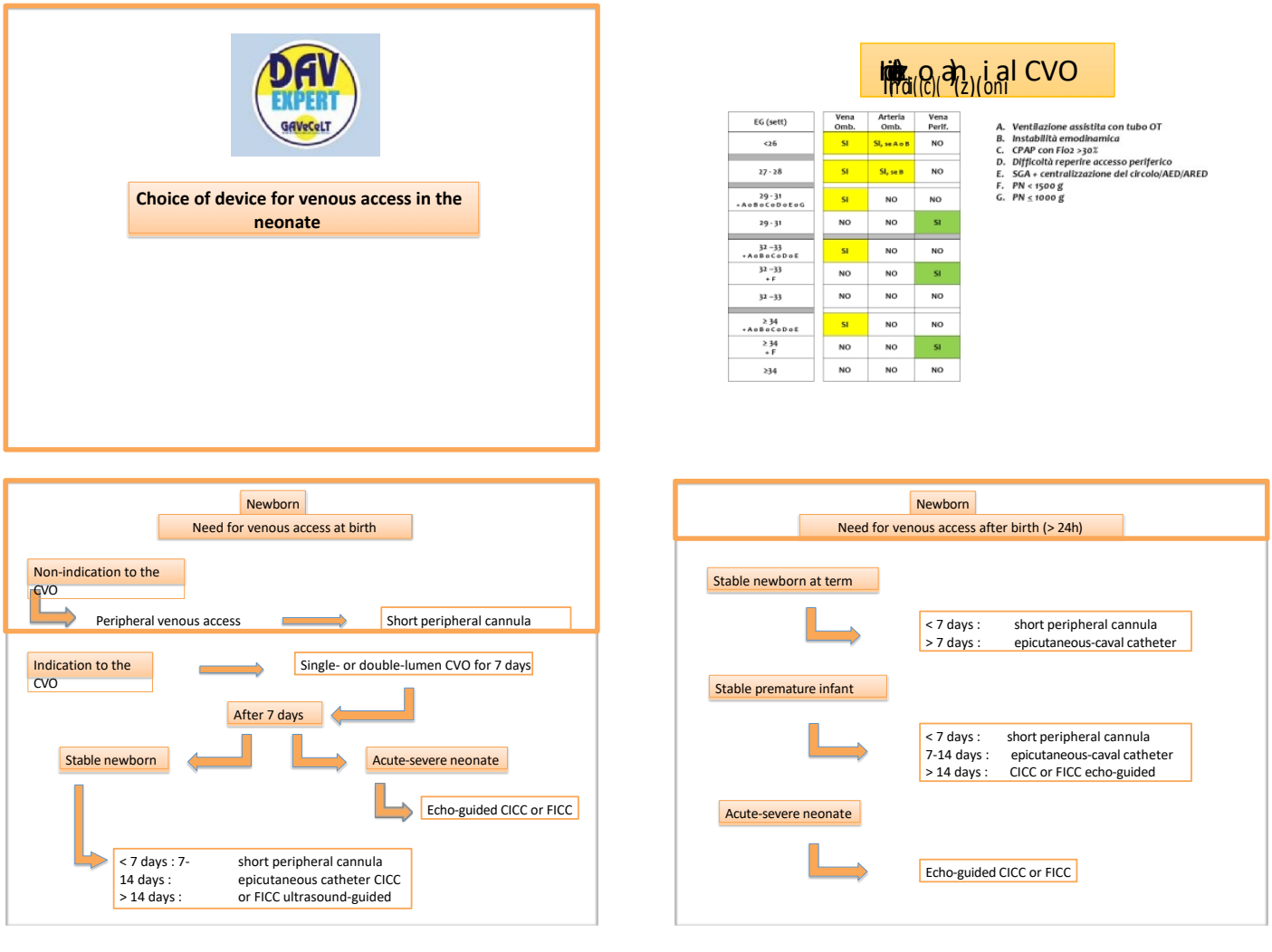


TABLE 5

Figure 4



EG (sett)	Vena Omb.	Arteria Omb.	Vena Perif.
<26	SI	SI, se A o B	NO
27 - 28	SI	SI, se B	NO
29 - 31 + A o B o C o D o E o G	SI	NO	NO
29 - 31	NO	NO	SI
32 -33 + A o B o C o D o E	SI	NO	NO
32 -33 + F	NO	NO	SI
32 -33	NO	NO	NO
≥ 34 + A o B o C o D o E	SI	NO	NO
≥ 34 + F	NO	NO	SI
≥34	NO	NO	NO

PART TWO - IMPLANTATION OF VENOUS ACCESS DEVICES

Once the appropriateness of the choice of a particular venous access has been identified, it is of utmost importance that the implantation manoeuvre is performed (a) correctly (and thus following the recommendations of international guidelines) and (b) by specifically and appropriately trained personnel. Indeed, the implantation manoeuvre has been shown to play a crucial role in reducing the risk of mechanical, infectious and thrombotic complications. While it was once believed that the only risks associated with the implantation manoeuvre were those linked to any immediate mechanical damage related to the venipuncture and to the progress of the catheter in the venous system, it is now known that many late complications (infectious and non-infectious) are also caused or favoured by inappropriate behaviour at the time of the insertion of the device.

One example for all is the risk of bacterial contamination during the implantation phase, which can result in an infectious complication - mild, severe or life-threatening - occurring even many days later. In this respect, one of the strongest recommendations - valid for the insertion of any type of venous access - is hand washing and the use of gloves.

hand hygiene, refer to the relevant company *policies*, which must comply with the recommendations of the World Health Organisation. Regarding the use of gloves for venous access insertion, international guidelines recommend: (a) to wear clean gloves during the insertion of peripheral venous catheters, as long as the implant site is not palpated after the application of skin antiseptics (if this is unavoidable, sterile gloves must be worn beforehand); (b) to wear sterile gloves during the insertion of any central venous catheter (short, medium and long term) and of peripheral catheters with a prolonged duration (Midline and 'long' peripheral cannulae).

INSERTION OF PERIPHERAL VENOUS ACCESS DEVICES

The insertion of a peripheral venous access can be performed by direct puncture of a visible or palpable superficial vein (in the case of agocannulas) or by ultrasound-guided cannulation of a deep vein using a direct Seldinger technique (long peripheral cannulae) or a modified Seldinger technique (Midline catheters).

The placement of an agocannula-type peripheral venous access (either the normal type or the 'integrated' type, i.e. with a pre-assembled extension and pre-assembled NFC) involves a procedure whose salient points are as follows:

- a vein of sufficiently large calibre must be chosen and an agocannula whose calibre must be proportionate to the clinical use, but not exceeding that purpose; veins in stable (forearm, arm) rather than unstable (hand, wrist, elbow crease, cervical region) areas should be chosen in preference; placement in unstable areas is only justified in the case of agocannulas placed in an emergency/urgency (room, operating theatre, radiology room, etc.), which are removed within 24-48 hours;
- The agocannula should be placed with clean gloves, after washing the operator's hands and skin antisepsis with chlorhexidine 2% in 70% IPA;
- during the insertion manoeuvre, the operator - wearing non-sterile gloves - must not touch the previously disinfected venipuncture area;
- the agocannula should be fixed with sterile devices (transparent adhesive semi-permeable membrane) and never with a plaster. In the case of agocannulas intended to remain in place for more than 24 to 48 hours, or in agocannulas for which a high risk of bleeding from the emergence site or a high risk of

accidental dislocation, it is a good idea to apply a small amount of cyanoacrylate glue to the emergency site, immediately before applying the transparent membrane.

The placement of an ultrasound-guided peripheral venous access, such as a long peripheral cannula or a Midline catheter, involves a procedure based on the following steps:

- choice by ultrasound of a vein whose calibre is at least three times the calibre of the chosen catheter, preferably in a location that allows an emergence site of maximum stability; for midlines, the emergence site must be located in the middle third of the arm (Dawson's green zone); for long peripheral cannulae (or *mini-midlines*), other venipuncture sites may also be used, either on the arm or the forearm, as long as they are away from flexion zones (wrist, antecubital fossa); as a first choice, *mini-midlines* should be inserted in forearm veins (cephalic or basilic vein) or in the cephalic vein in the arm, to spare arm veins (brachial and basilic) potentially useful for future PICC or Midline placement;
- Appropriate asepsis and maximum barrier protection, i.e. hand washing, sterile gloves, sterile gown, mask, cap, skin antisepsis with chlorhexidine 2% in 70% IPA, sterile perforated drape, appropriate sterile covering of the ultrasound probe;
- *out-of-plane* ultrasound-guided venipuncture (with vein visualised in short axis), after local anaesthesia for infiltration (preferably ropivacaine 7.5-10 mg/ml);
- catheter placement by direct Seldinger technique (in the case of long peripheral cannulas) or indirect/modified (in the case of Midlines):
- washing the catheter with physiological saline and closing the system with needle-free connectors (NFC) at neutral pressure;
- Appropriate catheter fixation with sterile devices: transparent adhesive semi-permeable dressing, with or without a 'sutureless' system, after application of a minimal amount of cyano-acrylate glue to the emergence site.

The techniques currently recommended for the correct placement of a peripheral venous access are described in detail and commented on in the ERPIUP document (European Recommendations for the Appropriate Indication and Use of Peripheral Accesses) developed by WoCoVA, which can be downloaded from the GAVeCeLT website.

INSERTION OF CENTRAL VENOUS ACCESS DEVICES IN THE SHORT TO MEDIUM TERM

For short- and medium-term central venous accesses (CICCs, FICCs and PICCs, including non-tunnelled catheters for short-term haemodialysis), it is accepted that implantation can be performed at the patient's *bedside* (*bedside*), provided that the asepsis measures described below are observed.

The implantation of short to medium-term central venous accesses is entrusted exclusively to healthcare personnel (doctors or nurses) specifically and adequately trained to perform the manoeuvre. In particular, the placement of PICCs is entrusted only to doctors and nurses who have completed a training course specifically focused on the placement of peripherally inserted central venous catheters (PICCs). The placement of CICCs and FICCs by nurses is also restricted nurses who have completed training courses specifically focused on the placement of central insertion central venous catheters (CICCs) or femoral (FICCs).

Informed consent must be collected directly from the operator (doctor or nurse) who performs the implantation manoeuvre, as required by current law.

No pre/post implant antibiotic prophylaxis is indicated.

The procedure should preferably be performed using insertion *packs* specifically set up for PICC, CICC and FICC implantation; they usually contain all the material needed for the manoeuvre but not usually included in the catheter kits (maximum barrier precautions, probe covers, syringes, cable for intracavitary ECG technique, transparent dressing, etc.). The use of insertion *packs* - recommended by international guidelines - is a winning strategy that can reduce time, costs and the risk of complications related to the potential use of sub-optimal materials.

The essential steps of the installation are as follows:

- Prior to implantation, a careful pre-procedural ultrasound examination should be performed to assess all veins in the arm (in the case of PICCs: the RaPeVA protocol), all veins in the supra/subclavian region (in the case of CICCs: the RaCeVA protocol), and/or veins in the inguinal-femoral region (in the case of FICCs: the RaFeVA protocol). This will make it possible to select the most appropriate vein in terms of calibre and position, also in relation to the most desirable emergence site.
- Skin preparation: trichotomy should only be performed if indispensable and always using the specific atraumatic trichotomes (so-called *clippers*). Where possible, it is recommended - before procedure begins - to wash the patient's skin, from the neck down, with chlorhexidine soap solutions.
- Correct aseptic technique always involves hand washing by the operator and the adoption of maximum barrier protective measures (sterile gloves, sterile gown, non-sterile mask, non-sterile cap, ample covering of the patient, sterile probe cover with appropriate length probe cover). The skin should be disinfected with chlorhexidine 2% in 70% IPA. The use of iodopovidone 10% should be restricted to patients with a known chlorhexidine allergy.
- After local anaesthesia (a few ml of ropivacaine 7.5-10 mg/ml), an *ultrasound-guided out-of-plane* venipuncture is performed with a short-axis vein (e.g.: brachial vein, basilic vein, brachial section of axillary vein, common femoral vein, deep femoral vein) or *in-plane* with a short or oblique-axis vein (e.g.: internal jugular vein, thoracic section of axillary vein) or *in-plane* with a long-axis vein (e.g.: supraclavicular approach to the subclavian vein, anonymous vein).(e.g.: internal jugular vein, thoracic section of the axillary vein) or *in-plane* with a vein in a long axis (e.g.: supraclavicular approach to the subclavian vein, anonymous vein and external jugular vein), or *in-plane* with a vein in an oblique axis (e.g.: thoracic section of the axillary vein, deep femoral vein). The subclavian approach to the axillary vein can be achieved either by an *out-of-plane* puncture in the short axis or by an *in-plane* puncture *in* the oblique axis: depending on the operator's judgement either of these two techniques may be preferable in certain clinical situations. The superficial femoral vein can often be easily punctured in the short, *out-of-plane* axis; if it is located below the superficial femoral artery, however, it is more easily punctured *in* the oblique, *in-plane* axis. The use of ultrasound-guided central venipuncture is a method that significantly reduces time, complications and costs and can potentially be performed with any ultrasound scanner, as long as it is equipped with a linear probe. The only situation in which it might be justified to omit the use of ultrasound guidance is the placement of a central venous access in a serious emergency situation, with proven unavailability of the ultrasound scanner: in this case, it is recommended to use only common femoral vein venipuncture/incannulation and to remove the catheter as soon as possible. In all other situations (in practice, in all central venous accesses of any type, with the sole exception of CVO and ECC in neonates), ultrasound-guided venipuncture is imperative (see ESA 2020 and INS 2024 guidelines).
- After venipuncture, the cannulation manoeuvre will be performed using either the direct or indirect Seldinger technique, depending on the type of device available. Placement of a PICC in a deep vein in the arm always involves the indirect ('modified') Seldinger technique. Even in the case of accesses to veins in the sub/supraclavicular or inguinofemoral region, this technique is often preferable because it is less traumatic: this often involves the *off-label* use of a PICC or the use of a CICC after puncture using a micro-introduction kit. The latter strategy is particularly recommended in the case of axillary venipuncture or in the case of 'difficult' venipuncture of any other vein.

- In the case of PICCs and CICCs with subclavian insertion, there is a certain risk of misdirection of the metal guide and/or catheter towards the ipsilateral internal jugular or in other abnormal directions. In these cases, it is a good idea to provide for the possibility of checking the direction (*tip navigation*) using the linear ultrasound probe positioned supraclavicularly.
- After an axillary (subclavian) or subclavian (supraclavicular) venipuncture, it is a good idea to immediately check the integrity of the pleura by ultrasound during the procedure itself, by visualising in the intercostal space the so-called *sliding* of the pleural leaflets (use of linear probe).
- In all central venous accesses, the *tip location* must be verified directly during the manoeuvre itself. For **PICCs** and **CICCs**, it is necessary to verify intra-procedurally that the tip is in the vicinity of the superior atrial cable junction (immediately above or immediately below). The safest, most accurate and most cost-effective technique for this purpose is the intracavitary ECG method. The correct position (cavo-atrial junction) corresponds to the visualisation on the intracavitary ECG of the P-wave peak. In cases where this method is not applicable due to atrial fibrillation, rather than the 'conventional' method (which is based on P-wave variations), the 'modified' ECG method (which is based on f-wave variations) can be used. If the ECG method (conventional or modified) does not provide clear and unambiguous results, it is recommended to also use the tip localisation method in trans-thoracic echocardioscopy, by means of *bubble test*, with a convex or sectorial probe. This method can also be used alone, if the ECG method is not applicable for clinical reasons (no visible P-wave in a non-fibrillating patient; difficult evaluation of f-waves) or logistical reasons (urgent CICC placement, no ECG monitor available). Post-procedural chest X-ray will only be indicated in cases where the results of the intracavitary ECG and echocardioscopy are doubtful. On the X-ray, the correct position of the tip at the cavo-atrial junction will be deduced from the presence of the catheter tip about 3 cm below the tracheal carina in the adult patient (about 2 cm in the child and about 1 cm in the neonate): positions between 1 and 5 cm below the carina are considered acceptable in the adult. The use of fluoroscopy as an intra-procedural tip position verification technique should always be avoided for any central venous access, including all non-tunnelled CICC and FICC dialysis catheters, as it less accurate, more expensive and more harmful than intracavitary ECG and echocardioscopy. In the case of **FICCs**, *tip location* methods will vary depending where the catheter tip is to be placed: if the tip is planned in the atrium, the correct position can be verified by intracavitary ECG or - better - by echocardioscopy with *bubble test* (using the subxiphoid window with convex probe or the apical window with sectorial probe, so as to obtain a direct view of right atrium and/or the junction between the atrium and the inferior vena cava); if the tip is planned in the subdiaphragmatic cava, it is recommended to verify the position by transhepatic ultrasound with *bubble test* (this method, performed with a convex or sectorial probe, allows the section of the inferior vena cava between the renal and suprahepatic veins to be visualised). It should be noted that the placement of FICCs without intraprocedural control is often associated with primary malpositions (catheter too short or in collateral veins) and is therefore only justified in emergencies. It should also be remembered that even for FICCs, intra-procedural radiological control by fluoroscopy is always to be avoided, as it is an inaccurate, expensive and harmful method, and that post-procedural radiological control - also inaccurate - should only be performed in exceptional cases.
- The planning of the catheter's emergence site is of particular importance for the future of the venipuncture route in question. In the case of **PICCs**, the ideal emergence site is positioned in the middle 1/3 of the arm, midway between the elbow and axilla; if the venipuncture site is too high and falls in the proximal 1/3 of the arm, it will be advisable to move the emergence site further down by tunnelling. In the case of **CICCs**, a subclavian emergence site should be preferred (obtainable with subclavian puncture of the axilla); immediately supraclavicular emergence sites (from supraclavicular puncture of the subclavian or anterior or after 'low' puncture of the internal jugular) are a possible second option; in particular cases, it may be advantageous - after supraclavicular/subclavicular puncture - to opt for tunnelling towards the ipsilateral arm (tunnelling

chest-to-arm). The emergency neck site (from 'high' internal jugular vein puncture) and the emergency inguinal site (from common femoral puncture) are to be avoided (or used only for emergency venous accesses planned to last no longer than 24-28 hours). The tunnelling options available for PICC, CICC and FICC are described in the RAVESTO protocol.

- As recommended by the , catheter fixation with sutures should always be avoided. The presence of the suture creates a chronic infectious skin granuloma that inevitably promotes contamination of the venous access. The catheter should be fixed with 'sutureless' or skin adhesion systems (such as Statlock or Griplok) or with transparent dressings that have an integrated fixation system (such as SorbaView Shield) or with subcutaneous anchorage (such as SecurAcath). Subcutaneous anchorage system SAS) placement is recommended (a) in all adults at high risk of dislocation (intensive care patients undergoing frequent mobilisations; cognitively impaired or uncooperative or agitated patients; etc.) and (b) in patients where sutureless skin adhesion fixation may be unreliable (risk of MARSI; anticipation of profuse sweating, etc.); and (c) in patients where sutureless skin adhesion may be unreliable (risk of MARSI; anticipation of profuse sweating, etc.).); on cost-effectiveness grounds, it is also recommended to use subcutaneous anchorage (c) for all medium-term catheters (PICCs, tunnelled CICCs, FICCs with mid-thigh emergence site) intended to remain in situ for prolonged periods (e.g. one month or more).
- In all central venous catheters, there is a risk of immediate or early bleeding from the puncture site and/or the emergency site of the catheter (especially in patients who are coagulopathic due to drugs, hepatopathy, nephropathy or other causes; or after PICC insertion in which skin has become too loose): the best way to achieve immediate and safe haemostasis is to apply cyanoacrylate glue to the emergency site, a strategy that is recommended in 100% of cases. The use of glue in fact allows a definitive dressing to be placed immediately on the emergency site, saving the need for a temporary dressing to be replaced at 24 hours. In the case of tunnelled central venous catheters, cyanoacrylate will also be the best method of closing the service skin incision at the venipuncture site.
- After glue application, the emergency site should be protected with a semi-permeable adhesive transparent dressing, which may remain in situ for up to one week. The emergency site must be clearly visible and therefore sterile gauze should not be placed under the dressing. Highly breathable transparent membranes (MVTR greater than 1500 g/m^2/day), edged, and sufficiently wide should be preferred. In the case of central accesses placed in emergency, in the momentary unavailability of cyano-acrylate, sterile gauze may be placed to cover the emergency point, under the transparent dressing: in this case, however, the dressing should be changed at 24 hours or - better - the catheter should be directly removed and replaced.

It is a good idea to provide - at company and/or operating unit level - a precise *checklist* for the implantation of central venous access, in order to minimise the risk of deviations from agreed procedures. An example of a *checklist* is shown in Table 6.

On the other hand, there are well-codified protocols for the placement of short-term central venous accesses in the literature: these protocols constitute veritable '*bundles*' of insertion, easily translatable into procedural *checklists*:

- the ISP-2 (Safe Implantation of PICCs) protocol: see Table 7;
- the ISAC-2 (Safe Implantation of CICCs) protocol: see Table 8;
- the ISF (Safe Implantation of FICCs) protocol: see Table 9.

Table 10 summarises the ECHOTIP protocol for the use of ultrasound *for tip navigation/tip location* in the adult patient. Table 11 summarises the RAVESTO protocol for tunnelling options.

TABLE 6

Figure 5

EXAMPLE OF A CHECKLIST FOR PLACING A CENTRAL VENOUS ACCESS

BEFORE THE PROCEDURE

1. Patient identification
2. Checking the correct indication central venous access and the absence of any contraindications (allergies, infectious risk, coagulation status)
3. Verification that the patient is informed of the indication and complications; signing of informed consent
4. Verification of the presence of all necessary material for the procedure
5. Pre-procedural ultrasound study of the patient's veins and marking of the insertion site
6. Correct patient positioning
7. Hand hygiene according to protocol
8. Skin antisepsis with chlorhexidine 2% in 70% isopropyl alcohol or, in the case of known chlorhexidine intolerance, with iodopovidone 10%.
9. Maximum barrier precautions (non-sterile mask, non-sterile cap, sterile gloves, sterile gown, sterile *full-body* drape, sterile probe cover)

DURING THE PROCEDURE

1. Appropriate use of local anaesthesia and/or sedation as indicated
2. Echogenic venepuncture
3. Ultrasound confirmation of the correct intravenous position of the guide and its direction
4. Verification of intravascular catheter placement by aspiration of blood and washing with saline solution
5. Intra-procedural monitoring of catheter tip position by intracavitary ECG and/or echocardioscopy
6. Catheter flush and *lock* with saline solution
7. Catheter closure with *needlefree connector* and application of *port protector*
8. Fixing with *sutureless* system
9. Use of cyanoacrylate glue to seal the emergency site and for possible closure of skin breaches
10. Covering with transparent semi-permeable adhesive dressing and date indication
11. Confirmation that the sterile field is maintained throughout the procedure

TABLE 7

Figure 6

ISP-2 PROTOCOL FOR THE SAFE IMPLANTATION OF PICC

1. Systematic ultrasound exploration of all veins in the arm (from the elbow to the axilla) and the major veins in the subclavian and supraclavicular area, following the RaPeVA (*Rapid Peripheral Vein Assessment*) protocol
2. Hand hygiene, skin disinfection with chlorhexidine 2% in alcohol solution and use of maximum barrier protection (non-sterile mask and cap, sterile gloves, sterile gown, large sterile field on the patient and long probe cover for the ultrasound probe)
3. Selection of the most appropriate vein in terms of depth and calibre, depending on the calibre of the planned catheter (1:3 ratio of catheter outer diameter to vein inner diameter), using the ZIM system: if the ideal venipuncture site is located in Dawson's yellow zone, tunnelling the PICC to obtain the emergence site in the green zone
4. Clear ultrasound identification of the brachial artery and median nerve prior to venipuncture (and therefore use of ultrasound equipment that allows clear identification of the nerve)
5. Short-axis *out-of-plane* ultrasound-guided venipuncture using appropriate micro-introduction kits (21G echogenic needle, nitinol *soft straight tip*, good quality micro-introducer-dilator)
6. Control and direction of the catheter (*tip navigation*) by ultrasonography of the supraclavicular region (visualisation of the catheter in the subclavian vein and anaesthetic vein), particularly in cases where there are obstacles to progression or when no changes in the P wave are appreciated on the intracavitary ECG
7. Checking the central tip *location* using the intracavitary ECG method, in the modified variant in the case of patients with atrial fibrillation, possibly corroborated by the *tip location* using transthoracic echocardiography with 'bubble test' (according to the ECHOTIP protocol)
8. Application of cyanoacrylate glue to the emergency site + fixation with sutureless systems (preferring subcutaneous anchorage systems in patients with a high risk of dislocation) + covering with a semi-permeable transparent dressing with good breathability (high MVTR - *moisture vapor transfer rate*).

TABLE 8

Figure 7

ISAC-2 PROTOCOL FOR THE SAFE IMPLANTATION OF CICC

1. Reasoned vein selection by systematic ultrasound examination of the veins in the supra/subclavian region (using the RaCeVA protocol); plan tunnelling - if indicated - according to the RAVESTO protocol
2. Appropriate aseptic technique: hand hygiene, skin antisepsis with chlorhexidine 2% in 70% isopropyl alcohol, maximum barrier protection
3. Use of ultrasound for ultrasound-guided venipuncture of the selected vein and subsequent ultrasound control of the correct direction of guidance (*tip navigation*) and absence of pneumothorax
4. Intra-procedural verification of *tip location* by intracavitary ECG and/or by echocardioscopy with *bubble test* (according to ECHOTIP protocol)
5. Protection of the emergency site from bleeding and contamination risk by application of cyanoacrylate glue
6. Adequate stabilisation of the catheter using *a sutureless device* with skin adhesion or subcutaneous anchorage
7. Covering the emergency site with a highly breathable semi-permeable transparent membrane (high MVTR).

TABLE 9

Figure 8

ISF PROTOCOL FOR SAFE IMPLANTATION OF FICC

1. Reasoned vein selection by systematic ultrasound examination of the veins of the groin and thigh (using RaFeVA protocol); in elective FICC placements not intended for haemodialytic procedures, plan the mid-thigh emergency site (common femoral vein puncture + tunnelling, or superficial femoral vein puncture with or without tunnelling (see RAVESTO protocol)
2. Appropriate aseptic technique: hand hygiene, skin antisepsis with chlorhexidine 2% in 70% isopropyl alcohol, maximum barrier protection
3. Use of the ultrasound scanner for ultrasound-guided venipuncture of the selected vein and subsequent ultrasound control of the correct direction of guidance (*tip navigation*)
4. Intra-procedural verification of *tip location*: if the tip is to be in the right atrium, use the intracavitary ECG method and/or echocardioscopy with *bubble test* (according to the ECHOTIP protocol); if the tip is to be in the inferior vena cava, use a length estimation by skin retrieval with intra-procedural echocardioscopy with *bubble test* (according to the ECHOTIP protocol), but consider a post-procedural abdominal x-ray in selected cases
5. Protection of the emergency site from bleeding and contamination risk by application of cyanoacrylate glue
6. Adequate stabilisation of the catheter using *a sutureless device* with skin adhesion or subcutaneous anchorage
7. Covering the emergency site with a highly breathable semi-permeable transparent membrane (high MVTR).

TABLE 10

Figure 9

Summary of the ECHOTIP protocol central venous access in the adult patient

ECHOTIP protocol for CICC		
	Probe	*Technique*
Tip navigation	Linear 7-12 MHz	Visualisation of vessels as in the RaCeVA protocol
Tip location	Sectorial 2-6 MHz (or convex 3-8 MHz)	Visualisation of microbubbles in the right atrium in less than 1 second (subcostal or apical window)
ECHOTIP protocol for PICCs		
	Probe	*Technique*
Tip navigation	Linear 7-12 MHz	Visualisation of vessels as in RaPeVA and RaCeVA protocol
Tip location	Sectorial 2-6 MHz (or convex 3-8 MHz)	Visualisation of microbubbles in the right atrium in less than 2 seconds (subcostal or apical window)
ECHOTIP protocol for FICC		
	Probe	*Technique*
Tip navigation	Linear 7-12 MHz (femoral and external iliac v.) Convex 3-8 MHz (common iliac vein and vena cava)	Visualisation of vessels as in RaFeVA protocol + visualisation of the inferior cava
Tip location	Sectorial 2-6 MHz (or convex 3-8 MHz)	Tip in atrium: immediate visualisation of micro-bubbles in right atrium (subcostal or apical window) Tip in vena cava: visualisation of micro-bubbles in right atrium in 1-2 seconds

TABLE 11

Figure 10

RAVESTO PROTOCOL FOR CVC TUNNELLING OPTIONS
(RAVESTO= Rapid Assessment of Vascular Exit Site and Tunneling Options)

Type of CVC	**Type of tunnelling**	**Indications for tunnelling**
PICC	Tunnel from yellow zone to green zone	Small veins in the yellow zone; PICCs for long-term therapy
CICC (supraclavicular puncture)	Tunnel to the subclavian area	CICC for long-term therapy; short-term CICC but difficult supraclavicular emergency site or impossible to manage
	Tunnel to the arm	Emergency site in cervical-thoracic difficult or impossible to manage
	Tunnel to the back	Uncooperative patients and/or patients with cognitive disorders
CICC (subclavian puncture)	Tunnel to the thoracic area	CICC for long-term therapy; short-term CICC but difficult or impossible subclavian emergency site or too much near the tracheostomy
	Tunnel to the arm	Emergency site in cervical-thoracic difficult or impossible to manage
	Tunnel to the back	Uncooperative patients and/or with cognitive disorders
FICC (groin puncture)	Mid-thigh tunnel	Contraindication to CICC/PICC in bedridden patients
	Tunnel to the abdomen	Contraindication to CICC/PICC in ambulatory patients
FICC (mid-thigh puncture)	Tunnel distal thigh area	Contraindication to CICC/PICC in bedridden patients with expected long treatment
	Tunnel to the abdomen	Contraindication to CICC/PICC in ambulatory patients

IMPLANTATION OF LONG-TERM CENTRAL VENOUS SYSTEMS

Long-term central venous systems include tunnelled-cuffed catheters (CCTs), non-cuffed but stabilised tunnelled catheters with subcutaneous anchorage, thoracic ports, PICC-ports, FICC-portslong-term haemodialysis catheters (tunnelled-cuffed).

Again, no pre/post implant antibiotic prophylaxis is ever indicated.

The implantation of long-term central venous accesses is entrusted exclusively to healthcare personnel (doctors or nurses) who are specifically and adequately trained to perform the manoeuvre. In particular, the placement of ports, PICC-ports, and FICC-ports is entrusted only to doctors and nurses who have completed a training course specifically focused on the placement of fully implantable systems.

Informed consent must be collected directly from the operator (doctor or nurse) performing the implantation manoeuvre, in accordance with current laws.

The procedure should follow the same recommendations as described above, with a few significant differences:

- the placement of long-term systems cannot take place *bedside* but requires a dedicated environment such as the procedure room of a *day hospital* or intensive care unit; in exceptional cases, the operating room may be an alternative (albeit more expensive and less cost-effective) option;
- the implantation of totally implantable systems must be performed with insertion *packs* specifically prepared for the implantation of ports, PICC-ports and FICC-ports, which must contain all the necessary material that is not foreseen in the port kit (maximum barrier precautions, probe cover, ECG cable, disposable surgical instruments, transparent membrane, scalpel blade, etc.). On the other hand, the implantation of tunnelled catheters (both cuffed and stabilised with subcutaneous anchorage) requires the use of *packs* similar to those used for PICC, CICC and FICC implantation. The use of insertion *packs* - recommended by international guidelines - is a winning strategy that can reduce time, costs and the risk of complications related to the use of sub-optimal materials.
- the use of ultrasound-guided venipuncture is always imperative, as it is a manoeuvre that is only performed in elections and never in emergencies;
- Equally indispensable and imperative is intraoperative verification of *tip location*, using the intracavitary ECG method (conventional or modified) and/or echocardioscopy. In this field, fluoroscopy is less accurate, more costly, more harmful for the patient and the operator, and less cost-effective than the two above-mentioned methods: its use is admissible only in exceptional cases (i.e. exclusively for cupped-tunnelled catheters for haemodialysis in which difficulties in catheter progression are likely to occur and the veins need to be studied with contrast medium), and in any case always in combination with the much more precise methods of echocardioscopy and intracavitary ECG;
- In thoracic ports, the *reservoir* should preferably be placed 2-3 cm from the head of the humerus, medial to the pectoral deltoid groove, no more than 2 cm below the clavicle, above the pectoralis major muscle; in PICC ports, the *reservoir* should be placed above the biceps muscle, at the transition between the yellow and Dawson's green zones; in FICC ports, the *reservoir* should preferably be placed on the thigh, above the quadriceps. Except in exceptional situations (excessively large pocket), it is best not to attach the *reservoir* with stitches to the muscle fascia;
- in the case of tunnelled CICCs inserted into the supraclavicular/subclavicular veins, the tunnel must be long enough to bring the emergency site into the subclavicular or arm (*chest- to-arm* tunnel); in the case of tunnelled FICCs, the emergency site will preferably be packed in half

thigh or near the knee. In the case of tunnelled PICCs, the emergence site should be in Dawson's green zone (middle third of the arm). When using cuffed catheters, it is a good idea to plan the position of the cuff inside the tunnel at least 2 cm away from the emergence site; an alternative to the use of the cuff is the use of tunnelled catheters that are not cuffed but rather stabilised with subcutaneous anchorage (less expensive, easier to tunnel, and easier to remove);

- for all fully implantable systems, it is recommended not to use transcutaneous sutures for close the *reservoir* pocket. In order to avoid contamination of the subcutis, the skin should be closed with a layer of intradermal stitches with rapidly resorbable monofilament suture + a superficial layer of glue (cyanoacrylate).
- For CCTs, it is recommended to temporarily fix the catheter to the skin by means of fixation systems *sutureless* with skin adhesion. The use of subcutaneous anchorage to further stabilise the cuffed catheters is not recommended. Such fixation devices should remain for at least 3 weeks, and in any case until the cuff has stabilised in the subcutis. In the case of non-cuffed but stabilised tunnelled catheters with subcutaneous anchorage, the anchorage device should obviously be left indefinitely.

There are well-defined protocols for the implantation of fully implantable systems in the literature:

- The ISP-Port protocol (secure PICC-port implantation) (Table 12)
- The ISALT-3 protocol (safe implantation of thoracic ports) (Table 13).

TABLE 12

Figure 11

ISP-Port Protocol for the Safe Implantation of PICC-Ports

1. Systematic ultrasound exploration of all veins in the arm (from the elbow to the axilla) and the major veins in the subclavian and supraclavicular area, following the RaPeVA (*Rapid Peripheral Vein Assessment*) and RaCeVA (*Rapid Central Vein Assessment*) protocols.
2. Hand hygiene, skin disinfection with chlorhexidine 2% in alcohol solution and use of maximum barrier protection (non-sterile mask and cap, sterile gloves, sterile gown, large sterile field on the patient and long probe cover for the ultrasound probe).
3. Selection of the most appropriate vein in terms of depth and calibre, depending on the planned catheter calibre (1:3 ratio of catheter outer diameter to vein inner diameter), using the ZIM system: the area where the *reservoir* should preferably be housed is the upper half of Dawson's green zone; therefore, if the ideal venipuncture site is located in Dawson's yellow zone, the catheter should be tunnelled so that the *reservoir* is housed in the green zone.
4. Clear ultrasound identification of the brachial artery and median nerve prior to venipuncture (and therefore use of ultrasound scanners that allow clear identification of the nerve).
5. Short-axis *out-of-plane* ultrasound-guided venipuncture using appropriate micro-introduction kits (21G echogenic needle, nitinol *soft straight tip*, good quality micro-introducer-dilator).
6. Checking the central tip *location* by means of the intracavitary ECG method - in the modified variant in the case of patients with atrial fibrillation - possibly corroborated by *tip location* by means of transthoracic echocardiography with *bubble test* (according to the ECHOTIP protocol).
7. In cases where there are obstructions to progression or when no P-wave changes are appreciated on the intracavitary ECG, control and direction of the catheter (tip *navigation*) by ultrasound of the supraclavicular region (visualisation of the catheter in the subclavian vein and anonymous vein) (according to the ECHOTIP protocol).
8. Creation of the pocket above the biceps muscle by hydro-dissection under local anaesthesia, with a volume equal to that of the reservoir. Closure of the dermis by intradermal inverted stitch suture and application of cyanoacrylate glue to the skin. Covering for at least 3 days with a semi-permeable transparent dressing with good breathability (high MVTR - *moisture vapor transfer rate*).

TABLE 13

Figure 12

ISALT-3 Protocol for the Safe Implantation of Long-Term Accesses (thoracic ports)

1. Systematic ultrasound evaluation of supra/sub-clavicular veins (according to the RaCeVA protocol), taking into consideration the calibre of the vein, its depth, safety of venipuncture and ease of tunnelling.
2. Aseptic technique during implantation: hand hygiene, skin antisepsis with chlorhexidine 2%, maximum barrier protection.
3. Percutaneous ultrasound-guided cannulation of the best available vein, with preference for the axillary vein (if adequate) so as to avoid tunnelling above the clavicle.
4. Ultrasound examination of the pleura to exclude pneumothorax.
5. Ultrasound control of the direction of the metal guide and catheter (*tip navigation*), according to the ECHOTIP protocol.
6. Intra-procedural *tip location* check by intracavitary ECG (conventional method or modified method, in case of atrial fibrillation) and/or echocardioscopy with *bubble test* (according to ECHOTIP protocol).
7. Putting the *reservoir* above the pectoralis major muscle, preferably no more than 2 cm below the clavicle and at least 3 cm from the head of the humerus.
8. Closure of the pocket using resorbable monofilament intradermal stitches and cyanoacrylate glue.

REMOVAL OF CENTRAL VENOUS ACCESSES

The removal of uncuffed central venous catheters of the CICC, PICC, or FICC type (tunnelled or not, with or without subcutaneous anchorage) is relatively simple and involves the following:

- In the case of CICC removal, positioning of the patient in a supine position;
- Pre-procedural ultrasound examination of the veins where the catheter is located, if there is anamnestic or objective data to suspect catheter-related, symptomatic or asymptomatic venous thrombosis;
- removal of the dressing;
- removal of the catheter, after removal of the subcutaneous anchoring device (if in place);
- immediate compression of the skin breach (in the case of removal of a CICC, for at least one to two minutes);
- closure of the skin breach with cyanoacrylate glue; if there is bleeding from the emergency site, glue should be applied when the blood flow is under control.

In contrast, the removal of totally implantable systems (ports) and most tunnelled catheters (CCTs) requires a small incision under local anaesthesia and dedicated instrumentation. The port removal manoeuvre cannot be performed *bedside* but requires a dedicated environment such as the procedure room of a *day hospital* or intensive care unit; in exceptional cases, the operating room may be alternative option (although more expensive and less cost-effective); moreover, port removal should preferably be performed using procedural *packs* specifically prepared for this purpose, containing the necessary devices (mask, cap, perforated drape, scalpel blade, syringes, needles, disposable surgical instruments, etc.).

The key recommendations are as follows:

- Pre-procedural ultrasound examination of the veins where the catheter is placed, in order to exclude the presence of catheter-related venous thrombosis;
- skin antisepsis with chlorhexidine 2% in 70% IPA;
- local anaesthesia with an appropriate volume of ropivacaine 7.5 mg/ml;
- removal of the system, taking care to first remove the intravascular part of the catheter and then the rest of the device;
- closure with a layer of intradermal suture with rapidly resorbable monofilament+ a superficial layer of glue (cyanoacrylate). If the system is removed due to infection of the device and there is suppuration in the subcutis, the wound should be left partially open for healing by second intention.
- the removal of long-term central venous accesses is entrusted exclusively to healthcare personnel (doctors or nurses) specifically and adequately trained to perform the manoeuvre.

CENTRAL VENOUS ACCESS IN THE PAEDIATRIC PATIENT

The insertion of central venous accesses in the paediatric patient basically follows the recommendations for the adult, with some differences:

- *bedside* placement should be avoided, even for short- to medium-term CVCs; all central venous accesses in paediatric patients should preferably be implanted in a procedure room or - in exceptional cases - in the operating theatre;
- the placement of central venous accesses in paediatric patients is entrusted exclusively to doctors and nurses who have completed a training course specifically focused on the placement of central venous catheters in children.
- *Tip navigation* by means of echoscopy is particularly easy in the paediatric patient and should always be used during manoeuvres, either by exploration of the supraclavicular fossa with a linear probe or by means of a micro-convex probe positioned in the parasternal or sub-xiphoid area;
- the simultaneous use of the two currently most reliable *tip location* systems is recommended, i.e. the intracavitary ECG (always using a 'conventional' technique, since atrial fibrillation is not found in children) and echoscopy (echocardioscopy in the subxiphoid area or transhepatic lower vena cava) using a micro-convex or micro-sectral probe; both methods are always easy to perform in the paediatric patient, to extent that there are no situations in which radiological control (neither intra-procedural by fluoroscopy nor post-procedural by chest X-ray), which is also particularly harmful and inaccurate in these patients, is indicated;
- Tunnelling is recommended in most CICCs placed in election (with the exception of axillary vein CICCs in non-tracheostomised children), in most FICCs placed in election (with the exception of superficial femoral vein FICCs in mid-thigh), and in all PICCs in which the veins in Dawson's green zone are too small for the calibre of the catheter;
- cyanoacrylate glue should always be used even in paediatric patients, both to seal the emergency site and to close the skin incision at the venipuncture site in the case of tunnelling;
- in all paediatric CVCs placed in election (PICCs, CICCs, FICCs), and therefore also in the case of short- to medium-term non-tunnelled accesses, it is always indicated to resort to stabilisation by means of subcutaneous anchorage (SAS), considering the high risk of dislocation; the only exception being non-tunnelled CICCs and FICCs inserted under emergency conditions and therefore destined to be removed within 24-48 hours; apart from this exception, all other external central venous accesses in paediatric age must be fixed with subcutaneous anchorage.

INSERTION CENTRAL VENOUS ACCESS IN THE NEONATE

As already explained, there are three devices for central venous access in the newborn: the CVO, the epicutaneous-caval catheter (ECC) and the CVC inserted ultrasound-guided in the supraclavicular (CICC) or inguinal (FICC) site. All three devices should be inserted using aseptic technique (hand hygiene, maximum barrier precautions, skin antisepsis with chlorhexidine 2% in 70% PAH) and all three should be inserted by specifically and adequately trained medical or nursing staff.

With regard to umbilical venous catheters (CVO), it is necessary to use insertion *packs* specifically set up for CVO/ECC implantation. After estimating the length of the catheter, the correct placement of the CVO involves the use of a micro-convex or micro-sectral ultrasound probe, which - positioned in the epigastric location - will be indispensable for following the trajectory of the catheter (*tip navigation*) until the final positioning of the tip near the inferior cavo-atrial junction (*tip location*). It is emphasised that the strategy of 'blind' placement with post-procedural radiological control is not recommended by current guidelines (see INS 2024) and is associated with greater risks for the patient (caused by delayed control of placement, exposure to X-rays, and inaccuracy of the method) than the strategy of intra-procedural control by ultrasound.

In the case of epicutaneous-cavity catheters (ECC), it is necessary to use insertion *packs* specifically set up for CVO/ECC implantation. The most appropriate superficial vein for insertion is chosen after adequate and systematic examination of the patient's *superficial* veins, according to the RaSuVa (*Rapid Superficial Vein Assessment*) protocol, performed with and without a tourniquet, with the naked eye and/or using the NIR technique. Given equal venous availability, the preferred site for venipuncture is the antecubital area, with the saphenous vein at the malleolus being a second choice. After catheter length estimation, proper ECC placement involves the use of a micro-convex ultrasound probe to follow the trajectory of the catheter (*tip navigation*) until final tip placement near the superior or inferior cavo-atrial junction (*tip location*). It is emphasised that the strategy of 'blind' placement with post-procedural radiological control is not recommended by current guidelines (see INS 2024) and is associated with greater risks for the patient (due to delayed control of placement, exposure to X-rays and non-accuracy of the method) than the strategy of intra-procedural control by ultrasound. The catheter must be fixed by means of cyanoacrylate glue and a highly breathable transparent membrane (MVTR > 1500 g/sqm/day), without using sutures.

As far as echoguided CVCs are concerned (which in the newborn are almost invariably inserted as CICCs in the anonymous vein or as FICCs in the common femoral vein), their insertion exactly repeats the recommendations for short-term CVC implantation in the paediatric age, according to the ISAC-Ped protocol. The insertion *pack* is used and the combined use of the technique of intracavitary ECG and echocardioscopy for *tip location* is imperative; tunnelling also imperative as well as protection/stabilisation of the catheter by subcutaneous anchoring, cyanoacrylate glue and transparent membrane.

There are protocols in the literature for implanting CVO and ECC (in the newborn), and ultrasound-guided CVC (in the child and newborn):

- The ISAC-Ped protocol (safe implantation of paediatric central accesses) (Table 14)
- The Neo-ECHOTIP and ECHOTIP-Ped protocols, with recommendations for the use of echocardioscopy for tip navigation and tip location in newborns and infants (Table 15 and 16).
- The ISCaVO protocol (safe implantation of CVOs) (Table 17)
- The ISiCEC protocol (safe implantation of epicutaneous-cava catheters) (Table 18).

TABLE 14

Figure 13

ISAC-Ped Protocol for the Safe Implantation of Central Venous Access in the Paediatric Patient

1. Reasoned vein selection by systematic ultrasound examination (according to RaCeVA, RaPeVA and RaFeVA protocols)
2. Appropriate aseptic technique: hand hygiene, maximum barrier protection and skin antisepsis with chlorhexidine 2% in IPA 70%.
3. Use of the ultrasound scanner for ultrasound-guided venipuncture of the selected vein and subsequent ultrasound control of the absence of pneumothorax or other insertion-related complications
4. Intra-procedural verification of the central position of the tip using the intracavitary ECG technique and/or by echocardioscopy (according to the ECHOTIP-Ped protocol
5. Tunnelling the catheter to get the emergence site in optimal position
6. Protecting the emergency site with cyanoacrylate glue
7. Catheter stabilisation by means of a *sutureless device* (preferably use subcutaneous anchorage in all CVCs placed in election) and semi-permeable transparent membrane with high MVTR (*moisture vapor transfer rate*).

TABLE 15

Figure 14

Summary of the ECHOTIP-Ped protocol for CVCs in the paediatric patient

ECHOTIP-Ped Protocol for CICC		
	Probe	*Technique*
Tip navigation	Linear *hockey stick* 10-14 MHz	Visualisation of vessels as in the RaCeVA protocol
Tip location	Micro-convex 4-8 MHz (or micro-sectorial 3-7 MHz)	Visualisation of microbubbles in the right atrium in less than 1 second (subcostal window or apical)
ECHOTIP-Ped protocol for PICCs		
	Probe	*Technique*
Tip navigation	Linear *hockey stick* 10-14 MHz	Visualisation of vessels as in RaPeVA and RaCeVA protocol
Tip location	Micro-convex 4-8 MHz (or micro-sectorial 3-7 MHz)	Visualisation of microbubbles in the right atrium in less than 1 second (subcostal or apical window)
ECHOTIP-Ped Protocol for FICC		
	Probe	*Technique*
Tip navigation	Linear *hockey stick* 10-14 MHz (or micro-convex 4-8 MHz)	Visualisation of vessels as in RaFeVA protocol + visualisation of the inferior cava
Tip location	Micro-convex 4-8 MHz	Tip in atrium: immediate visualisation of microbubbles in right atrium (subcostal or apical window) Tip in vena cava: direct visualisation of microbubbles in inferior vena cava

TABLE 16

Figure 15

Summary of the Neo-ECHOTIP protocol central venous access in the neonate

Catheter	*Protocol*	*Probe*	*Window*
Umbilical venous catheter	Tip navigation	Micro-sector 7-8 MHz	Longitudinal subcostal
	Tip location	Micro-sector 7-8 MHz	Longitudinal subcostal
Epicutaneous-caval catheter (to superior vena cava)	Tip navigation	Linear *hockey stick* 10-14 MHz	Same windows as RaCeVA and protocol RaPeVA
	Tip location	Micro-sector 7-8 MHz	Bicaval subcostal Apicale 4 rooms
Epicutaneous-caval catheter (to inferior vena cava)	Tip navigation	Linear *hockey stick* 10-14 MHz	Same windows as protocol RaFeVA
	Tip location	Micro-sector 7-8 MHz	Longitudinal subcostal
CICC	Tip navigation	Linear *hockey stick* 10-14 MHz	Same windows as protocol RaCeVA
	Tip location	Micro-sector 7-8 MHz	Bicaval Apical 4-chamber subcostal
FICC	Tip navigation	Linear *hockey stick* 10-14 MHz+ micro-sectoral 7-8 MHz	Visualisation of vessels as in the RaFeVA + protocol longitudinal subcostal
	Tip location	Micro-sector 7-8 MHz	Longitudinal subcostal

TABLE 17

ISCaVO Protocol
Safe umbilical venous catheter implantation

1) Pre-procedural, clinical and ultrasound evaluation
2) Adoption of pre-assembled insertion packs
3) Appropriate aseptic technique (hand hygiene, skin antisepsis with chlorhexidine 2% in 70% IPA, maximum barrier precautions)
4) Appropriate choice of vein calibre (depending on the calibre of catheter required)
5) Eco-guided tip navigation and tip location, according to the Neo-ECHOTIP protocol
6) Catheter stabilisation and emergency site protection (using sutureless systems, cyanoacrylate glue and transparent membranes)
7) Ultrasound checks (periodic, post-procedural) of tip position
8) Device removal within 4-5 days

TABLE 18

ISiCEC Protocol
Safe implantation of epicutaneous catheters

1) Systematic pre-procedural assessment of superficial veins (using the RaSuVa protocol
2) Adoption of pre-assembled insertion packs
3) Appropriate aseptic technique (hand hygiene, skin antisepsis with chlorhexidine 2% in 70% IPA, maximum barrier precautions)
4) Eco-guided tip navigation and tip location, according to the Neo-ECHOTIP protocol
5) Catheter stabilisation and emergency site protection using cyanoacrylate glue and high MVTR transparent membranes
6) Ultrasound checks (periodic, post-procedural) of tip position
7) Removal of the device within two weeks

PREVENTION OF VENOUS CATHETER THROMBOSIS

The moment of implantation plays a key role in preventing thrombotic complications.

Definition of venous catheter thrombosis

A venous catheter thrombosis is understood to be the presence - in the stretch of vein traversed by the catheter - of a venous thrombosis from an endothelial lesion caused either by penetration of the catheter into the vein or by mechanical and/or chemical trauma caused by the catheter tip on the venous endothelium. Venous thrombosis should be distinguished from occlusion of the lumen caused by clots (see below under mechanical complications) and from the so-called '*fibrin sleeve*', which is actually a fibroblastic sheath that tends to progressively cover the catheter in its intravascular tract, and which should be interpreted as a foreign body reaction by the blood tissue.

With this in mind, a possible classification of the events often grouped under the term 'catheter thrombosis' is as follows:

- fibroblastic sleeve (so-called *fibrin sleeve*: ultrasound shows it as a sleeve positioned around the outer walls of the catheter, at any point along its course; typically, it is not adherent to the endothelium walls but may coat the catheter along its entire length, interfering with its function (this was particularly the case with closed-tip valved catheters, which are no longer used); on removal of the catheter, it can often still be appreciated ultrasound-visually as it floats within the lumen of the vein. It poses no risk of pulmonary embolism. Since it is connective tissue, it is not sensitive to thrombolytics.
- peripheral' or rather 'proximal' venous thrombosis, i.e. near the entrance of the catheter into the vein: i.e. in the basilic-brachial-axillary tract in the case of PICCs or near the jugular-succlavian-anonimal *carrefour* in the case of catheters inserted in the veins of the sub/supraclavicular region (CICC) or in the femoral-iliac tract in the case of FICCs. This type of thrombosis can be occluding or non-occluding the vessel, and recognises its etiopathogenesis in endothelial trauma at the point of venous cannulation or in an inequality between the diameter of the cannulated vein and the diameter of the catheter (if the catheter in fact occupies more than a third of the diameter of the vein, the blood flow is reduced and the risk of thrombosis increases). The presence of such a thrombosis normally does not interfere with the use of the catheter, which can be left in place, obviously initiating an appropriate anticoagulant treatment, e.g. with heparin bpm at therapeutic dosage.
- central' or rather 'distal' venous thrombosis (i.e. near the catheter tip); this type of thrombosis - in the case of CICCs and PICCs - typically involves the superior vena cava and/or anonymous veins; the etiopathogenesis often lies in a non-ideal central position (e.g. when the tip is too far from the cavo-atrial junction and/or is in direct contact with the vein wall, causing mechanical and/or chemical damage). When occlusive, it can result in superior cava syndrome. Venous thrombosis in the vicinity of the catheter tip is often associated with malfunction; however, it is best not to remove the device immediately, but only after an adequate period of anticoagulant treatment at therapeutic dosage.

Prevention strategies

Catheter-related venous thrombosis is only partially preventable, as the patient's thrombophilic tendency plays an important role in it, whether congenital (due to pathologies present at birth, with an often hereditary component) or acquired (linked to the underlying pathology or - more rarely - to therapies).

However, there are evidence-based recommendations that can reduce the risk of catheter thrombosis:

- avoid insertion of a venous access near or on the same side of a recent venous thrombosis;
- choose a vein whose calibre is at least three times the calibre of the catheter (which means 4Fr catheters require veins of at least 12Fr = 4mm in diameter, 5Fr catheters require veins of at least 15Fr = 5mm, etc.);
- in the case of central venous accesses or peripheral venous accesses (long peripheral cannulae and Midline), always use ultrasound-guided venipuncture to minimise the traumatism of the manoeuvre;
- in the case of CICCs or FICCs where the use of 18G-19G needles and the simple Seldinger technique is envisaged, prefer the alternative use of a micro-introduction kit to reduce vascular trauma;
- in the case of central venous accesses, ensure that the tip of the catheter is correctly positioned near the cavo-atrial junction, with the tip pointing downwards (intra-procedural verification of the position of the tip can be done, with maximum safety, accuracy and cost-effectiveness, by the intracavitary ECG method, possibly with the complement of echocardioscopy);
- in the case of central femoral accesses (FICC), ensure that the tip is in the subdiaphragmatic section of the inferior vena cava, above the branch of the renal veins (higher positions carry a high risk of thrombosis: the risk is greatest when the tip is in the supra-hepatic veins); in special cases (bedridden patients who need to use the FICC for haemodynamic monitoring), the tip will be positioned in the right atrium;
- In the case of both peripheral (agocannulae, Midline, etc.) and central (PICC, CICC, FICC, etc.) venous accesses, it is important to stabilise the device so that catheter movement at the emergency site is minimised or reduced to zero; friction of the catheter against endothelium of the encapsulated vein is in fact a further potential cause of thrombosis. Precautions to reduce catheter mobility include: rational choice of emergence site, appropriate fixation with a 'sutureless' system with skin adhesion or subcutaneous anchorage, stabilisation with cyanoacrylate glue where necessary, and finally the preferential use of semi-permeable transparent adhesive dressings:
- prevention by prophylactically dosed antithrombotics is only indicated in selected patients (previous catheter-related venous thrombosis; congenital thrombophilic pathologies; previous non-catheter-related venous thrombosis in patients with pathologies known to be associated with thrombotic risk; etc.).

Table 19 summarises the GAVeCeLT recommendations for the prevention of venous thrombosis at the time of central venous access implantation.

TABLE 19

Figure 16

Recommendations for the prevention of catheter-related venous thrombosis

1. Choose for venipuncture a vein whose internal diameter is at least three times the external diameter of the catheter (vein diameter in mm = equal to or greater than the catheter diameter in Fr)
2. Always use ultrasound-guided venipuncture and prefer micro-introduction kits
3. Use intra-procedural *tip location* methods (prefer - wherever applicable - the intracavitary ECG method or echocardioscopy with *bubble test*), placing the catheter tip near the cavo-atrial junction
4. Properly stabilise the catheter using a multimodal strategy (appropriate emergency site+ cyanoacrylate glue+ *sutureless device*+ semi-permeable transparent dressing)

PREVENTION OF MECHANICAL COMPLICATIONS OF VENOUS ACCESSES

The mechanical complications of venous accesses constitute a very heterogeneous group of complications, but they recognise the main moment of prevention at the time of implantation.

The main mechanical complications of venous accesses are listed here:

- dislocation of the catheter in its extra-vascular tract: this occurs - in most cases - through inappropriate catheter fixation. Dislocation of a peripheral catheter often results in loss of venous access. Dislocation of a central catheter, on the other hand, may be partial or complete; if a PICC or CICC-type catheter placed in an adult patient has dislodged by more than 4 cm, the tip can no longer be considered 'central' and the system must be replaced. CCTs can also become dislodged when the cuff is pulled out through tunnelling (typically, because it was initially placed too far to the surface); subcutaneous anchoring is currently the system that most effectively reduces the risk of dislocation.
- intravascular *tip migration* (*tip migration*), without dislocation of the extra-vascular tract; the tip of an originally well-positioned central venous catheter may unexpectedly find itself in another location (often in the ipsilateral jugular vein), where the risk of venous thrombosis is significantly increased; tip migration is particularly frequent in catheters placed too high in the superior cava, and/or too thin, and/or in silicone, and/or after coughing, vomiting, crying (and other conditions associated with increased intrathoracic pressure);
- ruptures of the extra-vascular or intra-vascular tract: these may be due to inappropriate manoeuvres of catheter flushing with high pressure, or inappropriate use of a non-power *injectable* catheter for high-pressure contrast medium infusion, or inappropriate manoeuvres of dressing removal using sharps. Rupture of a central venous access always results in either complete removal or guided replacement of the catheter.
- *pinch-off* syndrome (clamping of the catheter in its extra-vascular subcutaneous tract): this is only encountered after 'blind' subclavian puncture by the subclavian route. After the advent of ultrasound-guided venipuncture and the desirable definitive abandonment of 'blind' subclavian subclavian puncture, this complication will disappear.

Prevention strategies

The prevention of ruptures and dislocations is mainly based on the adoption of external central venous catheters (PICC, CICC, FICC, CCT) preferably *power-injectable* in new-generation polyurethane rather than in standard polyurethane or silicone. In the presence of a long-term external central venous catheter in silicone, especially if it is valved, it is a good idea to remove the device beforehand and replace it with a new-generation polyurethane device, in order to prevent the onset - more or less inevitable - of mechanical complications.

For all catheters, both central and peripheral, the principle then applies that dislocation can be avoided by careful stabilisation of the system (appropriate position of the emergence site + *sutureless* fixation + semi-permeable transparent adhesive membrane + use of cyanoacrylate glue). For CCTs, it is important at the time of implantation to position the cuff inside the tunnel appropriately (at least 2 cm from the emergence site). The system that guarantees the best stabilisation, however, is subcutaneous anchoring.

Table 20 summarises the GAVeCeLT recommendations for the prevention of mechanical complications of venous accesses.

TABLE 20

Figure 17

GAVeCeLT recommendations for the prevention of mechanical complications

1. Use only *power-injectable* polyurethane catheters.
2. Never use silicone catheters.
3. Do not use cutting edges of any kind (scissors, etc.) when changing the dressing.
4. Properly stabilise the catheter using a multimodal strategy (appropriate emergency site+ cyanoacrylate glue+ *sutureless device*+ semi-permeable transparent dressing)
5. Use subcutaneous anchoring systems in external catheters with a high risk of dislocation.

PREVENTION OF HAEMORRHAGIC COMPLICATIONS

Hemorrhagic complications of venous accesses are closely linked to the implantation manoeuvre, but may be favoured by the presence coagulation disorders secondary to pathology or drug treatment: they occur immediately during implantation or in the first 48 hours.

Examples of haemorrhagic complications that may occur include:

- subcutaneous bruising;
- persistent bleeding from the emergency site, or the site of venepuncture;
- haematomas (subcutaneously, along the tunnel, intramuscularly or otherwise in the soft tissue, inside the port pocket, etc.);
- haemothorax, haemo-mediastinum, and other major haemorrhagic complications (due to accidental puncture/lesion of an artery).

Prevention strategies

Prevention of haemorrhagic complications is based on the following strategies: (a) entrusting the procedure to specifically and appropriately trained medical and nursing staff; (b) systematic adoption of appropriate insertion *bundles*; (c) mandatory use of ultrasound-guided venepuncture for all central venous accesses and long-duration peripheral accesses; (d) use of micro-puncture and micro-introduction kits (21G needles, 0.018" nitinol micro-guides, etc.), whenever possible; (e) use of cyanoacrylate glue to seal the emergency site and to close any other skin incisions (e.g. to close the port pocket or the incisions necessary for tunnelling); (f) abandonment - always and in any case - of the use of skin sutures.

An important aspect in the prevention of haemorrhagic complications is also constituted by a careful preoperative assessment of the patient's coagulation status, in terms of both pathological (plateletopenia, elevation of the PT/INR ratio) and pharmacological alterations (ongoing treatment with anticoagulants, anti-platelets, etc.). A recent GAVeCeLT Consensus (downloadable from the GAVeCeLT website) addressed this issue.

A schematic summary of the recommendations of this Consensus is presented in Table 21.

TABLE 21

Figure 17a

Management of patients with coagulation disorders or undergoing antithrombotic treatment who are candidates for insertion/removal of venous access devices (**DAV**). (*GAVeCeLT Consensus 2022*)

	DAV MINIMALLY INVASIVE (all peripheral access DAVs, non-tunnelled PICCs, non-tunnelled mid-thigh FICCs)	**DAV** MODERATELY INVASIVE (tunnelled PICCs, inguinal FICCs, non-tunnelled CICCs, non-tunnelled dialysis CVCs	**DAV** HIGHLY INVASIVE (tunnelled CICCs, tunnelled FICCs, tunnelled dialysis CVCs, all fully implantable systems)
Coagulation disorder			
PT/INR >1.5 and/or aPTT ratio >1.3	No contraindications	Relative contraindication	Absolute contraindication. Normalise PT/INR <1.5
Platelet count <50×10^9/L	No contraindications	Relative contraindication	Absolute contraindication. Platelet transfusion if the procedure cannot be postponed. Or: opt for a less invasive.
Antithrombotic therapy			
Vitamin Kantagonists	Do not suspend	target PT/INR<3 (*bridging* with LMWH is not recommended). For emergency procedures, in case of PT/INR>4, consider the use of prothrombin factors, fresh frozen plasma or vitamin K	If the default therapeutic range is PT/INR 2-3, perform the procedure when the value is between 2 and 2.5. If the default therapeutic range is PT/INR 2.5-3.5 (e.g. in some patients with a mechanical prosthetic valve), perform the procedure when the value is between 2.5 e 3. *Bridging* with LMWH/UFH is not recommended.
Direct oral anticoagulants (DOAC)	Do not suspend	Perform the procedure 12h after the last dose of DOAC. Resume no less than 6h after the procedure.	**DABIGATRAN**: discontinue 24-36 h (if CrCl>50mL/min) or 48 h (if CrCl<50mL/min). Resume after 24 hours. **APIXABAN, EDOXABAN, RIVAROXABAN**: Discontinue 24 h (if CrCl>30mL/min) or 48 h (if CrCl<30mL/min). Resume after 24 h.
Unfractionated heparin (UFH)	Do not suspend	Suspend 4h before the procedure. Resume 6h later the procedure.	Suspend 4-6h before the procedure. Start again 6-8h later
Low molecular weight heparin (LMWH)	Do not suspend	Discontinue the dose before the procedure. Start again after 12h after procedure.	Perform the procedure 8-12h after a prophylactic dose or 24h after a therapeutic dose. Resume no less than 12h after the procedure.
Fondaparinux	Do not suspend	Discontinue the dose before the procedure. Start again 12 hours after the procedure.	In case of therapeutic dose 5-7.5-10mg: discontinue 36h (if CrCl>50ml/min). Resume 12 h after the procedure.
Mono-therapy anti-platelet (SAPT)	Do not suspend	Do not suspend	Do not suspend
Dual anti-platelet therapy (DAPT)	Do not suspend	In an emergency, do not suspend. For elective procedures, discontinue one of the two drugs (as for highly invasive manoeuvres)	in patients at low/intermediate thrombotic risk, continue acetylsalicylic acid but discontinue the other drug (TICAGRELOR: discontinue 3 days, CLOPIDROGREL, DIPYRIDAMOL: suspend 5 days, PRASUGREL: suspend 7 days). Resume the day after the procedure. In patients at high thrombotic risk, consider postponing the procedure until the risk is low/intermediate (1 month or more) and opt for a procedure less invasive.

PART THREE - MANAGEMENT OF VENOUS ACCESS DEVICES

Complications of venous accesses, particularly infectious ones, are a major cause of morbidity and mortality and are responsible for prolonged hospital stays and increased costs. It has been calculated that a single episode of catheter-related sepsis (CRBSI) in the ICU costs more than € 15,000 and results in an average length of stay of more than 12 days. On the other , the literature amply describes and validates experiences in which, through proper management of venous catheters characterised by a few simple interventions, a considerable decrease or even zeroing of complications, particularly infectious ones, has been achieved. In the prevention of complications related to the use of venous catheters and especially CRBSI, the use of bundles has proved particularly useful, with adherence checked by means of dedicated checklists.

GENERAL RECOMMENDATIONS

The aim of the prevention strategies set out in this document, as recommended by the most authoritative international guidelines for some years now, must be to eliminate vascular catheter-related sepsis (CRBSI) or at least to achieve the lowest possible value. With regard to hand washing and the use of gloves, please refer to what has already been reported in part two of this document.

Surveillance

In order to be able to define need for and effect of catheter-related sepsis prevention strategies, it is desirable that in each Operating Unit d contact persons are identified who record the incidence of CRBSI expressed as the number of sepsis per 1000 days of catheter life and defined as follows. The diagnostic definition of catheter-related bacteremia is as given in the 2009 IDSA guidelines:

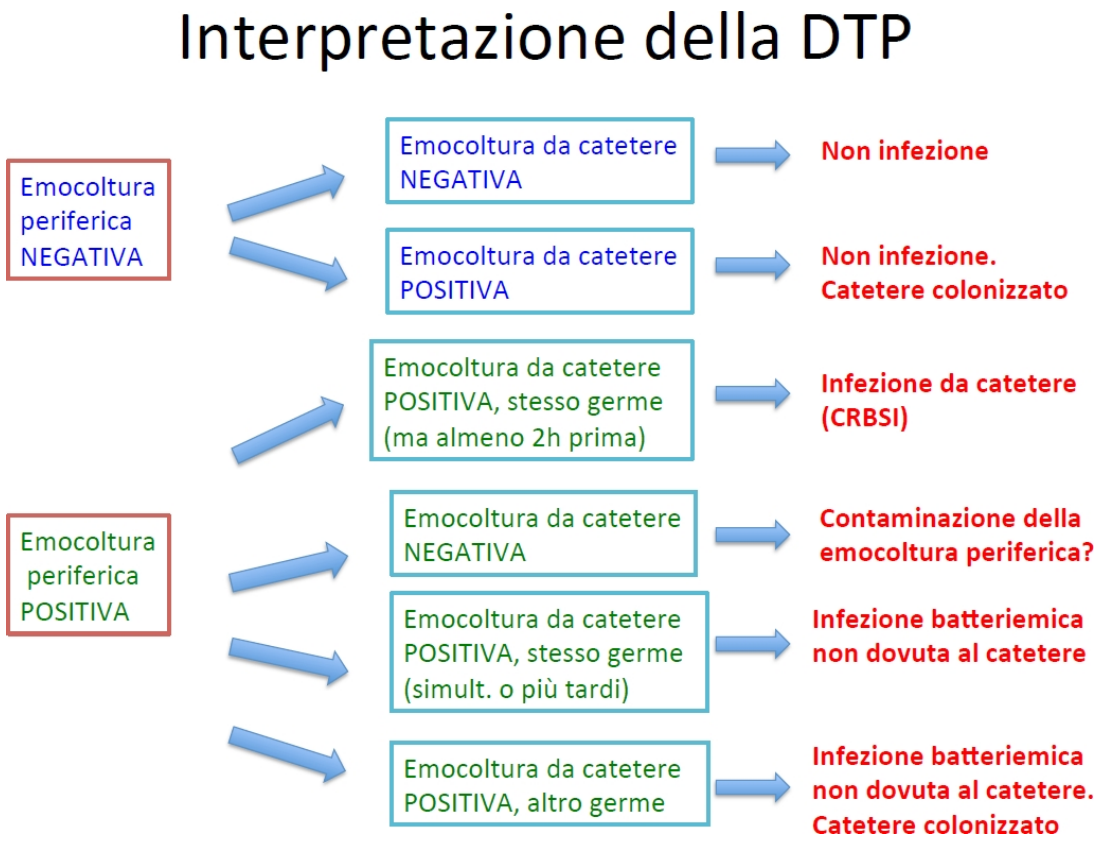
- Patient with central venous catheter with signs of SIRS (*Systemic Inflammatory Response Syndrome*), characterised by two or more of the following conditions: CT> 38 °C or< 36 °C; heart rate > 90 bpm; respiratory rate > 20 attos/min. or PaCO2 < 32 mmHg; leucocytosis (> 12,000/mmc) or leucopenia < 4,000/mmc), having no alternative source of infection and presenting at least one of the following criteria:
  - isolation of the same micro-organism (same species and same antibiogram) from a blood culture taken from a peripheral vein and from the culture of the tip of the freshly removed central venous catheter;
  - or: isolation of the same micro-organism (same species and same antibiogram) from a blood culture from a peripheral vein and a blood culture from a central venous catheter with a positive time of two or more hours earlier for the blood culture from the venous catheter than for the blood culture from the peripheral vein (DTP = *Differential Time to Positivity*).

It therefore follows that in most cases the most advisable and most cost-effective system (to avoid inappropriate removal of CVCs that are not responsible for the infection) is DTP: a negative blood culture both from the periphery and from the catheter rules out bacteremia; a positive blood culture only from the periphery but not from the catheter argues for a false positive due to contamination during the peripheral blood culture; Both positive blood cultures, but with catheter positivity at least two hours prior to periphery positivity, point to a bacteremia caused by the catheter (CRBSI= *catheter-related blood stream infection*); both positive blood cultures, but with catheter positivity at the same time or later than periphery positivity, point to a bacteremia not caused by the catheter (see Table 22: DTP interpretation scheme).

TABLE 22

Figure 18

INTERPRETATION SCHEME OF PAIRED BLOOD CULTURES
(DTP - Differential Time to Positivity)



Using Bundles and Checklists

In accordance with what international guidelines suggest, the main tools provided to healthcare professionals to be applied in daily clinical practice for the prevention of venous catheter-related infections are *bundles* and *checklists* developed *ad hoc*; some examples are given in this document.

The implementation of the contents of this document (in particular *bundles* and *checklists*) will be carried out through specifically agreed training events within the company.

As a useful reminder of any training event in this area, we quote the GAVeCeLT *bundle* for the prevention of bacteraemic central venous catheter infections (Table 23), as well aś the PIDAV protocol for the prevention of infections from venous access devices (Table 24), which refers more broadly to the prevention of all infections potentially associated with any venous access device, peripheral or central.

Strategies for replacing venous catheters

With regard to short-term peripheral venous catheters (agocannulas), on the basis of recent studies and a review carried out by the Cochrane, scheduled replacement every 72-96 hours should no longer be implemented. Agocannulas will only be replaced if clinically indicated, due to the occurrence of complications (phlebitis, extravasation, dislocation, occlusion); it is recommended that such complications be detected as early as possible, through an inspection of the catheter's emergence site and a check on the patency of the system to be carried out at least at each change of shift by the nursing staff.

Routine replacement of central venous catheters at scheduled intervals does not reduce the risk CRBSI and is a practice strongly discouraged by all guidelines.

The replacement of a central venous catheter (on a metal guidewire, or by ex novo placement elsewhere) will only be implemented on the basis of clinical indications.

Ultimately, it is now well established that all venous catheters, both central and peripheral, should be removed/replaced not at scheduled intervals but only if clinically indicated, i.e. at the end of use or due to the onset of complications. The only exceptions are venous catheters inserted in emergencies, which must be removed within 48 hours even in the absence of complications, and CVOs, which must be removed within a few days.

INDICATIONS FOR THE REMOVAL OF ANY VENOUS ACCESS DEVICE (DAV):

- DAV no longer useful;
- DAV no longer appropriate as a type in relation to its intended use;
- DAV with complication requiring removal (documented CRBSI, for example, or other);
- DAV rejected by the patient.

CVC (PICC-CICC-FICC) GUIDANCE:

- CVC to be replaced with more appropriate CVC (e.g. single-lumen to bilumen);
- CVC with mechanical lesions of the outer tract;
- malpositioned CVC (due to partial dislocation or *tip migration*). CONTRAINDICATIONS

TO GUIDE REPLACEMENT OF A CVC (PICC-FICC):

- Suspected (or confirmed) device infection;
- Presence of suspected emergency site infection;
- Sonographic evidence of catheter-related thrombosis;
- Fibroblast sheath malfunctioning.

TABLE 23

Figure 19

GAVeCeLT bundle for the prevention of CVC infections (PICC-CICC-FICC)

1) the time of implantation:

- Hand hygiene, skin antisepsis with chlorhexidine 2% in 70% isopropyl alcohol and maximum barrier precautions
- Rational choice of emergency site (preference: half-arm for PICCs, subclavian reg. for CICCs, half-thigh for FICCs)
- Always use ultrasound-guided venepuncture
- Stabilisation and protection of the catheter at the emergence site using cyanoacrylate glue, *sutureless device* and semi-permeable transparent membrane

2) During management:

- Hand hygiene
- Skin antisepsis with chlorhexidine 2% in alcohol
- Use of chlorhexidine-eluting felts for non-tunnelled catheters
- *Sutureless device* stabilisation and catheter protection at the emergence site and semi-permeable transparent membrane
- Passive disinfection of *needle free connectors* using disinfectant caps (*port protectors*)
- Immediate removal of central venous catheter no longer required

TABLE 24

Figure 20

PIDAV Protocol - Prevention of Infections from Venous Access Devices

1. **CORRECT** INDICATION - Checking the indication for venous access, choosing the most appropriate device (peripheral vs. central) and removing it as soon as it is no longer essential.
2. **CORRECT ASEPSI** - Hand hygiene with hydroalcoholic gel, before implantation and before and after each handling manoeuvre; maximum barrier precautions during insertion of central access or peripheral access devices of long duration; skin antisepsis with chlorhexidine 2% in alcohol - in sterile single-dose applicators - before implantation and at dressing change.
3. **CORRECT CHOICE OF EMERGENCY SITE** - For peripheral accesses, avoid flexion zones; for central accesses, prefer (in order) the middle third of the arm, the subclavicular zone and the supraclavicular zone; avoid the neck or groin emergency site (except in emergencies); tune a central venous access device if this is necessary to optimise the emergency site.
4. **CORRECT IMPLANTATION TECHNIQUE** - Always use ultrasound-guided implantation for placement of central devices and peripheral devices of long duration.
5. **APPROPRIATE FIXATION** - always avoid sutures and patches; instead, stabilise the device with an appropriate sutureless system (integrated in the dressing, or skin adherent, or subcutaneously anchored).
6. **EMERGENCY SITE PROTECTION** - Use semi-permeable, highly breathable transparent membranes combined with chlorhexidine-releasing felts or seal the emergency site with cyanoacrylate glue.
7. **PROTECT THE INFUSION LINE** - Disinfect access ports by wiping with 2% chlorhexidine alcohol solutions or applying *port protectors* (disinfectant caps) over needleless connectors; flush and close the system with saline only, using pre-filled syringes.
8. **FACILITATING THE ADOPTION OF THESE RECOMMENDATIONS** - Use dedicated trolleys, all-inclusive kits and *checklists*, both for installation and management.

In the case of an indication for removal of the catheter for CRBSI, replacement cannot therefore be performed on a guidewire but the catheter must be repositioned in another location; in exceptional cases, metal-guided replacement of an infected or colonised CVC with an antimicrobial CVC may be considered. In the patient with CRBSI or sepsis of other origin, considering the risk of colonisation by haematogenous route, the type of venous catheter to be inserted will be verified on a case-by-case basis, in collaboration with the infectivologist.

Please note that immediate removal of both the central and peripheral venous catheter is essential when it is no longer indicated.

SPECIFIC RECOMMENDATIONS: MEDICATION MANAGEMENT

Emergency catheter site monitoring

The emergence site of a short to medium-term central venous catheter (PICC, CICC, FICC) or a Midline should be inspected or palpated daily for:

- check the condition of the dressing;
- early detection of symptoms or signs of infection (erythema, exudate, blood, pain, etc.).

The presence of signs of infection of the emergence site of a non-tunnelled CVC (PICC, CICC, FICC) is an indication for removal, considering the very high risk that such local infection may induce CRBSI.

The emergence site of an agocannula or long peripheral catheter (*mini-midline*) should be inspected at least at every nursing shift change in order to detect complications requiring removal at an early stage. For this purpose, a *score* such as the *Visual Exit Site Score* recommended by the Infusion Nurses Society (INS) Standards should be used. The simultaneous presence of reddening of the emergence site and pain on palpation is indication for device removal; the presence of reddening without pain or pain on palpation without signs of reddening is not an indication for removal, but does lead to closer surveillance of the emergence site.

Emergency catheter site management

Emergency catheter site management includes:

- removal of the old dressing (transparent semi-permeable membrane) and chlorhexidine-releasing felt (if present);
- removal of the *sutureless device* (unless it is a subcutaneous anchorage);
- skin antisepsis around the emergency site;
- application of the new *sutureless device* (unless subcutaneous anchoring);
- application of the chlorhexidine-releasing felt (if indicated) and the new dressing (transparent semi-permeable membrane).

Skin antisepsis of the emergency site

Skin antisepsis of the emergency site of a venous catheter should always be performed with chlorhexidine gluconate 2% in 70% isopropyl alcohol (IPA), using single-dose, single-use, sterile applicators.

Chlorhexidine should be applied to the emergency site by rubbing vigorously *with the no-touch* technique for 30 seconds and allowed to dry for 30 seconds. Only in neonates should rubbing be avoided (which may create mechanical damage to the skin) and the antiseptic should be applied by 'dabbing' the

surface. In the case of patients known to be intolerant/allergic to chlorhexidine, an antiseptic based on iodopovidone 10% is used as an alternative, again rubbing vigorously, using the *no-touch* technique, but allowing to dry for at least 120 seconds.

No antiseptic or antibiotic ointments should be routinely applied to the emergency site, with the possible exception of haemodialysis catheters, where such ointments may play a role.

Choice of dressing and frequency of replacement

The emergence site of a venous catheter (central or peripheral) must be covered and protected with a transparent semi-permeable dressing, preferably highly breathable (with MVTR greater than 1500 g/sqm/day).

It is preferable to use a partially or fully edged transparent dressing for central venous catheters; for peripheral venous catheters, an unedged transparent dressing is sufficient.

In the case of children and infants, the transparent dressing should be of a size proportionate to the area to be covered and should absolutely be highly breathable (MVTR greater than 1500), given the high transcutaneous transpiration characteristic of this patient population.

Transparent dressings should be used for all venous catheters, (a) because they allow visualisation/surveillance of the emergence site, (b) because they help stabilise the catheter more effectively than other types of dressings by preventing *in-out* movement of the catheter itself, which promotes infection and thrombosis, and (c) because - if high MVTR - they keep the emergence site dry.

The semi-permeable transparent dressing should be replaced every seven days or whenever it is detached or if moisture is present underneath it. In the case of neonatal catheters, the transparent dressing - if not detached and undamaged - may remain in place for periods of more than one week.

In the case of proven intolerance to semi-permeable transparent dressings, the emergency site may be covered with gauze dressings, but these should be replaced every 48 hours (and whenever soiled, detached or wet). A possible further indication for gauze dressing is the presence of a MARSI, or bleeding or gushing of serum from the emergency site (which can be avoided, however, by local application of cyanoacrylate glue).

In the above-mentioned cases (sweating, bleeding, etc.), as soon as the problem is resolved, the emergency site must be covered again with transparent semi-permeable dressings.

Indications for the use of chlorhexidine continuous-release devices and the use of cyanoacrylate glue

Continuously-released 2% chlorhexidine polyurethane felts for the protection of the emergence site of a short- or medium-term central or peripheral venous catheter (Midline type) are indicated by guidelines as an effective strategy for the prevention of catheter-related infections. They should be used in all patients in whom a non-tunnelled central venous catheter (CICC, PICC, FICC) has been implanted. The felts should be placed from the first dressing, and not at the time of implantation; at the time of implantation, it is recommended instead to seal the emergence site with a small amount of cyanoacrylate glue (preferably, butyl-cyanoacrylate or butyl-octyl-cyanoacrylate), as described above in the recommendations for the insertion technique.

Glue has a similar ability to discourage bacterial contamination via the extraluminal route, but in addition - in comparison with felt - it has the ability to block any blood or serum leakage from the emergency site. Available scientific evidence shows that cyanoacrylate glue does not damage polyurethane catheters and that the incidence of allergic reactions is very rare if not exceptional. In view of the theoretical possibility of skin alterations due to lack of perspiration caused by covering with cyanoacrylate, at the moment, however, it is recommended (a) to place the glue in a minimum quantity sufficient to seal the

emergency and/or close the skin incision, and (b) to place the glue only at time of implantation, without repositioning it routinely at each dressing change. The data currently available indicate that cyanoacrylate glue can and should also be used at the time of implantation of venous catheters in children and infants (e.g. to fix agocannulas and ECCs, obviously always combined with transparent dressings, even in premature infants:). On the other hand, the use of chlorhexidine-eluting felts is not recommended in premature infants.

Description of correct dressing technique

- Hand hygiene (preferably using hydroalcoholic gel)
- Wear clean, non-sterile gloves
- Remove the semi-permeable transparent membrane with appropriate technique (i.e. without mobilising the catheter)
- Remove chlorhexidine-releasing felt (if present)
- Remove the *sutureless device* with appropriate technique (unless the catheter is fixed by subcutaneous anchorage)
- Remove clean gloves
- New hand hygiene
- Wear sterile gloves
- Skin antisepsis around the emergency site with chlorhexidine gluconate 2% in 70% isopropyl alcohol dispensed through sterile single-dose, single-use applicators
- Application of the new *sutureless device* (unless the catheter is fixed by subcutaneous anchorage)
- Application of chlorhexidine felt (if catheter is not tunnelled)
- Application of the new transparent semi-permeable dressing
- Date stamp on the dressing
- Recording of the medication in the nursing record, with completion of the corresponding checklist.

The correct dressing technique is illustrated by videos available on the GAVeCeLT website.

The adoption of dressing *packs* is to be recommended - where possible - to simplify the entire manoeuvre described above, in particular for the emergency site management of midlines and external central venous catheters (CICC, PICC, FICC). The use of such *packs* is associated with time and cost savings, as well as optimisation of material use.

SPECIFIC RECOMMENDATIONS: MANAGEMENT OF INFUSION LINES

Frequency of replacement of infusion lines

Infusion sets, when used continuously, must be replaced every 96 hours, with the following exceptions:

- if the sets were used for the infusion of blood or blood products, they must be replaced immediately at the end of the infusion;
- Infusion sets used for the administration of parenteral nutrition containing lipids or for the administration of lipid-based solutions must be replaced every 24 hours;
- sets used for the administration of chemotherapy must be immediately replaced and disposed of in accordance with the company's recommendations on the subject.

The optimal replacement frequency of infusion sets used for discontinuous administrations is still an unresolved issue. It seems prudent, however, to replace the infusion line at the end of each infusion cycle.

Selection and use of needle free connectors

The *hub* (connection point) of venous catheters must be closed by needle free connectors (NFC) and not by standard plugs.

NFCs, in addition to guaranteeing greater operator safety in the administration of intravenous infusions through vascular catheters in view of the non-use of needles, when characterised by a special internal mechanism (neutral *displacement*) prevent the occlusion of venous catheters by reducing or even eliminating the *backflow* phenomenon when disconnecting the infusion lines.

As suggested by the Guidelines on the Prevention of Infections Associated with Venous Catheters (EPIC 2014), the use of NFC reduces bacterial colonisation more effectively than the use of standard plugs.

It is preferable not to use positive or negative displacement NFCs. The NFCs to be preferred are those with neutral *displacement*, with *a luer-lock* coupling mechanism for infusion lines, characterised by a smooth and regular outer surface, so that the connection surface can be disinfected as effectively as possible.

NFCs should not be used for catheters intended for haemodialysis or apheresis, as they reduce flow.

In the case of continuous use of the vascular catheter, NFCs should be replaced together with the infusion line. In the case of intermittent use of the catheter, they should be replaced at least once a week at dressing changes.

Aseptic system access technique

Access to the venous catheter by connecting the infusion lines to the NFCs must be performed using aseptic technique.

Disinfection of NFCs must be achieved by applying *port protectors* (disinfectant caps with a *luer lock* mechanism containing a sponge soaked in 70% isopropyl alcohol). They can disinfect the connection surface of NFCs in a few minutes and maintain this disinfection for up to seven days. *Port protectors* should be applied to the NFC at the time of implantation; they should be removed at the time of connection of the infusion line and reapplied after disconnection of the infusion line and adequate flushing of the catheter with saline using the 'push *and stop*' technique.

Therefore, to properly access the venous catheter via NFC, operators will need to adopt this sequence:

- hand hygiene;
- wear clean, non-sterile gloves;
- remove the *port protector*;
- connect the infusion line;
- new hand hygiene.

Upon disconnection of the infusion lines:

- hand hygiene;
- wear clean, non-sterile gloves;
- remove infusion lines according to the above criteria and dispose of them in accordance with the company's recommendations on the subject;
- flush with saline solution (with a volume of at least twice the dead space of the system - e.g. 10 ml in the adult patient - but three to four times the dead space - 20 ml in the adult patient - if blood, blood products or parenteral nutrition containing lipids have been infused) and *start and stop* push-button technique;
- apply a new *port protector*;
- new hand hygiene.

Disinfection of NFCs can alternatively be achieved (albeit less effectively - mainly due to lower *compliance* by operators) by vigorously wiping for at least 15 seconds with wipes soaked in 2% chlorhexidine in 70% isopropyl alcohol or with gauze soaked in 2% chlorhexidine in 70% isopropyl alcohol, before and after accessing the system. In both cases, a *no-touch* technique must be guaranteed.

In this case, in order to access the venous catheter correctly, the correct sequence will be modified as follows:

- hand hygiene;
- wear clean, non-sterile gloves;
- Vigorously wipe the connection surface of the NFC for at least 15 seconds with wipes or gauze soaked in 2% chlorhexidine in 70% isopropyl alcohol, avoiding touching the connection surface after applying disinfectant;
- connect the infusion line;
- new hand hygiene.

At the time of the disconnection of the infusion lines, however:

- hand hygiene;
- wear clean, non-sterile gloves;
- remove infusion lines according to the above criteria and dispose of them in accordance with the company's recommendations on the subject
- flush with saline solution (with a volume of at least twice the dead space of the system - e.g. 10 ml in the adult patient - but three to four times the dead space - 20 ml in the adult patient - if blood, blood products or parenteral nutrition containing lipids have been infused) and 'start and stop' push-button technique;
- disinfect the NFC again in the manner already indicated;
- carry out routine hand washing.

It is reiterated that this alternative modality is characterised by lower cost-effectiveness and a greater risk of infection, linked to the operators' lack of *compliance* with both the manoeuvre in its entirety and the correctness of the individual steps (especially with regard to the time of application and action of the disinfectant). We therefore recommend the adoption of 'passive' disinfection of the NFC by means of *port protectors* in all situations.

It is highly advisable that basic central venous access management manoeuvres (dressing management and infusion line management) are presented to operators in the form of *bundles* that can be translated into operational *checklists*. Table 25 and Table 26 provide an example of a *checklist* for changing the dressing of a CVC and an example of a *checklist* for periodic flushing of a CVC.

TABLE 25

Figure 21

Example of a *checklist* for changing a CVC dressing in the adult patient

BEFORE THE PROCEDURE

1. Patient identification
2. Verification of correct dressing indication (weekly expiry date or presence of soiled, detached or wet dressing)
3. Check that the patient is informed of the manoeuvre
4. Verification of the presence of all necessary material for the procedure
5. Hand hygiene according to protocol

DURING THE PROCEDURE

1. Use of clean, non-sterile gloves
2. Palpation of the emergency site to check for pain
3. Removal of the transparent membrane and chlorhexidine-releasing felt (if present)
4. Visual inspection of the emergency site
5. Removal of the skin-adhesive *sutureless* system (if no subcutaneous anchoring system present)
6. Skin antisepsis with chlorhexidine 2% in 70% isopropyl alcohol or - in case of known chlorhexidine intolerance - with iodopovidone 10%.
7. Opening the material required for the new dressing
8. Use of sterile gloves, after new hand hygiene according to protocol
9. Application of the new dressing: chlorhexidine-releasing felt (if indicated), *sutureless* skin-adhesive system (if no subcutaneous anchoring system is present), and semi-permeable transparent adhesive membrane (with date stamp)
10. Confirmation that the sterile field is maintained throughout the procedure

TABLE 26

Figure 22

Example of a *checklist* for periodic CVC flushing in the adult patient

BEFORE THE PROCEDURE

1. Patient identification
2. Checking that the system is flushed correctly (weekly or suspected malfunction from lumen occlusion)
3. Check that the patient is informed of the manoeuvre
4. Verification of the presence of all necessary material for the procedure
5. Hand hygiene according to protocol

DURING THE PROCEDURE

1. Use of clean, non-sterile gloves
2. Clamping the infusion line and removing the *needlefree connector*
3. Disinfection of the connection cone
4. Application of new *needlefree connector* and declamping of infusion line
5. Button flush with 10ml saline solution
6. Application of *port protectors*

Maintaining the patency of the system

Occlusion of the lumen of a venous catheter can be due to a variety of causes: clots (after blood samples or infusion of blood or blood products), lipid aggregates (during parenteral nutrition with lipids), drug precipitates (often after simultaneous or close infusion of incompatible drugs), contrast medium (after CT or MRI examinations using particularly viscous contrast media). Occlusion may be complete or partial; a particular type of partial occlusion is *persistent withdrawal occlusion* (PWO), when the catheter infuses but does not aspirate.

The prevention of occlusion is essentially based on an adequate flushing protocol with physiological saline, by means of a hand-operated syringe with a pulsating *start and stop* technique, before and after each infusion. In the adult patient, flushing the central venous catheter with 10 ml of physiological saline under normal conditions is recommended; after blood or blood product infusion, or after parenteral nutrition with lipids, or after mdc injection, it is best to flush with 20 ml. In children and neonates, however, the dead space of the central venous catheter should be known and flushed with 2 times the dead space under normal conditions, and 4 times the dead space after blood samples, or after infusion of blood or blood products, or after parenteral nutrition with lipids, or after mdc injection.

Alongside this good *flushing* practice, it is also good to close each lumen of the system, at the end of use, with saline solution (*lock*). The use of *lock* solutions with anticoagulant properties (e.g. heparin or citrate) only plays a role in catheters used for haemodialysis or apheresis. For all other short-, medium- or long-term venous accesses (including agocannulas, *mini-midline*, midline, PICC, CICC, FICC, port, PICC-port, FICC-port, CCT, ECC, CVO, etc.), the use of heparin solutions has no evidence of efficacy and should be avoided.

In patients who are not hospitalised but are followed in outpatient clinics or at home or in *day hospital*, it is preferable to use sterile syringes pre-filled with saline solution for the periodic flushing of medium- to long-term central venous catheters used intermittently.

Another important aspect in the prevention of occlusions is the adoption of NFC (*needlefree connectors*) with neutral 'pressure', in order to avoid reflux of blood into the catheter at the moment disconnection from the venous line.

In situations where the action of such pressure-neutral caps cannot be exploited (e.g. when removing a Huber needle from a port), it is necessary to use manoeuvres that leave a 'positive pressure' within the system. Three different techniques can be used to leave a positive pressure when removing the Huber: (a) when removing a straight Huber needle, without extension, connected with syringe via *luer-lock* connection, single-operator removal is possible (removal of the needle while continuing the infusion); (b) when removing a standard Huber needle with extension, two operators are required (one operator removes the Huber using two hands while the other operator maintains a continuous infusion via the syringe); (c) when using special Huber needles with positive pressure, even if equipped with an extension, removal by one operator is possible.

Maintaining the patency of haemodialysis or apheresis catheters is based on (a) active *flushing* with physiological saline (*flush*), using the push/pause technique, using 20ml per lumen in the adult patient, and (b) closing the system (*lock*) with 4% citrate solution (in an amount equal to the dead space+ 20%). The use of the lock with citrate appears more cost-effective and safer than the use of the lock with heparin.

Table 27 shows the GAVeCeLT recommendations for the prevention of central access occlusions in the adult patient.

TABLE 27

Figure 23

Recommendations for the prevention of occlusions of the lumen of venous accesses

1. *Push/pause* flush with saline (2 times the dead space) before and after each infusion
2. *Push/pause*' flushing with saline (3-4 times the dead space) after blood product infusion or after lipid infusion or after catheter or after contrast medium infusion
3. Use *lock* with anticoagulants (heparin or citrate) only in catheters used for dialysis and apheresis
4. Use external catheters (Midline, PICC, CICC, FICC etc.) always *power injectable*, made of polyurethane; never use silicone external catheters; never use valved catheters
5. Administering parenteral nutrition in a dedicated lumen using a nutripump
6. Avoid 'cocktails' of drugs
7. Use '*no-reflux*' strategies: avoid 'backflow' at system disconnection, using only NFC at neutral pressure; leave positive pressure when removing the Huber from the port

Use of antimicrobial *lock* for prophylactic purposes

Locking venous catheters with non-antibiotic antimicrobial substances is widely described in the literature and has been shown to be effective in preventing CRBSI in patients with dialysis catheters and in patients with repeated episodes of CRBSI despite good adherence to the aseptic technique (prophylactic *lock*).

The *lock* currently most advisable in this regard is the *lock* with taurolidine 2% (for catheters not involving use of anticoagulants) or the *lock* with taurolidine 1.35%+ citrate 4% (for haemodialysis or apheresis catheters involving the use of anticoagulants). However, this prophylactic *lock* should not be used routinely, but limited to situations with a high risk of CRBSI. In selected cases, prophylaxis of haemodialysis catheter infections may be implemented by *lock* with tetrasodium EDTA.

Recommendations for the management of totally implantable systems (ports)

For the management of fully implantable systems, the recommendations outlined so far apply. Some peculiar aspects are as follows:

- Antisepsis of the skin prior to Huber's needle placement should always be carried out with 2% chlorhexidine in 70% isopropyl alcohol (application for 30 seconds + waiting for 30 seconds).
- Insertion of the Huber needle must always be performed with sterile gloves: the operator's non-dominant hand must hold the reservoir in place while the dominant hand inserts the needle.
- The Huber needle should be removed immediately when no longer required and in any case replaced after no more than seven days.
- Huber's needle should be protected and stabilised with a semi-permeable transparent, broad edged dressing to minimise the risk of needle loosening.
- The extension connected with Huber's needle must be closed by a neutral pressure NFC, which must be replaced according to the criteria already indicated.
- Huber's needle removal should be performed using the 'positive pressure' technique, as described above.
- When not in use, the fully implantable system (port or PICC-port) must be periodically *flushed* and *locked* with saline, using the technique described above, monthly (every 4 weeks) or - if logistical problems dictate - quarterly (every 12 weeks).

Totally implantable systems are intended for use mainly outside the hospital (in the outpatient or day hospital); if a patient - e.g. undergoing outpatient chemotherapy treatment - has to be admitted to hospital, the port should not be used unless specifically and appropriately trained medical or nursing staff are responsible for managing such access.

It should be remembered that totally implantable systems are particularly prone to obstructive complications (occlusion of the lumen by drugs or clots), which are sometimes difficult to resolve. For this reason, in principle, the use of the port should be avoided for routine blood sampling, for haemotransfusions, for the administration of contrast medium, or for parenteral nutrition with lipid emulsions.

Finally, it should be remembered that the strategy of leaving an unused port in place for years or indefinitely is antiquated and counterproductive. As a general rule, it is advisable to remove any totally implantable system that is no longer used for chemotherapy, unless a new use is deemed possible within 6-9 months.

Recommendations for the management of long-term tunnelled catheters (cuffed tunnelled or non-cuffed tunnelled but subcutaneously anchored)

For the management of long-term tunnelled catheters, the recommendations outlined so far apply.

Some peculiar aspects are as follows:

- Although it is not possible to make recommendations on the need to cover the well-healed insertion site of tunnelled venous catheters indefinitely, this manoeuvre is nevertheless considered preferable, not least in order to protect the catheter from accidental pulling.
- The tunnelled catheter must always be closed with an NFC.

Recommendations for preventing overflow

Extravasation is the accidental infusion of vesicant substances into the subcutaneous tissue and/or muscle, rather than intravascularly. This complication - particularly serious in terms of clinical consequences and particularly costly from an economic point of view - is almost exclusively the prerogative of ports, and occurs due to the accidental mobilisation of the Huber needle from the *reservoir*, with the antiblastic chemotherapeutic substances being spread into the surrounding tissues.

Prevention is based on a series of precautions concerning the choice, implantation and management of the device:

- Choice of device - While it is true that infrequent access for chemotherapy is an indication for the placement of a port rather than an external catheter, it is also true that if the device is to be used for chronically-infusing chemotherapy by means of an elastomeric pump at home, e.g. for 48 continuous hours, the implantation of a PICC or other external catheter (free of the risk of extravasation) is more prudent; in fact, the risk of accidental dislodgement of the Huber at home (e.. at night) is greater than in *day hospital*. At the specific and justified request of the patient, or under special logistical conditions, when a home crono-infusion port has to be implanted, it should be considered that a PICC-port is likely to entail less risk of extravasation than a thoracic port, since the Huber needle can be stabilised more effectively on the arm than in the subclavian area.
- Port implantation - Implantation technique plays a key role: a *reservoir* that is too small or too deep or too unstable will be a significant risk factor for overflow.
- Port management - The prevention of overflow also and above all lies in (a) an appropriate *reservoir* puncture technique, (b) the choice of an appropriate length Huber needle (e.g. 17-20mm rather than 13-15mm), (c) the use of a semi-permeable dressing to stabilise the Huber, and (d) the adoption of a sufficiently large (e.g. 10 x 15cm) and edged dressing.

ABBREVIATIONS USED IN THE TEXT

CCT - tunnelled cuffed venous catheter; can be inserted either centrally (CICC), brachially (PICC) or femorally (FICC)
CDC - Centers for Disease Control
CICC - central venous catheter inserted after puncturing a 'central' vein, i.e. in the sub/supraclavicular region (v.anonima, v.axillary, v.subclavian, v,internal jugular, etc.); may be tunnelled or not
CLABSI - Central Line Associated Bloodstream Infection
CRBSI - Catheter-Related Bloodstream Infection
CRE - Carbapenem-Resistant Enterobacteriaceae
CVC - central venous catheter (i.e. with a tip placed in the superior cava, inferior cava or right atrium): the definition includes both CICCs and PICCs;
CVO - umbilical venous catheter DAV -
Venous Access Device
DAV-Expert - expert system for choosing the most appropriate DAV: available at www.gavecelt.it or as free App for *smartphones*
DIVA - Difficult IntraVenous Access
DTP - Differential Time to Positivity
EBPM - low molecular weight heparin
ECC - Epicutaneous-cava catheter
ECHOTIP - protocol for the use ultrasound for tip navigation and tip location of central venous accesses in the adult patient
ECHOTIP-Ped - protocol for the use ultrasound for tip navigation and tip location of central venous accesses in the paediatric patient
EPIC - Evidence-based Practice for Infection Control
ERPIUP - European Recommendations for the Proper Indication and Use of Peripheral access
ESA - European Society of Anaesthesia
FICC - central venous catheter inserted in a vein of the lower limb (common femoral vein, superficial femoral vein); may be tunnelled or not
Fr (French) - unit of measurement of catheter gauge: refers to outer diameter (1 Fr= 1/3 mm) G (Gauge) - unit of measurement of catheter lumen: refers to inner area
GAVeCeLT - Long Term Central Venous Access Group
GAVePed - Paediatric Venous Access Group
IDSA - Infectious Diseases Society of America
INS - Infusion Nurses Society
IPA - Isopropyl Alcohol
ISAC - Secure Central Access Protocol
ISAC-Ped - Protocol for the Safe Implantation Central Access in the Paediatric Patient ISALT - Protocol for the Safe Implantation of Long-Term Access
ISF - protocol for the Safe Implantation of FICCs
ISP - protocol for the Safe Implantation of CICCs
ISP-Port - Protocol Safe PICC Implantation MARSI - Medical Adhesive Related Skin Injury
MRSA - Methicillin Resistant Staphylococcus aureus
MVTR - Moisture Vapor Transfer Rate (unit of breathability: grams of water/square metre/24 hours)
Neo-ECHOTIP - protocol for the use ultrasound for tip navigation and tip location of central venous accesses in the neonate
NFC - Needle Free Connector

NIR - surface vein visualisation technology (<7mm depth) using a wavelength in the near-infrared spectrum (Near Infra-Red)
PEBA - Poly-ether-bloc-amide
PICC - central venous catheter inserted into a vein of the upper limb (basilic , brachial vein, axillary vein, cephalic vein, etc.); may be tunnelled or not
PIDAV - Protocol for the Prevention of Infections from Venous Access Devices
PWO - 'persistent withdrawal occlusion', i.e. a malfunction whereby the catheter infuses but does not suction.
RaCeVA - Protocol for Rapid Central Vein Assessment RaFeVA
- Protocol for Rapid Femoral Vein Assessment RaPeVA -
Protocol for Rapid Peripheral Vein Assessment RaSuVA -
Protocol for Rapid Superficial Vein Assessment
RAVESTO - Protocol for Rapid Assessment of the Vein Exit Site and Tunneling Options MRI - Magnetic Resonance Imaging
SAS - subcutaneous anchoring system
SHEA - Society for Healthcare Epidemiology of America
SIRS - Systemic Inflammatory Response Syndrome
CT - Computed Tomography ZIM -
Zone Insertion Method
WoCoVA - World Conference on Vascular Access

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