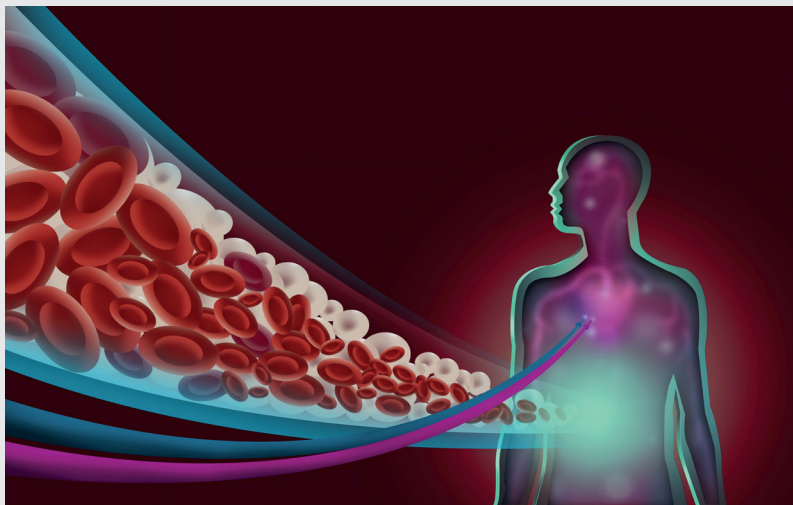




European Renal Best Practice

Clinical Practice Guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults

a summary by
European Renal Best Practice
(ERBP)



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Support and Financial Disclosure Declaration

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Introduction

A vascular access makes life-saving haemodialysis possible. For that, the access needs to function properly, allowing adequate blood flow for uraemic retention solute removal, while minimizing the risk of systemic infection. In 2007, European Best Practice Guidelines (EBPG) – the predecessor of the current European Renal Best Practice (ERBP) – drafted a set of recommendations to guide decisions on referral, assessment, access choice, surveillance, and management of complications [1]. Since then, not only the evidence underlying these recommendations but also the process of guideline development itself have evolved substantially [2]. In response, ERBP set out to update this prior work and to this end collaborated with various stakeholders within the field, including representatives of the Vascular Access Society (VAS), nephrologists, vascular access surgeons, radiologists, dialysis nurses, researchers, patients and their carers. An attempt to adhere to increasingly stringent guideline development methodology has required certain sacrifices in terms of scope. As a result, the current guideline does not necessarily cover the same topics as the previous version. Some are shared, but some were archived in favour of new questions prioritised by both healthcare providers and the people they care for. Details of the scoping procedure and its results have been published separately [3].

Development of this guideline followed a rigorous process of evidence review and appraisal, based on systematic reviews of results from clinical trials and observational data where necessary. The structured approach was modelled after the GRADE system, which ascribes grades to the certainty of the overall evidence and strength for each recommendation [4]. Where appropriate, the guideline development group issued ungraded advice for clinical practice, which was not part of a systematic evidence review.

The 2019 clinical practice guideline specifically covers peri- and postoperative aspects of arteriovenous (AV) fistulas and grafts. A second part, under development when this guideline went to press, will cover aspects related to access choice, preoperative vessel assessment and central venous catheters. Despite the scarcity of high-certainty evidence for most areas in vascular access, ERBP was committed to developing a high-quality guideline, giving guidance where possible, and listing research recommendations where it was not. We hope the current and planned guideline will help assist the professional community in making decisions about vascular access processes, pathways and care; help patients and carers gain insight; and facilitate joint decision-making in this field.

Chapter 1. Medical treatments for promoting arteriovenous fistula maturation

1.1. We suggest any decision to give aspirin, ticlopidine or clopidogrel in adults with end-stage kidney disease during the first two months after arteriovenous fistula creation for the sole purpose of improving maturation, must balance a reduction in thrombosis against uncertain effects on maturation and bleeding. (2C)

1.2. We suggest any decision to give perioperative heparin in adults with end-stage kidney disease during arteriovenous fistula creation, must balance an increase in arteriovenous fistula patency at one month against an important increase in bleeding complications. (2C)

1.3. We suggest any decision to apply far infrared therapy in adults with end-stage kidney disease during the first three months after arteriovenous fistula creation, must balance a possible reduction in thrombosis against uncertain effects on maturation and bleeding. (2C)

1.4. There are insufficient randomized controlled trial (RCT) data to make a recommendation for ticagrelor, prasugrel, dipyridamole, sulphinpyrazone, warfarin or other oral anticoagulants, fish oil, statins, vonapanitase, glyceryl trinitrate, iontophoretic injection of *Salvia miltiorrhiza*, or prednisolone for improving arteriovenous fistula maturation in adults with end-stage kidney disease. (-D)

Advice for clinical practice:

- do not stop mono-antiplatelet treatment in adults undergoing arteriovenous (AV) access creation.

Rationale

We identified seven systematic reviews of randomized controlled trials (RCTs) assessing benefits and harms of various medical adjuvant treatments to increase overall patency of arteriovenous (AV) fistulas and AV grafts [5-11]. All these reviews were judged to be of moderate to high quality with AMSTAR scores of 8 to 10/11. The reviews included studies measuring maturation outcomes after six to 12 weeks and patency outcomes measured several months later. Unfortunately, the meta-analyses did not separate studies reporting maturation outcomes from studies reporting longer term patency outcomes. The next paragraph describes the nature and content of the included systematic reviews that were used to identify relevant randomized trials. Based on group consensus, for this chapter, we chose to only consider RCTs and meta-analyses measuring patency outcomes before or at 12 weeks, as an arbitrary cut-off to distinguish maturation from long-term patency and only in those studies assessing AV fistulas.

Interpreting the available data in the context of maturation is challenging for various reasons. Most studies assessing antiplatelet agents report on short-term vascular access thrombosis rather than successful dialysis. This is problematic as a reduction in AV fistula thrombosis does not necessarily translate into improved maturation. It is true that fistula thrombosis precludes successful use of the AV access for dialysis, but if the current treatments, predominantly, aimed at reducing platelet aggregation and

coagulation, increase the risk of bleeding, a local haematoma may cause irreparable loss of the access even before it has ever been used. In addition, access thrombosis may be treated using endovascular or surgical techniques, and antiplatelet agents have uncertain effects on reducing interventions for assisting maturation.

Authors use different definitions for the concept of AV fistula maturation and that also complicates interpretation of the data. Some investigators treat maturation as a pre-cannulation outcome based on surrogate measures of vessel diameter and blood flow. Whether or not an AV fistula is successfully used for dialysis later on is often ignored. The guideline development group judged that an improvement in maturation using pre-cannulation definitions would not be enough to issue a supporting recommendation.

Lastly, many studies report primary unassisted patency after one year and do not distinguish between the maturation phase and long-term patency of a matured AV fistula. As harmful effects of treatments may change over time, differences in primary unassisted patency may well be non-proportional too. In other words, what benefits the maturation process may be different from what benefits the matured AV fistula.

The guideline development group felt that for a positive recommendation, interventions had to improve successful use of the AV access. We judged that in the absence of evidence for a positive effect of successful cannulation, evidence for an effect on intermediate outcomes such as AV access thrombosis would not be enough to advocate treatment. But rather than formulating a neutral statement, the group also wanted to highlight existing ambiguity by communicating the items to be weighed in decision-making.

After initial recommendations were drafted, the group decided to add a statement advising not to stop antiplatelet treatment in adults already treated with antiplatelet agents for other reasons. Although this chapter did not directly aim to answer that question, it was felt that the current evidence supporting continuation of antiplatelet treatment in adults undergoing non-cardiac surgery would tip the uncertain benefit for maturation in favour of continuing treatment [12].

Chapter 2. Surgical and endovascular interventions for promoting arteriovenous fistula maturation

2.1. We suggest using regional block anaesthesia rather than local anaesthesia for arteriovenous fistula creation in adults with end-stage kidney disease. (2C)

2.2. We suggest there is insufficient evidence to support end-of-vein to side-of-artery over side-of-vein to side-of-artery anastomosis for arteriovenous fistula creation in adults with end-stage kidney disease. (2C)

Rationale

Two systematic reviews [13, 14] and 16 RCTs assessing eight different interventions were identified [15-30].

RCTs provided low-to-medium certainty evidence overall. However, lack of standardization in outcome reporting made inference particularly difficult.

Five RCTs were found to provide evidence for block anaesthesia in comparison with local anaesthesia. Only one RCT was considered at low risk of bias, while the other four were considered at high risk of bias. All studies suggested benefit of using regional block anaesthesia, but there were several considerations that limited the strength of the recommendation to a discretionary one. First, the risk of bias in these studies was generally high, and outcome data were mostly limited to surrogate outcomes. Secondly, switching from local anaesthesia to regional block anaesthesia could unwisely complicate the procedure, may increase costs and possibly even delay the access procedure. Thirdly, the main advantage of regional block anaesthesia was felt to be vein dilation, which could also be achieved by other means, such as creating warm conditions.

For the comparison of end-of-vein to side-of-artery versus side-to-side anastomosis, there were three RCTs, which were considered at high risk of bias, with available results insufficient to recommend one type of anastomosis over another, but equally insufficient to indicate equipoise between the two.

Three reports were available on the comparison of clips versus sutures for AV fistula creation. Sample sizes were small, and the studies had important shortcomings, leaving important uncertainty as to the benefit of one technique over the other. Considering this uncertainty, the guideline development group felt that technique choice should be left to the surgical team based on the experience and personal preference. It was felt any recommendation would confuse the end user rather than clarify any ambiguity, such that no recommendation was formulated.

The guideline group considered the other trials to be preliminary at best, providing limited basis for formulating a recommendation in either direction. Hence, they decided to refrain from making statements related to vein ligation, suture technique, angioplasty or techniques for creating a brachio basilic AV fistula.

Chapter 3. Surgical and endovascular interventions for non-maturing arteriovenous fistulas

3.1. We suggest there is insufficient evidence to support open surgical over endovascular interventions as the preferred treatment for non-maturing arteriovenous fistulas in adults with end-stage kidney disease. (2D)

Advice for clinical practice:

- decisions on how to treat non-maturing AV fistulas are likely best based on the local resources, experience and success rates and
- institutions likely benefit from building a dedicated multidisciplinary vascular access team, with clinical experience in various techniques available for non-maturing AV fistulas.

Rationale

No RCTs comparing the benefits or harms of surgical or radiological endovascular interventions versus one another or versus no treatment were identified.

A recent narrative review that included an attempt at comprehensively searching multiple databases, found 28 non-randomized uncontrolled studies recording clinical success, one-year primary patency or one-year secondary patency of various surgical and radiological endovascular [31].

Several surgical and endovascular interventions are available to help non-maturing AV fistulas reach a stage where they can be used successfully for haemodialysis. Both surgical and endovascular procedures achieve moderate primary patency and rather good secondary patency at one year. The variability in outcome for both categories is large, probably due to differences in the study population, and perhaps also due to differences in expertise of the vascular access team. The trade-offs from aggressive efforts to maximize AV fistula maturation may be prolonged catheter use as creation of an alternative permanent vascular access is delayed. Multiple re-interventions may be taxing for patients and ultimately reduce quality of life in comparison with rapid creation of an alternative access or even permanent catheter use. Many of these questions remain unanswered to date.

Also, data are limited to primary and secondary patency at one year, and seldom provide insight into true longevity of the AV access. AV fistulas that require intervention before maturation have shorter secondary patency duration than those that mature without an intervention. The cumulative AV fistula survival is markedly inferior in patients requiring two or more interventions to achieve maturation as compared with those requiring one or no intervention. In addition, AV fistulas requiring more than one intervention to achieve maturation need more interventions to maintain long-term patency once haemodialysis using that AV fistula is started.

It seems reasonable to assume that clinical multidisciplinary expertise in the absence of clear guidance may be even more important than it is for other areas. Building and nurturing a team of dedicated vascular access specialists may be what maximizes success. It allows team members to gain experience in the various techniques available, and to monitor success as well as complications at a local level. In the absence of clear evidence that favours one intervention over another, or even comparative studies assessing the trade-offs and harms associated with interventions to aid the non-maturing fistula, at least having a structured approach may benefit outcomes.

Comparative studies between surgical and endovascular interventions are scarce, retrospective and uncontrolled for some of the baseline characteristics that may influence both choice of procedure and outcome. With the data currently at hand, the guideline group felt the available evidence to be insufficient to suggest one approach over another.

Chapter 4. Self-administered interventions for arteriovenous fistula maturation

4.1. We suggest that a standardized exercise programme involving hand-and-arm exercises may improve arteriovenous fistula maturation in adults with end-stage kidney disease. (2C)

4.2. There is insufficient evidence to support specific exercise programmes or physical interventions to promote arteriovenous fistula maturation in adults with end-stage kidney disease. (-D)

Advice for clinical practice:

- involving patients more actively in preparing for haemodialysis may improve self-management skills, health literacy and thereby well-being.

Rationale

We found two RCTs, both comparing different self-administered hand exercises [32, 33]. Neither indicated one intervention to be superior over another, but data were sparse, and the studies were at high risk of bias. In addition, we found one RCT comparing a structured exercise programme versus no exercises, which provided some evidence that such a programme may be beneficial [34]. We found this evidence to be of low certainty due to risk of selection bias and wide confidence intervals from sample size restrictions. More importantly, outcome measures were of a surrogate nature, using clinical and ultrasonographical criteria-based maturation rather than successful dialysis. One month may be too soon to assess the finality of a maturation process and data might have been different if the AV fistulas had been reassessed two weeks later.

The guideline development group felt it would be unlikely that simple exercises, such as hand squeezing, could have many harmful outcomes, provided that the patients waited until sufficient wound healing had occurred. Indeed, the no-exercise controlled trial did not report any important adverse events. Despite the study limitations, the guideline development group felt there was some indication that a structured exercise programme could be useful, and would not represent important resource implications, such that in the absence of important adverse events, they supported the use of such programmes in the postoperative phase of AV fistula creation.

There was one trial testing a new pneumatic device, but results were considered preliminary and outcomes surrogate in nature.

Chapter 5. Perioperative prophylactic antibiotics for preventing arteriovenous access infection

5.1. We recommend giving preoperative antibiotic prophylaxis for arteriovenous graft insertion in adults with end-stage kidney disease. (1C)

5.2. We suggest giving preoperative antibiotic prophylaxis for complex arteriovenous access procedures in adults with end-stage kidney disease. (2D)

5.3. We suggest not giving preoperative antibiotic prophylaxis for simple arteriovenous access procedures in adults with end-stage kidney disease. (2D)

Advice for clinical practice:

- simple AV access procedures include the creation of a native radiocephalic or native brachiocephalic AV fistula and
- complex AV access procedures include those that are not considered simple.

Rationale

There are no randomized trial data on perioperative antibiotic prophylaxis

for AV fistula creation. The guideline development group felt that in the absence of direct evidence, they should rely on extrapolation of evidence for antibiotic prophylaxis for preventing surgical site infections in general. They drew on an evidence review conducted by the British National Institute for Health and Care Excellence in January 2017 [35]. The review process found evidence supporting antibiotic prophylaxis to patients before clean surgery involving the placement of a prosthesis or implant; this was based predominantly on the evidence for a clinically relevant reduction in surgical site infections for this category. There is far less evidence related to clean and simple procedures, a single randomized trial indicating evidence for no effect. Our guideline development group considered the creation of a native fistula to be a 'clean' and short surgical procedure, in a non-contaminated area. Hence, they judged antibiotic prophylaxis non-mandatory in this setting.

In cases where prosthetic materials are used, two RCTs provided low certainty evidence for a clinically relevant reduction in surgical site infections. This is in line with the conclusion from the evidence review conducted for the NICE guideline [35]. We found no evidence for preferring one type of antibiotic over another in this setting. The guideline development group judged both first-generation cephalosporins as well as vancomycin or teicoplanin could be considered, depending on the local practice and epidemiology of methicillin resistance.

Chapter 6. Timing of first cannulation

Arteriovenous fistulas

6.1. In adults requiring haemodialysis, we suggest arteriovenous fistulas can be cannulated four weeks after creation if they are considered suitable for cannulation on clinical examination. (2C)

6.2. In adults requiring haemodialysis, we recommend against cannulating arteriovenous fistulas sooner than two weeks after their creation. (1B)

6.3. In adults requiring haemodialysis, we suggest against cannulating arteriovenous fistulas in between two and four weeks after their creation, unless this can avoid placement of a central venous catheter for haemodialysis. (2C)

Arteriovenous grafts

6.4. In adults requiring haemodialysis, we recommend that 'early cannulation type' arteriovenous grafts can be cannulated as soon as wound healing permits. (1B)

6.5. In adults requiring haemodialysis, we suggest against cannulating a 'standard type' arteriovenous graft sooner than two weeks after insertion, unless this can avoid placement of a central venous catheter for haemodialysis. (2B)

Advice for clinical practice:

- in practice, suitability for cannulation on clinical examination is determined by the presence of a palpable vein and good thrill;
- if clinical examination is inconclusive, then ultrasound with flow

- measurement may help in deciding whether or not to cannulate;
- bedside ultrasound-guided cannulation may be helpful in avoiding complications and decreasing the number of failed cannulations;
- using single-needle dialysis, low dialysis blood flows and smaller needles (17 gauge) may prevent harm to AV fistulas, which are cannulated early;
- wound healing refers to the tissue around the body of the graft, rather than the incision site.

Rationale

We found no RCTs, only observational studies assessing the effect of timing of first cannulation on outcome in AV fistulas [36-43]. Several observational studies consistently indicate that cannulating an AV fistula within 14 days of its creation importantly increases – almost doubles - the risk of unsuccessful dialysis and/or later AV fistula failure compared with cannulating an AV fistula after 14 days. The evidence for waiting another 14 days is less impressive and not consistent. In addition, the negative effects of a further delay, that is, the need for urgent central venous catheter placement, have never been studied and may counterbalance the positive effects of fistula longevity. In the absence of this evidence, the guideline development group felt that in this case avoiding placement of a catheter weighed more heavily and by allowing another 14 days for further maturation weighed less in comparison with the previous case. In the absence of the need for urgent dialysis, it seems reasonable to allow for an additional 14 days of further maturation before attempting to cannulate the AV fistula. This also holds true for those already receiving dialysis via a tunnelled catheter, unless a problem with the catheter should arise.

AV fistulas with a palpable vein and good thrill at four weeks after their creation can be cannulated successfully in most cases. In this situation, additional ultrasound measures are unlikely to be helpful. However, in the absence of such a thrill, there is low-quality evidence in line with clinical practice suggesting that an AV fistula diameter of >4-5 mm or a blood flow >500 mL/min indicates the fistula has matured and can be cannulated successfully. In the absence of a thrill a diameter of <4 mm and a blood flow of <400 ml/min make it highly suspicious that the AV fistula will fail without intervention. Although other techniques to assess AV fistula characteristics have been proposed, further study is needed to assess their added value.

One small RCT [44] and several observational studies [37, 41, 45-48] provide moderate certainty evidence that cannulating an AV graft within two days of its insertion has no negative consequences for short- or long-term AV graft outcome, including infection rates. This is the case even with standard PTFE grafts. There does not seem to be an increase in the complication rate, but early cannulation of standard PTFE grafts has never found its way into routine practice around the world. RCTs of the new grafts designed for early cannulation are not available. One retrospective study showed no increase in complications when cannulation of an early cannulation graft within the first 72 hours was compared with cannulation after 3 weeks. How this influences the added benefit of avoiding temporary and tunnelled central venous catheter placement is unclear, but it can only be expected to further tip the benefit-harm balance in favour of supporting early cannulation when necessary.

Chapter 7. Vascular access surveillance

Arteriovenous fistulas

7.1. We suggest the evidence for technical surveillance in addition to clinical monitoring of a functional arteriovenous fistula to detect and pre-emptively correct a haemodynamically important arteriovenous access stenosis in adults is inconclusive and needs more research. (2C)

Arteriovenous grafts

7.2. We suggest against technical surveillance in addition to clinical monitoring of a functional arteriovenous graft to detect and pre-emptively correct a haemodynamically important arteriovenous access stenosis in adults, unless it occurs in the context of a clinical study. (2C)

Rationale

For a screening programme to be successful, two important elements are needed. Not only should the screening test be effective at detecting the presence of an underlying significant stenosis, there should also be evidence that subsequent correction of the stenosis prolongs AV access survival.

In weighing benefits against harms, the guideline development group assigned the most value to patient survival and permanent access loss.

A Cochrane systematic review including 14 RCTs was used as the evidence base to inform the recommendation [49]. The evidence to date indicates that technical surveillance and subsequent pre-emptive correction of an AV access stenosis may possibly and slightly reduce the risk of permanently losing an AV fistula. It also appears that this effect may be smaller for AV grafts, if it exists at all. This is regardless of which surveillance technique is used or which intervention is subsequently performed. In addition, there is moderate quality evidence that even possible remediable access failure is probably not importantly reduced by pre-emptive intervention, whatever the intervention may be.

For AV fistulas, technical surveillance and pre-emptive correction seem to have a larger effect than the overall estimate indicated, but caution is required in interpreting both the relative and absolute effect sizes obtained by the review. First, although visual inspection of the forest plot indicated effect modification by access type, there was no statistical indication that heterogeneity truly exists. Translating the obtained subgroup effect estimate may thus overestimate the true effect. A more conservative estimate assumes the overall relative risk of 0.8 with its confidence interval. The corresponding absolute effect heavily depends on the baseline risk of access failure in the control group, which is expected to be (much) larger in the people already suspected to have an access stenosis than in those who are not. By estimating baseline risk from the studies, the relative effect of 0.8 translates into an estimated 5 fewer AV fistulas being lost for every 100 patients screened and an estimated 6 fewer for every 100 patients undergoing pre-emptive correction of a documented stenosis after one year. There is better quality evidence for AV fistula thrombosis. There is moderate quality evidence that surveillance and pre-emptive correction moderately reduce the risk of fistula thrombosis, the relative risk of 0.5

translating into an estimated absolute 15 fewer AV fistula thromboses for every 100 patients surveilled for one year and an estimated 23 for every 100 patients undergoing pre-emptive correction of a documented stenosis. This needs to be weighed against the increased number of diagnostic angiograms, which may ultimately not change the number of invasive procedures a person needs to undergo. The value patients put on being able to have these planned – in case of surveillance, rather than having to undergo them in emergency setting – in the case of access thrombosis, may sway the balance of perceived benefits and harms. Fewer catheters may be required, but the overall effect on the infection rate remains unclear to date. Additional demands on individual radiology services may also limit the feasibility of routine surveillance programmes. Because of uncertainties around the absolute reduction in risk of AV fistula failure, which needs to be weighed against an increased number of diagnostic angiograms, the guideline development group ultimately refrained from speaking out for or against technical surveillance.

A more recent RCT compared two strategies of surveillance: 'classic' or first-generation versus 'classic plus access blood flow-based' or second-generation surveillance [50]. There was moderate evidence that access blood flow-based surveillance resulted in reduced access thrombosis, and reduced AV fistula abandonment without increasing the total number of interventions the patients had to undergo. Although this does not directly answer the question, it seems to indicate the superiority of access blood flow-based surveillance over classic surveillance methods. However, the guideline development group felt that at this stage, more research was needed before any specific recommendation could be made.

Chapter 8. Medical treatments for maintaining long-term arteriovenous access patency

Arteriovenous fistulas

8.1. We suggest any decision to give fish oil to adults with end-stage kidney disease in the year following arteriovenous fistula creation, must balance improved patency at one year against an unknown risk of bleeding and other side effects. (2C)

8.2. We suggest far infrared therapy may be considered for improving long-term arteriovenous fistula patency in adults with end-stage kidney disease. (2C)

8.3. There are insufficient RCT data to make a recommendation for aspirin, clopidogrel, ticlopidine, warfarin, sulphinpyrazone, vonapanitase, beraprost sodium, cholecalciferol, statins, dipyridamole or dipyridamole combined with aspirin to be given for maintaining long-term arteriovenous fistula patency in adults with end-stage kidney disease. (-D)

Arteriovenous grafts

8.4. We recommend against warfarin in combination with antiplatelet agents, and against clopidogrel in combination with high-dose aspirin for reducing arteriovenous graft thrombosis in adults with end-stage kidney disease. (1C)

8.5. We suggest any decision to give fish oil in the year following arteriovenous graft creation in adults with end-stage kidney disease must balance any improvement in graft patency at one year against an unknown risk of bleeding. (2C)

8.6. There are insufficient randomized controlled trial data to make a recommendation for aspirin, clopidogrel, ticlopidine, warfarin, beraprost sodium, statins, dipyridamole or dipyridamole combined with aspirin to be given for maintaining long-term arteriovenous graft patency in adults with end-stage kidney disease. (-D)

Rationale

Five systematic reviews of RCTs assessing benefits and harms of various medical adjuvant treatments to increase patency of AV fistulas and AV grafts were identified. We judged all these reviews to be of moderate to high quality with AMSTAR scores of 8 to 10/11 [5, 6, 9-11]. All the reviews included both studies measuring patency outcomes after six weeks to 12 weeks, as well as patency outcomes measured several months later. Based on group consensus, for this section, we chose to only consider studies measuring patency outcomes after 12 weeks, as an arbitrary cut-off to distinguish maturation from long-term patency.

The guideline development group felt that for a positive recommendation, interventions had to improve successful use of the AV access. It was judged that in the absence of evidence for a positive effect of successful cannulation, evidence for an effect on access thrombosis would not be enough to advocate treatment. Although it is true that access thrombosis precludes successful use of the fistula for dialysis, a reduction in access thrombosis does not necessarily translate into improved patency. If these interventions, predominantly aimed at reducing platelet aggregation and coagulation, increase the risk of bleeding, then a local haematoma may cause irremediable access loss. In contrast, access thrombosis may be treated with endovascular or surgical procedures, whereby patency is maintained or restored. In general, there were very few studies suggesting a positive effect of a given intervention, and positive outcomes were rarely confirmed by independent sources. Often though, rather than formulating a neutral statement, the group also wanted to highlight existing ambiguity by communicating the items to be weighed in decision-making.

Chapter 9. Cannulation techniques for arteriovenous fistulas

9.1. We suggest against using area technique for cannulating arteriovenous fistulas in adults treated with haemodialysis. (2D)

9.2. We suggest using either a rope-ladder or buttonhole technique for cannulating arteriovenous fistulas in adults treated with haemodialysis, and letting the choice to be dependent on local expertise and arteriovenous fistula characteristics. (2D)

Advice for clinical practice:

- antiseptic measures and practical aspects of the cannulation procedure are important in reducing the infection risk associated with buttonhole cannulation and
- AV grafts are usually only cannulated using a rope-ladder technique.

Rationale

Three systematic reviews were identified [51-53], including five RCTs comparing buttonhole with 'control' cannulation in AV fistulas [54-59].

The technique used for cannulation of an AV fistula has uncertain effects on patient and access survival. RCT data are scant and contradictory, making any inference for critical outcomes quite problematic. Similarly, high certainty data for quality of life that could steer judgement in decision-making are currently not available. The supposition that the buttonhole technique causes less cannulation pain is not supported by current RCTs. However, the use of local analgesic treatment possibly influenced the extent to which pain could be objectively measured. In addition, the cannulation technique used in control groups was ill-defined for most studies.

There is evidence suggesting that the buttonhole technique leads to an increased risk of local and systemic infections as compared with rope-ladder cannulation. However, the guideline development group felt that risk may partly be modified through appropriate antiseptic measures. There is also low certainty evidence from two studies suggesting that buttonhole cannulation causes less extensive aneurysm formation although patency rates appear to be similar.

The guideline development group felt the RCT evidence base did not allow a clear recommendation in favour of a specific cannulation technique. In the absence of such evidence, they felt their advice should incorporate a large observational study including more than 7000 patients, indicating area technique to be associated with poorer AV fistula survival than the other two techniques [60].

The group felt it reasonable to support both rope-ladder and buttonhole cannulation techniques according to centre expertise, AV fistula characteristics and patient preference. Often, the length of the fistula cannulation segment will dictate whether to opt for buttonhole or rope-ladder. The guideline development group also agreed that all centres would benefit from maintaining a minimal level of experience with the different techniques within the vascular access team.

From the observational data, it becomes apparent that there is large variability in how different techniques are applied in clinical practice. A single label (buttonhole, rope-ladder, area cannulation) often covers different practices, which complicates interpretation of the evidence that is available. In that perspective, the guideline development group advised to have a quality improvement programme in place where outcomes of cannulation are registered and analysed at regular intervals.

Chapter 10. Needle types for arteriovenous fistulas

10.1. We suggest using either sharp needles or plastic cannulas for cannulating arteriovenous fistulas in adults treated with haemodialysis. (2C)

10.2. We recommend using blunt needles only for buttonhole cannulation of arteriovenous fistulas in adults treated with haemodialysis. (1D)

Advice for clinical practice:

- a quality improvement programme including recording and monitoring of the needle types and cannulation techniques alongside with arteriovenous access outcomes can help to monitor quality, guide changes in cannulation practice if needed, and improve quality of vascular access care and
- arteriovenous grafts are usually only cannulated using sharp steel needles.

Rationale

Three RCTs assessing different needle designs were identified [61-63]. The type of needle used for cannulation of an AV fistula has very uncertain effects on patient and access survival. RCT data are scant, making any inference for critical outcomes quite problematic. Similarly, high certainty data for quality of life that could steer judgement in decision-making are currently not available. It appears that sharp steel needles less often result in failed cannulation than blunt ones. In addition, the professed benefit of less cannulation pain with blunt steel needles in buttonhole cannulation is not supported by current RCT data. Unfortunately, those data are sparse. Only one, very small, trial tested sharp needles in AV fistulas cannulated using the buttonhole technique, and the buttonhole technique was originally described using blunt needles – the aim being not to injure the cannulation tract [63].

There is only one small RCT assessing the proposition that synthetic materials used for cannulation result in less damage to the AV fistula vessel. Again, however, sample size limitations prevent preference of one material over the other [61].

Chapter 11. Timing of intervention for arteriovenous fistula thrombosis

11.1. We suggest attempting to declot a thrombosed arteriovenous fistula in adults as soon as possible under optimal conditions and before the next haemodialysis treatment. (2D)

11.2. We suggest attempting to declot a thrombosed arteriovenous fistula in adults, even if there has been a delay of days to weeks. (2D)

Rationale

There were no RCTs comparing the benefits and harms of earlier versus later interventions for declotting a thrombosed AV fistula. There were four retrospective analyses assessing the effect of time to intervention on outcome of the AV fistula [64-67]. All were inherently at very high risk of bias through selection, attrition and failing to reach the optimal information

size. AV fistula outcomes were mostly reported in terms of technical success and data on primary or secondary patency were largely absent.

AV access failure is a common and serious complication, leading to increased temporary catheter use, access creation at multiple sites and after many years and multiple access failures to a catastrophic inability to provide haemodialysis in some cases. Thrombosis is one of the most frequent causes of access failure and successful declotting can save the access from permanent failure.

Intuitively, one would think that the earlier the intervention (surgical or radiological) is undertaken, the more likely it will result in successful access salvage, as delay can only result in clot organization, retraction and fibrosis. Indeed, for this reason, many have considered AV access thrombosis an emergency, necessitating immediate intervention. However, the evidence to support this assumption is very sparse. There have been no randomized trials assessing the effect of increasing time-to-intervention within a reasonable timeframe on access outcome, and the observational data are limited and at high risk of being biased.

In addition, there may be biologic reasons for challenging the existing paradigm. Given that acute thrombosis is associated with vessel wall inflammation and endothelial injury, and such early active inflammation may be prothrombotic in itself, it is biologically plausible that some delay in intervention may in fact avoid rapid recurrence of thrombosis after intervention.

Also, a recommendation favouring the shortest possible window for intervention may have important implications for service delivery and healthcare resources. One of the included studies assessed the causes for delay in intervention – the majority were due to lack of interventional radiology unit availability [65]. A statement favouring rapid intervention could also inadvertently lead to worse outcomes if less experienced operators must intervene in suboptimal conditions during out-of-office hours. Finally, most cases of access thrombosis are associated with an outflow stenosis which may not be amenable to surgical treatment. Adequate imaging of the inflow and outflow is best performed and thrombectomy and stenosis treated simultaneously [68-71].

In the absence of a clear understanding of the trade-offs at present, it seems reasonable that the timing of the intervention weighs up different factors, including the urgency for a functioning dialysis access and the availability of optimal logistical conditions to perform the best possible intervention.

Whereas there seems to be little data to support an aim for the maximum time-to-intervention, the existing data support intervention, irrespective of the time delay. Even after two days, 70% of procedures are still technically successful (corresponding to a three-month primary patency in 63%), and up to one week, still about one in five can technically be salvaged [64, 65]. It challenges the widely held view that late intervention is likely to be futile. Modern mechanical thrombectomy devices could be even more effective in restoring patency several days after the thrombotic event [72, 73].

Chapter 12. Surgical and endovascular interventions for arteriovenous access thrombosis

12.1. We suggest the choice between surgical and endovascular interventions for arteriovenous access thrombosis be defined by the condition of the patient and their vascular access, as well as local expertise as there is no evidence one approach improves outcomes over another. (2B)

Rationale

There is little randomized evidence available addressing this issue. The three RCTs found were mostly designed to evaluate the efficacy or superiority and safety of specific (endovascular) techniques or devices rather than comparing, more generally, surgical over endovascular approaches for AV access thrombosis [74-76]. In addition, no study compared any of the available procedures in AV fistulas, all participants had AV grafts. Lastly, surgical outcomes are biased if a new anastomosis, that is, proximalization of the AV access is included in the surgical treatment. Observational studies suggest that thrombectomies with adjuvant treatment to correct an underlying problem result in better outcomes than endovascular intervention [77]. The appropriate comparator is surgical balloon thrombectomy (without altering the anastomosis) versus endovascular intervention. Such a study has not been conducted. This heterogeneity of procedures employed, type of interventions and comparators and outcomes analysed prevent us from drafting definitive conclusions or recommendations favouring one approach over the other.

Reference List

1. Toridoir J, Canaud B, Haage P, et al. EBPG on Vascular Access. *Nephrology Dialysis Transplantation* 2007;22(suppl 2):ii88-ii117
2. Zoccali C, Abramowicz D, Cannata-Andia JB, et al. European best practice quo vadis? From European best practice guidelines (EBPG) to European renal best practice (ERBP). *Nephrology Dialysis Transplantation* 2008;23(7):2162-2166
3. Van Der Veer SN, Haller MC, Pittens CACM, et al. Setting priorities for optimizing vascular access decision making - An international survey of patients and clinicians. *PLoS ONE* 2015;10(7)
4. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;336(7650):924
5. Bashar K, Healy D, Browne LD, et al. Role of far infra-red therapy in dialysis arterio-venous fistula maturation and survival: Systematic review and meta-analysis. *PLoS ONE* 2014;9(8):e104931
6. Palmer SC, Di Micco L, Razavian M, et al. Antiplatelet agents for chronic kidney disease. *Cochrane Database of Systematic Reviews* 2013:CD008834
7. Palmer SC, Di Micco L, Razavian M, et al. Antiplatelet therapy to prevent hemodialysis vascular access failure: systematic review and meta-analysis. *American Journal of Kidney Diseases* 2013;112-122
8. Smith GE, Souroullas P, Cayton T, et al. A systematic review and meta-analysis of systemic intraoperative anticoagulation during arteriovenous access formation for dialysis. *Journal of Vascular Access* 2016;17(1):1-5
9. Tanner NC, Da Silva A. Medical adjuvant treatment to increase patency of arteriovenous fistulae and grafts. *The Cochrane database of systematic reviews* 2015(7):CD002786
10. Viecegli AK, Irish AB, Polkinghorne KR, et al. Omega-3 polyunsaturated fatty acid supplementation to prevent arteriovenous fistula and graft failure: a systematic review and meta-analysis of randomized controlled trials. *American Journal of Kidney Diseases* 2018;72(1):50-61
11. Wan Q, Yang S, Li L, et al. Effects of far infrared therapy on arteriovenous fistulas in hemodialysis patients: a meta-analysis. *Renal failure* 2017;39(1):613-622
12. Lewis SR, Pritchard MW, Schofield-Robinson OJ, et al. Continuation versus discontinuation of antiplatelet therapy for bleeding and ischaemic events in adults undergoing non-cardiac surgery. *Cochrane Database of Systematic Reviews* 2018;7:CD012584
13. Bashar K, Medani M, Bashar H, et al. End-To-Side versus Side-To-Side Anastomosis in Upper Limb Arteriovenous Fistula for Dialysis Access: A Systematic Review and a Meta-Analysis. *Annals of Vascular Surgery* 2018;47:43-53
14. Ismail A, Abushouk AI, Bekhet AH, et al. Regional versus local anesthesia for arteriovenous fistula creation in end-stage renal disease: a systematic review and meta-analysis. *Journal of Vascular Access* 2017;18(3):177-184
15. Aitken E, Jackson A, Kearns R, et al. Effect of regional versus local anaesthesia on outcome after arteriovenous fistula creation: a randomised controlled trial. *Lancet* 2016;388(10049):1067-1074
16. Beigi AA, Masoudpour H, Alavi M. The effect of ligation of the distal vein in snuff-box arteriovenous fistula. *Saudi Journal of Kidney diseases and Transplantation* 2009;20(6):1110-1114
17. Kakkos SK, Tsolakis IA, Papadoulas SI, et al. Randomized controlled trial comparing primary and staged basilic vein transposition. *Frontiers in Surgery* 2015;2:14
18. Khan MW, Khan MM, Qadir I, et al. Comparative study of efficacy of end-to-side with side-to-side arteriovenous fistula in patients on hemodialysis. *Pakistan Journal of Medical and Health Sciences* 2015;9(1):235-238
19. Laskar M, Cornu E, Leman A, et al. Anastomosis of small caliber vessels. Comparison between continuous or interrupted suture. *Presse Medicale* 1988;17(22):1152-1153
20. Meena S, Arya V, Sen I, et al. Ultrasound-guided supraclavicular brachial plexus anaesthesia improves arteriovenous fistula flow characteristics in end-stage renal disease patients. *Southern African Journal of Anaesthesia and Analgesia* 2015;21(5):12-15
21. Mozaffar M, Fallah M, Lotfollahzadeh S, et al. Comparison of efficacy of side to side versus end to side arteriovenous fistulae formation in chronic renal failure as a permanent hemodialysis access. *Nephro-Urology Monthly* 2013;5(3):827-830
22. Sahin L, Gul R, Mizrak A, et al. Ultrasound-guided infraclavicular brachial plexus block enhances postoperative blood flow in arteriovenous fistulas. *Journal of Vascular Surgery* 2011;749-753
23. Schild AF, Raines J. Preliminary prospective randomized experience with vascular clips in the creation of arteriovenous fistulae for hemodialysis. *American Journal of Surgery* 1999:33-37
24. Shoshiashvili V, Tataradze A, Beglarishvili L, et al. Influence of type of anesthesia on hemodynamic parameters and outcome of dialysis arteriovenous fistula operations. *Georgian Medical News* 2015;-(249):20-27
25. Thomsen M, Bengtsson M, Lassvik C, et al. Adjuvant intravenous sympathetic block with guanethidine in construction of arteriovenous fistulas for blood access. *Acta Chirurgica Scandinavica* 1983;149(2):141-145
26. Veroux P, Giaquinta A, Tallarita T, et al. Primary balloon angioplasty of small (<2 mm) cephalic veins improves primary patency of arteriovenous fistulae and

- decreases reintervention rates. *Journal of Vascular Surgery* 2013;57(1):131-136
27. Walker S. U Clips for arteriovenous anastomosis: a pilot, randomized study. *ANZ Journal of Surgery* 2012:630-632
 28. Wedgwood KR, Wiggins PA, Guillou PJ. A prospective study of end-to-side vs. side-to-side arteriovenous fistulas for haemodialysis. *British Journal of Surgery* 1984;71(8):640-642
 29. Yildirim V, Doganci S, Yanarates O, et al. Does preemptive stellate ganglion blockage increase the patency of radiocephalic arteriovenous fistula? *Scandinavian Cardiovascular Journal* 2006;40(6):380-384
 30. Zeebregts CJ, van den Dungen JJ, van Det RJ, et al. Randomized clinical trial of continuous sutures or non-penetrating clips for radiocephalic arteriovenous fistula. *British Journal of Surgery* 2004;91(11):1438-1442
 31. Tordoir JHM, Zonnebeld N, van Loon MM, et al. Surgical and endovascular intervention for dialysis access maturation failure during and after arteriovenous fistula surgery: review of the evidence. *European Journal of Vascular and Endovascular Surgery* 2018;55(2):240-248
 32. Kong S, Lee KS, Kim J, et al. The effect of two different hand exercises on grip strength, forearm circumference, and vascular maturation in patients who underwent arteriovenous fistula surgery. *Annals of Rehabilitation Medicine* 2014;38(5):648-657
 33. Salimi F, Majd NG, Moradi M, et al. Assessment of effects of upper extremity exercise with arm tourniquet on maturity of arteriovenous fistula in hemodialysis patients. *Journal of Vascular Access* 2013;14(3):239-244
 34. Fontseré N, Mestres G, Yugueros X, et al. Effect of a postoperative exercise program on arteriovenous fistula maturation: a randomized controlled trial. *Hemodialysis International* 2016;20(2):306-314
 35. National Institute for Health and Care Excellence. Surgical site infections: prevention and treatment (NICE Guideline CG74). (02/2017; date last accessed).
 36. Allon M, Imrey PB, Cheung AK, et al. Relationships Between Clinical Processes and Arteriovenous Fistula Cannulation and Maturation: A Multicenter Prospective Cohort Study. *American Journal of Kidney Diseases* 2018;71(5):677-689
 37. Culp K, Flanigan M, Taylor L, et al. Vascular access thrombosis in new hemodialysis patients. *American Journal of Kidney Diseases* 1995;26(2):341-346
 38. Medkouri G, Aghai R, Anabi A, et al. Analysis of vascular access in hemodialysis patients: a report from a dialysis unit in Casablanca. *Saudi journal of kidney diseases and transplantation: an official publication of the Saudi Center for Organ Transplantation, Saudi Arabia* 2006;17(4):516-520
 39. Ravani P, Brunori G, Mandolfo S, et al. Cardiovascular Comorbidity and Late Referral Impact Arteriovenous Fistula Survival: A Prospective Multicenter Study. *Journal of the American Society of Nephrology* 2004;15(1):204-209
 40. Rayner HC, Pisoni RL, Gillespie BW, et al. Creation, cannulation and survival of arteriovenous fistulae: Data from the dialysis outcomes and practice patterns study. *Kidney International* 2003;63(1):323-330
 41. Saran R, Dykstra DM, Pisoni RL, et al. Timing of first cannulation and vascular access failure in haemodialysis: an analysis of practice patterns at dialysis facilities in the DOPPS. *Nephrology Dialysis Transplantation* 2004;2334-2340
 42. Wilmink T, Hollingworth L, Stevenson T, et al. Is early cannulation of an arteriovenous fistula associated with early failure of the fistula? *Journal of Vascular Access* 2017;18(Suppl. 1):92-97
 43. Wilmink T, Powers S, Hollingworth L, et al. Effect of first cannulation time and dialysis machine blood flows on survival of arteriovenous fistulas. *Nephrology Dialysis Transplantation* 2018;33(5):841-846
 44. Sottirai VS, Stephens A, Champagne L, et al. Comparative results of early and delayed cannulation of arteriovenous graft in haemodialysis. *European Journal of Vascular and Endovascular Surgery* 1997;13(2):139-141
 45. Dawidson JJ, Ar, Rajab A, et al. Early use of the Gore-Tex Stretch Graft. *Blood Purification* 1996:337-344
 46. Feldman L, Shani M, Mursi J, et al. Effect of timing of the first cannulation on survival of arteriovenous hemodialysis grafts. *Therapeutic Apheresis & Dialysis: Official Peer-Reviewed Journal of the International Society for Apheresis, the Japanese Society for Apheresis, the Japanese Society for Dialysis Therapy* 2013:60-64
 47. Glickman MH, Burgess J, Cull D, et al. Prospective multicenter study with a 1-year analysis of a new vascular graft used for early cannulation in patients undergoing hemodialysis. *Journal of vascular surgery* 2015;62(2):434-441
 48. Hakaim AG, Scott TE. Durability of early prosthetic dialysis graft cannulation: results of a prospective, nonrandomized clinical trial. *Journal of Vascular Surgery* 1997:1002-1005; discussion 1005-1006
 49. Ravani P, Quinn RR, Oliver MJ, et al. (2016) Pre-emptive correction for haemodialysis arteriovenous access stenosis. *Cochrane Database of Systematic Reviews*, 10.1002/14651858.CD010709.pub2.
 50. Aragoncillo I, Abad S, Caldes S, et al. (2017) Adding access blood flow surveillance reduces thrombosis and improves arteriovenous fistula patency: a randomized controlled trial. *Journal of vascular access*, 10.5301/jva.5000700.
 51. Grudzinski A, Mendelssohn D, Pierratos A, et al. A systematic review of buttonhole cannulation practices and outcomes. *Seminars in Dialysis* 2013;26(4):465-475
 52. Muir CA, Kotwal SS, Hawley CM, et al. Buttonhole cannulation and clinical

- outcomes in a home hemodialysis cohort and systematic review. *Clinical journal of the American Society of Nephrology* 2014;9(1):110-119
53. Wong B, Muneer M, Wiebe N, et al. Buttonhole versus rope-ladder cannulation of arteriovenous fistulas for hemodialysis: a systematic review. *American Journal of Kidney Diseases* 2014;64(6):918-936
 54. Chow J, Rayment G, San Miguel S, et al. A randomised controlled trial of buttonhole cannulation for the prevention of fistula access complications. *Journal of Renal Care* 2011;37(2):85-93
 55. MacRae J, Ahmed S, Atkar R, et al. A randomized trial comparing buttonhole with rope ladder needling in conventional hemodialysis patients. *Clinical Journal of the American Society of Nephrology* 2012;7(10):1632-1638
 56. MacRae J, Ahmed S, Hemmelgarn B. Arteriovenous fistula survival and needling technique: long-term results from a randomized buttonhole trial. *American Journal of Kidney Diseases* 2014;63(4):636-642
 57. Struthers J, Allan A, Peel R, et al. Buttonhole needling of arteriovenous fistulae: a randomized controlled trial. *ASAIO journal* 2010;56(4):319-322
 58. Toma S, Shinzato T, Fukui H, et al. A timesaving method to create a fixed puncture route for the buttonhole technique. *Nephrology Dialysis Transplantation* 2003;18(10):2118-2121
 59. Vaux E, King J, Lloyd S, et al. Effect of buttonhole cannulation with a polycarbonate PEG on in-center hemodialysis fistula outcomes: a randomized controlled trial. *American Journal of Kidney Diseases* 2013;62(1):81-88
 60. Parisotto MT, Schoder VU, Miriunis C, et al. Cannulation technique influences arteriovenous fistula and graft survival. *Kidney international* 2014;86(4):790-797
 61. Marticorena RM, Dacouris N, Donnelly SM. Randomized pilot study to compare metal needles versus plastic cannulae in the development of complications in hemodialysis access. *Journal of Vascular Access* 2018;19(3):272-282
 62. Moore J, Jarvis E. Comparison of large-gauge hollow-bore haemodialysis access needles: a randomised controlled trial. *Nephrology* 2015;20(53):60-89
 63. Morselli C, Chiari P, Aliberti T, et al. Sharp versus blunt dialysis needle use with buttonhole method: Open randomised trial. *Journal of Renal Care* 2015;41(4):213-221
 64. Diskin CJ. The importance of timing of surgery for hemodialysis vascular access thrombectomy. *Nephron* 1997;75(2):233-237
 65. El-Damanawi R, Kershaw S, Campbell G, et al. Successful restoration of arteriovenous dialysis access patency after late intervention. *Clinical Kidney Journal* 2015;8(1):82-86
 66. Graor RA, Risius B, Denny KM, et al. Local thrombolysis in the treatment of thrombosed arteries, bypass grafts, and arteriovenous fistulas. *Journal of Vascular Surgery* 1985;2(3):406-414
 67. Sadaghianloo N, Jean-Baptiste E, Gaid H, et al. Early surgical thrombectomy improves salvage of thrombosed vascular accesses. *Journal of Vascular Surgery* 2014;59(5):1377-1384.e1371-1372
 68. Beathard GA. Percutaneous transvenous angioplasty in the treatment of vascular access stenosis. *Kidney International* 1992;42(6):1390-1397
 69. Cohen MA, Kumpe DA, Durham JD, et al. Improved treatment of thrombosed hemodialysis access sites with thrombolysis and angioplasty. *Kidney International* 1994;46(5):1375-1380
 70. Kanterman RY, Vesely TM, Pilgram TK, et al. Dialysis access grafts: anatomic location of venous stenosis and results of angioplasty. *Radiology* 1995;195(1):135-139
 71. Trerotola SO, Vesely TM, Lund GB, et al. Treatment of thrombosed hemodialysis access grafts: Arrow-Trerotola percutaneous thrombolytic device versus pulse-spray thrombolysis. Arrow-Trerotola Percutaneous Thrombolytic Device Clinical Trial. *Radiology* 1998;206(2):403-414
 72. Maleux G, De Coster B, Laenen A, et al. Percutaneous rheolytic thrombectomy of thrombosed autogenous dialysis fistulas: technical results, clinical outcome, and factors influencing patency. *Journal of Endovascular Therapy* 2015;22(1):80-86
 73. Marcelin C, D'Souza S, Le Bras Y, et al. Mechanical Thrombectomy in Acute Thrombosis of Dialysis Arteriovenous Fistulae and Grafts Using a Vacuum-Assisted Thrombectomy Catheter: A Multicenter Study. *Journal of Vascular and Interventional Radiology* 2018;29(7):993-997
 74. Barth KH, Gosnell MR, Palestrant AM, et al. Hydrodynamic thrombectomy system versus pulse-spray thrombolysis for thrombosed hemodialysis grafts: a multicenter prospective randomized comparison. *Radiology* 2000;217(3):678-684
 75. Uflacker R, Rajagopalan P, Selby J, et al. Thrombosed dialysis access grafts: randomized comparison of the Amplatz thrombectomy device and surgical thromboembolism. *European Radiology* 2004;14(11):2009-2014
 76. Vogel PM, Bansal V, Marshall MW. Thrombosed hemodialysis grafts: lyse and wait with tissue plasminogen activator or urokinase compared to mechanical thrombolysis with the Arrow-Trerotola percutaneous thrombolytic device. *Journal of Vascular and Interventional Radiology* 2001;12(10):1157-1165
 77. Lambert G, Freedman J, Jaffe S, et al. Comparison of surgical and radiological interventions for thrombosed arteriovenous access. *The journal of vascular access* 2018:1129729818762007

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WHAT ARE ITS AIMS? Our aim is to improve the lives of people with kidney disease in a sustainable way by communicating knowledge in a format that stimulates its use in clinical practice throughout Europe.

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