CLINICAL PRACTICE GUIDELINE

VASCULAR ACCESS FOR HAEMODIALYSIS

UK Renal Association

6th Edition

Final Version

(based on literature search up to 31.03.15)

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Contents

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Declaration of conflict interest

Dr Mick Kumwenda – sponsorship from industry to take part in multicentre studies: AstraZeneca, Merck Schering Plough, educational meetings: Amgen, Roche, Abbott, Ortho-Biotech and Synermed.
Dr Sandip Mitra – sponsorship from industry to participate in multicentre studies and attendance to educational meetings (Baxter, Fresenius, Amgen and Leo Pharma)
Dr Claire Reid – none

Introduction

The ideal vascular access should provide safe and effective therapy by enabling the removal and return of blood via an extracorporeal circuit. Vascular access should be easy to use, reliable and have minimal risk to the individual receiving haemodialysis. However, the provision of good quality access, whilst it is a fundamental aspect of the treatment of haemodialysis patients, remains difficult to achieve. Native access, in particular arteriovenous fistulae, requires prior planning and has a high primary failure rate. Arteriovenous grafts utilizing replacement of synthetic or biological material in conjunction with native vessels again require planning and surgical expertise. Venous catheters (both tunnelled and non-tunnelled) are in common usage and in a smaller number of patients remain the only form of access that is available, yet offer inferior therapy. This guideline updates the section on vascular access in the haemodialysis module of the 5th edition of the Renal Association guidelines published on-line at www.renal.org in 2011 and it is recommended that cross reference is made to the 6th edition of Clinical Guidelines Planning, Initiating and Withdrawal of Renal Replacement Therapy UK Renal Association published recently. The guideline recommendations are based on literature review from relevant publications in journals cited on MEDLINE, Pub Med and Up-To-Date up to March 2015.
The modified GRADE system has been adopted by the Renal Association. Clinical Practice Guidelines Committee and has been used to grade the recommendations in all of the modules in the 5th edition of the Renal Association guidelines. It explicitly describes both the strength of the recommendations and the quality of the underlying evidence, with the aim of maximising applicability to standard clinical practice (1-4). The modified GRADE system grades level of expert recommendation as "strong" (Grade 1) or "weak" (Grade 2) according to balance of benefits, risk, burden and cost. The quality or level of evidence is assessed as "high" (Grade A), "moderate" (Grade B), "low" (Grade C) or "very low" (D) depending on factors such as study design, directness of evidence and consistency of results.

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Summary of clinical practice guideline for vascular access for haemodialysis

1. **Preferred type of vascular access (Guideline 1.1)**

Guideline 1.1 – Incident and prevalent patients

We recommend that all patients with end stage kidney disease who commence haemodialysis or are on long-term haemodialysis should dialyse with an arteriovenous fistula as first choice, an arteriovenous graft as second choice, a tunnelled venous catheter as third choice and a non-tunnelled temporary catheter as an option of necessity (1A).

2. Preservation of sites for native vascular access (Guidelines 2.1-2.2)

Guideline 2.1 – Preservation of peripheral veins for vascular access

We suggest that all patients that may require haemodialysis should have education on forearm vein preservation (2C).

Guideline 2.2- Avoiding vessel injury

We suggest that healthcare workers should avoid unnecessary venepunctures of peripheral venous access in the upper limb intended for creation of vascular access (2B).

3. Pre-operative assessment (Guidelines 3.1-3.2)

Guideline 3.1 Vessel assessment

We recommend that clinical assessment and, when appropriate, imaging of both arteries and veins of upper arms should be performed to assess vessel suitability for access creation (1B).

Guideline 3.2- Central vein stenosis

We recommend that imaging to exclude central vein stenosis should be done in all patients with previous central venous cannulation (1B).

4. Timing of creation of vascular access (Guideline 4.1)

Guideline 4.1 Creation of vascular access

We recommend that the exact timing of placement of vascular access will be determined by rate of decline of renal function, co-morbidities and by the surgical pathway (1B).

5. Selection of access type (Guidelines 5.1 – 5.3)

Guideline 5.1 Order of preference for AVF

We recommend that the AVF should be placed as distally as possible in the non-dominant arm. Radiocephalic and brachiocephalic AVF are preferred to brachiobasilic transposition AVF (2C).

Guideline 5.2 Placement of AVG

We recommend that each centre should agree a policy on indications for placement and selection of type of AVG (1A).

Guideline 5.3 Placement of catheters

We recommend that catheters should only be placed as the last resort or in emergency situations when more permanent access is not available for dialysis (1A).

6. Maintenance of vascular access (Guidelines 6.1-6.5)

Guideline 6.1 – Needling technique

We recommend that the rope-ladder and buttonhole techniques should be used for cannulation of AVF and rope-ladder for AVG (2B).

Guideline 6.2 Access patency

We recommend that pharmacological and mechanical strategies are in place to maintain or restore access patency (1C).

Guideline 6.3 – Vascular access monitoring

We recommend that all patients on long term haemodialysis should have their vascular access monitored and maintained to minimise failure, to allow timely planning for subsequent replacement with definitive vascular (or peritoneal) access and to avoid the need for emergency access (1B).

Guideline 6.4 – Vascular access stenosis and thrombosis

We recommend that each centre should have facilities for surgical and radiological intervention for prompt and timely treatment of AVF/Graft stenosis; a local standard policy should be developed (1B).

Guideline 6.5 – Vascular access surveillance

We suggest that systematic observation and advanced surveillance should be employed to predict and prevent access failure (1C).

7. Prevention of catheter related infections (Guidelines 7.1-7.4)

Guideline 7.1 – Minimise the use of venous catheters
We recommend that central venous catheters should be employed as a method of last resort for longer term vascular access to reduce the overall risk of infectious complications and the burden of central venous stenosis in haemodialysis patients (1B).
Guideline 7.2 – Minimising the risk of catheter related infection
We recommend that aseptic technique should be mandatory at every manipulation of central venous dialysis catheters (2C).
Guideline 7.3 – Minimising the risk of catheter related infection
We recommend that the catheter exit site should be cleaned with Chlorhexidine 2% (1A).
Guideline 7.4 – Minimising the risk of catheter related infection
We recommend that an antimicrobial or antibiotic lock solution be used to reduce catheter related bacteraemia and other infections (1A).

8. Complications of vascular access (Guidelines 8.1-8.3)

Guideline 8.1 – Treatment of access infection and related bacteraemia.
We recommend that central venous catheters should be removed in all seriously ill haemodialysis patients with catheter related bacteraemia and an alternative access placed if possible (1A).
Guideline 8.2 – Prevention of arteriovenous aneurysmal formation
We suggest that good needling technique is the cornerstone for preserving arteriovenous fistulae and preventing aneurysmal formation (2B).
Guideline 8.3 – Treatment of ischemia related to arteriovenous fistulae or grafts
We suggest that the development of peripheral ischaemia related to arteriovenous fistulae or grafts should trigger an early review by the vascular access surgeon to allow proactive intervention and prevent the onset of gangrene or need for amputation (2B).

Summary of audit measures recommended for dialysis access for adults with end stage kidney disease

1.60% of all incident patients with established end stage kidney disease commencing planned haemodialysis should receive dialysis via a functioning arteriovenous fistula (AVF) or arteriovenous graft (AVG).

2.80% of all prevalent long term dialysis patients should receive dialysis treatment via definitive access: AVF or AVG or Tenckhoff catheter.

3. The annual Staphylococcus aureus bacteraemia rate in the prevalent haemodialysis population should be less than 2.5 episodes per 100 HD patients and less than 1.0 for MRSA over 2 years.

Full Clinical Practice Guideline

Rationale for clinical practice guideline for vascular access for haemodialysis

1. Preferred type of vascular access (Guideline 1.1)

Guideline 1.1 – Incident and prevalent patients
We recommend that all patients with end stage kidney disease who commence haemodialysis or are on long-term haemodialysis should dialyse with an arteriovenous fistula as first choice, an arteriovenous graft as second choice, a tunnelled venous catheter as third choice and a non-tunnelled temporary catheter as an option of necessity (1A).

Rationale for Guideline 1.1

There are three principle forms of vascular access available for the treatment of patients for end stage kidney disease with haemodialysis. In order of preference, these are arteriovenous fistulae, arteriovenous grafts using prosthetic or biological material and finally either tunnelled or non tunnelled catheters placed in a central vein. Many studies have shown the superiority of AVFs compared to the other forms of haemodialysis. AVF have better patency rates, access survival, lower number of interventions during the entire life span of access type, lower rates of access related sepsis and the overall morbidity and mortality is much lower compared to AVG and central venous haemodialysis catheters (1). Furthermore, both hospitalisation frequency and costs are the lowest with AVF access (2).

It is imperative that the goal for the provision of access should be patient focused and requires a coordinated and multidisciplinary approach in assessing and educating patients in advance of the need for renal replacement therapy in order to provide optimal dialysis access (3).

There is wide variation in the provision of permanent dialysis access in the UK and across the globe despite several published vascular access guidelines. The UK Renal Registry Vascular access Audit (2012) demonstrated high prevalence of AVF (70.4%) where there had been a surgical assessment for AVF at least 3 months prior to starting dialysis. However, those who started HD with catheters had poor AVF/AVG conversion rates at 3 months (40-66%), with 33-60% still dependent on catheters. This part of the access pathway is process dependent and potentially modifiable in a group of patients who are regularly attending the renal units. Patients and staff education and awareness programmes are necessary to complement access care pathways for optimal outcomes. Variations in local processes (such as referral time delay for permanent access, surgical assessment for AVF prior to commencement of HD) and service delivery characteristics (such as presence of dedicated lists for vascular access surgery and tunnelled line placements, venous mapping and Tenckhoff catheter placements, fistula salvage and patency restoration pathways) play a major role in defining the prevalence of dialysis access types (4). The combination of AVF and AVG for haemodialysis and Tenckhoff catheters for peritoneal dialysis constitute ideal access types for all prevalent long term dialysis patients and should be implemented at the earliest where possible. In the 17th annual report of the Renal Registry (2014) it was noted that twenty four centres were 2 or 3 standard deviations below the 65% Renal Association target for incident patients starting haemodialysis as recommended in the 2011 vascular access guidelines and thirty one out of thirty nine centres were below the 85% target for prevalent patients dialysing via AVF and AVG. In the 2013 DOPPS report (5) of vascular access use in eleven countries the total use of AVF and AVG was > 80% in 7 countries including the UK at 81.6%. Patient preference for a catheter varied from 1% of HD patients in Japan and 18% in the United States. The tendency

for some patients to prefer catheters, together with reluctance to undergo access surgery may underlie some of the poor 3 month conversion rates seen in the UK. This may be mitigated by addressing pre-emptive rates of access construction and improved patient education. In this Clinical Practice Guideline we have made recommendations for definitive dialysis access targets for both incident and prevalent patients as a minimum standard to reflect what is achievable in the UK as shown from the Renal Registry audit reports (6).

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2.Preservation of sites for native vascular access (Guidelines 2.1-2.2)

Guideline 2.1 – Preservation of peripheral veins for vascular access

We recommend that all patients that may require haemodialysis should have education on forearm vein preservation (2C).

Guideline 2.2- Avoiding vessel injury

We recommend that healthcare workers should avoid unnecessary venepuncture of peripheral venous access in the upper limb intended for creation of vascular access (2B).

Rationale for guidelines 2.1-2.2

In general the preferred rule for the formation of arteriovenous access is to start distally and move proximally in the non-dominant arm.Venous preservation should form part of the strategy for future vascular access in patients with progressive chronic kidney disease. This has several advantages, firstly any neurovascular complications of surgery are confined to the non-dominant arm. Secondly, it allows for easy use of the dominant arm during dialysis. Starting distally also allows easier conversion to a more proximal fistula should the first attempt fail. There is some evidence for superior long-term patency in distal fistulae although maturation rates can be disappointing at the wrist. Repeated veno-puncture above the wrist of the non-dominant arm should be avoided in order to preserve the forearm cephalic, antecubital and upper arm veins (1, 2). Both patients and health care workers should receive education on venous preservation in patients with advanced chronic kidney disease who are likely to require dialysis in the near future (3,4). Venepuncture of cephalic veins of non-dominant arm should be prohibited, wearing of Medic alert bracelets may be helpful in preserving veins for future access creation (5).

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3. Pre-operative assessment (Guidelines 3.1-3.2)

Guideline 3.1 Vessel assessment

We recommend that clinical examination and, when appropriate, imaging of both arteries and veins of upper arms should be performed to assess vessel suitability for access creation (1B).

Guideline 3.2- Central vein stenosis

We recommend that imaging to exclude central vein stenosis should be done in all patients with previous central venous cannulation (1B).

Rationale for guidelines 3.1-3.2

AVF placement should be arranged at least 6 months and AVG at least 6 weeks before the need for dialysis. The challenge for nephrologists is predicting accurately when dialysis will be required. For the surgeons the challenge is to construct access that will be adequate for cannulation during dialysis and have sufficient longevity.

Careful history and examination of both arms by the nephrologist should be completed well in advance of referral to the surgeon to elicit any factors that are associated with AVF failure. These clinical factors include previous central venous cannulation, repeated veno-puncture of peripheral vessels, hypotension, heart failure, an abnormal Allen's test and non-visible veins despite tourniquet application and inadequate vessel (1). Use of magnetic resonance or conventional contrast venography is wise in cases where the central veins have been cannulated to avoid constructing access ipsilateral to a central vein occlusion (2). While this is possible it does lead to significant limb swelling and it is not always possible to re-open central veins where indicated using endovascular techniques.

The use of duplex ultrasound scanning is now common practice for arterial evaluation. The presence of heavy calcification may affect access maturation, and most studies have recommended a minimum arterial diameter of at least 1.6mm.Venous evaluation should include a luminal diameter of at least 2.0mm and a length of continuity with the proximal vein without obstruction (3). Vein diameter has been identified as a major determinant of outcome but despite routine preoperative vein mapping the rate of AVF maturation remains abysmally low. In a systematic review Wong CS et al identified 3 trials with a total of 402 patients. The meta-analysis showed a trend (not statistically significant) in the improvement in AVF maturation with vessel mapping (4). Imaging may not be required in patients with adequate vessels on clinical examination for access creation.

More recently some studies have shown the value of measuring arterial elasticity. Paulson WD using a CR-2000 device measured arterial elasticity preoperatively and showed that those patients who had low elasticity indexes were associated with AVF failure (5). This technique remains confined to research setting at present.

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4.Timing of creation of vascular access (Guideline 4.1)

Guideline 4.1 Creation of vascular access

We recommend that the exact timing of placement of vascular access will be determined by rate of decline of renal function, co-morbidities and by the surgical pathway (1B).

Rationale for Guideline 4.1

This section is also covered in the 6th edition of Clinical Guidelines Planning, Initiating and Withdrawal of Renal Replacement Therapy UK Renal Association (1).Vascular access planning should commence at some point after an individual reaches CKD stage 4. A systematic review did not identify any randomised controlled trial which addressed whether early referral to prepare for dialysis had any advantage over late referral (2). However, in the 27 longitudinal cohort studies being referred earlier to a nephrologist resulted in a reduction in mortality and hospitalization, a higher uptake of peritoneal dialysis, a decreased likelihood of requiring temporary vascular access at the start of dialysis and increased likelihood of having an AVF. .

Compared to AVF, prosthetic AVG do not require a maturation period. However, depending on the type of graft it may be necessary to allow two to three weeks after implantation prior to needling. This is to ensure that the graft becomes incorporated in the tissues to avoid perigraft haematoma on decannulation. Prosthetic grafts also have significant shorter patency rates. Consequently, in individuals in whom an arteriovenous graft is deemed to be the appropriate access, placement should be delayed until a time closer to the expected date of dialysis. With the advent of newer “self-sealing “grafts cannulation is possible within a few hours of graft placement (3). Recent technological advances using tissue-engineered AVGs have shown promise to provide an attractive, viable option for vascular access (4).

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5. Selection of access types (Guidelines 5.1-5.3)

Guideline 5.1 Order of preference for AVF
We recommend that the AVF should be placed as distally as possible in the non-dominant arm. Radiocephalic and brachiocephalic AVF are preferred to brachiobasilic transposition AVF (2C).

Guideline 5.2 Placement of AVG
We recommend that each centre should agree a policy on indications for placement and selection of type of AVG (1A).

Guideline 5.3 Placement of catheters
We recommend that catheters should only be placed as the last resort or in emergency situations when more permanent access is not available for dialysis (1A).

Rationale for guidelines 5.1-5.3

There are no randomised studies to compare sites for AFV formation but good clinical practice should prevail and the distal proximal approach increases the number of sites for future attempts to place vascular access. The principle key is a multidisciplinary approach to plan timely placement and meticulous monitoring to identify any complications that may compromise the long-term survival of usable vascular access (1).There are several arterio-venous anastomotic options in the arm but the commonest are as follows:

1.Snuff box AVF- the cephalic vein is anastomosed to the radial artery at the snuffbox.

2. Brescia Cimino AVF – the cephalic vein is anastomosed to the radial artery anastomosis at the wrist.

3.Brachiocephalic AVF – the upper arm cephalic vein is anastomosed to the brachial artery in the antecubital fossa.

4.Brachiobasilic transposition AVF– the basilic vein or median cubital vein is anastomosed to the brachial artery at the antecubital fossa. In the same procedure (single stage) or at a subsequent procedure (two stage), the basilic vein is mobilised throughout its length to a subcutaneous position away from the medial cutaneous nerve of the forearm and the brachial artery to allow safe needling.

In most AVF the anastomosis is constructed in an end of vein to side of artery configuration to avoid distal venous hypertension. The number of possible configurations ultimately depends on the expertise of the surgeon. There are many other options such as ulnarbasilic transposition, saphenous vein and femoral vein transposition although these are much less frequently performed.

Overall the primary failure rates of AVF are high ranging between 15 and 60% in most series (2). For immediate dialysis in the absence of a functioning AVF most centres choose central venous catheters. Non tunnelled catheters should be avoided due to a higher risk of sepsis and current recommendations advise the use of non- tunnelled catheters to be restricted to no more than 1 week placed in the internal jugular or in the femoral vein (3, 4). Tunnelled catheters on the other hand have been accepted as bridge access whilst arranging for more permanent access.

Placement of both tunnelled and non-tunnelled catheters should be performed under ultrasonographic guidance to reduce the risk of procedure related complications (5).The right internal jugular vein has a direct route to the right atrium compared to the left side and is recommended for catheter placement, furthermore this approach is associated with lower risk of complications such as venous stenosis; catheter related infections; catheter thrombosis and perioperative complications. Catheter placement in the subclavian, external jugular and femoral veins should be avoided due to a higher risk of venous stenosis compared to the internal jugular veins (6-7).

The use of AVG has increased in Europe and US but remains low in the UK. In the UK Renal Registry 17th Report only 1.2% of haemodialysis patients started dialysis with an AVG (8).

The commonest graft configurations are:

1.Forearm loop AVG – anastomosis from brachial artery to graft and from graft to an antecubital fossa vein, with the graft adopting a looped configuration in the forearm.

2.Brachioaxillary AVG – anastomosis from brachial artery to graft and from graft to a vein in the axilla, with the graft adopting a straight configuration at in the upper arm.

3.Femoro-femoral AVG – anastomosis from the femoral artery (superficial femoral artery preferred) to graft and from graft to femoral vein with the graft adopting a looped or straight configuration in the thigh.

There is an infinite variety of possible configurations using grafts as all that is needed is a patent artery and a vein that runs unobstructed to the heart. It is possible to use a graft or the newer hybrid stent grafts to reconfigure existing access to bypass stenosed segments of native AVF. Current observational studies favour the use of synthetic grafts (9). Several configurations of PTFE grafts are on the market from different companies which differ in configuration by the alteration of graft characteristics including: wall thickness, ringed reinforcements, outer wraps and coating of the internal luminal surface. However no

randomised controlled trials have been conducted to compare grafts. Newer self-sealing grafts to allow early cannulation have been developed (10).With frequent surveillance and intervention, patency rates of these grafts can be comparable to AVF (11).

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6.Maintenance of vascular access (Guidelines 6.1-6.5)

Guideline 6.1 – Needling techniques

We recommend that the rope-ladder and buttonhole techniques should be used for cannulation of AVF and rope-ladder for AVG (2B).

Guideline 6.2 Access patency

We recommend that pharmacological and mechanical strategies are in place to maintain or restore access patency (1C).

Guideline 6.3 – Vascular access monitoring

We suggest that all patients on long term haemodialysis should have their vascular access monitored and maintained to minimise failure, to allow timely planning for subsequent replacement with definitive vascular (or peritoneal) access and to avoid the need for emergency access (1B).

Guideline 6.4 – Vascular access stenosis and thrombosis

We recommend that each centre should have facilities for surgical and radiological intervention for prompt and timely treatment of AVF/Graft stenosis; a local standard policy should be developed (1B).

Guideline 6.5 – Vascular access surveillance

We suggest that systematic observation and advanced surveillance should be employed to predict and prevent access failure (1C).

Rationale for Guidelines 6.1-6.5

6.1 Needling techniques

Three standard techniques for access cannulation have been adopted in dialysis units across the globe:

1.Area puncture refers to cannulation of AVF on the same side.

2.Rope ladder – needle puncture sites are chosen on at a defined distance from each other along the access.

3.Buttonhole refers to a same site where the needles are placed at each dialysis session at the same angle and depth through a previously created track with sharp needles after which blunt needles are routinely used.

In a cross sectional survey of cannulation techniques in 171 centres from 2009 to 2012, 65.8% used the area puncture technique, 28.2% centres used the rope ladder technique and 6% used the buttonhole technique (1). When techniques were compared with access survival area puncture was associated with a significantly higher rate of access failure than the rope or buttonhole techniques. In a recent systematic review Wong et al analysed 23 studies that compared rope ladder to buttonhole cannulation techniques for AVF and although in the observational studies pain was reported by patients less frequently in the buttonhole group, there was no statistical difference in cannulation pain in the randomised controlled group (2). The risk of access infection was higher with the buttonhole technique which can be reduced with attention to hygiene. This suggests that area puncture should be avoided. Either rope ladder or buttonhole cannulation can be adopted depending on expertise of the cannulators. Protocols for the use of different cannulation techniques, training and troubleshooting strategies must be developed for each centre.

The timing of first cannulation after access creation varies between different countries but less than one month is not recommended. In a prospective Italian study, the median time to cannulation was one month and access failure was associated with earlier cannulation (3).

6.2 Access patency

Several strategies to maintain access patency have been studied:

1.Antiplatelet agents to prevent access thrombosis – the commonest cause of failure of established access is thrombosis and stenosis. Estimates based on trials have shown that the risk of AVF failure is about 15-30% per year and twice as common in AVG, from the Cochrane meta-analysis data suggested beneficial short term effects of anti-platelet drugs such ticlodipine, aspirin and clopidogrel over short periods of follow up (4). The effects of clopidogrel and aspirin on thrombosis of AVG were studied in 200 participants in the US. AVG thrombosis rates were no different in the group receiving clopidogrel and aspirin compared participants in the placebo arm. The study was terminated early due to increased episodes of bleeding associated with clopidogrel and aspirin (5). Dixon BS et al reported results of a large randomised controlled study of dipyridamole plus aspirin which significantly prolonged the duration of primary unassisted graft patency, however, there was no difference in cumulative graft failure between the intervention group and control groups (6). The effect of clopidogrel on early failure of AVF was studied in nearly 900 participants in the US (7). Fistula thrombosis rate reduced in 12.2% of participants compared to 19.5% of participants in the placebo arm but crucially the secondary end point of suitability for dialysis did not differ between the two groups.

2.Systemic anticoagulation

Crowther et al in 2002 published on the use of low dose warfarin with a target INR of 1.4 to 1.9 (8). The primary end point was graft thrombosis but the trial was terminated due to an increase in the number of major bleeding events in the treatment group. The conclusion was that warfarin was harmful in this setting.

3.Fish oil (Omega3 fatty acids)

Omega 3 fatty acids inhibit platelet aggregation, and have anti-inflammatory effects and anti-proliferative actions. Even in high doses Omega 3 fatty acids are well tolerated, gastro-intestinal adverse events are frequently reported. In a randomized multi-centre placebo controlled trial, patients who received fish oil (4 g/day) with new AVG developed less graft thrombosis than those that had placebo (primary patency rate at one year was 75.6% vs 14.9% in the placebo arm). in addition there were less radiological or surgical interventions to maintain patency in the active arm (9).

4.Far Infrared (FIR) therapy to improve patency

FIR therapy has been shown to improve endothelial function in coronary arteries and cardiac function in patients with heart failure (10). In a study of 145 HD patients (11), a WS TY101

FIR emitter was used to measure the effect on AVF maturation and long-term patency. Patients who received FIR therapy for 1 year had a lower incidents (12.5 versus 30.1%; P < 0.01) and relative incidents (one episode per 67.7 versus one episode per 26.7 patietnt-months;p<0.03) of AVF malfunction and a better unassisted patency of AVF (85.9 versus 67.6%; P < 0.01). Bashar et all (12) identified four randomised controlled studies which showed that over a follow up period of 12 months unassisted primary patency was better with FIR (pooled risk ratio 1.23[1.12-1.35,p=0.00001).Similarly, two studies reported benefit with secondary patency with FIR (pooled risk ratio 1.11[1.04-1.19],p=0.001). The main limitation with the current evidence regarding FIR therapy is that all 4 of the included studies had been conducted at a single centre. Additionally the trials were not blinded.

Overall antiplatelet agents should be considered for a 4-6 month period after access creation to reduce AVF primary failure rates, provided there are no contraindications. Antiplatelet agents confer no benefit for prevention of failure in AVG. Fish oil may be of benefit in the in the prevention of AVG thrombosis, however this has only been shown in one small study. Warfarin anticoagulation for the prevention of access failure should be avoided and non-pharmacological means such as FIR are a promising non-invasive adjuvant therapy to improve patency in AVF but further research is required before their use can be recommended.

Other drugs shown to improve patency of vascular access in observational studies include statins, calcium channel blockers and angiotensin converting enzyme inhibitors but until larger studies are conducted the use of these drugs to improve patency of vascular access cannot be recommended at present.

6.3.Vascular access monitoring

Vascular access monitoring is defined as the physical examination of vascular access to determine whether or not there are clinical signs to suggest the presence of access dysfunction. Once abnormalities of access are detected further access evaluation is mandatory to allow early diagnosis and prompt treatment to prevent access loss or failure.

The blood flow through AVF increases to maximum within 3-6 weeks, a functioning AVF should be visible, palpable with a thrill near the AVF anastomosis. Successful AVF maturation and usability can be defined as a measured AVF diameter of >5mm with a fistula blood flow of >500ml/min and AVF deemed “mature” or “usable” by experienced dialysis or vascular access nurse. The combination of these parameters has a 95% chance for successful use of AVF for dialysis (13). AVF stenosis is suspected if there is a palpable pulse at the arterial end with a faint thrill or there is failure of AVF to collapse with arm elevation or a discontinuous thrill and change of the character of bruit. Swelling and prominent venous collaterals may indicate AVF stenosis. Physical examination performed by skilled staff may reach a positive predictive value of stenosis as high as 70-90% for AVG and 90% specificity

and 38% sensitivity in AVF, in a study of 177 patients referred with dysfunctional AVF, there was a moderate correlation of physical examination and angiographic examination for AVF inflow stenosis ($\kappa = 0.49$), outflow stenosis ($\kappa = 0.58$) and thrombosis ($\kappa = 0.52$) (14). Physical examination of vascular access to determine whether or not there are clinical signs to suggest the presence of access dysfunction is an essential component of dialysis patient review. Once abnormalities of access are detected further evaluation is mandatory to allow early diagnosis and prompt treatment to prevent access loss or failure. The physical examination should be considered routine and undertaken during fistula maturation phase and subsequently during AVF use on dialysis. Clinical observation, palpation and auscultation (look,feel,and listen approach) is an essential step in access monitoring to pick up signs of infection, haematoma, aneurysm and access stenosis.

Other objective observations that may indicate dysfunction include; an unexplained drop in dialysis adequacy, prolonged bleeding from needle sites, percentage of recirculation, and changes in access dynamic venous and arterial pressures measured at low blood flows at the beginning of each dialysis session. In isolation, all these monitoring techniques have limited value in the clinical setting.

6.4 Vascular access stenosis and thrombosis

Ito Y et al (15) compared the outcomes of the treatment of thrombosed dialysis access. The 2 year patency rates for AVG and AVF were much more superior with surgery and balloon angioplasty compared to surgical repair alone or endo-luminal intervention alone.

Intervention techniques vary with local radiological and or surgical expertise. In a recent systematic review and meta-analysis Tordoir J (16) found that studies done before 2002 showed better primary and secondary patencies with surgical thrombectomy compared to endo-luminal intervention for AVG but later studies beyond 2002 showed better results with endo-luminal intervention as radiological techniques improved.

Newer techniques in addition to angioplasty with conventional balloons include the use of high pressure balloon and cutting balloon angioplasty (17,18) but no head to head multicentre studies have been conducted yet for us to make any recommendations on choice of angioplasty techniques.

6.5 Vascular access surveillance

Vascular access surveillance is defined as the assessment of vascular access using specialised instrumentation to measure function. It is not uncommon that monitoring and surveillance are used interchangeably in the literature. Access flow measurements, duplex Doppler ultrasound in addition to direct as well as derived static pressure measurements are the commonest techniques in access surveillance. There is considerable variability in the frequency of surveillance in AVF and AVG. Some centres perform flow measurements every 6 months or more frequently (3 monthly). Other centres may only investigate for troubleshooting access

problems. The measurement of blood flow (Qa) to predict the development of graft stenosis has been assessed in several observational studies. So far there is no evidence that surveillance has led to the reduction of thrombosis or increase in longevity of AVG (19).

In a randomised controlled study, Polkinghorne et al (20) assigned 137 patients dialysing via AVF to monthly Qa measurements. Patients with Qa measurements <500ml/min were referred for angiographic studies and AVF stenosis was twice as likely to be diagnosed as in the control group. Overall surveillance with Qa followed by angiographic and pre-emptive angioplasty has led to the reduction of thrombosis of AVF but such strategy has failed to show increased survival of AVF despite intervention.

We suggest that each unit should develop locally agreed protocols for access monitoring, surveillance and the treatment of thrombosis and stenosis associated with dialysis access in order maintain access longevity. Vascular access nurses play an essential role to maintain an access monitoring/surveillance programme.

Whilst it is to be hoped that patency can be maintained with either a fistula or graft, surveillance assessment may indicate that a particular access is not salvageable. In such a situation planning for the next vascular access should take place in a time frame to minimise the risk of dialysis via a central venous catheter.

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7.Prevention of catheter related infections (Guidelines 7.1-7.4)

Guideline 7.1 – Minimise the use of venous catheters

We recommend that central venous catheters should be employed as a method of last resort for longer term vascular access to reduce the overall risk of infectious complications and the burden of central venous stenosis in haemodialysis patients (1B).

Guideline 7.2 – Minimising the risk of catheter related infection

We recommend that aseptic technique should be mandatory at every manipulation of central venous dialysis catheters (2C).

Guideline 7.3 – Minimising the risk of catheter related infection

We recommend that the catheter exit site should be cleaned with Chlorhexidine 2% (1A).

Guideline 7.4 – Minimising the risk of catheter related infection

We suggest that an antimicrobial or antibiotic lock solution be used to reduce catheter related bacteraemia and other infections (1A).

Rationale for Guidelines 7.1 – 7.4

Current practice has shown the increased frequency of catheters in incident patients worldwide. . Several studies have reported haemodialysis catheter related rates between 0.6 and 6.5 episodes per 1000 catheter days mainly due to Gram-positive organisms and in 20-43% of infections Staphylococcus aureus is the main culprit. Methicillin-resistant S. aureus (MRSA) accounts for 12-38% of haemodialysis catheter related bacteraemia (1). Metastatic infectious (endocarditis, osteomyelitis, thrombophlebitis, septic arthritis, spinal epidural abscess, and large atrial thrombi) occur up to 44% most of the requiring hospital admissions. In a recent meta-analysis, Ravani P et al (2) conducted a systematic review of cohort studies to compare the risk of death, infection and cardiovascular events in patients on haemodialysis using AVF, AVG and central venous catheters. They included 62 studies of a total of 586337 patients. Compared to AVF, those patients dialysing with a catheter had a higher risk of all cause mortality (risk ratio = 1.53(95% CI 1.41-1.67), fatal infections (2.12, 1.79-2.52) and cardiovascular events (1.38, 1.24-1.54). The risk was also higher in those patients dialysing with catheters compared to grafts, for all cause mortality (1.38, 1.25-1.52), fatal infections (1.45,1.19-1.93) and cardiovascular events (1.12, 1.11-1.43). When AVF were compared to AVG , those patients using grafts had a higher all-cause mortality (1.18, 1.09-1.27), and risk of fatal infections (1.36,1.17-1.58). In a cost analysis study Ortega et al (3) found that patients who dialysed with a fistula throughout the study period had the lowest cost per death prevented at € 3318 compared to € 9471 for preventing one death in patients who dialysed patients with a catheter throughout the study period. We suggest that catheter placement should be avoided unless in situation where there are no alternatives to more permanent access.

For venous catheters, the exit site remains a potential source of infection. The exit site should be cleaned with Chlorhexidine 2%. This has been shown to be superior to povidine in a number of settings (4). The exit site should be covered with a non-occlusive secure dressing to protect the exit site between dialysis. Patients should be educated on the importance of

maintaining the integrity of the dressing and the importance of reporting of problems with the exit site.

At each dialysis the exit site should be inspected and evidence of inflammation recorded and appropriate intervention should take place. This may require enhanced cleaning, topical therapy or antibiotics or intravenous therapy depending on the extent of any infection. A Cochrane meta-analysis explored the benefit of a number of exit sites strategies (5). The use of mupiricin ointment reduced the risk of catheter related bacteraemia (odds ratio 0.17) and reduced catheter related infections related to staphylococcus aureus carriage. Catheter lock solutions have been increasingly studied. In broad terms they are divided into antibiotic and antimicrobial lock solutions, these include gentamicin, taurolidine and citrate. Several meta-analyses have been performed in recent years all of which confirmed the benefit of antibiotic lock solutions but do not give insights as to the optimal choice (6,9). Concerns have been raised about the development of antimicrobial resistance (10) and inadverntly infusion of high concentration of citrate, only 4% citrate should be used in this setting (11).

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8.Complications of vascular access (Guidelines 8.1-8.3)

Guideline 8.1 – Treatment of access infection and related bacteraemia.
We recommend that central venous catheters should be removed in all seriously ill haemodialysis patients with catheter related bacteraemia and an alternative access placed if possible (1A).

Guideline 8.2 – Prevention of arteriovenous aneurysmal formation
We suggest that good needling technique is the cornerstone for preserving arteriovenous fistulae and preventing aneurysmal formation (2B).

Guideline 8.3 – Treatment of ischemia related to arteriovenous fistulae or grafts
We suggest that the development of peripheral ischaemia related to arteriovenous fistulae or grafts should trigger an early review by the vascular access surgeon to allow proactive intervention and prevent the onset of gangrene or need for amputation (2B).

Rationale for guideline 8.1-8.3

Diagnosis of catheter related bacteraemia is confirmed by the isolation of the same organism from blood cultures from a peripheral site and the catheter. Infection of an arteriovenous fistula normally responds well to either oral or intravenous antibiotic therapy. In this setting, bacteraemia are commonly acquired during cannulation and respond well to antibiotics. Several different strategies for the treatment of catheter related bacteraemia have been adopted over the last decade: 1) Administer intravenous antibiotics alone – this carries a high failure rate and has a highest risk of bacteraemia recurrence . 2)Prompt catheter removal - this leads to disruption of dialysis and placement of a temporary catheter is required if alternative dialysis access is not available. 3) Catheter locks as adjunctive treatment to intravenous antibiotics 4) Catheter removal and re-insertion of a new catheter via guide wire exchange. A systematic review and metanalysis of management options for access salvage in the case of catheter related bacteraemia included 28 studies and found that antibiotic lock solution with

systemic antibiotics and guidewire exchange was more superior to treatment with systemic antibiotics alone (OR, 2.08; 95% CI, 1.25 to 3.45; P<0.01 for antibiotic lock solution; OR, 2.88; 95% CI, 1.82 to 4.55; P<0.001 for guide wire exchange versus systemic antibiotics).When bacteraemia was due to Staph Aureus, guide wire exchange was more likely to eradicate infection compared to systemic antibiotics or antibiotic lock solution (OR, 3.33; 95% CI, 1.17 to 9.46; P=0.02; OR, 4.72; 95% CI, 1.79 to 12.46; P=0.002, respectively). Based on these observations we suggest that tunnelled haemodialysis catheter-related bacteraemia should be treated with either guide wire exchange or antibiotic lock solution in addition to systemic antibiotics in order to maximise the chances of eradication of catheter related bacteraemia.

The dilemma is to maintain access for the purpose of dialysis whilst maximising cure of infection. Catheter related infection in the haemodialysis population can be a serious and potentially life threatening event. Consequently, tunnelled catheter should be removed if bacteraemia is due to Staph Aureus, MRSA and if the patient is serious ill or there is evidence of metastatic infection. All non-tunnelled catheters should be removed if associated with catheter related bacteraemia.

Arteriovenous grafts have the second highest rate of infection in dialysis patients and infection of an arteriovenous graft has a worse prognosis than infection of arteriovenous fistulae. Commonest cause of infection is staphylococcus aureus (26.32%) followed MRSA (21.05%) and Pseudomonas Aeruginosa (5.26%) (3) Commonly, surgical exploration, repair, drainage and/or removal maybe required together with a prolonged course of antibiotics depending on the extent of infection (4, 5). Failure to recognize graft infection may result in rupture of the graft.

Each unit should have protocols in place for the management of sepsis associated with catheter and graft infections which should include choice of empirical antibiotics to cover common organisms as guided by the local microbiology department.

AVF related infections are uncommon. Infection can occur at anastomosis or cannulation site. The presence of aneurysms, infected thrombi or localized abscess formation increases the risk of fistula rupture and surgical intervention may be required to either salvage or tie off the fistula. There is a higher frequency of AVF associated infection with buttonhole cannulation, however there is no evidence that the use of the buttonhole technique should be discontinued. There is lack of evidence on the duration of antibiotic treatment for AVF infections but a course of antibiotics for six weeks has been suggested (6).

Vascular malformations of either arteriovenous fistulae or grafts are common. Prevention with good needling technique is appropriate and the cornerstone for preserving arteriovenous fistulae. Aneurysm formation can lead to graft or fistula failure with thrombosis. It can also lead to sudden rupture of the access with potentially serious consequences. There are no good

evidence based guidelines concerning the management of aneurysms in this setting but careful liaison with vascular radiology and surgical colleagues can develop local strategies for intervention.

Access induced ischaemia can be apparent from symptoms and clinical examination. The cause should be determined with appropriate imaging methodology.

Access induced ischaemia is a serious complication that can result in amputation. The incidence of symptomatic ischaemia is observed in up to 8% of the haemodialysis population and is more common in elderly patients and those with pre-existing vascular disease such as diabetics or atherosclerosis. High flow arteriovenous fistulae can induce a steal phenomenon and is therefore more common in proximally located fistulae (7). Patients may have a pale or cold hand with or without pain during exercise and/or haemodialysis but then can progress to ischaemic pain at rest and finally atrophic changes such as ulceration, necrosis and gangrene. For some patients this may require arteriovenous fistula or graft ligation, alternative access or a change to alternative modality.

Efforts to reduce flow such as banding and distal arterial extension can be performed. The DRIL (Distal Revascularization and Interval Ligation) procedure has been performed successfully in a number of studies (8). The PAVA (Proximal Arteriovenous Anastomosis) procedure utilises a graft interposition to move the arterial anastomosis from the elbow to the axilla. This is haemodynamically identical to a DRIL procedure but may be safer (9). The use of tunnelled catheter or transfer to PD is also valid options in this setting .

Central venous catheter dysfunction is a common event in haemodialysis. A reduction or cessation of blood flow interrupts therapy and reduces the adequacy of solute and fluid control. Catheter dysfunction can be minimized by careful catheter insertion techniques under fluoroscopic guidance (10) and strict post-insertion care. A forceful saline flush forms part of initial treatment catheter-related thrombosis and if unsuccessful is followed by intraluminal lytic enzyme instillation (urokinase or tissue-plasminogen activator or alteplase). There is no evidence that one thrombolytic agent is more superior than others (11), the catheter clearance success rates are similar with these agents (12).

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Sepsis Audit

1.Staphylococcus aureus (MRSA and MSSA) Infection:

Centres should audit all Staphylococcus aureus bacteraemia episodes recorded as episodes per 100 patient years or episodes per 100 catheter days or episodes per 100 AVF years.

2. Other multi drug resistant organisms:

Data should be collected on all episodes of VRE

The service audit minimum standard

The annual Staphylococcus aureus bacteraemia rate should be less than 2.5 episodes per 100 HD patients and less than 1.0 for MRSA over 2 years

Suggested research topics

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1. Optimal timing for definitive access creation.
2. Barriers to service delivery in the creation and maintenance of optimal vascular access in dialysis.
3. Benefits of structured physical examination and surveillance programme in AVF outcomes.
4. Indications and choices of AVG.
5. Comparative analysis of lock solutions and thrombolytic agents for catheters.