Preparation and placement of vascular access

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GUIDELINES

No recommendations possible based on Level I or II evidence.

SUGGESTIONS FOR CLINICAL CARE
(Suggestions are based on Level III and IV evidence)

- All patients, especially those with co-morbid conditions, should be referred to a vascular access surgeon well in advance of the anticipated need for haemodialysis. The exact timing depends on patient-related factors and local facilities (Level III evidence)
- Several procedures may be required to establish a useable native arteriovenous fistula. Maturation of arteriovenous fistula may be prolonged (3 months or more) in some patients (Level III evidence)

IMPLEMENTATION AND AUDIT

An implementation study was conducted in 2007-2009 to identify the barriers and facilitators for vascular access creation. Strategies for improving vascular access creation were identified and implemented. These strategies included the implementation of a pre-dialysis clinical care pathway as well as frequent audit and feedback for the participating renal units.

BACKGROUND

Chronic haemodialysis patients should be referred early to the nephrologist and vascular surgeon to allow sufficient time for education, planning, access creation and maturation[1]. Patients who are referred late to the nephrologist commonly miss out on important education and are less likely to be involved in the treatment process regarding modality choices and timing of access. As a result of late referral, many who are eligible to have haemodialysis will commence dialysis with a catheter instead of an arteriovenous fistula. Patients dialysing with a central venous catheter are more susceptible to infections, hospitalisations and increased risk of death [2-4].

A recent systematic review on timing of referral for vascular access placement failed to identify any studies comparing patients who were referred to vascular surgery for access placement [5]. However, the review did identify a study by Oliver et al[6] which compared late and early access creation in 5924 incident haemodialysis patients. Early access creation (≥ 4 months before dialysis) was associated with a lower risk of death and sepsis, with a relative risk of 0.76 (95% CI 0.58 – 1.00) and 0.57 (95% CI 0.41 – 0.79) respectively.

Access creation is a time consuming process as it involves, surgical referral, surgical assessment, patient education, access creation and access maturation. The access needs to mature adequately before it can be cannulated as early cannulation can result in access failure. The process can be prolonged further if there are any post-operative complications, as surgical revision and intervention may be required.

At present, the optimum timing for referral to vascular surgery for vascular access placement is based on expert opinion and choices made by patients and physicians[5]. In Australia and New Zealand the
proportion of patients who commence haemodialysis with adequate access is 40% and 25% respectively[7], indicating the need to improve practice.

The objective of this guideline is to review and summarise the evidence on preparation and placement of vascular access.

SEARCH STRATEGY

**Databases searched:** MeSH terms and text words for haemodialysis were combined with MeSH terms and text words for arteriovenous fistula, arteriovenous shunt and vascular access, and combined with MeSH terms and text words for referral and consultation, and then combined with Cochrane highly sensitive search strategy for randomised controlled trials. The search was carried out in Medline (1966 to October Week 3, 2009). The Cochrane Renal Group Register was also searched for trials not indexed in Medline. An update of the search was conducted in Medline (Nov. 2011) using the same MeSH terms and text words.

**Date of initial search:** 22 October 2009
**Date of update search:** November 2011.

WHAT IS THE EVIDENCE?

No systematic reviews or randomised controlled clinical trials are available on this topic. However there are a number of prospective, retrospective and pre and post-test studies which identify the need for adequate timing of access creation. The following is a summary of the evidence from observational studies.

The mortality risk of patients needing access creation depends on a number of factors. Patients who are referred late to the nephrologist and who have less nephrologist visits prior to commencing haemodialysis have a higher mortality risk (RR 1.68 CI 1.31-2.15)[8] as well as an increased risk of arteriovenous fistula failure (HR 1.55 CI 1.04-2.32)[9]. These patients are also less likely to receive standard renal care, are in a worse clinical state and are more likely to commence emergency dialysis[10]. Unplanned dialysis start means the use of a temporary catheter which is also associated with increased mortality and arteriovenous fistula failure[9, 11, 12]. It is evident from a series of retrospective studies that early referral to the nephrologist, timely access (greater than four months before dialysis start) and increased number of visits to the nephrologist prior to commencing dialysis, are associated with decreased co-morbidity, decreased temporary catheter use, better metabolic status at start of dialysis and decreased initial hospital stay[6, 13, 14].

Timing is also critical in the process of vascular access creation and use. The longer a patient has to wait for access creation, be it from the time of referral to the time of surgical assessment; from the time of surgical assessment to the time of access creation; or from access creation to first cannulation, the less likely they are to start with a permanent access[15]. Thus, late referral to the nephrologist and fewer visits to the nephrologist are associated with decreased AVF use at haemodialysis commencement, increased temporary catheter use, increased initial hospital stay and emergency dialysis[16, 17].

A single centre, pre and post-test study by Polkinghorne et al has identified that the combined use of a vascular access nurse to coordinate the surgical waiting list as well as the use of an algorithm to prioritize surgery, were critical to improving the number of patients commencing haemodialysis with an AVF (AVF creation was 56% pre implementation versus 75% post implementation, p=0.007)[18].

A number of studies have identified patient specific factors which are associated with decreased rates of arteriovenous fistula creation. These patient characteristics include: female gender, older age, larger body mass index, diabetes, lower education, inability to ambulate independently, lack of participation in treatment modality choices and non-preservation of blood vessel[15, 16]. Patients who are either: female, have peripheral vascular disease, are obese or older ≥65 years, have a decreased likelihood of having an arteriovenous fistula created (AOR 0.37, 0.55, 0.76, 0.85) respectively[19].
A cross sectional analysis of Australian dialysis patients by Polkinghorne et al identified Type I diabetes mellitus, female gender and older age as significantly associated with higher use of arteriovenous grafts. Female gender, diabetes mellitus (Type I and II) are also associated with catheter use at initial haemodialysis[20]. The increased use of AVG and catheters in these patients predisposes them to a greater mortality risk. Another cross sectional study by Graham et al[21] also identified female gender, peripheral vascular disease and shorter duration of haemodialysis as independent predictors of catheter use. They stated that 68.9% of the patients with central venous catheters have vascular factors or medical contraindications that preclude AV fistula creation.

Evidence shows that fistula adequacy (blood flow ≥350ml/min) is affected by specific patient characteristics. Fistula adequacy was lower in older versus younger patients (30.0 vs 53.5%, P=0.03), in diabetics versus non-diabetics (35.0 vs 54.1%, P=0.061) and in overweight versus non-overweight patients (34.5 vs 55.2%, P=0.07). The study also showed that forearm fistulas had poorer adequacy compared to upper arm fistulas, particularly in women, older patients and diabetics[22].

Arteriovenous fistula maturation can be affected by clinical and hemodynamic risk factors. A study by Voormolen et al[23] showed that patients with preoperative clinical risk factors (such as age, gender, race) had excess non-maturation risk of 21% and a relative risk of 1.7, and patients with pre-operative hemodynamic risk factors (arterial diameter) had a non-maturation excess risk of 24% and a relative risk of 1.7. If there are post-surgical hemodynamic risk factors present, the excess non-maturation risk increases to 50% and the relative risk increases to 4.3.

It is necessary for renal facilities to implement interventions to reduce catheter use. One such study by Kulawik et al[24] implemented vascular access education for medical staff, vascular mapping, provided information for early referral of patients with immature fistula; monthly catheter tracking; conference calls as well as site visits and feedback from staff, vascular manager/coordinator and the medical director of the facility. A total of 23 facilities (n=1,329) took part in the program and all showed catheter reduction post intervention (31.6 ± 6% pre-intervention to 13.9 ± 6% post-intervention, P=0.001). 10/23 facilities met the project goal (31.9 ± 6% pre-intervention, 7.3 ± 4% post-intervention, P=0.002). The involvement of the medical director had a positive effect on achieving the goal (P=0.003), the presence or absence of a vascular access coordinator had no effect on catheter reduction.

In another study by Lacson et al[25], patients were referred to a national treatment options program (TOPs) where they were given pre-dialysis treatment options education. Their outcomes were compared with patients receiving usual care during the same period. For participants who decided to have HD therapy, the adjusted OR was 2.06 (95%CI: 1.88 to 2.26) for starting with a fistula or graft. The adjusted HR for all outcomes was 0.61 (95%CI: 0.50 to 0.74, P<0.001) for TOPs participants compared with patients undergoing usual care. The study had its limitations related to selection bias.

**SUMMARY OF THE EVIDENCE**

Current evidence indicates that: early referral to the nephrologist; increased number of visits to the nephrologist prior to the start of haemodialysis; shorter waiting times to see the surgeon; shorter waiting times to get access created are all associated with increased AVF creation and use at haemodialysis start, as well as decreased mortality risk, decreased initial hospital stay and decreased temporary catheter use.

Priority should be made to assess and refer patients with specific risk factors. These patient risk factors include: female, older age (≥65 years), larger body mass index, diabetics, lower level of education and peripheral vascular disease. If they have pre-operative hemodynamic risk factors then they should also be assessed and referred sooner rather than later. Priority should be made to follow-up these patients to address any post-surgical hemodynamic problems to prevent fistula failure.

The use of an algorithm to prioritize surgical lists as well as the involvement of a vascular access nurse to coordinate surgical waiting lists, are crucial elements to improving timely access creation. The implementation of other quality improvement strategies to reduce catheter use may also be necessary.
WHAT DO THE OTHER GUIDELINES SAY?

Kidney Disease Outcomes Quality Initiative: (2006)[26]
a. Patients with a glomerular filtration rate (GFR) less than 30mL/min/1.73m² (CKD stage 4) should be educated on all modalities of kidney replacement therapy options, including transplantation, so that timely referral can be made for the appropriate modality and placement of a permanent dialysis access, if necessary. (A)
b. A fistula should be placed at least 6 months before the anticipated start of HD treatments. This timing allows for access evaluation and additional time for revision to ensure a working fistula is available at initiation of dialysis therapy. (B)
c. A graft should, in most cases, be placed at least 3-6 weeks before the anticipated start of haemodialysis therapy. Some newer graft materials may be cannulated immediately after placement. (B)

UK Renal Association: 2008-2011[27]
Guideline 3.1 - Planning of vascular access
We suggest that planning for access should commence when patients enter CKD stage. (2C)

Guideline 3.2 – 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. (1C)

Canadian Society of Nephrology: (2006)[28]
Establish AV fistulae when the patient has an estimated GFR of 15-20mL/min and progressive kidney disease (Grade D, opinion).

European Best Practice Guidelines: (2007)[1]
1.1 An early plan for venous preservation should be a substantial part of pre-dialysis care and education in any chronic kidney disease (CKD) patient regardless the choice of treatment modality (Evidence level IV)
1.2 Every chronic renal failure patient, who have opted for haemodialysis, should start dialysis with a functioning vascular access (Evidence level III)
1.3 Potential chronic haemodialysis (HD) patients should be ideally referred to the nephrologist and/or surgeon for preparing vascular access when they reach the stage 4 of their CKD (glomerular filtration rate <30mL/min/1.73m²) or earlier in case of rapidly progressive nephropathy or specific clinical conditions such as diabetes or severe peripheral vascular disease (Evidence level III)

International Guidelines: No recommendation.

SUGGESTIONS FOR FUTURE RESEARCH

Conduct a randomised trial of nurse lead patient pre-dialysis education versus usual care, on AVF placement and use in incident haemodialysis patients.

CONFLICT OF INTEREST

Pamela Lopez-Vargas and Kevan Polkinghorne have no financial affiliation that would cause a conflict of interest according to the conflict of interest statement set down by KHA-CARI.
REFERENCES


APPENDICES

Table 1. Characteristics of included studies timing of referral, mortality and catheter use

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>N</th>
<th>Study Design</th>
<th>Participants</th>
<th>Follow Up (months)</th>
<th>Comments and Results</th>
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</table>
| Ethier et al (2008)1    | >35,000| Prospective study   | Haemodialysis patients Data used from Dialysis Outcomes and Practice Patterns Study (DOPPS) |                    | ● Patients were significantly (P < 0.05) less likely to start dialysis with a permanent VA if treated in a facility that (1) had a longer time from referral to access surgery evaluation or from evaluation to access creation and (2) had longer time from access creation until first AVF cannulation.  
● Patients were less likely to use an AVF versus other VA types if female, of older age, having greater body mass index, diabetes, peripheral vascular disease or recurrent cellulitis/gangrene.  
● Countries with greater prevalence of diabetes were less likely to use an AVF.                                                                 |
| Lorenzo et al (2004)2   | 538    | Prospective study Three centres | Incident haemodialysis patients                                                | 60                 | ● Of 281 planned patients, 73% initiated therapy with an AVF.  
● Of 257 unplanned patients, 70% initiated therapy with a catheter (P < 0.001).  
● At 12 months, the number of deaths was 3 times higher in both the unplanned versus planned groups and catheter versus AVF groups.  
● The joint effect of unplanned dialysis initiation and catheter use had an additive impact on mortality (HR, 2.89)  
● Combined influence of both variables was associated with greater morbidity and mortality than either variable alone.                          |
| Ravani et al (2004)3    | 535    | Prospective study   | Patients commencing haemodialysis with an AVF >18 years of age                 |                    | ● 513 (96%) received AVF  
● CVD, access utilization < 1mo after placement and referral within 3 months of dialysis start were associated with a reduction in primary AVF survival.  
● CVD, maturation time <15 d and presence of CVC at haemodialysis initiation were associated with lower secondary AVF survival.  
● CVD, late referral, temporary catheters and early cannulation contribute to AVF failure  
● Recommended AVF be allowed to mature at least 1 month before cannulation.                                                                                                                                 |
| Stack (2003)4          | 2264   | Prospective study   | Incident haemodialysis patients                                                | 24                 | ● Late referral to the nephrologist is associated with increased mortality risk (RR 1.68; CI:1.31-2.15)  
● Multiple visits to the nephrologist prior to starting dialysis lowers the risk of death (RR 0.8; CI: 0.62-1.03)                                                                 |
| Roderick (2002)5       | 250    | Prospective study   | Incident haemodialysis patients                                                |                    | ● Late referred patients were less likely to receive standard renal care and were in a poorer clinical state at the start of dialysis  
● 96 patients were referred late and 43 of these late referrals would have been avoidable.                                                                 |
<p>| Rayner et al (2003)6    | 3674   | Prospective observational study | Incident haemodialysis, hemofiltration, or haemodiafiltration patients from |                    | ● There is large variation in: fistula use between countries; the time interval between referral for AVF and creation; the time interval between creation and AVF cannulation. |</p>
<table>
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</table>
| DOPPS study > 17 years of age |         |                                   |                                 |                   | and first cannulation  
  - Cannulation ≤14 days post creation is associated with 2.1fold increased risk of fistula failure (P=0.006)  
  - Increased risk of fistula failure for patients with prior temporary access (RR=1.81) or who were female (RR=1.51)                                                                                                                                                                                                                   |
| Oliver et al (2004) | 5924    | Retrospective cohort study 1994 - 2001 | Haemodialysis patients          |                   | ● Patients who had access created earlier than 4 months before starting dialysis, had less co-morbidity and were less likely to start as an inpatient                                                                                                                                                                                                  |
| Avorn et al (2002) | 2398    | Retrospective cohort study January 1991 – June 1996 | Haemodialysis patients          |                   | ● 35% had their first nephrologist consultation ≤90 days prior to starting HD (i.e. late referral)  
  ● Late referrals were 42% more likely to start with a CVC compared to those seen early by a nephrologist (OR = 1.42, 95%CI =1.17-1.71)  
  ● Patients referred to a nephrologist ≥90 days were 38% more likely to have vascular access surgery c.f. to those referred late (OR=1.38)  
  ● Inadequate development of vascular access in patients with late nephrologist referral unnecessarily contributes to the burden of disease experienced by this vulnerable patient population                                                                                                                                 |
| Goransson LG and Bergrem H (2001) | 242    | Retrospective cohort study Single centre | Incident dialysis patients      |                   | ● Of the patients starting haemodialysis, all (late referrals) LR started on a temporary vascular access. About 43% of the (early referrals) ER started on a functioning arteriovenous fistula (P < 0.0001).  
  ● Duration of hospital stay in connection with start of dialysis was 31 days (7-73) in the LR as compared with 7 (1-59) days in the ER (P < 0.0001)  
  ● Early referral to nephrologist is associated with: lower age; a higher likelihood of pre-dialytic transplantation; better metabolic status at start of RRT; a higher proportion starting haemodialysis on a functioning arteriovenous fistula; and a shorter duration of the initial hospital stay                                                                                       |
| Roubicek et al (2000) | 309     | Retrospective Cohort study January 1, 1989, and December 31, 1996 Single centre | Patients commencing haemodialysis |                   | ● 177 patients (58%) had an early referral (ER) 16 or more weeks before the start of dialysis, and 93 patients (31%) had a late referral (LR) of less than 16 weeks before dialysis.  
  ● LR have greater initial morbidity (initial emergent dialysis, pulmonary oedema, severe hypertension, temporary vascular access placement for first dialysis and prolonged initial hospitalization)  
  ● Survival analysis showed no difference between the two groups: 3-month survival rates were 96% in both groups, 1-year survival rates were 90% in the ER and 89% in the LR group, and 5-year survival rates were 52% in the ER and 56% in the LR group.  
  ● Referral pattern was not associated with a greater risk for death and long-term outcome of haemodialysis patients was not modified by delayed nephrological care                                                                                           |
| Polkinghorne et al (2009) | 184    | Prospective before and after study | Incident haemodialysis patients |                   | ● Implementation of a vascular access coordinator and the use of an algorithm, improved coordination of surgical waiting lists  
  ● 19% more patients commenced HD with an AVF (56% pre-implementation = 52%) compared to those with a CVC after implementation of the plan.                                                                                                                                                                                                         |
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</tr>
</thead>
<tbody>
<tr>
<td>Single centre 2005 – 2006</td>
<td></td>
<td>Single centre</td>
<td></td>
<td>126 months</td>
<td>Multifaceted intervention significantly increased the proportion of pts starting HD with an AVF</td>
</tr>
<tr>
<td>Stehman-Breen (2000)[12]</td>
<td>1449</td>
<td>Retrospective cohort study</td>
<td></td>
<td></td>
<td>Characteristics which reduce the likelihood of patients receiving a fistula include: older age, larger body mass index, female, inability to ambulate independently, renal disease due to diabetes, poor education, no participation in modality choice, no preservation of blood vessels</td>
</tr>
<tr>
<td>Allon et al (2000)[13]</td>
<td>1824</td>
<td>Prospective study multi centre</td>
<td>Participants enrolled in the HEMO study (baseline phase)</td>
<td>48</td>
<td>34% of the patients had avf. this proportion varied markedly among the individual dialysis units (P&lt;0.001) Demographic and clinical factors associated with lower likelihood of having a fistula – 1. lower in females (AOR 0.37, 95%CI, 0.28-0.48); 2. lower in patients with peripheral vascular disease (AOR 0.55, 95%CI, 0.38-0.79); 3. lower in blacks (AOR 0.64, 95%CI, 0.46-0.89); 4. lower in obese patients (AOR 0.76, 95%CI, 0.65-0.87); 5. lower in older patients (AOR 0.85 95%CI, 0.78-0.94)</td>
</tr>
<tr>
<td>Miller et al (1999)[14]</td>
<td>126</td>
<td>Prospective study</td>
<td>Haemodialysis patients</td>
<td>24</td>
<td>Only 47 fistulas developed sufficiently to be used for dialysis Fistula adequacy (blood flow &gt;350ml/min) was lower in older (age ≥65) versus younger patients (age &lt;65) (30 vs 53.5%, P=0.03) Adequacy also marginally lower in diabetics versus non-diabetics (35 vs 54.1%, P=0.061) and in overweight (BMI ≥27kg/m2) versus non-overweight patients (34.5 vs 55.2%, P=0.07) Adequacy was also lower for forearm versus upper arm fistulas (34 vs 58.9%, P=0.012). Adequacy of forearm fistulas was particularly poor in women (7%), older patients (12%) and diabetics (12%) Upper arm fistulas were adequate in 56% of women, 54% of older patients and 48% of diabetics</td>
</tr>
<tr>
<td>Polkinghorne et al (2003)[15]</td>
<td>4968</td>
<td>Cross-sectional cohort study 30 Sept, 2001</td>
<td>Australian incident and prevalent haemodialysis patients &gt;18 years of age</td>
<td></td>
<td>AVF 61% incident versus 77% prevalent cohort AVG 11% incident versus 19% prevalent cohort CVC 28% incident versus 4% prevalent cohort Age and female gender increased AVG rate Type I diabetes mellitus (DM) increased AVG rate in incident cohort BMI, PVD and CVD increased AVG in the prevalent cohort Female gender, Type I &amp; II DM and late referral increase central venous catheter use in the incident cohort Female, cigarette smoking &amp; PVD increased CVC use in the prevalent cohort Geographic location also predicted access type</td>
</tr>
<tr>
<td>Graham et al (2008)[16]</td>
<td>599</td>
<td>Cross-</td>
<td>Prevalent chronic haemodialysis</td>
<td>N/A</td>
<td>All nephrologists (n=17) agreed AVF is the optimal HD access</td>
</tr>
<tr>
<td>Study ID (author, year)</td>
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| Voormolen et al (2009)[17] | 33 studies | Systematic review | 12 studies were concerning treatment for non-maturing fistulae; and 21 studies were about risk stratification | | ● 58.0% of patients used AVF; 39.7% used CV catheters and 2.3% used AVGs.  
● Female gender, peripheral vascular disease and shorter duration of haemodialysis were independent predictors of CV catheter use.  
● 68.9% of the patients with CV catheters has vascular factors or medical contraindications that precluded AV fistula creation.  
● Patients with preoperative clinical risk factors had excess non-maturation risks of 21% (95% CI 11% - 30%) and a relative risk of 1.7 (95% CI 1.3-2.1).  
● Patients with preoperative hemodynamic risk factors had average estimated excess risks of 24%(95% CI 15% -33%) and a relative risk of 1.7 (95% CI 1.4- 2.0).  
● Patients with hemodynamic risk factors present shortly after operation had excess non-maturation risks of 50% (95% CI 42% - 58%) and a relative risk of 4.3 (95% CI 3.4-5.5).  
● Patients can be treated for AVF non-maturation early on; however there is a need to identify those at risk of non-maturation with an early postoperative assessment of hemodynamic risk factors. |
| Kulawik et al (2009)[18] | 1,329 | Quality improvement Report | Chronic haemodialysis facilities with high catheter rates, within Network 7, implemented a catheter reduction toolkit. Multicentre, USA. | 24 | ● All 23 facilities reduced catheter use from 31.6 ± 6% (pre-intervention) to 13.9 ± 6% (post-intervention), P=0.001.  
● 10 facilities met the goal set by the project and reduced catheter use to 7.3±4% , P=0.001 |
| Lacson et al (2011) [19] | 3,165 | Quality improvement report | Patients initiating dialysis were referred to a national treatment options program (TOPs). Multicentre, USA | 16 | ● For patients who selected in-centre HD therapy, the adjusted OR was 2.06 (95% CI: 1.88 to 2.26, P<0.001) for starting dialysis therapy with a fistula or graft, compared to non-TOPs attendees.  
● Patient survival at 90 days was significantly better for TOPs participants, the adjusted HR for death was 0.61 (95% CI: 0.50 to 0.74, P<0.001) compared to non-TOPs participants. |