Selection of type of 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)

- Whenever possible it is suggested that a native arteriovenous fistula is created and used for haemodialysis, as it is superior to an arteriovenous graft and to a central venous catheter. (Level III evidence)
- When a native arteriovenous fistula is not possible, an artificial arteriovenous graft should be used in preference to a central venous catheter. Arteriovenous grafts have similar patency to arteriovenous fistula after accounting for arteriovenous fistula primary failure at the expense of greater interventions to maintain patency. (Level III evidence)

IMPLEMENTATION AND AUDIT

An implementation study was conducted by CARI in 2007-2009 to identify the barriers and facilitators for vascular access creation, as well as identifying implementation strategies for improving vascular access creation in patients commencing chronic haemodialysis. Strategies to facilitate timely access creation included the implementation of a pre-dialysis clinical care pathway as well as frequent audit and feedback of unit results.

BACKGROUND

Patients with chronic kidney disease need to consider which treatment modality they will have once their disease has progressed to end-stage kidney disease. For patients who consider haemodialysis as an option, the decision needs to be made in a timely manner so that adequate vascular access is achieved before starting dialysis.

The preferred choice of access is the arteriovenous fistula (AVF) [1] because of its longevity and lower risk of complications compared with arteriovenous grafts (AVG) and catheters[2].

While the prevalence of arteriovenous fistulae use in Australia and New Zealand is 75%, the number of prevalent patients using a catheter has increased[3]. In addition the proportion of patients commencing haemodialysis with an AVF is decreasing. In Australia the proportion of patients starting dialysis with an AVF or AVG is 40% and in New Zealand it is 25%[3]. In the U.S. the proportion of patients with a maturing or functional fistula at the start of haemodialysis is 31% - 34% with 4 out of 5 patients starting dialysis with a catheter[4]. AVF use in prevalent patients is 24% in the US compared to 80% in Europe [5, 6].

Possible reasons for differences in fistula creation are patient comorbidities, access to medical care and facility preferences. Data from the Dialysis Outcome and Practice Pattern Study (DOPPS) [5] indicates that patient comorbidity is greater in the USA compared to Europe: diabetes mellitus (46 versus 22%), peripheral arterial obstructive disease (23 versus 19%), coronary artery sclerosis (37 versus 25%) and larger body mass index (25.1 versus 24.1 kg/m²). In Australia and New Zealand patients who are
diabetic, female, younger than 25 years and who are referred late (first seen by a nephrologist <3 months before starting haemodialysis), were less likely to start dialysis with an AVF or AVG[3].

Facility preferences may also influence the type of access created. For example in the DOPPS study it was identified that in facilities where the medical director and nurses preferred grafts, patients were more than twice as likely to have a graft than a fistula (AOR=2.3, p<0.01)[6].

The objective of this guideline is to review and summarise the evidence on selection of type of access with reference to mortality, access type, access patency and cost.

**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 and observational studies. 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. Additional separate searches were conducted for patency and cost. An update of the search was conducted in Medline (December 2011 and March 2013) using the same MeSH terms and text words.

**Date of initial search:** October 2009.

**Date of update searches:** December 2011 and March 2013.

**WHAT IS THE EVIDENCE?**

No randomised controlled clinical trials were found using the search strategy for this topic. It is unlikely that an RCT would ever be conducted on this topic. The following is a summary of the evidence from observational studies.

Ravani at al recently performed a systematic review of the clinical outcomes between vascular access type in haemodialysis patients. Sixty two cohort studies comprising 586,337 patients were included in the review. Subjects using central venous catheters had significantly increased risk for all cause death (RR 1.53, 1.40-1.67), fatal infection (RR 2.12, 95% C.I. 1.79-2.52) and cardiovascular events (RR1.38, 1.24-1.54) compared to those using arteriovenous fistulae. Compared to arteriovenous fistula, those using arteriovenous grafts had an increased risk of all-cause mortality (RR 1.18, 1.09-1.27) and fatal infection (RR 1.36, 1.17-1.58) but not cardiovascular events (RR 1.07, 0.95-2.11). In absolute terms the authors calculated that catheter and arteriovenous graft use were associated with 80–134 and 16-54 additional deaths per 1000 person-years compared with arteriovenous fistula use respectively[7].

A systematic review and meta-analysis by Murad et al also showed a significant reduction in the risk of death (RR 0.76) and access infection (RR 0.18) in fistulas compared to grafts [8]. Patients who dialyse with an AVF for the first three months of dialysis have a lower risk of death (RR=0.39) compared to patients who commence dialysis with a catheter and subsequently change to a fistula or who remain with a catheter only. Also the proportion of hospital admissions is less for patients dialysing with a fistula versus catheter-fistula versus catheter only patients (16%, 33% and 62%) respectively [9]. An analysis of USRDS data for 4 854 patients commencing dialysis by Wasse et al [10] concluded that patients using an AVF at initiation of dialysis and at 90 days, have a decreased risk of cardiovascular-related (CV) death compared with patients with a CVC, adjusted HR 0.85 (95%CI: 0.65, 1.11) at initiation; and Adj HR 0.69 (95%CI: 0.56, 0.84; P<0.05) at 90 days. At the end of the four-year observation period, 78% of the patients using an AVF were free of CV-related death, compared with 68% of patients using an AVG and 65% using a CVC (P<0.0001).

In contrast to the above, a retrospective study by Chan et al [11], which included 1471 patients, concluded that the use of an AVF in elderly (> 65 years) patients, either diabetic or non-diabetic, did not have a significant mortality benefit compared to an AVG. Odds ratio (OR) for mortality was 1.34 (95%CI: 0.92-1.95, P=0.123) and OR 1.05 (95%CI: 0.80-1.36, P=0.735) for diabetic and non-diabetic patients using an AVF versus an AVG, respectively.
Another major outcome to impact on the selection of access type is the patency rates including stenosis and primary failure of arteriovenous fistulas compared to arteriovenous grafts. In a study by Koksoy et al. it was identified that the primary patency for brachio-cephalic and brachio-basilic fistulas at one and three years of follow up was 87% and 81% for brachio-cephalic and 86% and 73% for brachio-basilic respectively. There was no significant difference in 30 day mortality, wound complications, 24hr thrombosis, postoperative haemorrhage, maturation and time to maturation between the groups. A number of studies have shown that primary and assisted-primary patency rates are significantly higher in arteriovenous fistulas compared to arteriovenous grafts [13-17]. In a study by Rooijens et al [14] patients were randomised to have either a radio-cephalic arteriovenous fistula (RCAVF) or an arteriovenous graft (PTFE). Results showed that primary and assisted primary 1-year patency was significantly better for the PTFE graft. (33 ± 5.3% vs 44 ± 6.2% (P=0.03) and 48 ± 5.5% vs 63 ± 5.05% (P=0.04) for the RCAVF and PTFE graft respectively). However, patients in the PTFE graft group had more complications and interventions for access salvage, (43 in the RCVF group vs 79 interventions in the PTFE graft group, P=0.08). Keuter et al [13] also conducted an RCT, but in this study patients with failed primary/secondary access or inadequate arterial and/or venous vessels were randomised for either a brachio-basilic AVF (BBAVF) or a brachial-antecubital forearm (PTFE) loop. Patients in the BBAVF group had significantly higher primary and assisted-primary 1-year patency rates compared to the PTFE loop graft group (46 ± 7.4% vs 22 ± 6.1% (P=0.05) and 87 ± 5.0% vs 71 ± 6.7% (P=0.05) respectively. Again, complications and interventions were higher in the PTFE group. The incidence rates were 1.6 vs 2.7 complications per patient-year and 1.7 vs 2.7 interventions per patient-year, for the BBAVF vs PTFE group respectively.

The patency of an arteriovenous fistula can be affected by several factors and is also dependant on the type of fistula created. Female gender and haemodialysis prior to access creation are associated with loss of patency of radio-cephalic arteriovenous fistulas, whilst diabetes is associated with brachio-cephalic AVF failure [18]. Maya et al in a prospective study of 323 patients reported AVF to have lower rates of stenosis compared to AVGs (39.4% versus 68.7%, p<0.001) and that patients with fistulas are less likely to have two or more stenotic lesions (12.5% versus 33.1%, p<0.001)[19]. Arteriovenous fistula survival is superior to grafts regarding time to first failure (RR=0.53, p=0.002) [5], however catheter use prior to access creation increases the relative risk for first failure (RR=1.63, p=0.05)[20].

In a retrospective study by Maya et al, primary access failure rates were less common for brachio-basilic AVF and grafts compared with brachio-cephalic avf (18%, 15% and 38% respectively) [21]. Rooijens et al [22] also showed a significant primary failure rate in radio-cephalic avf (15.3%). Gibson et al showed that prosthetic grafts had an increased risk of primary failure compared with simple arteriovenous fistulas (RR, 1.41; P<0.001) [15].

Studies have also shown that the complication and intervention rates are lower in arteriovenous fistulas compared to grafts. In Keuter’s study, the brachio-basilic AVF group had 1.6 complications per patient-year and 1.7 interventions per patient-year compared to 2.7 complications and 2.7 interventions per patient-year in the PTFE group [13]. In the Rooijens study the radio-cephalic AVF group developed 102 complications and needed 43 interventions compared to the AVG group who developed 122 complications and needed 79 interventions for access salvage [14]. An upper arm arteriovenous fistula is associated with fewer complications, thrombosis and non-elective reintervention compared to a forearm loop arteriovenous graft, (42% versus 65%, p=0.006; 17% versus 42%, p=0.001 and 30% versus 50%, p=0.016) respectively [23]. In a meta-analysis by Lazarides et al [24] which included 11 studies (1509 patients), the transposed brachial-basilic AV fistula (BBAVF) was compared with the upper limb AV prosthetic graft. Results showed the pooled odds ratio (OR) for primary and secondary failure rates at 1-year to be: 0.67 (95%CI: 0.41 – 1.09) and 0.88 (95%CI: 0.69 – 1.12) respectively. The re-intervention rate was higher for prosthetic grafts (1.32 per graft) versus 0.54 per BBAVF.

Several studies have indicated that the cost of vascular access care is lower for arteriovenous fistulas compared to grafts. Ortega et al [9] conducted a cost-effectiveness analysis where the benefits were measured by cost and deaths prevented in patients receiving dialysis via an AVF alone, a catheter with fistula, or a catheter alone. Patients who dialysed with a fistula alone had the lowest cost of death prevented € 3318 compared to, € 9471 for patients with a catheter only. Similarly other studies have shown that the cost of vascular access creation and maintenance is lower for arteriovenous fistulas compared to grafts. For patients who commenced with an AVF the cost was US$404 compared to $3345 for those treated with a graft [25]. In another study by Manns et al, the mean cost of care per
Patient-year at risk for attempting an arteriovenous fistula or attempting a graft was CAN$7,989 and $11,685 respectively (P=0.01) [26]. Finally, in a mathematical model conducted to identify the impact of achieving a target level of 66% AVF, it was determined it would be cost-effective, saving US$840 million in access-related expenditures over the patient’s expected lifetime [27].

**SUMMARY OF THE EVIDENCE**

The evidence from observational studies indicates that the preferred choice of access should be the arteriovenous fistula followed by an arteriovenous graft, followed by a catheter.

Mortality risk is minimized if an AVF is used compared to a graft or catheter. Fistulas have lower rates of stenosis and the time to first failure is superior to grafts. The use of catheters at first dialysis has shown to increase the risk of death 1.6 times greater compared to fistulas and grafts. They are also associated with an increased risk of infection-related death 3.0 times greater than fistulas. The proportion of hospital admissions is also greatest for patients dialysing with a catheter alone (62%) compared to a fistula (16%).

Arteriovenous fistulas also have better patency rates and they are more cost-effective compared to grafts and catheters. Whilst fistulas are the preferred choice of access due to its associated benefits, precautions are still necessary as patency can be affected by predisposing factors such as diabetes, catheter use prior to access creation, female gender and older age.

**WHAT DO THE OTHER GUIDELINES SAY?**

**Kidney Disease Outcomes Quality Initiative**: (2006) [28]

a. The access should be placed distally and in the upper extremities whenever possible. If a primary AV fistula cannot be established, a synthetic AV graft is the next preferred type of vascular access. Catheters should only be used when other options are not possible.
   The order of preference for fistula placement should be:
   1. a wrist (radiocephalic) fistula (A)
   2. an elbow (brachiocephalic) fistula (A)
   3. a transposed brachial basilic vein fistula (B)

b. AVG of synthetic or biological material: (B)
   1. a forearm loop graft, preferable to a straight configuration.
   2. upper arm graft
   3. chest wall or “necklace” prosthetic graft or lower extremity fistula or graft

c. There is no convincing evidence to support tapered over uniform tubes, externally supported over unsupported grafts, thick- versus thin-walled configurations, or elastic versus non-elastic material. (A)

**UK Renal Association**: [29]

**Vascular Access for Haemodialysis: 2008-2011**

Guideline 1.1 – Incident patient vascular access
We recommend that any individual who commences haemodialysis should do so with an arteriovenous fistula as first choice, an arteriovenous graft as second choice, a tunnelled venous catheter as third choice and a non-tunnelled catheter as an option of necessity. (1B)

**Canadian Society of Nephrology**: (2006) [30]

1. Each centre should establish a dedicated team for vascular access. (Grade D, opinion)
2. Preserve arm veins suitable for placement of vascular access. Preservation should begin in patients with progressive kidney disease and an estimated GFR of less than 30ml/ min. (Grade D, opinion)
3. The preferred type of vascular access is a radio-cephalic native vessel arteriovenous fistula. (Grade C).

**European Best Practice Guidelines**: (2007)[31]

1.1 The access should provide sufficient blood flow to perform adequate haemodialysis (Evidence level II)
1.2 Autogenous arteriovenous fistulae should be preferred over AV grafts and AV grafts should be preferred over catheters (Evidence level III)
1.3 The upper extremity arteriovenous fistula should be the preferred access and should be placed as distal as possible (Evidence level III)
1.4 Fistula maturation should be monitored to allow pre-emptive intervention if needed (Evidence level III)

International Guidelines: No recommendation.

SUGGESTIONS FOR FUTURE RESEARCH

1. Randomised trial of AVF and AVG in elderly patients with failed radio-cephalic AVF assessing primary and secondary patency.

CONFLICT OF INTEREST

Pamela Lopez-Vargas and Kevan Polkinghorne have no relevant financial affiliations 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

<table>
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<tr>
<th>Study ID</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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</thead>
<tbody>
<tr>
<td><strong>Mortality, catheter use and access survival</strong></td>
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<tr>
<td>Ravani et al (2013)[7]</td>
<td>62 studies (n=586,337)</td>
<td>Systematic review and meta-analysis</td>
<td>Evaluation of the association between type of vascular access (AVF, AVG, CVC) and risk for death, infection and cardiovascular events.</td>
<td>N/A</td>
<td>Patients using catheters, had higher risks for: all-cause mortality, risk ratio (RR) =1.53 (95%CI: 1.41-1.67, P&lt;0.01); fatal infections RR = 2.12 (95%CI: 1.79-2.52, P = 0.82); and cardiovascular events RR = 1.38 (95%CI: 1.2-1.54, P=0.47) compared with individuals using fistulae. Patients using catheters had a higher risk for: mortality RR = 1.38 (95%CI: 1.25-1.52, P&lt;0.01); fatal infections RR = 1.49 (95%CI: 1.15-1.93, P = 0.23); and cardiovascular events RR = 1.26 (95%CI: 1.11-1.43, P=0.57) compared to patients using grafts. Patients with arteriovenous grafts had higher risk for all-cause mortality RR = 1.18 (95%CI: 1.09-1.27, P&lt;0.01); and fatal infection RR = 1.36 (95%CI: 1.17-1.58, P = 0.78), but no difference in risk for cardiovascular events RR = 1.07 (95%CI: 0.95-1.21, P=0.52) compared to individuals using fistulae. Catheter and graft use were associated with 106 (80-134) and 36 (18-54) additional deaths per 1000 patient-years compared to fistula use, respectively. There was a risk for selection bias in this study.</td>
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<td>Murad et al (2008)[8]</td>
<td>83 studies (n=69,816)</td>
<td>Systematic review and meta-analysis</td>
<td>Comparison between arteriovenous fistula and prosthetic access. Evaluated against patient-important outcomes.</td>
<td>N/A</td>
<td>The AVF compared to the prosthetic graft was associated with a significant reduction in the risk of death (RR 0.76) and access infection (RR 0.18) The AVF was associated with a non-significant reduction in the risk of postoperative complications (RR 0.73) The AVF had better primary and secondary patency at 12 and 36 months compared to the AVG</td>
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<td>Pisoni et al (2009)[1]</td>
<td>28 196</td>
<td>Prospective observational study (1996 – 2004)</td>
<td>Haemodialysis patients taking part in the Dialysis Outcomes and Practice Patterns Study (DOPPS) ≥ 18 years of age</td>
<td>96</td>
<td>Patients with a catheter and a graft have a greater mortality risk (RR=1.32 and RR=1.15 respectively) compared to patients using an AVF Greater facility catheter and graft use were associated with greater all-cause and infection-related hospitalization Vascular access practice differences accounted for nearly 30% of the greater US mortality compared with Japan.</td>
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<td>Ravani et al (2002)[20]</td>
<td>197</td>
<td>Prospective observational study Single centre (1995 – 2001)</td>
<td>All haemodialysis patients</td>
<td>20.4</td>
<td>All patients received an AVF but 60% commenced haemodialysis with a catheter. Diabetes and previous catheter use were independently associated with 85% and 63% greater relative risks for first fistula failure, but only</td>
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<td>Study ID</td>
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<td>Follow up  (months)</td>
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| Moist et al (2008)[32] | 55,101 [14,809 incident 40,292 prevalent] | Observational study | Incident and prevalent hemodialysis patients > 18 years of age | | ● diabetes led to a greater risk for final failure (relative risk: 2.38; P = 0.05).  
● Both the absence of pre-dialysis care and presence of co-morbidity influence access type at haemodialysis therapy initiation and fistula survival  
In the incident group: catheter use increased from 76.8% to 79.1%; fistula use decreased from 21.6% to 18.6%; and graft use remained between 2.1% to 2.6%.  
In the prevalent group: catheter use increased from 41.8% to 51.7%; fistula and graft use decreased from 46.8% to 41.6% and 11.4% to 6.7%, respectively  
Incident catheter use was associated with a 6 times greater risk of death compared with fistula or graft use combined |
| Wasse et al (2008)[10] | 4854 | Retrospective analysis | USRDS Clinical Performance Measures data for patients commencing haemodialysis between Oct 1999 and Dec 2004. | | ● There was a significant reduction in all-cause mortality in patients with AVF at 90 days HR 0.71 (95%CI: 0.62, 0.82, P<0.0001) compared with CVC use.  
● 55% of patients using an AVF 90 days after commencing dialysis survived to the end of the four year observation period, compared to 46% and 40% of patients with and AVG and CVC, respectively (P <0.0001)  
● AVF use at 90 days was also significantly associated with a lower risk of cardiovascular-related mortality (HR 0.69, 95%CI: 0.56, 0.84, P =0.0004) compared to CVC use.  
● There was no significant decrease in CV-related death with AVG use at dialysis start (HR 0.89, 95%CI: 0.73, 1.09, P=0.27) nor at 90 days (HR 0.95, 95%CI: 0.81, 1.13, P=0.532) compared with CVC use. |
| Chan et al (2007)[11] | 1471 | Retrospective analysis | Incident hemodialysis patients >18 years of age | | ● Elderly diabetic patients did not have significant mortality benefit from the use of AVF compared to AVG: odds ratio OR 1.34 (95%CI: 0.92-1.95, P=0.123)  
● Elderly non-diabetic patients did not have significant mortality benefit from the use of AVF compared to AVG: odds ratio OR 1.05 (95%CI: 0.80-1.36, P=0.735)  
● Elderly patients had no difference in odds for intervention referral for AVF compared to AVG: OR 1.49 (95%CI: 0.76-2.9, p=0.24) for diabetic patients; OR 1.48(95%CI: 0.95-2.3, p=0.08) for non-diabetic patients.  
● The potential benefits derived from AVFs compared with AVGs and central venous catheters may not apply universally.  
● National guidelines recommendations of vascular access choice may need to be modified for elderly patients. |
<p>| Polkinghorne | 3752 | Retrospective study | All Australian and New Zealand | 12.07 | ● Catheter use was predictive of mortality, where patients are 2.6 times |</p>
<table>
<thead>
<tr>
<th>Study ID</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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<tr>
<td>et al (2004)[2]</td>
<td>1999 – 2002</td>
<td>Hemodialysis patients</td>
<td></td>
<td>(median)</td>
<td>more likely to die from an infection. Patients with AVG also had a significantly increased risk of death.</td>
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<tr>
<td>Pastan (2002)[33]</td>
<td>7497</td>
<td>Retrospective cohort study</td>
<td>Hemodialysis patients</td>
<td></td>
<td>Proportion of deaths due to infection was 3.4% versus 1.2% versus 0.8% for pts dialysing with a catheter, graft or fistula respectively. All-cause related death and infection-related death was 1.4 and 3.0 times greater in patients with a catheter compared to patients with an AVF. Catheter use associated with younger age, black race, female, short duration since starting dialysis and impaired functional status.</td>
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**Patency**

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<tr>
<th>Study ID</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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<tr>
<td>Huber et al (2003)[16]</td>
<td>34 studies</td>
<td>Systematic review</td>
<td>Haemodialysis patients with arteriovenous fistulae (AVF) or arteriovenous grafts (AVG)</td>
<td>NA</td>
<td>Primary patency rates for AVFs at 6 and 18 months was 72% and 51% respectively. Primary and secondary patency rates were 62.5% (95% CI: 54.0 - 70.3%) and 66.0% (95% CI: 58.2-73.0%) respectively.</td>
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<td>Rooijens et al (2004)[22]</td>
<td>38 studies</td>
<td>Meta-analysis</td>
<td>Haemodialysis patients with radiocephalic arteriovenous fistulae (RCAVF)</td>
<td>NA</td>
<td>Primary failure rate of RCAVF was 15.3% (95% CI: 12.7 – 18.3%). Primary and secondary patency rates were 62.5% (95% CI: 54.0 - 70.3%) and 66.0% (95% CI: 58.2-73.0%) respectively.</td>
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<tr>
<td>Lazarides et al (2008)[24]</td>
<td>11 studies (1509 patients)</td>
<td>Meta-analysis</td>
<td>Haemodialysis patients with brachio-basilic fistulae (BBAVF) and patients with upper limb AV prosthetic grafts.</td>
<td></td>
<td>The pooled OR for the primary failure rate at one year was 0.67 (95% CI: 0.41 – 1.09) with no difference in outcome between the two groups (P=0.11). Pooled OR for the secondary failure rate at one year was 0.88 (95% CI: 0.69 – 1.12), also showing no difference between the two groups (P=0.29). There were 255 re-interventions in 470 BBAVFs (0.54 per BBAVF) compared with 922 re-interventions in 694 grafts (1.32 per graft).</td>
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<td>Koksoy et al (2009)[12]</td>
<td>100</td>
<td>Prospective randomized study</td>
<td>Haemodialysis patients who had lost distal AVF. Randomized into brachiocephalic (BC) or brachiobasilic (BB) groups</td>
<td>43.2 ± 1.8</td>
<td>Mean duration of operation was significantly shorter in the brachiocephalic (BC) group compared with the brachio-basilic (BB) group (p&lt;0.001). There was no significant difference in the thirty day mortality, wound complications, 24hr thrombosis, postoperative haemorrhage, maturation, and time to maturation between the groups. Primary patency at 1 and 3 years of follow-up was 87% and 81% for the BC group and 86% and 73% for the BB group (P=0.7).</td>
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<td>Keuter et al (2008)[13]</td>
<td>105</td>
<td>Randomized multicentre study</td>
<td>Haemodialysis patients with failed primary/secondary access or inadequate arterial and/or venous vessels. Patients were randomized for either</td>
<td>12</td>
<td>Primary and assisted-primary 1-year patency rates were significantly higher in the BBAVF group: 46% ± 7.4% vs 22 ± 6.1% (P=0.05) and 87 ± 5.0% vs 71 ± 6.7% (P=0.045) for the BBAVF and PTFE group, respectively. The incidence rate of complications was 1.6 per patient-year in the...</td>
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| Rooijens et al (2005)[14] | 383 total 182 randomised | Prospective randomised study | Pre-haemodialysis patients needing vascular access. A subgroup of patients were randomised for either a radiocephalic arteriovenous (RCAVF) graft or a prosthetic (polytetrafluoroethylene [PTFE]) graft | 12                | BBAVF group vs 2.7 per patient-year in the PTFE group.  
  - Patients in the BBAVF group had 1.7 vs 2.7 interventions per patient-year in the PTFE group.  
  - Primary and assisted primary 1-year patencies were 33 ± 5.3% vs 44 ± 6.2% (P=0.03) and 48 ± 5.5% vs 63 ± 5.0% (P=0.035) for the RCAVF and prosthetic AVF respectively.  
  - Patients with RCAVFs developed 102 complications vs 122 complications in the prosthetic AVF.  
  - The RCAVF group needed 43 interventions for access salvage vs 79 in the prosthetic graft group (P=0.077). |
| Maya et al (2004)[19]       | 323      | Prospective study             | Haemodialysis patients referred for a fistulogram during a 2-year period   |                   |  
  - 543 fistulograms were performed: 358 in grafts and 185 in fistulas  
  - Significant stenosis was substantially lower in fistulas than grafts (39.4% versus 68.7%; P < 0.001)  
  - Female gender, residual stenosis, and high post-procedure access pressure ratio are each predictive of shorter access patency after elective angioplasty |
| Pisoni et al (2002)[5]      | >6400    | Prospective study             | Haemodialysis, hemofiltration, or hemodiafiltration patients from DOPPS study >17 years of age |                   |  
  - Access use in Europe was: 66% AVF, 31% catheters and 2% grafts versus 15%, 60% and 24% in the US respectively.  
  - AVF survival was superior to grafts regarding time to first failure (RR=0.53, P=0.0002),  
  - AVF survival was longer in EUR compared with the US (RR=0.49, P=0.0005).  
  - AVF and grafts displayed better survival if used when initiating HD compared with being used after commencing dialysis with a catheter.  
  - Facilities’ preferences and approaches to vascular access practice are major determinants of vascular access use |
| Gibson et al (2001)[15]     | 1583     | Prospective study             | Haemodialysis patients                                                     | 11                |  
  - Primary patency rates at 1 and 2 years for simple AVFs were 56.1% and 39.8% respectively, compared with 38.2% and 24.6% for synthetic grafts (P<0.001)  
  - Prosthetic grafts were associated with a 41% increase in risk of primary failure compared with simple AVFs (RR, 1.41; 95% CI, 1.22 – 1.64; P<0.001) |
| Kalman et al (1999)[17]     | 384      | Prospective study             | Haemodialysis patients                                                     | 24                |  
  - Primary success for AVFs and AVGs at 2 years was 54% and 18% respectively (P<0.001; log rank test)  
  - Primary assisted success for AVFs and AVGs at 2 years was 62% and 44% respectively (P<0.001; log rank test)  
  - Secondary success for AVFs and AVGs at 2 years was 70% and 60% respectively (P=0.331; log rank test) |
| Weale et al (2008)[18]      | 658      | Retrospective study           | Patients undergoing a first surgical access procedure for a                 | 24                |  
  - Age did not affect usability; primary or secondary patency of either RCAVFs or BCAVFs. |

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<table>
<thead>
<tr>
<th>Study ID</th>
<th>N</th>
<th>Study Design</th>
<th>Participants</th>
<th>Follow up (months)</th>
<th>Comments and Results</th>
</tr>
</thead>
</table>
|         |    |                       | radiocephalic (RC) or brachiocephalic (BC) arteriovenous fistula (AVF)       |                   | - Female sex (HR, 2.24; 95% CI, 1.387 to 3.643; P=0.001) was associated with an increased risk of RCAVF non-use,  
- Diabetes (HR, 2.095; 95% CI, 1.261 to 3.482; P=0.004) was associated with an increased risk of BCAVF non-use.  
- Only female sex (HR, 1.679; 95% CI, 1.261 to 2.236; P = .001) and prior hemodialysis (HR, 1.363; 95% CI, 1.0.29 to 1.804; P = .031) were associated with loss of patency of RCAVFs.  
- Even patients ≥ 80 years who are considered suitable for surgical access placement, should not be denied a RCAVF solely because of age. |
| Fitzgerald et al (2005)[23] | 146 | Retrospective study   | Haemodialysis patients                                                       | 24                | - Time to first use: 3.8mths for upper arm arteriovenous fistula (UA-AVF) and 1.8mths for forearm looped arteriovenous graft (FAL-AVG)  
- Complication rates were 42% for UA-AVF and 65% for FAL-AVG  
- Thrombosis was more common in FAL-AVFs than UA-AVFs (42% vs. 17%, p = 0.001),  
- Non-elective reintervention more common in FAL-AVGs than UA-AVFs (50% vs. 30%, p = 0.016)  
- Patency rates were similar at 1 and 2 years  
- UA-AVF's may be a better choice for chronic haemodialysis access because of a lower incidence of complications and non-elective reinterventions. |
| Maya et al (2009)[21] | 678 | Retrospective study   | Haemodialysis patients                                                       |                   | - Primary access failures were less common for BB AVF and grafts compared with BC AVF (18%, 15%, and 38%; hazard ratio of BC avf vs BB avf 2.76; 95% CI 1.41 to 5.38, P<0.003).  
- Vascular diameters predicted primary failure in patients with a BC AVF (p< 0.001).  
- When primary failures were excluded, cumulative access survival was similar for BB and BC avf, but superior to that of grafts.  
- Access interventions per year were lower for BB and BC avf than for grafts (0.84, 0.82 and 1.87 respectively, P<0.001) |
| Cost    |    |                       |                                                                               |                   |                                                                                                                                                                                                                                                                                                                                                   |
| Manns et al (2005)[26] | 239 | Prospective study     | Haemodialysis patients                                                       | 12                | - 18.4% of all hospital admissions were vascular access related complications  
- Mean cost of access care per patient-year at risk for maintaining a catheter exclusively, attempting an arteriovenous fistula, or attempting a graft was CAN$9,180 (median $3812), $7,989 (median $4641) and $11,685 (median $8152) respectively (P=0.01)  
- Risk of death in the first year was 51%, 15.9% and 15.1% for catheter only, avf and graft patients respectively. |
<p>| Lee et al (2002)[25]    | 166 | Prospective study     | Haemodialysis and peritoneal dialysis patients                               | 12                | - The cost of vascular access care was lower by more than fivefold for patients who began the study period with a functioning native AVF. |</p>
<table>
<thead>
<tr>
<th>Study ID</th>
<th>N</th>
<th>Study Design</th>
<th>Participants</th>
<th>Follow up (months)</th>
<th>Comments and Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ortega et al (2005)[9]</td>
<td>96</td>
<td>Retrospective cohort study 1996 - 2003</td>
<td>Hemodialysis patients divided into 3 groups: Fistula only patients (G1), Catheter plus fistula (G2), Catheter only patients (G3)</td>
<td></td>
<td>• G1 patients appear to have a lesser risk of death (relative risk, 0.39) than G2 and G3 patients, as do G2 relative to G3 patients.</td>
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<tr>
<td></td>
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<td></td>
<td>• Patients with an adequate and functioning AVF lived longer than the others, and the cost of each 'death prevented' was lower € 3,318, € 7,982 and € 9,471 for G1, G2, and G3 respectively.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The lack of an adequate AVF at the start of haemodialysis significantly decreases survival, even if: patients are not diabetic; are referred to a nephrologist early; and planned haemodialysis is initiated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• If AVF access were 66% rather than the observed 35%, then the Centre for Medicare and Medicaid Services would save $840 million in access-attributed expenditures over the expected lifetime of these patients.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The shift to 66% AV fistula creation would mean an incremental cost of $40,000 per year of life gained.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The 66% AV fistula target is cost-effective.</td>
</tr>
</tbody>
</table>
### Table 1a. Characteristics of included RCTs

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>N</th>
<th>Setting</th>
<th>Participants</th>
<th>Intervention (experimental group)</th>
<th>Intervention (control group)</th>
<th>Follow up (months)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koksoy et al (2009)[12]</td>
<td>50 = BCAVF 50 = BBAVF</td>
<td>RCT  Single centre, Turkey</td>
<td>Haemodialysis patients who had lost distal AVF with patent basilic and cephalic veins greater than 3 mm in diameter, were randomised to have either a brachiocephalic arteriovenous fistula (BCAVF) or a brachiobasilic arteriovenous fistula (BBAVF)</td>
<td>Creation of BCAVF</td>
<td>Creation of a BBAVF</td>
<td>43.2 ± 1.8</td>
<td>Outcome measures: duration of operation; mortality, wound complications, 24 hr thrombosis, postoperative haemorrhage, maturation, primary and secondary patency.</td>
</tr>
<tr>
<td>Keuter et al (2008)[13]</td>
<td>52 = BBAVF 53 = PTFE loop</td>
<td>RCT  Multicentre study, Netherlands</td>
<td>Patients with failed primary/secondary access or inadequate arterial and/or venous vessels were randomised for either a BBAVF or a prosthetic brachial-antecubital forearm loop (PTFE loop)</td>
<td>Creation of a BBAVG</td>
<td>Creation of a PTFE loop</td>
<td>12</td>
<td>Primary and assisted-primary 1-year patency rates; Secondary patency rates; complications</td>
</tr>
<tr>
<td>Rooijens et al (2005)[14]</td>
<td>92 = RCAVF 90 = PTFE</td>
<td>RCT  Multicentre study, Netherlands</td>
<td>Pre-haemodialysis patients needing vascular access. A subgroup of patients were randomised for either a radiocephalic arteriovenous (RCAVF) graft or a prosthetic (polytetrafluoroethylene [PTFE]) graft</td>
<td>Creation of a RCAVF</td>
<td>Creation of a PTFE graft</td>
<td>12</td>
<td>Primary and assisted primary 1-year patency; secondary patencies; complications and interventions</td>
</tr>
</tbody>
</table>

### Table 2a. Methodological quality of randomised trials

<table>
<thead>
<tr>
<th>Study ID (author, year)</th>
<th>Method of allocation concealment *</th>
<th>Blinding (participants)</th>
<th>Blinding (investigators)</th>
<th>Blinding (outcome assessors)</th>
<th>Intention-to-treat analysis †</th>
<th>Loss to follow up (%)</th>
<th>Comments ‡</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dietary protein restriction</strong></td>
<td>Computerised</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>–</td>
</tr>
<tr>
<td>Koksoy et al (2009)[12]</td>
<td>Computerised</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unclear</td>
<td>–</td>
</tr>
<tr>
<td>Keuter et al (2008)[13]</td>
<td>Computerised</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unclear</td>
<td>–</td>
</tr>
<tr>
<td>Rooijens et al (2005)[14]</td>
<td>Not stated</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Unclear</td>
<td>–</td>
</tr>
</tbody>
</table>

* Choose between: central; third party (e.g. pharmacy); sequentially labelled opaque sealed envelopes; alternation; not specified.
† Choose between: yes; no; unclear.
‡ Quality score – “How successfully do you think the study minimised bias?” Choose between: very well (+); okay (Ø); poorly (−).
Table 3a. Results and quality rating for dichotomous outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Study ID (author, year)</th>
<th>Intervention group (no. of patients with events/no. of patients exposed)</th>
<th>Control group (no. of patients with events/no. of patients exposed)</th>
<th>Relative risk (RR) [95% CI]</th>
<th>Risk difference (RD) [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complications</td>
<td>Koksoy et al (2009)[12]</td>
<td>BBAVF 7/50</td>
<td>BCAVF 6/50</td>
<td>1.17 [0.42, 3.23]</td>
<td>0.02 [-0.11, 0.15]</td>
</tr>
<tr>
<td></td>
<td>Rooijens et al (2005)[14]</td>
<td>RCAFV 102/86</td>
<td>PTFE 122/84</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Interventions</td>
<td>Koksoy et al (2009)[12]</td>
<td>BBAVF 4/50</td>
<td>BCAVF 8/50</td>
<td>0.50 [0.16, 1.55]</td>
<td>-0.08 [-0.21, 0.05]</td>
</tr>
<tr>
<td></td>
<td>Keuter et al (2008)[13]</td>
<td>BBAVF 1.7 per patient-year</td>
<td>PTFE 2.7 per patient-year</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Rooijens et al (2005)[14]</td>
<td>RCAFV 43/86</td>
<td>PTFE 79/84</td>
<td>0.53 [0.43, 0.66]</td>
<td>-0.44 [-0.56, -0.32]</td>
</tr>
</tbody>
</table>

*NA = Not available

Table 3b. Results and quality rating for continuous outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Study ID (author, year)</th>
<th>Intervention group (mean [SD])</th>
<th>Control group (mean [SD])</th>
<th>Difference in means (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of operation (min)</td>
<td>Koksoy et al (2009)[12]</td>
<td>BBAVF 86.02 (4.39)</td>
<td>BCAVF 44.68 (2.16)</td>
<td>41.34 [39.98, 42.70]</td>
</tr>
<tr>
<td>Duration of maturation (days)</td>
<td>Koksoy et al (2009)[12]</td>
<td>BBAVF 33.4 (1.78)</td>
<td>BCAVF 39.4 (3.89)</td>
<td>-6.00 [-7.19, -4.81]</td>
</tr>
<tr>
<td>Survival rate (months)</td>
<td>Koksoy et al (2009)[12]</td>
<td>BBAVF 43.61 (2.4)</td>
<td>BCAVF 39.52 (2.2)</td>
<td>4.09 [3.19, 4.99]</td>
</tr>
<tr>
<td>1-year primary patency (%)</td>
<td>Keuter et al (2008)[13]</td>
<td>BBAVF 46 (7.4)</td>
<td>PTFE 22 (6.1)</td>
<td>24.00 [21.35, 26.65]</td>
</tr>
<tr>
<td>Secondary patency rates (%)</td>
<td>Keuter et al (2008)[13]</td>
<td>BBAVF 89 (4.6)</td>
<td>PTFE 63 (5.9)</td>
<td>-15.00 [-16.72, -13.28]</td>
</tr>
<tr>
<td></td>
<td>Rooijens et al (2005)[14]</td>
<td>RCAFV 52 (5.5)</td>
<td>PTFE 79 (5.1)</td>
<td>-27.00 [-28.59, -25.41]</td>
</tr>
</tbody>
</table>