Ultrasound monitoring to detect access stenosis in hemodialysis patients: a systematic review

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CRD summary
This review concluded that there was no evidence that screening with access blood flow measurements or Doppler ultrasound benefited haemodialysis patients with grafts; screening might prevent access thrombosis in arteriovenous fistulas, but might not reduce the risk of access loss and the resource use. The review was generally well conducted and the cautious conclusions accurately reflect the available data.

Authors' objectives
To determine whether routine measurement of access blood flow or Doppler ultrasound improved the clinical outcomes in haemodialysis patients and to determine whether any benefits were greater for fistulas than for grafts.

Searching
MEDLINE, EMBASE, Pascal, the Cochrane Library, and Scopus were searched for articles from inception to May 2007, without restriction for language or publication status. The detailed search strategies were reported online.

Study selection
Randomised or quasi-randomised controlled trials, in adult haemodialysis patients with permanent arteriovenous access (fistulas or grafts) were eligible for inclusion if they compared surveillance by access blood flow measurement or Doppler ultrasound with another method, such as static or dynamic venous pressure or clinical monitoring, or no surveillance. Included trials had to report one of the following outcomes: access loss (defined as abandonment of access), thrombosis (regardless of whether this resulted in access loss), primary patency, secondary patency, resource use (such as the number of procedures or hospital days), and adverse events. The primary outcome was access thrombosis.

All the included trials compared screening, using regular access blood flow measurements or Doppler ultrasound, with standard care. The median follow-up period was 15 months (range six to 30 months). In most of the trials, all participants also received clinical monitoring surveillance. The mean age of participants, in the intervention group, ranged from 55 to 63 years and the percentage who were male ranged from 34 to 67, where reported. The baseline median access blood flow was 1,108mL per min (range 442 to 1,801mL/min) and stenosis was defined as at least 50% reduction in luminal diameter, in all trials, except one that did not report a definition.

Titles and abstracts were screened by a topic specialist and a methodologist and any trial that was considered to be relevant by either of them was retrieved. The full texts were assessed for inclusion by two reviewers and any disagreements were resolved by discussion with a third person.

Assessment of study quality
The quality of the included trials was assessed using criteria associated with internal validity: method of allocation concealment, randomisation technique, double blinding, and description of withdrawals. Information on the funding source was also extracted.

Two reviewers independently assessed trial quality and any disagreements were resolved by discussion with a third party.

Data extraction
For dichotomous outcomes, data were extracted on the number of events in the intervention and control groups and these were used to calculate the relative risk with 95% confidence interval and the relative rate, which was the treatment rate divided by the control rate. Hazard ratios for the time to event data were extracted directly from the included trials.
One reviewer extracted the data and a second reviewer checked it for accuracy.

**Methods of synthesis**

Summary effect measures were calculated for each outcome using a random-effects model, weighted by the inverse variance. Meta-regression was used to assess whether the access type (graft or fistula) influenced the association between access blood flow or Doppler-based surveillance and access thrombosis; the data were analysed separately by access type where the results of the meta-regression were significant. A sensitivity analysis was also conducted to explore the impact of dynamic venous pressure monitoring as a co-intervention.

Between-trial heterogeneity was assessed using the $I^2$ statistic. Publication bias was not assessed due to the small number of included trials.

**Results of the review**

Eleven articles, reporting findings of 12 comparisons with a total of 1,164 participants, were included in the review. All but one of the trials were fully randomised, but only three reported adequate methods of allocation concealment. Blinding of participants was reported by only two trials and another trial reported blinding of both participants and outcome assessors. An intention-to-treat analysis was used in three trials and most of them (10) reported some information on withdrawals or loss to follow-up.

The meta-regression supported the grouping of the data by access type.

**Arteriovenous fistula** (four trials): Access blood flow or Doppler ultrasound screening significantly decreased the risk of access thrombosis (RR 0.47, 95% CI 0.28 to 0.77; four trials), but did not change the risk of fistula loss (RR 0.65, 95% CI 0.28 to 1.51; two trials), nor overall resource use. Two trials indicated a significant increase in time to thrombosis and one trial indicated a significant increase in time to access loss. One trial indicated a significant decrease in the number of catheterisations and another in hospitalisations. Grouping of trials by the use of dynamic venous pressure monitoring did not significantly affect the results. One trial reported an adverse event (excess bleeding after dialysis).

**Grafts** (eight trials): Screening did not significantly affect the risk of thrombosis (six trials), time to thrombosis (one trial), and the risk of graft loss (four trials). Two trials examined the time to access loss in patients with grafts and found no effect for screening. Screening increased the number of percutaneous interventions (RR 1.29, 95% CI 1.04 to 1.60; five trials) and decreased the risk of daily catheter insertions (RR 0.59, 95% CI 0.37 to 0.93; one trial) in patients with grafts.

**Authors’ conclusions**

There was no evidence that screening with access blood flow measurements or Doppler ultrasound was of benefit to patients with grafts. Access blood flow screening might prevent access thrombosis in arteriovenous fistulas, but might not reduce the risk of access loss and the extent of resource use.

**CRD commentary**

This review addressed a clearly stated research question, which was defined by appropriate inclusion criteria. A number of sources of potentially relevant trials were searched and no restrictions on language or publication status were made, which reduces the risk of bias and maximises the retrieval of relevant trials. Measures were taken, throughout the review process, to reduce the potential for error and bias. The methodological quality of included trials was assessed and included in the interpretation of the results. The meta-analysis techniques were broadly appropriate, but their interpretation would have been aided by the reporting of the results of individual trials.

The authors’ conclusions were appropriately cautious.

**Implications of the review for practice and research**
Practice: The authors stated that the available data did not support the routine use of access blood flow screening for patients with arteriovenous grafts. For patients with arteriovenous fistulas, clinicians should offer screening based on the decreased risk of an intermediate clinical outcome (fistula thrombosis), but there was no proven benefit and not offering screening was also valid.

Research: The authors stated that access blood flow screening, for patients with arteriovenous fistula, should be further evaluated in a large randomised controlled trial, powered to detect decreases in the risk of fistula loss and resource use. For grafts, future research should investigate how to improve the efficacy of percutaneous intervention. Future trials should report thrombosis, access loss, costs, and hospitalisation by treatment groups to aid the interpretation of the results.

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