

EDUCATIONAL ARTICLE

Population Requirements for Vascular Access Surgery

K. Donovan*

University Hospital of Wales, Cardiff, UK

The native arterio-venous fistula provides the best access for haemodialysis. The dialysis population is growing in number, becoming more elderly, and has increasingly complex medical co-morbidity. The ability to establish and maintain optimal haemodialysis access in this population requires the planning and commissioning of operating and diagnostic facilities and the training of sufficient suitable surgical specialists. This article outlines the major factors that influence the demand for and requirements of a vascular access service for the renal failure population.

Keywords: Dialysis; Vascular access; Demography.

Introduction

The delivery of good haemodialysis with adequate clearance of harmful accumulating solutes is fundamentally dependent on the quality of access to a patient's circulatory system. This must be reliably and repeatedly accessible, should provide high blood flow rates, and have low complication rates. Published evidence, national guidelines, and current professional opinion are all agreed that the gold standard to achieve good access is the native arterio-venous fistula (AVF). Since, Brescia and Cimino first described a novel and reliable method of an AVF formation,¹ numerous variations and adaptations have evolved, and the provision and maintenance of the many types of vascular access has become a complex, multi-disciplinary sub-specialty in its own right.

To assess population requirements for access surgery a number of interrelated variables need consideration:

- The number of new (incident) patients.
- The size of the stock of patients who are on dialysis or with transplants (prevalence).
- The co-morbidity of patients.
- The type of access desired.

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*Corresponding author. Dr Kieron Donovan, Consultant Nephrologist, University Hospital of Wales, Heath Park, Cardiff CF14 4XW, UK.

E-mail address: donovankl@cf.ac.uk

- Targets and standards to achieve.
- Audit of performance against these standards.

The Dialysis Population—The Size of the Problem

The number of patients requiring dialysis is growing across the developed and developing world, though at quite different rates.^{2–4} In the UK overall growth of the prevalent dialysis population is 5% per annum but as much as 8% per annum for haemodialysis.³ There is a dynamic relationship between incidence, transplant rate/success and overall mortality that determines the prevalent population on dialysis (Fig. 1) and ultimately determines the crude numbers of patients requiring access surgery. However, there are a number of other factors that could also influence the demands on surgery and the types of access offered:

- Patient age/co-morbidity

Patients accepted for dialysis are increasingly elderly and with co-morbidities such as vascular diseases and malignancies. Such patients tend to require more support during their treatment and so tend to default to supervised haemodialysis facilities. In patients with severe co-morbidity, poor vessels, or who have a limited prognosis, creation of an AVF may be neither possible nor appropriate.

- Diabetes

Type II diabetes mellitus is now the commonest cause of renal failure in the Western world^{2,4} and is

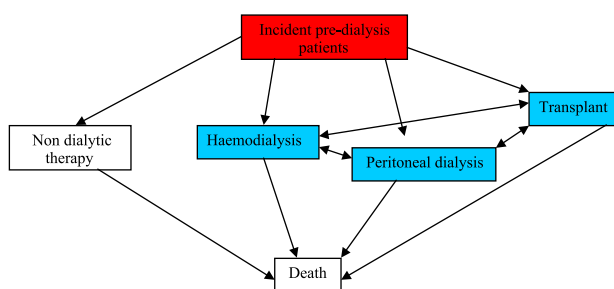


Fig. 1. Dynamic relationship between new (incident—red) patients and modes of renal replacement therapy in established (prevalent—blue) patients in the renal failure population.

associated with vascular disease and cardiac problems. The outcome of AVFs created in patients with diabetes is worse than those in non-diabetics,⁵ creating more subsequent work in the form of revision surgery and/or interventional radiology.

- Modality choice

Generally, about 60–70% of patients choose haemodialysis as their treatment modality and, therefore, require vascular access.^{2,4} In countries with a high proportion of peritoneal dialysis (PD) vascular access load is less, as was the case in the UK in the 80's and early 90's. More recently haemodialysis proportions in the UK have increased in line with the rest of Europe.^{2,3} Despite advances in technology, PD still has a comparatively limited treatment lifetime, averaging around 2–3 years after which HD is the only remaining therapy mode in the absence of a transplant.

- Late presenters

There is a significant tranche of patients who require urgent dialysis within weeks or days of presentation. Such late presenters comprise about 15–30% of all new patients, and are important for several reasons:⁶ firstly, they start dialysis with temporary catheters which has been shown to compromise future AVF survival;⁷ secondly, they have had no time for formal education or information about dialysis options and they are much more likely to opt for haemodialysis as long term treatment; thirdly, there will be a delay in providing permanent access due to their immediate instability, the wait for them to make a modality choice and subsequent delays in operation and maturation. These patients are intensive consumers of resource and they have a much worse outcome than patients who have been through the low clearance renal education system with planned and established access.

- Access patency

Vascular access that is unreliable, troublesome, or prone to thrombosis or infection will inevitably create more work increase hospitalisation, and may result in inadequate dialysis and associated medical problems.⁸ The establishment of timely, reliable vascular access from the outset reduces the subsequent access workload. Surveillance and early intervention when access fails to mature or if function becomes problematic may obviate the need for repeat operations.⁹

The combination of primary choice of dialysis mode, the preferences of late presenters, the relatively limited lifespan of PD as a treatment, the co-morbidity and dependence of the dialysis population, and the dearth of organ donors for transplantation inevitably increases pressure on in-centre haemodialysis capacity and vascular access surgery provision.

What is Best?

Both the numbers and types operations required will influence the shape of a vascular access service for the renal failure population. There is general agreement that, where possible, a native AVF should be the first choice.^{3,10} Despite higher primary failure rates, reduced secondary failures of autologous fistulae ensure improved success over prosthetic fistulae or permanent central lines.⁷ Once matured, patency at 5 years is about 50%.^{11,12} Primary failure rates are influenced by the site of AVF creation; the use of more distal veins, age, obesity, diabetes, vascular disease,⁵ a history of previous failure or a vein diameter of <2 mm.¹³ Higher risk patients may warrant a more thorough pre operative assessment using Doppler mapping and more frequent post-operative assessment to ensure satisfactory fistula maturation.¹⁴ Surgical and radiological intervention may improve outcome in problematic AVFs.⁹ Autologous fistulae have fewer complications than prosthetic grafts with 2–5 times lower infection rates^{15,16} 4 times lower thrombosis rates and 3 times lower reintervention rates.¹⁷

Prosthetic AV grafts, using native harvested veins or synthetic materials such as PTFE, offer an alternative sealed subcutaneous access in patients with unsuitable veins which is clearly superior to tunnelled lines but inferior to autologous AV fistulae in terms of survival and complication rates.⁷

Tunnelled lines have the advantage of providing immediate access and they may be used when an AVF or graft is contraindicated, technically impossible or refused, but in other respects they are inferior to native AVFs and grafts. The commonest reasons for failure of

tunnelled lines are infection, with bacteraemia occurring at about 2 per 1000 catheter days,^{18,19} and poor blood flow (<300 ml/min), which occurs at least once during the life of a catheter in almost 90% of patients.²⁰

Medical practice is increasingly driven by protocols and evidence based targets. In the UK the Renal Association has outlined minimum standards against which most units are now audited by electronic data returned to the UK Renal Registry²¹ but as yet no data about vascular access has been recorded or analysed. The UK Renal Association targets for access²¹ are similar to those already achieved across Western Europe in the DOPPS I study.⁷ They state that 67% planned patients should start dialysis with an AVF; that 80% of prevalent patients have a functioning AVF, and that once referred to a surgeon, no patient should wait for >4 weeks for an AVF.

The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) recommendations for vascular access are that an AVF should be used in 40% of prevalent and 50% of incident patients. Catheters should be used in 10% of prevalent patients. The suggested order of access preference is for a radio-cephalic AVF, then brachio-cephalic, followed by a synthetic graft, brachio-basilic transposition and finally a tunnelled line.¹⁰

What are We Actually Doing?

Accurate data from around the world provide useful insights into the patterns of provision of vascular access. Many countries and regions have reliable databases that greatly facilitate audit and allow observation of changes of practice. These include the USRDS, ANZDATA, ERA-EDTA and UK Renal Registry. The Dialysis Outcomes and Patterns Practice Study (DOPPS) I and II are landmark, longitudinal, prospective studies of dialysis practice based on standardised information collection. The original study, started in 1996, included data from 17,000 patients in over 300 facilities in Germany, UK, Japan, France, Spain and the USA. DOPPS II was started in 2002, included patients from the original cohort of countries and added others from Australia, Belgium, New Zealand and Sweden.

It is clear that there are widely disparate patterns of vascular access. For example, pooled data from the European countries involved showed that all, with the exception of the UK, achieved and exceeded the UK Renal Association Standards (Table 1). Despite the recommendations of NKF-K/DOQI, the pattern of practice in the USA differs markedly from that in Europe and Japan and it has been suggested that this is

Table 1. Summary data from the DOPPS I study showing achievements in vascular access provision in Europe and the USA for incident and prevalent patients

	Incident patients		Prevalent patients	
	Europe	USA	Europe	USA
AVF	66	15	80	24
CVC	31	60	8	17
Graft	2	24	10	58
Permanent access at start	75	54		

a result of different co-morbidities.^{7,22} Nevertheless there is some encouraging evidence that the NKF-K/DOQI suggestions and targets are altering practice and improving the prevalence of AVFs in the USA.²³

What is Needed Now and in the Future?

Estimates of the access workload required to meet European targets are based on experience over a number of years in large centres. In 2001, the UK Kidney Alliance suggested that one operating session was required per 120 patients on dialysis. This was based on observations in several large UK centres where they estimated that there would be 100 AVFs, 50 PD catheter insertions, 100 tunnelled lines and 400 temporary lines per million population served by a unit.²⁴ This model assumes current UK demography, workloads and practice. As HD prevalence rises and there is a shift towards permanent AV fistulae from temporary lines then the number of AVF related procedures would need to increase.

Data from one unit in South Wales, where the prevalence of AVF is above the UK average at 80%+, used a model based on the incidence and prevalence rates/2 to estimate the number of access procedures necessary.²⁵ Using the latest UK data suggesting an annual dialysis incidence of 100 per million and a dialysis prevalence of 350 per million, the model predicts the need for 200 surgical procedures per million population per annum, of which about ~65% would be AVF related. As both incidence and prevalence continue to rise the requirements will also grow.

Models of care to enable the delivery of this service will vary according to local surgical expertise, theatre space and interventional radiological support. Nephrology services should identify the size and complexity of their vascular access requirements and commission expertise and resources accordingly. In some countries, including the UK, over-reliance on the small pockets of expertise concentrated in large transplant centres has resulted in under-investment in the many new dialysis

units who may lack local expertise, and as a result, fail to meet the minimum standards. The challenge is to address this deficit in resource and plan for the future. A number of models of service delivery have been suggested including the building of separate specialist access units or even mobile access theatres; the development of vascular surgical networks with renal centres, and the establishment of renal support as a core element in future vascular surgical appointments. The Vascular Society of Great Britain and Northern Ireland has recognised this important need and has encouraged training in renal access work by vascular surgical trainees.

Conclusions

The establishment of reliable vascular access for haemodialysis patients is critical to their future care and outcome. Where possible, a native AVF should be created and maintained by dedicated access or vascular surgeons and interventional radiologists. Demand for these procedures is increasing due to the rise in demand for dialysis and the increasing complexity of the patients. Current suggested guidelines and targets are not met consistently and to do so will require significant investment in skilled personnel and supporting facilities. Identification and characterisation of the population requirements is essential to give an indication of the resources needed, though the precise model through which to deliver the care is still undecided. Increasing the expertise in vascular access within vascular surgical training and raising the profile of this life enhancing subspecialty is a 'sine qua non'.

Summary

- Establishment and maintenance of reliable vascular access is key to the success of haemodialysis.
- The native arteriovenous fistula is the gold standard.
- Demand for primary access and revision surgery will grow as numbers and complexity of patients on dialysis continue to increase.
- International audit shows diversity in the provision and patterns of access surgery.
- Models to enable estimates of the number of procedures required and regular audit should facilitate the planning and allocation of resource and skills.
- Investment in vascular surgical training, operating facilities, and interventional radiology is required to address current shortfalls and future demand.

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