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Full Title: A national appraisal of haemodialysis vascular access provision in Scotland

Short Title: A national appraisal of haemodialysis vascular access provision in Scotland

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Online-only supplementary material:

1. Recommendations arising from Scottish Vascular Access Appraisal project
2. Clinical process diagrams describing the clinical pathways for vascular access creation and vascular access maintenance in Scottish renal units

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Abstract

Purpose

Published registry data demonstrates longstanding variation in the utilisation of different vascular access (VA) modalities between Scottish renal units; this may reflect different clinical processes between centres. A comprehensive appraisal was undertaken to understand the processes underpinning VA creation and maintenance across Scotland.

Methods

A mixed methods approach was utilised. Fifty-two semi-structured interviews were conducted with patients and clinicians in all ten, adult and paediatric, Scottish renal units. Interview transcripts were subjected to thematic analysis. Clinical activity data was prospectively collected for six weeks, and correlated with registry data.

Results

VA accounts for a large clinical workload. There was significant inter-centre variation in the utilisation of different VA modalities, and patients described frustrating, dissatisfying experiences. VA creation and maintenance pathways functioned best when nephrologists, surgeons and radiologists were co-located on the same campus with close multi-disciplinary working, protected clinical time, and proactive VA maintenance. No unit routinely measured or discussed procedure outcomes or strategic aspects of their service..

Conclusions

Varied clinical outcomes reflected varied clinical processes. Optimised clinical pathways, staff education and measurement of clinical outcomes may improve VA service quality and facilitate safer, more effective, patient-centred care.

Key Words

Arteriovenous fistula

Central venous catheter

Health services administration

Hemodialysis

Interdisciplinary communication

Vascular access

Introduction

The morbidity and mortality profile of haemodialysis (HD) varies significantly depending on means of the vascular access (VA) used(1,2). A tension exists between the logistical challenges of delivering the survival benefit of arteriovenous fistulae (AVF), against the comparative ease of placing central venous catheters (CVC). AVF creation requires formal surgical procedures that frequently prove unsuccessful, then several weeks maturation before use; whereas CVCs can be inserted rapidly, with minimally invasive procedures, and used immediately.

Significant worldwide variation has been observed in the proportion of patients using AVF versus CVCs for haemodialysis(3-5). In Scotland variation is seen between individual centres that serve similar populations(5-7), implying differences in VA service organisation between centres.

VA and its inherent complexity can be framed in the context of socio-technical systems literature, where systems are groups of interdependent and interacting components that together form a whole(8,9). Component interaction is complex and generates the system's emergent properties(10). Whole system analysis is needed to inform meaningful change(10). We characterised VA in this way and attempted to understand it as a complex system, seeking to identify system components and the nature of their interactions. We appraised the organisation of VA services in every Scottish renal unit in this way, and contextualised our findings using clinical activity data. We intended that this would illuminate opportunities to improve clinical care.

Methods

We drew upon validated socio-technical frameworks(9,11,12) to design our mixed-methods data collection strategy.

Qualitative data collection

We conducted semi-structured interviews in every Scottish renal unit. We utilised recruitment strategies and interviewing techniques(13) that have proven successful in other 'hard to reach' areas of practice(14). Interviewees were recruited by purposive sampling, augmented by snowballing(14-16). At least one nephrologist, surgeon, radiologist, vascular access nurse (VAN) and (adult) patient were interviewed per centre for maximum variation(15). Interviews were conducted until data saturation(17,18) was reached.

Interviews were conducted privately, with just interviewers and solo interviewees present. (For logistical reasons one interview involved two interviewees.)

Interviewees provided written consent. One researcher (SO) led every interview with supplementary questioning by accompanying researchers. A structured interview guide, constructed with reference to socio-technical systems principles(11) and qualitative interviewing literature(13), was augmented by emergent probing(13) and constant comparison to optimised interview format and data capture(19,20).

Interviews were audio-transcribed. One researcher (SO) became immersed in the data(19), conducting line-by-line thematic analysis(18,21) using NVivo version 10 (QSR International Pty; Melbourne, Australia). The coded dataset was further analysed and summary themes drawn out for detailed consideration by group consensus.

Quantitative data collection

Each adult centre was invited to prospectively record VA-related clinical activity over a six-week period (26/01/15 – 06/03/15), using pre-formatted spreadsheets to record hospital attendances, requested and completed radiological or surgical procedures. This was considered alongside published registry data>.

Data was analysed using Microsoft Excel (Microsoft Corporation; Seattle USA) and Tableau version 8.1 (Tableau Corporation; Seattle, USA). Data was anonymised at individual participant and patient level, but renal units remained identifiable.

Ethical approval

The Scottish Renal Registry has permission from the Scottish Government to hold non-anonymised individual-level patient data. This study was considered 'service evaluation' and further ethics committee review was not sought.

Results

Workload

A high VA-related workload was recorded across Scotland, with 520 separate radiological and surgical procedures performed across a six-week period (table 1).

[table 1]

Published registry data(5) demonstrates the proportions of VA modalities used in each centre.

Thematic Analysis

Insights into vascular access service provision, and potential improvements, are summarised in four broad themes:

1) *Patient Experience*

No centre routinely surveyed patients' opinions or experiences having access created, maintained or used. Patients expressed gratitude towards individual clinicians but spoke negatively of their lived experience. Patients reported multiple, painful attempts to insert CVCs; and futile passage through convoluted fistula-creation pathways only for the fistula to fail:-

“In fact at one stage I thought oh ‘I’ve got to have this again – I’ll just die’ you know... I’d rather just go on and be... it was really bad.” (Patient)

Clinicians reported robust VA education programmes for patients, but patients had only vague recollections of such education despite giving detailed accounts of other clinical experiences.

2) *Access Creation*

Clinical pathways in use by each renal unit are presented in web appendix 2.

(Web appendix 2 – Clinical process diagrams describing the clinical pathways for vascular access creation and vascular access maintenance in Scottish renal units)

Clinicians considered fast clinical pathways key to successful access creation, but no unit routinely monitored timelines. Most nephrologists considered VA creation referral when renal function passed an arbitrary threshold ranging between estimated glomerular filtration rate (eGFR) 12-20ml/min. Projected haemodialysis timing was universally considered better than eGFR, but no unit had reliable ways of predicting this.

Most centres utilised specialist nurse-provided “RRT education”, with subsequent VA referral for patients choosing haemodialysis. PD typically involved different staff and

separate pathways. Referral mechanisms ranged from informal verbal discussion to standardised, electronic forms.

Capacity to perform duplex ultrasound vein mapping was considered important. Units describing “rapid” access creation typically had co-located imaging, surgical and nephrology services, and operated ‘one-stop clinics’ with a surgeon, VAN and sonographer present. VAN and surgeons in Unit 7 reported success with VAN-led assessment and theatre listing without direct surgeon involvement; exploratory procedures were scheduled if no obvious approach was apparent.

Every centre afforded ‘routine’ priority to access-related procedures, and commonly displaced them for non-clinical reasons including other patients approaching ‘treatment time guarantees’. Most procedures were conducted under local anaesthetic except in unit 9, where routine anaesthetic pre-assessment accounted for a substantial proportion of delayed or cancelled surgery.

The unit 1 operating surgeon routinely provided anticipatory instructions for proceeding if the AVF failed to mature; this was highly unusual elsewhere. In unit 9 the VAN reviewed postoperative patients six times in the two weeks after surgery; elsewhere patients were seen once, at four to six weeks.

3) *Access Maintenance*

Clinical pathways in use by each renal unit are presented in web appendix 2.

(Web appendix 2 – Clinical process diagrams describing the clinical pathways for vascular access creation and vascular access maintenance in Scottish renal units)

Only unit 3 formally trained dialysis nurses to assess and cannulate AVF. Surgeons considered the absence of such training to impede access management.

Centres defined 'surveillance' differently. Most units reported formal AVF assessment at every dialysis session but did not routinely document this. Many staff suggested this assessment was performed to a variable standard and frequently omitted. Routine surveillance processes varied between satellite dialysis centres associated with the same renal unit.

Clinicians disagreed on the most useful elements of surveillance, but generally agreed that proactive approaches were better. Interviewees felt a composite of regular fistula assessment, analysis of dialysis indices and clear escalation policies were required. Units 2, 4 and 5 reported this approach had substantially improved AVF prevalence while markedly reducing unscheduled hospital attendances and out-of-hours procedures. Adequate surgical and interventional radiology resource appeared crucial to support proactive surveillance; several units (1, 3, 7, 8, 9) reported frustration that proactive approaches created demands for services that outstripped the available resource.

No centres formally protected interventional radiology slots for VA procedures. This was attenuated by 'high functioning', multi-disciplinary team meetings (MDT) with nephrology, surgery, radiology, sonography (in some centres) and VAN representation. Proactive centres held these at least three-weekly, with agendas determined by recent surveillance activity. Case discussion led to rapid procedure scheduling, and proactive creation of alternative access before existing strategies failed. AVF thrombosis was rare in these centres. Unit 6 maintained functional MDT working without formal meetings; this reflected low patient numbers, clinicians' willingness to engage with problems, and frequent informal interactions facilitated by the hospital's layout. Poorly functioning MDTs were characterised by infrequent case discussion, limited access to interventional procedures and high reported rates of

fistula failure. Lack of nephrology, surgery and radiology co-location made this more likely. In one case it was reported that the three specialty groups had never met one another.

While most units aspired to providing combined surgical and radiological de-clotting procedures for AVF thrombosis, few achieved this in practice. Proactive units considered the past intervention history before operating upon thrombosed AVFs. Some regarded thrombosed AVF as markers of poor surveillance.

“But, you know, I think it’s probably the identification of what you’re supposed to do is the important thing and places that have... lots of thrombectomies are probably not identifying those fistulas that are just about to go down in a satisfactory manner...” (Radiologist)

4) Service Performance and Development Needs

Most centres struggled to track patients’ journeys, or to prioritise patients awaiting specific procedures if additional capacity became available. Just centre 8 used an electronic patient record for this purpose.

Clinicians’ knowledge of access-related processes and timelines was variable.

Individuals commonly circumvented pathways; many nephrologists reported “corridor discussion” referrals to surgeons without involving VAN or other referral processes.

Referrers considered this an efficient way to push patients through the pathway, but operators reported unseen consequences including adverse impacts upon other scheduled procedures, missed opportunities to engage patients in surveillance pathways, and inefficient utilisation of the available resources.

No centre routinely audited, discussed or published VA procedure outcomes. Primary and secondary AVF patency were not formally recorded. Audit was typically only conducted in the context of medical student projects. No units had a VA service manager; a forum for strategic service discussion; or regular, VA-specific, morbidity and mortality meetings. VA was largely absent from organisational corporate structures, with the financial costs associated with service delivery typically absorbed by multiple budgets without formal oversight. Almost no clinical activity was “job planned” although some reported designated time for MDT meetings.

Clinicians’ attitudes towards different modalities varied between centres. High CVC usage centres often colloquially termed tunnelled CVCs “permanent lines”, while centres with lower CVC use labelled all CVCs “temporary lines”.

“All lines are temporary, tunnelled or not! They are not allowed to call them anything other than temporary, until we get fistula.” (Nephrologist)

Arteriovenous grafts were used infrequently. There was uncertainty about their maintenance.

“As far as grafts are concerned, we are sort of still feeling our way because I haven’t done very many of them, so we probably would do scans now and again just so that we’ve got an idea of what’s happening.” (Surgeon)

PD usage was low throughout Scotland. Some nephrologists expressed interest in increasing utilisation, particularly where alternative options required CVCs.

“If this is a patient just presenting and they’ve got a reasonably good chance of getting a transplant in the future, there’s a strong case for pushing PD more and preserving their central veins.” (Nephrologist)

Significant educational needs were identified. Most centres relied upon 'see one, do one' approaches to AVF care. The absence of VA-related competences in nephrology training curricula(22) was repeatedly alluded to. Staff involved in peri-procedural care, including surgical ward nurses, radiology nurses and anaesthetists, seemed largely forgotten.

Discussion

This was a comprehensive appraisal of VA service configuration and function across Scotland, prompted by the marked variation in VA modality use between renal units serving similar populations. We aimed to extend understanding beyond the technical aspects of care, and hoped to illuminate opportunities to bridge the clear evidence-practice gap. Through our exploration of how patients interact with the multi-disciplinary VA team, we encountered several opportunities for improvement.

A high clinical workload was demonstrated, equivalent to almost 1 in 3 patients in the entire Scottish HD population undergoing a procedure or imaging study within the six-week period. While this sampling window was chosen for convenience, these data were anecdotally reported to show "typical" clinical activity patterns. Further work is required to confirm this. It was apparent that most VA clinical work was performed by clinicians working across multiple departments, often slotting cases around existing workload without strategic oversight of financial cost or clinical quality. VA services were almost entirely absent from provider organisations' corporate structures. Without senior management recognition of VA workload and formal clinical time allocation it remains susceptible to displacement by competing pressures, as described elsewhere(23,24).

The importance of clearly described clinical pathways for VA creation, maintenance and routine use was apparent. The observed lack of formally allocated clinical time for VA procedures seemed to pose the most significant challenge to most centres, and we recommend that provider organisations address this as a priority.

The necessity of formalised MDT working was clear: the centres with the poorest functioning MDT groups were those with the lowest proportions of incident and prevalent AVF use. The best use of MDT meetings appeared to be the discussion of patients with failing VA, and proactive creation of new VA in advance of the existing strategy failing. The centres reporting this tended to have the highest proportions of prevalent patients dialysing with an AVF, and anecdotally had the lowest rates of unscheduled VA care.

Vulnerability was observed across Scotland, with services reliant upon key individuals, and poorly defined arrangements for working out-of-hours. Threatened VA was not generally considered a “medical emergency”, and often did not receive the aggressive intervention merited by such presentations. It is recommended that services consider regional collaboration, particularly where dealing with unscheduled care or more technically complex cases.

We employed several evidence-based techniques to limit bias, acknowledging the limitations of qualitative methodology. Our sampling strategy ensured comprehensive stakeholder involvement, highlighting major challenges and potential solutions in this complex field that reflect the multidisciplinary, clinical and

organisational elements of care. This could be regarded as contrasting with the traditional, single-specialty perspective of guideline-writing groups(25,26).Our large sample size facilitated triangulation within and between centres. Thedirect involvement of researchers who are VA clinicians was considered essential in view of the significant clinical and logistical complexity of the area. Alternative strategies, including using external researchers to gather data, were likely to miss subtleties of this specialised field and financially unviable. Colleagues who routinely worked together were not interviewed by one another, and the researchers themselves were not interviewed for the study.

Our results clearly demonstrate the value of understanding clinical processes from a systems perspective. Many opportunities to enhance patients' experience, reduce financial cost and improve clinical outcomes are described, most of which were hitherto poorly understood or unrecognised.

We recommend taking a more patient-centred approach to assessing VA service performance. At present, "quality" is judged mostly according to the proportions of patients who use AVF (or AVG) for their first and subsequent haemodialysis sessions(27). This crude measure fails to account for external influences like transplant availability and PD utilisation, and the small patient group for whom CVC represents optimal VA. Our study suggests that patients judge "success" by their hospital experiences, their perceived utility and impact upon their daily routine. Quality might be better represented in measuring the proportions of patients receiving haemodialysis using the best available "personalised access solution".

Conclusions

This study highlights the high clinical workload associated with delivering VA services, and emphasises the importance of well defined, adequately resourced, clinical pathways. The importance of patients' experience is highlighted, along with the potential success to be found with more patient-focused service design. We have made several recommendations to healthcare provider organisations which are provided as web appendix 1.

(Web appendix 1 – Recommendations arising from the Scottish Vascular Access Appraisal project)

Our systems-based approach has proved to be a novel, illuminating means of investigating clinical processes. We hope that the resulting insights will facilitate meaningful changes that set a course towards safer, more effective, patient-centred care.

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Tables

Procedure	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Total:
	1	2	3	4	5	6	7	8	9	
AVF Creation	6	3	5	5	7	2	17	23	4	72
AVF Ligation	0	0	0	1	0	0	1	4	0	6
AVF Declot	1	0	4	0	1	1	1	3	0	11
AVF Revision	4	3	5	0	0	3	10	7	0	32
AVG Creation	1	1	3	0	2	1	1	4	0	13
AVG Ligation	0	0	1	0	0	0	0	0	0	1
AVG Declot	0	0	0	0	0	0	0	5	0	5
AVG Revision	0	1	0	0	0	0	0	1	0	2
Fistulogram	0	6	6	0	4	1	0	4	4	25
Fistuloplasty	3	2	7	5	1	5	7	21	8	66
Ultrasound Scan	0	30	1	0	0	29	63	35	0	158
TCVC Insertion	5	7	5	5	10	0	0	34	4	70
TCVC Removal	4	1	0	0	0	0	0	5	0	10
TCVC Declot	0	1	0	0	0	0	0	0	0	1
TCVC Exchange	0	0	0	0	5	0	0	10	0	15
NTCVC Insertion	0	0	8	1	1	0	0	8	4	22
Lineogram	0	0	0	0	0	0	0	0	3	3
Tenckhoff Insertion	0	0	1	3	3	0	0	0	0	7
Tenckhoff Exchange	0	0	1	0	0	0	0	0	0	1

Table 1 – Number of vascular access investigations undertaken in each adult renal service in Scotland between 26/01/2015 – 06/03/2015 inclusive.

