A journey in reversing practice patterns: a multidisciplinary experience in implementing DOQI guidelines for vascular access

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Abstract

Background. The National Kidney Foundation has established detailed guidelines due to increasing morbidity and costs related to haemodialysis vascular access in the end-stage renal disease population.

Methods. A quality assurance multidisciplinary committee was formed to implement the Dialysis Outcome Quality Initiative (DOQI) guidelines in September, 1999. Beginning January 2000, a ‘Save the Vein Programme’ was implemented and native fistulae became the angioaccess of first choice for new patients. In addition, an effort was made to replace failed non-autogenous vascular accesses with autogenous fistulae. Shortly after, pre-operative evaluation of the vascular anatomy of the arm by Doppler ultrasound became the standard of care. The 1 year period prior to January 2000 was used for comparison.

Results. Total fistula creation in the year 1999 was 48. In the first year after the Save the Vein Programme was begun, 77 new fistulae were created and 96 fistulae in the following year. Concurrently, 50 grafts were constructed in 1999; this number decreased to 46 in 2000 and to 15 in 2001. The percentage of functional fistulae in incident patients increased from 20 to 60% (\(P<0.001\)). Similarly, in prevalent patients, functional fistulae increased from 24 to 44% (\(P<0.004\)). For all patients, there was a reduction in the hospitalization rate from 98 to 79% (\(P<0.001\)) and of vascular-related admissions from 67 to 53%.

Conclusion. A reversal in practice pattern from graft to fistulae creation was achieved by the successful implementation of DOQI guidelines. This also resulted in a reduction in morbidity.

Keywords: DOQI guidelines; haemodialysis vascular access; native arteriovenous fistulae; practice pattern; PTFE graft; tunnelled haemodialysis catheter

Introduction

At the close of December 1999, our case mix at Hackensack University Medical Center (HUMC) out-patient haemodialysis facility was 27, 31 and 42%, respectively, for native arteriovenous (NAV) fistulae, polytetrafluoroethylene (PTFE) grafts and central tunnelled catheters (CTCs) despite the accumulating evidence of increased graft morbidity and cost [1]. Of the 98 subcutaneous arteriovenous accesses created in 1999, 50 were grafts, and 24 of the 52 incident patients (IPs) had PTFE grafts as their initial access. The loss of all peripheral veins in 31% of our prevalent patient (PP) population had resulted in a CTC being the access of last resort, exposing them to increased morbidity risk and shortened life expectancy [2].

Because of the multifaceted causes of vascular access problems, and following the guidance of others [3], a multidisciplinary quality assurance Haemodialysis Vascular Access Committee (HDVAC) was established in 1999 in our institution to implement the Dialysis Outcome Quality Initiative (DOQI) guidelines for the management of vascular access. The committee directed its efforts toward the implementation of an NAV fistula-first strategy [4]. It was postulated that this policy would lead to diminished PTFE graft and CTC use.

Here we describe how the implementation of these guidelines led us to surpass the recommended DOQI goals. We also noted a significant reduction in vascular access morbidity as evidenced as a reduction in hospitalization rate.
Subjects and methods

HUMC is affiliated with the University of Medicine and Dentistry of New Jersey. For the management of end-stage renal disease (ESRD), the renal service offers haemodialysis, chronic ambulatory peritoneal dialysis and renal transplantation. The haemodialysis services in our hospital-based facility had increased from 11 to 33 stations over a 2 year period. With four treatment shifts daily, it had reached full utilization, serving an average of 250 PPs per week.

The Hemodialysis Vascular Access Committee

The HDVAC was comprised of two physicians each from the divisions of nephrology, vascular surgery and interventional radiology, two haemodialysis nurses, the nurse director of the i.v. infusion centre and a clinical pharmacologist. A member of the Performance Improvement Department served as the coordinator. The medical director of the dialysis unit headed the committee. Its modus operandi was inspired by the Deming principles commonly known as the PDSA (plan–do–study–act) management improvement cycle [5].

The ‘plan’ phase

The following steps were undertaken: (i) the ‘Save the Vein Programme’ (STVP) (Figure 1) was created to protect the venous vasculature of hospitalized patients at risk of requiring haemodialysis within a year; (ii) an endovascular surgeon with special expertise and interest in NAV fistula creation was recruited by the institution; (iii) NAV fistula creation was to be attempted first in all IPs; (iv) a concerted effort was made by the vascular surgeons to replace all failed PTFE grafts and CTCs with a NAV fistula; (v) CTCs were to be used only as ‘bridge’ catheters, if all other approaches failed, or if subcutaneous angioaccess was not possible because of the patient’s anatomy or medical condition, or if the patient refused; and (vi) the nephrologists were encouraged to participate in identifying, evaluating and planning the vascular access placement.

The ‘do’ phase

The STVP was discussed at departmental meetings, and then approved by the Hospital Medical Board. The Department of Nursing Education provided education for hospital nursing staff. Education pamphlets, identification cards and bracelets were issued to qualifying patients to protect the veins in the designated arm from venipuncture. A list of common i.v. medications with phlebitic potential was compiled with the cooperation of the Pharmacy Department, and special caution was recommended if their use was under consideration.

Pre-operative vascular evaluation with venous and arterial mapping of the upper extremity by Doppler ultrasound became an integral part of STVP in the year 2000. Ultrasound scans of the superficial veins of the forearm and arm were first conducted from the wrist to the axilla of the non-dominant upper extremity. The other arm was used if there were contraindications to its use, for example, if there have been a previous mastectomy on that side or there was a pacemaker wire. The minimal diameter necessary for the creation of a fistula was 2.5 and 2 mm for the artery and vein, respectively [6].

The ‘study’ phase

A vascular access database application was created using Microsoft Access. It initially included: demographic information; the primary and secondary diagnoses; the date of the first outpatient haemodialysis; the type and site as well as the dates of access creation, its first use and failure; and the nephrologist and vascular surgeon. The application was subsequently expanded to include interventions, complications and causes of graft failure.

Information was abstracted from the monthly operating room report, and then compared with progress notes, haemodialysis flow sheets and the examination of the patient. Vascular access-related hospitalizations (ICD-9 codes 996.1, 996.62, 996.73) were extracted from the hospital billing database. These data were made available for review at the monthly HDVAC meeting. The medical record number and an assigned code to each physician protected confidentiality and yet allowed for peer review.

The ‘act’ phase

A subgroup of HDVAC members designed the ‘Save the Fistula Protocol’ and a corresponding algorithm to outline the medical and nursing management of NAV fistulae. It was clear that a change in the practice pattern demanded careful follow-up in the dialysis setting to sustain the gains reached and maintain the momentum achieved by the PDSA methodology.

Definitions and statistics

IPs were defined as those introduced to out-patient haemodialysis within a designated calendar year providing they stayed on treatment for >90 days. PPs were those receiving treatment at this facility on a given date. The hospitalization rate was determined by dividing the number of patients admitted at least once during the year by the total number of patients during that calendar year [7]. The bridge catheter...
is a CTC used for temporary haemodialysis access while waiting for fistula or graft maturation. Primary access failure was said to have occurred if the fistula failed to mature within 90 days of fistula creation, did not allow repeated cannulation and did not sustain at least a 300 ml/min pump rate [8].

Haemodialysis vascular events during 1999 were used as a control, and compared with the 2 years following the initiation of this programme. The Graph Pad software program was used for statistical calculations between groups, which included the Fisher two-tailed test, the $\chi^2$ progressive test, and the calculation of confidence interval and relative risk [9].

Results

Population

There were 351 established patients in 1999, 384 in 2000 and 383 in 2001. Transient patients from other haemodialysis units were excluded. Medical diagnosis and illness severity were not exclusion criteria. Our PP population had an average age of 66.3 years, with 59.9% over 65 years. The aetiology of the renal disease was diabetes mellitus in 36.6%, hypertension in 25.2%, glomerulonephritis in 17.3% and other in 19.6%; there were 1.3% missing records; 42.2% were female.

Reversal of practice pattern

Figure 2 illustrates the pattern of vascular access creation in both the IPs and PPs during the study period. The total number of NAV fistulae created by the end of 2001 doubled from 48 to 96, while PTFE graft construction was reduced from 50 to 15. There was a substantial increase in NAV fistulae constructed in IPs, from 22 to 59, while PTFE grafts in IPs diminished from 24 to seven.

Of the fistulae created in 1999, 29% (14 out of 34) were proximal; 25 transposed brachiobasilic were first created in 2000. By the end of 2001, 69% (66 out of 96) were proximal with 33 transposed brachiobasilic.

The percentage of primary failure for fistulae created in 1999 was 44% (21 out of 48), 51% (39 out of 77) in 2000 and 30% (30 out of 101) in 2001.

Prevalent patients with functional vascular access

As demonstrated in Figure 3, there was a reversal of functional angioaccess use from PTFE graft to NAV fistulae. At the end of March 1999, 24% (62) of our ESRD population had functional NAV fistulae, 29% (75) had PTFE grafts and 42% (122) had a CTC. By the end of the study period, fistula use had reached 44% ($P < 0.004$), exceeding the DOQI recommendation. The use of PTFE grafts in the interim was reduced to 16%, while the CTCs remained virtually unchanged at 44%. Analysis of the 112 CTCs in use at the end of the study period showed 36% (41) bridge catheters; 31% (35) were used for permanent use after all arteriovenous access sites were unavailable or exhausted; 21% (23) of patients refused a subcutaneous fistula; 12 (13%) had a medical contraindication prohibiting its creation; in the latter group, 10 had advanced heart failure, two had bilateral mastectomies and one could not undergo general anaesthesia. In 1999, two NAV fistulae replaced failed PTFE grafts, seven in 2000 and nine in 2001. Two patients switched to an NAV fistula after using a CTC for >1 year in 1999, nine in 2000 and seven in 2001.

Incident patients with functional fistulae and grafts

Data on the IP population with functional NAV fistulae in 1999, 2000 and 2001 are shown in Table 1.
A vascular access was considered functional when successfully cannulated more than three consecutive times. The median fistula maturation time was 61, 64 and 69 days for 1999, 2000 and 2001, respectively. ‘Bridge’ CTCs were used while NAV fistulae matured. The median fistula maturation time was 61, 64 and 69 days for 1999, 2000 and 2001, respectively.

**Effect on hospitalization rate**

Two years after commencement of this initiative, there was an 18% drop in the hospitalization rate. Ninety-eight percent of our patients were hospitalized at least once in 1999, 90% in 2000; \( P < 0.001 \), relative risk (RR) 0.91, confidence interval (CI) 0.88–0.95 and only 79% \( P < 0.001 \), RR 0.88, CI 0.83–0.94) in 2001. The number of vascular access admissions per patient was reduced by 21% in 2 years, from 0.67 per patient in 1999 to 0.53 per patient in 2001.

**Discussion**

Since haemodialysis was proven as a lifesaver for the management of ESRD, nephrologists have searched for the ideal haemodialysis vascular access. It should have a long use-life, deliver an adequate flow and have a low rate of complications [3].
The implementation of the NAV fistulae-first strategy had to overcome multiple obstacles. First, our mean age was 7 years older than the average of ESRD patients in the State of New Jersey, 13% more of our patients were over 65 years of age. Years of advanced age has been shown to be the most consistent negative predictor for the creation of successful NAV fistulae [10]. Secondly, the established vascular access practice pattern leaned toward PTFE graft creation [11]. Thirdly, many of our surgeons felt that veins were unavailable for NAV fistulae creation. The HDVAC concentrated first on the development and implementation of the hospital-wide STVP [3] to address the surgeons’ concern that veins were not available due to previous mechanical, chemical and infectious injury inflicted to forearm veins from prior venipunctures [12].

A review of the available literature revealed that the resolve of the surgeon [6] and nephrologist [13] and their close collaboration, combined with the establishment of a clear strategy, would be the prime determinant of success. The establishment of a multidisciplinary vascular access committee, that applied evidence-based DOQI guidelines as its framework of action, and the recruitment of a surgeon with a special interest in angioaccess creation provided the impetus for the restoration of the AV fistula as the first choice for haemodialysis access.

The computerized collection of data, their analysis and the issuing of monthly report cards was important to achieve our goal. They were discussed at the monthly HDVAC meetings and probably fuelled competition among surgeons, unmasked errors and provided a continuous stimulus for further improvement.

Preoperative duplex Doppler ultrasound imaging permitted the definition of arterial and venous anatomy undetected by physical evaluation [6]. In 2000, 43 cases were studied and its use was expanded later to study suspected inflow and outflow stenosis post-operatively. In 2001, a total of 157 cases were studied.

The introduction of the brachiobasilic fistulae technology [14], when conventional fistulae failed, contributed to an increase in NAV fistula use in the both the PP and IP population. In the time frame of 2 years, 32 transposed functional basilic fistulae were created, replacing failed PTFE grafts or CTCs. Even though we still lack enough cases to assess the long-term outcome, our experience suggests that there will be a reduced primary failure rate, and fewer complications than with the PTFE graft.

Two years were needed to reach the recommended DOQI goals for fistula creation in the PP and IP patient population; this achievement, coupled with a reduction of the primary failure rate from 44 to 30%, eliminated the negative bias against fistula creation, particularly in a geriatric population. Concurrently, the number of PTFE grafts created was reduced from 50 to 15, ensuring future venous preservation [1].

Since it was postulated that the creation of an increased number of native NAV fistulae would lead to diminished PTEF graft and CTC use, the persistence of catheter use above 40% in our PPs remains a source of concern. Although the dramatic reversal in surgical practice patterns allowed us to surpass the recommended DOQI goals, a reassessment of our strategy is in order to expand fistula creation in ~200 of our patient population (excluding patients where veins are unavailable or when patients have a medical contra-indication). Even the 36% rate of our bridge catheters should and could be reduced since it has been shown that subsequent NAV fistula survival is negatively affected by prior CTC use [15].

The HDVAC has designed a challenging ‘Save the Fistulae’ algorithm outlining the management of NAV fistula in the dialysis setting. It provides guidelines for the reduction of our primary failure rate: (i) pre-dialysis fistula surveillance; (ii) the initial use of smaller and sharper needles at a low flow rate and if necessary adjustment of the haemodialysis prescription; (iii) post-haemodialysis haematoma prevention by adjustment of the heparin dose; and (iv) and avoidance of needle dislodgement. Also the assignment of an expert ‘cannulator’ was started to help overcome patient apprehension of painful cannulations [16]. This will also shorten bridge catheter use [17].

Although the proportion of our NAV fistulae used within 3 months of haemodialysis initiation has increased from 14 to 30%, only 12.9% were used as the primary access at first haemodialysis. This rate compared poorly with the 15% reported in the USA, and 66% in European facilities [18]. The early involvement of the nephrologist in vascular access creation, at least 3 months prior to the predicted date of haemodialysis, is essential in influencing the outcome of dialysis access [17,18]. The practising nephrologist could seek guidance from a recently published algorithm based on objective clinical information [19]. Early referral to the surgeon will allow more time for angioaccess monitoring, and use of early corrective early salvage techniques prior to fistula use [20].

This study provides a description of a successful continuous quality assurance effort. It led to our ability to surpass the recommended 40 and 50% goals for NAV fistulae use in the prevalent and incident haemodialysis patient population, respectively. This initial effort was achieved in no small part by a reversal in surgical patterns of practice generated by the introduction of new surgical approaches and a thorough pre-operative evaluation. This was facilitated by the creation of a multidisciplinary committee, the application of DOQI guidelines, the generation and use of data collection in an ongoing manner, and the STVP.

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