Accelerated increase of arteriovenous fistula use in haemodialysis centres: results of the multicentre CIMINO initiative

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Abstract

Background. In the Netherlands, arteriovenous fistulas (AVFs) are used in 60–65% of the haemodialysis patients and this compares poorly with the European average. A multicentre guidelines implementation programme, CIMINO, was initiated aiming at increasing the use of AVFs.

Methods. Physicians and dialysis staff in 11 participating centres (N = 1092 vascular accesses) were strongly and repeatedly advised to adhere to current guidelines with extra attention for pre-operative duplex examination and salvaging of failing and failed fistulae. Specially appointed access nurses prospectively registered all created vascular accesses using an internet-linked database. In 22 other centres (N = 1566 accesses), the CIMINO programme was not offered and they were considered the control group.

Results. On 1 January 2006, average follow-up time of the CIMINO group and the control group were 13.3 months and 34.1 months, respectively. A total of 598 new vascular accesses (77% AVFs) were created in the CIMINO group. Prevalent AVF use increased from 58.5% (range: 31–79%) to 62.7% (range: 45–83%) in the CIMINO group and from 65.5% (range: 31–91%) to 67.3% (range: 42–91%) in the control group. The increase in AVF use per year was significantly quicker than in the control group (P < 0.05). Use of untunelled catheters decreased whereas that of tunnelled catheters increased.

Conclusions. This initiative shows that a multicentre guidelines implementation programme results in an accelerated increase of AVF use in comparison with a time control group. These data suggest that the choice of access placement depends predominantly on centre-specific factors.

Keywords: arteriovenous fistula; haemodialysis; practice pattern; quality improvement; vascular access

Introduction

An ideal vascular access for haemodialysis allows repetitive puncturing at an access blood flow of at least 400–500 ml/min, and has excellent patency with low complication rates. It is well accepted that the native arteriovenous fistula (AVF) meets best with these expectations and therefore, it is the preferred type of vascular access according to the current guidelines [1,2]. Numerous articles have emphasized the importance of AVF use and several reviews have addressed points for consideration how to increase AVF placement [3–5]. The Dialysis Outcomes and Practice Pattern Study (DOPPS), in which the Netherlands was not included, reported that an AVF was used by 80% of European and 24% of the American prevalent haemodialysis patients at the end of the previous decade [6]. Furthermore, the percentage of AVF use in these different dialysis units displayed a great range among European (39–100%) and among American units (0–87%) [6]. Since the late 1980s AVFs have been used by 60–65% of the haemodialysis patients in the Netherlands [7,8]. Moreover, a national survey we held in 2002–03 displayed not only an unchanged percentage of AVF use (59%), but also a great range in both type of vascular access use (AVFs: 31–91% and grafts: 3–57%) and anatomical location. As an effort to increase AVF use, we initiated and implemented a multicentre guidelines implementation programme, CIMINO (Care Improvement by Multidisciplinary approach for Increase of Native Vascular Access Obtainment), in 11 access centres in the Netherlands. Our goal was to achieve an increase of AVF use in the prevalent haemodialysis population. As a control group, we analysed vascular access use in a large
sample of dialysis centres in which our programme was not presented.

**Subjects and methods**

On 1 January 2003, a total of 3552 patients were on haemodialysis in the Netherlands (www.renine.nl). Information on the prevalent number of AVFs, (bio)grafts, tunnelled and untunnelled catheters (TC and UC) was obtained in late 2002 and 2003, and included 2701 vascular accesses in 35 centres representing 76% of the entire Dutch haemodialysis population.

For logistical reasons, 12 of these centres were approached for participation in the CIMINO-programme in the central part of the Netherlands in 2004. Three centres were not interested in participation. Two centres, which did not contribute to the baseline data, volunteered resulting in 11 participating centres (two academic, eight general hospitals and one other dialysis institution; total: N = 1092 accesses). The remaining 26 centres served as a control group.

**Assessment of AVF use**

In the control group, prevalent vascular access use as obtained at baseline in 2002 and 2003 was used for analysis. In the CIMINO group, access use was determined at each centre’s individual programme starting date, the first centre on 1 May 2004 and the last on 1 July 2005.

In January 2006, nephrologists of the 26 non-CIMINO dialysis centres (four academic centres, 19 centres in general hospitals and three other dialysis institutions) were sent a questionnaire on prevalent haemodialysis access use. If this mailing remained unanswered for 1 month, a second mail was sent to the nursing staff of the dialysis units.

**Guidelines implementation programme**

In 2003, the Vascular Access Society presented the most recently updated guidelines on vascular access care by means of clearly structured flow charts supported by literature based evidence and expert opinions (www.vascularaccesssociety.org) [2]. Before the start of our programme, the investigators (H.J.H. and P.J.B.) visited all participating vascular access teams (VATs) and presented a lecture on these ‘European guidelines’. Furthermore, translated summaries were provided and the VATs were encouraged to adhere to these guidelines during the CIMINO programme. All haemodialysis patients or patients with chronic renal failure (CRF) requiring a new permanent vascular access during this follow-up period were included. The order of preference of access placement was (i) distal arm AVF, (ii) proximal arm AVF, (iii) basilic vein transposition or graft insertion and (iv) central venous catheter. It was advised to always perform a standard additional pre-operative duplex examination. Furthermore, the caretakers were encouraged to attempt salvaging procedures for the failing and the failed fistula. In each centre a dedicated vascular access coordinator was appointed, 0.1 nurse full-time equivalent, to register practice patterns in a newly developed internet-linked database. In-centre analysis allowed participating physicians to evaluate their own practice patterns during the entire project. Aggregate data were only available to the coordinating centre at the University Medical Centre Utrecht in Utrecht. Newsletters were sent regularly to update physicians and nurses on proceedings and progress.

**Statistical analysis**

Statistical analysis was carried out using SPSS 12.0 for Windows® (SPSS Inc. Chicago, IL, USA). The rate of change in AVF use was determined by subtraction of two time percentages divided by the follow-up duration and expressed as annual changes. Linear regression, weighted by the prevalent number of haemodialysis patients at baseline, was used to estimate the slope of annual changes in AVF use in the CIMINO and control group. Ninety-five percent confidence intervals (95% CI) were calculated around estimates. When the slope estimate of the CIMINO group was outside the 95% CI around the estimate of the control group, the rates were considered statistically significantly different.

**Results**

Twenty-two non-CIMINO access centres (85%) responded to the second questionnaire sent in early 2006, and were considered as control group. Baseline demographics of the entire Dutch haemodialysis population, the CIMINO group (N = 11 centres) and the control group (N = 22 centres) are shown in Table 1.

Prevalent AVF use increased from 65.5% to 67.3% in the control group, and from 58.5% to 62.7% in the CIMINO group (Table 2). Graft use decreased 4% in the CIMINO group but did not change in the control group. In both groups, UC use decreased, from 11.4% to 5.3% in CIMINO and from 8.6% to 4.8% in the control group. TC use increased 5.9% in CIMINO and 2.2% in the control group.

**Table 1. Demographics and primary diagnoses of end-stage renal disease in the entire Dutch haemodialysis population, the CIMINO group (N=11 centres) and the control group (N=22 centres) on 1 January 2004**

<table>
<thead>
<tr>
<th></th>
<th>Netherlands</th>
<th>CIMINO</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>62.1 ± 15.7</td>
<td>62.1 ± 15.2</td>
<td>62.0 ± 15.7</td>
</tr>
<tr>
<td>Male gender (%)</td>
<td>57.7</td>
<td>59.2</td>
<td>57.1</td>
</tr>
<tr>
<td>Primary diagnosis ESRD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glomerulonephritis (%)</td>
<td>13.6</td>
<td>14.2</td>
<td>13.8</td>
</tr>
<tr>
<td>Interstitial nephritis (%)</td>
<td>11.4</td>
<td>12.3</td>
<td>11.7</td>
</tr>
<tr>
<td>Cystic kidney disease (%)</td>
<td>9.8</td>
<td>10.3</td>
<td>9.9</td>
</tr>
<tr>
<td>Other congenital/hereditary (%)</td>
<td>2.1</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Other multisystem diseases (%)</td>
<td>6.3</td>
<td>4.2</td>
<td>7.1</td>
</tr>
<tr>
<td>Renal vascular disease (%)</td>
<td>21.9</td>
<td>24.6</td>
<td>18.3</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>15.6</td>
<td>15.3</td>
<td>14.0</td>
</tr>
<tr>
<td>Others (%)</td>
<td>4.9</td>
<td>3.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Unknown (%)</td>
<td>14.4</td>
<td>13.5</td>
<td>17.7</td>
</tr>
<tr>
<td>Total no. of patients</td>
<td>3605</td>
<td>1034</td>
<td>1568</td>
</tr>
</tbody>
</table>
During this observation period, 598 new vascular accesses were created and included in the CIMINO group. Of these, 77% were fistulas, 14% were grafts and 9% catheters. Patient characteristics of incident patients in CIMINO are shown in Table 3.

Further analysis of the CIMINO group showed that the range in prevalent AVF use varied from 31% to 79% at baseline (median: 64%) and from 45% to 83% in January 2006 (median: 66%). In the control group, the range of AVF use varied from 31% to 91% (median: 72%) at baseline and from 42% to 91% (median: 70%) in January 2006.

### Table 2. Prevalent distribution of types of vascular accesses in the CIMINO group and the control group at baseline and on 1 January 2006

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
</tr>
<tr>
<td>CIMINO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVF</td>
<td>639</td>
<td>721</td>
</tr>
<tr>
<td>Graft</td>
<td>263</td>
<td>231</td>
</tr>
<tr>
<td>TC</td>
<td>124</td>
<td>137</td>
</tr>
<tr>
<td>UC</td>
<td>1029</td>
<td>1150</td>
</tr>
<tr>
<td>Total</td>
<td>1092</td>
<td>1150</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVF</td>
<td>1026</td>
<td>1174</td>
</tr>
<tr>
<td>Graft</td>
<td>284</td>
<td>313</td>
</tr>
<tr>
<td>TC</td>
<td>122</td>
<td>175</td>
</tr>
<tr>
<td>UC</td>
<td>134</td>
<td>83</td>
</tr>
<tr>
<td>Total</td>
<td>1566</td>
<td>1745</td>
</tr>
</tbody>
</table>

N, absolute number of accesses; AVF, arteriovenous fistula; TC, tunnelled catheter; UC, untunnelled catheter.

### Table 3. Patient characteristics of incident patients in CIMINO

| Characteristic                                | No. of permanent vascular accesses | No. of patients | Age (years) | Male gender (%) | Previous RRT (%) | Duration of RRT prior to access placement (months) | Previous coronary artery disease (%) | Previous peripheral vascular disease (%) | Previous cerebrovascular disease (%) | Caucasian ethnicity (%) | Current smoker (%) | BMI (kg/m²) | Diabetes mellitus (%) | Diabetes as primary cause ESRD (%) |
|------------------------------------------------|-----------------------------------|-----------------|-------------|-----------------|------------------|---------------------------------------------------|-------------------------------------|-------------------------------------|-------------------------------|---------------------|----------------|-----------------------|-------------------------------|
| No. of permanent vascular accesses             | 598                               | 461             | 64.6 ± 14.4| 58              | 59               | 14 ± 34                                            | 23                                  | 11                                  | 13                            | 80                  | 20             | 25.1 ± 4.5            | 31                            | 12                          |

Means are depicted ± SD. RRT, renal replacement therapy; BMI, body mass index; ESRD, end-stage renal disease.

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Further analysis of the CIMINO group showed that the range in prevalent AVF use varied from 31% to 79% at baseline (median: 64%) and from 45% to 83% in January 2006 (median: 66%). In the control group, the range of AVF use varied from 31% to 91% (median: 72%) at baseline and from 42% to 91% (median: 70%) in January 2006.

### Interval corrected prevalence changes

On 1 January 2006, average follow-up time of CIMINO and the control group were 13.3 and 34.1 months, respectively. In the CIMINO group, prevalent AVF use increased by 3.5% per year (range: −6.6% to 10.9% per year). During the implementation programme, graft use decreased 3.4% per year, TCs increased 4.2% per year and UCs decreased 4.3% per year. In the control group, fistula use increased by 1.2% per year (range: −5.7% to 12.4% per year), graft use decreased 0.2% per year, TC use increased 0.9% per year and UC use decreased 1.9% per year.

### Relation between AVF use at baseline and annual change in AVF use

Figure 1 shows the relation between prevalent AVF use at baseline and change of the percentage of AVF use per year. The solid circles and the solid line represent the individual results and the regression line of the centres in the control group. The open circles and the dashed line represent the individual results and the regression line of the centres in the CIMINO group. Slopes of the regression lines differ significantly (p < 0.05) indicating an accelerated increase of AVF use within the CIMINO group.

### Discussion

This prospective, multicentre, multidisciplinary guidelines implementation programme demonstrated an accelerated prevalent AVF use in comparison with a large control group. This was predominantly observed in clinics where AVF use was <75% at the start of the observation period. Furthermore, AVF use displayed a wide range among the participating centres but these
ranges narrowed during the project. The third major observation was a clear switch from untunnelled to TC use.

**Change in time**

Since the appearance of the first Dialysis Outcomes Quality Initiative (DOQI) guidelines in 1997, several reports have shown that dramatic changes in access placement can be achieved in a short period of time [9–13]. However, those studies were performed in centres that were characterized by low fistula incidence and prevalence levels at baseline. Our intervention group and the control group started at 58.5% and 65.5% prevalent AVF use, respectively.

Higher baseline fistula levels can be expected to yield smaller annual increments in AVF use when guidelines are implemented, which is indeed seen in our initiative (Figure 1). The CIMINO programme, however, shows that an increase in AVF use can be performed quicker than in general practice. The variability of differences in AVF use per year also suggests an important role for centre-specific aspects. Furthermore, Figure 1 shows that when a clinic is already using AVFs in 75% of the eligible subjects, increase in use is not easy achievable. This is in line with data from DOPPS II which showed that 74% of the prevalent accesses in countries surrounding the Netherlands are fistulas [14].

**Range and demographics**

Wide ranges of fistula use in the CIMINO group (45–83%) and the control group (42–91%) are a remarkable observation in a small country like the Netherlands. In addition, high and low fistula prevalence centres were randomly spread over the country. For instance, the centre with the lowest percentage of fistulas (42%) and the one with the second highest percentage (90%) in 2006 were <60 km apart (data not shown). Similar findings have been reported before [15,16] and such differences are not likely to be explained solely by demographics (Table 1).

Four out of five of the centres of the CIMINO group with <60% AVFs at baseline showed great improvements in fistula use, in two centres up to almost 11% increase per year. These centre-specific results outnumber other single centre achievements [9,10]. Two centres that already had high AVF baseline levels managed to increase the use even more. This is an interesting observation because the closer a haemodialysis population gets to 100% fistula use the more patients with compromised vessels have to be included. Indeed, registry data reported averages up to 86% prevalent AVF use [17,18].

Demographics and patient characteristics such as race, presence of peripheral vascular disease and body mass index (BMI) are known to differ between the US and Europe [6], and have been associated with lower fistula prevalence levels [15,19]. This may partially explain (inter)national differences in practice patterns [6]. However, in conformity with our findings, the HEMO study found substantial variations in AVF use among dialysis units in single metropolitan areas [15]. Moreover, access surgery performed by a surgical trainee is thought to result in more graft placement instead of fistulas [6]. O’Hare et al. [20] demonstrated that the choice of vascular access placement also depends on differences between individual surgeons.

Our results strongly suggest that centre-specific characteristics are of paramount importance in vascular access placement and give further support to the idea that access surgery should only be performed by experienced and skilled surgeons willing to meet the ‘AVF only’ standards.

**Catheters**

Central venous catheters (CVC) are known to have much higher risks of complications than fistulas. In our initiative, CVC use decreased from 17.2% to 14.8% and was lower than European average [14]. A comparison between DOPPS I and II, however, showed an increase in CVC use in both Western Europe and the United States in the recent years [6,14,21]. Mendelssohn et al. [14] showed that average time from referral to vascular surgeon and actual surgery is commonly 2–4 weeks. Maturation generally takes at least 4–6 weeks [2]. Therefore, it is striking that typical timing for creating a permanent vascular access is <8 weeks in 67% of the European facilities and in 77% of the American facilities [14]. In order to prevent catheter placement in end-stage renal disease patients awaiting AVF use, nephrologists should start to prepare CRF patients for haemodialysis well in advance, i.e. at least 6 months prior to expected haemodialysis [1,2].

Another interesting observation is the clear switch of UC to TC use in both the CIMINO and the control group. Tunnelled cuffed catheter (TCC) use is thought to be beneficial to UCs when needed for dialysis for more than 14 days [22]. The K/DOQI guidelines advise to insert TCC when haemodialysis duration is expected to be longer than 1 week [1].

**Limitations**

Many aspects of our implementation plan may have contributed to the accelerated increase of AVF prevalence and it remains difficult to determine which was, or were, particularly helpful. It may have been the availability of (translated) outlines of guidelines, the repeated mentioning of the necessity to adhere to the guidelines, the presence of the vascular access coordinator or the availability of the easily accessible database for evaluation of centre specific results. For logistical reasons we approached the centres on geographical basis, i.e. primarily located in the middle part of the Netherlands. As can be seen in Table 1, both the CIMINO group and the control group were an adequate reflection of the entire Dutch population.
haemodialysis population. These aspects give further support to the idea that current findings are the result of the programme.

Due to higher early thrombosis rates and longer maturation time than grafts, fistulae require extra effort on the short term to become functional. On the long term however, AVFs are accompanied by prolonged patency and less vascular access-related morbidity. So, increasing prevalent AVF use should ultimately lead to improved access care for haemodialysis patients.

A cost-effectiveness analysis was not included in our implementation programme. However, extra costs which come with the programme, i.e. 0.1 nurse full-time equivalent are limited and cost limitation resulting from increased AVF use is likely to be substantial [23]. Furthermore, catheter and graft use have been associated with decreased patient survival [24–26], so an increase in AVF placement might even affect mortality rates.

Conclusion

Initiatives like CIMINO and the large scale ‘Fistula First’ (www.fistulafirst.org) are meant to provide the VAT with tools to achieve vascular access care improvement. Although awareness seems to increase in the recent years, extra effort is still needed to promote implementation of access guidelines in the field of nephrology and, maybe even more important, in vascular surgery and radiology. We have shown that an accelerated increase in AVF use is possible in an average group of access centres. These data also strongly suggest that centre-specific factors are of paramount importance for vascular access care.

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Conflict of interest statement. None declared.

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24. Astor BC, Eustace JA, Powe NR, Klag MJ, Fink NE, Coresh J. Type of vascular access and survival among incident


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Appendix

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