OPTIMAL TIMING FOR VASCULAR ACCESS CREATION

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Swedish Access Meeting 2019, February 7-8, 2019

• No conflict of interest
IDEAL VS OPTIMAL

IDEAL

• An ideal is a model of something perfect or without equal. As an adjective, *ideal* describes this ultimate standard for excellence, or something that exists only as an idea.
• PERFECT OR THE BEST POSSIBLE

OPTIMAL

• THE BEST OR MORE FAVOURABLE
• EFFECTIVE POSSIBLE IN A PARTICULAR SITUATION.

Oxford dictionary
Optimally (ideal)...

All patients starting hemodialysis should have a well-functioning permanent vascular access that can be successfully used from the first dialysis onwards.
1. What type of permanent vascular access?

2. When is that “optimal timing” for VA creation?
VASCULAR ACCEESSES...

I AVF

II AVG

III CVC
Kaplan-Meier cumulative mortality curve, by type of vascular access in use among 616 participants in the Choices for Healthy Outcomes in Caring for End-Stage Renal Disease (CHOICE) Study.

Brad C. Astor et al. JASN 2005;16:1449-1455

Kidney Int 62:1109-24, 2002;
cJASN 2(4):708-714, 2007;
JASN 24: 465–473, 2013....

EBPG,
K-DOQI,
VAS Society,
CARI,
CSN,
Japan society for Dialysis Therapy,

ESVS (2018)

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Best type of permanent vascular access?

- ↓ risk of infection,
- ↓ Mt risk
- ↓ risk of thrombosis,
- ↓ costs of maintenance,
- ↑ Qb → ↑ Kt/V,
- ↑ longevity.
VASCULAR ACCESSES...

AVF
III T (4-12 weeks)

AVG
II T (24h - 2 weeks)

CVC
I T (immediately)
When to create autologous AVF?

What is Optimal?
Neither too early nor too late **but on time.**
Too early vs too late

AVF that are never be used

- Slow CKD progression to ESRD,
- Patient died of non-nephrology-related course (especially the elderly)

Temporary CVC need

- ↑ risk of infection,
- ↑ cardiovascular events,
- ↑ Mt risk
- ↑ Cost of hospitalization,
- risk of future CV stenosis,
- uncomfortable.
OPTIMAL time ... enough time

... to evaluate who is the eligible patient for RRT and then to adequately prepared he/she for hemodialysis as a modality of renal replacement therapy.

He/she has to be familiar with chosen type of treatment, underwent preoperative preparation (physical and CDU examination of blood vessels), vascular access has to be created, matured, functional and ready for use with minimal risk of damage.
To achieve this goal, we will need tools to...

1. identify patients in whom creation of AVF is deemed (un)suitable,

2. to estimate rate of progression to end-stage renal disease (ESRD),
   + time for access to vascular surgery,
   + time for vascular access maturation.
Hurdles...in time

- T1 - time from referral to AVF placement (CKD progression + decision for AVF creation + preoperative evaluation-CDU + surgical evaluation and creation)
- T2 - time FOR AVF maturation
- T3 - time FOR AVF cannulation

TC – cumulative time (T1+T2+T3)
1. Identify patients in whom creation of AVF is deemed (un)suitable

PATIENT

- comorbidities
- AGE
- referral & compliance
- Vessel characteristics

Eligible PTS

YES

- HD (AVF, AVG, CVC)
- PD
- Tx

NO

- Conservative therapy

Non Eligible PTS

RRT

YES

Eligible PTS

NO

Non Eligible PTS
Compliance...

When you don’t take your medication, you undermine healthcare provided by the United States of America...

...and the terrorists win!!

Heavy handed... but effective.

Doctor Team Patient
Figure 2. Risk factors associated with primary and secondary failure.

Conclusions: CVD, late referral, temporary catheters, and early cannulation are associated with impaired AVF survival. It is recommended that AVF be allowed to mature at least 1 month before cannulation.
Vascular access type at HD initiation in USA

Incident hemodialysis patients, 2016. USRDS, 2016
IV. Data on AVF/CVC on initiating HD

![Bar chart showing percentage of patients who started hemodialysis with AVF and temporal vascular catheter in 2010, 2011, 2012, and 2013.](image)

Fig. 2 Percentage of patients who started hemodialysis with AVF and temporal vascular catheter in 2010, 2011, 2012, and 2013

Int Urol Neph (2017); 49:319-324
Optimal timing for vascular access creation

Tamara K. Jemcov1,2, Wim Van Biesen3

Jemcov and Biesen

TABLE I - Studies analyzing the mean eGFR at the time of AVF creation and consequently, the rate of HD initiation during follow-up

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean eGFR at the time of AVF creation</th>
<th>Follow-up period</th>
<th>% of hemodialysis starts during follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bansal et al 2013 (31)</td>
<td>16.1 mL/min/1.73 m²</td>
<td>One year</td>
<td>61%</td>
</tr>
<tr>
<td>O’Hare et al 2007 (8)</td>
<td>17.7 mL/min/1.73 m²</td>
<td>One year</td>
<td>25%</td>
</tr>
<tr>
<td>Kimball et al 2011 (32)</td>
<td>&gt;15 mL/min/1.73 m²</td>
<td>One year</td>
<td>49%</td>
</tr>
<tr>
<td>Weber et al 2009 (33)</td>
<td>12 mL/min/1.73 m²</td>
<td>Two years</td>
<td>70%</td>
</tr>
<tr>
<td>Oliver et al 2012 (34)</td>
<td>No data</td>
<td>Three years</td>
<td>81%</td>
</tr>
</tbody>
</table>

eGFR = estimated glomerular filtration rate; AVF = arteriovenous fistula; HD = hemodialysis.
AVF group, n=125 and no AVF group, n=198
eGFR 12ml/min/1.73 ≤ 25ml/min/1.73m²

Median nephrology contact time > 12 months

72% success AVF creation

follow up 2 years

HD start 70% 61%
72% AVF and 28% CVC CVC 100%

After 6 months
82% AVF : 18% CVC 44%AVF: 56%CVC

Conclusion: The success rate of early AVF creation is reasonable and complication when identified can be remedied without a need for a catheter, thus ultimately maximizing the use of AVF in dialysis pts.
2. to estimate rate of progression to end-stage renal disease (ESRD)

Risk Models to Predict Chronic Kidney Disease and Its Progression: A Systematic Review

Justin B. Echouffo-Tcheugui\(^1,\ast\), Andre P. Kengne\(^2,3,4,5\ast\)

- 17 prediction models,
- many of them developed using inappropriate methods and generally poorly reported.

**Conclusion:** These findings suggest that the development and clinical application of CKD risk models is still in its infancy. Specifically, these findings indicate that the existing models need to be better calibrated and need to be externally validated in different populations.
Objective: To develop and validate predictive models for progression of CKD.

Design, settings & pts: demographic, clinical, and laboratory data from 2 independent (development and validation) Canadian cohorts of pts (>8000) with CKD 3-5 (e-GFR (EPI), 10-59 mL/min/1.73 m²).

Results: The most accurate model included age, sex, eGFR, albuminuria, serum calcium, serum phosphate, serum bicarbonate, and serum albumin. In the validation cohort, this model was more accurate than a simpler model that included age, sex, eGFR, and albuminuria.

Conclusion A model using routinely obtained laboratory tests can accurately predict progression to kidney failure in patients with CKD 3-5.
Multinational Assessment of Accuracy of Equations for Predicting Risk of Kidney Failure
A Meta-analysis

Navdeep Tangri, MD, PhD, FRCPC; Morgan E. Grams, MD, PhD; Andrew S. Levey, MD; Josef Coresh, MD, PhD; Lawrence J. Appel, MD; Brad C. Astor, PhD, MPH; Gabriel Chodick, PhD; Allan J. Collins, MD; Ognjenka Djurdjev, MSc; C. Raina Elley, MBCHB, PhD; Marie Evans, MD, PhD; Armen X. Garg, MD, PhD; Stein I. Hallan, MD, PhD; Lesley A. Inker, MD, MS; Sadayoshi Ito, MD, PhD; Sun H. Jee, Ph.D; Csaba P. Kovacs, MD; Florian Kronenberg, MD; Hiddo J. L. Heerspink, PharmD, PhD; Angharad Marks, MBChB, MRCP, MSc, PhD; Girish N. Nadkarni, MD, MPH; Sankar D. Navaneethan, MD, MPH; Robert G. Nelson, MD, PhD; Stephanie Titze, MD, MSc; Mark J. Sarnak, MD, MS; Benedicte Stengel, MD, PhD; Mark Woodward, PhD; Kunitsoshi Iseki, MD, PhD; for the CKD Prognosis Consortium

30 cohorts and > 700 000 pts


Kidney Failure Risk Equation (4 Variable)

Estimate risk of progression to end-stage renal disease in CKD patients using age, sex, eGFR and proteinuria.

Sex?
- Male
- Female

Age?
- 67 Years

eGFR?
- 32 mL/min/1.73m²

Urine Albumin Creatinine Ratio? (Note units carefully)
- 5.2 mg/g

Patient location?
- North America
- Non-North America
Kidney Failure Risk Equation (4 Variable)

Estimate risk of progression to end-stage renal disease in CKD patients using age, sex, eGFR and proteinuria.

Results

<table>
<thead>
<tr>
<th>Risk of progression to kidney failure requiring dialysis or transplantation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Over 2-Years:</strong></td>
</tr>
<tr>
<td>0.52%</td>
</tr>
<tr>
<td><strong>Over 5-Years:</strong></td>
</tr>
<tr>
<td>1.99%</td>
</tr>
</tbody>
</table>

For patients with CKD Stage 3, we consider a 5-year risk of kidney failure of 0-5% as low risk, 5-15% as intermediate risk, and >15% as high risk.
Identify patients in whom creation of AVF is deemed (un)suitable

- Patient comorbidities
- Age
- Sex
- Vessel characteristics
- CDU
- Patient referral & compliance

RRT

YES

- PD
- Tx
- HD (AVF, AVG, CVC)

YES

- A. Maturation time
- B. Surgical capacity + skill & experience
Population and age...
Incident patients accepted for RRT in 2016, at day 1
by age category

Incidence by age category
for all registries

- 75+: 357,7
- 65-74: 304,2
- 45-64: 142,2
- 20-44: 41,3
- 0-19: 7,3

Incidence (per million age-related population)

Incidence by age category
by type of data provided by registry

- All countries
  - 75+: 27
  - 65-74: 25
  - 45-64: 27
  - 20-44: 34
  - 0-19: 13

- Individual data
  - 75+: 31
  - 65-74: 23
  - 45-64: 31
  - 20-44: 31
  - 0-19: 10

- Aggregated data
  - 75+: 21
  - 65-74: 23
  - 45-64: 38
  - 20-44: 16
  - 0-19: 16
vol 2 Figure 1.4 Trends in adjusted ESRD incidence rate, by age group, in the U.S. population, 2000-2015

Data Source: Reference Table A.2(2) and special analyses, USRDS ESRD Database. Standardized for sex and race. The standard population was the U.S. population in 2011. Abbreviation: ESRD, end-stage renal disease.
Women and native AVF

• Predictors of adequacy of arteriovenous AVF in HD pts. Allon et al. Kid Int 1999;56: 275-80,
• Gender differences in outcomes of AVF in HD pts. Miller et al. Kid Int 2003;63:346-52,
Primary fistula failure, sorted by age, gender, and fistula location.

Peterson W J et al. CJASN 2008;3:437-441

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Women and AVF

Table 3. Multiple variable logistic regression model of factors associated with fistula failure to mature in patients with preoperative vascular mapping

<table>
<thead>
<tr>
<th>Clinical Factor</th>
<th>Hazard Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (≥65 vs &lt;65 yr)</td>
<td>1.98</td>
<td>1.03 to 3.80</td>
</tr>
<tr>
<td>Gender (female vs male)</td>
<td>2.42</td>
<td>1.32 to 4.45</td>
</tr>
<tr>
<td>AVF location (forearm vs upper arm)</td>
<td>2.25</td>
<td>1.22 to 4.17</td>
</tr>
</tbody>
</table>

Peterson et al. Disparities in fistula maturation persist despite preoperative vascular mapping.

Women and AVF

### TABLE VI - DIFFERENCES IN CONTINUOUS VARIABLES BETWEEN MEN AND WOMEN

<table>
<thead>
<tr>
<th></th>
<th>Men (Mean/Rank Sum)</th>
<th>Women (Mean/Rank Sum)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>4233.000</td>
<td>3270.000</td>
<td>0.371340</td>
</tr>
<tr>
<td>Smoking</td>
<td>3703.500</td>
<td>3799.500</td>
<td>0.067781</td>
</tr>
<tr>
<td>ARd&lt;sup&gt;a&lt;/sup&gt; (mm)</td>
<td>2.0167</td>
<td>1.8357</td>
<td>0.012384</td>
</tr>
<tr>
<td>AB&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;a&lt;/sup&gt; (mm)</td>
<td>3.8934</td>
<td>3.1570</td>
<td>0.000000</td>
</tr>
<tr>
<td>CVd&lt;sup&gt;a&lt;/sup&gt; (mm)</td>
<td>2.2697</td>
<td>2.1661</td>
<td>0.205995</td>
</tr>
<tr>
<td>VD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4167.500</td>
<td>3335.500</td>
<td>0.577224</td>
</tr>
<tr>
<td>FMD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2689.500</td>
<td>2981.500</td>
<td>0.022537</td>
</tr>
</tbody>
</table>

<sup>a</sup>Independent t test (Mean).
<sup>b</sup>Mann-Whitney test (Rank Sum).

ARd = arteria radialis diameter; CVd = cephalic vein diameter; FMD = flow mediated dilatation; RI = resistance index; VD = vein distensibility.

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**Fig. 2 - Arteriovenous fistula outcome during the following period of maturation.**
- **S** = success maturation after 4 weeks
- **PRS** = prolonged success maturation after 8 weeks

Jürg Schmidli a,*, Matthias K. Widmer a, Carlo Basile a, Gianmarco de Donato a, Maurizio Gallieni a, Christopher P. Gibbons a, Patrick Haage a, George Hamilton a, Ulf Hedin a, Lars Kamper a, Miltos K. Lazarides a, Ben Lindsey a, Gaspar Mestres a, Marisa Pegoraro a, Joy Roy a, Carlo Setacci a, David Shemesh a, Jan H.M. Tordoir a, Magda van Loon a,
ESVS Guidelines Committee b, Philippe Kolh, Gert J. de Borst, Nabil Chakfe, Sebastian Debus, Rob Hinchliffe, Stavros Kakkos, Igor Koncar, Jes Lindholt, Ross Naylor, Melina Vega de Ceniga, Frank Vermassen, Fabio Verzini,
ESVS Guidelines Reviewers c, Markus Mohaupt, Jean-Baptiste Ricco, Ramon Roca-Tey

Keywords: Guideline, Arteriovenous access, Vascular access, Arteriovenous fistula, Arteriovenous graft, Renal insufficiency, Haemodialysis, Surveillance, Complications, ESRD

<table>
<thead>
<tr>
<th>Recommendation 8</th>
<th>Class</th>
<th>Level</th>
<th>Refs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative ultrasonography of bilateral upper extremity arteries and veins is recommended in all patients when planning the creation of a vascular access.</td>
<td>I</td>
<td>A</td>
<td>106,107,109</td>
</tr>
</tbody>
</table>
Maturation & cannulation time

- Optimal 4 - 6 weeks,
- Not recommend to puncture < 2 weeks (Kidney Int. 2003;63(1):323-330)

**Figure 6.** Typical time to first arteriovenous (AV) fistula (AVF) cannulation, by country, based on Dialysis Outcomes and Practice Patterns Study (DOPPS) 5 medical director’s response to the question “How long after surgery are new AV fistulae typically cannulated for the first time?” included on the medical director survey administered during DOPPS 5. Australia-New Zealand, China, France, Russia, and Turkey not shown due to limited data. Abbreviations: Bel, Belgium; Can, Canada; Ger, Germany; GCC, 6 Gulf Cooperation Council countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates; Ita, Italy; Jpn, Japan; Spa, Spain; Swe, Sweden; UK, United Kingdom; US, United States.


CVD+AGE


Figure 2. Kaplan-Meier curves of time to AVF failure (primary patency from first cannulation) by use of catheters (CVC) at the initiation of HD (left) and by the time to maturation in days (right). Reproduced with permission from Ravani et al.\textsuperscript{36}

Ravani et al, JASN 2004
Conclusion
A functioning AVF may be associated with a slowing of the eGFR decline. A further properly designed trial will detect the role of confounding variables. The results of this initial investigation suggest that such a trial may show an unexpected and highly beneficial effect of timely creation of AVF, namely in slowing of the decline of renal function, perhaps delaying the initiation of dialysis. This has obvious cost saving and decreased Mb and Mt implications involving a very large number of pts.
<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>NKF-KDOQI/USA</td>
<td>„patients with GFR &lt;30 mL/min/1.73 m² should be educated on RRT modalities... VA (AVF) at least 6 months before the anticipated start of HD treatments“ (2006)</td>
</tr>
<tr>
<td>EBPG/ Europe</td>
<td>„CKD patients should be referred to a nephrology service when the eGFR declines &lt;30 mL/min/1.73 m²“...it is recommended that the fistula is created at least 2–3 months before the earliest likely date for starting hemodialysis. Prosthetic graft AVFs do not need a maturation period and can be cannulated 2–3 weeks after implantation (EBPG, 2007)</td>
</tr>
<tr>
<td>CSN/ Canada</td>
<td>„...vascular access creation should be considered at an eGFR of 15-20 mL/min/1.73 m²“ (2006, CNS Guideline)</td>
</tr>
<tr>
<td>CARI/ Australia</td>
<td>„all patients should be referred to a vascular access surgeon in advance of the anticipated need for HD. The referral should be earlier in patients with comorbidities, such as vascular disease or diabetes. The exact timing also depends on local availability of vascular surgery services“ (KHA-CARI, 2013)</td>
</tr>
<tr>
<td>Japan Soc for Dial Ther</td>
<td>“VA construction should be considered when eGFR is &lt; 15 ml/min/1.73 m² as well as taking into account clinical conditions. AVF should be constructed at least 2 to 4 weeks before the initial puncture”</td>
</tr>
<tr>
<td>UK - RA</td>
<td>recommends to plan vascular access already at the point where an individual reaches CKD stage 4, the exact timing of placement of VA is determined by the rate of decline of GFR, co-morbidities and by the average duration the surgical pathway.</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• It should be intention to start HD over permanent VA (AVF) in majority timely reffered CKD pts. except in comorbid and frail elderly,
• For estimation of the timing to start of RRT, the Tangri KFRE should be used,
• The time for pre-emptive AVF placement should be determined according to pts characteristics and taking into account local logistical and organizational circumstances,
• Ideally, the AVF should be constructed at least 4 weeks before the initial cannulation,
• In most pts, creating an AVF only when they reach an eGFR <15 mL/min/1.73 m² would allow to achieve this goal, whilst avoiding spurious interventions in pts who will never need dialysis.
„The time is here long enough for those who are willing to use it.“

Leonardo da Vinci

„We must use time as a tool, not as a couch.“

John F.Kennedy