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A patient centered decision making dialysis access algorithm

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Abstract: Much controversy surrounds the establishment of proper planning, placement and management (the best practice pattern) of dialysis access. These include the dialysis type and modality selection, timing of access placement and who places the access. The lack of and the difficulty of performing randomized studies with multiple confounding factors, in an extremely heterogeneous and rapidly changing ESRD population demographics, only partly explains the dialysis access conundrum. Add to this the rapidly developing and competing technologies, the wide spectrum of the professional experience, bias and socio-economic forces to make the ESRD problems as multivariate and complex as life itself.
This overview describes a dialysis access algorithm approach to the patient needing renal replacement therapy, considering long-term improved patient outcome as the ultimate objective. (J Vasc Access 2007; 8: 59-68)

Key words: *End Stage Renal Disease, Dialysis Access, Algorithm, Duplex Doppler Ultrasonography, Hemodialysis, Peritoneal Dialysis*

Defining the problem

The world population is experiencing an exponential growth of **end stage renal disease (ESRD)** requiring **renal replacement therapy (RRT)**. In the US alone, there were over 472,000 ESRD patients in 2004, consuming 7.2% of the Medicare budget and $32.5 billion in total costs (1). With an annual growth of 4%, the ESRD population is projected to grow to more than 650,000 by 2010 (1). Currently there are three RRT options: **renal transplantation, hemodialysis (HD) and peritoneal dialysis (PD)**. While renal transplantation remains the most desired RRT of choice, the proportion of ESRD patients receiving renal transplant has not changed in the past decade (1). Thus, the majority of ESRD patients depend upon various dialysis modalities for sustaining life. For patients with chronic kidney disease of stage IV (glomerular filtration rate of 15-30 ml/min), the choice of dialysis modality and therefore dialysis access varies greatly among different countries and communities. Indeed, the choice between dialysis modalities is remarkably different. While PD is the prevalent dialysis mode in less than 8% in the US, and 11.4 % in Italy, it is the primary mode of dialysis access in many other countries like UK, New Zealand and Mexico (1).
Complex psychosocial and economic factors, pre-ESRD education, patient preference, nephrology and surgery training patterns, skills and bias are examples of the many confounding factors influencing the crucial selection of the best RRT modality for the individual patient (Tab. I) (2-6).
Proper planning is of paramount importance to timely initiate RRT, in order to prevent serious uremic complications, avoid the use of dialysis catheters, and improve patient outcome and quality of life in a cost-effective way (7). Planning for RRT must begin in CKD stage IV to allow patients and families to understand various treatment options and make judicious decisions, thereby allowing orderly planned initiation of dialysis with an appropriate access (8). On the contrary however, the growth of ESRD population in the US has been accompanied by decreased utilization of peritoneal dialysis, increased use of AV grafts and tunneled cuffed catheters and decreased use of AVF (9, 10). Many studies have shown that this practice pattern has contributed to increased morbidity and mortality as well as soaring healthcare costs (11-14). In the wake of low utiliza-

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TABLE I - FACTORS INFLUENCING DIALYSIS MODALITY SELECTION

General factors
– Patient desire, including lifestyle, profession
– Socioeconomic factors
– Patient education on dialysis issues and options
– Nephrologists' education (Equal education on HD and PD; comfort level with dialysis modality)
– Co-morbidity severity
– Surgical experience and technical support
– Stage of CKD/ESRD

Favoring HD
– Patient restrictions to learn the PD technique
– PD training facility availability
– Abdominal stoma (i.e. colostomy)
– Previous (multiple) abdominal surgeries
– Recurrent abdominal inflammatory events
– Overweight, hygiene issues

Favoring PD
– Presence and status of vein and arteries, hemodialysis access problems
– Travel distance to dialysis facility
– Heparin intolerance
– Lower cost

TABLE II - GLOBAL MISSION STATEMENT FOR THE DIALYSIS ACCESS TEAM

To do the right thing for your fellow men
At the right time,
In the right amount,
For the right reason
Within the framework of
Your conscience,
Skills, and knowledge
Modeled by the culture and society laws,
In which you live

tion of native AV fistulae (1) and recent K-DOQI recommendations (15), the Centers for Medicare and Medicaid Services (CMS) launched a National Vascular Access Improvement Initiative in 2003 emphasizing a "Fistula First" approach, to increase the use of AVFs in the hemodialysis patient cohort with the goal of exceeding a prevalent rate of at least 40% in chronic hemodialysis patients (16). This goal has recently been raised to more than 66% by year 2009 (17).

Doing the Right Thing the Right Way

In the broadest term, practice patterns correlate to outcomes including patient and technique survival, access outcome, and cost to society at large.
Individuals, institutions, governments, and specialty societies may direct and subliminally influence the selection of dialysis modality. The most visible and widespread effort in this regard is the CMS (Center for Medicare and Medicaid Services) FISTULA FIRST National Vascular Access Improvement Initiative (16). Similarly the ISPD (International Society for Peritoneal Dialysis) is stressing the underutilization of the PD modality, especially in the Western societies (18). The selection of dialysis access is of great importance in planning a successful transition to dialysis treatment of patients approaching ESRD. A sound long-term dialysis access is designed to maximize patient quality of life, improve survival and be cost-effective. (19)
Rather than emphasizing the doctrine of one modality fitting all, doing the right thing for each patient, each time, is ethically and morally the better model (Tab. II). **The issue is not who places the access but who does it right, every time, to everyone, and everywhere**. It should be outcome and patient driven. The decision-making algorithm for two similar patients may therefore vary, based on individual circumstances summarized in Table I.
Generally, outcomes of native vein AVFs are superior to those of grafts (20). When used as a patient's first access, AVF survival is superior to grafts regarding time to first failure (RR=0.53) (21). However, no randomized controlled trial have been performed comparing AVFs and grafts, and comparisons may therefore be flawed by a selection bias, since PTFE patients are older by about 10 years and have higher co-morbidities (diabetes, cardio-vascular disease, lupus) associated with poorer vascular anatomy.
Although wrist (radio-cephalic) and elbow (brachio-cephalic) primary AVFs are the preferred HD access type (easy to place, low cost, superior patency, low complication rate, including lower incidence of stenosis, infection, and vascular steal phenomenon), they also have some drawbacks. The major disadvantage of the wrist (radio-cephalic) AVF is a possible lower blood flow rate, compared to other access types. Another drawback of radio-cephalic AVFs is their initial high failure rate of about 15 % and a secondary patency rate at 1 year of 62% (22). Also the increasing number of non-matured AVFs has resulted in more patients needing long-term catheter dialysis access.
Therefore, it is difficult to decide which is the best access for the single patient with advanced renal fai-

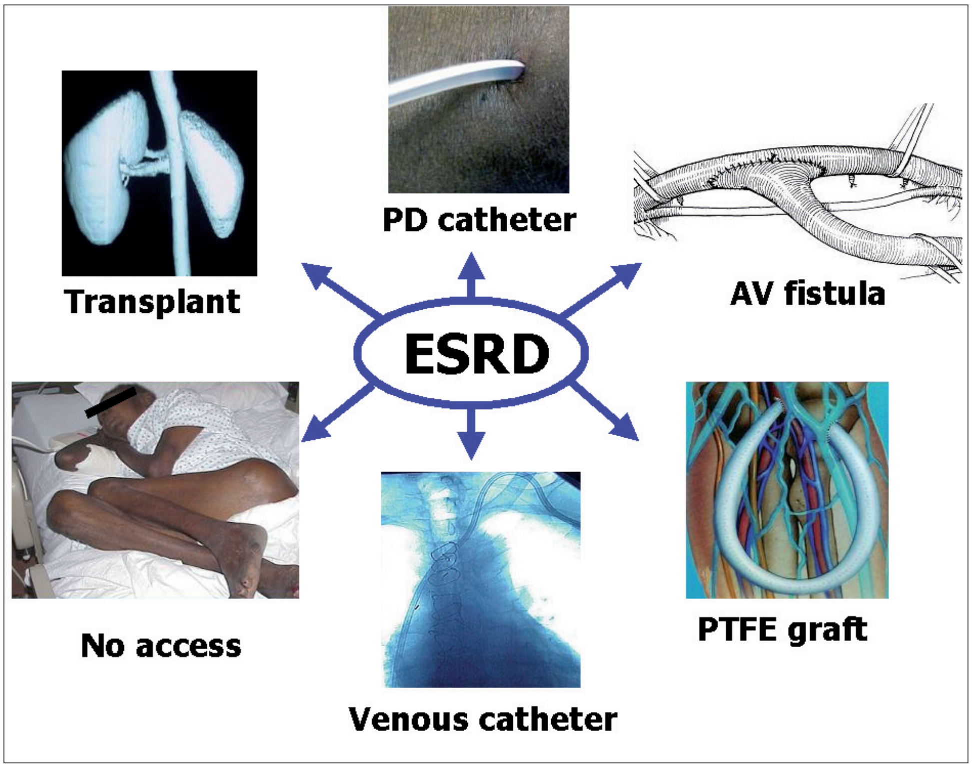

Fig 1 - ***These images depict the six ESRD treatment modality options available for the patient, in approximate order of overall outcome effectiveness (clockwise starting from transplant). Many confounding forces, some of which are outlined in Table I, influence the decision. During the life of an ESRD patient three or even four of these life-sustaining treatments are sequentially or repeatedly used.***

lure, who may present to the access creator in many different ways. We believe that the different dialysis modalities and access types must **not** be seen as competitive but rather complementary, where over the lifetime maximal utilization is the overall outcome goal and strategy.

Ideal World vs. Reality

Figure 1 depicts the possible treatment options available to the uremic patient. Three of these alternatives refer to hemodialysis (HD), being AVFs, PTFE grafts and central venous catheters.
In the ideal world the impending renal failure diagnosis is proactively managed with a pre-emptive living donor kidney transplant (ESRD Stage 4-5). In CKD patients with type I diabetes mellitus a deceased donor simultaneous kidney and pancreas transplant is the preferred event. However, a living donor kidney followed by a subsequent deceased donor pancreas is an equally logical option (Fig. 2). In sharp contrast, because of patient denial and late consideration for dialysis access placement, the reality is plagued by the fact that half of all patients initiate hemodialysis with a dual lumen catheter. Moreover, of all current prevalent dialysis patients, only a small fraction (3.7 % or about 15.000) (1) in the US receives kidney transplant annually. In situations where timely and accurate and perhaps passionate pre-ESRD education is given to the patient,

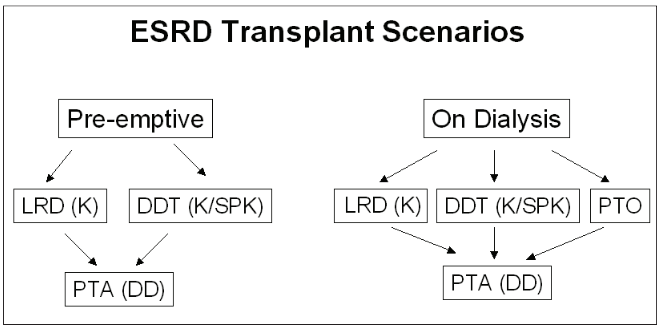

Fig 2 - ***This flow diagram depicts the ESRD Kidney (K) and Pancreas (Type 1 diabetes only) transplant options.***
(LRD: Living Related Donor. DDT: Deceased Donor Transplant. SPK: Simultaneous Pancreas and Kidney. PTO: Pancreas Transplant Only. PTA: Pancreas Transplant After Kidney)

a significantly higher number of CKD patients (40%) choose PD and only a small fraction start HD with a temporary catheter (4-6).

A Practical Patient Driven Algorithm

The following algorithms and strategies outline decision-making processes based on a multitude of factors, some of which are summarized in Table I. The intention is to have universal applications driven by the spirit of the mission statement of **Doing the Right Thing the Right Way,** which is expressed in Table II. This mission statement also implies a seamless and

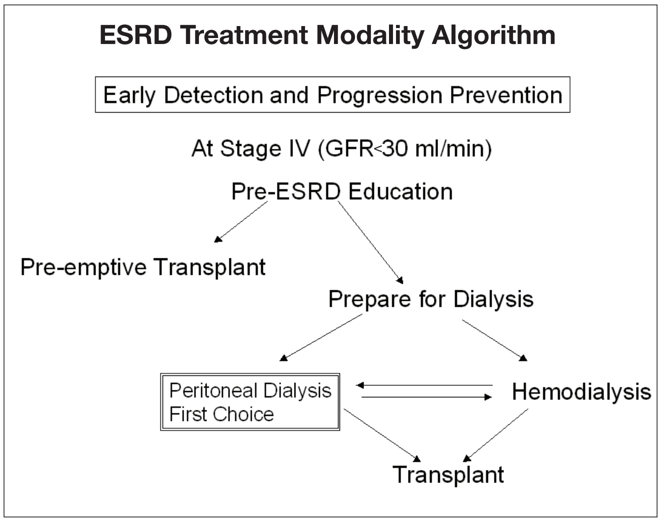

Fig 3 - ***Although rarely reflected in reality, this cartoon depicts a patient driven (optimal) ESRD modality sequential treatment strategy, emphasizing the benefits of peritoneal dialysis as the first option.***

transparent teamwork approach. It represents a **continuum of care** treatment model of the ESRD patient where emphasis is placed on team members being in close geographic proximity (same building) and ideally in the same clinic (23, 24). This allows timely decision making i.e. between the surgeon, the nephrologists and the interventional radiologist ("One-stop shopping"). This concept also implies fluid, clear, crisp and effective communication between key team members with emphasis on patient safety, outcome and comfort.

A dialysis access short and long term plan should be updated on a regular basis. With a proactive approach future access problems can be anticipated and addressed with the overall goal to avoid dialysis interruptions with temporary central vein catheter and associated morbidity.

Philosophically this approach implies that while thriving for the best practice option for each patient, the actual treatment modality may be quite different depending on a complex set of confounding circumstances. For example, the treatment modality option in a large university and research institution (perhaps participating in clinical studies) will be apart from that seen in a community hospital. The patients' options in a rural area are also likely to be limited compared to those in a large western city. Likewise in many developing countries dialysis and transplantation may not be offered. Also, culture, tradition and religious beliefs greatly affect the decision making process in treating the ESRD patient.

TABLE III - PERITONEAL DIALYSIS (PD) AS THE FIRST DIALYSIS MODALITY HAS SIGNIFICANT ADVANTAGES OVER HEMODIALYSIS (HD)

1. Survival advantage over most HD patients in first few years of treatment
2. Associated with better Quality of Life
3. Patient can remain in the workforce while dialyzing at night
4. Offers more freedom to travel
5. Maintains residual renal function longer
6. Less delayed function after renal transplant
7. Better long-term allograft functions
8. Provides more continuous dialysis
9. Less expensive to Society
10. AVF can be placed and mature anticipating future HD
11. No needle punctures for dialysis
12. Fewer blood borne infection transmissions

TABLE IV - MINIMAL VASCULAR REQUIREMENTS FOR A SUCCESSFUL AVF

- Anastomosis luminal diameter of at least 2.5 mm
- Lack of segmental stenosis of artery or vein
- Straight vein cannulation segment of at least 20 cm
- Vein cannulation segment less than 5 mm below skin surface
- Matured vein (or PTFE graft) diameter of at least 6 mm
- Flow rate of 500 ml/min or more
- Absence of central vein obstruction
- Segmental blood pressure differential of less than 20 mm Hg

Peritoneal Dialysis (PD) First, Hemodialysis (HD) Second

The concept of **PD First** implies that whenever feasible PD should be offered as the first dialysis modality (Fig. 3). First, PD provides a survival benefit for the first several years after dialysis initiation in the majority of patients (25-32). Moreover, patients who receive transplant while on PD have better long and short-term transplant outcomes compared to those patients who are on HD immediately prior to kidney transplant (33, 34). Second, while on PD, plans can be made to place a native vein AV fistula. The PD option allows extra time for the AVF to mature and for creative access options such as two-stage surgical procedures to optimize the access outcome effectiveness.

As all dialysis access modalities have a high failure rate over time, proactively placing a native vein AVF in a PD patient serves as a "life insurance", should the PD modality later fail. The benefits of the **PD First Concept** are summarized in Table III. PD and HD must not be seen as competitive therapies but rather complementary, where over time the dialysis access options are considered as integral parts of thoughtful long-term planning.

Two Effective Measures: Early Referral and Preservation of Veins

Two seemingly simple measures would dramatically improve the outcome of future dialysis access.

First, **early referral** to a nephrologist and to an access surgeon for evaluation increases the likelihood for placing a native vein AVF and avoiding morbidity from a temporary catheter placement (8). Therefore, when GFR approaches 30 ml/min, (CKD Stage 4), patient education about renal replacement therapy and dialysis access must begin and referral for preemptive transplant and dialysis access consideration be made.

Second, **preserving veins** by preventing veno-punctures and intravenous lines in potential future dialysis access veins for AVF placement also increases the chances for native vein AVF. There is much abuse of potential AVF veins from IV lines and blood draws. Only the dorsal aspect of the hand should be allowed for venous blood access. Patient undergoing HD can have blood draws done during dialysis treatment to preserve veins. These are simple policy decisions made by individuals with the vision and mission to do and implement the right thing. PICC lines (Peripherally Inserted Central Catheters) must not be used in patients with future dialysis need, and certainly not in stage 4-5 ESRD patients.

Although much education efforts have been done, intense concerted education of hospital workers must take place for both of these measures to become universally applied and consistently effective. National ESRD network organizations are well suited to implement this educational task.

Central Vein Dialysis Catheters

For lack of permanent access, approximately half of ESRD patients start dialysis with a temporary central vein catheter. While the use of central vein hemodialysis catheters is often life saving, there is a remarkable variation in their indications and frequency between dialysis units. For example, the average prevalent use of catheters for hemodialysis in the state of Texas was 23.7 % in March of 2006 (35), but varied between 2% to 40% among dialysis units. Of all prevalent patients on hemodialysis in the US (36) 6.6% were using a catheter while awaiting an AVF to mature. This number has doubled in two years from 3.8% in Oct 2003. The national prevalent average catheter use in the US was 27.0 % in 2005. The DOQI guidelines aim for less than 10% (15).

It will take concentrated educational efforts of the dialysis unit personnel, surgeons, nephrologists, radiologists and the patients in order to reduce catheter utilization. These efforts for improvement initiatives in dialysis access in general are urgently needed. Organizational and fiscal support currently is not well defined. Again, since ESRD programs are federally funded, the ESRD networks are the appropriate administrative entity to be charged with implementation and outcome documentation of such efforts.

Algorithm for Dialysis Access Selection

Dialysis access planning should start in the pre-ESRD stage, ideally in stage 4 CKD, when the glomerular filtration rate is 15 to 30 ml/min. In CKD stage 4, serum creatinine can be widely different in different patients. However, considering both serum creatinine and vessel quality, a rule of thumb could be to plan access surgery no later than a serum creatinine of 4 - 5 mg/dl in diabetic, or 7 mg/dl in non-diabetic patients. The rate of decline of GFR over time is perhaps the best predictive guide to timely referral and access placement (8).

Patient **History** and **Physical** examination **(H&P)** is by far the most important first step in assessing the course of action both prior to access placement and when evaluating an established access with problems. The thoughtful conduction of an **H&P** will yield proper patient selection for the most optimal dialysis modality and site of access placement (37, 38).

Physical Examination includes a detailed manual search for veins in both extremities. The examination must take into consideration the significance of previous chest surgery, pacemakers, presence of edema and collateral vein formation suggesting central vein pathology. Vascular examination must assess both the arterial as well as the venous system (37,38) A **Duplex Doppler Ultrasonography (DDU)** is used to confirm or correct this impression. A (radial) artery diameter of 2 mm or less is likely to yield an AVF that will not adequately mature and, therefore, will fail because of an inappropriate blood flow (less than 500 ml/min). Likewise, an AV anastomosis diameter of 2.5 mm or less is likely to yield inadequate flow rate (39, 40) (Tabs. IV and V).

TABLE V - THE MOST RELEVANT FEATURES ADDRESSED BY DUPLEX DOPPLER VASCULAR EXAMINATION

Arterial system
– Artery size from the axilla to hand including the arch
– Dual arteries in upper arm, i.e. high bifurcation
– Degree of arterial wall calcification
– Arterial stenotic lesions
– Blood flow at defined segments

Venous system
– Detailed venous anatomy in arm and leg as needed
– Vein size mapping from wrist to axilla
– Vein patency and presence or lack of stenosis
– Patency and flow pattern of subclavian vein
– Presence of diving venous branch at antecubital fossa

PTFE grafts
– Diagnose type and location of intra-luminal pathology
– Assess degree of intra-luminal wall hyperplasia
– Diagnose and measure degree and site of stenosis
– Assess presence and size of aneurysms and wall adherent thrombus
– Determine presence of peri-graft fluid (infection, bleeding)
– Blood flow measurement in ml/min

TABLE VI - INDICATIONS FOR DULPEX DOPPLER EVALUATION OF DIALYSIS ACCESS

1. Extremity edema/swelling
2. Prominent/collateral veins on extremity
3. Size differential between extremities
4. History of central vein catheters
5. Previous access surgeries below or above the planned site
6. Previous surgeries on arm, neck or chest

TABLE VII - INDICATIONS TO ASSESS AN ESTABLISHED HEMODIALYSIS ACCESS

1. Post-operative assessment of anatomy and blood flow
2. Dialysis needle puncture difficulties
3. Abnormal anatomy i.e. enlarging aneurysms
4. Suspected source of infection/abscess
5. Thrombosed access
6. Extremity swelling/edema
7. Hand ischemia-"steal"

When Can the Dialysis Access be Used?

PD catheter

Most PD unit policies recommend waiting 3-4 weeks before fluid exchanges. In case of urgent need for dialysis a PD frequent exchange may be started with smaller volumes exchanges (i.e. 500-1000 ml), rather than placing a cuffed central vein catheter (41, 42). After small umbilical, incisional, and inguinal hernias repaired with mesh without entering the peritoneal cavity dialysis can continue without delay. In other cases smaller volume for 2-4 weeks may be appropriate. After an open laparotomy procedure or other extensive procedures, a temporary IJ catheter for 3-4 week is indicated while the PD catheter patency is maintained by intermittent flushing (41).

Hemodialysis access

A hemodialysis access suitability for cannulation can effectively be assessed (physical examination) by an experienced dialysis nurse or technologist. A baseline Duplex Doppler assessment of a new HD access is advised prior to its use (Tab. V)

Wrist AVF. In contrast to PTFE grafts, AVF are less predictable and associated with slower and delayed maturation of 4-8 weeks. In our experience about 30% of wrist fistulae do not mature and require revisions or placement of new access. Due to the often-smaller size and difficult anatomy (most commonly due to obesity) cannulation difficulties and complications are common. Whereas in a non-obese person with excellent vein anatomy a fistula may be used within days to 1-2 weeks after surgery in emergency situations, it is advisable to wait 3-4 weeks allowing the fistula vein to increase in size and become "arterialized". Characteristics of a mature/useable AVF include (15):

- A sticking vein segment length of 15-20 cm, to allow for needle puncture site rotation.
- A consistent diameter of 6 mm or more.
- A blood flow rate of 500 ml/min or more.

Upper Arm AVF. This is typically created with a brachial artery to cephalic vein anastomosis at or above the antecubital fossa. Same rules apply as with wrist AVF, although flow rates tend to be higher. One peculiar venous anatomic abnormality seen in 39- 55% of upper arm AVFs is a stenosis in the cephalic vein just before it joins the subclavian vein in a segment of cephalic vein that is curved. This cephalic arch stenosis may be resistant to angioplasty, although with the availability of ultra-high pressure angioplasty balloons that can reach pressures of 23-40 Atm, effective dilatation is now more consistent. However, complications related to angioplasty may occur more frequently, and the long-term durability of angioplasty for stenosis in this location has yet to be proven (43, 44).

PTFE grafts. Graft maturation is more predictive and can consistently be used for HD after 2 weeks, although it may be better to wait 3-4 weeks to allow incorporation of the graft material with surrounding tissue. Assessment criteria include degree of swelling, redness, pulse quality, and presence of palpable thrill. Again, a baseline duplex Doppler with volume flow is advised (15).

VASCULAR ACCESS: SPECIFIC ISSUES

Established functioning access. An established access (AVF or PTFE graft) may be assessed for a number of reasons each of which with a different set of investigative steps (Tabs. V-VII).

It is advisable to have a **baseline** set of information on all new vascular accesses. The extent and content of dialysis access surveillance depends on available resources and technical skills. The surgeon is often asked if an access is ready to be used for dialysis. An experienced dialysis nurse is also an excellent resource to advise about specific access suitability for needle punctures. Just by physical examination the access quality can be determined with great certainty (i.e. presence, extent and characteristics of a palpable thrill and pulse quality). **Duplex Doppler Ultrasonography (DDU)** can accurately assess the access diameter, presence of abnormalities, size and degree, location, and length of intraluminal pathology, arterial and venous anastomosis size (diameter) and volume flow in ml/min (Tab. VII). In a proactive dialysis access program the baseline access DDU findings serve as a guide to future interventions.

Access Flow measurement. With acceptable access anatomy, the blood flow rate becomes the most predictive measure to assess the hemodialysis access suitability for repeat needle punctures. Most DDU machines have the automatic inbuilt capability to calculate access blood flow based on access transection surface area times mean flow velocity. The blood flow range used during hemodialysis treatment may vary from 180-200 ml/min to 500 ml/min. A mature wrist AVF tends to have a flow of 300-800 ml/min, while forearm PTFE loop grafts and brachial artery to vein AVF at the antecubital fossa typically have flow rates in excess of 1000 ml/min. A flow rate of 300-500 ml/min or less may not be sufficient, causing a dialysis machine alarm from inflow access collapse. The insufficient flow may result from artery stenosis anywhere along the arm into the axilla or chest. More commonly, an anastomosis stenosis of 2.5 mm or less is found, that may be treated with balloon angioplasty or surgical revision as indicated. Low flow states may also be a result of an outflow (venous) or graft anastomosis stenosis (hyperplasia). Outflow stenosis is associated with increased intra-access pressure ("hammer pulse"). An intra-access stenotic lesion, often found between aneurysms can be detected by physical examination in which case there is a hammer pulse proximal and a soft pulse downstream of the obstructive segment. Flow rates of 600-800 ml/min or less are associated with poor access survival especially in AV grafts. Also, independent of baseline level of access flow, a significant blood flow drop (25%) over a limited time (3-4 weeks) is suggestive of underlying anatomic pathology. In such a case, fistulogram and balloon angioplasty or corrective surgical revision are warranted.

Cannulation difficulties are associated with numerous factors, such as puncturing skills and experience, obesity (access depth), aneurysms, intra access abnormal anatomy (i.e. hyperplasia, wall adhered thrombus, venous valves), and serpentine winding access conduit. Defining and communicating access anatomy to the dialysis unit often resolves the problems.

Aneurysms are commonplace both in AVFs and AV grafts. Unless cosmetically unacceptable or physically bothersome, corrective measures are taken when skin viability changes occur. These decisions are based on physical examination. DDU examination usually does not add in diagnostic power assessing the aneurysm but is used to assess the overall access (i.e. anastomosis size, access volume flow rate, subclavian vein) prognosis before corrective interventions are taken.

Thrombosed access. DDU is of limited value but will determine the presence and size of a patent (compressible) outflow vein as well as other unexpected pathology.

Extremity swelling/edema usually occurs as a complication of prior central vein dialysis catheters. Examining the subclavian vein may reveal a stenosis, thrombosis, or suggest a more proximal obstruction in case of abnormal flow pattern (lack of respiration induced flow fluctuation or augmentation upon compressing on the arm). Confirmation and treatment of suspected central vein stenosis/occlusion typically requires venography, guiding the decision regarding interventional procedures such as angioplasty with or without stenting.

Hand Ischemia or so-called "steal" occurs in 6-10% of AV graft cases, but rarely with wrist AVFs (<1%). Detailed history and physical examination is quite

accurate in confirming the diagnosis. The vascular laboratory finger pressure determination helps to quantify the degree of severity. Furthermore, partial manual compression of the AVF anastomosis helps to determine the degree of correction (restoration) possible with a banding intervention (45), the more extensive DRIL (Distal Revascularizaton Interval Ligation) procedure (46, 47) or with proximalization of the arterial inflow anastomosis (48).
Manual compression of the access will relieve the patients from symptoms (i.e. pain tingling) in cases of acute ischemia, confirming the diagnosis. DDU of the proximal artery will direct further diagnostic accuracy and treatment options since inflow obstruction from proximal arterial stenosis is present up to one third of cases. If suspected by DDU, arteriogram and balloon angioplasty of the proximal inflow artery is the next logical step.

Portable ultrasound devices

Small, portable, high-resolution ultrasound devices are extremely valuable tools to determine the exact central venous anatomy, and to guide puncture for placement of central vein catheters and lines, as recommended by the KDOQI guidelines (15). Again, the right internal jugular vein is the preferred site for dual lumen cuffed, tunneled catheter insertion. It is strongly recommended using ultrasound guidance for **all** large vein access interventional procedures (49). Abnormal anatomy is encountered in 30% of cases (50).

The micro puncture set

In addition to the aid of ultrasound guidance, central vein catheters can be placed using the micro puncture technique. This technique uses a micropuncture set that consists of a 0.018 micro guide wire; puncture needle (21 gauge), a double catheter 4.0 or 5.0 French introducer and an inner sheath.
The main benefit of the combined use of the micropuncture technique and ultrasound is the increased safety with the small caliber (21-gauge) needle and the knowledge of vascular anatomy. Use of micropuncture technique minimizes peri-vascular bleeds, and thereby decreases the risk of post placement vascular compression and subsequent venous stenosis at the insertion site.

CONCLUSION

Detailed patient history and examination are the mainstay of dialysis access modality selection, including site and type of access. The same applies to maintenance of access for longevity.
As a lifelong access utilization strategy, peritoneal dialysis should be considered as the first dialysis modality in all suitable cases, followed by appropriately planned hemodialysis.
Duplex Doppler Ultrasonography Examination is the logical step following history and physical examination for pre-operative vascular mapping in determining the optimal hemodialysis access type and site. Further more, Duplex testing will diagnose the majority of vascular access complications and direct the proper surgical or interventional radiology management.
All central vein dialysis access catheters are placed using the micro puncture guide wire technique with portable ultrasound device as guidance.

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