Intraoperative Flow Measurements Ensure AV Access Function

- Quantifies Integrity of Flow
- Foreshadows AV Access Maturation
- Guides Revision Procedures
Best Practice: Flow-assisted AV Access Creation and Revision

Transonic® intraoperative flow measurements provide on-the-spot or continuous measurements of volume flow for a functional assessment of an AV access. These measurements can foreshadow successful maturation of an AV fistula or graft, alert the surgeon to potential difficulties and guide the surgeon in achieving target flow values during an access revision.

SURGICAL ACCESS CREATION
As surgeons construct more and more AV fistulas, their maturation is key to long-term hemodialysis. Measuring flow at the time of AV fistula construction assures the surgeon that hidden flow obstructions do not jeopardize early post-op patency. Moreover, studies demonstrate that quantitative flow data as fistulas are being surgically created can predict future maturation. Similarly, measuring flow during PTFE graft placements can help predict patency.

FLOW-BASED ACCESS REVISION SURGERY
When an AV access needs to be surgically revised or a high flow fistula is banded, intraoperative flow measurements take the guesswork out of such revisions by providing the surgeon with quantitative data to reach the desired flow levels.

“Flow reduction using intraoperative access flow monitoring is an effective and durable technique allowing for the correction of distal ischemia and cardiac insufficiency in patients with a high-flow autogenous access.”

“Intraoperative measurements of access blood flow provide objective, reliable data that correlate to outcome. Routine use of this technology might lead to more efficient management of patients undergoing hemodialysis access surgery.”

“During banding of AVGs, it is very difficult to reduce access flow without causing a thrombosis. Therefore, one must measure flow to quantify the reduction.”
Presentation, “Banding (How I do it),” I Davidson, MD, CIDA, 2011.

TRANSIT-TIME ULTRASOUND TECHNOLOGY
MEASURES VOLUME FLOW, NOT VELOCITY

Two transducers pass ultrasonic signals, alternately intersecting the vessel in upstream and downstream directions. The difference between the two transit times yields a measure of volume flow.
AV Access: Vascular Flowprobes

Transonic’s Vascular Flowprobes measure volume flows intraoperatively in vessels from 1.5 mm to 14 mm to detect blood flow obstructions before leaving the operating room. This ability to correct otherwise undetectable flow restrictions provides the surgeon with a unique opportunity to improve the outcome for his or her patient.

OptiMax® Flowprobes

OptiMax® Flowprobes also offer two reflector shapes and five sizes to accommodate different surgical preferences and patient anatomies. The skin tabs secure the Flowprobe so that continuous hands free measurements can guide vascular constructions, banding or revisions. After the target flow is attained and the procedure is completed, the Probe can then be quickly removed. The L reflector Flowprobe design allows the Probe to be slipped on and off a carotid artery easily, facilitating quick pre- and post-procedure measurements.

Fig. 1: Handle Flowprobes: FMV-Series and FME-Series sizes from 1.5 mm to 14 mm. The FMV-Series simple J-style reflector defines the ultrasound flow sensing window, holds ultrasound couplant gel in place, and maintains the vessel in alignment with the Probe. A flexible neck allows positioning of the Probe head to conform to vessel orientation.

Fig. 2: Anatomy of an OptiMax® Flowprobe.

Fig. 3: The OptiMax® family with J reflectors (shown) and L reflectors (not shown) are available in 4, 6, 8, 10 and 12 mm.
AV Access: Vascular Flowmeters

Transonic’s new Optima Flow-QC® Flowmeter takes transit-time ultrasound flow measurement resolution to the highest level. The Optima’s unprecedented resolution accompanies lower offsets, and doubles the accuracy for low flows.

The Optima Flowmeter enables use of our Vascular Flowprobes for AV access surgery. Flowprobes are available in from 1.5 - 14 mm sizes. Their flexible neck permits optimal Probe positioning and easy measurement.

- Provides unsurpassed accuracy and resolution
- Ensures inflow, conduit and outflow patency
- Provides immediate, quantitative flow measurements

The AureFlo® system continuously measures, displays, records and documents absolute volume flow and other derived parameters. Shown here with the new HT353 single-channel Optima Flowmeter.

Transonic Systems Inc. is a global manufacturer of innovative biomedical measurement equipment. Founded in 1983, Transonic sells “gold standard” transit-time ultrasound flowmeters and monitors for surgical, hemodialysis, pediatric critical care, perfusion, interventional radiology and research applications. In addition, Transonic provides pressure and pressure volume systems, laser Doppler flowmeters and telemetry systems.
Medical Note

Transit-Time Ultrasound Intraoperative Blood Flow Measurements during Arteriovenous Fistula Creation

Protocol courtesy of Jose Zamora, M.D. San Diego, CA

Introduction
This protocol for measuring intraoperative blood flow during AV fistula creation has two goals:
1) To increase the probability of successful AV fistula maturation with quantitative blood flow measurements.
2) To ensure that the newly created fistula is not immediately robbing the lower arm of flow and setting the stage for ischemic “steal” syndrome.

Measurement Steps (after AV Fistula Construction)
1. Identify Vessel to BeMeasured
   Identify and expose the AVF’s venous outflow. Identify and expose the arterial conduit distal to the AVF anastomosis.
2. Select Flowprobe Sizes (FMV or FTV-Series)
   Measure the vein and artery’s diameters with a gauge. Select a Probe so that the vein will fill between 75% - 100% of the ultrasonic sensing window of the Flowprobe (Fig. 1).
   
<table>
<thead>
<tr>
<th>Probe Size</th>
<th>Nonrestrictive Vessel Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 mm</td>
<td>1.2 - 3.2 mm</td>
</tr>
<tr>
<td>4 mm</td>
<td>3.2 - 5.3 mm</td>
</tr>
<tr>
<td>6 mm</td>
<td>4.5 - 7.5 mm</td>
</tr>
</tbody>
</table>

3. Check Blood Pressure
   If systolic BP is greater than 100 mmHg, continue with measurement. If systolic BP is less 100 mmHg, low AV fistula flow may be caused by low BP. Wait until BP increases to more than 100 mmHg.

4. Apply Flowprobe to Vessel
   1. Select a site wide enough to accommodate the Probe’s acoustic reflector.
   2. Apply sterile gel to the Flowprobe to ensure good ultrasound coupling.
   3. Apply the Flowprobe to the vessel, bending the Flowprobe’s flexible neck so that the entire vessel lies within the sensing window of the Probe and aligns at a 90° angle with the Flowprobe handle (Fig. 1).
   4. Check the Signal Quality Indicator on the AureFlo® or Flowmeter display to verify good acoustic contact.
   5. Listen to the pitch of FlowSound®. The higher the pitch, the greater the flow.

A. FISTULA MATURATION TEST
A1. Measure Venous Outflow*
   End-to-End or Venous End-to-Arterial Side Anastomosis: When the AVF is constructed with an end-to-end or venous-end-to-arterial-side anastomosis, simply measure venous outflow distal to the venous anastomosis (Fig. 2).

   Fig. 2: Measuring venous outflow flow in a fistula anastomosed end to side.

   If the anastomosis is constructed with a venous-side-to-arterial-side anastomosis or end-artery-to-venous-side anastomosis, occlude the vein proximal to the venous anastomosis while measuring flow distal to the anastomosis (Fig. 3). If spasm occurs, papaverin can be locally infiltrated along the artery and vein while flow is continuously monitored.

   Fig. 3: Measuring venous outflow flow in a fistula anastomosed side to side.
Intraoperative Blood Flow Measurements

Flow-Assisted Fistula Creation

B. “STEAL” TEST

B1. Measure Fistula Arterial Flow

Measure brachial or radial arterial flow that supplies the fistula distal to the AV fistula anastomosis in order to detect imminent threat of ischemic “steal” syndrome (ISS) (Figs. 4-5).

B2. Evaluate Flow Values

Check that flow values are well above zero and that the direction of flow is running toward the hand (distally) and not reversed so that it is flowing (proximally) into the AV fistula. If in doubt, zero flow by occluding the artery immediately next to the Flowprobe (Fig. 5).

No “Steal” Indication

If the blood flow running distally to the hand is well above zero, there is no imminent threat of “steal”.

“Steal” Indication

If blood flow running to the hand is close to zero and/or flow is reversed and moving up the arm toward the AV fistula, the fistula may be banded. Flow is then remeasured in the arterial segment of the artery distal to AV anastomosis (Fig. 5). This step is repeated until the surgeon is satisfied that there is sufficient flow running distal from the AV fistula anastomosis to the hand and the threat of “steal” is not imminent.

DOCUMENT FLOWS

After applying a Flowprobe to the artery or vein, wait ~ 10-15 seconds for mean readings to stabilize. When flow readings are stable, flow data can be captured by recording or taking a snapshot on the Aureflo®, or by pressing PRINT on a HT300-Series Flowmeter. If the HT300-Series flow reading is negative on the LED, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

Fig. 4: Artery filling 75-100% of the Probe’s sensing window.

Fig. 5: Flow supplying the hand is measured with the Flowprobe placed on the artery distal to the AV anastomosis. Flow is zeroed by occluding the artery immediately adjacent to the Flowprobe.

THRESHOLDS FROM THE LITERATURE

Thresholds (mL/min) to Predict AV Fistula Maturation: Comparison of Studies

<table>
<thead>
<tr>
<th>AV Fistulas</th>
<th>Flow (mL/min)</th>
<th>Failure within 90 days (Requiring Intervention)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiocephalic</td>
<td>&lt; 170</td>
<td>56 %</td>
<td>.001</td>
</tr>
<tr>
<td>&gt;= 170</td>
<td>15 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachiocephalic</td>
<td>&lt; 280</td>
<td>64 %</td>
<td>.01</td>
</tr>
<tr>
<td>&gt;= 280</td>
<td>18 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: In radiocephalic fistulas, initial flows of less than 170 mL/min correlated with failure within 90 days. In brachiocephalic fistulas, that threshold was 280 mL/min.

<table>
<thead>
<tr>
<th>Flow Rate (mL/min)</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 100</td>
<td>Abandon site</td>
</tr>
<tr>
<td>100 - 300</td>
<td>At risk for early failure; observe closely; allow to mature &gt; 4-6 weeks before using</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>Allow to mature 4-6 weeks before using</td>
</tr>
</tbody>
</table>

Table 2: AV Fistula guidelines as identified by Johnson study.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiocephalic</td>
<td>&gt; 140 (n = 21)</td>
<td>&gt; 170 (n = 94)</td>
<td>&gt; 160 (n = 50)</td>
<td>&gt; 200 (n = 109)</td>
</tr>
<tr>
<td>Brachiocephalic</td>
<td>&gt; 308 (n = 49)</td>
<td>&gt; 280 (n = 128)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Comparison of AV Fistulas threshold studies to predict maturation.

References:


Arteriovenous Fistula Construction

**Fistula Maturation and Steal Tests**

**PROTOCOL**

1) **Create AVF;** Identify & expose:
   a. AV fistula venous outflow
   b. Distal arterial flow

2) **Measure Vein Diameter;** Select Flowprobe sizes.

3) **Check systolic BP \( \geq 100 \text{ mmHg} \)**
   If \(< 100 \text{ mmHg} \), wait until BP \( \geq \) mmHg

**A. Fistula Maturation Test**

- **A1a.** Measure venous outflow distal to anastomosis
- **A1b.** Measure venous outflow distal to anastomosis while occluding vein proximal to anastomosis
- **A2.** Evaluate Flow per pre-established thresholds
  - Radiocephalic: \( >250-300 \text{ ml/min} \)
  - Brachioccephalic: \( > 400 \text{ ml/min} \)
  - Basilic vein transposition: \( > 500 \text{ ml/min} \)
- **A3.** Examine anastomosis and site. Revise, if necessary
- **A4.** Remeasure and evaluate Flow per pre-established thresholds
- **A5.** Fistula maturity tenuous
  1. Alert dialysis staff to suspect fistula (Monitor fistulas with flows between 100-300 ml/min weekly).
  2. Revise 2).
  3. Seek another fistula site 1).

**B. Steal Test**

- **B1.** Measure arterial flow distal to anastomosis while occluding vein proximal to anastomosis to detect imminent steal.
- **B2.** Evaluate flow values.
  - Check that flow runs distally and is \( > \) zero.
  - (Clamp to zero, if in doubt.)
- **B3.** Steal possible; band fistula & remeasure distal arterial flow.
- **B4.** Repeat steps above until distal arterial flow indicates that steal is not imminent.
Equipment

HT354 Single-channel Optima Flowmeter for measuring flow.

OptiMax®-FTV Series Flowprobes

Optimax® (Hand-free) Flowprobes enable extended flow measurements during surgery to guide intraoperative procedures. Specially-designed tape-on supports, affixed to a flexible neck, stabilize the Probe on the vessel during a procedure. The ultrasound sensing window is designed with a J reflector so that the Probe can be slipped around a vessel and remain in place.

Vascular Flowprobes: FMV-Series Vascular Flowprobes feature a short handle and a J-style reflector designed for spot flow checks. The Probe’s flowsensing head consists of a simple J reflector that defines the ultrasound flow sensing window, holds ultrasound couplant gel in place, and maintains the vessel in alignment within the Probe lumen. A flexible neck allows positioning of the Probe head to conform to vessel orientation.

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Medical Note

Intraoperative Blood Flow Measurement during AV (Prosthetic) Graft Construction

INTRODUCTION
Flow cannot be measured directly on newly inserted prosthetic ePTFE grafts (Fig. 1) because air within the synthetic graft walls attenuates ultrasound signal transmission. Graft outflow is therefore measured on the outflow vein following completion of both the arterial and venous anastomoses (Figs. 2, 3). If the distal vein has not been ligated, flow is still measured proximal to the anastomosis, while the distal unligated section of the vein is temporarily occluded (Fig. 4).

MEASUREMENT STEPS:
1. IDENTIFY VESSELS TO BE MEASURED
Identify the exposed segments of the venous outflow conduit for the graft. Determine the optimum site (wide enough to accommodate the Probe’s acoustic reflector) for applying the Probe, and clean the vein at this site from fat and excess tissue.

2. SELECT FLOWPROBE SIZES
Estimate the diameter of the outflow vein with a gauge. Select a Probe size so that the vein will fill between 75% - 100% of the lumen of the Probe.

<table>
<thead>
<tr>
<th>NOMINAL PROBE SIZE</th>
<th>ACCEPTABLE VESSEL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 mm</td>
<td>3.2 - 5.3 mm</td>
</tr>
<tr>
<td>6 mm</td>
<td>4.5 - 7.5 mm</td>
</tr>
</tbody>
</table>

3. APPLY FLOWPROBE
Apply sterile Aquasonic® Gel to the Flowprobe to provide ultrasound coupling between the Probe body and Probe reflector. Apply the Flowprobe to the vein, proximal to the anastomosis, bend the Probe’s flexible neck segment as necessary, so that the entire vein lies within the lumen of the Probe and aligns with the Probe body (Fig. 5). Listen to the pitch of FlowSound® as the Flowprobe is applied to the vein. The higher the pitch, the greater the flow.

   Check the Signal Quality Indicator (bucket display) on the Flowmeter’s front panel or AureFlo’s green bars for ultrasound acoustic contact. An acoustic error message will be displayed if ultrasound contact falls below an acceptable minimum.

Table 1: In prosthetic grafts, initial flows of less than 400 mL/min foreshadowed failure within 90 days.\(^1\)

<table>
<thead>
<tr>
<th>Graft Type</th>
<th>Flow (mL/min)</th>
<th>Failure within 90 Days (Requiring Intervention)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE Grafts</td>
<td>&lt; 400</td>
<td>65 %</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>&gt; 400</td>
<td>40 %</td>
<td></td>
</tr>
</tbody>
</table>

References

4. MEASURE AND EVALUATE VENOUS OUTFLOW
With the Flowprobe positioned as under Step 3, measure venous average flow as displayed on the Flowmeter. An initial venous outflow < 400 mL/min is associated with a higher rate of initial graft failure. As the site recovers from surgery, flow will increase to levels preferred for hemodialysis (> 600 mL/min).

5. DOCUMENT FLOWS
After applying a Flowprobe to a vein, wait ~ 10-15 seconds. When flow readings are stable, flow data can be captured by recording or taking a snapshot on the AureFlo®, or by pressing PRINT on a HT300-Series Flowmeter. If the HT300-Series flow reading is negative on the LED, press INVERT to reverse the polarity of the flow reading from negative to positive before printing out the waveform.

6. MEASURE POTENTIAL FOR STEAL SYNDROME (OPTIONAL)
With the Flowprobe placed on the vein as previously, measure flow with, and without, occlusion of the artery distal to the arterial anastomosis. The difference between the two readings equals flow in the distal branch of the artery. When the flow reading without distal occlusion is higher than the reading with occlusion, blood in the distal branch is flowing retrograde to augment fistula flow and vascular steal may develop. (Note: Alternately, distal arterial flow can be measured directly by placing a Flowprobe on a properly cleaned arterial site distal to the anastomosis.)

PROTOCOL

1. Construct AV Graft:
   Identify & expose venous outflow.

2. Measure Outflow Vein Diameter;
   Select Flowprobe size.

3. Measure Blood Pressure
   Systolic BP > 100 mmHg
   End-to-end or venous end-to-
   arterial side anastomosis.
   4a. Apply Flowprobe
   4b. Wait until systolic BP > 100 mmHg
   Side-to-side or arterial end-to-
   venous side anastomosis.

5. Measured venous outflow distal to anastomosis
   5a. Measure outflow distal to anastomosis while
       occluding vein proximal to anastomosis

6. Evaluate Flow per pre-established thresholds
   Venous Outflow > 400 mL/min
   7a. AV Graft likely to be able to be used
   7b. Examine anastomosis and site.
       Revise, if necessary
   Flow meets threshold
   Flow does not meet
   pre-established threshold

7. Remeasure and Evaluate Flow
   per pre-established thresholds
   Flow does not meet
   pre-established threshold
   9. AV Prosthetic Graft use tenuous.
      Abandon, construct another graft.

www.transonic.com
Flow-guided AV Fistula Banding

Courtesy of M. R. Scheltinga, M.D., Máxima Medical Center, Veldhoven, The Netherlands.

**Why Band a High Flow Fistula?**
The need to increase venous outflow resistance in an arteriovenous fistula (AVF) used to deliver hemodialysis results from:

**Hemodialysis Access-Induced Distal Ischemia (HAIDI)**
Clinically significant HAIDI, that occurs primarily in diabetic patients, is a potentially devastating complication of an AVF. The surgeon’s challenge is to relieve the distal ischemia, but maintain a functional AVF for hemodialysis. One strategy is to band the AVF to increase AVF flow resistance, thereby reducing AVF flow and increasing distal flow.

**Cardiac Overload**
When AVF flow is too high (~>2L/min), cardiac function can become compromised resulting in cardiomegaly. Banding increases AVF resistance and lowers fistula flow, thereby reducing excessive stress on the heart.

**Flow-Guided Fistula Banding**
The surgeon begins with a pre-operative AVF flow level (determined by a Transonic® Hemodialysis Monitor in the dialysis clinic) and pre-sets the percent decrease in AVF flow to be achieved by banding. As the band is tightened, AVF venous outflow is measured intraoperatively. These continuous measurements guide the surgeon in achieving a target AVF flow value.

**Flow Measurement Steps**

0. **Preoperative:** From preoperative surveillance in the hemodialysis clinic, determine % drop in flow to be achieved by banding.

1. **Identify & Expose Venous Outflow of Fistula:** Make a second 1.5-cm incision at least 10 cm downstream (of the upper arm cephalic or basilic vein) towards the axilla away from the dialysis cannulation sites. Identify and expose the AVF venous outflow. Check if this part of the vein is suitable for measurements (no scar tissue/aneurysms/adhesions).

2. **Select Flowprobe Size (FTV-Series):** Measure the vein’s diameter. Select a Probe so that the vein will fill between 75% - 100% of the flow sensing window of the Probe (Fig. 1).

3. **Apply Flowprobe to venous outflow site.**

4. **Measure baseline flow. Calculate target flow (baseline flow times % decrease).**

5. **Tighten band. Remeasure flow.**

6. **Repeat step 5 until flow reaches intraoperative target flow.**

**Flow Measurement Protocol**

0. **Pre-operative:** Determine % fistula flow decrease to be achieved by banding.

1. **Expose AV fistula and its venous outflow (2 incisions).**

2. **Expose venous outflow diameter and select Flowprobe size.**

3. **Apply Flowprobe to venous outflow site.**

4. **Measure baseline flow. Calculate target flow (baseline flow times % decrease).**

5. **Tighten band. Remeasure flow.**

6. **Repeat step 5 until flow reaches intraoperative target flow.**
Flow-guided AV Fistula Banding Cont.

Photo essay below shows continuous measurement of blood flow with a vascular flowprobe directing a fistula banding procedure, courtesy of M. R. Scheltinga, M.D., Dept. of Surgery, Máxima Medical Center, Veldhoven, The Netherlands.

Figs. 1, 2: HAIDI: Banding of an AV fistula (AVF) may be indicated for hemodialysis access induced distal ischemia (HAIDI). Preoperative angiography of HAIDI patient with radiocephalic AVF shows the absence of hand arteries visualization (Fig. 1). Tissue necrosis in the hand (Fig. 2) also indicates presence of HAIDI.

Fig. 3: Banding: Minimally invasive positioning of a Transonic® Flowprobe guides the degree of tightening of a 5 mm Dacron band during this procedure.

Fig. 4: A 5 mm Dacron band is fixed using a clip and stitches. In this patient, AVF thrill was maintained and radial arterial pulses returned.

Fig. 5: Banding may also be performed for a high flow AV fistula (HFA) > 2L/min. This patient suffered from fatigue in the presence of a 3.7 L/min upper arm AVF.

Fig. 6: If HFA is also associated with HAIDI, measurement of finger pressures is also required. Once an optimal combination of access flow (> access thrombotic threshold level, generally > 500 mL/min) and finger pressure (>50 mmHg) is attained, the band is fixed.

REFERENCES

www.vascularprocedures.com/html/algemeen/home.php

Vascular Access Management
“A Circle of Care®”

Proactive vascular access management depends upon a trio of Transonic® flow measurements that guide the surgeon, the nephrologist and the interventionalist throughout the natural history of a vascular access.

- Surgical creation of AV access: Transit-time ultrasound (intraoperative) flow measurements foretell successful maturation.
- During hemodialysis: Transonic® ultrasound dilution measurements provide ongoing surveillance and trending to detect development of hemodynamically significant stenoses.
- Intervention/Revision: When an access problem is identified, intragraft flow measurements guide the interventional radiologist during percutaneous transluminal angioplasty (PTA). Intraoperative flow measurements guide surgical revisions to resolve complications such as “steal” syndrome.
Access Creation: Intraoperative Blood Flow Measurements

The Centers for Medicare and Medicaid Services (CMS) Fistula First Break-through Initiative’s success has transformed the hemodialysis access in the United States from a “graft-oriented culture” to a “fistula-oriented culture.” Since 2012 more than 60% of American hemodialysis patients have AV fistulas.\(^1\) Yet, the number of fistulas that do not mature (estimated to be between 28-50%)\(^2\) continues to confound and challenge the hemodialysis care provider.

In his landmark 1998 study in Surgery, Johnson et al reported that for an AV fistula to mature, a venous outflow equal or greater than 100 mL/min at its creation is advised. For an AV prosthetic graft, an initial venous outflow of less than 250 mL/min is associated with a higher rate of initial graft failure.\(^3\) As the access matures and arterializes, flow generally increases to levels needed for hemodialysis (greater than 500 mL/min). To ensure adequate flow for hemodialysis, Transonic\(^\circledR\) intraoperative blood flow measurements provide the surgeon with quantitative flow values during creation of the access (Fig. 1). Johnson and others report that intraoperative blood flow rates at access creation directly correlate to access outcomes including: patency, number of interventions, and length of hospital stays.

“Adequate blood flow in peripheral hemodialysis fistulae and grafts is vital to the success of hemodialysis and to the survival of the patient. Reduction in flow ... presages failure of the access device itself. Access flow can therefore be considered a fundamental property of the access that should be monitored.” -- Depner, TA et. al.
Hemodialysis: Surveillance

The Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines for Vascular Access and the National Kidney Foundation codified Dr. Depner’s advocacy of access flow monitoring by stating “prospective surveillance of AV grafts and fistulas for hemodynamically significant stenosis, when combined with correction, improves patency and decreases the incidence of thrombosis.” Canadian, Australian and European Guidelines also call for surveillance during hemodialysis to forestall stenosis formation and prolong the life of the access. Intra-access measurements (ultrasound dilution technology) are cited as the preferred method for surveillance.

Transonic’s ultrasound dilution technology is recognized as the “gold standard” intra-access flow measurement technology for hemodialysis patient surveillance. The method uses Transonic Flow-QC® Hemodialysis Monitors and Flow/dilution Sensors to directly measure dialysis adequacy (delivered blood flow, recirculation) for on-the-spot correction of problems during hemodialysis and to trend vascular access flow to detect flow limiting problems wherever they occur in a vascular access (Fig. 2). Cardiac output and associated parameters can also be measured with this technology during the dialysis treatment.
Vascular Access Revision

Intra-graft Flow Measurements

During angioplasty, a Transonic® ReoCath® Flow Catheter and Endovascular Flowmeter provide the interventionalist with immediate flow feedback (Fig. 3) for quantitative confirmation that a hemodynamically significant stenosis has been corrected or that elastic recoil has not compromised the flow correction.

Intraoperative Flow Measurements

When surgery is the access revision option, intraoperative flow measurements inform during the revision. Transonic® quantitative measurements replace guesswork especially when an access needs to be banded to mitigate ischemic steal syndrome.

Conclusion

In the outcomes-driven climate of proactive end-stage renal disease (ESRD) care, Transonic® quantitative flow measurements are integral to successful and comprehensive vascular access management. During creation of the access, during hemodialysis and/or during interventions or revisions, respective Transonic® flow measurements inform and guide the surgeon, nephrologist and/or interventionalist as they seek to create and maintain a healthy access for their patients. Transonic® flow-based “Circle of Care” is a cornerstone for proactive Vascular Access Management.

REFERENCES

1 http://www.fistulafirst.org/