

Vascular Sonography Formula & Criteria Study Guide

An In-Depth Review by Dr. Alice Matthews

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*Based on Kupinski, "Diagnostic Medical Sonography: The Vascular System"
Formulas, diagnostic criteria, analogies, and clinical applications.*

PART 1: HEMODYNAMICS

Bernoulli Principle

Total Energy = Potential Energy (pressure) + Kinetic Energy (velocity)

What this means: In a closed system, energy is conserved. When blood speeds up through a narrowing, its pressure drops. When it slows down, pressure rises. You cannot increase both at the same time.

Analogy: Hold your thumb over a garden hose. The water sprays faster (velocity up), but the pressure inside the hose at that point actually drops. Release your thumb, the water slows down and the pressure comes back up. Same total energy, just redistributed.

Clinical application: This is how we estimate pressure gradients across stenotic heart valves. The simplified Bernoulli equation ($\Delta P = 4v^2$) converts a Doppler velocity into a pressure drop. A valve with a jet velocity of 4 m/s has a pressure gradient of 64 mmHg.

Poiseuille's Law

$$Q = \frac{\pi(P_1 - P_2)r^4}{8\eta L}$$

Variable	Meaning	Relationship to Flow
Q	Volume flow rate	What we are solving for
$P_1 - P_2$	Pressure gradient	Directly proportional
r	Vessel radius	Directly proportional to r^4
η	Viscosity	Inversely proportional
L	Vessel length	Inversely proportional

What this means: Flow depends on four things, but radius dominates everything. Because radius is raised to the **fourth power**, even small changes in vessel diameter produce enormous changes in flow.

Analogy: Imagine two garden hoses, one with a 1-inch opening and one with a 2-inch opening. You might expect the bigger hose to carry twice as much water. It actually carries **16 times** as much ($2^4 = 16$). This is why a 50% diameter reduction in an artery is such a big deal: flow drops dramatically.

Clinical application: This law explains why atherosclerosis matters. A plaque that narrows an artery by just 50% of its diameter reduces potential flow by a factor of 16. It also explains why viscosity matters: polycythemia (high hematocrit) increases viscosity and reduces flow.

Resistance

$$R = \frac{\Delta P}{Q}$$

What this means: Resistance is the opposition to blood flow. It equals the pressure drop across a vessel divided by the flow through it. Higher resistance means you need more pressure to maintain the same flow.

Resistances in Series

$$R_{\text{total}} = R_1 + R_2 + R_3$$

Analogy: Like construction zones on a highway, one after another. Each zone adds delay. Two 50% stenoses in the same artery are worse than one because their resistances add up.

Resistances in Parallel

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Analogy: Like adding checkout lanes at a grocery store. Each new lane reduces the overall wait. This is exactly what collateral arteries do: when the main vessel is blocked, parallel pathways open up and total resistance drops.

Clinical application: This is why collateral development matters. A patient with a chronic SFA occlusion may have minimal symptoms if robust collaterals have formed (parallel resistance). But a patient with tandem stenoses in the same vessel (series resistance) may be much worse off.

Reynolds Number

$$Re = \frac{v \times d \times \rho}{\eta}$$

$$Re < 2,000 = \text{Laminar} \quad Re > 2,000 = \text{Turbulent}$$

What this means: Reynolds number predicts whether flow will be smooth and orderly (laminar) or chaotic (turbulent). It increases with velocity, vessel diameter, and blood density. It decreases with viscosity.

Analogy: Think of a calm river (laminar) versus rapids (turbulent). Increase the speed of the water, widen the channel, or make the water thinner, and eventually the smooth flow breaks apart into chaos. The Reynolds number is the tipping point.

Clinical application: Turbulence on Doppler shows up as spectral broadening and a “filled-in” spectral window. At a stenosis, velocity increases, Reynolds number exceeds 2,000, and flow becomes turbulent. This is an indirect sign of disease.

Velocity and Flow

$$v = \frac{Q}{A}$$

What this means: Velocity equals flow divided by cross-sectional area. If the area narrows (stenosis), velocity must increase to maintain the same flow. This is the continuity principle.

Analogy: Put your thumb over a garden hose. The opening gets smaller, but the same volume of water still comes through, so it sprays faster. Blood does the same thing at a stenosis.

Why this matters: This is the entire basis of Doppler-based stenosis grading. We measure how fast blood is moving. If it is moving too fast, the vessel must be narrowed.

Arterial Compliance

$$C = \frac{\Delta V}{\Delta P}$$

What this means: Compliance is how much a vessel stretches when pressure increases. High compliance means the vessel expands easily. Low compliance means it is stiff.

Analogy: A new balloon (high compliance) stretches easily when you blow into it. An old, dried-out balloon (low compliance) resists expansion. Aging arteries are like old balloons: stiffer, less elastic, leading to higher systolic pressure.

Clinical application: Loss of compliance (arteriosclerosis) is why systolic blood pressure increases with age. It also explains why the arterial system loses its ability to smooth pulsatile flow into steady capillary flow (the “hydraulic filter” function).

Critical Stenosis

50% diameter reduction = 75% area reduction

What this means: A stenosis becomes hemodynamically significant when it reduces the cross-sectional area by about 75%, which corresponds to a 50% reduction in diameter. Below this threshold, the body compensates. Above it, pressure and flow begin to drop.

Analogy: A four-lane highway can handle lane closures. Close one lane (25% reduction), traffic still flows. Close two lanes (50%), things slow a bit. Close three lanes (75%), and traffic backs up. The critical point is when the number of open lanes can no longer handle the volume.

Important: The threshold varies with downstream resistance. A 50% stenosis in a vessel feeding a dilated vascular bed (like exercising muscle) may become symptomatic earlier than the same stenosis feeding a resting bed.

Laminar vs. Turbulent Flow

Feature	Laminar Flow	Turbulent Flow
Pattern	Smooth, parallel layers	Chaotic, random mixing
Velocity profile	Parabolic (fastest in center)	Flat (mixed velocities)
Center velocity	2× mean velocity	Close to mean velocity
Spectral Doppler	Clean window under systolic peak	Filled-in spectral window
Reynolds number	< 2,000	> 2,000
Where found	Normal straight vessels	Stenoses, bifurcations

Clinical application: Spectral broadening (loss of the clear window) is one of the earliest Doppler signs of stenosis. It means flow has transitioned from laminar to turbulent.

PART 2: CAROTID STENOSIS

ICA Stenosis Grading (Consensus Criteria)

This is the single most important table in vascular sonography. Memorize it.

Stenosis	PSV (cm/s)	EDV (cm/s)	ICA/CCA Ratio
Normal	< 125	< 40	< 2.0
< 50%	< 125	< 40	< 2.0
50 – 69%	125 – 230	40 – 100	2.0 – 4.0
≥ 70%	> 230	> 100	> 4.0
Near Occlusion	Variable (often low)	Variable	Variable
Occlusion	No flow detected	No flow	N/A

How to use this table: Start with PSV. It is the primary criterion. Use EDV and the ICA/CCA ratio as supporting evidence. All three should point to the same category. If they disagree, clinical judgment is needed.

Memory aid for the big thresholds: - PSV 125 and 230: Think “1-2-3” (125, 230) - EDV 40 and 100: Think “4 and 10” (times 10) - Ratio 2.0 and 4.0: Double and double again

Why EDV matters: EDV becomes elevated only with severe stenosis. It is the most specific criterion for ≥ 70% stenosis. An EDV > 140 cm/s suggests 80 – 99% narrowing.

Key Waveform Patterns

Tardus-Parvus (“late and small”) - Found **distal** to a significant stenosis - Delayed systolic upstroke + reduced peak velocity - Analogy: Water coming out of a kinked hose arrives late and weak

String Sign - Found in a **near-occlusion** - Blunted, low-velocity trickle with minimal diastolic flow - Analogy: The last drops from an almost-clogged pipe

Flow Separation - Normal finding in the **carotid bulb** - Brief flow reversal along the outer wall of the bulb - Disappears as plaque fills the bulb (actually a sign of a normal, open bulb)

Subclavian Steal

When the subclavian artery is stenosed proximal to the vertebral artery origin, blood reverses in the vertebral artery to supply the arm. The brain’s blood supply is “stolen.”

Stage	Vertebral Flow Pattern
Latent (Partial)	Systolic notching or mid-systolic deceleration
Partial Steal	Alternating antegrade/retrograde flow
Complete Steal	Fully reversed (retrograde) flow

Clinical application: If you see reversed vertebral flow, check the ipsilateral subclavian artery for proximal stenosis. Compare arm blood pressures: a difference > 20 mmHg suggests subclavian disease.

PART 3: TRANSCRANIAL DOPPLER (TCD)

Normal Intracranial Values

Vessel	Window	Depth (mm)	Mean Velocity (cm/s)	Flow Direction
MCA	Temporal	50 – 65	46 – 86	Toward
ACA	Temporal	60 – 75	41 – 76	Away
PCA	Temporal	60 – 70	33 – 64	Toward / Away
Carotid Siphon	Transorbital	60 – 70	37 – 82	Toward / Away
Vertebral	Suboccipital	60 – 90	27 – 55	Away
Basilar	Suboccipital	80 – 110+	30 – 57	Away

Memory aid: MCA is the workhorse vessel. It is the easiest to find (temporal window, 50-65 mm depth) and the most commonly monitored.

Note: About 10-20% of patients have an inadequate temporal bone window. No window does not mean no disease.

Vasospasm Detection (Lindgaard Ratio)

$$\text{Lindgaard Ratio} = \frac{\text{MCA Mean Flow Velocity}}{\text{Ipsilateral Extracranial ICA MFV}}$$

MCA MFV (cm/s)	Lindgaard Ratio	Interpretation
< 120	< 3	No spasm (or hyperemia)
120 – 200	3 – 6	Mild to moderate spasm
> 200	> 6	Severe spasm

Why we need the ratio: High MCA velocity alone could mean vasospasm OR hyperemia (globally increased blood flow). The Lindgaard ratio distinguishes them. In hyperemia, both MCA and ICA velocities are elevated (ratio stays low). In true vasospasm, only the MCA velocity is elevated (ratio climbs).

Timing: Vasospasm occurs 3-14 days after subarachnoid hemorrhage. This is the critical monitoring window.

Pulsatility Index

$$PI = \frac{PSV - EDV}{MFV}$$

What this means: PI measures how “spiky” the waveform is. A high PI means there is a big difference between systolic and diastolic flow (high resistance downstream). A low PI means flow is relatively steady (low resistance).

Clinical application: Elevated PI in intracranial vessels suggests increased intracranial pressure or distal obstruction. It is used in TCD monitoring and in obstetric Doppler (umbilical artery PI).

PART 4: PERIPHERAL ARTERIAL TESTING

Ankle-Brachial Index (ABI)

$$ABI = \frac{\text{Highest Ankle Systolic Pressure}}{\text{Highest Brachial Systolic Pressure}}$$

ABI	Interpretation
> 1.3	Abnormal: calcified, incompressible vessels
1.0 – 1.3	Normal
0.9 – 1.0	Borderline
0.7 – 0.9	Mild disease (claudication possible)
0.4 – 0.7	Moderate disease (claudication likely)
< 0.4	Severe / Critical ischemia (rest pain, tissue loss)

Analogy: Think of the ABI as a “report card” for leg circulation. The arm pressure is the control (the A student). The ankle pressure is the test subject. A ratio near 1.0 means the legs are keeping up. A ratio of 0.5 means the legs are failing.

When ABI is unreliable: Diabetics and patients with renal disease often have calcified arteries that will not compress. The cuff pressure reads falsely high (ABI > 1.3). Use the **Toe-Brachial Index** instead.

Toe-Brachial Index (TBI)

$$TBI = \frac{\text{Toe Systolic Pressure}}{\text{Brachial Systolic Pressure}}$$

$$\text{Normal TBI} > 0.7$$

Why it works when ABI does not: Digital arteries rarely calcify, even in diabetics. The toe pressure remains compressible and reliable.

Segmental Pressures

Cuffs are placed at the high thigh, low thigh (above knee), calf, and ankle. Pressures are compared between levels and between legs.

$$\text{Gradient} > 20\text{-}30 \text{ mmHg between adjacent segments} = \text{significant stenosis}$$

How to localize disease: - Drop from high thigh to low thigh: SFA disease - Drop from calf to ankle: tibial disease - Drop from one leg to the other at the same level: unilateral disease

Exercise Testing

ABI drop > 0.15-0.20 after treadmill = abnormal

Why exercise matters: Some stenoses are not hemodynamically significant at rest but become significant during exercise when flow demand increases. A normal resting ABI with an abnormal post-exercise ABI confirms arterial disease.

Lower Extremity Duplex: Velocity Ratio

$$V_r = \frac{PSV_{\text{at stenosis}}}{PSV_{\text{proximal normal segment}}}$$

Stenosis	Velocity Ratio
Normal / < 50%	$V_r < 2.0$
50 – 69%	$V_r > 2.0$
70 – 99%	$V_r > 3.0$
Occlusion	No flow

Analogy: Imagine two sections of highway. If cars are going 60 mph in the normal section and 120 mph through the construction zone, the ratio is 2.0 (50% stenosis). If they are going 180 mph, the ratio is 3.0 (70%+ stenosis). Speed increases because the same number of cars must squeeze through a narrower space.

Waveform Morphology

Waveform	Phases	Flow Reversal	Indicates
Triphasic	3	Yes (early diastole)	Normal resting extremity
Biphasic	2	No	Mild disease or post-exercise vasodilation
Monophasic	1	No	Significant proximal disease

Clinical tip: A triphasic waveform that becomes monophasic after exercise and stays monophasic suggests disease. A normal vessel will recover its triphasic pattern within minutes.

PART 5: PERIPHERAL VENOUS

DVT Diagnosis: Primary Signs

Finding	What It Means
Non-compressibility	#1 criterion. Normal veins collapse flat with probe pressure. Clot-filled veins do not.
Visible thrombus	Echogenic material within the lumen
Absent flow	No color or spectral Doppler signal
Absent augmentation	No flow increase with distal compression

Finding	What It Means
Loss of phasicity	Continuous flow instead of respiratory variation (proximal obstruction)

Analogy: Compressibility is like squeezing a tube of toothpaste versus squeezing a stick of chalk. The toothpaste tube (normal vein) collapses easily. The chalk (clotted vein) does not budge.

Acute vs. Chronic DVT

Feature	Acute (< 14 days)	Chronic (weeks to months)
Echogenicity	Hypoechoic (dark)	Hyperechoic (bright)
Vein size	Dilated	Contracted
Attachment	May be free-floating	Firmly adherent to wall
Compressibility	None	Partial (may partially compress)
Collaterals	Absent	Present
Vein wall	Smooth, thin	Thickened, irregular

Why this matters: Acute DVT is a medical emergency (risk of PE). Chronic DVT is managed differently (may not need anticoagulation). Misidentifying chronic thrombus as acute can lead to unnecessary treatment.

Virchow's Triad

The three conditions that promote venous thrombosis:

1. **Stasis:** Slow or stagnant blood flow (immobility, bed rest, long flights)
2. **Vessel wall injury:** Trauma, surgery, catheter placement
3. **Hypercoagulability:** Clotting disorders, cancer, pregnancy, oral contraceptives

Analogy: Like the fire triangle (fuel + heat + oxygen). Remove any one element and the risk drops. All three together create the perfect storm for clot formation.

Venous Reflux: Time Thresholds

Vessel	Abnormal Reflux Duration
Saphenous veins (GSV, SSV)	> 500 ms (0.5 sec)
Deep femoropopliteal veins	> 1,000 ms (1.0 sec)
Perforating veins	> 350 ms

How reflux is tested: With the patient standing or in reverse Trendelenburg, squeeze the calf and release. In a competent system, flow goes up and stops. In an incompetent system, blood falls backward (refluxes) through the leaky valves. Time the reflux. If it exceeds the thresholds above, the valves are incompetent.

Memory aid: "5-10-3.5" : Saphenous 500, Deep 1000, Perforators 350 (all in milliseconds).

CEAP Classification (Venous Disease Severity)

Class	Description
C0	No visible or palpable signs
C1	Telangiectasias (< 1 mm) or reticular veins (1 – 3 mm)
C2	Varicose veins ($\geq$ 3 mm)
C3	Edema
C4a	Pigmentation or eczema
C4b	Lipodermatosclerosis or atrophie blanche
C5	Healed venous ulcer
C6	Active venous ulcer

Clinical application: CEAP provides a standardized language for documenting venous disease severity. C4-C6 indicates advanced chronic venous insufficiency.

Venous Recovery Time (VRT)

$VRT < 20$ seconds = significant reflux

Measured by photoplethysmography (PPG). After calf pumping, the time for veins to refill indicates valve competence. Fast refill means leaky valves.

PART 6: ABDOMINAL VASCULAR

Abdominal Aortic Aneurysm (AAA)

$AAA \geq 3.0$ cm or $\geq 1.5 \times$ normal diameter

Normal aortic diameter: 1.5 – 2.5 cm

AAA Diameter	Surveillance / Action
3.0 – 3.9 cm	Every 2 – 3 years
4.0 – 4.9 cm	Every 6 – 12 months
5.0 – 5.4 cm	Every 3 – 6 months
≥ 5.5 cm	Intervention recommended

Analogy: Think of the aorta like a tire. A small bulge (3 cm) needs monitoring. A bigger bulge (5+ cm) needs repair before it blows out. The bigger the aneurysm, the thinner the wall, and the higher the risk of rupture.

Measurement: Always outer wall to outer wall, in the anteroposterior plane, perpendicular to the long axis of the vessel.

Endoleak Classification (Post-EVAR)

Type	Source	Urgency
I	Attachment site (proximal or distal seal)	Urgent repair
II	Branch vessel backflow (lumbar, IMA)	Often self-limited; monitor
III	Modular disconnect or fabric tear	Requires repair
IV	Graft porosity (early post-op)	Transient; usually resolves
V	Endotension (sac grows, no visible leak)	Monitor closely

Memory aid: Types I and III are **high-pressure leaks** (need repair). Types II and IV are **low-pressure** (usually benign). Type V is the mystery: the sac grows but you cannot find a leak.

Renal Artery Stenosis

Renal-Aortic Ratio (RAR)

$$RAR = \frac{\text{Renal Artery PSV}}{\text{Aortic PSV}} \quad RAR > 3.5 = >60\% \text{ stenosis}$$

Direct Criteria

Finding	Stenosis
Renal artery PSV > 180 – 200 cm/s	> 50%
Renal artery PSV > 250 cm/s	Severe
RAR > 3.5	> 60%

Resistive Index (Intrarenal)

$$RI = \frac{PSV - EDV}{PSV}$$

RI Value	Interpretation
< 0.7	Normal
> 0.7	Suggests parenchymal disease or obstruction

Analogy: The RI is like a “stiffness score” for the kidney. A healthy kidney with open, elastic vessels has a low RI (blood flows freely in diastole). A diseased kidney with fibrosis or rejection has a high RI (blood flow drops off in diastole because the tissue is stiff).

Mesenteric Artery Stenosis

Artery	PSV Threshold	EDV Threshold	Stenosis
Celiac	≥ 200 cm/s	≥ 55 cm/s	≥ 70% / ≥ 50%
SMA	≥ 275 cm/s	≥ 45 cm/s	≥ 70% / ≥ 50%

Clinical context: Mesenteric ischemia requires stenosis of at least two of three mesenteric vessels (celiac, SMA, IMA) to become symptomatic, because the collateral network between them is robust. Single-vessel stenosis is usually compensated.

Key finding: Post-prandial pain (“intestinal angina”) occurs because the gut demands more blood after eating, but the stenosed vessels cannot deliver it.

TIPS Surveillance

Parameter	Normal	Stenosis Suspected
Stent velocity	90 – 190 cm/s	< 50 or > 200 cm/s
Main portal vein	30 – 47 cm/s	Significantly altered

Key point: Both too-low AND too-high velocities in the TIPS stent suggest a problem. Low velocity may mean thrombosis. High velocity may mean stenosis within the stent.

IVC Assessment

Parameter	Normal	Abnormal
Diameter	1.5 – 2.5 cm	> 2.5 cm (dilated)
Respiratory collapse	≥ 50% with inspiration	< 50% collapse

Clinical application: A dilated IVC that does not collapse with inspiration suggests elevated right atrial pressure (right heart failure, fluid overload, pericardial disease).

PART 7: BYPASS GRAFT SURVEILLANCE

Graft Stenosis Criteria

Finding	Threshold
PSV at stenosis	> 300 cm/s
Velocity ratio (V_r)	> 3.5
ABI decrease	> 0.15 from baseline

Why surveillance matters: The #1 cause of vein graft failure within 2 years is **myointimal hyperplasia**, a smooth muscle cell overgrowth at anastomotic sites or valve cusps. Catching it early (when the graft is still open) allows intervention before thrombosis.

Surveillance Schedule

Time After Surgery	Frequency
0 – 3 months	Baseline scan
3 – 12 months	Every 3 months

Time After Surgery	Frequency
12 – 24 months	Every 6 months
> 24 months	Annually

Intraoperative Completion Criteria

Procedure	PSV	EDV	V_r
Carotid endarterectomy	< 130 cm/s	< 50 cm/s	–
Bypass graft	< 200 cm/s	–	< 2.0

PART 8: HEMODIALYSIS ACCESS

Fistula Maturation Criteria ("Rule of 6s")

Parameter	Requirement
Vein diameter	≥ 6 mm
Access flow	≥ 600 mL/min
Depth from skin	< 6 mm
Maturation time	6 – 12 weeks typical

Analogy: The “Rule of 6s” is your checklist before a fistula is ready for use: 6 mm wide, 600 mL/min flow, less than 6 mm deep. If any criterion is not met, the fistula needs more time or intervention.

Access Surveillance

Parameter	Normal	Abnormal
Access flow	600 – 1,200 mL/min	< 600 mL/min
Stenosis velocity	–	> 400 – 600 cm/s
High-output risk	–	> 2,000 mL/min (cardiac burden)

PART 9: TRANSPLANT EVALUATION

Renal Transplant

Parameter	Normal	Concerning
Anastomotic PSV	–	> 200 – 250 cm/s (stenosis)
Intrarenal RI	< 0.7	> 0.8 (rejection risk)

Clinical application: Rising RI in a transplant kidney is an early warning sign of rejection, renal vein thrombosis, or obstruction. Serial monitoring is essential in the first weeks after transplant.

PART 10: STATISTICS FOR THE VASCULAR LAB

Diagnostic Accuracy Formulas

$$\text{Sensitivity} = \frac{TP}{TP + FN} \quad \text{Specificity} = \frac{TN}{TN + FP}$$

$$PPV = \frac{TP}{TP + FP} \quad NPV = \frac{TN}{TN + FN}$$

$$\text{Accuracy} = \frac{TP + TN}{\text{Total Tests}}$$

Term	What It Answers	Memory Aid
Sensitivity	“Can it find disease?”	SeNsitivity = true positives out of all N egatives ruled out
Specificity	“Can it rule out disease?”	SPecificity = true negatives out of all P ositives ruled in
PPV	“If positive, is it real?”	Depends heavily on prevalence
NPV	“If negative, am I safe?”	Depends heavily on prevalence

Analogy: Sensitivity is like a metal detector at the airport. A highly sensitive detector catches every piece of metal (few false negatives), but it might also beep for belt buckles (false positives). Specificity is the ability to tell a weapon from a belt buckle. You want both to be high.

Kappa Statistic (Observer Agreement)

Kappa	Agreement
< 0.20	Poor
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 – 1.00	Excellent

What it means: Kappa measures how much two observers agree beyond what you would expect by chance. A kappa of 0.80+ means two sonographers looking at the same scan almost always agree.

MASTER QUICK REFERENCE

Key Formulas

Formula	Equation
Poiseuille’s Law	$Q = \frac{\pi \Delta P r^4}{8 \eta L}$
Resistance	$R = \Delta P / Q$
ABI	Ankle pressure / Brachial pressure

Formula	Equation
Velocity Ratio	$V_r = PSV_{\text{stenosis}} / PSV_{\text{normal}}$
Resistive Index	$RI = (PSV - EDV) / PSV$
Pulsatility Index	$PI = (PSV - EDV) / MFV$
Lindegaard Ratio	MCA MFV / Extracranial ICA MFV
Renal-Aortic Ratio	Renal PSV / Aortic PSV
Sensitivity	$TP / (TP + FN)$
Specificity	$TN / (TN + FP)$

Key Thresholds to Memorize

Threshold	Value
ABI normal	0.9 – 1.3
ABI critical ischemia	< 0.4
TBI normal	> 0.7
ICA 50% stenosis PSV	125 cm/s
ICA 70% stenosis PSV	230 cm/s
ICA 70% stenosis EDV	100 cm/s
AAA definition	≥ 3.0 cm
AAA repair threshold	≥ 5.5 cm
Renal artery RAR	$> 3.5 = >60\%$
SMA 70% PSV	≥ 275 cm/s
Celiac 70% PSV	≥ 200 cm/s
Saphenous reflux	> 500 ms
Deep vein reflux	> 1,000 ms
Reynolds number (turbulence)	> 2,000
Critical stenosis	50% diameter / 75% area
Bypass graft stenosis PSV	> 300 cm/s
RI normal (renal)	< 0.7

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