

COMPREHENSIVE MOCK EXAM 3

Supplemental to: Ultrasound Physics Board Review 2026-2027

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ARDMS SPI (Sonography Principles and Instrumentation) Examination, Inteleos -- 110 questions, single-best-answer, four options (A-D), domain-weighted per official ARDMS SPI Content Outline

Board-Review Questions

1. A sonographer nearly connects the wrong patient's exam to the worklist but catches the error before any images are saved or a report is generated. Under standard patient-safety terminology, this event is best classified as a:

- A. Sentinel event
- B. Adverse event
- C. Near miss
- D. Never event

2. Which of the following best describes the purpose of a hospital's "Speak Up" initiative as it applies to a sonography department?

- A. Require patients to sign a general consent for every imaging exam
- B. Mandate two-person verification before invasive procedures
- C. Encourage patients to ask questions and voice concerns about their own care
- D. Standardize how critical values are reported to physicians

3. A department reviews a random sample of stored images each quarter against fixed technical benchmarks (adequate depth, correct labeling, gain). Six months later, the department launches a new project to reduce mean exam turnaround time. The first activity is best classified as _____, and the second as _____.

- A. QI; QA
- B. QA; QA
- C. QI; QI
- D. QA; QI

4. A sonographer switches to a new high-level disinfectant for endocavity probes. Before first use, which document should be consulted for its hazardous-ingredient information, first-aid measures, and required PPE?

- A. The manufacturer's IFU for the probe

- B.** The department's QA log
- C.** The AIUM Prudent Use Statement
- D.** The Safety Data Sheet (SDS) for the chemical

5. A patient with an implanted cardiac pacemaker is scheduled for an abdominal ultrasound. Which statement about diagnostic B-mode ultrasound and the pacemaker is correct?

- A.** The exam must be rescheduled until device interrogation clears it
- B.** A magnet must be placed over the device before scanning
- C.** Diagnostic ultrasound imaging does not electromagnetically interfere with the device
- D.** Only phased-array transducers are contraindicated near the device

6. Immediately after a needlestick injury during an ultrasound-guided biopsy, the sonographer's first action should be to:

- A.** Immediately notify the ordering physician of the incident
- B.** Complete a formal incident report before doing anything else
- C.** Determine the source patient's bloodborne pathogen status first
- D.** Wash the exposed area and begin the post-exposure protocol

7. A sonographer realizes, after the patient has left, that the wrong side was labeled on a completed exam that was already released to the referring physician. The most appropriate next step is to:

- A.** Quietly relabel the images in the archive and stay silent
- B.** Report the error through the facility's disclosure process for correction
- C.** Wait and see whether the referring physician happens to notice
- D.** Document the error only if the patient specifically asks about it

8. Before an ultrasound-guided thoracentesis, confirming a patient's advance directive/code status is most directly relevant to:

- A.** Selecting the correct transducer frequency for this procedure
- B.** Determining the appropriate probe disinfection level beforehand
- C.** Calculating the precise needle-guide entry angle needed
- D.** Planning the team's response if the patient decompensates

9. A registered sonographer allows continuing medical education requirements to lapse past the registry's renewal deadline. The most likely consequence is:

- A.** Credential status becomes inactive until requirements are met
- B.** Automatic downgrade to student status
- C.** No consequence as long as employment continues
- D.** The facility's accreditation is revoked

10. Facility policy requires the emergency crash cart in the ultrasound suite to be checked and logged:

- A.** Only after it is used
- B.** On a defined recurring schedule regardless of use
- C.** Annually during accreditation survey
- D.** Only when a new sonographer is oriented

11. For an ultrasound-guided procedure with a laterality component, marking the intended procedure site on the patient before the time-out is a required element of the:

- A.** Universal Protocol
- B.** HIPAA minimum necessary standard
- C.** AIUM Prudent Use Statement
- D.** Spaulding classification

12. A fixed acoustic power is transmitted through a transducer aperture. When the beam is focused to a smaller cross-sectional area at the focal zone, which of the following changes?

- A.** Intensity increases while power remains unchanged
- B.** Power increases while intensity remains unchanged
- C.** Both power and intensity increase
- D.** Neither power nor intensity changes

13. A structure much smaller than the ultrasound wavelength scatters energy according to Rayleigh scattering. If the operating frequency is doubled, the scattered energy from that structure increases by approximately a factor of:

- A.** A factor of approximately 2
- B.** A factor of approximately 16
- C.** A factor of approximately 4
- D.** A factor of approximately 8

14. Which mechanism describes energy loss when molecules absorb acoustic energy during compression but return it out of phase during relaxation, converting it to heat?

- A.** Specular reflection
- B.** Diffraction
- C.** Mode conversion
- D.** Relaxation absorption

15. A transvaginal early first-trimester exam is being performed with a soft-tissue path only, no bone in the beam path. The appropriate thermal index to monitor is:

- A.** The bone thermal index (TIB)
- B.** The cranial thermal index (TIC)
- C.** The soft-tissue thermal index (TIS)
- D.** MI alone; no thermal index applies

16. A transducer's output intensity in water is 100 mW/cm^2 . Using the standard 0.3 dB/cm/MHz-cm derating factor at 5 MHz and a depth of 2 cm (total loss = $0.3 \times 5 \times 2 = 3 \text{ dB}$, approximately a 50% reduction), the derated (in-situ) intensity is closest to:

- A.** 100 mW/cm^2
- B.** 75 mW/cm^2
- C.** 25 mW/cm^2
- D.** 50 mW/cm^2

17. As a fundamental-frequency pulse propagates into tissue, the second-harmonic component's amplitude typically:

- A.** Is greatest at the transducer face and decreases steadily with depth
- B.** Builds progressively with depth from nonlinear distortion, then falls as attenuation dominates
- C.** Stays essentially constant with depth regardless of attenuation or distortion
- D.** Depends only on transducer frequency, not on the fundamental's amplitude

18. For a simple concave (bowl-shaped) piezoelectric element, tightening the radius of curvature (making the bowl deeper) has which effect on the natural focal length?

- A.** Focal length increases
- B.** Focal length decreases
- C.** Focal length is unaffected by curvature
- D.** Focal length becomes infinite

19. In real-time 4D imaging, "volume rate" is best understood as the 3D analog of 2D frame rate, and like frame rate it is fundamentally limited by:

- A.** Transducer element count alone, independent of the volume acquired
- B.** The display monitor's refresh rate during image playback
- C.** The available size of the system's cine-loop buffer

D. The pulse-echo round-trip time needed across the whole volume

20. Conceptually, an array transducer with element spacing greater than about half a wavelength behaves similarly to an optical diffraction grating, producing:

A. Secondary interference maxima that behave like optical grating lobes

B. An increase in axial resolution only, with no other effect

C. A single undivided beam containing no side-lobe energy at all

D. Complete elimination of the array's main lobe entirely

21. For a smooth, specular interface, as the angle of incidence moves away from perpendicular (normal), the amplitude of the echo returned directly back to the transducer:

A. Decreases, and may fall to near zero at large oblique angles

B. Increases proportionally with angle

C. Stays constant regardless of angle

D. Increases only for interfaces with large impedance mismatch

22. A pulsed system has a spatial peak, temporal peak (SPTP) intensity of 1000 mW/cm^2 and a duty factor of 0.01% (0.0001). The approximate spatial peak, temporal average (SPTA) intensity is:

A. 1000 mW/cm^2

B. 10 mW/cm^2

C. 0.1 mW/cm^2

D. 100 mW/cm^2

23. At a tissue interface, 25% of the incident intensity is reflected. Assuming negligible absorption exactly at the interface, the transmitted intensity fraction is:

A. 75%

B. 100%

C. 50%

D. 25%

24. A manufacturer shortens the pulse length (lowers the Q-factor, widens the bandwidth) of a transducer to improve axial resolution. The expected trade-off is:

A. Improved penetration occurs with no change in resolution at all

B. Reduced penetration, since the shorter broadband pulse carries less sustained energy

C. Both penetration and resolution improve simultaneously with no trade-off

D. Penetration is completely unaffected by this pulse-length change

25. A pulse contains 3 cycles at a frequency of 6 MHz in soft tissue (propagation speed 1540 m/s, so wavelength = $1540/6,000,000 = 0.257$ mm). The spatial pulse length is closest to:

A. 0.77 mm

B. 1.54 mm

C. 0.26 mm

D. 2.31 mm

26. Beyond the focal zone, overall signal loss with increasing depth results from the combined effect of:

A. Absorption alone, since the beam no longer diverges at all

B. Divergence alone, since tissue absorption becomes negligible beyond focus

C. Both geometric divergence and tissue absorption acting together

D. Refraction alone, independent of either divergence or absorption

27. Compared with a muscle-fat interface, a soft tissue-air interface produces a reflection coefficient that is:

A. Slightly higher, because both are soft-tissue-range impedances

B. Identical, since reflection coefficient does not depend on the specific tissues involved

- C. Lower, because air has a lower density than fat
- D. Far higher, because the impedance mismatch between soft tissue and air is extreme

28. A matching layer is added between the piezoelectric element and the patient's skin. For optimal energy transmission at the transducer's center frequency, the matching layer thickness should equal:

- A. One-quarter of the wavelength in the matching layer material
- B. One full wavelength in tissue
- C. One-half of the wavelength in the piezoelectric element
- D. The same thickness as the backing layer

29. Compared with conventional PZT ceramic elements, capacitive micromachined ultrasonic transducers (CMUTs) are primarily valued for:

- A. Lower manufacturing cost compared with PZT at any scale
- B. A higher tolerance for Curie-point-related thermal limits
- C. An inherently wider bandwidth from their membrane-based construction
- D. Complete elimination of the need for a matching layer

30. A standard curvilinear (convex) array uses a fixed acoustic lens for elevational focusing, meaning the elevational focal depth:

- A. Cannot be adjusted electronically and is set by the physical lens
- B. Can be adjusted electronically at any depth, same as azimuthal focusing
- C. Automatically tracks the operator's selected focal zones
- D. Is eliminated entirely, since only 1.5D arrays require elevational focus

31. A vertical band of missing echo information running the full depth of the image, corresponding to one or more nonfunctional elements, is best described as:

- A. A reverberation artifact from repeated internal reflection

- B.** An element dropout, or 'picket fence,' artifact
- C.** A range ambiguity artifact from excessive depth
- D.** A grating lobe artifact from element spacing

32. The physical width of a transducer's scanning surface is its "footprint," while the portion of elements actually firing for a given pulse is the:

- A.** Kerf
- B.** Matching layer
- C.** Active aperture
- D.** Backing material

33. A high-frequency laparoscopic probe intended for repeated intraoperative sterilization must be designed with:

- A.** Fully sealed, autoclave- or sterilant-compatible housing and cable materials
- B.** A disposable single-use element array
- C.** A standard non-sealed handle, since only the tip contacts tissue
- D.** An open backing layer to allow gas sterilant penetration to the element

34. A biplane transrectal probe differs from a standard end-fire transrectal probe in that it:

- A.** Uses only a single linear-array element throughout
- B.** Requires an external position sensor for image reconstruction
- C.** Incorporates two independent arrays for simultaneous imaging
- D.** Cannot be used to guide a prostate biopsy

35. A department adopts wireless, cradle-charged transducers. From an infection-control standpoint, the charging cradle itself:

- A.** Should be included in the routine environmental cleaning schedule

- B.** Never requires cleaning, since only the probe touches the patient
- C.** Fully replaces the need for probe disinfection between patients
- D.** Is regulated in the same way as a sharps container

36. Dual-aperture ultrasound imaging uses two separate, spatially distinct arrays imaging the same target simultaneously, primarily to:

- A.** Double the frame rate with no other real benefit
- B.** Eliminate the system's need for beamforming entirely
- C.** Improve lateral resolution by combining two insonation angles
- D.** Allow two separate patients to be scanned simultaneously

37. Extended continuous-wave Doppler use can generate enough element heat to risk:

- A.** Improved sensitivity resulting from thermal expansion effects
- B.** A permanent frequency downshift only, with output unaffected
- C.** Depoling of the piezoelectric material, degrading performance
- D.** Automatic recalibration of the transducer's center frequency

38. A curvilinear transducer with a tighter (smaller) radius of curvature, compared with one with a larger radius, produces:

- A.** A wider surface field of view but more lateral distortion
- B.** A narrower field of view but with less distortion
- C.** An identical field of view and distortion in both cases
- D.** Improved axial resolution only, with no other change

39. Repeated sharp bending of the cable at the point where it enters the transducer handle is a common cause of:

- A.** Element depoling from repeated mechanical stress

- B.** Intermittent or complete signal loss from wire fatigue
- C.** Improved image uniformity across the field of view
- D.** Increased bandwidth from the added mechanical flexing

40. Listed from the surface contacting the patient inward toward the cable, the correct order of a standard transducer's acoustic stack is:

- A.** Backing, element, matching layer, lens
- B.** Lens, backing, element, matching layer
- C.** Lens, matching layer, element, backing
- D.** Matching layer, lens, backing, element

41. When comparing two transducer models, a higher number of pins/contacts in the system connector is a practical (though not absolute) indicator of:

- A.** A higher number of independent channels the array drives
- B.** A higher operating frequency than lower-pin-count models
- C.** A longer cable length between probe and system
- D.** A larger, thicker acoustic matching layer design

42. Depth markings along the shaft of a transesophageal echocardiography probe primarily allow the operator to:

- A.** Select the correct imaging frequency automatically
- B.** Identify which array (sagittal vs transverse) is active
- C.** Confirm and standardize the insertion depth for reproducible standard views
- D.** Trigger automatic probe sterilization tracking

43. Endocavity probes are generally designed with shorter cables than general-purpose handheld abdominal probes primarily because:

- A.** Endocavity exams require higher frequencies that mandate shorter cables
- B.** Their closer-range working position needs less reach than full-body scanning
- C.** Shorter cables inherently improve the probe's axial resolution
- D.** Longer cables would exceed standard sterilization chamber dimensions

44. A small-footprint, high-frequency "hockey stick" linear probe is best suited for:

- A.** Deep abdominal aortic and retroperitoneal imaging
- B.** Transcranial Doppler through the temporal bone window
- C.** Superficial structures and vascular access in confined spaces
- D.** Transrectal prostate imaging and biopsy guidance

45. A "wet cell" mechanical transducer design differs from a "dry cell" design in that the wet cell:

- A.** Requires no internal fluid coupling medium whatsoever
- B.** Uses only a single, entirely stationary element
- C.** Uses an internal fluid path to couple the moving element
- D.** Is used exclusively in standard linear array probes

46. A system increases frame rate without reducing image depth or line density by receiving and processing multiple receive lines from a single broad transmit pulse. This technique is called:

- A.** Parallel receive, or multi-beam, beamforming technique
- B.** Spatial compounding of multiple steered frames
- C.** Coded excitation with matched-filter receive processing
- D.** Synthetic aperture imaging reconstruction

47. Cardiac gating that acquires data continuously throughout the cardiac cycle and reconstructs the desired phase afterward, as opposed to triggering acquisition only at a preselected point in the cycle, is called:

- A. Prospective gating**
- B. Retrospective gating**
- C. Free-running acquisition**
- D. Triggered acquisition**

48. During an ultrasound-guided procedure, visualizing the entire needle shaft as a continuous bright line within the imaging plane, from skin entry to target, describes the:

- A. Out-of-plane approach**
- B. Freehand approach without guidance**
- C. In-plane approach**
- D. Biplane approach**

49. B-flow imaging visualizes moving blood directly within a grayscale image, without angle dependence or aliasing, by:

- A. Applying the Doppler shift equation to grayscale pixels directly**
- B. Digitally tracking moving blood reflectivity while suppressing stationary tissue**
- C. Inverting the existing color Doppler map onto B-mode**
- D. Using only spectral Doppler data converted into grayscale**

50. An automated measurement tool outlines the bladder wall on a filled bladder image and reports wall thickness. This measurement is most clinically useful for assessing:

- A. Overall renal function and filtration rate**
- B. The frequency of visible ureteral jets**
- C. Total bladder volume at the time of scanning**
- D. Chronic outlet obstruction causing wall hypertrophy**

51. An automated caliper tool measures thyroid isthmus thickness on a transverse midline image. This measurement is primarily useful for:

- A.** Detecting isolated isthmus hypertrophy or enlargement
- B.** Grading the isthmus's overall Doppler vascularity
- C.** Calculating the gland's total thyroid volume
- D.** Staging any underlying thyroid malignancy

52. A "smart" auto-gain feature analyzes the brightness histogram of the current image and adjusts overall gain to center the distribution, rather than relying on a fixed default gain setting. This approach primarily improves:

- A.** The system's overall axial resolution
- B.** The real-time acquisition frame rate
- C.** Consistency of brightness across varying body habitus
- D.** Overall color and spectral Doppler sensitivity

53. An automated tool calculates testicular volume from three orthogonal caliper placements using the ellipsoid formula. Compared with a true irregular testicular shape, this method:

- A.** Is always exact, since testes are perfect ellipsoids
- B.** Provides a reasonable approximation but can misestimate volume
- C.** Cannot be applied at all in pediatric patients
- D.** Requires accompanying Doppler data to calculate correctly

54. Low mechanical index, contrast-specific imaging modes are designed primarily to:

- A.** Preserve microbubble integrity while detecting their nonlinear response
- B.** Maximize microbubble destruction for a therapeutic effect
- C.** Eliminate the need for any contrast agent
- D.** Increase spatial resolution well beyond conventional B-mode

55. A cardiac imaging system automatically begins cine-loop capture at the onset of each detected QRS complex. This ECG-triggered capture ensures:

- A. Elimination of respiratory motion artifact entirely
- B. Fully automatic Doppler angle correction
- C. Consistent capture of complete cardiac cycles
- D. Automatic calculation of the ejection fraction

56. An automated measurement of common bile duct wall thickness (distinct from luminal diameter) is most useful for evaluating suspected:

- A. Choledocholithiasis alone
- B. Cholangitis/wall inflammation
- C. Gallbladder polyps
- D. Pancreatic duct dilation

57. Serial automated tracking of adrenal gland size and any incidental nodule dimensions across follow-up exams is primarily intended to:

- A. Detect interval growth suggesting a significant lesion
- B. Calculate the gland's overall cortisol production
- C. Replace the need for any CT correlation
- D. Measure the adrenal gland's vascular resistance

58. A "dual live" display mode that shows two simultaneously acquired images (e.g., B-mode and color) side by side, each with independently adjustable gain and depth, is primarily used to:

- A. Increase the system's overall frame rate
- B. Allow direct real-time comparison without toggling modes
- C. Automatically fuse the two images into one
- D. Fully replace the need for a second transducer

59. In a reconstructed 3D ultrasound volume, navigating independently through the A-plane, B-plane, and C-plane views allows the operator to:

- A.** Automatically calculate organ volume without any tracing
- B.** Increase the volume acquisition's frame rate
- C.** Apply color Doppler retrospectively to any plane
- D.** Inspect any cross-section without re-scanning the patient

60. Before relying on the on-screen needle-guide overlay line during a guided procedure, the sonographer should first:

- A.** Increase the current imaging frame rate
- B.** Switch immediately to harmonic imaging mode
- C.** Verify the overlay against an actual needle pass
- D.** Disable the time-gain compensation curve

61. An automated tool outlines carotid plaque on a longitudinal image and reports total plaque area, in addition to any echogenicity classification. Tracking plaque area over serial exams is most useful for assessing:

- A.** Disease progression independent of percent-stenosis calculation
- B.** The vessel's Doppler peak systolic velocity
- C.** The system's current wall filter settings
- D.** Optimal color gain and scale settings

62. An automated biplane method calculates left atrial volume from two orthogonal apical views, analogous to the biplane method used for:

- A.** The IVC's respiratory collapsibility index value
- B.** Left ventricular ejection fraction (Simpson's method)
- C.** The calculated aortic valve area measurement

D. The mitral inflow E/A ratio value

63. In compression (strain) elastography, a "strain ratio" displayed by the system compares the relative stiffness of:

A. A lesion's region of interest to adjacent normal tissue

B. The pre-contrast image to the post-contrast image

C. Two entirely separate patients' stored exams

D. The transducer's anterior face to its posterior face

64. Automated caliper placement for second-trimester nuchal fold thickness measurement differs from first-trimester nuchal translucency measurement in that it:

A. Uses a different view and a later gestational window

B. Uses the identical view and gestational window

C. Measures a Doppler waveform, not a caliper distance

D. Is only ever performed after 28 weeks

65. A "smart exam" feature auto-selects an imaging protocol (preset, measurement package, worksheet) based on the referral indication entered at the worklist. The primary benefit is:

A. Complete elimination of sonographer judgment

B. Fully automatic diagnosis generation

C. Reduced setup time and consistent protocol adherence

D. Fully automatic Doppler angle correction

66. Automated short-axis measurement of a para-aortic/retroperitoneal lymph node is preferred over long-axis measurement for serial tracking because short-axis:

A. Correlates more closely with pathologic significance

B. Is always the larger of the two dimensions

- C. Is technically easier to obtain in every case
- D. Is a required part of every Doppler protocol

67. Live tri-plane cardiac imaging simultaneously displays three separate imaging planes from a single acquisition, primarily to:

- A. Allow multi-wall assessment within a single cardiac cycle
- B. Simply triple the overall acquisition frame rate
- C. Automatically calculate the stroke volume
- D. Eliminate the need for any Doppler at all

68. Automated caliper placement for interventricular septal (IVS) thickness is typically performed at end-diastole because:

- A. End-systole provides a more reproducible measurement
- B. End-diastole is when contrast enhancement peaks
- C. The septum is thinnest at end-diastole
- D. End-diastole is the conventional reference for comparison

69. In suspected infantile hypertrophic pyloric stenosis, automated caliper measurement of pyloric muscle wall thickness and canal length is used primarily to:

- A. Assess the infant's overall gastric emptying time
- B. Meet established thresholds for pyloric hypertrophy
- C. Calculate the infant's total stomach volume
- D. Grade the overall severity of reflux disease

70. Point-of-care measurement of optic nerve sheath diameter (ONSD), obtained a fixed distance behind the globe, is used as a noninvasive screening indicator for:

- A. A retinal detachment within the posterior globe

- B.** An open globe rupture injury pattern
- C.** Elevated intracranial pressure transmitted along the sheath
- D.** A dislocated or subluxed crystalline lens

71. When M-mode is activated, the system displays a linked cursor line on the simultaneous B-mode image. The purpose of this linkage is to:

- A.** Automatically calculate the current heart rate
- B.** Increase M-mode's overall temporal resolution
- C.** Apply color Doppler along the M-mode line
- D.** Confirm which anatomic structure the trace represents

72. Automated caliper measurement of fetal femur length, correlated against a gestational-age table, is one component of:

- A.** The amniotic fluid index calculation
- B.** Biophysical profile scoring components
- C.** Standard fetal biometry for dating and growth
- D.** The placental grading system

73. A tool that automatically outlines a vessel's cross-sectional area on a transverse image, independent of any Doppler data, is used to support a subsequent manual:

- A.** A resistive index calculation for that vessel
- B.** A volume-flow calculation using area and velocity
- C.** A pulsatility index calculation for that vessel
- D.** A manual wall filter adjustment

74. A "smart crop" feature in 3D surface rendering automatically adjusts the rendering threshold to suppress overlying structures (e.g., amniotic fluid or adjacent limbs) that obscure the surface of interest. This primarily improves:

- A.** The clarity of the rendered surface image
- B.** The underlying 2D grayscale resolution
- C.** The color Doppler frame rate
- D.** The overall acquisition volume rate

75. Automated caliper measurement of renal pelvis anteroposterior (AP) diameter on a transverse image is the primary metric used to:

- A.** Grade the severity of hydronephrosis
- B.** Calculate total kidney volume
- C.** Assess renal cortical thickness
- D.** Evaluate ureteral peristalsis

76. A workflow feature that flags when a newly captured image is nearly identical to one already saved in the same exam is intended to:

- A.** Automatically delete the duplicate without input
- B.** Improve overall Doppler accuracy
- C.** Increase the acquisition frame rate
- D.** Reduce redundant images and prompt confirmation

77. Continuous-wave Doppler across the pulmonary valve in a neonate demonstrates a high-velocity systolic jet with spectral broadening. This pattern is most consistent with:

- A.** Tricuspid regurgitation
- B.** Pulmonary valve stenosis
- C.** Patent ductus arteriosus
- D.** Ventricular septal defect

78. Pulsed Doppler of the fetal inferior vena cava, sampled near the right atrium, normally shows a triphasic pattern. Progressive loss of forward flow during atrial contraction on this tracing suggests:

- A.** Worsening fetal cardiovascular compromise
- B.** Normal fetal breathing movement artifact
- C.** Maternal hypotension only, with no fetal significance
- D.** A technically inadequate Doppler angle

79. Absent hepatic artery Doppler signal within the first week after liver transplantation is managed very differently than absent signal detected at 6 months, primarily because:

- A.** Early thrombosis is a surgical emergency; late thrombosis may not be
- B.** Late thrombosis is always considered more urgent
- C.** Both are managed identically regardless of timing
- D.** Hepatic Doppler cannot detect thrombosis at either time

80. A pulsatile, color-filled cystic-appearing structure adjacent to the pancreatic head, with a "yin-yang" flow pattern on color Doppler, most likely represents an aneurysm of the:

- A.** Splenic artery
- B.** Hepatic artery
- C.** Superior mesenteric artery
- D.** Gastroduodenal artery

81. Sudden absence of Doppler flow in a previously patent superior mesenteric artery, in a patient with a known cardiac source of embolus, is most consistent with:

- A.** Acute SMA embolic occlusion
- B.** Non-occlusive mesenteric ischemia (NOMI)
- C.** Median arcuate ligament syndrome
- D.** Mesenteric venous thrombosis

82. In a patient with portal hypertension, a tortuous, hepatofugal-flow vessel arising from the left portal vein and coursing toward the umbilicus represents a recanalized:

- A.** Paraumbilical vein
- B.** Umbilical artery
- C.** Ductus venosus
- D.** Splenic vein

83. Compared with the normal triphasic hepatic vein waveform, a cirrhotic liver typically demonstrates a waveform that is:

- A.** Essentially unchanged from the normal pattern
- B.** Even more sharply triphasic than normal
- C.** Purely arterial in overall appearance
- D.** Dampened and monophasic from reduced compliance

84. Detecting internal vascularity (flow) within an IVC thrombus in a patient with renal cell carcinoma most strongly suggests:

- A.** A bland (non-tumor) thrombus
- B.** Tumor thrombus extension rather than simple bland clot
- C.** That the IVC is not actually involved
- D.** An artifact from mirror-image duplication

85. An enlarged, edematous ovary with absent venous flow but preserved arterial flow on Doppler in a patient with acute pelvic pain is best explained by:

- A.** Normal, expected ovarian physiology in this setting
- B.** Confirmation that torsion has been fully excluded
- C.** An underlying tubo-ovarian abscess instead
- D.** The ovary's dual blood supply allowing residual flow

86. Color Doppler demonstrating a single feeding vessel entering the base of an echogenic intracavitary endometrial lesion is known as the:

- A.** Whirlpool sign
- B.** Vascular pedicle sign
- C.** Yin-yang sign
- D.** Spoke-wheel sign

87. Isolated fallopian tube torsion, without concurrent ovarian torsion, most often occurs in association with a:

- A.** A paratubal cyst or hydrosalpinx near a normal ovary
- B.** A normal tube with no predisposing lesion at all
- C.** A coexisting uterine fibroid found incidentally nearby
- D.** A previously placed tubal ligation clip at that site

88. A small, anechoic to hypoechoic space within the placenta demonstrating slow, swirling internal echoes ("lake sign") on grayscale, without abnormal Doppler flow into the myometrium, most likely represents a:

- A.** A placenta accreta spectrum lesion
- B.** A vascular placental chorioangioma
- C.** A benign placental lake, or venous lacuna
- D.** A retroplacental hematoma from abruption

89. A crescentic collection between the chorion and uterine wall in early pregnancy demonstrates no internal color Doppler flow. This absence of flow is expected because a subchorionic hematoma is:

- A.** An area of active bleeding needing urgent care
- B.** Avascular clotted blood, so absent flow is expected
- C.** Always directly associated with fetal demise

D. Impossible to distinguish from a chorioangioma

90. Pulsatile flow within the umbilical vein, normally a continuous, nonpulsatile venous waveform, is considered an ominous finding most closely associated with:

- A. Normal, entirely benign fetal hiccup movements**
- B. Severe fetal cardiovascular compromise, often with growth restriction**
- C. A simple, technically explainable maternal positioning artifact**
- D. An arterial vessel that was technically mislabeled here**

91. A well-circumscribed, anechoic epididymal head lesion with posterior enhancement and no internal color Doppler flow is most consistent with a:

- A. A simple epididymal cyst or spermatocele**
- B. An epididymitis-related abscess collection nearby**
- C. A solid, vascular epididymal tumor mass**
- D. A dilated scrotal varicocele instead**

92. A wedge-shaped, hypoechoic intratesticular lesion demonstrating absent internal Doppler flow, with normal flow in the surrounding testicular parenchyma, is most consistent with:

- A. Global testicular torsion**
- B. Segmental testicular infarction**
- C. A simple testicular cyst**
- D. Diffuse orchitis**

93. In suspected Fournier's gangrene, echogenic foci with "dirty" posterior shadowing within the scrotal wall represent gas, which primarily affects the Doppler exam by:

- A. Increasing color sensitivity in that region**
- B. Having essentially no effect on image quality**

- C. Obscuring both grayscale and Doppler assessment beneath it
- D. Causing a false-positive high-velocity Doppler signal

94. Before a full subclavian steal pattern (complete flow reversal) develops, the vertebral artery ipsilateral to a proximal subclavian stenosis may first show:

- A. A completely normal, unchanged antegrade waveform
- B. Complete, fixed reversed flow already at rest
- C. Entirely absent flow in the vessel
- D. A 'pre-steal' pattern of diminished antegrade flow

95. A significant stenosis of the innominate (brachiocephalic) artery can produce abnormal Doppler waveforms in both the:

- A. The left carotid and left vertebral arteries only
- B. The right carotid and right subclavian/vertebral arteries
- C. The abdominal aorta only, with no other vessel involved
- D. The contralateral carotid artery exclusively, not this side

96. A competitive cyclist presents with exertional leg pain and diminished Doppler signal in the external iliac artery only during simulated exercise positioning, with a normal resting exam. This presentation is characteristic of:

- A. May-Thurner iliac vein compression syndrome
- B. Popliteal artery entrapment syndrome instead
- C. External iliac artery endofibrosis, or cyclist syndrome
- D. Fibromuscular dysplasia of the iliac artery

97. Following a brachial artery catheterization, absent Doppler flow distal to the puncture site with a normal proximal waveform most likely represents:

- A. Acute thrombosis of the brachial artery here

- B.** A brachial artery pseudoaneurysm at the site
- C.** A completely normal, expected post-procedure finding
- D.** Venous thrombosis of the adjacent brachial vein

98. Assessing whether a newly created radiocephalic AV fistula has matured sufficiently for dialysis cannulation commonly uses the "Rule of 6s," which includes flow volume, depth, and:

- A.** Resistive index above 0.8
- B.** A pulsatility index below 0.5
- C.** Systolic velocity above 400 cm/s
- D.** Vein diameter of at least approximately 6 mm

99. Color Doppler assessment in a patient with a palpable penile plaque and suspected Peyronie's disease is primarily used to:

- A.** Evaluate cavernosal arterial flow and any erectile dysfunction
- B.** Diagnose the plaque itself, which needs Doppler
- C.** Exclude a coexisting, unrelated testicular torsion
- D.** Measure the overall prostate gland volume

100. Doppler velocity criteria for grading in-stent restenosis after carotid artery stenting differ from criteria used for a native, non-stented carotid artery primarily because:

- A.** Stents eliminate the need for any velocity criteria
- B.** Native NASCET-based thresholds apply identically, unadjusted
- C.** Only diameter is measured; velocity is not assessed
- D.** Altered wall compliance shifts thresholds, requiring stent-specific criteria

101. Doppler assessment of a prosthetic heart valve for regurgitation focuses on identifying and measuring the regurgitant jet's origin and extent, which is a distinct assessment from:

- A. The peak/mean gradient used to assess valve stenosis
- B. M-mode imaging of the prosthetic valve leaflets
- C. 2D visualization of the valve's sewing ring
- D. Simple auscultation findings at the bedside

102. Echocardiographic Doppler findings supporting persistent pulmonary hypertension of the newborn (PPHN) include right-to-left or bidirectional shunting across a patent ductus arteriosus or foramen ovale, along with:

- A. Low estimated pulmonary artery pressure overall
- B. Elevated pressure estimated from the TR jet
- C. Complete absence of tricuspid regurgitation
- D. A structurally absent ductus arteriosus entirely

103. Coronary flow reserve, assessed by comparing coronary Doppler flow velocity at rest versus during pharmacologic or physiologic stress, evaluates:

- A. The severity of any valve regurgitation present
- B. Overall systemic vascular resistance levels
- C. The coronary circulation's capacity to augment flow
- D. The estimated left atrial filling pressure

104. On grayscale and color Doppler of the spermatic cord in suspected testicular torsion, a coiled, twisted appearance of the cord itself is known as the:

- A. Yin-yang sign
- B. Spoke-wheel sign
- C. String sign
- D. Whirlpool sign

105. A patient with a mature dialysis AV fistula develops hand coolness, pain, and diminished digital perfusion. Doppler evaluation for suspected access-related steal syndrome would expect to find:

- A.** Increased antegrade flow distal to the anastomosis
- B.** No change compared with the contralateral side
- C.** Retrograde flow diverted into the low-resistance fistula
- D.** Completely absent flow throughout the entire fistula

106. Distinguishing acute embolic SMA occlusion from non-occlusive mesenteric ischemia (NOMI) on duplex is most directly supported by demonstrating:

- A.** Diffusely reduced velocities throughout the mesenteric tree
- B.** A discrete, abrupt cutoff within an otherwise patent SMA
- C.** Distinguishing a focal cutoff from diffusely reduced flow
- D.** Identical Doppler findings seen in both conditions

107. A Doppler shift of 3000 Hz is measured at a 60-degree angle of insonation using a 5 MHz transducer (propagation speed 1540 m/s, $\cos 60^\circ = 0.5$). Using $v = (\text{shift} \times c) / (2 \times f_0 \times \cos \theta)$, the calculated flow velocity is closest to:

- A.** 46 cm/s
- B.** 184 cm/s
- C.** 23 cm/s
- D.** 92 cm/s

108. A Doppler waveform has a peak systolic velocity of 80 cm/s, an end-diastolic velocity of 20 cm/s, and a mean velocity of 45 cm/s. Using $PI = (PSV - EDV) / \text{mean velocity}$, the pulsatility index is closest to:

- A.** 0.75
- B.** 1.33
- C.** 3.0

D. 0.60

109. A hepatic artery peak systolic velocity of 90 cm/s is measured alongside a main portal vein velocity of 15 cm/s. The hepatic artery-to-portal vein velocity ratio is:

- A.** Approximately 1.5
- B.** Approximately 3
- C.** Approximately 0.6
- D.** Approximately 6

110. A trauma patient has a duplex exam showing absent flow in the popliteal artery distal to a posterior knee dislocation, with normal flow proximally and in the contralateral limb. This pattern is most consistent with:

- A.** A technically inadequate Doppler insonation angle
- B.** Chronic popliteal artery entrapment syndrome
- C.** Acute traumatic popliteal occlusion needing urgent evaluation
- D.** Normal post-reduction vasospasm needing no work-up

Answers

1. C. No harm reached the patient because the error was caught before completion, which is the defining feature of a near miss. A sentinel event or adverse event requires that harm or an unintended clinical consequence actually occurred; a never event is a specific, defined category of serious preventable occurrence, not a caught error.

2. C. "Speak Up" is a patient-engagement campaign encouraging patients to actively participate in and question their own care. It is not itself a consent policy, a verification protocol, or a critical-value reporting standard, though it complements all three.

3. D. Measuring performance against a fixed benchmark is quality assurance (QA); launching a project to actively improve a metric is quality improvement (QI). The two terms describe distinct activities and are commonly confused.

- 4. D.** The Safety Data Sheet is the standardized document containing a chemical's hazard information, first-aid measures, and required protective equipment. The IFU covers device use, not chemical hazard data.
- 5. C.** Diagnostic ultrasound uses mechanical (acoustic) energy, not electromagnetic fields of a type or intensity that interferes with cardiac implantable devices, unlike electrocautery or MRI. No special precautions specific to the pacemaker are required for routine B-mode imaging.
- 6. D.** Immediate wound care (washing) and initiating the facility's post-exposure protocol come first; notification, incident reporting, and determining source status are important but sequential steps that follow the initial first-aid response.
- 7. B.** Errors that have already reached a report or a clinical decision must be disclosed and corrected through the facility's formal process, both to fix the record and to maintain the duty of candor to the patient and referring physician.
- 8. D.** Advance directive/code status determines how the team should respond if a complication (bleeding, pneumothorax, cardiac event) occurs during an invasive procedure; it has no bearing on transducer selection or disinfection level.
- 9. A.** Registries place a credential in inactive status when CME requirements lapse, requiring the sonographer to complete outstanding requirements before the credential is reinstated; it does not typically revoke accreditation of the facility or the person's underlying registration entirely.
- 10. B.** Emergency equipment must be checked on a defined recurring schedule so it is reliably ready at the moment of an actual emergency, not only after use or during periodic surveys.
- 11. A.** Site marking before the time-out, specifically for procedures with a laterality or multiple-site component, is a core element of the Universal Protocol, distinct from HIPAA, the Prudent Use Statement, or infection-control classification schemes.
- 12. A.** Power (total acoustic energy per second) is conserved when the beam is focused; concentrating that same power into a smaller area increases intensity (power per unit area) without changing the power itself.
- 13. B.** Rayleigh scattering intensity is proportional to frequency to the fourth power. Doubling frequency therefore increases scattered energy by $2^4 = 16$ -fold, a disproportionately large increase compared with the simple frequency-proportional relationships elsewhere in imaging physics.
- 14. D.** Relaxation absorption describes molecular-level energy loss from the phase lag between compression and the molecule's return to equilibrium; this is distinct from reflection, diffraction, or mode conversion, which are not absorption mechanisms.

- 15. C.** TIS applies when the beam path is entirely through soft tissue with no bone in the field, as in an early transvaginal scan. TIB and TIC apply when bone is near the focus or in a cranial/near-bone window, respectively.
- 16. D.** Total derating loss = $0.3 \text{ dB/cm/MHz} \times 5 \text{ MHz} \times 2 \text{ cm} = 3 \text{ dB}$, which corresponds to roughly a 50% reduction in intensity, giving a derated intensity near 50 mW/cm^2 from a 100 mW/cm^2 output value.
- 17. B.** Second-harmonic content is generated progressively as the fundamental wave propagates and distorts nonlinearly, so its amplitude builds with depth before ultimately falling off once tissue attenuation (which is greater at the higher harmonic frequency) dominates.
- 18. B.** A tighter radius of curvature brings the geometric focus closer to the element, shortening (decreasing) the focal length, analogous to a more strongly curved optical lens or mirror.
- 19. D.** Just as 2D frame rate is limited by the pulse-echo round-trip time needed to interrogate the full 2D field, volume rate in 3D/4D is limited by the round-trip time needed to interrogate the entire acquired 3D volume, which is a much larger data set per acquisition.
- 20. A.** When element spacing exceeds roughly half a wavelength, the periodic array acts like a diffraction grating, producing secondary lobes of constructive interference (grating lobes) in addition to the main beam.
- 21. A.** A specular reflector returns the strongest echo when insonated at normal (perpendicular) incidence. As the angle moves away from normal, less of the reflected energy travels back toward the transducer, and the received amplitude falls, potentially to near zero at large oblique angles.
- 22. C.** SPTA is calculated as SPTP multiplied by the duty factor: $1000 \text{ mW/cm}^2 \times 0.0001 = 0.1 \text{ mW/cm}^2$, illustrating how much lower the time-averaged intensity is compared with the brief peak intensity during the pulse.
- 23. A.** Energy is conserved at an interface: reflected and transmitted intensity fractions must sum to 100% when absorption at the interface itself is negligible, so $100\% - 25\% \text{ reflected} = 75\% \text{ transmitted}$.
- 24. B.** A shorter pulse (broader bandwidth, lower Q-factor) improves axial resolution but carries less total acoustic energy per pulse and is generally associated with reduced penetration compared with a longer, narrower-bandwidth pulse, illustrating the classic resolution-versus-penetration trade-off.
- 25. A.** Wavelength = propagation speed / frequency = $1540 \text{ m/s} / 6,000,000 \text{ Hz} = 0.257 \text{ mm}$. Spatial pulse length = number of cycles x wavelength = $3 \times 0.257 \text{ mm} = \text{approximately } 0.77 \text{ mm}$.
- 26. C.** Beyond the focal zone the beam both diverges geometrically (spreading the same energy over a larger area) and continues to lose energy to tissue absorption/attenuation; both effects act together to reduce signal with depth.

- 27. D.** Reflection coefficient magnitude depends on the degree of acoustic impedance mismatch between two media. Soft tissue and air have an extremely large impedance mismatch, producing near-total reflection, far greater than the comparatively small mismatch between two soft-tissue types like muscle and fat.
- 28. A.** A quarter-wavelength matching layer thickness (calculated using the wavelength within the matching layer material itself) minimizes reflection and maximizes transmitted energy at the transducer's operating frequency, which is the standard acoustic-matching design principle.
- 29. C.** CMUTs are membrane/capacitor-based devices whose mechanical compliance gives them an inherently wide operating bandwidth compared with resonance-limited PZT ceramic elements, which is their principal advantage rather than cost or Curie point.
- 30. A.** A standard curved array's elevational plane is focused by a fixed physical acoustic lens, so unlike azimuthal (in-plane) focusing, which is electronically steerable across multiple zones, elevational focal depth is mechanically fixed at manufacture.
- 31. B.** A full-depth vertical band of missing signal corresponding to a bad element or row of elements is the classic visual signature of element dropout, sometimes called a "picket fence" artifact, distinct from reverberation, range ambiguity, or grating lobes.
- 32. C.** "Footprint" refers to the physical scanning surface dimensions of the probe, while "active aperture" refers specifically to the subset of elements actually transmitting/receiving for a given pulse, which can be smaller than the full footprint.
- 33. A.** A probe intended for repeated intraoperative sterilization (autoclave or chemical sterilant) must have a fully sealed housing and sterilant-compatible cable and connector materials to withstand the sterilization process without damage or compromised infection control.
- 34. C.** A biplane transrectal probe contains two separate arrays oriented to acquire sagittal and transverse planes simultaneously, unlike a standard end-fire probe, which typically requires physical rotation to switch between planes.
- 35. A.** Because the charging cradle is a surface the probe (and potentially the operator's hands) contacts between patient uses, it should be included in the department's routine environmental cleaning schedule; it does not substitute for probe-level disinfection.
- 36. C.** By combining returns from two spatially separated apertures viewing the same target from different angles, dual-aperture imaging can improve lateral resolution and reduce certain artifacts, similar in principle to spatial compounding but using genuinely separate arrays rather than steered beams from one array.

- 37. C.** Sustained continuous-wave output generates continuous heat in the piezoelectric element; if this heat approaches the material's Curie point during operation, it risks depoling, which permanently degrades the element's electromechanical (piezoelectric) performance.
- 38. A.** A tighter radius of curvature spreads the same number of scan lines over a wider angular sector near the transducer face, producing a wider superficial field of view but also greater lateral geometric distortion of structures at depth compared with a larger, gentler radius.
- 39. B.** The cable-to-handle junction is a common point of mechanical stress; repeated sharp bending there fatigues and can fracture the fine internal conductor wires, producing intermittent or complete signal dropout, distinct from depoling or bandwidth effects.
- 40. C.** From the patient surface inward, the standard order is: acoustic lens (patient contact), matching layer(s), piezoelectric element, and backing material (damping, farthest from the patient), which is the sequence that allows energy to be efficiently transmitted forward and unwanted reverberation absorbed behind the element.
- 41. A.** Because each independent channel generally requires its own electrical connection, a system connector with more pins is a practical, though imperfect, indicator that the probe can drive a larger number of independent elements/channels.
- 42. C.** TEE probe shaft depth markings let the operator confirm and reproduce a standardized insertion depth for each of the conventional imaging planes/views, supporting a consistent, guideline-based examination.
- 43. B.** Endocavity exams are performed at a fixed, close working position near the probe's insertion point, requiring less cable reach than a general-purpose probe used to scan across a patient's full body habitus and positioning range.
- 44. C.** A small-footprint, high-frequency "hockey stick" probe is designed to access confined superficial spaces (small joints, pediatric or peripheral vessels) that a standard-sized linear probe cannot easily contact, at the expense of penetration depth needed for deep structures.
- 45. C.** A wet-cell mechanical design uses an internal fluid-filled path to acoustically couple the moving scanning element(s) to the housing and acoustic window, distinguishing it from a dry-cell design that couples mechanically without an internal fluid bath.
- 46. A.** Parallel receive (multi-beam) beamforming processes several receive lines from a single wide transmit pulse simultaneously, increasing frame rate without necessarily sacrificing depth or line density, unlike compounding, coded excitation, or synthetic aperture methods, which address other trade-offs.

- 47. B.** Retrospective gating collects data continuously across the full cardiac cycle and reconstructs the phase of interest afterward using the recorded ECG trace, offering more flexibility than prospective gating, which triggers acquisition only at a single predetermined point.
- 48. C.** The in-plane approach keeps the entire needle shaft within the 2D imaging plane so it appears as a continuous line, allowing the operator to track the needle tip's position throughout the pass, unlike the out-of-plane approach, which shows only a cross-sectional dot.
- 49. B.** B-flow enhances and tracks the backscatter signal from moving red blood cells directly within the grayscale image while suppressing stationary tissue, avoiding the angle dependence and aliasing inherent to Doppler-shift-based color or spectral techniques.
- 50. D.** Increased bladder wall thickness reflects detrusor hypertrophy from chronic outlet obstruction or bladder dysfunction, distinct from bladder volume (a separate calculation) or renal function, which is not directly assessed by wall thickness.
- 51. A.** Isthmus thickness is used mainly to detect isolated isthmus enlargement or hypertrophy, which can occur independent of overall gland volume or nodule vascularity assessed by other measurements.
- 52. C.** Histogram-based auto-gain adapts the applied gain to the actual brightness distribution captured in a given patient, improving consistency of image brightness across the wide range of body habitus and attenuation encountered clinically, rather than affecting resolution, frame rate, or Doppler sensitivity.
- 53. B.** Because the testis is not a perfect ellipsoid, the ellipsoid-formula volume calculation is a useful approximation but is subject to systematic over- or underestimation compared with true anatomic volume; it can be applied in pediatric patients and does not require Doppler data.
- 54. A.** Low-MI contrast-specific sequences use minimal acoustic power so microbubbles remain intact and can be imaged repeatedly over time via their characteristic nonlinear response, in contrast to high-MI techniques that intentionally destroy bubbles.
- 55. C.** Triggering cine capture at each QRS onset ensures that stored loops reliably contain complete, consistently bounded cardiac cycles for review and measurement, rather than arbitrary or partial segments.
- 56. B.** Bile duct wall thickening, as opposed to simple luminal dilation from a stone, is a marker of active inflammation and is most relevant to evaluating suspected cholangitis rather than gallbladder polyps or pancreatic duct pathology.
- 57. A.** Serial size tracking of an adrenal nodule is done specifically to detect interval growth, which raises concern for a clinically significant lesion; it does not measure hormone production or vascular resistance and does not eliminate the eventual need for cross-sectional correlation in indeterminate cases.

- 58. B.** Dual live display lets the operator directly compare two simultaneously acquired image types (for example, B-mode alongside color) in real time without switching modes, useful for guidance and comparison rather than for increasing frame rate or replacing a second transducer.
- 59. D.** Because a full 3D volume has already been acquired, navigating the A, B, and C orthogonal planes lets the operator inspect any cross-section of that volume retrospectively without needing to rescan the patient in that specific plane.
- 60. C.** Because needle-guide overlay calibration can drift from its factory or setup alignment, the sonographer should verify the displayed guide line against an actual needle pass before relying on it for a subsequent, more critical pass.
- 61. A.** Tracking total plaque area over time provides information about disease progression or regression that is independent of, and complementary to, the vessel's percent-stenosis calculation, which reflects luminal narrowing rather than plaque burden.
- 62. B.** The biplane left atrial volume method uses two orthogonal apical views and disk-summation geometry analogous to Simpson's biplane method for calculating left ventricular ejection fraction, rather than to IVC, valve, or inflow assessments.
- 63. A.** Strain ratio in compression elastography numerically compares the amount of tissue deformation in a lesion's region of interest against a reference region of normal adjacent tissue, giving a relative stiffness value rather than comparing images across time or patients.
- 64. A.** Second-trimester nuchal fold thickness is obtained on an axial view of the fetal head at a later gestational window than first-trimester nuchal translucency, and the two measurements screen for related but distinct aneuploidy markers rather than being interchangeable.
- 65. C.** Auto-selecting a protocol based on the entered indication standardizes which measurements and presets are used for a given exam type, reducing setup variability and time, without eliminating sonographer judgment or generating a diagnosis.
- 66. A.** Short-axis lymph node measurement is less sensitive to the node's orientation relative to the imaging plane and correlates more reliably with pathologic significance than long-axis length, which is why it is the preferred metric for serial size tracking.
- 67. A.** Tri-plane imaging captures three separate planes from a single beat, allowing simultaneous assessment of multiple myocardial walls without repositioning the transducer between beats, improving both efficiency and temporal consistency of the comparison.
- 68. D.** End-diastole is the conventional, standardized timing point for wall-thickness measurements (including IVS) because it provides a consistent reference across exams and patients, not because the septum is thinnest or contrast is greatest at that phase.

- 69. B.** Established numeric thresholds for pyloric muscle wall thickness and canal length distinguish a hypertrophic, obstructive pylorus from a normal one, forming the core diagnostic criteria for infantile hypertrophic pyloric stenosis rather than assessing motility or stomach volume.
- 70. C.** Optic nerve sheath diameter enlarges as cerebrospinal fluid pressure transmitted along the optic nerve sheath rises, making ONSD a noninvasive point-of-care screening tool for elevated intracranial pressure rather than for globe or lens pathology.
- 71. D.** The linked B-mode cursor shows exactly which anatomic line the M-mode trace is sampling in real time, letting the operator confirm correct structure alignment; it does not itself calculate heart rate or apply Doppler.
- 72. C.** Femur length, correlated against established gestational-age tables, is one of the standard biometric parameters (along with BPD, HC, and AC) used for fetal dating and growth assessment, distinct from amniotic fluid, biophysical profile, or placental grading.
- 73. B.** An automated vessel cross-sectional area measurement supplies one of the two components (area x time-averaged velocity) needed for a manual volume-flow calculation; it is not itself a resistive index, pulsatility index, or wall filter tool.
- 74. A.** Smart crop automatically removes overlying obscuring structures from the rendered surface image, improving the clarity of the 3D rendering itself; it does not change the underlying 2D grayscale resolution, Doppler frame rate, or acquisition volume rate.
- 75. A.** Renal pelvis AP diameter is the standard metric used to grade hydronephrosis severity, distinct from kidney volume, cortical thickness, or peristalsis assessment, which use different measurements or techniques entirely.
- 76. D.** A duplicate-image flag is a workflow aid intended to reduce unnecessary redundant storage and prompt the sonographer's own decision about which image to retain; it does not autonomously delete images or affect Doppler accuracy or frame rate.
- 77. B.** A high-velocity, turbulent systolic jet across the pulmonary valve on continuous-wave Doppler is the characteristic finding of pulmonary valve stenosis, distinct from the diastolic or continuous patterns seen with tricuspid regurgitation, PDA, or VSD.
- 78. A.** Progressive loss of the normal forward a-wave component in the fetal IVC reflects rising right atrial/central venous pressure and is a recognized sign of worsening fetal cardiovascular compromise, not a benign artifact.
- 79. A.** Early post-transplant hepatic artery thrombosis threatens the graft's sole arterial blood supply before adequate collaterals have formed and is treated as a surgical emergency, whereas late thrombosis may be better tolerated because collateral arterial supply has often developed by that time.

- 80. D.** A pancreatic-head-region pseudoaneurysm with a swirling "yin-yang" Doppler pattern in this specific anatomic location is characteristic of a gastroduodenal artery aneurysm, distinguishing it by location from splenic, hepatic, or SMA aneurysms.
- 81. A.** An abrupt loss of flow in a vessel with a known embolic source points to acute embolic occlusion, in contrast to NOMI (a diffuse low-flow state without a discrete occlusion), median arcuate ligament syndrome (external compression, not embolic), or venous thrombosis (a different vessel entirely).
- 82. A.** A recanalized paraumbilical vein is a classic portosystemic collateral pathway arising from the left portal vein and directed toward the umbilicus in portal hypertension; the umbilical artery, ductus venosus, and splenic vein do not follow this specific course or origin.
- 83. D.** Cirrhosis reduces hepatic parenchymal compliance, which dampens the normal triphasic hepatic vein waveform into a flattened, monophasic pattern, rather than preserving or accentuating the normal triphasic morphology.
- 84. B.** Internal color flow within a thrombus is a key feature distinguishing tumor thrombus (which has its own blood supply) from bland, avascular clot, and is clinically important in renal cell carcinoma given its propensity for venous/IVC tumor extension.
- 85. D.** The ovary receives blood from both the ovarian artery and a branch of the uterine artery, so residual arterial flow can persist despite torsion-related venous outflow obstruction; this means preserved arterial flow does not exclude the diagnosis.
- 86. B.** A single vessel entering the base of a polypoid endometrial lesion is termed the vascular pedicle sign, a recognized Doppler feature supporting an endometrial polyp, distinct from the whirlpool, yin-yang, or spoke-wheel signs used for other entities.
- 87. A.** Isolated tubal torsion is uncommon but is classically associated with a predisposing paratubal cyst or hydrosalpinx that adds mass and mobility to the tube itself, distinct from torsion involving the ovary.
- 88. C.** A placental lake (venous lacuna) is a benign, slow-flow venous space with swirling but grossly normal internal echoes and no abnormal flow extending into the myometrium, distinguishing it from the irregular vascular lakes and myometrial interface abnormalities of accreta spectrum or the distinct appearance of a chorioangioma or hematoma.
- 89. B.** A subchorionic hematoma represents clotted, avascular blood, so the absence of internal Doppler flow is an expected and reassuring finding rather than evidence of active bleeding, fetal compromise, or a mass like chorioangioma.
- 90. B.** Loss of the umbilical vein's normal continuous flow pattern in favor of pulsatility reflects transmitted abnormal cardiac/central venous pressure and is considered an ominous sign of severe fetal compromise, most often seen with advanced growth restriction.

- 91. A.** An anechoic, well-circumscribed epididymal lesion with posterior enhancement and no internal flow has the classic sonographic appearance of a simple cystic lesion (epididymal cyst/spermatocele), distinguishing it from an abscess, tumor, or varicocele, all of which have different Doppler or morphologic features.
- 92. B.** A focal, wedge-shaped avascular area with preserved flow in the surrounding parenchyma indicates a segmental (partial) infarction rather than global torsion, which would show absent flow throughout the entire testis, or a cyst/orchitis, which have different appearances.
- 93. C.** Gas within the scrotal wall produces dense acoustic shadowing that degrades or obscures both grayscale detail and any color Doppler signal in the tissue deep to it, which can limit full assessment in suspected Fournier's gangrene.
- 94. D.** A pre-steal pattern shows early, partial waveform changes (reduced systolic antegrade flow or a mid-systolic notch) that precede the fully developed, complete flow reversal of an established subclavian steal, reflecting a spectrum of severity rather than an all-or-nothing finding.
- 95. B.** Because the innominate artery is the common origin for both the right common carotid and right subclavian arteries, a proximal innominate stenosis can produce abnormal Doppler findings in both downstream territories, unlike a stenosis isolated to one branch vessel.
- 96. C.** External iliac artery endofibrosis is a position- and exertion-dependent flow-limiting condition described in cyclists, typically normal at rest with reduced flow reproduced only in the provocative hip-flexed cycling position, distinguishing it from May-Thurner, popliteal entrapment, or fibromuscular dysplasia.
- 97. A.** Absent flow distal to a recent arterial puncture site, with a normal waveform proximal to it, is most consistent with acute thrombotic occlusion at or just beyond the puncture, rather than a pseudoaneurysm (which would show a to-and-fro pattern) or venous pathology.
- 98. D.** The commonly cited "Rule of 6s" for AV fistula maturation includes an outflow vein diameter of at least approximately 6 mm, in addition to adequate flow volume and depth from the skin surface, as practical bedside criteria for cannulation readiness.
- 99. A.** Doppler evaluation in Peyronie's disease assesses cavernosal arterial inflow and any coexisting erectile dysfunction alongside grayscale characterization of the plaque itself, since Doppler does not detect the fibrous plaque directly.
- 100. D.** A carotid stent alters the vessel's wall compliance and hemodynamics, which shifts the velocity thresholds used to diagnose in-stent restenosis upward compared with native-vessel NASCET-based criteria, so stent-specific criteria are required rather than applying native-vessel values unchanged.

- 101. A.** Prosthetic valve stenosis is assessed via the transvalvular pressure gradient, a distinct measurement from the regurgitant jet assessment used to grade prosthetic valve regurgitation, even though both use Doppler on the same valve.
- 102. B.** An elevated pulmonary artery pressure estimate derived from the tricuspid regurgitant jet velocity, together with right-to-left or bidirectional ductal/atrial shunting, supports the diagnosis of PPHN, reflecting persistently elevated pulmonary vascular resistance after birth.
- 103. C.** Coronary flow reserve compares resting and stress-induced coronary flow velocities to evaluate how much the coronary circulation (microvascular and epicardial) can augment flow under increased myocardial demand, distinct from valve, systemic vascular resistance, or atrial pressure assessments.
- 104. D.** A twisted, coiled appearance of the spermatic cord itself on grayscale and color Doppler is termed the whirlpool sign, a direct sonographic sign of torsion distinct from the yin-yang (pseudoaneurysm), spoke-wheel (FNH), or string (severe stenosis) signs used elsewhere.
- 105. C.** In dialysis-access steal syndrome, blood is preferentially diverted from the distal artery into the lower-resistance fistula circuit, producing retrograde (reversed) flow in the artery distal to the anastomosis rather than normal or increased antegrade distal flow.
- 106. C.** A discrete, abrupt flow cutoff at a focal point favors an embolic occlusion, while diffusely reduced velocities throughout the mesenteric arterial tree without a focal cutoff favor NOMI's global low-flow state; recognizing both patterns together is what allows the two entities to be distinguished on duplex.
- 107. D.** Solving $v = (\text{Doppler shift} \times \text{propagation speed}) / (2 \times \text{transmit frequency} \times \cosine \text{ of the angle})$
 $= (3000 \text{ Hz} \times 1540 \text{ m/s}) / (2 \times 5,000,000 \text{ Hz} \times 0.5)$ yields approximately 0.924 m/s, or about 92 cm/s.
- 108. B.** $PI = (PSV - EDV) / \text{mean velocity} = (80 - 20) / 45 = 60 / 45$, which is approximately 1.33.
- 109. D.** The hepatic artery-to-portal vein velocity ratio is calculated simply as 90 cm/s divided by 15 cm/s, which equals 6.
- 110. C.** Absent distal popliteal flow after a posterior knee dislocation, with normal flow proximally and on the contralateral side, indicates an acute traumatic arterial occlusion at or near the injury site, a vascular emergency requiring urgent evaluation rather than a technical artifact or self-resolving vasospasm.