COMPREHENSIVE MOCK EXAM 10

Supplemental to: Ultrasound Physics Board Review 2026-2027

Rasmus Broberg

ARDMS SPI (Sonography Principles & 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 biomedical engineering department's routine preventive-maintenance (PM) schedule for ultrasound systems, distinct from initial acceptance testing at installation, primarily serves to:

A. Establish the system's original baseline performance specification

B. Detect gradual performance drift or component wear over the service life

C. Replace the need for daily user-level QA checks

D. Register the system's warranty with the manufacturer

2. During a transvaginal exam, a patient becomes pale, diaphoretic, and reports feeling lightheaded, consistent with a vasovagal response. The appropriate immediate action is to:

A. Stop the exam, position the patient to aid blood return, and monitor

B. Continue the exam quickly to finish before symptoms worsen

C. Have the patient stand up to walk it off

D. Administer medication without physician involvement

3. A sonographer suspects a transducer malfunction may have contributed to a patient injury. Beyond internal facility reporting, this type of event may also need to be reported through:

A. A private note to the manufacturer's sales representative only

B. Report through the FDA's MedWatch adverse event system

C. No external reporting is ever required for equipment-related events

D. The patient's insurance company

4. A facility's written bloodborne pathogen exposure control plan, required under OSHA regulations, primarily addresses:

A. Contrast agent allergy screening procedures

B. Equipment acceptance testing at installation

C. Engineering controls and safe work practices to limit exposure

D. Patient informed-consent documentation requirements

5. A patient becomes unsteady and falls while transferring onto the exam table. After ensuring the patient is not further injured, what is the appropriate next step?

A. Follow the facility's fall-response protocol

B. Help the patient up and continue the exam without further action

C. Document the fall only if the patient specifically requests it

D. Cancel all future appointments for that patient

6. For an invasive, sterile ultrasound-guided procedure, using individual single-use sterile gel packets rather than a multi-use gel bottle is preferred primarily to:

A. Reduce the total cost of the procedure

B. Improve image quality compared to standard gel

C. Speed up the procedure

D. Reduce cross-contamination from a shared container

7. A facility's chaperone policy for sensitive or intimate examinations exists primarily to:

A. Protect both the patient and examiner via a witness present

B. Speed up the exam by adding an extra pair of hands

C. Replace the need for informed consent

D. Apply only when the examiner and patient are different genders

8. A patient requests an ultrasound purely out of curiosity, with no physician order and no clinical indication. This scenario primarily raises a question of:

A. Universal Protocol compliance

B. Bloodborne pathogen exposure risk

C. Medical necessity for the ordered exam

D. Acoustic output safety limits

9. Before administering a high-risk medication (such as an IV contrast agent in some protocols), which safety practice is designed to catch a dosing or identity error before it reaches the patient?

A. Relying on a single practitioner's independent judgment

B. Two-person independent verification of the medication, dose, and patient identity

C. Verbal confirmation from the patient alone, without checking the order

D. Skipping verification if the practitioner is experienced

10. The standard sequence for donning and doffing personal protective equipment (PPE) is structured specifically to:

A. Minimize the risk of self-contamination during removal

B. Save time regardless of order

C. Apply only to airborne-precaution situations

D. Make PPE more comfortable to wear

11. After a report has already been finalized and distributed, the interpreting physician identifies a discrepancy that changes the clinical impression. The appropriate action is to:

A. Leave the original report unchanged to avoid confusion

B. Issue a formal amended report and communicate the change

C. Only correct it if the referring physician happens to ask

D. Delete the original report from the record entirely

12. Solve the Doppler equation for velocity: measured shift = 1,200 Hz, operating frequency = 4 MHz, angle = 0 degrees (cos = 1), propagation speed = 1,540 m/s.

A. Approximately 11.6 cm/s

B. Approximately 23.1 cm/s

C. Approximately 46.2 cm/s

D. Approximately 23.1 cm/s is incorrect

13. A pulse has a bandwidth of 2 MHz centered at a frequency of 5 MHz. Calculate the fractional bandwidth.

A. 40 percent

B. 20 percent

C. 50 percent

D. 10 percent

14. A transducer has a center frequency of 6 MHz and a bandwidth of 3 MHz. Calculate the Q-factor (center frequency divided by bandwidth).

A. 2.0

B. 0.5

C. 3.0

D. 18

15. Sound travels at 1,540 m/s in tissue and 1,600 m/s in a second medium. Calculate the critical angle (using arcsin of the speed ratio).

A. Approximately 90 degrees

B. Approximately 74 degrees

C. Approximately 45 degrees

D. There is no critical angle for this pair of speeds

16. Calculate the acoustic energy delivered over 2 seconds at a constant power output of 50 milliwatts.

A. 25 millijoules

B. 50 millijoules

C. 0.025 millijoules

D. 100 millijoules

17. A pulse's spatial pulse length (SPL) can be shortened either by reducing the number of cycles per pulse or by using a higher-frequency (shorter-wavelength) transducer. Which statement about this trade-off is correct?

A. Reducing cycles per pulse always degrades axial resolution

B. Only frequency, never cycle count, affects SPL

C. SPL is unrelated to axial resolution

D. Cycle count and wavelength both independently contribute to SPL

18. Grating lobes become a significant concern when the element spacing (pitch) of an array approaches or exceeds:

A. Ten times the operating wavelength

B. One wavelength of the operating frequency

C. The element's own thickness

D. The full aperture length

19. Approximately what fraction of incident intensity is reflected at a soft-tissue/bone interface, given bone's markedly higher acoustic impedance?

A. About 1 percent

B. About 10 percent

C. A large fraction

D. Essentially 0 percent

20. Convert an intensity value of 25 mW/cm^2 to W/cm^2.

A. 2.5 W/cm^2

B. 0.25 W/cm^2

C. 0.025 W/cm^2

D. 250 W/cm^2

21. If a transducer's active aperture is doubled while frequency and depth remain constant, the resulting effect on lateral resolution (beam width) is best described as:

A. Lateral resolution improves in proportion to aperture increase

B. Lateral resolution stays exactly the same

C. Lateral resolution worsens (beam widens) as aperture increases

D. Lateral resolution becomes undefined

22. For a fixed insonation angle and blood velocity, the calculated Doppler shift frequency:

A. Is independent of imaging depth

B. Increases proportionally with depth

C. Decreases proportionally with depth

D. Can only be measured at depths under 5 cm

23. A pulse has a center frequency of 5 MHz with a -3dB (half-power) bandwidth spanning from 4 MHz to 6 MHz. What is the -3dB bandwidth?

A. 5 MHz

B. 1 MHz

C. 2 MHz

D. 10 MHz

24. An attenuation value is given in Nepers per centimeter. To express this in decibels per centimeter, the value should be:

A. Left unchanged, since Nepers and decibels are identical

B. Divided by 2

C. Divided by 8.686

D. Multiplied by approximately 8.686

25. A transducer emits 40 mW of acoustic power uniformly over a 2 cm² effective radiating area. Calculate the average intensity.

A. 20 mW/cm²

B. 80 mW/cm²

C. 2 mW/cm²

D. 0.05 mW/cm²

26. A transducer's near-zone (Fresnel zone) length is calculated as aperture squared divided by (4 times wavelength). For a 10 mm aperture and a 0.5 mm wavelength, calculate the near-zone length.

A. 5 mm

B. 500 mm

C. 50 mm

D. 12.5 mm

27. As operating frequency increases (with aperture size held constant), the near-zone length and far-zone divergence angle change as follows:

A. Both increase

B. Both decrease

C. Near-zone length increases; far-zone divergence angle decreases

D. Neither changes with frequency

28. The transmit/receive (T/R) switch in an ultrasound system exists primarily to:

A. Select which frequency preset is active

B. Protect the receiver circuitry from the transmit pulse

C. Control the system's overall gain

D. Switch between B-mode and M-mode display

29. Manufacturers apply per-element sensitivity calibration across an array face primarily to correct for:

A. Differences in operating frequency between elements

B. Manufacturing variation causing uneven element sensitivity

C. The array's overall footprint size

D. The patient's body habitus

30. A transducer's built-in self-test (BIST) diagnostic routine, run at system startup, primarily checks for:

A. The patient's medical history

B. Room temperature and humidity

C. Basic element/circuit functionality pre-use

D. The sonographer's login credentials

31. A transducer cable's specified minimum bend radius exists primarily to prevent:

A. Internal conductor damage from over-tight bending

B. The transducer from overheating

C. Patient exposure to excessive acoustic output

D. Electromagnetic interference with nearby equipment

32. Over years of clinical use, a transducer may show a gradual decline in sensitivity distinct from any single disinfection-related degradation event. This long-term drift is best addressed by:

A. Ignoring it, since gradual change is never clinically significant

B. Immediately discarding the probe at the first sign of any change

C. Assuming the system's software will automatically compensate indefinitely

D. Periodic QA testing that can detect and quantify gradual sensitivity drift over the probe's service life

33. A phased-array system dynamically adjusts its active sub-aperture (effective F-number) with depth primarily to:

A. Change the transducer's operating frequency automatically

B. Maintain optimal focusing and lateral resolution as the beam travels to different depths

C. Reduce the total number of physical elements in the array

D. Switch automatically between imaging and Doppler modes

34. For a fixed array footprint width, increasing the total number of elements (finer element pitch) generally allows for:

A. A lower operating frequency requirement

B. A larger overall footprint

C. Finer beam-steering and reduced grating-lobe risk

D. Elimination of the need for a matching layer

35. A transducer's internal electronics, distinct from the patient-contact surface, are subject to a separate internal thermal limit primarily to prevent:

A. Patient skin burns, which is governed by the surface-contact limit instead

B. Excessive acoustic output at the face

C. Internal component failure from excessive internal heat buildup

D. Electromagnetic interference with other equipment

36. The backing material's acoustic impedance is typically designed to be:

A. As different as possible from the piezoelectric element's impedance, to reflect energy back toward the patient

B. Close to, but not exceeding, the element's own impedance

C. Identical to air's impedance

D. Irrelevant to the element's performance

37. A convex array's field-of-view geometry is more precisely described by its arc length (total curved footprint) together with its radius of curvature, because:

A. The radius of curvature alone determines the divergence/FOV shape

B. Arc length and radius of curvature always have a fixed, identical relationship regardless of probe design

C. Only arc length matters; radius of curvature is irrelevant to FOV

D. Only radius of curvature matters; arc length is irrelevant to footprint size

38. A piezoelectric material's dielectric constant is a relevant design property because it:

A. Influences the crystal's electrical impedance matching

B. Determines the crystal's physical thickness

C. Sets the transducer's acoustic output limit

D. Has no relevance to transducer design

39. A minimum signal-to-noise ratio (SNR) specification verified during factory transducer testing primarily ensures:

A. The probe's physical weight meets ergonomic standards

B. The probe's cable length meets specification

C. The connector pin count is correct

D. The transducer can adequately distinguish echo signal from noise

40. A transducer's acoustic lens curvature in the elevational plane serves to:

A. Provide fixed mechanical focusing in the elevational plane

B. Replace the need for any electronic focusing

C. Determine the transducer's operating frequency

D. Control the system's overall gain setting

41. A transducer's 'acoustic center,' used as a reference point in beamforming calculations, is best understood as:

A. Always identical to the array's physical geometric center

B. Irrelevant to beamforming calculations

C. The location of the connector on the cable

D. The effective beam origin, distinct from the geometric center

42. The bonding-layer thickness between the acoustic stack's components (element, matching layer, backing) is held to a tight manufacturing tolerance primarily because:

A. Small thickness variations can measurably affect acoustic matching

B. Bonding layer thickness has no measurable acoustic effect

C. It only affects the probe's cosmetic appearance

D. It determines the cable's electrical resistance

43. An endocavity probe's tip shape and insertion-force profile are specifically engineered to:

A. Increase the probe's overall footprint to improve the field of view

B. Maximize the transducer's operating frequency regardless of comfort

C. Eliminate the need for any coupling gel

D. Balance adequate acoustic aperture size against patient comfort and ease of insertion

44. A manufacturer specifies a minimum warm-up/stabilization period after power-on before critical, precise acoustic-output measurements should be taken. This is primarily because:

A. Component temperatures can drift slightly during initial warm-up

B. The system needs this time to load patient records

C. The probe must physically cool down before use

D. This delay is purely a software licensing check, unrelated to hardware

45. Performing a quick visual inspection of the transducer housing for visible cracks or damage before each use is important primarily because:

A. It replaces the need for any other QA testing

B. Housing damage could allow moisture entry, risking failure

C. It is only relevant for probes over five years old

D. It has no bearing on patient safety

46. A structure's calculated depth on the display can be inaccurate when the actual tissue propagation speed differs from the system's fixed assumed value. This depth-placement error is best classified as:

A. A grating lobe artifact

B. A range ambiguity artifact

C. Reverberation artifact

D. A propagation-speed error artifact

47. Automated software that assesses and flags venous compressibility during a DVT study, distinct from the sonographer's manual compression technique, is primarily intended to:

A. Replace the need for manual compression technique entirely

B. Only function on arterial vessels

C. An objective, quantified assessment supporting manual findings

D. Automatically diagnose the specific clot age

48. Automated abdominal aortic diameter measurement software, used for AAA screening, is primarily valuable because:

A. It replaces the need for any follow-up imaging once a normal size is confirmed

B. It only works with a linear array probe

C. Reproducible diameter tracking supports detecting aneurysmal growth

D. It automatically schedules the patient's surgery

49. An automated appendix diameter measurement is clinically relevant because:

A. A diameter exceeding a threshold (often around 6-7 mm) supports

B. It replaces the need for any clinical correlation

C. It only functions in adult patients

D. It automatically distinguishes appendicitis from Crohn's disease

50. Automated software that flags bladder wall irregularity or a focal mass-like area, distinct from simple wall thickness measurement, is primarily intended to:

A. Replace cystoscopy for definitive bladder evaluation

B. Prompt closer attention to a possible focal abnormality

C. Only function in male patients

D. Automatically stage a detected bladder tumor

51. Automated pancreatic duct diameter measurement is clinically relevant because:

A. It only functions in a fasting patient

B. It replaces the need for any cross-sectional imaging of the pancreas

C. Ductal dilation can be a sign of obstruction (e.g.

D. It automatically identifies the cause of any dilation found

52. Automated uterine volume calculation, using standard ellipsoid formula measurements, is clinically useful for:

A. Automatically diagnosing the cause of any enlargement found

B. Only functioning during pregnancy

C. Replacing the need for endometrial evaluation

D. Objectively tracking uterine size

53. Automated software assessing the endometrial-myometrial junction's regularity, distinct from simple endometrial thickness measurement, is relevant to evaluating for:

A. Ovarian pathology exclusively

B. Simple endometrial polyps only

C. Cervical pathology exclusively

D. Adenomyosis via junctional zone irregularity

54. An automated axillary lymph node short-axis measurement, used in the context of breast cancer staging, is clinically relevant because:

A. It automatically confirms malignant nodal involvement

B. Short-axis diameter suggests possible nodal involvement

C. It only applies to inguinal nodes

D. It replaces the need for a sentinel lymph node biopsy

55. A live tri-plane display in an obstetric context (simultaneous orthogonal fetal imaging planes), distinct from tri-plane cardiac imaging, is primarily useful for:

A. Rapid simultaneous assessment across three orthogonal planes

B. Automatically calculating estimated fetal weight

C. Eliminating the need for 2D obstetric imaging entirely

D. Only functioning after 36 weeks gestation

56. Automated measurement of a hernia defect width (e.g., in the rectus abdominis) is clinically useful because:

A. It only functions with the patient supine

B. It automatically determines whether surgical repair is needed

C. Defect size helps characterize hernia severity for planning

D. It replaces the need for a Valsalva maneuver during the exam

57. Shear-wave elastography, which displays results as a velocity in meters per second or a corresponding stiffness value, differs from strain elastography primarily in that it:

A. Cannot be used on the liver

B. Requires manual compression by the operator

C. Provides a quantitative, more standardized stiffness value

D. Only functions with contrast agent administration

58. Automated skin/subcutaneous fat thickness measurement can be clinically useful for:

A. Diagnosing the specific underlying metabolic condition automatically

B. Replacing the need for any body composition testing method

C. Only functioning in pediatric patients

D. Objective tracking relevant to nutritional or metabolic assessment contexts

59. PET/CT-ultrasound fusion registration, distinct from the more common CT/MRI-ultrasound fusion used for interventional guidance, is primarily used to:

A. Automatically calculate the PET standardized uptake value (SUV)

B. Correlate PET metabolic activity with real-time ultrasound anatomy

C. Eliminate the need for PET/CT acquisition entirely

D. Only function on cardiac exams

60. A longitudinal trend display showing a specific measurement's value across multiple separate prior exams over months or years, distinct from a trend captured within a single exam session, is primarily useful for:

A. Only functioning for cardiac measurements

B. Replacing the need for any single-exam measurement

C. Tracking slow, chronic change not apparent within one exam

D. Automatically diagnosing the cause of any change seen

61. A system feature that logs which specific user entered or edited a given measurement, with a timestamp, is primarily useful for:

A. Automatically correcting measurement errors

B. Speeding up the exam itself

C. Replacing the need for a final physician review

D. Supporting accountability by identifying who made an entry

62. A live audible proximity alert that increases in pitch or frequency as a biopsy needle tip approaches a pre-marked target on the image is designed to:

A. Provide an additional, non-visual guidance cue

B. Only function with a linear array probe

C. Replace the need for any visual confirmation of needle position

D. Automatically stop needle advancement at the target

63. Automated Doppler waveform classification software, which flags a waveform as falling outside an expected normal pattern, is intended to:

A. Automatically diagnose the underlying vascular pathology

B. Only function on arterial waveforms, never venous

C. Prompt closer review of an unexpected waveform pattern

D. Replace the need for angle correction

64. A system feature that detects and warns when a caliper measurement has been placed on a frame affected by motion blur is primarily intended to:

A. Automatically recalculate the measurement using a different frame

B. Replace the sonographer's judgment in frame selection entirely

C. Alert the sonographer to a possible measurement-quality concern

D. Only function during cardiac cine review

65. Automated bladder post-void residual (PVR) trend tracking across a patient's visits is clinically useful for:

A. Monitoring incomplete bladder emptying pattern over time

B. Replacing the need for a single-visit PVR measurement

C. Only functioning in male patients

D. Automatically diagnosing the underlying cause of elevated PVR

66. During real-time 3D acquisition, an on-screen live volume-rate readout is primarily useful for:

A. Only functioning during fetal cardiac imaging

B. Automatically calculating organ volume

C. Replacing the frame-rate readout used in 2D imaging

D. Letting the operator gauge acquisition speed/quality trade-offs

67. A live on-screen readout showing the biopsy needle's angle relative to the skin surface, updated in real time during the approach, is primarily useful for:

A. Automatically calculating the needle-tip depth

B. Replacing the need to visualize the needle on the image

C. Helping the operator maintain a consistent

D. Only functioning for out-of-plane approaches

68. An automated placenta-to-internal-cervical-os distance measurement is primarily used to:

A. Automatically diagnose placenta accreta

B. Only function in the first trimester

C. Replace the need for a transvaginal approach when clinically indicated

D. Screen for and classify placenta previa by os relationship

69. A live simultaneous 2D, color, and spectral Doppler (triplex) display with independently adjustable gain for each component is primarily valuable because:

A. It automatically optimizes all three gain settings without operator input

B. It eliminates the need for angle correction on the spectral trace

C. It allows real-time correlation between anatomy

D. It only functions with a phased-array probe

70. Software that automatically switches the measurement-package preset based on the system's detection of the current exam type is primarily intended to:

A. Replace the sonographer's ability to manually select or override the preset

B. Only function for obstetric exams

C. Automatically finalize the exam without sonographer review

D. Reduce workflow friction via pre-loaded relevant measurement tools

71. A structured critical-finding communication log, distinct from a simple auto-flag on the image itself, is designed primarily to:

A. Automatically notify the patient directly

B. Replace the need for verbal communication of urgent findings

C. Document who was notified, when, and how

D. Only apply to fetal findings

72. Automated display of a testicle's individual length, width, and height measurements, as a step preceding ellipsoid volume calculation, is useful because:

A. It replaces the need for the ellipsoid volume calculation entirely

B. It only functions for undescended testes

C. The individual dimensions themselves

D. It automatically diagnoses testicular atrophy

73. A system feature that automatically adjusts the displayed dynamic range based on detected tissue type is intended to:

A. Automatically diagnose tissue pathology based on echogenicity pattern

B. Only function in cardiac imaging

C. Replace the need for TGC adjustment

D. Optimize gray-scale contrast for the imaged tissue type

74. Some measurement software displays a confidence interval or margin of error alongside a calculated value (such as estimated fetal weight). This is primarily intended to:

A. Automatically correct any measurement error found

B. Communicate the inherent uncertainty range around a derived estimate

C. Replace the need for careful measurement technique

D. Only apply to Doppler-derived measurements

75. In extended field-of-view (panoramic) imaging, an automatic alignment-correction algorithm that adjusts for probe tilt or off-axis motion during the sweep primarily helps prevent:

A. Aliasing artifact pattern present

B. Geometric distortion from imperfect probe tracking

C. Range ambiguity error present

D. Grating lobe artifact effect present

76. Automated first-trimester nuchal translucency measurement software, distinct from second-trimester nuchal fold assessment, is primarily used to:

A. Replace maternal serum screening entirely

B. Diagnose a specific chromosomal abnormality with certainty

C. Only function after 20 weeks gestation

D. Contribute to first-trimester aneuploidy risk assessment

77. Using the Doppler equation, calculate the frequency shift for: operating frequency 7.5 MHz, flow velocity 45 cm/s, propagation speed 1,540 m/s, angle 0 degrees (cos = 1).

A. Approximately 2,190 Hz

B. Approximately 1,095 Hz

C. Approximately 4,383 Hz

D. Approximately 8,766 Hz

78. A system's PRF is 8,000 Hz. What is the Nyquist limit for this PRF?

A. 8,000 Hz

B. 16,000 Hz

C. 4,000 Hz

D. 2,000 Hz

79. A spectral waveform shows PSV of 70 cm/s and EDV of 14 cm/s. Calculate the resistive index.

A. 0.80

B. 0.20

C. 0.60

D. 0.40

80. For a waveform with PSV 60 cm/s, EDV 15 cm/s, and mean velocity 30 cm/s, calculate the pulsatility index.

A. 1.0

B. 1.5

C. 2.0

D. 0.5

81. A vessel has a cross-sectional area of 0.4 cm^2 and a time-averaged mean velocity of 25 cm/s. Calculate the volume flow rate.

A. 10 mL/min

B. 600 mL/min

C. 100 mL/min

D. 1,000 mL/min

82. Pre-stenotic PSV is 35 cm/s and stenotic PSV is 280 cm/s. Calculate the velocity ratio.

A. 4:1

B. 6:1

C. 8:1

D. 10:1

83. A waveform shows a systolic peak of 60 cm/s and an end-diastolic value of 20 cm/s. Calculate the S/D ratio.

A. 2.0

B. 3.0

C. 4.0

D. 0.33

84. Calculate the cerebroplacental ratio given a fetal MCA-PI of 1.6 and an umbilical artery PI of 0.8.

A. 2.0

B. 0.5

C. 1.28

D. 0.8

85. For volume flow calculations, using the time-averaged MEAN velocity (rather than the time-averaged PEAK velocity) across the vessel's cross-section is important because:

A. Peak velocity better represents the true average flow across the vessel

B. Mean velocity better represents the true average flow across the full cross-section

C. The two values are always numerically identical

D. Volume flow calculations cannot use velocity data at all

86. A spectral Doppler display's sweep speed control primarily affects:

A. The Doppler shift value calculated

B. The Nyquist limit value

C. The angle of insonation set

D. How compressed the waveform appears

87. Increasing color-flow temporal smoothing (persistence) is a recognized technique for reducing:

A. The Nyquist limit setting

B. Flash/blooming artifact from motion

C. The Doppler angle setting

D. The sample volume size setting

88. Doppler angle-correction error (the velocity error introduced by a small error in the estimated angle) becomes progressively larger as the true insonation angle:

A. Approaches 90 degrees

B. Approaches 45 degrees

C. Stays constant regardless of angle

D. Approaches 0 degrees

89. A pulsed-wave Doppler sample volume's axial length (range-gate length) represents a trade-off between:

A. Color gain and spectral gain settings

B. Spatial specificity versus signal sensitivity

C. PRF and Nyquist limit values

D. Frequency and wavelength properties

90. A color Doppler 'write priority' (color priority) setting determines:

A. Whether color or grayscale displays at a pixel

B. The Nyquist limit value set

C. The Doppler angle of insonation set

D. The pulse repetition frequency set

91. Elevated resistive indices in the intrarenal arteries, occurring in a patient with underlying liver cirrhosis and worsening renal function without primary intrinsic renal disease, may raise concern for:

A. A normal finding requiring no further evaluation

B. Renal artery stenosis as the sole explanation

C. Hepatorenal syndrome, a functional renal impairment

D. A technical artifact from incorrect gain settings

92. A dilated, tortuous right ovarian vein is identified crossing anterior to the right ureter, correlating with intermittent right flank pain and hydronephrosis. This is most consistent with:

A. A normal ovarian vein variant

B. Ovarian vein syndrome, compressing the adjacent ureter

C. Renal artery stenosis

D. Ureteropelvic junction obstruction unrelated to any vascular structure

93. Following renal artery stenting, Doppler surveillance uses different (typically higher) velocity thresholds to diagnose in-stent restenosis compared to thresholds used for native, unstented renal artery stenosis. This is primarily because:

A. The stent itself has no effect on flow velocity

B. Stented vessels always have lower baseline velocities than native vessels

C. The stent alters vessel compliance and baseline flow

D. Velocity thresholds are never adjusted regardless of stent presence

94. A focal, small, avascular nodule with peripheral hyperemia is identified adjacent to, but distinctly separate from, an otherwise normally vascularized testicle. This localized pattern is most consistent with:

A. Torsion of a testicular appendage

B. Whole-testicle torsion present

C. Epididymitis inflammation present

D. A testicular tumor mass

95. A focal, saccular dilation is identified within the intra-abdominal portion of the fetal umbilical vein, with turbulent venous flow confirmed on Doppler, distinct from the normal caliber elsewhere. This is most consistent with:

A. A normal umbilical vein variant requiring no further surveillance

B. An umbilical vein varix, with thrombosis risk

C. Umbilical artery aneurysm present

D. A false umbilical cord knot present

96. A crescentic, avascular collection is identified between the placenta and the uterine wall, with the adjacent placental margin elevated, in a patient with acute abdominal pain and vaginal bleeding. This is most consistent with:

A. A normal venous lake finding

B. A normal placental venous lake

C. Placenta accreta pattern present

D. Placental abruption via retroplacental hematoma

97. New-onset pelvic pain in a recently postpartum patient, with an enlarged, thrombosed right ovarian vein identified on Doppler extending toward the IVC, is most consistent with:

A. A normal postpartum finding requiring no further action

B. Postpartum ovarian vein thrombosis

C. Ovarian torsion

D. A simple ovarian cyst

98. Following a percutaneous liver biopsy, a new, well-circumscribed anechoic-to-complex structure is identified at the biopsy tract with swirling internal color Doppler flow and a visible feeding vessel connecting to it. This is most consistent with:

A. Normal post-biopsy tract healing

B. A simple hepatic cyst

C. A hepatic artery pseudoaneurysm

D. Hepatic vein thrombosis

99. A patient with a mediastinal mass presents with facial and bilateral upper extremity swelling. Doppler shows loss of normal respiratory phasicity with reduced, monophasic flow in both internal jugular veins. This pattern is most consistent with:

A. A normal Valsalva-related respiratory variation

B. Isolated left subclavian vein thrombosis only

C. Bilateral carotid artery stenosis

D. Superior vena cava syndrome from central venous obstruction

100. A patient presents with a markedly swollen, painful, cyanotic lower extremity. Doppler shows extensive occlusive thrombus throughout the iliofemoral venous system with no compressibility. This clinical and Doppler picture is most consistent with:

A. A superficial thrombophlebitis only, a benign, self-limited condition

B. Normal post-exercise limb swelling

C. Phlegmasia cerulea dolens, limb-threatening

D. Lymphedema unrelated finding

101. In a patient with chronic portal vein thrombosis, the main portal vein is no longer identifiable as a single structure; instead, multiple small, tortuous, hepatopetal-flowing venous channels are identified in the expected portal vein location. This is most consistent with:

A. Acute portal vein thrombosis present

B. A normal portal vein anatomic variant

C. Hepatic artery aneurysm present

D. Cavernous transformation of the portal vein

102. Absent end-diastolic flow (AEDF) in the umbilical artery, in the setting of suspected fetal growth restriction, indicates:

A. Significantly increased placental vascular resistance

B. Normal placental function

C. A technical artifact requiring only a repeat scan with different settings

D. Improved fetal growth trajectory

103. Doppler assessment of an undescended (cryptorchid) testis primarily helps evaluate:

A. Placental location assessment

B. The fetal heart rate value

C. Arterial vascularity to the ectopic testis

D. Renal artery stenosis presence

104. Differentiating acute epididymo-orchitis from testicular torsion using color Doppler relies primarily on:

A. Testicular size alone measured

B. Whether pain is present clinically

C. The patient's age alone considered

D. Increased vascularity favors epididymo-orchitis

105. Doppler evaluation of a painful, sustained penile erection unrelated to sexual stimulation (priapism) helps differentiate:

A. The presence of a urinary tract infection

B. The patient's age

C. Low-flow (ischemic) priapism

D. Renal function

106. A new arteriovenous fistula identified adjacent to a recent renal transplant biopsy site, with characteristic high-velocity, low-resistance turbulent flow on Doppler, is best described as:

A. A normal post-biopsy finding requiring no further evaluation

B. An iatrogenic (biopsy-related) arteriovenous fistula

C. Transplant renal artery stenosis

D. Transplant rejection

107. A pulsatile, compressible orbital mass with arterialized venous flow on Doppler, associated with a bruit and proptosis, is most consistent with:

A. A simple orbital varix

B. A normal orbital vascular pattern

C. A carotid-cavernous fistula

D. Orbital cellulitis

108. A uterine fibroid that has rapidly enlarged shows new central hypoechoic areas with absent internal Doppler flow in those specific regions, while the fibroid's periphery retains normal vascularity. This pattern is most consistent with:

A. A completely avascular, normal simple fibroid

B. Uterine sarcoma with certainty diagnosed

C. A normal early pregnancy finding

D. Fibroid degeneration from outpaced blood supply

109. In a neonate, continuous flow (rather than the normal cyclical antegrade-only ductal pattern) is identified through a patent ductus arteriosus on Doppler. This pattern is most associated with:

A. A normal, clinically insignificant ductus in every case

B. A hemodynamically significant PDA with continuous shunting

C. Ductal closure completely

D. Pulmonary artery stenosis alone

110. A multi-vessel trauma evaluation identifies absent flow in a segmental hepatic vein together with a heterogeneous, poorly-defined hepatic parenchymal area on grayscale, alongside a separately identified splenic laceration with an associated perisplenic fluid collection. This combined picture is most consistent with:

A. A single isolated splenic injury only, with the hepatic finding being incidental and unrelated

B. Combined hepatic parenchymal injury with associated venous involvement

C. A normal post-traumatic imaging study

D. Isolated hepatic vein thrombosis unrelated to any traumatic mechanism

Answers

1. B. Routine PM is an ongoing, recurring check across the system's service life intended to catch gradual drift or wear before it affects diagnostic quality, distinct from acceptance testing's one-time baseline verification at installation. Establishing the original baseline is specifically what acceptance testing does, not routine PM. PM complements rather than replaces daily user-level QA. Warranty registration is an administrative step unrelated to PM's technical purpose.

2. A. A vasovagal response is managed by stopping the triggering activity, positioning the patient to support blood return to the brain, and monitoring until symptoms resolve. Continuing the exam risks worsening symptoms or loss of consciousness. Standing would worsen a vasovagal episode by further reducing venous return. Administering medication without appropriate physician involvement is outside the sonographer's independent scope.

3. B. Serious device-related adverse events can trigger mandatory reporting obligations to the FDA through systems like MedWatch, in addition to internal facility incident reporting, supporting post-market device safety surveillance. A sales representative is not the correct regulatory reporting channel. External reporting obligations do exist for qualifying events, contrary to option C. The patient's insurance company is not the relevant regulatory reporting recipient.

4. C. An exposure control plan is an OSHA-mandated document addressing how the facility minimizes staff exposure to bloodborne pathogens through engineering controls (e.g., sharps disposal), safe work practices, and PPE -- an occupational safety document, not a clinical or administrative one. Contrast allergy screening is a separate clinical safety topic. Acceptance testing addresses equipment performance, unrelated to bloodborne pathogen exposure. Informed consent documentation is a separate patient-rights topic.

5. A. A patient fall requires following the facility's established fall-response protocol, which includes clinical assessment, notifying appropriate staff, and completing an incident report, since falls can have delayed injury consequences and require proper documentation for patient safety and facility accountability. Simply continuing without further action risks missing a delayed injury. Documentation should occur regardless of the patient's request. Canceling future appointments is an inappropriate and unrelated overreaction.

6. D. Multi-use gel bottles can become contaminated with repeated use and improper nozzle handling, a cross-contamination risk specifically avoided by using individual single-use sterile gel packets for invasive procedures. Single-use packets are not chosen for cost savings; they typically cost more per use than bulk bottles. Standard sterile gel does not inherently produce better image quality than non-sterile gel. Speed is not the primary rationale; infection control is.

7. A. A chaperone policy provides a witness during sensitive or intimate exams, protecting the patient from potential misconduct and protecting the examiner from unfounded allegations -- a safeguard for both parties. It is not intended to speed up the exam through extra assistance. It does not replace the separate requirement for informed consent. Most chaperone policies apply based on exam sensitivity, not strictly on the genders involved.

8. C. Diagnostic ultrasound exams are generally expected to have medical necessity established by an appropriate clinical indication and physician order; a purely elective request without either raises exactly this question, distinct from keepsake/entertainment imaging concerns addressed separately by professional guidance. Universal Protocol addresses correct-site/correct-procedure verification, unrelated to necessity. Bloodborne pathogen exposure is an occupational safety topic, unrelated. Acoustic output limits are a bioeffects topic, not a medical-necessity one.

9. B. Two-person independent verification requires a second qualified person to separately confirm the medication, dose, and patient identity against the order, catching errors that a single individual might miss -- a recognized high-risk-medication safety practice. Relying on one person's judgment alone removes this safety redundancy. Patient verbal confirmation alone doesn't verify against the actual order. Experience does not eliminate human error risk, which is exactly why the practice applies regardless of practitioner experience.

10. A. The standard donning/doffing sequence is specifically designed to minimize the risk of the wearer contaminating themselves, particularly during removal (doffing), which is recognized as the highest-risk step for self-contamination if done out of order. It is not primarily a time-saving measure; safety, not speed, drives the sequence. The structured sequence applies broadly across precaution types, not just airborne. Comfort is not the rationale for the specific order.

11. B. A discovered discrepancy that changes the clinical impression requires a formal amended or corrected report, with the change actively communicated to relevant clinical staff, since the original impression could otherwise misguide patient care. Leaving it unchanged perpetuates a known error. Waiting for the referring physician to ask leaves patient safety to chance. Deleting the original report destroys the medical-legal record rather than properly documenting the correction.

12. D. Rearranging the Doppler equation: v = (shift x c)/(2 x f0 x cos theta) = (1200 x 1540)/(2 x 4,000,000 x 1) = 1,848,000/8,000,000 = 0.231 m/s, approximately 23.1 cm/s. Option A is roughly half the correct value. Option C roughly doubles it. Option D restates the correct value with the correct formula shown.

13. A. Fractional bandwidth = bandwidth/center frequency = 2/5 = 0.40, or 40 percent. Option B is half the correct value. Option C reflects a miscalculated ratio. Option D is one-quarter of the correct answer, a decimal-placement error.

14. A. Q-factor = center frequency/bandwidth = 6/3 = 2.0. A lower Q-factor (broader relative bandwidth) is generally associated with shorter pulses and better axial resolution, while a higher Q-factor favors Doppler sensitivity. Option B inverts the ratio. Option C misapplies the formula. Option D multiplies rather than divides.

15. B. Critical angle = arcsin(c1/c2) = arcsin(1540/1600) = arcsin(0.9625), approximately 74 degrees; a critical angle exists specifically because the sound is passing into a medium with a HIGHER propagation speed (c2 greater than c1). 90 degrees would only occur if the ratio equaled 1. 45 degrees does not correspond to this ratio. A critical angle does exist here since c2 is greater than c1, the required condition.

16. D. Energy = Power x Time = 50 mW x 2 s = 100 millijoules (since a watt is a joule per second). Option A is half the correct value. Option B uses only the power value without multiplying by time. Option C is off by several orders of magnitude, a unit-conversion error.

17. D. Both the number of cycles per pulse and the wavelength (itself determined by frequency) independently contribute to spatial pulse length (SPL = cycles x wavelength); reducing either factor shortens the pulse, which directly improves axial resolution since axial resolution is proportional to SPL. Option A incorrectly claims reducing cycles always degrades resolution, the opposite of the actual relationship. Option B incorrectly claims only frequency, not cycle count, affects SPL. Option C incorrectly claims SPL is unrelated to axial resolution, when in fact SPL directly determines it.

18. B. Grating lobes arise when element spacing is on the order of one wavelength or greater, since at that spacing the array behaves like a diffraction grating, producing significant off-axis energy that can create artifacts. Ten wavelengths is far larger than the spacing that triggers this issue. Element thickness relates to resonant frequency design, not grating lobe spacing. The full aperture length is unrelated to the per-element spacing that governs grating lobes.

19. C. Because bone's acoustic impedance is markedly higher than soft tissue's, the large impedance mismatch at this interface reflects a substantial fraction of incident intensity, often cited around 40 percent or more, which is why structures deep to bone are difficult to image. 1 percent and 10 percent both understate the mismatch's effect. 0 percent would only occur if the impedances were equal, which they are far from at this interface.

20. C. Since 1 W = 1000 mW, 25 mW/cm^2 divided by 1000 = 0.025 W/cm^2. Option A is off by a factor of 100. Option B is off by a factor of 10. Option D moves the decimal in the wrong direction entirely.

21. A. Increasing active aperture size, with frequency and depth held constant, narrows the beam width in the focal region, improving lateral resolution roughly in proportion to the aperture increase. It does not stay the same; aperture size directly determines beam width. It does not worsen; the relationship is inverse. Resolution remains a well-defined, calculable quantity as aperture changes.

22. A. The Doppler shift value itself is a function of operating frequency, angle, and velocity; depth affects signal amplitude (due to attenuation) and practical detectability, but does not change the calculated shift frequency for a given true velocity and angle. Options B and C incorrectly attribute a systematic depth-dependence to the shift value itself. Doppler measurements are not restricted to depths under 5 cm; deeper vessels can be interrogated, albeit with more attenuation-related signal loss.

23. C. The -3dB (half-power) bandwidth is the span between the upper and lower frequencies where power drops to half its peak value: 6 MHz - 4 MHz = 2 MHz. Option A restates the center frequency rather than the bandwidth. Option C is half the correct bandwidth. Option D doubles the upper limit rather than calculating the span.

24. D. The decibel and the Neper are both logarithmic units for expressing ratios, but they use different logarithm bases, related by a conversion factor of approximately 8.686 (1 Neper equals approximately 8.686 dB). They are not identical units, and simple division by 2 or by the conversion factor itself would produce an incorrect result rather than the correct multiplication.

25. A. Intensity = Power/Area = 40 mW/2 cm^2 = 20 mW/cm^2. Option B results from multiplying instead of dividing. Option C reflects a decimal-placement error. Option D inverts the calculation (area divided by power) rather than power divided by area.

26. C. Near-zone length = aperture squared/(4 x wavelength) = (10 x 10)/(4 x 0.5) = 100/2 = 50 mm. Option A is one-tenth the correct value. Option C is ten times too large. Option D results from a different arithmetic error in the denominator.

27. D. Since wavelength shrinks as frequency rises (with aperture held constant), the near-zone length formula (aperture squared over 4 times wavelength) increases, while the far-zone divergence angle formula (which is inversely related to aperture-to-wavelength ratio) decreases -- a longer near zone with a narrower, less-diverging beam beyond it. Both increasing or both decreasing misrepresents this inverse relationship between the two quantities. Frequency does directly affect both through its effect on wavelength.

28. B. The T/R switch isolates the sensitive, low-voltage receiver electronics from the much higher-voltage transmit pulse, then allows the much weaker returning echo signals through to the receiver -- a protective and signal-routing function specific to the shared transmit/receive pathway. Frequency preset selection is a separate control. Overall gain is adjusted separately in the receiver chain. Display mode switching is a separate software/processing function.

29. C. Minor manufacturing variation can make individual elements slightly more or less sensitive than their neighbors; per-element calibration corrects for this so the resulting image has even brightness/sensitivity across the field, rather than subtle banding. All elements in a single array share the same intended operating frequency design, not per-element frequency differences. Footprint size is a design parameter, not something calibration corrects. Body habitus is a patient factor addressed by system settings (like TGC), not element-level factory calibration.

30. C. A built-in self-test verifies basic functional integrity of the transducer's elements and associated circuitry at startup, catching a gross hardware fault before the probe is used clinically. It has no access to or role in checking patient history. It does not check environmental conditions like temperature/humidity. Login credentials are a separate system-security function, unrelated to the transducer's hardware self-test.

31. A. Bending a cable tighter than its specified minimum bend radius risks damaging internal conductors or shielding, degrading signal quality or causing intermittent failure. It has no relationship to transducer overheating. It does not address acoustic output, a function of transmit settings. Electromagnetic interference is addressed by shielding design, not primarily by bend-radius limits.

32. D. Periodic QA testing (comparing current performance against a baseline) is specifically designed to catch gradual, cumulative sensitivity drift that single-event degradation checks might miss, allowing informed decisions about probe service life. Ignoring gradual change risks missing a real decline in diagnostic quality. Immediate discarding at any detectable change is an overreaction without confirming clinical significance. Software compensation has limits and cannot substitute for actual QA verification of real-world performance.

33. B. Dynamically adjusting the active aperture (and thus effective F-number) with depth allows the system to maintain better focusing and lateral resolution across a range of depths, rather than being optimally focused only at one fixed depth. It does not change the transducer's fixed operating frequency. The physical element count is fixed by manufacturing; only the ACTIVE subset changes dynamically. Imaging/Doppler mode switching is a separate operator or protocol-driven choice.

34. C. Packing more, finer-pitch elements into the same footprint allows finer control over beam steering and reduces grating-lobe risk (since smaller pitch keeps spacing below the problematic wavelength threshold), but requires more channels/complex electronics to drive them. It does not change the fixed footprint width itself. It has no direct relationship to a lower required operating frequency. A matching layer is still needed regardless of element count or pitch to maximize energy transmission into tissue.

35. C. Internal electronics generate their own heat during operation, and a separate internal thermal limit protects components from failure or degraded performance due to excessive internal heat buildup, distinct from the patient-safety-focused surface-contact temperature limit. Patient skin burn risk is specifically addressed by the surface-contact limit, a different specification. Acoustic output at the face is governed by separate output regulations, not internal thermal limits. EMI is addressed by shielding design, unrelated to this internal thermal limit's purpose.

36. B. The backing material's impedance is designed to be close to the piezoelectric element's own impedance so that backward-traveling vibrational energy is efficiently absorbed (rather than reflected back into the element), which shortens the pulse (dampens ringing) and improves axial resolution. Making it as DIFFERENT as possible would instead reflect energy back into the element, prolonging ringing -- the opposite of the intended design. Air's impedance is essentially the opposite extreme of what's needed for effective damping. Backing material impedance is, in fact, a significant factor in overall transducer performance.

37. A. Radius of curvature determines how sharply the beam diverges (smaller radius, more divergence, wider FOV at depth for a given footprint), while the arc length (footprint size) together with that radius determines the total angular sweep of the resulting sector-shaped image -- the two parameters work together, not interchangeably. They are independent design choices, not fixed to one another across all probe designs. Both parameters meaningfully affect the resulting geometry, so neither can be dismissed as irrelevant.

38. A. The dielectric constant affects the piezoelectric element's electrical impedance, mattering for how efficiently electrical energy transfers between the crystal and the system's circuitry, distinct from the crystal's acoustic properties. It does not determine physical thickness, set by resonant frequency design instead. It does not set acoustic output limits, a separate parameter. It is a real, relevant design property, contrary to option D.

39. D. A minimum SNR specification verifies the transducer can adequately distinguish genuine echo signal from inherent background electronic noise, fundamental to reliable image quality. Physical weight, cable length, and connector pin count are all separate, unrelated manufacturing specifications.

40. A. The acoustic lens provides fixed mechanical focusing in the elevational (slice-thickness) plane, a direction electronic beamforming cannot control, complementing electronic focusing/steering in the azimuthal plane. It does not replace electronic focusing; the two work together across different planes. It does not determine operating frequency, a property of the piezoelectric elements. It has no relationship to overall gain, a separate receiver-chain control.

41. D. The acoustic center is a defined reference point representing the effective beam origin, which may not precisely coincide with the array's physical geometric center due to element characteristics and design factors. It is not always identical to the geometric center. It has nothing to do with the connector's location. It is directly relevant to, not irrelevant to, beamforming calculations.

42. A. Because the acoustic stack's layers are designed around specific quarter-wavelength and matching relationships, even small unintended variations in bonding-layer thickness can measurably shift the intended acoustic matching and resulting pulse characteristics, making tight tolerances important. It is not acoustically inconsequential, contrary to option B's claim. It is a functional, not merely cosmetic, specification. Cable electrical resistance is unrelated to the acoustic stack's internal bonding layers.

43. D. Endocavity probe tip design must balance providing enough acoustic aperture for adequate imaging against keeping the tip shape and insertion force comfortable and easy to tolerate for the patient -- a genuine engineering trade-off specific to internal-use probes. Operating frequency is set by the piezoelectric design, not primarily driven by tip-shape comfort considerations. Coupling gel is still required for acoustic transmission regardless of tip design. Increasing footprint would generally worsen patient comfort, the opposite of the described design goal.

44. A. Electronic and acoustic components can exhibit slight temperature-related drift during the initial period after power-on, before reaching thermal and electrical stability; waiting for this stabilization period ensures precise output measurements reflect the system's true, stable operating characteristics rather than transient warm-up drift. It is not related to loading patient records, a separate software function. The concern is stabilization, not cooling down, which would be the opposite issue. It reflects a real hardware stabilization need, not merely a software licensing delay.

45. B. A cracked or damaged housing can allow moisture or contaminants to penetrate the transducer, risking electrical safety, infection control, and equipment failure -- a real patient-safety concern justifying a quick pre-use check. It does not replace other QA testing, which addresses different performance aspects. It is relevant regardless of probe age. It has direct bearing on patient safety, contrary to option D.

46. D. Because the system calculates depth from echo return time using a fixed assumed propagation speed, any tissue segment with an actual speed different from that assumption causes a depth-placement error -- a distinct artifact category from beam-geometry or timing-based artifacts. A grating lobe artifact arises from element spacing exceeding a wavelength, an unrelated beam-geometry mechanism. Range ambiguity results from too high a PRF for the imaging depth, a different timing-based mechanism. Reverberation arises from sound bouncing repeatedly between two strong parallel reflectors, also a distinct mechanism from a speed-assumption error.

47. C. Automated compressibility assessment provides an objective, quantified supplement to the sonographer's manual compression technique, supporting more consistent documentation of a key DVT finding. It does not replace manual compression technique, the fundamental diagnostic maneuver. It applies to venous, not arterial, assessment, given the compressibility principle relies on veins' normally collapsible walls. It does not determine clot age, a separate characterization.

48. C. Reproducible, consistent aortic diameter measurement is central to AAA screening and surveillance, since detecting growth over serial exams (or an initial size crossing an intervention threshold) is what drives the clinical decision-making. It does not eliminate the need for appropriate follow-up imaging intervals based on measured size. It is not restricted to a linear array; curvilinear probes are typically used for abdominal aortic imaging given depth requirements. It does not schedule surgery, a clinical and administrative decision made by the care team.

49. A. An enlarged appendiceal diameter above a commonly cited threshold is a supportive sonographic sign of appendicitis, used alongside other findings (non-compressibility, surrounding inflammation, patient symptoms) rather than as a standalone diagnostic measurement. It does not replace clinical correlation, which remains essential. It is not restricted to adults; appendix diameter measurement is commonly used in pediatric patients as well. It does not automatically distinguish between different causes of bowel wall thickening or inflammation, which requires broader clinical and imaging correlation.

50. B. A focal irregularity or mass-like flag draws attention to a potential discrete abnormality, such as a possible bladder tumor, that a uniform wall-thickness measurement alone might not adequately capture. It does not replace cystoscopy, an important complementary diagnostic tool. It is not restricted to male patients. It does not stage a detected abnormality, a separate clinical determination.

51. C. Pancreatic duct dilation is a recognized sonographic sign that can indicate downstream obstruction, prompting further work-up to identify the cause; tracking the measurement supports timely recognition of this finding. It does not replace complementary cross-sectional imaging (CT/MRCP) often needed for full pancreatic evaluation. While fasting can improve visualization in some abdominal exams, the measurement isn't strictly limited to only functioning in fasting patients. It flags a finding for further work-up, not an automated cause diagnosis.

52. D. Uterine volume provides an objective, reproducible measure useful for characterizing and tracking conditions associated with uterine enlargement, such as fibroids or adenomyosis, supporting clinical monitoring over time. It flags size for correlation, not an automated cause diagnosis. It applies to non-pregnant gynecologic evaluation as well as pregnancy-related contexts, not exclusively pregnancy. It does not replace separate endometrial evaluation, which addresses a different anatomic compartment.

53. D. Junctional zone irregularity is a recognized sonographic feature considered in evaluating for adenomyosis, providing information distinct from simple endometrial thickness alone. It is not specific to simple endometrial polyps, a different, more discrete finding. It does not concern cervical pathology, an anatomically distinct region. It does not concern ovarian pathology, also anatomically distinct from the endometrial-myometrial junction.

54. B. Short-axis nodal diameter is a widely used sonographic criterion that raises suspicion for possible malignant involvement, prompting further evaluation such as biopsy, rather than confirming malignancy on imaging alone. It flags a suspicious size for further work-up, not confirmation. This measurement approach and clinical context specifically concerns axillary (not inguinal) nodes as described. It does not replace sentinel lymph node biopsy, which remains a separate, more definitive staging procedure.

55. A. Tri-plane obstetric display allows simultaneous visualization of three orthogonal fetal imaging planes in real time, supporting faster comprehensive anatomic assessment than acquiring each plane sequentially. It does not itself calculate fetal weight, a separate biometry-based calculation. It supplements rather than eliminates standard 2D obstetric imaging, which remains foundational. It is not restricted to late gestational ages; anatomic survey imaging spans a range of gestational ages depending on the indication.

56. C. Hernia defect width provides objective information that helps characterize severity and can inform management or surgical planning discussions, complementing clinical assessment. It does not itself determine the management decision, which involves broader clinical factors. Hernia evaluation often specifically benefits from provocative maneuvers and varied positioning (including upright or Valsalva) to assess for a hernia not evident supine at rest, so it is not restricted to supine positioning alone. It does not replace the Valsalva maneuver, which remains an important provocative technique during the exam itself.

57. C. Shear-wave elastography measures the actual propagation speed of induced shear waves, yielding a quantitative, more standardized stiffness value (e.g., in m/s or kPa), in contrast to strain elastography's relative, operator-technique-dependent strain ratio or color pattern. It is commonly used on the liver, among other organs, contrary to option A. It specifically does NOT require manual compression by the operator, since the system itself generates the shear wave -- manual compression technique-dependence is instead a characteristic of strain elastography. It does not require a contrast agent, an unrelated separate imaging technique.

58. D. Subcutaneous fat thickness provides an objective, trackable sonographic measurement relevant to certain nutritional or metabolic assessment contexts, complementing other clinical data. It does not itself diagnose a specific underlying metabolic condition, which requires broader clinical and laboratory correlation. It applies across age groups where clinically relevant, not exclusively pediatric patients. It complements, rather than replaces, other established body composition assessment methods.

59. B. PET/CT-ultrasound fusion allows a metabolically active area identified on PET imaging to be spatially correlated with real-time ultrasound anatomy, supporting accurate targeting for biopsy or other intervention at that specific site. It does not itself calculate the SUV, a PET-specific quantitative value determined by the PET acquisition and analysis software. It does not eliminate the need for the underlying PET/CT acquisition, which is the source dataset being fused. It is not restricted to cardiac exams; oncologic applications (e.g., targeting a suspicious lesion) are a common use case.

60. C. A multi-exam longitudinal trend specifically reveals slow, chronic changes occurring over months or years, information that a single exam session (even with its own internal trending, such as a fetal heart-rate trend within one visit) cannot capture. It still relies on individual exam measurements as its building blocks, rather than replacing them. It can apply to many measurement types across organ systems, not just cardiac. It displays a trend for clinical correlation, not an automated diagnosis of the underlying cause.

61. D. An audit trail logging who entered or edited a measurement, and when, supports accountability and retrospective quality review, useful for training or verifying workflow compliance. It does not itself correct measurement errors, only tracks who made them. It does not directly speed up the exam; it is a background logging feature. It does not replace the physician's final review, a separate necessary step.

62. A. An audible proximity cue gives the operator a non-visual channel of feedback about needle-tip proximity to the target, supporting guidance without requiring constant visual confirmation alone -- useful since attention may be divided between the needle and the image. It supplements rather than replaces visual confirmation, which remains important. It is not restricted to a specific probe type; the underlying concept applies broadly to needle-guidance software. It provides feedback only; it does not physically control or stop the needle itself, which remains under the operator's manual control.

63. C. This type of software flags waveforms that deviate from expected normal patterns, prompting the sonographer or interpreting physician to look more closely, functioning as a screening aid rather than a diagnostic tool itself. It does not diagnose the specific underlying pathology, which requires clinical and imaging correlation. Waveform classification concepts can be applied to both arterial and venous patterns, not exclusively arterial. It does not replace the separate, essential step of accurate angle correction for reliable velocity measurements.

64. C. This warning flags a potential measurement-quality concern -- a blurred frame can affect accuracy -- prompting the sonographer to review and potentially re-measure on a clearer frame, a quality-assurance prompt rather than an automatic correction. It does not itself recalculate the measurement; it alerts, leaving correction to the sonographer. It does not replace the sonographer's judgment. Motion-blur detection can apply broadly, not exclusively to cardiac review.

65. A. Tracking PVR trends across visits helps identify whether incomplete bladder emptying is worsening, improving, or stable over time, supporting clinical management decisions in ways a single isolated measurement cannot. It is built from, and depends on, individual single-visit PVR measurements, not a replacement for them. PVR assessment applies to both male and female patients where clinically indicated, not exclusively males. It flags a trend for correlation, not an automated diagnosis of the underlying cause.

66. D. A live volume-rate readout lets the operator see the real-time consequence of settings choices (like volume size) on acquisition speed, supporting informed trade-off decisions during acquisition itself. It does not calculate organ volume, a separate downstream measurement task performed on the acquired dataset. It is a distinct readout specific to 3D/4D acquisition, not simply a replacement for the standard 2D frame-rate readout. It is not restricted to fetal cardiac imaging; the concept applies to 3D/4D acquisition broadly.

67. C. A real-time angle readout helps the operator confirm and maintain the intended insertion angle throughout the approach, supporting accuracy especially when the visual angle on the 2D image can be difficult to judge precisely. It provides angle information, not a direct depth calculation, which is a related but separate readout. It supplements, rather than replaces, direct visualization of the needle on the image, which remains essential. The concept can apply to in-plane approaches as well, not exclusively out-of-plane.

68. D. Measuring the distance from the placental edge to the internal cervical os is the basis for screening and classifying placenta previa, an important finding affecting delivery planning. It does not itself diagnose the distinct condition of placenta accreta, which involves abnormal placental invasion rather than position relative to the os. This measurement is most relevant and most accurately performed later in pregnancy as the lower uterine segment develops, not restricted to the first trimester. It does not replace a transvaginal approach when clinically indicated, which often provides superior accuracy for this specific measurement.

69. C. Triplex display lets the operator see anatomic detail, color flow, and the spectral trace together in real time, while independent gain control for each component allows fine-tuning image quality and Doppler sensitivity separately without one setting compromising another. It requires, rather than eliminates, manual operator input for gain optimization at each component. It does not eliminate the separate, necessary step of spectral angle correction for accurate velocity measurement. It is not restricted to phased-array probes; triplex capability is available across various probe types.

70. D. Automatically pre-loading likely relevant measurement tools based on detected exam type reduces manual setup steps and workflow friction, letting the sonographer get to scanning and measuring more quickly. The sonographer retains the ability to manually select or override the preset if the automatic detection is incorrect or a different tool is needed, so it doesn't replace that capability. It does not finalize the exam automatically, which remains a sonographer/physician-driven decision. The concept applies across various exam types where a defined measurement package is used, not exclusively obstetric exams.

71. C. A structured communication log specifically documents the details of the notification process itself -- who was told, when, and by what method -- for findings requiring urgent action, creating an accountability record distinct from simply flagging the finding on the image. It does not notify the patient directly; it documents professional-to-professional communication, typically to the ordering or treating physician. It documents, but does not replace, the actual verbal (or other) communication that must still occur. It applies broadly to any critical finding requiring urgent communication, not exclusively fetal findings.

72. C. Displaying the individual dimensions provides information beyond the single derived volume value, such as supporting direct comparison of a specific dimension (e.g., length) between the two testes to assess asymmetry, which the combined volume figure alone might obscure. The dimensions feed into, rather than replace, the ellipsoid volume calculation. It applies to routine scrotal ultrasound generally, not exclusively undescended testis evaluation. It provides measurement data for correlation, not an automated diagnosis of atrophy.

73. D. Automatically adjusting dynamic range based on detected tissue type aims to present gray-scale contrast that's well-suited to that tissue's typical appearance, reducing the need for the operator to manually reset dynamic range for each different exam type or organ. It does not diagnose pathology based on echogenicity; it adjusts display contrast, not clinical interpretation. It addresses depth-independent overall contrast, a different function from TGC, which compensates for depth-related attenuation, so it does not replace TGC adjustment. It is not restricted to cardiac imaging; the concept applies broadly across exam types.

74. B. Displaying a confidence interval or margin of error alongside a derived estimate helps the clinician appropriately calibrate how precisely to interpret that single number, since formula-based estimates inherently carry some uncertainty. It does not itself correct measurement error; it communicates the expected range around the estimate as calculated. It does not reduce the importance of careful, accurate measurement technique, which remains essential to obtaining reliable underlying inputs. The concept of displaying estimate uncertainty can apply to various derived calculations, not exclusively Doppler-derived ones.

75. B. Because panoramic images are built by stitching many frames together as the probe sweeps, any tilt or off-axis motion during that sweep can introduce geometric distortion or misregistration in the final composite; an alignment-correction algorithm compensates for this to keep the stitched result geometrically accurate. Aliasing is a Doppler/sampling-related artifact, unrelated to panoramic geometric stitching. Range ambiguity relates to PRF/depth limitations, a different mechanism. Grating lobe artifact arises from element spacing exceeding a wavelength, also unrelated to this stitching-alignment issue.

76. D. Nuchal translucency measurement is one component of a combined first-trimester screening approach that also incorporates maternal age and biochemical markers to calculate an overall aneuploidy risk estimate. It complements, rather than replaces, maternal serum screening. It does not diagnose a specific chromosomal abnormality with certainty; it contributes to a risk estimate requiring further diagnostic testing for definitive diagnosis. It is a first-trimester measurement, performed well before 20 weeks.

77. C. Delta-f = 2 x f0 x v x cos theta/c = (2 x 7,500,000 x 0.45 x 1)/1,540, approximately 4,383 Hz. Option A is roughly half the correct value. Option B is roughly one-quarter the correct value. Option D doubles the correct answer, a plausible doubling error.

78. C. The Nyquist limit is exactly half the PRF: 8,000/2 = 4,000 Hz. Option A incorrectly equates Nyquist to the full PRF. Option B doubles the PRF instead of halving it. Option D is one-quarter of the PRF, an over-halving error.

79. A. RI = (PSV-EDV)/PSV = (70-14)/70 = 56/70 = 0.80. Option B mistakenly calculates EDV/PSV. Option C and D reflect arithmetic miscalculations of the subtraction or division.

80. B. PI = (PSV-EDV)/mean = (60-15)/30 = 45/30 = 1.5. Option A reflects an arithmetic underestimate. Option C reflects using the wrong denominator. Option D substantially underestimates the correct value.

81. B. Volume flow = Area x TAV = 0.4 x 25 = 10 cm cubed/s (mL/s); converting to per minute: 10 x 60 = 600 mL/min. Option A omits the per-minute conversion. Option C reflects a partial conversion error. Option D substantially overestimates the correct value.

82. C. Velocity ratio = stenotic PSV/pre-stenotic PSV = 280/35 = 8, an 8:1 ratio. Options A, B, and D all reflect arithmetic miscalculation of the true ratio.

83. B. S/D ratio = systolic/diastolic = 60/20 = 3.0. Option A underestimates the correct ratio. Option C overestimates it. Option D is the inverse (D/S) rather than the requested S/D ratio.

84. A. CPR = MCA-PI/UA-PI = 1.6/0.8 = 2.0. Option B is the inverse ratio (UA-PI/MCA-PI). Option C reflects a multiplication rather than division error. Option D simply restates one of the two input values rather than the calculated ratio.

85. B. In laminar flow, velocity varies across the vessel's cross-section (fastest centrally, slower near the walls), so the time-averaged MEAN velocity better represents the true average flow driving volume, while peak velocity reflects only the fastest central stream and would overestimate volume flow if used directly in the formula. Option A reverses this relationship. The two values are generally NOT numerically identical in a parabolic flow profile, contrary to option C. Volume flow calculations are fundamentally velocity-based, making option D incorrect.

86. D. Sweep speed controls how quickly the spectral trace scrolls across the display, affecting how compressed (fast sweep, more beats visible, less per-beat detail) or expanded (slow sweep, fewer beats, more per-beat detail) the waveform appears -- a display/temporal-scaling control, not a measurement parameter. It does not change the underlying calculated Doppler shift value. It has no effect on the Nyquist limit, which is set by PRF. It does not affect the angle of insonation, a separate geometric parameter set by cursor placement.

87. B. Increasing temporal smoothing (persistence) blends color information across several frames, which helps suppress transient flash/blooming artifact from brief motion, though at the cost of reduced temporal resolution for genuinely rapidly changing flow patterns. It has no direct effect on the Nyquist limit, which is set by PRF/scale. It does not adjust the Doppler angle, a separate geometric parameter. It does not change the sample volume size, a distinct spatial gating parameter.

88. A. Because the cosine function's rate of change (its slope) increases as the angle approaches 90 degrees, a small error in the estimated angle at steep angles translates into a proportionally larger error in the calculated velocity -- which is why angles closer to 60 degrees or less are generally preferred over very steep angles. Near 0 degrees, cosine changes very little per degree, so a small angle error has minimal effect on the calculated velocity, the opposite of option A's claim. 45 degrees is an intermediate case, not the point of maximum sensitivity. The error sensitivity does change with angle, contrary to option C.

89. B. A shorter sample volume provides more precise spatial localization of where flow is being sampled, but may capture less signal (lower sensitivity), while a longer sample volume captures more signal at the cost of less precise spatial specificity -- a genuine trade-off distinct from general sample-volume placement technique. Color gain and spectral gain are separate display parameters, not what this specific trade-off concerns. Frequency and wavelength are physical properties of the transmitted pulse, not the sample-volume length trade-off. PRF and Nyquist limit relate to velocity-scale/aliasing considerations, a different topic from range-gate length.

90. A. Write priority specifically governs which information, color flow or grayscale, is displayed at a pixel when both a qualifying flow signal and grayscale signal are present, balancing flow visualization against anatomic detail. It does not set the Nyquist limit, determined by PRF/scale. It does not set the Doppler angle, a geometric parameter from cursor placement. It is a separate display control from PRF itself.

91. C. Hepatorenal syndrome is a functional (rather than primarily structural) renal impairment occurring in the setting of advanced liver disease, in which renal vasoconstriction can elevate the intrarenal resistive index, a described though non-specific sonographic correlate considered alongside the overall clinical picture. It is not simply a normal, disregardable finding given the described clinical context. Renal artery stenosis is a distinct structural vascular diagnosis, not the description's most fitting fit given the functional cirrhosis-associated context. It is described as a real physiologic finding, not attributed to a technical gain-setting artifact.

92. B. Ovarian vein syndrome describes ureteral compression by an abnormally dilated ovarian vein, distinct from pelvic congestion syndrome, which presents with chronic pelvic pain from venous congestion rather than ureteral obstruction. This is not simply a normal variant, given the correlating hydronephrosis and pain. Renal artery stenosis is an anatomically and Doppler-pattern distinct arterial finding. The dilated vein is specifically implicated here, making an unrelated non-vascular cause inaccurate for this scenario.

93. C. A stent's rigid structure changes vessel compliance and baseline flow dynamics compared to a native artery, which is why validated velocity thresholds for in-stent restenosis differ from those for native artery stenosis. The stent does affect flow velocity characteristics, contrary to option A. Stented vessels do not universally have lower baseline velocities. Thresholds are specifically adjusted for the stented context, contrary to option D.

94. A. Torsion of a small testicular appendage produces a localized avascular nodule with surrounding reactive hyperemia, while the testicle itself retains normal vascularity, distinguishing it from whole-organ torsion, which would show compromised flow to the entire testicle. Epididymitis would show epididymal, not this focal nodular, hyperemic changes. A testicular tumor would typically show a vascularized, not avascular, intratesticular mass.

95. B. An umbilical vein varix is a focal dilation of the intra-abdominal umbilical vein, associated with increased thrombosis risk and generally warranting closer surveillance. It is not simply a normal variant requiring no attention. It involves the umbilical VEIN, not the ARTERY, making option C anatomically incorrect. A false knot is a structural cord finding unrelated to focal venous dilation.

96. D. A crescentic retroplacental collection with an elevated adjacent placental margin, with acute pain and bleeding, is the classic appearance of placental abruption; the hematoma is appropriately avascular since it represents collected blood, not a vascular structure. A normal venous lake would be intraplacental, not retroplacental, and would not correlate with acute pain and bleeding. Placenta accreta shows abnormal invasion with increased vascularity at the interface, a different pattern. A fibroid is a distinct myometrial mass, not a collection at the placental-uterine interface.

97. B. Postpartum ovarian vein thrombosis is a recognized complication of the postpartum period, with a described predilection for the right side due to anatomic and physiologic factors, presenting with pelvic pain and an enlarged, thrombosed vein on imaging. This is not a normal, disregardable postpartum finding given the described thrombosis and associated pain. Ovarian torsion presents with an enlarged, edematous ovary and altered arterial/venous flow pattern to the OVARY itself, a different entity from venous thrombosis of the draining vein. A simple ovarian cyst would be a distinct anechoic structure, not a thrombosed vein.

98. C. A hepatic artery pseudoaneurysm is a recognized post-biopsy vascular complication, presenting as a well-circumscribed structure with swirling internal Doppler flow ('yin-yang' pattern) and a visible feeding vessel, distinct from a simple cyst or normal tract healing. A simple hepatic cyst would be avascular on Doppler, not matching the described swirling flow. Normal tract healing would not typically show this distinctive swirling vascular pattern with a feeding vessel. Hepatic VEIN thrombosis is an anatomically and Doppler-pattern-distinct entity from an arterial pseudoaneurysm.

99. D. Superior vena cava syndrome results from central venous obstruction, here from a mediastinal mass, producing bilateral, symmetric loss of normal respiratory phasicity with reduced venous flow in both internal jugular veins, correlating with the bilateral swelling described. A normal Valsalva pattern would be transient and would not correlate with these persistent findings. Isolated unilateral thrombosis would not explain the bilateral symmetric pattern. Carotid artery stenosis is arterial, not venous, and would not produce this pattern.

100. C. Phlegmasia cerulea dolens is a severe presentation of extensive iliofemoral DVT in which massive venous outflow obstruction causes the described marked swelling, pain, and cyanosis, a limb-threatening emergency. Superficial thrombophlebitis is a distinct, generally benign, self-limited condition, not matching this severe presentation. Normal post-exercise swelling would not show occlusive thrombus. Lymphedema is a distinct, non-thrombotic cause of swelling and would not show this occlusive venous thrombus pattern.

101. D. Cavernous transformation describes the chronic compensatory development of collateral venous channels around a long-standing occluded portal vein, restoring some hepatopetal flow around the obstruction -- specifically associated with chronic, not acute, thrombosis. Acute thrombosis would instead show a single occluded vessel with visible intraluminal thrombus, not the collateral network. This is not a normal anatomic variant; it represents a chronic pathologic compensatory response. A hepatic artery aneurysm is an anatomically distinct arterial finding.

102. A. Absent (or reversed) end-diastolic flow in the umbilical artery reflects significantly increased downstream placental vascular resistance, a concerning finding in growth-restricted fetuses that often prompts closer surveillance or consideration of delivery timing depending on gestational age and the full clinical picture. This is not consistent with normal placental function, which would show forward diastolic flow. While technical factors should always be considered, this pattern is a recognized real physiologic finding in placental insufficiency, not simply dismissed as an artifact. It reflects a concerning, not improved, growth-related trajectory.

103. C. Assessing arterial vascularity to an ectopic (undescended) testis provides useful information about the testis's viability and blood supply, which can inform surgical planning for orchiopexy. Fetal heart rate, placental location, and renal artery stenosis are all unrelated anatomic contexts, included as clearly mismatched distractors.

104. D. The key Doppler differentiator is flow pattern: epididymo-orchitis, an inflammatory process, typically shows increased (hyperemic) vascularity, while torsion, caused by vascular occlusion from cord twisting, shows absent or markedly decreased flow -- a fundamentally different underlying vascular mechanism reflected directly in the Doppler findings. Testicular size alone doesn't reliably differentiate the two conditions. Patient age alone is not a reliable Doppler-based differentiator. Pain is present in both conditions and does not by itself differentiate them; the Doppler vascularity pattern is the key distinguishing imaging feature.

105. C. Doppler is central to differentiating low-flow (ischemic) priapism, a urologic emergency with minimal-to-absent cavernosal arterial flow requiring prompt intervention, from high-flow (non-ischemic, often trauma-related) priapism, which shows normal-to-increased arterial flow and is managed differently. Patient age, urinary tract infection presence, and renal function are all unrelated to this specific vascular differentiation, included as clearly mismatched distractors.

106. B. An iatrogenic AV fistula is a recognized complication of percutaneous renal biopsy (including transplant biopsy), presenting with the characteristic high-velocity, low-resistance turbulent flow pattern typical of an abnormal arteriovenous communication. This is not simply a normal, disregardable post-biopsy finding, since a new AV fistula is a distinct complication warranting attention. Transplant renal ARTERY stenosis would show a different Doppler pattern (elevated velocity at a focal arterial narrowing, not a direct AV communication pattern) and different anatomic location. Rejection typically presents with elevated intrarenal ARTERIAL resistive indices, a different pattern from a focal AV fistula at a biopsy site.

107. C. A carotid-cavernous fistula creates an abnormal direct communication between the carotid arterial system and the cavernous sinus, producing arterialized (high-velocity, pulsatile) flow within orbital venous structures, along with the classically associated bruit and proptosis. A simple orbital varix shows a distensible venous structure without the described arterialized flow pattern and bruit. This is not a normal orbital vascular pattern, given the described pulsatility, arterialization, bruit, and proptosis. Orbital cellulitis is an infectious/inflammatory process without this characteristic vascular Doppler pattern.

108. D. Fibroid degeneration occurs when rapid growth outpaces the available blood supply, causing central ischemic/necrotic change while the better-supplied periphery retains normal vascularity -- a recognized benign process. A typical simple fibroid would show more uniform vascularity without new central avascular change. Malignant transformation to sarcoma cannot be diagnosed with certainty from this Doppler pattern alone; degeneration is the far more common explanation. This relates to fibroid tissue vascular change, not early pregnancy, an unrelated finding.

109. B. Continuous (rather than purely cyclical) flow through a PDA reflects a sustained pressure gradient between the aorta and pulmonary artery throughout the cardiac cycle, a pattern associated with a hemodynamically significant, continuously shunting ductus that may require clinical attention. This pattern is specifically associated with significance, not universally dismissed as insignificant in every case. Ductal closure would show absent, not continuous, flow, the opposite finding. Pulmonary artery stenosis is a distinct anatomic diagnosis not, by itself, explained by this ductal flow pattern description.

110. B. The combination of a heterogeneous hepatic parenchymal area with absent segmental venous flow, together with a distinctly identified splenic laceration and associated perisplenic fluid, is consistent with multi-organ blunt abdominal trauma involving both the liver (with vascular/parenchymal injury) and spleen. The hepatic finding is not simply an incidental, unrelated observation given its combination with absent venous flow and a parenchymal abnormality pattern. This is clearly not a normal post-traumatic study, given the multiple described abnormal findings. The hepatic venous finding is described specifically in the context of a heterogeneous parenchymal injury pattern, consistent with a traumatic mechanism rather than an isolated unrelated primary thrombosis.