

Week 5: Procedure Prep, Clinical Safety & Post-Procedure

CVSG2280 Cardiovascular Registry Review by Dr. Alice Matthews

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Registry weight. This week feeds the **Clinical Care & Safety** domain of the ARDMS RDCS (Adult Echo, V24.2): Anatomy/Physiology 15%, Pathology 40%, **Clinical Care/Safety 11%**, Measurement/Views 25%, Instrumentation 9%. On the CCI RCS it maps to **Domain A (Patient Care, Communication & Lab Operations, 9%)** plus **Domain E (Quality Assurance, 13%)**; the five domains are A (Patient Care, Communication & Lab Operations) 9%, B (Anatomy & Physiology) 24%, C (Pathophysiology) 25%, D (Integration of Data & Sonographic Technique) 29%, and E (Quality Assurance) 13%. Together that is roughly one in five registry items, and it is the highest-yield "easy points" block because the answers are procedural rather than computational.

Note to students: This week follows the [ASE Guidelines & Professional Practice Standards](#), the [ASE infection-control statements](#), and the [AIUM official statements on ALARA and bioeffects](#). Use the [ASE 2015 Chamber Quantification](#) values for any number you document. **What last week's EOM gives you:** Week 4 taught you to grade valve disease; this week is where you learn to safely *produce* that exam, document it, and escalate a critical finding. Always defer to the protocol your clinical site follows.

At a Glance: this week in one box

Must-know numbers. TI keep < 0.4 (early OB only; no cardiac limit); MI keep < 1.9 (OB; no cardiac limit). Fasting: TTE none; stress 4 to 6 hr; TEE nothing solid after midnight, clear liquids permitted up to 2 hr before the exam (modern ASA fasting guidance). Agitated saline: 1 mL contrast + 1 mL saline + 1 mL air, use within 5 min. PACS archival 7 to 10 yr (HIPAA/CMS). 2D frame rate > 30 Hz. Stat report ≈ 1 hr; routine ≈ 24 hr. Trophon soak 5 to 10 min; Tristel ≈ 1 min per side.

Formulas you will reuse. $RVSP = 4V_{TR}^2 + RAP$ (the one quantitative formula that resurfaces here, when a newly detected PASP > 35 to 40 mmHg with RV strain becomes a critical finding to escalate). Sensitivity and specificity define test performance for QA.

Top 3 EOM traps. (1) ALARA thermal/mechanical limits are an **obstetric** concern, not a cardiac one. (2) The sonographer escalates a critical finding to the reading physician; the sonographer does **not** diagnose or counsel the patient. (3) A TEE probe needs **high-level disinfection** (semi-critical), not just an alcohol wipe.

Patient Clinical History Review & Prior-Study Comparison

Before a transducer touches the patient, the exam is already half done at the chart. ★ The first job of every echo is to confirm the right patient is getting the right study for the right reason. Match the patient name, date of birth, and medical record number on the wristband to the electronic record, then confirm the order is in the chart, legible, and signed by an identifiable ordering physician.

Indication verification. The ordered study must answer a real clinical question: rule out endocarditis, follow known aortic stenosis, assess EF after a myocardial infarction, evaluate a new murmur. ★ If the indication does not match the clinical scenario, flag it before you scan. Note the priority: **stat** studies turn around in roughly 1 to 2 hours and reorder your schedule; **routine** studies turn around in about 24 hours.

Prior-study comparison. Pull the baseline echo, any stress result, and relevant imaging from other modalities out of PACS. The clinical value of a follow-up echo is the *change* from prior: improved, worsened, stable, or a genuinely new finding. A "new" wall-motion abnormality or a "new" effusion means something very different from a chronic one, and you cannot tell which it is without the comparison.

Common Trap

A follow-up TTE shows mild aortic stenosis with a peak velocity of 3.4 m/s. The prior study from eight months ago is available in PACS, but the schedule is busy, so the sonographer reports the current numbers without opening it. **What is the error?**

The entire reason for a serial echo is the trend. A peak velocity that rose from 2.2 to 3.4 m/s in eight months is rapidly progressing disease and changes management urgency, even though both readings are below the severe cutoff. Always retrieve and compare the prior study; the delta, not the snapshot, is the clinical answer.

Echo Order Verification and Appropriateness

The order tells you which exam to set up, and each exam has a different prep footprint. ★ Confirm the study type before you prepare the room.

- **Diagnostic TTE:** no fasting, no IV unless contrast is anticipated, left lateral decubitus positioning.
- **TEE:** NPO, sedation, IV access, anticoagulation reversal kit at bedside, semi-critical probe disinfection.
- **Stress echo:** fasting 4 to 6 hr, IV access for dobutamine/atropine, continuous ECG and blood-pressure monitoring, a stress team in the room.
- **Contrast (bubble) study:** IV access, agitated-saline preparation, monitoring for the rare reaction.
- **POCUS / follow-up / post-intervention:** focused question, often abbreviated protocol.

Appropriateness criteria (ACC/AHA framework) decide whether an echo is justified for a given scenario; the indication on the order is the sonographer's anchor for the whole study.

Ergonomic Safety for the Sonographer

Career-ending injuries in sonography are musculoskeletal, not radiologic. Protecting yourself is a registry-tested clinical-care competency.

- **Probe grip:** neutral wrist, light grip; avoid the angled, white-knuckle hold that drives repetitive strain.
- **Monitor:** screen at eye level, about 60 cm away, perpendicular to your body so you do not rotate your trunk.
- **Seating:** feet flat, knees near 90 degrees, controls within knee-height reach so you are not stretching for a knob.
- **Posture:** keep the scanning arm close; avoid sustained reaching, shoulder elevation, or trunk rotation.
- **Breaks:** stretch and give the hand relief every 30 to 45 minutes.

Memory hook: "Neutral, Eye-level, Arm-close, Reach-low" (NEAR) keeps the four ergonomic pillars in order, because everything you need should stay *near* you.

Patient Positioning, Prep, and Hemodynamics

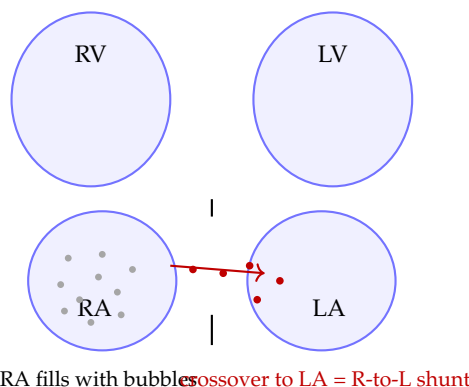
Standard TTE setup. Left lateral decubitus brings the heart against the chest wall and opens the apical and parasternal windows; head of bed up about 30 degrees keeps the patient comfortable and aids filling. Place ECG leads so the trace is visible on screen for timing every gated measurement.

Fasting and access by study type.

Study	Fasting	IV access
Diagnostic TTE	None	Only if contrast planned
Stress echo	4 to 6 hr	Yes (dobutamine, atropine)
TEE	NPO after midnight; clear liquids to 2 hr pre	Yes (sedation)
Contrast echo	None	Yes (18-gauge preferred)

Monitoring. Continuous pulse oximetry and ECG during stress and TEE. Blood pressure baseline and then every 1 to 2 min during exercise stress, every 3 to 5 min during dobutamine stress.

Agitated saline (bubble study). ★ Make it fresh from **1 mL contrast agent + 1 mL normal saline + 1 mL air**, agitated briskly between two syringes through a 3-way stopcock, and inject **within 5 minutes**. Bubbles in the right heart followed by left-heart opacification within 3 to 5 beats suggests a right-to-left shunt (PFO/ASD).



Agitated-saline bubble study (schematic): microbubbles opacify the right atrium; a stream crossing the interatrial septal defect into the left atrium within 3 to 5 beats confirms a right-to-left shunt (PFO/ASD).

Common Trap

A bubble study is prepared, but the room phone rings and the injection happens about ten minutes after the saline was agitated. The study is read as "no shunt." **What is the error?**

Agitated-saline microbubbles decay quickly; the contrast must be injected within about 5 minutes of preparation. A stale, under-bubbled injection produces a false negative for shunt. Re-agitate fresh contrast and repeat before concluding there is no PFO.

Universal Precautions and Infection Control

Hand hygiene before and after every patient is the single highest-impact infection-control step. ★ Wear gloves for all patient contact (nitrile or latex-free if allergy), add a gown for splash risk, and a mask for respiratory precautions. Use **single-use coupling gel packets** only; bulk gel bottles are a known reservoir for contamination. Dispose of IV needles in an approved sharps container and contaminated materials in biohazard bags.

Probe disinfection is the most tested item in this section. The required level depends on what the probe touched, not on how dirty it looks.

TABLE W5-B: Probe disinfection levels (ASE / AIUM standard)

Level	What it touched	Method	Time	Probes
Non-critical	Intact skin only	70% alcohol wipe or hospital disinfectant	1 to 2 min	Standard TTE
Semi-critical	Mucosa (oral, esophageal)	High-level disinfection: Tristel wipes or Trophon bath	Tristel $\approx$ 1 min/side; Trophon 5 to 10 min	TEE, esophageal
Critical	Sterile field or high infection risk	Steam autoclave if compatible, else HLD + sterile cover	Per manufacturer cycle	Intraoperative

Sonographer responsibility: document the time the probe went to disinfection and returned, and never use a TEE probe until the disinfection log is complete. That log is a legal and patient-safety record, not a formality.

Common Trap

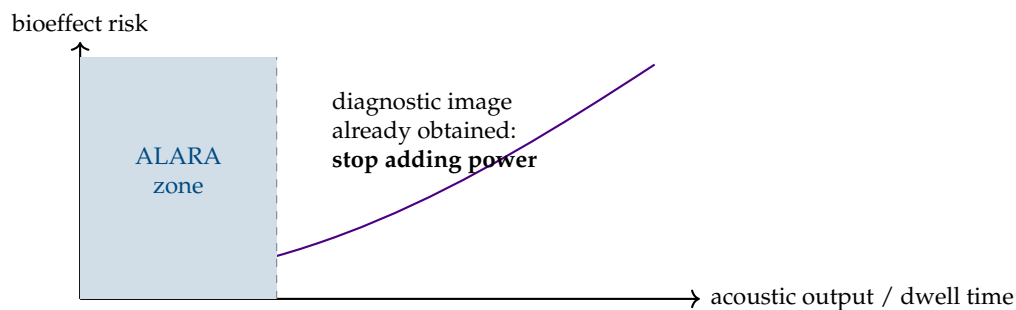
A TEE probe is wiped down with a 70% alcohol pad between two patients and returned to service. **What is the error?**

A TEE probe contacts esophageal mucosa, so it is **semi-critical** and requires **high-level disinfection** (Tristel wipe kit or a Trophon enzymatic bath of 5 to 10 min), not a surface alcohol wipe. An alcohol wipe is adequate only for a non-critical TTE probe that touched intact skin.

Ultrasound Safety: ALARA Principle & Bioeffects

ALARA (As Low As Reasonably Achievable) means use the lowest acoustic output and shortest exposure that still answers the clinical question. Bioeffects are either **thermal** (tissue heating from absorption) or **mechanical** (cavitation and acoustic streaming).

- **Thermal index (TI):** estimates tissue temperature rise. Keep $TI < 0.4$ in early-trimester obstetrics. ★ There is **no thermal limit for cardiac imaging** because the heart is not a developing fetus.
- **Mechanical index (MI):** estimates cavitation likelihood. Avoid $MI > 1.9$ in obstetrics. Again, **no strict cardiac limit**.
- In cardiac scanning, honor ALARA by minimizing total exam time, avoiding prolonged color Doppler dwell on one region, and using continuous-wave and harmonic imaging only when the diagnostic question requires the added power.



Risk rises with output and dwell time. ALARA means staying in the left zone once the image is diagnostic.

Common Trap

A registry item asks for the maximum allowable thermal index during an adult transthoracic echo. A student answers "0.4." **What is the error?**

The $TI < 0.4$ ceiling is an **early-obstetric** guideline. Adult cardiac imaging has **no fixed TI or MI limit**; the governing principle is ALARA, meaning use the lowest output and shortest time consistent with a diagnostic study. The trap rewards a memorized number over the underlying principle.

Machine and Probe Care

- **Daily:** wipe the transducer face with a lint-free cloth between patients; inspect for cracks.
- **Weekly:** deep-clean coupling wells; check the probe body and cable for damage.
- **Cables:** coil loosely, never kink; protect connector pins with dust caps when stored.
- **Storage:** room temperature, ventilated (not sealed in a humid case), away from heat, cold, and vibration.
- **Lifespan:** transducers typically last about 5 to 7 years before replacement, manufacturer dependent.

Report Preparation and Documentation

The exam is not complete until it is documented and archived. ★ A final report is signed and available per lab protocol: roughly 1 hour for stat, 24 hours for routine.

Required chart elements (IAC/ASE standard).

- Patient demographics (name, DOB, MRN, date of exam) and the indication for the study.
- Interpretation by the reading physician (cardiologist or radiologist), with measurements (chamber sizes, wall thickness, EF, gradients, valve areas, PASP).
- Qualitative assessment (wall motion, valve morphology, pericardium, aorta) and an impression with recommendation and follow-up timing.
- Comparison to the prior study when available.

Archival and quality metrics. DICOM images are stored in PACS for **7 to 10 years** per federal regulation (HIPAA, CMS). Optimal 2D needs a frame rate **above 30 Hz**; each study is rated optimal, adequate, or suboptimal for image quality.

Critical Findings Communication

A **critical finding** requires immediate physician notification rather than routine report release. ★ The sonographer's scope is to relay the finding to the reading physician first; the sonographer does **not** diagnose or counsel the patient directly.

Common Trap

During a TTE the sonographer sees a large circumferential pericardial effusion with right-ventricular diastolic collapse. The patient asks "Is something wrong?" and the sonographer explains that it looks like tamponade and that a drain will probably be needed. **What is the error?**

Two errors. First, this is tamponade physiology, a critical finding that must be escalated to the reading cardiologist *immediately*, not held for the routine report. Second, the sonographer overstepped scope by diagnosing and counseling the patient. The correct action is to notify the physician at once, document the time and the name of the person notified, and let the physician communicate with the patient.

TABLE W5-C: Critical findings requiring immediate notification

Finding	Echo clue	Why critical
Tamponade	RV diastolic + RA systolic collapse, IVC plethora, large effusion	Hemodynamic collapse; urgent pericardiocentesis
Acute aortic dissection	Intimal flap, true vs false lumen (often TEE)	Life-threatening; urgent surgery
Endocarditis with complication	Paravalvular abscess, fistula, new severe regurgitation	Sepsis, shock, septic emboli
LV thrombus post-MI	Mobile apical mass with akinetic apex	Imminent stroke risk
Newly severe AS	Peak > 4 m/s, AVA < 1.0 cm ² , mean > 40 mmHg	Syncope, sudden death risk
PE with RV strain	RV/LV > 1.0, McConnell sign, D-sign	Acute RV failure

Memory hook: the critical six spell **TADPLE-PE**: Tamponade, Aortic Dissection, endocarditis with Paravalvular abscess, LV thrombus, severe AS (Ejection obstruction), and PE with RV strain. If you see one, you pick up the phone before you finish the worksheet.

Communication protocol. Notify the reading cardiologist immediately (phone, secure message, or stat alert); give the key measurement and the imaging location (view, frame); document the time and the name of the person notified. The physician may then order a stat TEE, CT, or cath-lab evaluation.

Figure pending: large pericardial effusion with right-heart chamber collapse, the echo signature of tamponade physiology.

Indications: TTE versus TEE

★ A high-frequency registry pattern is matching the clinical question to the right modality. TTE is the first-line, noninvasive workhorse; TEE is reserved for questions TTE cannot answer well because of shadowing, distance, or the need for fine detail.

Clinical question	First choice	Why
EF, chamber size, wall motion	TTE	Noninvasive, full chamber assessment
Murmur, native valve grading	TTE	Adequate windows in most adults
Suspected endocarditis, TTE negative	TEE	Far more sensitive for small vegetations, abscess
Prosthetic valve dysfunction	TEE	Prosthesis shadows the structure behind it on TTE
Source of embolism (LAA thrombus, PFO)	TEE	LAA and atrial septum seen far better
Aortic dissection (descending thoracic)	TEE	Descending aorta is close to the esophagus
Intraoperative valve repair monitoring	TEE	Probe stays in place during surgery

TEE contraindications. Relative: esophageal varices, cervical spine instability, recent upper-GI surgery. ★ Absolute: **active upper-GI bleed.**

Common Trap

A patient with atrial fibrillation needs the left atrial appendage cleared of thrombus before cardioversion. The team orders a transthoracic echo. **What is the error?**

The left atrial appendage is poorly seen on TTE; TEE is the test of choice for LAA thrombus before cardioversion. Ordering a TTE for this question risks a false-negative clearance and a thromboembolic stroke at cardioversion.

Stress Echocardiography Basics

The purpose is to provoke ischemia (by exercise or pharmacology) so that latent regional wall-motion abnormalities appear. ★ **Exercise** (supine or upright bicycle) is preferred when the patient can do it because it is more physiologic; **pharmacologic** stress (dobutamine 5 to 40 mcg/kg/min, or adenosine 140 mcg/kg/min) is used when the patient cannot exercise.

Stop the test for any of these endpoints.

- Severe symptoms (chest pain, dyspnea).
- Ischemic ST-segment depression greater than 2 mm (horizontal or downsloping).
- Hypotension (systolic < 90 mmHg with symptoms).
- New wall-motion abnormality.
- Significant arrhythmia.

Memory hook: the five stop signs are the **five S's**: Symptoms, ST-change, Systolic-drop, Segment (new wall motion), and Squiggle (arrhythmia). Any one of them ends the study.

Contraindications: acute MI (less than 2 days), unstable angina, severe symptomatic AS, uncontrolled severe hypertension, acute PE. The sonographer optimizes the baseline images, holds image quality through the motion of stress, recognizes the stop endpoints, and communicates with the stress team.

Quality Assurance in Echocardiography

QA is how a lab proves its studies are trustworthy. ★ Two test-performance terms are registry staples: **sensitivity** (the proportion of diseased patients the test catches; few false negatives) and **specificity** (the proportion of healthy patients the test correctly clears; few false positives).

Internal consistency checks. A good study is internally coherent: LVOT stroke volume should roughly match mitral-inflow stroke volume (within about 10%); a severe MR should come with a dilated LA and LV; severe AS should come with LV thickening and a normal or small cavity. If the numbers and the morphology disagree, remeasure.

Accreditation. IAC accreditation requires credentialed sonographers, physician interpretation standards, ongoing continuing education, and equipment-maintenance logs. Image quality is graded optimal (all windows clear), adequate (some limitation but diagnostic), or suboptimal (major limitation, reduced confidence).

Registry Connection

A highly **sensitive** screening test rules disease **out** when negative ("SnNout"); a highly **specific** test rules disease **in** when positive ("SpPin"). Echo for endocarditis is sensitive on TEE; a negative TEE makes endocarditis unlikely.

Essential Formulas

W5 is process-heavy and formula-light: the quantitative work lives in Weeks 4 and 7. One formula resurfaces here because it turns a measurement into a *critical finding*.

RV systolic pressure from the TR jet: $RVSP = 4V_{TR}^2 + RAP$

Plain English: square the tricuspid-regurgitation jet velocity, multiply by four (simplified Bernoulli), and add the estimated right atrial pressure read from IVC size and collapse. **Why it matters here:** a newly elevated PASP above 35 to 40 mmHg with RV strain is one of the critical findings you escalate immediately, so you must be able to produce this number at the machine and recognize when it crosses into "call the physician" territory.

Test performance (QA): Sensitivity = $\frac{TP}{TP + FN}$ and Specificity = $\frac{TN}{TN + FP}$

Plain English: sensitivity is how many truly sick patients the test flags; specificity is how many truly well patients it clears. **Why it matters:** these define whether an echo finding can be trusted to rule a disease in or out, the language of every QA and accreditation discussion.

Workflow Cheat Sheet: Prep by Study Type

Study	Fasting	IV access	Monitoring	Disinfection
Diagnostic TTE	None	If contrast	Standard	Non-critical (alcohol wipe)
Contrast (bubble)	None	Yes, 18-gauge	Pulse ox	Non-critical
Stress echo	4 to 6 hr	Yes	ECG + BP q1 to 5 min	Non-critical
TEE	NPO; clears to 2 hr	Yes (sedation)	Continuous ECG, pulse ox	Semi-critical (HLD)
Intraoperative	Per anesthesia	Per anesthesia	Continuous	Critical (sterile)

Glossary

- **IAC** — Intersocietal Accreditation Commission; sets echo lab standards
- **ALARA** — As Low As Reasonably Achievable; ultrasound safety principle
- **TI** — thermal index; estimated tissue temperature rise
- **MI** — mechanical index; likelihood of cavitation
- **Bioeffects** — tissue effects of ultrasound (thermal or mechanical)
- **HLD** — high-level disinfection (kills all but bacterial spores)
- **Tristel** — pre-packaged HLD wipe kit; about 1 min per side
- **Trophon** — automated enzymatic disinfection bath; 5 to 10 min
- **Coupling gel** — single-use acoustic medium between probe and skin
- **PPE** — personal protective equipment (gloves, gown, mask)
- **Stat** — immediate priority (about 1 to 2 hr turnaround)
- **PACS** — Picture Archiving and Communication System (image archive)
- **DICOM** — medical imaging file/interchange standard
- **Agitated saline** — bubble contrast for right-to-left shunt detection
- **Indication** — clinical reason an echo was ordered
- **Appropriateness criteria** — guidelines justifying a study
- **Prior-study comparison** — baseline imaging used to track change
- **Image quality score** — optimal / adequate / suboptimal rating
- **Sensitivity** — true positives among all diseased ($TP/(TP+FN)$)
- **Specificity** — true negatives among all healthy ($TN/(TN+FP)$)
- **TEE** — transesophageal echocardiography
- **RVSP** — RV systolic pressure ($4V_{TR}^2 + RAP$)

Registry Connection

This week feeds the ARDMS RDCS **Clinical Care & Safety** subdomain (patient prep, ALARA/bioeffects, infection control, documentation) and the CCI RCS **Domain A** (patient care, communication, lab operations) plus **Domain E** (quality assurance). Expect **single-best-answer** items: pick the right disinfection level for a probe, choose TTE versus TEE for a clinical question, identify which finding must be escalated immediately, and state the ALARA principle (no fixed cardiac TI/MI limit). A few items pair with calculation (RVSP from a TR jet) but most reward clean procedural reasoning. **Carry forward into Week 6:** the prep, safety, and escalation framework here is the clinical wrapper around the cardiomyopathy, pulmonary hypertension, and arrhythmia pathology you grade next.

Study smart. Scan with confidence.

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