Rancho Los Amigos National Rehabilitation Center

CARDIOLOGY SERVICE POLICY AND PROCEDURE

SUBJECT: TRANSTHORACIC ECHOCARDIOGRAM (TTE)

Policy No.: Cardiology 3
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PURPOSE:

I. To outline the process for performing a Transthoracic Echocardiogram (TTE).

POLICY:

I. TTE is performed by a sonographer who has passed the Los Angeles County Department of Health Services echocardiography competency exam.

PROCEDURE

II. Getting Started:

A. Check for previous studies per and review key elements
B. Optimize instrument settings prior to starting study
C. Verify indication for exam
D. Review order and understand physician's request

III. Procedure Preparation:

A. Review the order for type of study to be performed. A verbal order may be used for stat echocardiography and an order will be will be posted in the electronic medical record (Orchid) as soon as possible.
B. Enter patient information into ultrasound system (from Orchid work list or manually)
C. Enter demographics, heights, weight, BP, sonographers' name, all other information as needed.

IV. Patient Preparation:

A. Explain procedure to patients
B. Verify patient ID
C. Instruct patient to lie on left side
D. Apply electrodes and attach lead

V. Digital Capture

A. Make sure that you have adequate ECG signal
B. Patients in sinus rhythm 2 beat captures are used

C. Patient in A Fib or any irregular rhythm 3-5 beat captures should be used as needed
D. When capturing a bubble contrast study use 5-10 second loops.

If images are suboptimal (greater than or equal to two adjacent segments in an apical view) and primary question is LV function and wall motion, consider use of a transpulmonic agent (echo contrast) after discussion with Cardiology Fellow or Attending.

Basic Exam (note: in general obtain a 2 D image of the view first, followed by color / spectral Doppler in order to provide anatomic orientation). In general, spectral Doppler and M-mode should be captured at a sweep speed of 50 mm/s speed. Use 25-50 mm/s speed to demonstrate respirophasic changes that require documentation of changes across several cardiac cycles and 100 mm/s speed when making timing measurements.

Optimization of Doppler signals. Doppler display occupies about 2/3 of scale for each velocity.
Pay particular attention to:

- Narrow aiming sector to optimize color and frame rate
- If 2D imaging is poor (esp. in apical views) or two or more LV segments are unable to be assessed, contrast may be considered to enhance the image.
- Proper setting of the scale, gain, filter, compress and reject with CW & PW Doppler
- Look at extracardiac structures
- Use off-axis images when necessary

IMAGING PROTOCOL

I. Parasternal Long-Axis View

A. Rule out the effusions and examine extracardiac structure by increasing depth, then reduce depth to assess cardiac structures. Digitally capture 2D view without color Doppler for routine dimensional measurements. Zoom of aortic and mitral valve. The measurements include wall thickness and chamber dimension.
B. Measurement of dimensions of the Ventricular Septal Thickness, Left Ventricular End-Diastolic Dimension and Posterior Wall Thickness in end-diastole at the level of the mitral valve chordae.
C. Measurement of Left Ventricular end-systolic dimension in the end systole at the level of the mitral valve chordate.
D. Measure Ascending Aorta (routinely measured by 2D at level of the sinus). The additional measurements of the diameters of aortic annulus, sino-tubular junction and mid ascending aorta are needed when abnormal aorta is suspected. A separate ascending aorta image may be required.
E. Measure the Left Atrial Dimension in the end-systole.
F. Perform Color flow Doppler of AV/MV/Ventricular septum (require separate captures). Aortic and mitral valves with zoom and color Doppler as needed.
G. A Right Ventricular Outflow view may be obtained as clinically needed (congenital heart disease)

II. RV inflow view

A. Capture 2D image first
B. Perform Color flow Doppler of Tricuspid Valve for Tricuspid Regurgitation.
C. Measure Peak Tricuspid Regurgitant Velocity for calculation of RA/RV pressure gradient

III. Parasternal Short-Axis View

A. Capture at level of Aortic Valve (imaging AV, TV, PV and Left Atrium), examine Aortic, Pulmonic and Tricuspid Valve Leaflet Structures with 2D, PW, CW and color Doppler
B. Aortic valve level:
    1. 2D image first
    2. Aortic valve with zoom and color Doppler
    3. Pulmonic valve and pulmonary artery with color Doppler
    4. Pulsed and CW Doppler across the pulmonic valve
    5. Perform CW Doppler to obtain tricuspid regurgitant velocity to calculate Pulmonary Artery Systolic Pressure if Tricuspid Regurgitation is present

IV. Left ventricle (2D):

A. Capture 2D LV at basal, middle (papillary muscle) and apex levels
B. LV at the MV leaflet level with zoom and color Doppler in the presence of mitral valve disease as needed

V. Apical 4-Chamber View

A. Capture 2 D image (without color Doppler) to examine the structure and wall motion; avoid foreshortening of the left ventricle. Using a narrow 2D sector and /or zoom to improve image quality to assess LV wall motion and thrombus. Adjust depth, focal point, probe setting (frequency) and gains to optimize images
B. Color Flow Doppler of Mitral Valve, Tricuspid Valve and Aortic Valve
C. Perform Pulsed Doppler of the Mitral Valve with the sample Volume at the leaflet tips, measure E/A waves velocities
D. Perform tissue Doppler of lateral and septal mitral annulus to measure E', for E/E' ratio as needed
E. Perform Color M-mode Doppler as needed
F. Perform CW of Mitral Valve, Tricuspid Valve
G. Left Ventricular volumes are measured in diastole and systole to obtain an ejection fraction. During tracing, pay particular attention to: apical foreshortening; including (not excluding) papillary muscle in tracing; apical alignment; mitral annulus. If calculated EF is significantly discordant with visual estimate, review, acquire and measure additional cardiac cycles.
H. Each of the above measurements will be frozen and then acquired.
I. Measurement of Left and Right atrium area as needed
J. PW Doppler of pulmonary veins (sample volume 3-4 mm) as needed.

VI. Apical 5-Chamber View

A. Aortic valve with color, LVOT, PW and CW Doppler, pay attention to the position of PW sample volume.

VII. Apical 2-Chamber View

A. Perform 2 D image, take care not to foreshorten the image
B. LV wall assessment, optimization using appreciate depth, 2D sector and zoom function
C. Mitral valve with color Doppler
D. Left atrial area and volumes as needed

VIII. Apical 3-chamber view (apical long-axis view)

A. Perform 2 D image, take care not to foreshorten the image

B. Color flow Doppler of the Mitral Valve and the Aortic Valve
C. Perform PW/CW of LVOT /Aortic Valve (in presence or suspicious of aortic stenosis or calcification or LVOT obstruction. Pay attention to the position of PW sample volume.

IX. Subcostal View

A. Perform 2 D image
B. Perform Color flow Doppler of the Mitral and Tricuspid Valve and Interatrial and Interventricular Septa to look for shunt
C. Perform CW for the Tricuspid Regurgitant velocity to calculate pressure gradient as needed
D. Rotate transducer to bring in The Inferior Vena Cava and observe for collapse (For capture set for 3–5 second to appropriately capture. Be sure to include inspiration / expiration and "sniff" if needed)
E. Color flow of Hepatic Vein/Inferior Vena Cava
F. Perform Pulsed Doppler of the Hepatic Vein / the Inferior Vena Cava flow
G. Perform 2D subcostal short-axis view as needed (if parasternal view is not optimal)

X. Suprasternal View

A. Perform 2D image of Aortic arch upper descending aorta as needed
B. PW & CW Doppler as needed

XI. Right Parasternal View

A. Perform 2D image of the Ascending aorta as needed, especially if aortic dissection & aneurysm are suspected
B. Perform CW Doppler as needed for aortic stenosis

Additional off-axis 2D image/color Doppler imaging may be performed as needed to supplement standard views (eccentric mitral regurgitation, congenital heart disease, etc.)

SPECIAL CONDITIONS

I. Aortic Stenosis or Suspected Aortic Stenosis

A. Measure LVOT at the parasternal long-axis view
B. "Zoom" on LVOT; adjust focal point and gain, to optimize measurement of LVOT diameter.
C. In the apical 5-chamber view, obtain PW aortic outflow with appropriate position of PW sample volume, trace the best wave form.
D. In the apical 5-chamber view, obtain CW of aortic outflow
E. In the apical long-axis view, perform PW and CW of aortic flow.
F. Dedicated non-imaging CW Doppler in multiple locations, at the Apex, Suprasternal Notch and Right Parasternal Border (reposition patient onto right side position may be required) to obtain maximal velocity.
G. Trace the best Doppler wave form for calculation of aortic valve area using Continuity Equation
H. Pay attention to the size of LVOT, PW LVOT flow, ascending aorta and arch.
I. Obtain zoom and optimized view of the valve in the parasternal short axis view

II. Aortic Regurgitation

A. Pay attention to the morphology and mechanism of the aortic regurgitation (e.g. bicuspid, flail, prolapse) including jet direction and origins

B. Pay attention to the size of the annulus, ascending aorta, arch and co-existing AS assessment
C. Measure deceleration slope on continuous wave (CW) Doppler of AI from apical 4 or 3 chamber views as needed.
D. Imaging Suprasternal Notch (SSN) and perform pulsed Doppler of Descending Aorta Flow distal to the Subclavian Artery to check for Diastolic Flow Reversal as needed

III. Prosthetic Aortic Valve

A. Type and size of prosthesis (from consult, note or patient card) should be entered into report if information available.
B. Peak and mean gradients and CW velocities (from apical 5 chamber or apical long axis views right sternal or suprasternal notch flow.) Average 3 the best beats for patient in A Fib as needed.

IV. Assessment of Degree of aortic regurgitation

A. Review prior report and / or images; if gradients / regurgitation are significantly different, review to reconcile if there has been a true change.

V. Pulmonic Stenosis

A. Perform Pulse Doppler of the Pulmonic Flow in Parasternal Short Axis and RVOT
B. Use CW Doppler (Pedoff) at Left Parasternal Border
C. Calculate pressure gradient by tracing CW.

VI. Pulmonic Insufficiency

A. If trivial, demonstrate with color Flow Doppler. If there is significant PI, use CW to obtain gradient/deceleration slope.

VII. Mitral Stenosis

A. Pay attention to the morphology including subvalvular apparatus.
B. Trace CW of Mitral Valve Inflow for mean and peak pressure gradients (average of three beats with A Fib).
C. Obtain deceleration slope of mitral CW at 100 mm/sec for measurement of pressure Half-time).
D. In short axis, obtain optimized view at leaflet tips and trace mitral orifice for valve area (native valve only) if possible

VIII. Mitral Regurgitation (more that mild)

A. Pay attention to the mechanisms of MR (chordal rupture; flail leaflet; myxomatous degeneration; papillary muscle infarct; chordal thickening/rheumatic changes) including the origin & jet direction
B. Demonstrate presence of Mitral Regurgitation with color Doppler, search for maximal color mapping of regurgitation if eccentric mitral regurgitation is present in multiple views including off-axis view. If mitral regurgitation is more than moderate, consider calculation of ERO by PISA method as needed.
C. “Zoom” of the Mitral Valve
D. Baseline shift of color Doppler to reduce aliasing velocity to approximately 30-40 cm / sec)
E. Measure aliasing radius from first blue / red aliasing interface to regurgitant orifice (PISA shell) in the frozen color Doppler image
F. Obtain peak Mitral Regurgitant Velocity from CW of mitral regurgitation
G. Pulmonary venous flow obtained if possible with emphasis on systolic flow component

IX. Prosthetic Mitral Valves

A. Type and size of prosthesis (from chart, op note or patient card)
B. Peak and mean gradient by CW
C. Calculation of MV area by Continuity Equation
D. Search for MR in multiple view

X. Tricuspid Regurgitation

A. Pay attention to the morphology and mechanism of TR (RV dilatation, prolapse, flail, etc.) including jet direction
B. Show presence of Tricuspid Regurgitation with color flow
C. Obtain regurgitant velocity with CW or CW with image color flow
D. If severe regurgitation, obtain pulse wave Doppler of the hepatic vein in the Subcostal View for Systolic Flow Reversal

XI. Pulmonary Systolic Artery Pressure Calculation

A. Measure Tricuspid regurgitation velocity using imaging CW (RV inflow, parasternal short-axis, A4C and Subcostal) and Pedoff probes from apical window as needed. Use highest velocity obtained to estimate RV-RA gradient, using the modified Bernoulli equation.
B. If IVC is normal and collapses add 5 mm Hg to the above equation
C. If IVC is dilated and partially collapses (less than ½), add 10 mm Hg to the above equation
D. If IVC is dilated and doesn't collapse add 15 mm Hg to the above equation

XII. Pericardial Effusion

A. Look for RV collapse and RA collapse using 2D mode and M-mode in multiple views (parasternal, apical and subcostal views
B. M-mode through RV at mitral valve level in short axis- run at 100 cm/min speed
C. M-mode RV in the Parasternal Long Axis as needed
D. Pulse mitral inflow at 25-50 mm/min speed to look for changes with inspiration and expiration
E. Perform 2D and Pulsed Doppler of the Hepatic Vein / the Inferior Vena Cava flow. Dilation of hepatic venous flow indicates increase in RA pressure.

XIII. Hypertrophic Cardiomyopathy

A. Pay attention to LV thickness including maximal septal thickness, SAM and eccentric mitral regurgitation caused by SAM.
B. Pulse along the LVOT to show acceleration (dagger shape) to elicit location of pressure gradient if possible (sample volume should be placed at the site of obstruction, view frozen and image acquired at each level of LV to actually show the exact site of the obstruction
C. Perform CW Doppler to obtain maximal intraventricular / LVOT pressure gradient
D. Localization of the LVOT gradient using PW, distinguish from intra-cavitary gradients
E. Spectral Doppler is performed in apical 4-, 5 and 3 chamber view to obtain the best image.
F. If LVOT velocity is > 3cm/sec, ask physician regarding provocative test- amyl nictrateas needed. ; Valsalva maneuver acceptable if patient can perform adequately.

XIV. Diastolic function

A. Obtain mitral pulsed Doppler inflow, pay attention to wave forms with good quality (easily see E and A wave)

XV. M-mode color Doppler of mitral inflow

A. Obtain tissue Doppler lateral and septal mitral annulus flow with the best quality possible
B. Measurement of E, A, deceleration time, E'

XVI. Constrictive pericarditis

A. Use of 2D and M-mode to assess abnormal septal motion in multiple views
B. Obtain mitral and tricuspid inflow with respirameter, pay attention to wave forms with good quality (easily see E and A wave if possible)
C. Obtain tissue Doppler lateral and septal mitral annulus flow
D. 2D image of inferior vena cava
E. Doppler of hepatic venous flow with respirameter

XVII. Aortic Aneurysm Assessment

A. Measure the aorta at the following levels and carefully look for intimal flap

1. Aortic Annulus
2. Sinus of valsalva
3. Sino-tubular junction
4. Mid Ascending (at level of right Pulmonary artery)
5. Arch
6. Upper descending

XVIII. Special procedure

A. Saline contrast will be used in following conditions:

1. Order by physicians
2. Stroke or TIA with age of <55 years-old.
3. Unknown reason of dilation of RV and RA
4. Request for assessment of pulmonary hypertension by physician, unable to obtain satisfactory TR after the best effort in multiple views
5. Visible defect in atrial septum suspicious for ASD, or known or suspected congenital disease that includes shunt abnormalities

B. Definity Contrast

1. Contraindications to Definity:
2. Right-to-left, bidirectional, or transient right-to-left cardiac shunts (excluding PFOs)

   a. Hypersensitivity to perflutren
   b. Hypersensitivity to blood, blood products, or albumin (in the case of Optison only)

3. When to use Definity (adopted from the American Society of Echocardiography (ASE) and Intersocietal Accreditation Commission of Echocardiography (IACEL)):

4. Poor endocardial border definition (defined as the inability to detect **two or more contiguous segments** in any three of the apical windows) for quantification of chamber dimensions, volumes, ejection fraction and assessment of regional wall motion.

5. When left ventricular thrombus is suspected.

6. To assess conditions such as apical hypertrophic cardiomyopathy (or to better assess septal thickness in the setting of asymmetric septal hypertrophy).

7. Should be considered in studies that are technically difficult.

8. May be used in conjunction with treadmill, bicycle, arm crank or pharmacological stress testing to optimize endocardial border definition or enhance Doppler signals.

9. For improving the evaluation of regional right ventricular wall motion. (See IV,H)

10. For improving Doppler image quality, especially the tricuspid regurgitant jet that is used to estimate pulmonary artery systolic pressure. (See IV,I).

11. How to give Definity:

12. If a bolus is to be used, it is recommended to give it as a 0.5mL dose of a dilution of Definity (which is: one vial of Definity diluted in 8.5 mL of saline in a 10-12cc syringe).

13. Key components for optimizing contrast (for echo technicians):
14. Very low mechanical index <0.2

15. Place the focus at the level of the mitral annulus

16. Visually determine whether the Definity administration is optimal by assessing the homogeneity of LV cavity opacification from the apex to the mitral annular plane in the apical views

17. Gain and compression settings should be adjusted to reduce background signals coming from myocardium or blood

18. Minimize shadowing or attenuation by lowering the infusion rate or reducing the size of the bolus injection and flush rate

19. Attenuation observed with a bolus injection will resolve with time, so image acquisition should be delayed until the attenuation disappears. Once the attenuation is minimized, and apical swirling is not present, the sonographer can begin acquisition.

20. Begin acquisition in the apical four-chamber, two-chamber, and long-axis views.

21. For evaluation of the right ventricular (RV) wall motion, contrast media must be given at lower infusion rates so as not to cause RV shadowing.

22. For improving Doppler image quality, such as CW of tricuspid valve to evaluate TR, the Doppler gain settings should be lowered for this application, to reduce background noise.

23. Adverse Reactions:

24. Anaphylactic or other allergic reactions are rare. With respect to anaphylaxis, respiratory distress due to bronchospasm is the most serious concern. Other reactions include shock (hypotension).

    1. If anaphylaxis→call rapid response team or code team

25. Allergic reactions can include: back pain (most common), urticarial, facial or laryngeal edema, seizures, and convulsions.

    1. If back pain occurs during Definity administration, discontinue injection and monitor vital signs. No further treatment is needed, and in most cases the pain resolves spontaneously within a few minutes. If contrast is needed again in patients who have experienced back pain with Definity, an alternative contrast agent such as Optison should be used.

    2. If allergic reaction→stop injecting and monitor patient's vital signs for 30 minutes.

XIX. Completion of Study

A. The TTE images will be uploaded to the electronic medical record by the echocardiography technician. The cardiologist will enter the findings into the electronic medical record.

B. See Policy and Procedures for reporting any potential life-threatening/critical abnormalities. Also notify the reading physician, do not allow patient to leave the lab.

C. If there is any questions about image quality, special views or procedures needed to answer all clinical questions, notify the reading physician before a patient leaves the lab.

D. Disconnect the patient and remove gel with wash cloth. Wipe the probe with a disposable disinfectant cloth to disinfect

E. Place linen in laundry bag and change linens

REFRENCES:

1. **INTERSOCIETAL ACCREDITATION COMMISSION ECHOCARDIOGRAPHY, www.intersocietal.org**