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| Clinical Guideline for:  **Contrast agent preparation & administration in Echocardiography** |

**SUMMARY**

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| This guideline outlines the process of preparation and administration of ultrasonic contrast agents used in Echocardiography, both in transthoracic (TTE) & transoesophageal (TOE) procedures. Independent practice with these agents should only be performed by staff that have completed the TTE competency and undergone a period of supervised practice. |

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# 1. INTRODUCTION & PURPOSE

* 1. This clinical guideline is applicable to staff that have achieved competency in the preparation and administration of contrast agents used in Echocardiography in the Cardiology department at the Royal Devon and Exeter NHS Foundation Trust (hereafter referred as the Trust).
  2. Echocardiography can give valuable clinical information and is a widely requested test, but in the wrong setting, may be inaccurate or delay appropriate patient care or discharge.
  3. The use of agitated saline and transpulmonary contrast (SonoVue) in Echocardiography may be used to obtain further diagnostic data or to optimise a suboptimal study. Their indications & contraindications are different and will be listed further on this document.
  4. The purposes of this guidance are to standardise the preparation and administration of contrast agents in Echocardiography and to maximise the efficiency of the Echocardiography service.

# 2. BACKGROUND

2.1 The patent foramen ovale (PFO) is an important component of the foetal circulation as it allows oxygenated blood to pass from the right atrium (RA) to the left atrium (LA), ensuring that blood rich in oxygen reaches the foetal brain. At birth, the aeration of neonatal lungs causes a drop in pulmonary vascular resistance, causing the RA pressure to drop below the LA pressure, closing the foramen ovale. Any temporary increase in RA pressure above the LA will result in right-to-left shunt. Permanent closure of the foramen ovale typically happens at 2 years of age. In approximately 25% of the population, this does not occur.

2.2 The patency of this communication has been linked with several conditions such as cryptogenic stroke, transient ischemic attack (TIA), migraine, platypnoea-orthodeoxia syndrome and decompression sickness in scuba divers.

2.3 The larger defect of an atrial septal defect (ASD) is amongst the most common acyanotic congenital cardiac lesions, occurring in 0.1% of births and accounting for 30%-40% of clinically important shunts in adults.

2.4 The detection of PFO or ASD by transthoracic echocardiography is greatly improved by using agitated saline contrast injection. Intravenous (IV) administration of agitated saline enhances backscatter of the ultrasound waves, highlighting venous blood flow. As the bubbles created are too large to cross the pulmonary circulation, visualisation of contrast in the left heart suggests either intracardiac or transpulmonary shunting.

2.5 The use of provocative manoeuvres such as Valsalva, sniff or cough transiently increase the RA pressure above the LA, further enhancing the sensitivity of this procedure for the detection of atrial shunts.

2.6 Despite the advantages of using agitated saline to improve shunt detection, transoesophageal echocardiography is still the gold standard for atrial septal anatomy assessment.

2.6 A significant number of echocardiographic studies at rest have suboptimal endocardial border definition. This is defined as the inability to visualise two or more contiguous segments in any three of the apical windows when assessing the left ventricle (LV). This can be facilitated by using transpulmonary contrast agents such as Sonovue.

2.7 Other clinical applications of agitated saline contrast may be the enhancement of Doppler signals in tricuspid regurgitation for estimation of pulmonary artery systolic pressures, and also the improvement of left sided valve Dopplers, such as aortic and mitral flows for a more accurate assessment of the severity of valve disease.

# 3. DEFINITIONS

* Patent Foramen Ovale (PFO)
* Atrial Septal Defect (ASD)
* Transthoracic Echocardiography (TTE)
* Inferior/Superior Vena Cava (IVC/SVC)
* Coronary sinus (CS)
* Ultrasound (US)

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# 4. DUTIES AND RESPONSABILITIES OF STAFF

**4.1 Role of the Medical/Clinical Head of Echocardiography & Lead Echocardiographer**

Ensuring this guideline is followed by all Echocardiographers competent to perform echocardiography with ultrasonic contrast agents.

**4.2 Role of staff who practice Echocardiography and are signed-off to prepare and administer contrast agents**

Perform these studies in accordance with the procedure described in this guideline, always ensuring appropriateness and patient safety.

# 5. CONTRAST AGENTS IN ECHOCARDIOGRAPHY

## 5.1 Agitated Saline Contrast Echocardiogram

### 5.1.1 Definition

Agitating saline with a small volume of air creates macrobubbles, which are too large to pass through the pulmonary circulation. Intravenous injection of agitated saline therefore only opacifies the RA and right ventricle (RV), unless there is some type of right to left shunt allowing bubbles to pass into the left heart. Agitated Saline contrast echocardiography is therefore used as a method of detecting such shunts.

### 5.1.2 Indications

* Suspected PFO - for example in embolic stroke in young patients without significant risk factors for stroke;
* Suspected hepatopulmonary syndrome;
* Suspected pulmonary arteriovenous malformation - for example in patients with hereditary haemorrhagic telangectasia (Osler-Weber-Rendu syndrome);
* Detection of persistent left sided SVC or unroofed CS (right and left arm injections should be performed in this cases);
* Echocardiography-guided pericardiocentesis.

### 5.1.3 Contra-indications

* Recent paradoxical embolus – as could have ‘thrombus in transit’. Aim for >3 weeks with anticoagulation or antiplatelet agents.
* Potential risk for air micro-embolism.

### 5.1.4 Protocol for the procedure

* Explain the procedure to the patient and obtain verbal consent;
* Obtain IV access or evaluate existing IV line for patency (to be done by competent staff in IV cannulation); US guided IV access may be used:
  + Choose a good forearm or antecubital vein, preferably on the right side if the patient is lying on the left for imaging;
  + The cannula size, preferably, should be at least 20 gauge (pink cannula);
  + When successful IV access is achieved, secure the cannula and check for patency by flushing it with a 10mL syringe with 3-5mls of 0.9% chloride sodium, as per Trust policy;
* Prepare the agitated saline contrast:
  + Obtain 2 sterile *luer-lock* syringes and a 3-way tap;
  + Draw 8.5mLs of 0.9% chloride sodium into one of the syringes with 0.5ml of room air and up to 1mL of the patient’s blood for optimised contrast;
  + Connect both syringes to the 3-way-tap;
  + Vigorously agitate the mixture back and forth between the 2 syringes;
  + When a suitable TTE view is obtained, rapidly inject the mixture through the IV access:
    - Preferable views are foreshortened apical 4-chamber view or subcostal 4-chamber view;
    - Use harmonic imaging to improve sensitivity to shunt detection;
* Image acquisition should begin just before the contrast reaches the RA and continue for at least 10 cycles after contrast appearance in the right heart;
* Perform at least 1 injection at rest, followed by at least 2 others performed with provocative manoeuvres such as coughing or typically the *Valsalva manoeuvre*. Provocative manoeuvres should be released when the contrast reaches the right atrium;
* At the end of the test, the Echocardiographer should report the findings appropriately and state any limitations and/or difficulties to the study. The final report should also contain the site and size of cannula and the name of staff that performed IV cannulation (or checked patency);
* If the contrast administration is made by a Cardiology Registrar or other trained doctor, it should also be included in the report.

### 5.1.5 Criteria for positive shunt & general considerations

* Typical intracardiac shunts (via interatrial or interventricular septum) are usually seen within the first 3 cardiac cycles and up to the 5th cycle after RA opacification;
* Pulmonary arteriovenous shunts are typically seen after the 5th cycle of contrast opacification of the RA. However this may happen sooner in high-output states;
* Saline contrast across a PFO may happen later than 3 beats if there is a delay in coughing or Valsalva manoeuvres;
* Competitive flow from the IVC can result in localised loss of contrast along the RA side of the atrial septum, thereby resulting in a false negative. In these situations, external compression of the liver can be used to reduce IVC flow and help distinguish IVC flow from negative contrast of an atrial septal defect.

## 5.2 Transpulmonary Contrast (Sonovue)

### 5.2.1 Definition

SonoVue is a proprietary contrast agent given intravenously. Unlike saline bubble contrast, Sonovue bubbles are small enough to pass through the pulmonary circulation and therefore do opacify the left heart, improving image quality and outlining left ventricular thrombus if present. The test is associated with a very small risk of anaphylaxis (< 1:10,000).

### 5.2.2 Indications

* To assess LV function in patients with poor echocardiographic windows;
* Quantification of LV volumes, LVEF and RWMAs;
* Suspected LV thrombus (and other intracardiac masses);
* Apical abnormalities in patients with Apical HCM;
* Noncompaction Cardiomyopathy;
* Post-MI complications;
* LA and LAA delineation to distinguish spontaneous contrast vs thrombus in transoesophageal echocardiogram;
* Used routinely during stress echocardiography to enhance definition of the LV myocardium;
* Cardiac perfusion imaging by echocardiography;

### 5.2.3 Contra-indications

* Absolute –
  + Previous sensitivity/anaphylactic reaction to Sonovue;
  + Current and evolving acute coronary syndrome or myocardial infarction
* Relative –
  + Recent acute coronary syndrome
  + NYHA III/IV heart failure
  + Unstable arrhythmia

### 5.2.4 Protocol

* Obtain IV access or assess existing IV line for patency (as per Trust guidance; to be done by competent staff in IV cannulation); US guided IV access may be used;
* Preparation of SonoVue as recommended by vendor in the packaging;
* Adjust the machine settings appropriately (MI 0.3 or lower, depending on the indication for the contrast study);
* Depending on the indication, obtain an adequate view of the chambers and/or structures to be assessed during the test;
* Inject 0.5ml of the 5ml vial, followed by a 5mL flush with 0.9% sodium chloride over 5-10 seconds;
* When assessing the LV, be mindful it takes a few seconds for the complete opacification of the cavity, particularly in low-flow states and so, do not acquire an image until adequate opacification has been achieved;
* At the end of the test, the Echocardiographer should report the findings appropriately and state any limitations and/or difficulties to the study. The final report should also contain the site and size of cannula and the name of staff that performed IV cannulation (or checked patency);
* If the contrast administration is made by a Cardiology Registrar or other trained doctor, it should also be included in the report.

### 5.2.5 Safety & Anaphylactic response

* Anaphylactic response to SonoVue is very rare, but possible (< 1:10,000);
* All staff involved should be aware of how to proceed if anaphylaxis in response to SonoVue happens;
* Cardiopulmonary resuscitation equipment should be available nearby, and all personal trained in resuscitation;
* Anaphylactic kits should be available and expiry dates checked prior to contrast administration;
* Once an allergic reaction is recognised, a Physician should be immediately notified, and vitals should be closely monitored;
* Depending on the severity of the anaphylactic reaction, you may require the MET team or the arrest team to support you (please ring 2222 for this);

# 6. REQUESTING CONTRAST ECHOCARDIOGRAMS

* Use the Trust request requesting system (MyCare/EPIC)
* For IP agitated saline contrast, please note that these studies should only be requested as inpatient if they will change management during that admission;
* If urgent, please discuss directly with the Echo Physiologists (C250 or x3995/2272) and Cardiology Registrar or Consultant (bleep 866 or CCU x 2837).

# 7. MONITORING COMPLIANCE / TRAINING

7.1 In order to monitor compliance with this guideline & maintain standards of care following implementation:

* All staff that have achieved competency to perform contrast studies should undergo an annual appraisal including their whole scope of practice.

7.2 All staff involved in echocardiography and evaluation of contrast imaging:

* Must be at least Band 6 and have co-reported 10 studies of either technique demonstrated using a written log (see annex for example).

7.3 All staff involved in contrast echocardiography, validating contrast study requests, administering contrast agents, evaluating adequacy of imaging and issuing the report:

* Must be accredited with the BSE or equivalent.
* Have undergone appropriate IV cannulation & IV administration training;
* Competency for contrast agent preparation & administration achieved;
* Final sign-off as competent to independently prepare and administer contrast agents from the Medical Lead for Echocardiography.

# 8. ASSOCIATED CLINICAL GUIDELINES OR POLICIES/PROCEDURES

* Clinical Guideline for Requesting inpatient adult echocardiography studies;
* Aseptic Technique;
* Consent to Examination or Treatment Policy;
* Hand Hygiene Policy;
* Infection Control Policy;
* Inoculation Injury Policy;
* Intravenous Therapy Policy;
* Procedure for insertion & removal of PVC;
* Venous Access Device Policy;
* Privacy, Dignity and Compassion.

# 9. REFERENCES

* Clinical Indications for Echocardiography. British Society of Echo (2011);
* Implementation of echocardiographic contrast agents into clinical practice: a United Kingdom National Health Service Survey on behalf of the British Society of Echocardiography (EHJ, 2012);
* Detection of Right-to-Left Atrial Communication Using Agitated Saline Contrast Imaging: Experience with 1162 Patients and Recommendations for Echocardiography (JASE, 2013);
* Guidelines for the Echocardiographic Assessment of Atrial Septal Defect and Patent Foramen Ovale: From the ASE and Society for Cardac Angiography and Interventions (JASE, 2015);
* Guidelines for the Use of Echocardiography in the Evaluation of a Cardiac Source of Embolism (JASE, 2016);
* Guidelines for the Cardiac Sonographer in the Performance of Contrast Echocardiography: Recommendations of the ASE Council on Cardiac Sonography (JASE, 2001) – subsequent updates in 2014 and 2018;
* SCST/AHCS standards of conduct, performance and ethics for Cardiac Physiologists/Scientists

# 10. ANNEXES

Annex 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Study type** | **Date** | **Patient ID** | **Performed & Reported by** | **Supervisor**  **(initials)** |
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