# Guidelines for the Cardiac Sonographer in the Performance of Contrast Echocardiography: A Focused Update from the American Society of Echocardiography

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In 2001, the American Society of Echocardiography (ASE) published a position paper that provided guidelines for the performance of contrast echocardiography by a sonographer.[1] The paper focused on the sonographer's role in four specific areas: understanding of microbubble physics and ultrasound instrumentation, recognition of indications for the use of contrast media, establishment of intravenous (IV) access privileges if necessary, and development of written policies for contrast agent infusion or injection.[1] It is the purpose of this paper to update sonographers on developments in these four areas and to provide useful tips that assist in optimizing the use of contrast media in an echocardiography laboratory. This will include the optimal use of both saline and left-sided contrast media, as well

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**Abbreviations**

**AMI** = Acute myocardial infarction

**ASE** = American Society of Echocardiography

**CP** = Chest pain

**FDA** = US Food and Drug Administration

**IAC** = Intersocietal Accreditation Commission

**IV** = Intravenous

**LV** = Left ventricular

**LVO** = Left ventricular opacification

**MI** = Mechanical index

**PFO** = Patent foramen ovale

**PHT** = Pulmonary hypertension

**RVSP** = Right ventricular systolic pressure

**TEE** = Transesophageal echocardiography

**TTE** = Transthoracic echocardiography

**UCA** = Ultrasound contrast agent

as safety information and recommended policies for left-sided contrast agent use.

## I. UPDATE ON KNOWLEDGE OF ULTRASOUND PHYSICS AND INSTRUMENTATION

Since the 2001 document, considerable progress has been made in the area of improving the visualization of a commercially available ultrasound contrast agent (UCA) for left ventricular (LV) opacification (LVO) and perfusion. With regard to details on the composition of commercially available microbubbles and microbubble physics, please refer to the "Contrast Agents" and "Contrast-Specific Ultrasound Imaging" sections in the 2008 ASE consensus statement.[2] Contrast enhancement for LVO using low–mechanical index (MI) harmonic imaging has been available on all ultrasound systems marketed within the past decade, and real-time very low MI techniques are available on nearly all commercially available systems. By definition, very low MI represents values $< 0.2$, low MI represents values $< 0.3$, intermediate MI represents values of 0.3 to 0.5, and high MI is any MI that exceeds 0.5. The real-time very low MI techniques permit the enhanced detection of microbubbles within the LV cavity and myocardium.[2] Although myocardial perfusion imaging is not an approved indication for UCAs, these very low MI imaging techniques have been used in multiple clinical studies to examine perfusion and improve the detection of coronary artery disease in the emergency department, improve the detection of coronary artery disease during stress testing, and improve the diagnostic evaluation of cardiac masses. Therefore, sonographers should be familiar with the advantages and drawbacks of each contrast imaging method (Table 1) and the physics related to each technique (Figure 1).

**Pulse-inversion Doppler** (originally developed by Advanced Technology Laboratories, now used by GE Healthcare, Little Chalfont, United Kingdom) is a tissue cancelation technique that overcomes motion artifacts by sending multiple pulses of alternating polarity into the cavity and myocardium. Although pulse-inversion Doppler provides excellent tissue suppression and high resolution by receiving only even-order harmonics, there is significant attenuation, especially in the basal myocardial segments of apical windows. **Power modulation** (originally developed by Philips Medical Systems, Andover, MA) is a technique that improves the signal-to-noise ratio at very low MIs (0.05–0.20). This technique is also a multipulse cancelation technique, only here, the power, or amplitude, of each pulse is varied. The low-power pulses create a linear response, whereas the slightly higher power pulse results in a linear response from tissue but a nonlinear response from microbubbles. The linear responses from the two different pulses (the amplified low-power pulse and the slightly higher power pulse) can be subtracted from each other. The transducer then only detects the nonlinear behavior, which emanates exclusively from the microbubbles. Power modulation also detects fundamental nonlinear behavior but does not have the resolution and image quality that pulse inversion offers. **Contrast pulse sequencing** (originally developed by Siemens Medical Solutions USA, Mountain View, CA) combines these multipulse techniques by interpulse phase and amplitude modulation, which although more complex has the purpose of enhancing nonlinear activity from microbubbles at a low MI and canceling out the linear responses from tissue. Contrast imaging with each specific pulse-sequence scheme can be used at very low MIs (<0.2) to assess LVO and myocardial contrast perfusion in real time with excellent spatial resolution. Sonographers should be aware of the variations in pulse-sequence schemes and use them if available whenever contrast is required (Table 1). The advantage, compared with B-mode low-MI harmonic imaging (LVO), is that there is better tissue cancelation and enhanced contrast from microbubbles. However, not all vendors have real-time very low MI imaging software available, and in these settings, low-MI (<0.3) harmonic imaging should be used.

This document provides instructions on how to set up very low MI real-time imaging, and the video examples provide specific examples as well as potential artifacts. The writing group recommends that sonographers who are just beginning to use UCAs, or who do not have very low MI imaging software available, start with the low-MI harmonic imaging methods described in Table 1. We recognize that experience is a critical factor in performing any aspect of ultrasound imaging, and we recommend to all sites that they work with their local contrast agent representatives to optimize contrast with low-MI imaging techniques and with their specific ultrasound vendors on how to effectively use real-time very low MI imaging software.

## II. UPDATE ON CONTRAST ADMINISTRATION POLICY AND ESTABLISHING INTRAVENOUS ACCESS

It is recognized that the establishment of IV access remains one of the biggest obstacles to administering UCAs in clinical echocardiography laboratories. Because UCAs are critical to improving the detection of regional wall motion abnormalities and improving the detection of Doppler signals, it is essential that sonographers work with hospital administrations to adopt a contrast program that promotes their use in technically difficult studies. In August 2012, the Intersocietal Accreditation Commission (IAC) officially released the new IAC standards and guidelines for adult echocardiography accreditation.[3] The guidelines require all cardiac ultrasound systems to have instrument settings to enable the optimization of UCAs. The IAC guidelines recommend using UCAs for all studies with suboptimal image quality and require a policy or process to enable alternative imaging for suboptimal studies. Several large clinically active cardiology programs have put in place policies for UCA use that assist sonographers in complying with current IAC guidelines. This update reemphasizes the 2001 statement that the ASE supports IV training for sonographers in hospital and clinic settings. This training requires knowledge of aseptic technique, venous anatomy, appropriate sites of access, risks to patients, and hospital approval to perform the technique. To