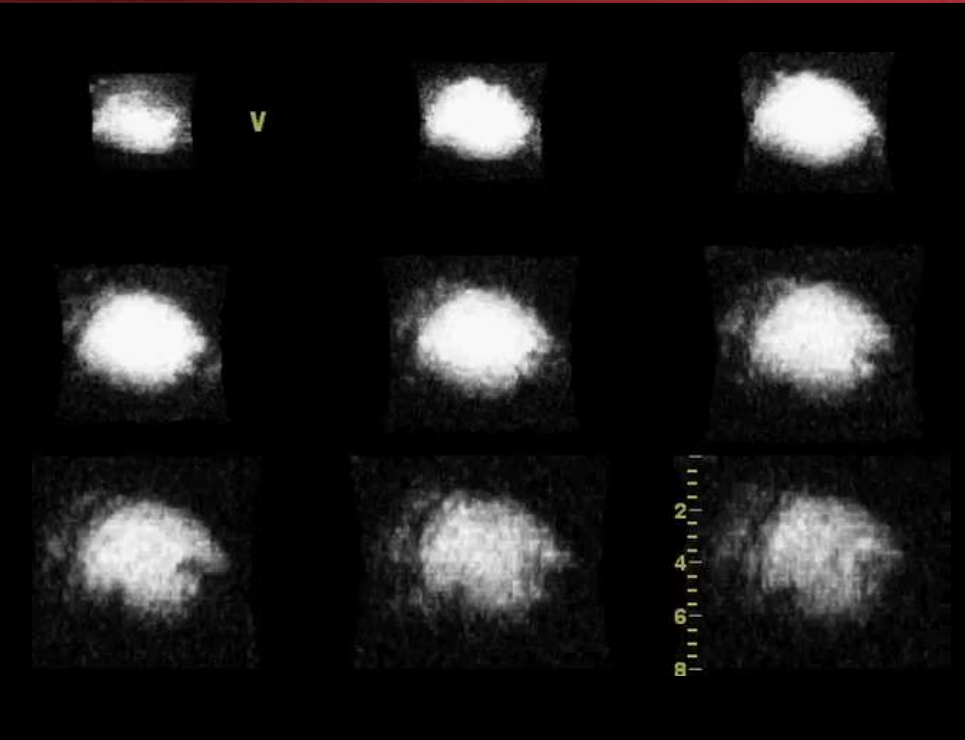


Marti McCulloch, MBA, BS, RCS, FASE
Houston, TEXAS



Enhanced Echo

*GE – Speaker Bureau
Bracco – Educational Grant
ASE & ACC*

What would you do?



Octave
Freq.: 1.6 MHz/3.2 MHz
Proc.: /11.0/2.0/6.0/0.7
Power: 0.0 dB
Depth: 19.0 cm



61
HR

- a) Order a CCTA
- b) Recommend anticoagulants
- c) Administer contrast
- d) Cardiac trabeculations - Normal

What would you do?



Octave
Freq.: 1.6 MHz/3.2 MHz
Proc.: /11.0/2.0/6.0/0.7
Power: 0.0 dB
Depth: 19.0 cm



61
HR

- a) Order a CCTA
- b) Recommend anticoagulants
- c) **Administer contrast**
- d) Cardiac trabeculations - Normal

Learning Objectives

Evolution of Contrast

List General Properties

Describe Interaction

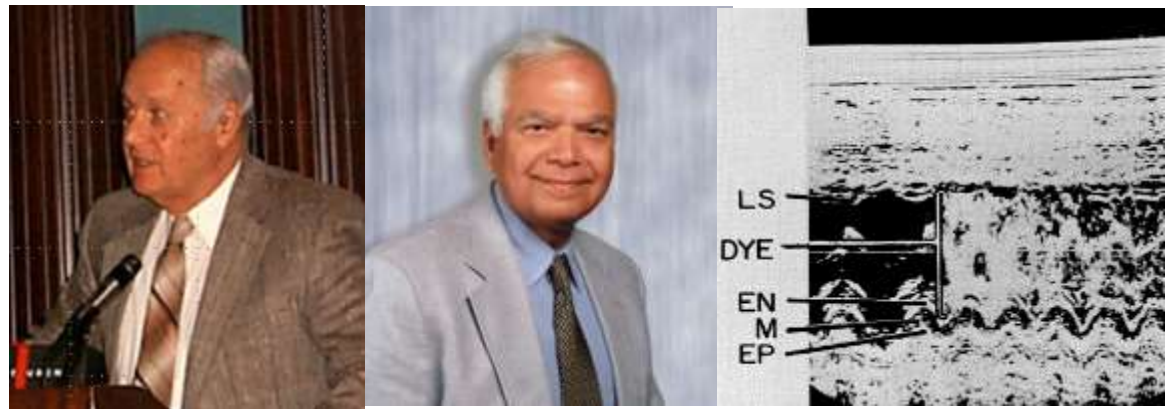
Instrumentation

Artifacts

Ultrasound Contrast Discovery

Agitated Saline

- Observed in 1968, after intra-aortic injection of saline
- Short-lived air bubbles formed by agitation
- Suitable only for right heart opacification, detection of tricuspid regurgitation and intracardiac shunts
- Unable to traverse pulmonary circulation

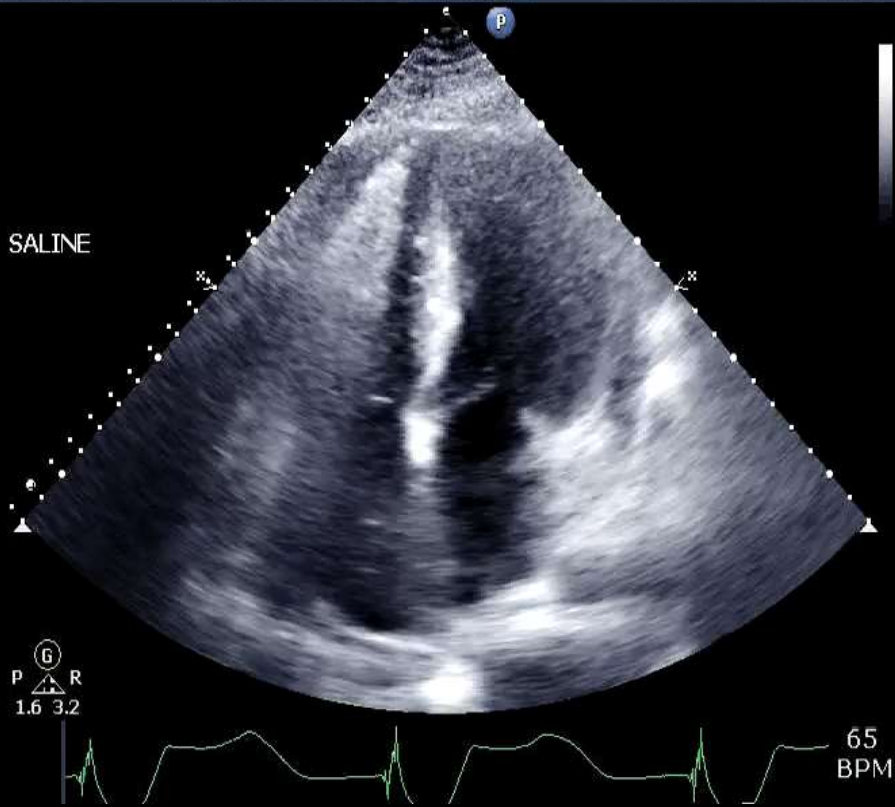


ICU patient 2 days post IHSS –

What is noted post saline injection?

ECHO
S5-1
32Hz
22cm

2D
HGen
Gn 57
C 50
2/2/4
100 mm/s



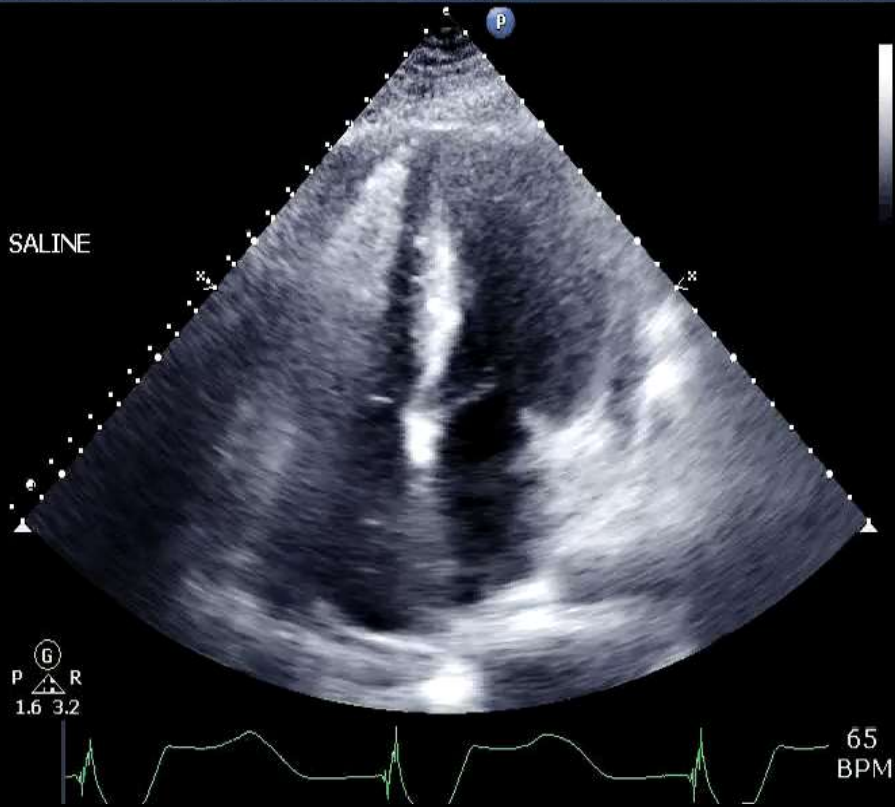
- a. Normal study
- b. ASD
- c. PFO
- d. VSD

ICU patient 2 days post IHSS –

What is noted post saline injection?

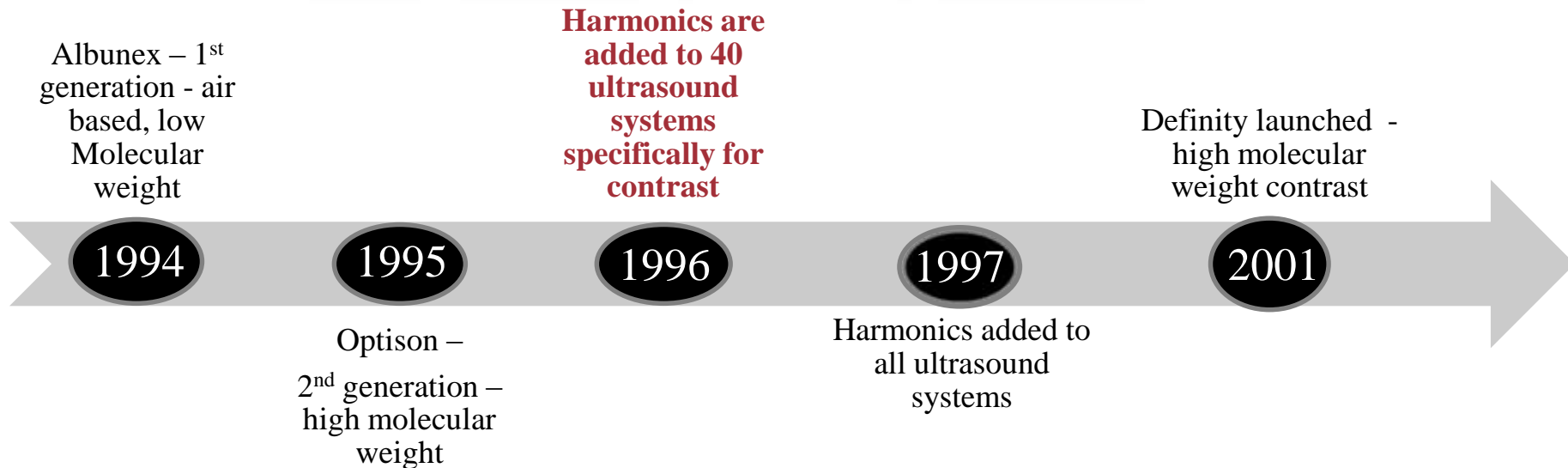
ECHO
S5-1
32Hz
22cm

2D
HGen
Gn 57
C 50
2/2/4
100 mm/s



- a. Normal study
- b. ASD
- c. PFO
- d. **VSD**

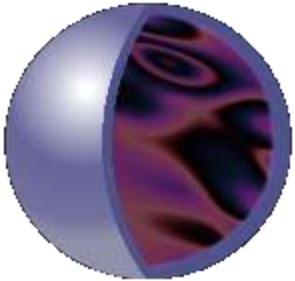
Stable Microbubbles



- In 1994 the first stable microbubble was approved by FDA (Albunex)
- Second generation contrast agents showed an increase in stability, longevity and signal intensity
 - Optison *1995
 - Definity *2001
- **These agent are small enough to cross the capillary bed & enhance endocardium**

Physical and Chemical

Properties

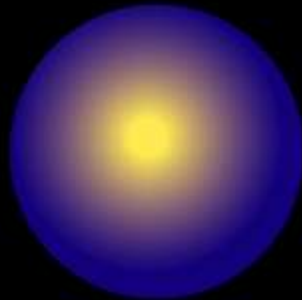
	Definity[®]	Optison[®]
Gas	Octafluoropropane	Octafluoropropane
Shell	Proprietary Phospholipid blend	Heat Treated Human Albumin

Ideal Enhanced Agent

- Nontoxic / easily eliminated
- Administered intravenously
- Easy passage through microcirculation
- Physically stable
- Acoustically responsive
 - Stable harmonics
 - Capable of rapid disruption

Contemporary Agents

- **Size**
- **Shell**
- **Gas**



Microbubble
2–8 μm

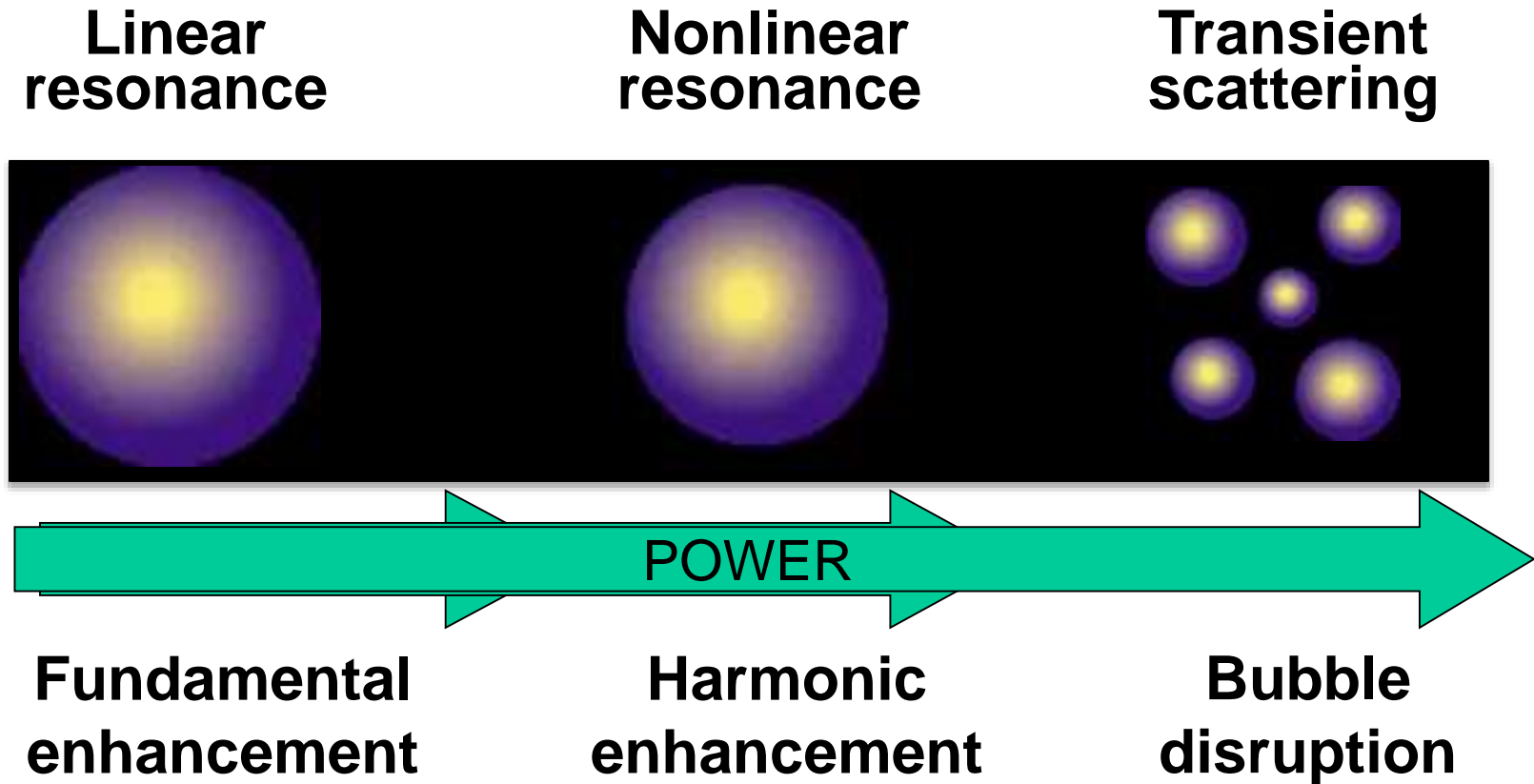


RBC
6–8 μm

Stabilized gas microbubbles
sized to pass through the
smallest capillaries



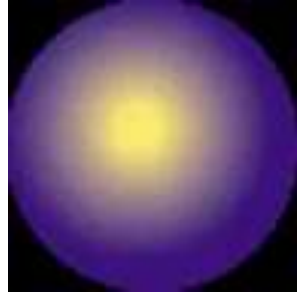
Interaction of Ultrasound with Enhancement Agent



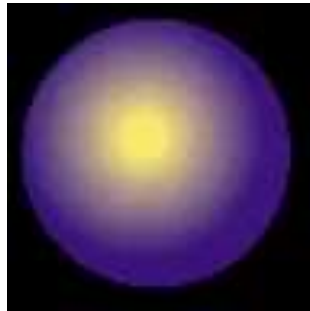
Resonance and Harmonics

Resonance

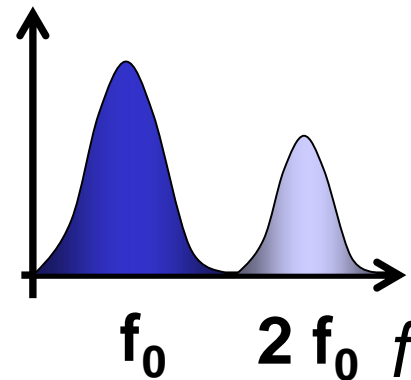
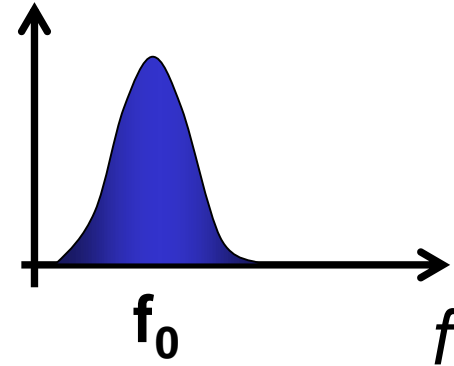
Linear



Non-linear

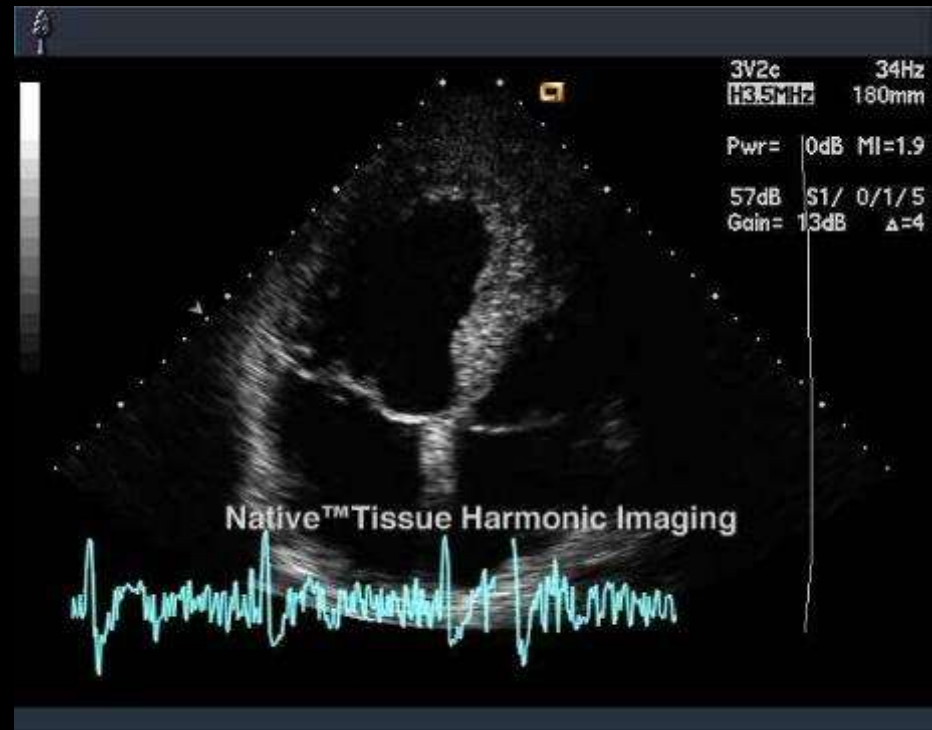
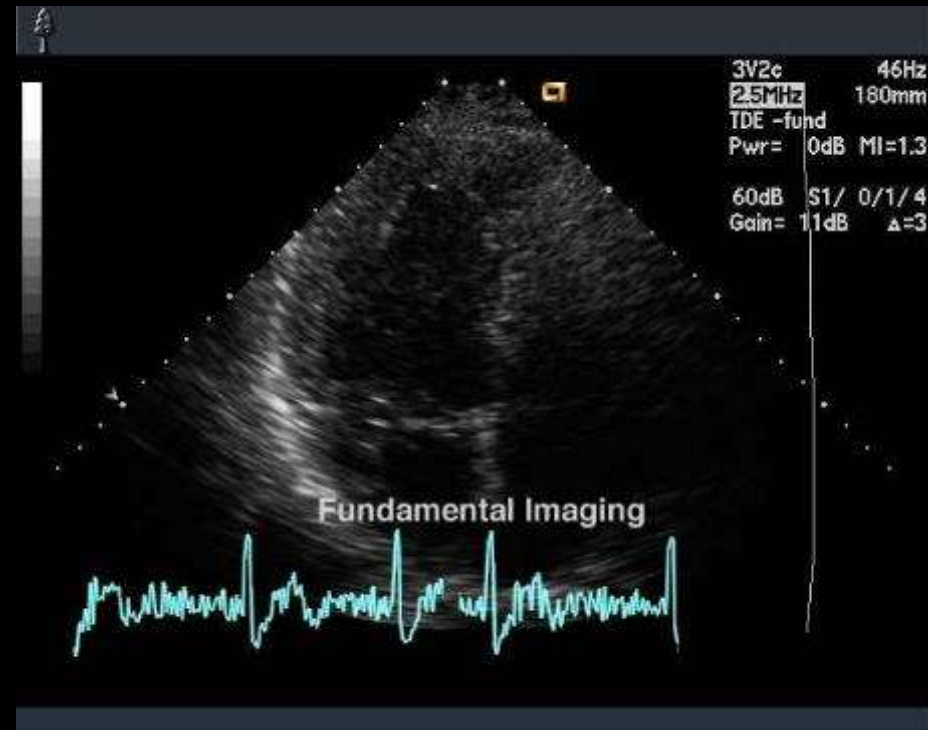
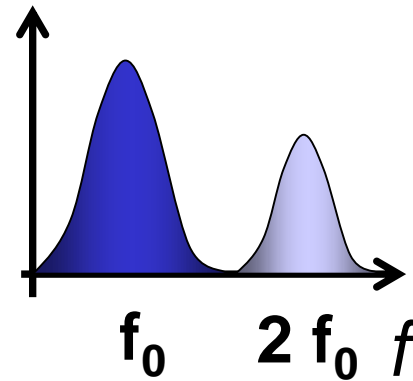
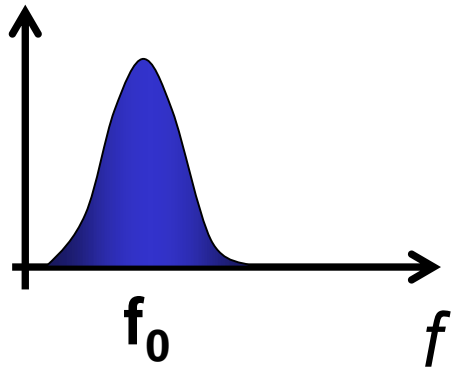


Reflected spectrum

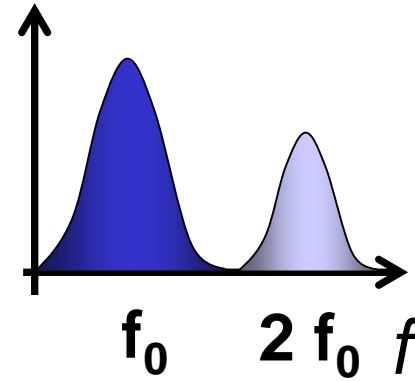
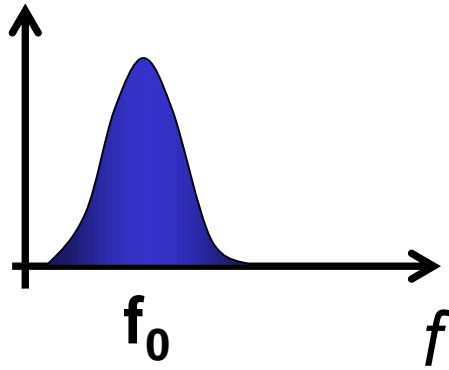


Burns. In Rumack et al, eds. *Diagnostic Ultrasound*. Vol. 1. 2nd ed.
St. Louis: Mosby; 1998:57.
de Jong et al. *Ultrasonics*. 1994;32:455.

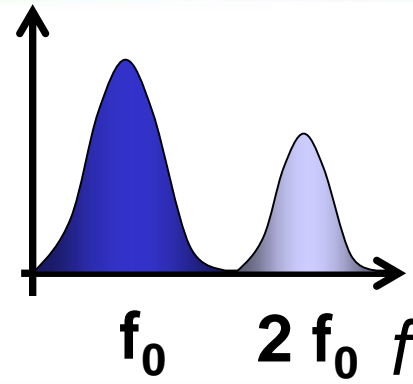
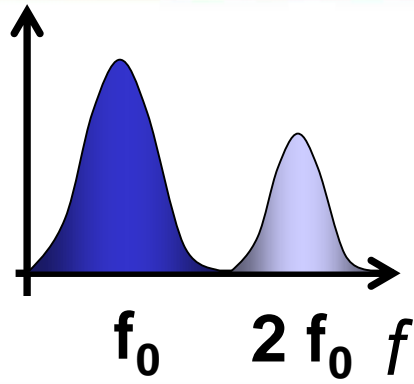
Fundamental vs Tissue Harmonic



Fundamental vs Harmonics



Tissue vs Contrast Harmonics



Tissue harmonic mode



Contrast harmonic mode

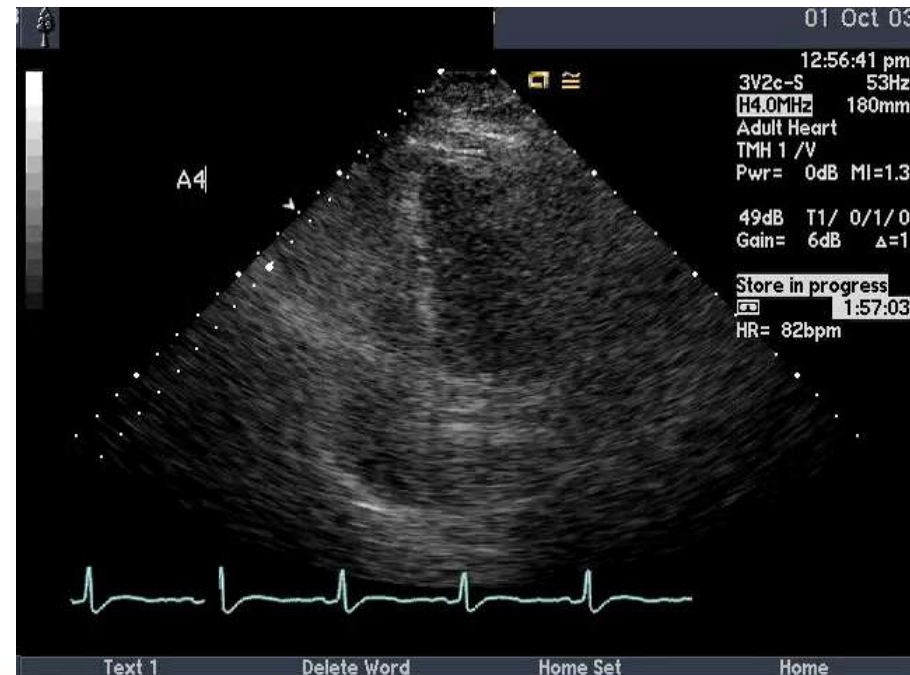
Clinical Echocardiography

- Echocardiography is the most commonly used cardiac imaging modality
- Provides real time information
 - Cardiac anatomy
 - Cardiac physiology
- Common usage is LV Func.
 - Global function
 - Regional wall motion



Limitations of Echocardiography

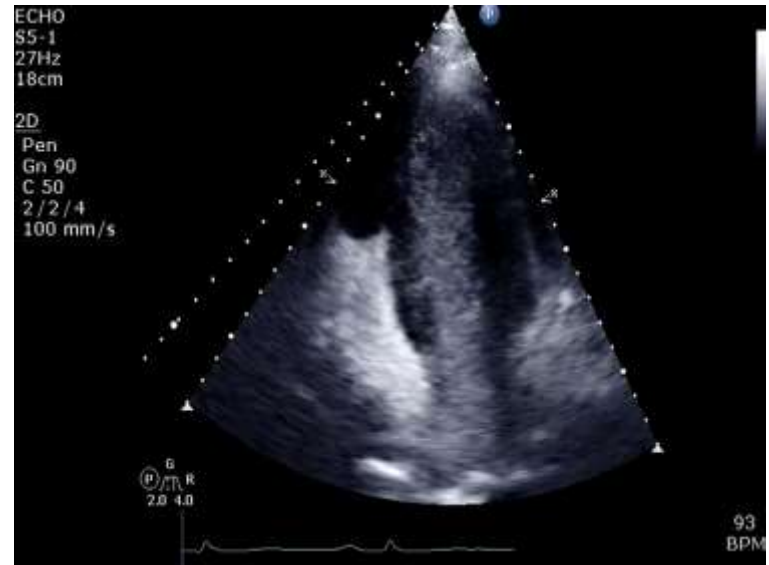
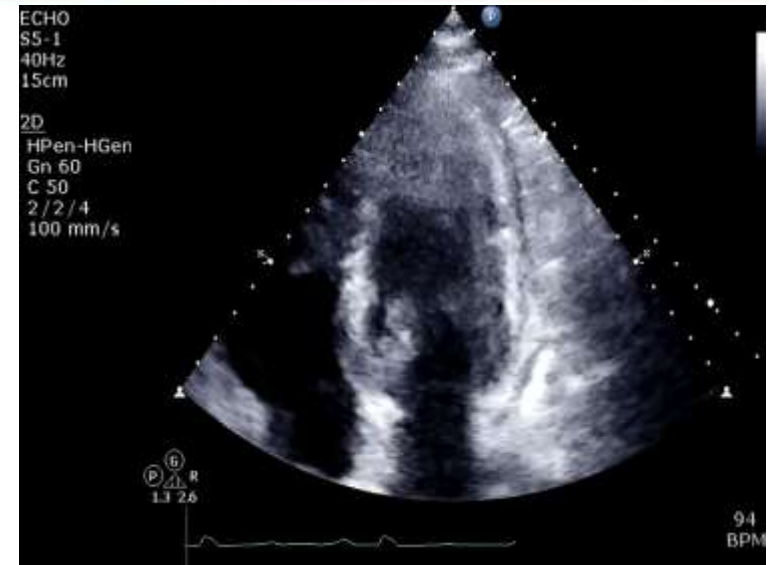
- Visualization of endocardium essential for assessment of LV function
- Operator dependent
- Endocardial dropout in 5%-15% of the studies
 - Obesity
 - Pulmonary disease
 - Chest deformity



Main and Grayburn. *Am Heart J.* 1999;137:144.

Limitations of Echocardiography

- Consequences of suboptimal images
 - Misdiagnosis
 - Low diagnostic confidence
 - Need for additional tests
 - Inter-observer variability



Kurt et al. *JACC*. 2009;53:9.

Ikonomidis et al. *Coronary Artery Dis*. 1998;9:567.

Zotz et al. *J Am Soc Echocardiogr*. 1996;9:1.

Barriers to Enhanced Echo

Need but...

- Cost
- Time (takes too long)
- Limited resources

*No need
because ...*

- *Physicians don't believe*
- *Sonographers too good*
- *Machines too good*
- *Perfect patients*

EXPEDITED PUBLICATION

Impact of Contrast Echocardiography on Evaluation of Ventricular Function and Clinical Management in a Large Prospective Cohort

Mustafa Kurt, MD, Kamran A. Shaikh, MD, Leif Peterson, PHD, Karla M. Kurrelmeyer, MD, FACC,
Gopi Shah, MD, FACC, Sherif F. Nagueh, MD, FACC, Robert Fromm, MD,
Miguel A. Quinones, MD, FACC, William A. Zoghbi, MD, FACC

Houston, Texas

Houston, Texas

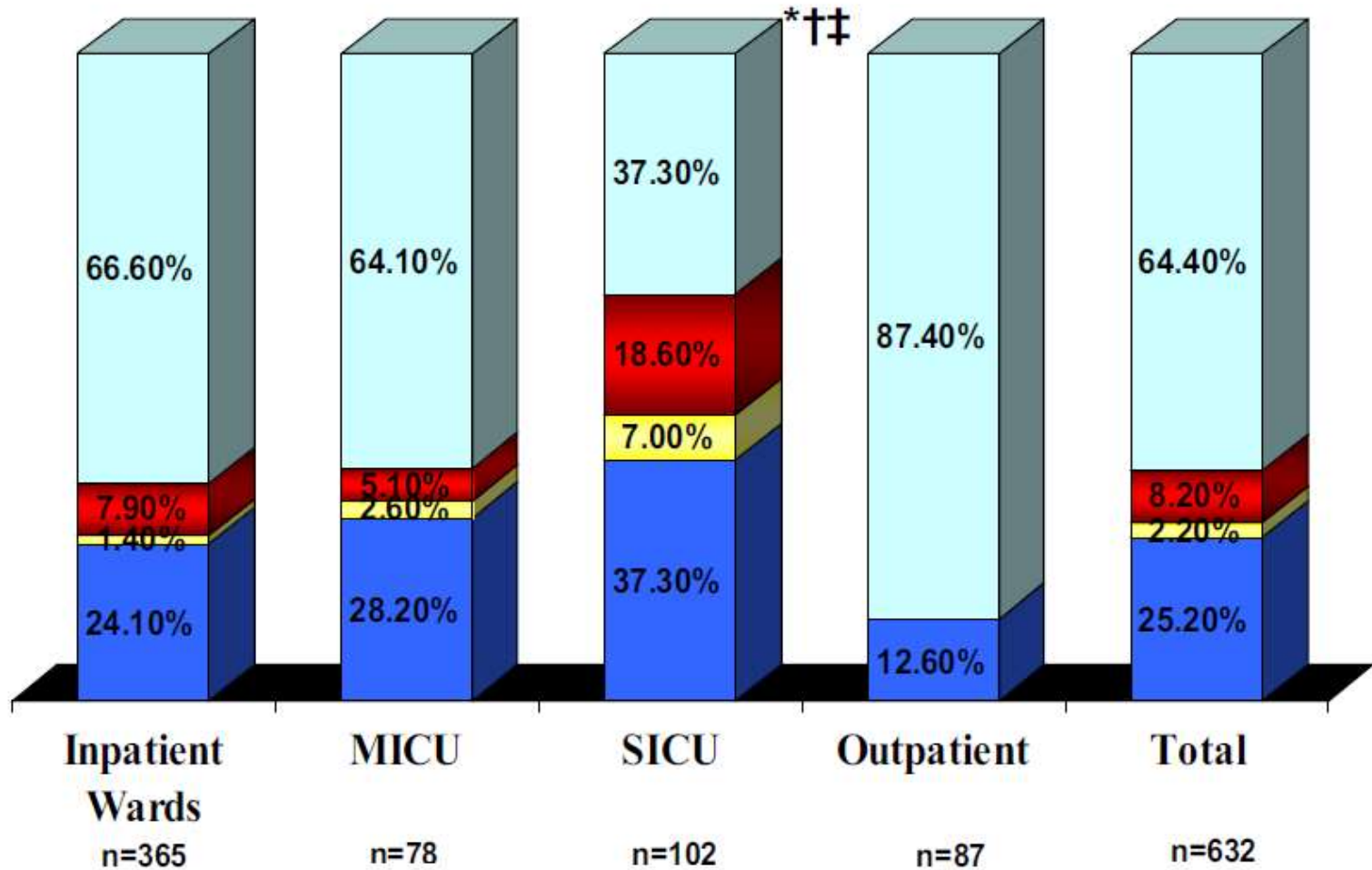
Miguel A. Quinones, MD, FACC, William A. Zoghbi, MD, FACC

Gopi Shah, MD, FACC, Sherif F. Nagueh, MD, FACC, Robert Fromm, MD

Kamran A. Shaikh, MD, Leif Peterson, PHD, Karla M. Kurrelmeyer, MD, FACC

Cost Benefit

- Procedure Avoided, only
- Medication Change, only
- Both Medication and Procedural Change
- Unchanged



What would you do?



Octave
Freq.: 1.6 MHz/3.2 MHz
Proc.: /11.0/2.0/6.0/0.7
Power: 0.0 dB
Depth: 19.0 cm



61
HR

- Order a CCTA
- Recommend anticoagulants
- Administer contrast
- Look at more images

What would you do?



Octave
Freq.: 1.6 MHz/3.2 MHz
Proc.: /11.0/2.0/6.0/0.7
Power: 0.0 dB
Depth: 19.0 cm

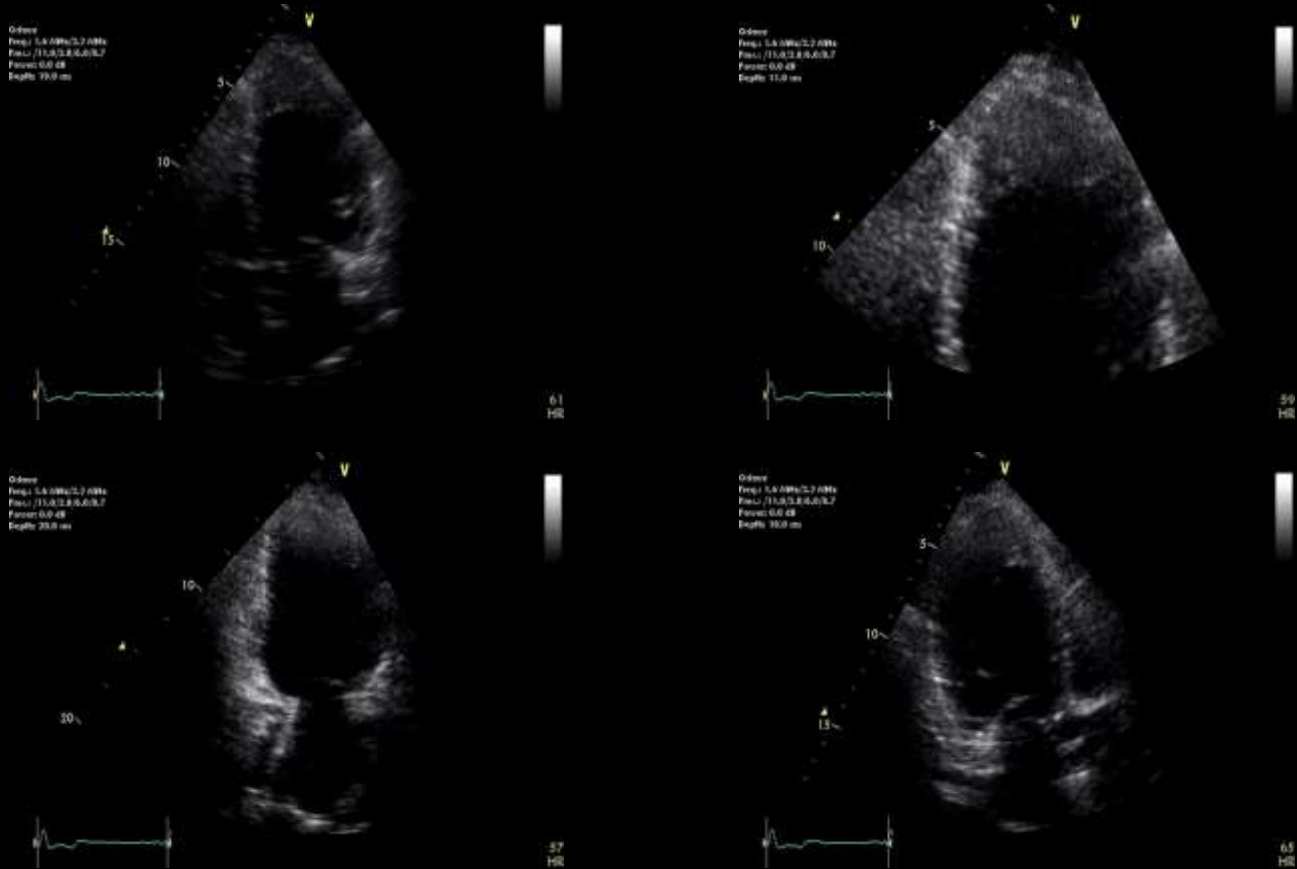


61
HR

- a) Order a CCTA
- b) Recommend anticoagulants
- c) Administer contrast
- d) **Look at more images**

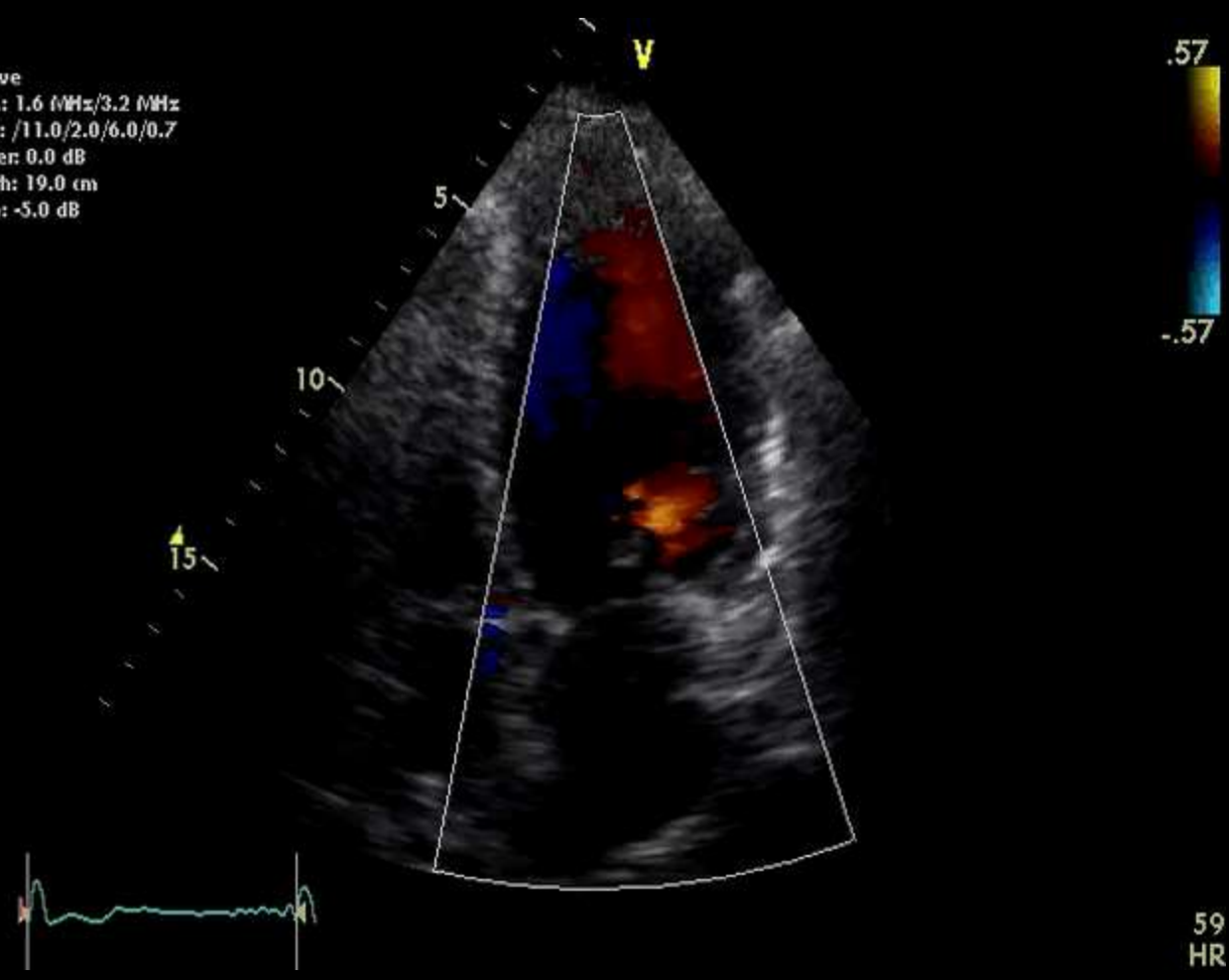
Cost Benefit

THE QUESTIONABLE APEX



Cost Benefit

Octave
Freq.: 1.6 MHz/3.2 MHz
Proc.: /11.0/2.0/6.0/0.7
Power: 0.0 dB
Depth: 19.0 cm
Gain: -5.0 dB



How would you interpret?

Onave
Freq.: 1.5 MHz/3.2 MHz
Proc.: /11/ 0/ 6/
Power: 0.0 dB
Depth: 16.0 cm



How would you interpret?



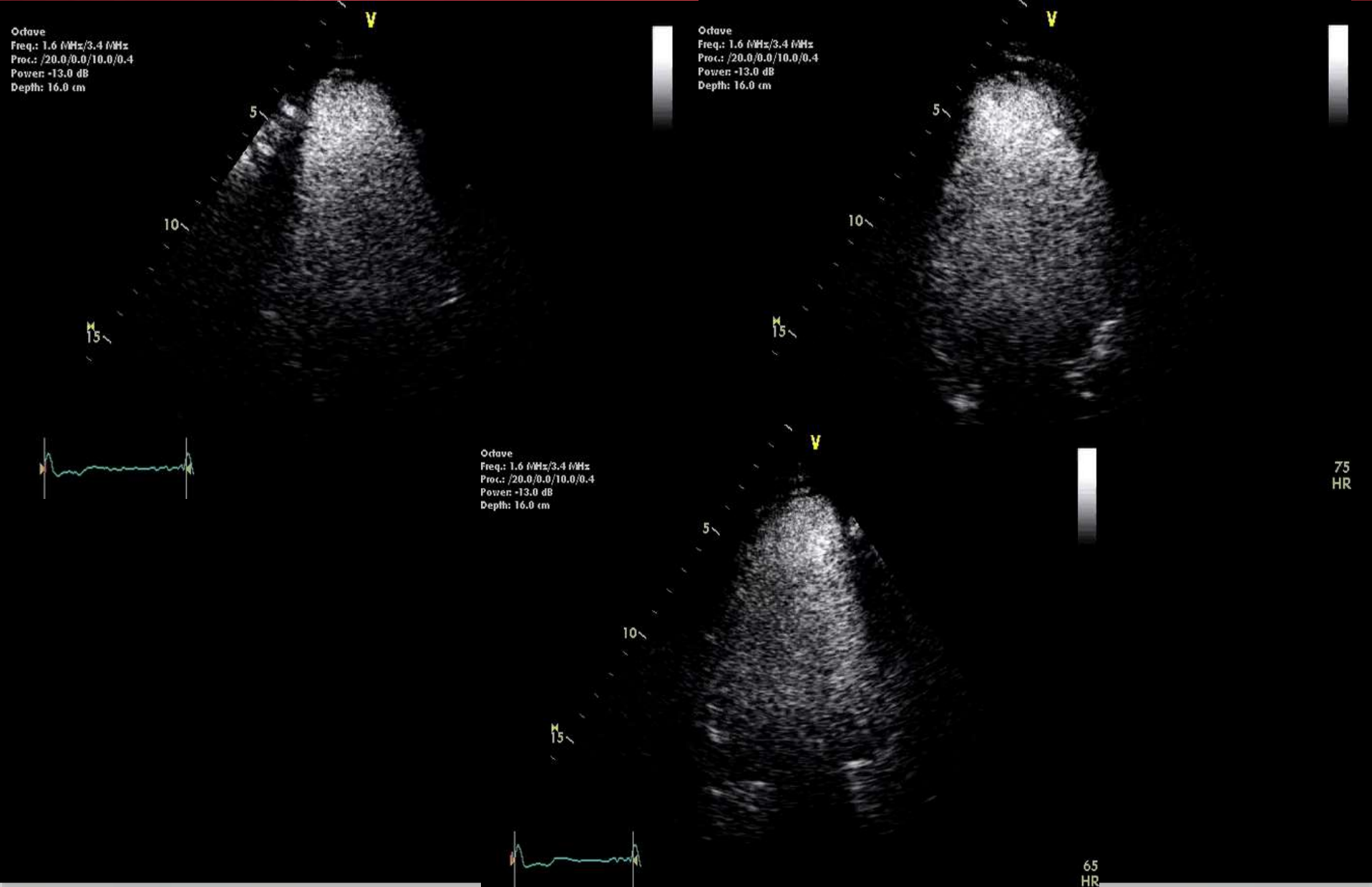
- a. Add contrast
- b. Thrombus
- c. Main bang artifact
- d. Normal Apex

How would you interpret?

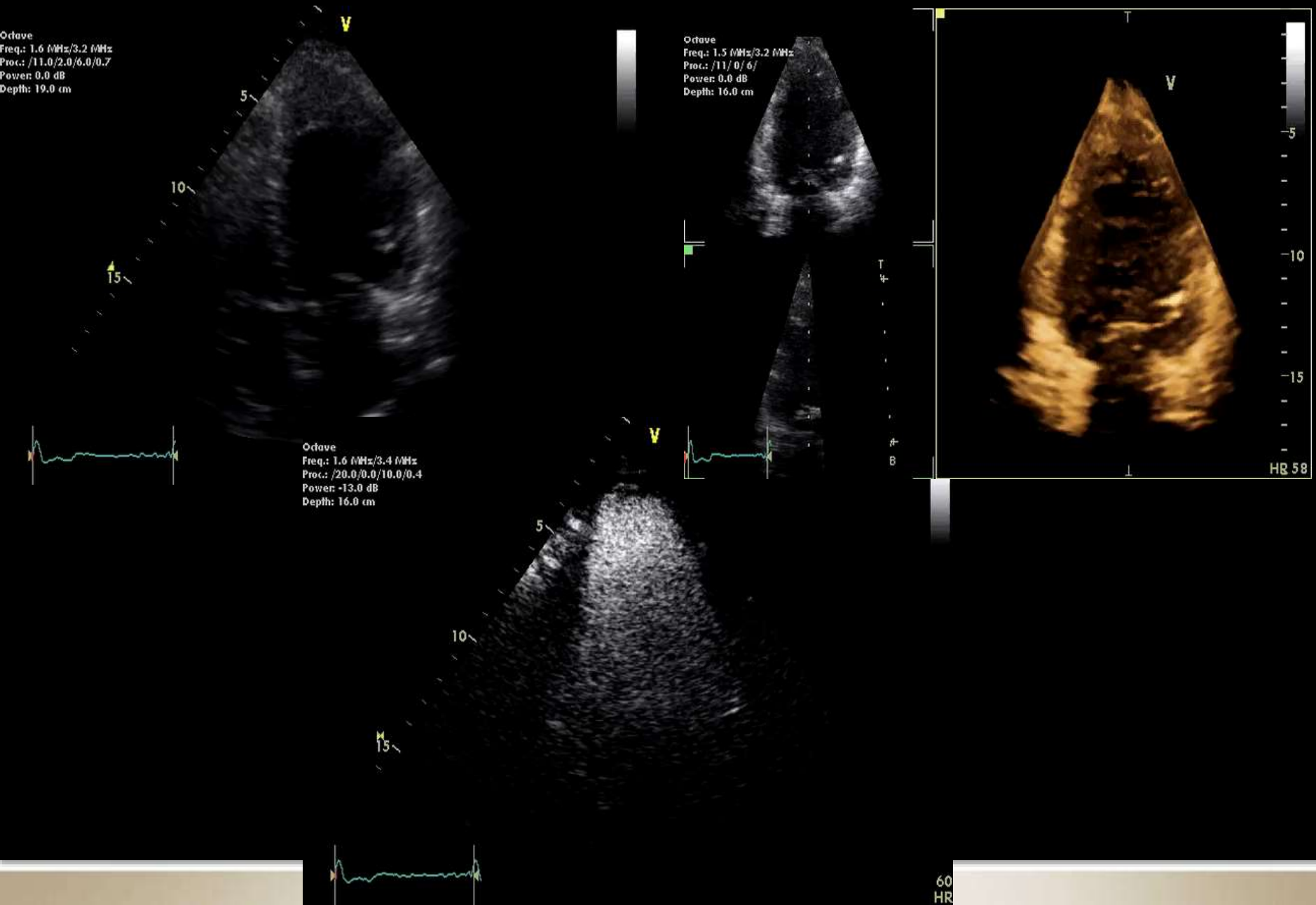


- Add contrast**
- Thrombus
- Main bang artifact
- Normal Apex

Cost Benefit

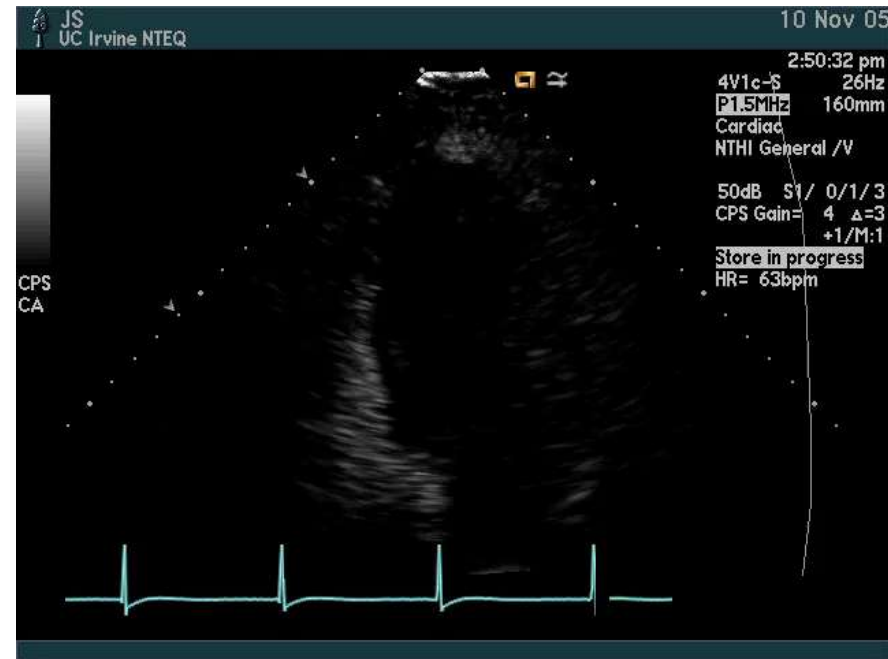


Cost Benefit



Enhanced Echocardiography

- Reduce additional testing/medication changes
- Increased sensitivity
- Heightened diagnostic confidence
- Improved accuracy and reproducibility
- Ergonomic impact



Kurt et al. *JACC*. 2009

Main and Grayburn. *Am Heart J*. 1999;137:144.

Difficult

Echo



Ergonomic Effect

The difficult echo can be a two fold situation



Tough to image patient

Uncomfortable scan position

1. McCulloch ML, Xie T, Adams D. The Painful Art of Scanning. Cardiac Ultrasound TODAY 2002 5(8): 2002.

National Institute of Occupational Safety and Health (NIOSH)

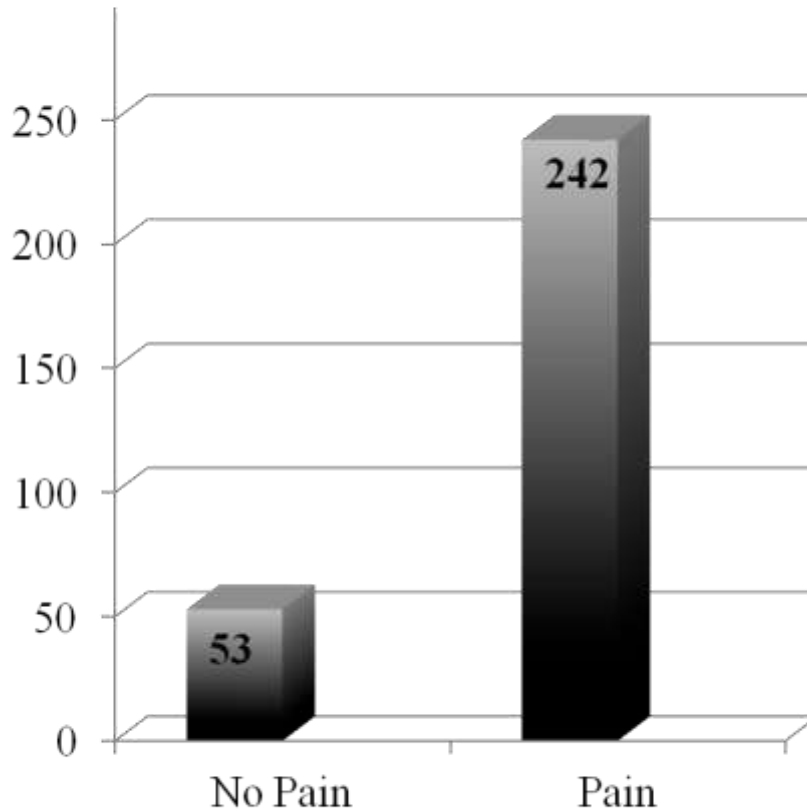
- Direct cost → \$ 418 Billion
- Indirect cost → \$837 Billion
- Overall cost → \$11.26 Trillion

30-40% Related to MSI

\$13 Billion to \$20 Billion

Cardiac US Today 8(5):69-96, 2002

Sonographer's Scanning in Pain



Overall results

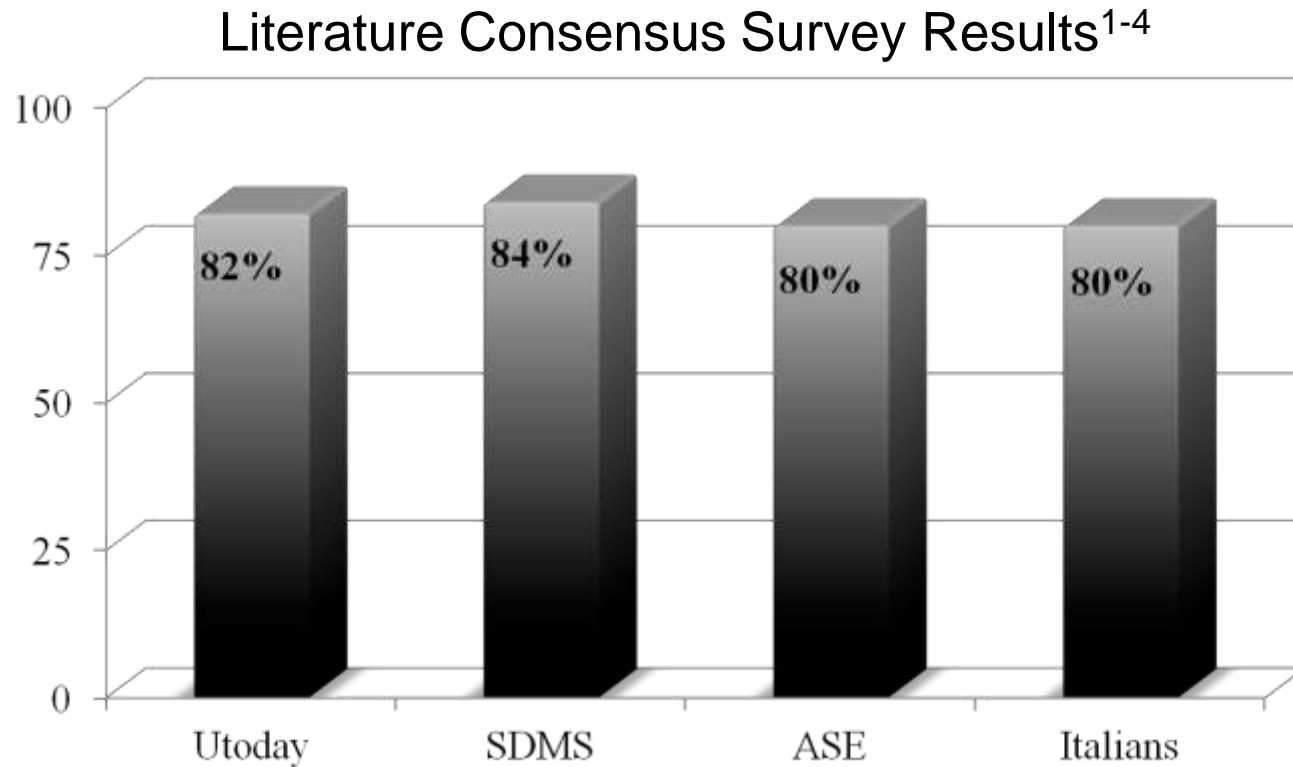
- 18% No Pain
- **82% Some Pain**

Break down

- 27% Minor
- **40% Major**
- **15% Disabling**

Cardiac US Today 8(5):69-96, 2002

Sonographer's Scanning in Pain



1. Cardiac US Today 8(5):69-96, 2002
2. SDMS 1997 Survey
3. ASE 1997;10:357-62
4. JOEM 1999;Vol 41:11:981-988

Enabling the Process



Risk Reduction (legal)



Policy and Procedures



IV Didactic and Competency



Contrast Administration Competency

1. Moos S, Odabashian J, Jasper S, et al. Incorporating ultrasound contrast in the laboratory: a series on contrast echocardiography, article 1. J Am Soc Echocardiogr 2000;13:240-7.
2. Burgess P, Moore V, Bednarz J, et al. Performing an echocardiographic examination with a contrast agent: a series on contrast echocardiography, article 2. J Am Soc Echocardiogr 2000;13:629-36.

Additional Support

SONOGRAPHERS' COMMUNICATION

Season of Thanks

We are well into the holiday season, and Thanksgiving is approaching. I have many things to be thankful for: family, friends, health, a career in cardiac ultrasound, and a role as a proud sonographer volunteer with ASE. Our careers in cardiac ultrasound, with all the advances and changes in our field, keep us busy and intellectually stimulated. Last year at this time we were struggling with the Black Box Warning that was issued for the contrast agents that we use. This year, I am thankful that the warning has been revised.

This was especially difficult for our lab. We had just completed all the changes to our contrast protocol. Our pharmacy now dispenses all the contrast agents at our medical center. We had just worked through changing the order set, in-servicing the pharmacists and pharmacy technicians. Now I was back to working out the new details with the pharmacists and the nursing staff. Luckily for me, we have made giving contrast a medical center-wide project in 2004. Contrast, if needed, is a routine part of all our echo studies.

A little history of contrast usage at my institution: we have been using contrast since the beginning. I was one of the last converts in the department. In case you didn't know, I'm an old sonographer. I started

contrast would possibly eliminate a more expensive procedure, help speed up diagnosis, treatment, and discharge. It has also developed a better relationship between the nurses and the sonographers. We were so successful that we expanded the training to the entire adult floors, recovery room, pre-op, and the emergency department nurses. Go to www.asecho.org and click the sonographer link to view a Power Point presentation about how to incorporate contrast into your lab.

Initially, the units re-



Peg Knoll, RDMS, FASE

Overcoming the IV Insertion Obstacle

Last month, Peg Knoll wrote about the implementation of a strategic plan to train the nursing staff at her medical center to embrace the utilization of contrast. I plan to follow her lead with a description of how and why we, at the Methodist DeBakey Heart & Vascular Center in Houston, TX, cross trained the sonographers to insert IV catheters.

Patient satisfaction survey results have been a hospital improvement tool utilized for years; in the past, how hospitals used the results varied depending on the institution. However, this is changing based on a recent decision by the U.S. Department of Health and Human Services to include certain aspects of the patient satisfaction survey results in the Hospital Compare quality tool. Now patients can easily go to the government Website, put in a zip code, and choose several hospitals for which to compare quality outcomes and satisfaction results. I went to the site, chose the three main competitive hospitals in the Texas Medical Center, and found the impact of the comparison results extremely powerful. This would be especially true for me if I were viewing the results from a patient perspective. Granted, satisfaction survey results are not a direct measure of quality, but rather a measure of the patient's perception of quality, but as the saying goes,

for the later and had our TEE nurse give the lecture to a majority of the staff on a Saturday. The didactic piece was obtained from the SDMS and included slides and workbook materials with a test at the end for IV certification. In addition, we had a "hands on" session after the didactic in order to familiarize the sonographers with starting IVs. At the time we practiced on ourselves but have since had an anatomical IV insertion training arm donated to us by a dear friend of the lab, Patty Gaillego. After the didactic and the hands-on sessions, the sonographers were given competency check-off sheets on which they needed to record five successful IV insertions consecutively prior to being signed off as competent. We chose five as our competency number (nursing is three) simply to increase the threshold by which we determined competence in case a legal issue were ever to arise.



Marti McCulloch, MBA,
BS, RDCS, FASE

Additional Support

Expanding the Role of the Cardiac Sonographer

This is the third Yellow Page to concentrate on incorporating the use of contrast in your lab.

The role of the cardiac sonographer continues to develop and increasingly includes such duties as IV insertion and contrast administration. A registered nurse has historically provided these functions, but today many labs do not have ready access to a nurse. The choice continues to be whether you fall victim to the perceived barriers of contrast or strive to be innovative. Wake Forest University Baptist Medical Center (WFUBMC) decided to utilize the strength of our team and find a way to make it work. This article outlines how WFUBMC enhanced the clinical knowledge their sonographers have to support an alternative model of contrast administration.

Several years ago, WFUBMC found that the wait times for patients who were to receive contrast were excessive. This extended time not only made the patient anxious, but left employees idle and unproductive while waiting for a nurse. The unpredictable nature of the need for a nurse to administer contrast to a patient undergoing a stress or transthoracic echo created an impediment to our workflow. We debated the idea of sonographer contrast administration as a viable solution. We sought the involvement of our nursing office to ensure we complied with established hospital standards, and looked forward to their counsel. Their approval required the establishment of a formal training program on contrast administration for our

injections to the echo lab because of the program's recent implementation and ready accessibility to a physician in case of complications. Our nurses have in-serviced the staff in our CCU and ICUs to administer contrast; this has become an annual training event for them. We are currently exploring the possibility of credentialed sonographers injecting contrast during portable studies.

We felt compelled to institute a policy that covered our sonographers administering contrast. The policy simply describes who is authorized to inject, the criteria required for completion of the prescribed course of study, an approved standardized checklist for contrast administration, and an annual competency review be performed. Our annual competency review requires each sonographer to successfully establish an IV and properly prepare and administer contrast on at least one patient. They are required to attend our annual contrast refresher class, which facilitates needed updates on currently available contrast agent changes, as well as reviewing the overall basics and technological advance-



Pamela R. Burgess, BS,
RDCS, RDMS, RVT, FASE

JASE 2009;22: (1)A26

AMERICAN SOCIETY OF ECHOCARDIOGRAPHY POSITION PAPER

Guidelines for the Cardiac Sonographer in the Performance of Contrast Echocardiography: Recommendations of the American Society of Echocardiography Council on Cardiac Sonography

Alan D. Waggoner, MHS, RDCS, Donna Ehler, BS, RDCS, David Adams, RDCS,
Sally Moos, RDCS, Judy Rosenbloom, RDCS, Cris Gresser, RN, RDCS,
Julio E. Perez, MD, FACC, and Pamela S. Douglas, MD, FACC,
*St Louis and Kansas City, Missouri; Durham, North Carolina; Charlottesville, Virginia;
Reseda, California; Toronto, Ontario, Canada; and Madison, Wisconsin*

“The American Society of Echocardiography (ASE) highly recommends that cardiac sonographers take the appropriate steps to become trained in the administration of the contrast agents used in echocardiography.”

Indications: Enhanced Echocardiography

ASE and IAC agree on the use of ultrasound contrast.

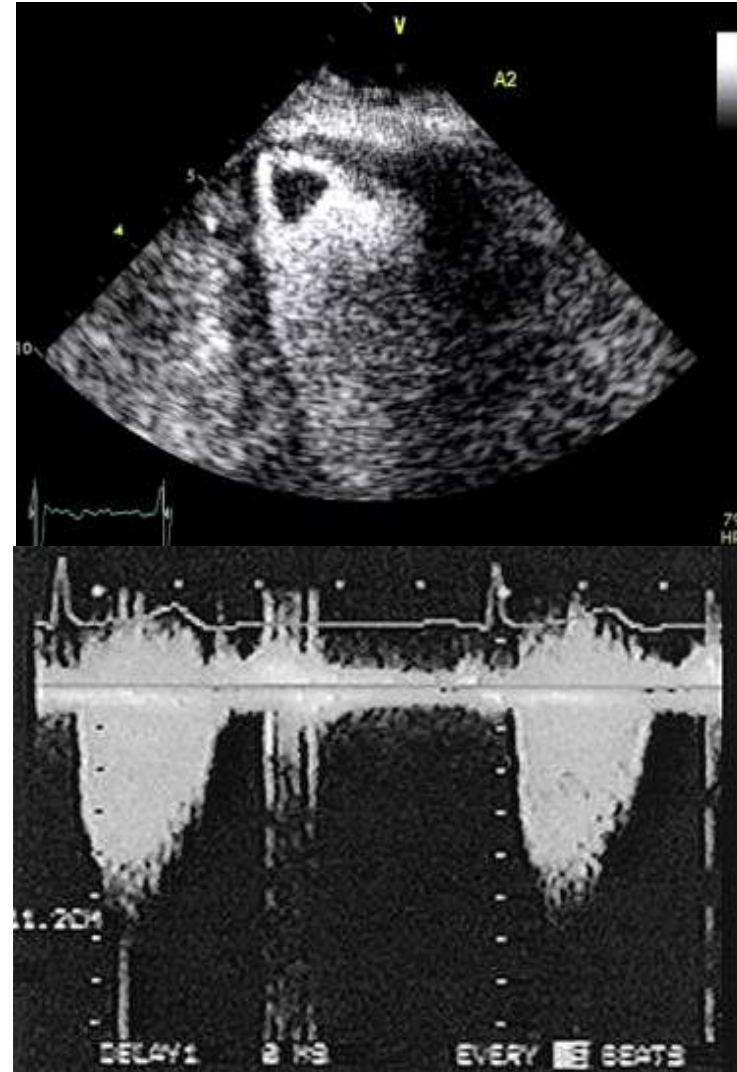
- The American Society of Echocardiography (ASE) and the 2013 *Intersocietal Accreditation Commission (IAC) Standards* recommend contrast when there is nonvisualization of **at least two of six contiguous** segments in the standard apical echocardiographic views^{1,2}
- These standards also discuss off-label uses, which have not been proven to be safe and effective for ultrasound imaging agents

1. Mulvagh SL et al. *J Am Soc Echocardiogr*. 2008;21:1179-1201.

2. IAC. *IAC Standards and Guidelines for Adult Echocardiography Accreditation*. 2013.

Additional Uses of Enhanced Echo

- Detection of intracardiac masses (eg, thrombi, tumors)
- Doppler enhancement
 - Pulmonary vein flow
 - Aortic stenosis
 - Valvular disease



Controls to be Adjusted

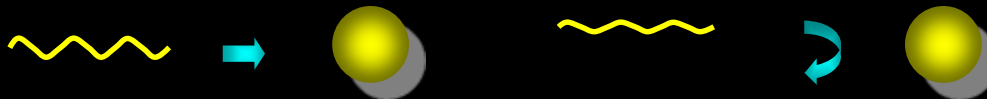
- Mechanical index (MI) - acoustic power output
 - Low MI decrease bubble destruction
 - High MI increases bubble destruction
 - Causes apical swirling
 - Decrease MI to eliminate swirling &/or re-inject
- Focus
 - Placement at level of Mitral Valve
 - minimize bubble disruption
 - reduce swirling at apex
- Gain - amplifies intensity of received echoes
- Dynamic Range - adjusts shades of gray

Acoustic Power

The higher the MI the more bubble destruction



The lower the MI the less bubble resonance



Balance between acoustic resonance and bubble destruction



Optimizing System Settings

Control	Feature	Setting	Benefit
Transmit Power (MI)	Regulates intensity of ultrasound sent into the body	Range of MI display of .2 to .8	Prolongs visualization by reducing bubble destruction
Focus	Adjusts where the beam is focused	Mid to far field	Decreases swirling effect at apex
Dynamic Range or Compression	Displays range of “shades of gray” on 2D image	Wide/High	Boosts visibility of softer echoes from contrast
Receiver or Overall Gain	Boosts amplification of received echoes	High	Compensates for lower transmit power (has no effect on bubbles)

CONTRAST ARTIFACTS

- Attenuation
- Swirling
- Rib artifact
- Respiratory interference
- No contrast

HE**ART**IFACT



ATTENUATION

CAUSES

- Contrast dose too high
- Flush too fast
- Infusion rate too high

CORRECTION

- Adjust MI
- Decrease dose
- Decrease the injection or infusion rate



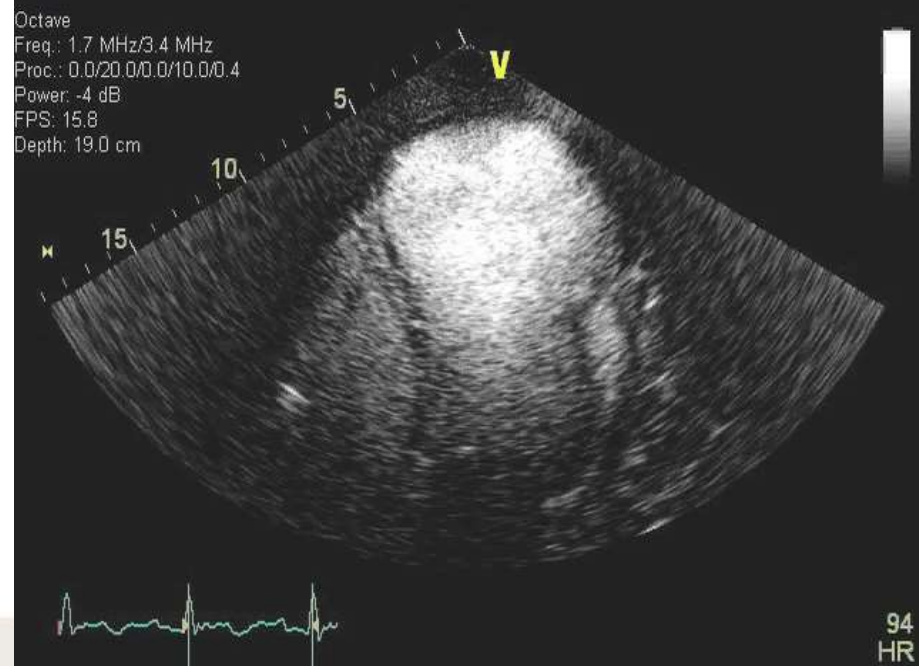
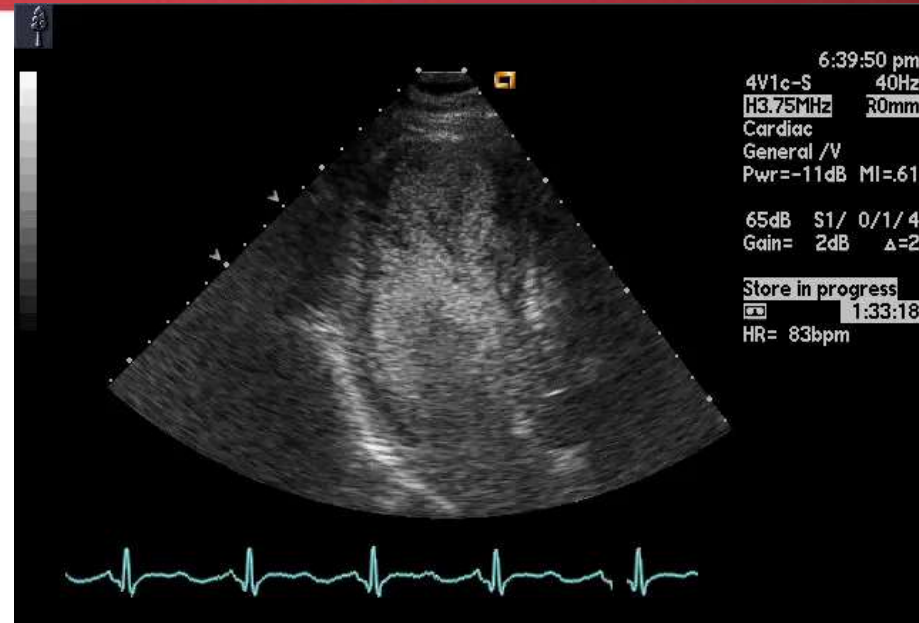
SWIRLING

CAUSES

- MI too high
- Incorrect focal placement
- Inadequate dosing
- Decreased LV function

CORRECTION

- Increase dose &/or flush rate
- Decrease MI
- Reposition the focus



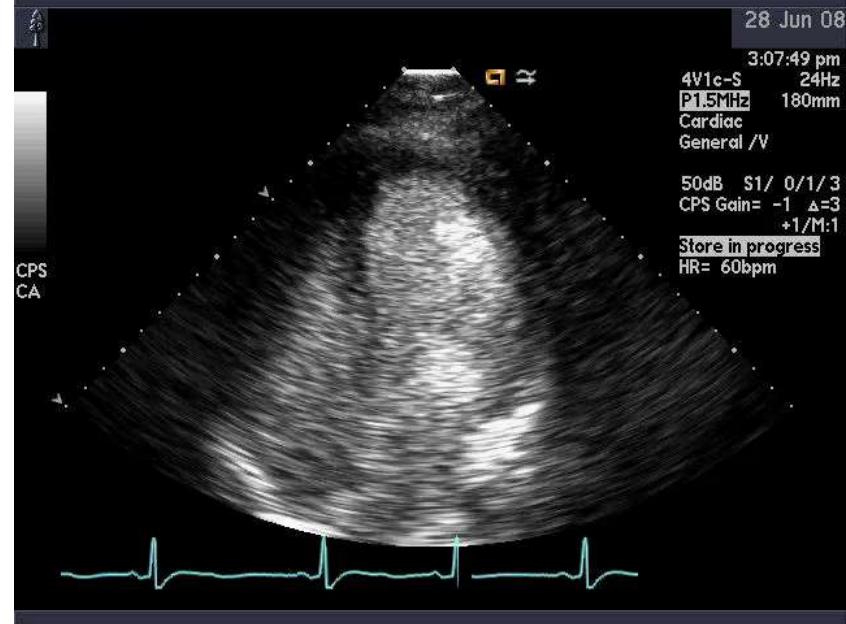
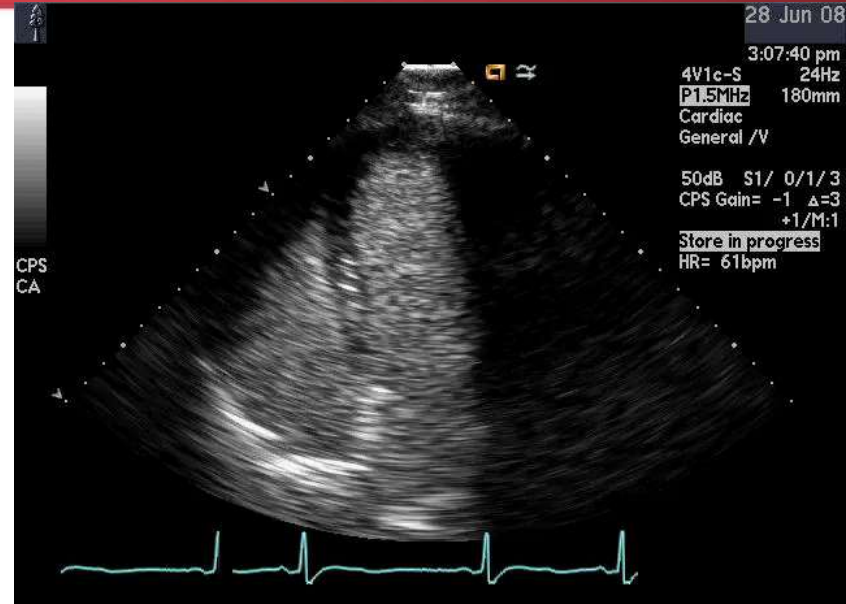
RIB ARTIFACT

CAUSES

- Limited acoustic window
- Small intercostal spaces

CORRECTION

- Reposition patient
- Obtain off axis views



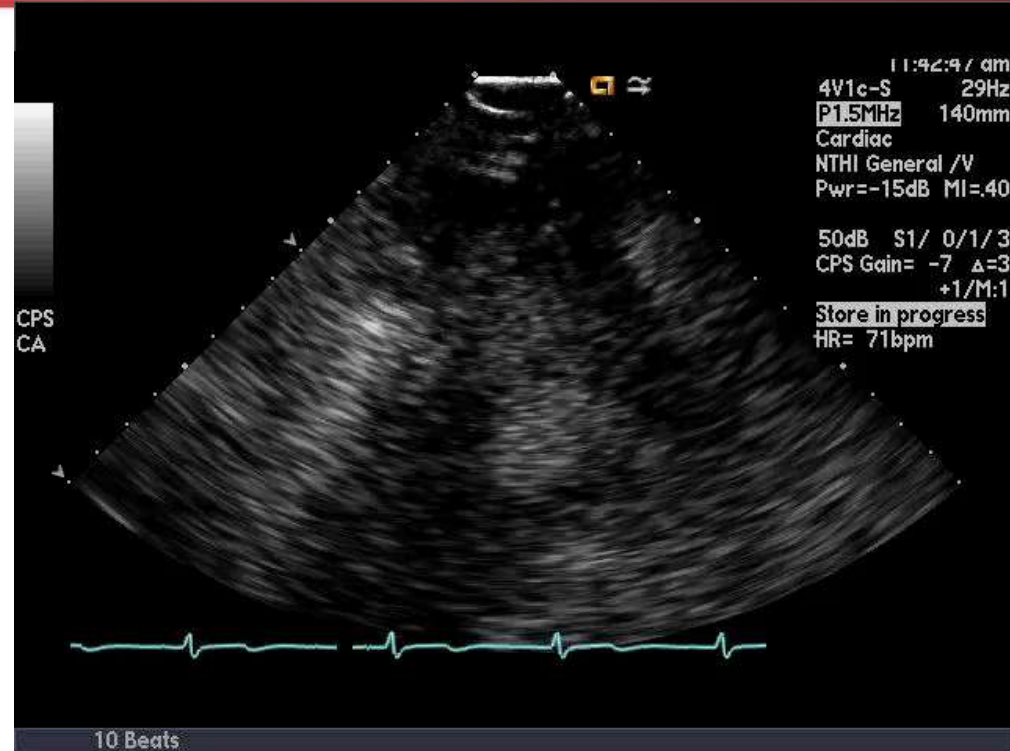
RESPIRATORY INTERFERENCE

CAUSES

- Patient breathing
- Lung placement

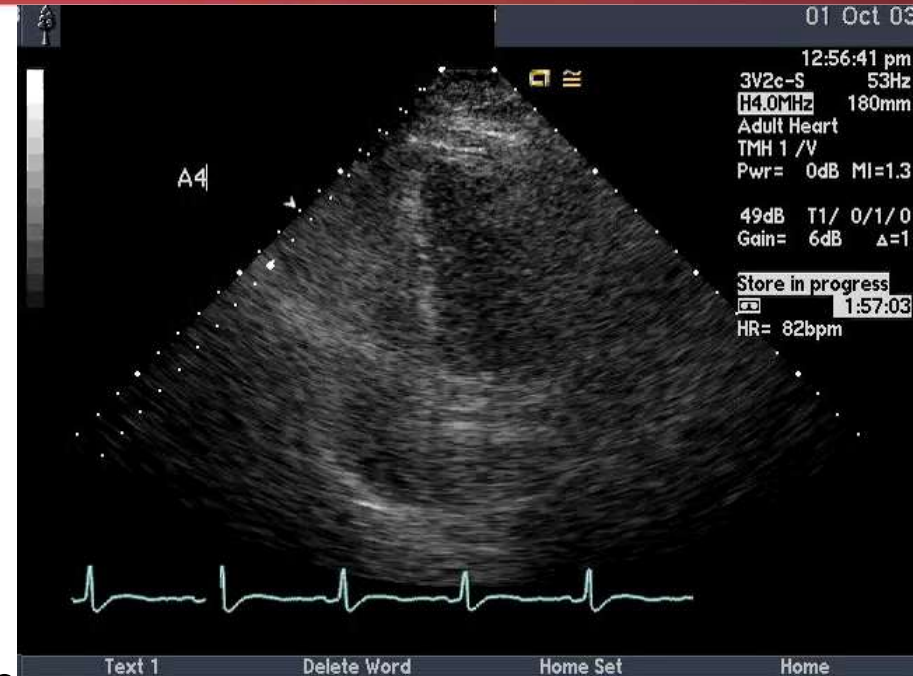
CORRECTION

- Reposition patient
- Observe pt respiratory cycle
- Explain to pt about holding breath when told

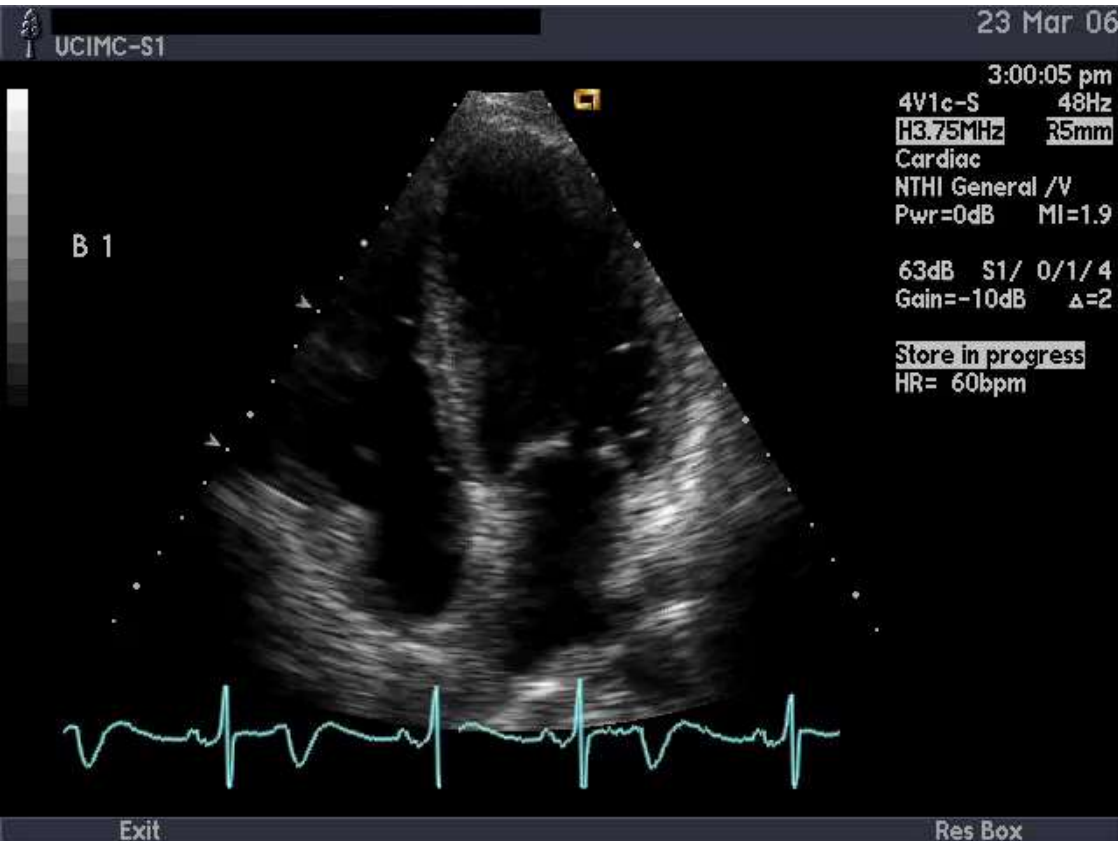


No Contrast Effect

- Slow heart rate
- Possible infiltration
- Deflate BP cuff
- Straighten patient's arm
- Stopcock position
- Insure that contrast was activated

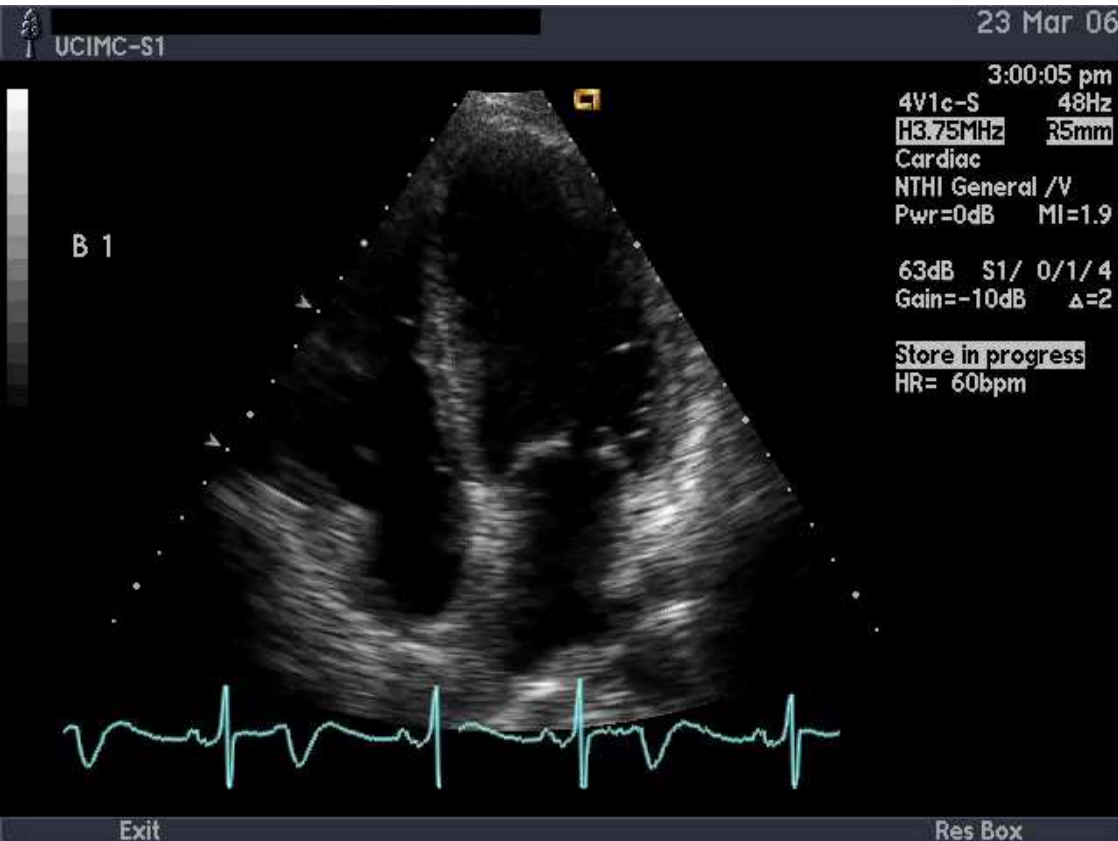


Name this agent...



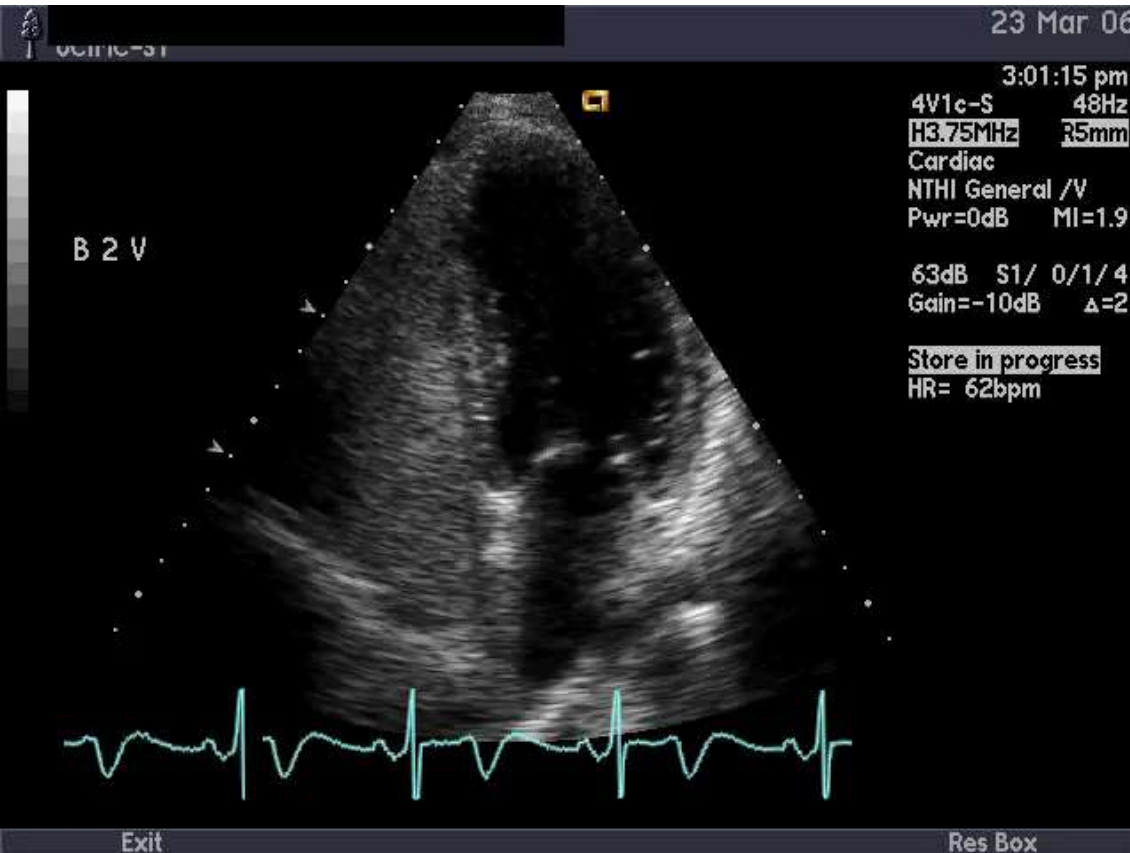
- Dobutamine
- Agitated Saline
- Optison
- Definity

Name this agent...



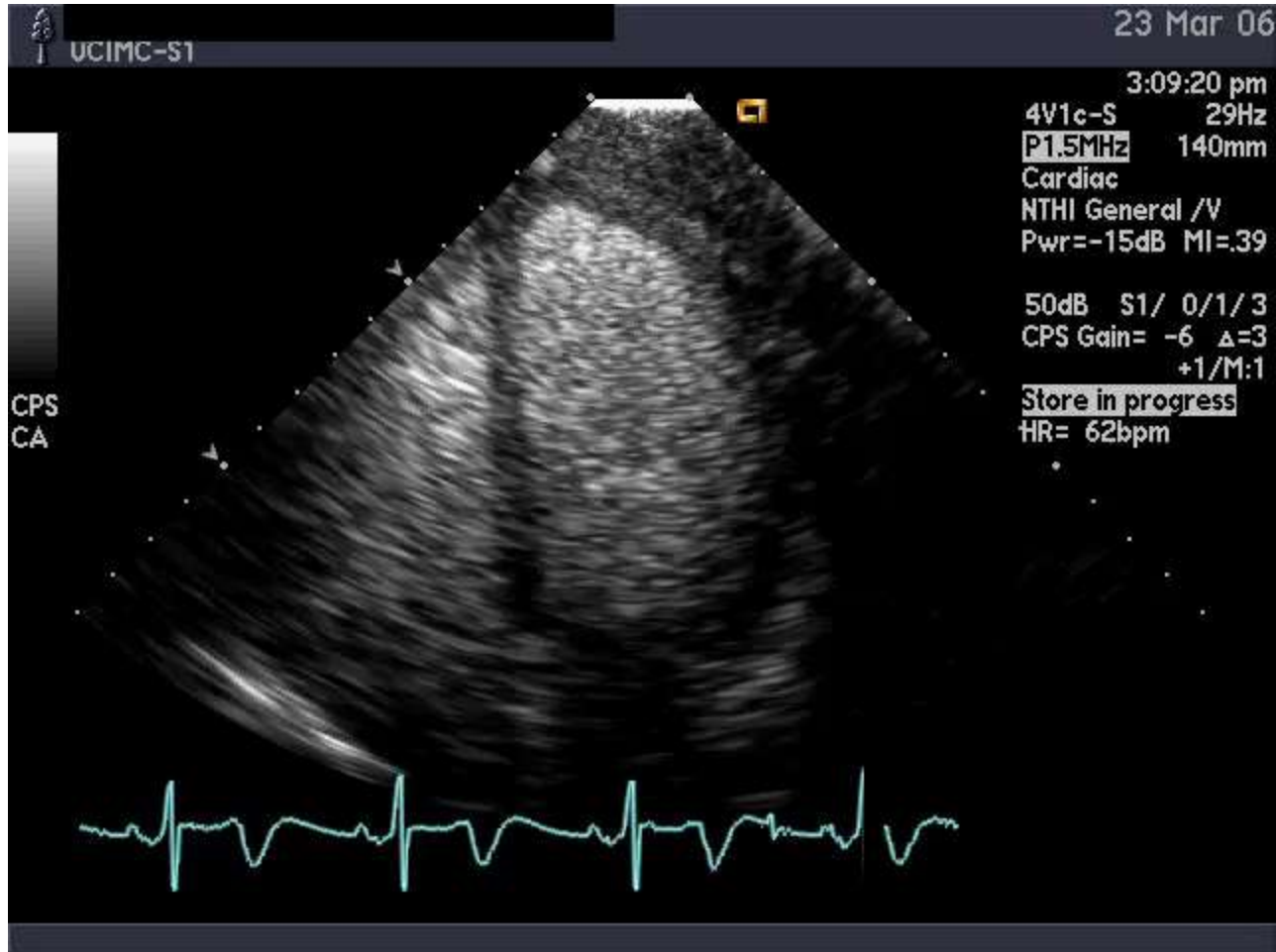
- Dobutamine
- Agitated Saline**
- Optison
- Definity

The following represents...



- a. PFO
- b. VSD
- c. ASD
- d. None of Above

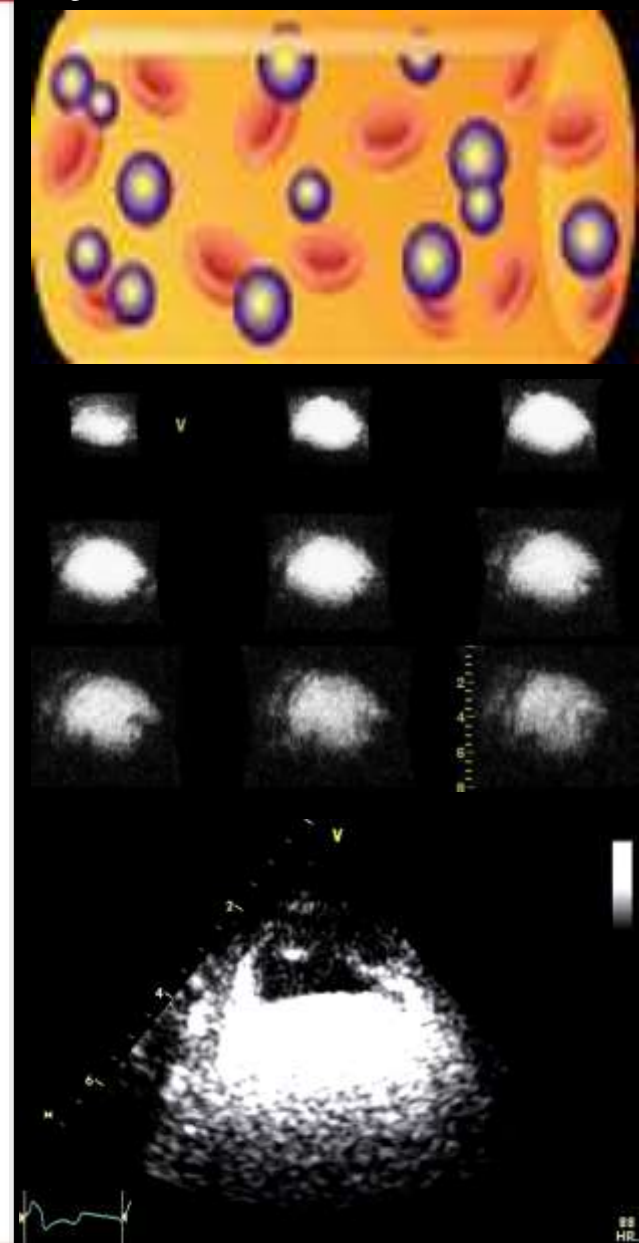
Agitated Saline Administered Post Contrast



Enhanced Echocardiography

Summary

- Non toxic – easily eliminated
- Traverse pulmonary bed
- Instrumentation and controls
- Improved determination of
 - LV volume
 - Regional and global LV function
- Improved visualization
- Rescue of non-diagnostic exams
- Detection of structural abnormalities
- Doppler signal enhancement



Thank You!

