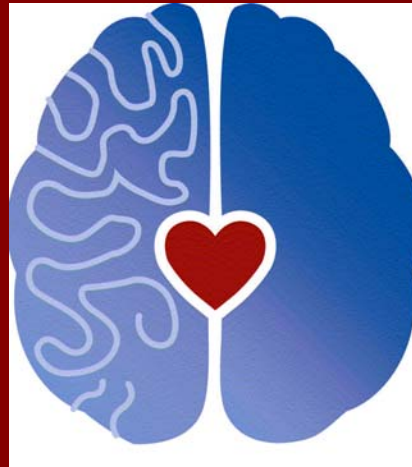


PARADOXICAL EMBOLISM: Making sense of ASD / PFO shunt studies



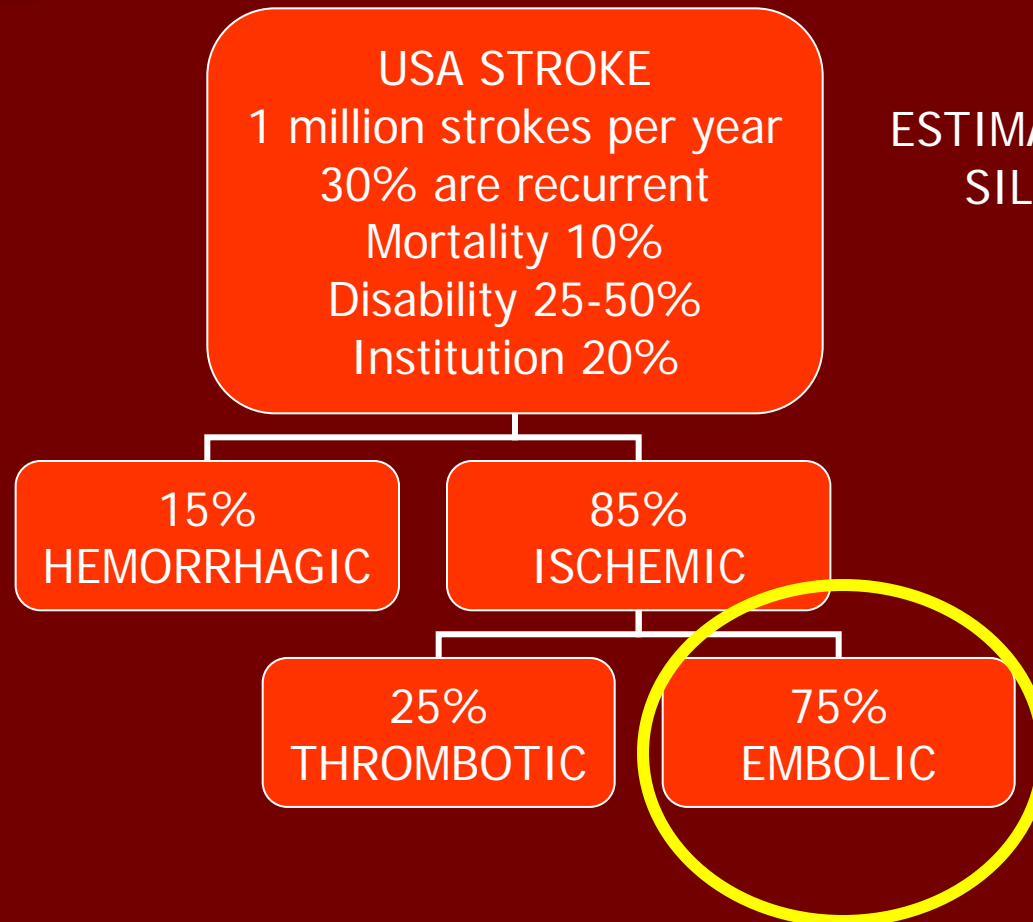
SHERMAN G. SORENSEN MD
SORENSEN CARDIOVASCULAR GROUP

DISCLOSURE

NOTHING TO DISCLOSE

CAUSES OF STROKE

Understanding the many different causes of stroke

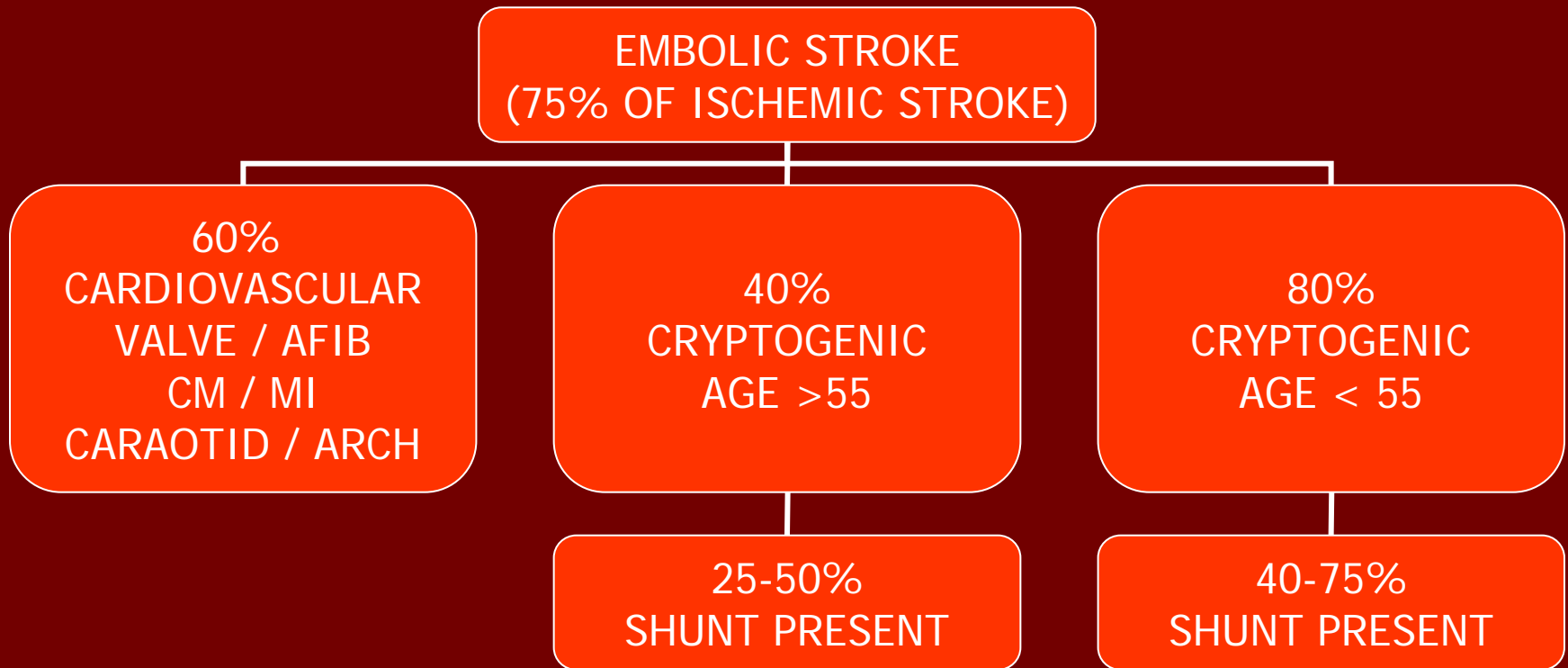


ESTIMATED 4-10 MILLION
SILENT STROKES

SOURCE: NINDS DATA BASE
AAN GUIDELINES 2006
REGARDS I, II, III

CRYPTOGENIC STROKE

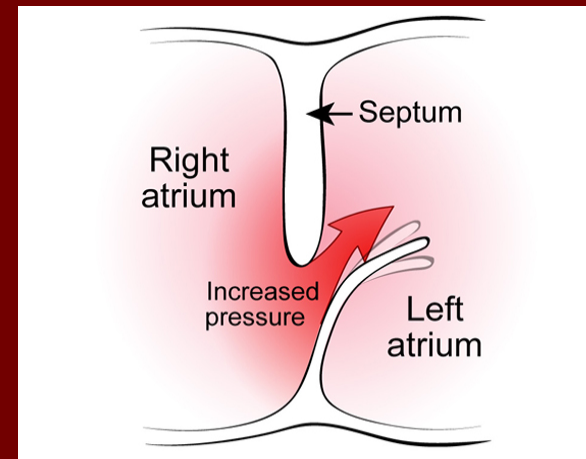
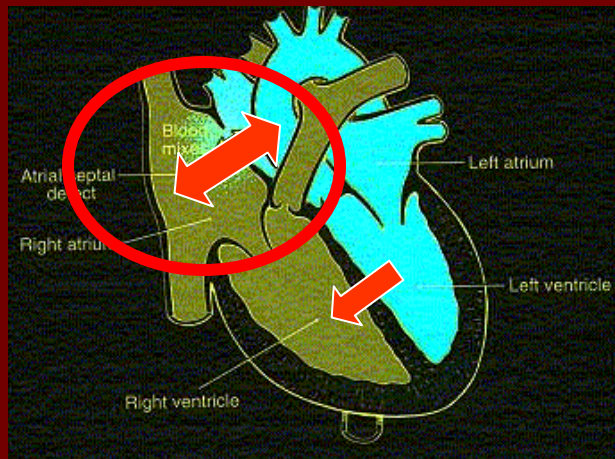
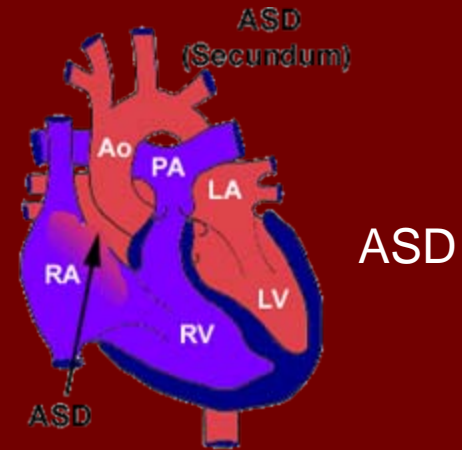
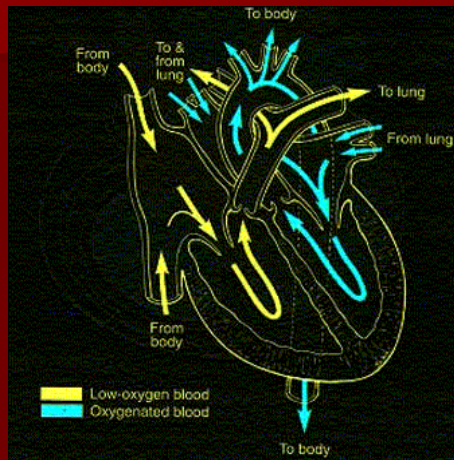
PARADOXICAL EMBOLISM AND SHUNT



NINDS DATA BASE
AAN 2006 GUIDELINES

INTRA-CARDIAC RIGHT-TO-LEFT SHUNTING

The mechanism of paradoxical embolism



IN HEALTHY ADULTS, RIGHT-TO-LEFT SHUNT IS UNIQUE TO ASD, PFO, AVM

Septal defects increase adverse outcome in a large and varied set of conditions

MACRO-EMBOLIZATION

- CVA /TIA
- LIVER TRANSPLANTATION
- SURGERY ; ORTHOPEDIC
- CV SURGERY
- PREGNANCY
- AIR TRAVEL
- CENTRAL LINES
- HYPER-COAGULABILITY
- SLEEP APNEA
- DVT / PULMONARY EMBOLI
- PULMONARY HYPERTENSION

MICRO-EMBOLIZATION / "HUMOURS" / O2

- HYPOXEMIA
- +PRESSURE VENT
- SLEEP APNEA
- COGNITIVE DYSFUNCTION
- ORTHODEOXIA /
PLATYPNEA
- DIVERS BRAIN / ++MRI
- DECOMPRESSION ILLNESS
- MIGRAINE HEADACHE
 - MIGRAINE STROKE
 - MIGRAINE WMH LOAD

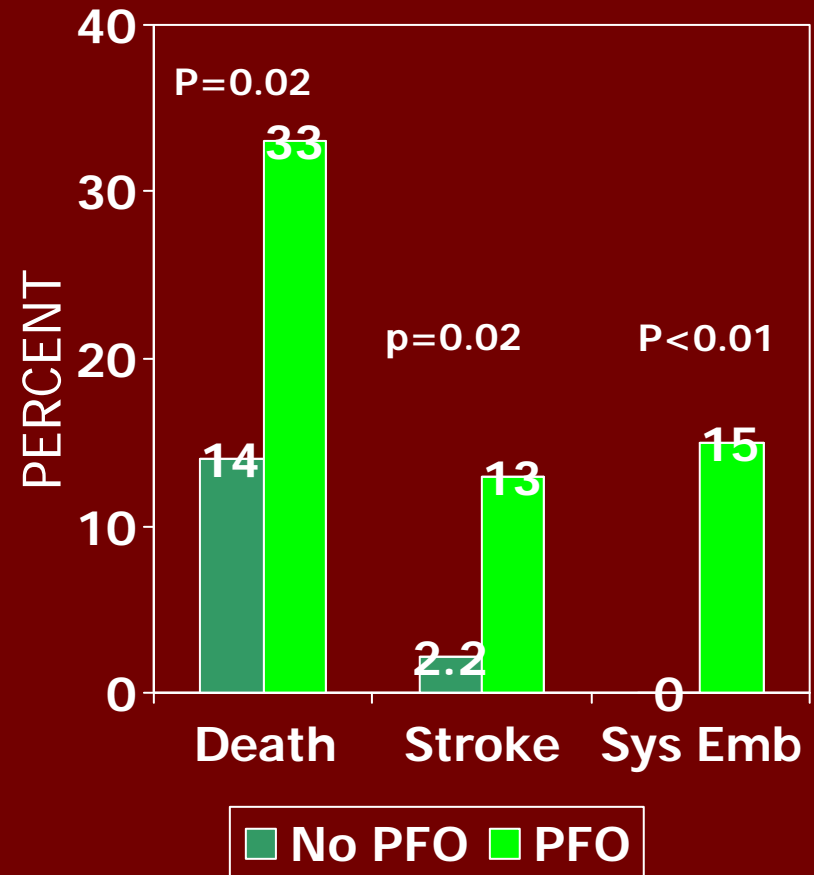
PARADOXICAL EMBOLIZATION IS GREATLY UNDERDIAGNOSED SINCE IT OCCURS AT LOWER RATES IN A BROAD RANGE OF DISCIPLINES.



PFO as a Predictor of Adverse Outcome in Patients with Major Pulmonary Embolism

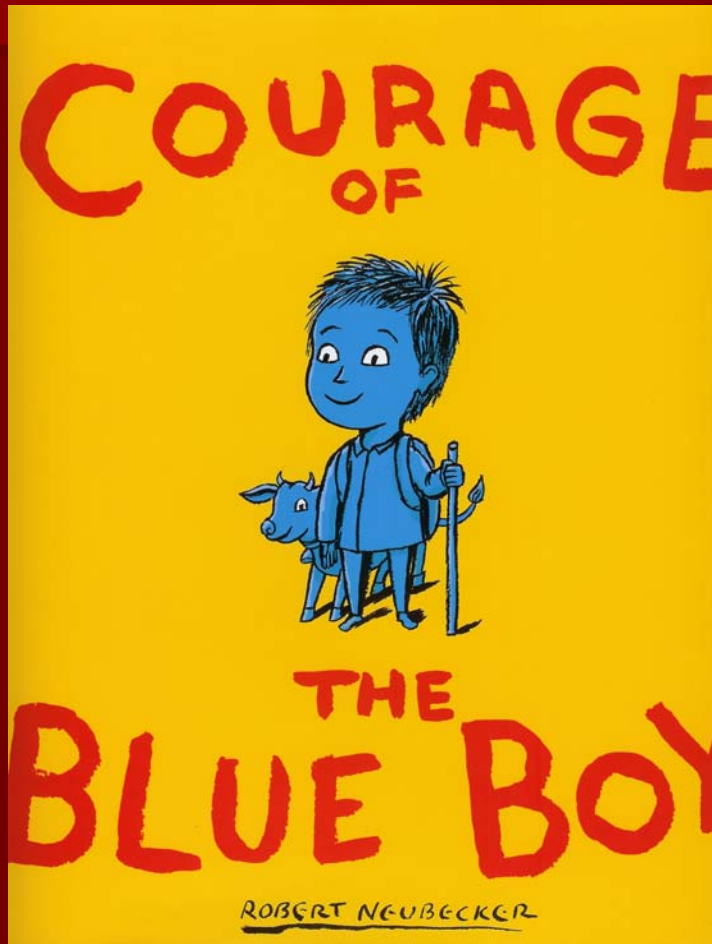
Konstantinides S et al. Circulation 1998; 97:1946

- 139 patients with major pulmonary embolism undergoing TEE
- 48 patients with PFO
- 91 patients without PFO
- Clinical endpoints
 - Death
 - Cerebral embolism stroke
 - systemic embolism
- PFO = independent predictor of death, CVA, peripheral embolism
- Mechanism: Paradoxical embolism



BLUE BABIES

What cyanotic congenital heart disease children can teach us about PDE



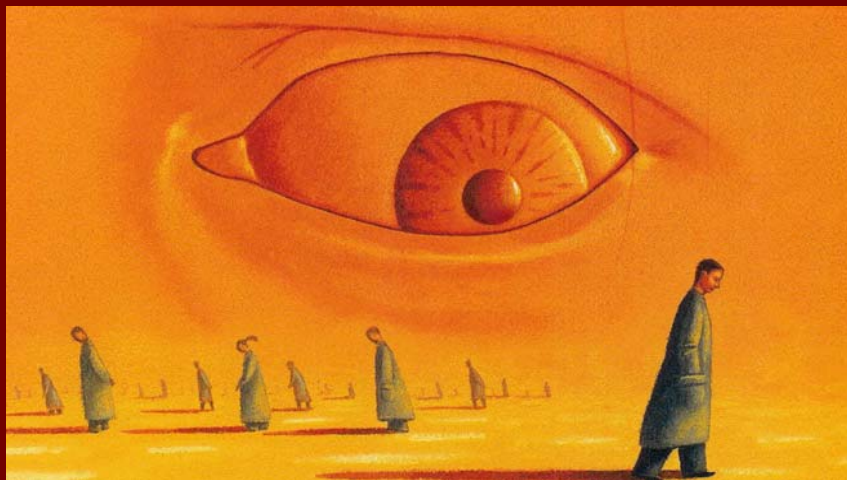
- Schmaltz
308 children / 8 year follow-up
13% Neuro events (CVA, BA)
- Mahle
24% PVL/infarct by MRI
67% new or worse MRI with surgery
- Conclusions: SHUNT RISK =
 - 1) *Size of shunt*
 - 2) *Duration of shunt*
 - 3) *Venous constituents*
 - 4) *Medical Procedures*

NOT ANATOMY SPECIFIC
ANATOMY / DEFECT TYPE ONLY
RELEVANT AS IT RELATES TO SIZE
AND DURATION

Source: Schmaltz AA et al; Monatsschr Kinderh 1980;128:606
Hirsch R et al; Isr Med Assoc 2006; 8:798
Mahle WT et al; Circulation 2002; 106:1109

WHY ALL THE FUSS AND CONFUSION?

How tiny bubbles confused us all.

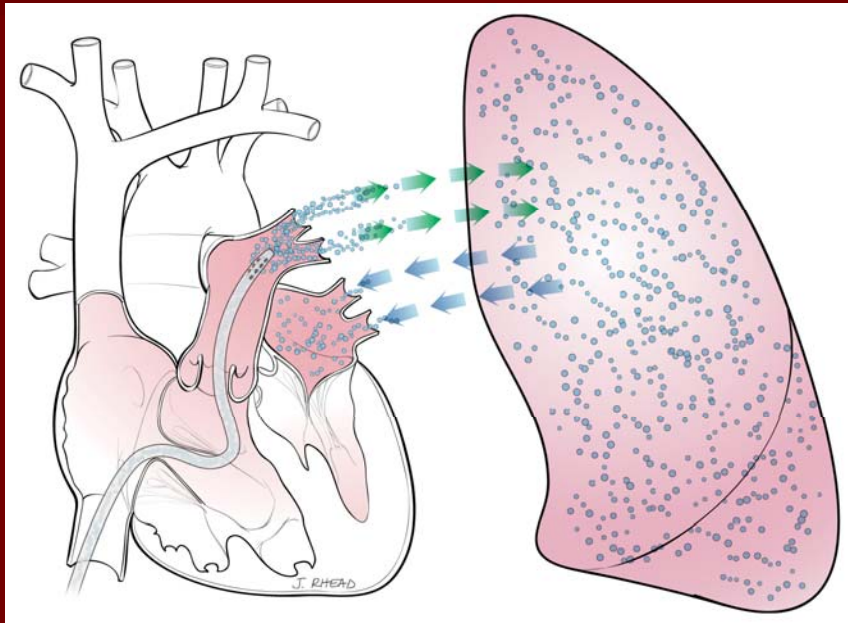


MYTHS OF SHUNT EVALUATION

- Any bubble = a PFO
- All PFOs are the same
- ASDs only shunt left-to-right
- TEE is the "gold standard"

MYTH

“Any bubbles seen in the left heart = the diagnosis of PFO.”



- 50 consecutive closure patients
- selective PA “bubble” injection
 - ICE imaging of LA
 - ICE imaging of pulmonic valve
 - Direct PA Nipride

■ TROUBLE WITH BUBBLES

- LA bubbles 83%
- Nipride increase 38%
- women > men
- Bubble latency in most

■ FALSE + BUBBLES

MIST 7%

ICC / SPENCER 24%

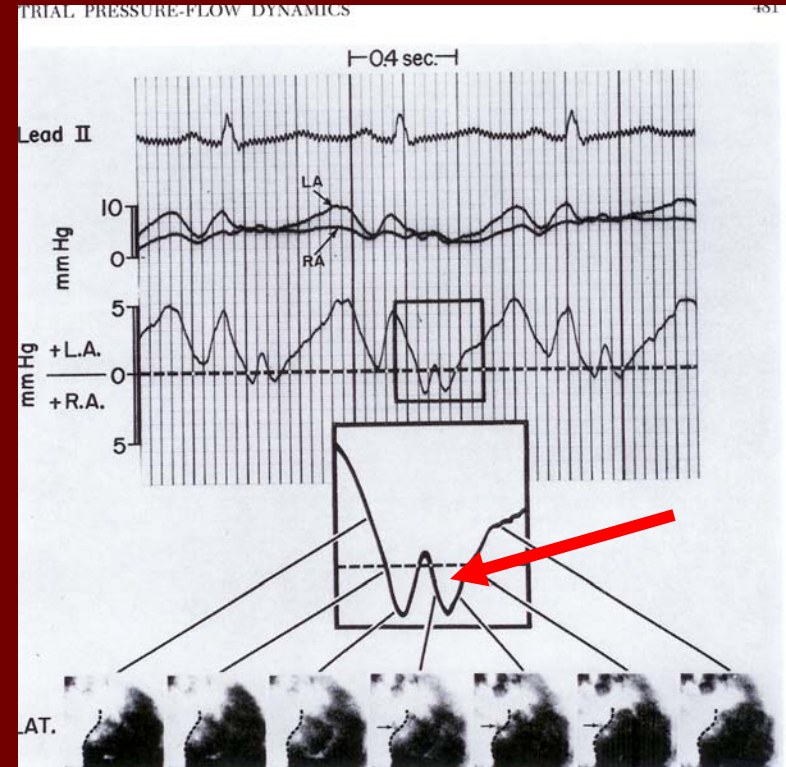
MAS 14%

MYTH

“ASD only have left-to-right shunt.”

- ASD TREATMENT IN ADULTS OVER 40
- PDE / CVA 5% of surgical patients
- PDE / CVA accounted for 15% of adverse events in the medical arm
- Surgical ASD repair for prevention of PDE

Konstantinedes S et al; NEJM 1992



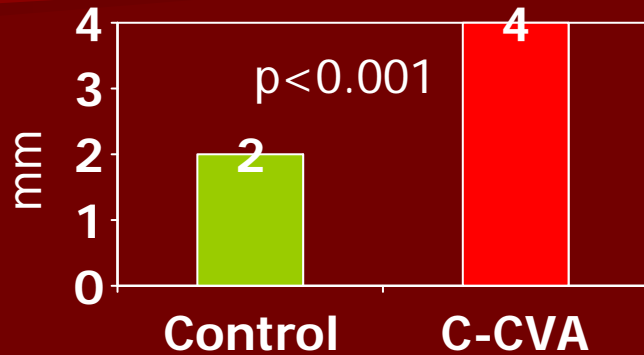
ASD are the least restrictive
Rest shunt occurs in ASD
with normal PA pressures

Levine AR et al Circulation 1968;374:476

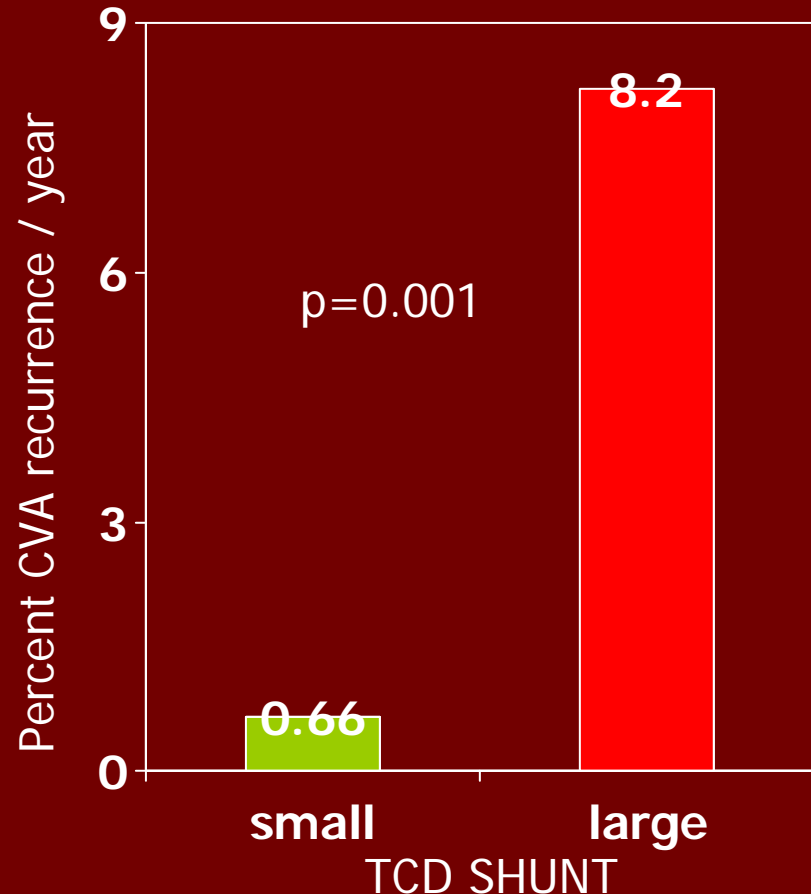
MYTH: ALL PFO ARE THE SAME

“Size matters.”

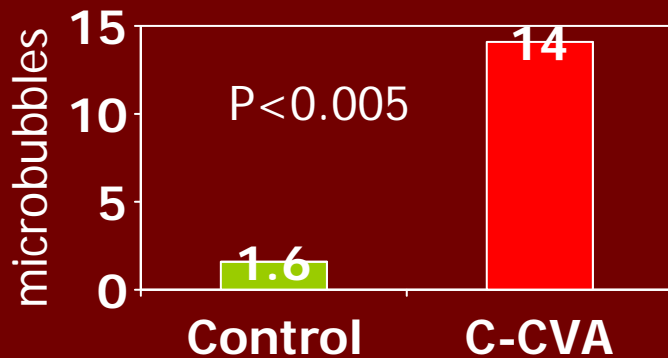
Anatomic Size



TCD Shunt Severity



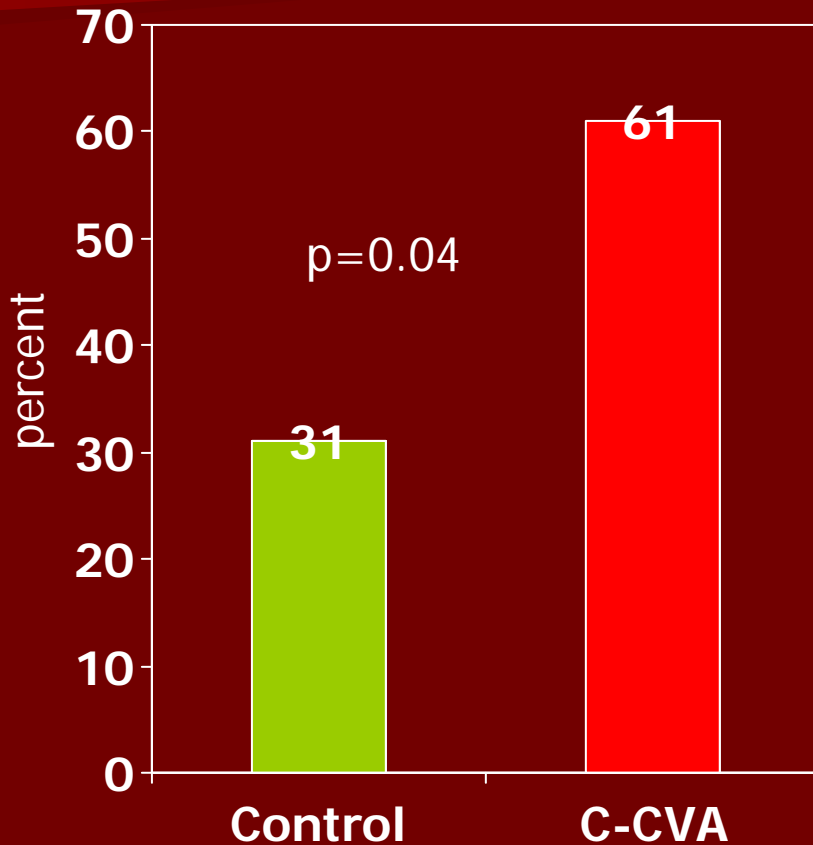
Physiologic Size



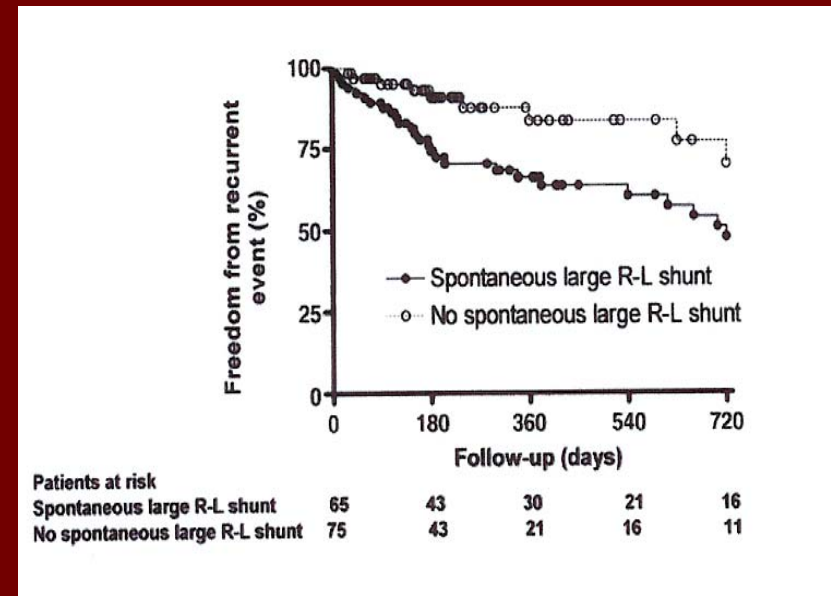
MYTH: ALL PFO ARE THE SAME

Rest Shunt: "Duration matters."

Any R-L Rest Shunt



Rest Shunt and Stroke in Migraine



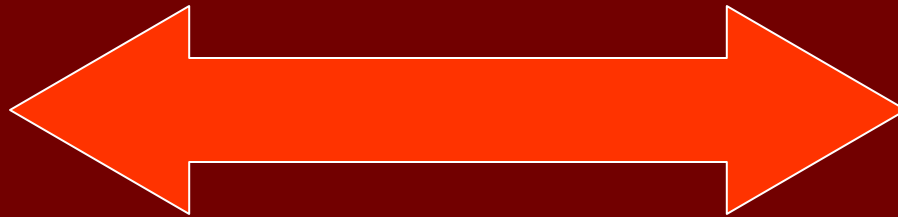
Giardini A Int J Cardiol 2007; 120: 357

MYTH: SHUNT TESTING AND TEE

Shunt quantification matters most

BEST SHUNT EVALUATION

BEST ANATOMY EVALUATION



TCD

Sensitive
Inexpensive
Quantitative
Severity
Duration
Reproducible
No risk
Minimal discomfort

TTE

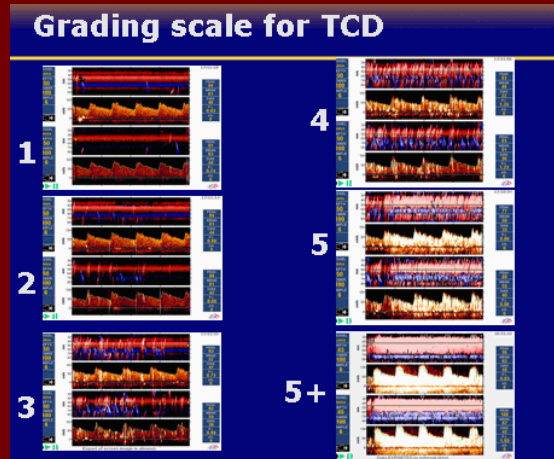
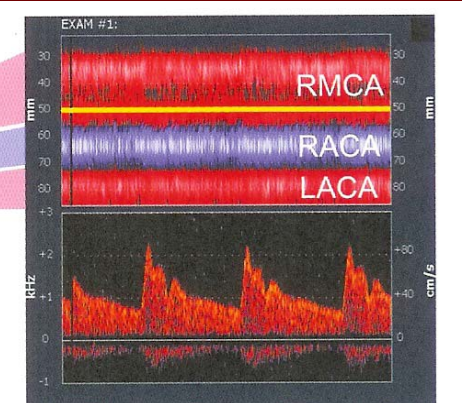
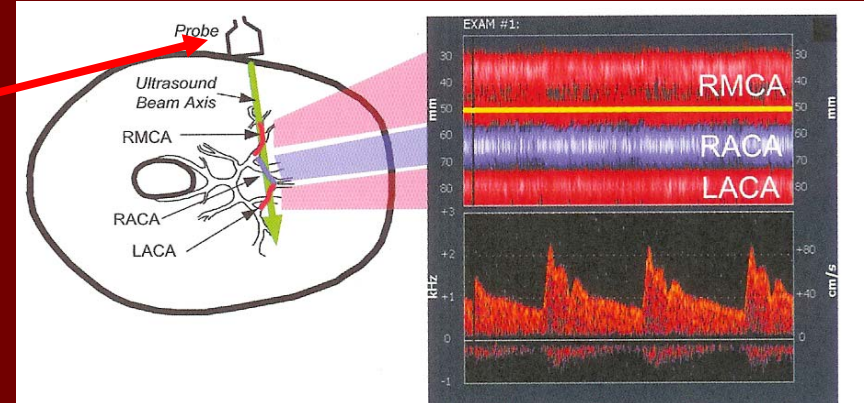
Good for adult anatomy
Combined with TCD
-cost effective
-available
-Specific atrial anatomy
procedurally important

TEE

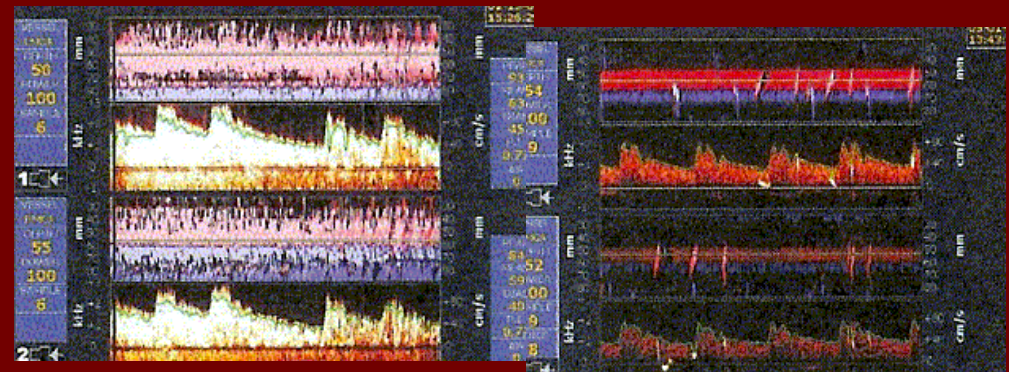
Best for anatomy
Worst for shunt
Expensive
Some risk
Hospital setting
Uncomfortable

CAN WE QUANTIFY RIGHT-TO-LEFT SHUNT?

TCD for RLS detection and quantification



SPENCER GRADING



BEFORE CLOSURE

3 MONTHS POST

CONCLUSIONS

- Paradoxical embolism due to atrial level right-to-left shunt is emerging as a major cause of neurological and other injury. New treatment options compel reliable assessment and quantification of shunt.
- The “any bubble” diagnosis of PFO is incorrect