

Lessons Learned: CO2 Angiography in the OIS

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Disclosures

Speaker's Bureau:

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- Lake Regional Medical
- Medtronic
- Philips Volcano

PITFALLS OF IODINATED CONTRAST

- Contrast induced nephropathy and acute renal failure
 - Rise of serum Cr 0.5 mg/dl
 - Rise of serum Cr greater than 25% baseline
- Contrast allergy
- Highly viscous which may limit visualization of critically stenotic vessels and makes injection via long or small bore catheters difficult

CIN (Contrast Induced Nephropathy)

- 3rd most common cause of hospital acquired acute renal failure (behind shock and nephrotoxic drugs).
- Dramatically increases mortality, morbidity, length of stay, and cost.
- Average increased cost \$10,345 in hospital and \$11,812 1st year.
- Only absolute prevention is no iodinated contrast.

Nash et al; Am Jour Kidney Dis.

Subramanion, S e tal; J Med Economics N:2007:119-134

Dangas, G et al; AmJCardio. 95 2005:13-19

Lindsey, J et al; AmJCardio. 94 2004:786-789

INDEPENDENT CIN RISK FACTORS

From: A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: Development and initial validation

J Am Coll Cardiol. 2004;44(7):1393-1399. doi:10.1016/j.jacc.2004.06.068

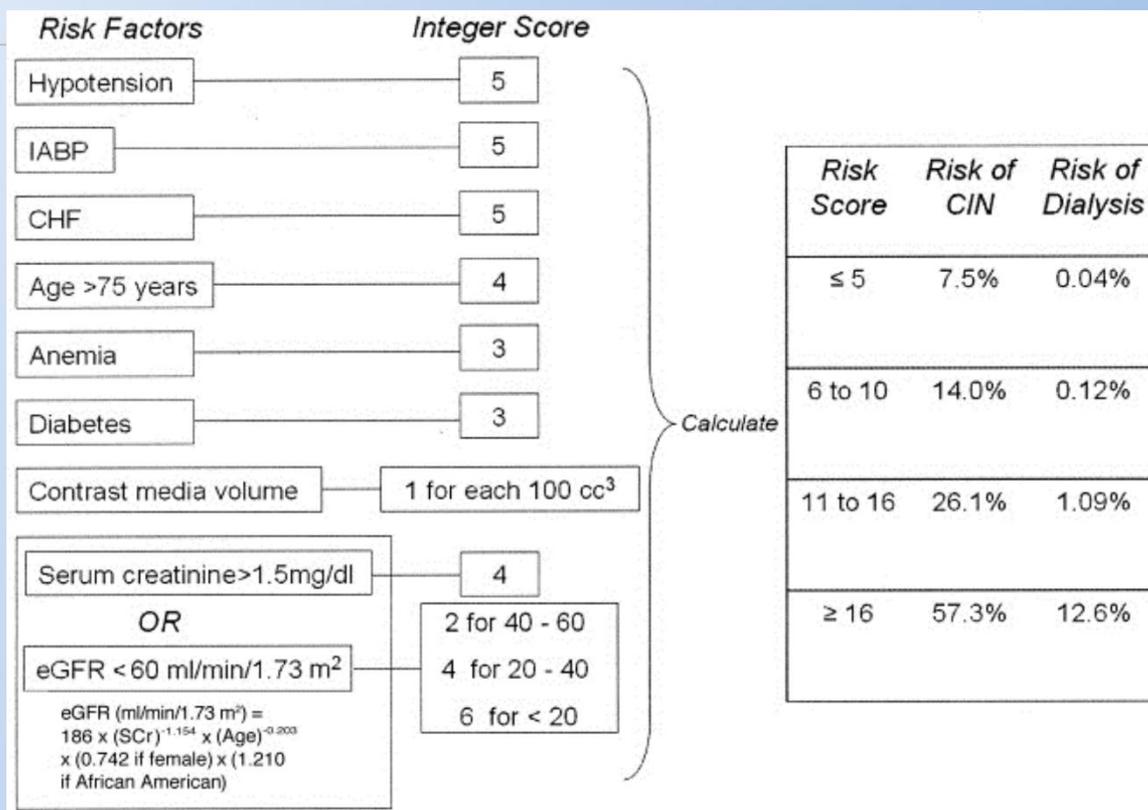


Figure Legend:

eGFR (ml/min/1.73 m²) =
 $186 \times (\text{SCr})^{-1.154} \times (\text{Age})^{-0.203}$
 $\times (0.742 \text{ if female}) \times (1.210 \text{ if African American})$

Scheme to define contrast-induced nephropathy (CIN) risk score. Anemia = baseline hematocrit value <39% for men and <36% for women; CHF = congestive heart failure class III/IV by New York Heart Association classification and/or history of pulmonary edema; eGFR = estimated glomerular filtration rate; hypotension = systolic blood pressure <80 mm Hg for at least 1 h requiring inotropic support with medications or intra-aortic balloon pump (IABP) within 24 h periprocedurally.

From: A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: Development and initial validation

J Am Coll Cardiol. 2004;44(7):1393-1399. doi:10.1016/j.jacc.2004.06.068

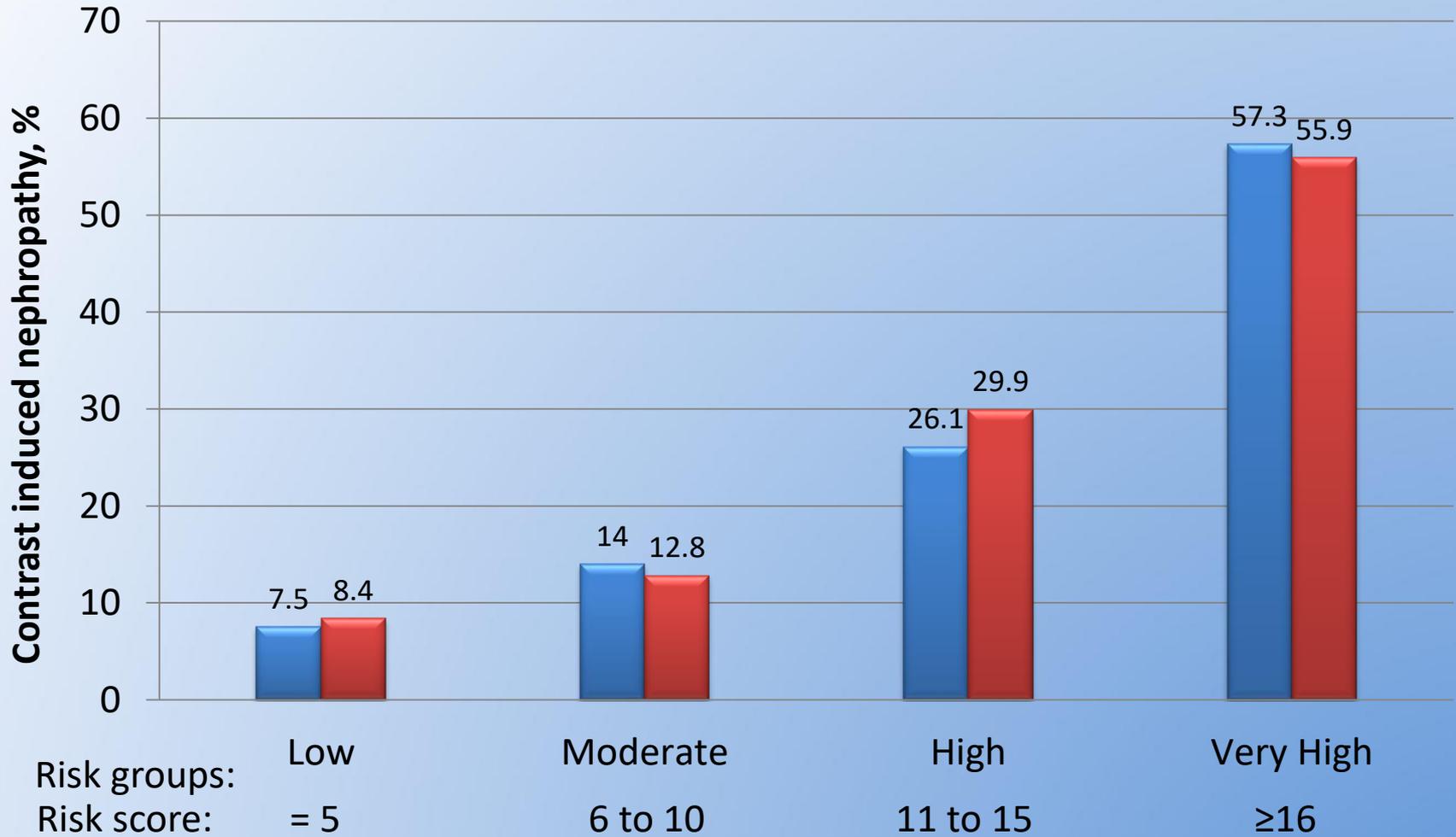


Figure Legend: The contrast-induced nephropathy risk score derived from the development dataset predicted this complication in the validation set, as well. Blue bars = development dataset; Red bars = validation dataset.

Risk of dialysis

From: A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: Development and initial validation

J Am Coll Cardiol. 2004;44(7):1393-1399. doi:10.1016/j.jacc.2004.06.068

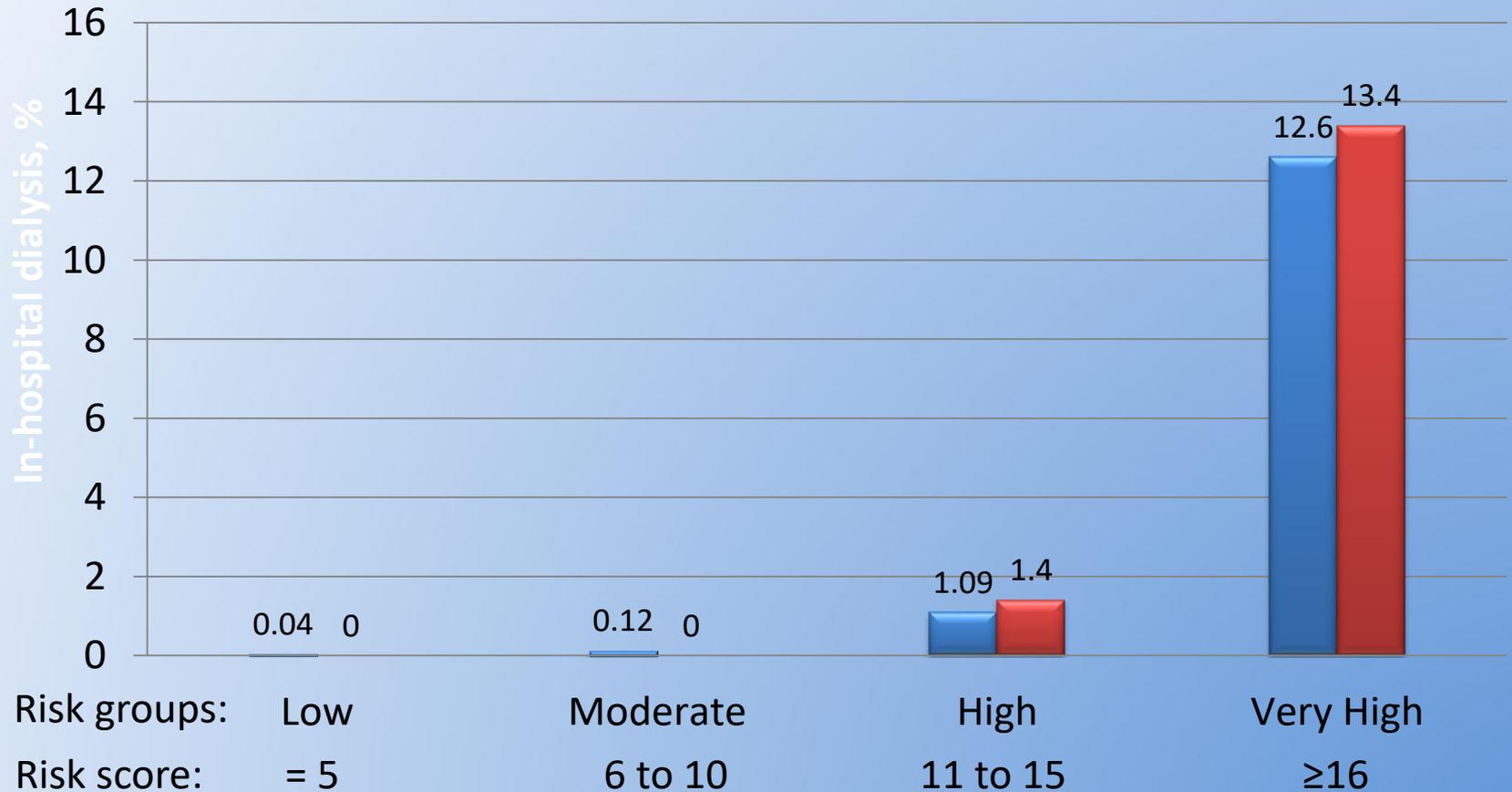


Figure Legend:

In-hospital hemodialysis can be predicted by a high or very high risk score value similarly in the development and validation datasets. Blue bars = development dataset; Red bars = validation dataset.

CIN RISK IS INCREASING IN PAD CASES

- Diabetes is epidemic
- More interventions are being performed
- More complex interventions (limb salvage)
- Older patients

CONTRAST ALLERGY

- Minor allergies and Anaphylaxis
 - Pre-medications required
 - Patient apprehension
 - Mortality risk

GAS X-RAY IMAGES

- X-ray travels more easily through gas therefore the image is the negative of that created by iodinated agents.
- There is less contrast therefore motion severely impairs image quality.

CHARACTERISITICS OF CO₂

- Non-toxic (no allergic response or nephrotoxicity)
- Non-flammable
- Buoyant
- Compressible
- Low viscosity
- Highly soluble (>40x more soluble than O₂ which is far more soluble than nitrogen)

OPTIMIZING CO2 IMAGES

- Requires DSA imaging.
- Use end-hole catheters (less bubbles). Place the catheter as close to the artery to be imaged as possible.
- Slow low-pressure injection
- Recognize that gravity affects imaging. May need to elevate lower leg, renal artery imaging may require rotation of patient if non-selective.

Correlation with Iodinated Contrast

- Seeger demonstrated close correlation in peripheral arterial imaging.
 - 92% when CO₂ was utilized as sole agent
 - 100% when supplemented by small doses of iodinated contrast.

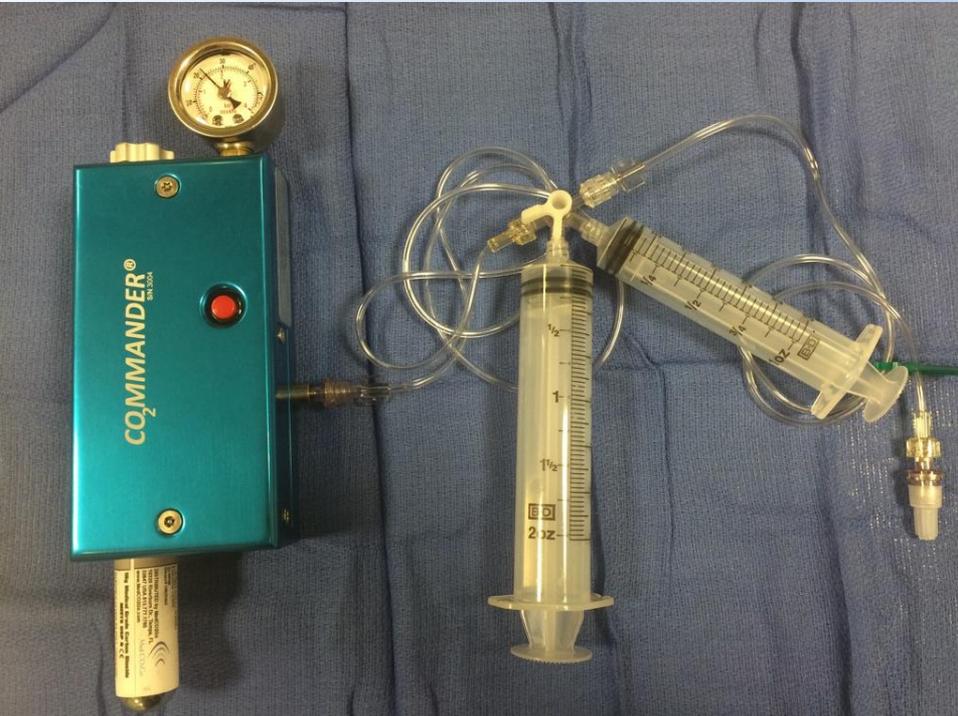
POSITIVES OF CO₂

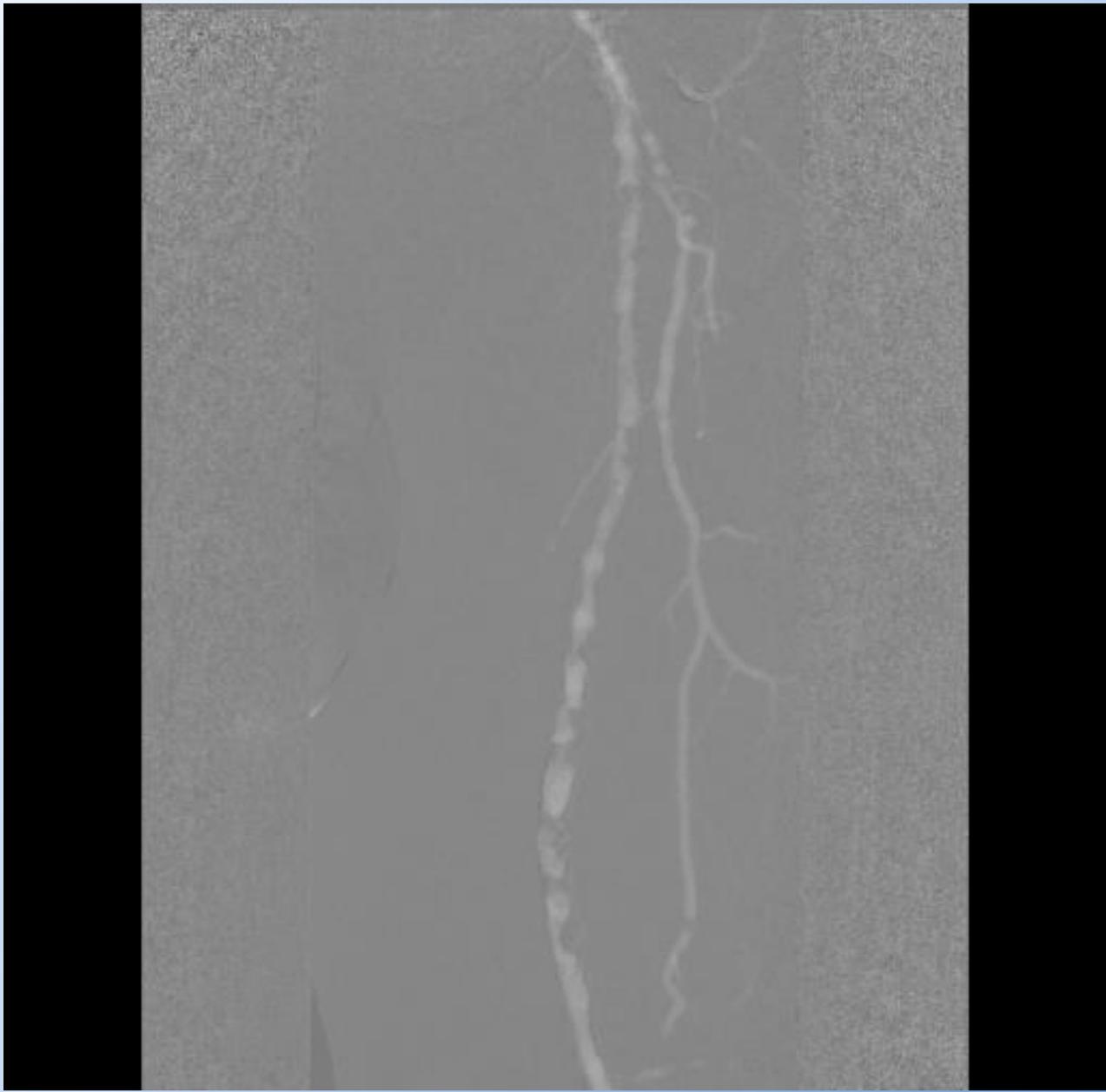
- No renal toxicity
- No dose limitations
- Can image via longer and smaller bore catheters because of less viscosity
- Less cost

NEGATIVES OF CO₂

- More radiation
- Must have CO₂ settings
- Most systems don't allow road mapping
- Motion artifact dramatically limits imaging
- Overlying gas may limit imaging
- May be sub-optimal in very large vessels
- Image quality slightly less crisp than iodinated contrast
- Can't use to image cerebral or coronary vessels

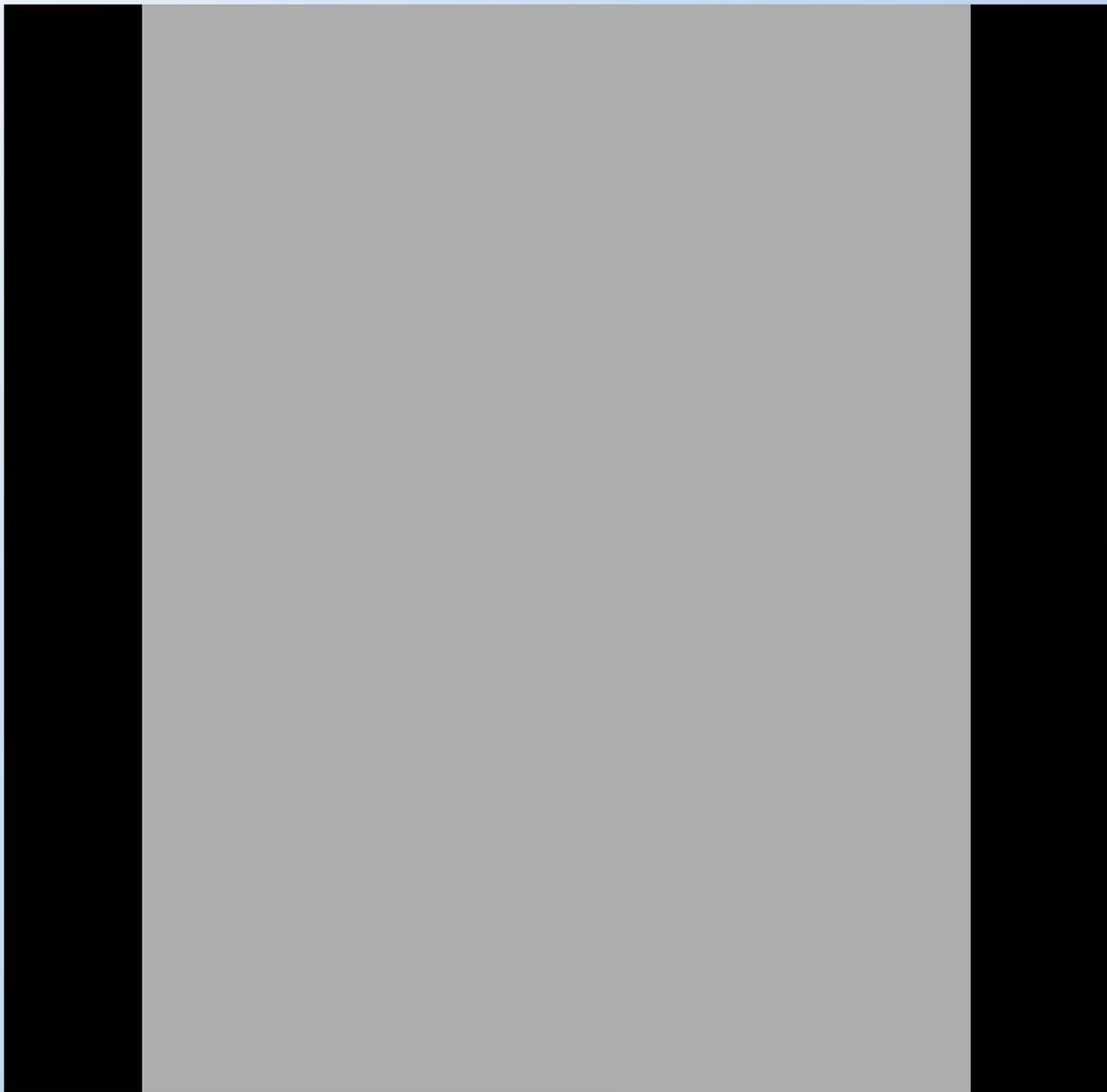
CO2 COMMANDER













Lossy



WHY CONSIDER CO₂ ANGIO

- Avoiding contrast induced nephropathy
 - Rise in serum Cr > .5 mg/dl
 - Rise of serum Cr > 25% baseline
- Avoiding severe allergic response
- Lower viscosity
 - Can image via smaller bore longer catheters
 - Can image with close tolerances (6F compatible device in 6F sheath as example.)
 - Occasionally allows visualization of critically stenotic grafts that appear totally occluded by iodinated contrast images.
- Cost
 - Two cents/cc vs. \$1.00
 - Indirect costs (longer stays, meds, dialysis, etc.)

CONCLUSION

- The only way to absolutely avoid CIN is to not administer iodinated contrast.
- In PAD there are viable options
 - External duplex guidance
 - CO2 angiography- THIS HAS TOTALLY CHANGED MY PRACTICE
 - 1) No renal function too impaired
 - 2) No limit on imaging – better results
 - 3) No pre-admission or prolonged stay
 - 4) Can image with smaller catheters (less viscous)

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