ICMR Case Presentations: Lessons From Year One

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February 1st 2018

Disclosures

- None

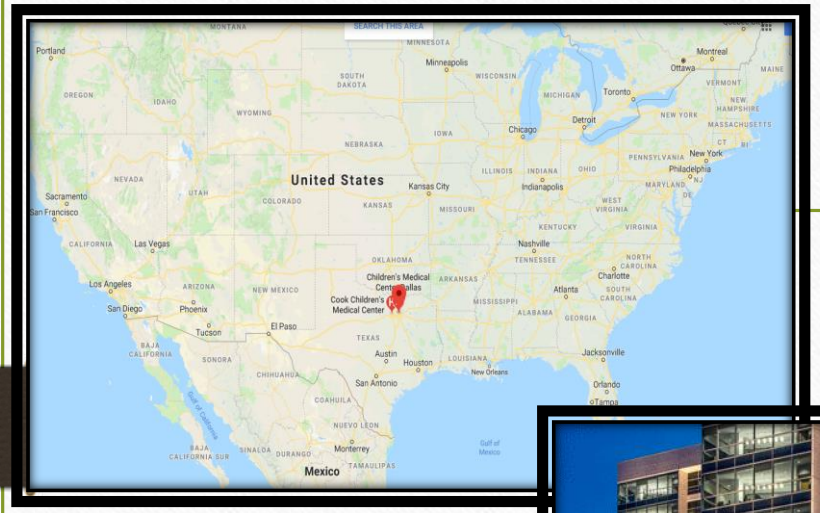
Outline

- Journey
- Infrastructure – MRI, Cath lab
- Process
  - Buy in - Institution and Colleagues
  - Funding
- Cases – Initial experience/lessons
- Missing Pieces
- Future

JOURNEY

- 2011-12: New Heart Center Surgical-Interventional Suites planning – Dr. Nugent and team
  - Cath lab and MRI- colocation planned, Phillips, no rail road, Marquet table (too expensive)
- 2013: New Heart Center – 78 Million Dollar renovation
- 2014 - Discussed visiting labs/centers for iCMR hands on – stalled as 'Migration' across the pond was imminent
- 2015: iCMR potential- discussed with Drs. RL and KR
  - Arrival of Drs. Greil and Hussain
- 2016 April: iCMR NHLBI Hands-On Workshop
  - Started meetings with MRI safety officer, planning at CMC, Dallas
- 2017 Jan-July: Planning, CMRI safety and institutional approvals, IRB, Safety checklists, dry runs/evac drills
- 2017 August: First iCMR case

INFRASTRUCTURE – DALLAS, TEXAS



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DALLAS COWBOYS

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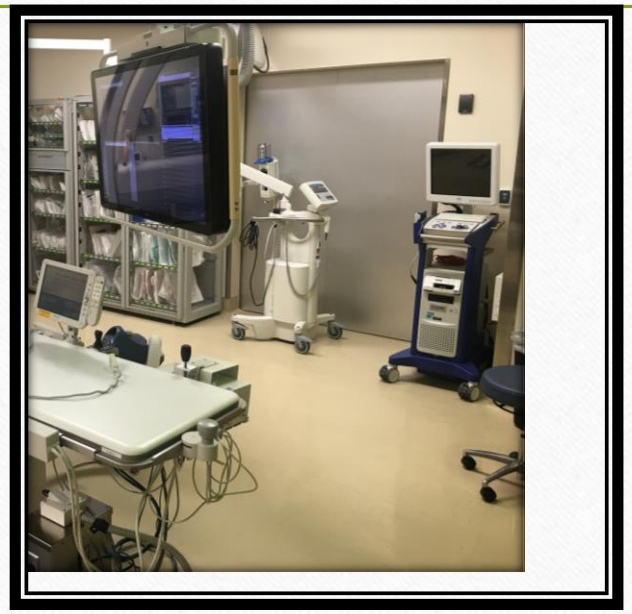
MRI and Cath Lab - Colocation

Hybrid Cath/OR Suite – within red line



Phillips Ingenia 1.5 T

Opens to red line and to outpatient via separate doors

PROCESS - Details

- Post Hands-On Workshop - Met with institutional leadership to get buy in
- Buy in from Cardiology colleagues – some initial success, ongoing proccess
- Meetings with MRI safety officer at CMC – discussed work flow, thanks to material and videos from the NIH team
  - Having oldies - Gerald and Tarique as part of the team helped to get approvals right away
- Cath lab, Anesthesia, and MRI staff/nursing – discussed steps and why this is important!
  - Give them ownership of certain aspects and ask for suggestions
  - Delegated work flow and safety checklists
- Jan-July 2017: Planning, CMRI safety and institutional approvals, IRB, Safety checklists, dry runs/evac drills

Its been 2 years!

Let's Just Do It!

- Funds approved (Not ready for use)
- No I suite (Interactive)
- No combi table ("Biceps technology")
- No PRiMe Gen (Anesthesia monitors)
- No Optoacoustics (Sign language)
- No projectors/large screens (pt's TV for movies)
- Tired of waiting → 

- IRB approval
- August 2017: First iCMR case at CMC, Dallas!

Before first case – August 2017

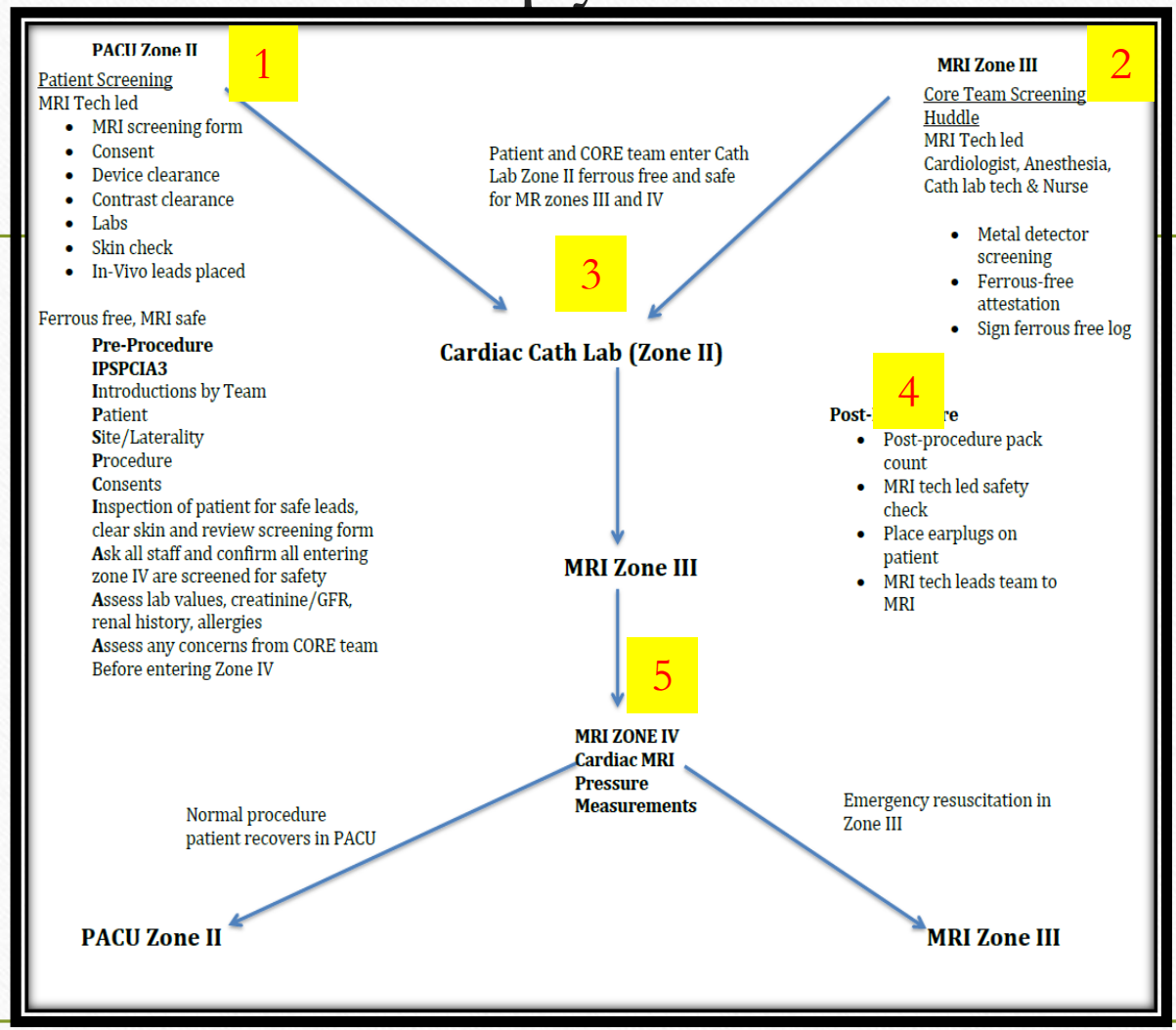
- Dry Run/Mock Drills Completed with core team and MRI safety officer X 2
  - Debrief after first one and made changes
- Clinical scenarios
  - Cath→MRI→Recovery
  - Cath→MRI→Cath→Recovery
- Complications: Patient evacuation to Zone III versus direct to cath lab reviewed
  - Specific roles and Personnel in charge assigned

Work Flow

CMR Fluoroscopy RHC

- Formed Core Team:
  - To keep same operators/anesthesia doc/nursing team for the first five cases
- Scheduling - Single dedicated admin calls pt/families for scheduling
- Insurance approvals – Clinically indicated Cath procedure, MRI clinical versus research to be specified, funds for 5 research based MRIs
- Consent at precath clinic visit or in Preop area

CMR Fluoroscopy RHC - Work Flow



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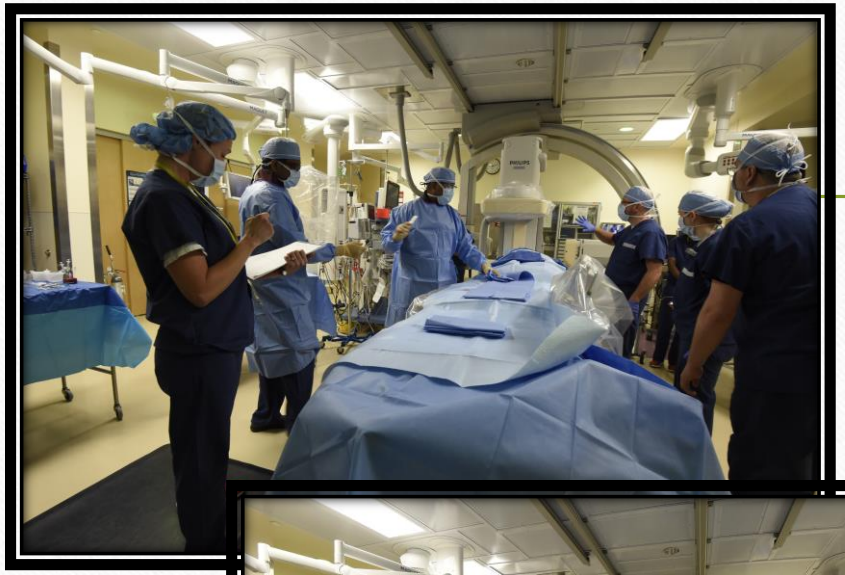
Day of Procedure

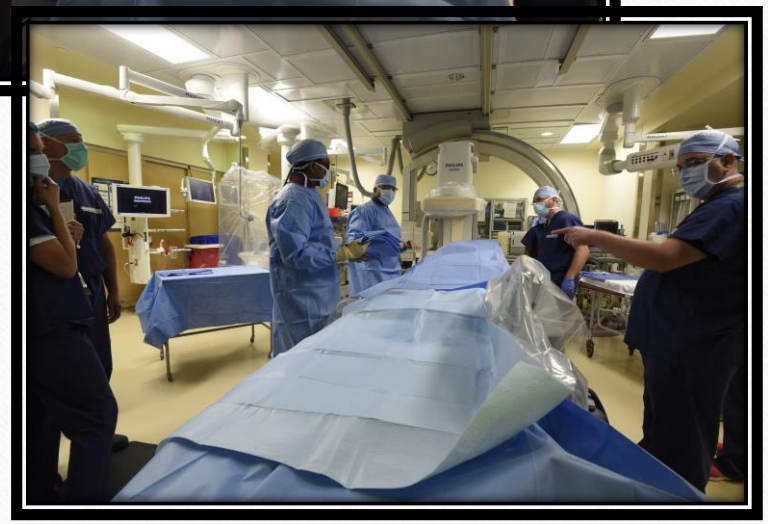
- Core team MRI safety check
  - Twirl, pockets sealed with tape
- Huddle/discuss case in MRI Zone III
- MRI magnet sterile drapes, diluted gadolinium 1/100
- Pt transfer to Cath lab
- → Anesthesia induction
- → Access – first 3 cases*

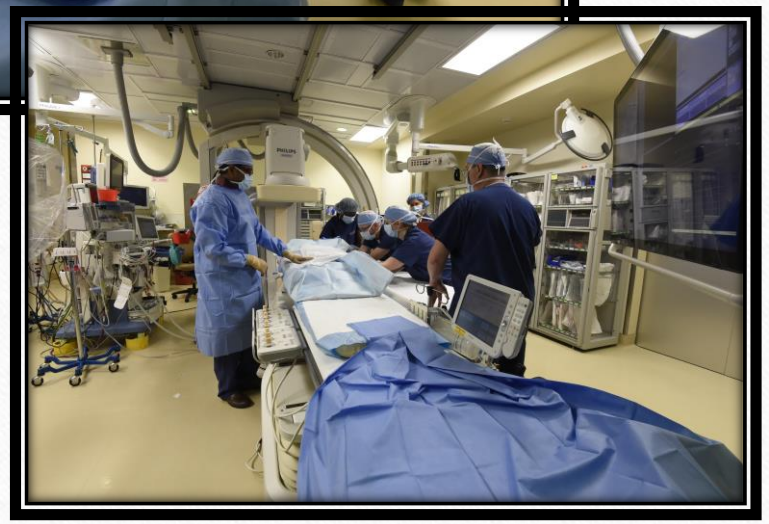
MRI Safety Checklist!
*Pre and *Post Access

Dedicated MRI (Marie and Amanda) and Cath (Phil/Maggie/Terry) personnel for Safety Checklist

“The Tex-Mex Burrito Wrap”







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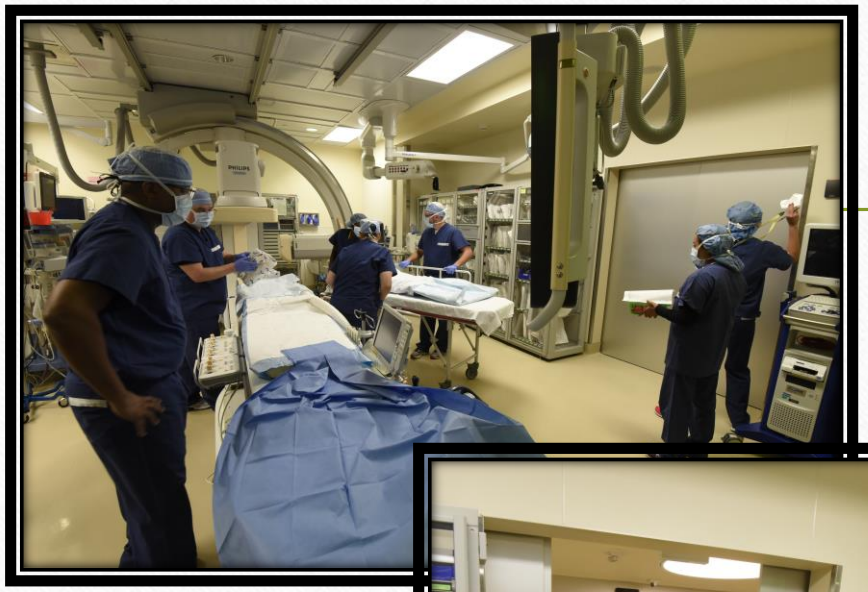
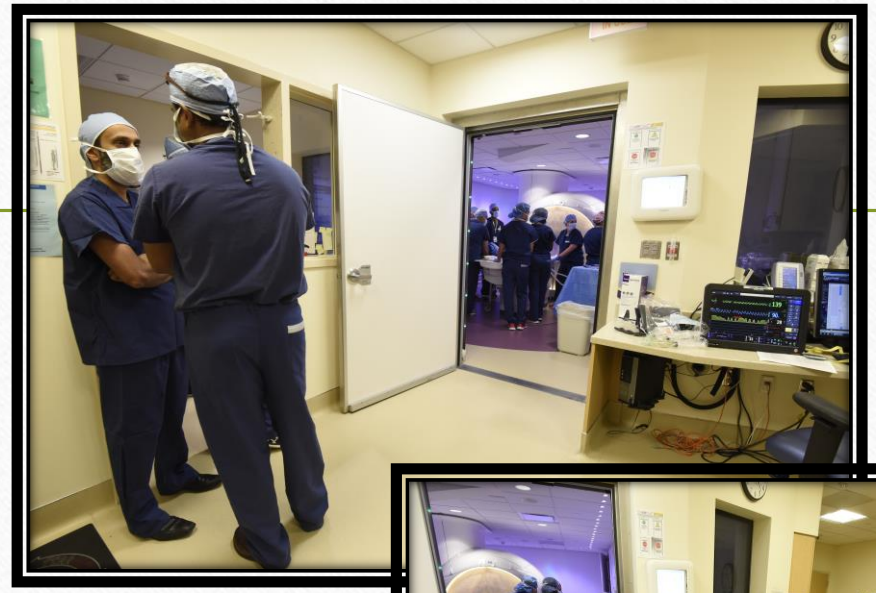
Transfer to MRI

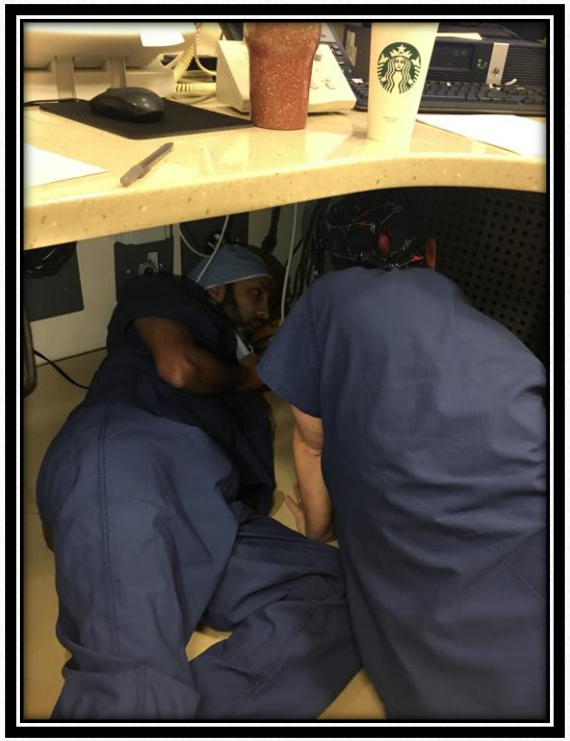




Cath lab recorder

MRI Control Room

Trouble shooting



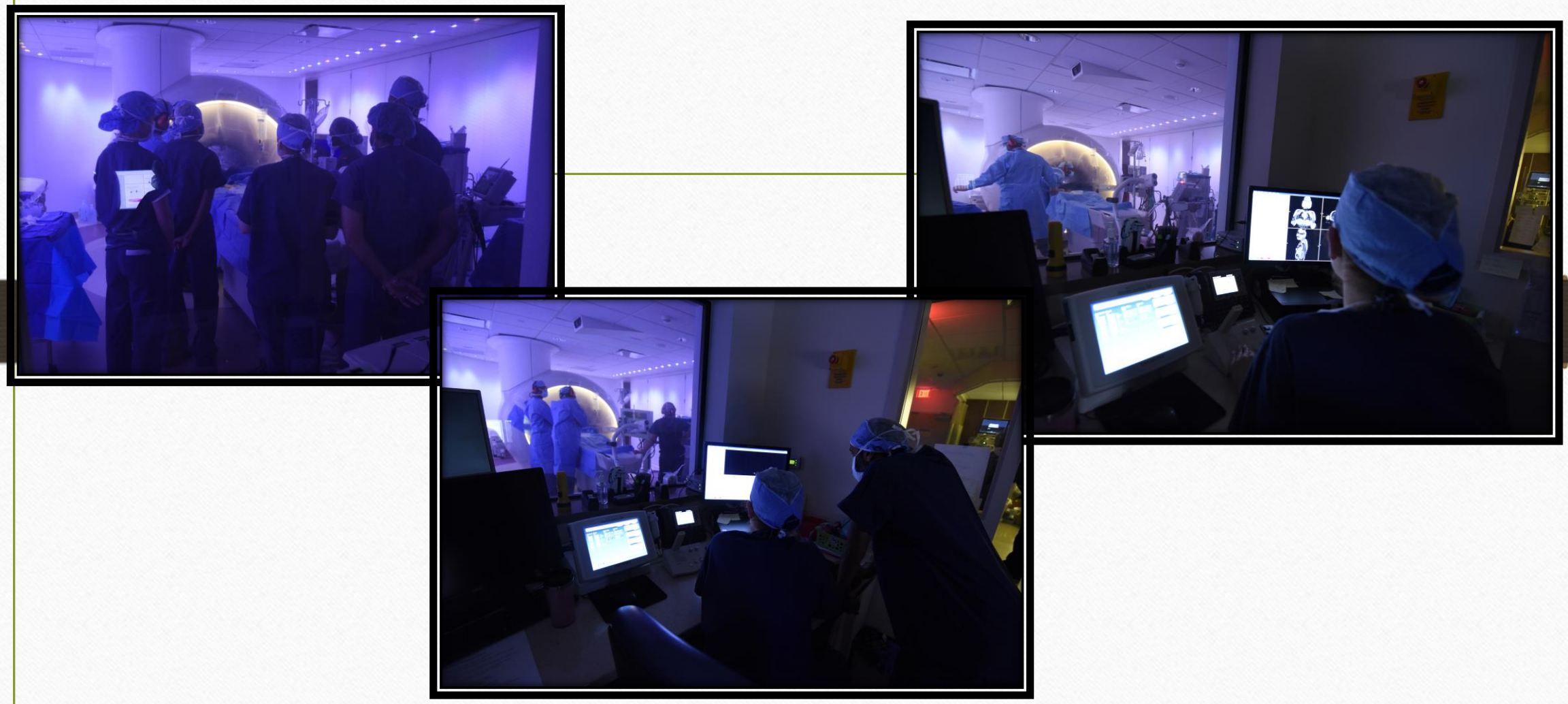
"No stone unturned"!

"Looks like our days at KCL on Monday mornings"!

Work Flow

- Baseline interactive sequence scan for geometry/stamps ~ 10 mins
- Right heart catheterization 15-20 mins – measure sats and pressures, calculate Qp and Qs (with Fick's) and PVR and SVR.
- MRI flows ≤ 10 mins: recheck pressures to calculate PVR with MRI Qp
- Hyperoxia/Nitric Oxide testing as needed
- If deemed to need catheter based intervention – transfer to Cath lab
  - Otherwise – Extubation in Zone III → post cath recovery

First case → Fifth case



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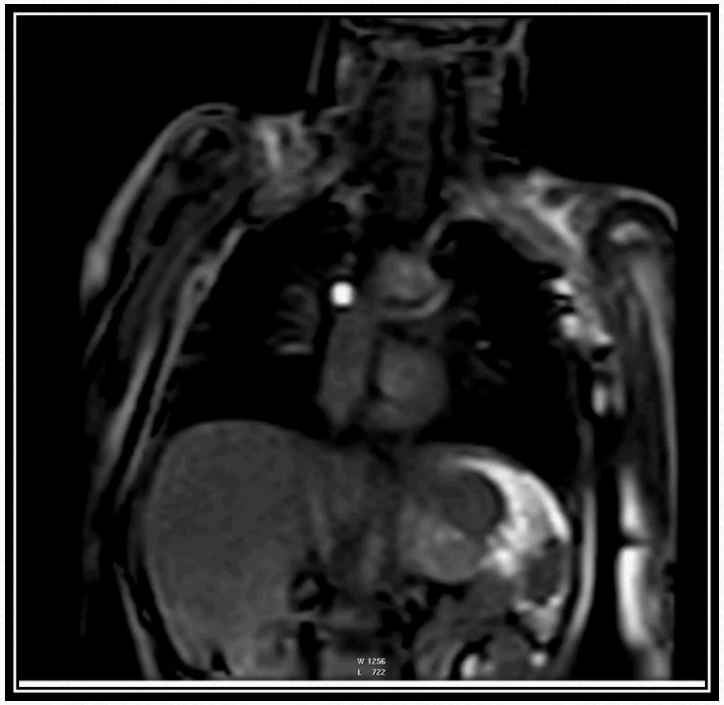
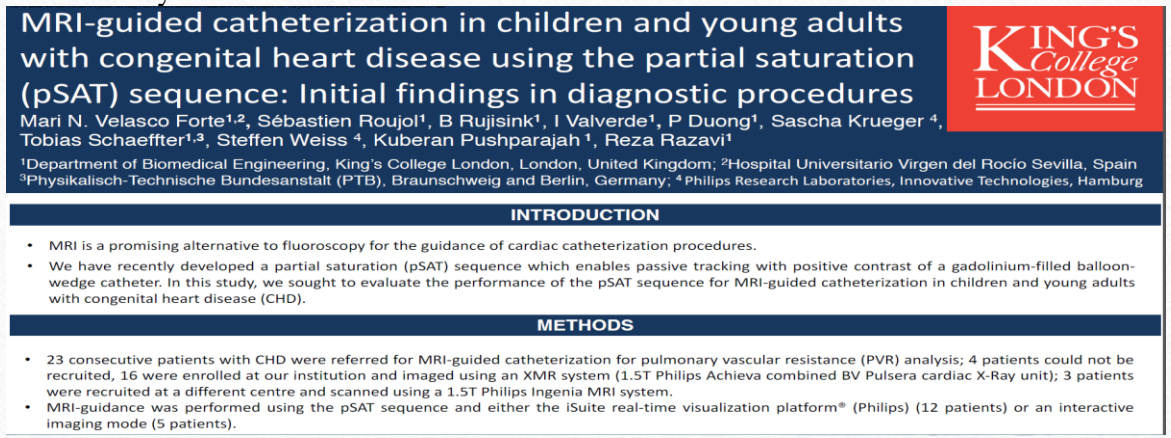
Case Example – Fontan, B/L Glenn, PA stenosis



- Partial Saturation (pSAT) sequence used by team at KCL.
  - allow for clear visualization of both cardiac anatomy and balloon-tip.

- Poster by MariNieves Velasco Forte MBBS.



MRI-guided catheterization in children and young adults with congenital heart disease using the partial saturation (pSAT) sequence: Initial findings in diagnostic procedures

Mari N. Velasco Forte[1,2], Sébastien Roujol[1], B Rujisink[1], I Valverde[1], P Duong[1], Sascha Krueger [4], Tobias Schaeffter[1,3], Steffen Weiss [4], Kuberan Pushparajah [1], Reza Razavi[1]

[1]Department of Biomedical Engineering, King's College London, London, United Kingdom; [2]Hospital Universitario Virgen del Rocío Sevilla, Spain [3]Physikalisch-Technische Bundesanstalt (PTB), Braunschweig and Berlin, Germany; [4]Philips Research Laboratories, Innovative Technologies, Hamburg

INTRODUCTION

- MRI is a promising alternative to fluoroscopy for the guidance of cardiac catheterization procedures.
- We have recently developed a partial saturation (pSAT) sequence which enables passive tracking with positive contrast of a gadolinium-filled balloon-wedge catheter. In this study, we sought to evaluate the performance of the pSAT sequence for MRI-guided catheterization in children and young adults with congenital heart disease (CHD).

METHODS

- 23 consecutive patients with CHD were referred for MRI-guided catheterization for pulmonary vascular resistance (PVR) analysis; 4 patients could not be recruited, 16 were enrolled at our institution and imaged using an XMR system (1.5T Philips Achieva combined BV Pulsera cardiac X-Ray unit); 3 patients were recruited at a different centre and scanned using a 1.5T Philips Ingenia MRI system.
- MRI-guidance was performed using the pSAT sequence and either the iSuite real-time visualization platform® (Philips) (12 patients) or an interactive imaging mode (5 patients).

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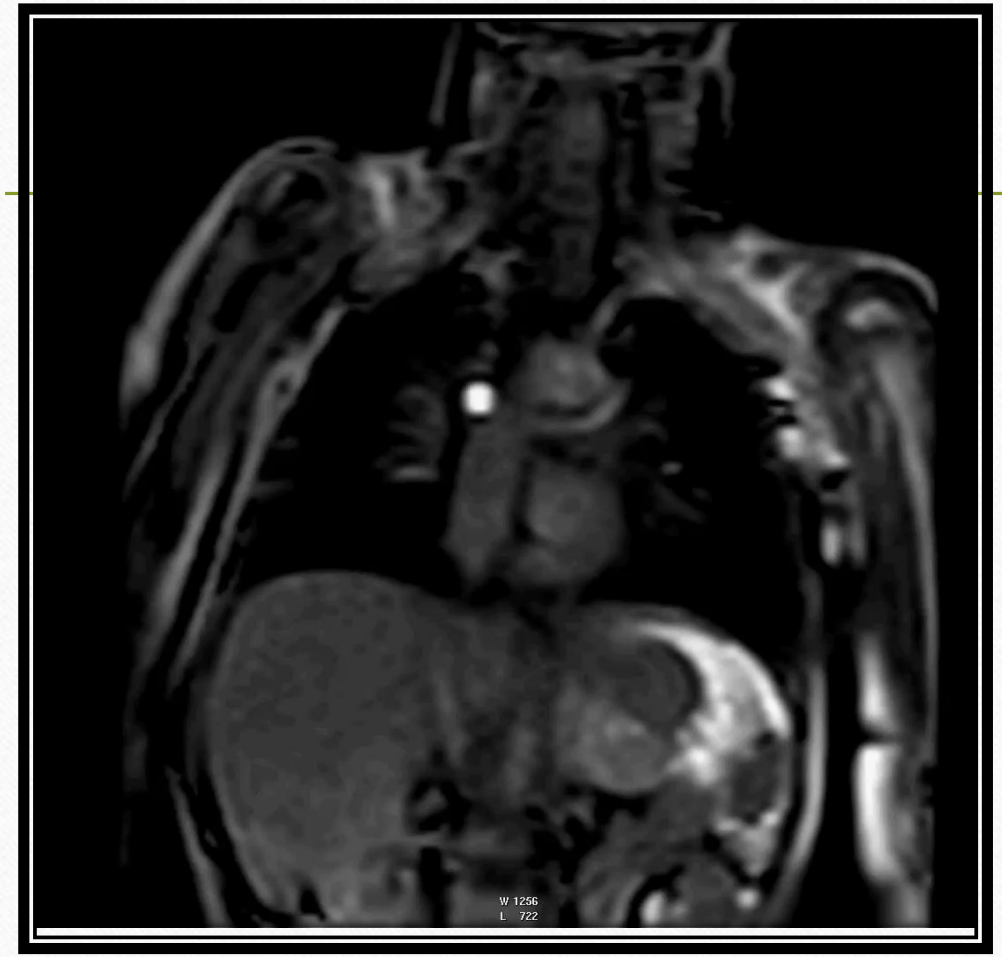

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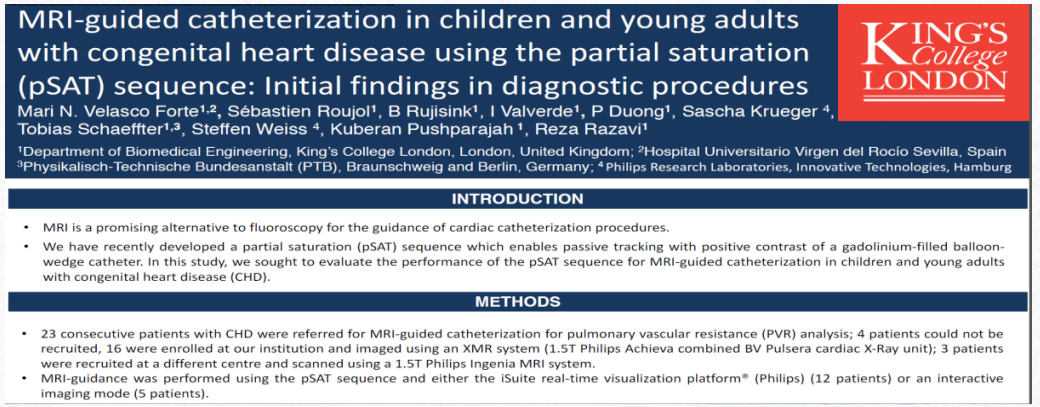

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KING'S College LONDON

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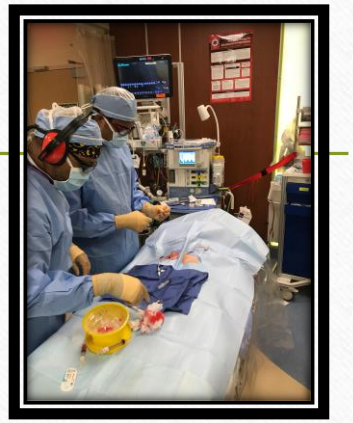
First Five Cases Information

- Age: 3 mths to 17 yrs
- Weight: 7.6 kgs to 54.2 kgs
- Ventricle:
  - 3 Single V patients (1 BT shunt, 1 b/l Glenn, 1 Fontan with b/l Glenn)
  - 2 Two V patients (TOF pts)
- Visualization – poor in pt 3 with Harrington rods
- Complications – None
  - Near misses: Two - accidental table movement into magnet, no problems encountered.
  - Solution: Deactivate the switch board on the operator side
- Need to decrease total anesthesia times

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Date	8/9/2017	8/13/2017	8/17/2017	11/29/2017	1/22/2018
Age	3m	1y11m	17y	2y	5y2m
Weight (kg)	7.6	11.5	54.2	13.3	17.4
Ventricular status	1V	1V	2V	2V	1V
Diagnosis	Heterotaxy (A,D,D), dextrocardia, common AVC, sup/inf ventricles, pulmonary atresia with discon PAs s/p unifocalization + BTS	Anatomically corrected malposition s/p modified DKS s/p b/l Glenn	TOF s/p repair, s/p surgical bioprosthetic pulm valve implantation s/p LPA stent	TOF w/ absent pulmonary valve s/p 12 mm Ao homograft, LeCompte maneuver	d-TGA, hypoplastic RV s/p Norwood, b/l Glenn, & fenestrated extracardiac Fontan
Indications	Single versus two ventricle repair assessment?	Surgical planning	RV volumes, LPA stenting?	RV volumes, balloon/stent homograft?	Fontan pressures. PLE? Fenestration?
Cath Access/Fr	RFA(4F), RFV (5F)	RFA(4F), RIJ/LIJ(5F)	RFA(4F), RFV(5-16F)	RFV(5F), RFA(20ga)	RFV(6F), RFA(20ga)
Visualizations? 1. Good 2. Satisfactory 3. Poor	1	1	2	1	1
Obtained all info? (Y/N)	Y	Y	Y	Y	Y
Cath (C1): Qp/Qs	5.7/3.8 = 1.5	1.9/4.6 = 0.4	3.2/3.2 = 1	4.08/4.08 = 1	3.5/3.5 = 1
MRI (C1): Qp/Qs	3.1/3.33 = 0.93	1.5/3 = 0.5	2.8/2.7 = 1	4.4/4.4 = 1	4.6/3.9 = 1.18
Condition 2	N/A	Cath lab repeat	N/A	N/A	20ppm iNO
Cath (C2): Qp/Qs	N/A	2.5/6.6 = 0.4/1	N/A	N/A	3.7/3.7 = 1
MRI (C2): Qp/Qs	N/A	N/A	N/A	N/A	5.9/4.6 = 1.3
Cath (C1): PVR (Wood U.m²)	1.4	2.6	2.2	1.47	2.0
MRI (C1): PVR (Wood U.m²)	2.6	2.85	2.4	1.4	2.2
Condition 2	N/A	Cath lab repeat	N/A	N/A	20ppm iNO
Cath (C2): PVR (Wood U.m²)	N/A	2.5	N/A	N/A	1.3
MRI (C2): PVR (Wood U.m²)	N/A	N/A	N/A	N/A	1.6
Total Time (mins) 1. Anesthesia 2. Sheath total 3. First RHC 4. Total Cath	1. 294 2. 128 3. 11 4. 119	1. 345 2. 283 3. 18 4. 65	1. 408 2. 321 3. 15 4. 134	1. 350 2. 170 3. 36 4. 36	1. 282 2. 242 3. 39 4. 157
Complications	None	None	None	Bed movement	Bed movement
Miscellaneous	Qp/Qs not matching up with MRI and Cath	Transferred to cath lab for repeat pressures and TEE	HD in cath lab LPA stent	Access obtained in MRI Zone 3 PAVM present	Access obtained in MRI Zone 3 AP collaterals

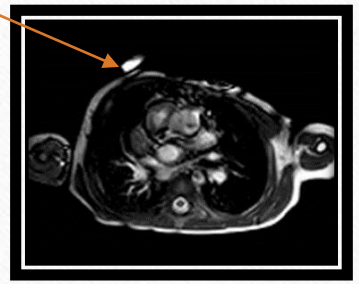
Lessons From 1st year



- Core team, drills, safety checks and Just do it!!!!
- Changes – Anesthesia and access moved to Zone III
- Arterial sheath changed to 18-20 G dilator
- Conscious about anesthesia time
  - Get started with initial MRI scan/geometries while pressure tubings are calibrated etc.

Lessons from 1st year …cont

- Visualization – diluted gadolinium syringe placed on the chest to confirm visualization
- Adjustments to partial saturation sequences
  - Based on patient body habitus and comorbities
  - Flip angle changes on the fly for better visualization
- Debrief is critical – build a team with sense of ownership!

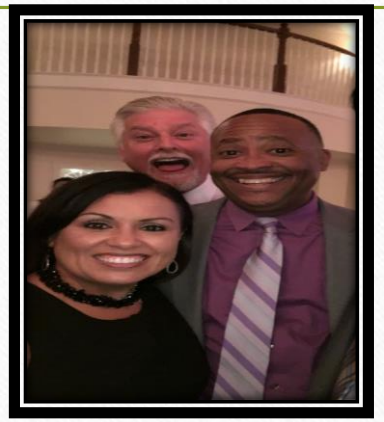


Missing Pieces - Future

- Visualization
  - Phillips I Suite – commercially available
  - Ceiling mounted projector (Shieled TV, Fancy bulb less projectors etc)
  - Screen – similar to NIH/CNMC labs (options looked into – Pole Mount large TV/Screens etc)
- Combi Transfer Table – waiting
- Wires for LHC and difficult RHC - Nanoimaging
- Communication – Optoacoustics
- Hemodynamic recording software
  - Sensis system, cath report in Syngodynamics
  - PRiME Gen system – Thanks to John Kakareka, ECA Inc.

Many Thanks To

Dr. Tarique Hussain Dr. Gerald Greil Maggie, Terry and Phil



Ms. Amanda Potersnak

Dr. Jenn Hernandez

The Heart Center Team – CMC/UTSW, Dallas

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Many Thanks to The Entire iCMR Team!

Dr. Robert Lederman Lab, NHLBI
Dr. Kanishka Ratnayaka, Dr. Toby Rogers et al.

King's College, London Team
Dr. Reza Razavi and team

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Questions

- Multi-instutional research collaboration?
- Collaborate between institutions, increase "n" and ask meaningful research questions?
- Have an multiinstitutional/international database/registry?