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ASSISTANCE PUBLIQUE HÔPITAUX DE PARIS

PARIS CENTRE DE RECHERCHE CARDIOVASCULAIRE PARCC H E G P

UNIVERSITÉ PARIS DESCARTES

USPC Université Sorbonne Paris Cité

M3C

40ème SEMINAIRE DE CARDIOLOGIE CONGENITALE ET PEDIATRIQUE

ARCFA

21 et 22 mars 2019

Imaginer demain

E Mousseaux

11h30-13h00 « Avant de savoir, il faut voir. »

L'IRM permet-elle de prendre des décisions. E. Mousseaux

Conflit d’intérêt : E Mousseaux

Aucun sur le plan de la recherche ou activité de soins

AVANT DE SAVOIR? IL FAUT VOIR

- 1987 : IRM cardiaque ne sera jamais possible !!!
- Il faut **voir** pour prendre une décision ?
- Comprendre ce que l'on voit ?

AVANT DE SAVOIR? IL FAUT VOIR

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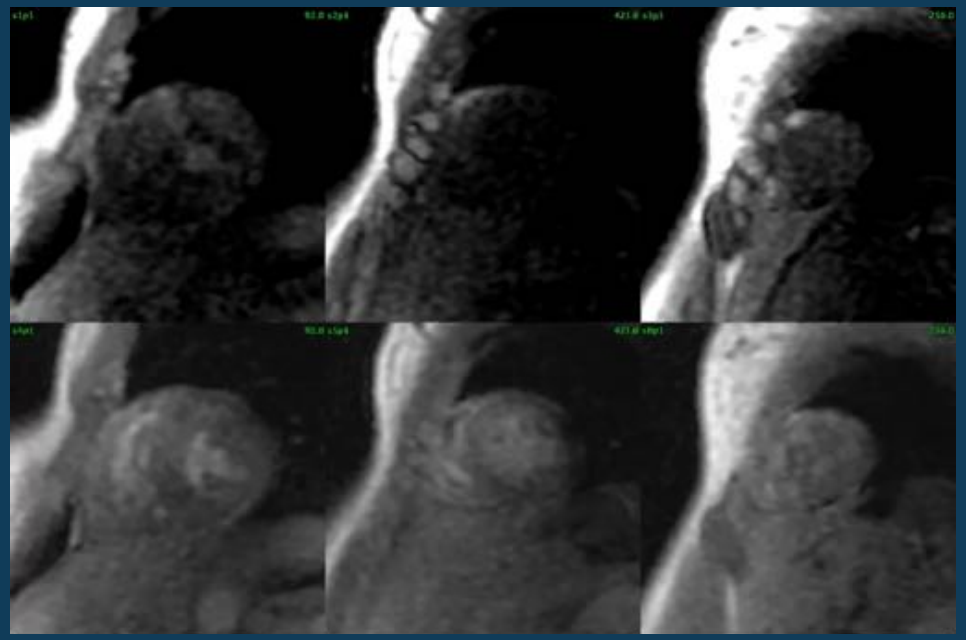
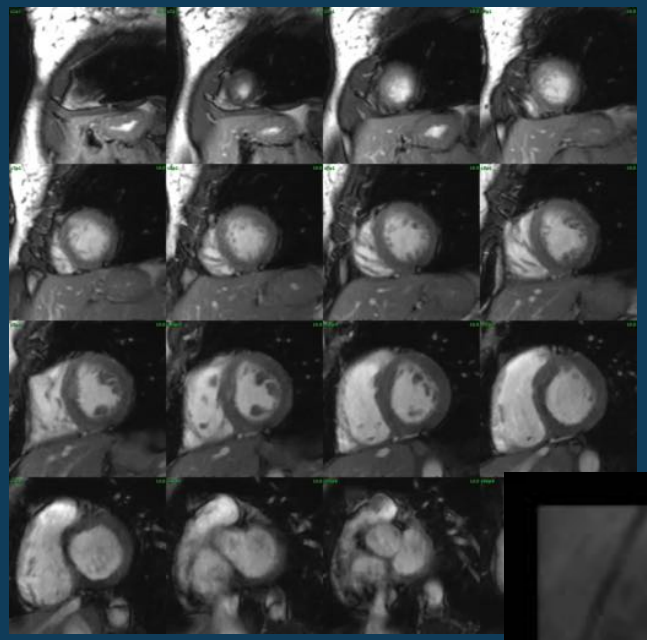
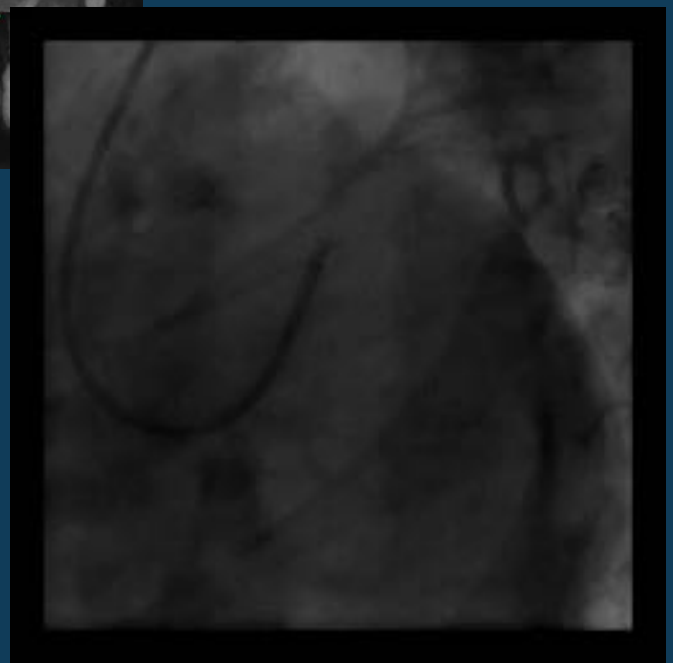
Adenosine stress perfusion + Function + LGE

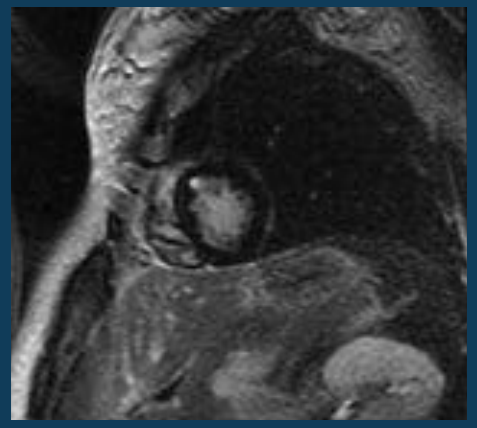
Stress

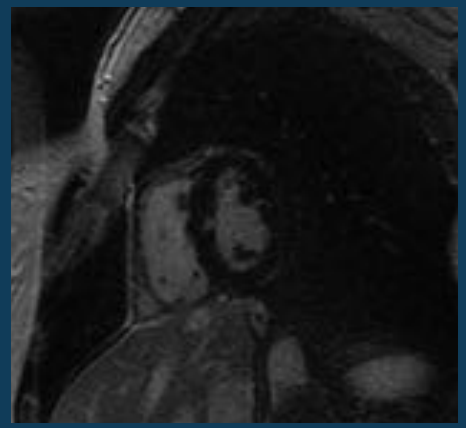
Rest

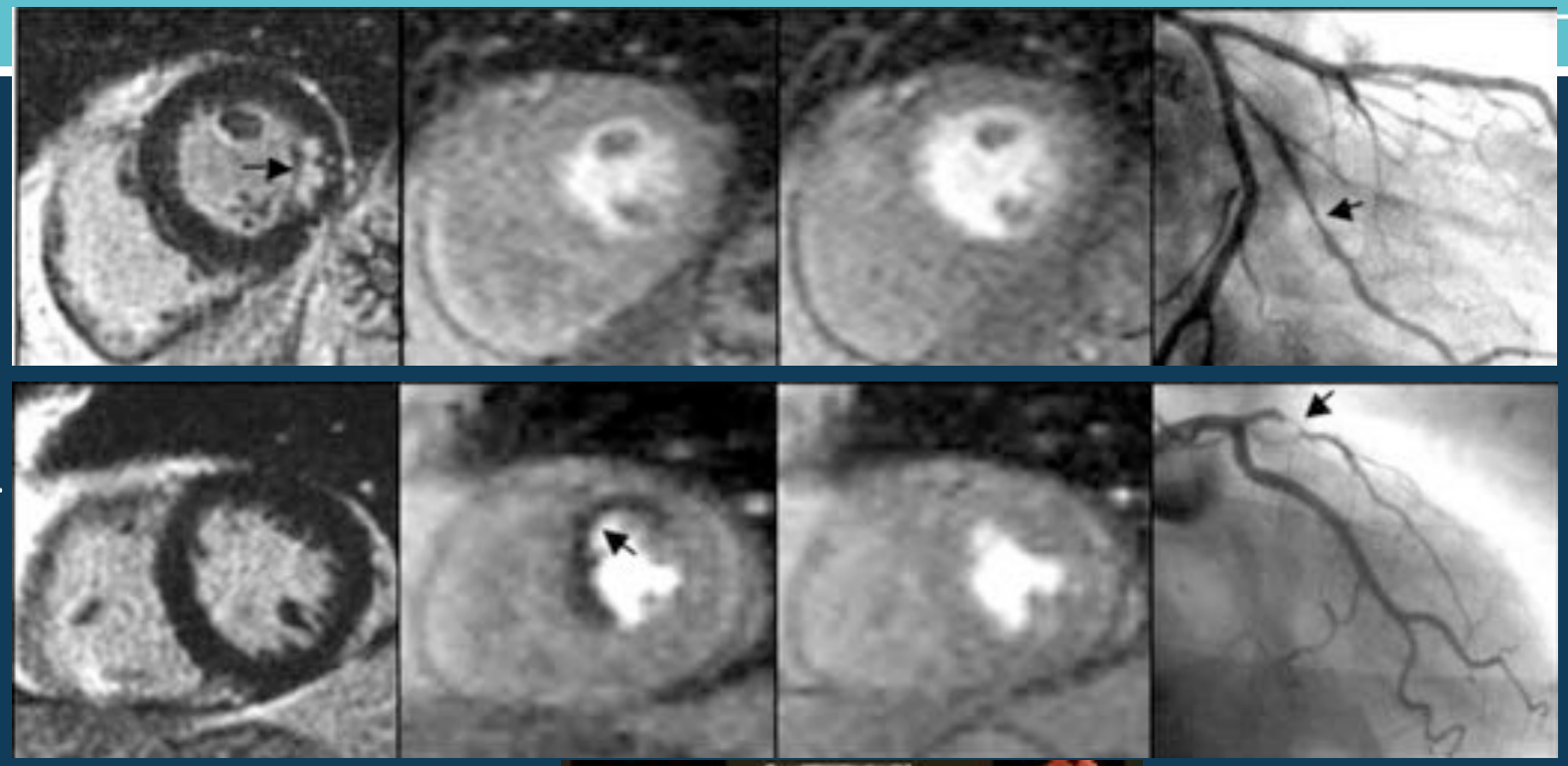




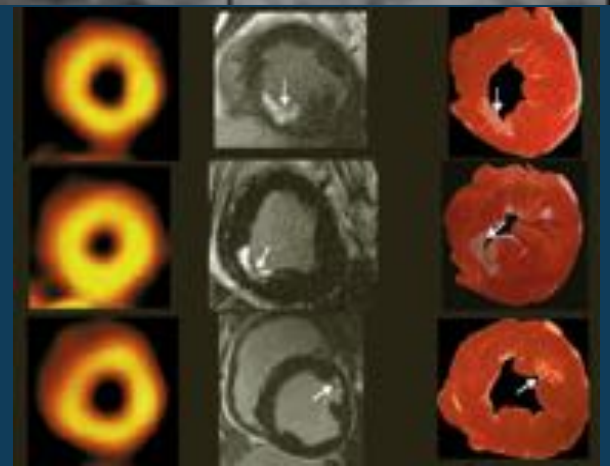








→ Il faut **voir** pour prendre une BONNE décision



Wagner, Lancet 2003; 361: 374

Association of Fibrosis With Mortality and Sudden Cardiac Death in Patients With Nonischemic Dilated Cardiomyopathy

A Gulati et al JAMA 2013

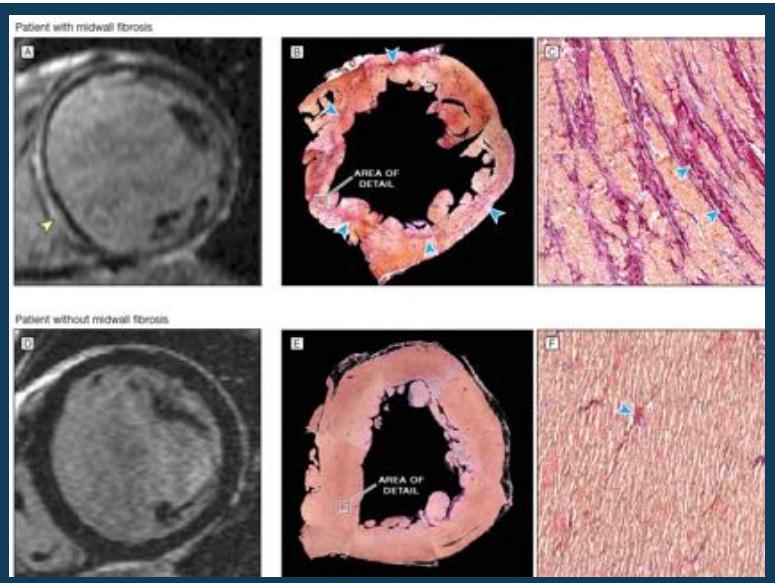
Circulation

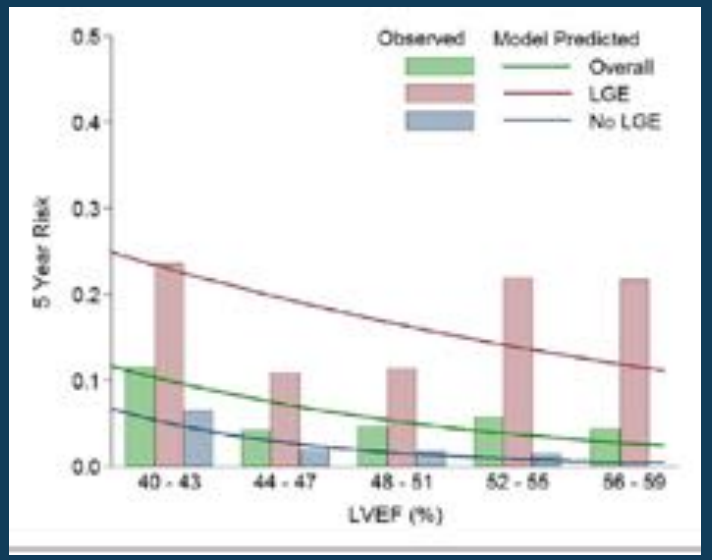
American Heart Association.

Association Between Mid-Wall Late Gadolinium Enhancement and Sudden Cardiac Death in Patients with Dilated Cardiomyopathy and Mild and Moderate Left Ventricular Systolic Dysfunction

Brian Halliday, Ankur Gulati, Aamir Ali, Kaushik Guha, Simon J. Newsome, Monika Arzanauskaite,

2017

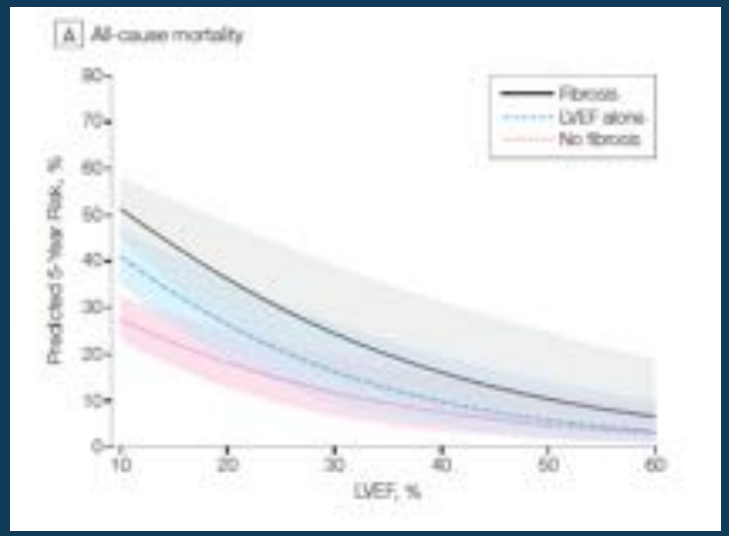




ICD if EF < 35%

But 70 to 80% of SCD occur with LVEF > 35%

-> Défibrilateur + précoce ??



Outcome	LGE Status	Events n (%)	Univariable		Multivariable*	
			HR (95% CI)	*P* Value	HR (95% CI)	*P* Value
SCD or Aborted SCD	LGE–	7 (2.3)	9.2 (3.9, 21.8)	<0.0001	9.3 (3.9, 22.3)	<0.0001
	LGE+	18 (17.8)				
SCD	LGE–	6 (2.0)	4.9 (1.8, 13.5)	0.002	4.8 (1.7, 13.8)	0.003
	LGE+	9 (8.9)				
Aborted SCD	LGE–	1 (0.3)	34.8 (4.6, 266.6)	<0.0001	35.9 (4.8, 271.4)	<0.001
	LGE+	10 (9.9)				

*Adjusted for left ventricular ejection fraction, New York Heart Association class, and age.

Comprehensive Cardiac Magnetic Resonance Imaging in Patients With Suspected Myocarditis

The MyoRacer-Trial

P Lurz et al JACC 2016

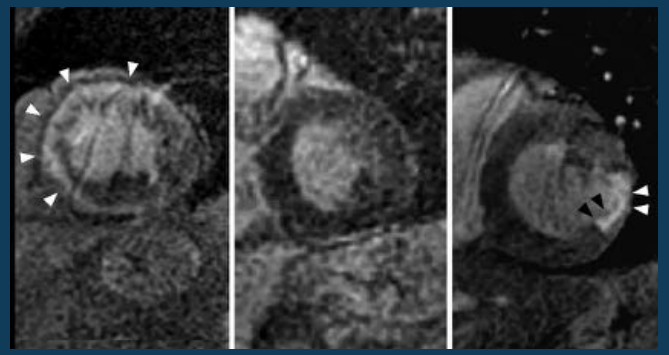
Prospective cohort of 129 patients with suspected Myocarditis

Acute suggestive symptoms

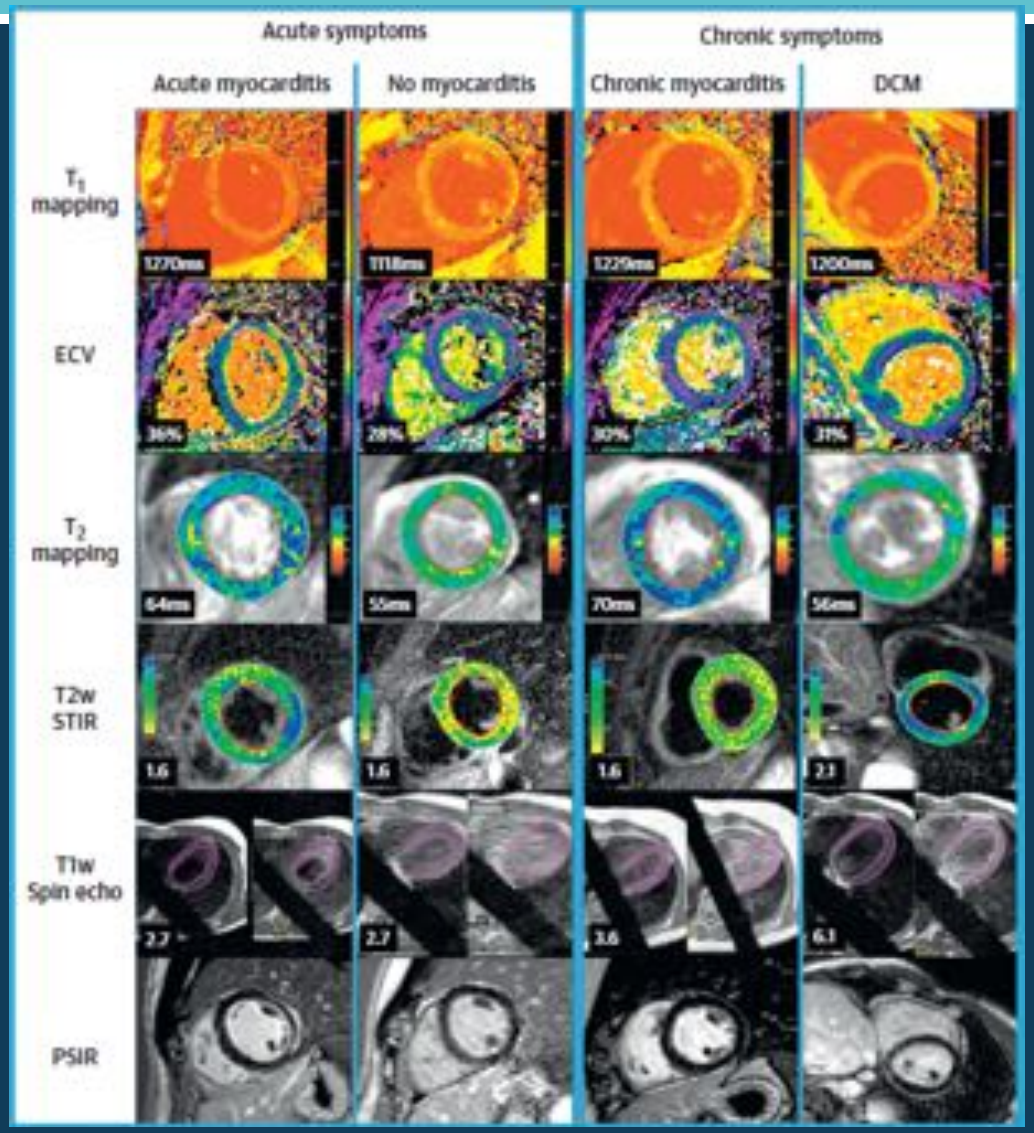
Excluded CAD

Versus EMB +++

Performances of each CMR criteria, Including 1.5 T vs 3T



< 14 days **> 14 days**



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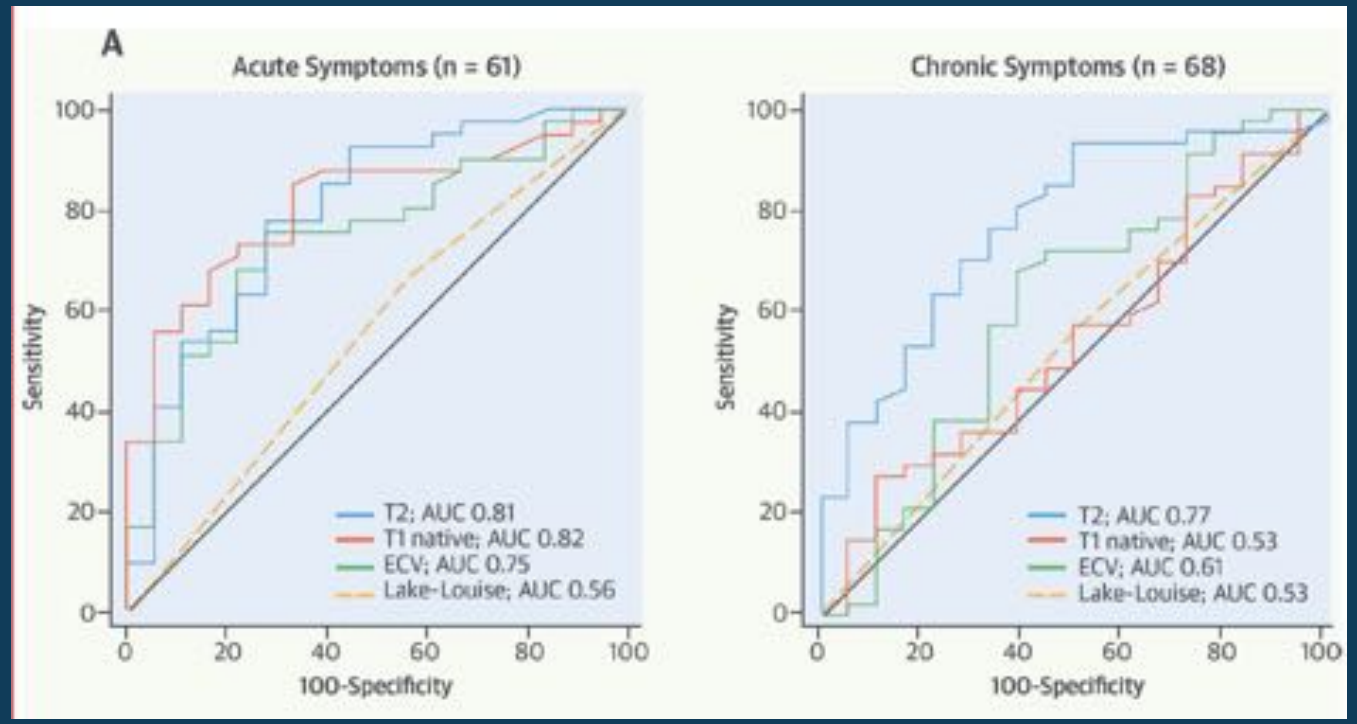


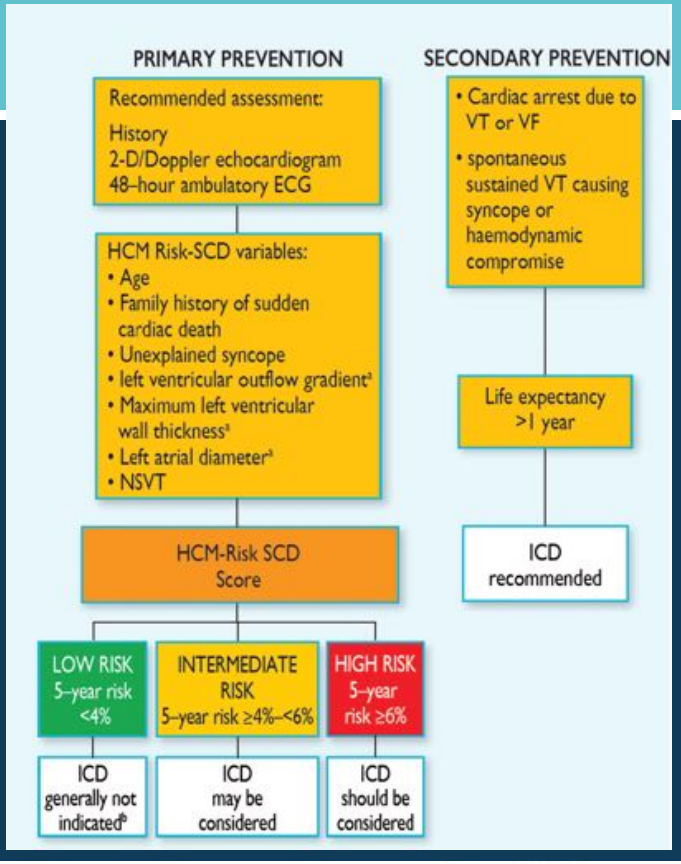
Acute symptoms
< 14 days
Vs > 14 days

Native T1, ECV, T2
In acute

T2 in chronic

Always > LLC
in both acute
and chronic

Recommendations for implantable cardioverter defibrillators based on HCM SCD score



$$\text{Probability}_{\text{SCD at 5 years}} = 1 - 0.998^{\exp(\text{Prognostic index})}$$

where Prognostic index = [0.15939858 × maximal wall thickness (mm)] − [0.00294271 × maximal wall thickness^2 (mm^2)] + [0.0259082 × left atrial diameter (mm)] + [0.00446131 × maximal (rest/Valsalva) left ventricular outflow tract gradient (mm Hg)] + [0.4583082 × family history SCD] + [0.82639195 × NSVT] + [0.71650361 × unexplained syncope] − [0.01799934 × age at clinical evaluation (years)].

*

*

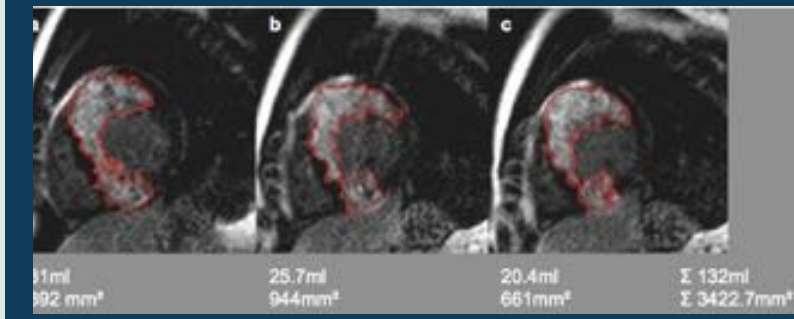
Panel 2: Risk factors for sudden death

Secondary prevention
- Cardiac arrest or sustained ventricular tachycardia

Conventional primary prevention risk markers
- Family history of sudden death due to hypertrophic cardiomyopathy
- Unexplained recent syncope
- Multiple repetitive non-sustained ventricular tachycardia (on ambulatory ECG)
- Hypotensive or attenuated blood pressure response to exercise
- Massive left-ventricular hypertrophy (thickness, ≥30 mm[a])
- Extensive and diffuse late gadolinium enhancement

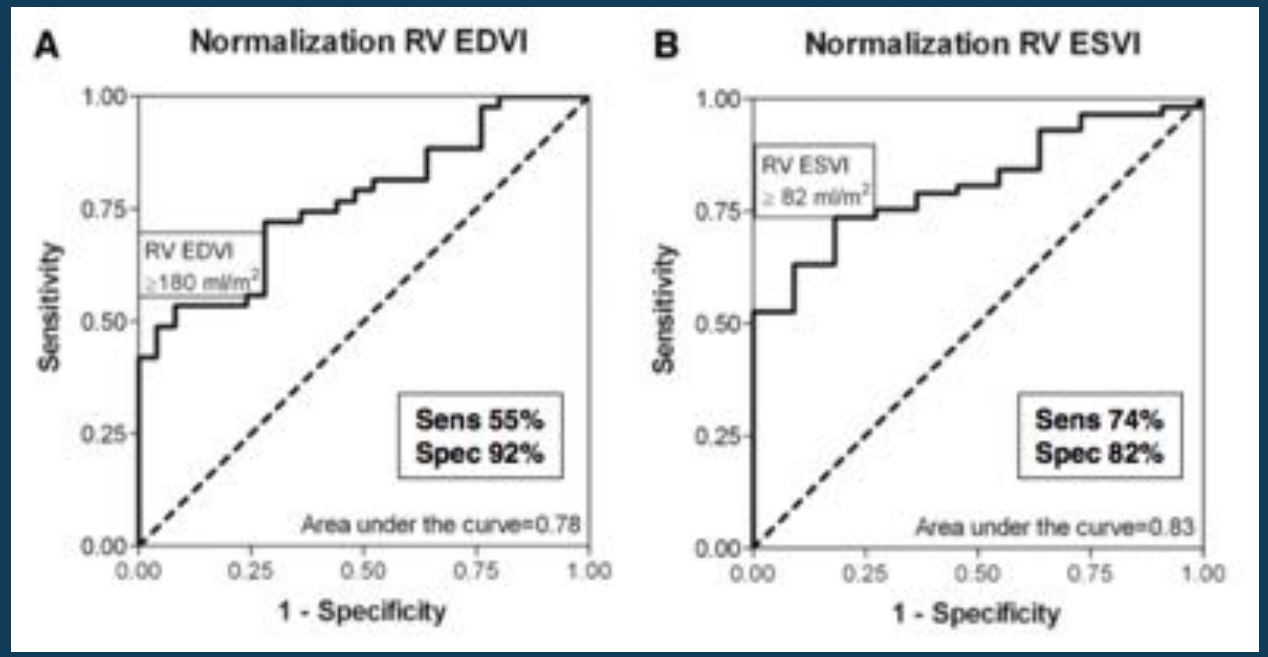
Potential high-risk subsets for primary prevention
- End-stage phase (ejection fraction <50%)
- Left-ventricular apical aneurysm and scarring

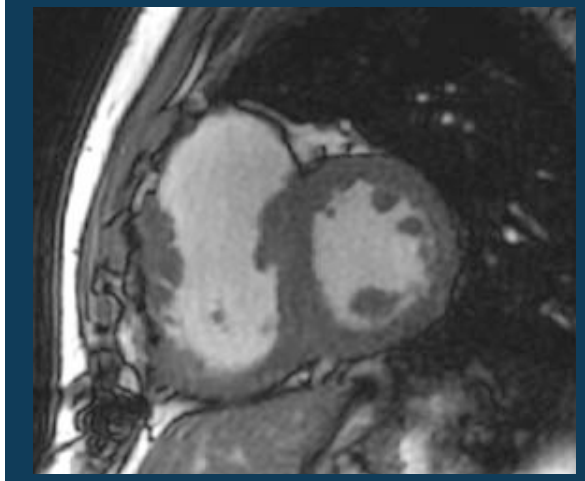
Potential arbitrators for primary prevention†
- Substantial left-ventricular outflow gradient at rest
- Alcohol septal ablation
- Multiple sarcomere mutations
- Modifiable
  - Intense competitive sports
  - Coronary artery disease

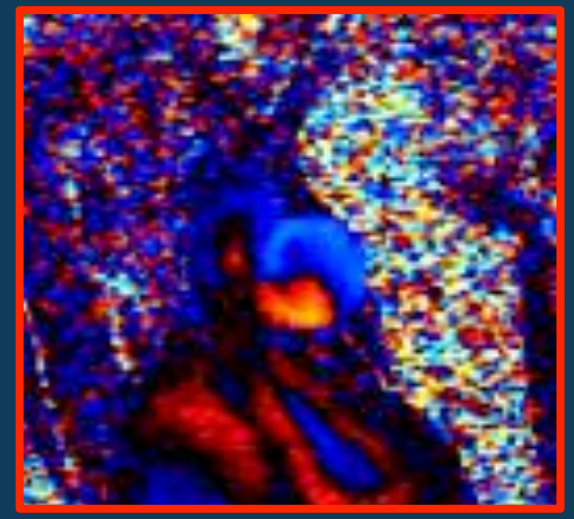


PM Elliot et al ESC 2014 vs BJ Maron et al Lancet 2013

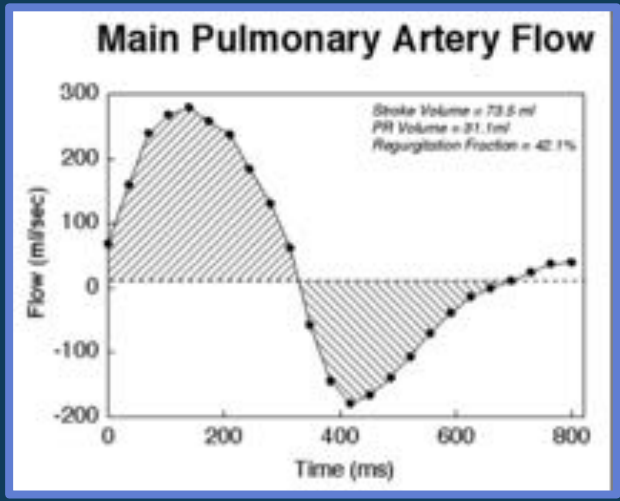
Cardiopathies Congénitales : Fallot
Oui IL FAUT VOIR le VD +++





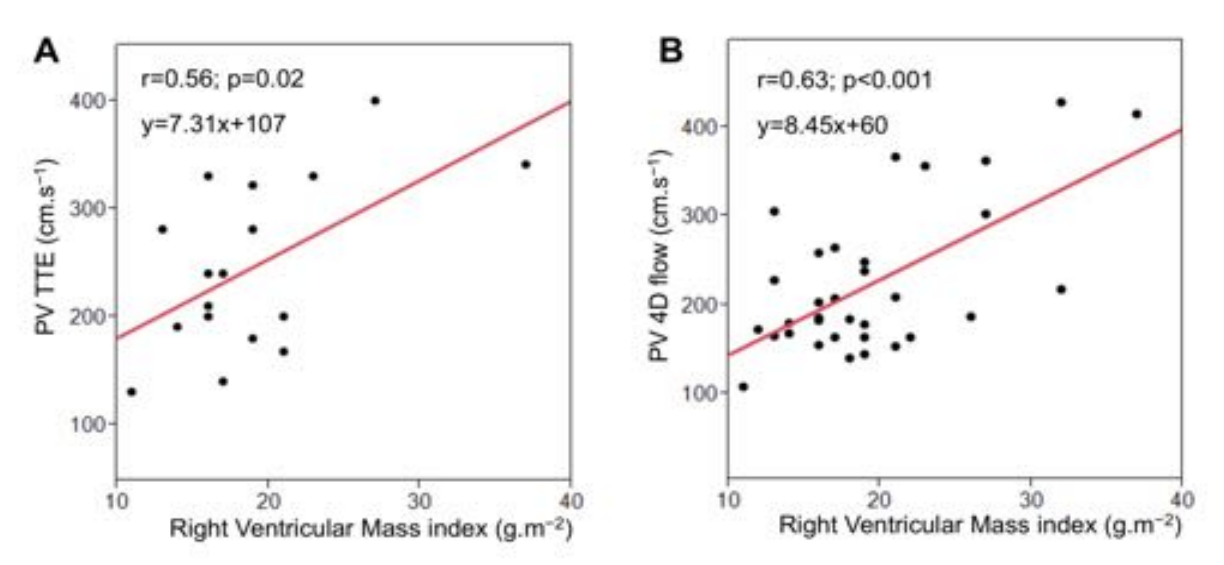


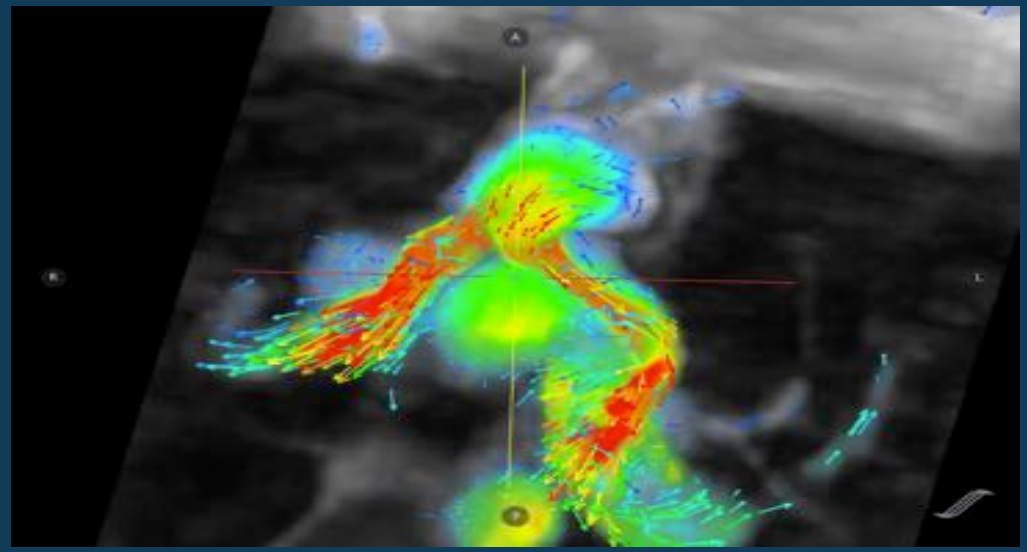
Oosterhof et al.
Circulation 2007

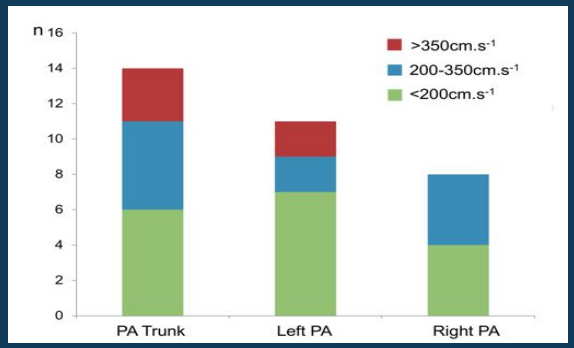


Modèle d'étude pour l'IM ou l'IRM devient supérieure à l'écho pour prédire la récupération fonctionnelle après remplacement valvulaire mitrale

V Max et sténose Valvulaire : modèle du Switch artériel





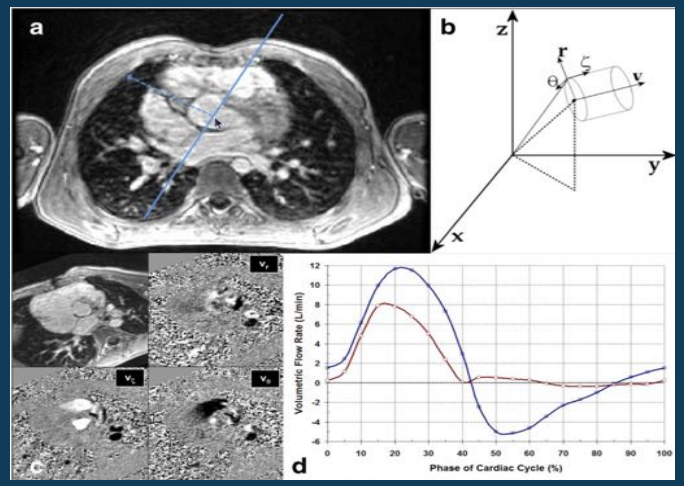


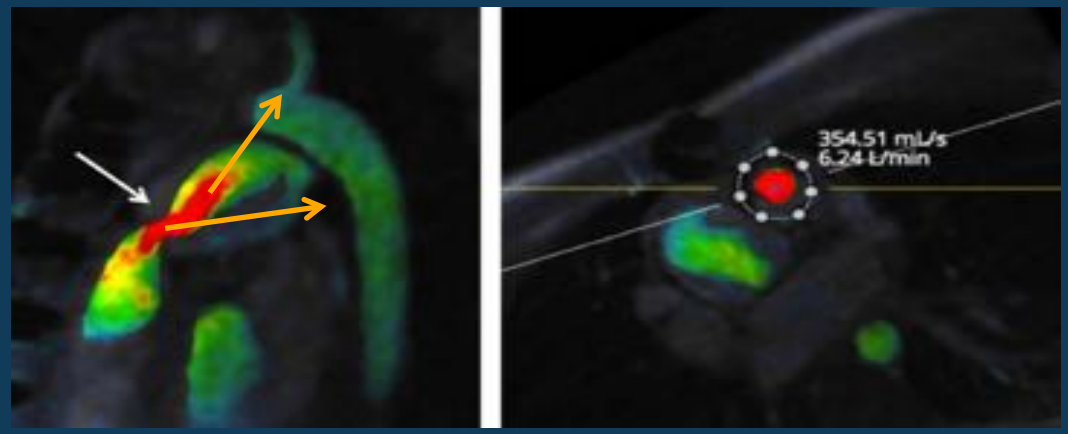
N = 17 US vs N = 33 4D flow

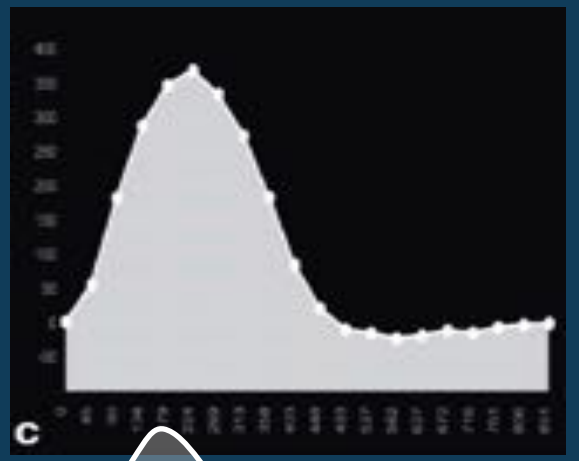
VOIR c'est VOIR, ne pas VOIR il n'y a pas d'espoir

RVOT obstruction by 4D flow MRI in adults with transposition of the great arteries after arterial switch operation . Zahra Belhadjer soumis 2019

Advantages of 4D vs 1D



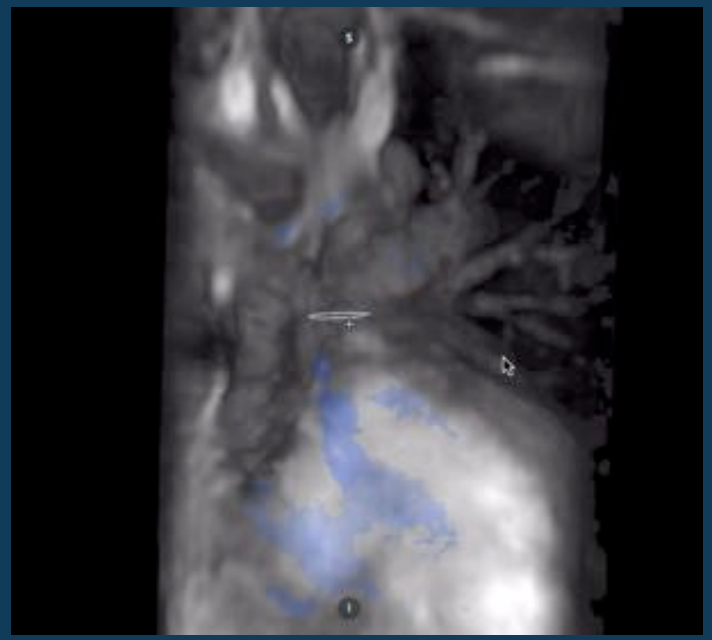


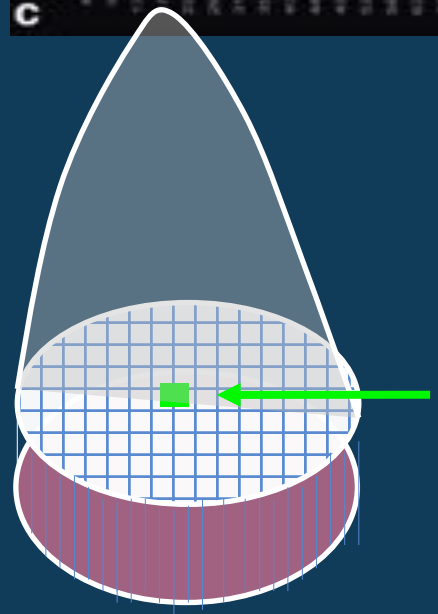


V Max

Fonction de son orientation

Fonction du débit sous jacent



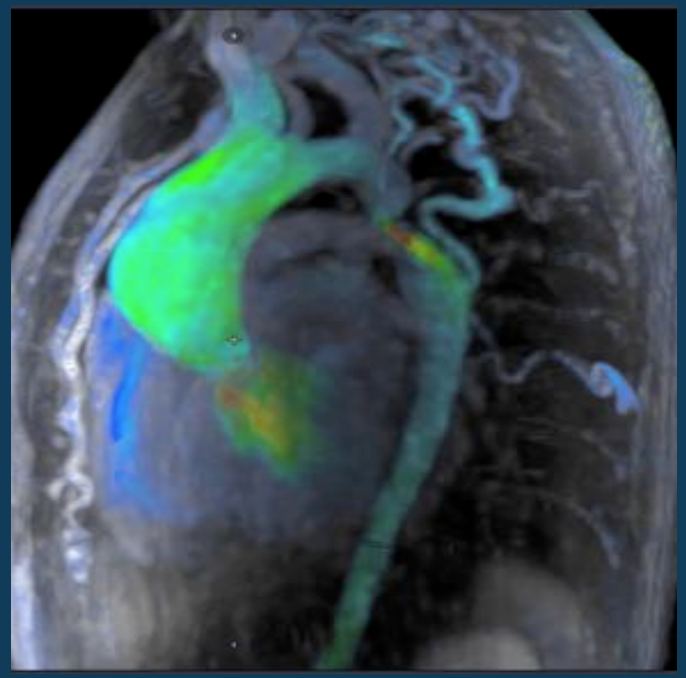


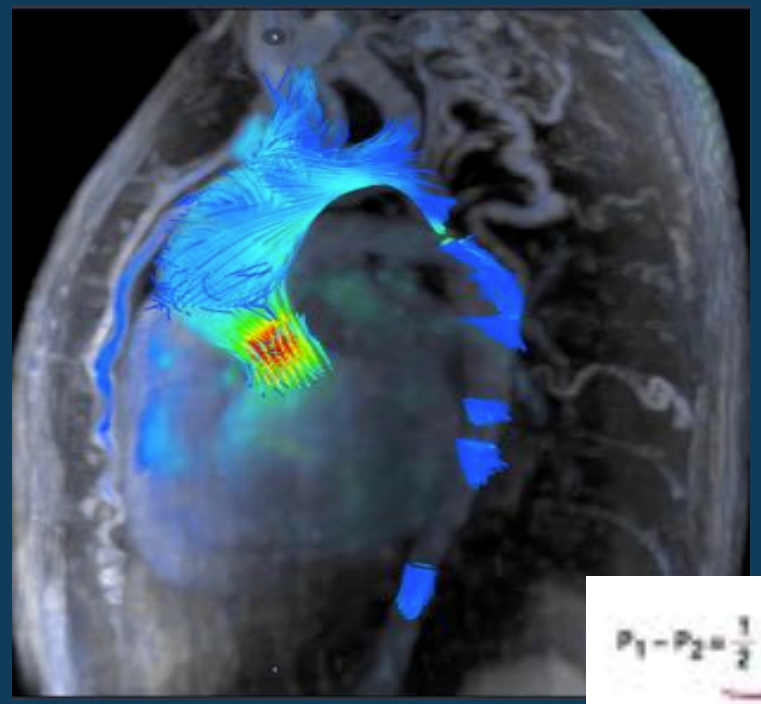
Congenital Heart Disease Assessment With 4D Flow MRI

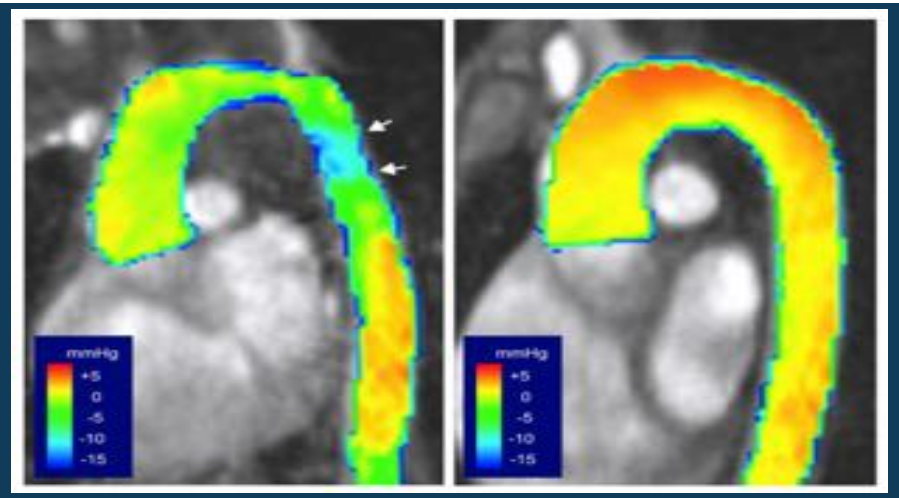
Shreyas S. Vasanawala, MD, PhD,[1]* Kate Hanneman, MD,[2] Marcus T. Alley, PhD,[1] and Albert Hsiao, MD, PhD

JMRI 1015

Pressure difference mapping







Coarctation repear

Healthy volunter

$$P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2) + \rho \int_1^2 \frac{\partial \vec{V}}{\partial t} ds + R(\vec{V})$$

CONVECTIVE ACCELERATION | FLOW ACCELERATION | VISCOUS FRICTION

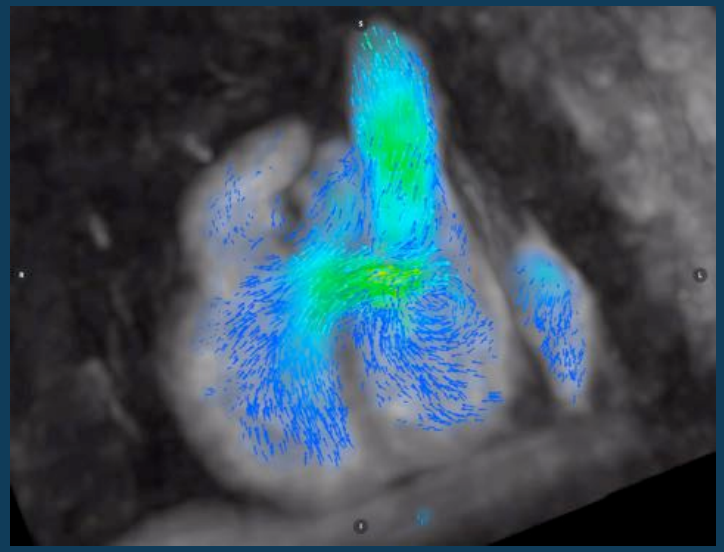
$$\Delta P = 4V_2^2$$

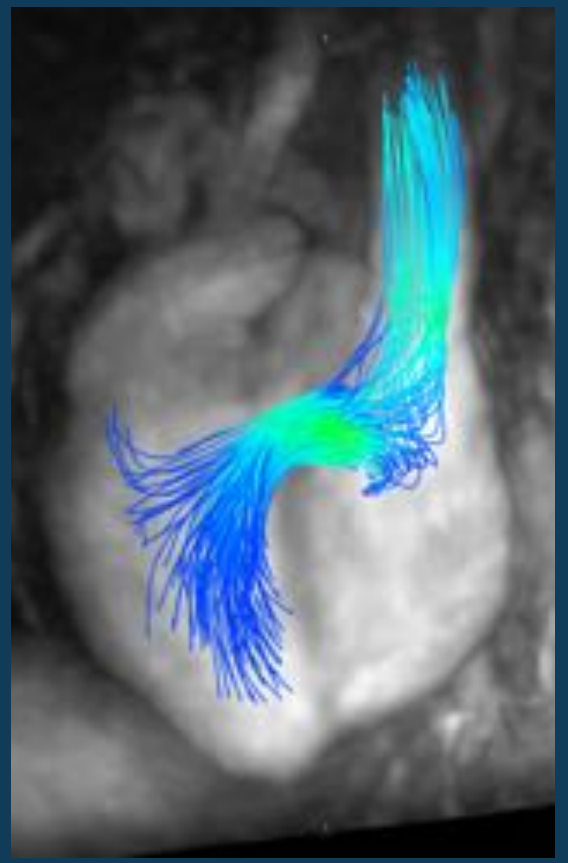
11h30-13h00 « Avant de savoir, il faut voir. »

IL FAUT SAVOIR et IL FAUT VOIR

Redescendons sur terre….

- Transpo CIV sténose pulmonaire
- → double switch faisable ? qualité du VG ??



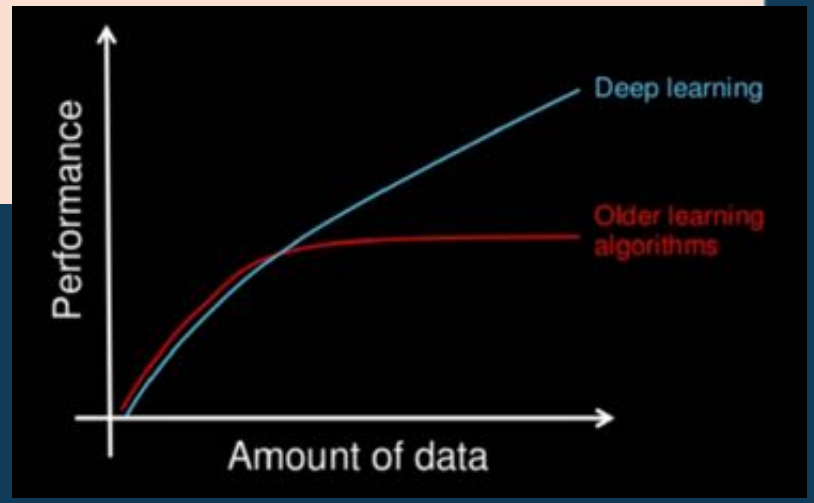


L'IRM permet de prendre la BONNE décision !!!!

À propos d'un cas …. du premier cas ….

Deep Blue 1997 vs Deep Fritz 2006 (55 euros)

Machine learning	Deep learning
- Besoin de moins de données - Économe financièrement (GPU, SSD, RAM) et « computationnellement » - Facile à interpréter	- Performance supérieure - Perf ↑ avec quantité de data

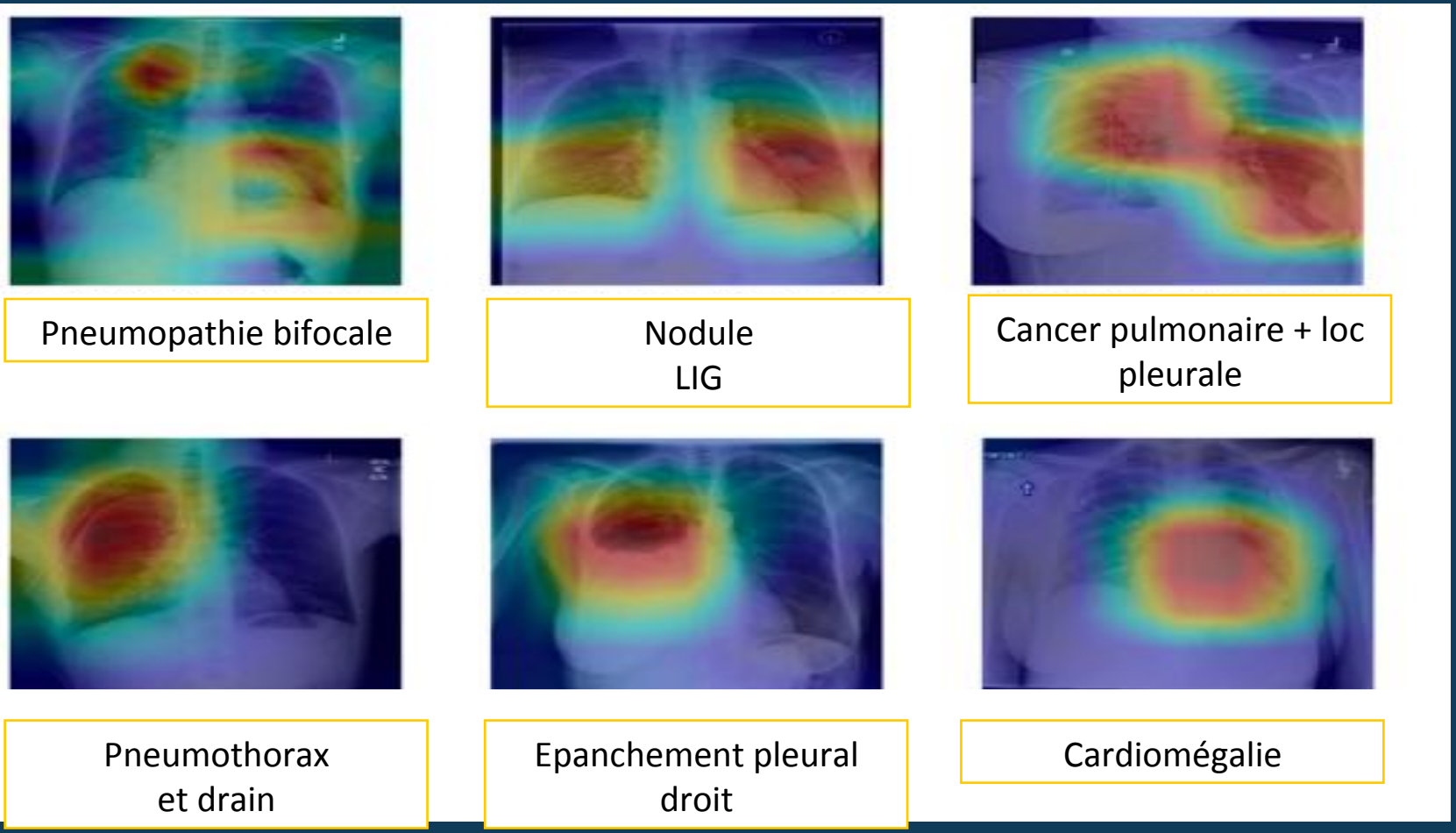


G Seif, Towards Data Science

Véracité : ne permet pas de contrôler le résultat
effet « Boite Noire »

- Facteurs confondants / causalité
  - différent de la corrélation

Technique de
« l'occlusion »

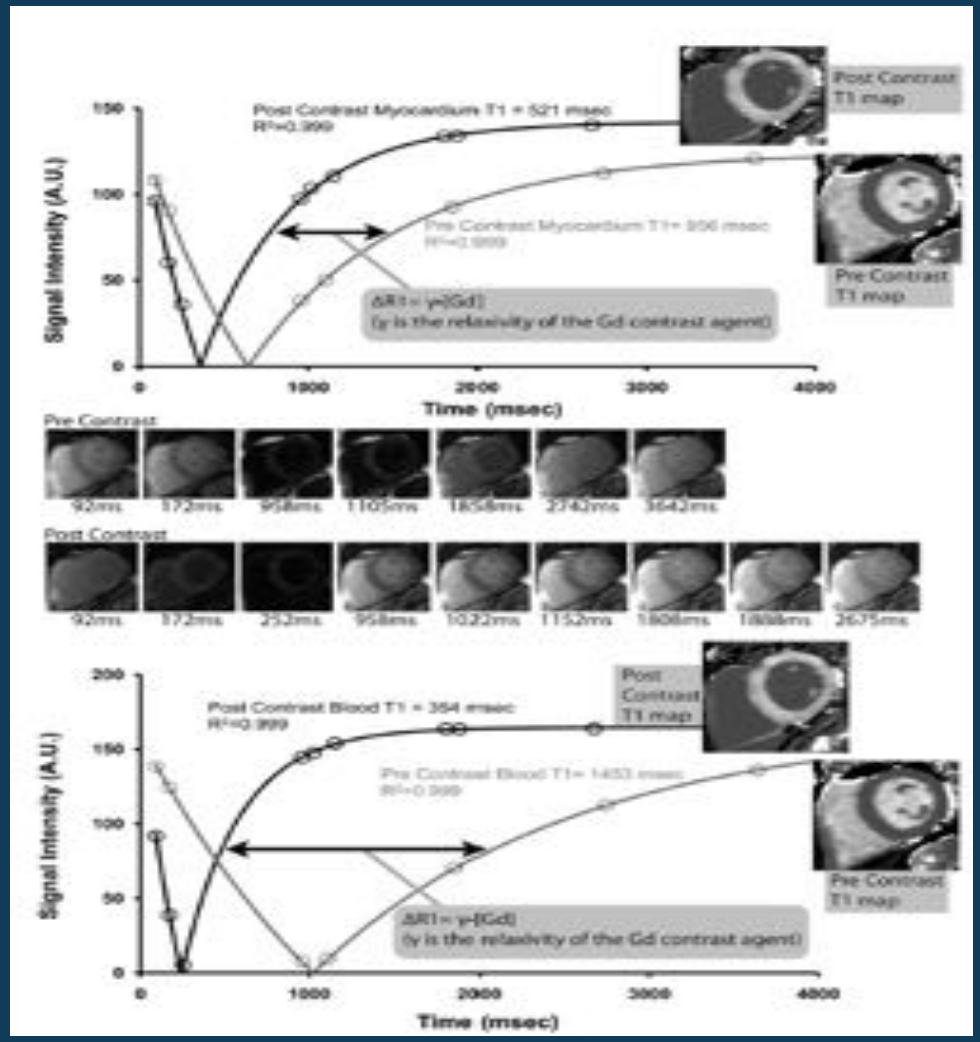


Rajpurkar et al, CheXNet, Arxiv 2017

Machine or Deep learning to totally automated T1 Estimates

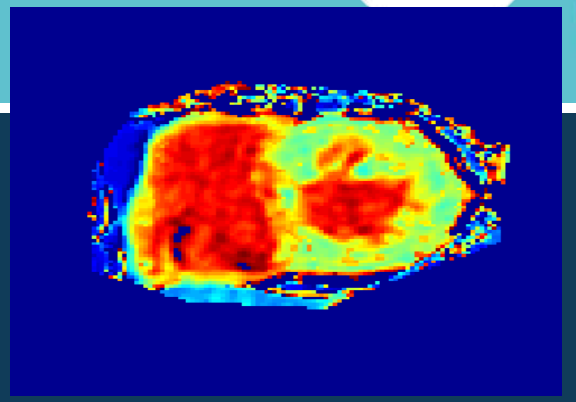
Myocardium

Native T1
vs Post Gd T1

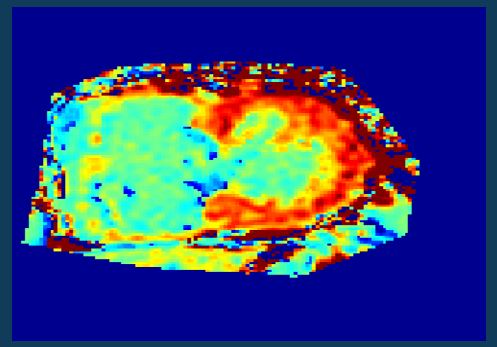


Blood

Native T1
Vs Post Gd T1



Native T1 mapping Image



Post Gd T1 and LGE image

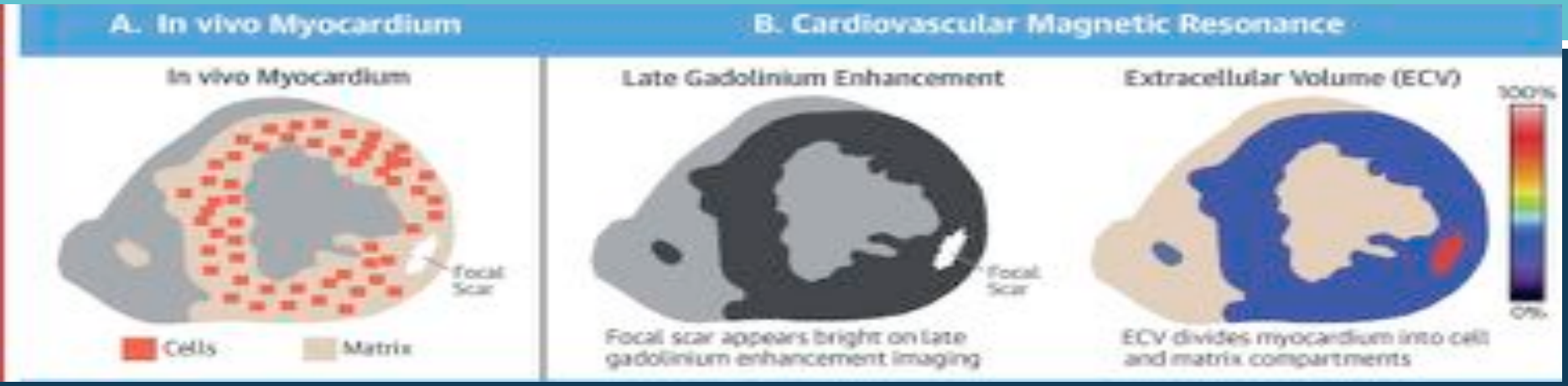
$$ECV = (1 - hematocrit)\frac{\left(\frac{1}{T1_{myo\ post}} - \frac{1}{T1_{myo\ pre}}\right)}{\left(\frac{1}{T1_{blood\ post}} - \frac{1}{T1_{blood\ pre}}\right)}$$

RESEARCH LETTER

Left Ventricular Hypertrophy Revisited

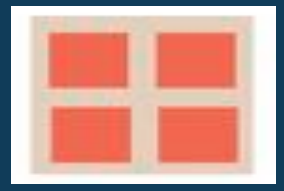
Cell and Matrix Expansion Have Disease-Specific Relationships

Treibel et al Circulation 2017



ECV 25%
LV Mass 100 ml
Cells 75 ml Matrix 25 ml

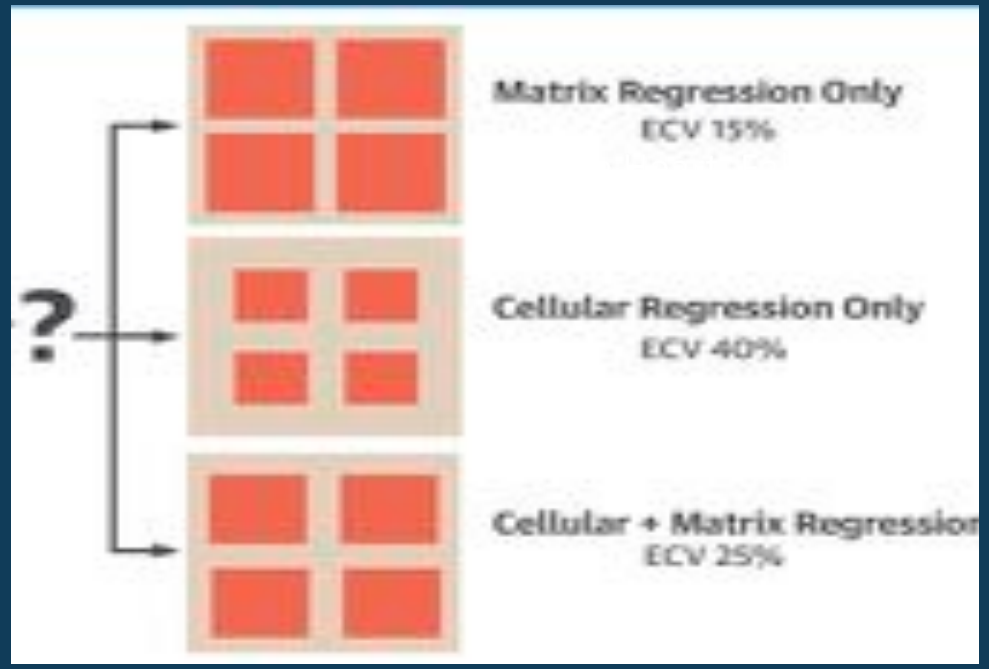
Normal LVM



Cell Volume = LV Mass x (1-ECV)
Matrix Volume = LV Mass x ECV

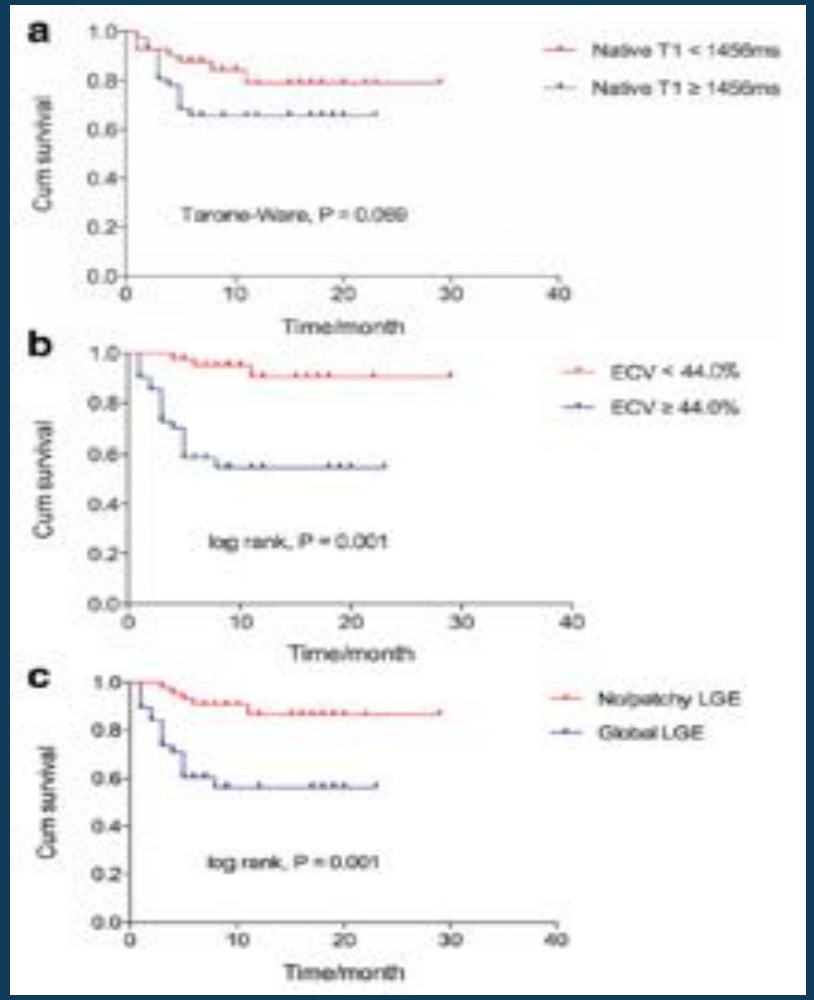
LVH when increased LVM
But with Cardiac MR

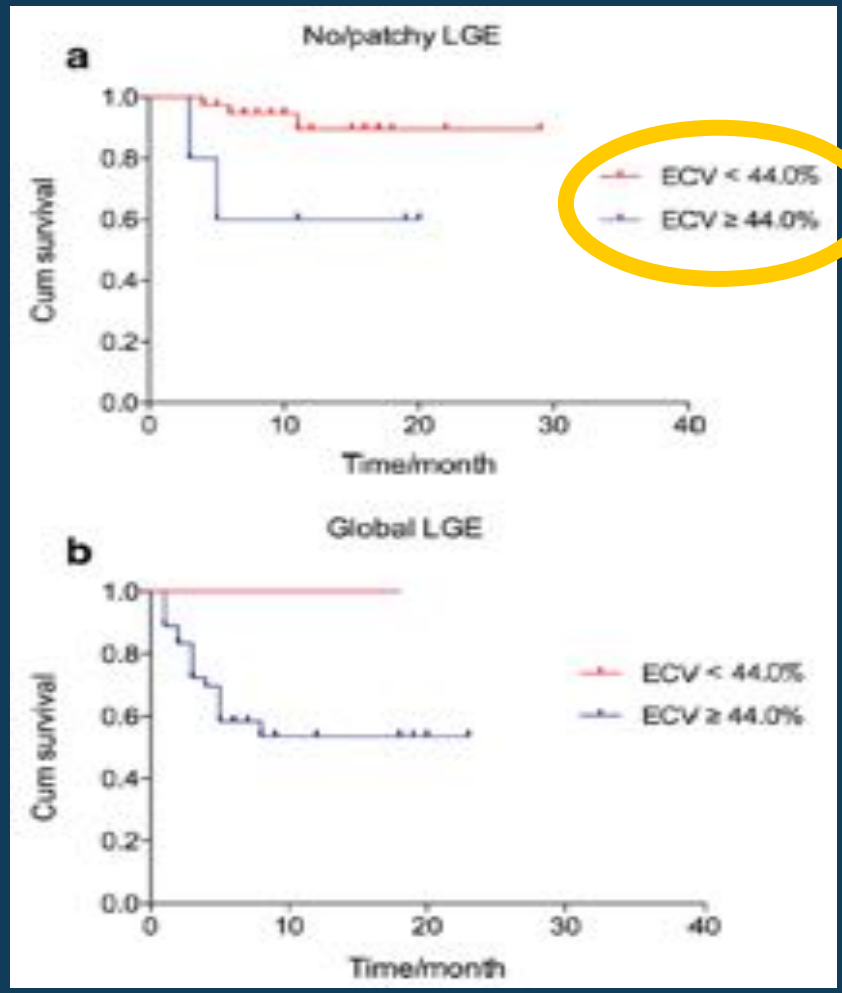
Increased LVM



The prognostic value of T1 mapping and late gadolinium enhancement cardiovascular magnetic resonance imaging in patients with light chain amyloidosis

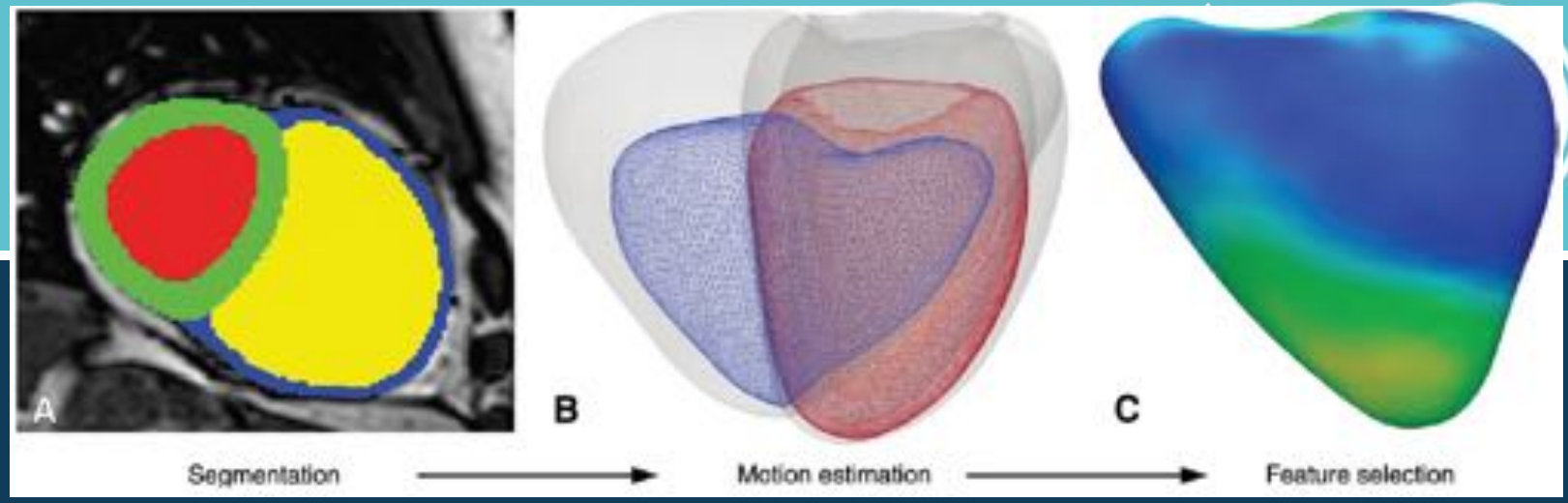
Lin et al JCMR 2018

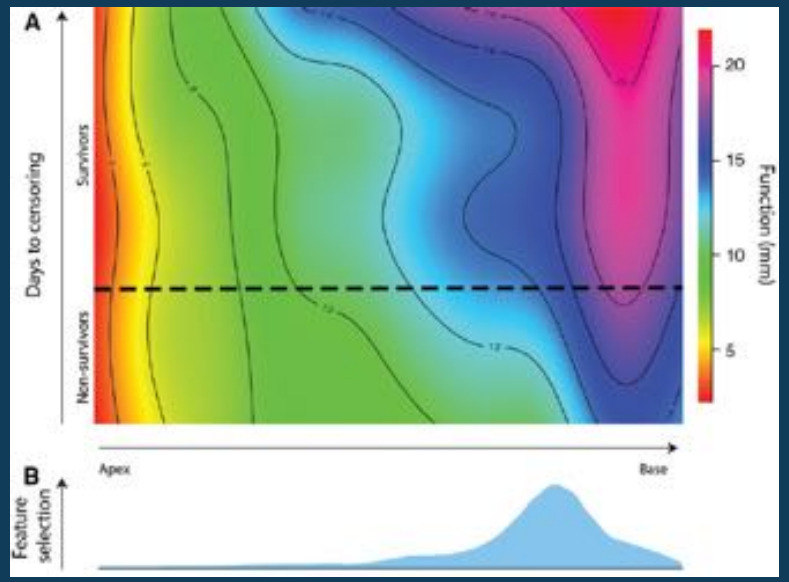


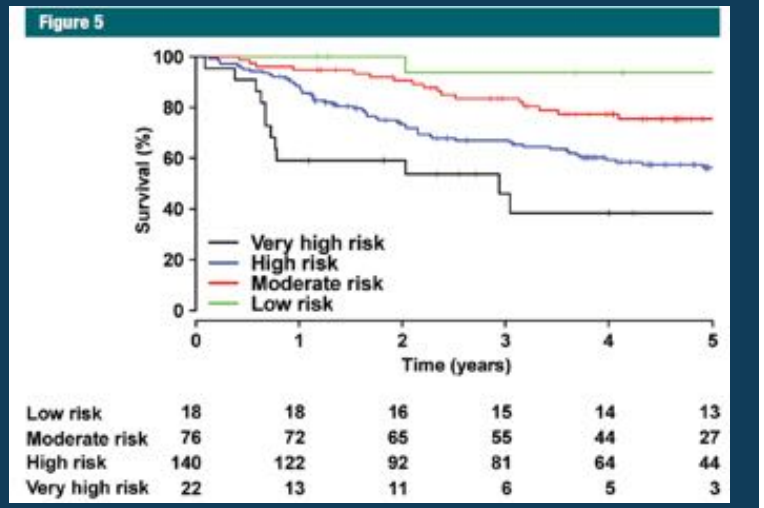


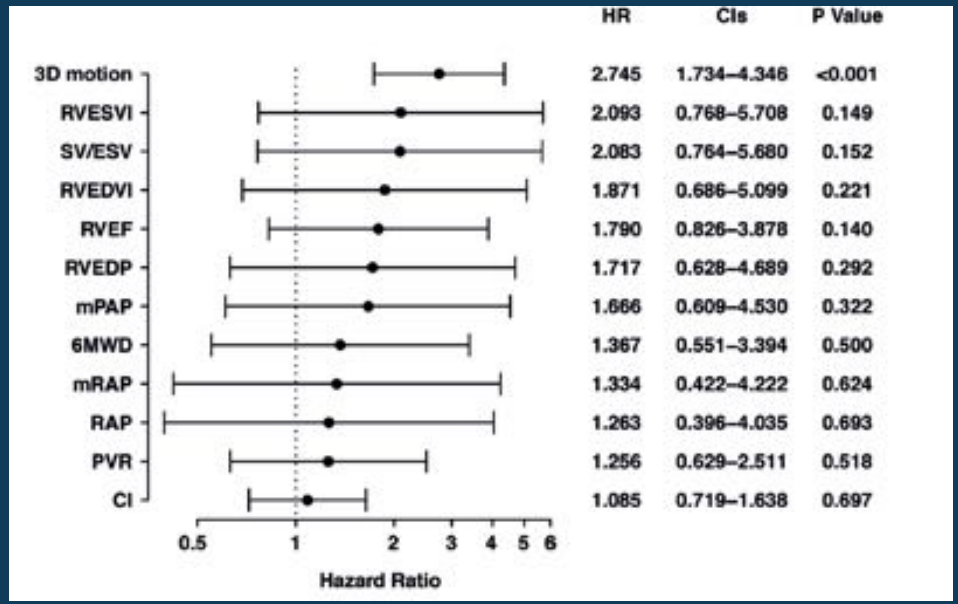
82 AL CA → 21 death (8 months): global LGE HR 4,8 vs ECV > 44% HR 7,2, both indpdt

Machine Learning of Three-dimensional Right Ventricular Motion Enables Outcome Prediction in Pulmonary Hypertension: A Cardiac MR Imaging Study[1]









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CONCLUSION

IRM cardiaque

« Ne sera jamais possible » → une Méthode de référence en Cardiologie

→ une Imagerie décisionnelle dans beaucoup d'indications

Voir ←→ Comprendre → intégré le passé et la culture (exemple du Doppler et Flux 4D)

L'image est communicante +++ → Décision , oui ….. est la bonne ? → basée sur des preuves

AI → partage de taches entre Ordinateur et l'Imageur

→ évolution vers la notion de Biomarqueur +++ « Boite Noire »

→ Accepter de perdre contre l'ordinateur afin de mieux s'adapter, se former

Thank you for your Attention

Special Thanks:

G Soulat, F.Pitocco, K.Dang Tran,

Y.Alattar, U.Gencer, P.Garrigoux, E Charpentier.