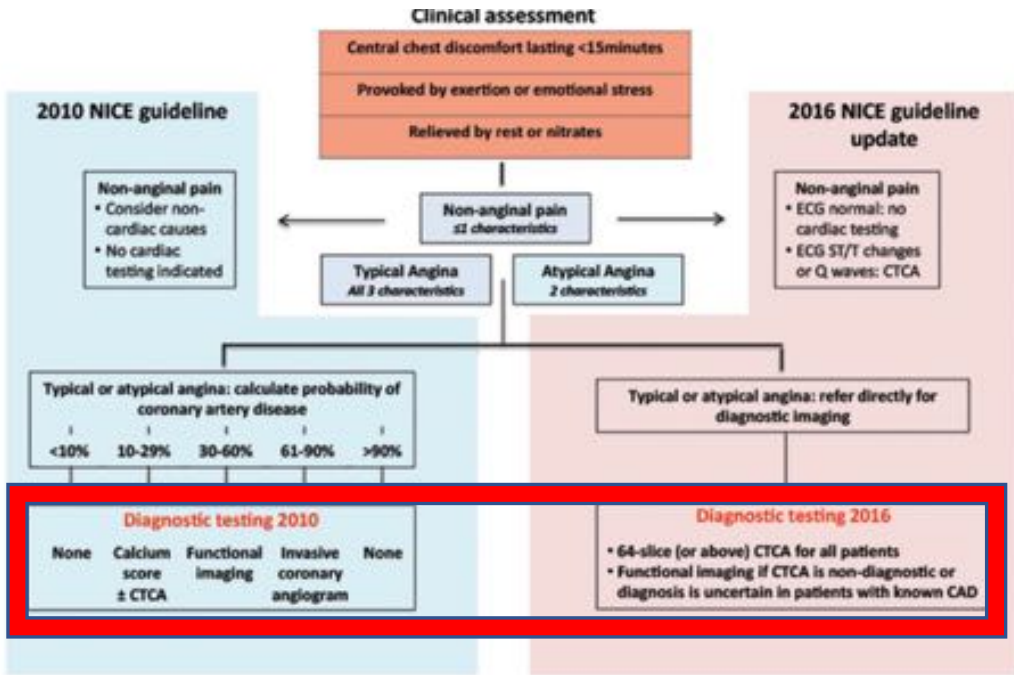
LE CORO SCANNER : la dure réalité

PATRICK DUPOUY
Pôle Cardio-Vasculaire Interventionnel Antony-Melun

National Institute for Health and Care Excellence updates the stable chest pain guideline with radical changes to the diagnostic paradigm

Adam Timmis,[1] Carl A Roobottom[2]



Heart 2017;103:982

ESC European Society of Cardiology
European Heart Journal (2019) 00, 1–71
doi:10.1093/eurheartj/ehz425

ESC GUIDELINES

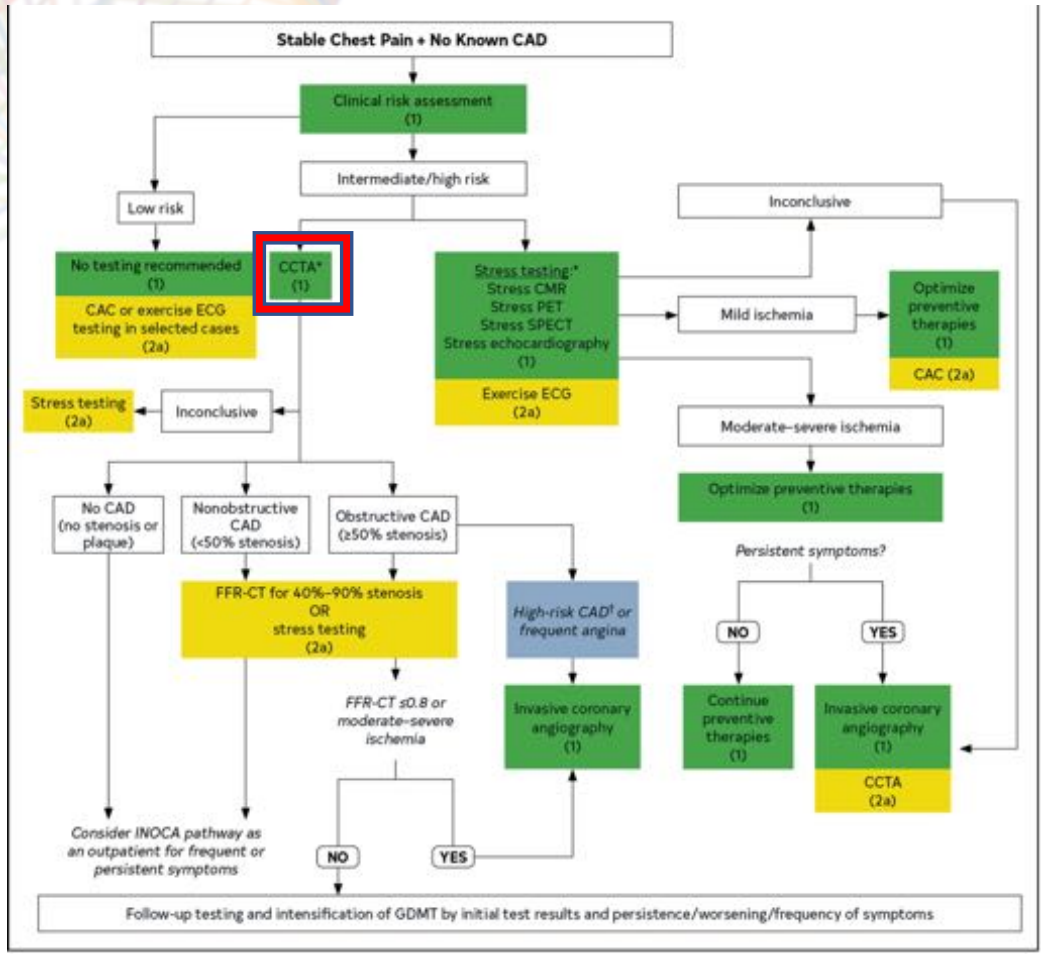
2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes

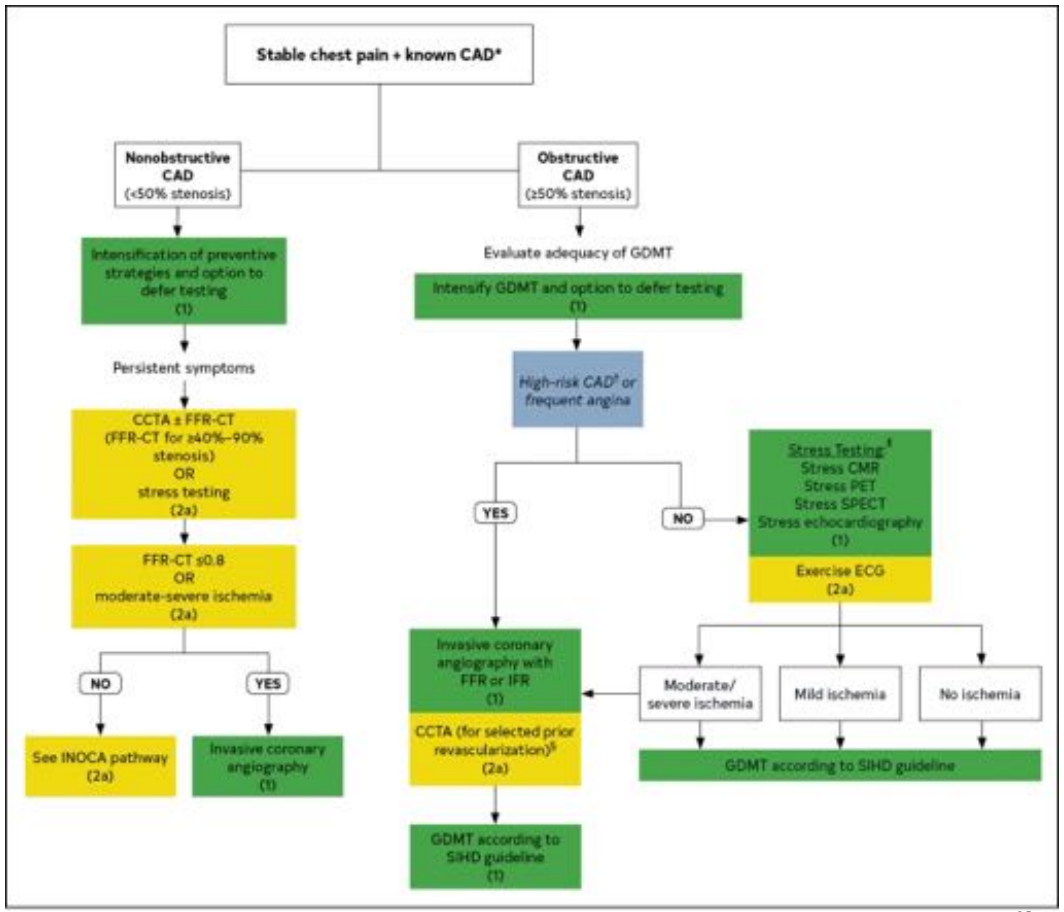
The Task Force for the diagnosis and management of chronic coronary syndromes of the European Society of Cardiology (ESC)

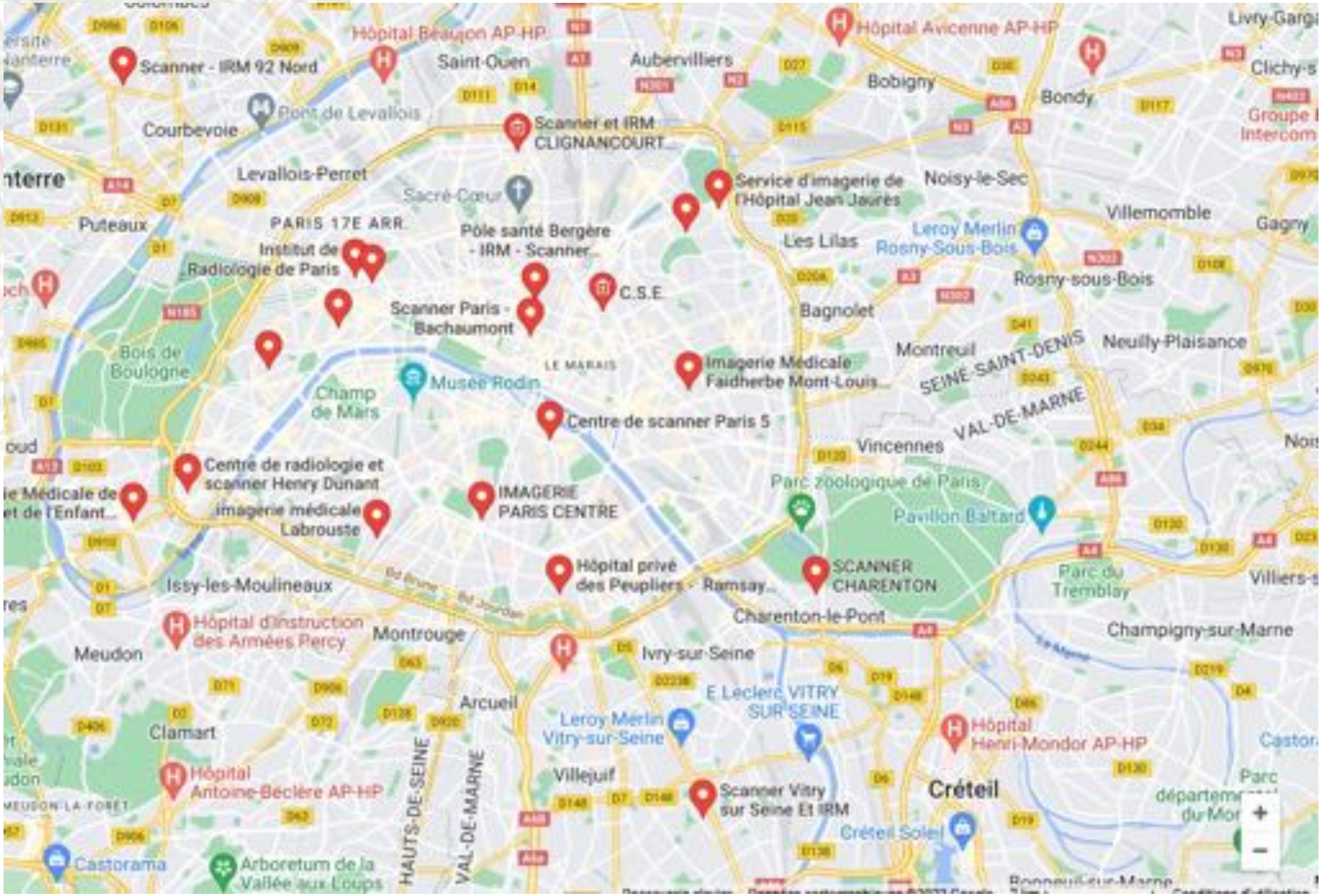
New major recommendations in 2019	
Basic testing, diagnostics, and risk assessment	
Non-invasive functional imaging for myocardial ischaemia or coronary CTA is recommended as the initial test for diagnosing CAD in symptomatic patients in whom obstructive CAD cannot be excluded by clinical assessment alone.	I
characteristics that influence test performance, local expertise, and the availability of tests	I
Functional imaging for myocardial ischaemia is recommended if coronary CTA has shown CAD of uncertain functional significance or is not diagnostic.	I
Invasive angiography is recommended as an alternative test to diagnose CAD in patients with a high clinical likelihood and severe symptoms refractory to medical therapy, or typical angina at a low level of exercise and clinical evaluation that indicates high event risk. Invasive functional assessment must be available and used to evaluate stenoses before revascularization, unless very high grade (>90% diameter stenosis).	I
Invasive coronary angiography with the availability of invasive functional evaluation should be considered for confirmation of the diagnosis of CAD in patients with an uncertain diagnosis on non-invasive testing.	IIa
Coronary CTA should be considered as an alternative to invasive angiography if another non-invasive test is equivocal or non-diagnostic.	IIa
Coronary CTA is not recommended when extensive coronary calcification, irregular heart rate, significant obesity, inability to cooperate with breath-hold commands, or any other conditions make good image quality unlikely.	III

AHA/ACC CLINICAL PRACTICE GUIDELINE

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines



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Hôpital Beaujon AP-HP
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Aubervilliers
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Arboretum de la Vallée aux Loups
HAUTS-DE-SEINE
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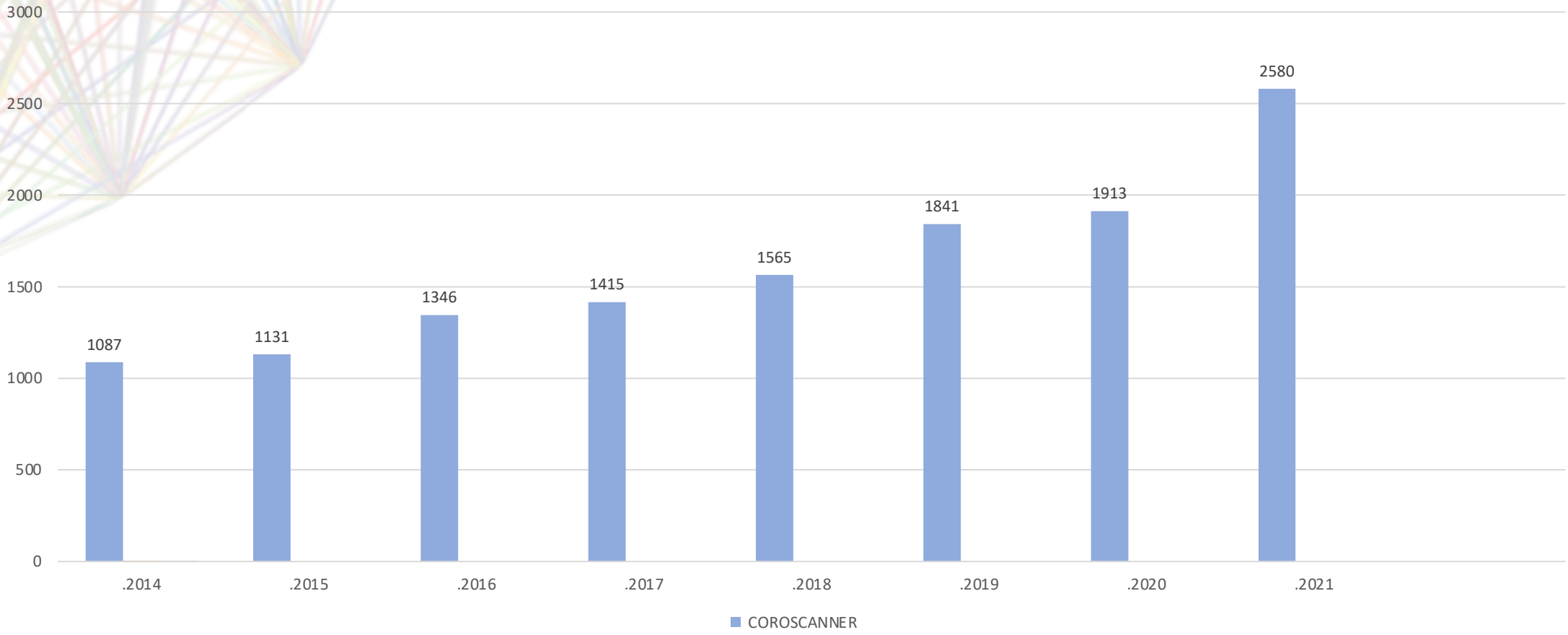
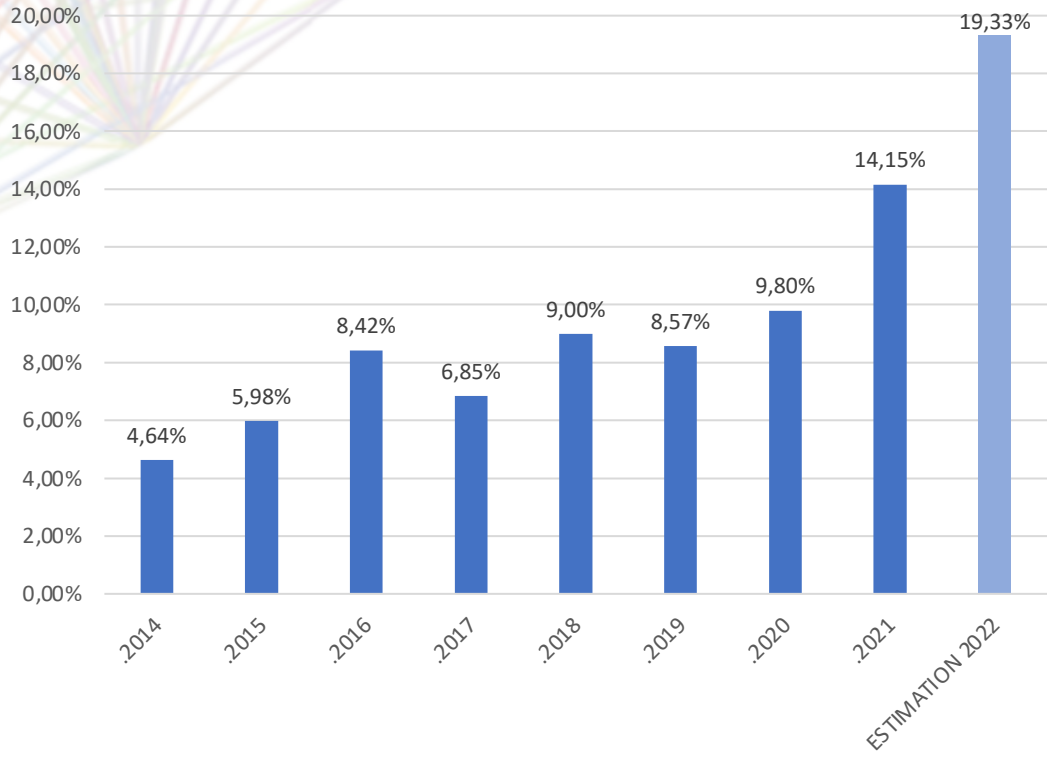
Le coro scanner et activité interventionnelle



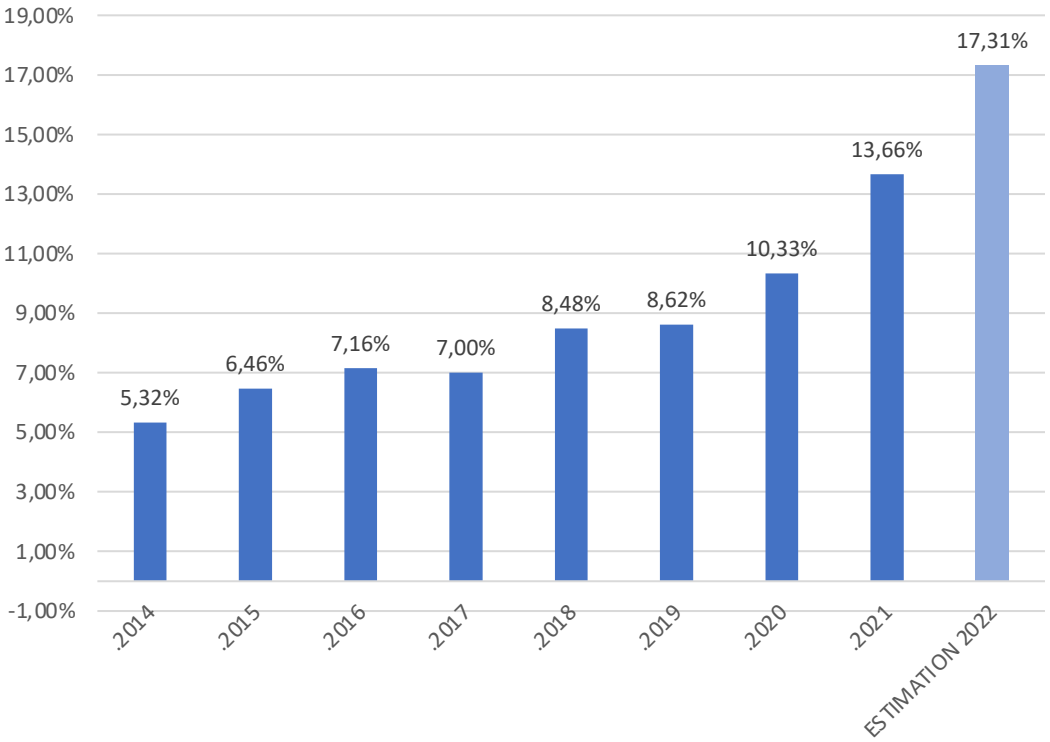
Remerciements P Commeau

Importance croissante du coro-scanner dans notre activité

Coronarographies



Angioplasties



Remerciements P Commeau

Over 20million patients present with chest pain every year in the USA (3% of primary care visits, 5% of emergency department visits) with >5million CCTAs performed in Organization for Economic Co-operation and Development countries. It is estimated that by 2025, 10%–15% of all CT scans performed globally will be CCTAs.

Board of Cardiac CT

Radiology: Cardiothoracic Imaging

ORIGINAL RESEARCH

Cardiac Imaging Trends from 2010 to 2019 in the Medicare Population

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Conflicts of interest are listed at the end of this article.

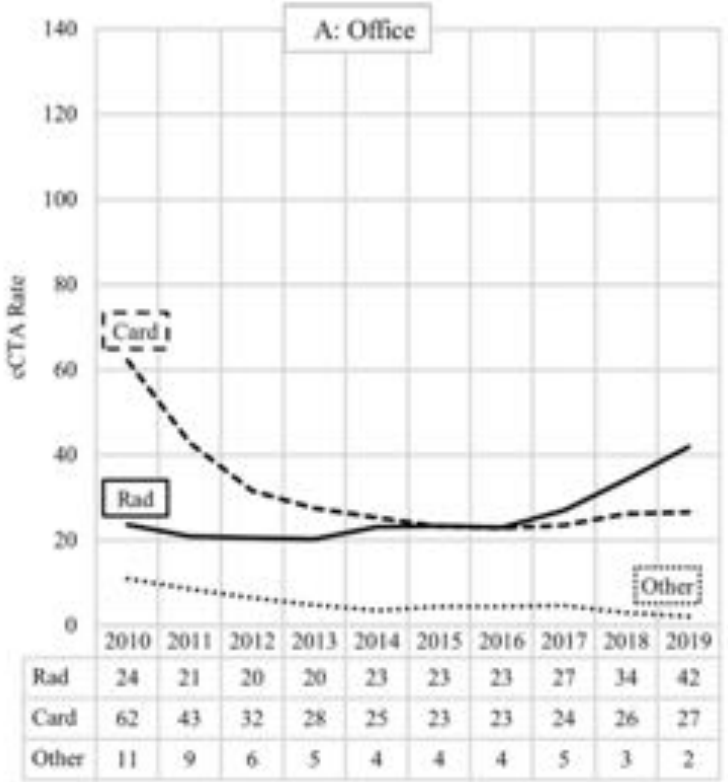
Radiology: Cardiothoracic Imaging 2021; 3(5):e210156 • https://doi.org/10.1148/ryct.2021210

Summary

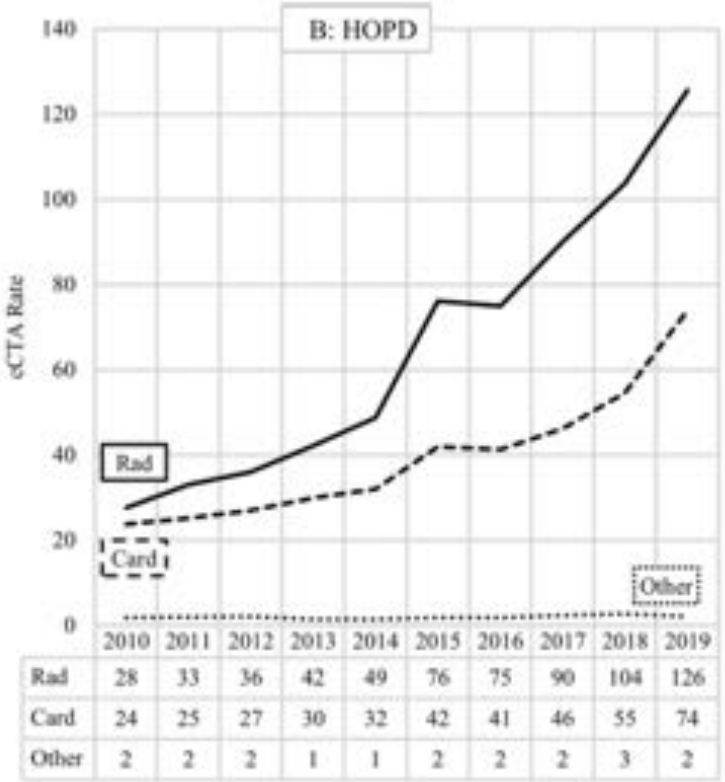
Cardiologist in-office echocardiography and myocardial perfusion imaging continue to shift to the hospital outpatient department, with increasing in-office cardiac PET utilization.

Key Points

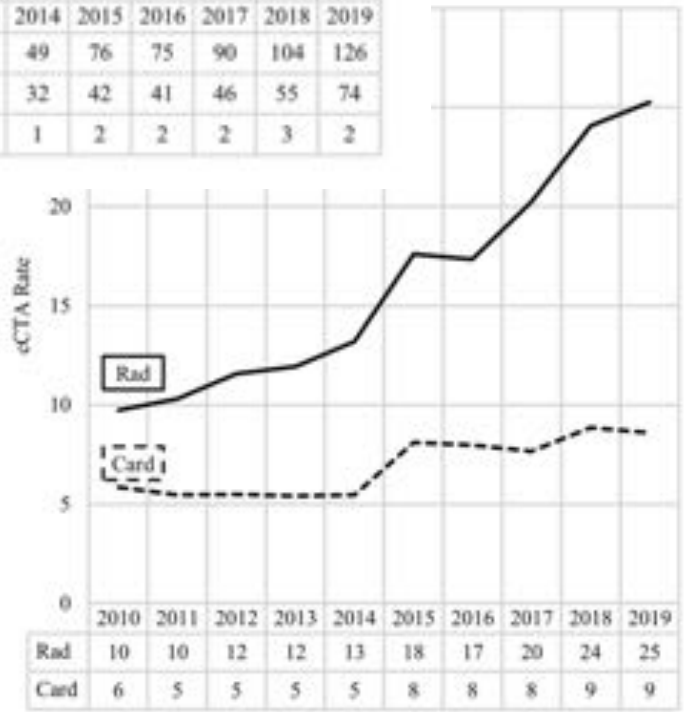
- From 2010 to 2019, cardiologist in-office myocardial perfusion imaging rates per 100 000 beneficiaries have dropped by 52% (4426 to 2119), with a corresponding rate increase in hospital outpatient departments (935 to 1598; +71%).
- During this same period, the rates of coronary CT angiography performed by radiologists more than tripled in hospital outpatient departments (28 to 126; +355%), but overall rates remain low compared with myocardial perfusion imaging.
- Rates of cardiac PET in cardiologist offices nearly tripled during this time (125 to 367; +193%), but rates of cardiac PET performed by radiologists in offices (eight to five; −38%) and hospital outpatient departments (10 to 19; +90%) saw little change.



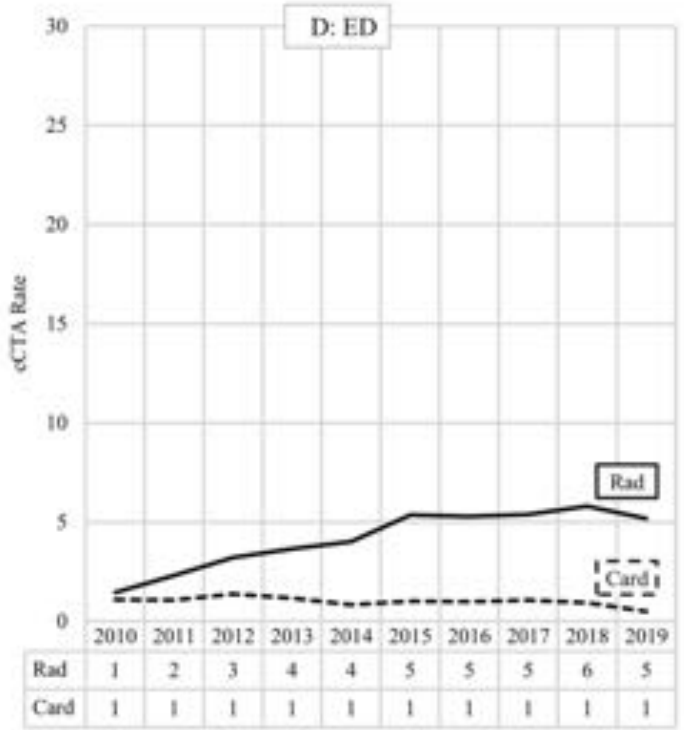
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rad	24	21	20	20	23	23	23	27	34	42
Card	62	43	32	28	25	23	23	24	26	27
Other	11	9	6	5	4	4	4	5	3	2



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rad	28	33	36	42	49	76	75	90	104	126
Card	24	25	27	30	32	42	41	46	55	74
Other	2	2	2	1	1	2	2	2	3	2



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rad	10	10	12	12	13	18	17	20	24	25
Card	6	5	5	5	5	8	8	8	9	9



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Rad	1	2	3	4	4	5	5	5	6	5
Card	1	1	1	1	1	1	1	1	1	1

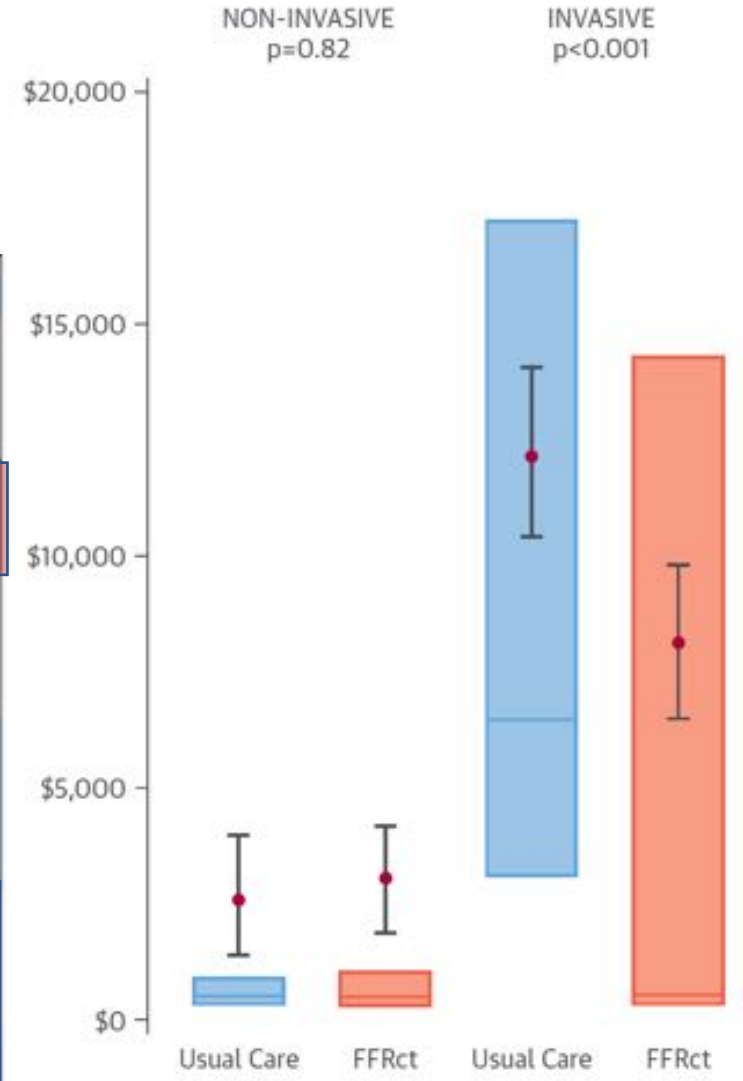
Figure 3: Coronary CTA (cCTA) rates per 100 000 Medicare beneficiaries by specialty and place of service. Card = cardiologist, ED = emergency department, HOPD = hospital outpatient department, Rad = radiologist.

PLATFORM STUDY n=584

TABLE 1 1-Year Clinical Outcomes

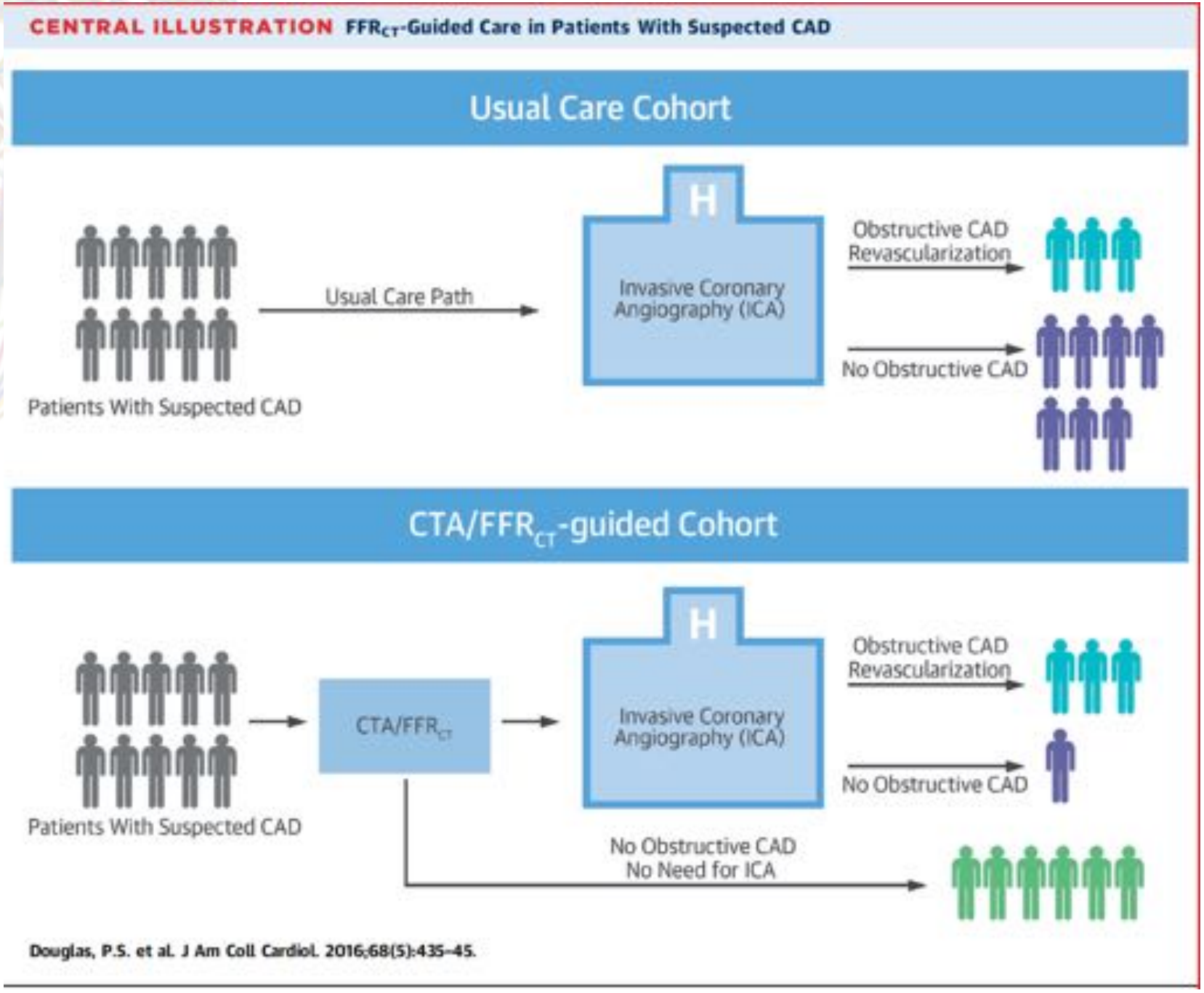
	Planned Noninvasive Test (n = 204)			Planned Invasive Test (n = 380)		
	Usual Care Strategy (n = 100)	FFR_{CT}-Guided Strategy (n = 104)	p Value	Usual Care Strategy (n = 187)	FFR_{CT}-Guided Strategy (n = 193)	p Value
Invasive catheterization without obstructive CAD*						
Patients	6 (6.0)	13 (12.5)	0.95	137 (73.3)	24 (12.4)	<0.001
Risk difference, %	-6.5 (-14.4 to 1.4)†			60.8 (53.0 to 68.7)†		
MACE						
Patients	1	0		2	2	
Percentage	1.00 (0.03-5.45)†	0.00 (0.00-3.48)†		1.07 (0.13-3.81)†	1.04 (0.13-3.69)†	
Risk difference, %	-1.00 (-12.67 to 10.68)‡			-0.03 (-8.55 to 8.47)‡		
MACE components						
All-cause death	0 (0.0)	0 (0.0)		1 (0.5)	0 (0.0)	
Nonfatal MI	1 (1.0)	0 (0.0)		1 (0.5)	1 (0.5)	
Hospitalization with urgent revascularization	0 (0.0)	0 (0.0)		0 (0.0)	1 (0.5)	
MACE or vascular complications						
Patients	1	1		4	7	
Percentage	1.00 (0.03-5.45)†	0.96 (0.02-5.24)†		2.14 (0.59-5.39)†	3.63 (1.47-7.33)†	
Risk difference, %	-0.04 (-11.73 to 11.62)‡			1.49 (-7.05 to 9.95)‡		
Cumulative radiation exposure			<0.001			0.21
Mean ± SD, mSv	6.42 ± 7.47	9.55 ± 10.56		10.36 ± 6.69	10.72 ± 9.62	
Median (IQR), mSv	2.57 (0.00-10.58)	4.91 (2.49-12.37)		7.00 (7.00-15.00)	7.94 (2.67-17.32)	

FIGURE 2 1-Year Costs by Stratum and Evaluation Strategy



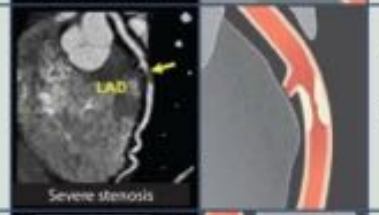
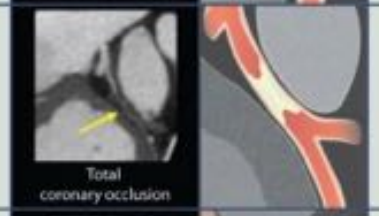
J Am Coll Cardiol 2016;68:435–45

CENTRAL ILLUSTRATION FFR_{CT}-Guided Care in Patients With Suspected CAD



Douglas, P.S. et al. J Am Coll Cardiol. 2016;68(5):435–45.

Score CAD RADS

CAD-RADS 0	0% No plaque or stenosis		None	• Reassurance. Consider non-atherosclerotic causes of chest pain
CAD-RADS 1	1- 24% Minimal stenosis or plaque with no stenosis**		None	• Consider non-atherosclerotic causes of chest pain • Consider preventive therapy and risk factor modification
CAD-RADS 2	25- 49% Mild stenosis		None	• Consider non-atherosclerotic causes of chest pain • Consider preventive therapy and risk factor modification, particularly for patients with non-obstructive plaque in multiple segments.
CAD-RADS 3	50-69% Moderate stenosis		Consider functional assessment	• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care*** • Other treatments should be considered per guideline-directed care***
CAD-RADS 4	A: 70-99% stenosis or B: Left main >50% or 3-vessel obstructive (≥70%) disease		A: Consider ICA**** or functional assessment B: ICA is recommended	• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care*** • Other treatments (including options of revascularization) should be considered per guideline-directed care***
CAD-RADS 5	100% Total occlusion		Consider ICA and/or viability assessment	• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factors modification per guideline-directed care*** • Other treatments (including options of revascularization) should be considered per guideline-directed care***
			Additional	

• Reassurance. Consider non-atherosclerotic causes of chest pain

• Consider non-atherosclerotic causes of chest pain
• Consider preventive therapy and risk factor modification

• Consider non-atherosclerotic causes of chest pain
• Consider preventive therapy and risk factor modification, particularly for patients with non-obstructive plaque in multiple segments.

• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care***
• Other treatments should be considered per guideline-directed care***

• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care***
• Other treatments (including options of revascularization) should be considered per guideline-directed care***

• Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factors modification per guideline-directed care***
• Other treatments (including options of revascularization) should be considered per guideline-directed care***

SYNTAX III REVOLUTION TRIAL

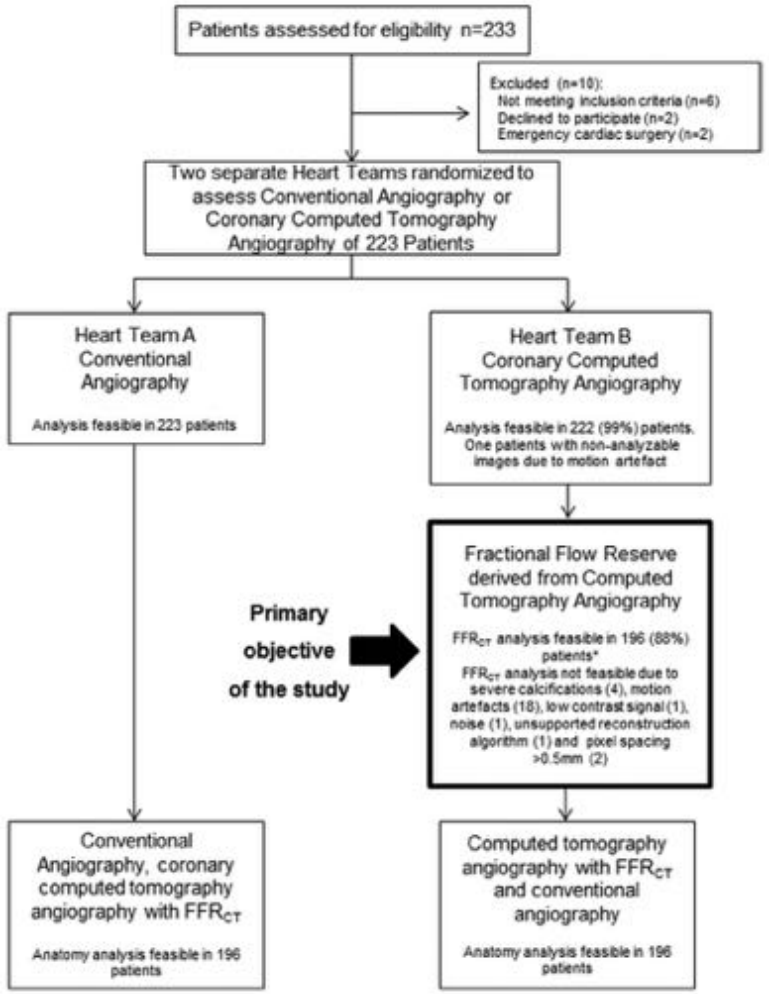


Table 3. Level of Agreement Between Conventional Angiography Only Versus Coronary CTA and Conventional Angiography With Functional Assessment by FFR_{CT}

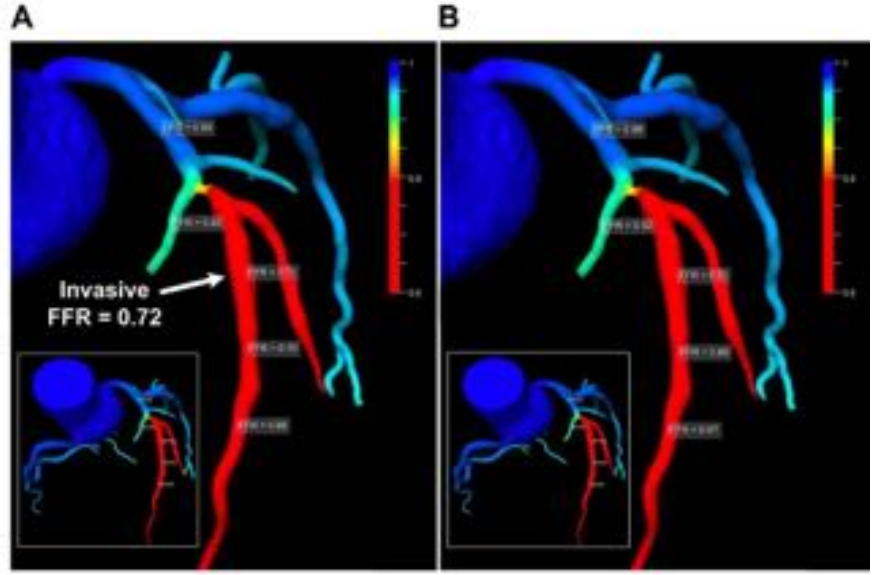
Recommendation Based on Angiography Only	Recommendation Based on Angiography and Coronary CTA With FFR_{CT}		
	CABG Only		PCI Only/Equipoise
CABG only	21.9% (43/196)		3.1% (6/196)
PCI only/equipoise	3.6% (7/196)		71.4% (140/196)
	Number	%, 95% CI	κ, 95% CI
Concordance	183	93.4 (88.9–96.4)	0.82 (0.73–0.92)

Circ Cardiovasc Interv. 2019;12:e007607

INTELLIGENCE ARTIFICIELLE

Figure 2. The four major categories (with example applications) of artificial intelligence tasks in clinical cardiac radiology. CAC, coronary artery calcium; CAD, coronary artery disease; CCTA, coronary computedtomographic angiography; EAT, epicardial adipose tissue; FFR-CT, fractional flow reserve-CT; PVAT, perivascular adipose tissue.

Br J Radiol 2020; 93: 20190812



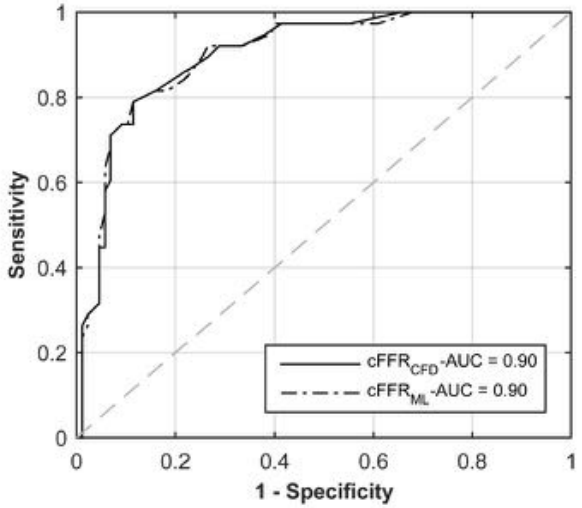


Fig. 13. Receiver-operator characteristic curves for 189 vessels, as obtained with $cFFR_{CFD}$ and $cFFR_{ML}$. AUC, area under the curve.

J Appl Physiol 121: 42–52, 2016.

Caractérisation et quantification automatique des Sténoses

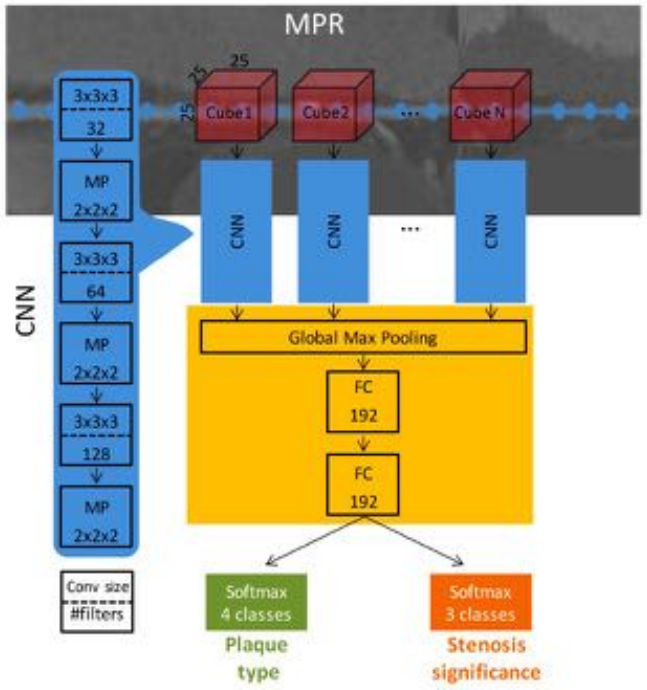


Figure 7. The input of the network is a sequence of cubes extracted from the MPR along artery centerline. A CNN extracts features out of each $25 \times 25 \times 25$ voxels cube, then a global max pooling and two dense (FC - fully connected) layers process the entire sequence. The output of the dense layers is fed into two softmax classifiers to simultaneously characterize plaque and stenosis. To match the total number of parameters compared to the proposed network, 196 units in each of dense layers were used. In total, the network had 341,191 parameters, vs. 340,295 parameters in the proposed network.

To conclude, this study presented an algorithm, based on a recurrent convolutional neural network, for automatic detection and characterization of coronary artery plaque, as well as detection and characterization of the anatomical significance of coronary artery stenosis. To the best of our knowledge, we are the first to propose an automatic method for both plaque and stenosis characterizations. This may enable automated triage of patients to those without coronary plaque, and those with coronary plaque and stenosis in need for further cardiovascular investigation.

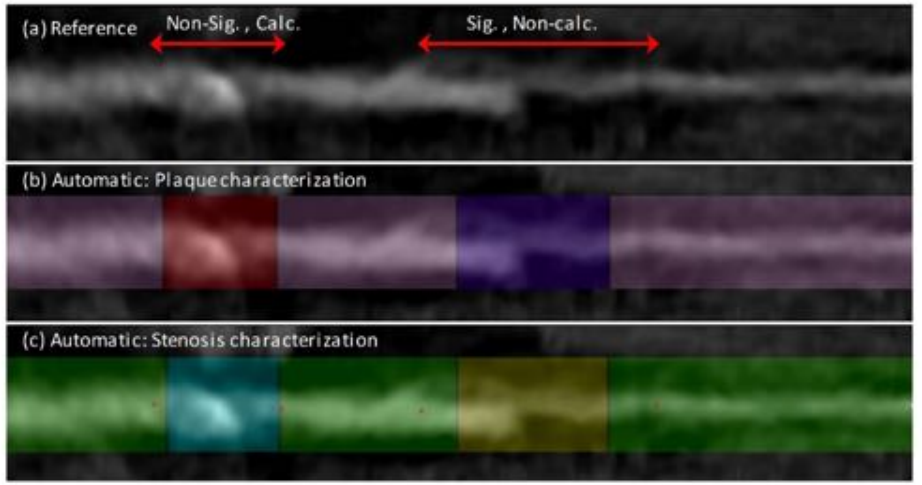
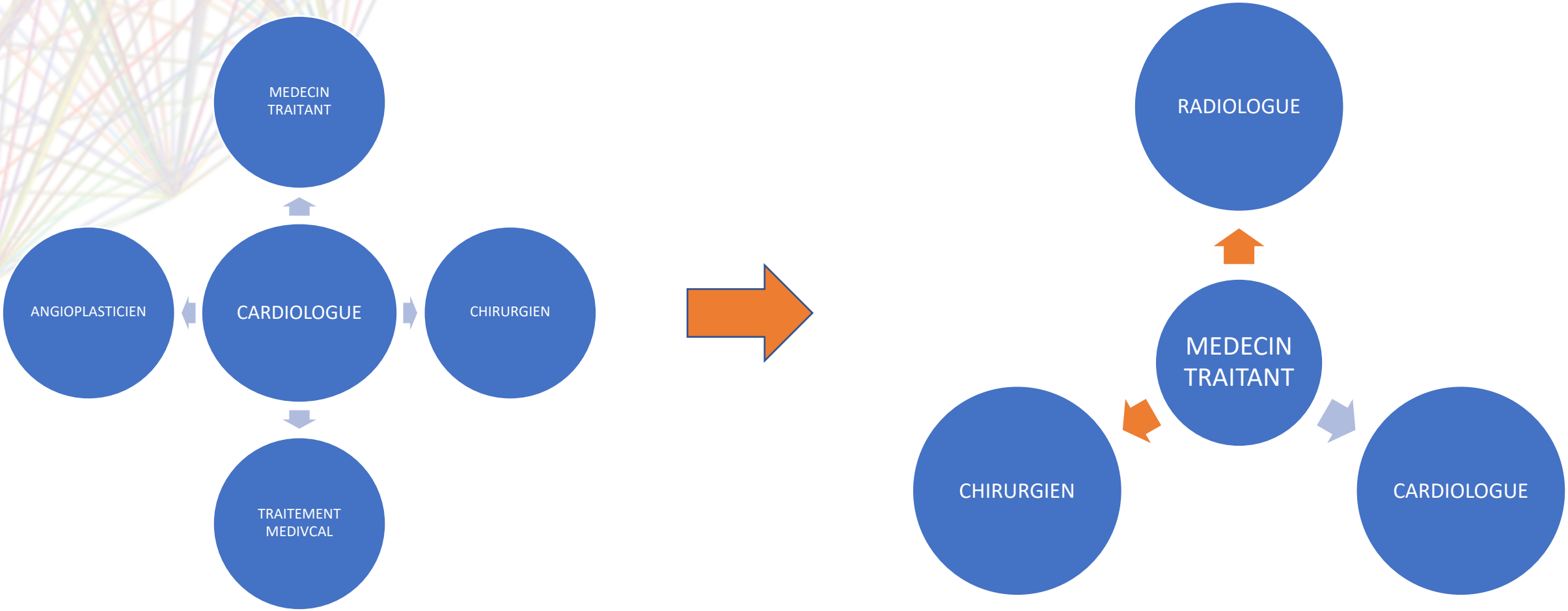


Figure 6. An example of a result for an entire artery. (a) MPR view of an artery with reference standard. Each arrow represents a manually annotated segment, its boundaries and the reference labels. Sig. = Significant stenosis, Non-Sig. = Non-significant stenosis. Calc. = Calcified plaque. Non-calc. = Non-calcified plaque. (b) Automatically predicted plaque labels (no-plaque, calcified, and non-calcified: purple, red, and blue overlays, respectively). (c) Automatically predicted stenosis labels (no-stenosis, non-significant, and significant: green, light blue and yellow, respectively). For illustration purposes only, all overlays were extended to a 25×25 voxels around the artery centerline, indicating the analyzed area.

Changement de paradigme



6 juillet 2021 JOURNAL OFFICIEL DE LA RÉPUBLIQUE FRANÇAISE Texte 33 sur 111

Décrets, arrêtés, circulaires

TEXTES GÉNÉRAUX

MINISTÈRE DES SOLIDARITÉS ET DE LA SANTÉ

Arrêté du 5 juillet 2021 portant homologation de la décision n° 2020-DC-0694 de l'autorité de sureté nucléaire du 8 octobre 2020 relative aux qualifications des médecins ou chirurgiens-dentistes qui réalisent des actes utilisant des rayonnements ionisants à des fins médicales ou de recherche impliquant la personne humaine, aux qualifications requises pour être désigné médecin coordonnateur d'une activité nucléaire à des fins médicales ou pour demander une autorisation ou un enregistrement en tant que personne physique

Annexe à la décision n° 2020-DC-0694 de l'Autorité de sûreté nucléaire du 8 octobre 2020 relative aux qualifications des médecins ou chirurgiens-dentistes qui réalisent des actes utilisant des rayonnements ionisants à des fins médicales ou de recherche impliquant la personne humaine, aux qualifications requises pour être désigné médecin coordonnateur d'une activité nucléaire à des fins médicales ou pour demander une autorisation ou un enregistrement en tant que personne physique

Domaine d'utilisation des rayonnements ionisants	Qualification nécessaire pour utiliser les rayonnements ionisants, selon le domaine d'utilisation	Qualification nécessaire, selon le domaine d'utilisation des rayonnements ionisants, pour être coordonnateur désigné par une personne morale ou demander une autorisation ou un enregistrement en tant que personne physique
Rayons X, hors scanographie, hors mammographie à des fins de diagnostic médical, y compris en téléradiologie	Docteur en médecine, quelle que soit la qualification ordinale 1	Sans objet
Rayons X à des fins de mammographie	Docteur en médecine qualifié en radiologie et imagerie médicale	Sans objet
Rayons X de type scanographie à des fins de diagnostic médical, y compris en téléradiologie	Docteur en médecine qualifié en radiologie et imagerie médicale ou docteur en médecine qualifié en médecine cardiovasculaire.	Docteur en médecine qualifié en radiologie et imagerie médicale ou docteur en médecine qualifié en médecine cardiovasculaire option « imagerie cardiovasculaire d'expertise ». Pour les professionnels ayant validé leur spécialité avant novembre 2022, une validation ordinale des acquis de l'expérience est nécessaire pour la reconnaissance de l'option.
Rayons X à des fins de pratiques interventionnelles radioguidées y compris par scanographie réalisées **en service de radiologie**	Docteur en médecine qualifié en radiologie et imagerie médicale	Docteur en médecine qualifié en radiologie et imagerie médicale
Rayons X à des fins de pratiques interventionnelles radioguidées réalisées **en dehors d'un service de radiologie**, à l'aide d'un appareil électrique de type scanographe ou non	Docteur en médecine qualifié en radiologie et imagerie médicale ou dans la spécialité médicale correspondant à la pratique interventionnelle concernée.	Docteur en médecine qualifié en radiologie et imagerie médicale ou dans une des spécialités médicales correspondant aux pratiques interventionnelles concernées.

L'arrêté du 5 Juillet 2021 redéfinit les critères de qualification des médecins pour l'usage des rayonnements ionisants. Cet arrêté intéresse grandement les cardiologues puisqu'il modifie profondément leurs conditions d'accès au scanner.

L'arrêté distingue deux situations différentes : la réalisation de l'acte scanographique en lui-même, et le fait d'être titulaire d'une autorisation.

- est habilité à réaliser un scanner à des fins de diagnostic médical, y compris en téléradiologie.

- Tout cardiologue peut être coordonnateur ou demander une autorisation ou un enregistrement en tant que personne physique, **à condition** d'être détenteur de l'option « imagerie cardiovasculaire d'expertise » ou, pour ceux ayant validé leur spécialité avant novembre 2022, d'une validation ordinale des acquis de l'expérience. Le médecin coordinateur est celui chargé de veiller à la coordination des mesures prises pour assurer la radioprotection des patients lorsque l'autorisation ou la notification de la décision d'enregistrement est délivrée à une personne morale.

Conclusions

- Le Coro Scanner est l'avenir de l'exploration coronaire
- Technologie en permanente révolution
- Vers la disparition de la coronarographie diagnostique ?
- Il est MAJEUR ET IMPERATIF que les cardiologues s'y investissent … la loi nous y autorise

> Le meilleur moyen de prédire l'avenir est de le créer
> Peter Drucker