

IA et dépistage des malformations cardiaques

E. Quarello

2021

Journées SOFFOET 24/09/2021

IMAGE

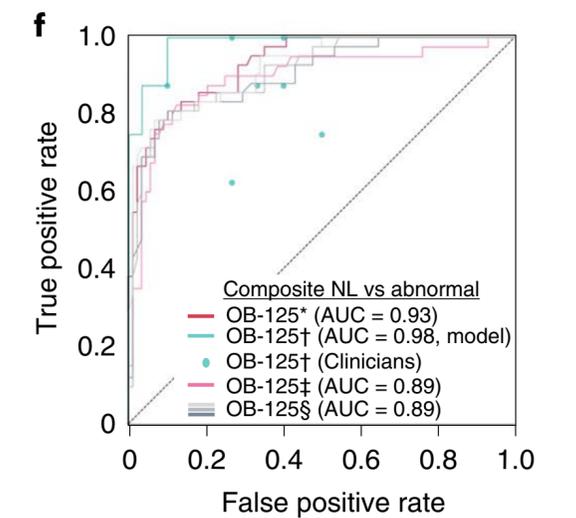
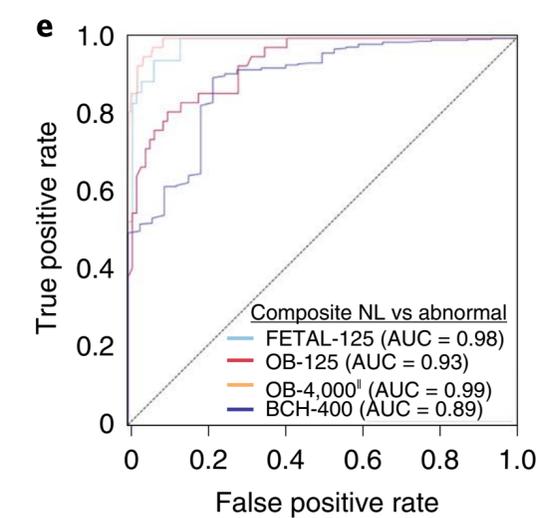
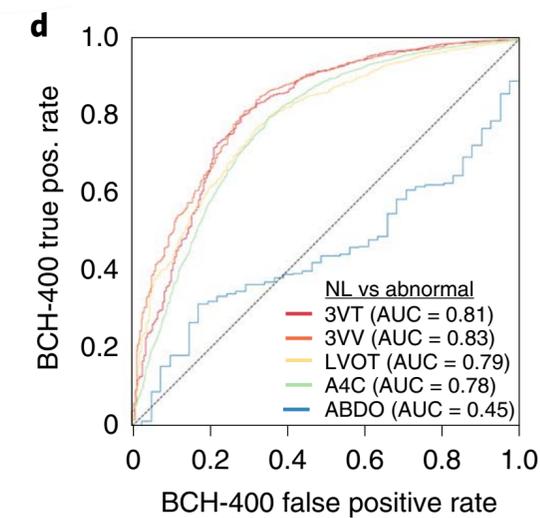
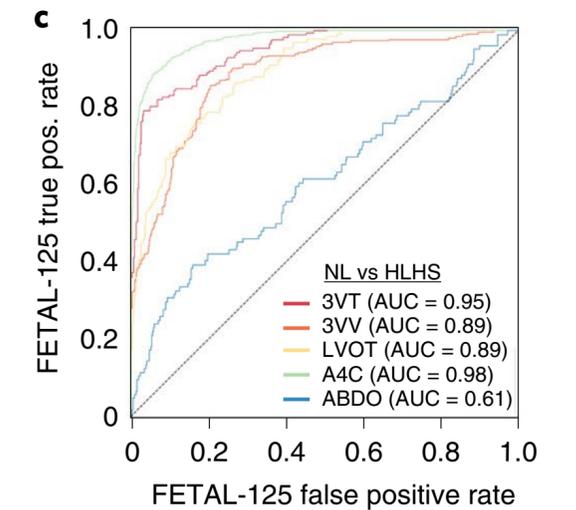
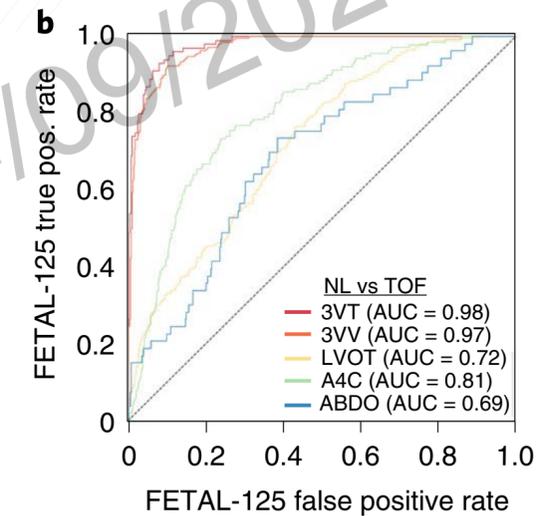
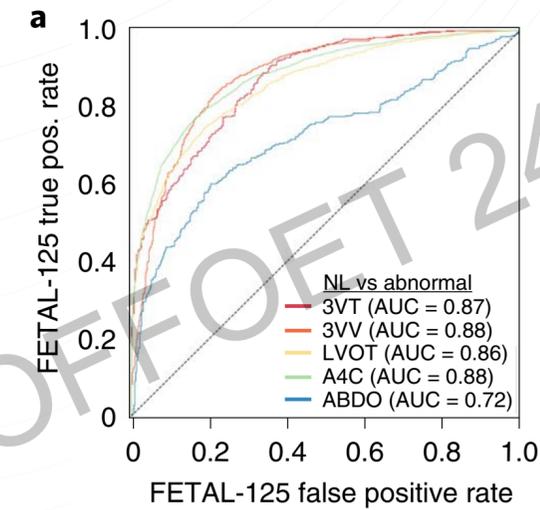
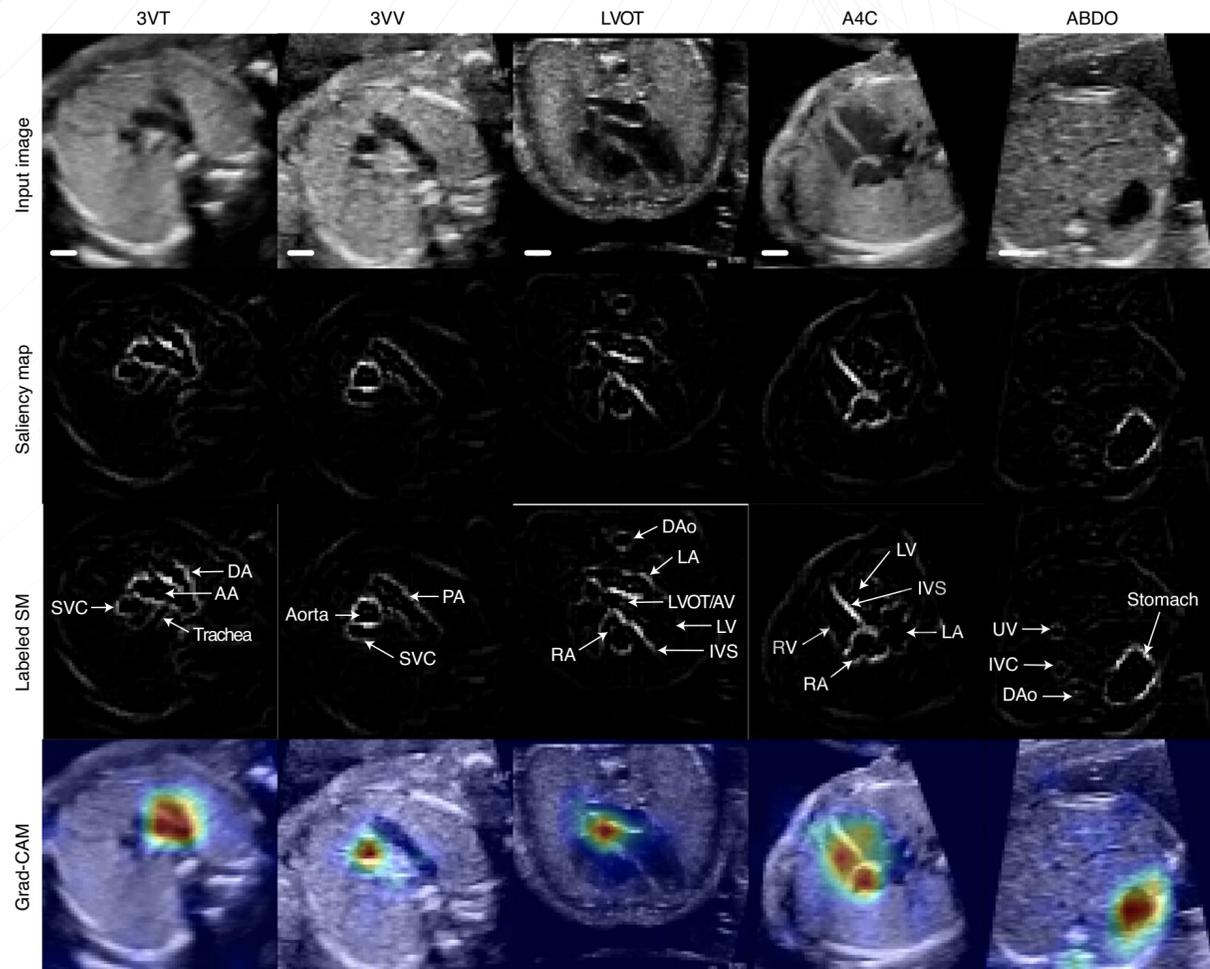
Institut Méditerranéen d'Imagerie Médicale Appliquée
À la Gynécologie, la Grossesse Et l'Enfance



An ensemble of neural networks provides expert-level prenatal detection of complex congenital heart disease

Rima Arnaout^{1,2,3,4,5}✉, Lara Curran^{1,2}, Yili Zhao⁶, Jami C. Levine^{7,8}, Erin Chinn^{1,2} and Anita J. Moon-Grady⁶

NATURE MEDICINE | VOL 27 | MAY 2021 | 882-891 |



Demain....

IA et dépistage

Journées SOFFOET \neq 24/09/2021

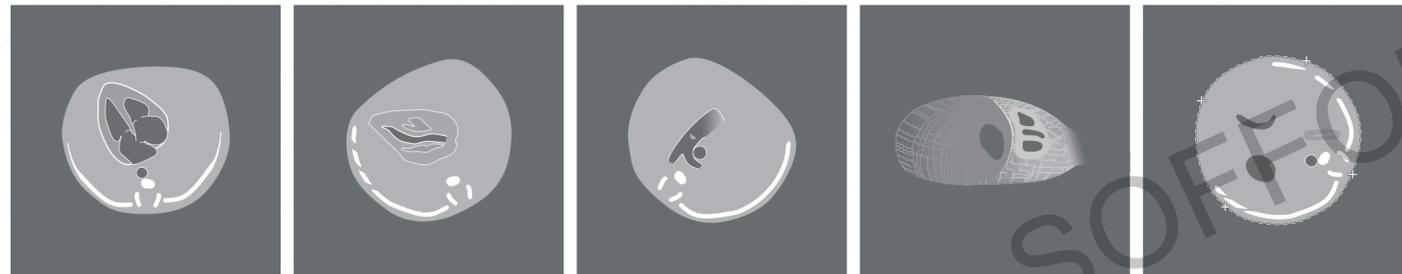
IA et diagnostic

En préambule...

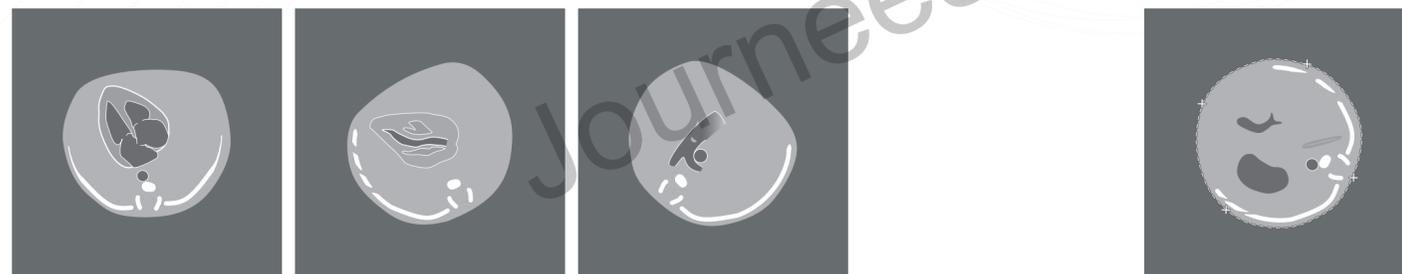
Conférence Nationale d'Échographie Obstétricale et Fœtale

L'échographie de dépistage prénatal

2e
trimestre



3e
trimestre



- Activité cardiaque (chiffrer la fréquence cardiaque si elle semble inhabituelle)

- Position du cœur
- Aspect des quatre cavités cardiaques
- Equilibre des cavités
- Position et aspect des gros vaisseaux
- Position et aspect de l'estomac

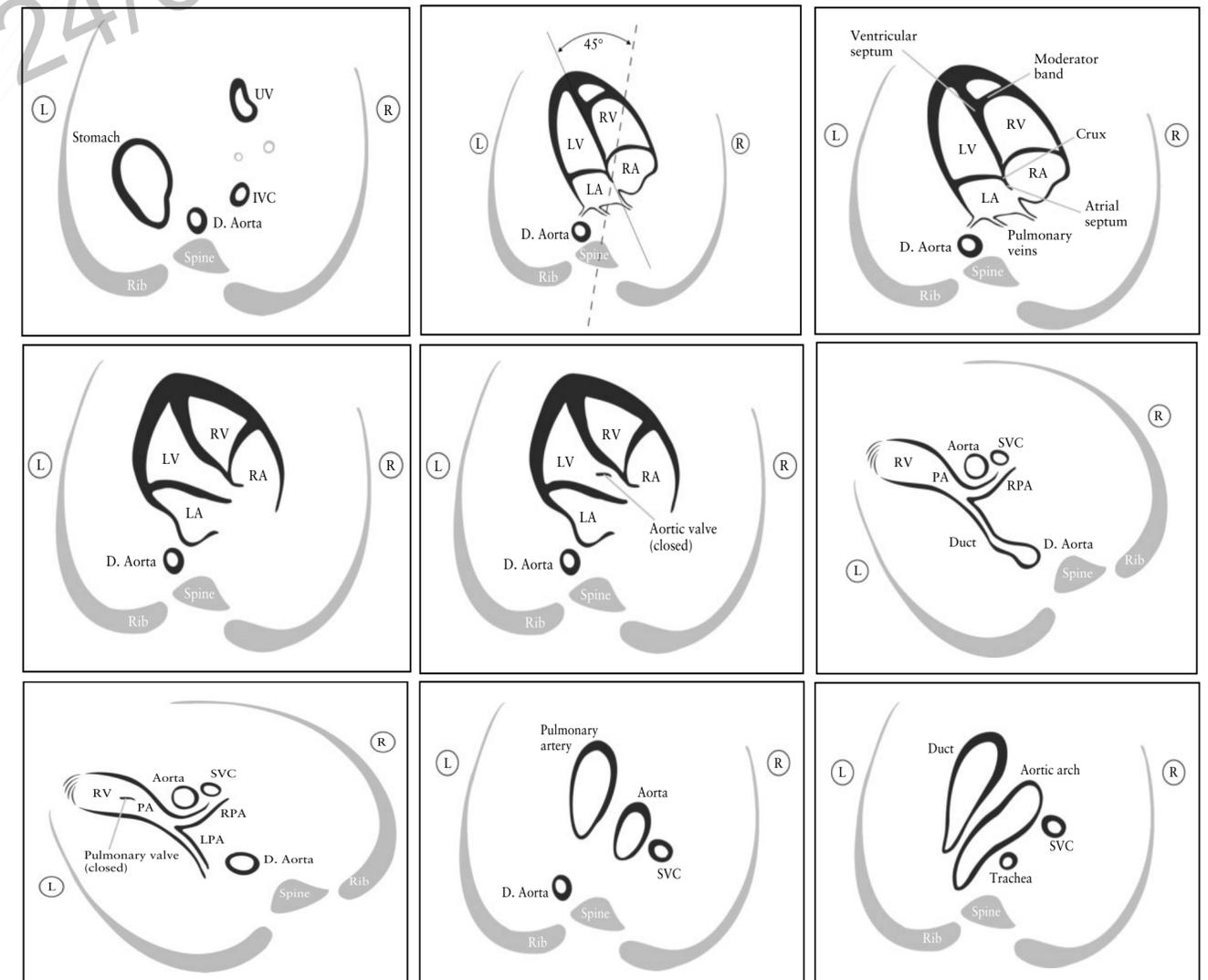
Ultrasound Obstet Gynecol 2013; 41: 348–359
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12403



isuog.org

GUIDELINES

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart



Why are congenital heart defects being missed?

A. E. L. VAN NISSELROOIJ¹, A. K. K. TEUNISSEN¹, S. A. CLUR², L. ROZENDAAL³,
E. PAJKRT⁴, I. H. LINSKENS⁴, L. RAMMELOO², J. M. M. VAN LITH¹, N. A. BLOM³
and M. C. HAAK¹

Ultrasound Obstet Gynecol 2020; 55: 747–757

Comparaison des échos de 58 CHD méconnues vs 56 CHD dépistées

49% des loupés: problème d'obtention ou de **qualité** des images

31% des loupés: CHD visibles, **défaut d'identification** malgré « bonnes images »

20% des loupés: CHD malgré « bonnes images » et anatomie normale

	CHD méconnues	CHD dépistées	
qualité > 12	32%	64%	p = 0,002
zoom suffisant	58%	84%	p = 0,01
qualité 4CV	2,7	3,9	p < 0,001
qualité 3Vx	3,0	3,8	p = 0,02
qualité VEG	1,9	3,3	p < 0,001
qualité VED	1,9	3,3	p < 0,001

Fetal Cardiac Screening

What Are We (and Our Guidelines) Doing Wrong?

Mark Sklansky, MD

Department of Pediatrics

Mattel Children's Hospital

David Geffen School of Medicine at UCLA

UCLA Children's Heart Center

Los Angeles, California USA

J Ultrasound Med 2016; 35:679–681

Greggory R. DeVore, MD

Department of Obstetrics and Gynecology

David Geffen School of Medicine at UCLA

Los Angeles, California USA

Likewise, fetal cardiac imaging, now having expanded to include additional views and modalities, needs to take the next step, raise the bar still further, and **focus on image quality.**

In summary, the time has come for a paradigm shift beyond requisite views and modalities. Fetal cardiac imaging should no longer be considered as a laundry list of views and imaging modalities; **moving forward, it is also the quality of the clips, and the angles at which they are acquired, that may make all the difference.**

Limites à la qualité = L'intervention de l'homme...

Why Don't Physicians Follow Clinical Practice Guidelines? A Framework for Improvement

Michael D. Cabana, MD, MPH

Cynthia S. Rand, PhD

Neil R. Powe, MD, MPH, MBA

Albert W. Wu, MD, MPH

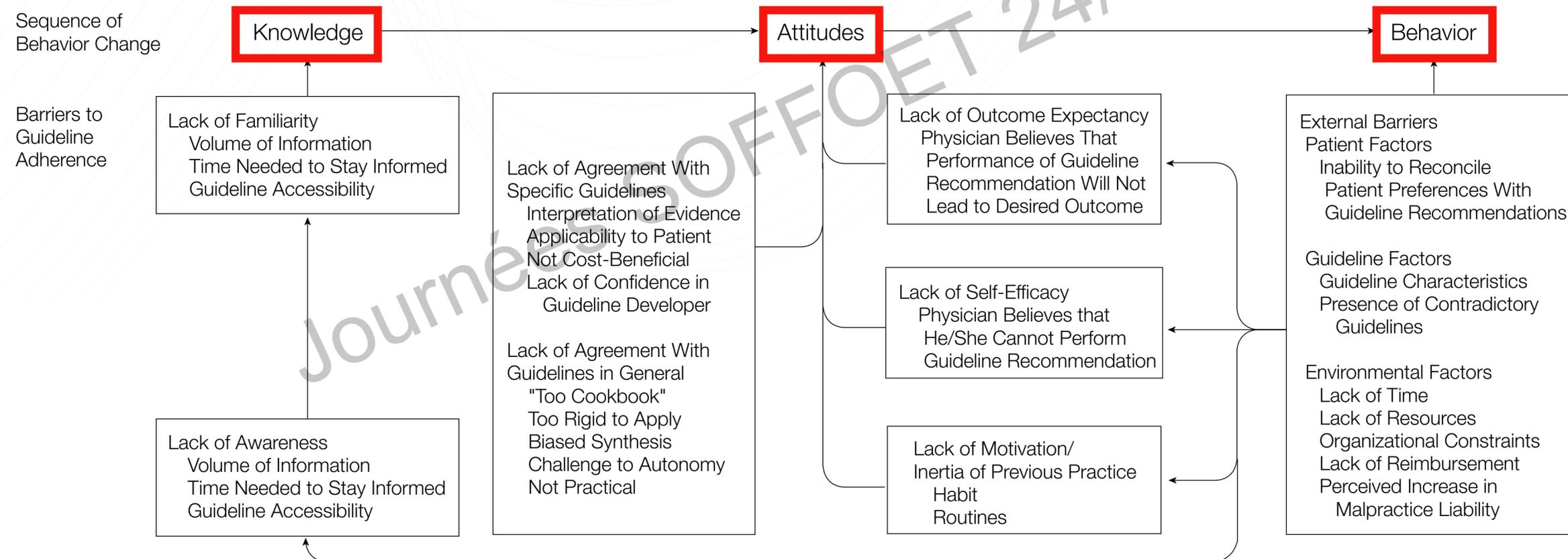
Modena H. Wilson, MD, MPH

Paul-André C. Abboud, MD

Haya R. Rubin, MD, PhD

JAMA, October 20, 1999—Vol 282, No. 15

Figure. Barriers to Physician Adherence to Practice Guidelines in Relation to Behavior Change



Understanding the Limitations of Fetal Cardiac Imaging

Patrick D. Schneider, MD,* Abraham Groner, MD†

NeoReviews Vol. 19 No. 3 MARCH 2018

Education in obstetrical ultrasound – an important factor for increasing the prenatal detection of congenital heart disease

NINA ASPLIN^{1,2}, ANNIKA DELLGREN² & PETER CONNER²

Acta Obstetrica et Gynecologica Scandinavica 92 (2013) 804–808

Barriers to Sonographer Screening for Fetal Heart Defects: A U.S. National Survey

Nelangi M. Pinto^a Kevin A. Henry^b Guo Wei^c Xiaoming Sheng^c Tom Green^c
Michael D. Puchalski^a Janice L.B. Byrne^d Anita Y. Kinney^e

Fetal Diagn Ther

Barrières au dépistage des cardiopathies congénitales

Physician Barriers and Facilitators for Screening for Congenital Heart Disease With Routine Obstetric Ultrasound

A National United States Survey

Nelangi M. Pinto, MD, MS^a, Kevin A. Henry, PhD, William A. Grobman, MD, MBA, Amen Ness, MD, Stephen Miller, MD, Sarah Ellestad, MD, Nina Gotteiner, MD, Theresa Tacy, MD, Guo Wei, MS, L. LuAnn Minich, MD, Anita Y. Kinney, PhD

J Ultrasound Med 2019; 9999:1–11

Fetal cardiac screening and variation in prenatal detection rates of congenital heart disease: why bother with screening at all?

Gurleen Sharland

Future Cardiol. (2012) 8(2), 189–202

Prenatal detection of critical cardiac outflow tract anomalies remains suboptimal despite revised obstetrical imaging guidelines

Heather Y. Sun MD¹ | James A. Proudfoot MSc² | Rachel T. McCandless MD¹

Congenital Heart Disease. 2018;1–9.

Artificial Intelligence in Cardiovascular Imaging:

JACC State-of-the-Art Review

Damini Dey, PhD^a, Piotr J. Slomka, PhD^a, Paul Leeson, MBBChir, PhD^b, Dorin Comaniciu, PhD^c, Sirish Shrestha, MS^d, Partho P. Sengupta, MD^d, and Thomas H. Marwick, MBBS, PhD, MPH^e

J Am Coll Cardiol. 2019 March 26; 73(11): 1317–1335.

Machine Learning in Fetal Cardiology: What to Expect

Patricia García-Canadilla^{a,b} Sergio Sanchez-Martinez^a Fatima Crispi^{a,c}
Bart Bijmens^{a,d,e}

Fetal Diagn Ther 2020;47:363–372

Digital medicine

More than meets the AI: refining image acquisition and resolution

www.thelancet.com Vol 396 November 7, 2020

IA et dépistage des cardiopathies congénitales

Routine Echocardiography and Artificial Intelligence Solutions

Mark J. Schuurings^{1*}, Ivana Išgum^{2,3,4}, Bernard Cosyns⁵, Steven A. J. Chamuleau^{1,4} and Berto J. Bouma¹

Automatic quality assessment for 2D fetal sonographic standard plane based on multitask learning

Bo Zhang, MD^a, Han Liu, BEng^b, Hong Luo, MD^{a,*}, Kejun Li, BEng^c

Medicine (2021) 100:4

Evaluation of deep convolutional neural networks for automatic classification of common maternal fetal ultrasound planes

Xavier P. Burgos-Artizzu^{1,2,3,4}, David Coronado-Gutiérrez^{1,2}, Brenda Valenzuela-Alcaraz¹, Elisenda Bonet-Carne^{1,3,4}, Elisenda Eixarch^{1,3,4}, Fatima Crispi^{1,3,4} & Eduard Gratacós^{1,3,4}

SCIENTIFIC REPORTS | (2020) 10:10200

Fast and accurate view classification of echocardiograms using deep learning

Ali Madani¹, Rami Arnaout², Mohammad Mofrad¹ and Rima Arnaout³

Digital Medicine (2018)1:6

Perspectives d'avenir...



Le consortium français AI DReAM

Accélérons le développement de l'IA en imagerie médicale

Intelligence artificielle



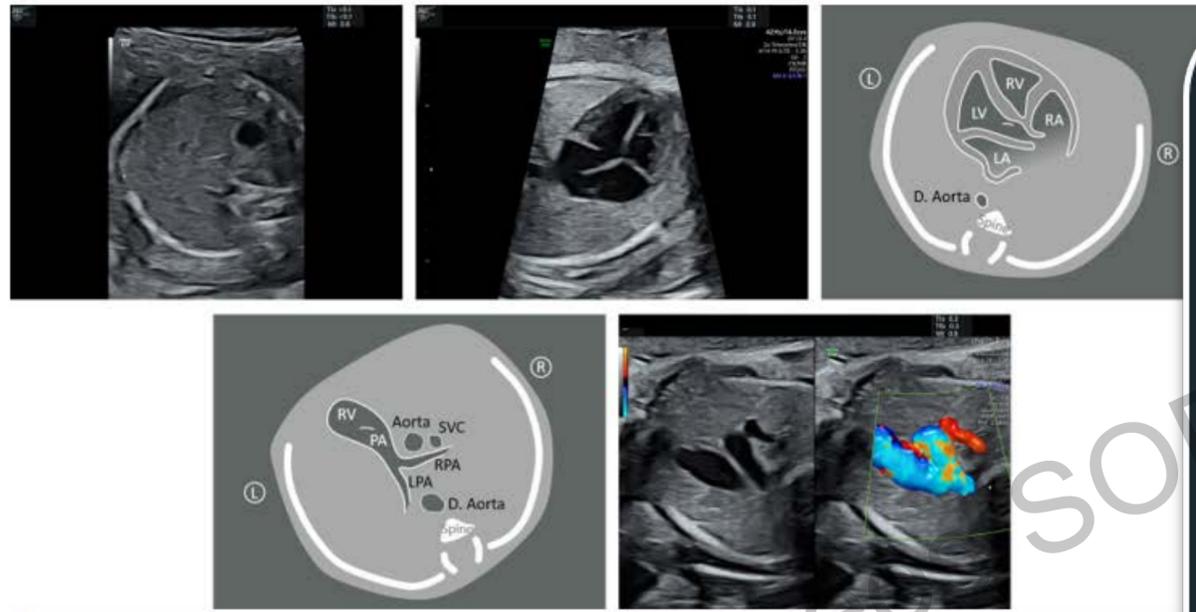
Machine Learning

Deep Learning

PRODUCT

Task1: Medical validation of fetal examination

View categories requested for cardiac examination



Examination is not valid

Some views are missing

Provided views correspond to the guidelines

DIAGNOLY

View categories requested for cardiac examination



Examination is valid

All the required views are provided

Provided views correspond to the guidelines

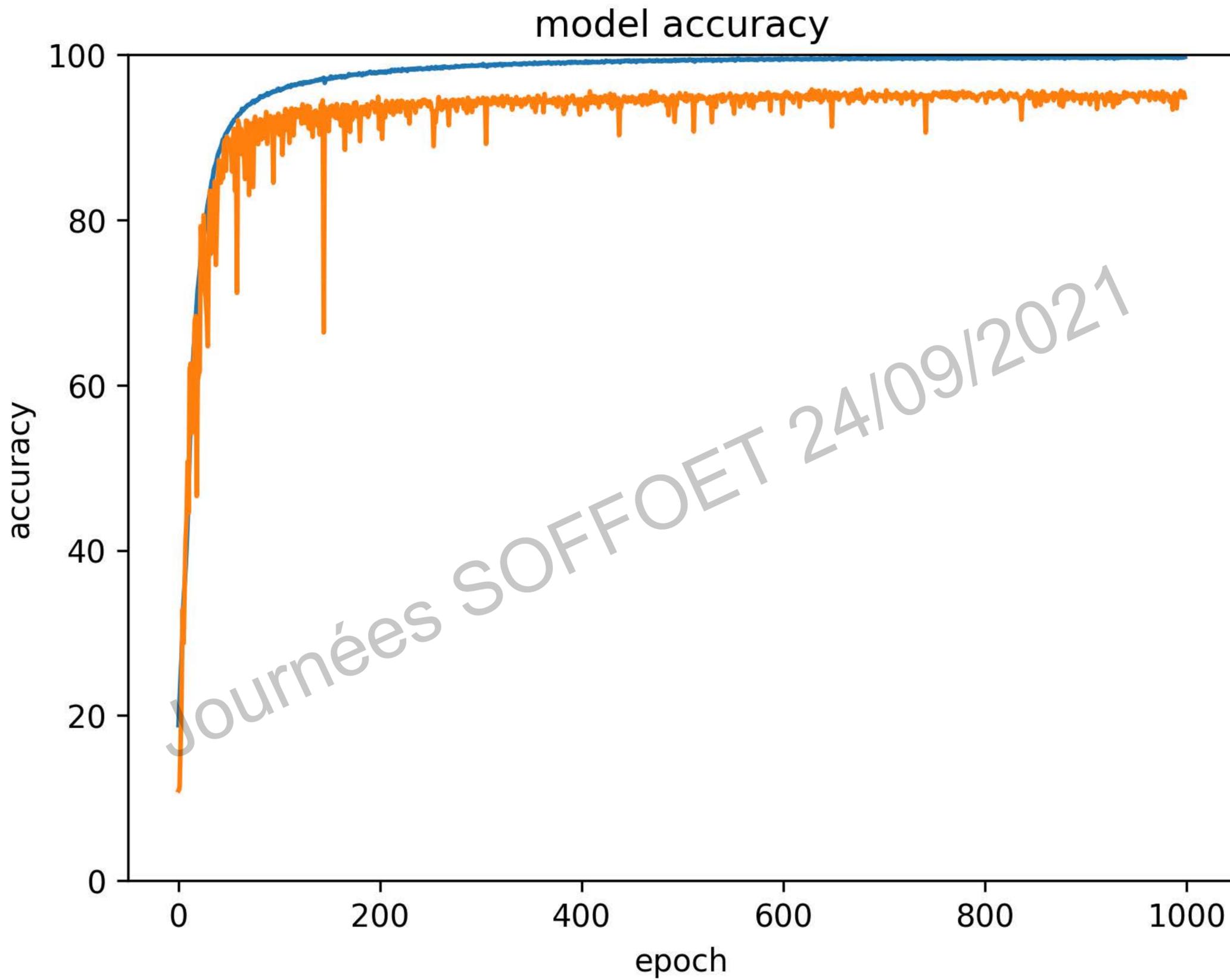
No pathological development suspected

DIAGNOLY

Are there all the fetal views required for a correct screening?

1 - Reconnaître la PRÉSENCE / ABSENCE des images requises

The screenshot shows a web browser window with the URL `app.diagnoly.com/fetal_examina`. The page title is "Fetal examination" and it includes a "Logout" link. On the left, there is a control panel with a "Click for upload or drop your images" button, a green "Process database" button, and a red "Clear database" button. Below this is an "Images database" section. The main content area displays five ultrasound image guidelines in a grid. The first row contains three images: a stomach view (labeled "Stomach", "UV", "IVC", "D. Aorta"), a four-chamber view (labeled "LV", "RV", "RA", "LA", "D. Aorta"), and a more detailed four-chamber view (labeled "RV", "LV", "RA", "LA", "D. Aorta"). The second row contains two images: a pulmonary view (labeled "RV", "PA", "Aorta", "SVC", "RPA", "LPA", "D. Aorta") and a ductus arteriosus view (labeled "Duct art", "Aortic arch", "SVC", "Trachea"). The fifth cell in the grid is a dark box with the text "Personalized view". At the bottom of the grid, a text prompt reads: "Please upload or drop ultrasound images corresponding to the following guideline views."



2 - Reconnaître la **QUALITÉ** des images requises

IA et **dépistage**



Comment reconnaître un bon vin ?

- . expérience
- . culture
- . connaissance
- . guides
- . prix .. ?
- . domaine
- . AOC
- . année
- . etc...

la qualité en échographie de dépistage

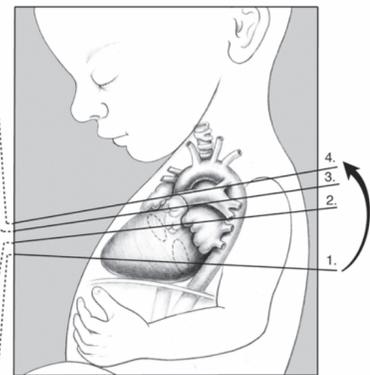
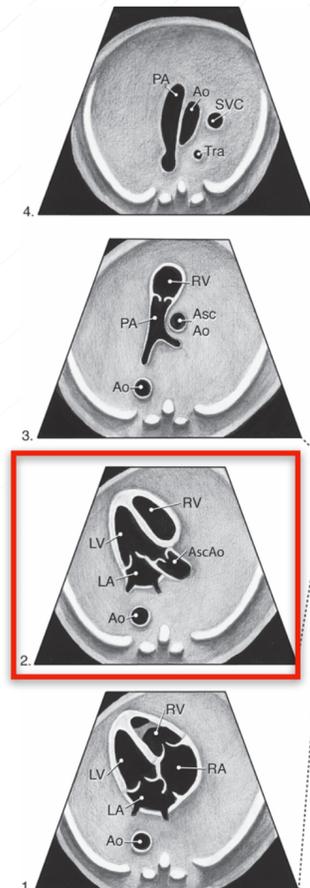
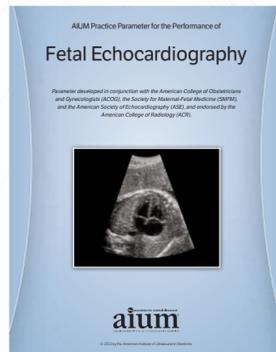
=

le Graal

Exemple de la voie d'éjection Gauche



2013



1. Four Chamber View
2. Left Ventricular Outflow Tract
3. Right Ventricular Outflow Tract
4. Three Vessels Trachea View

2013

Ultrasound Obstet Gynecol 2013; 41: 348-359
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12403



GUIDELINES

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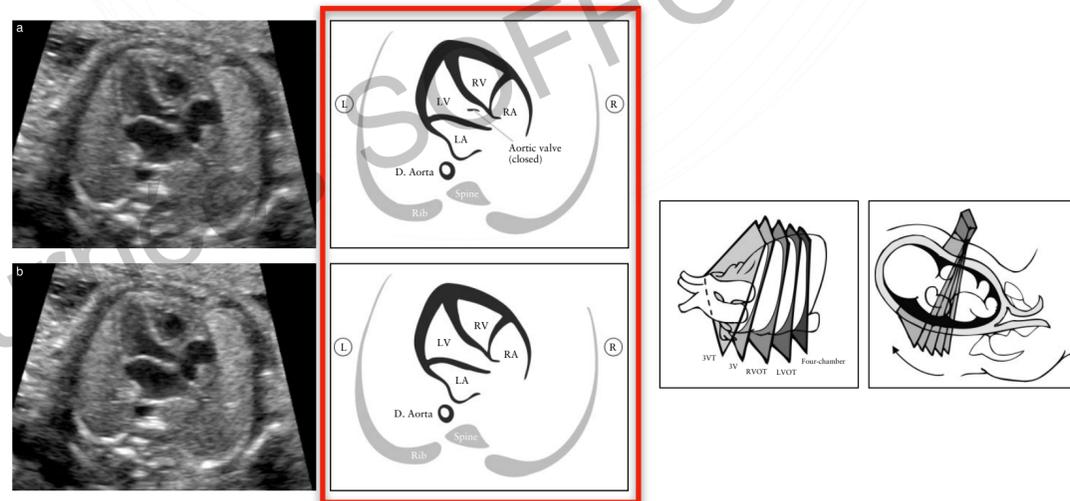


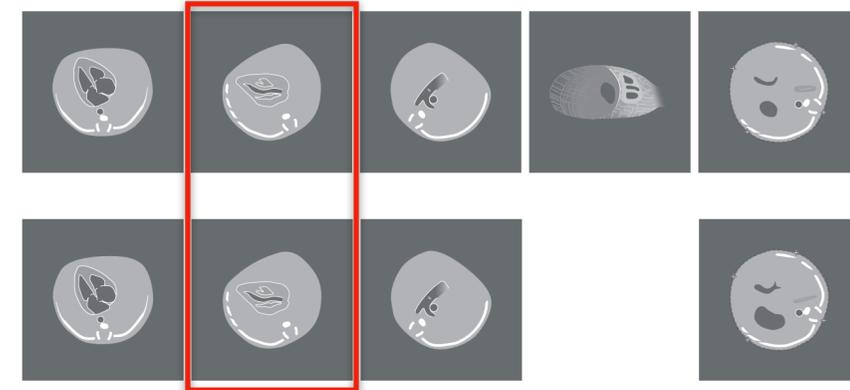
Figure 5 Left ventricular outflow tract (LVOT) view. This view shows a vessel connected to the left ventricle (LV). It is important to demonstrate continuity between the interventricular septum and the anterior wall of this vessel, which in the normal heart corresponds to the aorta. The aortic valve should not be thickened and should be shown to open freely. The aortic valve is closed in (a) and open in (b). D. Aorta, descending aorta; L, left; LA, left atrium; R, right; RA, right atrium; RV, right ventricle.

2016

Conférence Nationale
d'Echographie Obstétricale et Fœtale

L'échographie
de
dépistage prénatal

2e
trimestre



3e
trimestre

- Activité cardiaque (chiffrer la fréquence cardiaque si elle semble inhabituelle)

- Position du cœur
- Aspect des quatre cavités cardiaques
- Equilibre des cavités
- Position et aspect des gros vaisseaux
- Position et aspect de l'estomac

3 centres

2016 / 2017 / 2020

- . GHS Réunion
- . St Joseph Marseille
- . Cabinet du Var

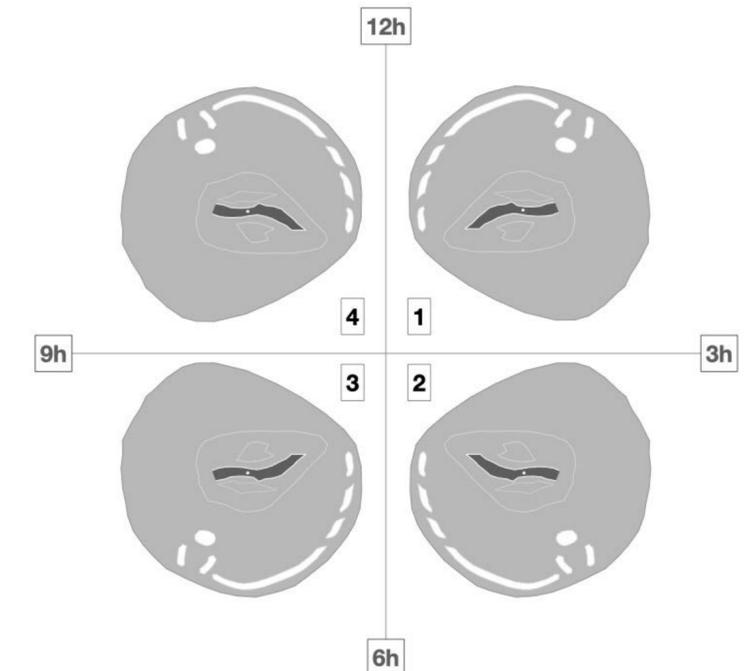
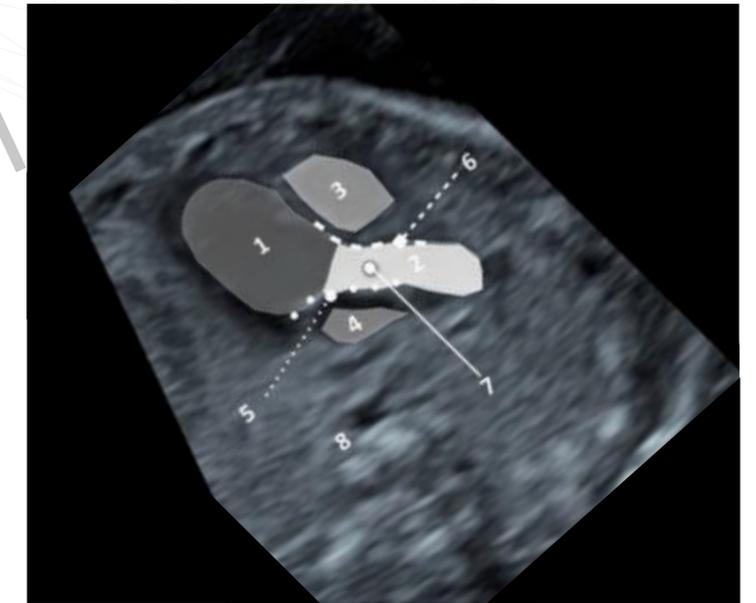
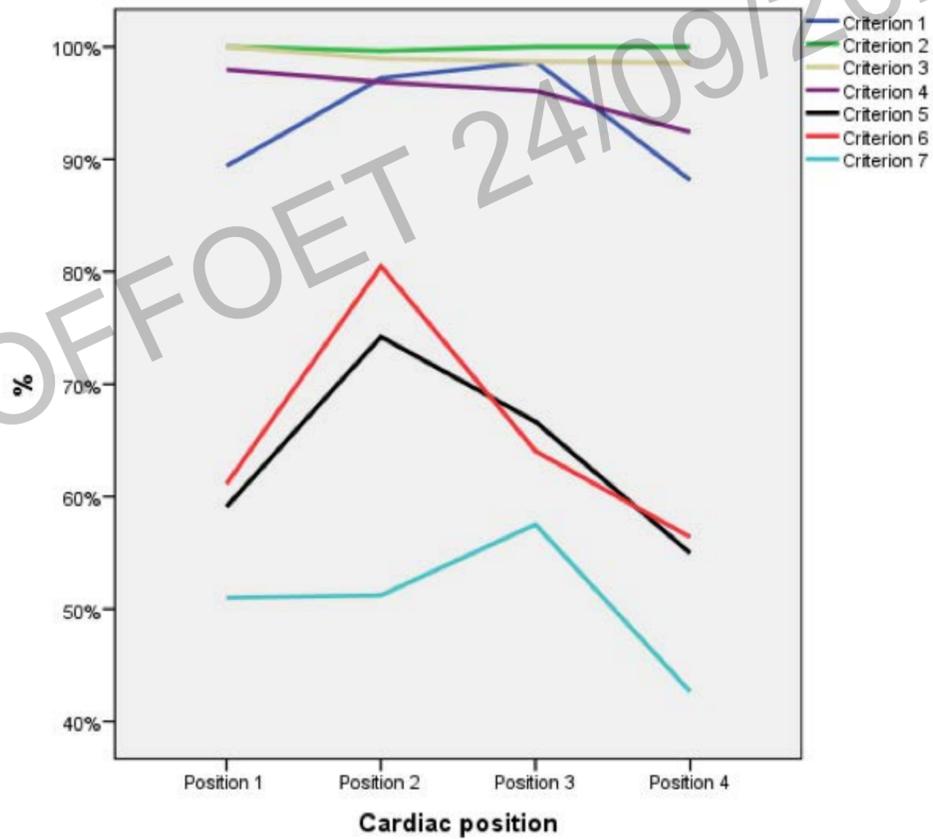
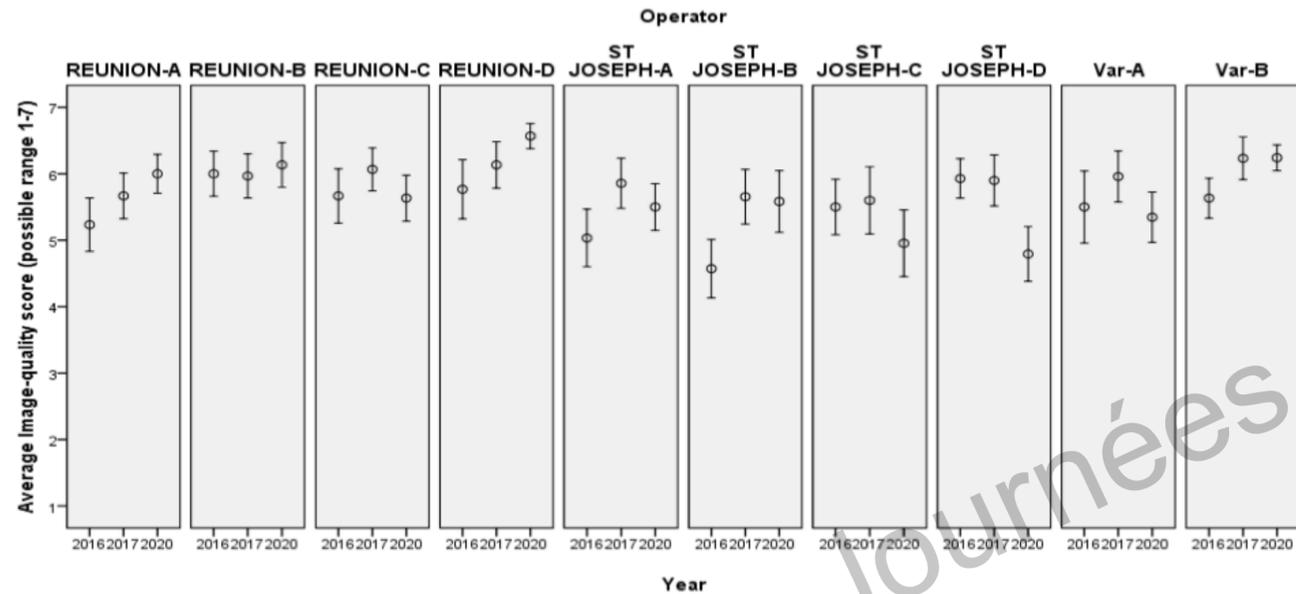
10 opérateurs

900 dossiers

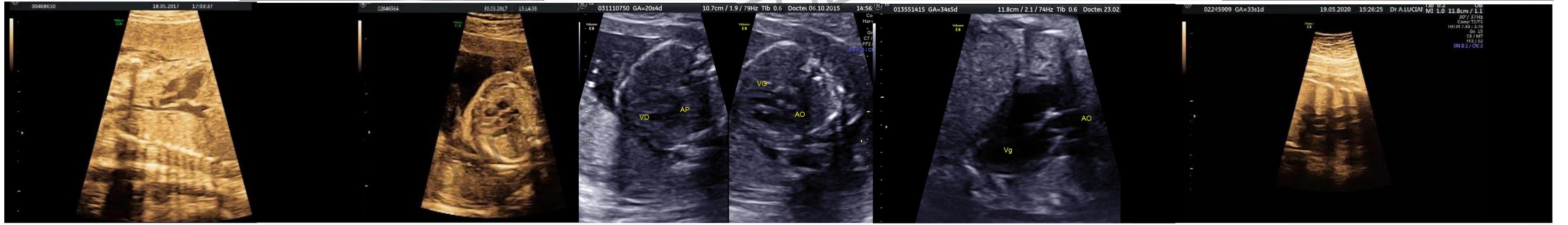
The left outflow tract in foetal echocardiography screening:
an audit of practices and quality criteria.

Maud REGOUIN MD ⁽¹⁾, Julien MANCINI MD PhD ⁽²⁾, Mr Antoine LAFOUGE ⁽³⁾, Coralie DUMONT MD ⁽¹⁾, Nathalie FONTAINE MD ⁽¹⁾, Stéphanie ROUSSIN MD ⁽⁴⁾, Mr Jimmy GUICHARD⁽⁵⁾, Edwin QUARELLO MD PhD ^(6,7)

Article submitted

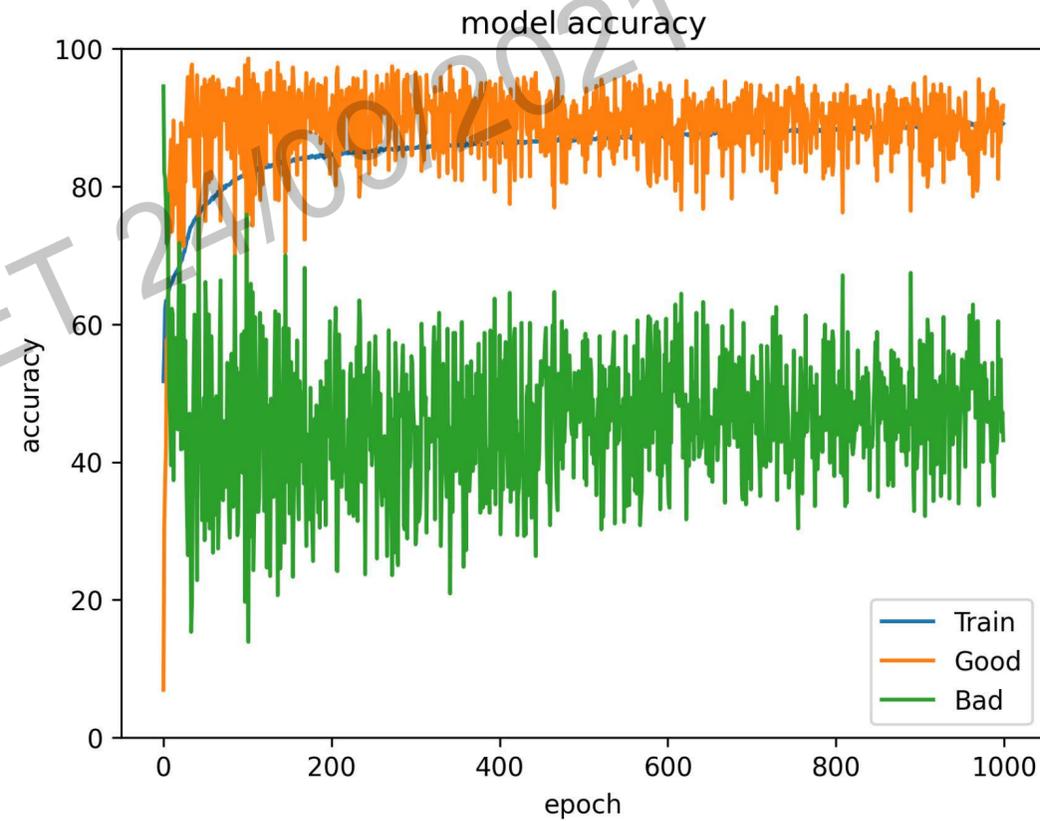
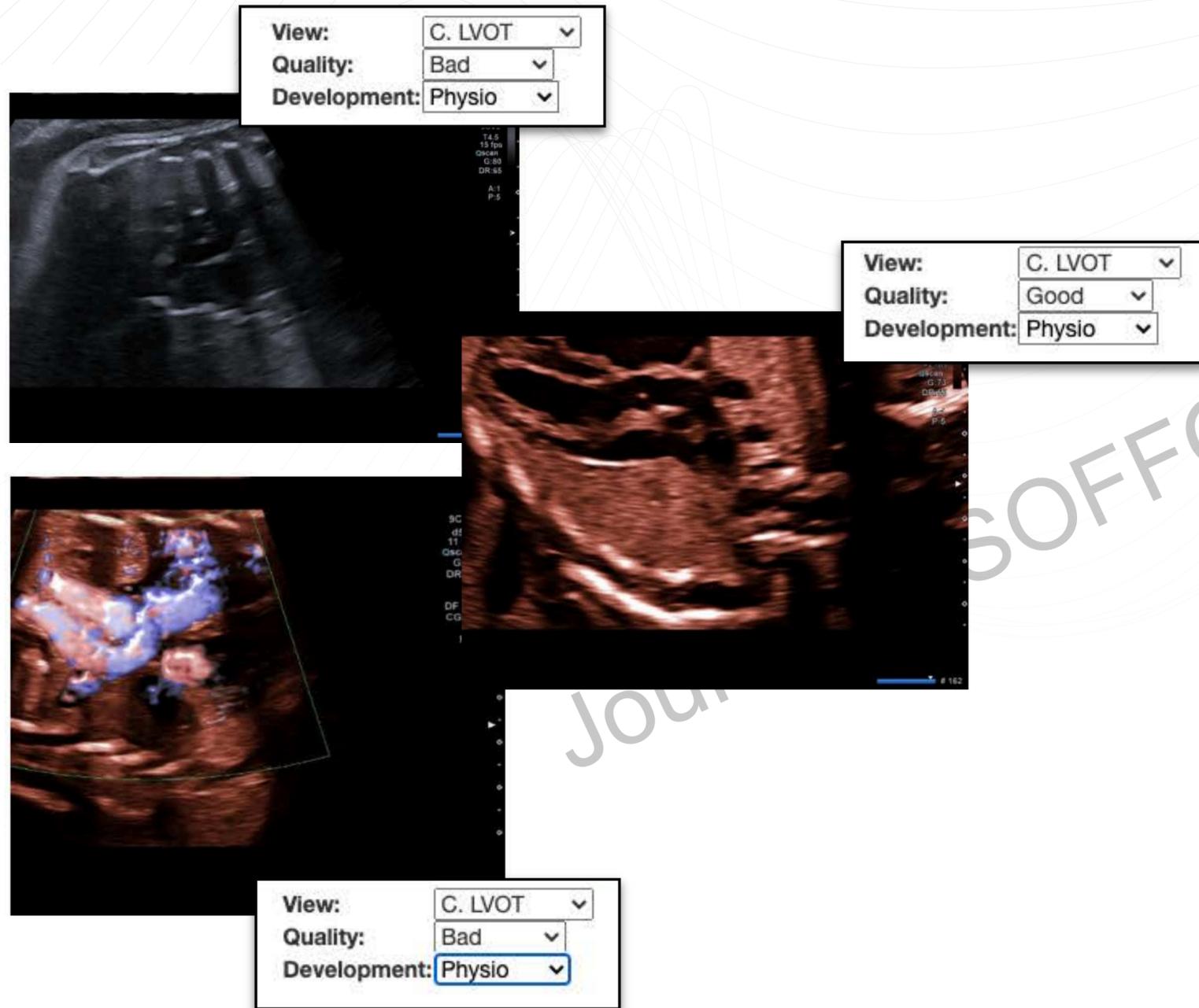


La qualité est bonne mais pas toujours **OPTIMALE**



Appréciation **SUBJECTIVE** des **Critères de qualité** de la voie d'éjection Gauche

Approche binaire de l'image 0 / 1



« Bonnes » images

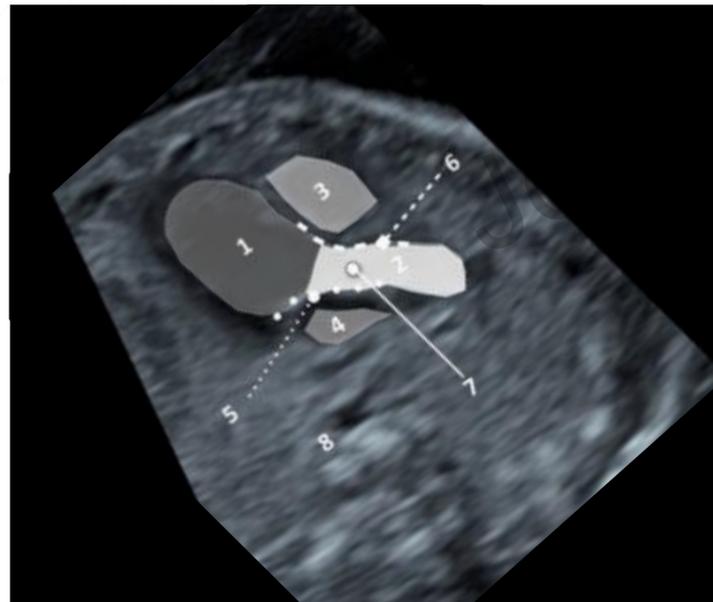
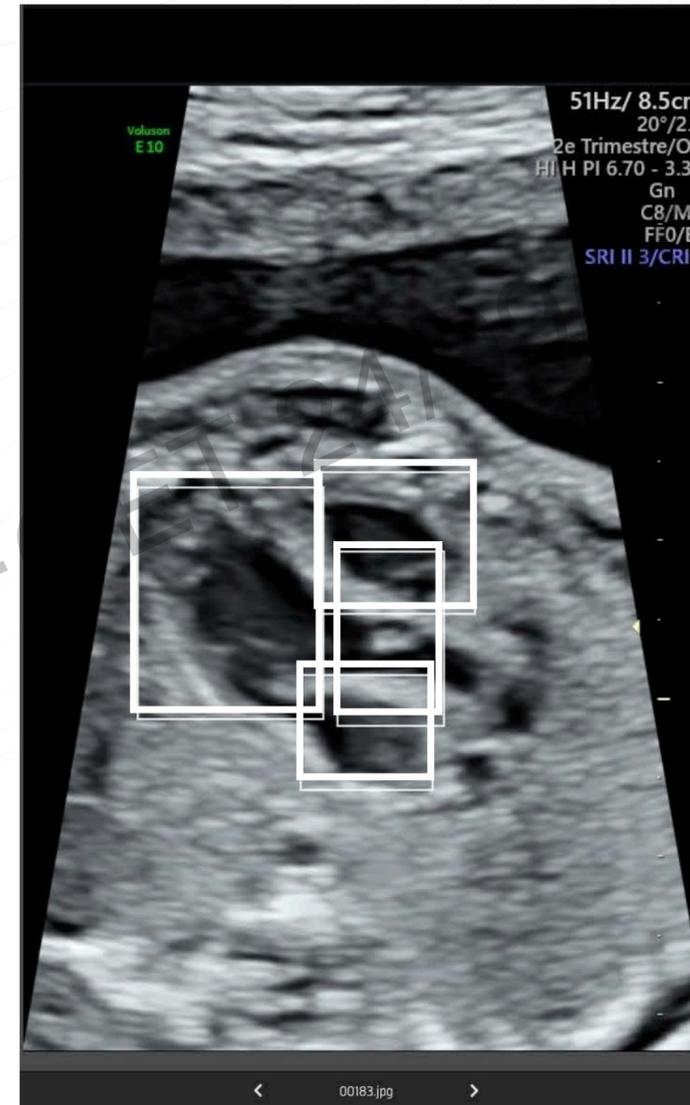
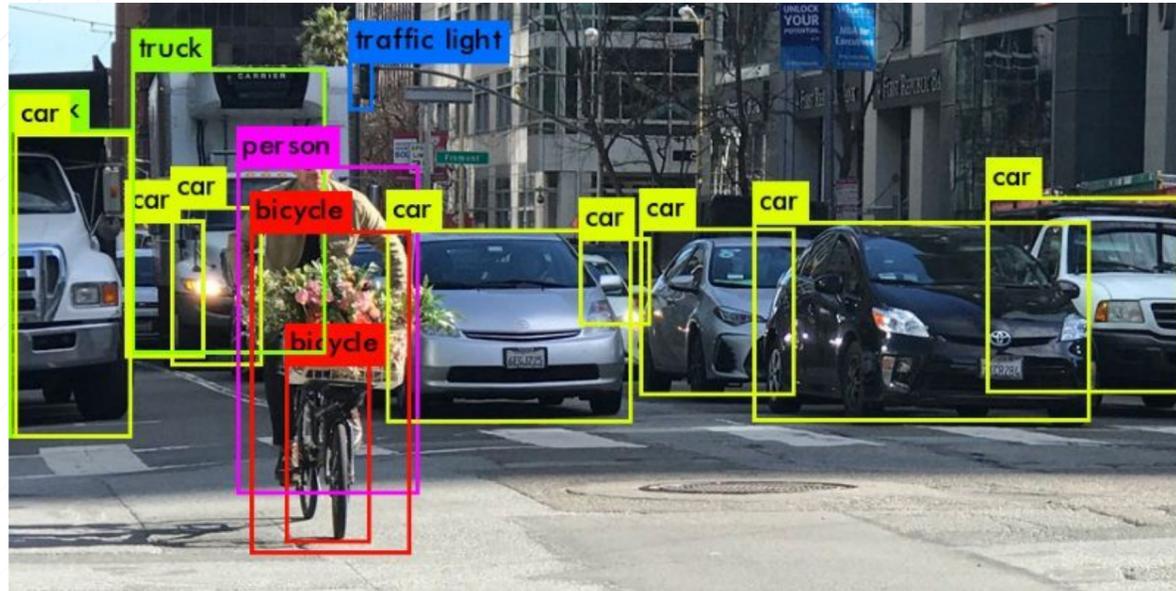
« Mauvaises » images

Entraînement du modèle pour la classification de la qualité

Appréciation **SUBJECTIVE** des **Critères de qualité** de la voie d'éjection Gauche

Approche binaire des critères de qualité

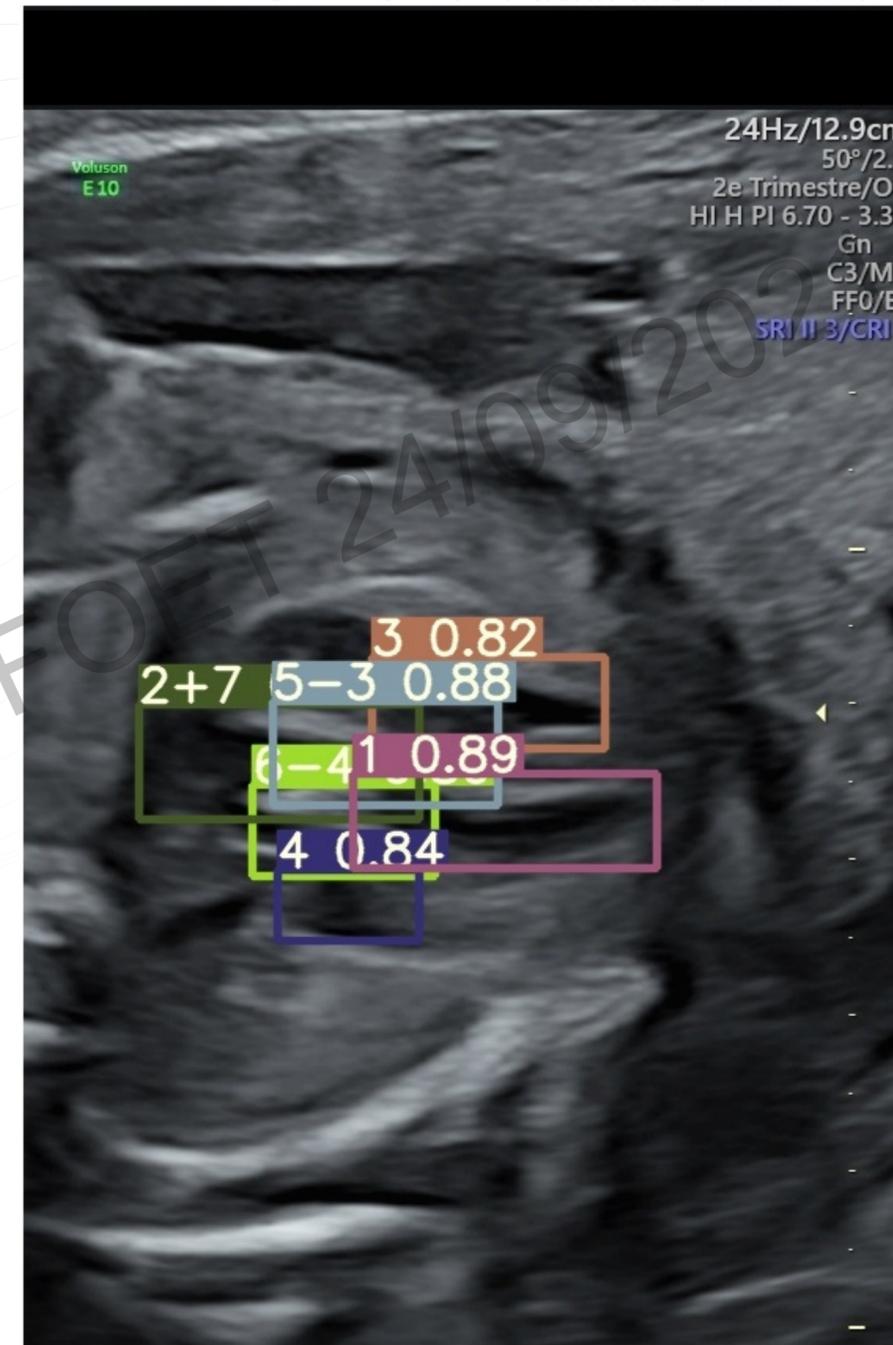
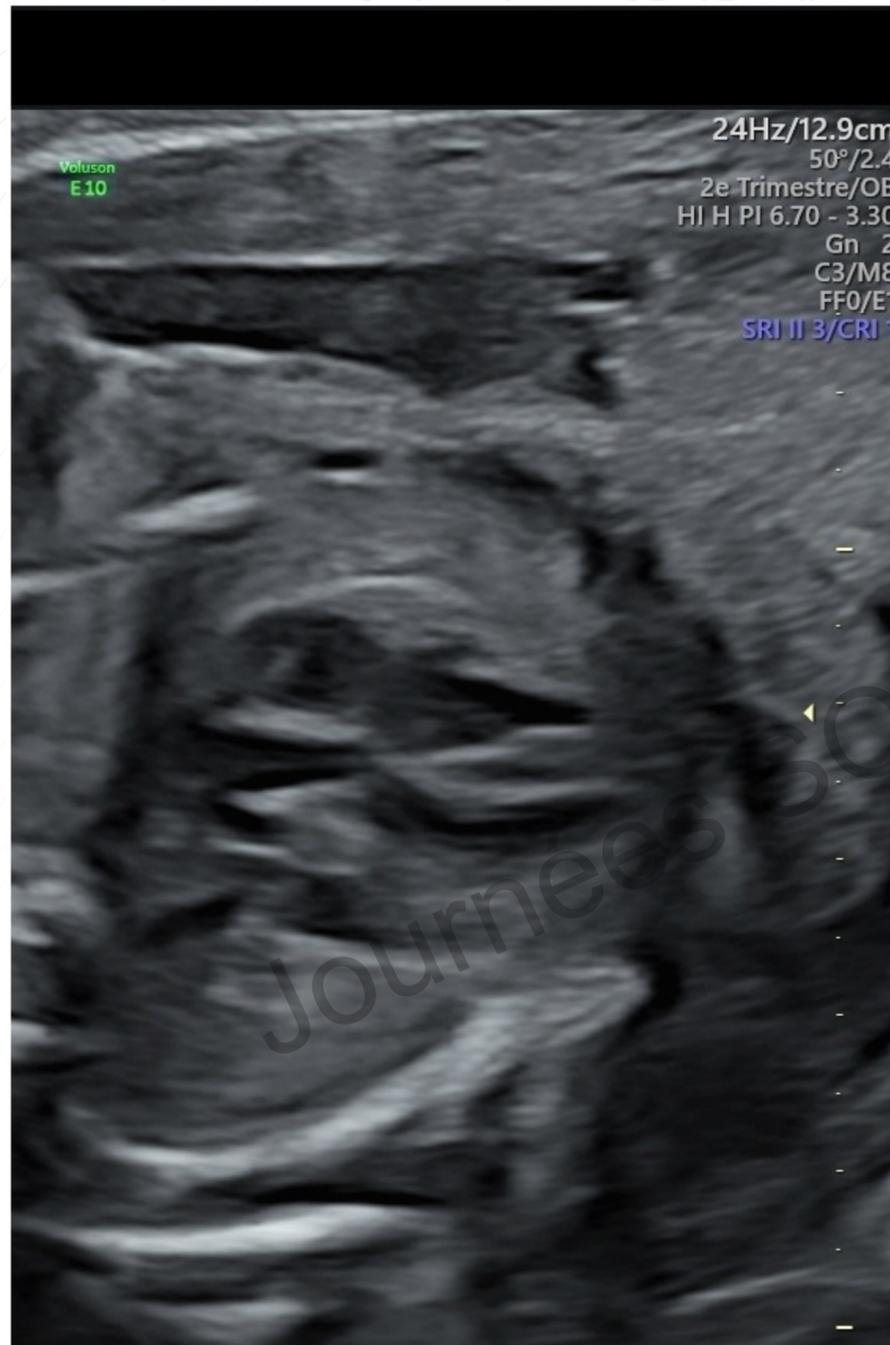
0 / 1



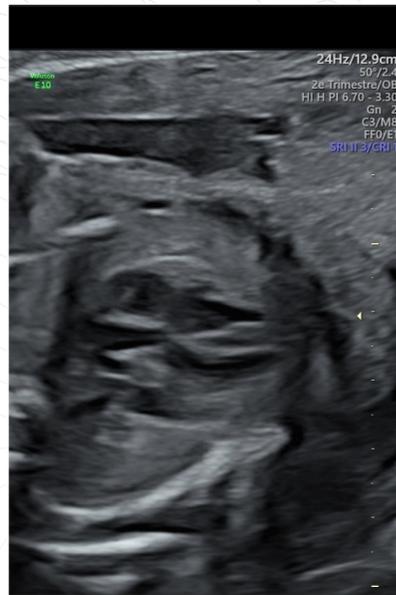
Demain....

Images fixes

IA et dépistage

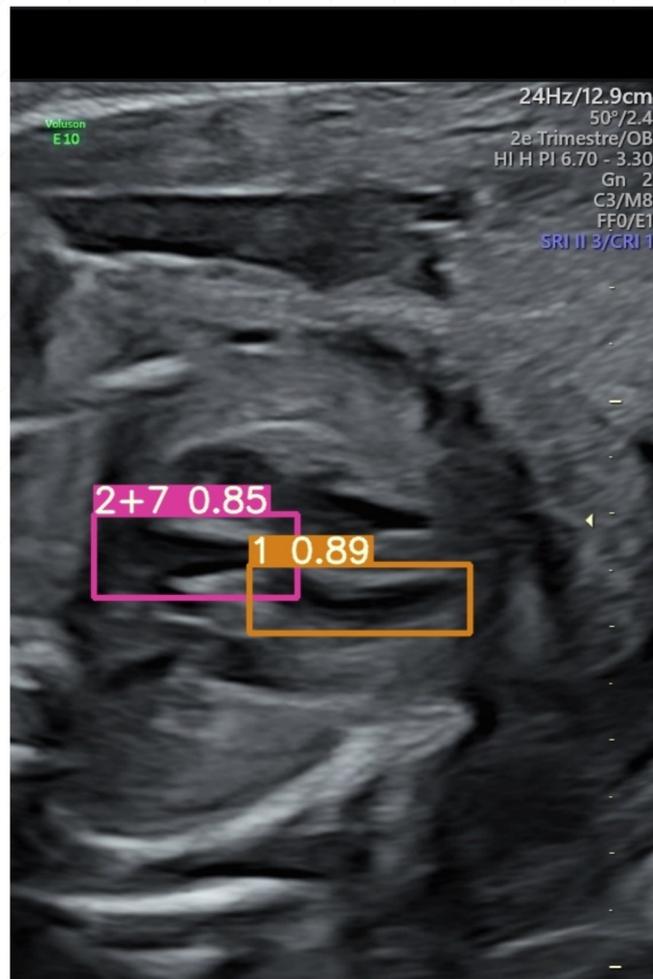


Demain....

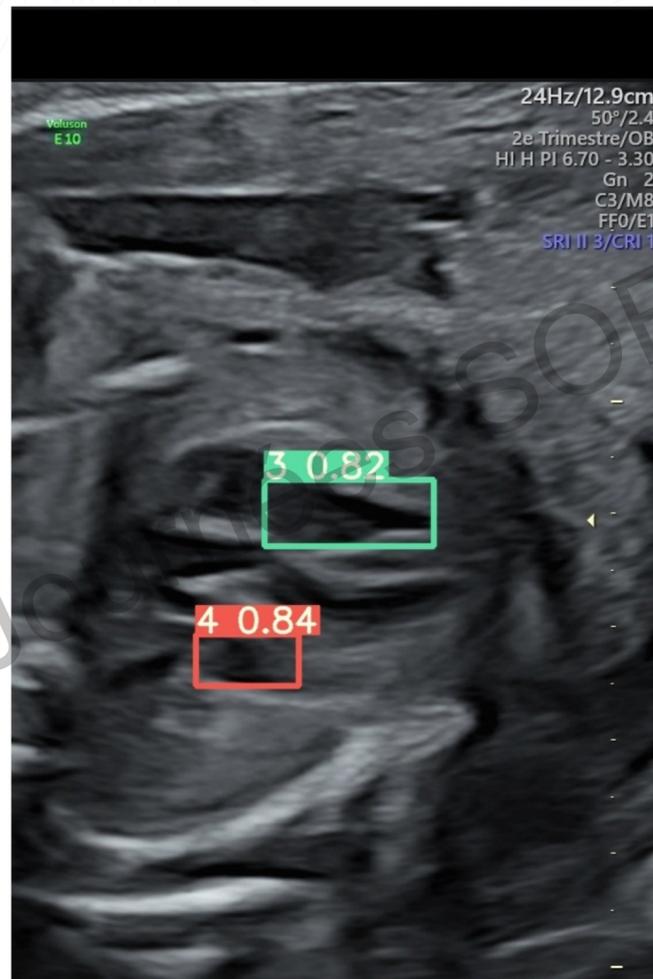


Images fixes

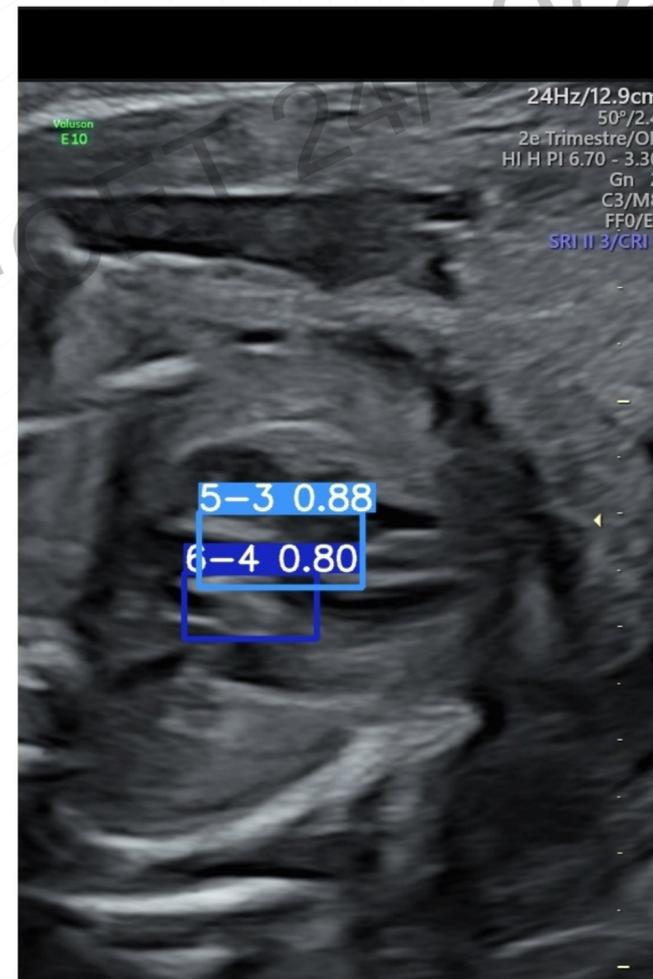
IA et dépistage



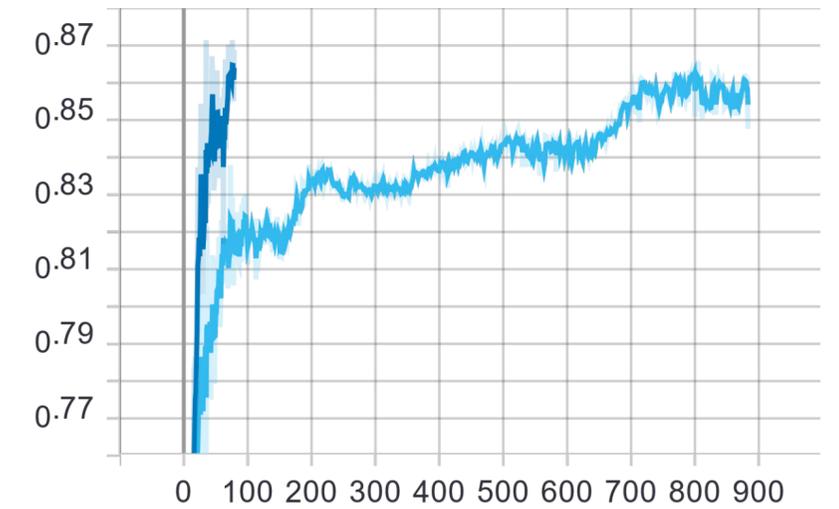
Critère 1 Critère 2 + 7



Critère 3 Critère 4



Critère 5 Critère 6



Demain....

En temps réel

IA et dépistage



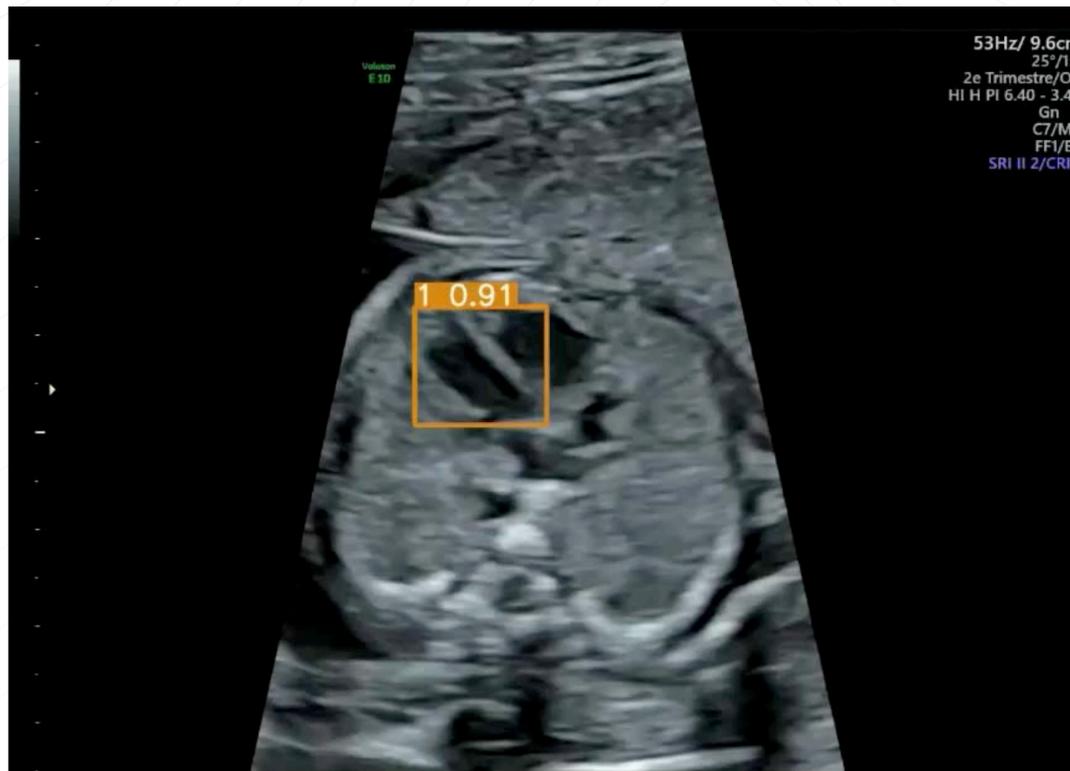
Critères **Simultanés**



Demain....

En temps réel

IA et dépistage



Critère 1 Critère 2 + 7

Critère 3 Critère 4

Critère 5 Critère 6

Critères **Séparés**



- . Nous sommes arrivés à une limite humaine
- . Continuer les formations / workshop / Hands on / etc..
- . Réfléchir à partager « nos recettes »
- . Objectiver la **qualité** et les **critères de qualité**
- . Contribuer au développement de l'IA

Journées SOFFOET 24/09/2021