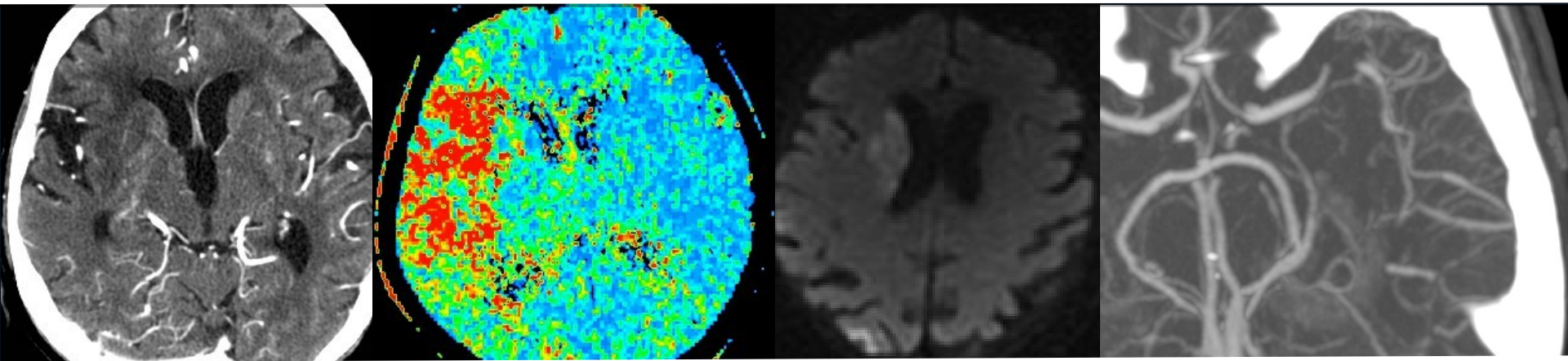


# L'imagerie de perfusion cérébrale dans l'évaluation du patient avec un AVC ischémique aigu



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Université de Montréal

Neuroradiologue, CHUM

SSVQ

16 novembre 2018



# Divulgation de conflits d'intérêts potentiels

**SSVQ**

Rien à déclarer

# Objectifs

- 1) Expliquer les principes de bases de l'imagerie de perfusion cérébrale par CT et IRM
- 2) Décrire la contribution de l'imagerie de perfusion dans l'évaluation de l'AVC ischémique aigu
- 3) Décrire d'autres indications potentielles de l'imagerie de perfusion cérébrale (AIT, diagnostic différentiel)

# Plan

- Technique
- Interprétation des paramètres
- Diagnostic AVC ischémique aigu (et AIT)
- Diagnostic différentiel
- Sélection patients

# Plan

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# CT vs IRM

## CT

- Quantitatif
- Bonne résolution spatiale
- Moins bonne couverture CC
- Disponible
- Irradiation

## IRM

- Qualitatif
- Moins bonne résolution spatiale
- Moins disponible
- Pas d'irradiation

# Technique



40-50 ml contraste iodé  
(e.g. Iohexol 350 mgI/ml)

30 ml NS

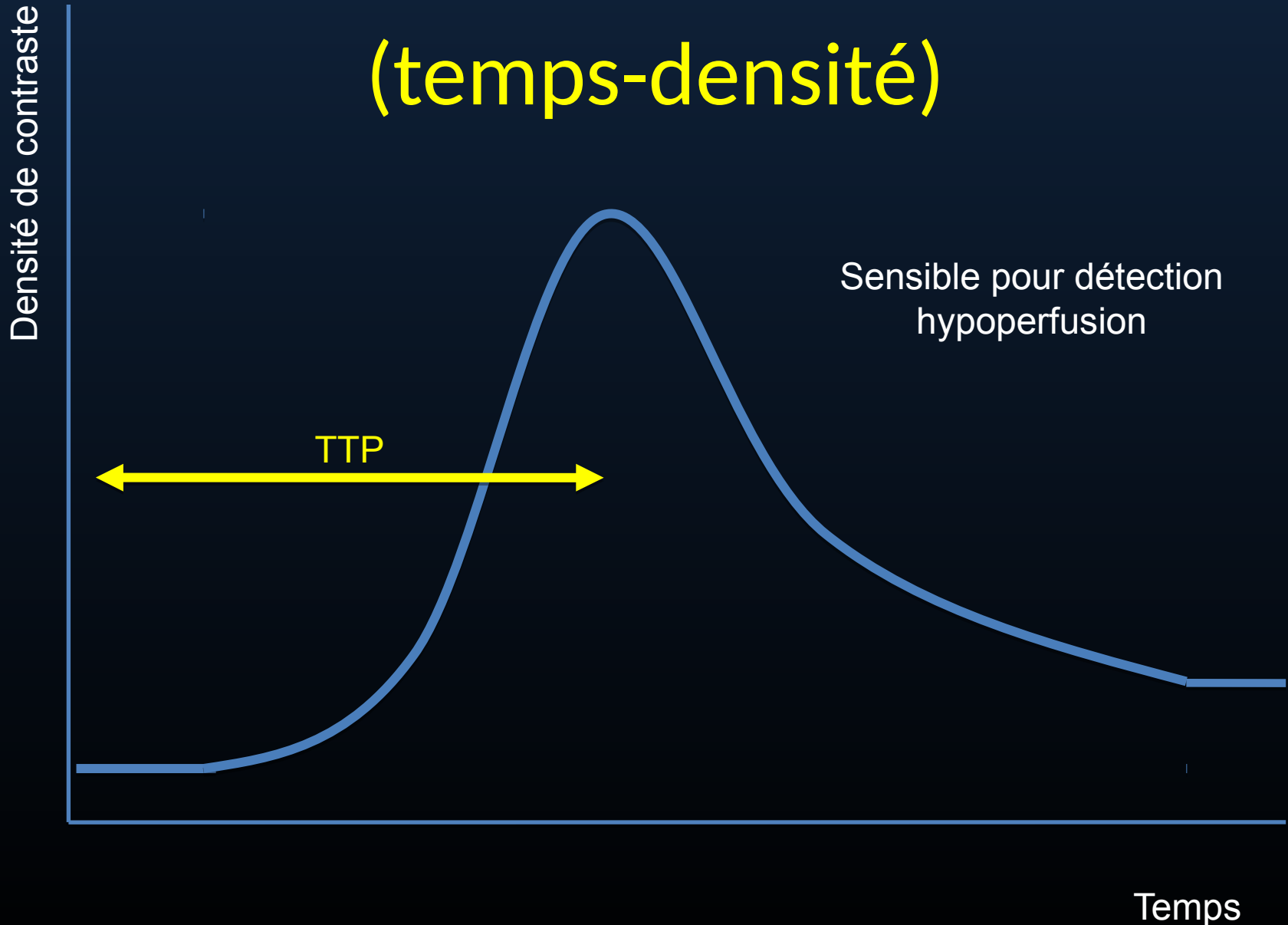
5 ml/sec

# Plan

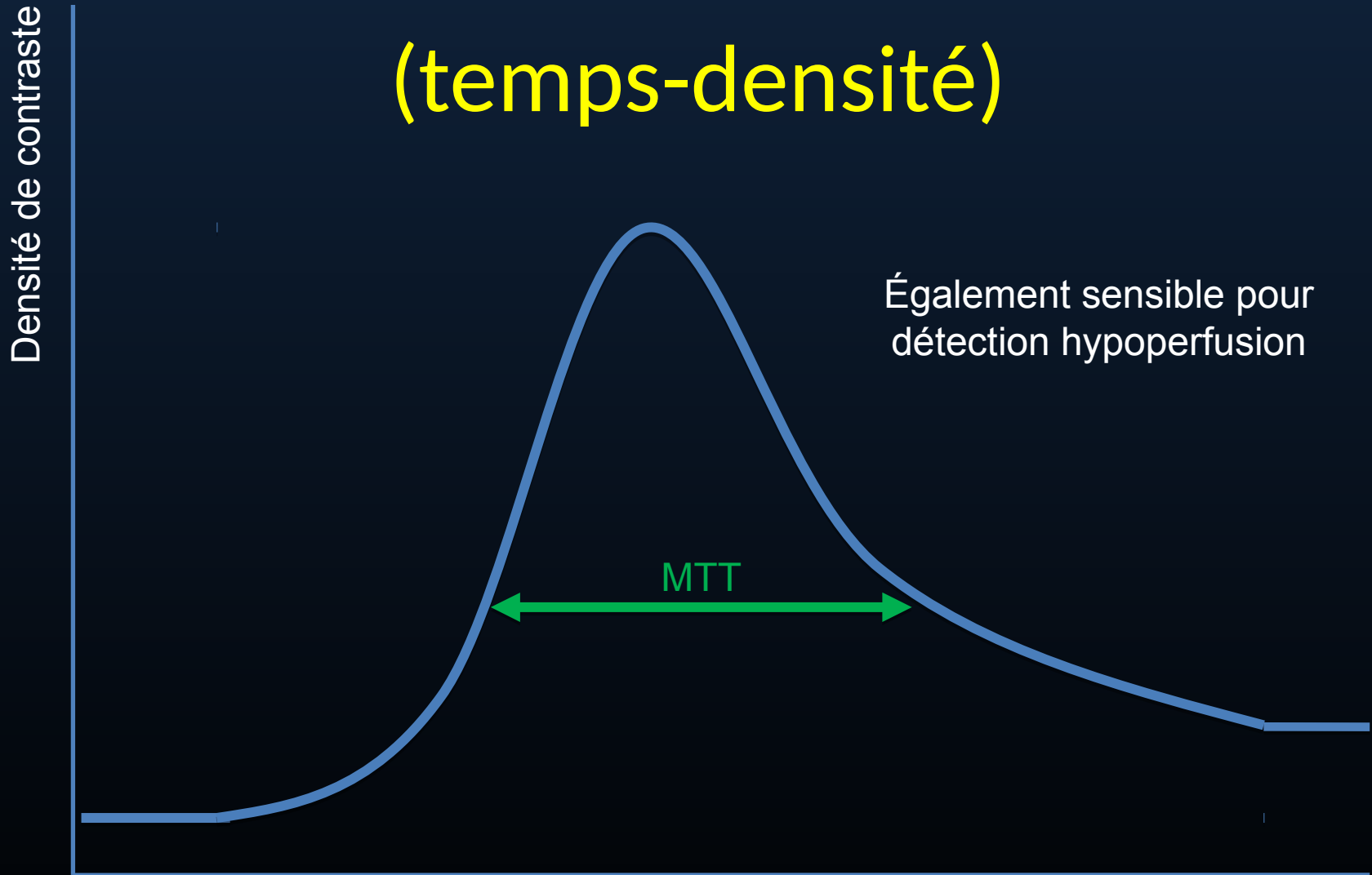
- Technique
- **Interprétation des paramètres**
- Diagnostic AVC ischémique aigu (et AIT)
- Diagnostic différentiel
- Sélection patients



# Courbe de rehaussement (temps-densité)



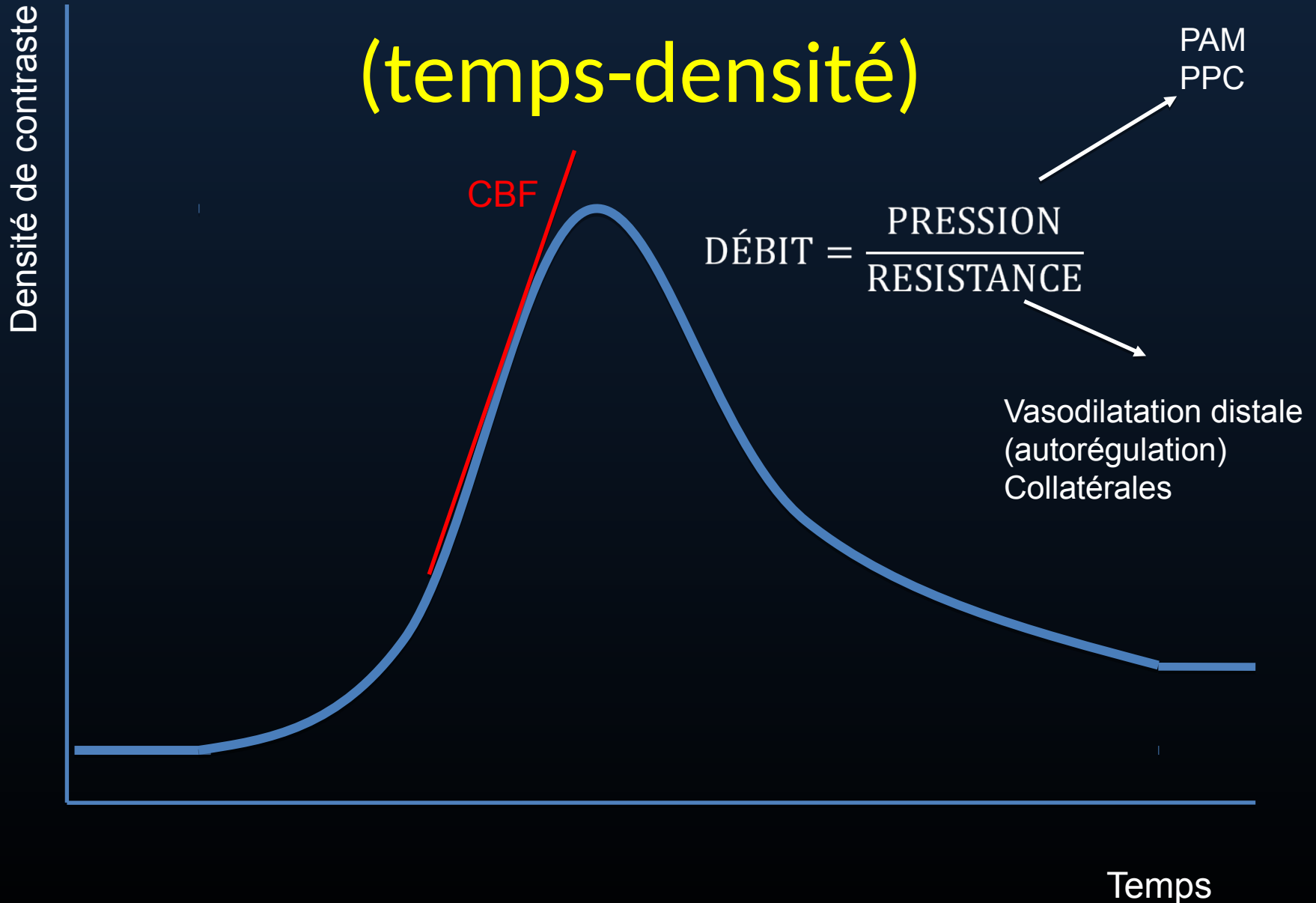
# Courbe de rehaussement (temps-densité)



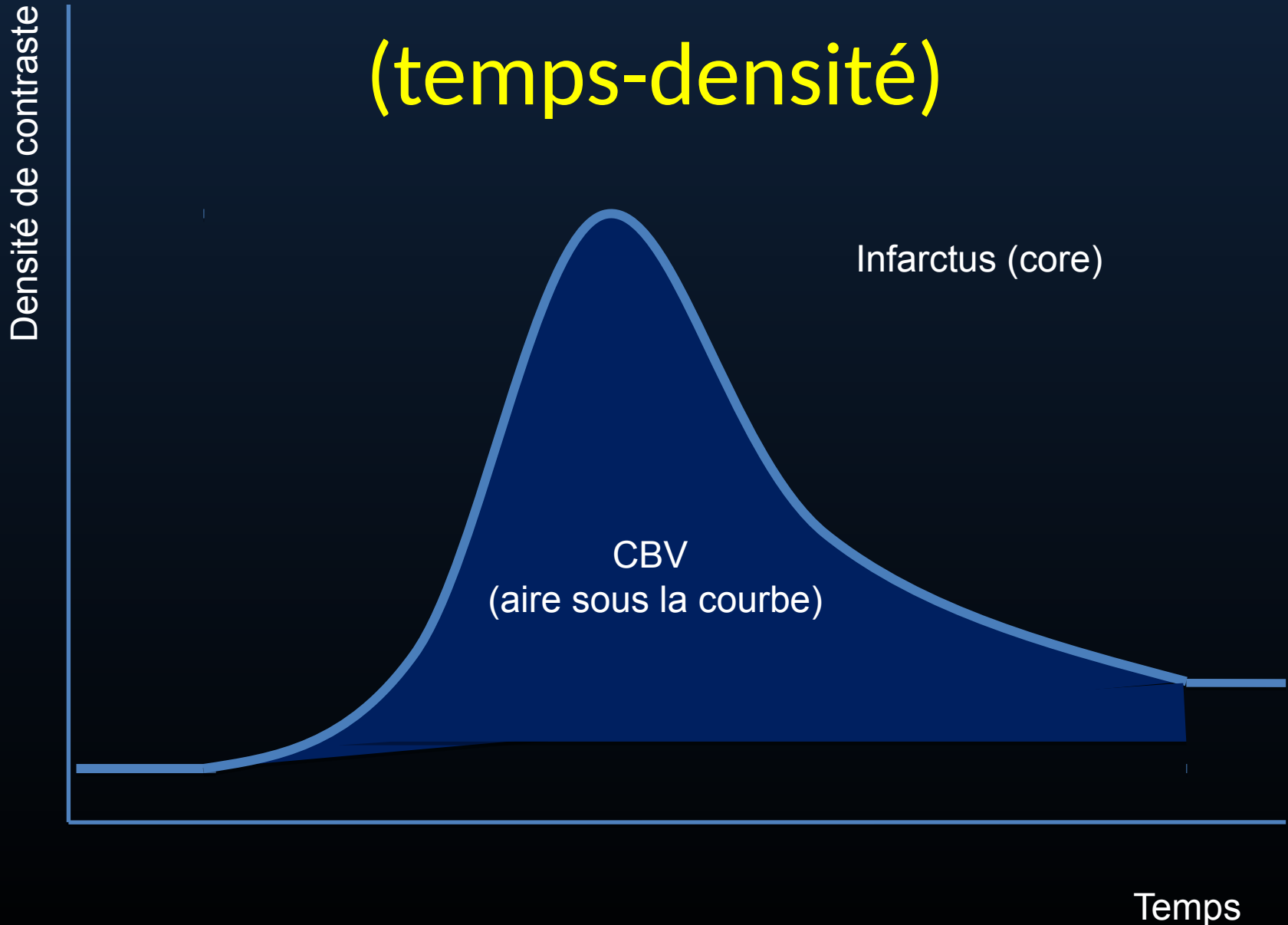
$$MTT = CBV/CBF$$

Temps

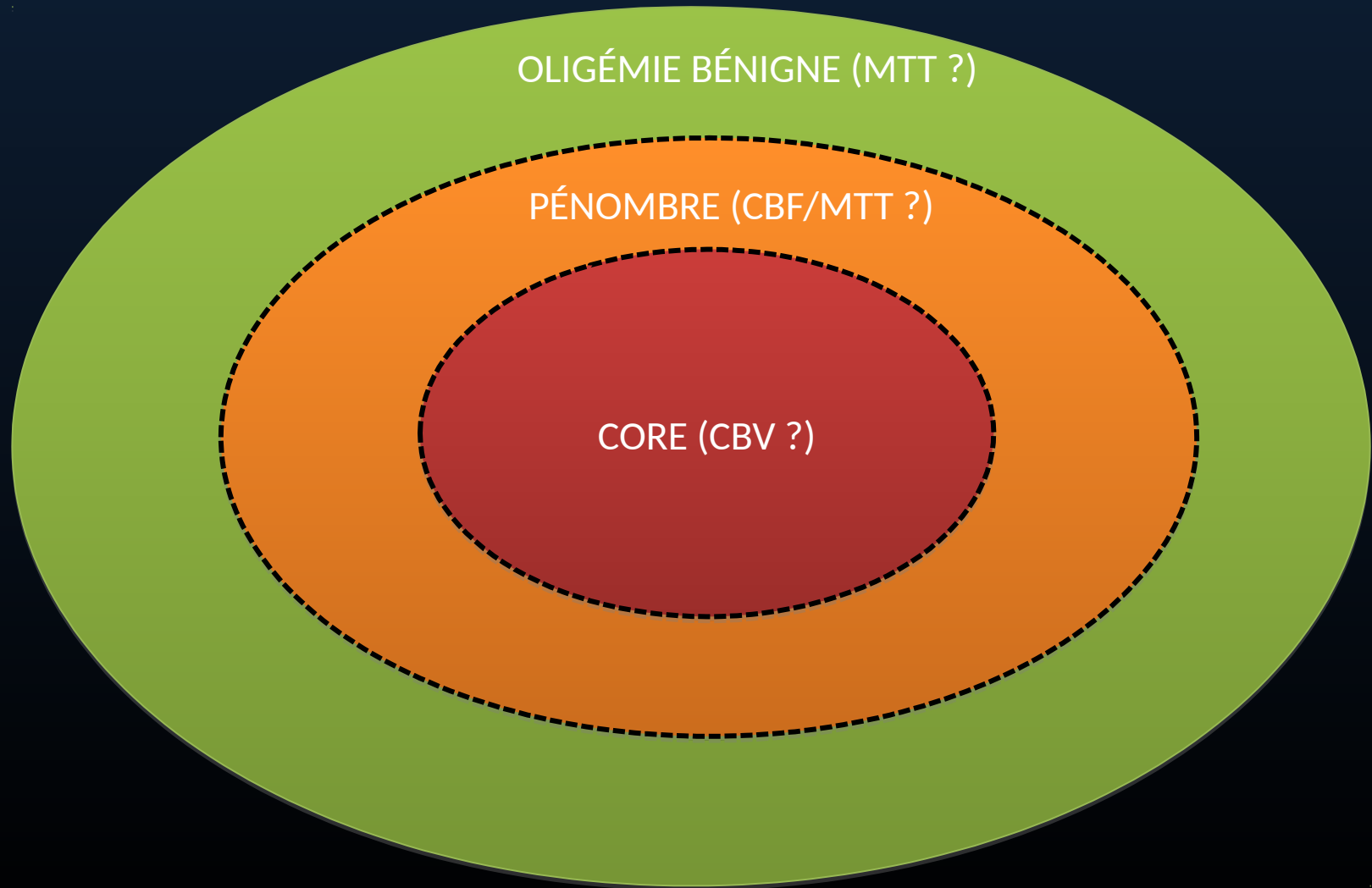
# Courbe de rehaussement (temps-densité)



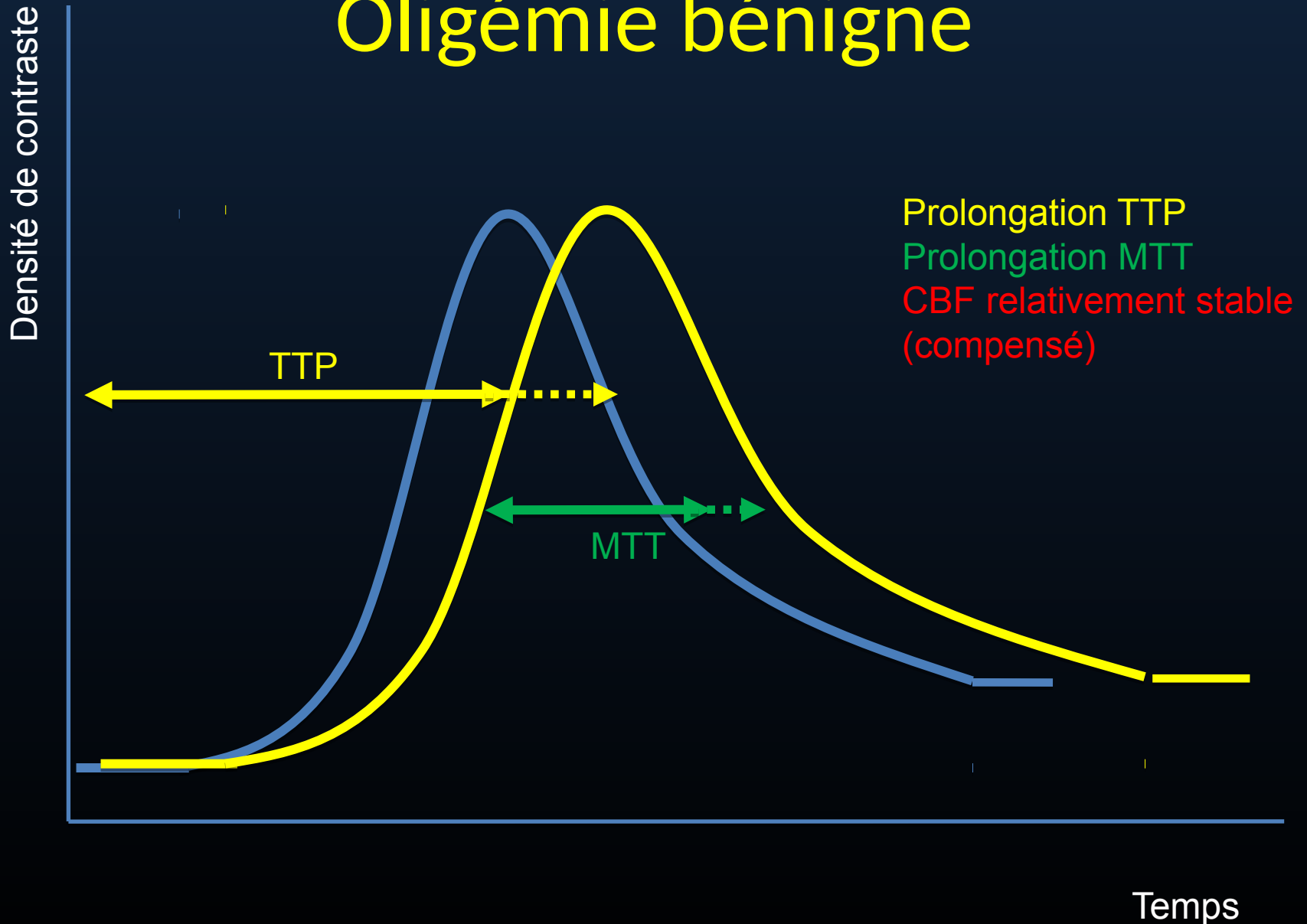
# Courbe de rehaussement (temps-densité)



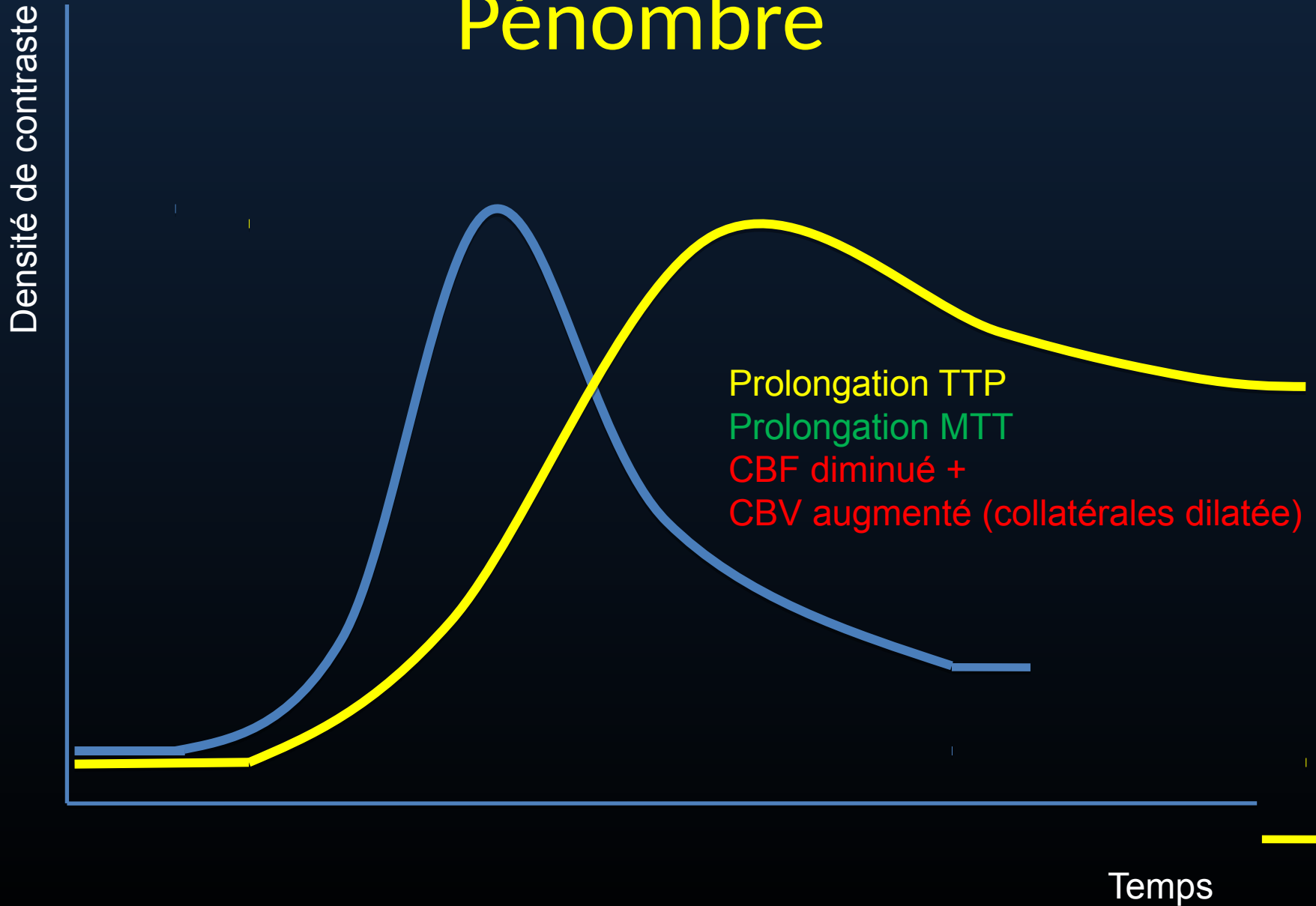
# Oligémie-Pénombre-Infarctus



# Oligémie bénigne



# Pénombre

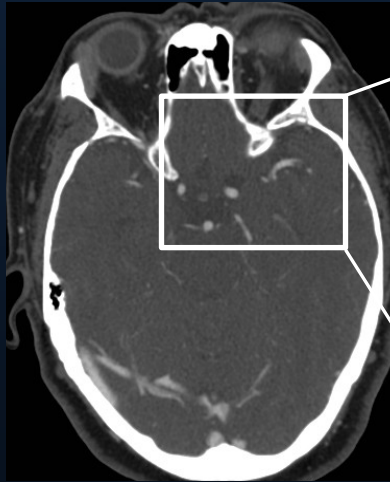


# Pénombre

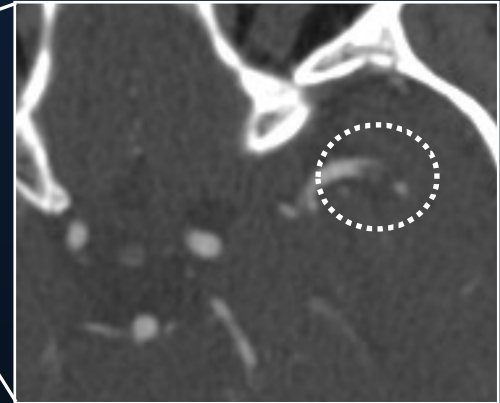
TDM sans contraste



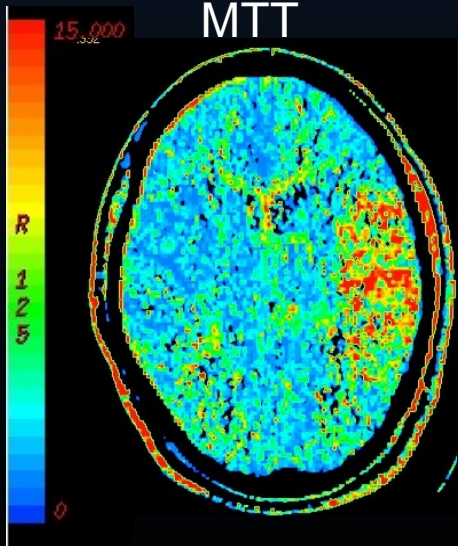
angioTDM



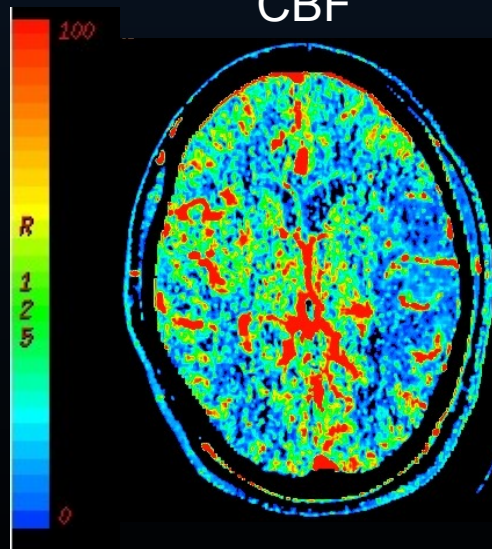
Occlusion M1 gauche



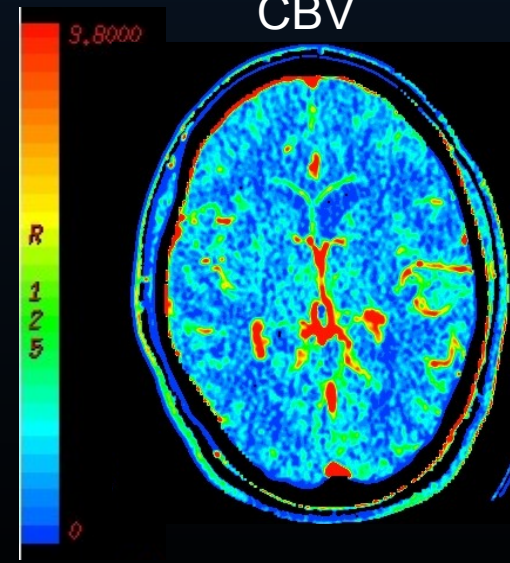
MTT



CBF

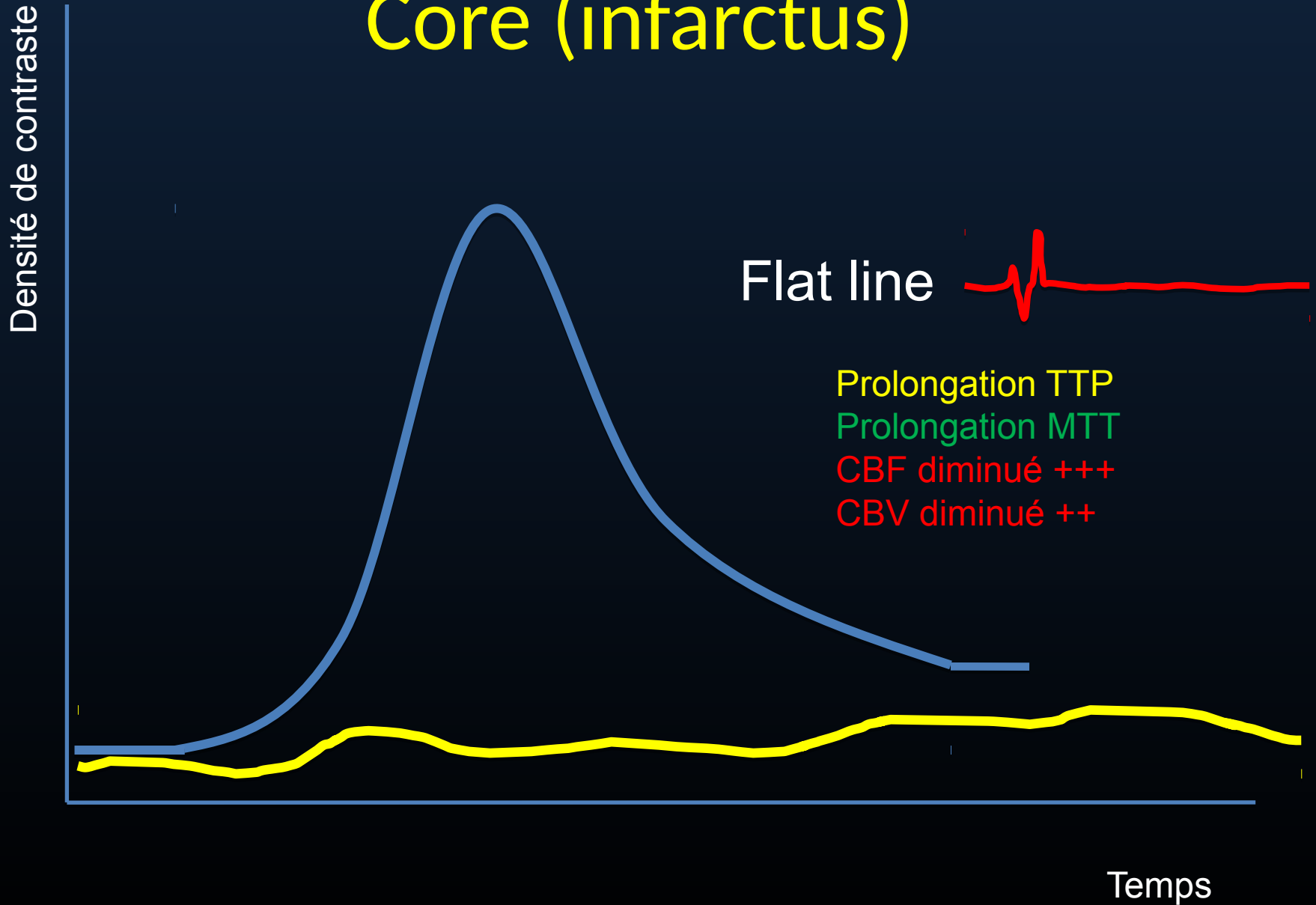


CBV





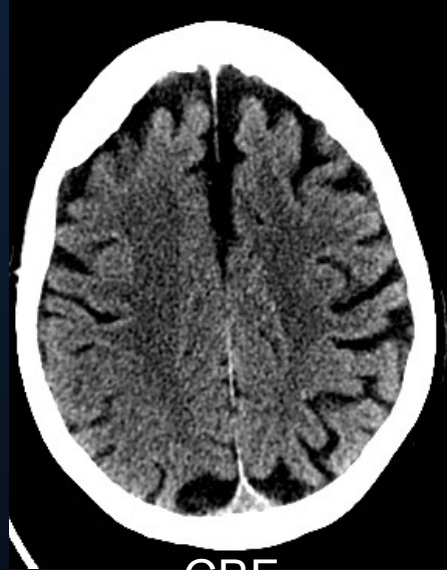
# Core (infarctus)



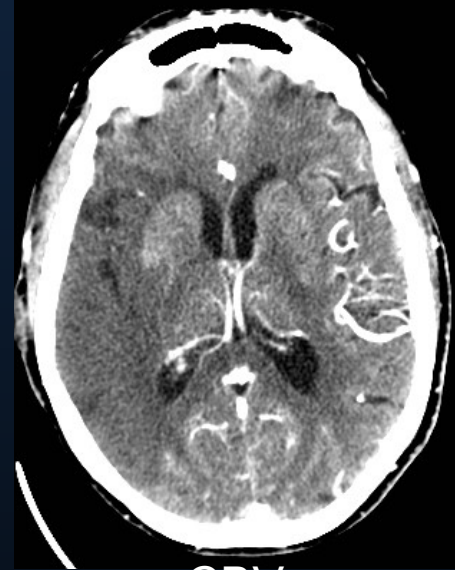
# Core (infarctus)



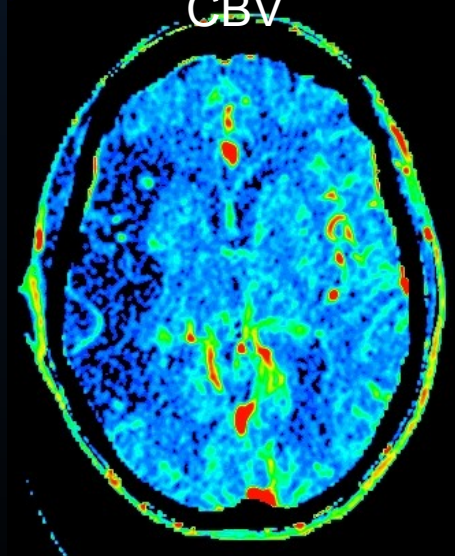
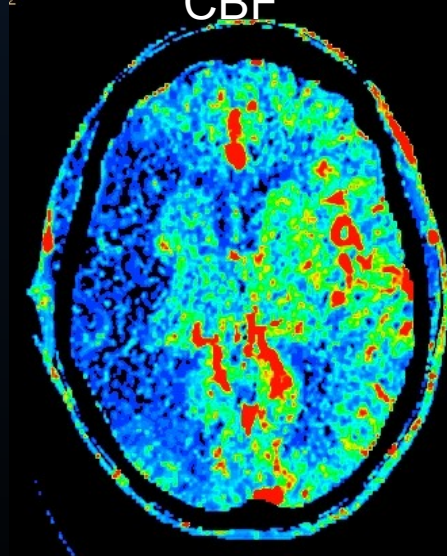
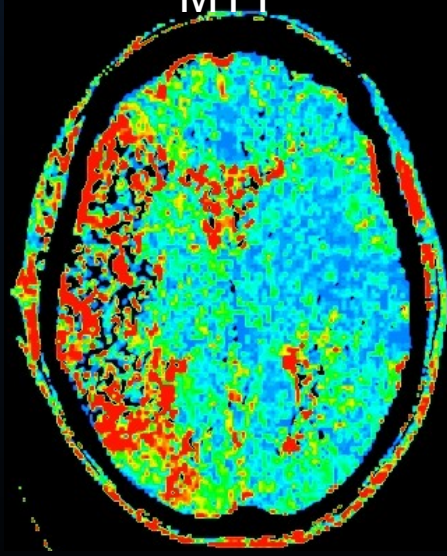
MTT



CBF



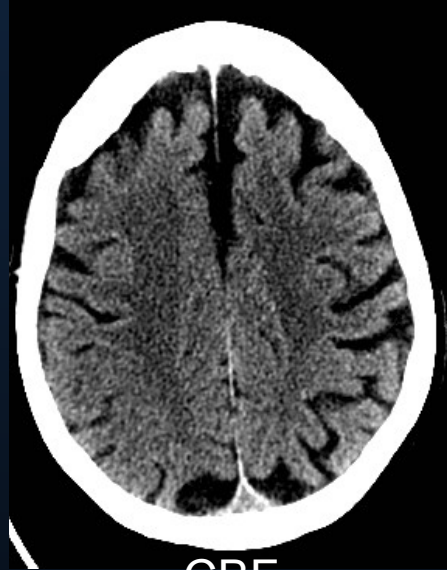
CBV



# Core (infarctus)



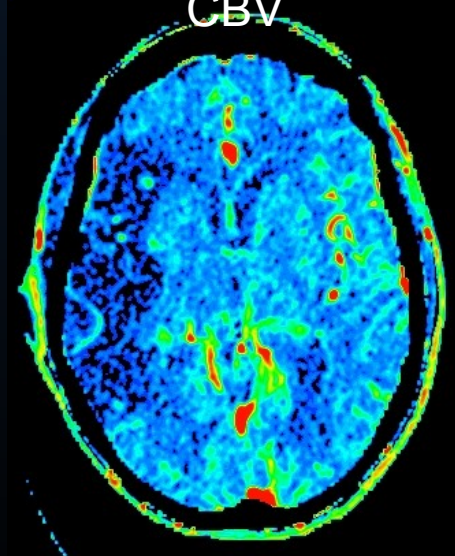
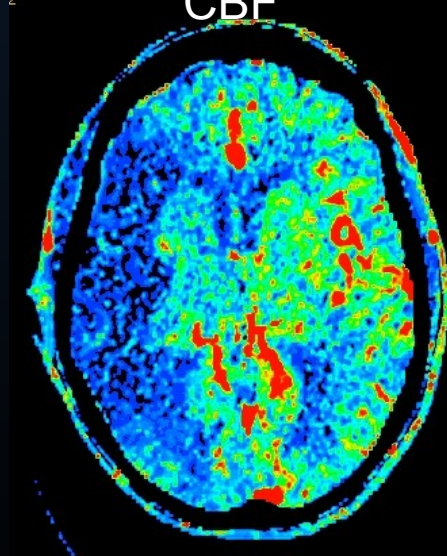
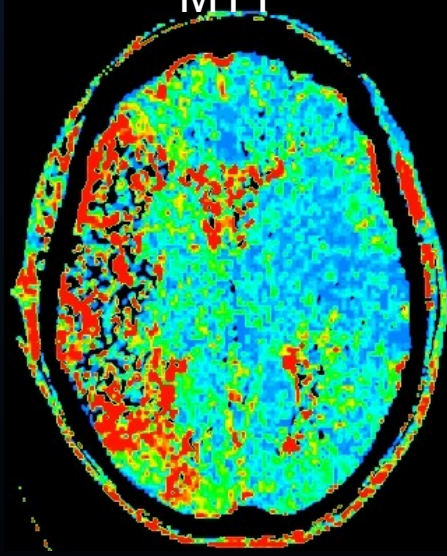
MTT



CBF



CBV



# Évaluation automatisée mismatch

## Penumbra Properties

? x

- Show on right hemisphere     Show on both hemispheres     Show on left hemisphere
- Restrict to gray matter

### Define Tissue at Risk

CBFD <

27 mL/100mL/min


Yellow

### Define Non-viable Tissue

CBVD <

1.2 mL/100mL

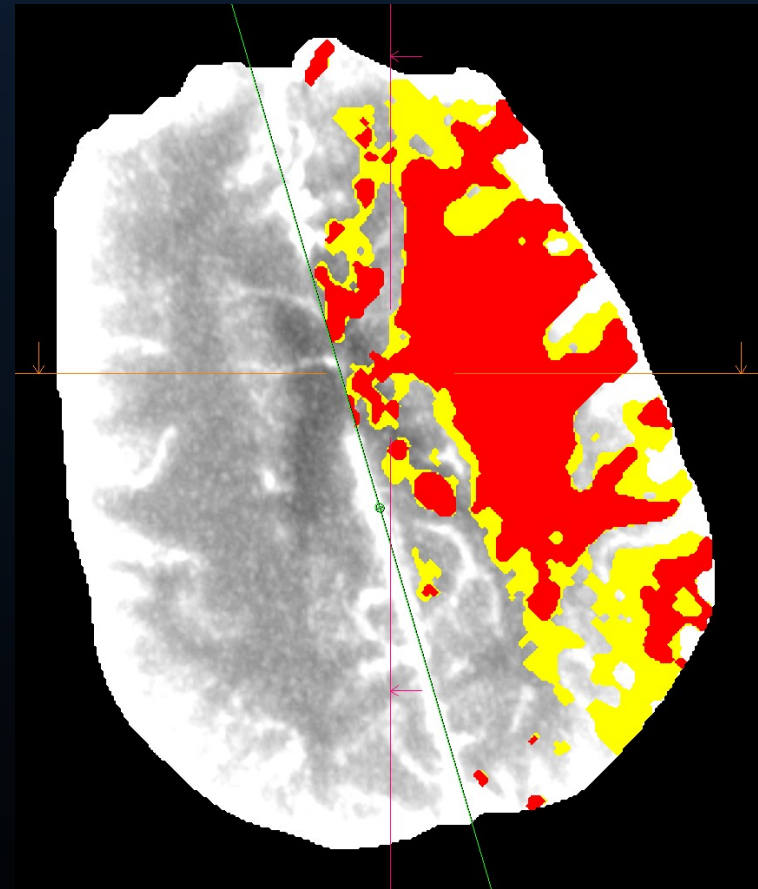
Red

 Please define permanent settings in the task configuration.

Apply

Default

Cancel



# T max

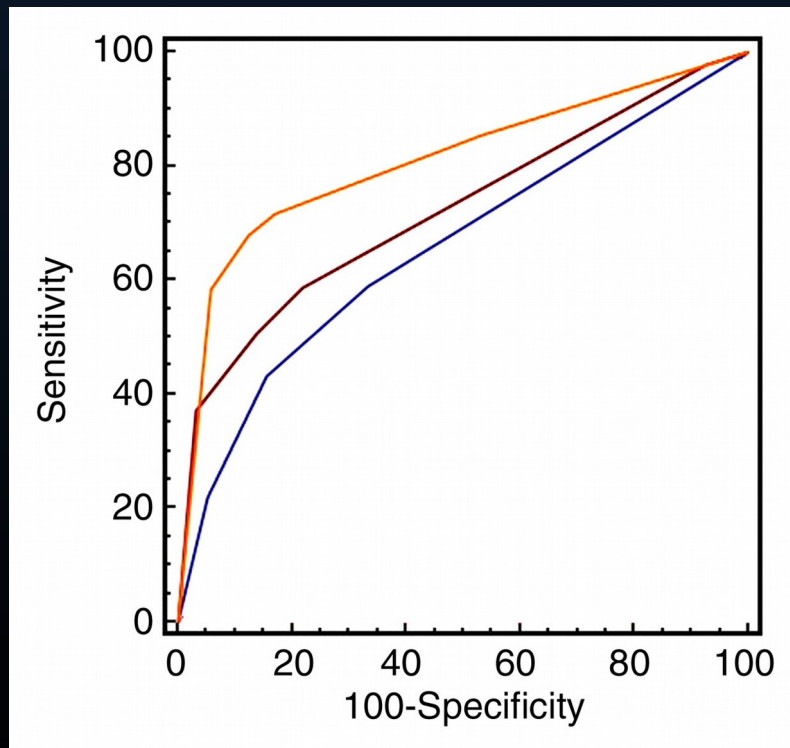
- Temps au maximum de la fonction résiduelle
- Délai d'arrivé entre *AIF* et le tissus
- Théoriquement pas le meilleur marqueur
  - Macrovasculaire plutôt que tissulaire
  - Sensible à la sélection de l'*AIF*
  - Pas de corrélation physiologique directe
- Couramment utilisé et validé
  - $T_{max} > 6$  secondes : pénombre

# Plan

- Technique
- Interprétation des paramètres
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# CT Perfusion

- Diminue la variabilité interobservateur
- Augmente sensibilité et spécificité



**NCCT + CTA + CTP**

**NCCT + CTA**

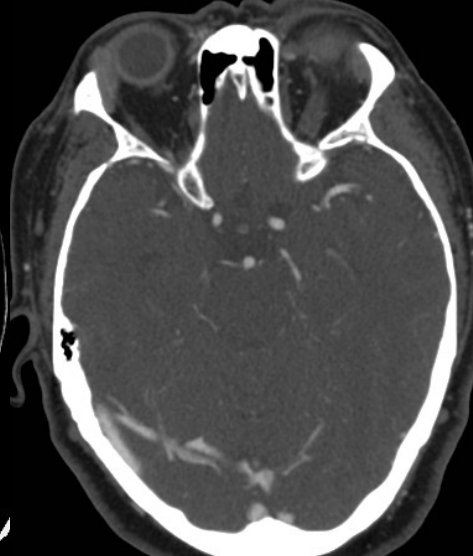
**NCCT**

# Détection ischémie précoce

NCCT



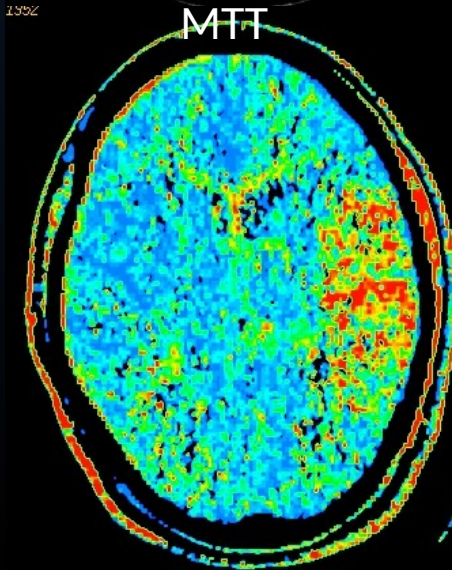
CTA



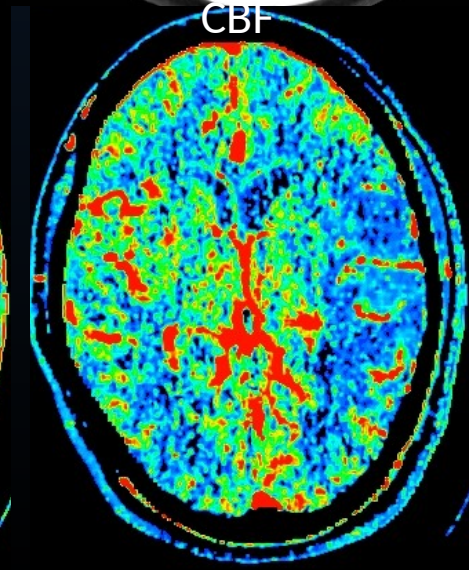
CTA-SI



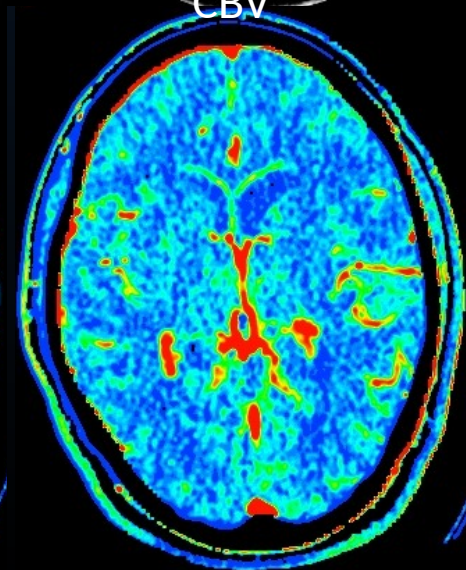
MTT



CBF



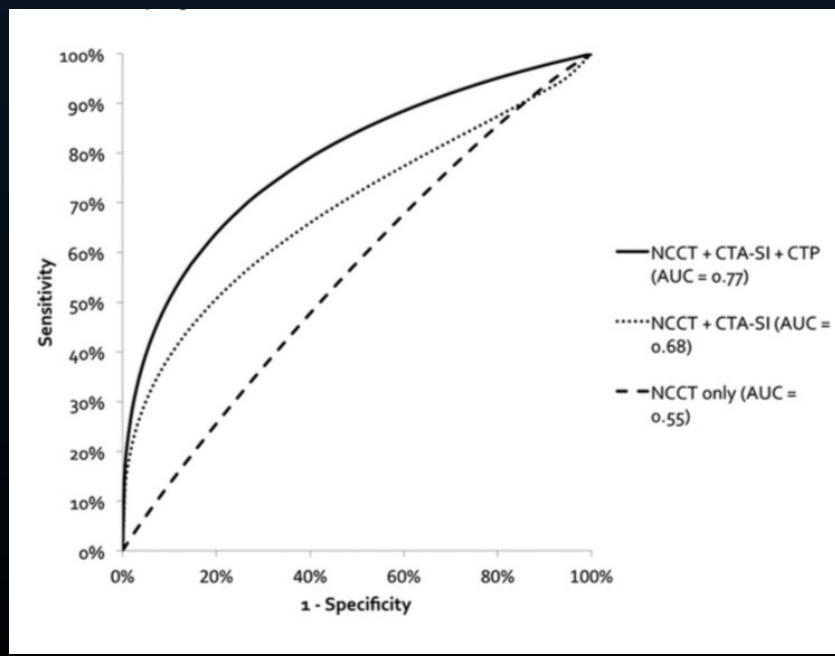
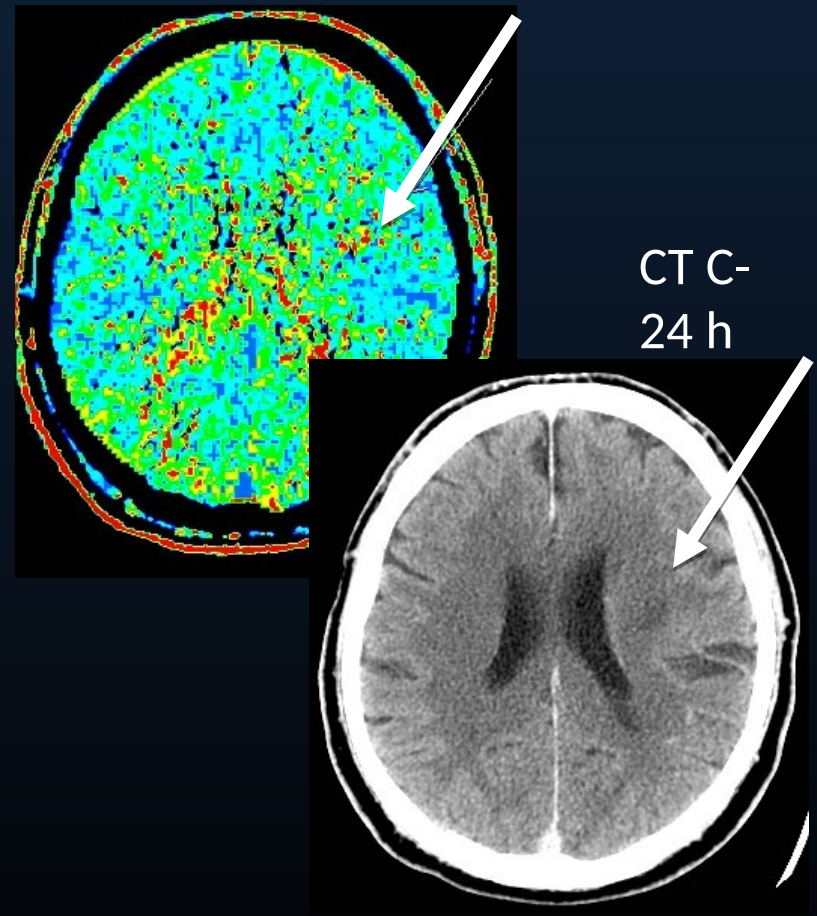
CBV





# AVC lacunaires

- Peu sensible mais spécifique
- TPP ou MTT



Benson et al. 2016 AJNR 37:2239 – 44

Das et al. AJNR 2015 36:1069 – 77

# AIT

- Faible risque de détérioration si perfusion normale (AVC lacunaire)<sup>1</sup>
- 30 % des aN perfusionnelles associées à nouvel infarctus à 1 semaine<sup>2</sup>
- **Augmentation sensibilité vs DWI<sup>3</sup>**
- **DWI - / Perfusion + : 22-23%<sup>2,4</sup>**

1:Poppe et al. Cerebrovasc Dis 2009;28:151–156

2: Lee et al. Neurology2017;88:2254–2259

3: J Clin Neurol. 2017 Apr; 13(2): 129–137, Qiao et al 2013, 34 (11) 2125-2130;

4: Grams et al. AJR. 2016;207: 157-162.

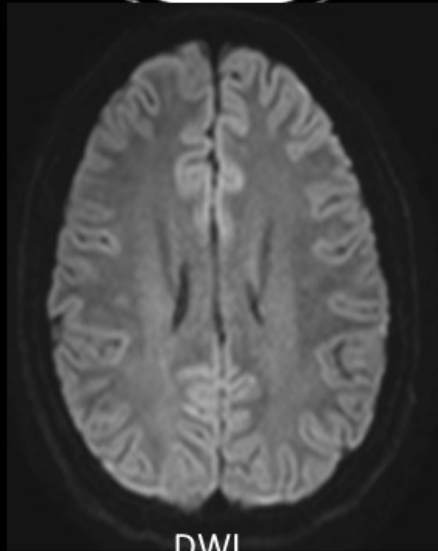
# Plan

- Technique
- Interprétation des paramètres
- Diagnostic AVC ischémique aigu (et AIT)
- Diagnostic différentiel
- Sélection patients

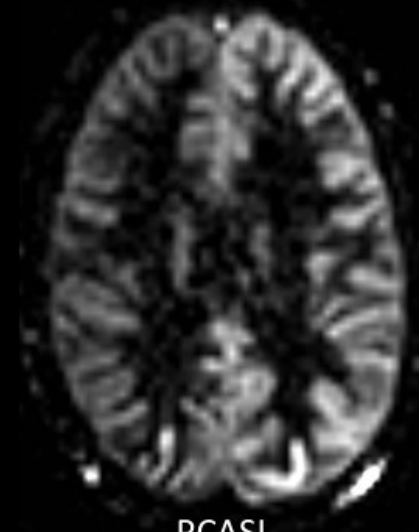
# Convulsions/Todd

- Patron variable, peut être normal
- Per-ictal : hyperperfusion
- Post-ictal: hypoperfusion
- Territoires variables:
  - Holo-hémisphérique à cortical focal
- Pas d'occlusion correspondante
- Croise territoires vasculaires
- DDx: hyperperfusion post-recanalisation, migraine, HaNDL

H 28 ans aphasie, hémiparésie droite < 2 heures



DWI

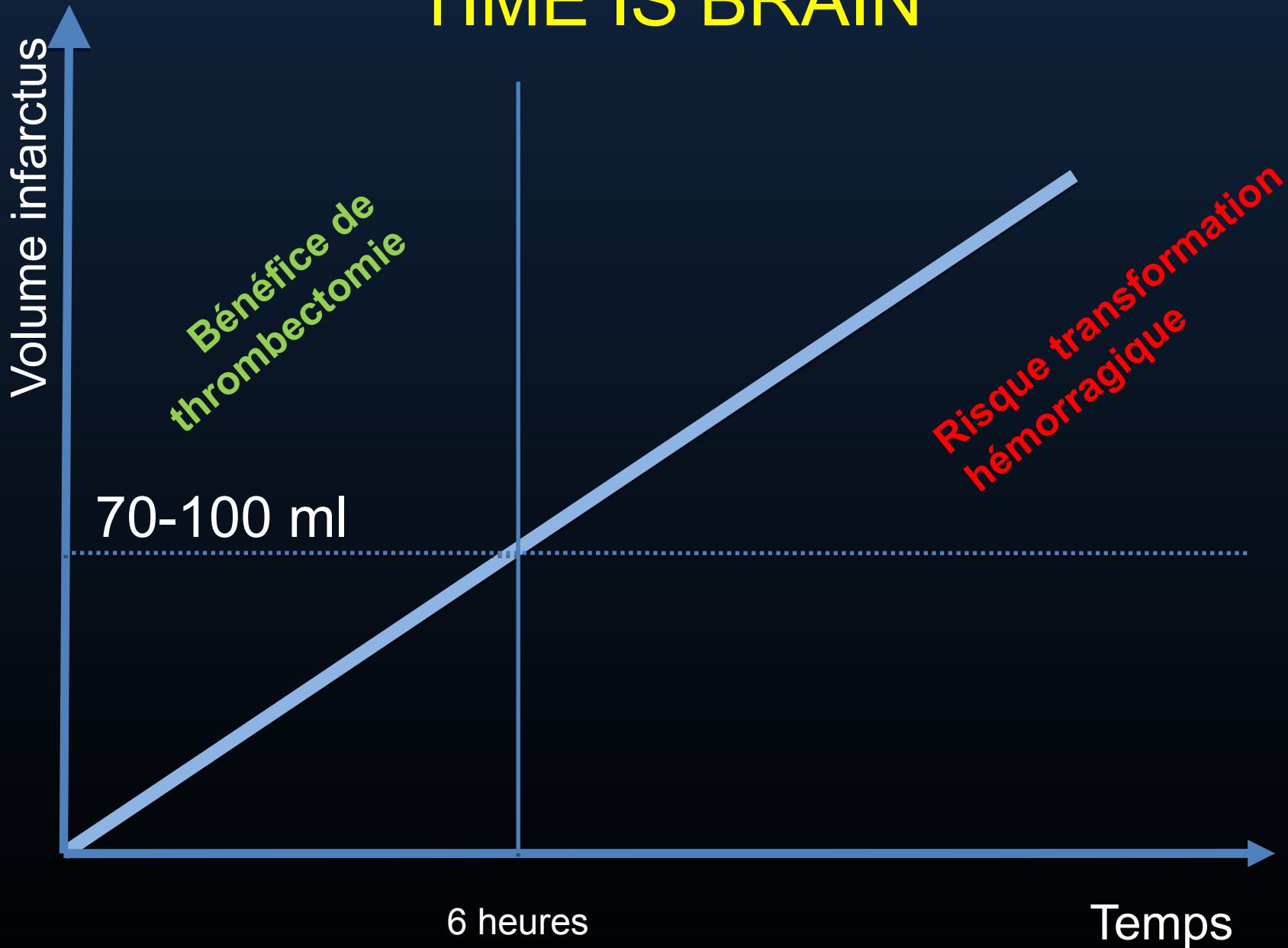


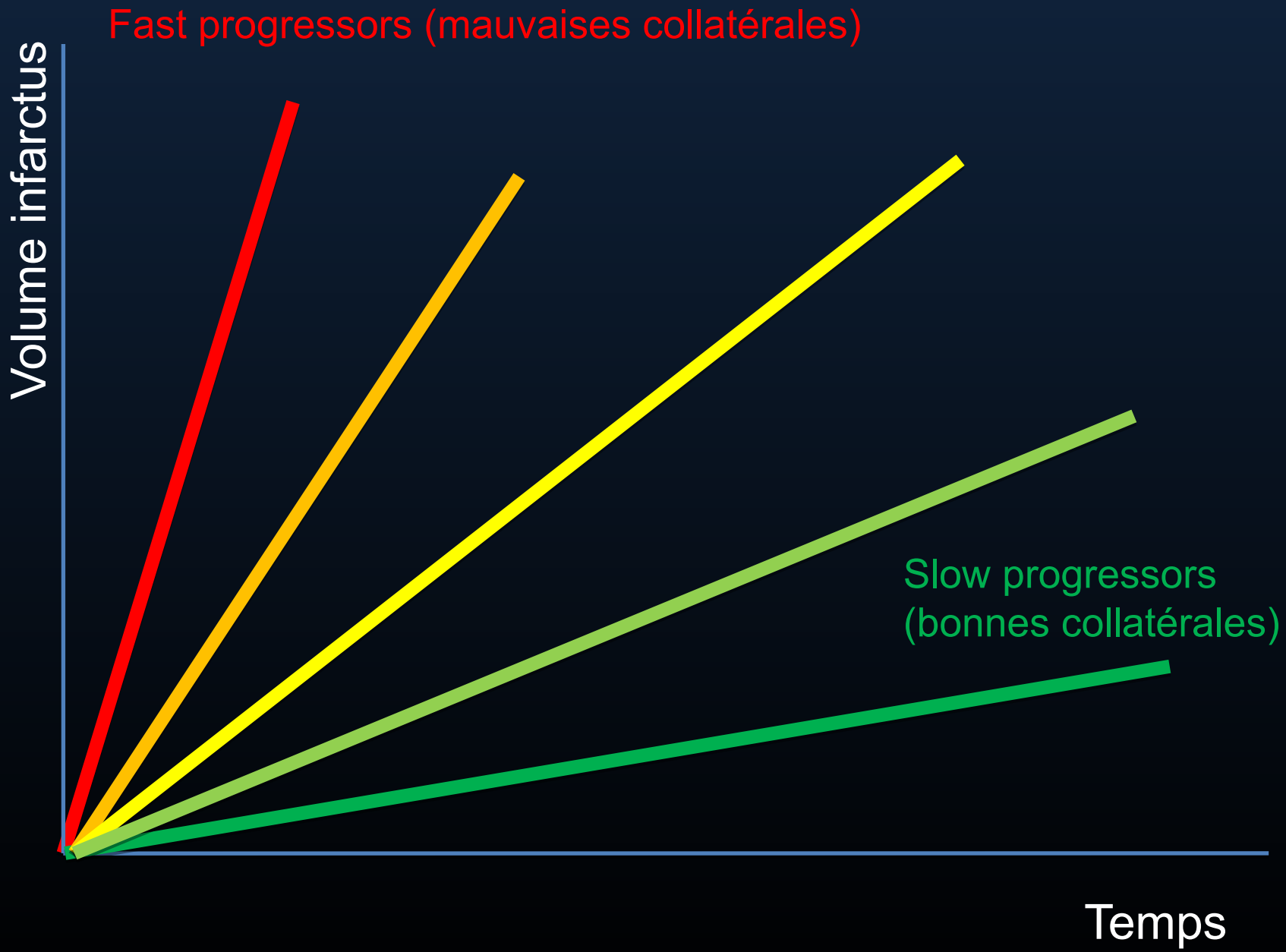
PCASL

# Plan

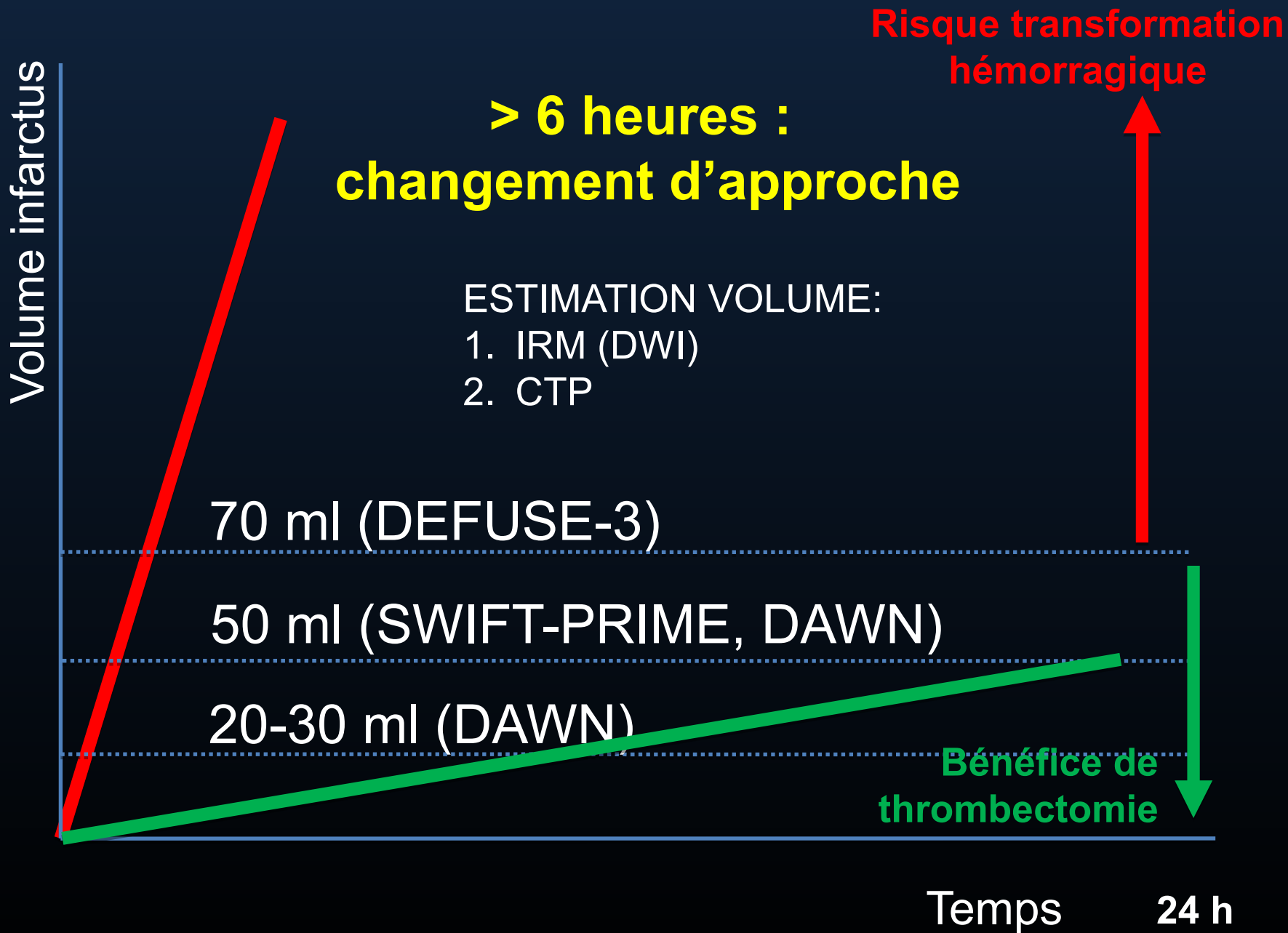
- Technique
- Interprétation des paramètres
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- Diagnostic différentiel
- Sélection patients

# TIME IS BRAIN









# DAWN

ORIGINAL ARTICLE

## Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct

Raul G. Nogueira, M.D., Ashutosh P. Jadhav, M.D., Ph.D., Diogo C. Haussen, M.D., Alain Bonafe, M.D., Ronald F. Budzik, M.D., Parita Bhuvra, M.D., Dileep R. Yavagal, M.D., Marc Ribo, M.D., Christophe Cognard, M.D., Ricardo A. Hanel, M.D., Cathy A. Sila, M.D., Ameer E. Hassan, D.O., et al., for the DAWN Trial Investigators\*

# DEFUSE-3

ORIGINAL ARTICLE

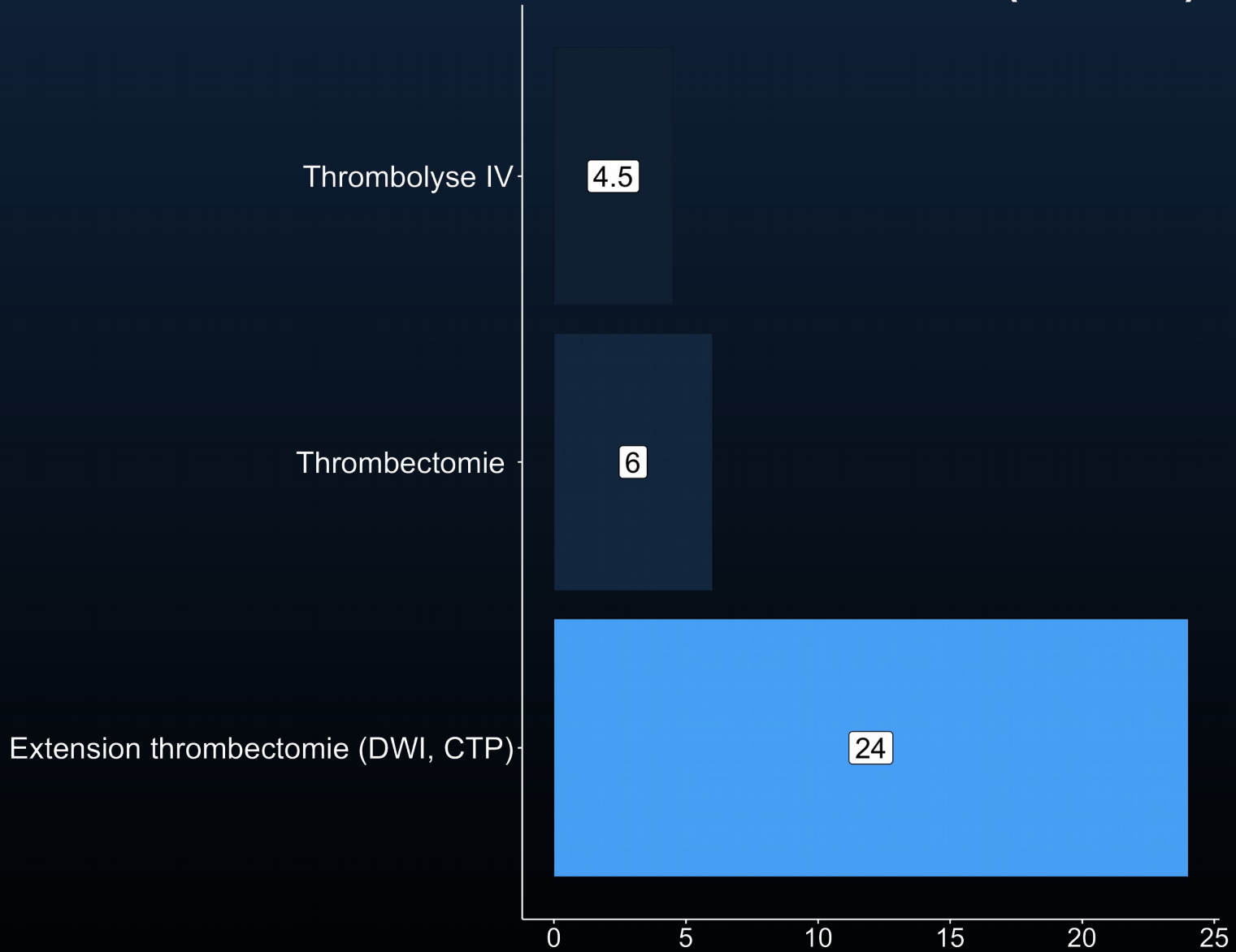
## Thrombectomy for Stroke at 6 to 16 Hours with Selection of Patients Using Diffusion-Weighted and Perfusion Imaging

Gregory W. Albers, M.D., Michael P. Marks, M.D., Stephanie Kemp, B.S., Soren Christensen, Ph.D., Jenny P. Teal, M.D., Michael J. Hill, M.D., Ryan A. McTaggart, M.D., Michel T. Torbey, M.D., May Kim-Tenser, M.D., Thabele Leslie-Mazwi, M.D., Amrou Sarraj, M.D., et al., for the DEFUSE 3 Investigators\*

2018

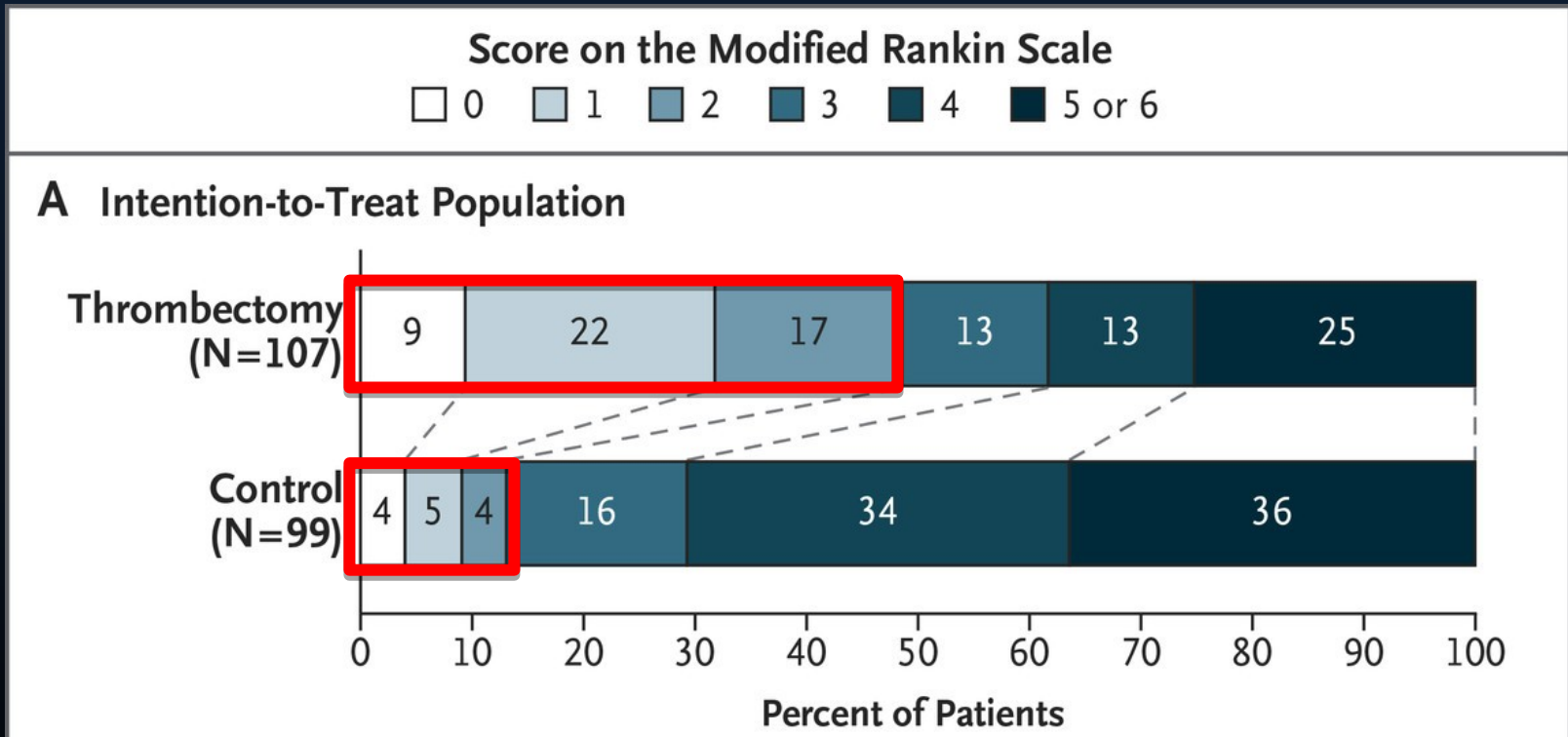


# Délai début des Sx (heures)



# DAWN

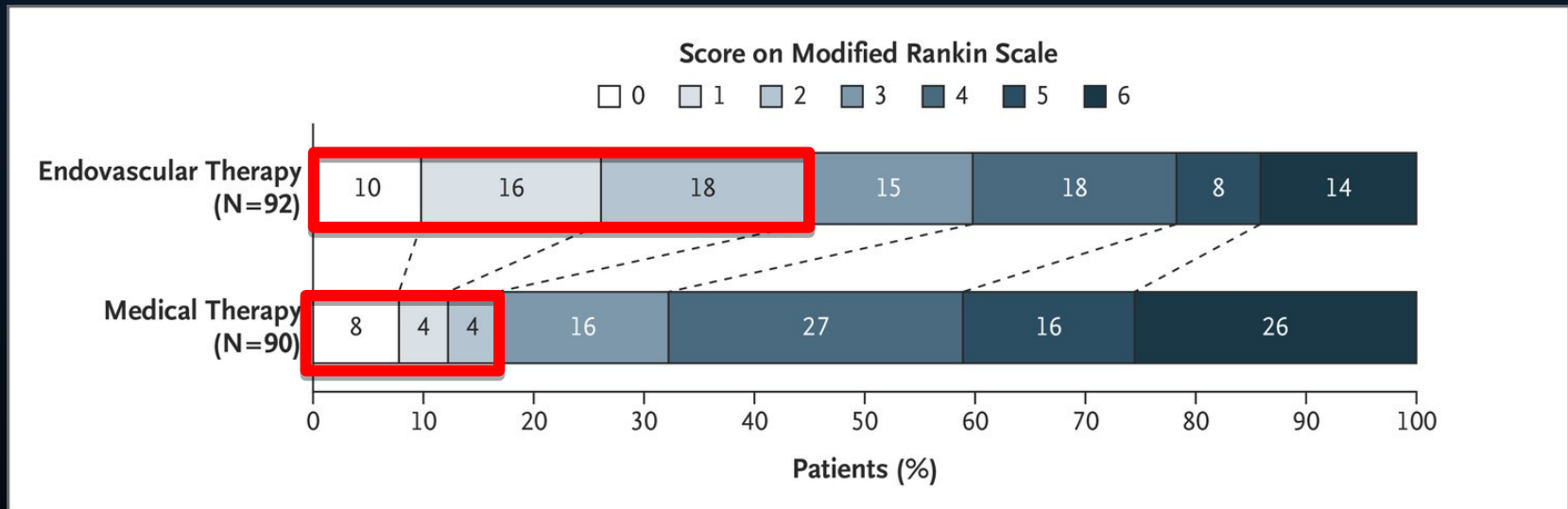
Distribution of Scores on the Modified Rankin Scale at 90 Days.



49 % (thrombectomie) vs 13 %

# DEFUSE-3

Scores on the Modified Rankin Scale at 90 Days.



45 % (thrombectomy) vs 17 %

# Mismatch

**DAWN**

**6-24 h**

- **Déficit Clinique vs Core**
  - A: > 80 ans, NIHSS  $\geq 10$ , infarctus 0-20 ml
  - B: < 80 ans, NIHSS  $\geq 10$ , infarctus 0-30 ml
  - C: < 80 ans, NIHSS  $\geq 20$ , infarctus 31-50 ml

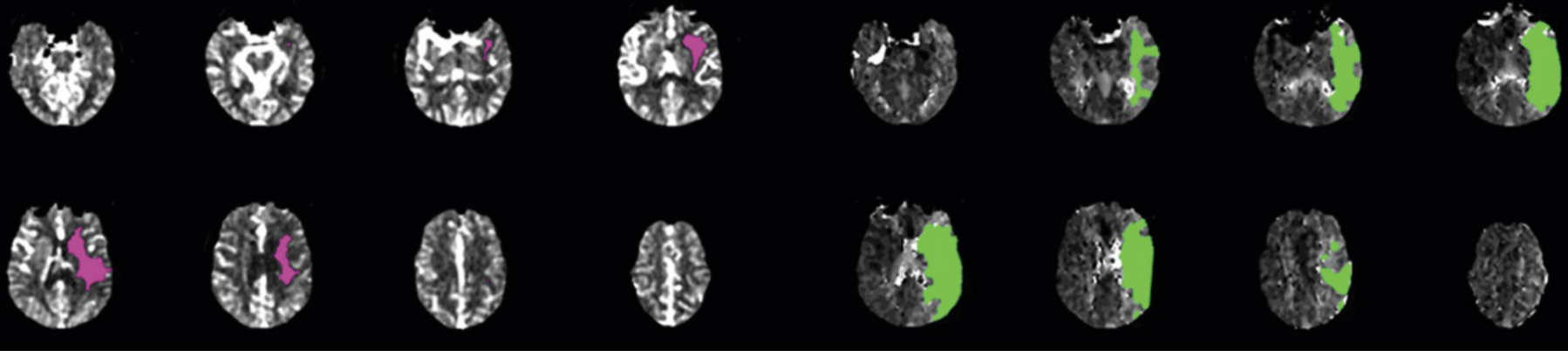
**DEFUSE-3**

**6-16 h**

- **Pénombre vs Core**
  - Core < 70 ml
  - Mismatch pénombre : core > 1.8
  - Volume pénombre  $\geq 15$  ml

# Évaluation infarctus/pénombre (RAPID)

- Infarctus (core)
  - DWI
  - CTP: rCBF < 30 % normal
- Pénombre
  - Tmax > 6 secondes



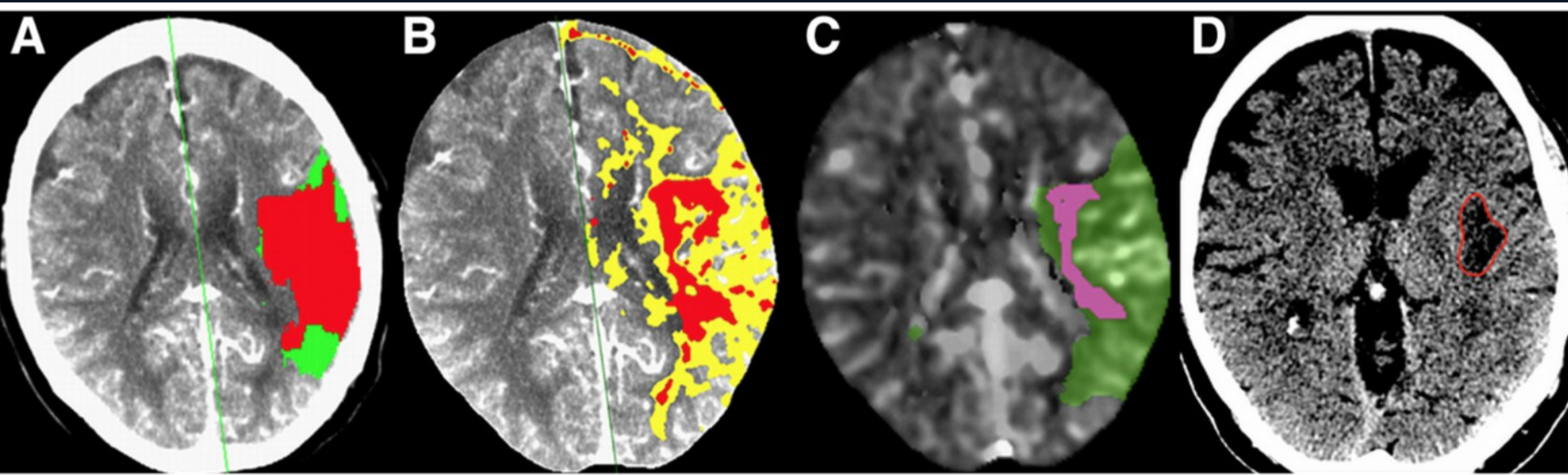
Volume of Ischemic Core, 23 ml

Volume of Perfusion Lesion, 128 ml

Mismatch volume, 105 ml  
Mismatch ratio, 5.6

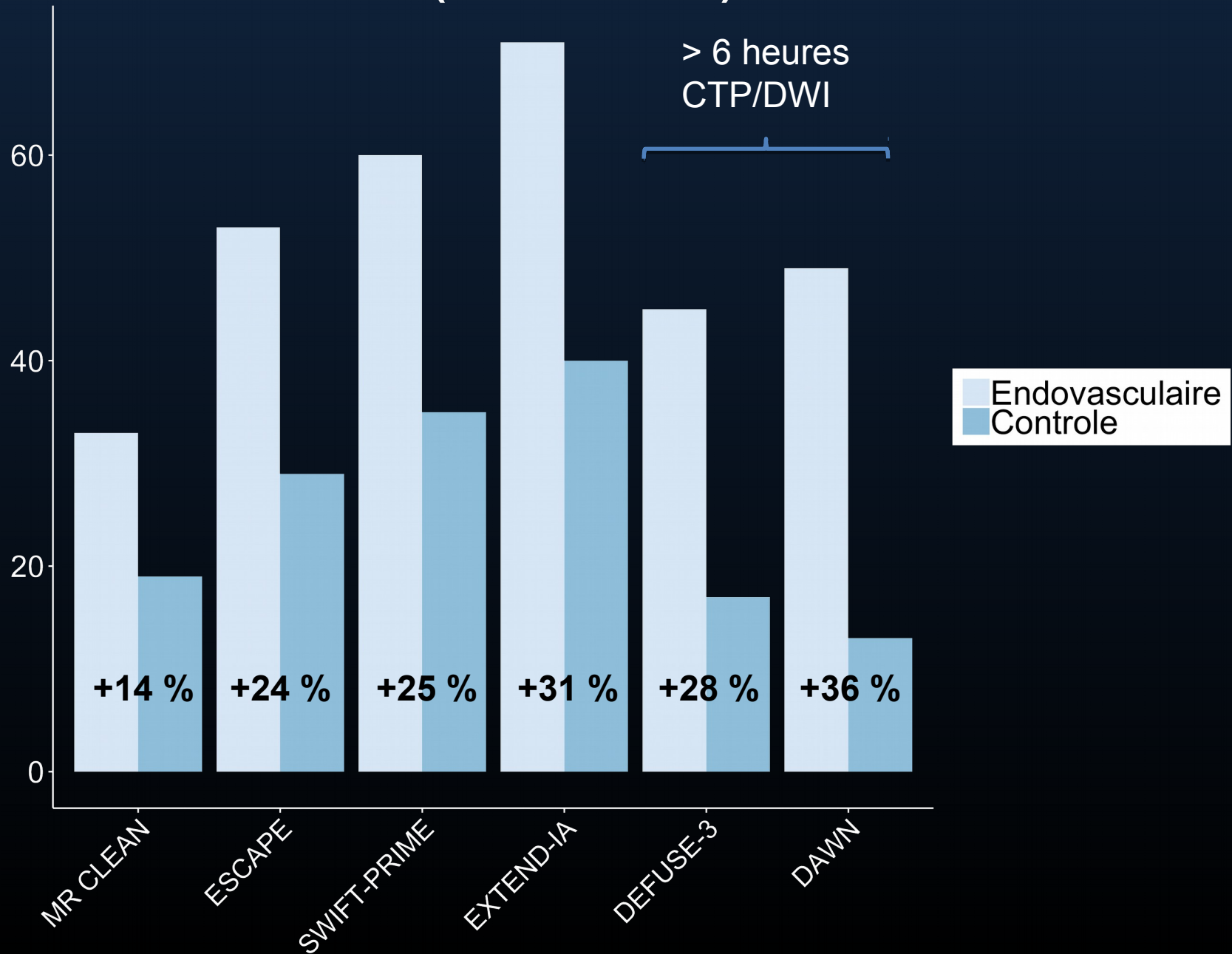
# Quel logiciel ?

- RAPID vs autres ?





# mRs $\leq$ 2 (fonctionnel)



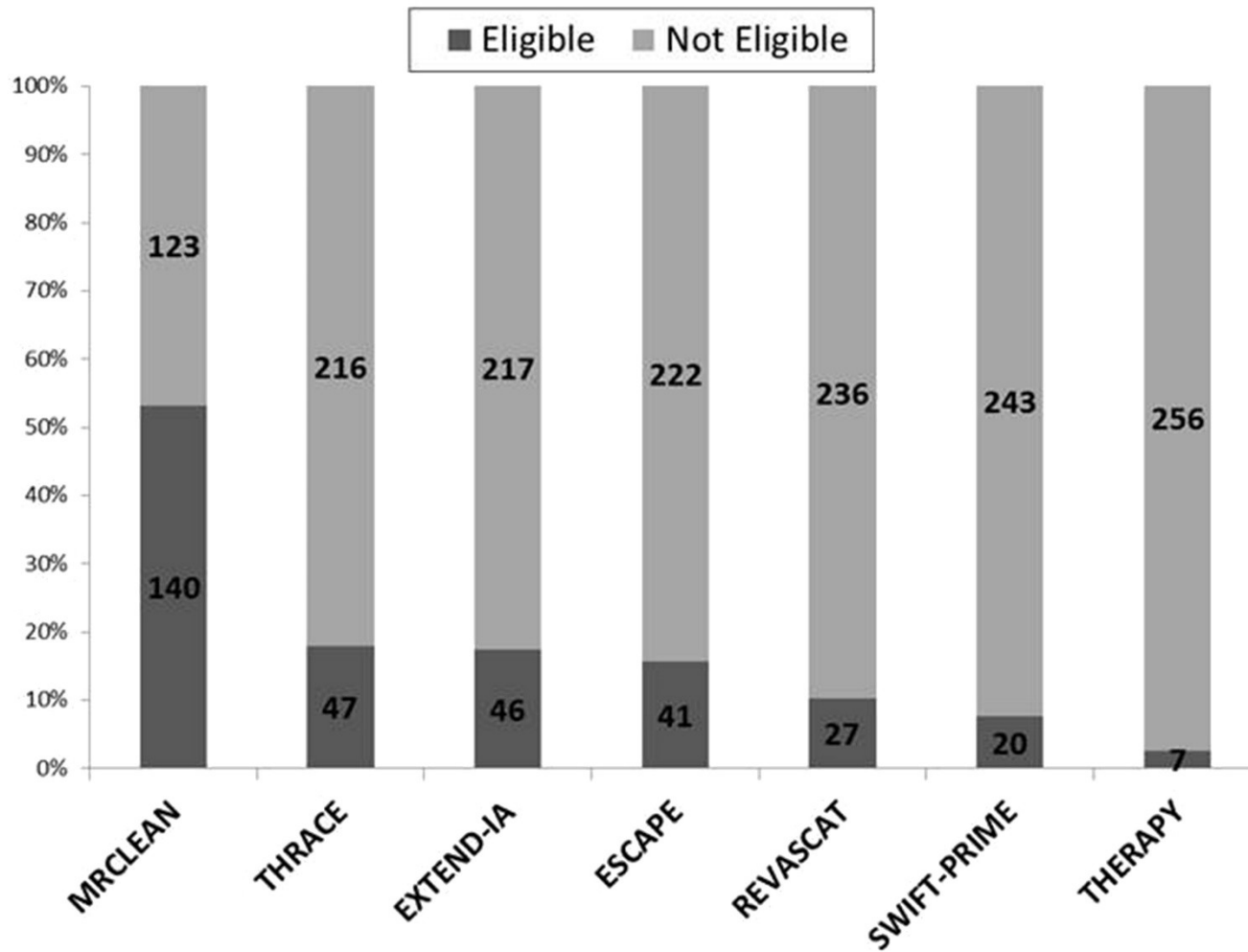


Figure 1. The number of patients meeting entry criteria for each of the studies.

# Est-ce que ça change quelque chose ?

## Imaging features and safety and efficacy of endovascular stroke treatment: a meta-analysis of individual patient-level data



Luis San Román\*, Bijoy K Menon\*, Jordi Blasco, María Hernández-Pérez, Antoni Dávalos, Charles B L M Majoie, Bruce CV Campbell, Francis Guillemin, Hester Lingsma, René Anxionnat, Jonathan Epstein, Jeffrey L Saver, Henk Marquering, John H Wong, Demetrius Lopes, Gernot Reimann, Hubert Desal, Diederik W J Dippel, Shelagh Coutts, Richard du Mesnil de Rochemont, Dileep Yavagal, Jean Christophe Ferre, Yvo B W E M Roos, David S Liebeskind, Robert Lenthall, Carlos Molina, Fahad S Al Ajlan, Vivek Reddy, Dar Dowlatshahi, Nader-Antoine Sourour, Catherine Oppenheim, Alim P Mitha, Stephen M Davis, Christian Weimar, Robert J van Oostenbrugge, Erik Cobo, Timothy J Kleinig, Geoffrey A Donnan, Aad van der Lugt, Andrew M Demchuk, Olvert A Berkhemer, Anna M M Boers, Gary A Ford, Keith W Muir, B Scott Brown, Tudor Jovin, Wim H van Zwam, Peter J Mitchell, Michael D Hill, Phil White, Serge Bracard, Mayank Goyal, on behalf of the HERMES collaborators†

### Summary

**Background** Evidence regarding whether imaging can be used effectively to select patients for endovascular thrombectomy (EVT) is scarce. We aimed to investigate the association between baseline imaging features and safety and efficacy of EVT in acute ischaemic stroke caused by anterior large-vessel occlusion.

Lancet Neurol 2018; 17: 895–904

This online publication has been corrected. The corrected version first appeared at

For large vessel occlusion stroke in the patient population studied by these trials are no longer considered ethically justifiable. This meta-analysis provides new evidence that patients with a broad range of baseline imaging characteristics, including those with large infarcts (ie, ASPECTS <6 or involvement of >33% of middle cerebral artery territory), poor collateral circulation, and any clot burden score, might benefit from EVT.

# Value of Computed Tomographic Perfusion–Based Patient Selection for Intra-Arterial Acute Ischemic Stroke Treatment

Jordi Borst, MD, MSc; Olvert A. Berkhemer, MD; Yvo B.W.E.M. Roos, MD, PhD;  
Ed van Bavel, PhD; Wim H. van Zwam, MD, PhD; Robert J. van Oostenbrugge, MD, PhD;  
Marianne A.A. van Walderveen, MD, PhD; Hester F. Lingsma, PhD;  
Aad van der Lugt, MD, PhD; Diederik W.J. Dippel, MD, PhD; Albert J. Yoo, MD;  
Henk A. Marquering, PhD\*; Charles B.L.M. Majoie, MD, PhD\*;  
on behalf of the MR CLEAN investigators

**Conclusions**—CTP seems useful for predicting functional outcome, but cannot reliably identify patients who will not benefit from intra-arterial therapy. (*Stroke*. 2015;46:3375-3382. DOI: 10.1161/STROKEAHA.115.010564.)

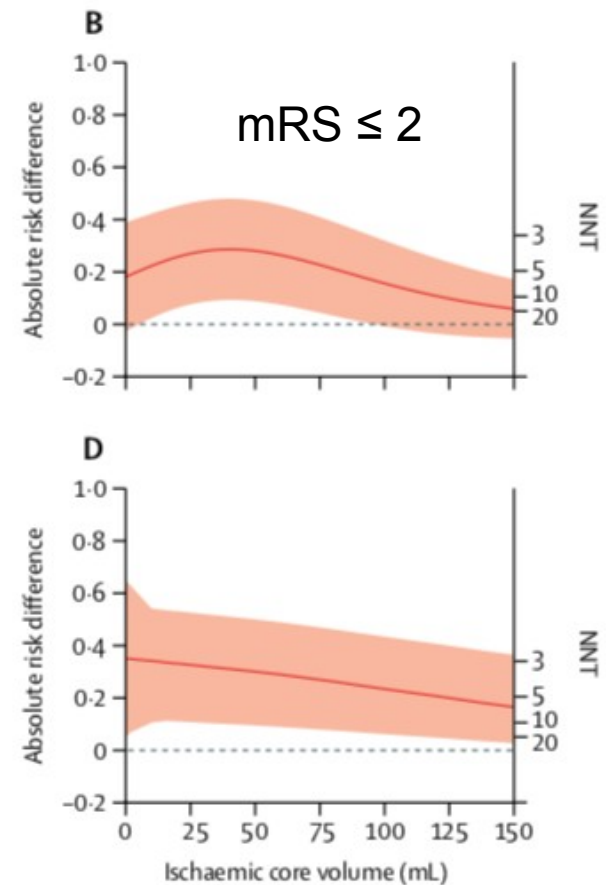
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# Penumbral imaging and functional outcome in patients with anterior circulation ischaemic stroke treated with endovascular thrombectomy versus medical therapy: a meta-analysis of individual patient-level data

Bruce CV Campbell, Charles B L M Majoie, Gregory W Albers, Bijoy K Menon, Nawaf Yassi, Gagan Sharma, Wim H van Zwam, Robert J van Oostenbrugge, Andrew M Demchuk, Francis Guillemin, Philip White, Antoni Dávalos, Aad van der Lugt, Kenneth S Butcher, Aboubaker Cherifi, Henk A Marquering, Geoffrey Cloud, Juan M Macho Fernández, Jeremy Madigan, Catherine Oppenheim, Geoffrey A Donn, Yvo B W E M Roos, Jai Shankar, Hester Lingsma, Alain Bonafé, Héléne Raoult, María Hernández-Pérez, Aditya Bharatha, Reza Jahan, Olav Jai Sébastien Richard, Elad I Levy, Olvert A Berkhemer, Marc Soudant, Lucia Aja, Stephen M Davis, Timo Krings, Marie Tisserand, Luis San Romá Alejandro Tomasello, Debbie Beumer, Scott Brown, David S Liebeskind, Serge Bracard\*, Keith W Muir\*, Diederik W J Dippel\*, Mayank Goyal\*, Jeffrey L Saver\*, Tudor G Jovin\*, Michael D Hill\*, Peter J Mitchell\*, for the HERMES collaborators



## Implications of all the available evidence

Patients should not be excluded from endovascular thrombectomy within 6 h of stroke onset purely on the basis of a large estimated ischaemic core. The patient's age and functional status, their views on disability outcomes (if known), and the expected time to achieve reperfusion should be considered alongside ischaemic core volume when estimating the attainable functional outcome and establishing the most appropriate treatment.

# Conclusion

- Rôle perfusion en évolution
- Problèmes de standardisation
- Imagerie maximale vs minimale

# Remerciements

- Jean Raymond
- François Guilbert
- Daniel Roy
- Alain Weill
- Céline Bard
- Manon Bélair
- David Landry
- Pierre Bourgouin
- JM Baillargeon

