Intima Media Thickness and Plaque measurement in Asymptomatic patients

What's Up ?

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Declaration of Conflict of Interest

- ✓ Royalties on IMT software

- ✓ R & D consultant for Medical Software

Identification of Pre-Symptomatic Patients at Intermediate CV Risk

CLINICAL EVENTS

Stenosis

Plaque

IMT

HTN/Diabetes
Cholesterol/Smoking

Diet
Genes

Atherosclerosis

Surrogate Marker

RiskFactors
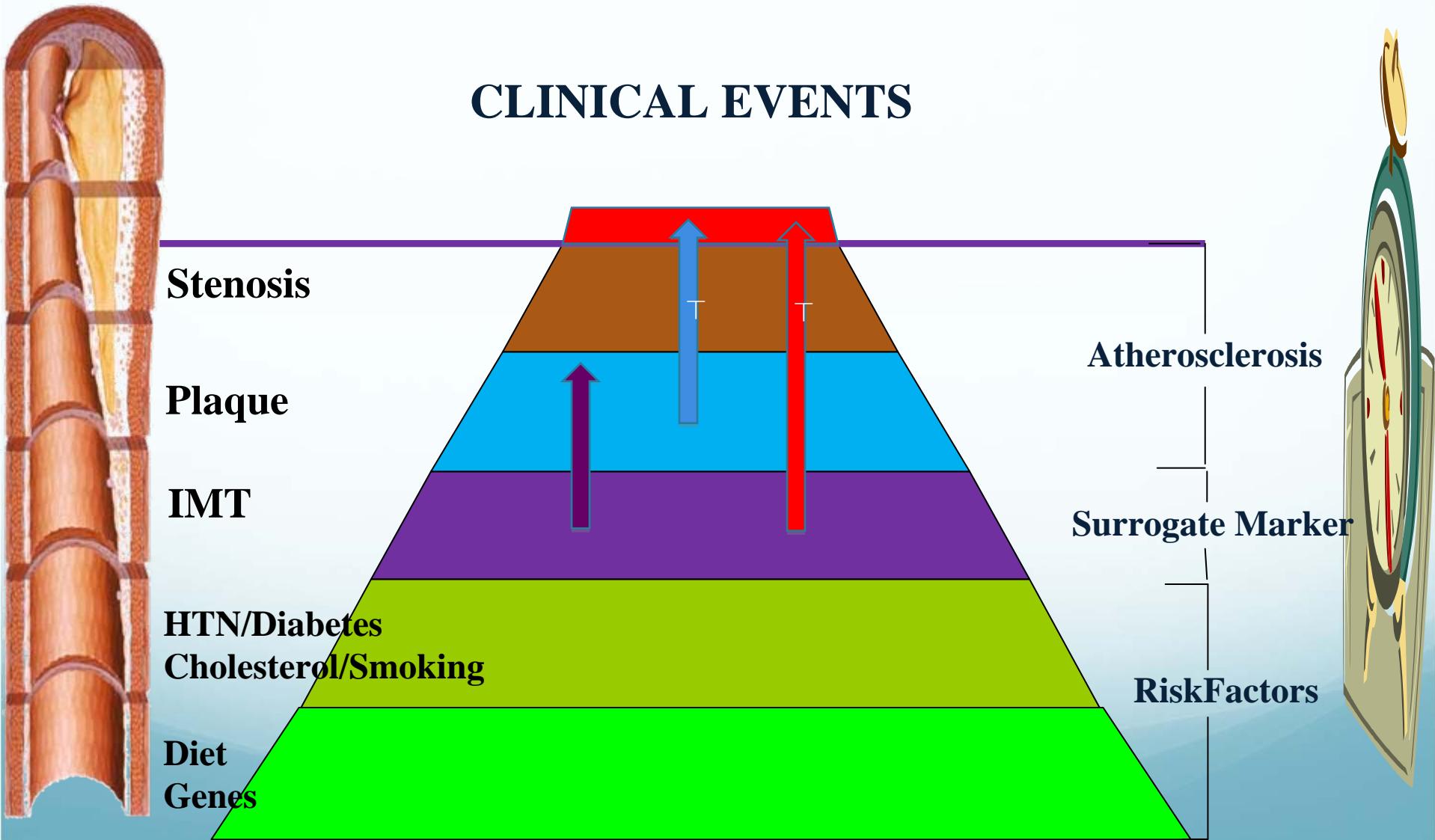
Common Sense

"The best test for prediction of the risk of atherosclerosis is the demonstration of atherosclerosis"

Dr. Ernest Schaeffer, Editor-in-Chief of Atherosclerosis

Early Atherosclerosis Detection
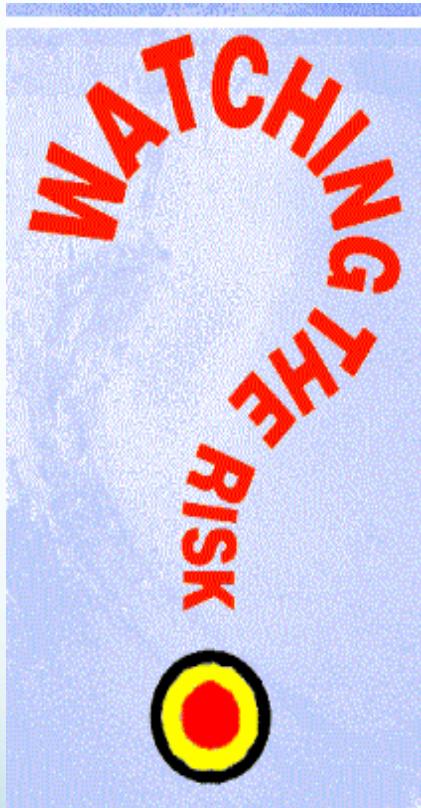
Ankle Arm Index : low sensitivity

Arterial Stiffness : too sensitive to BP

CAC : irradiation-repeatibility

CAC : irradiation-repeatibility

Intima Media Thickness -Plaque

P. Pignoli Circulation 1986

Intima Media Thickness
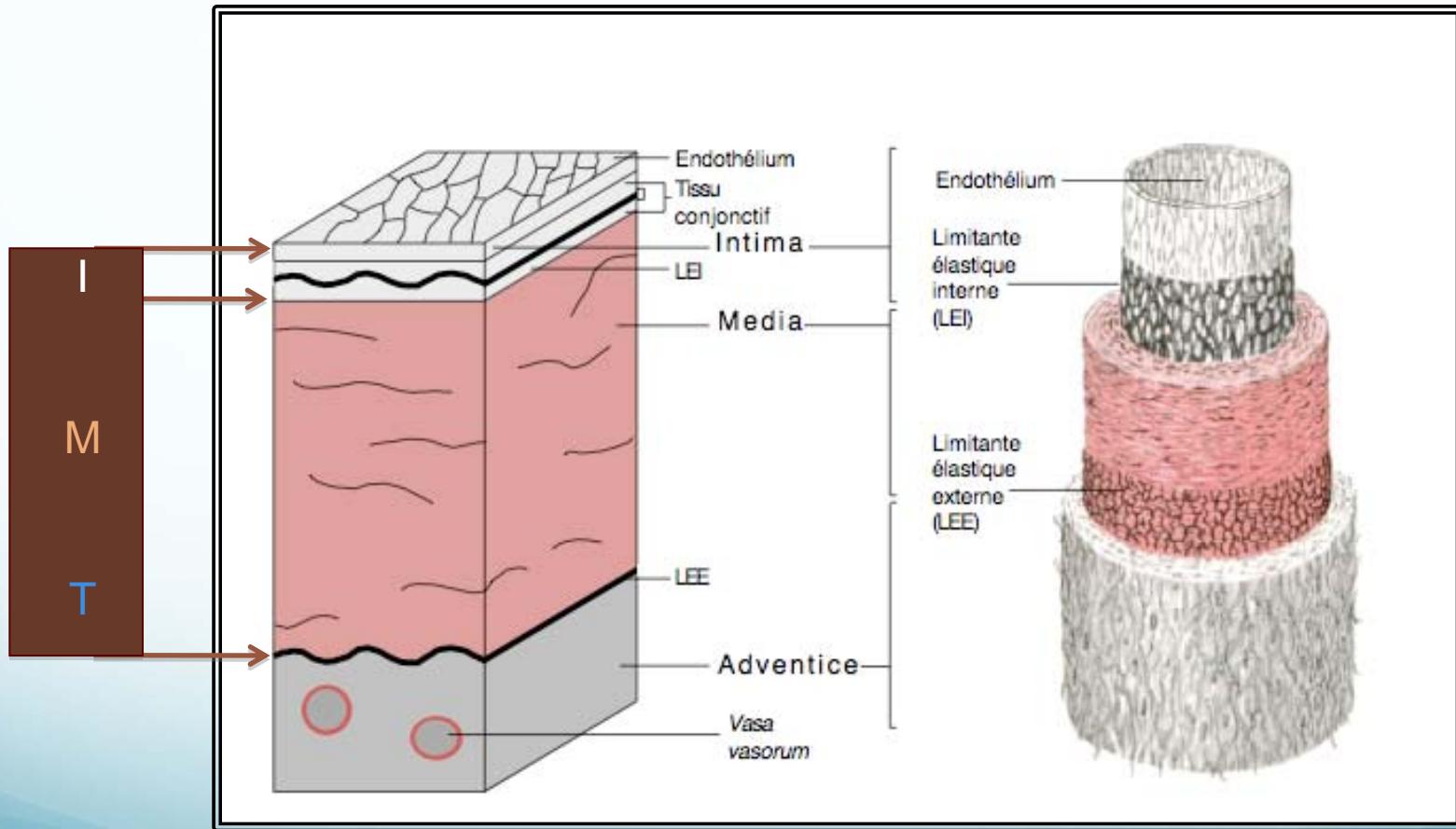
IMT of the Common Carotid Artery

Correlation between :

- Intima media thickness of tissue specimens
- **B-Mode** "Double line pattern"

$$r = O.9$$
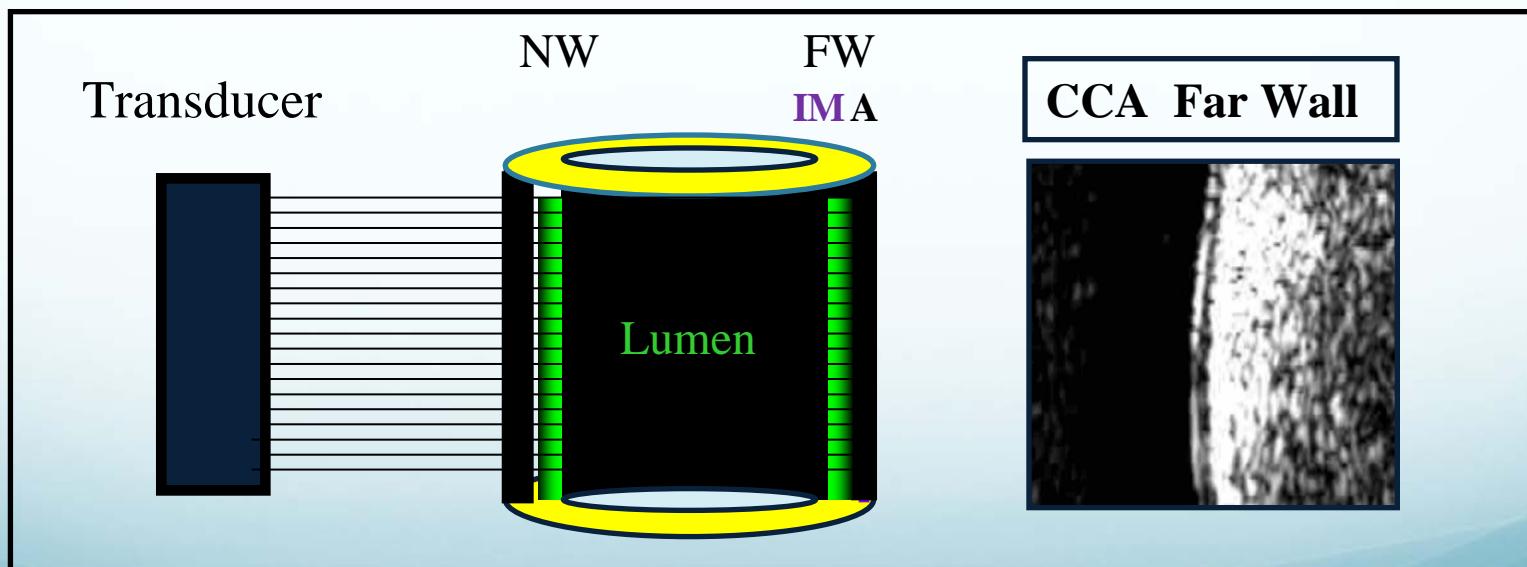
Mannheim Consensus

Mannheim Intima-Media Thickness Consensus

on Behalf of the Advisory Board of the 3rd Watching the Risk Symposium 2004, 13th European Stroke Conference, Mannheim, Germany, May 14, 2004

P.-J. Touboul   M.G. Hennerici   S. Meairs   H. Adams   P. Amarenco
M. Desvarieux   S. Ebrahim   M. Fatar   R. Hernandez Hernandez   S. Kownator
P. Prati   T. Rundek   A. Taylor   N. Bornstein   L. Csiba   E. Vicaut   K.S. Woo
F. Zannad

Cerebro Vascular Disease 2004 Updated in 2006 (Brussels) and 2011 (Hamburg)

Definition

Intima Media Thickening

(1) IMT is a double-line pattern visualized by echotomography on both walls of the common carotid arteries in a longitudinal view.
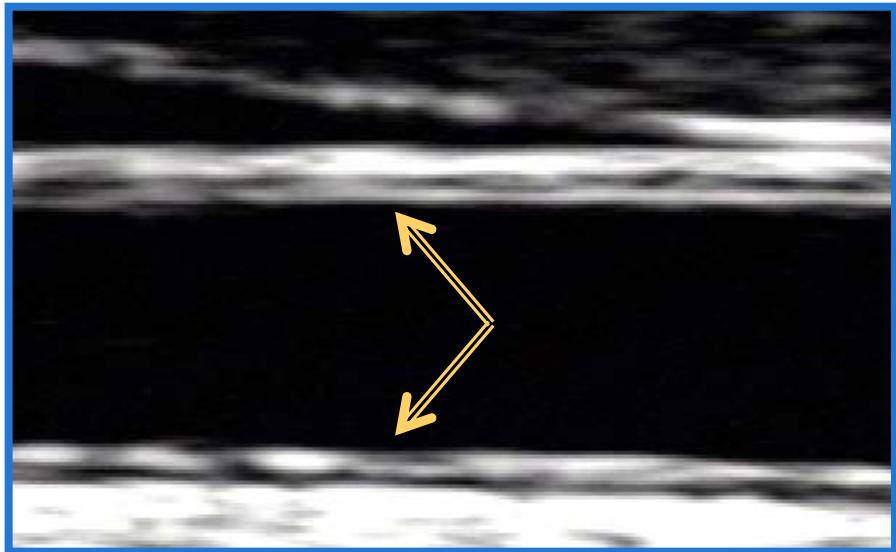
Plaque

(2) Plaque is a focal structure encroaching into the arterial lumen of at least 0.5 mm or 50% of the surrounding IMT value or demonstrates a thickness of at least 1.5 mm as measured from the media-adventitia interface to the intima-lumen interface.

P. Pignoli Circulation 1986
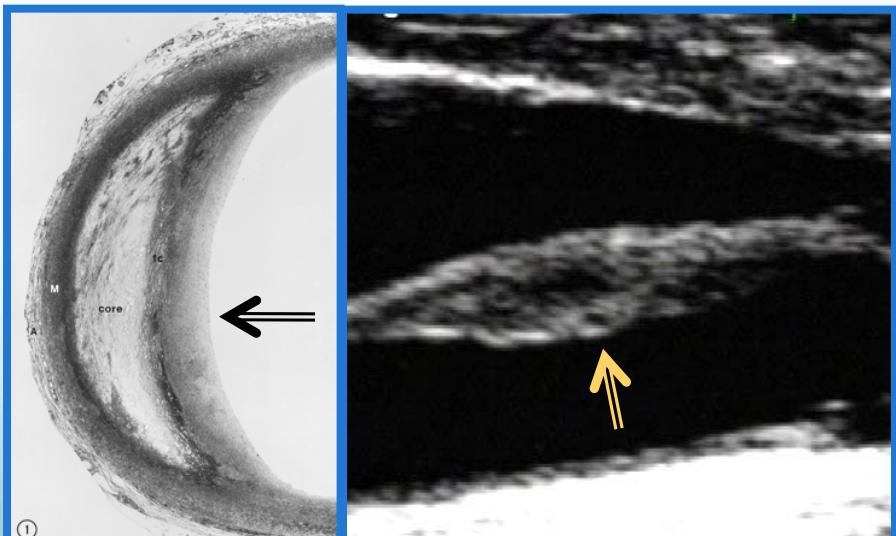
IMT and Plaque : EVA Study

CCAIMT predicts Carotid Plaque Occurrence

C Bonithon Kopp P-J Touboul ATVB 1996
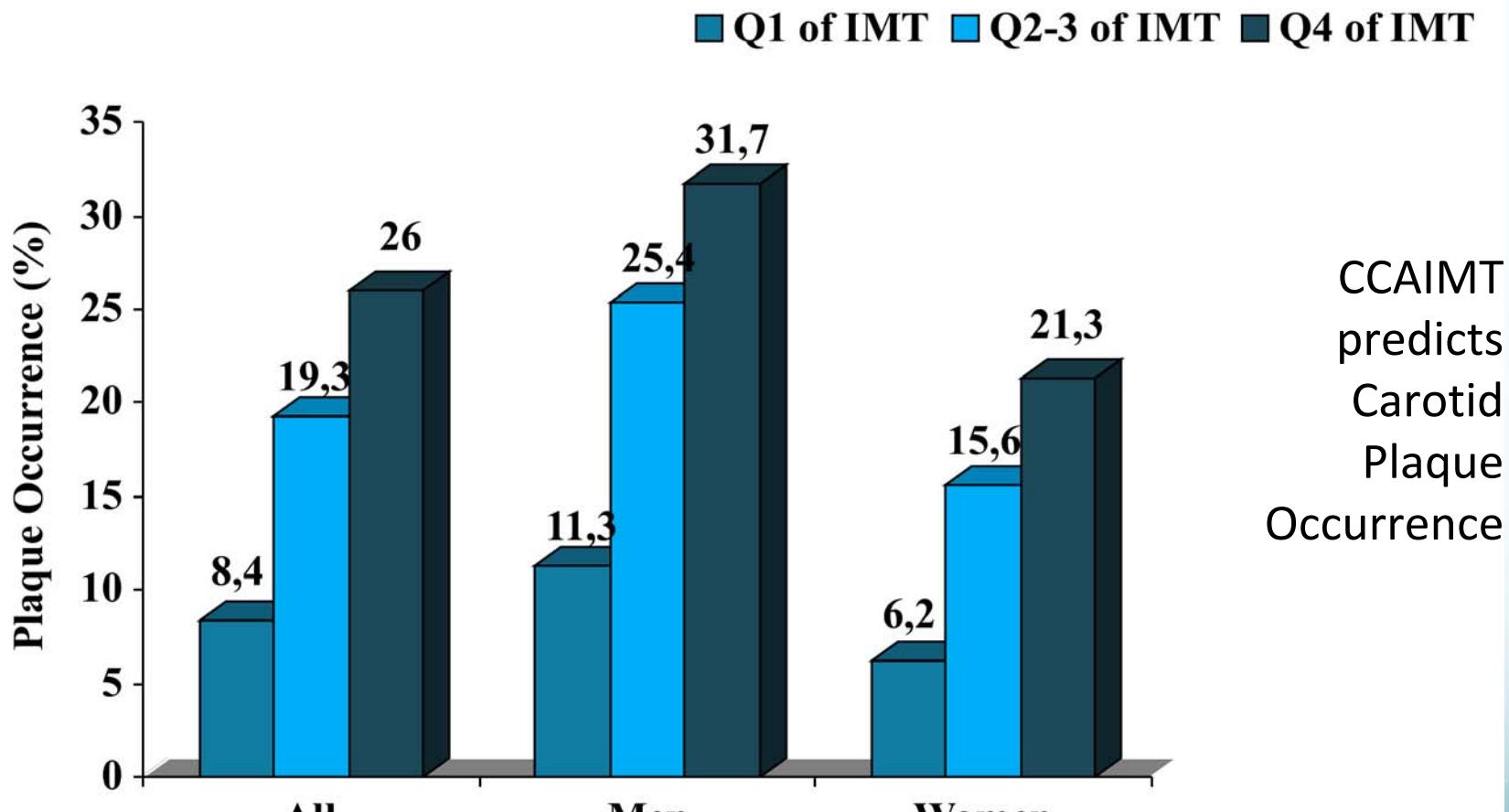
Current Risk estimation

- Based on RF in NCEP-ATPIII :
  - Hypertension (BP> 140/90 mmHg or treated).
  - Low HDL (<40mg/dl)
  - Age (men > 45 y ; women > 55 y)
  - Family history of premature CHD (1st degree relative in male <55y , in female <65y female).
  - < 2RF : low risk
  - ≥ 2RF : estimate 10y FRS
    - 5 to 10% : low risk
    - 5%to 20% or10% to 20% : intermediate risk
    - > 20% : high risk)

Current risk stratification limits

- Can miss individuals

- Does not take into account lifetime risk

- Does not address the physician need

Prevalence of Conventional risk factors in CHD patients N=87869

RF Prevalence

9% 1% 19,4

28%

43%

- RF =0
- RF=1
- RF=2
- RF=3
- RF=4
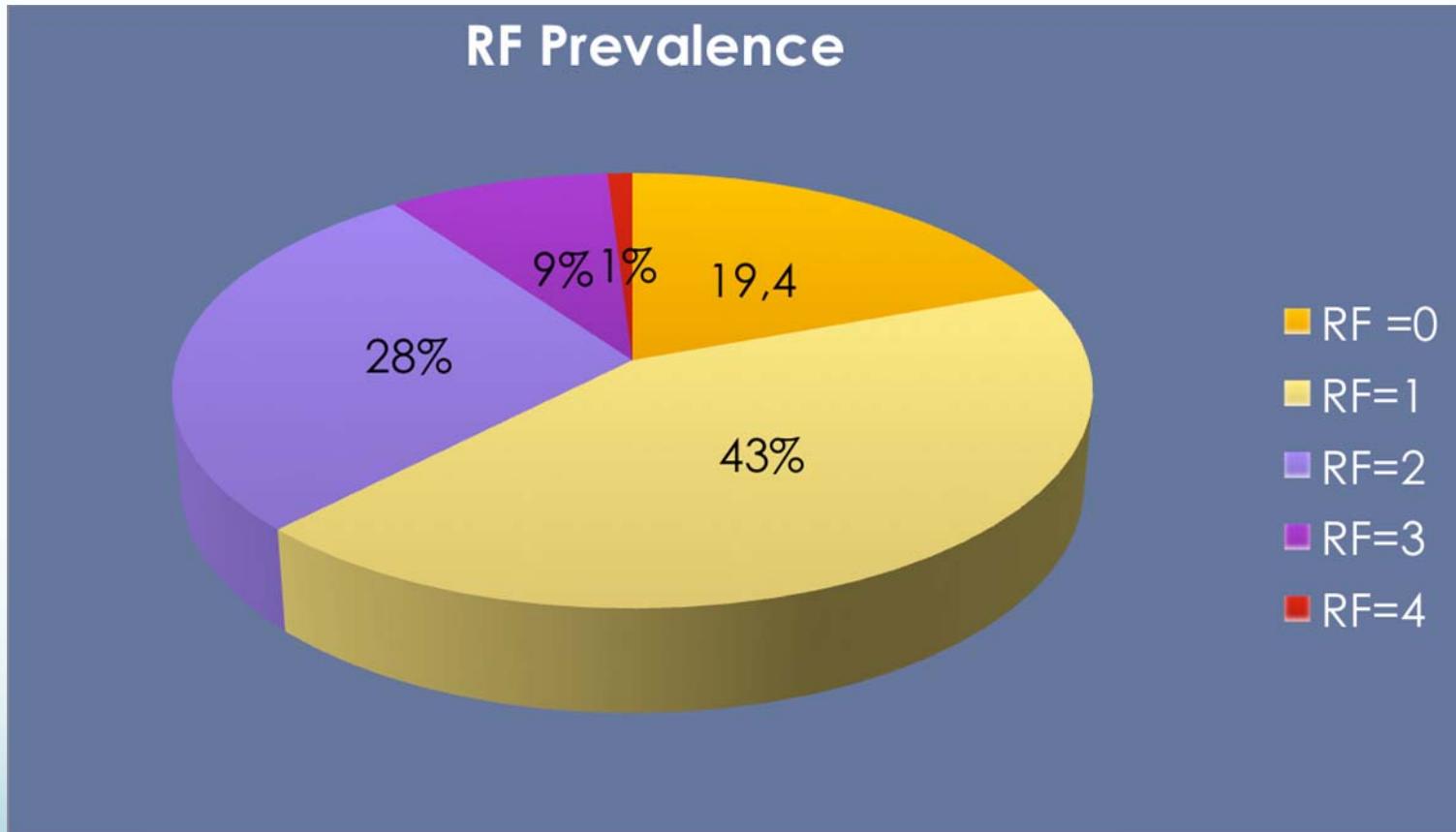
62,4 % have 0 or 1 RF

Khot U et al JAMA 2003;290:898-904

IMT & Plaque

- ARIC study, included 13,145 individuals followed for approximately 15 years for incident hard coronary events and revascularization.

- Carotid IMT measurements, which included both IMT and carotid plaque, were incremental to traditional risk factors for prediction of incident cardiovascular events.

- In particular, among intermediate-risk patients (10% to 20%, 10-year estimated risk group),

- Addition of carotid IMT and plaque information led to clinical net reclassification improvement of approximately 9.9%

Nambi V, Chambless L, Folsom A, et al. Carotid intima-media thickness and the presence or absence of plaque improves predictionof coronary heart disease risk in the Atherosclerosis Risk in Communities (ARIC) study. J Am Coll Cardiol 2010;55:1600 –7.

CHD incidence rate adjusted by CIMT categories with and without plaque
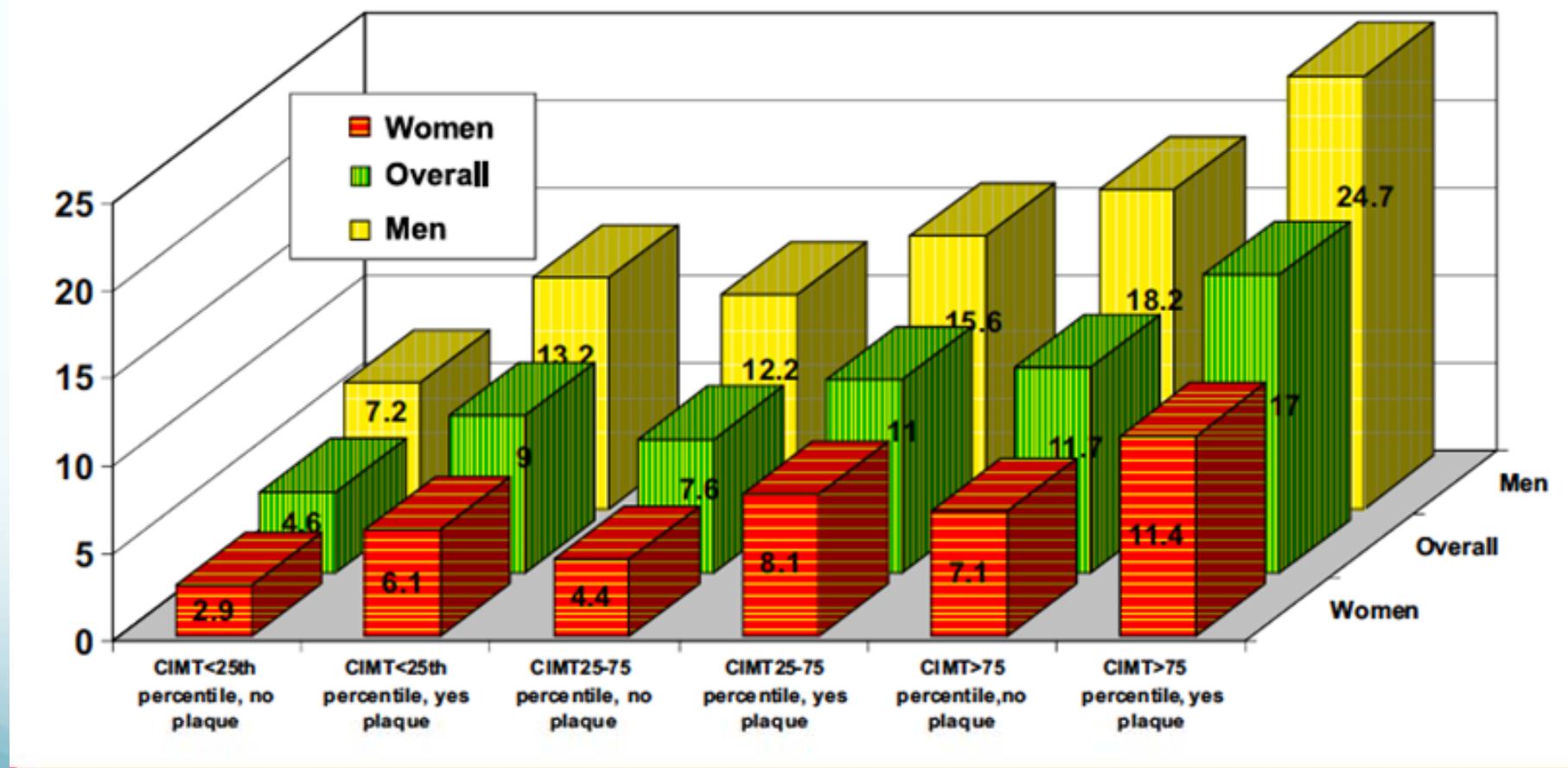
Nambi V, Chambless L, Folsom A, et al. Carotid intima-media thickness and the presence or absence of plaque improves predictionof coronary heart disease risk in the Atherosclerosis Risk in Communities (ARIC) study. J Am Coll Cardiol 2010;55:1600 –7.

IMT and Plaque

- IMT predicts plaque occurrence

- Higher is better : Plaque overcome IMT risk

IMT Acquisition

Recommendation	Explanation
Black and White Mode :	Color Flow decrease accuracy
CCA and Bifurcation :	Localize Bifurcation
Right & Left :	Both Carotid are required
CCA Plaque :	Avoid plaque if possible
Diastole :	Using cine loop or video
Straight segment :	Avoid loop or curvature
Multi angle procedure ? :	Time consuming - No proofs-

Mannheim Consensus 2011

IMT Measure

Recommendation	Explanation
Far Wall :	Better seen , validated
Situation 5mm below CB :	Avoid Remodeling
Region Free of plaque , loop , curvature : <> IMT, remodeling	
10mm :	Decrease standard error and deviation
Both Side :	IMT is asymetric (L > R)
QI > or = to 0.5 :	Increases accuracy
Mean of Right and Left :	Reference values

Mannheim Consensus 2011

IMT Acquisition and Measure
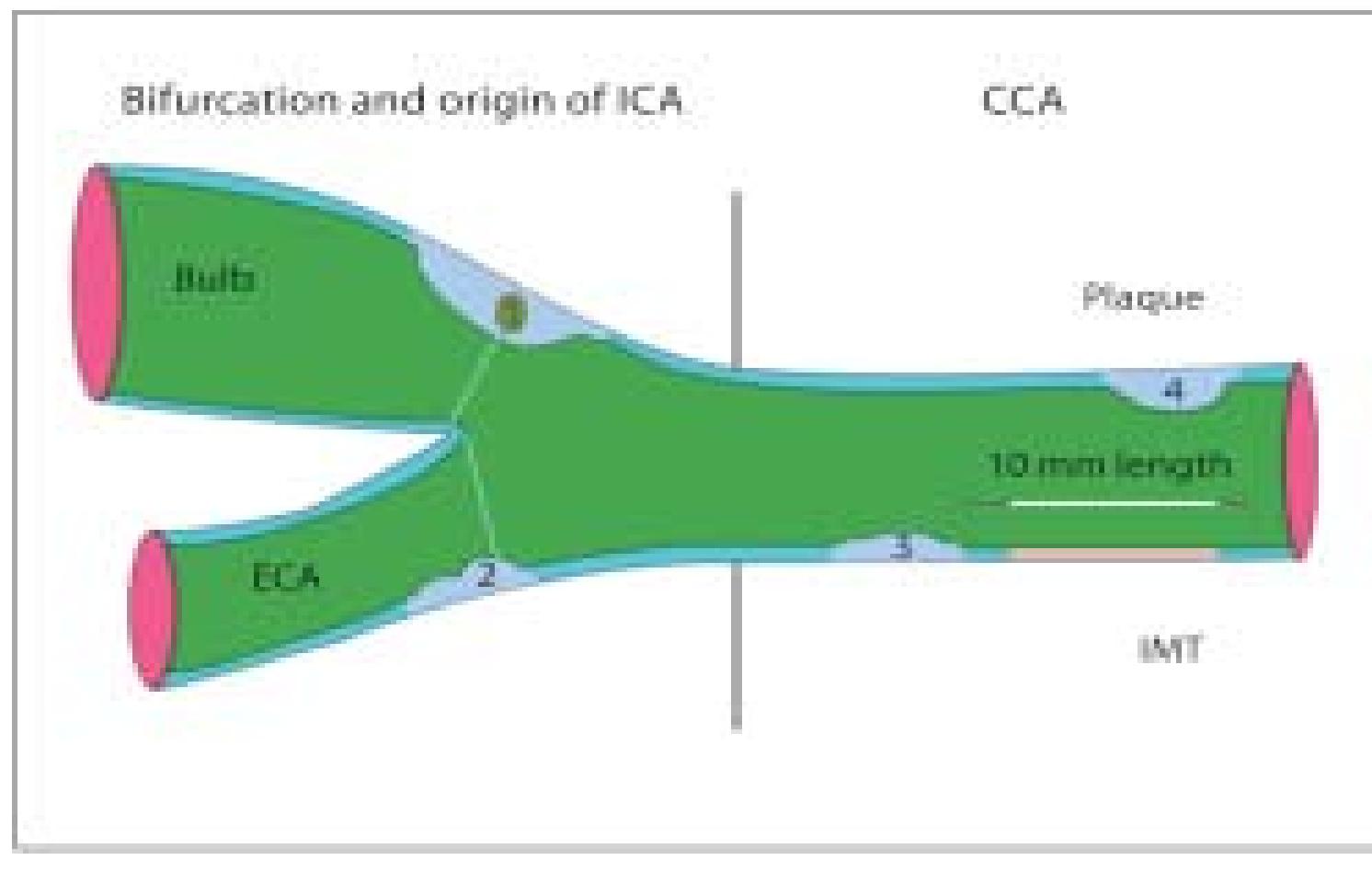
Plaque Evaluation

Recommendation		Explanation
CFDI	:	Color Flow increase accuracy
Longitudinal/CS	:	Better Localisation
Incidence with MaxT	:	Angle dependence
Thickness , Area , Structure	:	FU , Risk evaluation

Mannheim Consensus 2011

Whom to assess

- Symptomatic patients aged 40–70 years, at intermediate CVD risk (,6%–20% 10-year risk according to NCEP ATP III

- Family history of premature CVD in a first-degree relative;

- Indidivuals with one or more atherosclerosis risk factors to evaluate arterial consequences of their exposure to risk factors

Mannheim Consensus 2011

Reference Values

- In addition to regular patient 's information and général neuro vascular examination protocol , it is essentiel to :

    - Provide the number ,and already described characteristics of plaques,

    - Provide the mean IMT based on the average of both sides

    - Provide the age sex and ethnicity related reference value , aiming at evaluating the level of cardio vascular risk

Men

Age, y	30-39 (n=69)	40-49 (n=102)	50-59 (n=135)	60-69 (n=93)	70-79 (n=82)
P05	0.464	0.528	0.549	0.569	0.627
P10	0.519	0.560	0.585	0.618	0.647
P25	0.574	0.586	0.637	0.663	0.743
P50	0.616	0.653	0.701	0.738	0.798
P75	0.672	0.705	0.787	0.842	0.907
P90	0.749	0.756	0.836	0.909	0.955
P95	0.772	0.802	0.914	1.030	0.984

TABLE 2. Percentiles of Mean CCA-IMT Measurements by Decades and Gender in Subjects Without Modifiable Cardiovascular Risk Factors
P05, P10, P25, P50, P75, P90, P95 : 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles

Women

Age, y	30-39 (n=78)	40-49 (n=139)	50-59 (n=153)	60-69 (n=120)	70-79 (n=79)
P05	0.467	0.514	0.553	0.575	0.608
P10	0.492	0.539	0.586	0.612	0.658
P25	0.537	0.576	0.619	0.665	0.710
P50	0.588	0.640	0.669	0.752	0.758
P75	0.635	0.691	0.737	0.817	0.841
P90	0.670	0.726	0.789	0.865	0.882
P95	0.687	0.745	0.828	0.906	0.950

TABLE 2. Percentiles of Mean CCA-IMT Measurements by Decades and Gender in Subjects Without Modifiable Cardiovascular Risk Factors
P05, P10, P25, P50, P75, P90, P95 : 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles

Reference Values US

		Black women			Black men			White women			White men		
		45 y	55 y	65 y	45 y	55 y	65 y	45 y	55 y	65 y	45 y	55 y	65 y
LCCA	OLS	0.58	0.67	0.75	0.64	0.73	0.86	0.55	0.64	0.73	0.62	0.71	0.80
	P05	0.40	0.45	0.50	0.43	0.48	0.53	0.39	0.43	0.47	0.42	0.46	0.51
	P10	0.43	0.49	0.54	0.46	0.53	0.59	0.42	0.48	0.53	0.46	0.51	0.56
	P25	0.49	0.56	0.62	0.53	0.61	0.69	0.47	0.54	0.61	0.52	0.59	0.65
	P50	0.56	0.65	0.72	0.62	0.71	0.82	0.54	0.62	0.71	0.60	0.68	0.77
	P75	0.64	0.75	0.85	0.72	0.83	0.99	0.61	0.71	0.81	0.70	0.80	0.93
	P90	0.73	0.87	1.00	0.83	0.96	1.22	0.68	0.82	0.94	0.80	0.91	1.11
	P95	0.81	0.96	1.12	0.90	1.07	1.43	0.72	0.91	1.04	0.89	1.00	1.30
RCCA	OLS	0.59	0.69	0.76	0.63	0.74	0.87	0.55	0.64	0.72	0.59	0.68	0.79
	P05	0.40	0.47	0.53	0.42	0.47	0.60	0.38	0.45	0.47	0.40	0.45	0.50
	P10	0.44	0.51	0.56	0.46	0.53	0.64	0.41	0.48	0.52	0.44	0.49	0.56
	P25	0.51	0.59	0.63	0.52	0.61	0.72	0.47	0.55	0.60	0.50	0.57	0.65
	P50	0.58	0.68	0.74	0.61	0.72	0.85	0.53	0.62	0.69	0.57	0.66	0.76
	P75	0.65	0.78	0.85	0.71	0.84	1.01	0.61	0.71	0.81	0.66	0.77	0.90
	P90	0.72	0.91	0.97	0.81	0.96	1.18	0.68	0.81	0.93	0.75	0.88	1.07
	P95	0.77	1.03	1.06	0.89	1.05	1.30	0.73	0.88	1.03	0.83	0.96	1.25

Reference Values: Bogalusa Study

TABLE 1 Mean (± SD) of Intima-media Thickness (IMT) of Different Carotid Artery Segments in Young Adults by Race and Gender					Comparison*	
IMT Site	White Male	White Female	Black Male	Black Female	Race	Gender
Common carotid[†]	0.67 ± 0.09 (n – 137)	0.65 ± 0.08 (n – 220)	0.71 ± 0.09 (n – 60)	0.69 ± 0.09 (n – 87)	0.001	0.05
Carotid bulb[†]	0.89 ± 0.17 (n – 122)	0.81 ± 0.14 (n – 201)	0.89 ± 0.18 (n – 55)	0.89 ± 0.16 (n – 79)	0.001[‡]	0.001[§]
Internal carotid[†]	0.70 ± 0.12 (n – 116)	0.66 ± 0.14 (n – 180)	0.71 ± 0.13 (n – 52)	0.69 ± 0.11 (n – 77)	NS	0.05

*Adjusted for age; [†]average of 6 far wall measurements (3 right and 3 left) per subject.
[‡]Among women only; [§]among whites only.

Mean age : 32
Caucasien : 378
Black Americans : 150

CARMELA Normal Values
7 countries of Latin America

		Venezuela	Colombia	Argentina	Peru	Mexico	Equateur	Chili
	Overall (n = 3,071)	Barquisimeto (n = 565)	Bogotá (n = 414)	Buenos Aires (n = 287)	Lima (n = 585)	Mexico City (n = 498)	Quito (n = 411)	Santiago (n = 311)
Men								
25–34	0.601 (0.594–0.608)	0.550 (0.537–0.563)	0.564 (0.552–0.576)	0.691 (0.674–0.709)	0.571 (0.560–0.582)	0.671 (0.661–0.681)	0.648 (0.631–0.665)	0.522 (0.507–0.538)
35–44	0.631 (0.623–0.640)	0.576 (0.558–0.594)	0.585 (0.570–0.600)	0.703 (0.678–0.727)	0.614 (0.598–0.629)	0.680 (0.669–0.690)	0.693 (0.671–0.714)	0.592 (0.567–0.616)
45–54	0.671 (0.661–0.680)	0.613 (0.593–0.633)	0.653 (0.630–0.677)	0.760 (0.725–0.795)	0.647 (0.630–0.663)	0.711 (0.693–0.729)	0.711 (0.686–0.736)	0.631 (0.597–0.665)
55–64	0.719 (0.705–0.732)	0.649 (0.620–0.677)	0.717 (0.679–0.756)	0.780 (0.738–0.823)	0.685 (0.659–0.710)	0.728 (0.700–0.752)	0.824 (0.789–0.858)	0.672 (0.642–0.701)
Women								
25–34	0.591 (0.586–0.596)	0.549 (0.539–0.558)	0.547 (0.538–0.557)	0.668 (0.657–0.680)	0.571 (0.564–0.578)	0.671 (0.665–0.678)	0.617 (0.606–0.629)	0.515 (0.506–0.523)
35–44	0.612 (0.606–0.618)	0.567 (0.556–0.578)	0.573 (0.560–0.585)	0.701 (0.686–0.716)	0.601 (0.589–0.613)	0.678 (0.669–0.687)	0.654 (0.636–0.672)	0.567 (0.555–0.579)
45–54	0.665 (0.656–0.674)	0.603 (0.589–0.616)	0.651 (0.629–0.674)	0.739 (0.716–0.762)	0.651 (0.635–0.667)	0.689 (0.677–0.702)	0.731 (0.712–0.750)	0.593 (0.567–0.620)
55–64	0.706 (0.694–0.717)	0.667 (0.644–0.690)	0.666 (0.641–0.692)	0.786 (0.744–0.827)	0.685 (0.659–0.712)	0.714 (0.692–0.736)	0.774 (0.745–0.802)	0.661 (0.630–0.692)

Figures in parentheses are 95% CI.

Pierre-Jean Touboul & al on behalf of the CARMELA Study Investigators:Common Carotid Artery Intima-Media Thickness:The Cardiovascular Risk Factor Multiple Evaluationin Latin America (CARMELA) Study Results Cerebrovasc Dis 2011;31:43–50

Reference Values US : ARIC Study

		Black women			Black men			White women			White men		
		45 y	55 y	65 y	45 y	55 y	65 y	45 y	55 y	65 y	45 y	55 y	65 y
LCCA	OLS	0.58	0.67	0.75	0.64	0.73	0.86	0.55	0.64	0.73	0.62	0.71	0.80
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	P25	0.49	0.56	0.62	0.53	0.61	0.69	0.47	0.54	0.61	0.52	0.59	0.65
	P50	0.56	0.65	0.72	0.62	0.71	0.82	0.54	0.62	0.71	0.60	0.68	0.77
	P75	0.64	0.75	0.85	0.72	0.83	0.99	0.61	0.71	0.81	0.70	0.80	0.93
	P90	0.73	0.87	1.00	0.83	0.96	1.22	0.68	0.82	0.94	0.80	0.91	1.11
	P95	0.81	0.96	1.12	0.90	1.07	1.43	0.72	0.91	1.04	0.89	1.00	1.30
RCCA	OLS	0.59	0.69	0.76	0.63	0.74	0.87	0.55	0.64	0.72	0.59	0.68	0.79
	P05	0.40	0.47	0.53	0.42	0.47	0.60	0.38	0.45	0.47	0.40	0.45	0.50
	P10	0.44	0.51	0.56	0.46	0.53	0.64	0.41	0.48	0.52	0.44	0.49	0.56
	P25	0.51	0.59	0.63	0.52	0.61	0.72	0.47	0.55	0.60	0.50	0.57	0.65
	P50	0.58	0.68	0.74	0.61	0.72	0.85	0.53	0.62	0.69	0.57	0.66	0.76
	P75	0.65	0.78	0.85	0.71	0.84	1.01	0.61	0.71	0.81	0.66	0.77	0.90
	P90	0.72	0.91	0.97	0.81	0.96	1.18	0.68	0.81	0.93	0.75	0.88	1.07
	P95	0.77	1.03	1.06	0.89	1.05	1.30	0.73	0.88	1.03	0.83	0.96	1.25

IMT Plaque Report

What should include a complete report :

- Patient 's information and general neuro vascular examination protocol , it is essentiel to :
- Provide the number ,and already described characteristics of plaques,
- Provide the mean IMT based on the average of both sides
- Provide the age sex and ethnicity related reference value , aiming at evaluating the level of cardio vascular risk

Finally IMT

- Add to classic CV evaluation

- Is less powerfull than plaque for CV risk evalutaion

- Predicts plaque occurrence

- Screening tool for asymptomatic people at intermediate CV Risk

- Needs harmonized acquisition and measure