

AEROSPACE CARDIOLOGY · SLIDES 21-29

Cardiovascular Risk Assessment in Commercial Aviation

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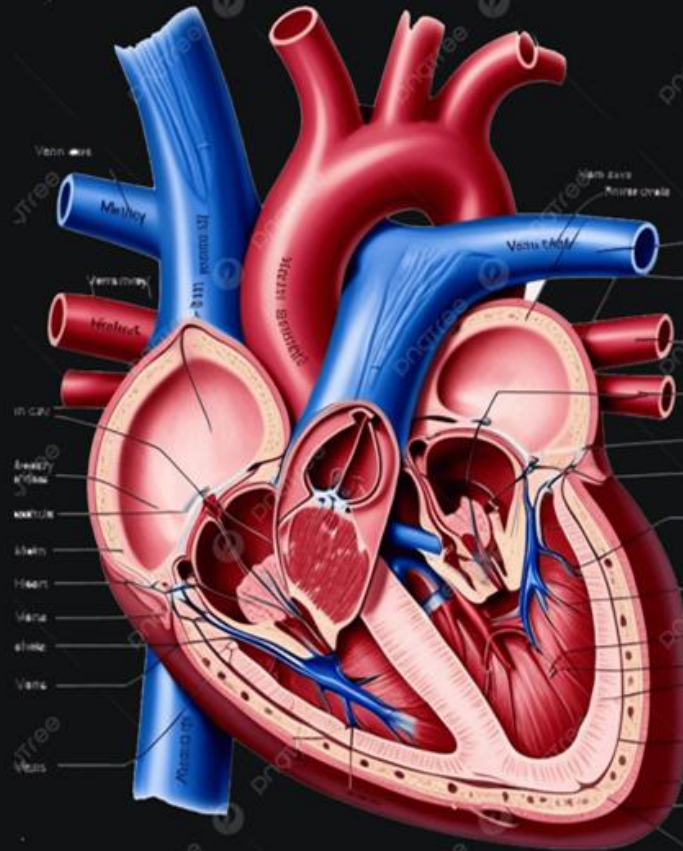
How established cardiovascular prevention principles are applied when the patient is responsible for hundreds of passengers. Designed for cardiologists, Aviation Medical Examiners (AMEs), aerospace medicine specialists, and civil aviation regulators.



Cardiovascular Disease: Risk Factors & Risk Assessment

A clinical framework for understanding, quantifying, and modifying cardiovascular risk — from pathophysiology to prevention.

CARDIOLOGY · INTERNAL MEDICINE · PREVENTIVE CARDIOLOGY



Why Cardiovascular Risk Matters

17.9M

Deaths Per Year

CVD is the world's leading cause of death — 1 in 3 globally

80%

Preventable

Of premature CVD deaths are attributable to modifiable risk factors

45

Years of Life Lost

Average years lost to premature cardiovascular mortality

- ❑ **Clinical imperative:** Atherosclerosis develops silently for **decades** before symptoms appear. Prevention must begin before disease manifests.



From Misconception to Evidence: The Framingham Revolution

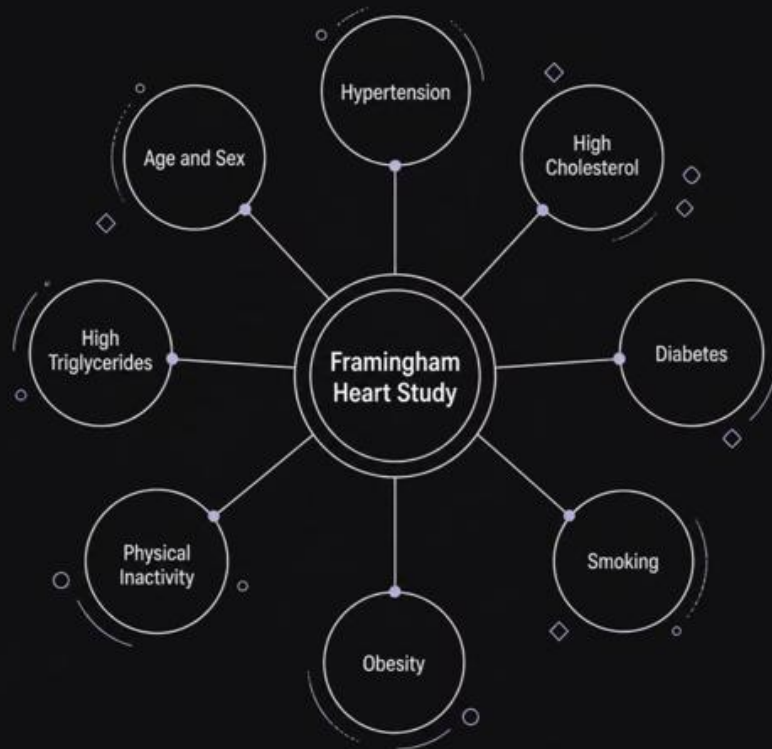


Before Framingham (1948)

- High blood pressure = "normal" aging
- Systolic pressure considered harmless
- Cholesterol viewed as clinically irrelevant
- Smoking underappreciated as a cardiac risk

The Study That Changed Everything

Launched in 1948, Framingham followed 5,209 adults prospectively — establishing the **multifactorial risk model** and proving CVD is predictable and preventable.



The Mathematics Behind Cardiovascular Risk



Cardiovascular Risk = Probability of Event × Severity of Outcome

Probability of Event

- Age · Sex · Blood Pressure
- LDL / Non-HDL · HDL
- Smoking · Diabetes · Obesity
- Physical Activity · Family History · Genetics

↓ Risk Calculator → Estimated Probability

Severity of Outcome

- Myocardial Infarction
- Stroke
- Heart Failure
- Cardiovascular Death

↓ Clinical Impact



Risk calculators estimate probability — not certainty.

How are cardiovascular risk scores calculated?

Why isn't LDL always directly included in every risk calculator?

Which risk calculator performs best in different populations?

Major Cardiovascular Risk Scores



Framingham Risk Score

Age · Sex · Smoking · BP · Total Cholesterol · HDL



Thai CV Risk Score

Age · Sex · Smoking · BP · Total Cholesterol · Diabetes



ACC/AHA Pooled Cohort Equation

Age · Sex · Race · SBP · Treatment · Diabetes · Smoking · HDL · Total Cholesterol

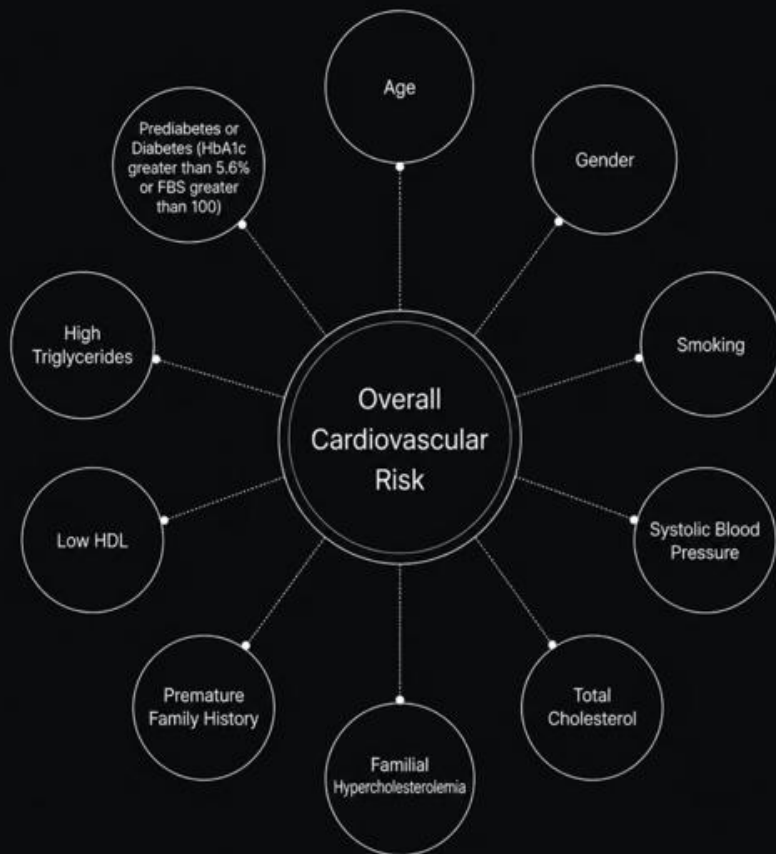


PROCAM Score

Age · LDL · HDL · Triglycerides · Smoking · Family History

Score	Population	Horizon	Outcome	Strength	Limitation
Framingham	US general	10-yr	CHD	Validated	Underestimates non-white risk
PCE	US multi-ethnic	10-yr	ASCVD	Race-specific	Overestimates in some cohorts
Thai CV	Thai	10-yr	CVD	Region-specific	Limited external validation
PROCAM	European	10-yr	CHD	LDL-focused	Less applicable globally

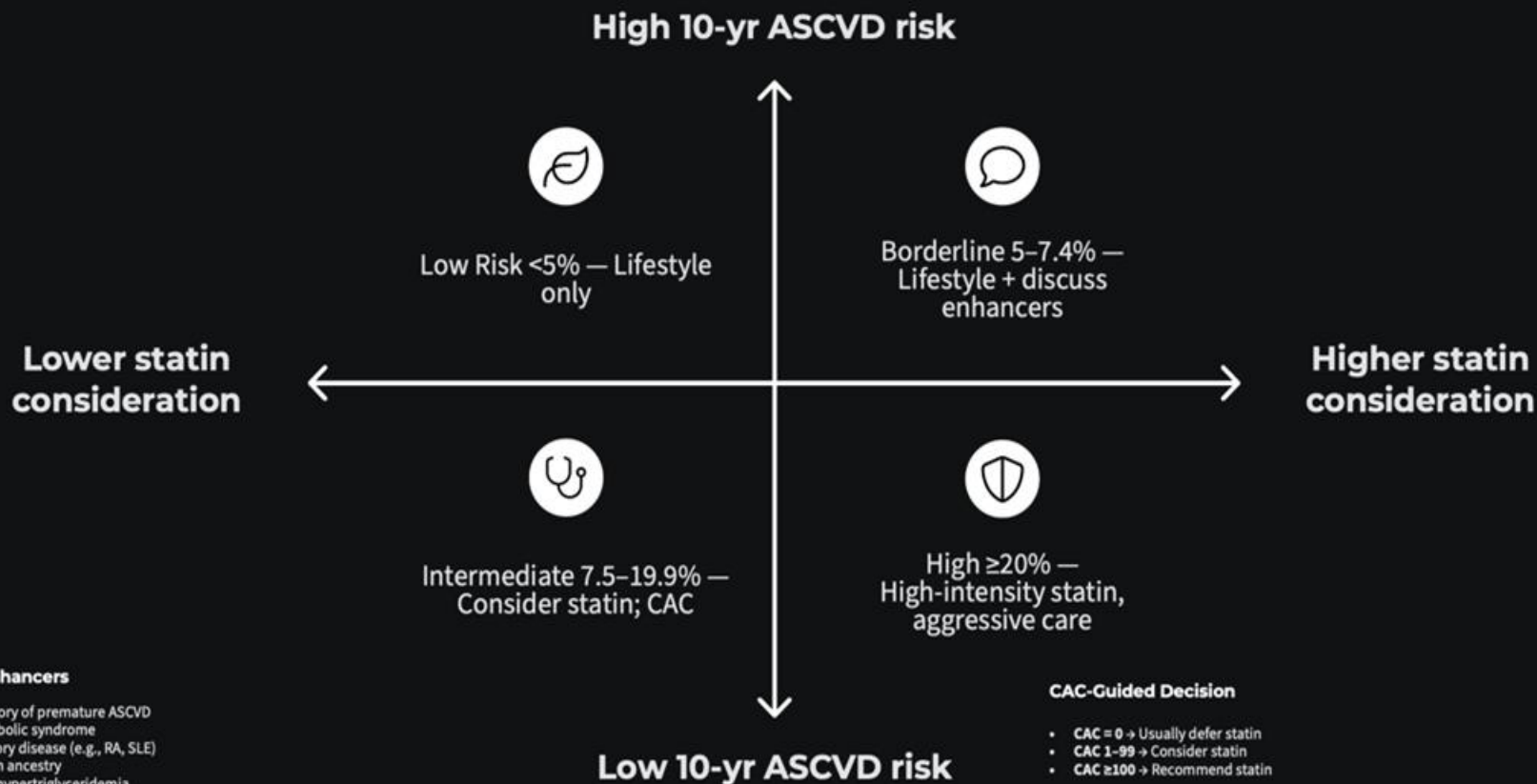
Bangkok Hospital Cardiovascular Risk Score



Ten Integrated Risk Factors

- Age · Gender
- Smoking status
- Systolic Blood Pressure
- Total Cholesterol
- Familial Hypercholesterolemia
- Premature Family History
- Low HDL · High Triglycerides
- Prediabetes / Diabetes (HbA1c >5.6% or FBS >100 mg/dL)

Primary Prevention: Assess ASCVD Risk and Guide Therapy



Non-Modifiable Risk Factors

These factors cannot be changed — but identifying them **stratifies baseline risk** and determines screening intensity and treatment thresholds.



Age

Risk doubles each decade after 45. Cumulative arterial exposure drives atherogenesis.



Ethnicity

South Asian, Black, and Indigenous populations carry elevated risk from genetic and socioeconomic factors.



Sex

Men develop CVD earlier; women's risk accelerates post-menopause as estrogen declines.



Family History & Genetics

First-degree relative with premature CVD (men <55, women <65) doubles risk. Polygenic scores refine stratification.

The Modifiable Risk Factor Landscape

These factors are **actionable targets** for prevention. Each contributes independently — and synergistically — to atherosclerotic burden.



Hypertension

RR 2× per 20/10 mmHg



Hyperlipidemia

LDL drives plaque formation



Diabetes

2–4× CVD risk equivalent



Smoking

2–4× MI risk; reversible



Obesity

Metabolic syndrome driver



Inactivity

Independent risk multiplier



Diet

Directly modifiable via nutrition



Alcohol

Dose-dependent harm



Stress

Chronic sympathetic activation

Modern Cardiovascular Risk Assessment



Step 1 — Calculate

Estimate 10-year ASCVD risk using validated calculators (PCE, Framingham, or population-specific scores).



Step 2 — Personalize

Integrate family history, risk enhancers, lifestyle factors, inflammatory disease, and ethnicity.



Step 3 — Reclassify

Use CAC scoring, imaging, biomarkers, or genetics to refine risk category and guide therapy.

Lifestyle

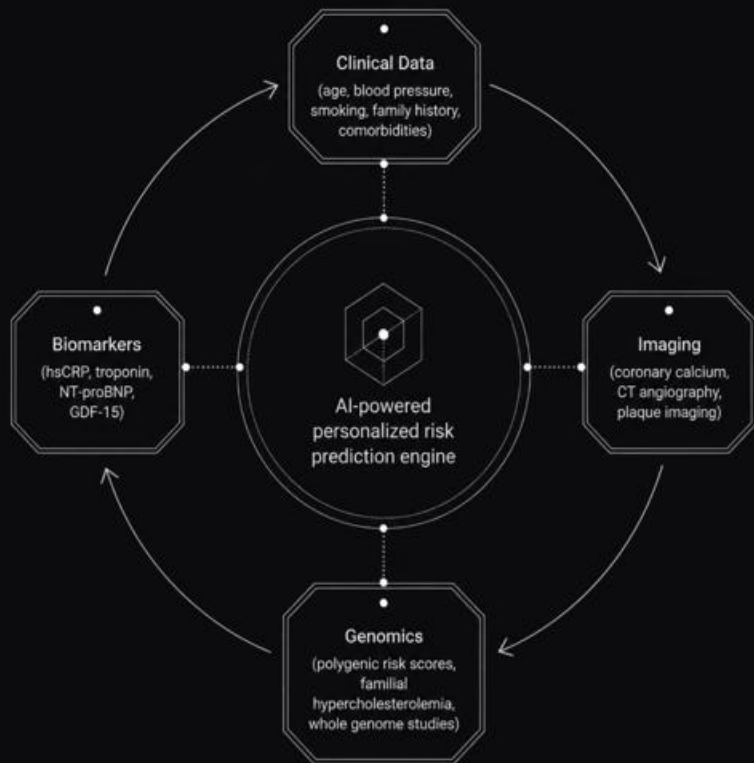
Statins

BP Control

Diabetes Mgmt

Follow-Up

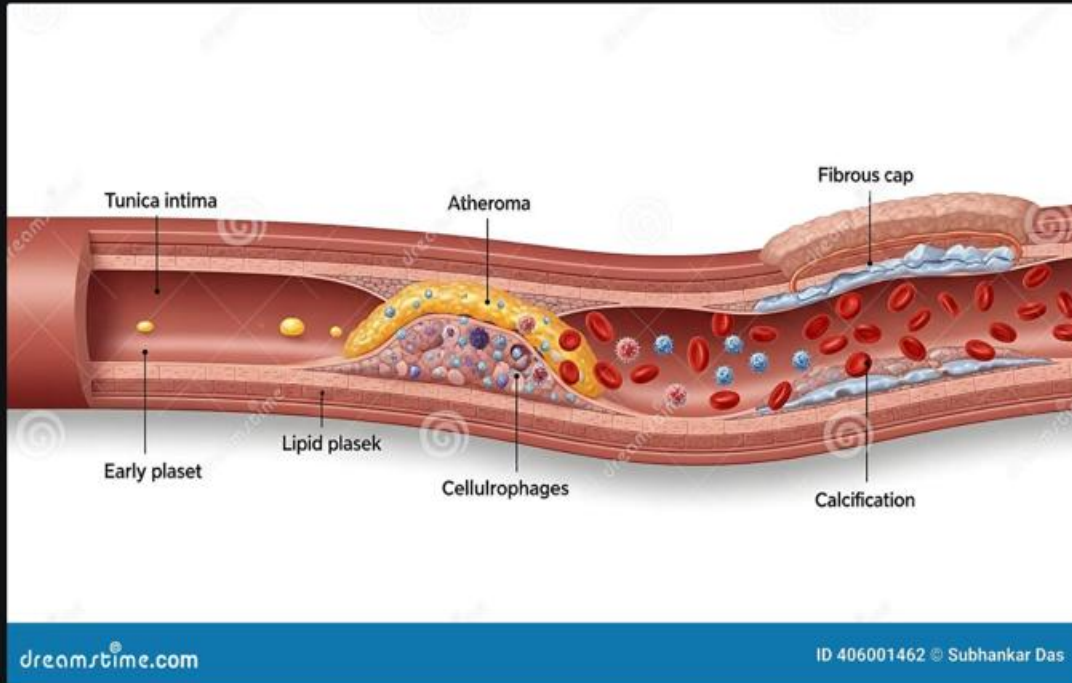
The Future of Cardiovascular Risk Prediction



Convergence Toward Precision Prevention

Integrating clinical data, advanced imaging, novel biomarkers, and genomics through AI enables individualized risk stratification beyond traditional population-based scores.

Hypertension: The Silent Killer



Historical Shift

Once dismissed as normal aging, Framingham proved BP is a **continuous, graded risk factor** — no safe threshold exists.

Key Evidence

- CVD risk **doubles** every 20/10 mmHg above 115/75
- Systolic pressure is a stronger predictor than diastolic
- JNC 7 → ACC/AHA 2017: target lowered to **<130/80**

Mechanism of Damage

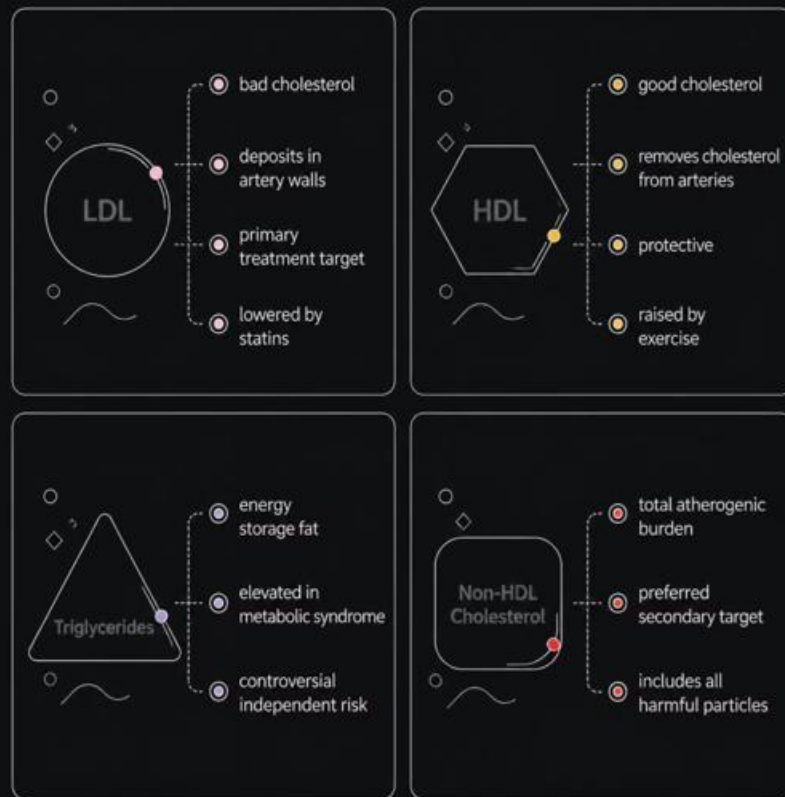
Chronic pressure injures endothelium, accelerates atherosclerosis, and drives LVH, CKD, and stroke.

Hyperlipidemia: The Lipid Cascade

Lipoprotein Roles in Atherosclerosis

- **LDL:** Primary atherogenic particle — deposits cholesterol in arterial walls, forming foam cells and plaque
- **HDL:** Reverse cholesterol transport — removes excess cholesterol; low levels increase risk
- **Triglycerides:** Independent risk marker; elevated in metabolic syndrome and diabetes
- **Non-HDL-C:** Captures all atherogenic particles; preferred secondary target

ACC/AHA Targets: Very high risk → LDL <55 mg/dL; High risk → <70 mg/dL. Statins remain first-line therapy.



Diabetes: A Cardiovascular Risk Equivalent



Why Diabetes Accelerates Atherosclerosis

Diabetes is a **CVD risk equivalent** — a diabetic without prior MI carries the same risk as a non-diabetic with prior MI.

HbA1c & Risk

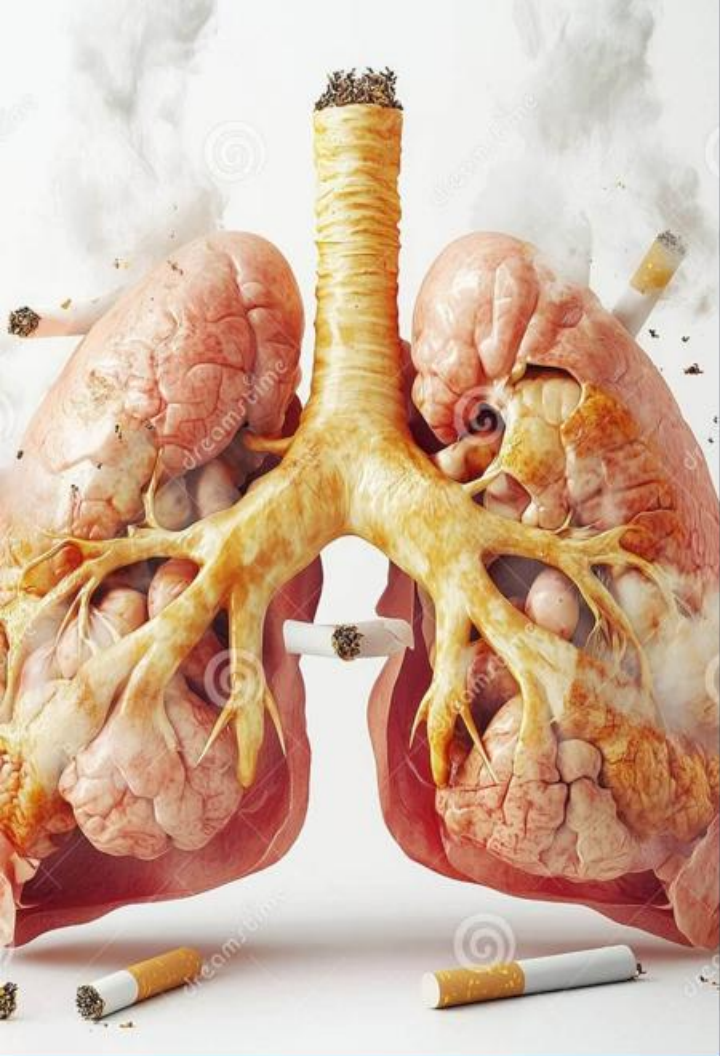
Each 1% rise in HbA1c increases CVD risk ~18%. Prediabetes already elevates risk.

Insulin Resistance

Drives endothelial dysfunction, chronic inflammation, and dyslipidemia — the metabolic triad.

Glycation & Inflammation

Advanced glycation end-products (AGEs) stiffen vessels and amplify oxidative stress.



DEEP DIVE

Smoking: The Most Preventable Cause of CVD

1

Endothelial Injury

Direct toxic damage to arterial lining — the initiating event in atherogenesis

2

Oxidative Stress

Free radicals oxidize LDL, accelerating plaque formation and instability

3

Thrombosis

Increases platelet aggregation and fibrinogen — promoting clot formation

4

Vasoconstriction

Reduces coronary blood flow and oxygen delivery to myocardium



Cessation benefit: CVD risk drops 50% within 1 year of quitting and approaches baseline within 15 years — one of medicine's highest-yield interventions.

Obesity, Risk Integration & Clinical Application

Obesity & Metabolic Syndrome

Visceral fat drives inflammation, insulin resistance, and dyslipidemia. BMI has limitations — waist circumference and body composition refine assessment.

The "**obesity paradox**" (better outcomes in established CVD) does not negate obesity's causal role in disease development.

Risk Assessment Tools

- **ACC/AHA Pooled Cohort Equations** — 10-year ASCVD risk
- **SCORE2** — European calibration
- **Coronary Artery Calcium (CAC)** — refines intermediate-risk decisions





THAILAND REPRESENTATIVE · ASIA-PACIFIC AVIATION MEDICINE CONFERENCE

Cardiovascular Risk Assessment in Commercial Pilots

Ensuring Flight Safety Through Evidence-Based Cardiovascular Screening

Presented in alignment with ICAO, CAAT, EASA, FAA, AsMA, ESC, and AHA standards

From Prevention to Operational Safety

"Traditional cardiovascular risk assessment aims to reduce long-term cardiovascular events. Aviation medicine has a different objective: preventing sudden pilot incapacitation during flight."

General Population

- Long-term event reduction
- Individual risk tolerance
- 10-year ASCVD threshold ~7.5%
- Shared decision-making
- Gradual treatment escalation

Commercial Pilot

- Sudden incapacitation prevention
- Public safety paramount
- Annual risk threshold <1%
- Regulatory standardization
- Zero tolerance for uncertainty

Cardiovascular Risk Factors Unique to Pilots

Occupational exposures modify cardiovascular risk beyond traditional calculators. The Thai CV Risk Score and ASCVD do not account for:

- Circadian disruption and chronic sleep deprivation
- Long-haul fatigue and autonomic dysregulation
- Chronic low-grade hypoxia at cabin altitude
- Psychosocial stress and decision fatigue
- Sedentary behavior and prolonged immobility
- Accelerated arterial aging in long-haul pilots



SLIDE 22

Why Cardiovascular Disease Matters in Aviation

13%

Medical Events

Cardiovascular causes of in-flight pilot incapacitation (FAA, 2022)

45

Mean Age

Average age at first cardiovascular certification event in commercial pilots

\$2.1B

Annual Cost

Estimated global economic impact of aviation medical disruptions (IATA)

3

Notable Incidents

Documented fatal accidents with cardiovascular incapacitation as primary cause (NTSB/ICAO)



Why Cardiovascular Disease Matters in Aviation

~20% of Pilot Medical Disqualifications

CVD is the leading cause of permanent medical grounding worldwide (FAA, EASA, 2023)

Sudden Incapacitation Risk

Even brief impairment in a multi-crew cockpit can trigger catastrophic operational failure

High Economic Cost

Pilot grounding, emergency diversions, and regulatory investigations carry substantial financial burden

Medical Certification Standards: A Global Comparison

Class 1 Medical — Initial cardiovascular assessment requirements by authority

Authority	ECG Frequency	Stress Test	BP Limit	Lipid Screen	Age Trigger
ICAO	At issuance	If indicated	Uncontrolled HTN	Recommended	≥40 yrs
FAA	Age ≥35, then q1–2yr	If indicated	No fixed limit	If indicated	≥35 yrs
EASA	At issuance, then q1–5yr	Age ≥40, q5yr	≤140/90 mmHg	Mandatory	≥40 yrs
CAAT	At issuance, then q1yr	If indicated	≤140/90 mmHg	Mandatory	≥40 yrs
CASA	At issuance, then q1–2yr	Age ≥40, q2yr	≤140/90 mmHg	Mandatory	≥40 yrs

Regulatory Framework: Global Standards

All require Class 1 Medical Certificate for commercial pilots, renewed every 6–12 months based on age and risk profile.

Authority	CAC Threshold	Stress Testing	ECG Frequency	CAG Revascularization
ICAO	≥15% (5-yr)	Every 5 yr after 40	Annual after 40	Individual review
FAA	≥10% (10-yr)	Every 2–5 yr after 40	Annual after 40	≥70% stenosis
EASA	SCORE2 ≥5%	Mandatory after 45	Annual after 40	≥50% stenosis
CAAT	Thai CV ≥10%	Per AME discretion	Annual after 40	Per AME discretion
CASA	≥15% (5-yr)	Every 3 yr after 45	Annual after 45	≥70% stenosis

Certification After Cardiovascular Disease

Grounding periods and return-to-flight criteria per FAA, EASA, and ICAO standards.

Condition	Grounding	Required Workup	Return-to-Flight Criteria
Hypertension	Until controlled	BP logs, ECG, echo	BP <140/90 mmHg; no end-organ damage
CAD / PCI	3–6 months	Stress test, CAG, LVEF	LVEF ≥50%; no ischemia; no angina
CABG	6–12 months	Stress test, CAG, LVEF	LVEF ≥50%; graft patency; no ischemia
Atrial Fibrillation	Until rate/rhythm controlled	Holter, echo, INR	Stable rhythm; no embolic events; anticoagulation acceptable
Valve Disease	Variable	Echo, stress echo	Mild disease only; no symptoms; normal LVEF
Heart Failure	Permanent (usually)	Echo, BNP, stress test	NYHA I only; LVEF ≥50%; no arrhythmia
Myocarditis	6–12 months	CMR, Holter, troponin	Normal LVEF; no arrhythmia; normalized biomarkers

Post-Intervention Aeromedical Certification

Evidence-based return-to-flight timelines following cardiovascular interventions

Condition / Procedure	Minimum Grounding	Re-evaluation Required	Certification Outlook
PCI (uncomplicated)	3–6 months	Exercise ECG, Echo, CCTA	Possible — Class 2 or restricted
CABG	6–12 months	Full functional assessment	Case-by-case; often restricted
MI (no revascularization)	6 months minimum	Stress imaging, LVEF $\geq 50\%$	Individualized; often Class 2
Valvular intervention	3–6 months	Echo, rhythm monitoring	Possible if no residual dysfunction
Heart transplant / VAD	Permanent	Not applicable	Unfit — Class 1 permanently

Prevention & Occupational Health Programs



Annual Cardiovascular Surveillance

Structured AME follow-up with risk score recalculation and lifestyle counseling



Fitness & Nutrition Programs

Airline-sponsored initiatives targeting physical activity, diet, and weight management



Fatigue Risk Management

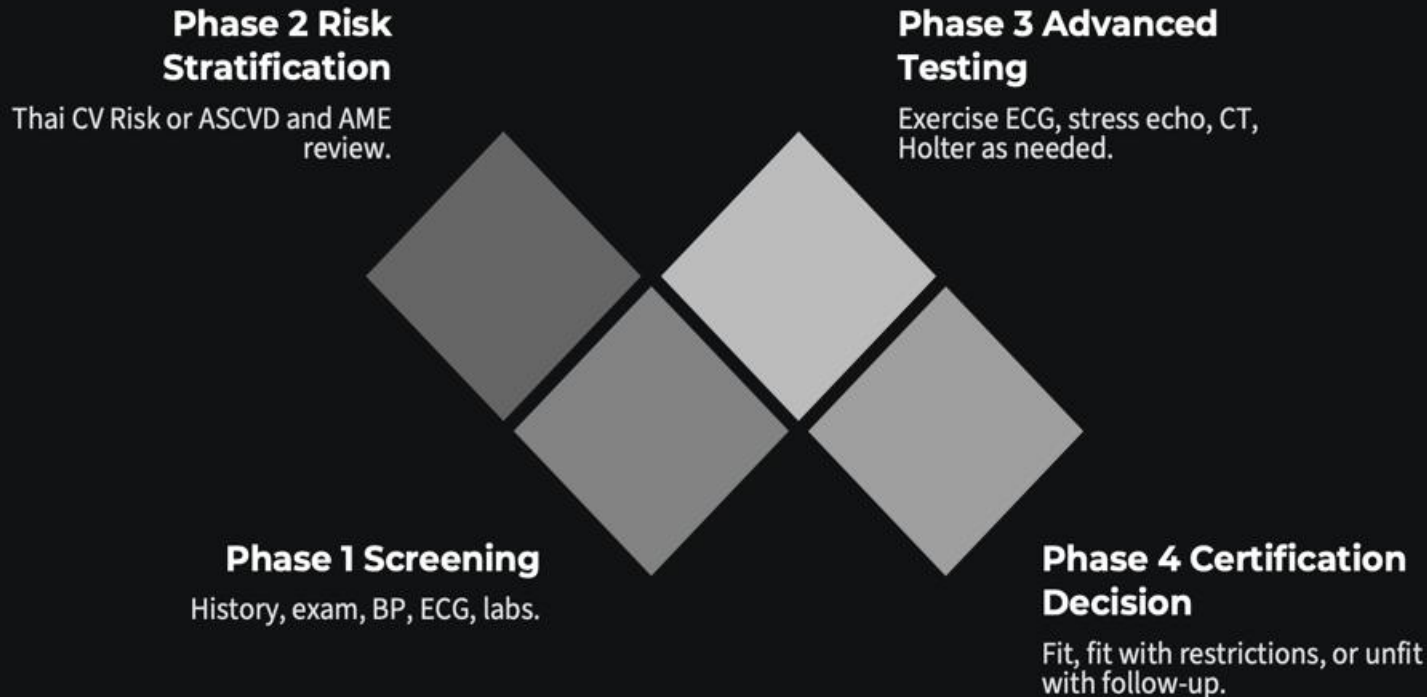
FRMS protocols addressing circadian disruption, sleep hygiene, and jet lag mitigation



Stress & Mental Health Support

Peer support, psychological screening, and confidential counseling resources

Cardiovascular Screening Pathway for Commercial Pilots



Beyond the Risk Calculator

Aviation medicine requires **anatomical** rather than statistical assessment. A pilot with a 5% 10-year risk may harbor vulnerable plaque.



Exercise ECG

Functional capacity ≥ 10 METs required; arrhythmia surveillance



Coronary CT Angiography

Plaque morphology, stenosis severity; preferred anatomical test (EASA)



Holter Monitoring

24–72 hr ambulatory ECG for arrhythmia detection



Stress Echocardiography

Wall motion abnormalities; ejection fraction under stress



Coronary Calcium Score

CAC ≥ 100 Agatston triggers further evaluation; CAC = 0 favorable



Cardiac MRI

Myocarditis, viability, cardiomyopathy characterization

Advanced Testing: When and How

Exercise ECG

First-line for intermediate-risk pilots; target ≥ 10 METs without ischemia (ACC/AHA 2023)

Coronary Artery Calcium (CAC)

CAC = 0 may support certification in borderline cases; CAC > 100 warrants cardiology referral

Coronary CT Angiography (CCTA)

Defines obstructive CAD anatomy; guides return-to-flight after abnormal stress testing

Echocardiography

Evaluates LV function, valvular disease, and cardiomyopathy; essential post-MI or post-PCI

Future of Aeromedical Cardiology

AI Risk Prediction

Machine learning models integrating ECG, imaging, and biomarkers for individualized risk stratification beyond traditional scores

Wearable ECG

Continuous in-flight rhythm monitoring; early arrhythmia detection; real-time data transmission to AME

Digital Biomarkers

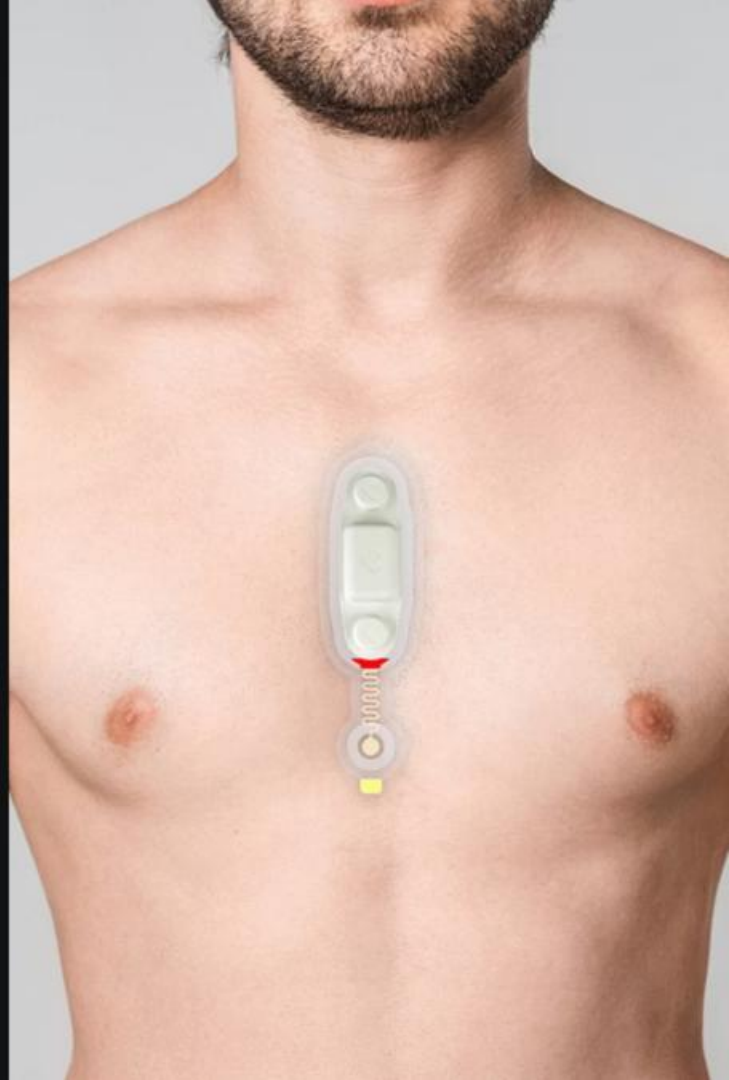
Heart rate variability, sleep architecture, and autonomic tone as early warning signals for cardiovascular decompensation

Remote Surveillance

Regulatory-approved telemedicine follow-up; reduced grounding intervals; personalized certification pathways



Key Limitation: No current regulatory framework (FAA, EASA, ICAO) formally accepts continuous monitoring data for certification decisions. Validation and standardization remain prerequisites.



SLIDE 28

Clinical Case Discussions

Case 1 — 55-Year-Old Captain

Hypertension on therapy; CAC score 180 Agatston; asymptomatic. Thai CV Risk 12%. **Discussion:** Does CAC alone warrant grounding? What additional testing is required?

Case 2 — 48-Year-Old First Officer

New-onset paroxysmal AF; $\text{CHA}_2\text{DS}_2\text{-VASc}$ = 1; started on DOAC. **Discussion:** Certification pathway? Anticoagulation compatibility with flight duties?

Case 3 — Pilot, 6 Months Post-PCI

RCA stent; LVEF 58%; negative stress echo; no angina. **Discussion:** Meets return-to-flight criteria? Additional surveillance required?

Rutgers - RWJMS Department of Medicine Grand Rounds

M&M (Morbidity and Mortality) Conference

Please join us on Zoom as

PGY2 IM Residents



Cherie Tan, MD



Scott Ventre, DO

Present a

"Morbidity, Mortality and Improvement Conference"

(All M&M cases are presented by residents or fellows)

Faculty Leader: Sugeet Jagpal, MD

June 12, 2020

12 noon to 1:00 pm

JOIN ZOOM MEETING

Details

<https://zoom.us/j/96263095855>

Meeting ID: 962 6309 5855

One tap mobile

+16465588556,,96263095855# US (New York)

Learning Objectives

After the conclusion of this activity, participants should be better able to:

- Dissect a clinical case and participate in a patient-centered discussion with the multidisciplinary care team
- Identify areas of improvement to prevent adverse events, mitigate systems errors, and augment medical knowledge

Intended Audience for series

This activity is designed for internal medicine physicians, general practitioners, family physicians, nurses, physicians' assistants and residents.

Creditation



In support of improving patient care, Rutgers Biomedical and Health Sciences is jointly accredited by the Accreditation Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialing Center (ANCC), to provide continuing education for the healthcare team.

Statement: Rutgers Biomedical and Health Sciences designates this live activity for a maximum of 1 AMA PRA Category 1 Credit™. Physicians should claim only the credit commensurate with the extent of their participation in the activity. **Nurses:** This activity is awarded 1 contact hour, (60-minute CE).

Disclosure

Tan, Ventre and Jagpal have no relevant financial relationships to disclose.

Speakers are required to disclose discussion of off-label/investigational uses of commercial products/devices in their presentation. These disclosures will be made to the audience at the time of the activity. Drs. Ranita Sharma, David Cohen, William Koets and Nora Cosgrove, RN (Content Reviewer) have no relevant financial relationships to disclose.

Special Considerations



Female Pilots

CVD risk rises post-menopause; hormonal factors require individualized assessment. Pregnancy mandates temporary grounding with structured return-to-flight protocols (FAA, EASA, CAAT).

Young Pilots

Screen for inherited conditions: hypertrophic cardiomyopathy, channelopathies, and familial hypercholesterolemia. Family history of sudden cardiac death is a critical red flag.

Aging Workforce

Enhanced surveillance beyond age 60; consider multimodality imaging and advanced risk stratification for extended-age operations.

Key Takeaways & Future Directions

→ **Standardize Screening Protocols**

Harmonize cardiovascular assessment across ICAO, FAA, EASA, and CAAT frameworks

→ **Strengthen Prevention Programs**

Implement airline-wide cardiovascular wellness, fatigue management, and occupational health initiatives

→ **Integrate Advanced Imaging**

Adopt CAC scoring and CCTA into evidence-based aeromedical decision pathways

→ **Expand Research & Collaboration**

Promote Asia-Pacific aerospace cardiology research, data sharing, and AME education

Cardiovascular Risk Assessment in Thailand

Current Practice, Evidence, Challenges and Future Directions

ESC · AHA · HEART ASSOCIATION OF THAILAND · APSC 2025

References: 1. Heart Association of Thailand. National CVD Prevention Guidelines. Bangkok: HAT; 2023. 2. Viswanath K, et al. Thai CV Risk Score: development and validation. Thai Heart J. 2022;35:112–24.

Why Cardiovascular Risk Matters

18M

CVD Deaths/Year

Leading global cause of mortality (WHO 2023)

7.4M

Asia-Pacific Deaths

40% of global CVD burden concentrated in the region

130K

Thailand Deaths/Year

CVD accounts for 28% of all Thai mortality

\$4.2B

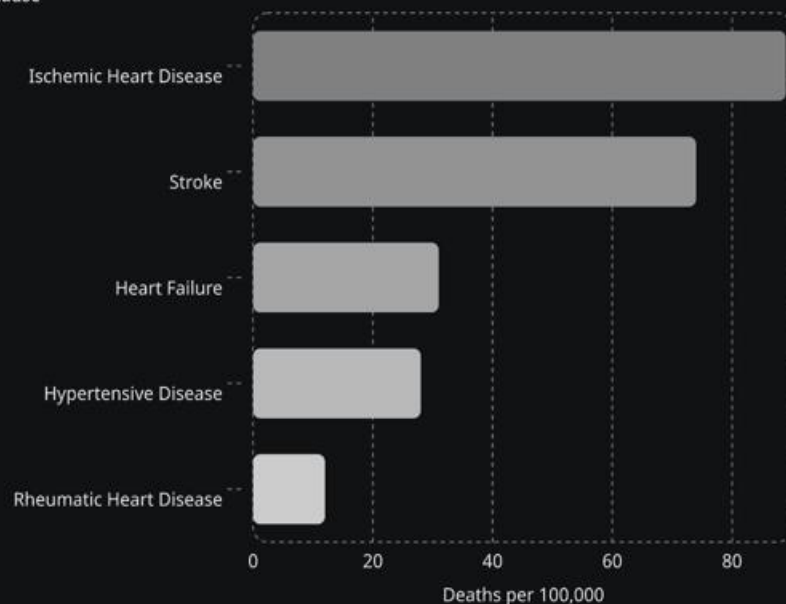
Annual Economic Cost

Thailand's direct and indirect CVD expenditure

References: 1. WHO. Global Health Estimates 2023. Geneva: WHO; 2023. 2. IHME GBD Study. Lancet. 2023;401:1123–45. 3. Thai MOPH. National Health Statistics. Bangkok: MOPH; 2023.

Cardiovascular Disease in Thailand

Cause



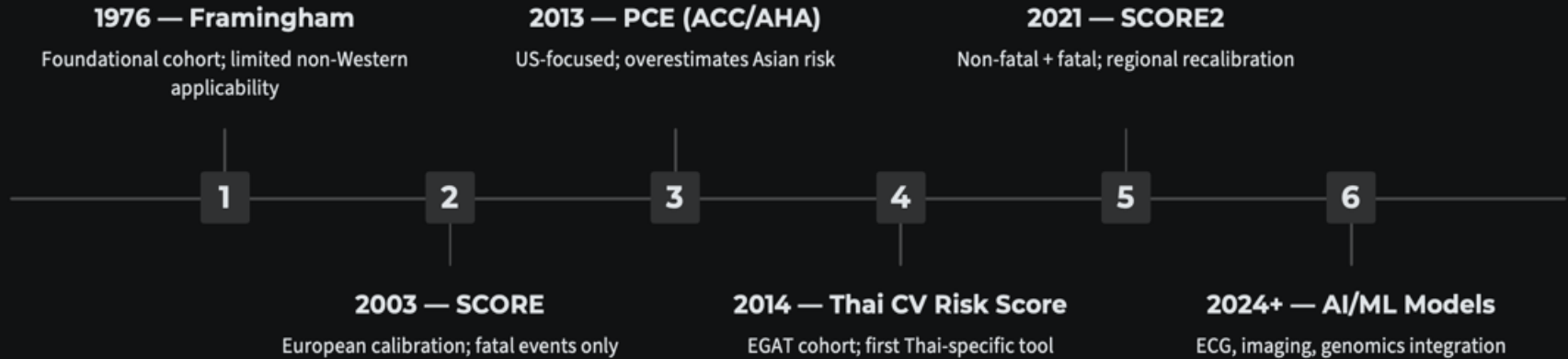
Risk Factor Prevalence (Thai NHES, 2022)

- **Hypertension:** 25% adults (urban 31% vs. rural 19%)
- **Diabetes:** 9.6% — rising fastest in Bangkok metro
- **Smoking:** 19% male; 2% female
- **Obesity (BMI ≥ 30):** 11% overall; 20% urban women
- **CKD (eGFR < 60):** 14% in adults > 60 years



Urban-rural divide: Bangkok CVD mortality 1.4× national average; Isaan region has highest stroke incidence.

Evolution of Cardiovascular Risk Prediction



References: 1. D'Agostino RB, et al. Circulation. 2008;117:743–53. 2. Viswanath K, et al. Thai Heart J. 2022;35:112–24. 3. SCORE2 Working Group. Eur Heart J. 2021;42:2439–54.

The Thai CV Risk Score

Development & Validation

- Derived from **EGAT cohort** (n=3,522; 1985–2010)
- Target: Thai adults **35–75 years**, no prior CVD
- Validated externally (Thai NHES, 2022)

Input Variables

- Age, sex, smoking, diabetes, SBP, TC/HDL ratio

Output

- 10-year hard CVD risk (%) — MI, stroke, CV death

Strengths vs. Limitations

- ✓ Thai-specific calibration; simple bedside use
- ✗ Excludes Lp(a), CKD, family history; no lifetime risk

References: 1. Sritara P, et al. EGAT Heart Study. Int J Epidemiol. 2023;52:891–900. 2. Viswanath K, et al. Thai Heart J. 2022;35:112–24. 3. Thai Lipid Society. Dyslipidemia Guidelines. Bangkok: TLS; 2023.

Comparison of Major CVD Risk Scores

Score	Population	Age Range	Key Variables	Validation	Primary Use
Thai CV Risk	Thai adults	35–75	Age, sex, smoking, DM, SBP, TC/HDL	EGAT + NHES	Thailand primary care
ACC/AHA PCE	US multi-ethnic	40–79	+ race, statin eligibility	MESA, ARIC	US statin decisions
SCORE2	European	40–89	Fatal + non-fatal CVD	SCORE2 cohort	ESC prevention
QRISK3	UK primary care	25–84	+ CKD, AF, deprivation	QResearch v40	NICE guidelines
China-PAR	Chinese adults	35–75	Geographic region, family history	China-PAR cohort	China prevention

❏ **Key insight:** PCE overestimates Thai risk by 30–50%; Thai CV Risk Score and China-PAR show best calibration for Southeast Asian populations. SCORE2 Asia-Pacific module is an emerging alternative. *References: 1. SCORE2 Working Group. Eur Heart J. 2021;42:2439–54. 2. Yang X, et al. Lancet. 2022;399:1234–44. 3. Viswanath K, et al. Thai Heart J. 2022;35:112–24.*

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Beyond Risk Scores: Advanced Diagnostic Tools

Identify Intermediate Risk

Risk between 5–10% prompts further testing.

Perform Imaging

Options: CAC, carotid IMT, ABI, CT angiography.

Calculate Thai CV Risk

Estimate 10-year cardiovascular risk percentage.

Reclassify & Manage

Adjust risk and decide statin or BP therapy.

Prevention: Lifestyle and Pharmacological

Lifestyle Interventions

- **Diet:** Thai Heart-Healthy Plate — reduce sodium, saturated fat
- **Exercise:** ≥ 150 min/week moderate aerobic + resistance
- **Weight:** Target BMI < 23 kg/m² (Asian cutoff)
- **Smoking:** Cessation counseling + pharmacotherapy
- **Sleep:** 7–9 hours; screen for OSA

Pharmacological Prevention

- **Statins:** Moderate-high intensity if 10-yr risk $\geq 10\%$
- **BP:** Target $< 130/80$ mmHg; ACEi/ARB first-line
- **GLP-1 RA / SGLT2i:** Diabetics with established CVD
- **PCSK9i:** Familial hypercholesterolemia or statin intolerance
- **Icosapent Ethyl:** TG 135–499 mg/dL on statin

References: 1. Thai Hypertension Society. Guidelines 2023. Bangkok: THS. 2. Thai Lipid Society. Thai Heart J. 2023;36:45–67. 3. ACC/AHA Primary Prevention. Circulation. 2019;140:e596–646.

Key Takeaways



Use Thai-Specific Tools

Thai CV Risk Score is calibrated for local epidemiology



Look Beyond the Score

CAC, carotid ultrasound refine intermediate-risk decisions



Address Emerging Risks

PM2.5, OSA, CKD amplify CVD risk in Thai populations



Embrace Innovation

AI, genomics, and digital health will transform prevention

Questions welcome. Thank you.