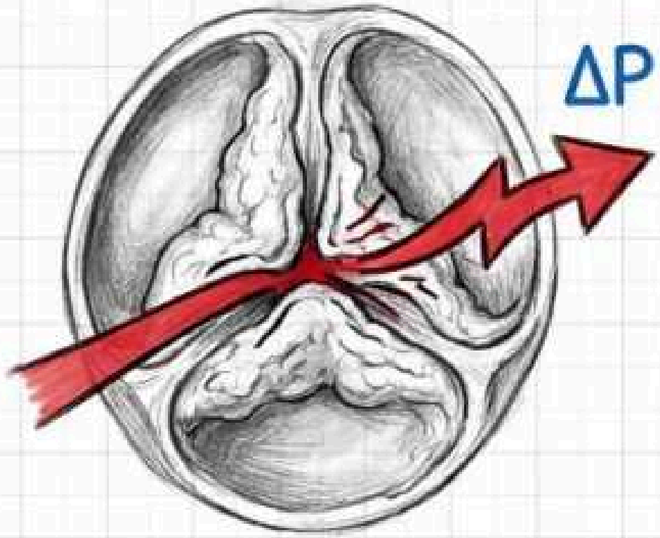
¶ 6.1

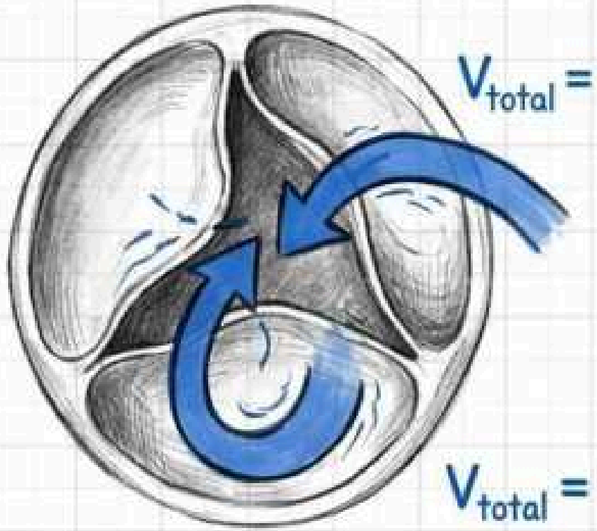
Stenosis



$$\Delta P = Q \times R$$

- Narrowed, stiff valve fails to open fully
- Chamber pushes harder
- Result: Severe pressure overload

Regurgitation



$$V_{total} = V_{forward} + V_{regurgitant}$$

$$V_{total} = V_{forward} + V_{regurgitant}$$

- Valve fails to close properly
- Blood leaks backward, forcing heart to pump it twice
- Result: Massive volume overload

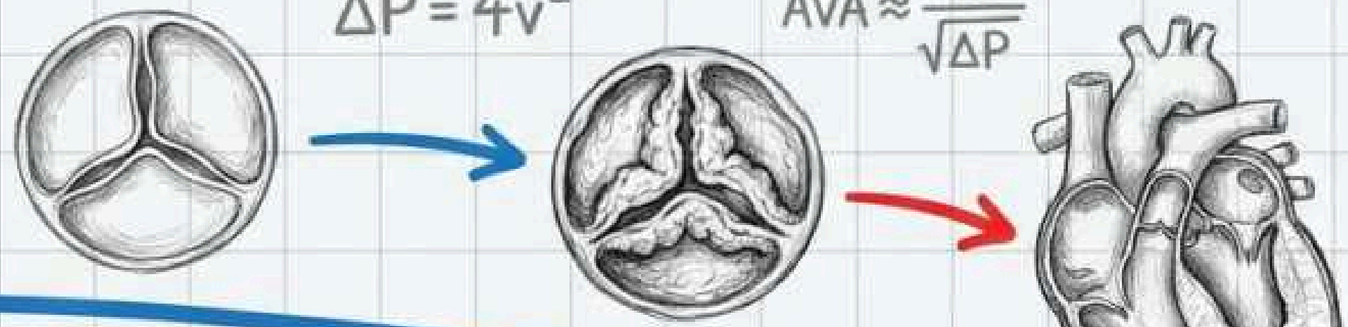
Either **mechanical failure** places an extra load on the heart, eventually driving the system toward **heart failure**.

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Aortic Stenosis Progression

¶ 6.2

- The Mechanism: Decades of age-related thickening and calcification gradually narrow the opening. Left ventricle thickens to maintain flow.



$\Delta P = 4v^2$

$AVA \approx \frac{CO}{\sqrt{\Delta P}}$

- The Clinical Cliff: Symptoms appear very late in the process (chest pain, fainting, breathlessness on exertion).

Cardiac Function

Symptoms Begin

$AVA = \frac{Pv}{dP}$

$\Delta P = 4v^2$

$AVA \approx \left(\frac{CO}{\sqrt{\Delta P}}\right)$

- The Prognosis: Once symptomatic, outlook worsens sharply without immediate treatment.

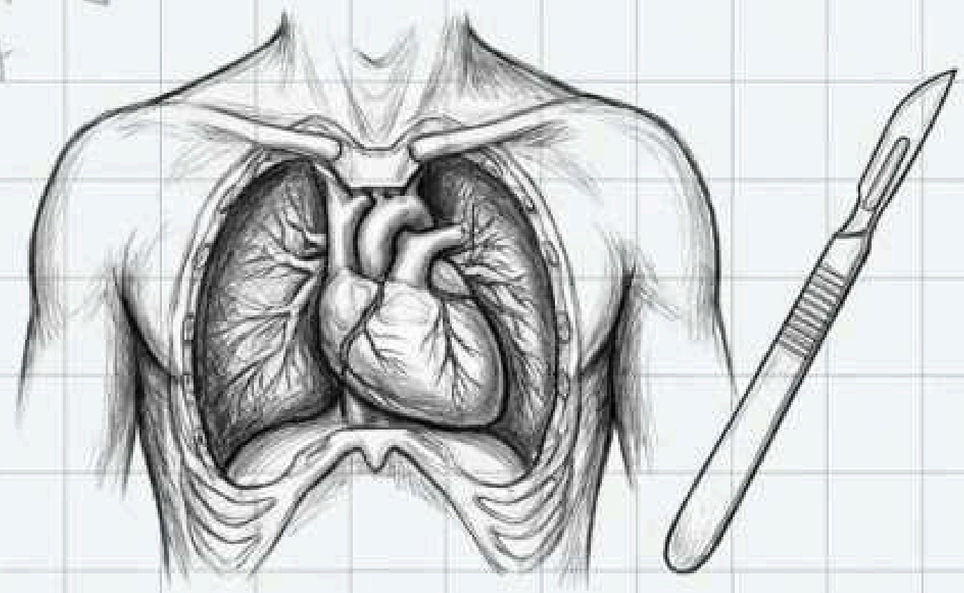
Age / Time

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Interventions for Aortic Stenosis

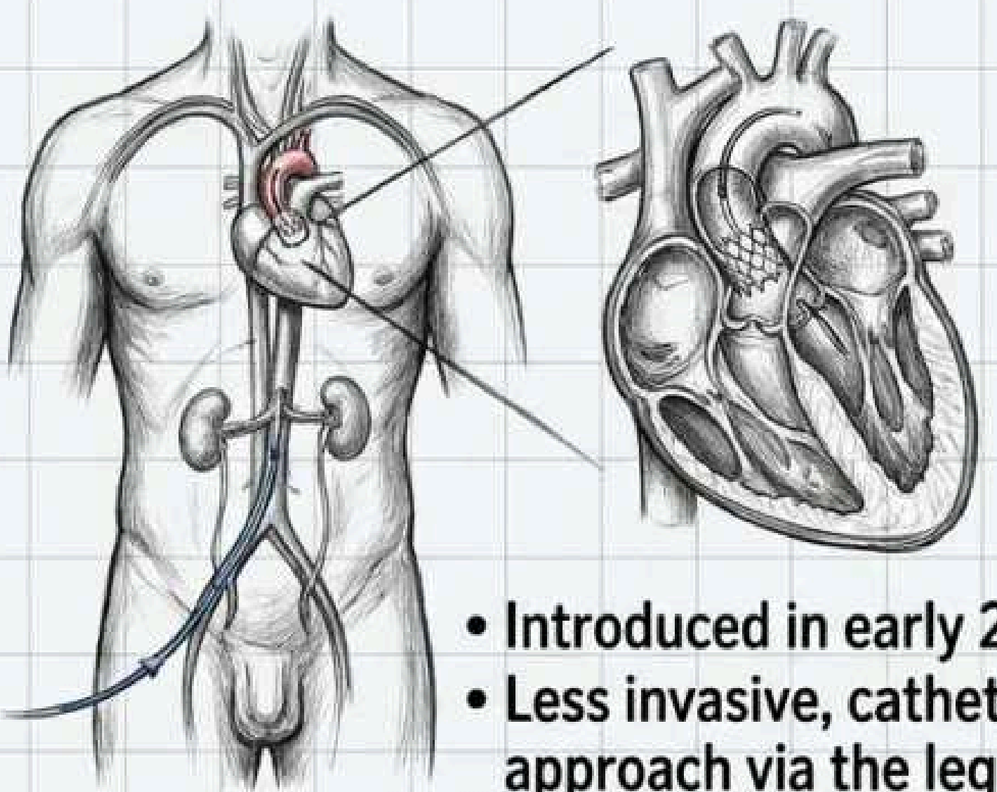
¶ 6.3

Open-Heart Surgery



- Surgical Replacement
- The traditional, highly invasive standard of care for valve replacement.

Transcatheter Aortic Valve Implantation (TAVI)



- Introduced in early 2000s
- Less invasive, catheter-based approach via the leg artery.

TAVI has revolutionized treatment, offering a life-saving option for older and high-risk patients who cannot survive traditional open-heart surgery.

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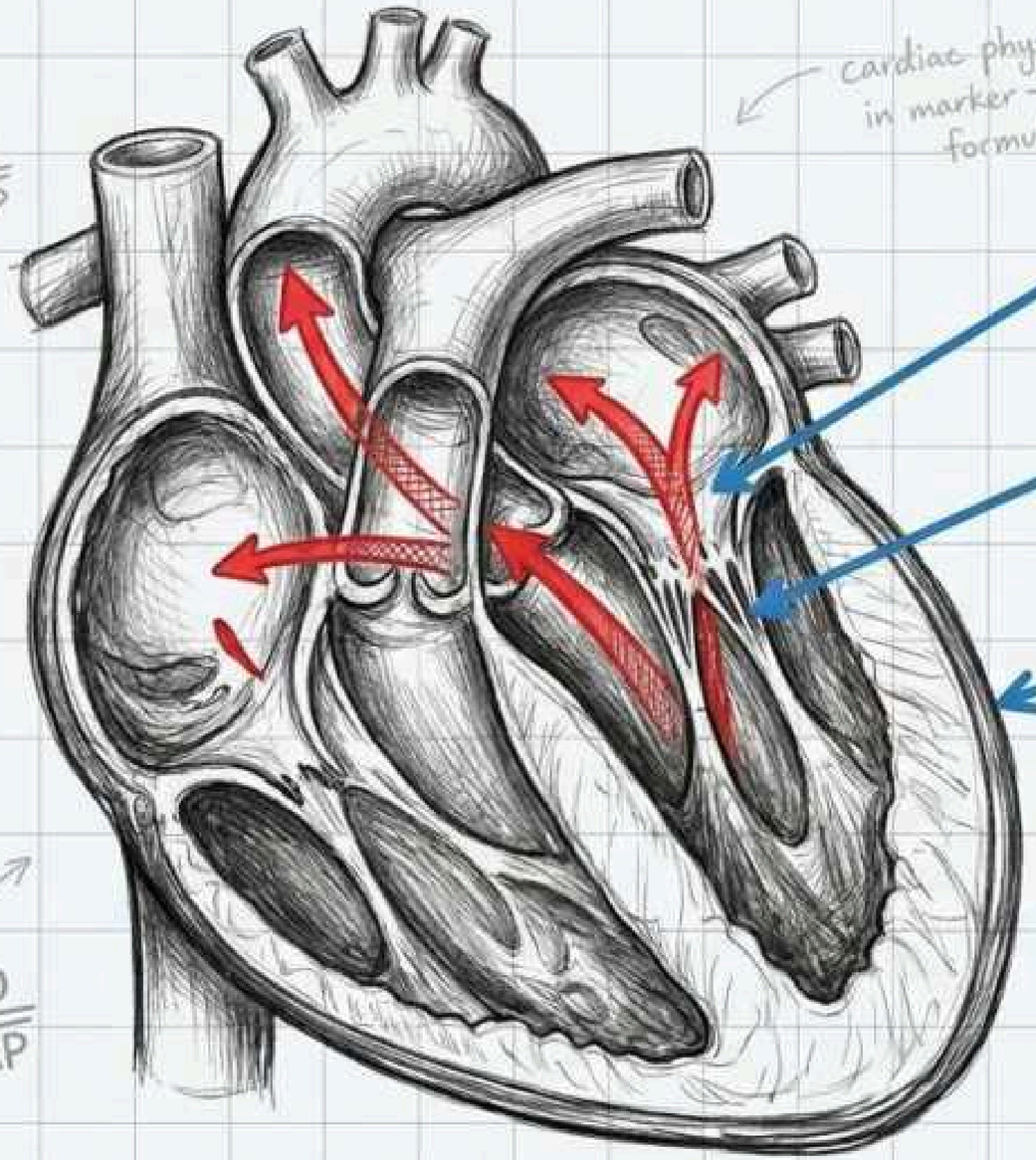
Mitral Regurgitation Mechanisms

¶ 6.4

Cardiac physiology

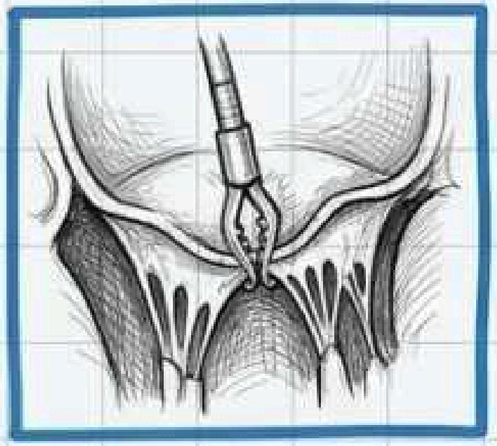
$$AVA \approx \frac{CO}{\sqrt{\Delta P}}$$

cardiac physiology in marker — thout formulas.



1. **Leaflets:** Degeneration of the valve leaflets.
2. **Support Structures:** Damage to chordae following a heart attack.
3. **Ventricle Wall:** Enlargement of a failing ventricle pulling the valve apart.

fine-tip-based mechanical scribble



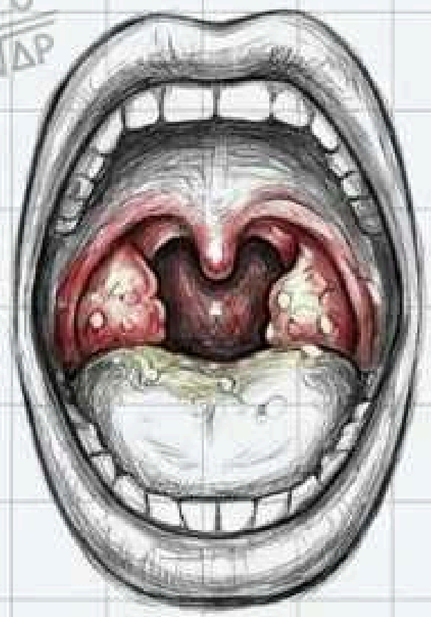
Severe leaks require surgical repair/replacement or intervention with a catheter-based clip.

$$AVA \approx \frac{CO}{\sqrt{\Delta P}}$$

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The Rheumatic Heart Disease Cascade

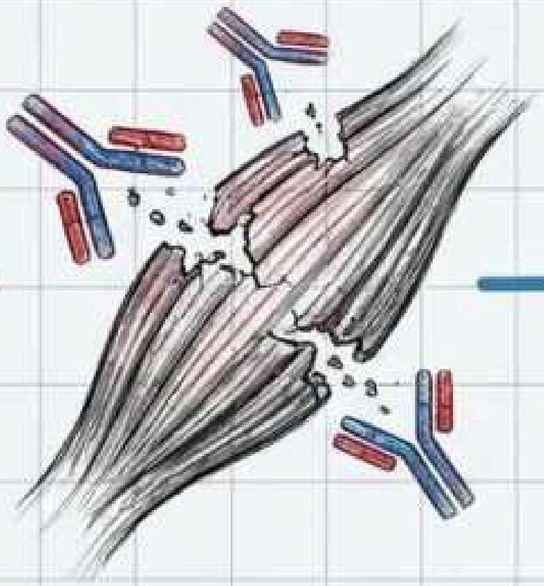
¶ 6.5



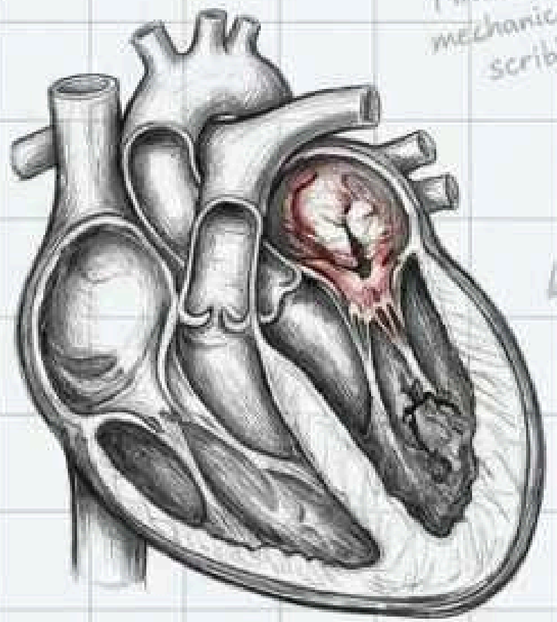
Childhood Streptococcal Throat Infection (Untreated)



STOP
Prompt Antibiotics



Rheumatic Fever (Aberrant Immune Reaction)



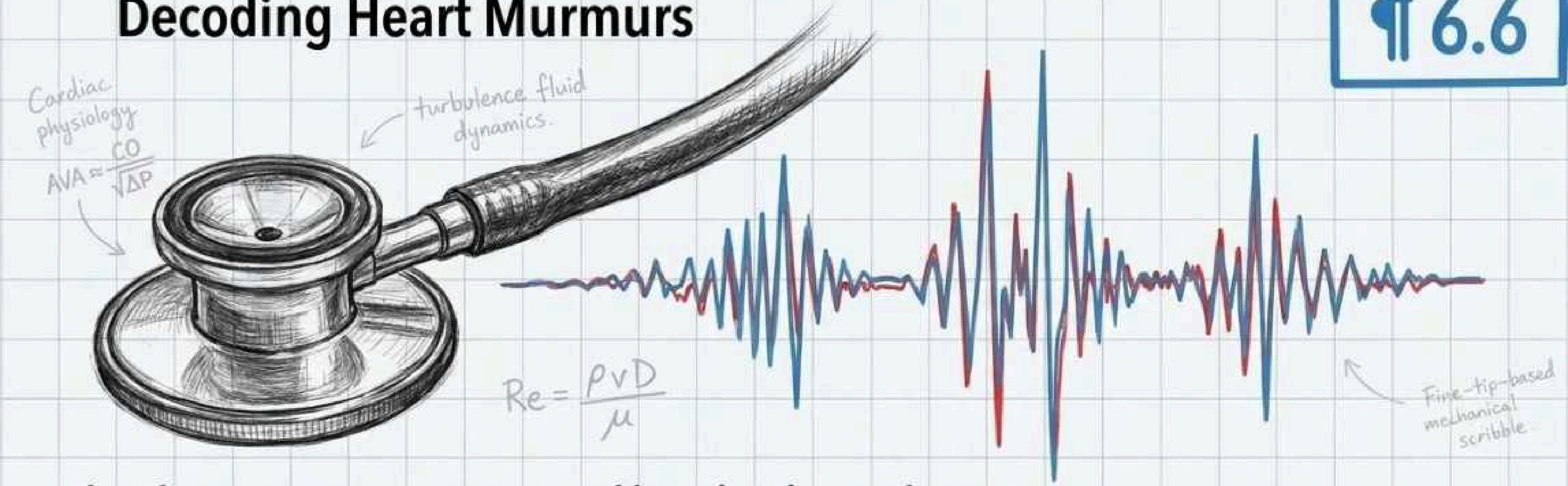
Rheumatic Heart Disease (Major global cause of valve damage)

Routine antibiotic care prevents this entire cascade, making the disease rare in developed healthcare settings.

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Decoding Heart Murmurs

¶ 6.6



The Phenomenon: An extra sound heard with a stethoscope, generated by turbulent blood flow across a valve.

Diagnostic Clues:

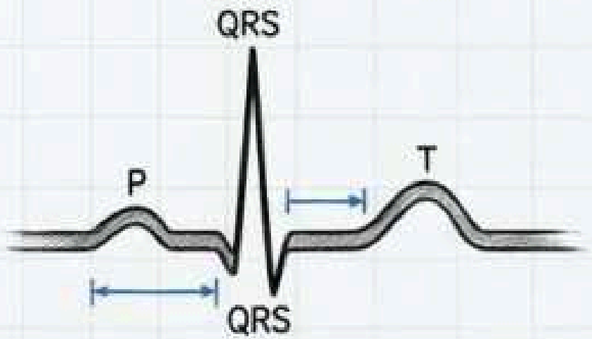
- **Timing:** Systolic or diastolic?
- **Location:** Heard best in aortic or mitral areas?
- **Character:** What is the pitch and shape of the sound?

Clinical Nuance: Not all turbulence indicates disease. "Innocent flow murmurs" are highly common in children and pregnant women.

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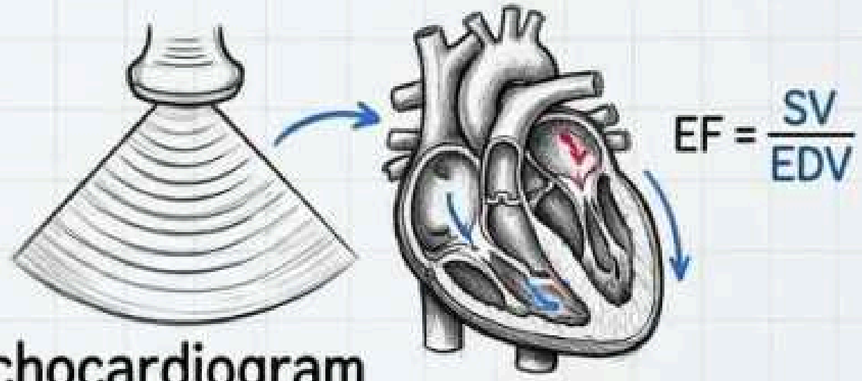
The Cardiac Assessment Toolkit

¶ 6.7



Electrocardiogram (ECG)

Maps rhythm, electrical strain, and signs of structural damage.



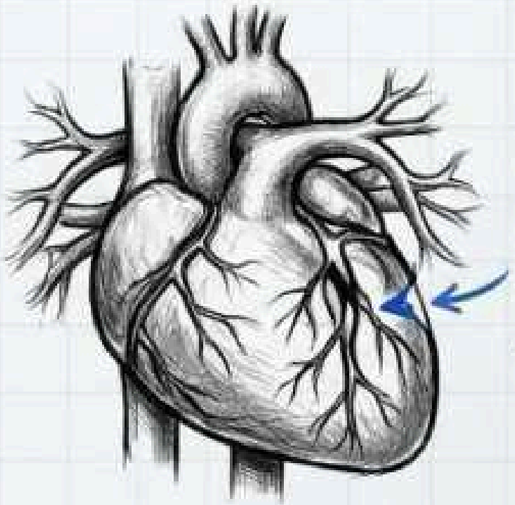
Echocardiogram

Uses ultrasound to visualize chamber size, valve movement, and calculate Ejection Fraction.



Exercise Tests

Evaluates how the heart copes under physiological stress.



Coronary Angiography

Uses X-rays and contrast dye to map narrowings in the coronary arteries.

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Advanced Imaging & Pre-Test Probability

¶ 6.8

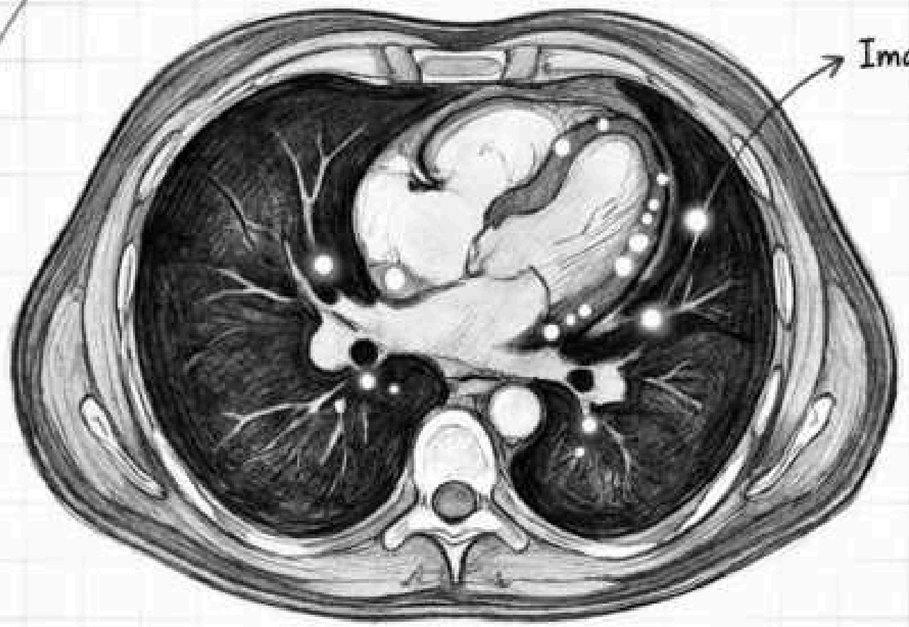
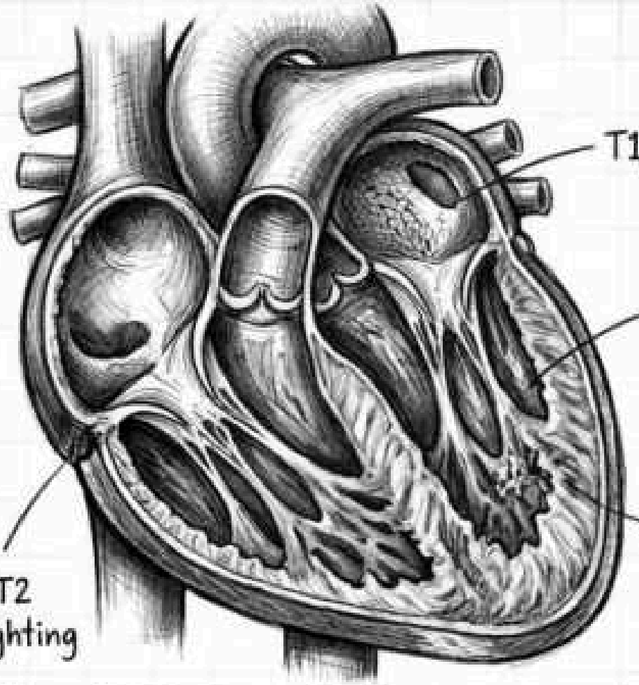


Image resolution:

$$r = k \times \frac{mat}{n}$$

$$r_o = k \cdots (reost)$$

Computed Tomography (CT): Measures coronary calcium (a key plaque indicator) and visualizes the arteries in 3D.



Cardiac MRI: Details heart muscle structure, revealing deep scarring and inflammation.

$$P(Disease) = \frac{P(Test|P|Disease)}{P(Test)}$$

$$P(Disease) = Pi(Test|Test)$$

$$P(Disease|Test) = \frac{P(Test|Disease)P(Disease)}{P(Test)}$$

The Logic of Testing: Every test carries costs and limitations. Modality selection is strictly governed by the principles of pre-test probability.

$$\frac{P(Test|Disease)P(Disease)}{P(Test)}$$

Drawing concept of PDisease and probability of probability.

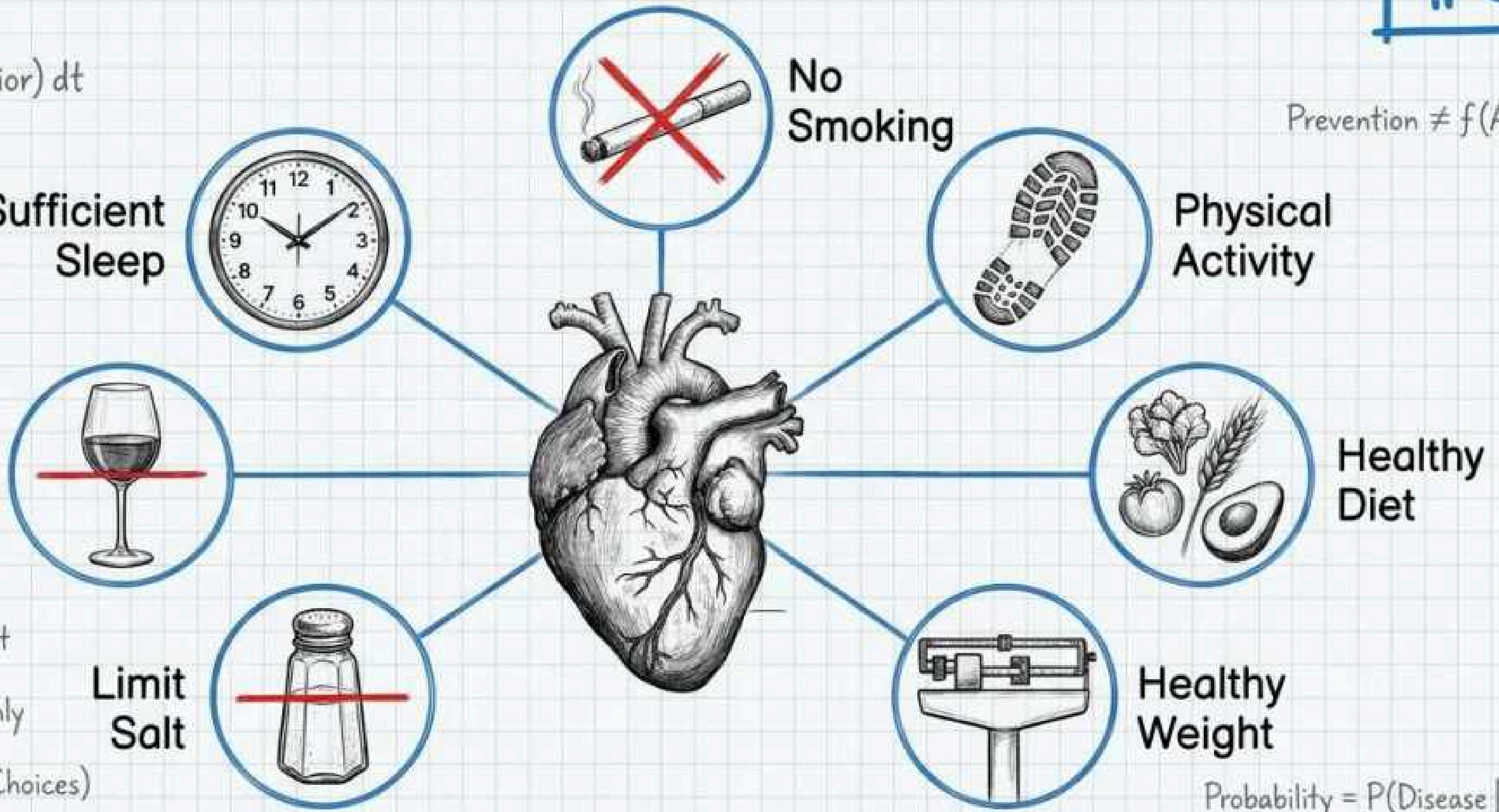
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Lifelong Cardiovascular Prevention

¶ 6.9

$$\text{Risk} \approx \int (\text{Behavior})\, dt$$

$$\text{Prevention} \neq f(\text{Age}) \text{ only}$$



$$\text{Risk} \approx \int (\text{Behavior})\, dt$$

$$\text{Prevention} \neq f(\text{Age}) \text{ only}$$

$$\text{Health} = \sum_{n} (\text{Daily Choices})$$

$$\text{Probability} = P(\text{Disease} \mid \text{Lifestyle})$$

These core behaviors substantially reduce the risk of heart disease and stroke across all ages. Prevention begins early in life.

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Medical Prevention & Absolute Risk

¶ 6.10



Treat High Blood Pressure



Lower Cholesterol (Statins & newer drugs)



Control Diabetes

$$Risk_{10yr} = f(\text{Age, Sex, Chol, BP, Diabetes, Smoking...})$$

Absolute Risk Assessment:

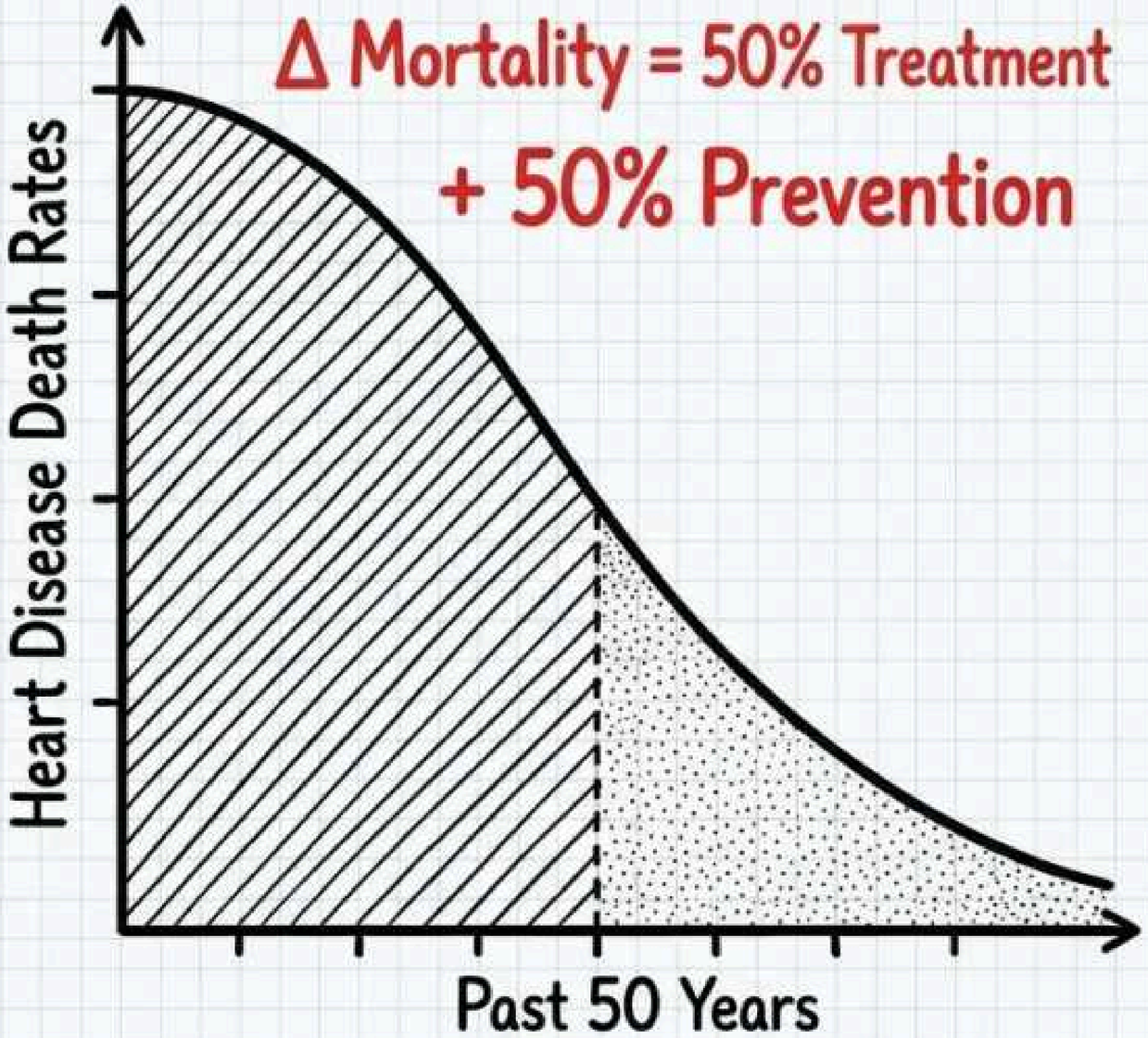
The decision to initiate medical prevention is not a guess. It is based on calculating the patient's absolute risk of an event over the next 10 years, combined directly with the patient's personal preferences.

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A Half-Century of Success

¶ 6.11

The Milestone: Over the last half-century, heart disease death rates in many countries countries have plummeted by more than half.



The Drivers:

- Better Treatment: Advanced management of heart attacks and failure.
- Aggressive Prevention: Reduced smoking, BP/cholesterol control.

Conclusion: Prevention and treatment combined represent one of medicine's greatest success stories.

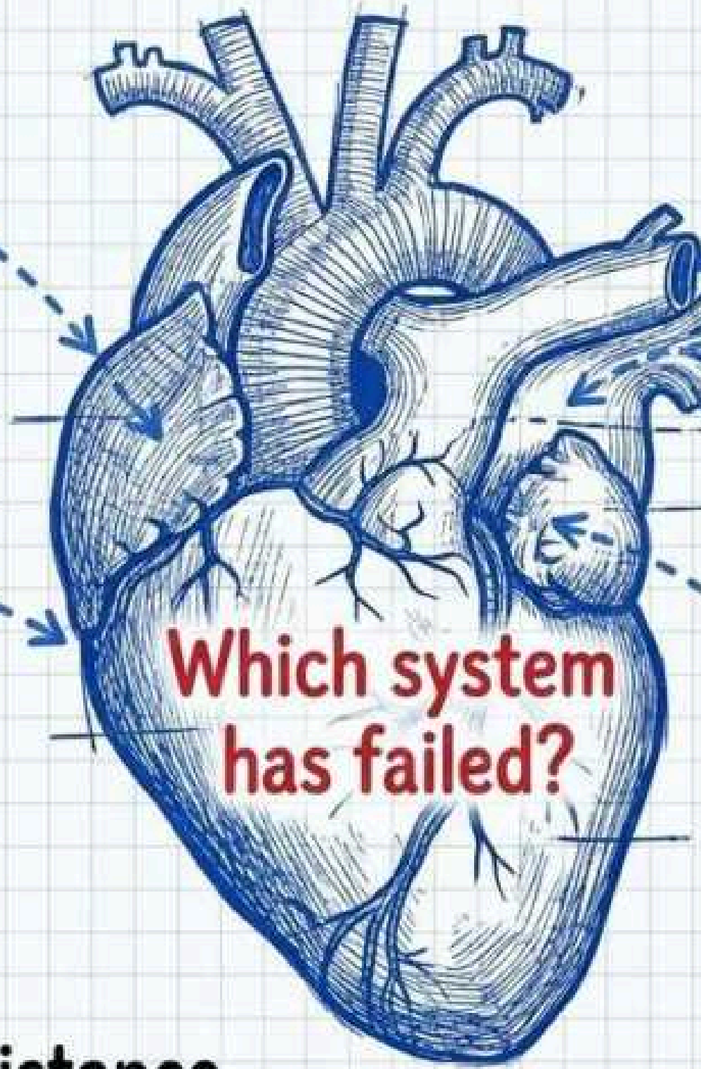
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The Master Metaphor of the Heart

¶ 6.12

Pump → Heart Muscle (Myocardium)

Pipes → Blood Vessels (Coronary ry Arteries)



Doors → Valves

Wiring → Conduction System

Δ Pressure = Flow × Resistance

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