



# **Transcatheter Aortic Valve Replacement (TAVR): *Past, present, and future***

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# Disclosures

*None*

# Objectives

- Discuss the prevalence of valvular heart disease
- Aortic valve disease causes
- Physical exam / symptoms of severe AS
- Testing modalities
- Therapies

# Louvre Museum, Paris, Fr



# Basilica of SacreCoeur de Montmartre



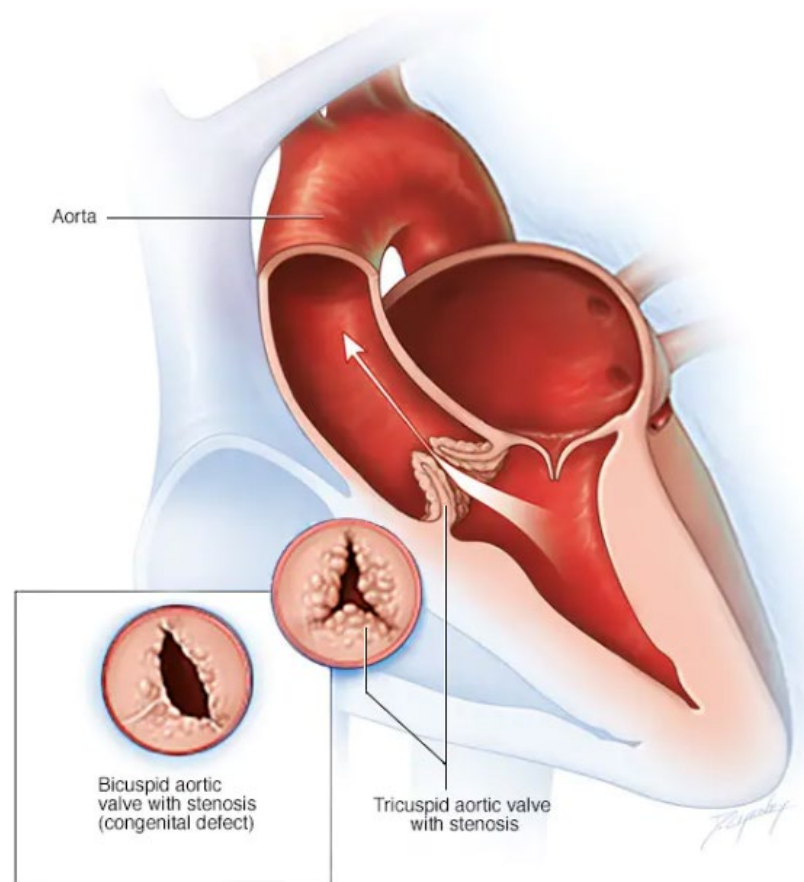
# Mr GQ

- 81 year old man with a history of hypertension
- Presents to his PCP for annual visit
- CC: Worsening SOB
- Baseline activity: 1 year ago – can walk around Pena Adobe (Lagoon Valley) 2.5 miles
- Now: Difficulty walking to his mailbox
- Physical exam:
  - BP 129/64 mmHg, HR 78 bpm
  - Appears younger than stated age
  - 3/6 SEM RUSB +pulsus parvus et tardus, +S1, no S2



**DDx for DOE + *systolic* murmur?**

# Aortic Valve Stenosis

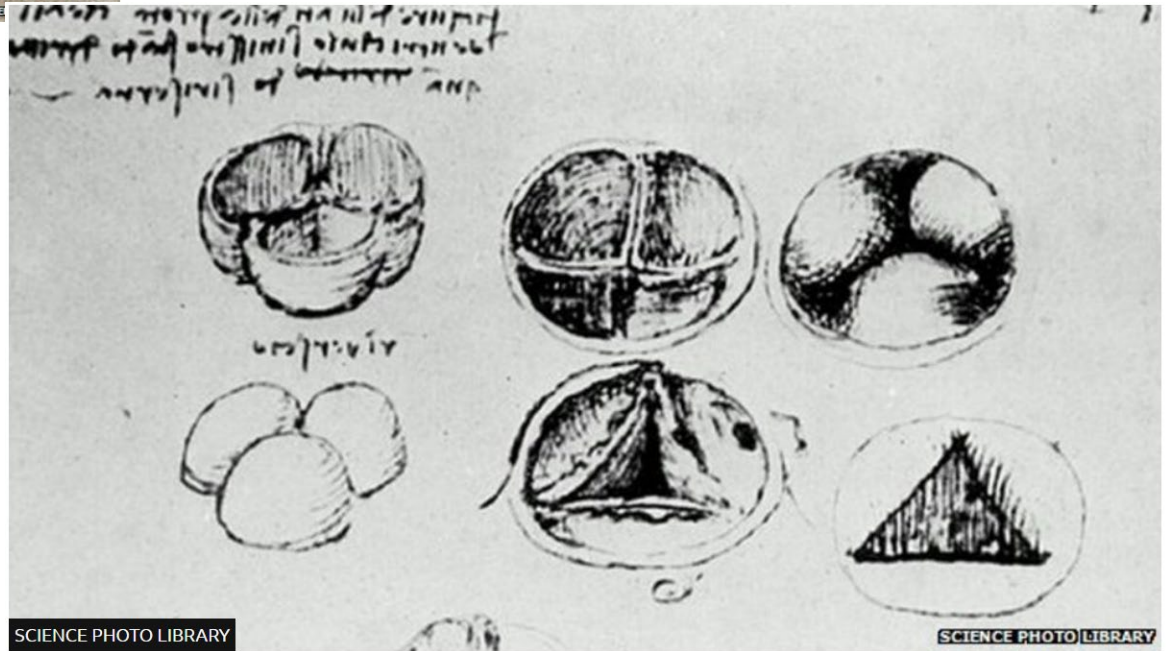


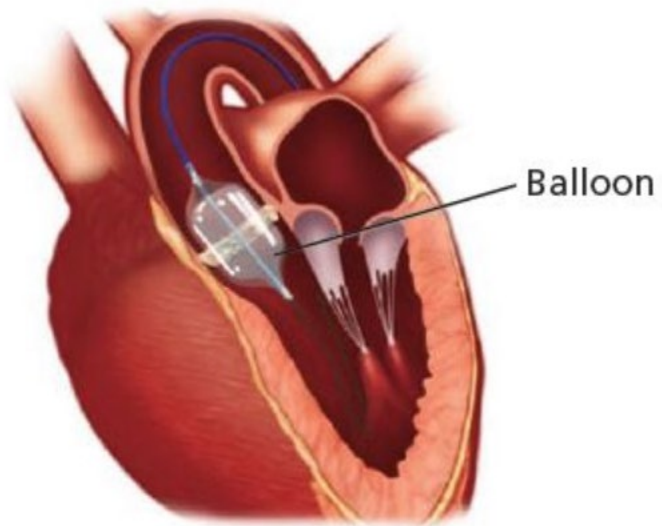
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**Aortic valve stenosis**



# Leonardo da Vinci (1512)





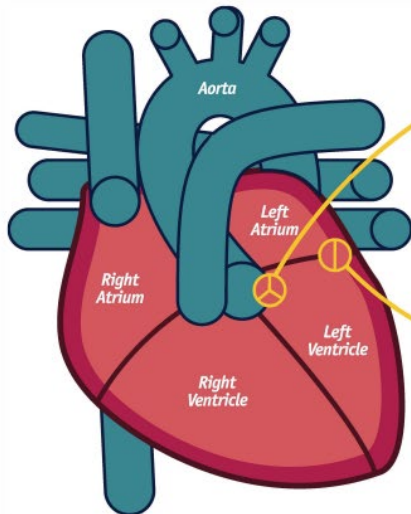
Alain Cribier and the first patient with TAVI,  
Rouen, 16 April 2002

# HEART VALVE DISEASE



## Know Your VALVES

Most heart valve problems involve the **aortic & mitral valves**.



**AORTIC VALVE**  
between the left ventricle and the main artery (aorta)

**MITRAL VALVE**  
between the left atrium and the left ventricle

### SIGNS & SYMPTOMS

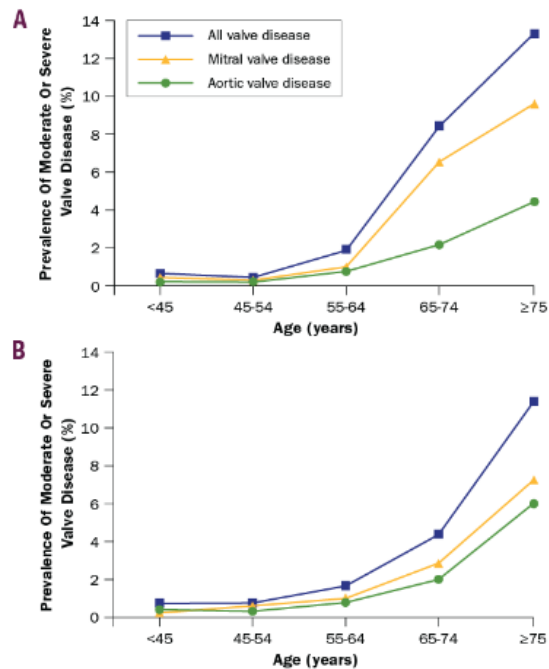
May vary, but often include:

- ▶ Heart murmur or unusual heartbeat
- ▶ Shortness of breath
- ▶ Swelling in the legs
- ▶ Chest pain
- ▶ Unusual fatigue
- ▶ Feeling dizzy or fainting

▶ **HEART VALVE DISEASE** happens when **at least 1 of the 4 valves** in the heart **no longer works** the way it should.

# Prevalence of valvular heart disease

## Prevalence of Valvular Heart Disease With Age



- **2.5%**

- % population develop valvular heart disease (industrialized countries)

- **Increasing age**

- Prevalence of moderate or severe aortic and mitral valve disease increases with age

Nkomo VT, Gardin JM, Skelton TN, et al. Burden of valvular heart diseases: a population-based study. Lancet 2006; 368:1005-11.

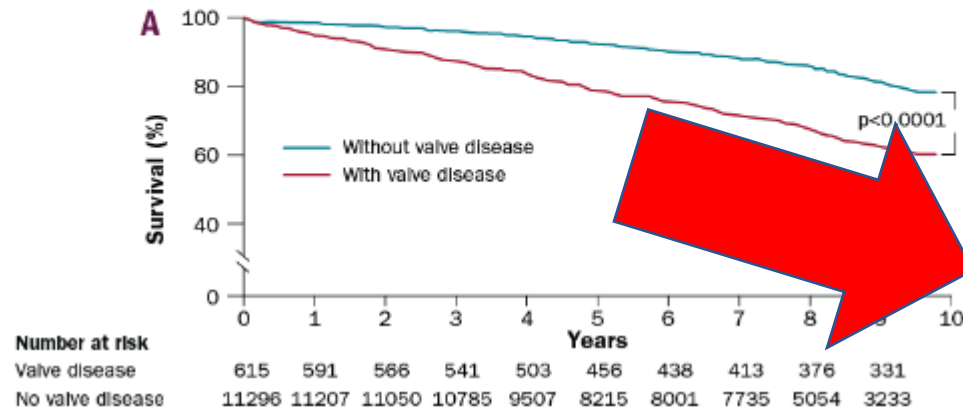
# Severe aortic stenosis here in Solano County

## 1,400 Solano County residents

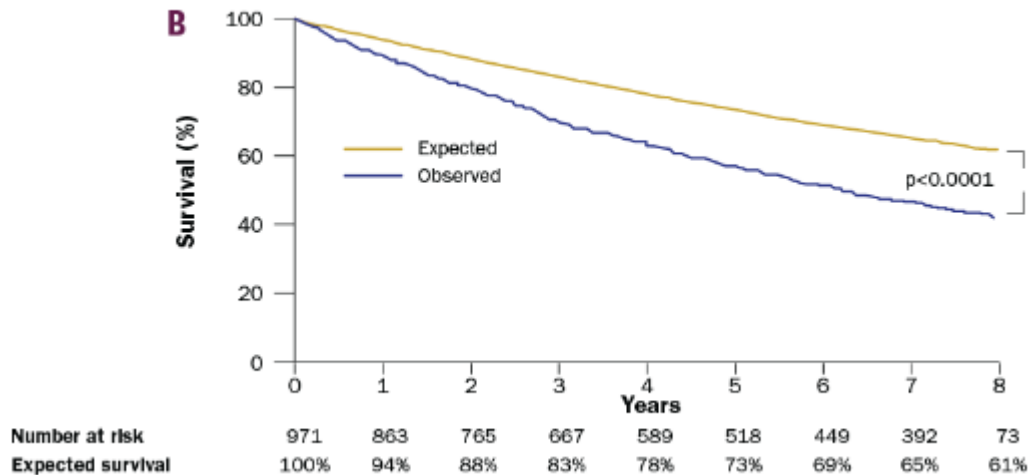
- Living with severe AS
- 440,000 people living in Solano County
- 16% older than age 65
- 2-5% prevalence of severe AS in pts > 65 years old

# Impact of disease and survival

## Survival After Detection of Moderate or Severe Valvular Heart Disease



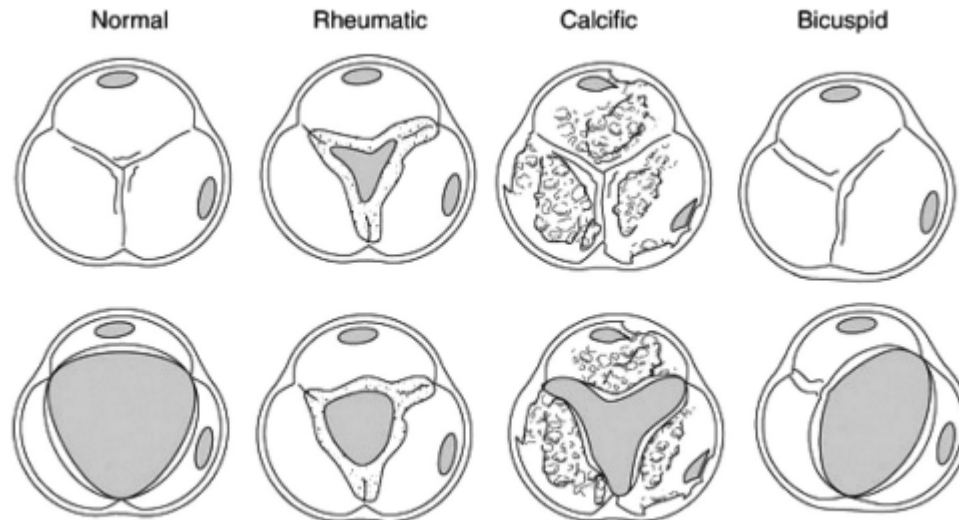
- Moderate or severe VHD has a negative impact on survival



Nkomo VT, Gardin JM, Skelton TN, et al. Burden of valvular heart diseases: a population-based study. Lancet 2006; 368:1005-11.



# Causes of valvular aortic stenosis



**Figure 1** Aortic stenosis aetiology: morphology of calcific AS, bicuspid valve, and rheumatic AS. (Adapted from C. Otto, Principles of Echocardiography, 2007).

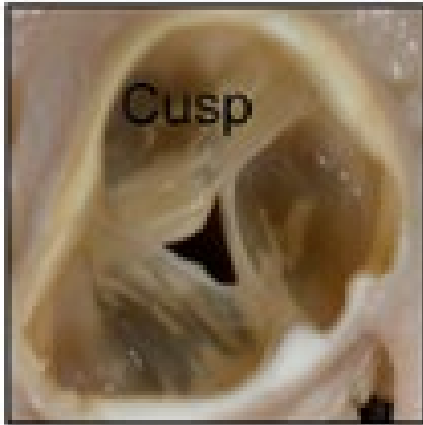
Baumgartner et al. Echo of aortic valve stenosis: JASE Apr 2017

1. Calcification of a tricuspid aortic valve
2. Calcification (secondary) of a bicuspid aortic valve
3. Rheumatic aortic valve disease

## Aortic Valve

**A**

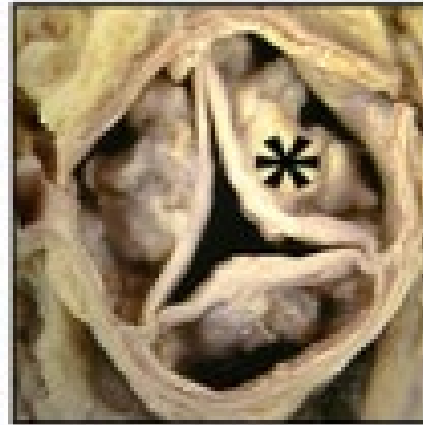
**Normal**



**Malformation  
(Bicuspid)**



**Disease  
(Calcific)**

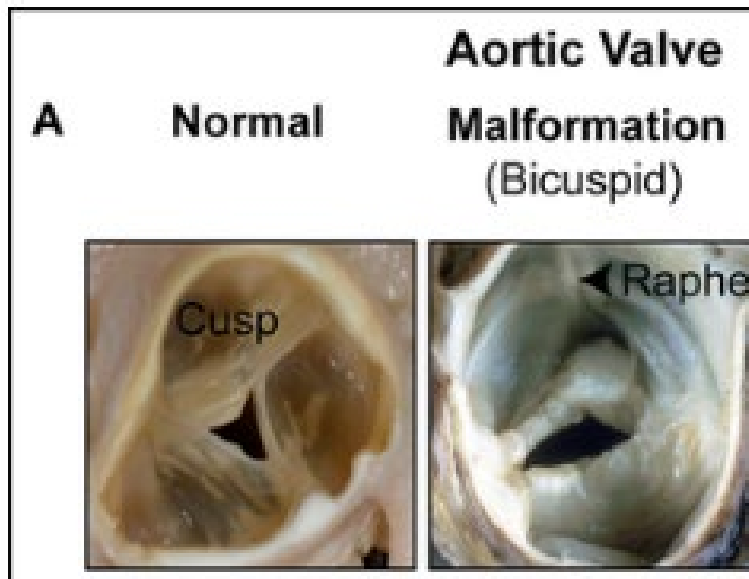




# Rheumatic Heart Disease

- Untreated, acute rheumatic fever can lead to rheumatic heart disease
- Pathophysiology poorly understood
- Largely eliminated in wealthy nations

# Bicuspid aortic valve disease

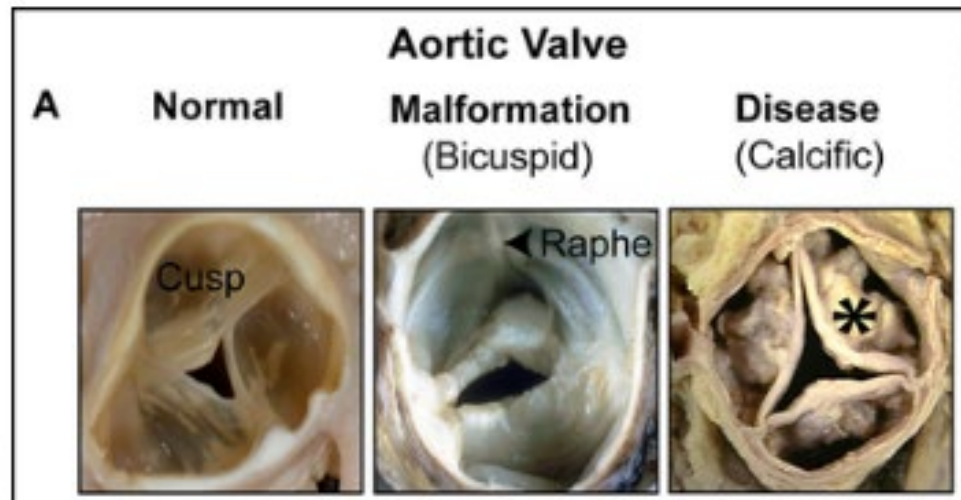


Krishnamurthy et al. J CV Trans Research, Dec 2014

- Most common congenital abnormality of the aortic valve
- 3:1 male predominance
- Dominates in younger patients with AS
- Ascending aortic aneurysm present in 50% of cases
- >50% of coarctation patients have bicuspid aortic valves

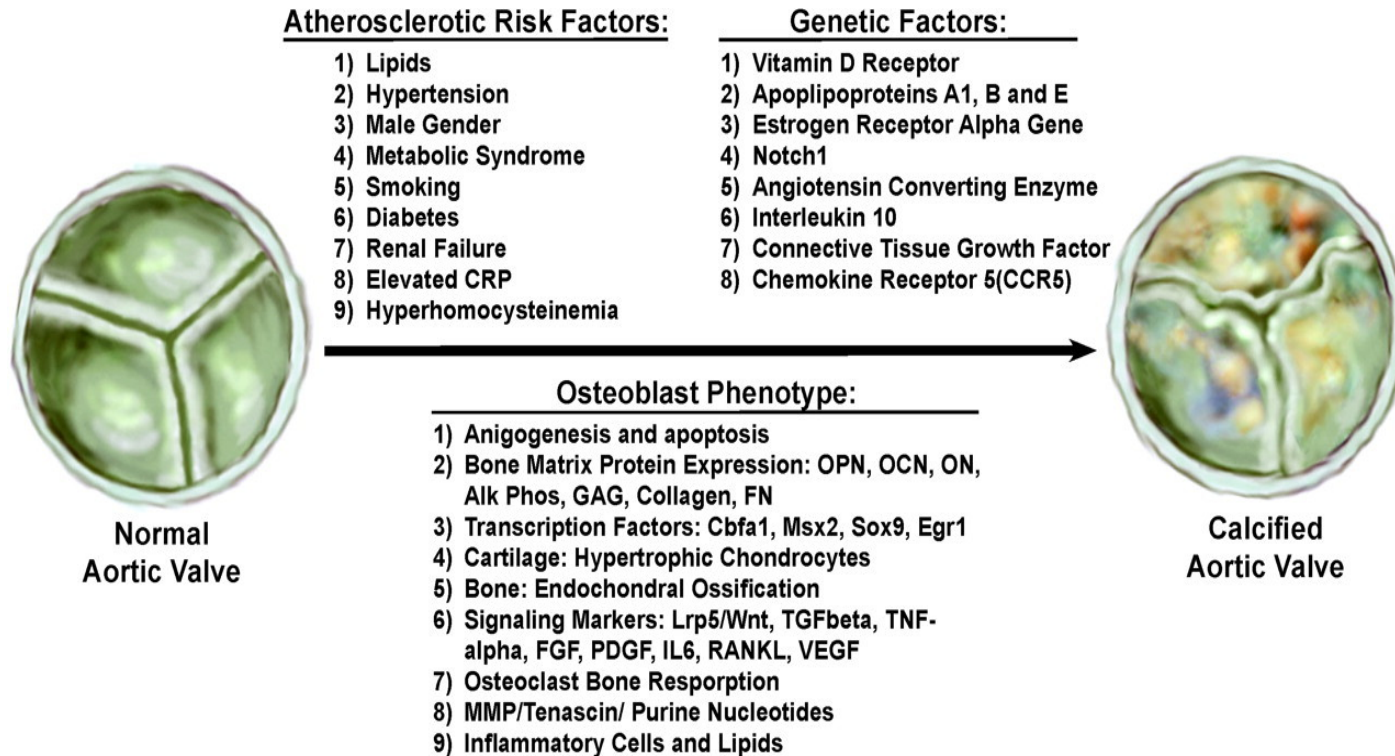
# Degenerative aortic valve disease

- Most common form of AS
- “Disease of the elderly”
  - Worsens with age



# Degenerative aortic valve disease

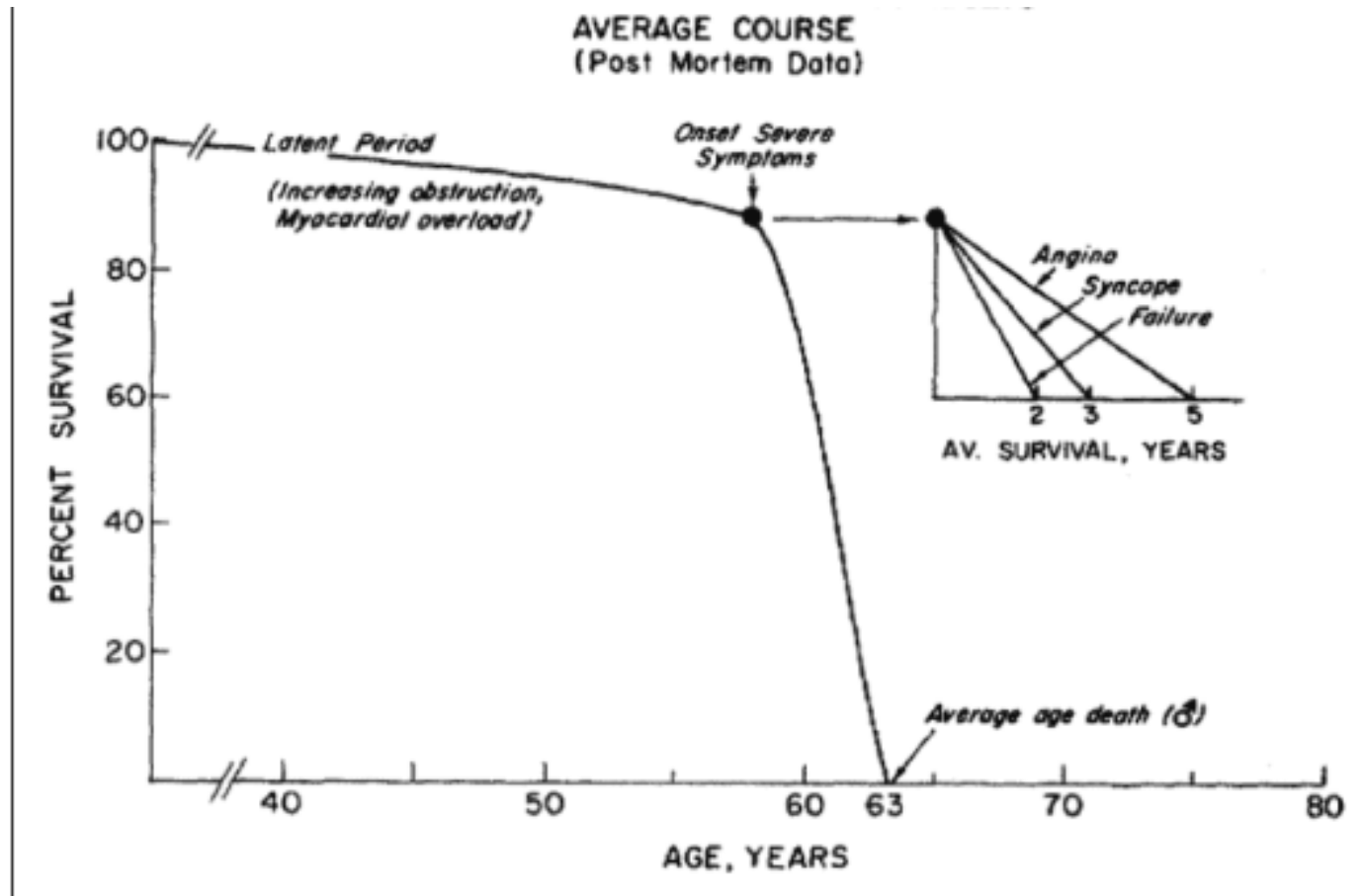
## RISK FACTORS



# Murmur

- Systolic ejection murmur
- Loudest at the RUSB
- Radiates to both carotids or apex
- Pulsus parvus et tardus: carotid pulse, low in amplitude and delayed

# AS Symptoms and Survival



# Symptoms

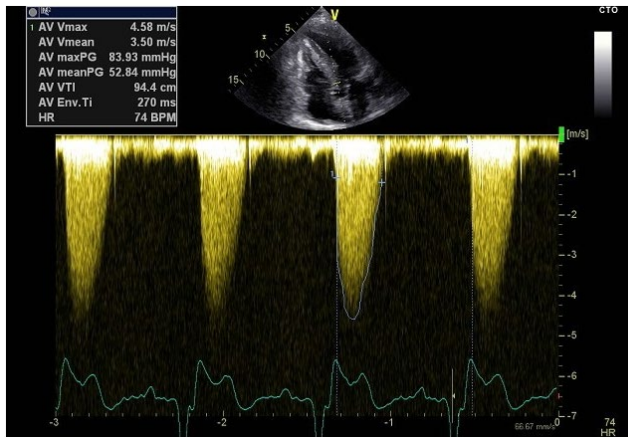
- Initial: Exertional dyspnea or reduced exercise capacity
- Patients can augment activity to minimize symptom burden
- Angina, HF, and syncope = classic late manifestations of severe AS





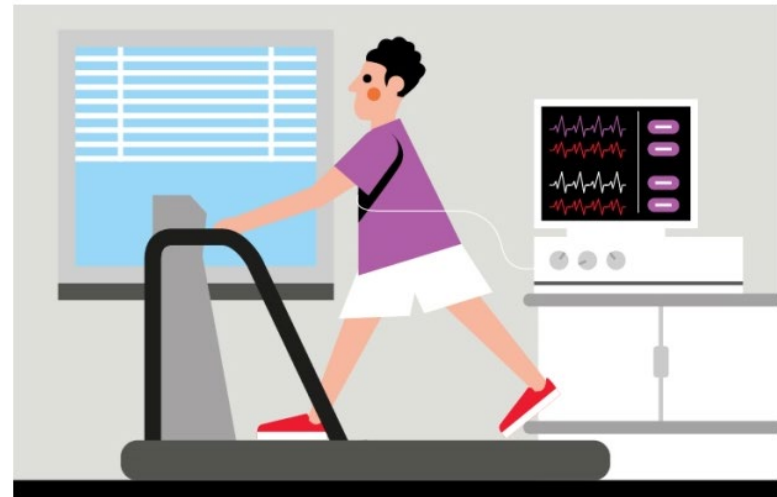
# Echo testing

- Severe AS:
  - Peak aortic valve velocity  $> 4$  m/s
  - Mean aortic valve gradient  $> 40$  mmHg (when flow is nml)
  - Valve area  $< 1$  cm<sup>2</sup>



# Treadmill stress testing

- Asymptomatic patients
- Functional capacity
- Confirm/refute asymptomatic status
- 1/3 of such asx pts have symptoms limiting exercise
- Decrease in SBP > 10 mmHg at peak exercise suggests imminent symptom onset



<https://www.bhf.org.uk/information-support/heart-matters-magazine/medical/tests/stress-test>

# Cardiac Catheterization

- Measurement of the LV and aortic pressures
- Rarely needed to confirm AS severity
- Used when echo data inconclusive



# Medical Treatment

- Primary prevention
  - Smoking cessation
- HTN
  - Especially important
  - AS + HTN increase load to the LV
- Activity prescription for severe AS:
  - Avoid strenuous activity
  - Avoid competitive sports
- Decompensated heart failure
  - Difficult to manage
  - Often needs hospitalization e.g. invasive hemodynamic monitoring

# Aortic Valve Replacement (AVR)

- Class I indications for AVR:
  - Severe symptomatic pts
  - Severe, asymptomatic pts with reduced LVEF (<50%)
  - Those requiring other cardiac surgery
- Only effective therapy for severe AS
- When to replace?

# Assess risk for AVR

- Determines patient longevity
- Society of Thoracic Surgeons (STS) predicted risk of mortality (PROM)
- Imperfect risk score; does not include frailty, other organ disease (e.g. PH), procedure specific (e.g. prior radiation)

- Low risk
  - STS-PROM < 4%
  - Non frail
- Intermediate risk
  - STS-PROM 4-8% or
  - Frail
  - 1 major organ system compromise
- High risk
  - STS-PROM > 8% or
  - Frail
  - >2 major organ system compromise
- Prohibitive
  - >3 major organ systems compromise
  - Severely frail

# Mr GQ

- 85M with severe, symptomatic aortic stenosis



## STS Short-term / Operative Risk Calculator Adult Cardiac Surgery Database - All Procedures

Answer All Questions that Apply for Accurate Estimates

**Planned Surgery**

Surgery Incidence

Surgical Priority

**Demographics**

Sex

Age (years)

Height (cm)

Weight (kg)

BMI (kg/m<sup>2</sup>)  BSA (m<sup>2</sup>)

Race

Payor / Insurance

**Laboratory Values**

Creatinine (mg/dL)

Hematocrit (%)

WBC Count (10<sup>3</sup>/μL)

Platelet Count (cells/μL)

**Preoperative Medications**

**Risk Factors/Comorbidities**

Diabetes

Family Hx of CAD

Hypertension

Liver Disease

Mediastinal Radiation

Unresponsive State

Dialysis

Cancer ≤ 5 yrs

Syncope

Immunocompromised

Endocarditis

Illicit Drug Use

Alcohol Use

Tobacco Use

**Pulmonary**

Chronic Lung Disease

Recent Pneumonia

Sleep Apnea

Home O<sub>2</sub>

**Vascular**

Cerebrovascular Dis.

Peripheral Artery Disease

Right Carotid Sten. ≥ 80%

Prior Carotid Surgery

Left Carotid Sten. ≥ 80%

**Cardiac Status**

Heart Failure

NYHA Classification

PreOp Mech Circ Support

Ejection Fraction (%)

**Coronary Artery Disease**

Prim. Coronary Symptom

Myocardial Infarction-when

No. of Diseased Vessels

**Valve Disease**

Aortic Stenosis

Mitral Stenosis

Aortic Root Abscess

Aortic Regurgitation

Mitral Regurgitation

Tricuspid Regurgitation

**Arrhythmia**

Atrial Fibrillation

Atrial Flutter

V. Tach / V. Fib

Sick Sinus Syn.

2<sup>nd</sup> Degree Block

3<sup>rd</sup> Degree Block

**Previous Cardiac Interventions (Select all that apply)**

CABG  Valve  PCI  Other

Clinical Summary

### Simulated Patient Summary

**Procedure Type: Isolated AVR**

Perioperative Outcome	Estimate %
Operative Mortality	1.85%
Morbidity & Mortality	5.47%
Stroke	1.03%
Reoperation	3.04%
Prolonged Ventilation	2.12%
Deep Sternal Wound Infection	0.035%
Long Hospital Stay (>14 days)	2.35%
Short Hospital Stay (<8 days)*	51.7%

\*higher values reflect a better outcome

### Clinical Summary

**Planned Surgery:** Isolated AVR, Elective, First cardiovascular surgery

**Demographics:** 85 year old, male, 85kg, 180cm, BMI: 26.2 kg/m<sup>2</sup>, BSA: 2.05 m<sup>2</sup>

**Lab Values:** Creatinine: 0.8 mg/dL, Hematocrit: 45%, WBC Count: 5 10<sup>3</sup>/μL, Platelet Count: 225000 cells/μL

**Risk Factors / Comorbidities:** Hypertension

**Cardiac Status:** Chronic heart failure, NYHA Class II, Ejection Fraction = 60%

**Coronary Artery Disease:** None/Other



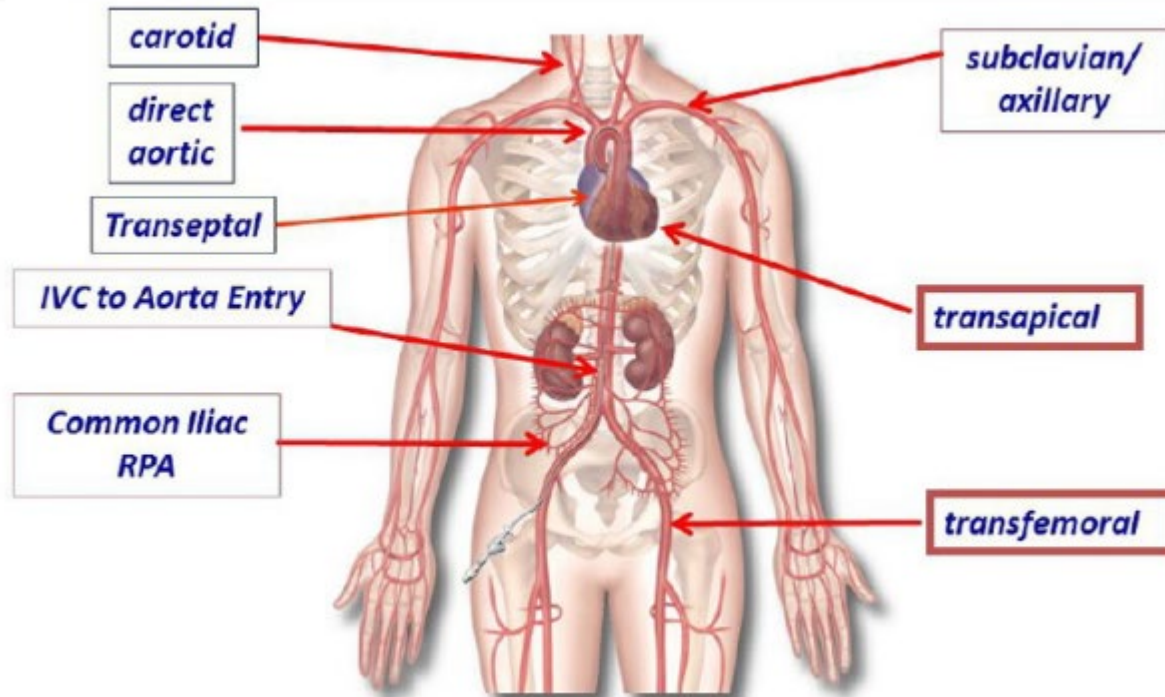
# TAVR

- Minimally invasive
- Cath-based procedure
- Bioprosthetic valve placed in the orifice of the aortic valve
- Transfemoral approach is most common (if possible)

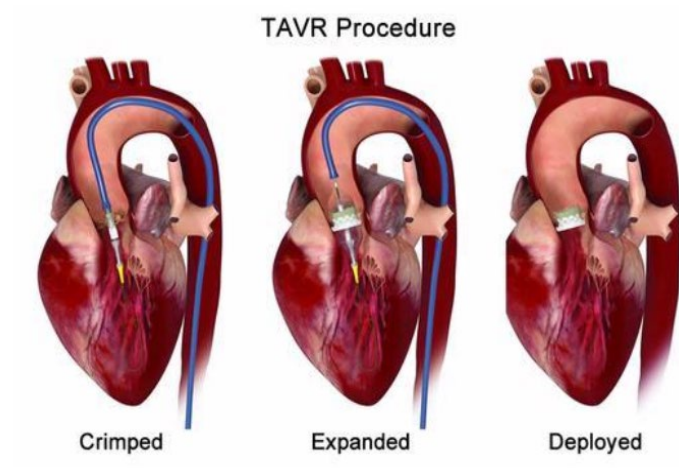


# TAVR

## Access Sites



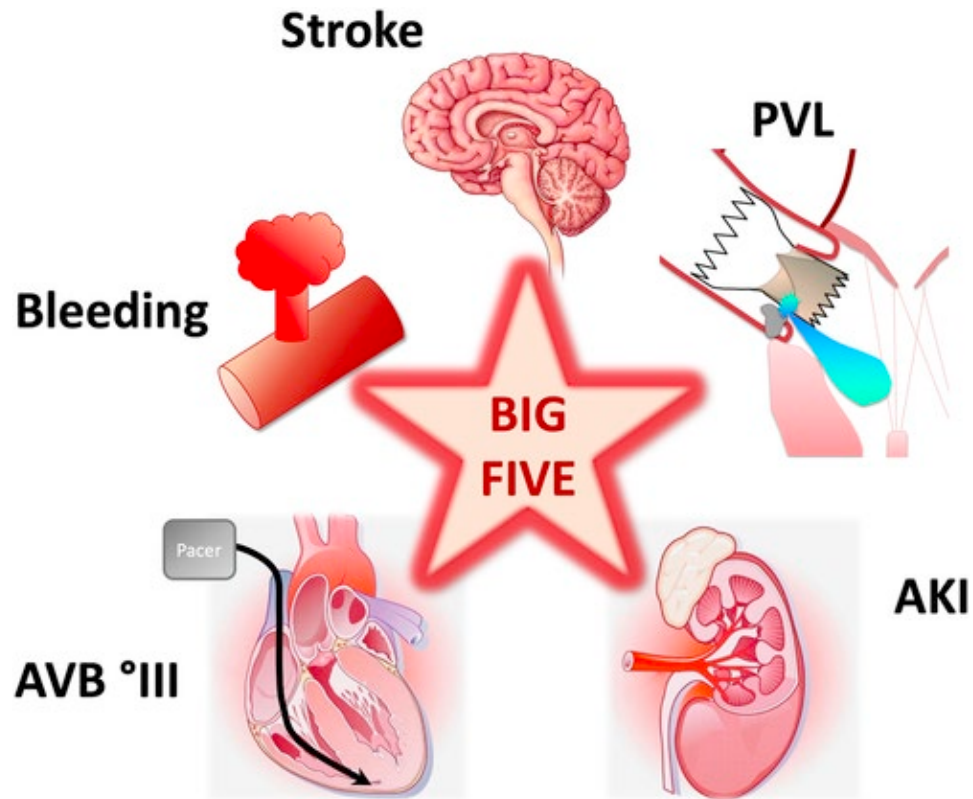
# TAVR Procedure



Length of Stay (TF TAVR): **< 72 hr** in 55 % patients

Kapadia et al. JACC, March 2019.

# Complications of TAVR



Eberhard Grube et al. *J Am Coll Cardiol Interv* 2019; 12:370-372.

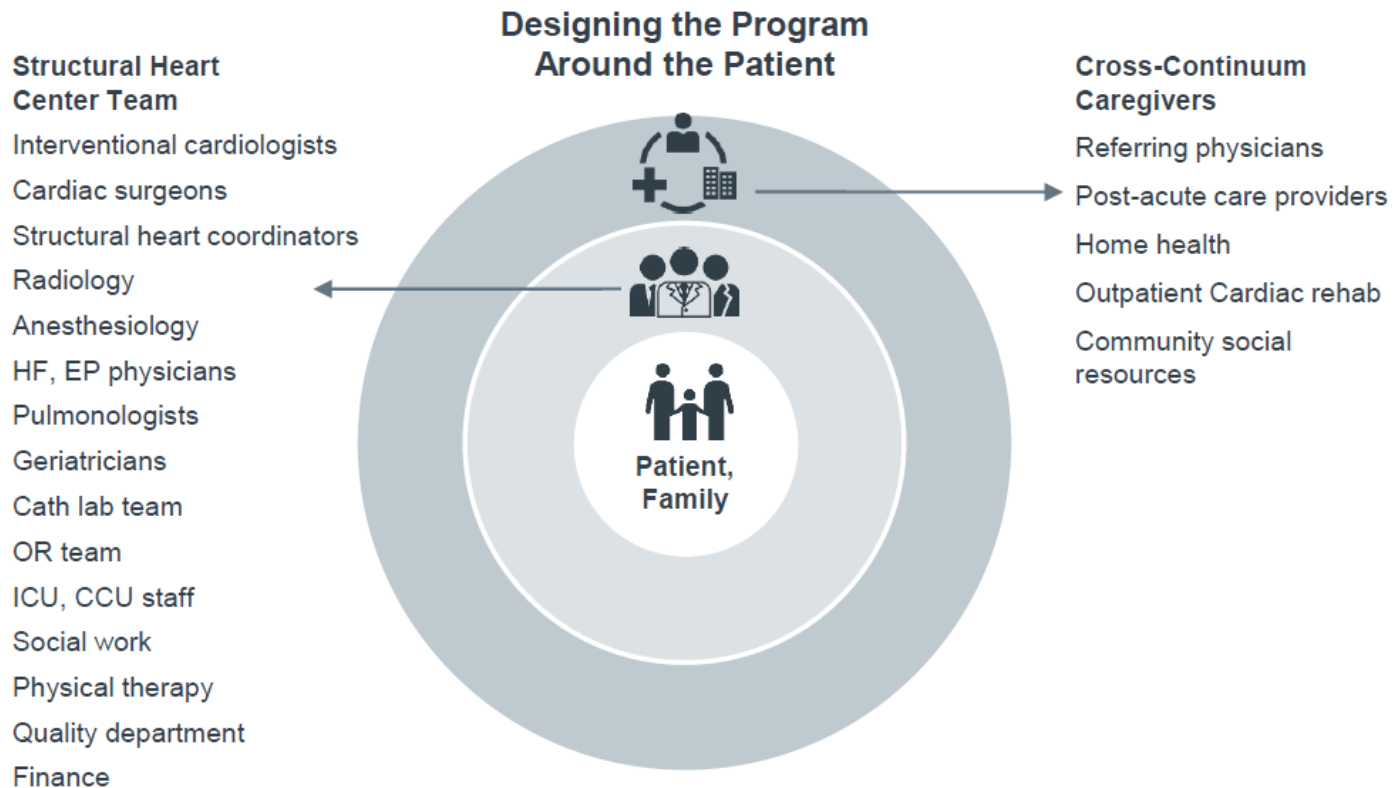
- **TAVR**

- Less major bleeding
- Shorter hospital length of stay
- Reduced incidence of stroke and a-fib

- **SAVR**

- Less paravalvular leak
- Less risk for pacemaker need
- Less vascular complications
- Decreased repeat procedure/surgery rates

# TAVR Team



# Amyloidosis

- 1 in 8 pts with aortic stenosis has concomitant cardiac amyloidosis
  - E.g. transthyretin amyloidosis
- Suspicion raised if:
  - Hx carpal tunnel syndrome
  - Hx lumbar spinal stenosis
  - Disproportionate findings of:
    - HF sx
    - BNP levels
    - Conduction abnormalities
    - Low voltage disproportionate to LV wall thickness
    - Classical LFLG AS
- Rapid pacing is poorly tolerated

# Low flow, low gradient AS

- Defined as having a low stroke volume ( $< 35 \text{ mL/m}^2$  or mean transvalvular flow rate  $< 210 \text{ mL/s}$ )



# Bicuspid aortic valve

- More marked LV remodeling
- Higher incidence of HF
- TAVR technically more challenging
  - Heavier calcification
  - Noncircular LV outflow tract

# Future Studies

- Long-term data on durability of TAVR valves pending
- Multiple trials assessing safety of early TAVR vs watchful waiting
  - Asymptomatic severe AS
  - Moderate AS with low EF

**Thank you!**