

The HK Institution of Engineers

Latest Advances in Heart Surgery

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The University of Hong Kong,

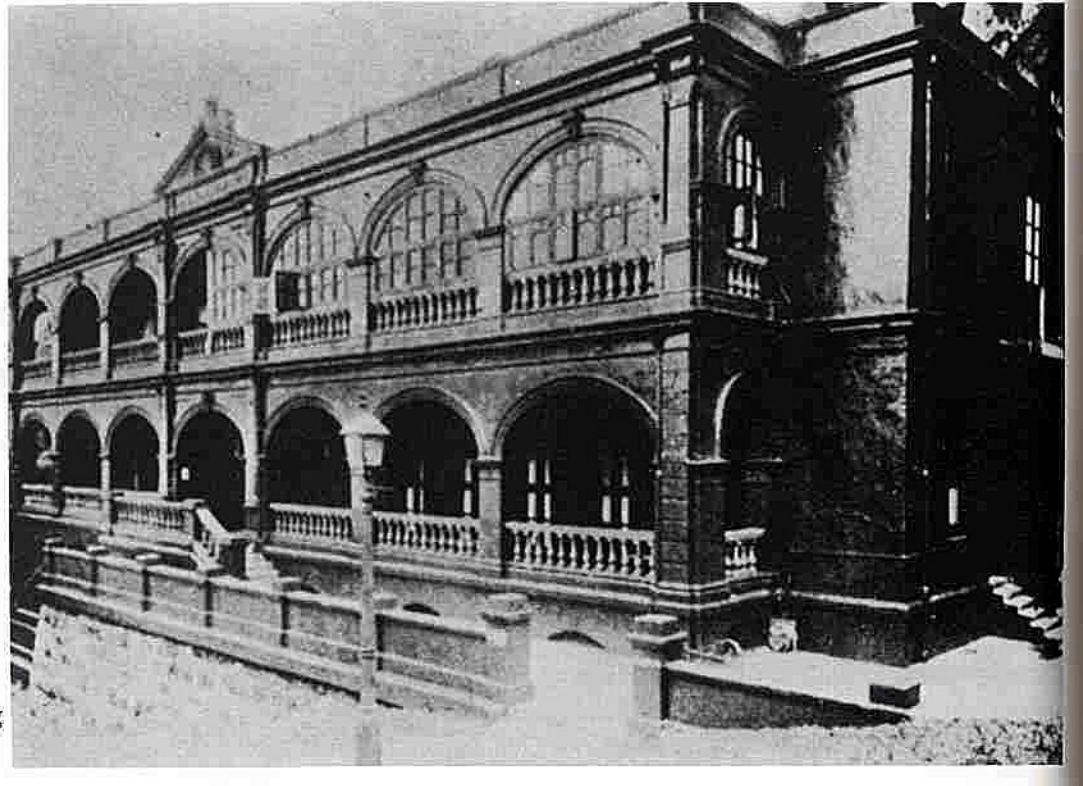
Queen Mary Hospital, Hong Kong SAR



College of Medicine for Chinese

Established in 1887

Two of the College's
leading hospitals in
about 1906.



The Ho Miu Ling
Hospital.

Alice Memorial Hospital – first training hospital in Hong Kong

Our first 2 Medical graduates - 1892



Dr Sun Yat-sen, one of the College of Medicine's first two graduates in 1892, and subsequently President of the Chinese Republic.

Dr. Sun Yat-Sen & Dr. Kong Ying-Wah

Sun Yat-sen (孫逸仙) (1866-1925) was a Chinese revolutionary and political leader who is often referred to as the "father of modern China". Sun played an instrumental and leadership role in the eventual overthrow of the Qing Dynasty in 1911. He was the first provisional President when the Republic of China was founded in 1912. He later co-founded the Kuomintang (KMT) where he served as its first leader.

Sun was a unifying figure in post-imperial China, and remains unique among 20th-century Chinese politicians

University of HK – faculty of Medicine



The College in 1908. Dr Li Shu fan is directly behind and between Rector F.H. May and Dr Ho Kai; from the Rector's right are E.H. Sharp, Standing Counsel, and next to him Dr R.M. Gibson and Dr R.A. Belilios; by Dr Ho Kai is Dr J.C. Thomson, the Secretary. Dean Francis Clark was away.

Chronology

- 1881 : Dr W Young starts to treat poor Chinese
- 1887 : Dr. Ho Kai built the Alice Memorial Hospital
- 1892 : Dr. Sun Yet-Sen graduated
- 1907 : “ Hong Kong College of Medicine”
- 1920 : First Chinese Professor appointed – Wang Chung-Yuk in pathology
- 1922 : Rockefeller foundation funded the chairs in Medicine, Surgery & ObsGyn
- 1937 : Queen Mary Hospital – HKU Medicine Teaching hospital
- 1941 – 1948 : University stopped during WW II
- 1970 : Medical student intake 150
- 1997 : Curriculum reform – Problem-based Learning
- 2005 : Name after philanthropist – Dr. Li Kar Shing
- 2018 : Medical student intake 240

Cardiothoracic Surgery in Grantham Hospital

- 1957 : Grantham Hospital for chest disease
- 1968 : Open heart surgery
- 1979 : Cardiac Catheter Lab.
- 1982 : Cardiothoracic Surgical Center
- 1992 : First heart transplant
- 1995 : First lung & heart-lung transplant
- 2001 : First Artificial Heart Implantation
- 2006 : Minimal Invasive Heart Surgery
- 2008 : Move from Grantham to Queen Mary Hospital
- 2011 : Implantable Ventricular Assist Device

The appearance and main entrance of Grantham Hospital in 1950's
五十年代的葛量洪醫院外觀及入口

ABERDEEN, HONG KONG

The Queen Mary Hospital Cardiothoracic Surgery Department

- 900+ cases heart / aorta surgery per year
- 400+ cases lung surgery per year
- The Only Paediatric Heart center
- The Only Heart and Lung Transplant center



Cardiothoracic Training

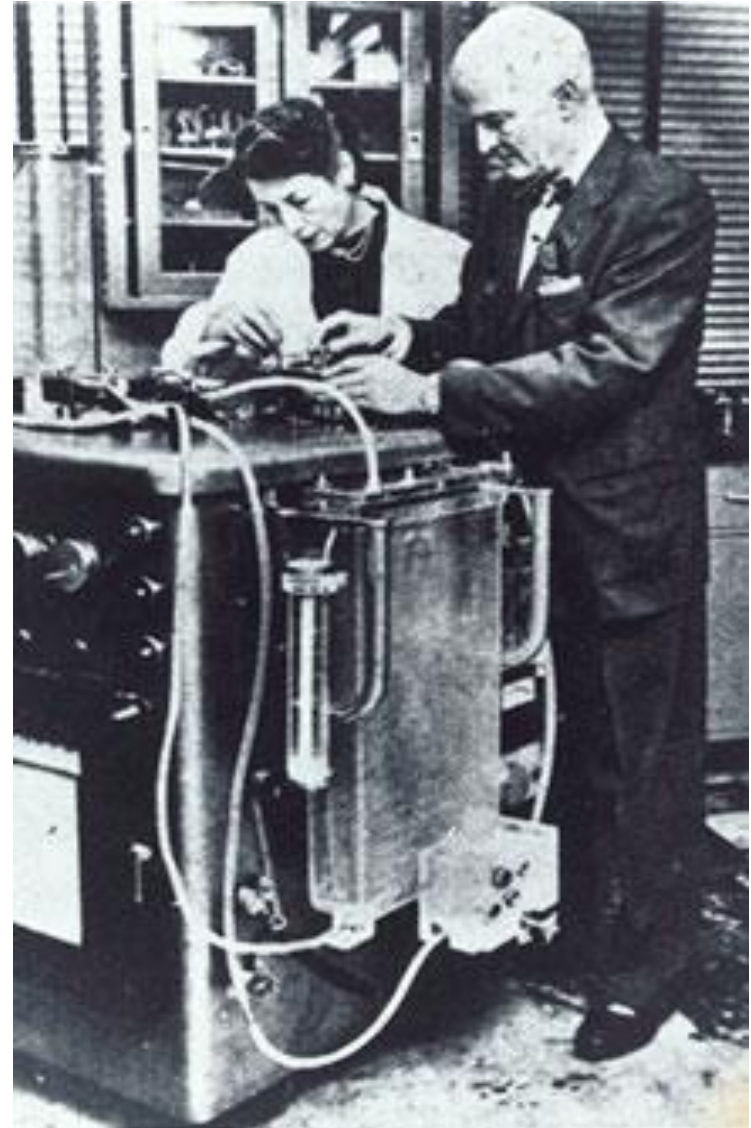
- MB BS
- MRCS part II
- High Surgical Trainee in CTS
 - 5 years training scheme
 - At 4th year : eligible for exit exam – Conjoint with College of Surgeon of Edinburgh / Singapore
 - Rotation among 3 cardiothoracic centers in HK each for 6 months
 - 150 cases – as principle surgeon [supervised]
 - Spend 6 – 12 months overseas training

Today's Talk

- **History of Heart Surgery**
- Coronary Artery Disease
- Heart Transplant and Artificial Heart Pump
- Minimal Invasive Heart Surgery
- Atrial Fibrillation and its therapy

History of cardiopulmonary bypass

- 1952 - Lillihei closed a septal defect with hypothermia alone (10 minutes)
- 1953 - Gibbon used his new invention to close the world first ASD with CP bypass – **time** was no longer a major factor !

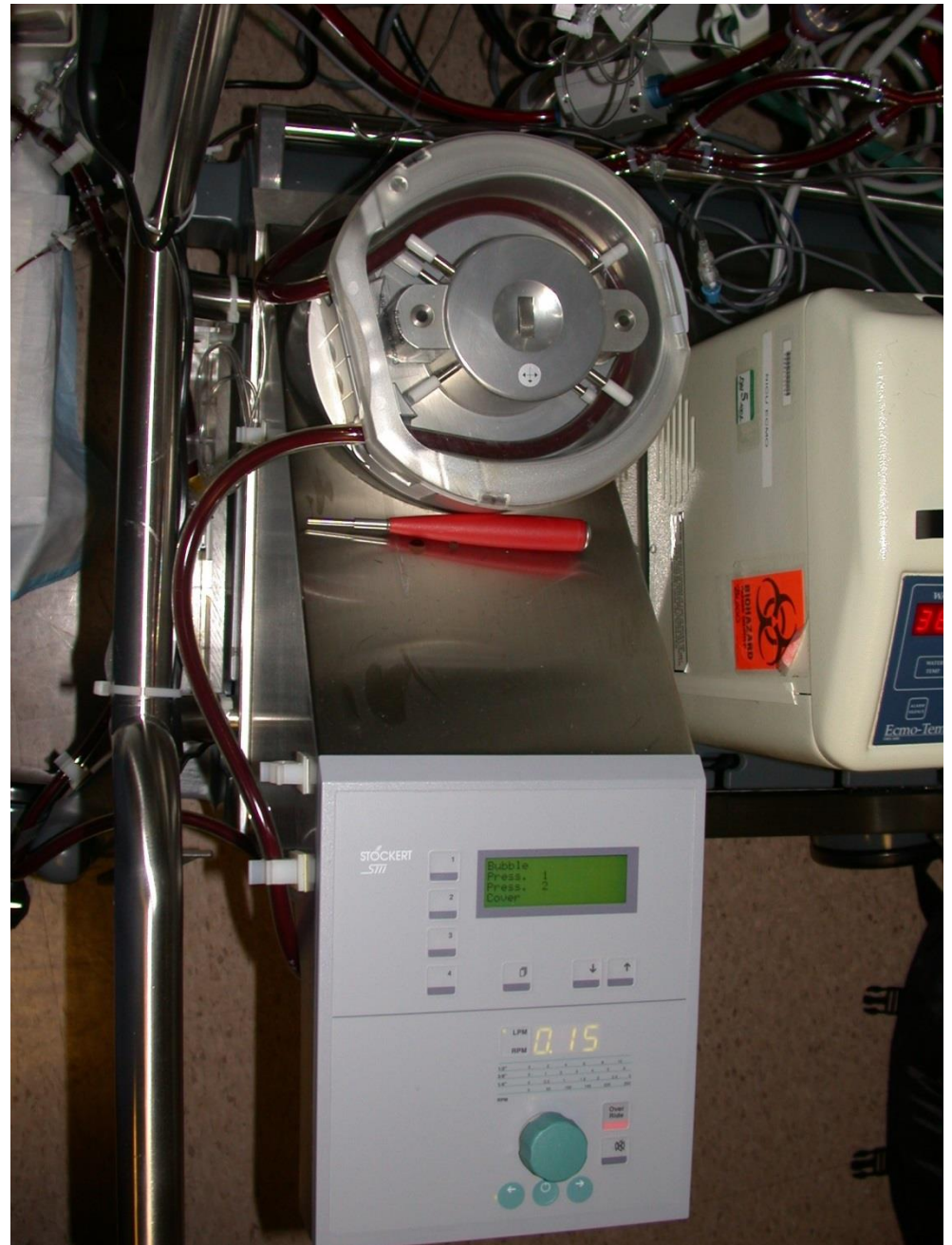


Cardiopulmonary Bypass Circuit

- Arterial pump
 - roller pump, centrifugal pump
- Venous drainage + reservoir
 - siphonage [passive] vs. vacuum suction [active]
- Oxygenator
 - large contact surface area
 - causing blood cells damage, trigger inflammation
- Heat exchange
 - gradient 10 - 14° C [avoid bubble formation]
 - maximum < 38° C

Roller Pump

- Squeezing blood forward in a tube
- Blood trauma
- Resistance dependent



Centrifugal pump

1. Preservation of platelet numbers, decreased complement activation and reduced microbubble transmission
2. Dependent on inflow and outflow
3. High pressure gradient



Cardiopulmonary Bypass Circuit

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Venous drainage

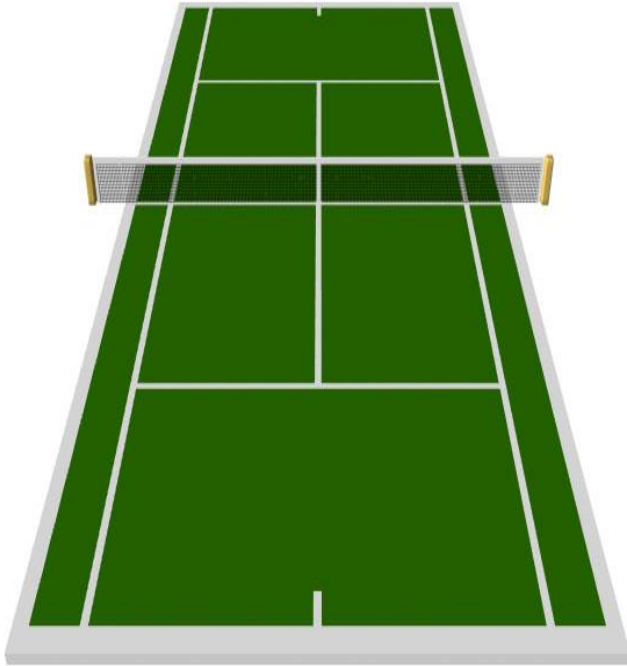
- Siphonage – by gravity
- Vacuum assist drainage
 - Faster drainage with smaller tube
 - Suction via pump
 - Avoid too high suction pressure



Cardiopulmonary Bypass Circuit

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Oxygenator



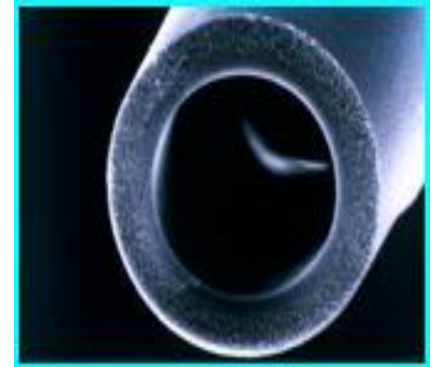
Human Lungs
 25m^2



Bypass Oxygenator
 4m^2

Oxygenator

- Largest surface area contact with blood
- Trauma and inflammatory reaction to blood
- membrane oxygenators
 - microporous
 - hollow fibers
 - siliatic

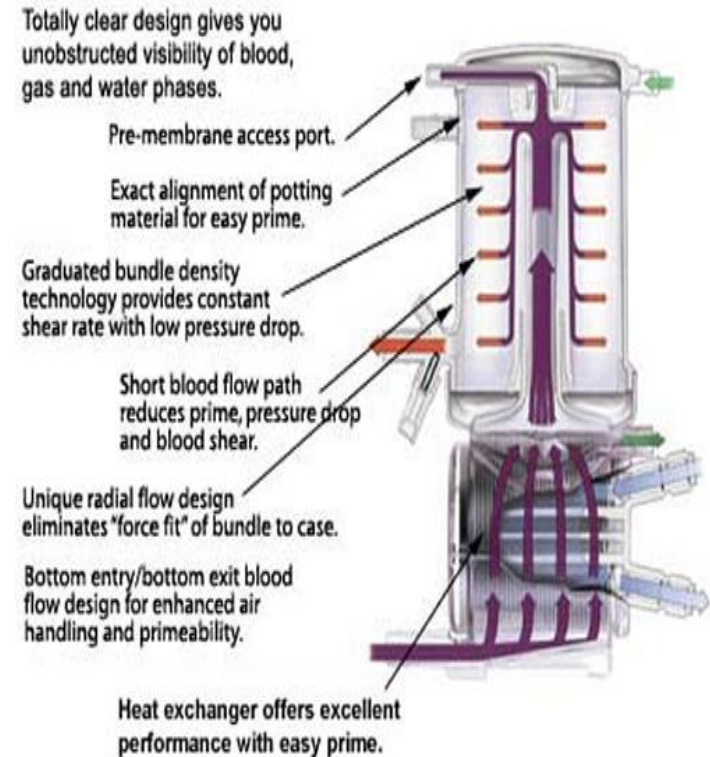


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Heat Exchange

- Temperature control of the blood is important
- Environmental temperature around 18 – 22 degree C
- Active cooling of the blood, lower core temperature
- Organs protection against ischaemia
- Deep hypothermia circulatory arrest – body temp < 20°C
- the brain can withstand 30 mins no blood flow

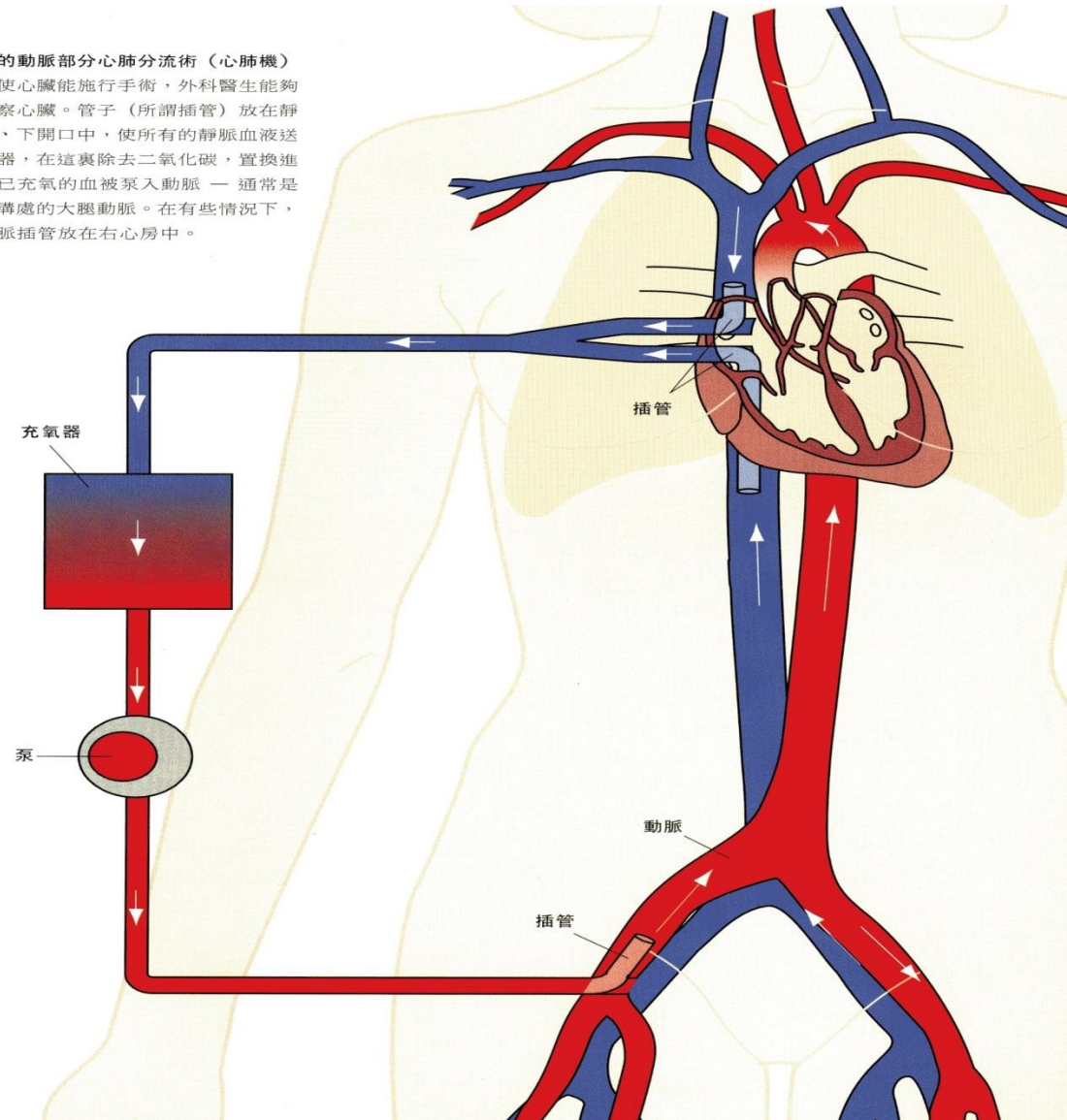
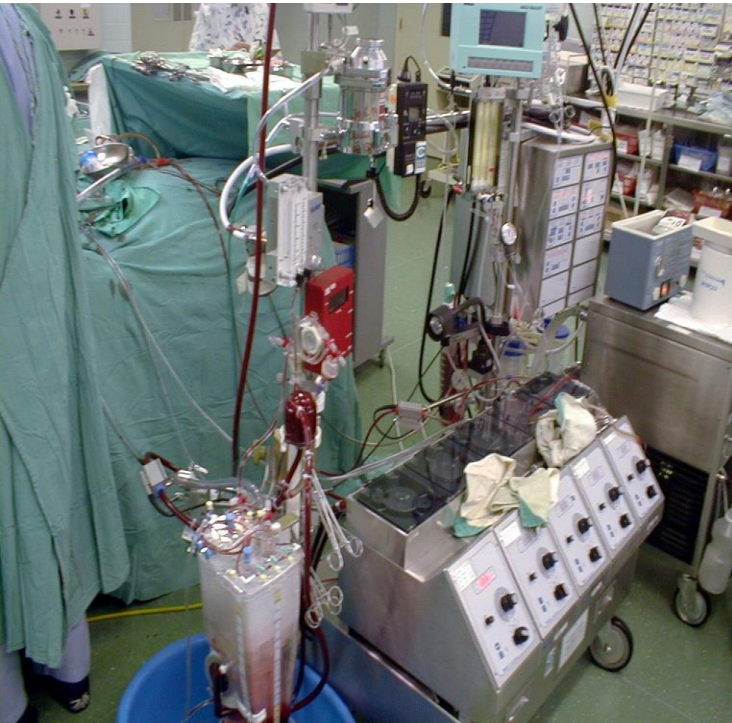


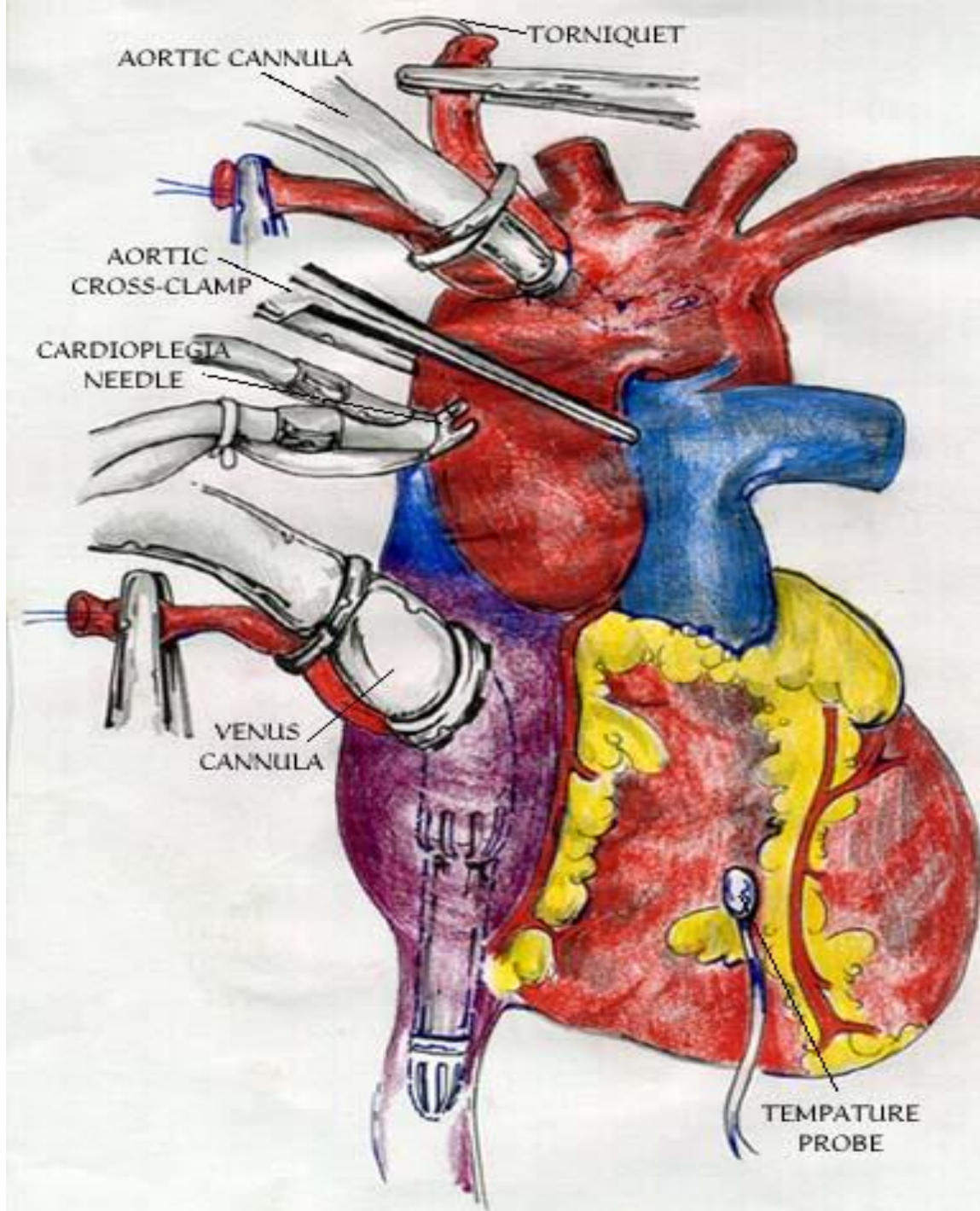
Cardiopulmonary Bypass

- Non-pulsatile arterial blood flow
- Blood components trauma
- Hemodilution
- Foreign surface exposure
- Inflammatory response trigger
- General stress response eg: hypothermia

Cardiopulmonary bypass

有病變的動脈部分心肺分流術（心肺機）
心肺機使心臟能施行手術，外科醫生能夠直接觀察心臟。管子（所謂插管）放在靜脈的上、下開口中，使所有的靜脈血液送到充氧器，在這裏除去二氧化碳，置換進去氧。已充氧的血被泵入動脈——通常是在腹股溝處的大腿動脈。在有些情況下，可將靜脈插管放在右心房中。





- History of Heart Surgery
- **Coronary Artery Disease**
- Heart Transplant and Artificial Heart Pump
- Minimal Invasive Heart Surgery
- Atrial Fibrillation and its therapy

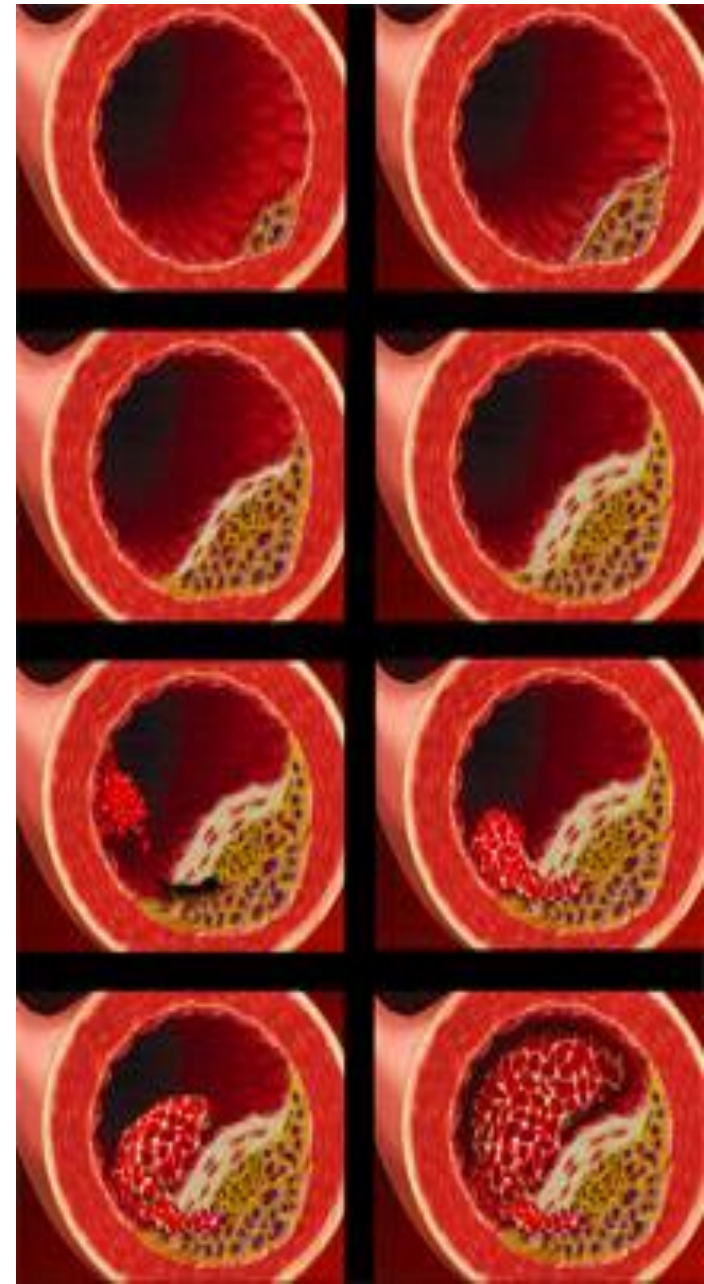
Risk Factors for Coronary Artery disease

- Hypertension
- Smoking
- Hypercholesterolaemia & ↑ Lipids
- Diabetes Mellitus
- Obesity
- Age
- Heredity
- Male gender
- ↑ Homocysteine



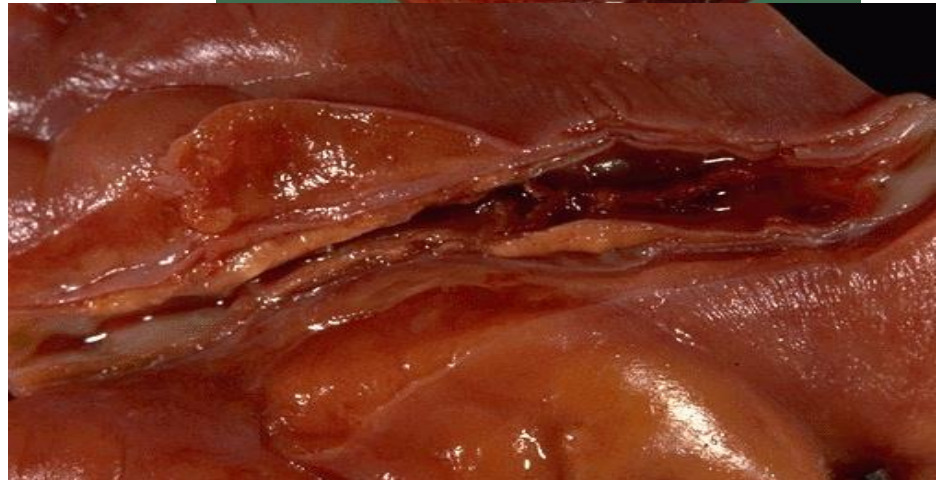
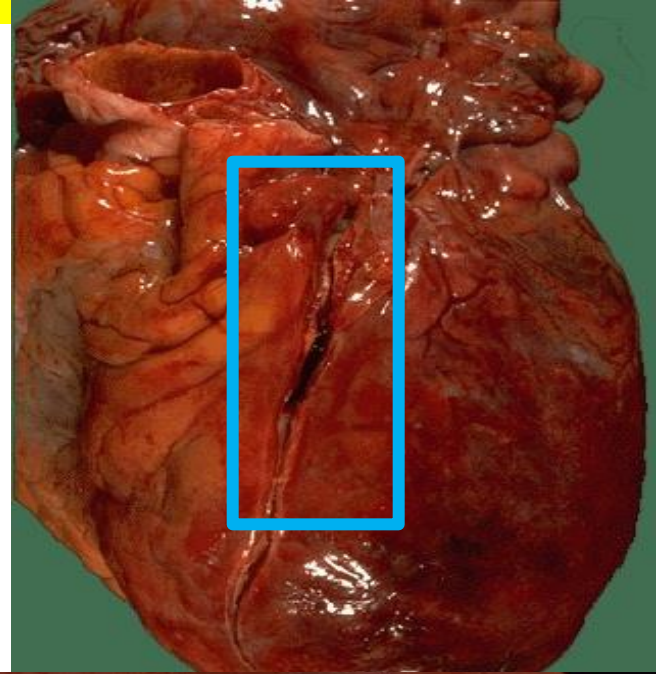
Pathogenesis of atherosclerosis

- Proliferation of smooth muscle cells
- ↑ connective tissue matrix
 - collagen, elastic fibers, proteoglycans
- Lipid accumulation
 - intracellular and extracellular
 - provoke inflammation response
- Plaque formation
- Advanced plaque lesion
 - calcification, haemorrhage
 - fissures & cracks in intima
 - progressive stenosis & occlusion



Acute coronary heart attack !

- Acute myocardial infarction
 - acute coronary thrombosis due to spasm or plaque rupture
 - ↑↑ incidence 6 am to 12 noon, Monday, Winter
- Ischemia - angina
 - chronic occlusion with collaterals





Treatment for acute coronary events

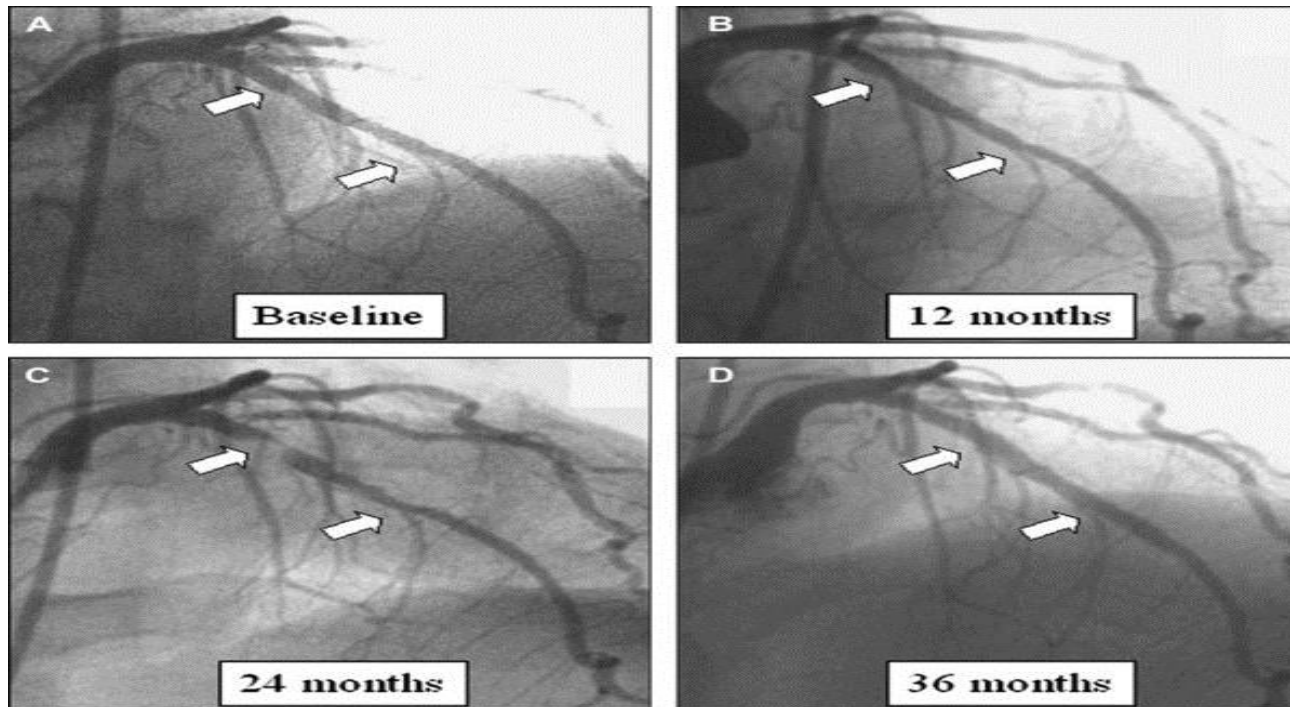
- Coronary thrombolysis and anti-platelets
- Intra-aortic balloon pump [IABP]
- Angioplasty & stenting
- Coronary artery bypass graft surgery

Treatment for acute coronary events

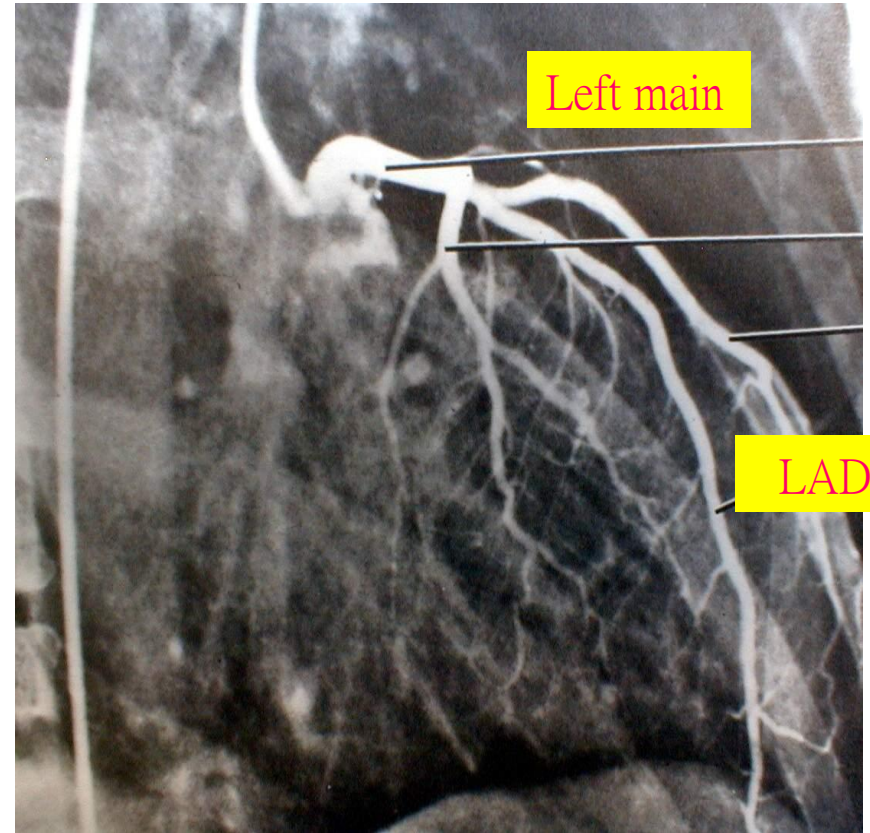
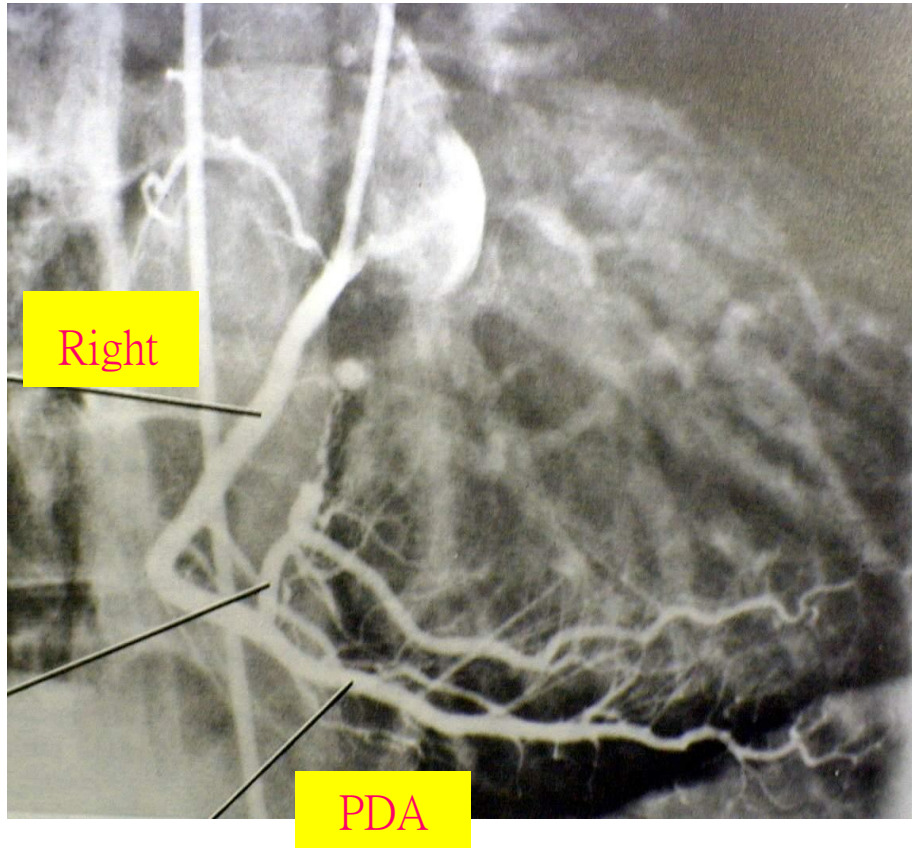
- Coronary thrombolysis and anti-platelets
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Coronary Angiogram

- Still the gold standard for diagnosis of coronary artery disease
- Alternative such as CT coronary angiogram or MRI are catching up

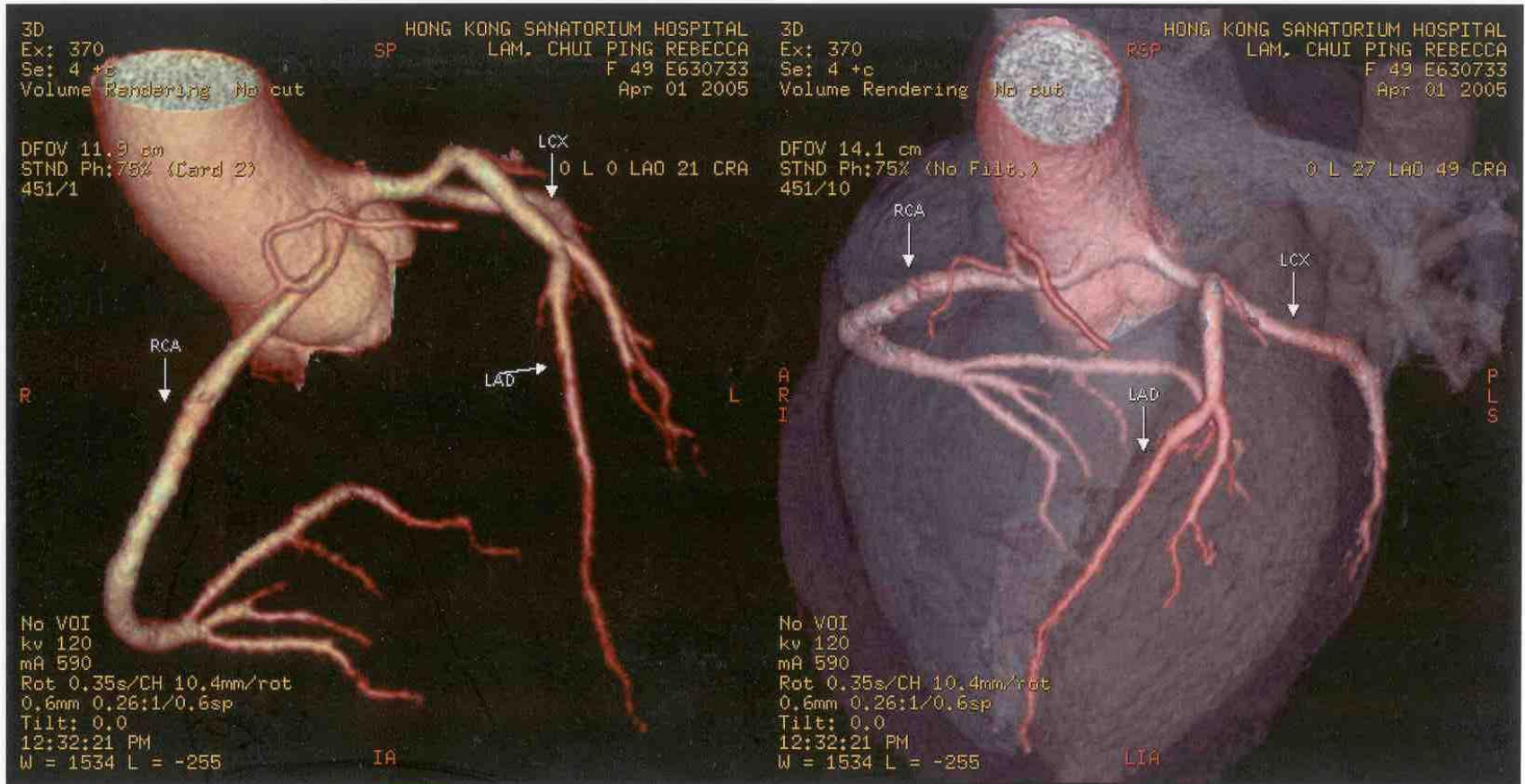


Anatomy of Coronary Artery



CT coronary angiogram

CT CORONARY ANGIOGRAPHY



Hong Kong Sanatorium & Hospital

CT Coronary Angiogram

Table 1 -- Systematic reviews: studies of patient-based analysis using 64-slice coronary CTA

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Year	N
Stein et al. ^[1]	98	88	93	96	2008	2045
Mowatt et al. ^[2]	99	89	93 ^[b]	100 ^[b]	2008	1286
Abdulla et al. ^[3]	98	91	94	97	2007	875
Gopalakrishnan et al. ^{[4], [a]}	96	91	93	96	2008	596
Sun et al. ^[5]	97	88	94	95	2008	1027

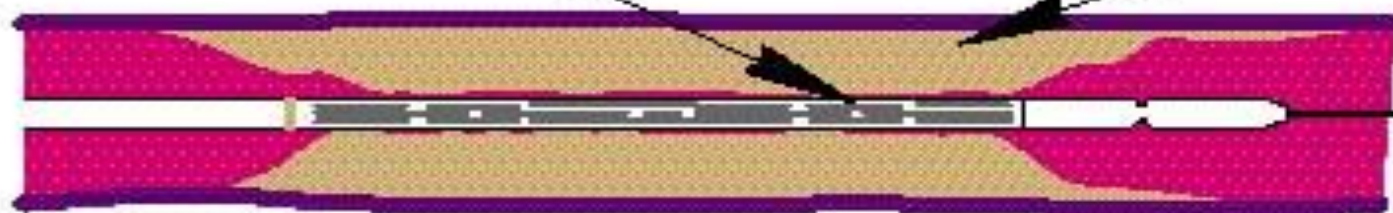
Abbreviations: NPV, negative predictive value; PPV, positive predictive value.

- a This analysis included one study with 40-slice MDCT.
- b PPV and NPV were reported as median values.

Coronary Stent

- 1977 Balloon Angioplasty
- 1993 Coronary metal stent
 Self expanding metal stent
- 2001 Coated stent
 Stent with heparin coating is an example
- 2003 Drug-eluting stent
 Cypher stent is an example. Sirolimus-eluting stent can limit in-stent restenosis due to endothelium overgrowth

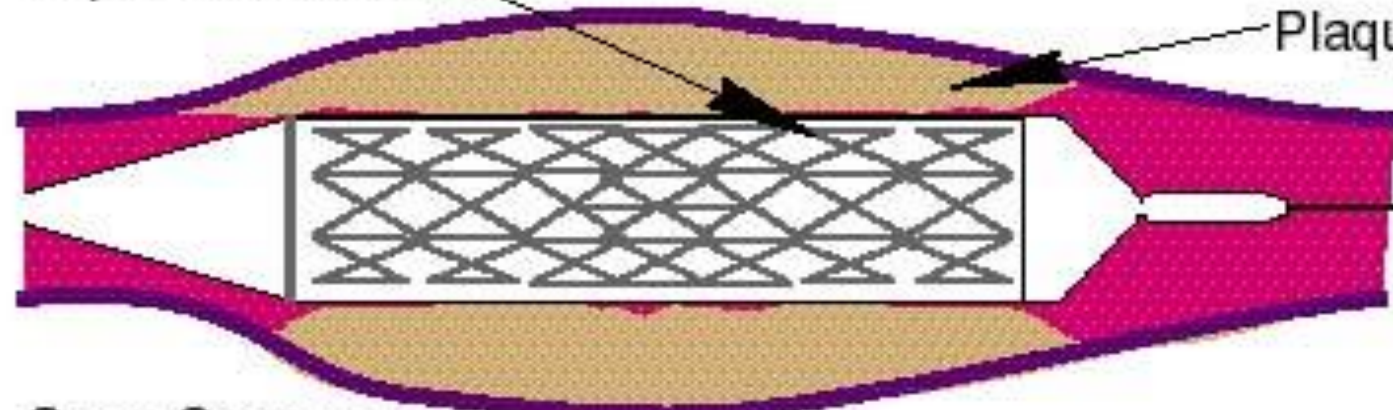
Catheter with Contracted Stent



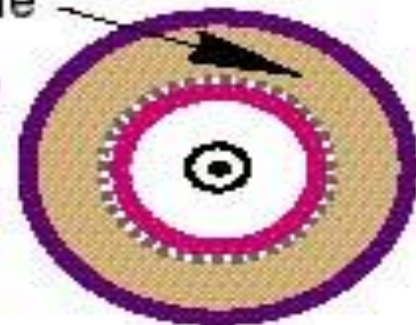
Plaque



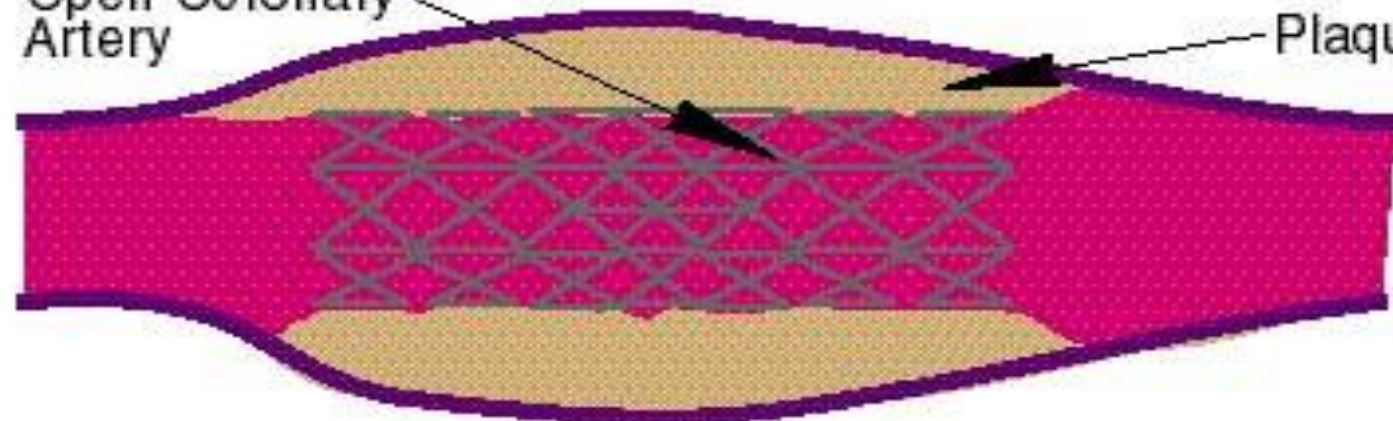
Catheter with Expanded Stent



Plaque



Open Coronary Artery



Plaque



Coronary artery balloon dilatation and stenting



History of CABG

Coronary Artery Bypass Graft Surgery

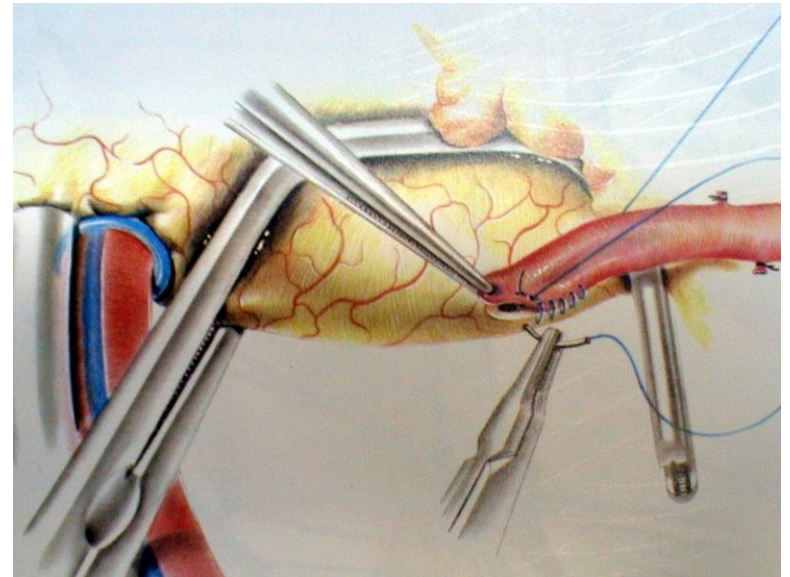
- 1954 - Murray connect an axillary artery to the LAD in animal study
- 1963 Garret applied leg vein to bypass heart coronary vessels (pioneer of today's CABG)
- Not until 1973 when Garret reported his findings with world wide acceptance.



Indications for CABG - Summary

- Triple vessels disease
- **Symptomatic patients not suitable for Balloon / Stenting**
- Diabetes mellitus with multi-vessels disease
- Compelling anatomy of coronary lesions
 - left main coronary artery stenosis
 - proximal LAD long lesions
 - Symptomatic or not
- Post-MI complications
 - post infarction VSD, LV aneurysm
 - ischemic mitral regurgitation

Coronary Artery Bypass Graft



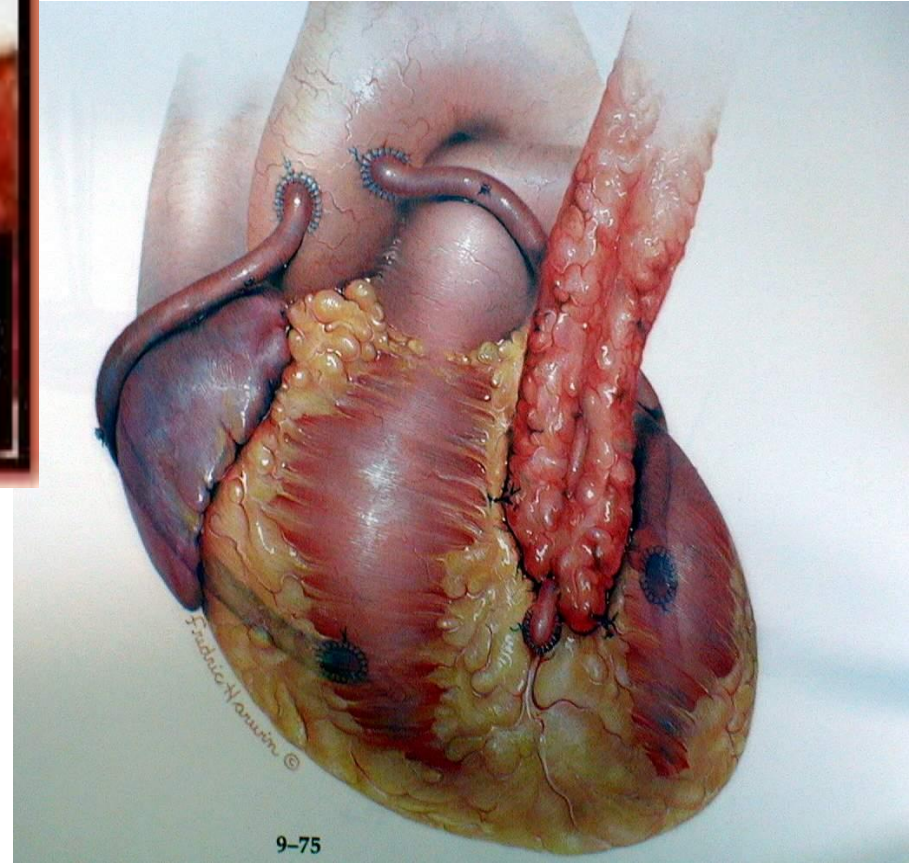
Arterial grafts

- Left internal mammary artery
 - good patency rate *10 years 90 %*
 - better survival rate and less complication
- Right internal mammary artery
 - more difficult for grafting
 - bilateral IMA ↑ complication and ↑ time
- Radial artery
 - Can use both hands
 - 10 years patency rate around 70-80%

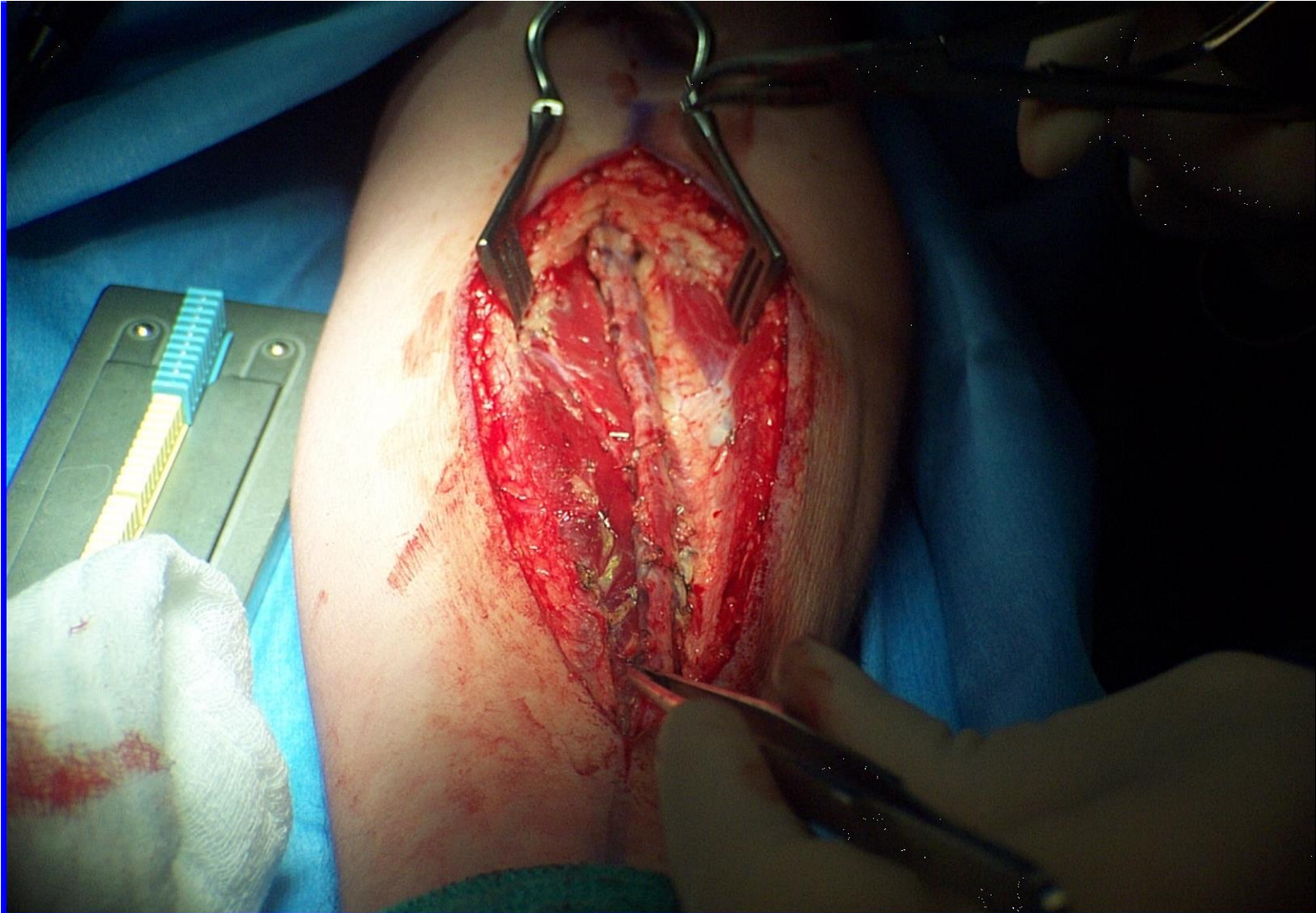
Internal mammary artery graft



QuickTime?and a
H.264 decompressor
are needed to see this picture.

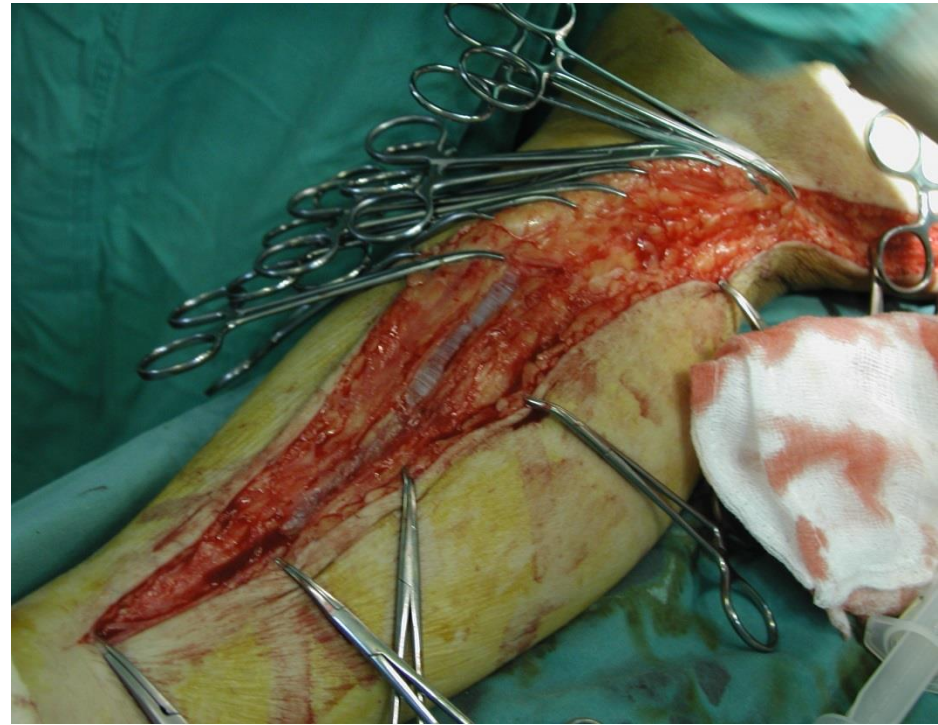


Radial artery graft



Vein grafts

- Greater saphenous vein
 - good length, easy to harvest, mild side effect
 - patency rate *10 years 50 %*

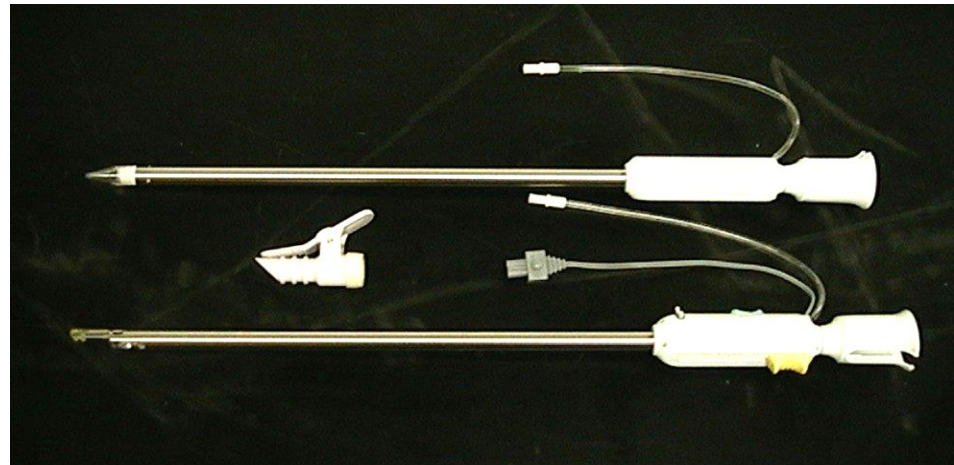
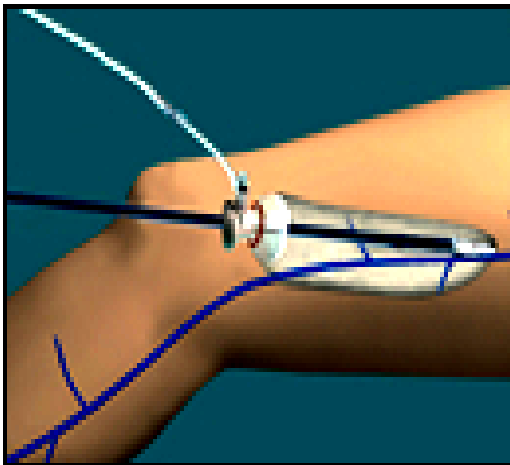


Wound complications



Endoscopic leg vein harvest system:

- Developed by Terumo Cardiovascular
- FDA approved Class II medical device
- Videoscopic minimal invasive technique
- Small incision 1-2 inches, 3 - 4 cuts and veins dissected underneath the skin tunnel



Endoscopic minimal invasive long saphenous vein harvest **EVH**

Video is unavailable here.

Video is unavailable here.

EVH post-op 2 week



EVH post-op 1 months



Endoscopic Radial [hand] Artery Harvest

Contraindications

- Peripheral vascular disease
- Dominant hand
- Artery injury eg: catheter
- End stage renal failure
- Arteritis eg: SLE



Post-CABG complications

Atrial arrhythmias	30%
Ventricular arrhythmias	5%
Leg wound infection	5%
Myocardial infarction	5%
Respiratory failure/infection	5%
Bleeding	3%
Sternal wound infection	3%
Stroke	3%
Renal failure	2%

Outcome events for CABG

Queen Mary Hospital

CABG in hospital mortality :

2 to 2.5% 2010 - 2015

Off Pump CABG or [Beating Heart CABG]

- 1970' s South American countries
 - Public could not afford CP bypass technology
- 1990' s Became popular in US & Europe
 - Avoid complications associated with CP bypass and perfusion
 - Shorter hospital stay and early recovery
 - Lower cost
 - May reduce general risk and mortality



Off Pump CABG

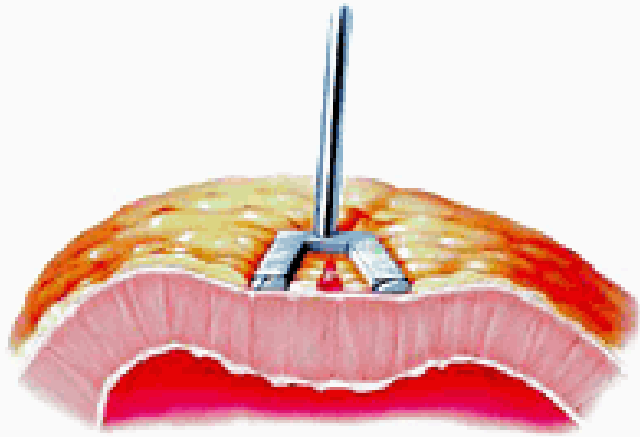


FIGURE 7

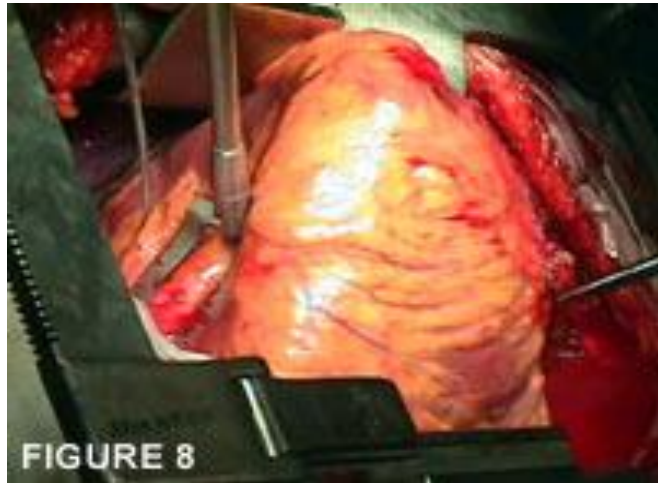
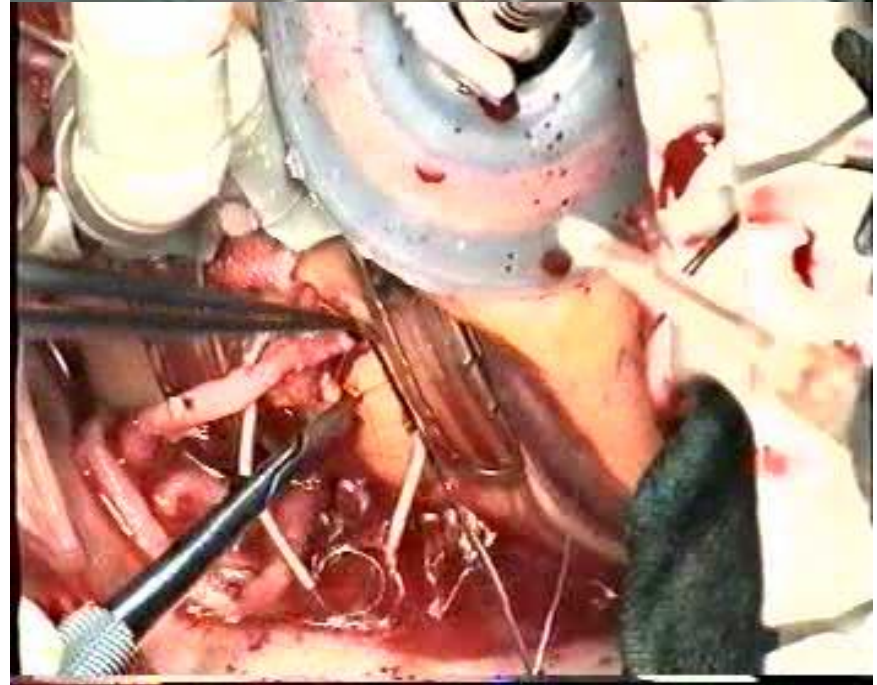


FIGURE 8



Off-pump CABG

- CABG with beating heart
- Learning curve and training
- Stabilizer
- Eradicate side effects from cardiopulmonary bypass
- ? Optimal anastomoses
- Multiple vessels disease more difficult

Off pump vs On pump CABG

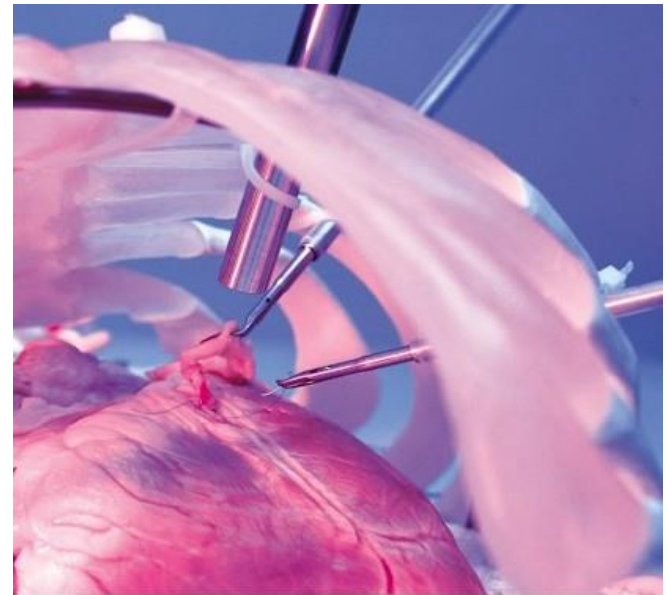
- Lower mortality ?
- Lower MI or stroke rate ✓
- Lower hospital cost ✓
- Lower general complications ±
- Long-term graft patency rate ?
- Results re-producible ?

Off-Pump CABG offers some survival benefit to some patient subgroups : redo CABG, diabetes, old age and Stroke patients

Robotic arm assist CABG



- 3-Dimension visual field
- advanced computer assist robotic arms, key hole surgery



Close-Up View of Zeus Robots Operating on a Model Heart

Da Vinci system II model Xi



Last Resort Therapy

- Heart transplantation
- Mechanical assist device
- Total artificial heart
- Stem cells / myoblast transplant



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That was how it
startedin 1967

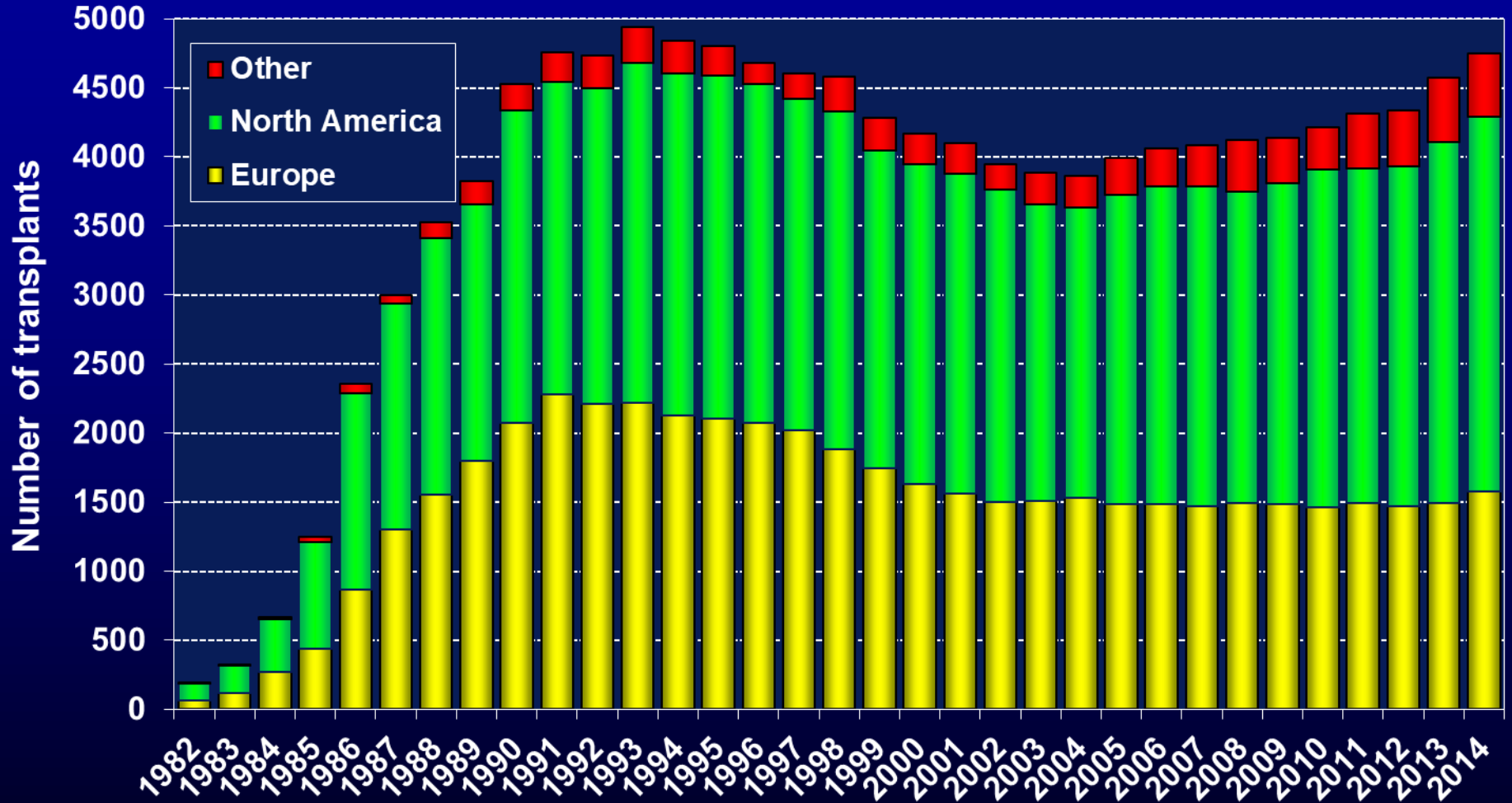


Heart transplantation

Historical background

- 1905 Carrel - heart transplantation in dog
- 1944 Medawar - concepts of organ rejection
- 1964 Shumway - technique of heart transplant
- 1967 Barnard - world first human heart transplant
- 1980 Stanford University - Cyclosporin A
- 1996 USA - 3500 heart transplant / year

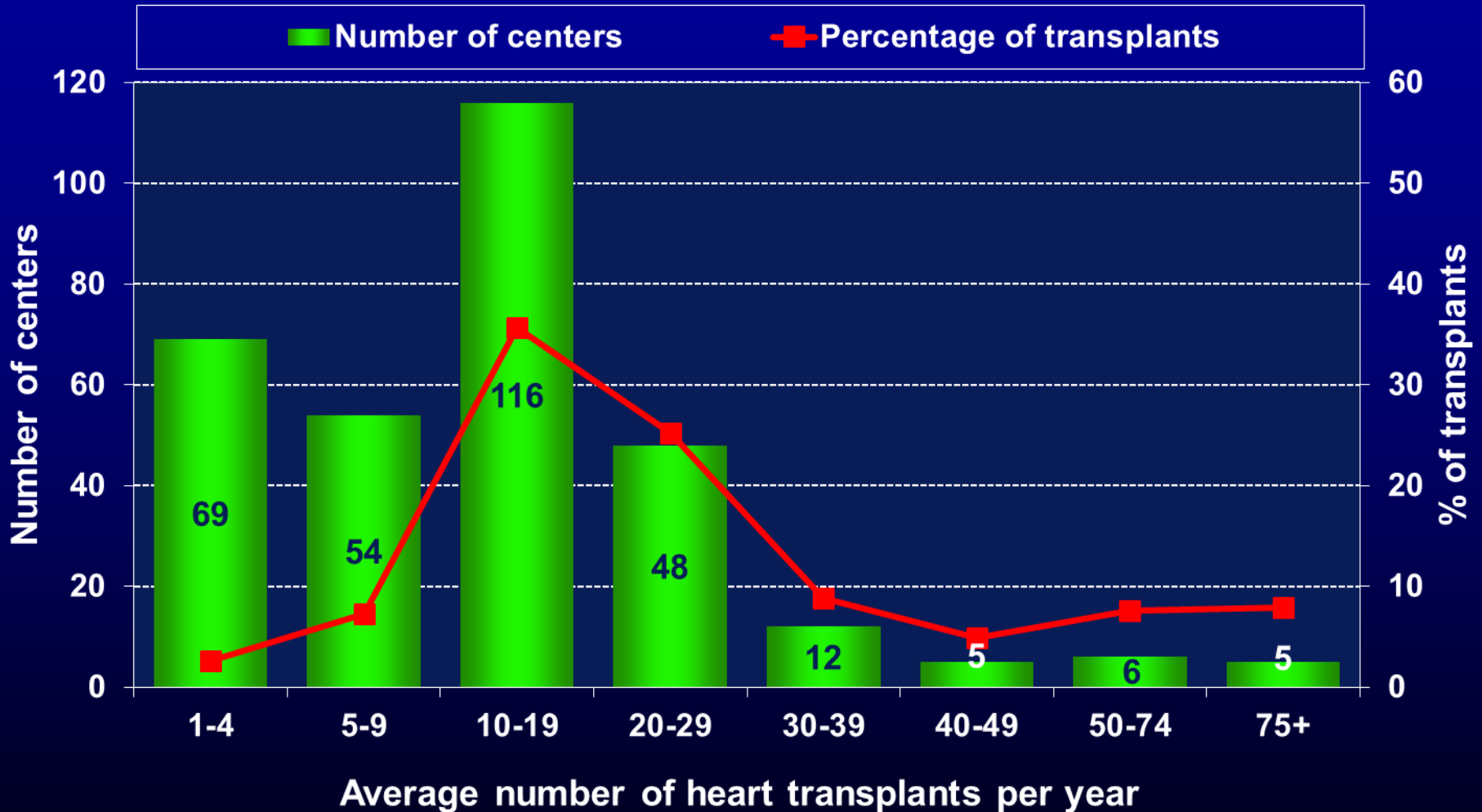
Number of Heart Transplants reported World Wide



NOTE: This figure includes only the heart transplants that are reported to the ISHLT Transplant Registry. As such, the presented data may not mirror the changes in the number of heart transplants performed worldwide

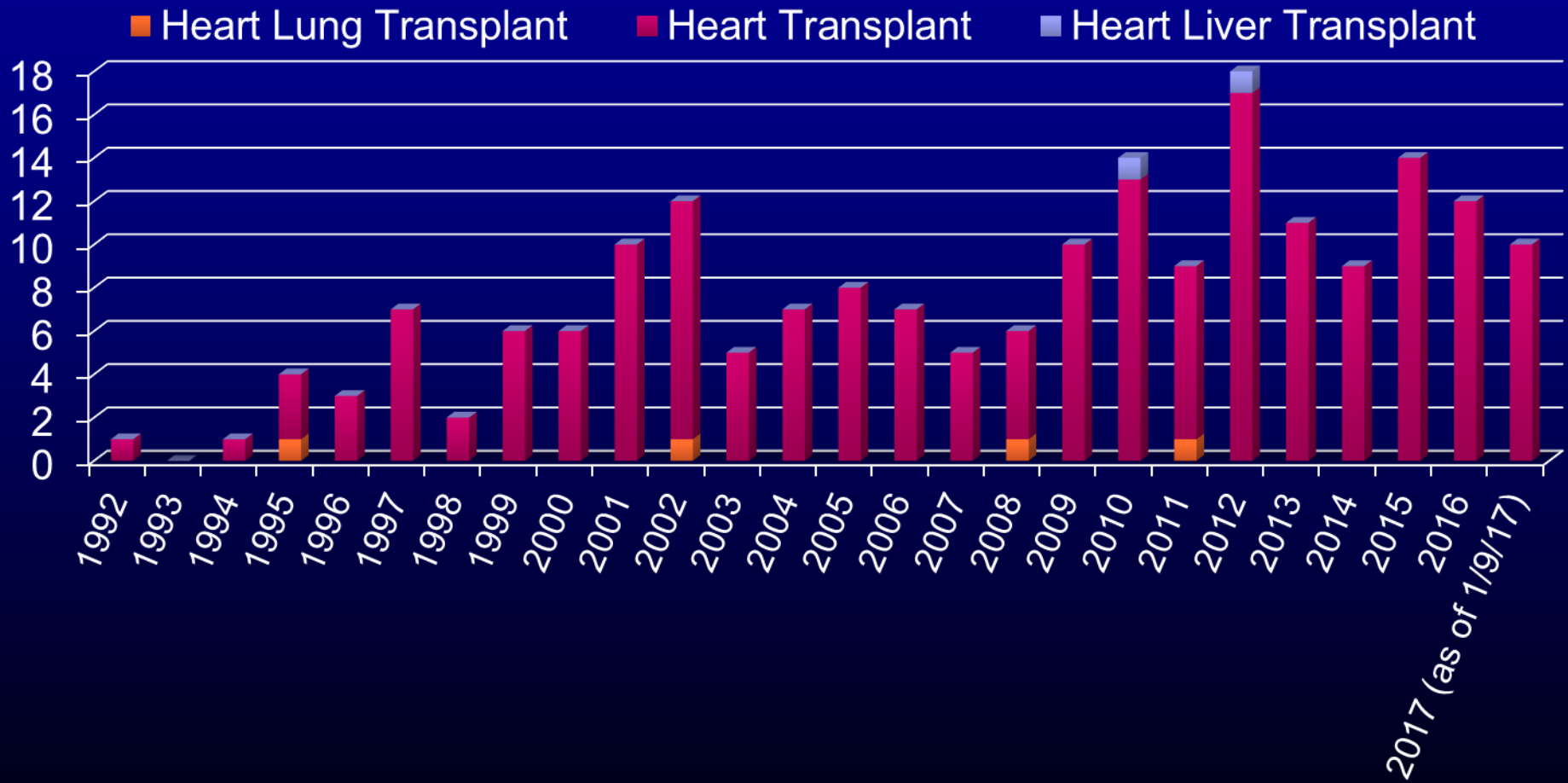
Average Central Heart Transplant Volume

Heart Transplants: (January 2009 – June 2015)

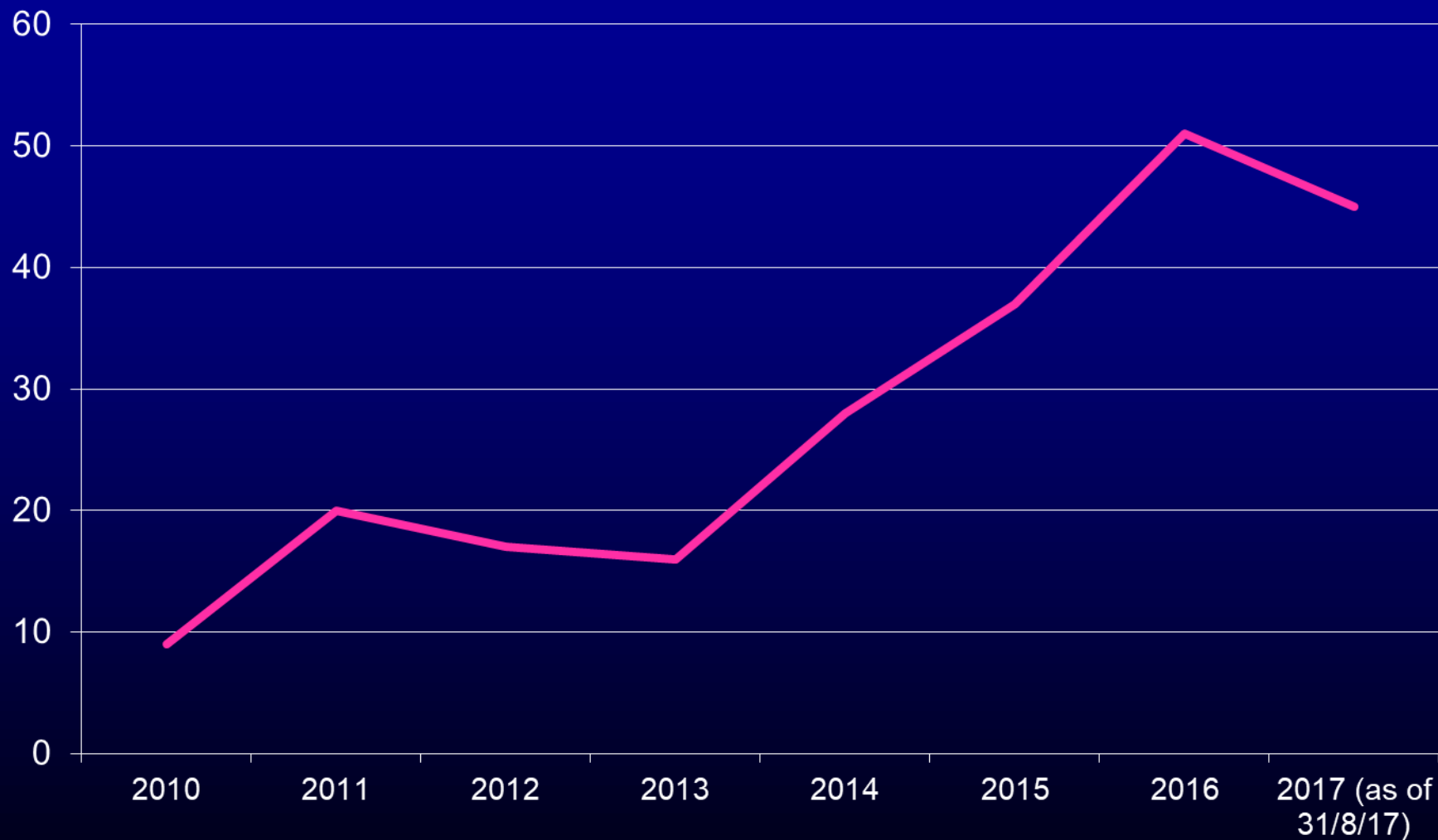


Number of Heart Transplants in HK

Total numbers of Heart Transplants: 191 (include. 2 Heart-Liver Tx)



Number of patients on heart transplant waiting list in Hong Kong



History of Heart Transplant in Hong Kong

Population : 7.5 Million

- 1st Heart Transplant 1992 - Grantham Hospital
- Brain stem death Law
- Artificial Heart [LVAD]program for BTT
- Annual Heart Tx : 10 - 15

Number of Heart Transplant Center : 1

- Queen Mary Hospital



Prof. CK Mok

Dr. SW Chiu

Cardiac donor criteria

- Age – newborn to 60+ (>50 may require a coronary angiogram)
- Negative history of cardiac disease
- Negative history of severe thoracic trauma
- No prolonged CPR, hypotension, or hypoxaemia*
- Normal ECG and echocardiogram*
- Inotropic support under 10mcg/kg/min on dopamine or dobutamine following restoration of volume*
- Negative for HIV and preferably negative for hepatitis B & C*

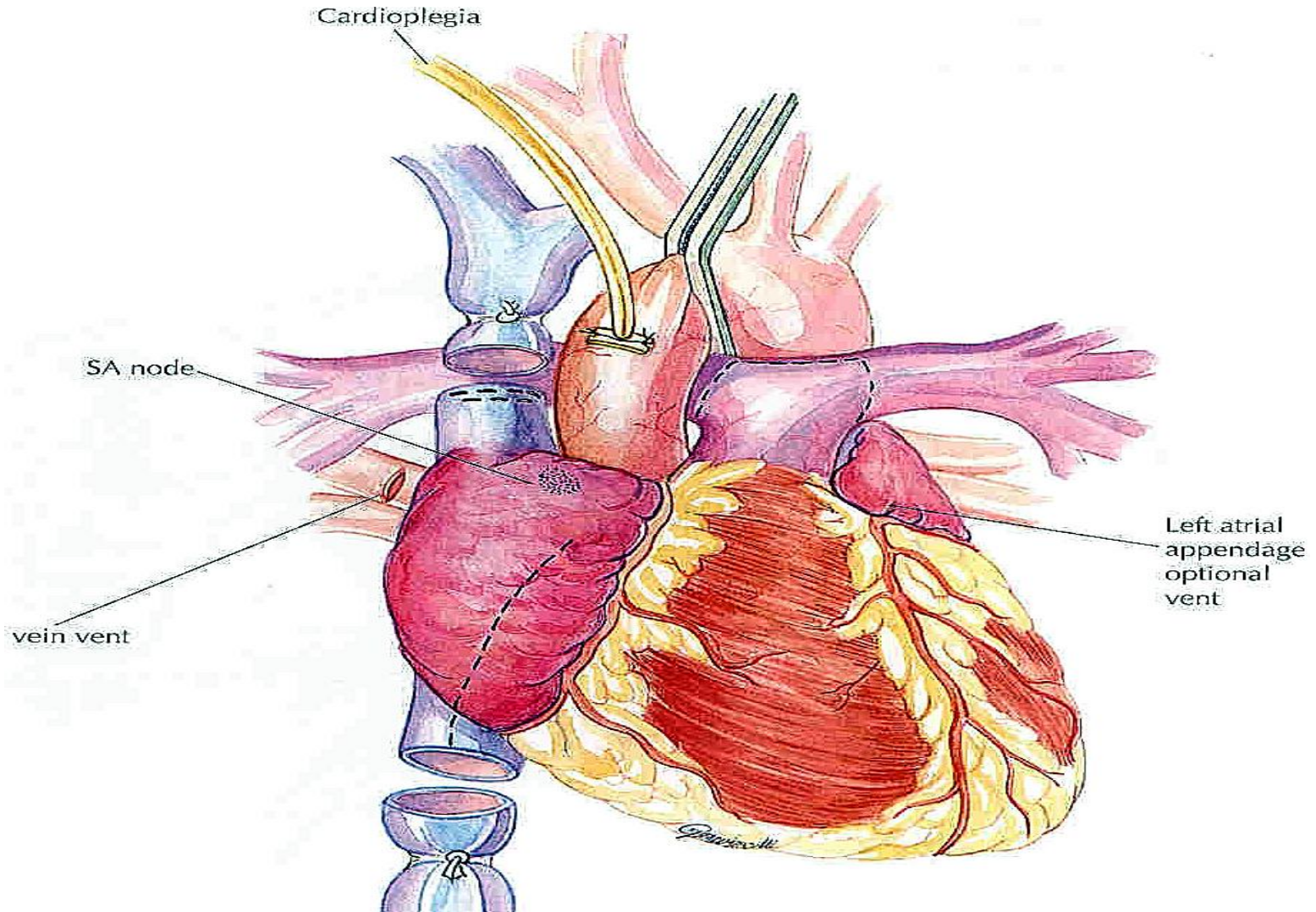
Matching of donors and recipients

- Compatible ABO blood group
- Body weight of donor \pm 20% body weight of recipient
- Other considerations include
 - Priority given to Status 1 patients, patients waiting for heart-lung transplantation
 - Time on waiting list
 - (Sensitized, positive PRA patients) negative lymphocytotoxic screening
- HLA matching not necessary

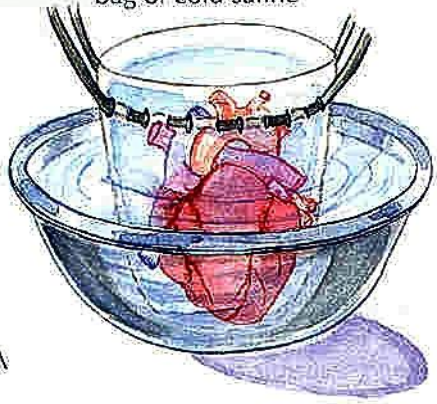
Donor heart preservation

- Cardio-protection – Custodial solution
- Removal
- Storage in 4° C Hartmann solution
- Can survive for over 4 hours in the Ice Box

Donor Heart Removal

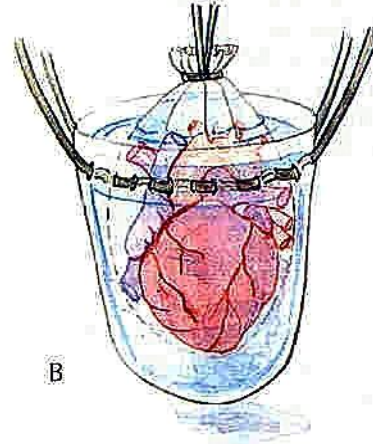


Heart immersed in a bag of cold saline



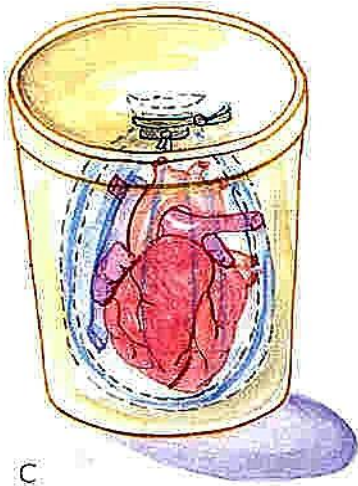
A

Heart placed in a second bag of cold saline for sterility precautions



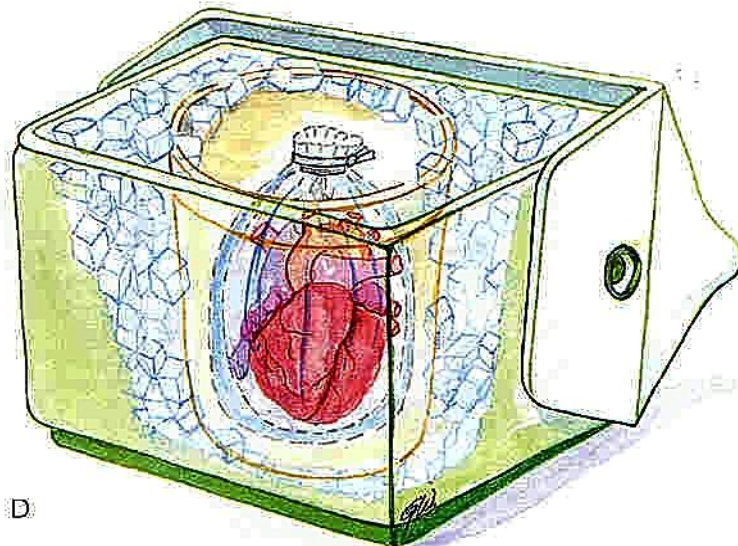
B

Heart placed in an air-tight container of cold saline



C

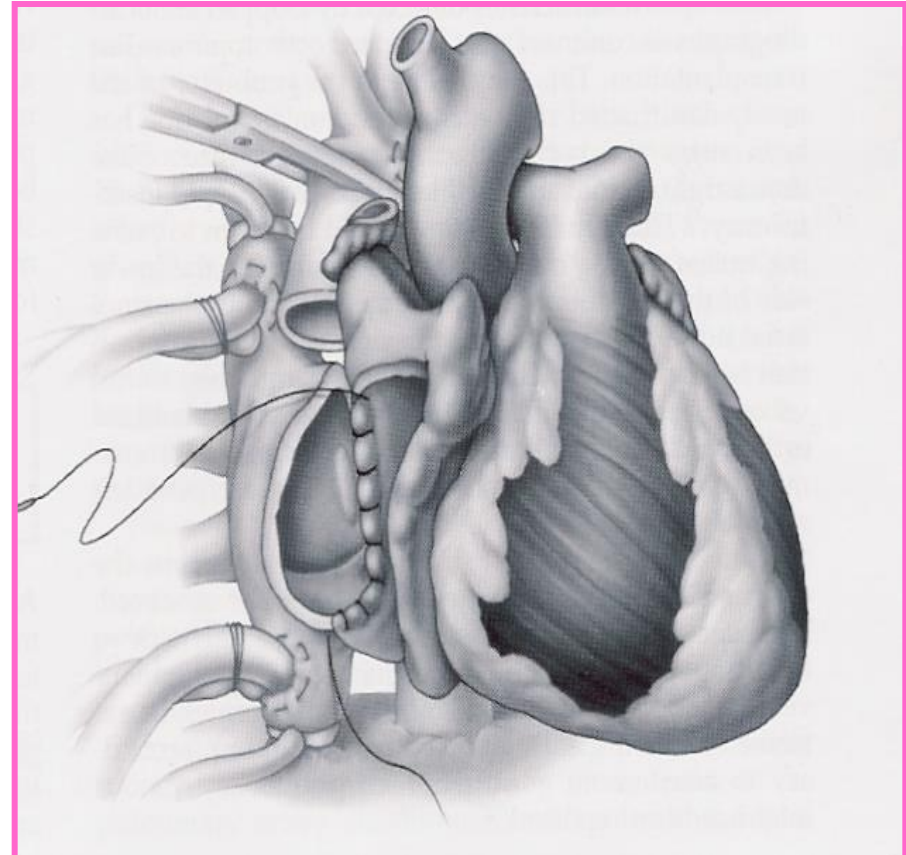
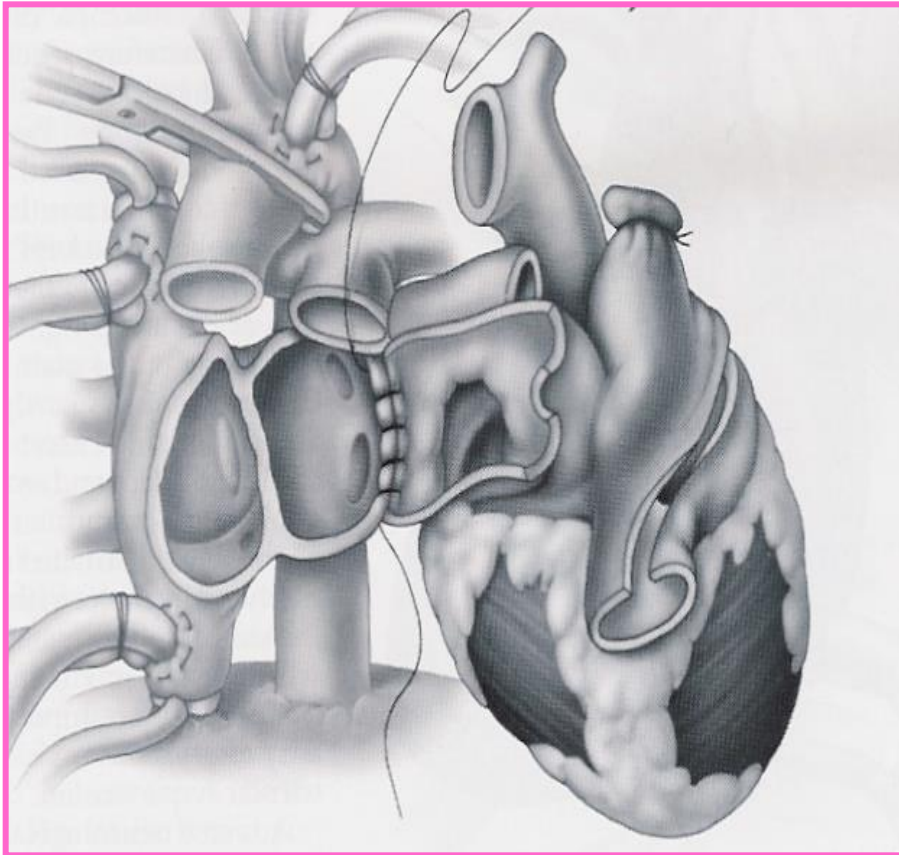
Air-tight container placed in a cooler with ice



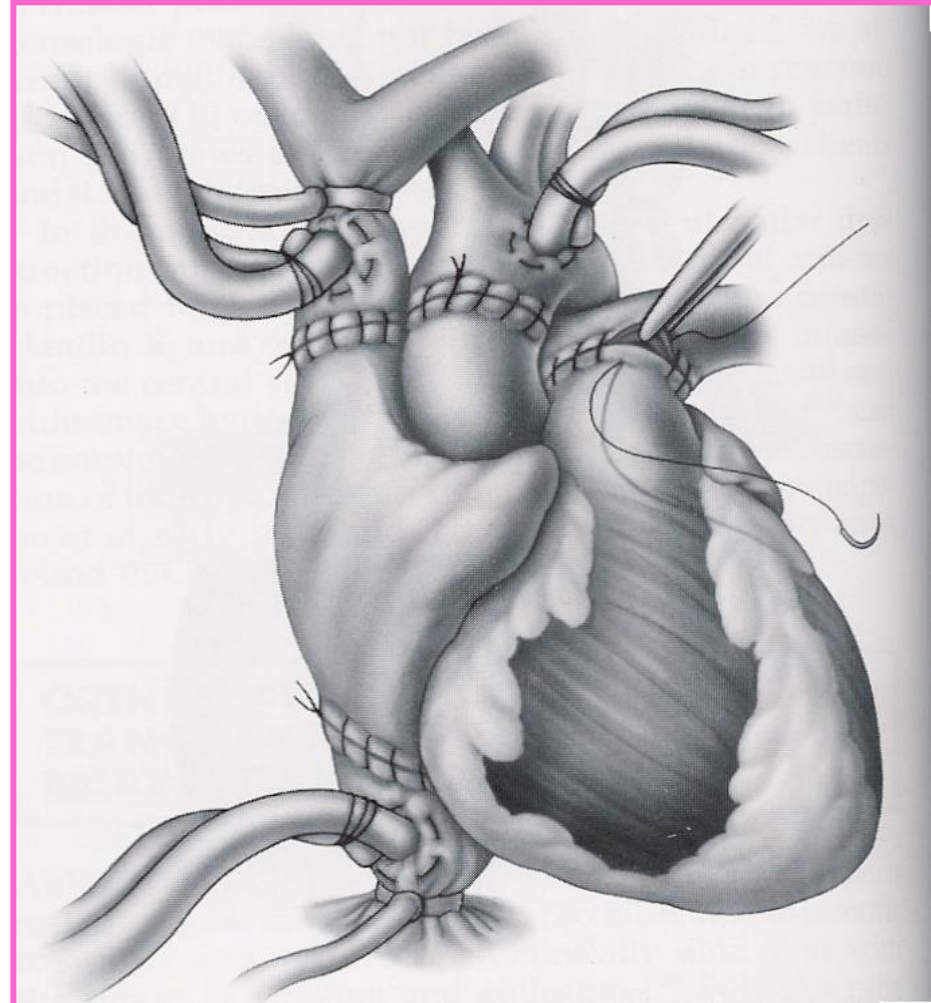
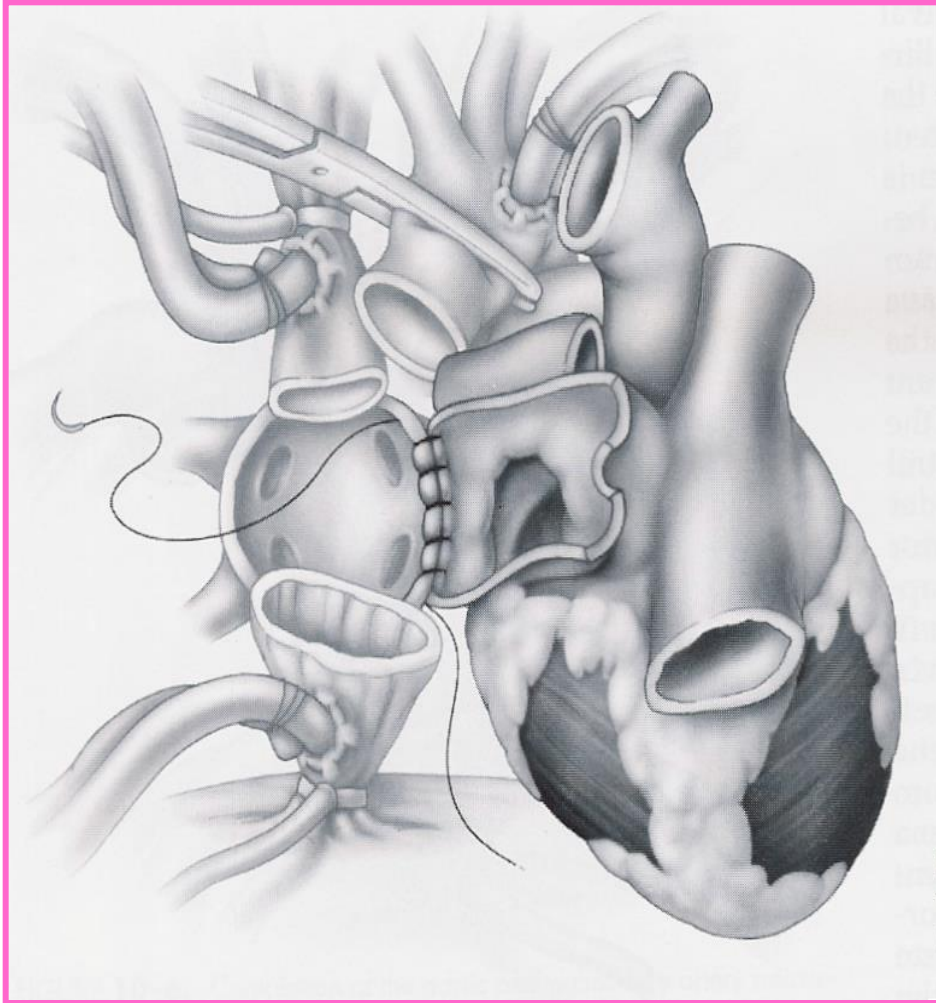
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FIGURE 5-6 Preparation for transportation.

Bi-atrial (Standford's) Technique

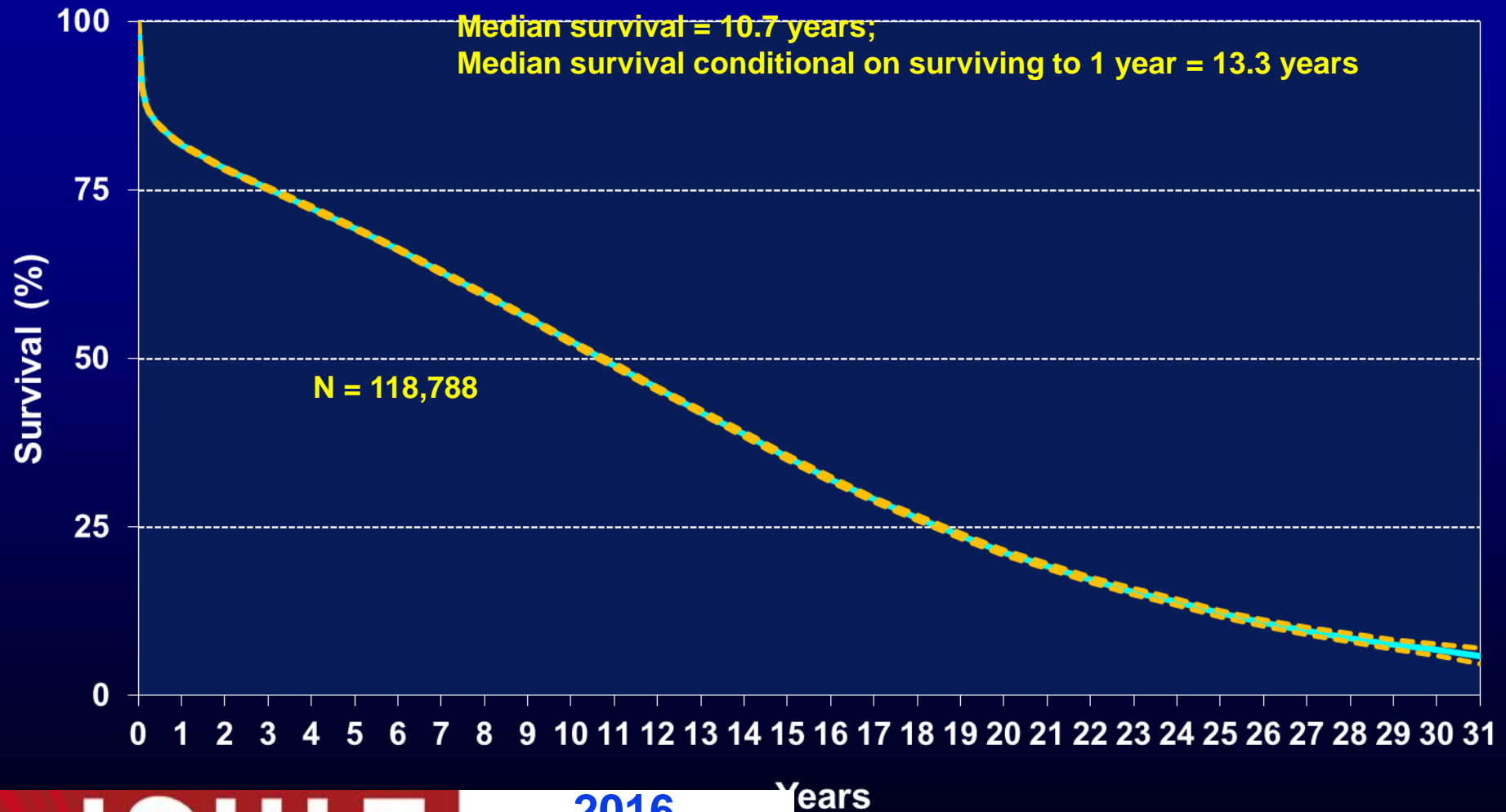


Bicaval Technique



HEART TRANSPLANTATION Survival World Wide

(Transplants: January 1982 – June 2015)



Years

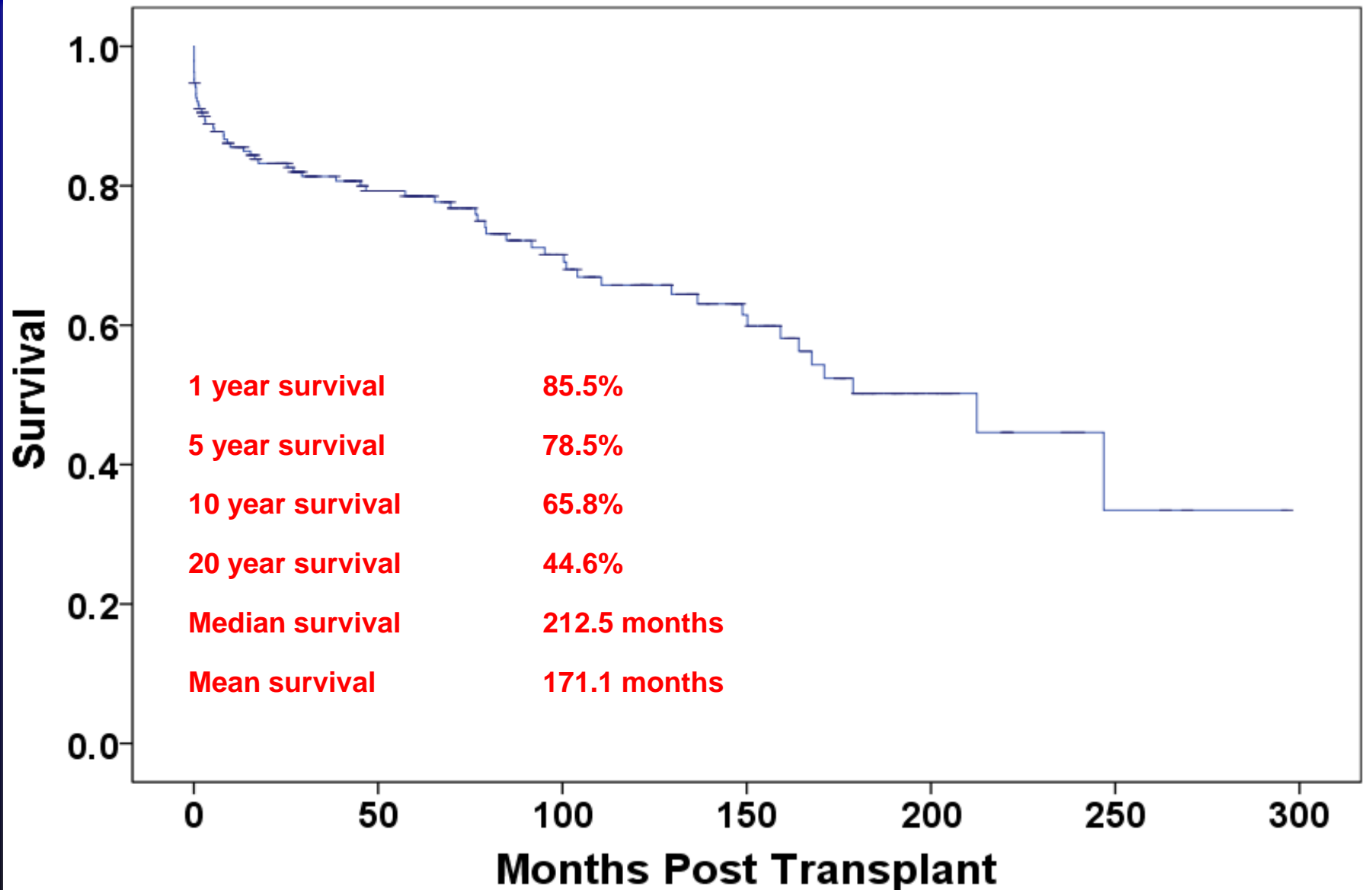
ISHLT

2016

ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION

JHLT. 2016 Oct; 35(10): 1149-1205

Heart Transplant Survival in HK



Potential Heart Transplant Candidates Referred to
the Grantham Hospital for Assessment 1992-2017

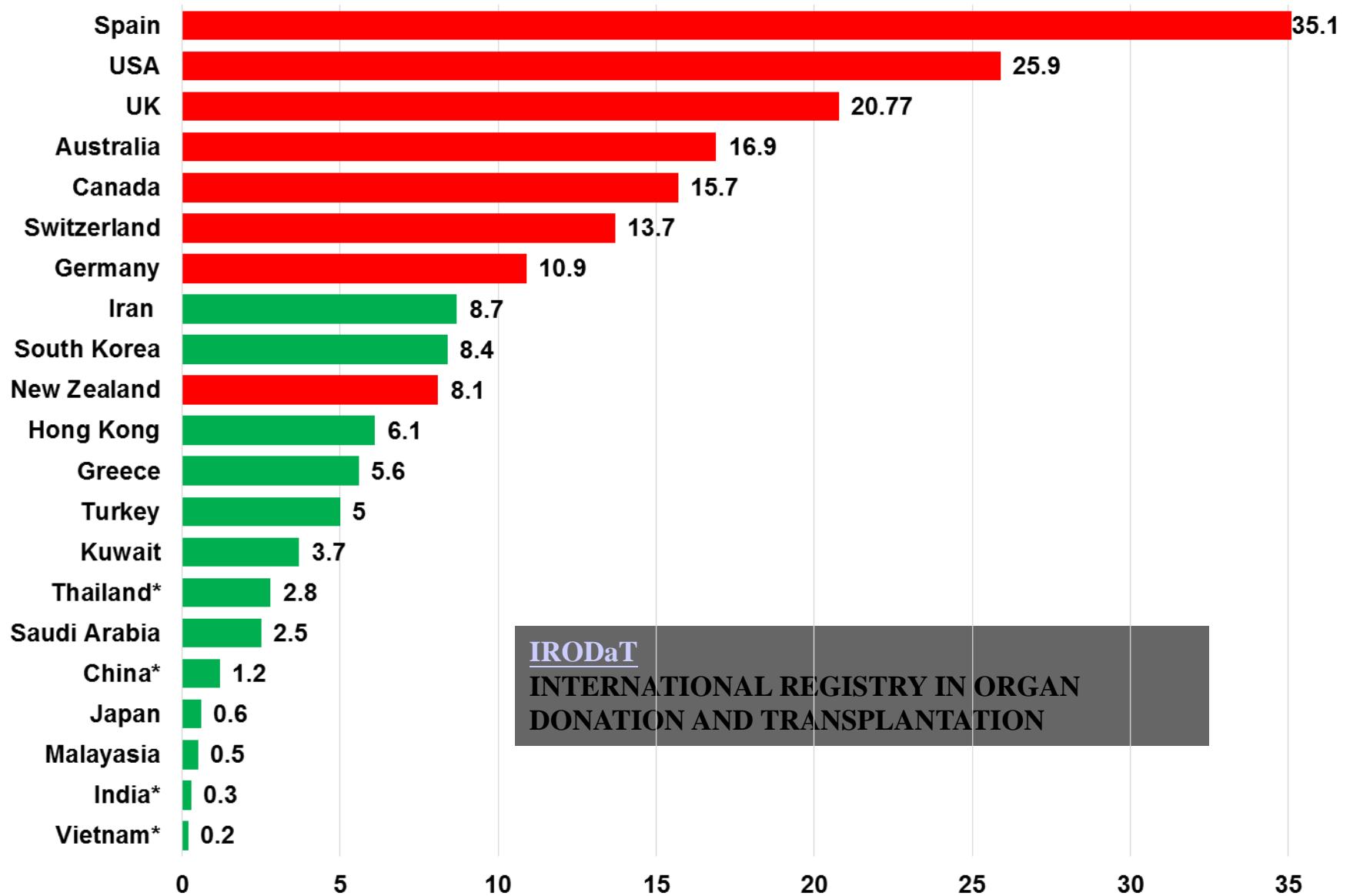
On average, 25 % of eligible
Heart Transplant patients
died while waiting for suitable
donor !

Heart Transplant in Asia

	2012	2013	2014	2015	2016
Korea	107	127	118	145	156
Taiwan	76	77	80	76	77
Japan	28	37	37	44	51
Thailand	12	12	23	24	16
Hong Kong	16	11	9	14	12
Singapore	2	4	0	6	6
Malaysia	0	1	0	1	0
Philippines	0	0	0	0	0
China	?	?	?	400+	400+
India	?	?	?	200+	200+

Sporadic data showing Iran, Lebanon, Oman, Vietnam also have heart transplant program but not consistent data

Worldwide Actual Deceased Organ Donors 2013



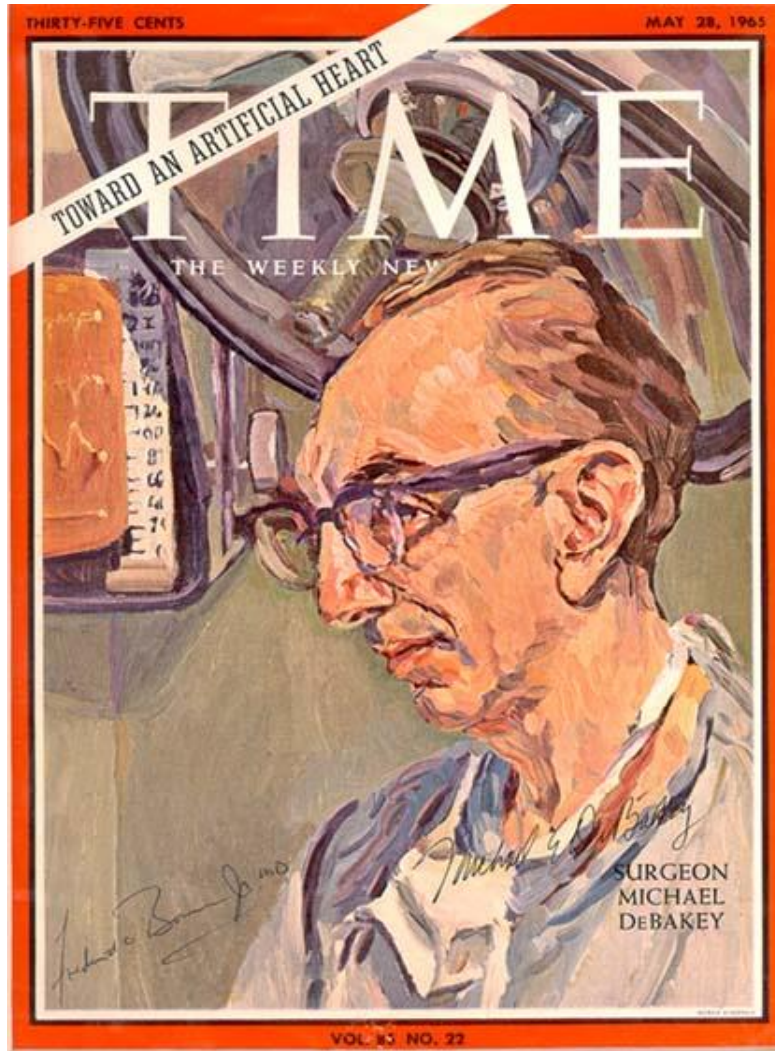
Survey about Organ Donation Hong Kong 2015

Reason for not donating	
Don't want violating the body	33%
Afraid and anxious	30%
My organs are not good enough	25%
My general health is poor, so my organs are also bad	23%
May generate bad luck if I sign up	15%
May hurt my family feeling	12%
I may not receive the best treatment when critical	8%
Religious	4%

Today's Status of Heart Transplant

- Survival is excellent
- Incidence of Acute Rejection is low
- Long term complications are still worrying
- No growth in past 10 years
- Growing demand for Mechanical Circulatory and VAD support

The man with the vision



Evolution of Mechanical Circulatory Support Devices



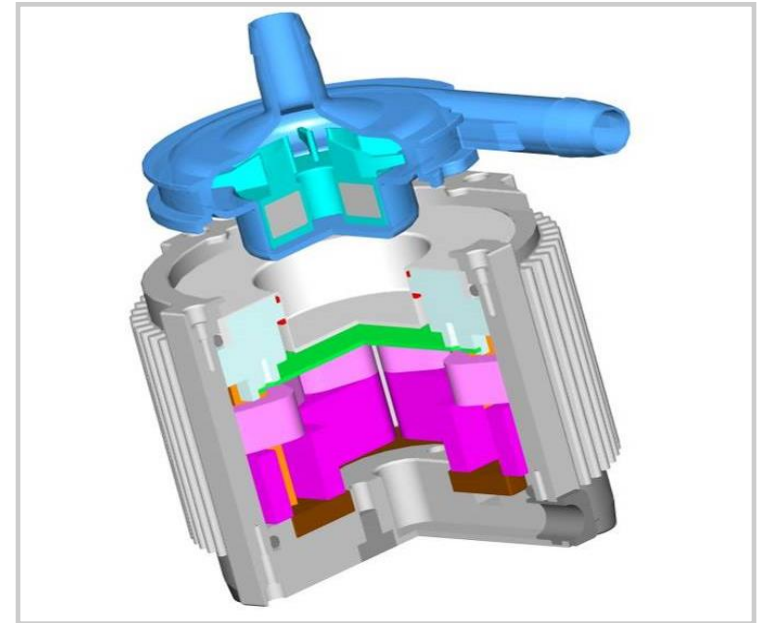
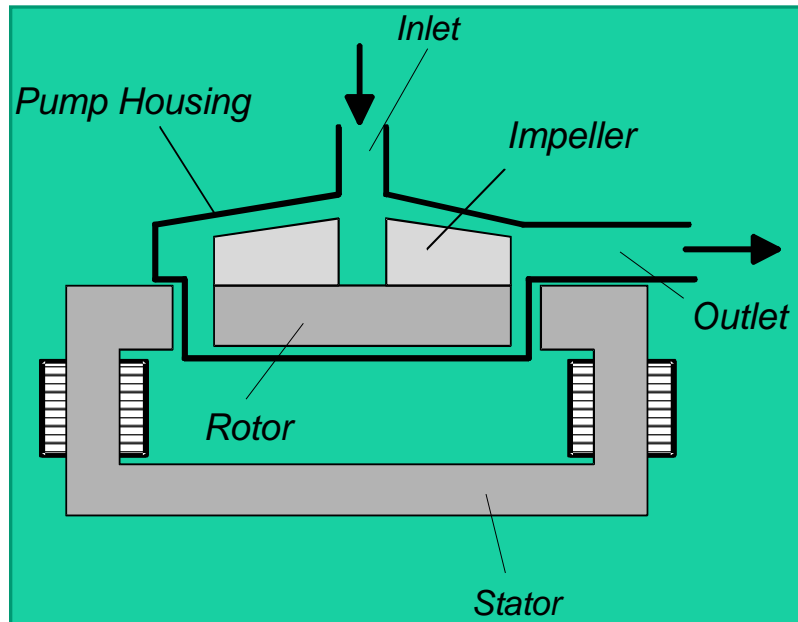
- Paracorporeal
- Pneumatic
- Pulsatile
- Uni- or
- biventricular
- Implantable
- Electric
- Pulsatile
- Large
- Multiple moving parts
- Implantable
- Electric
- Continuous flow
- Axial design
- Smaller
- Single moving part
- Implantable
- Electric
- Continuous flow
- Centrifugal design
- Smaller
- Bearingless
- Implantable
- Electric
- Continuous flow
- Axial design
- Smaller
- Partial support

The 'Ideal' Blood Pump

- Minimal priming volume and simple set up
- Gentle, atraumatic blood handling capabilities, comprised of biocompatible materials
- Minimal heat generation
- Minimal anticoagulant requirements
- Easy to visualize during support and transport
- Avoid oxygenator
- Able to fully support cardiac output (days/weeks)
- Cost effective



Bearingless Pump & Motor



- Active control of position and speed
- No bearing and seals
- Disposable pump head
- 31 cc priming volume
- 3/8 inch barbed inlet and outlet ports

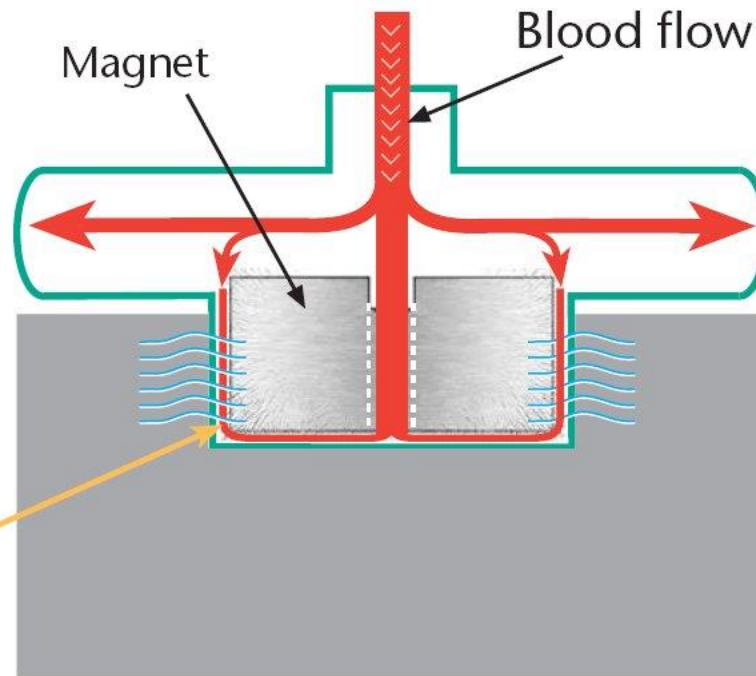
- Max. pump speed: 5500 RPM
- Max. flow: 9.9 LPM
- Medical grade polycarbonate
- Rotor has magnetic core

Magnetic Levitation

How Does Magnetic Levitation Work?

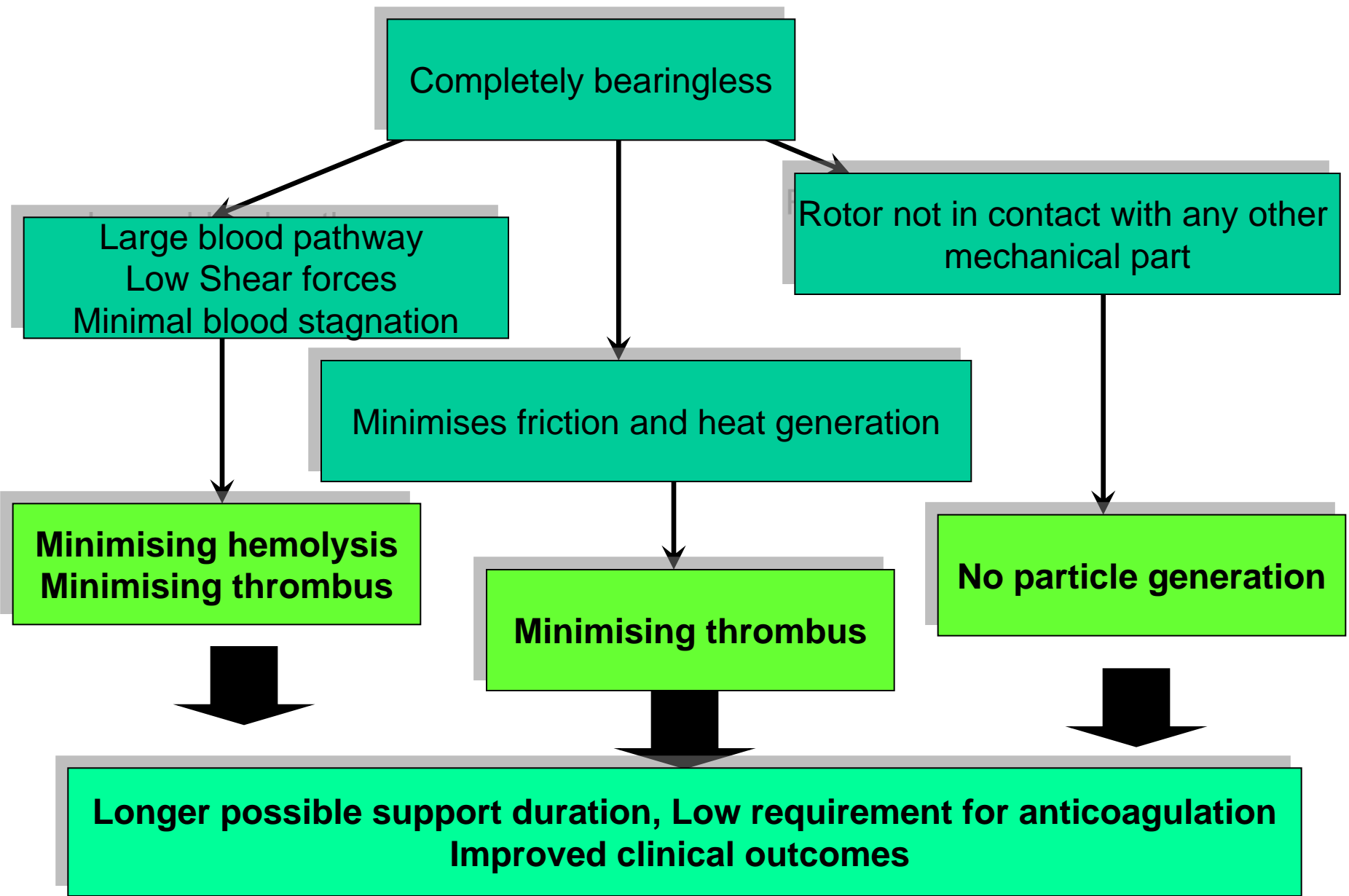
Magnetic force applied horizontally ensures that the impeller is held centrally in the blood pathway without the need for bearings.

Magnetic levitation



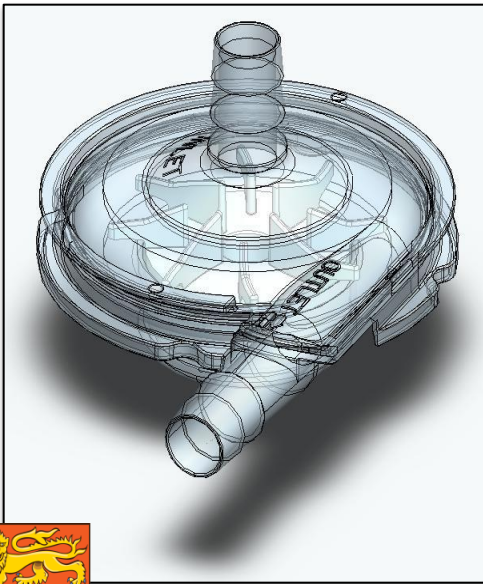
The drive system continuously measures the speed of the impeller and alters the strength of the rotating magnetic field to immediately compensate for any sudden changes in load.

Benefits of Magnetic Levitation Technology



Extracorporeal Blood Pump

- **Classical use of short term VADs**
- **Short-term VAD as bridge to device**
- **Short-term RVAD with chronic LVAD support**



Advantages of Short-Term VAD

Less expensive (10 % of Implantable VAD)

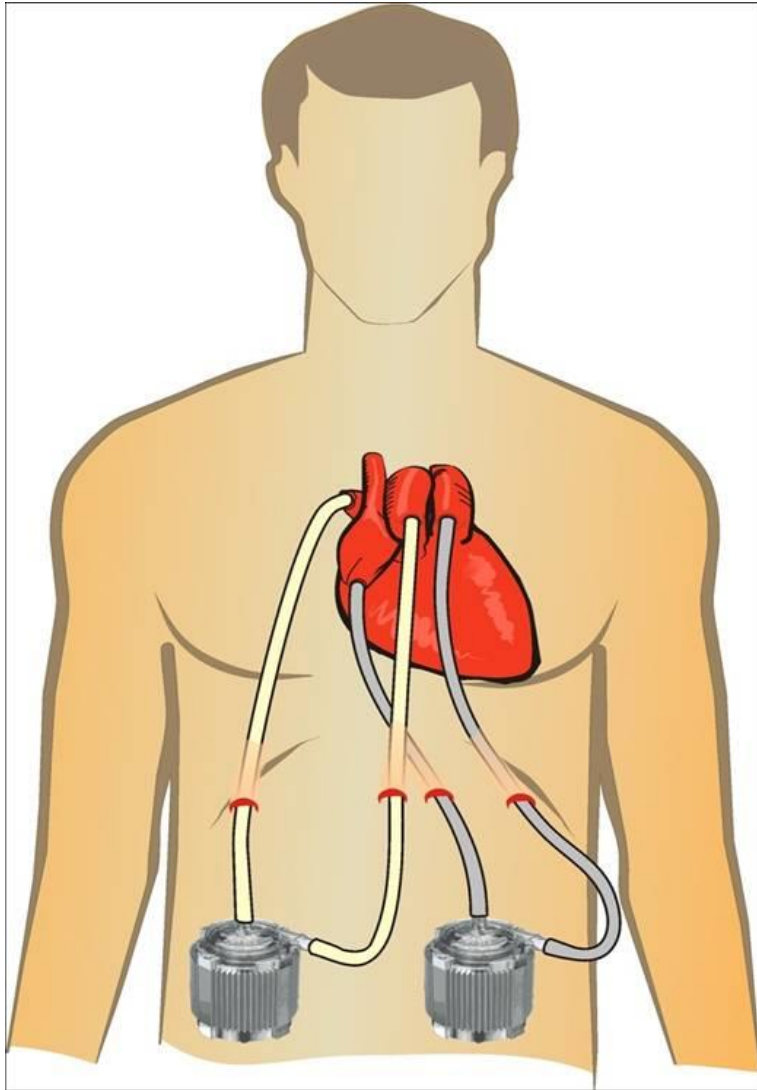
Versatile – additional Oxygenator

Better planning or transferral – bridge to decision

Can be used in both Left & Right heart



CentriMag Biventricular Support



車禍死者遺愛 昨晚移植心臟

命危小飛魚生機重燃

TRANSPLANT TEEN POURS HEART OUT

Candy Chan

Avid swimmer Lam Yin-tsun has been discharged from hospital — three months after a heart transplant saved the teenager's life.

"I must thank my parents, teachers and friends for the support and care," Lam, 13, said yesterday.

It was the first time she has spoken in public since her parents' desperate appeal for a heart donor after she developed acute myocarditis — an inflammation of the heart muscle — following a flu-like illness



Lam Yin-tsun, with her mother and father, left, is greeted by Secretary for Food and Health Ko Wing-man as she is discharged from hospital.



■ 林昨被宣布死亡，家人同意捐出其器官遺愛人間。

■ 小飛魚言臻有望重獲新生。
(資料圖片)

■ 醫護人員將載有器官膠箱運往瑪麗醫院。
(李國健攝)



Bridged To Recovery



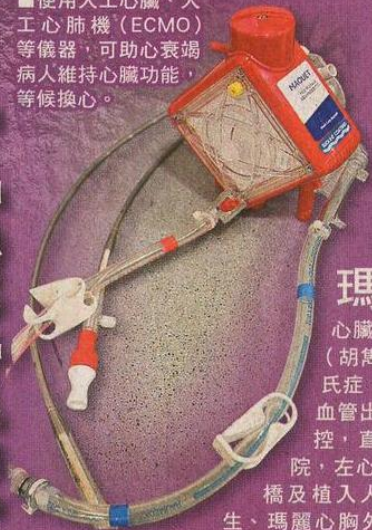
■使用人工心臟、人工心肺機 (ECMO) 等儀器，可助心衰竭病人維持心臟功能，等候換心。



主診醫生區永谷

患川崎氏症「買時間」助復原

五歲童「搭橋」植人工心臟



瑪麗醫院今年完成全亞洲同時進行「搭橋」及植入外置「人工心臟」最年輕病例。五歲的Jayden (胡雋星) 出世十個月後確診患川崎氏症，繼而併發冠狀動脈瘤，三條心血管出現不同程度梗塞，起初病情受控，直至今年六月惡化至心衰竭入院，左心功能僅餘兩成，要同時進行搭橋及植入人工心臟「保命」。主診醫生、瑪麗心胸外科主管區永谷昨稱，人工心臟為Jayden「買時間」令心臟休息，以便心臟功能回復。

區永谷笑稱：「Jayden留醫時無咩精神，大家叫佢Jayden cool，他目前康復進展理想，之後定期覆診跟進，相信心臟功能可回復至常人八、九成。」Jayden逐漸康復，不再cool，現在可踏單車，下周重返校園。

育有兩子的Jayden媽媽昨稱，長子Jayden是早產兒，確診川崎氏症繼而併發冠狀動脈瘤，兩條血管完全閉塞，一條血管嚴重狹窄，起初病情受控，未有衰竭病徵，他仍可上學。

豈料，他今年六月起不適，「每日嘔一次，又無晒胃口，成日話好累，好像肺炎」，送往瑪麗醫院治療。臨床確診他患心衰竭，當時心功能只是常人的兩成，要用兩種強心藥維持生命。

區永谷昨稱，Jayden在加護病房留醫近一個月後，心臟功能持續轉差，遂決定為他做搭橋手術處理心血管梗塞，但他的部分心肌壞死，「做完手術後都唔識跳」，同時為他植入體外左心室輔助器(人工心臟)，短暫代替心臟泵血功能，令心臟有時間休息，慢慢恢復功能。區坦言：「咁細個加上病情複雜，治療有難度，如果無人工心臟，

Jayden無可能出到手術室。」

Jayden在術後六天，心臟功能逐漸好轉可移除人工心臟，留醫至八月康復出院。Jayden媽媽稱：「起初得知病情咁差，好大打擊，最終人工心臟救佢一命。」

港28人正輪候換心

港島西醫院聯網昨公布一三/一四年度計劃，其中一項繼續加強支援人工心臟服務。區永谷稱，本港約有廿八名病人正輪候移植心臟，但器官難求，人工心臟可為末期心衰竭病人「買時間」，獲醫管局撥款配合，預計每年可處理約六宗內置人工心臟，以及十至十五宗外置人工心臟，足以應付全港病人需求。該院又會

增加可使用ECMO(人工心肺)的兒科病床。



■Jayden媽媽(左稱)：「好彩有人工心臟救咗佢一命。」

苦命女 求心續命

心臟瀕衰竭 生死一線

今晨一時版 三十五歲是人生黃金時期，但對王若嘉而言，卻不斷面對死神威脅。她原本一家四口生活美滿，豈料病魔逐一奪走她的家人，只餘下她一個人。她的哥哥在十一二歲時，打球突然猝死，才知患有先天性肌肥大，當時只有六歲的她被證實同患有該症，現靠「人工心臟」維持生命的王若嘉，生命懸於一線，急須換心臟命。

■三十五歲的王若嘉患有先天性肌肥大，現只能靠「人工心臟」維持生命，她期盼有心人捐心。

合適心臟捐贈者資料

血型：O+ 身高：167cm 體重：50kg
身體狀況：沒血壓高、糖尿病等長期病患

王若嘉說，一向走路不能太快，有時走十多步便要停下休息，兒時曾渴望能像身邊的同學般，可溜冰和坐過山車，長大後又希望周遊列國，但這些願望均未能達成。二十歲時，她首次進行大型開胸手術，醫生把一部心臟除顫器放到她體內。

母兄同患心臟病離世

她從事文職工作，以往下班後與中學時相識的男友拍拖行街，但近年身體狀況轉差，不用上班時，大部份時間會留在家中休息。數年前，

王患心臟病的外公及患其他重病的外公及患其他重病的父親，相繼離世。與她相依為命、同患先天性肌肥大的母親，亦在一個多月前，因心臟衰竭離世，令她十分傷心。

約三個月前，王因患上流感，被送至瑪麗醫院接受檢查，其後轉送至葛量洪醫院。葛量洪醫院心臟內科部門主管范瑜茵形容，王入院時的身體狀況甚差，先後注射兩支強心針，再接受開胸手術，安裝主動脈球囊輔助器保命。

約三星期前，王的腎功能突然急轉直下，遂被送至瑪麗醫院。瑪麗醫院心胸外科顧問醫生何嘉麗表示，醫生團隊於上月二十日，為王安

裝俗稱「人工心臟」的外置左右心室輔助器，將儀器兩條導管插在王的胸腔，回復她心臟的泵血功能。

心臟功能餘五分之一

何指，王的腎功能現時已有好轉，能將體內毒素排出，但「人工心臟」一般只有三個月的壽命，限期過後換機並不是理想的做法，加上王正服用亞士匹靈及薄血丸等藥物，大大增加胸腔駁口出血的風險。她又說，王的心臟功能只有正常人的五分之一，是現時等候換心的病人中，情況最嚴重，暫排在輪候冊首位。

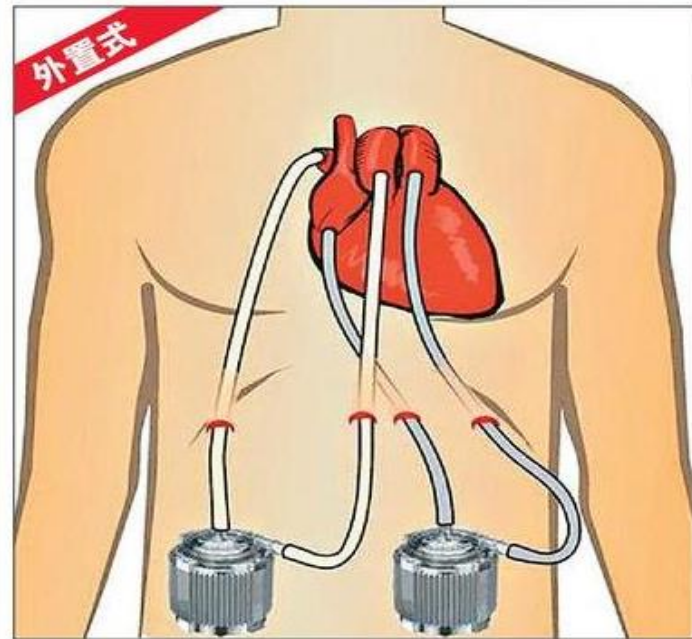
何又稱，要找一个血型同屬O+、身形與王差不多、約高一米六七的捐贈者，十分困難，但指醫護團隊會與王一起面對，等候合適的心臟。

望與男友結婚做正常人

王若嘉希望能盡快換到合適的心臟，手術後與男朋友結婚，組織家庭，過正常人的生活。「我沒有宗教，但樂觀，一直深信醫生能

■葛量洪醫院心臟內科門主管范瑜茵(左)及瑪麗醫院心胸外科顧問醫生何嘉麗。

- 35 year old girl
- Familial Hypertrophic obstructive cardiomyopathy
- CCU 4 weeks with IABP
- Both left / right heart failure
- Left / Right VAD CentriMag April 2014
- Heart Transplantation July 2014
- ICU stay 75 days



■可靈活用於左右心室，且便宜，惟易受細菌感染，且只能用數星期，病人亦需留醫。

成功換心 母感恩盼更多人登記器官捐贈

謙仔「人工心」吊命282日重生



謙仔等待一年後，終獲換心，昨日在媽媽陪同下出席記者會，說「多謝開心」。

11歲的鄧啟謙苦等一年，終於上周一（12日）接受心臟移植手術。謙仔昨早坐着輪椅出席記者會，見到大批攝影記者圍住他拍照，還親映的做出「Yeah」的手勢，又在媽媽的攙扶下緩慢走上台，對大家說「開心、多謝」。除了感謝捐心者及其家人，謙仔呼籲「見到病房有太多人等待」，希望能有更多人登記器官捐贈。瑪麗醫院心胸外科部門主管區永谷指，謙仔使用外置人工心臟輔助器吊命282日，成為亞太區內最年輕、使用時間最長的病人。

大公報記者 孫凌奕（文） 麥潤田（圖）

鄧啟謙於去年五月列入輪候心臟移植手術名單，如今已是一年多，謙仔母親去年十月還會公開為兒求心。謙媽昨日表示，見到兒子手術成功很開心亦很感激。她又憶述：「次次聽到他要換藥、換喉，都覺得好驚，去一次手術室就擔心多一次，擔心他和死神去搏，不知搏不搏得過。謙媽感謝捐心者家人做出「無私又偉大」的決定，又感謝醫護人員的悉心照顧，並稱讚「香港醫學生醫術是最頂尖、最好的」。

曾開胸人手按心救命

瑪麗醫院心胸外科部門主管區永谷表示，謙仔從去年九月植入外置人工雙心室輔助器，支撐了282日終等到合適心臟，成了亞太區內最年輕、使用「人工心」時間最長的病人。但使用「人工心」風險大，而裝置一般的壽命不超過100日，且四十日就必須更換其血泵裝置。其間謙仔曾多次出現嚴重併發症，包括腦中風等。10月來，進行了七次手術，更換15個人工心血泵，進行一次開胸手術和多次胃部內窺鏡治療。

其實，謙仔在去年九月首次植入「人工心」時，曾出現心臟停頓，幸在醫生全力救治下與「死神」擦身而過。瑪麗醫院心臟暨胸肺科部門主管鄧斯發透露，由於謙仔心臟功能實在太差，在術前麻醉時，突發心臟停頓。醫護團隊即刻為謙仔進行「人工心」，同時開胸骨，再用手直接為他按摩心臟，數分鐘後搶救成功。「僅一兩分鐘就返到轉頭，腦會缺血性中風。」

剛裝上人工心，必須要用呼吸機協助，謙仔不能說話。鄧斯發說，當時謙仔

情緒低落，不肯理人，當醫生評估以不使用呼吸機後，他說的第一句話是「我要飽奶和快樂」。他又透露，謙仔其實和普通小朋友一樣，喜歡打機、吃東西，為了哄他開心，醫生們也不時買些燒賣，搬去去看望他。

料最快兩三周後出院

歷經重重困難，謙仔終於上周一等到適合他的心臟。區永谷表示，手術進行八小時，由於心臟有四條大型血管連接外置人工心，因此心臟附近有好多疤痕和黏連，使得手術非常困難。幸手術成功，謙仔在手術後翌日便醒過來，第二天就可自行呼吸，恢復速度較一般病人快。謙仔剛入院時只有30公斤，如今長到50公斤，說明身體情況良好，預計兩三周後便可出院，未來除了要吃排尿管，相信可與平常小朋友一樣生活。



謙仔在等待換心期間，曾與足球小將相志奕在走廊走路散練，瑪麗醫院供相。



謙仔在媽媽的陪伴下坐着輪椅出席記者會，對着攝影記者遊歷地揮手。

鄧啟謙「心」路歷程

- 2014.12**
八歲的謙仔第一次出現心臟衰竭，在廣州醫院接受治療
- 2015.10**
九歲的謙仔左右心室功能均衰竭，左心室射血分率只有25%，診斷為原發性擴張型心肌病
- 2016.5**
入住瑪麗醫院心臟加護病房，需依賴強心藥穩定病情，列入輪候換心名單
- 2016.9**
10歲的謙仔情況非常差，需植入外置人工雙心室輔助器，術前麻醉期間曾出現心臟停頓
- 2016.10**
前腦頸葉出血需進行開胸手術，胃部出血需接受胃內窺鏡治療
- 2016.11**
成為心臟移植手術候選名單首位病人
- 2017.6**
11歲的謙仔終於於12日獲合適心臟，進行八小時手術

資料來源：瑪麗醫院



單志華於上月初接受換心手術，恢復良好，預計下周便可出院，瑪麗醫院供相。

工程師換心順利可下床慢走

【大公報訊】記者孫凌奕報導：自2008年以來，瑪麗醫院共進行過七名兒童心臟移植手術，其中五名兒童仍然生存，現時有一位17歲的男童正在等候心臟移植名單，已使用外置人工心室輔助器。瑪麗醫院兒童心臟科顧問醫生倫建成表示，17歲男童現在情況穩定，暫時毋須留院。

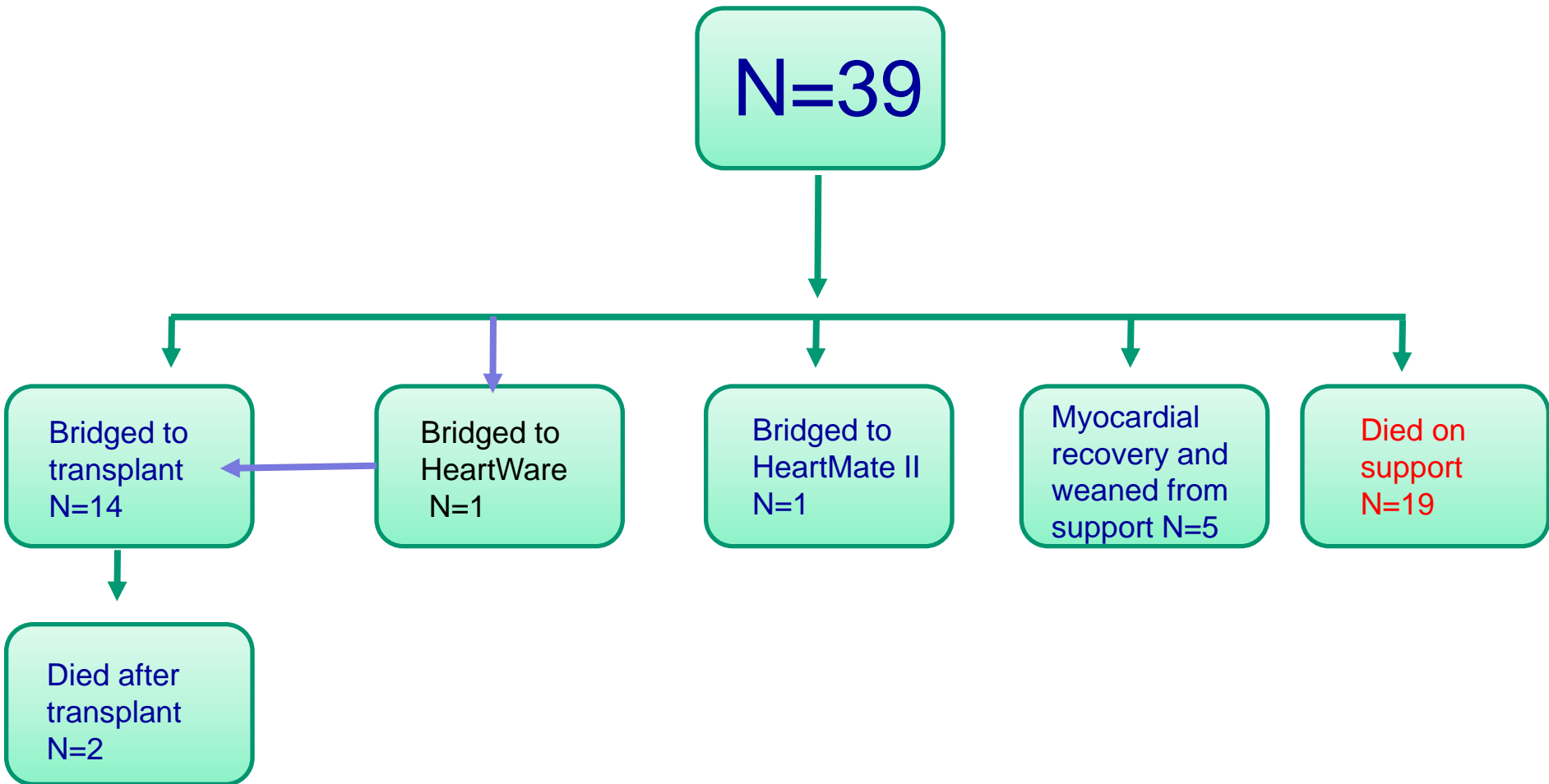
此外，電子工程師單志華亦於上月初成功完成心臟移植手術，葛量洪醫院心臟內科部門主管范瑞茵表示，單現於葛量洪醫院接受復康治療，現時已可下床緩慢行走，預計下周便可出院。

被問到小兒心臟移植手術，日後是否會搬去明年底投入服務的

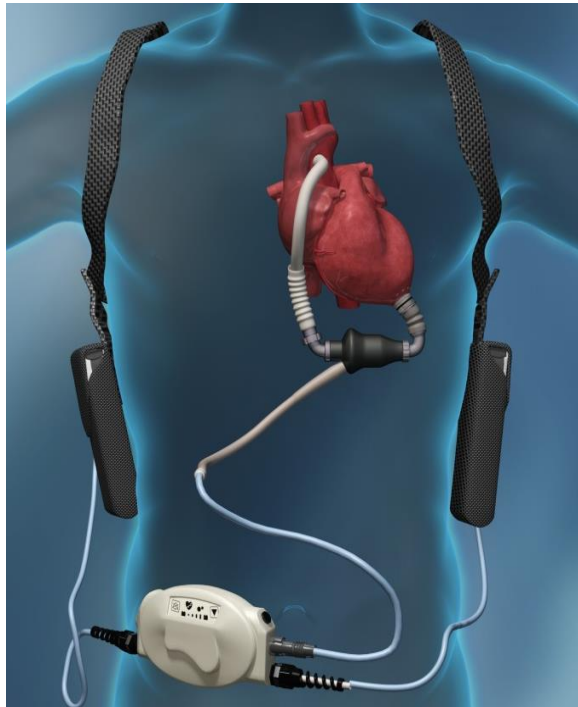
香港兒童醫院，瑪麗醫院心胸外科部門主管區永谷回應指，暫時未確定是否會在服務初期搬過去。由於小兒換心需要多專科配合，不止是心臟內外科醫生，更需要專門的兒童心臟藥劑科、資深的深切治療部護士等多專科配合，現不確定新兒童醫院初期是否具備充分資源。

Update of CentriMag Program

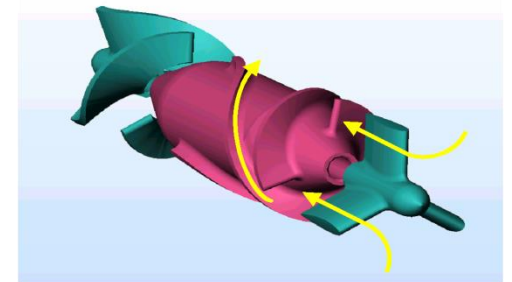
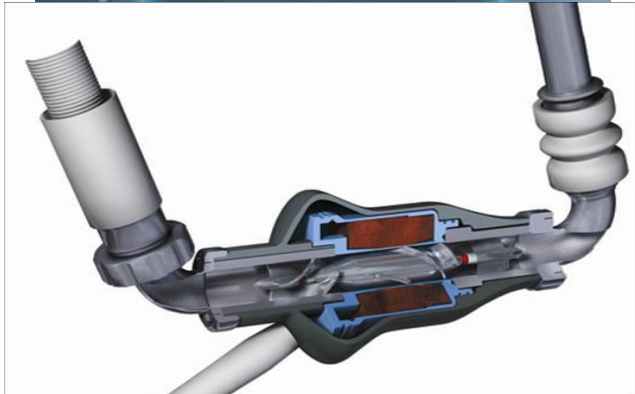
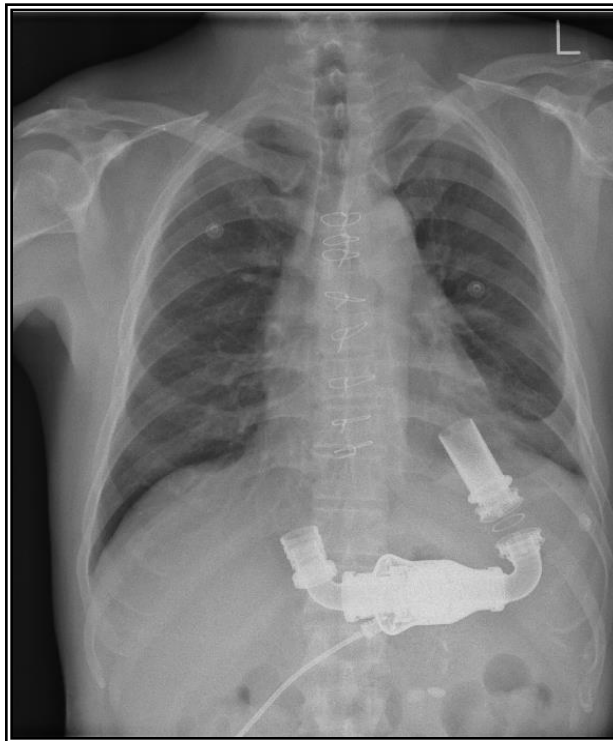
Queen Mary Hospital, July 2010-August 2017



Implantable Artificial Heart

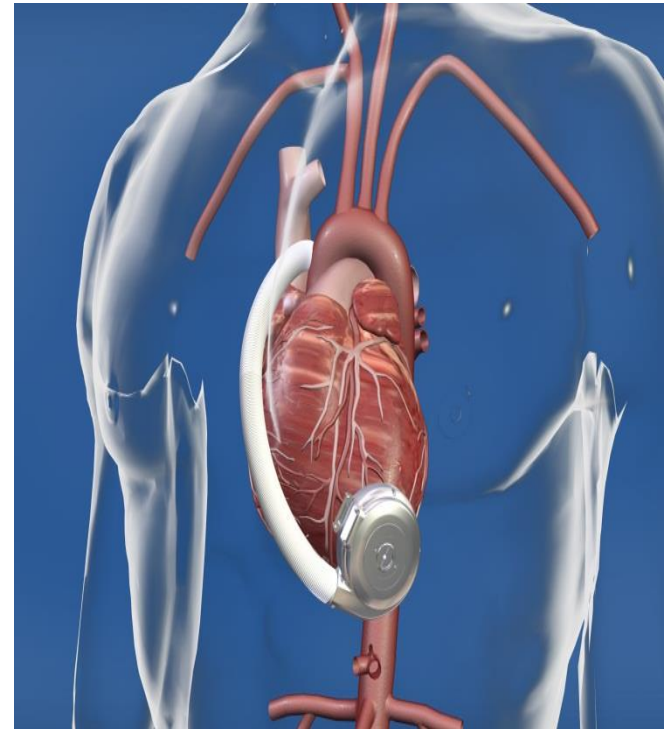


HeartMate II
[Thoratec]



The HeartWare® Ventricular Assist System

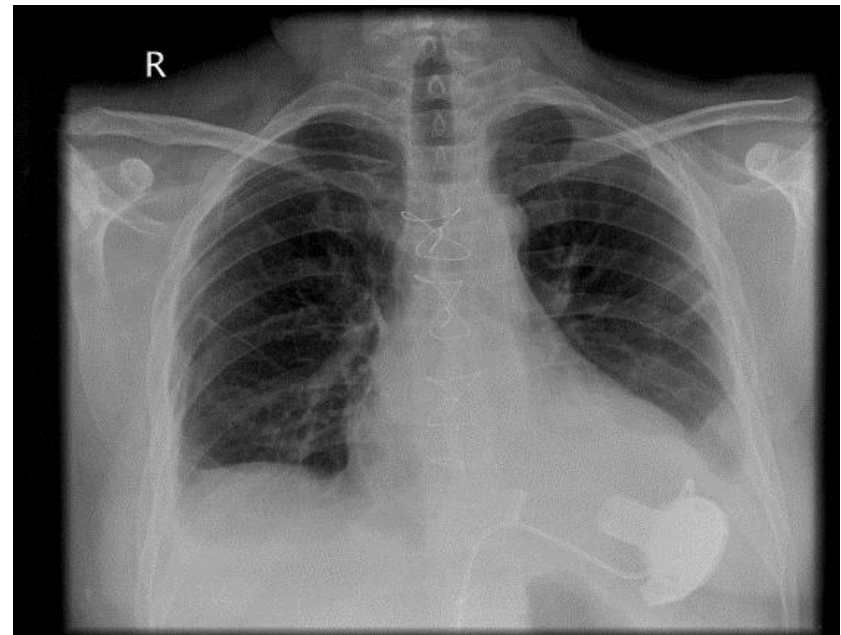
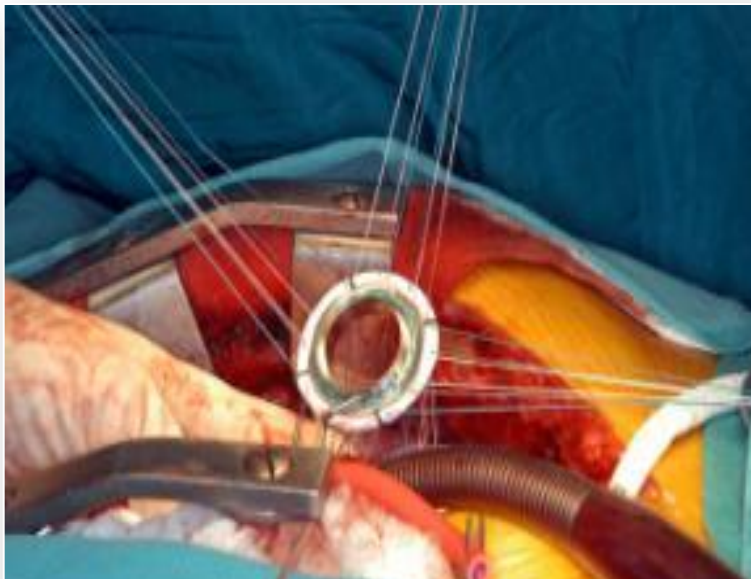
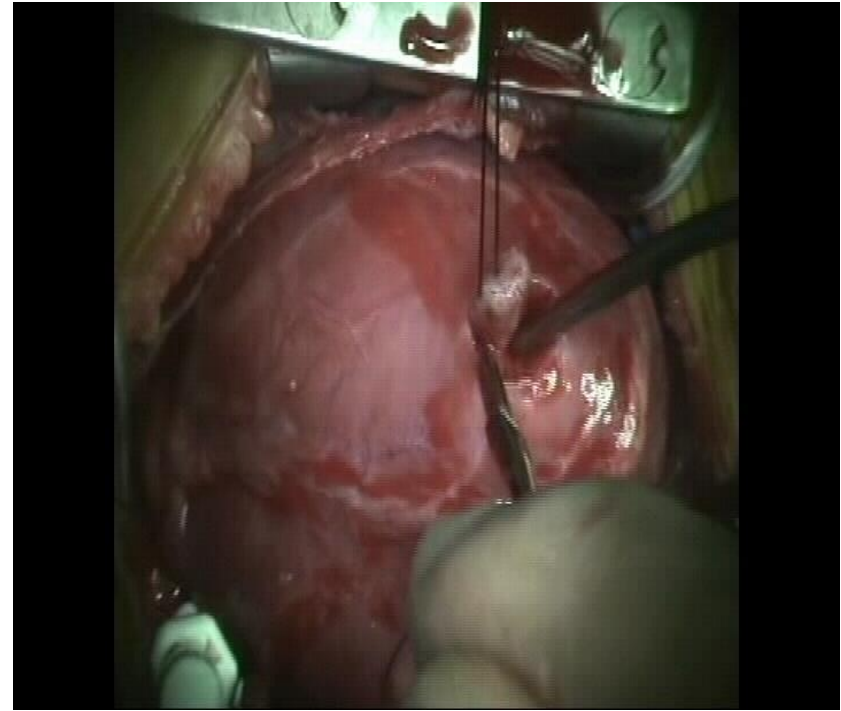
- Designed for full mechanical circulatory support
- Miniaturized implantable HVAD® pump
 - 50cc displacement volume
 - 50mm outside diameter
 - About the size of a “D” battery
- 10 liters of flow/min
- Hybrid magnetic and hydrodynamic impeller suspension.
 - Frictionless blood contacting surface
- Thin (4.2 mm), flexible driveline with fatigue resistant cables



Implantation Technique

Pericardial benefits

- No abdominal surgery
- No pump pocket
- Less surgical time
- Smaller BSA patients
- Fewer antibodies due to no blood transfusions



Centrifugal pump; Long Term Use

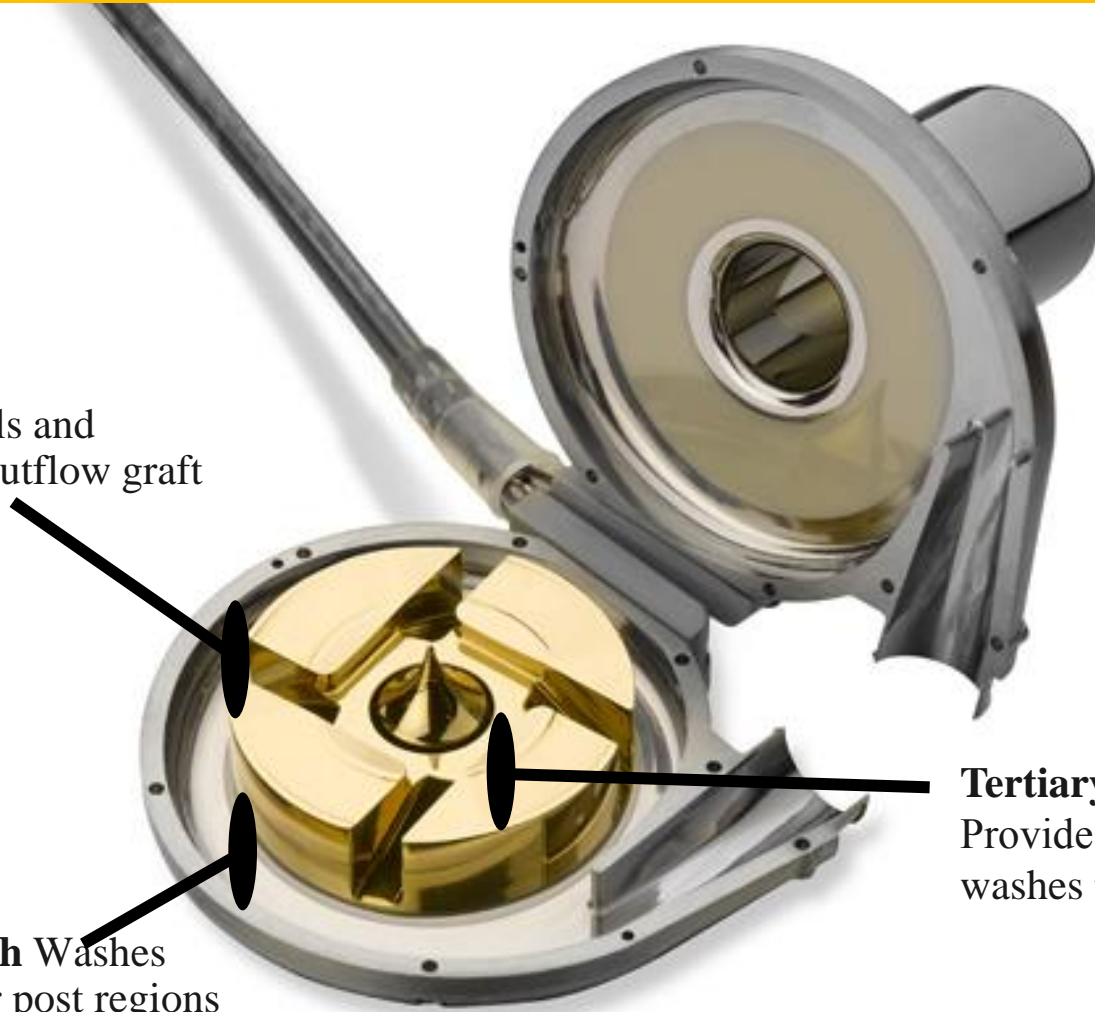
Primary flow path

Washes flow channels and immediately enters outflow graft

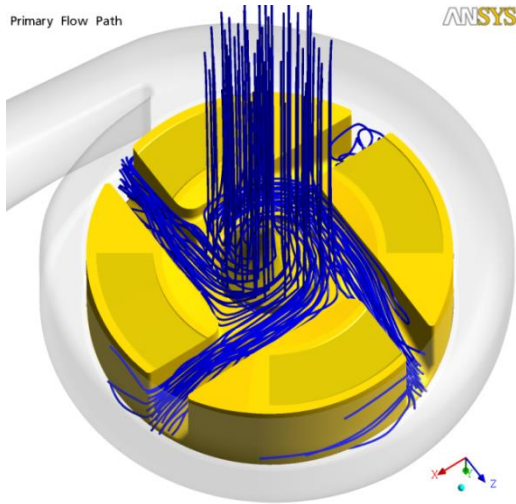
Secondary flow path Washes underside and center post regions

Tertiary flow path

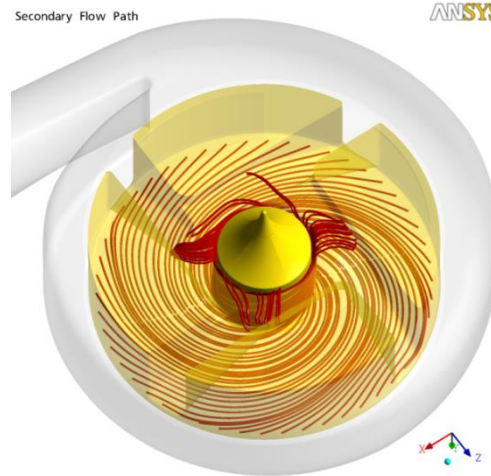
Provides fluid “cushion”; washes thrust bearings



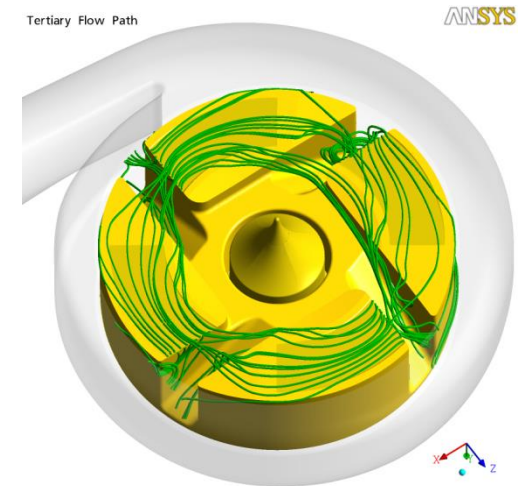
Simple, Elegant Fluid Dynamics



Primary flow path
Washes flow channels
and immediately
enters outflow graft



Secondary flow path
Washes underside and
center post regions



Tertiary flow path
Provides fluid
“cushion”; washes
thrust bearings

HeartWare Equipment

Accurate flow wave forms for analysis



2 small, long lasting batteries

Controller display with instructions for patients

Limitation of VADs

- Availability and Cost
- Constant changing of Models / Size / Shape
- Blood component damage
- Out-Patient and Long Term management
- Hypertension / Stroke – Axial pump
- Bleeding & Thromboembolism
- Durability & mechanical failure
- Infection

David Pierce was implanted HeartMate II
LVAD in May, 2004 - 2013



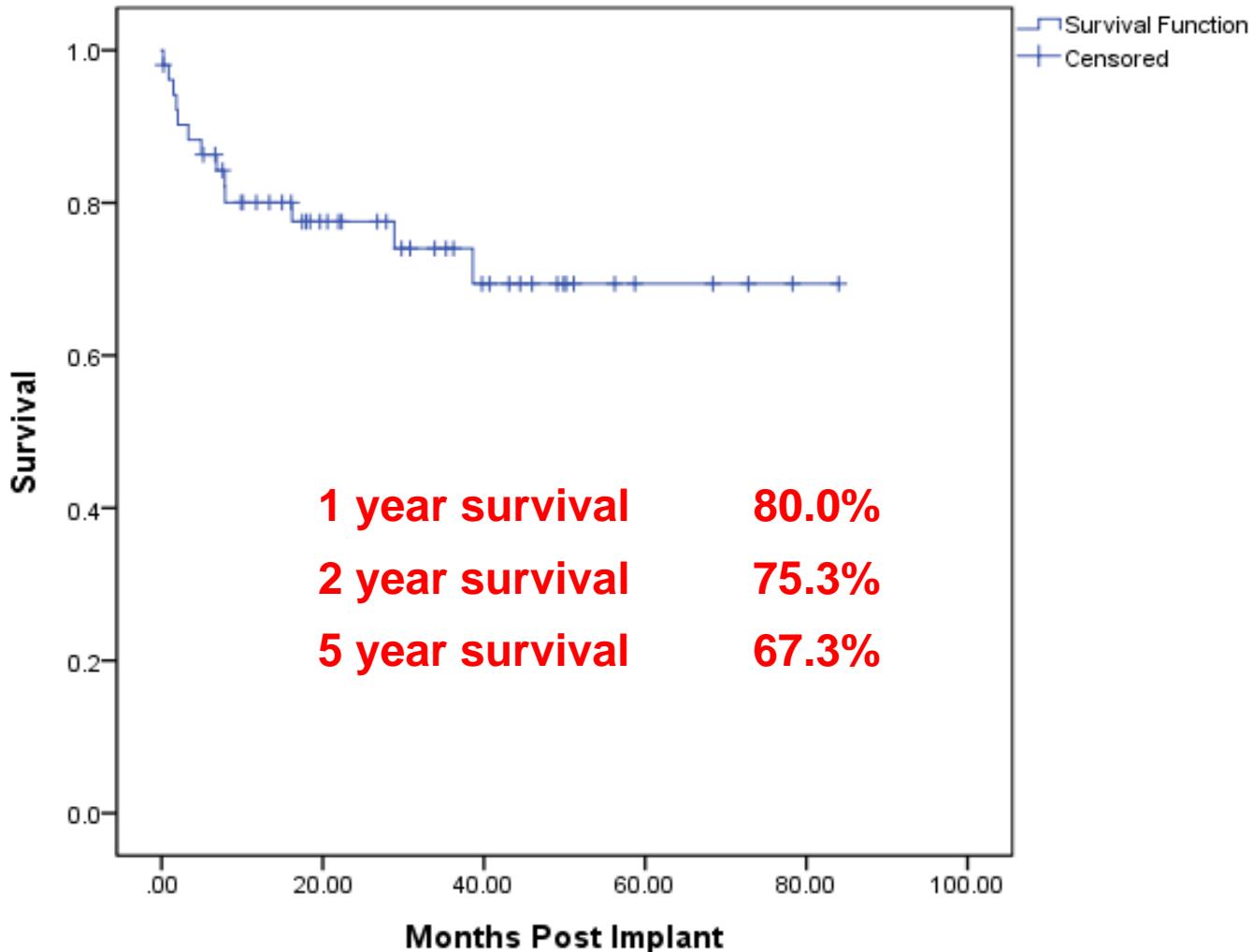
Implantable Artificial Heart Program in Queen Mary Hospital : 2010 - 2017



	August 2010-August 2017
52	End stage heart failure patients received LVAD
28	Discharged home with device
11	Bridged to transplant (1 died after transplant)
13	Died on device support

Indication for LVAD implantation	
46	Bridge to Transplant (BTT)
6	Destination Therapy (DT)

Actuarial survival of LVAD: a QMH experience



2017

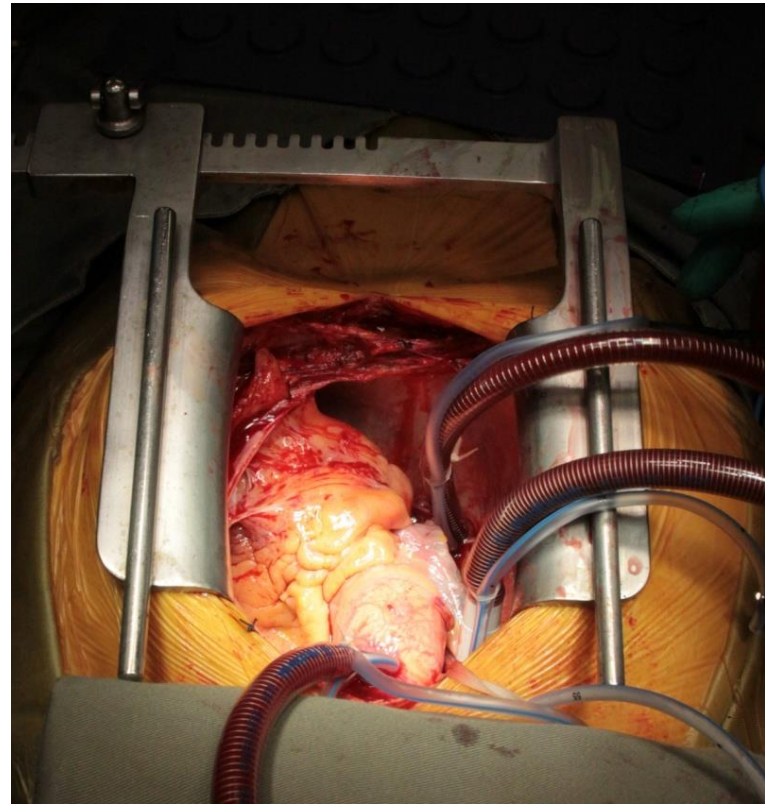
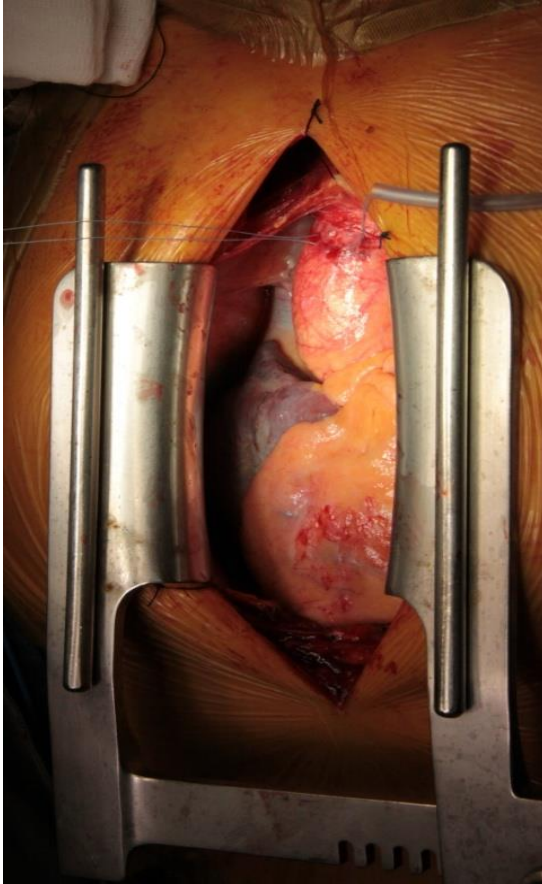
Queen Mary Hospital

Top 5 centers in Asia for
Heart Transplant and Artificial
Heart Surgery

Queen Mary Hospital

- History of Heart Surgery
- Coronary Artery Disease
- Heart Transplant and Artificial Heart Pump
- **Minimal Invasive Heart Surgery**
- Atrial Fibrillation and its therapy

Conventional Open Heart Surgery

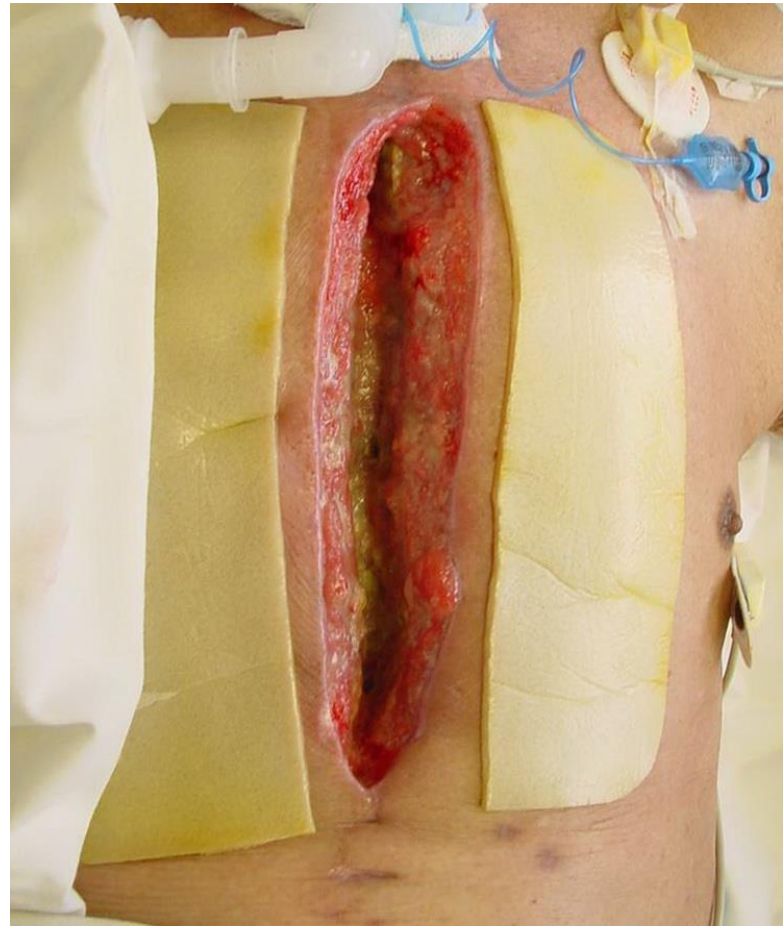


Conventional Open Heart Surgery

- Superficial wound usually takes 7 days to heal
- Sternum needs around 10 weeks to heal up
- Weight lifting exercise or activities not allowed



Wound Infection



Scar Problems

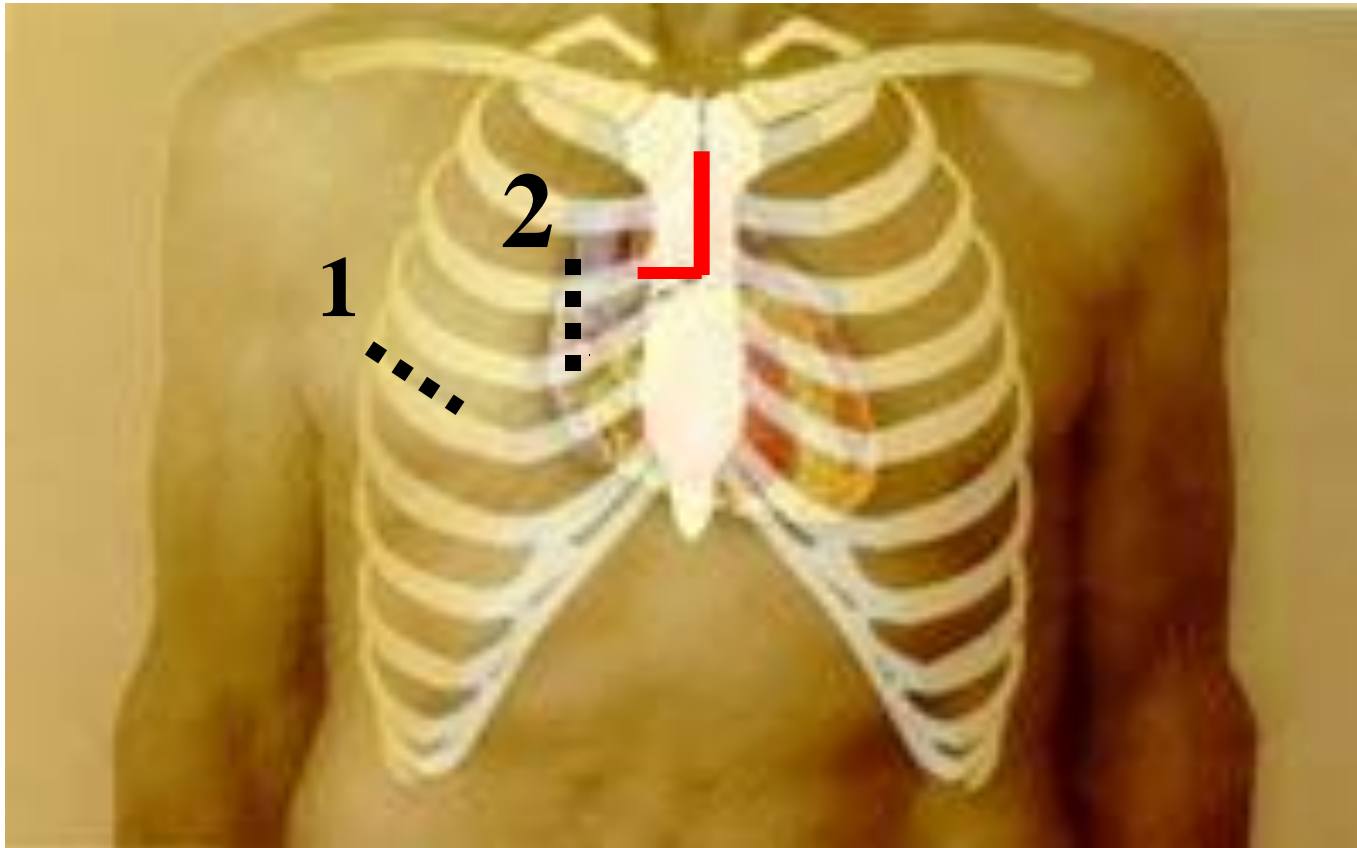


Incisions -

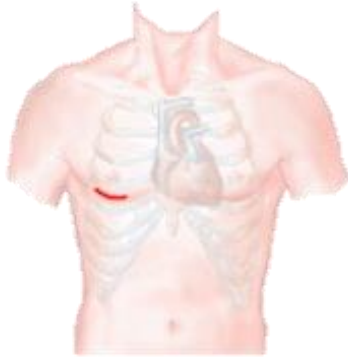
1 : Right lateral mini-thoractomy

2 : Right mini para-sternal

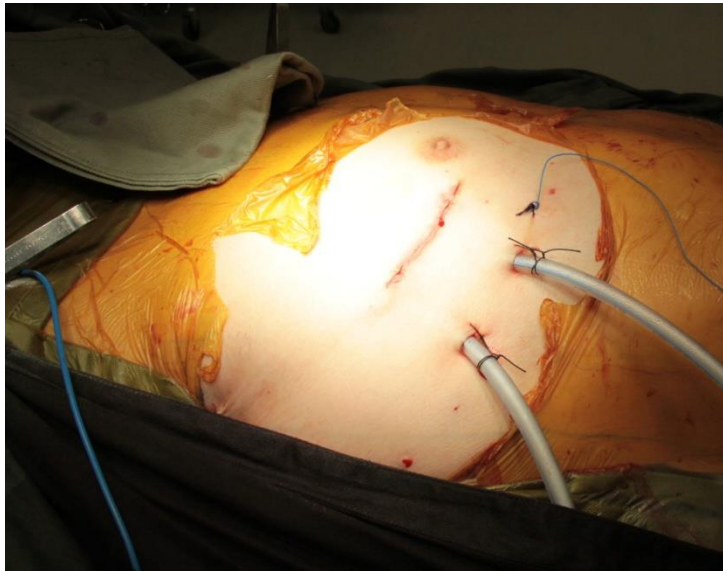
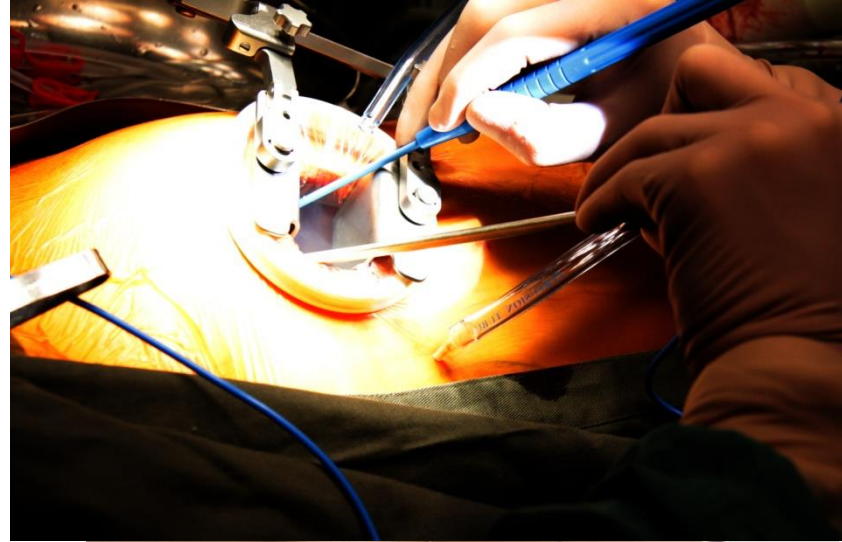
3 : **Upper hemi-sternotomy**



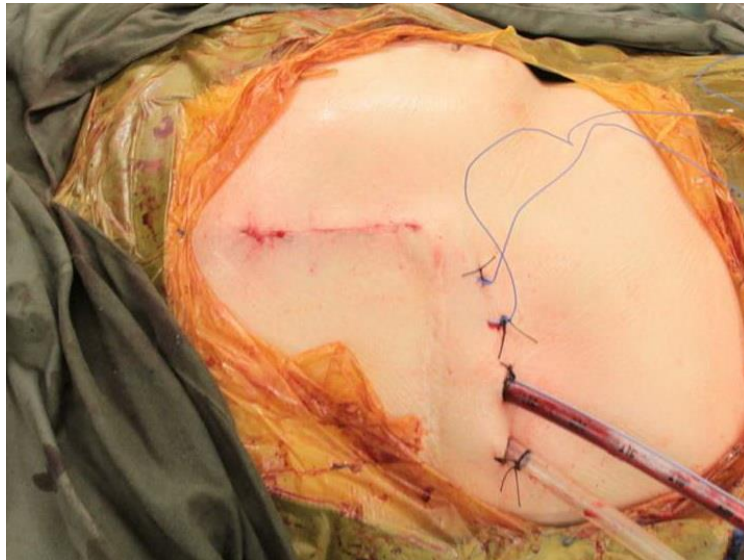
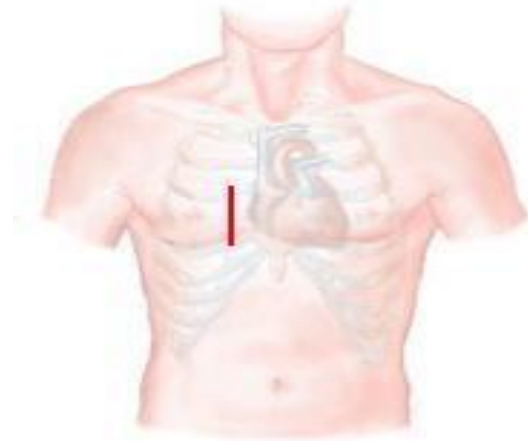
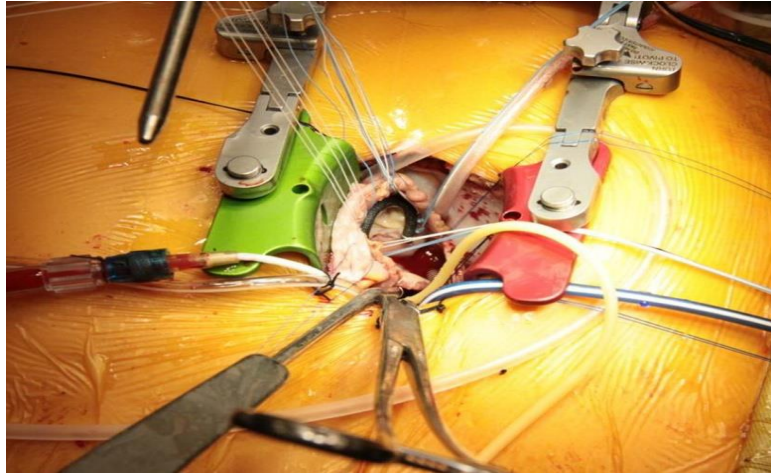
Lateral Mini-Thoracotomy



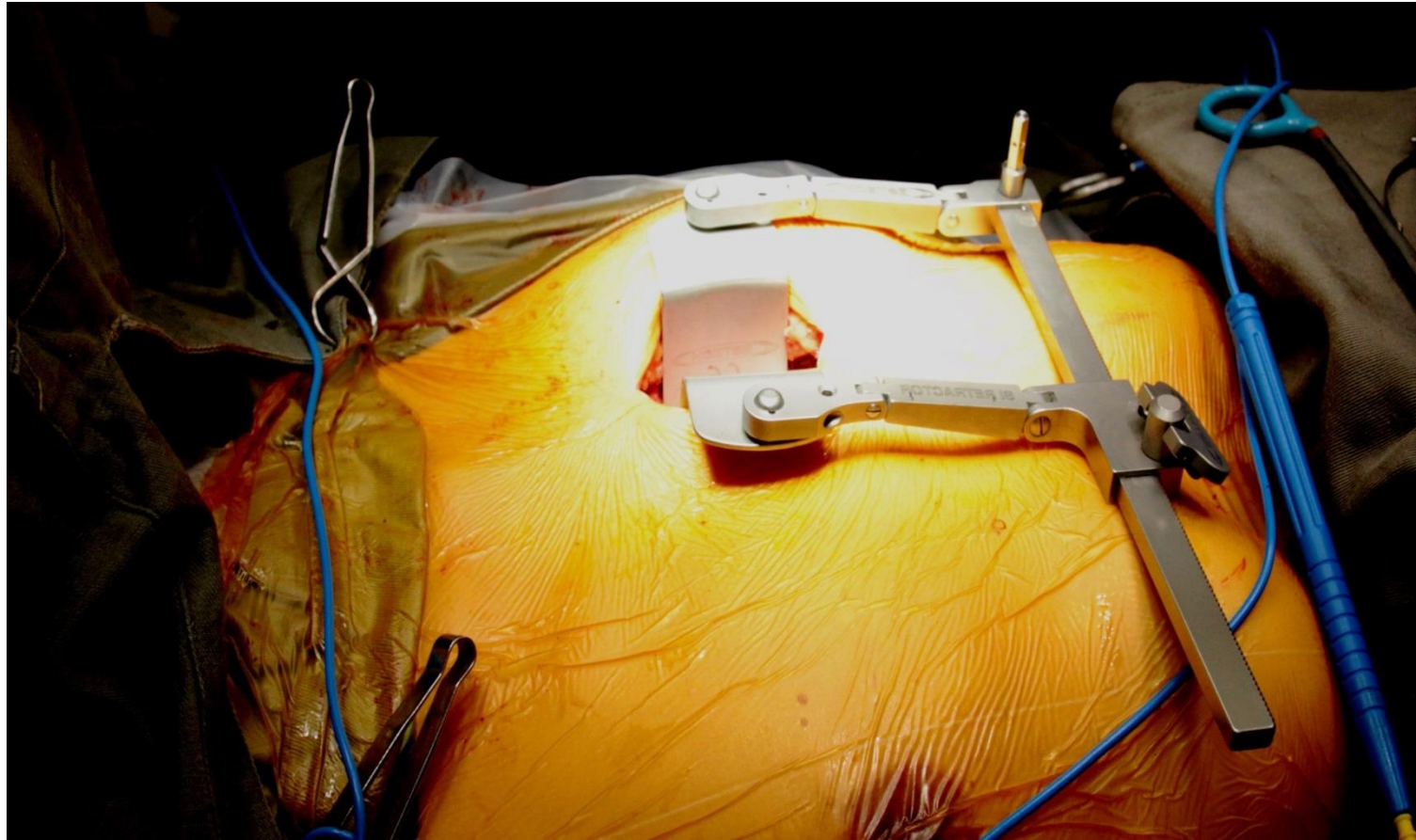
Small thoracotomy
微細肋骨之間切開術



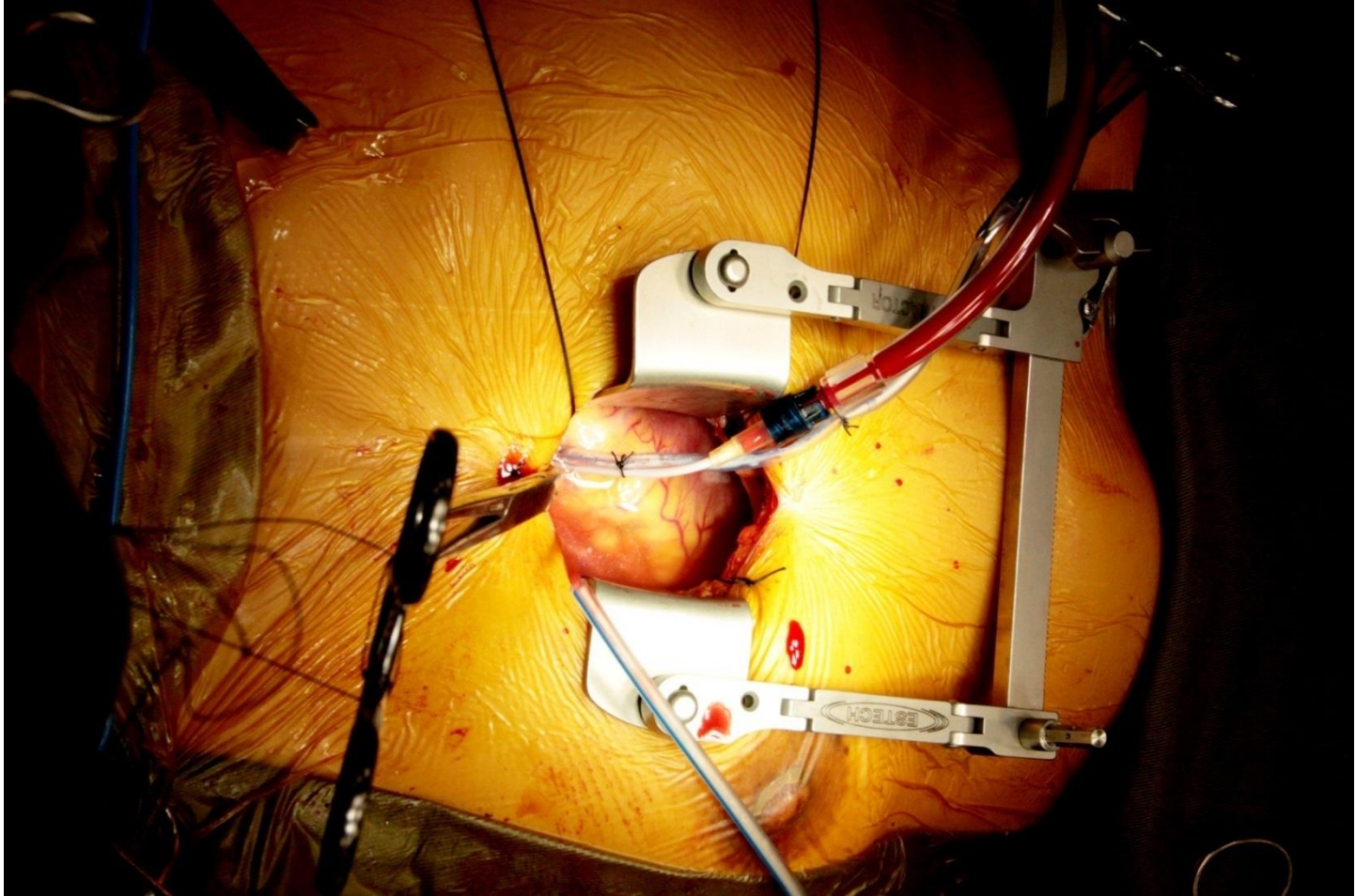
Right Paramedian Mini Thoracotomy



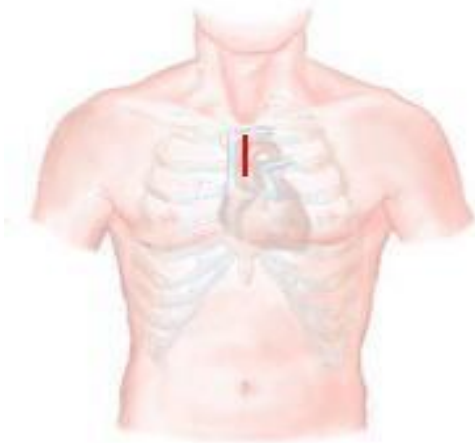
Right Paramedian Mini Thoracotomy



Right Paramedian Mini Thoracotomy



Upper Hemi - Sternotomy



Upper half sternotomy
上半胸骨切開術

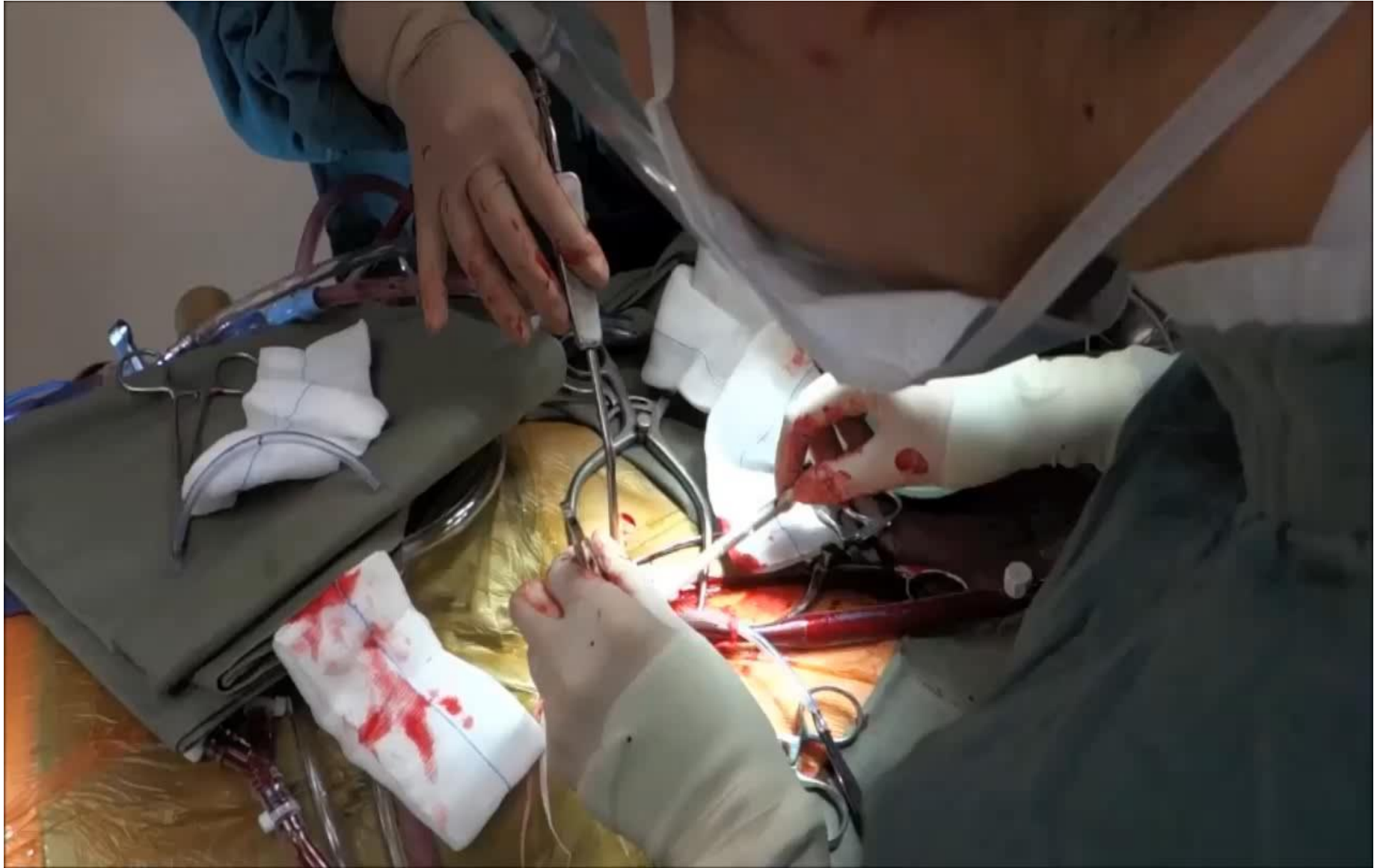


Since 2007 , Queen Mary Hospital

Our experience with minimal invasive heart operations [400 + cases] :

- Safe
 - Mortality < 1%
- No difference in morbidity vs conventional
 - Similar blood loss, similar infection rates
- Advantages
 - Less pain, better cosmetic, quicker recovery



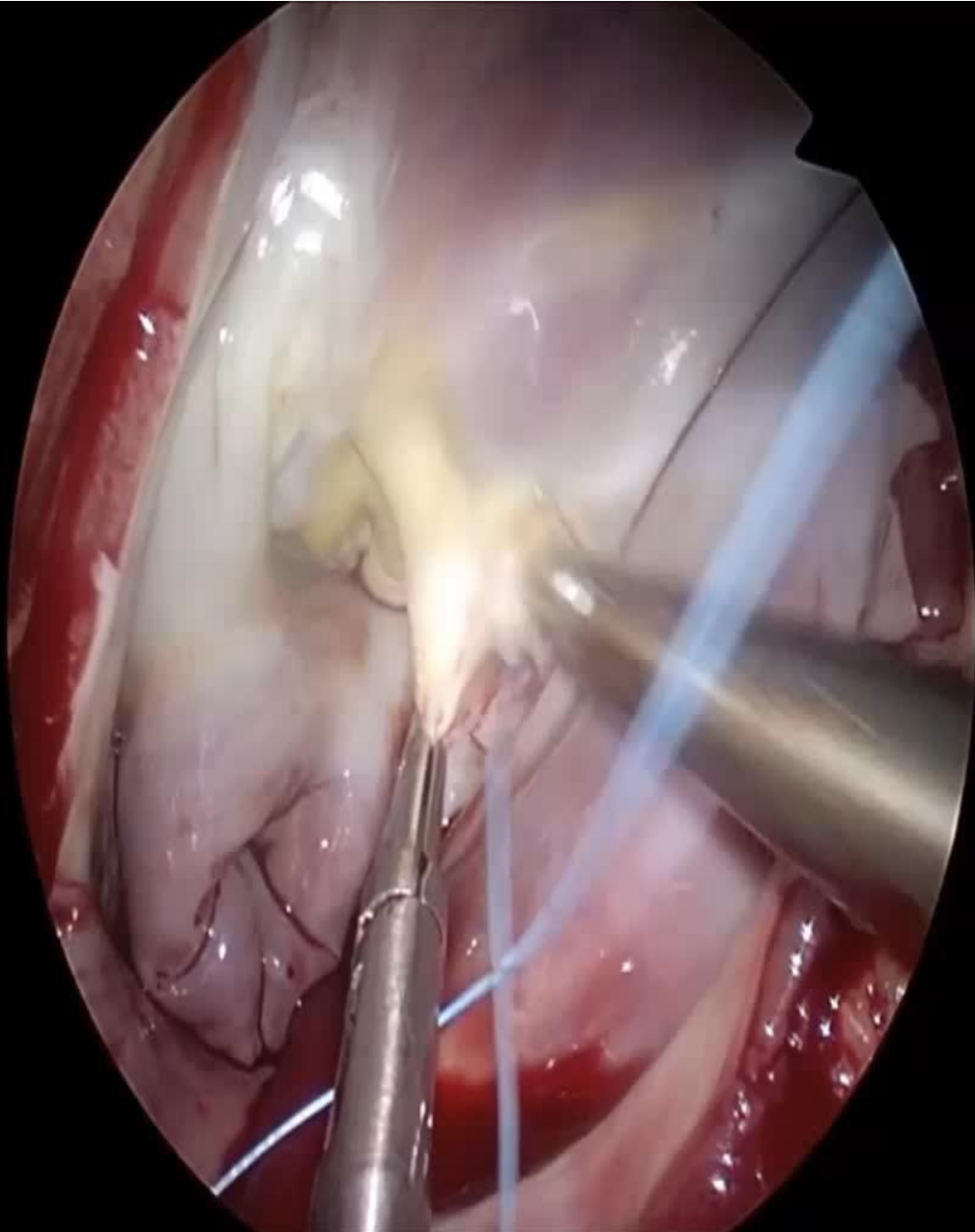


ID:
Name:

Sex: Age:
D.O.B.:
01/11/2012
11:24:21

CVP:1
D.F:2
■■■/---(0/2)
Eh:A2 Cm:1

Comment:■



Minimal Invasive Heart Surgery

- Heart Valve Surgery – repair and replacement
- Heart Septal defect repair
- Ablation Surgery for Atrial Fibrillation
- Ascending Aorta Surgery

Aortic Stenosis

- Correction is indicated for patients with symptomatic severe aortic stenosis

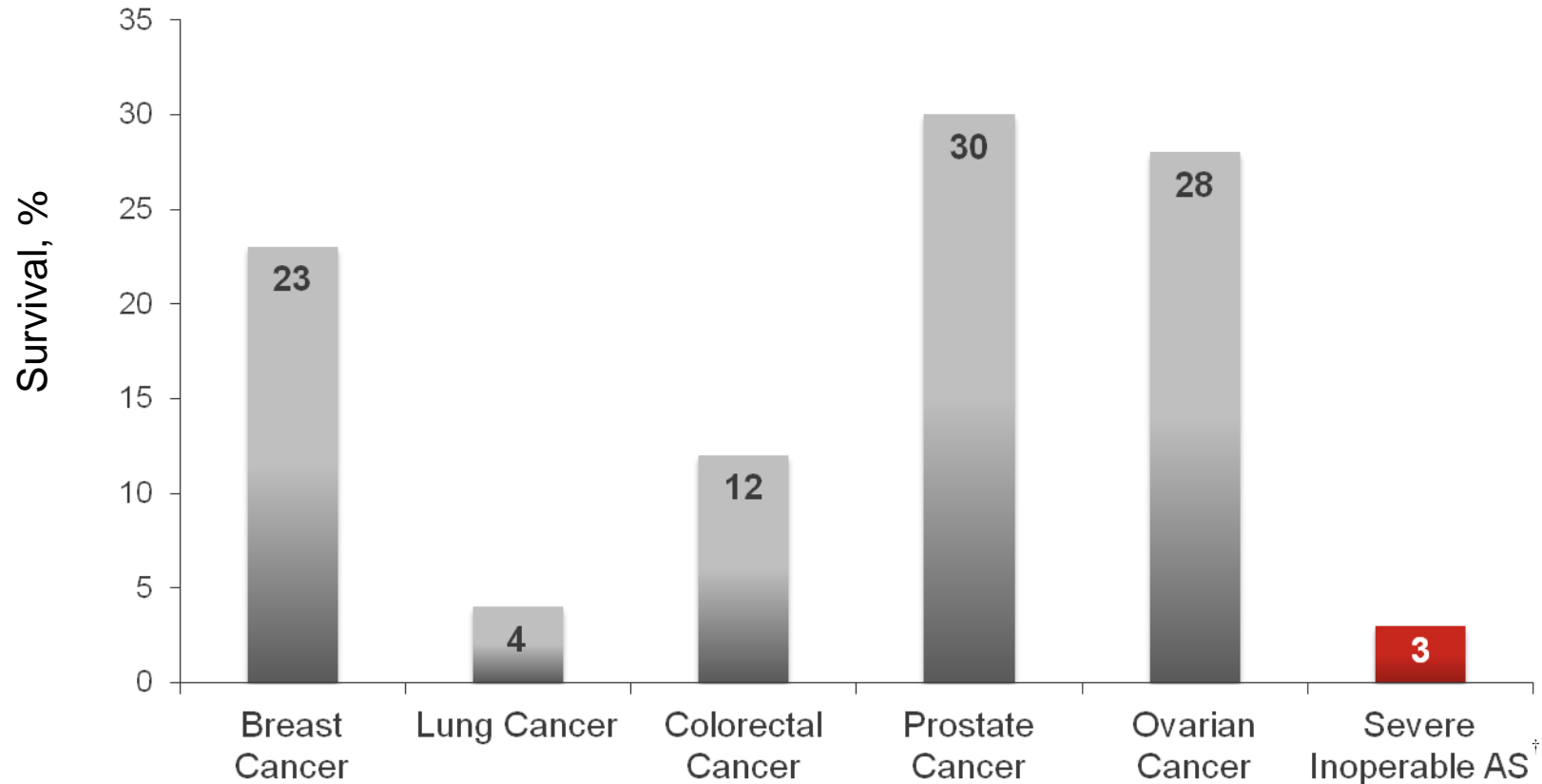
According to the ESC/AHA Guidelines, severe AS is defined by these characteristics:

- Aortic valve area: $<1 \text{ cm}^2$ or $<0.6 \text{ cm}^2/\text{m}^2 \text{ BSA}$
- Jet velocity: $>4.0 \text{ m/sec}$
- Mean transvalvular pressure gradient: $>50 \text{ mmHg (ESC)}$
 $>40 \text{ mmHg (AHA)}$

- Estimated operative/procedural mortality risk $\geq 15\%$
 - Typically evaluated using the logistic EuroSCORE
 - A multi-disciplinary agreement is required

Mortality With Standard Therapy Is Worse Than With Certain Metastatic Cancers

5-Year Survival: Metastatic Cancer*



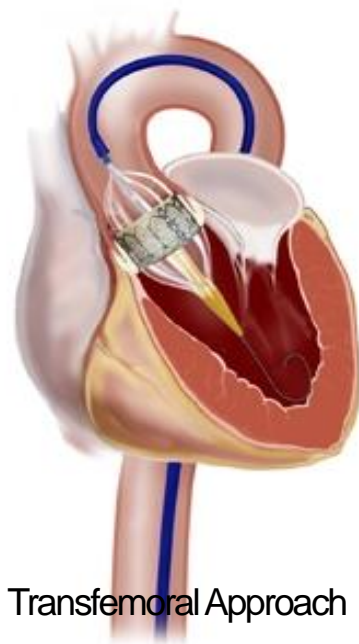
* National Institutes of Health. National Cancer Institute. Surveillance Epidemiology and End Results. Cancer Stat Fact Sheets. <http://seer.cancer.gov/statfacts/>. Accessed November 16, 2010.

[†] Using constant hazard ratio. Data on file, Edwards Lifesciences LLC.

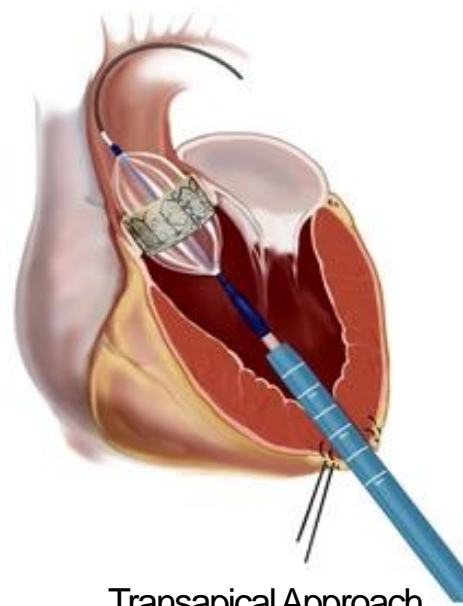
TAVI : Transcatheter Aortic Valve Implantation

“Today, TAVI allows patients who are at very high surgical risk or with contraindications to surgical AVR to benefit from an effective treatment of AS.”

—D. Himbert, Bichat-Claude Bernard Hospital, Paris²²



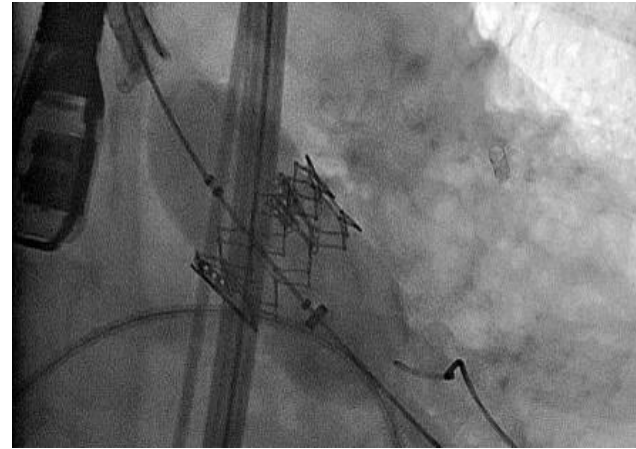
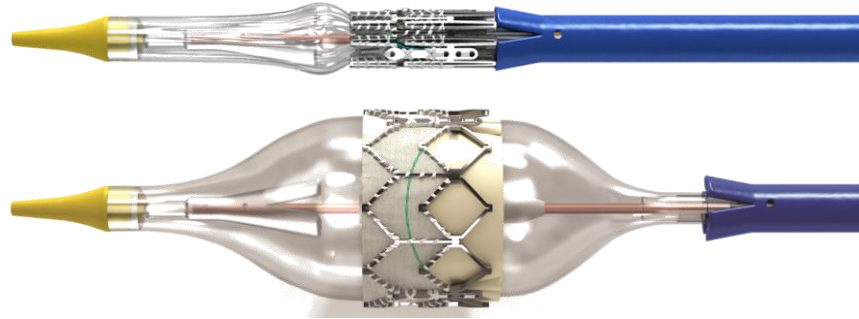
Transfemoral Approach



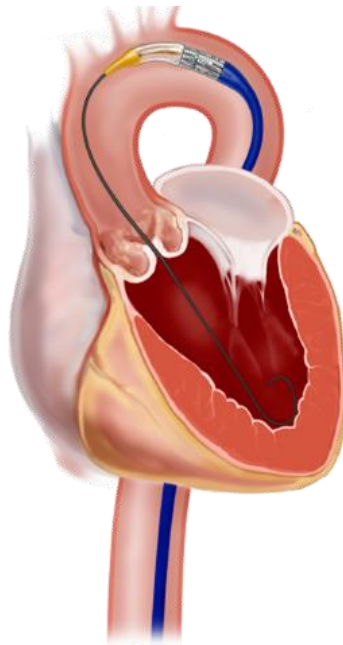
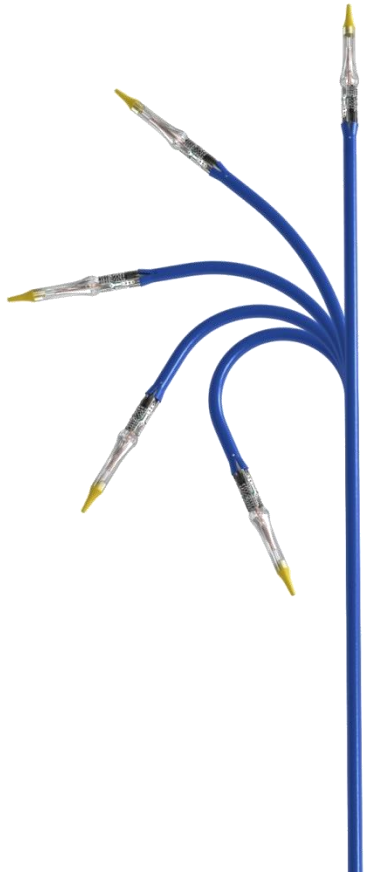
Transapical Approach

22. Himbert D, Descoutures F, Al-Attar N, et al. Results of transfemoral or transapical aortic valve implantation following a uniform assessment in high-risk patients with aortic stenosis. *J Am Coll Cardiol* 2009; 54:303-11.

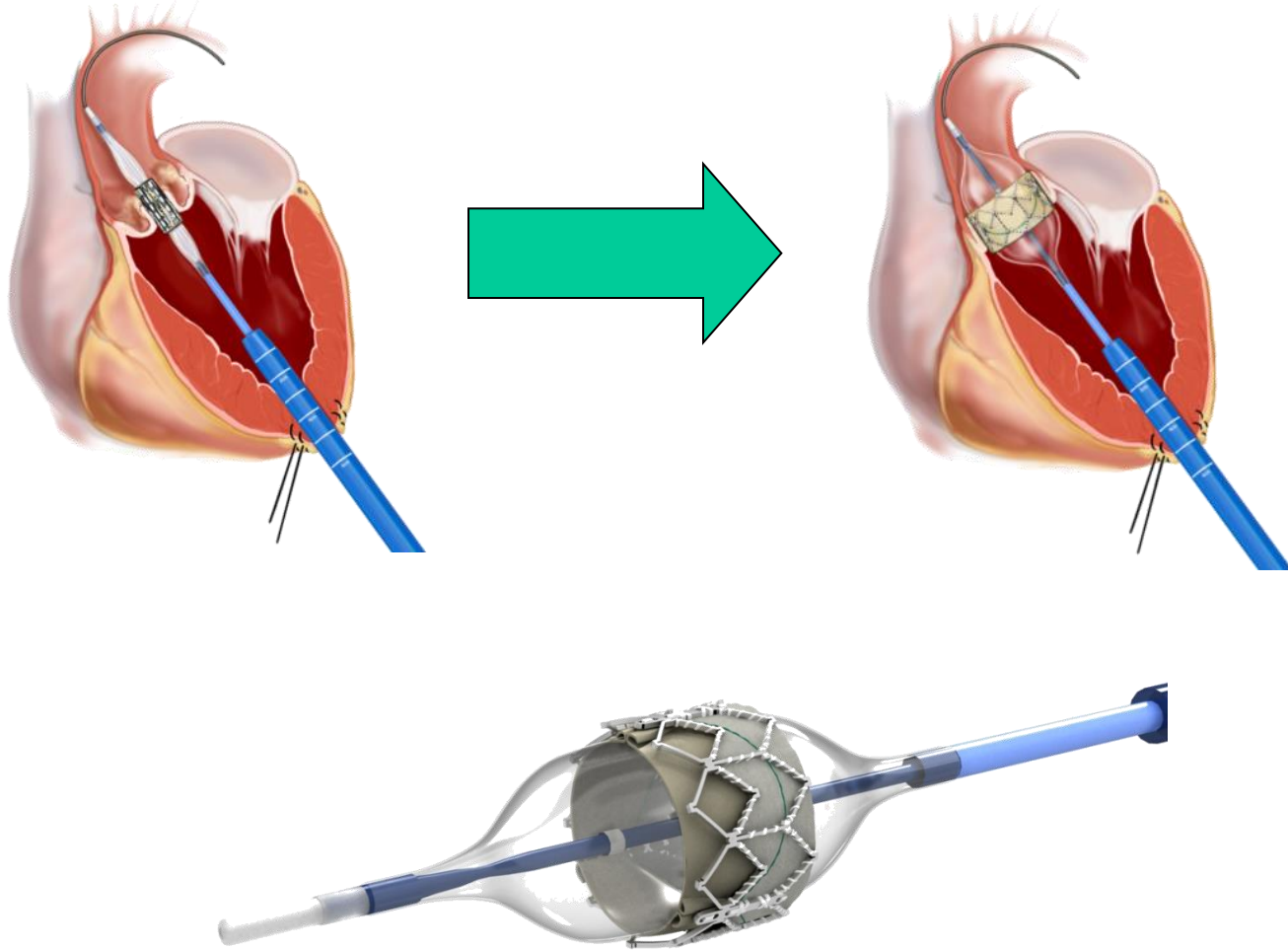
Balloon Expandable Delivery



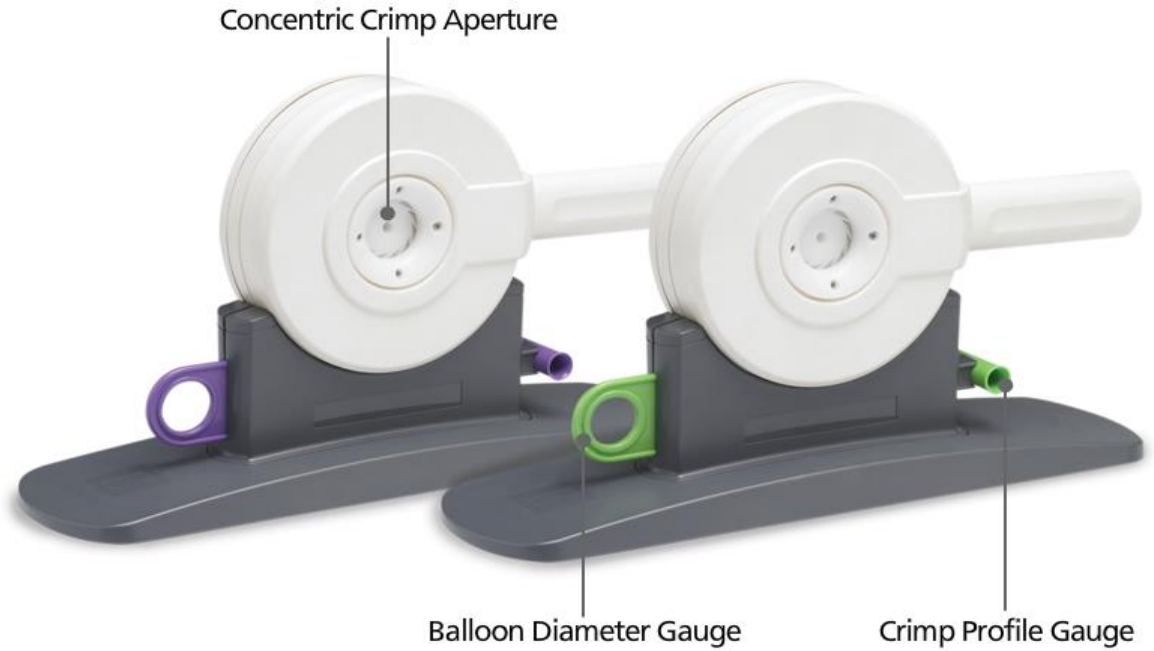
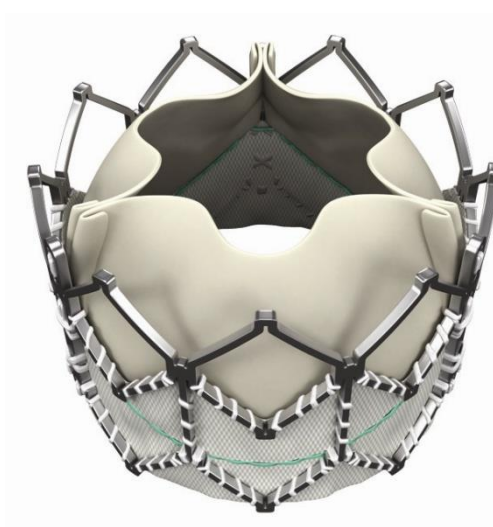
Transfemoral Delivery



Transapical Delivery

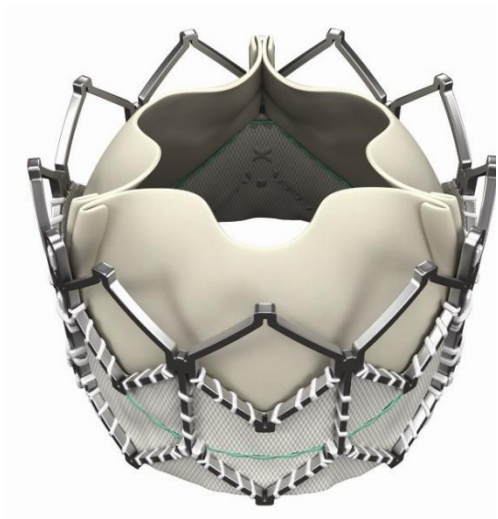


Valve Preparation

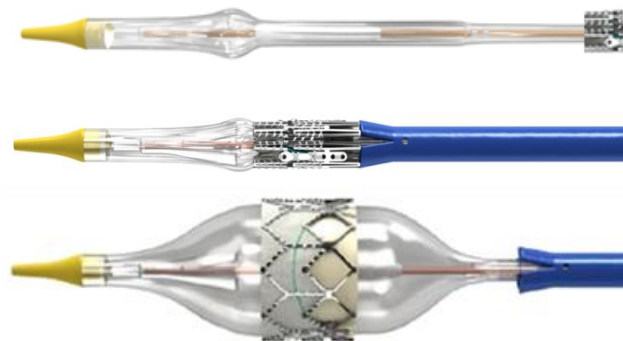


Edwards SAPIEN XT Transcatheter Heart Valve

Edwards SAPIEN XT THV



NovaFlex Transfemoral Delivery System

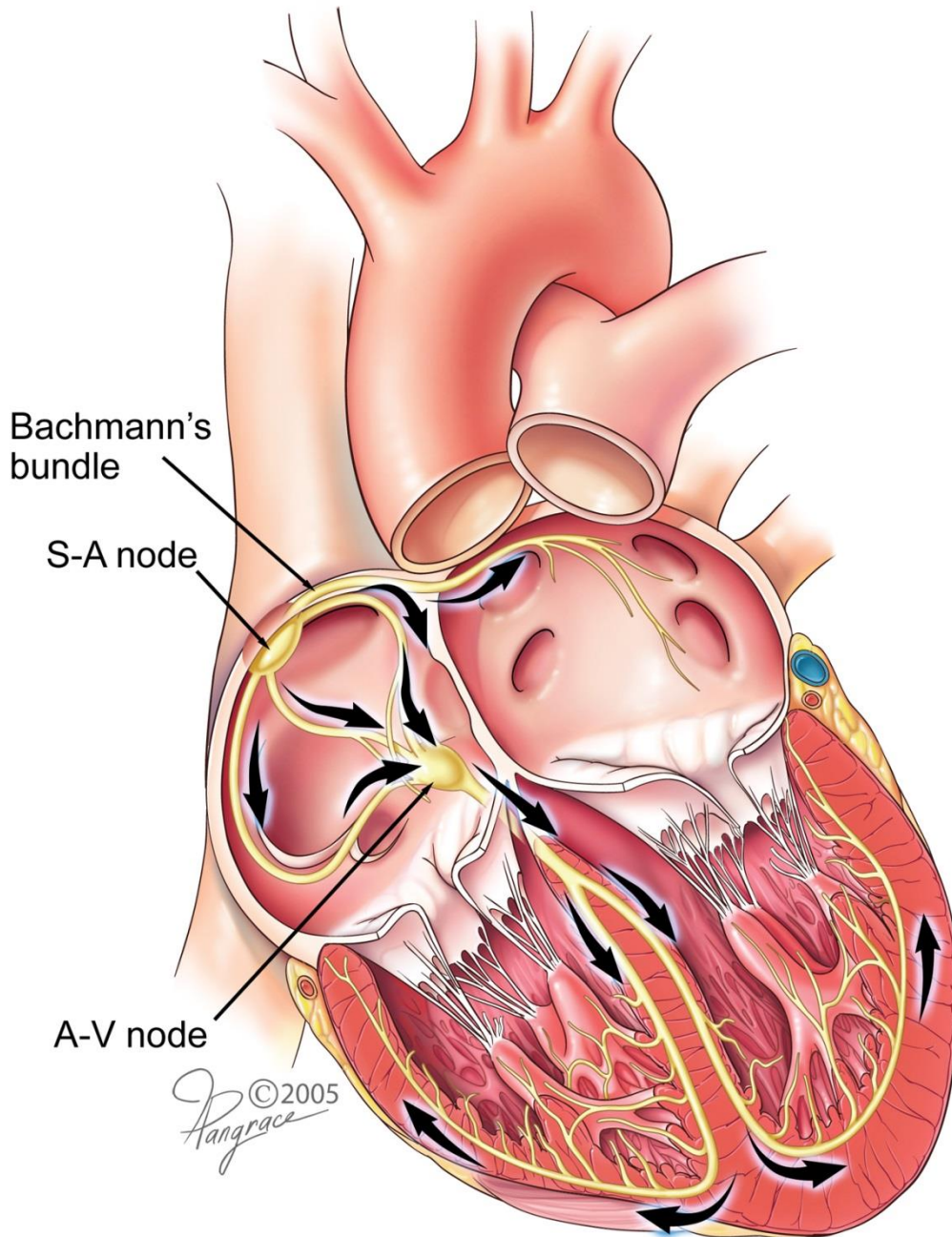


Ascendra2 Transapical Delivery System



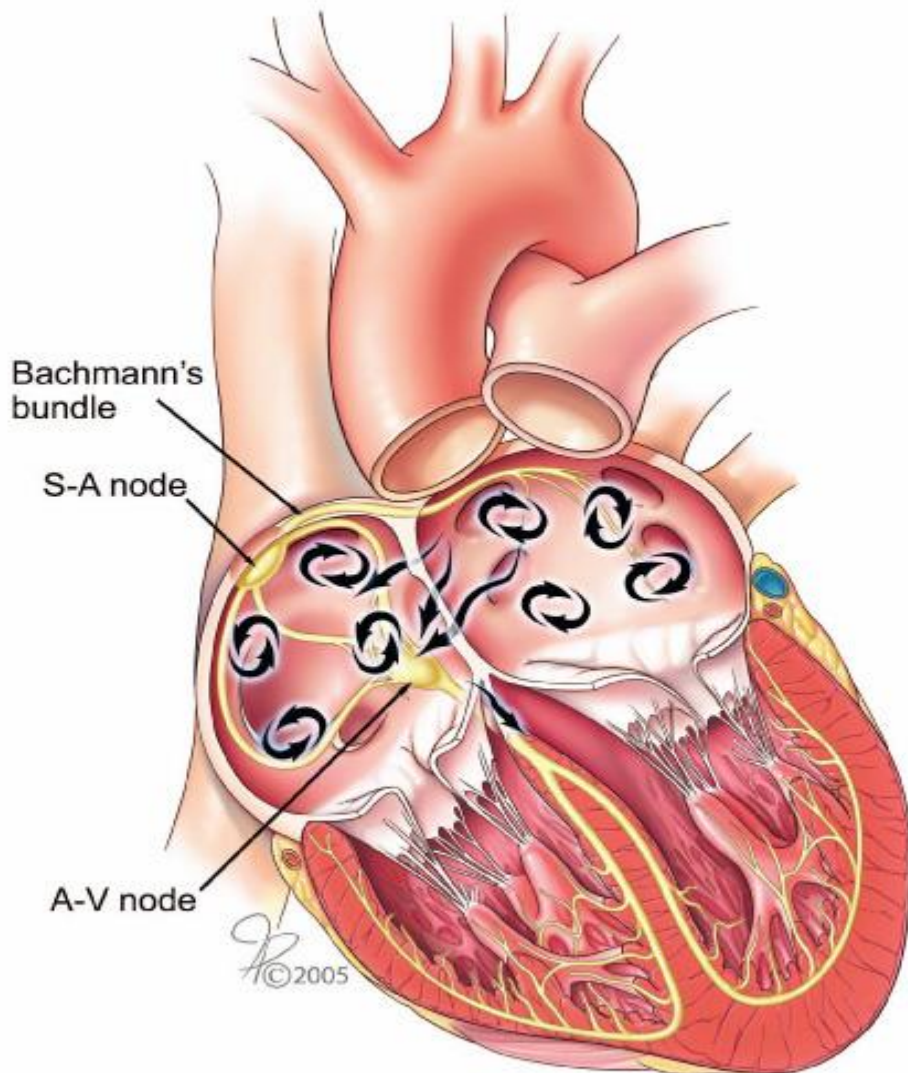
- History of Heart Surgery
- Coronary Artery Disease
- Heart Transplant and Artificial Heart Pump
- Minimal Invasive Heart Surgery
- Atrial Fibrillation and its therapy

Normal Heart Beat – Sinus Rhythm



ECG tracing of a normal heart rhythm.

Electric Activity in Atrial Fibrillation



Atrial Fibrillation

Prevalence

- Most common sustained arrhythmia
- Occurs in 0.4 - 2.0 % of general population Incidence as high as 10% in patients older than 80 years of age



Atrial Fibrillation

Complications

- 5 fold increased in the risk of stroke
- 35% of AF patients will have a stroke during their life time
- 31% of AF patients have no structural heart disease

- Gillinov AM. et al. Ann Thorac Surg 2002;74:2210 – 17
- Blackshear JL. et al. Ann Thorac Surg 1996;61:755 – 759
- Cox JL. et al. J Thorac Cardiovasc Surg 1999;118:833 – 40
- Neuroepidemiology 2003;22:118 - 123



Atrial Fibrillation

Treatment Options – Medical Approaches

Problems with medical approach

High complication rate from anticoagulants

- Risk is additive over lifetime
- 49% of AF patients cannot take blood thinner most commonly prescribed to prevent stroke

Anti-arrhythmic drugs are not benign

- Own set of complications that may be worse than

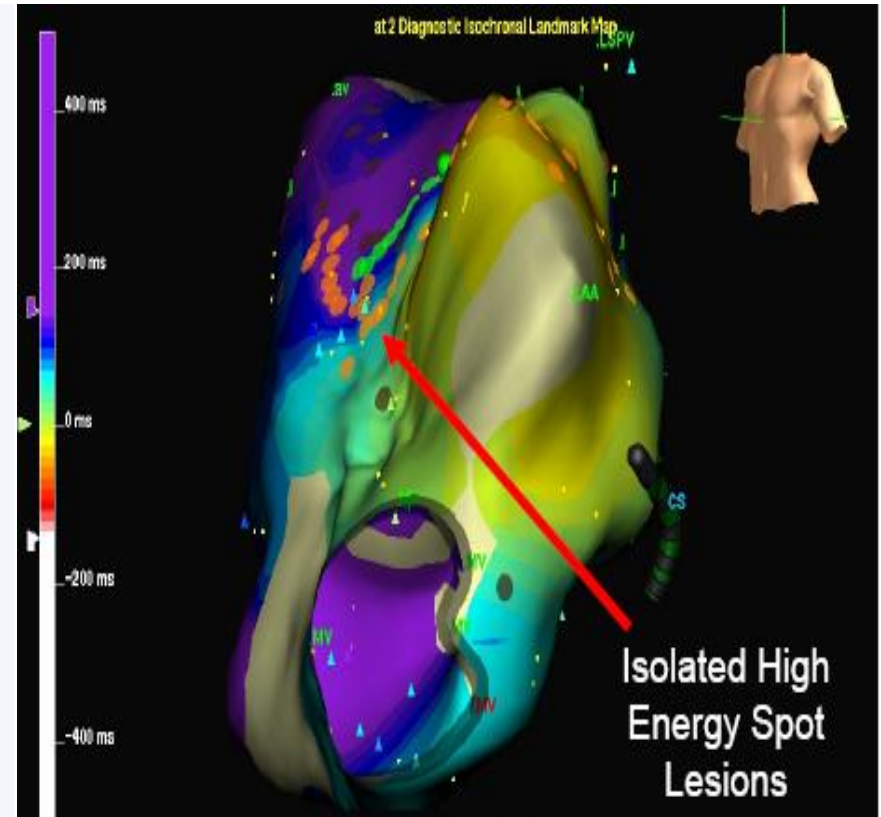
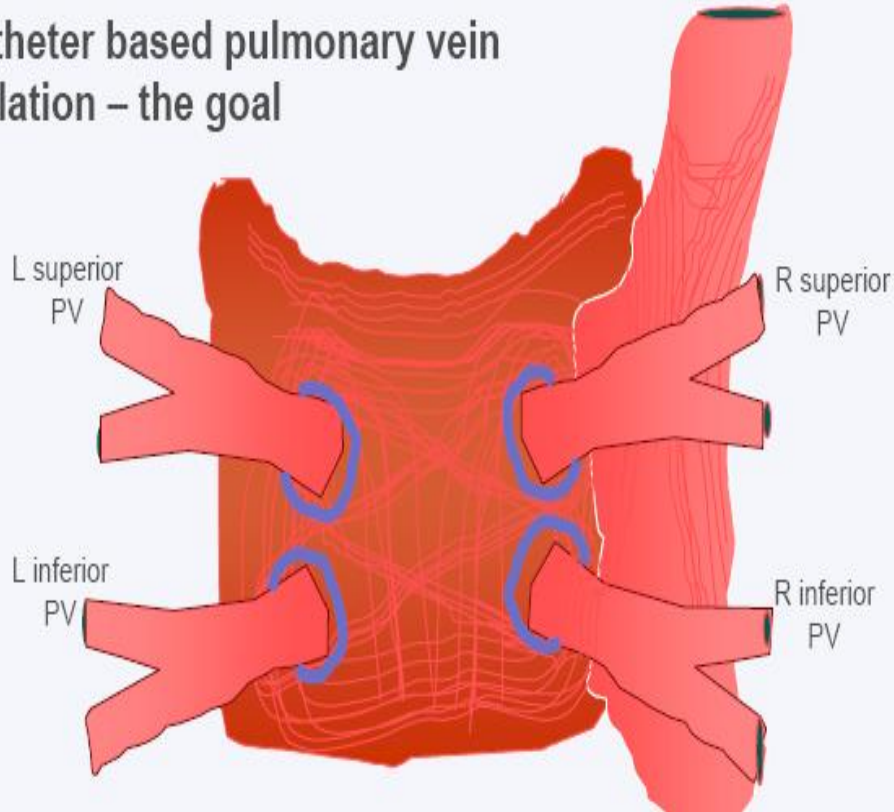
AFib



Atrial Fibrillation

Treatment Options – Catheter Based

Catheter based pulmonary vein isolation – the goal



Atrial Fibrillation

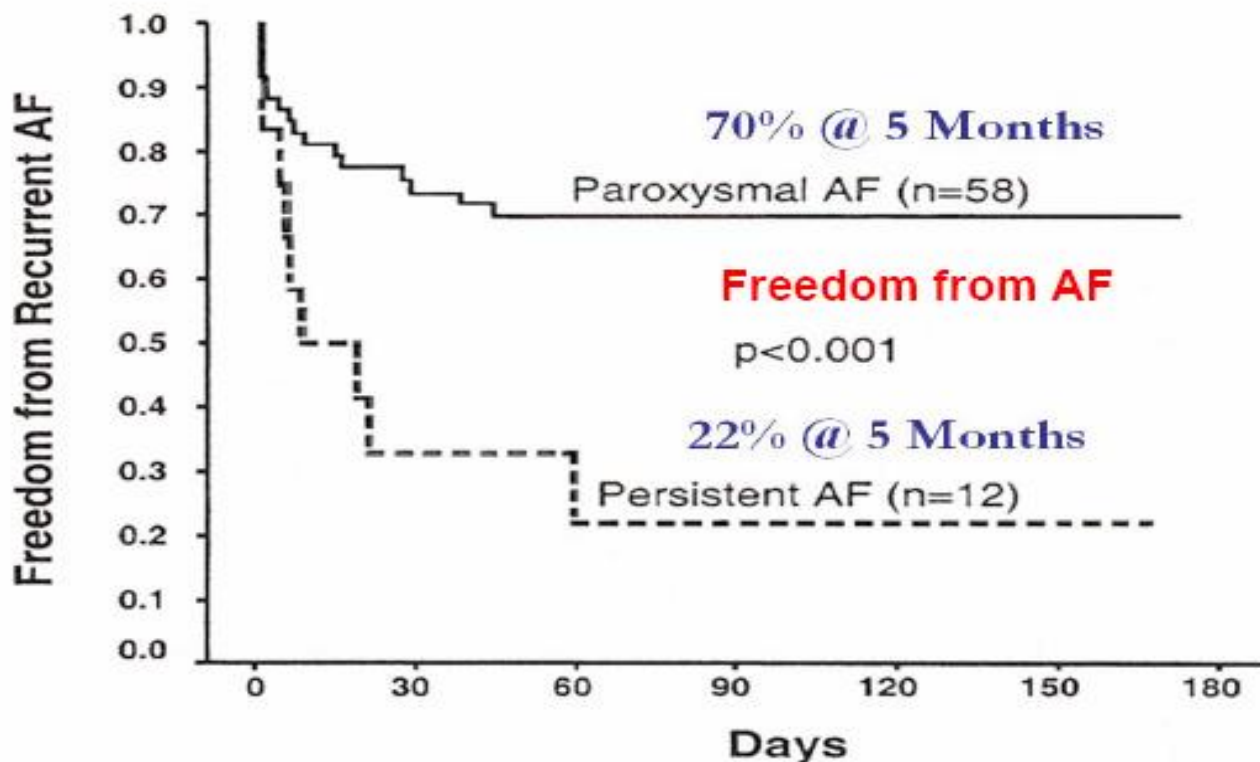
Catheter Based Ablation – The Challenges

- Technically difficult to create continuous lesion
- Transmurality not confirmed
- Poor long term outcomes
- Left Atrial Appendage not addressed
- Uncontrolled energy complications
- Esophageal fistula, embolic events
- Prolonged fluoro-radiation exposure



Atrial Fibrillation

Catheter Based Ablation – Long Term Results

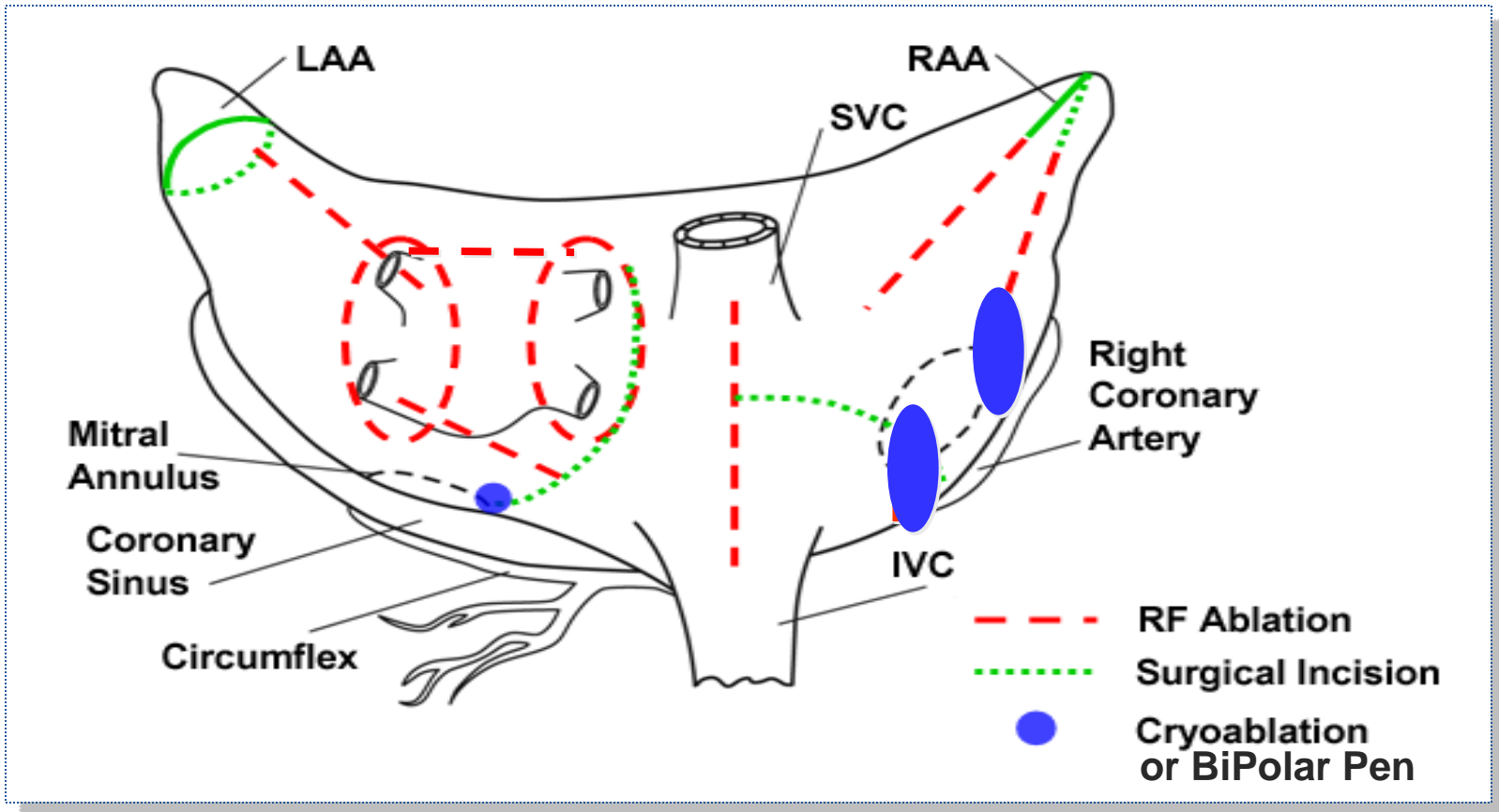


Oral H., Pulmonary Vein Isolation for Paroxysmal... Circulation 2002;105(9):1077-81.

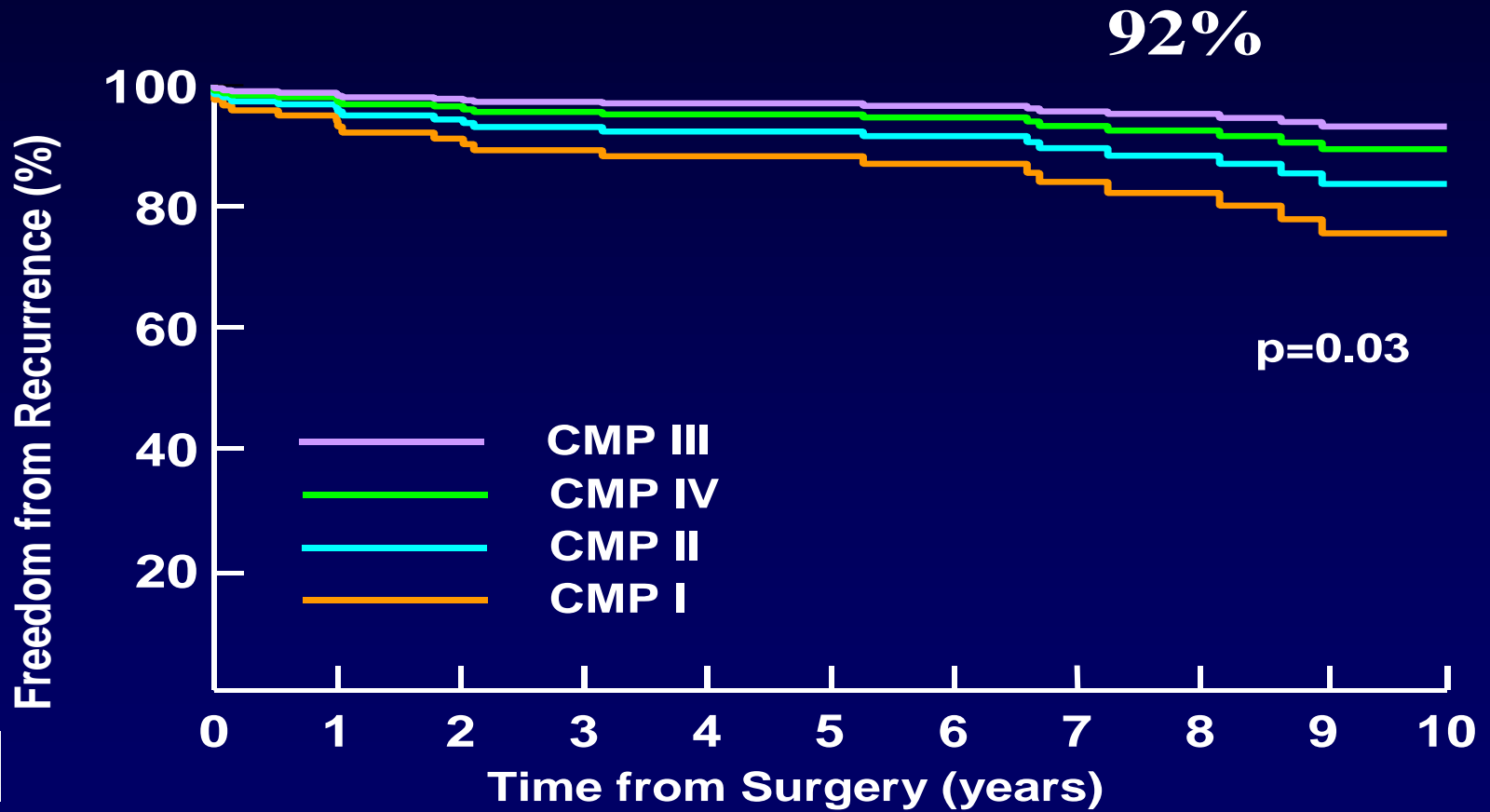


The Cox-Maze IV Procedure

Lesion set for Cox-Maze IV



Cox - Regression Freedom from Late AF Recurrence Stratified by Cox-Maze Procedure



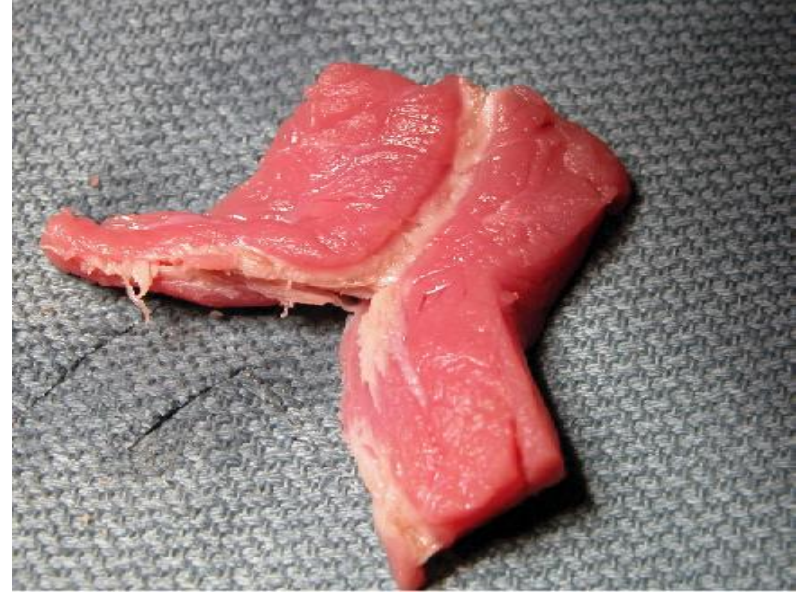
Energy Sources :

- Cooling / Cryo Ablation
- Microwave Ablation
- HIFU
- Laser (removed from market)
- Wet Radiofrequency Ablation, unipolar
- Dry Bipolar Radiofrequency Ablation



Radiofrequency Ablation

Electrical heat energy up to around 55 degree C will cause a permanent tissue damage and scar to stop electrical conduction



Cox-Maze Procedure On The Beating Heart

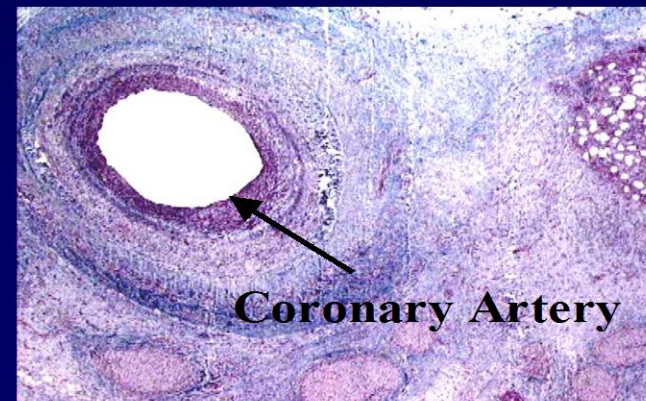
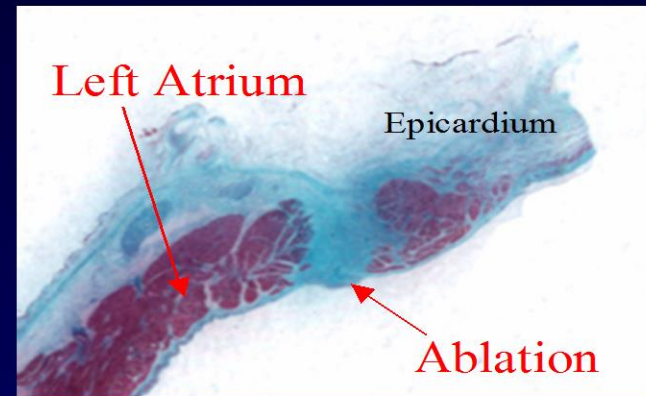
Results: Histology

- **Lesions**

- All atrial lesions were transmural
- 48 sections/animal

- **Coronary Arteries**

- No evidence of thrombosis or stenosis



Radiofrequency Ablation

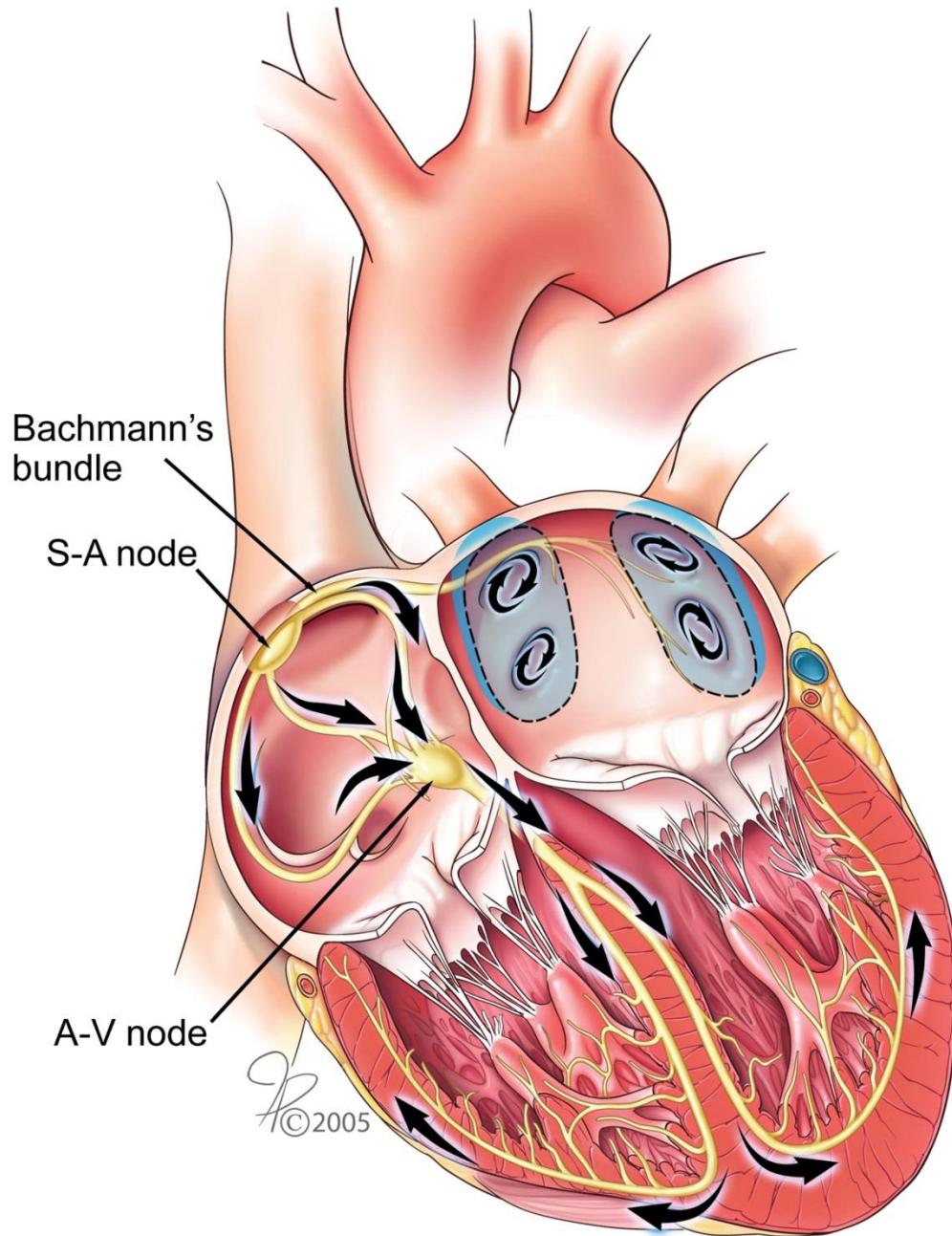


Atrial Fibrillation

Maze Operation - Radiofrequency ablation

Video is unavailable here.

Electrical Activity after Radiofrequency Ablation Surgery



Minimal Invasive Approach

Treatment Indications

Ablations may be performed on patients with A-Fib Who:

- Are refractory to anti-arrhythmic drugs
- Systemic embolus or Do not tolerate anticoagulants
- No significant cardiac lesions
- No significant COAD
- LA < 6 cm
- BMI < 35
- Failed catheter ablation

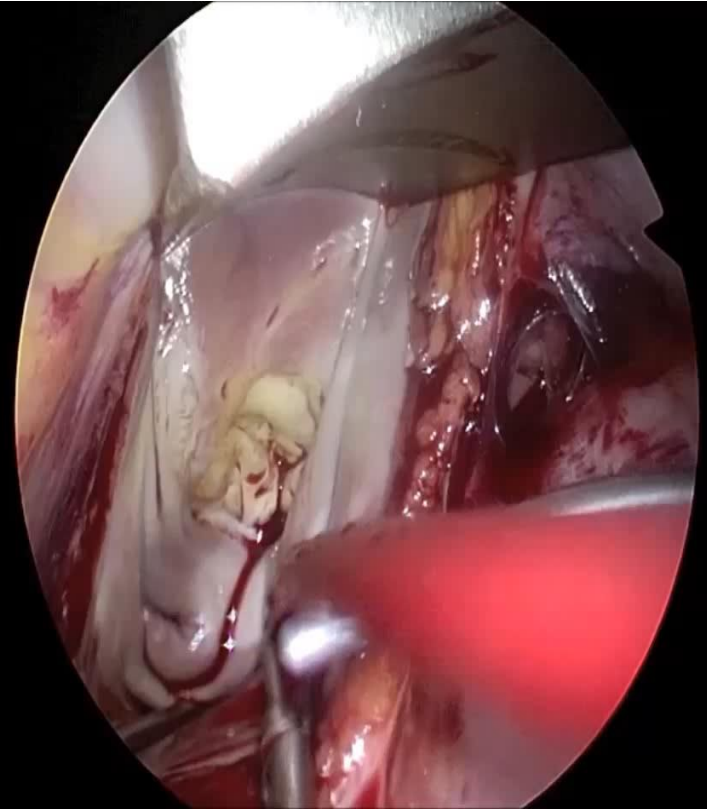


Thoracoscopic Approach

Surgical Technique

Video is unavailable here.

2)



Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation

Randall K. Wolf, MD,^a E. William Schneeberger, MD,^a Robert Osterday, PA,^a Doug Miller, MD,^a Walter Merrill, MD,^a John B. Flege, Jr, MD,^a and A. Marc Gillinov, MD^b



Schneeberger, Flege, Wolf, Merrill, Osterday, Miller (left to right)

Objective: Pulmonary vein isolation is curative in selected patients with atrial fibrillation. The objective of this study was to assess the feasibility and safety (midterm results) of video-assisted thoracoscopic epicardial pulmonary vein isolation.

Methods: Twenty-seven patients (22 male patients) with atrial fibrillation (18 paroxysmal, 4 persistent, and 5 permanent; average age, 57 years) underwent bilateral video-assisted thoracoscopic epicardial pulmonary vein isolation and excision of the left atrial appendage. All patients had had unsuccessful drug therapy or were intolerant to warfarin. A 5-cm working port and one 5-cm working port was achieved bilaterally by using a bipolar radiofrequency device. The left atrial appendage was excised with a surgical stapler.

90% Sinus Rhythm after 3 months

Results: Bilateral pulmonary vein isolation and left atrial appendage excision was performed successfully in all patients. There were no conversions to sternotomy or thoracotomy. All patients were extubated in the operating room. Postoperative complications in 3 patients were minor and resolved within 48 hours. One morbidly obese patient had more serious complications related to comorbid conditions.



QMH Cardiothoracic Team





Thank You