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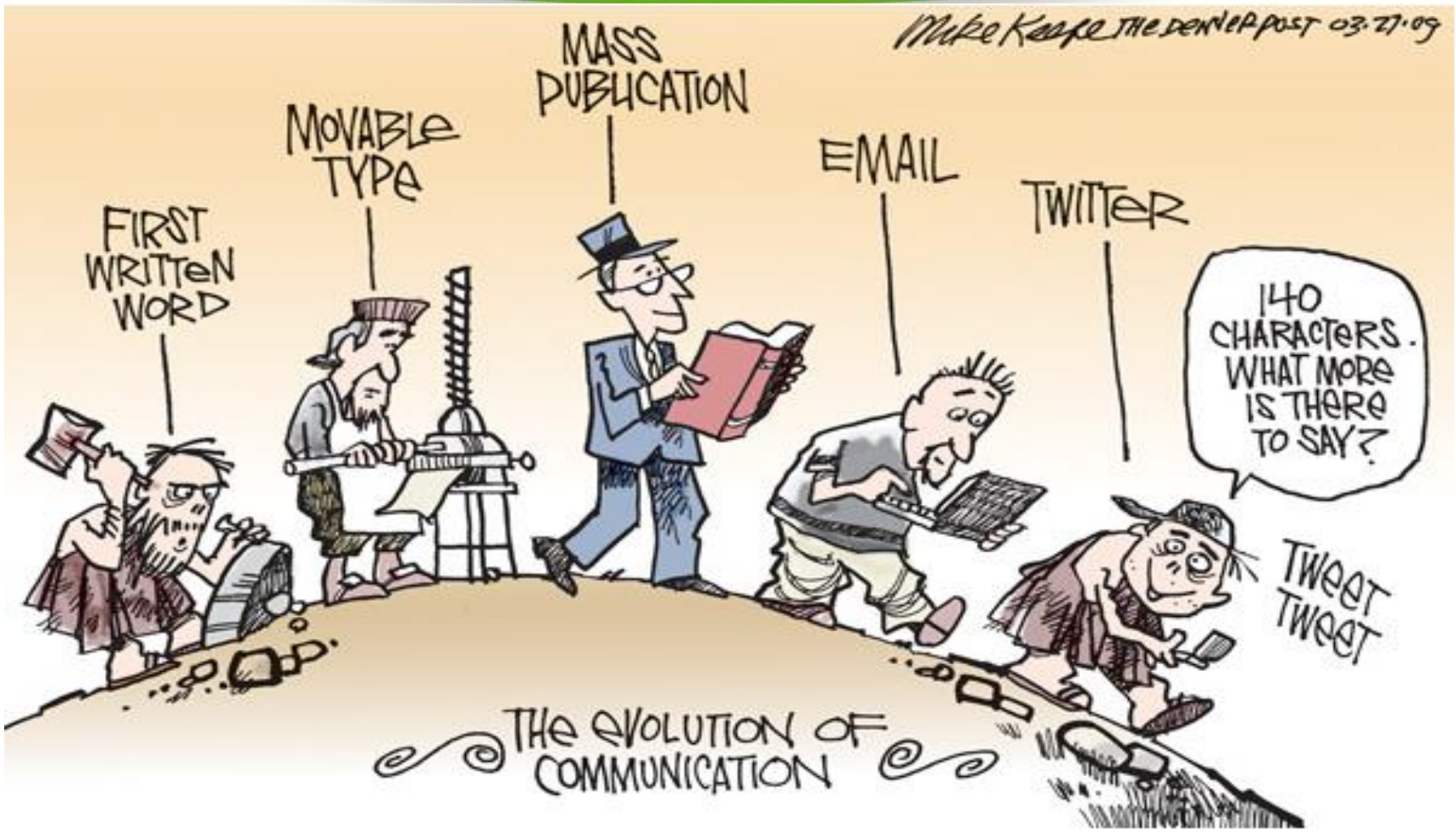
Overview of Advanced Mechanical Circulatory Support and Heart Transplantation

Bruce B Reid, MD Surgical Director
Artificial Heart Program/Heart Transplantation

Technology

Embracing Progress



Early Milestones in Cardiac Surgery

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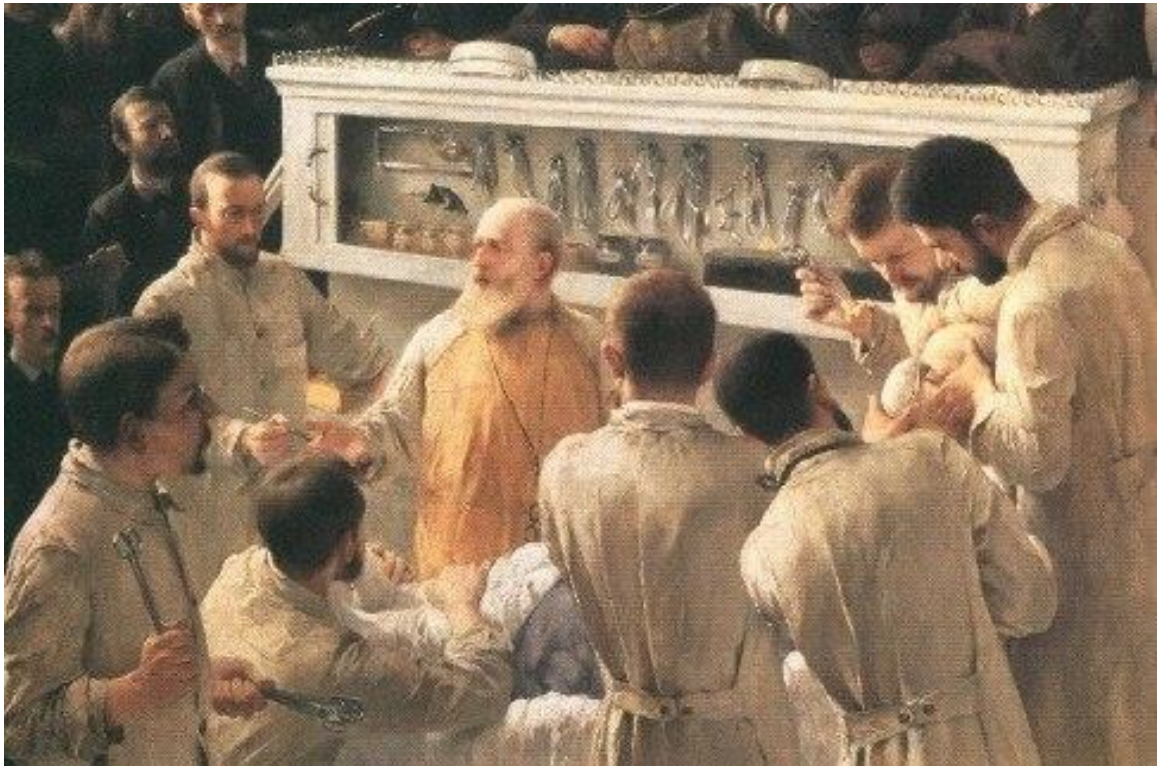
1800s

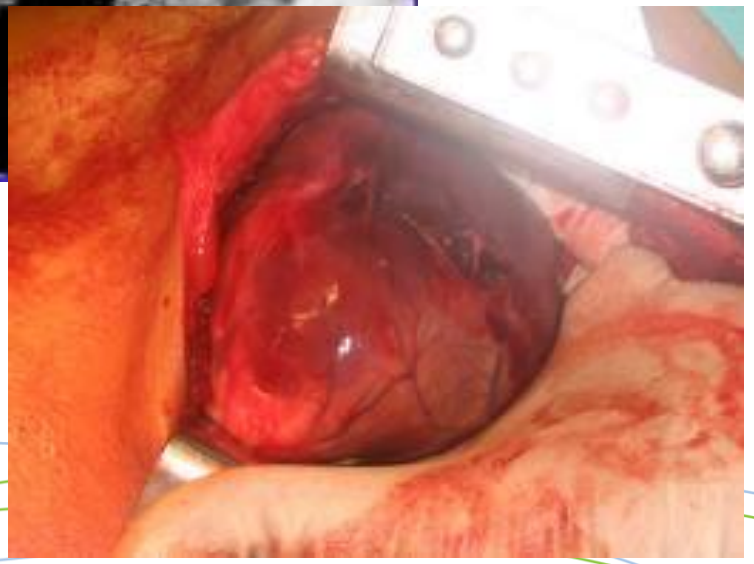


"A surgeon who tries to suture heart wounds deserves to lose the esteem of his colleagues."

Theodor Billroth (1829 – 1894)

Penetrating Cardiac Trauma

Dwight Harken, MD
1910-1993



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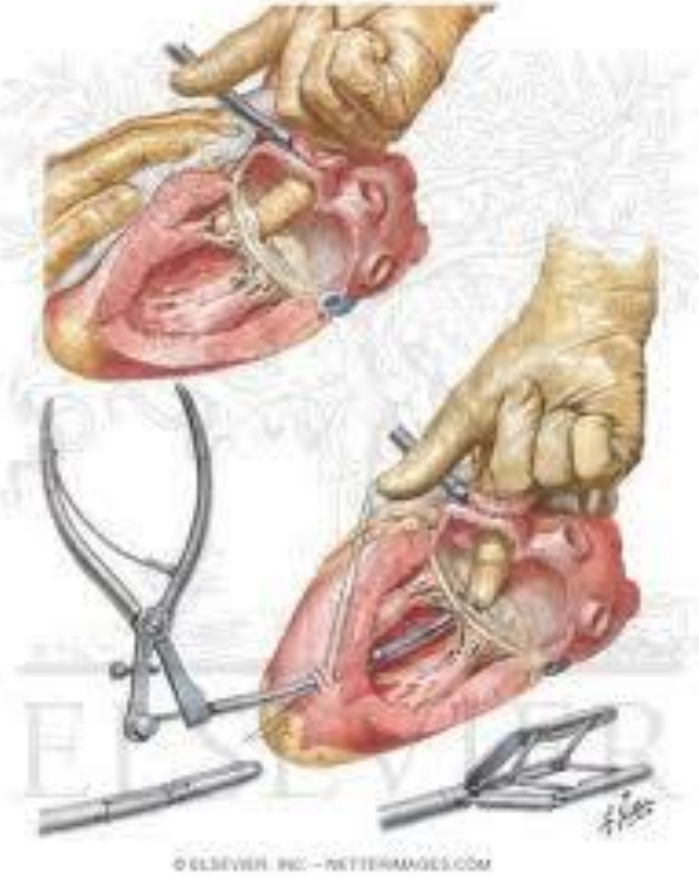
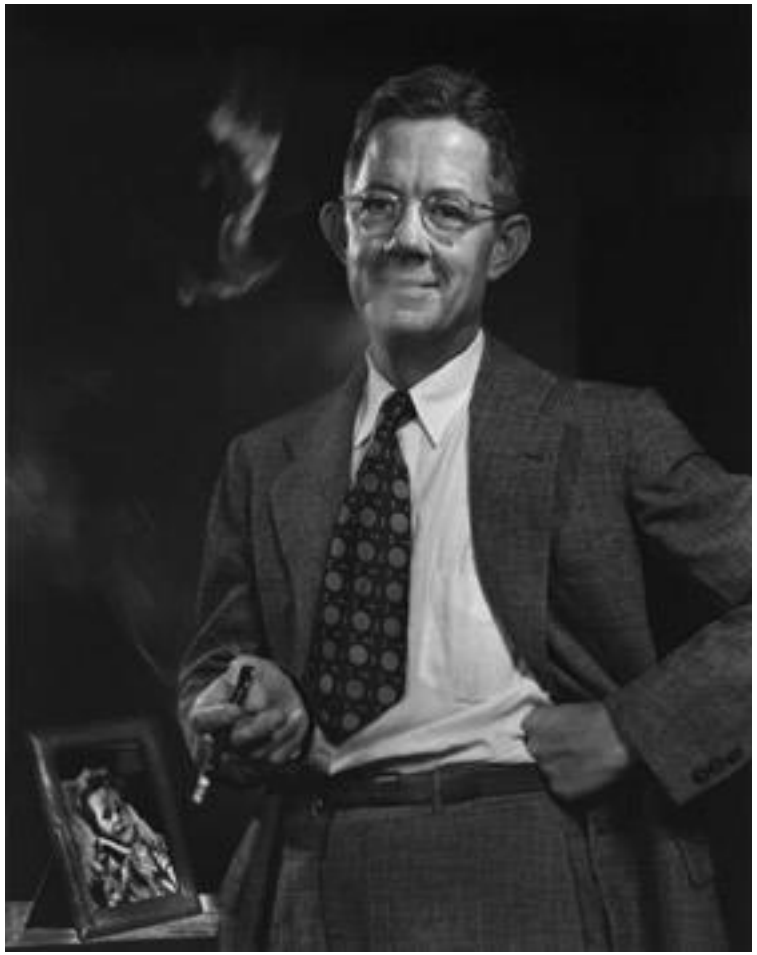
Closed Mitral Commissurotomy



Alfred T. Blalock, MD
1899-1964



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Johns Hopkins

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Helen B. Taussig, MD

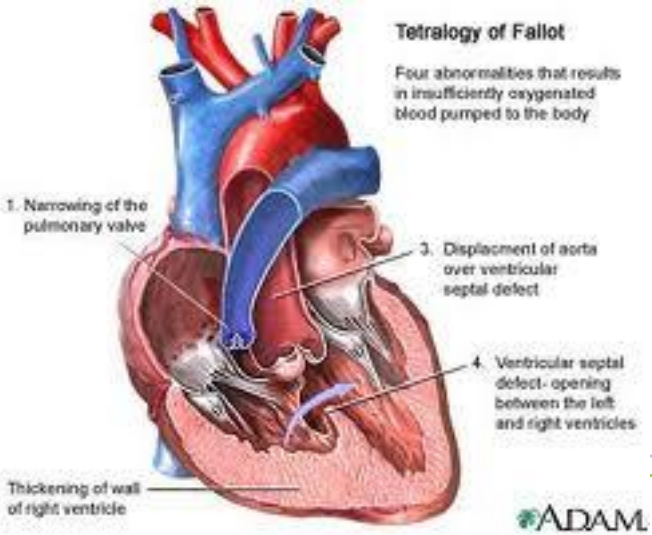
Intermountain Heart Institute

Intermountain Medical Center

Helen B. Taussig, MD
1898 - 1986

Johns Hopkins University

Helen B. Taussig, MD
1898 - 1986



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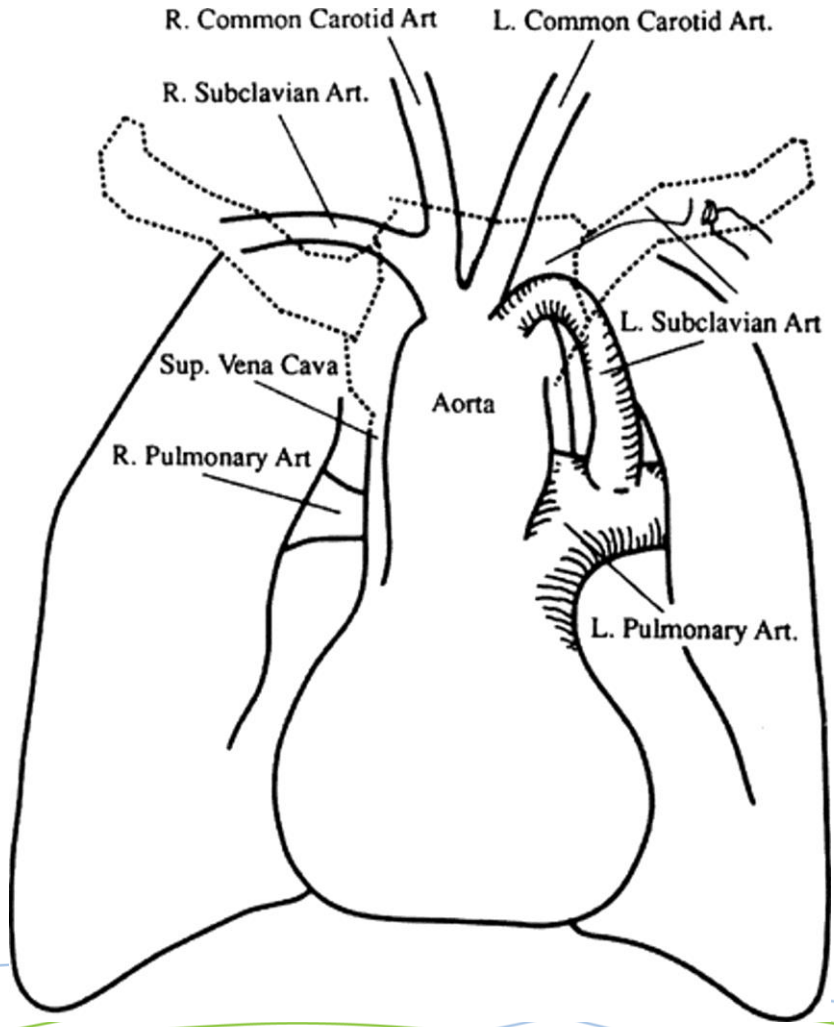
BT Shunt

Blalock A, Taussig HB:

The surgical treatment of malformations of the heart in which there is pulmonary stenosis or pulmonary atresia.

JAMA 1945; 128:189



Vivien Thomas

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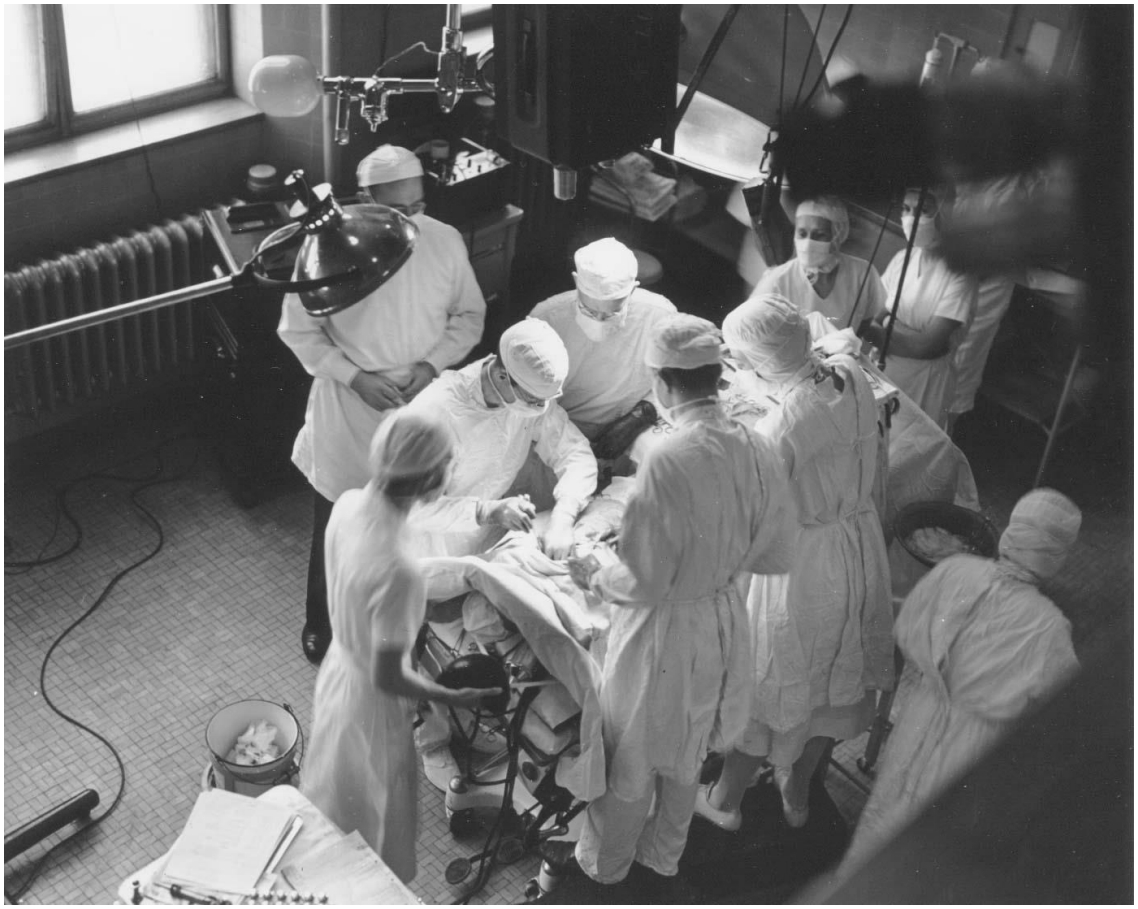
First Blalock-Taussig Shunt 1944



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E S

OPERATION: Nov. 29, 1944
Dr. Alfred Blalock
Ether - Oxygen - Dr. Harmel

ANASTOMOSIS OF LEFT PULMONARY ARTERY TO LEFT SUBCLAVIAN ARTERY

This patient was an undernourished child who had cyanosis on frequent occasions. The diagnosis was pulmonary stenosis.

Under ether and oxygen, administered by the open method, an incision was made in the left chest extending from the edge of the sternum to the axillary line in the third interspace. The second and third costal cartilages were divided. The pleural cavity was entered. The left lung looked normal. No thrill was felt in palpating the heart and pulmonary artery. The left pulmonary artery was identified and was dissected free of the neighboring tissues. The left pulmonary artery seemed to be of normal size. The superior pulmonary vein, on the other hand, seemed considerably smaller than normal to me. I had hoped that the artery to the left upper lobe might be sufficiently long to allow an anastomosis, but this did not appear to be the case. The left subclavian artery was then identified and was dissected free of the neighboring tissues. The vertebral artery and the branches of the thyrocervical axis were doubly ligated and divided. The subclavian was so short that there would not have been sufficient length for our purposes, had this not been done. The subclavian artery was then ligated distal to the thyrocervical trunk. A bulldog clip was placed on the subclavian artery at a point just distal to its origin from the aorta. The subclavian artery was then divided just proximal to the ligature. Two bulldog clips were then placed on the left pulmonary artery, the first clip being placed at the origin of the left pulmonary artery, and the second clip being placed just proximal to the point where the artery entered the lung. There was ample space between these two clips for our purpose. A small transverse incision was then made in the wall of the pulmonary artery. By the use of china beaded silk on fine needles, an anastomosis was then performed between the end of the left subclavian artery and the side of the left pulmonary artery. A posterior row of sutures was placed first. There was practically no bleeding following the removal of the bulldog clips.

The anastomosis seemed to be a satisfactory one, and the main point of worry comes from the small size of the left subclavian artery. I was disturbed because I could not feel a thrill in the pulmonary artery after the clips were removed. I do not believe that this was due to any clot in the subclavian artery, because it seemed to pulsate vigorously. It is possible that it was due to a low pressure in the systemic circulation. I do not actually know what the systemic pressure was. Another possibility was that it might have been due to spasm of the subclavian artery. My only regret was that the subclavian artery was not bigger. It is possible that the increased red cell count in this patient may have predisposed to thrombosis.

(over)

Surgical Pioneers

Dr. Alfred Blalock Vivien Thomas

PHOTOS BY BY THE ALAN MASON CHESNEY MEDICAL ARCHIVES OF THE JOHNS HOPKINS MEDICAL INSTITUTIONS

Blue Babies

NEW YORK HERALD TRIBUNE, FRIDAY, FEBRUARY 15, 1946

'Blue Babies' Who Were Restored to Health and Doctors Who Did It

Herald Tribune—Rice
Michael Rose, five and a half, of 220 Boscobel Place, the Bronx

Herald Tribune—Rice
Alan Beck, three and a half, of 1700 Sterling Place, Brooklyn

Herald Tribune—Acme
Marilyn Firsenbaum, nine and a half, 80 Chester Street, Brooklyn

Herald Tribune—Kavallines
Harry Goldzweig, seven, of 935 Fifty-seventh Street, Brooklyn

How 2 Doctors Give New Lives To Blue Babies

Blalock-Taussig Operation, First Tested on Dogs, Reroutes Flow of Blood

By Lester Grant

BALTIMORE, Feb. 14.—This is the story of the work of two doctors—a man from Georgia and a woman from Massachusetts—who met in Baltimore and combined their talents to save the lives of "blue babies."

The doctors are Alfred Blalock, forty-six, surgeon in chief at Johns Hopkins Hospital here and professor of surgery at the Hopkins Medical School, and Helen B. Taussig, forty-seven, physician in charge of the cardiac clinic of the Harriet Lane Home for Invalid Children. The Harriet Lane Home constitutes the pediatrics division of Johns Hopkins Hospital.

The surgery, known as the Blalock-Taussig operation, first was used on an infant on Nov. 29, 1944. Its development since then is one of the most exciting stories in

Herald Tribune—Acme
Dr. Alfred Blalock and Dr. Helen B. Taussig at Johns Hopkins Hospital in Baltimore

Switching Arteries Sidetracks Blood and Oxygen to Otherwise Starved Lungs

The "Blue" Babies' Blood Lacks Vital Oxygen Because the Artery (1) From the Heart to the Lung Is Constricted. By Severing an Artery of the Arm (2), Tying It Off (3) and Attaching It to the Lung Artery (4) the Constriction Is By-Passed.

Saving Our Doomed 'Blue' Babies

By Robert D. Potter
Science Editor

A WOMAN physician's courageous research and imagination, and the skill of one of the world's great surgeons have combined to bring hope that many "blue" babies—hitherto considered doomed to early death—may be saved.

These babies are blue because they are suffering from a lack of oxygen in their blood streams, in a condition known as cyanosis. The artery from their heart to their lungs is so constricted that their blood never gets oxygen to make cheeks rosy.

Their lips are blue. Their toes are blue, and they can walk only a few feet without exhaustion. Doctors used to give them only a few tortured years to live.

But now medicine can give hope . . . and more . . . for since Nov. 20, 1944, Dr. Blalock, Professor of Surgery at Johns Hopkins University in Baltimore, has been conquering the "blue" baby malady by rerouting an artery from the arm and making it carry blood to the lungs where it can receive its vital oxygen.

Nearly 70 operations have been performed on "blue" babies. In many cases almost miraculous recovery has come.

It is Dr. Blalock's fingers that wield the knife in the delicate operation that exposes the heart and transplants its vital arteries. But behind the brilliant operation he has perfected are years of painstaking research by Dr. Helen B. Taussig.

Daughter of the late Prof. F. W. Taussig, world-famous Harvard economist, Dr. Taussig had watched "blue" babies come to her heart clinic at Johns Hopkins Hospital.

In many cases she discovered that the artery leading to the lung from the heart was narrowed so that an insufficient supply of blood was reaching the lungs to receive its vital oxygen. Dr. Taussig reasoned that a surgical operation might be able to short-circuit the constriction and sidetrack blood into the lungs. On paper, when the diagram of the art-

the blood would pick up its life-giving oxygen. Then it would go back to the heart again to move outward through the body.

But could it be done? It is one thing to have a plumber re-arrange a piping system and something quite different to lay bare the human heart, sever one of its main arteries, splice it to another main artery and sustain life in the patient in the process. Dr. Blalock said he would try.

Since the pioneer attempt the operation has been largely successful, although it is one filled with danger. Among the first 70 patients, 14 died. The odds are 5 to 1 for success.

Now that the news of Dr. Blalock's operation is known through the country the list of patients grows daily. Blue little Bonnie Stewart of Florida, daughter of a daddy killed on Saipan, went to Baltimore with her grandmother. Today Bonnie walks and plays like other children.

The case of six-year-old Mike Schirmer — the boy with the "itchy zipper" — shows what can be done.

Six-Year-Old Mike Schirmer of Baltimore Could Walk Only Five Feet Without Resting Before the Operation. He Shows His "Itchy Zipper" — the Incision for the Operation.

Little Bonnie Stewart of Florida Is Another of the 70 Children Saved by the New Johns Hopkins Surgery.

Mike's "itchy zipper" is the healing incision over his heart where Dr. Blalock went in to do the operation. But let his mother tell his story:

"Michael could only walk five feet and then he'd have to squat down on the sidewalk and rest.

"I had to wheel him everywhere. Strangers would stop his carriage and

was no hope that Mike could grow up. But then came new hope, for Dr. Mansderfer told us about the operation of Dr. Blalock.

"They took him to the operating room and brought him back two hours later. It was a miracle.

"After only two weeks of convalescence he came home and he has been on the go ever since. If anyone wants anything he'll run and get it. He's up and down stairs 75 times a day. He climbs on bureaus and tables just for the joy of jumping off. He wears me out. But I love it."

The Blalock-Taussig operation is not a simple one. It takes from an

branches of the pulmonary artery (to the lungs) are two large blood vessels. One connects the heart and the arm, the other the heart and the head. Dr. Blalock chooses the most convenient — usually the arm artery — and severs it. One end is clamped off and the other closed permanently.

The end nearest the heart is then spliced to the nearest branch of the pulmonary artery. The clamps are removed and the blood that would ordinarily flow to the arm goes into the lung. There it becomes enriched with vital oxygen and the baby's blue lips quickly begin to turn red.

What happens to the arm?

Nature has provided other blood vessels which take up the blood load

Blalock and Taussig in London

Legacy to Children

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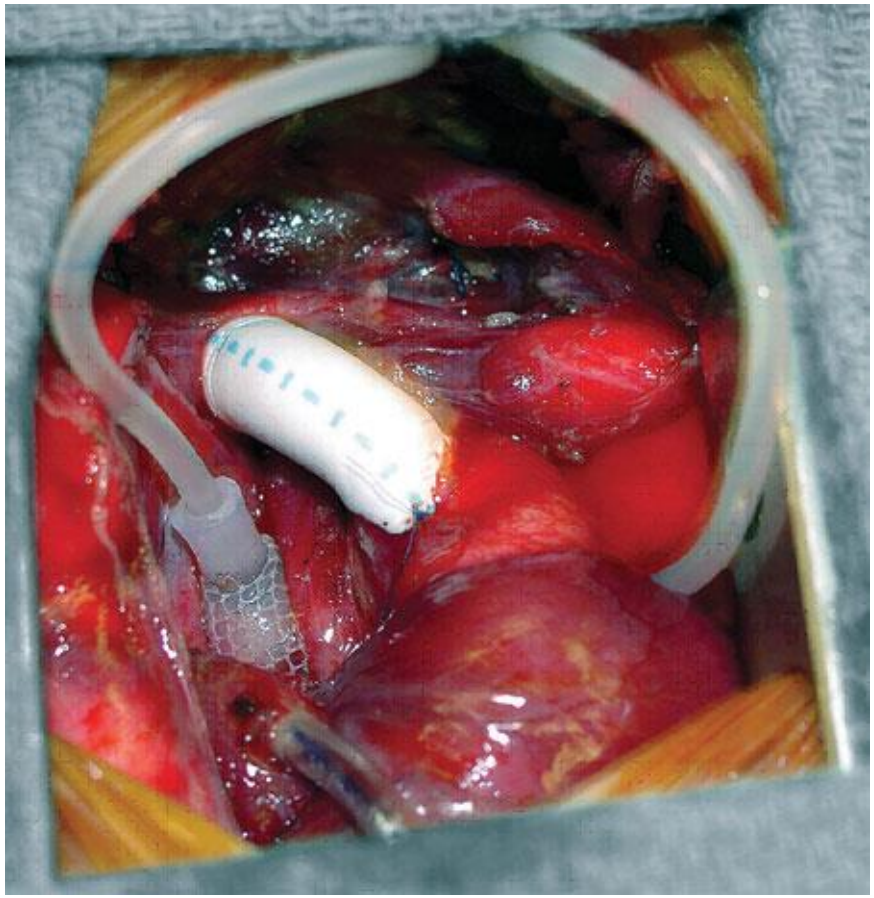
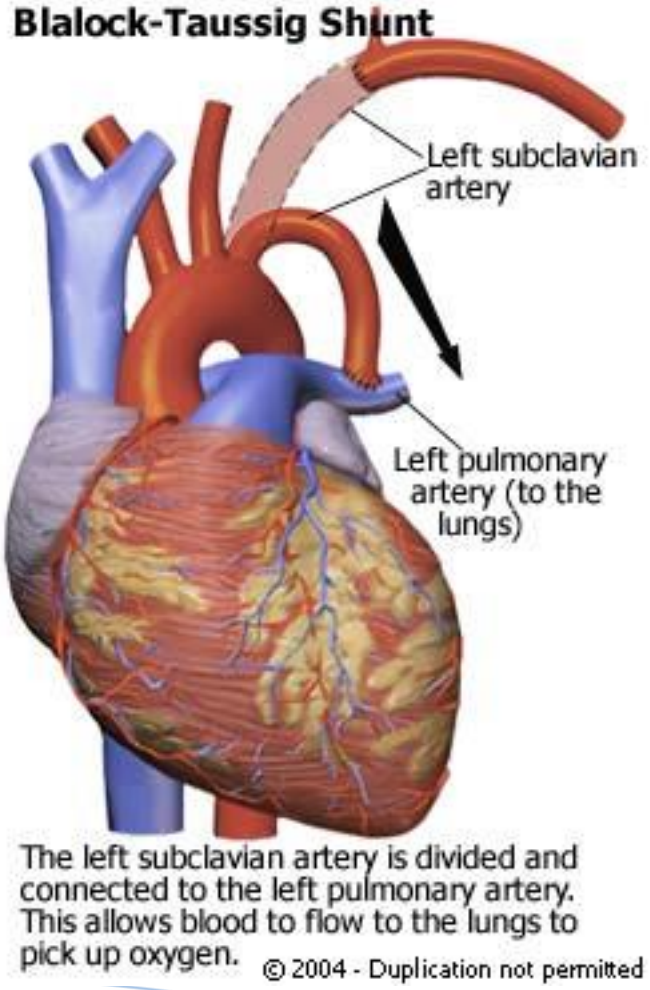
Blalock-Taussig Shunt





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Johns Hopkins University

C. Walton Lillehei, MD
1918 - 1999

Donor

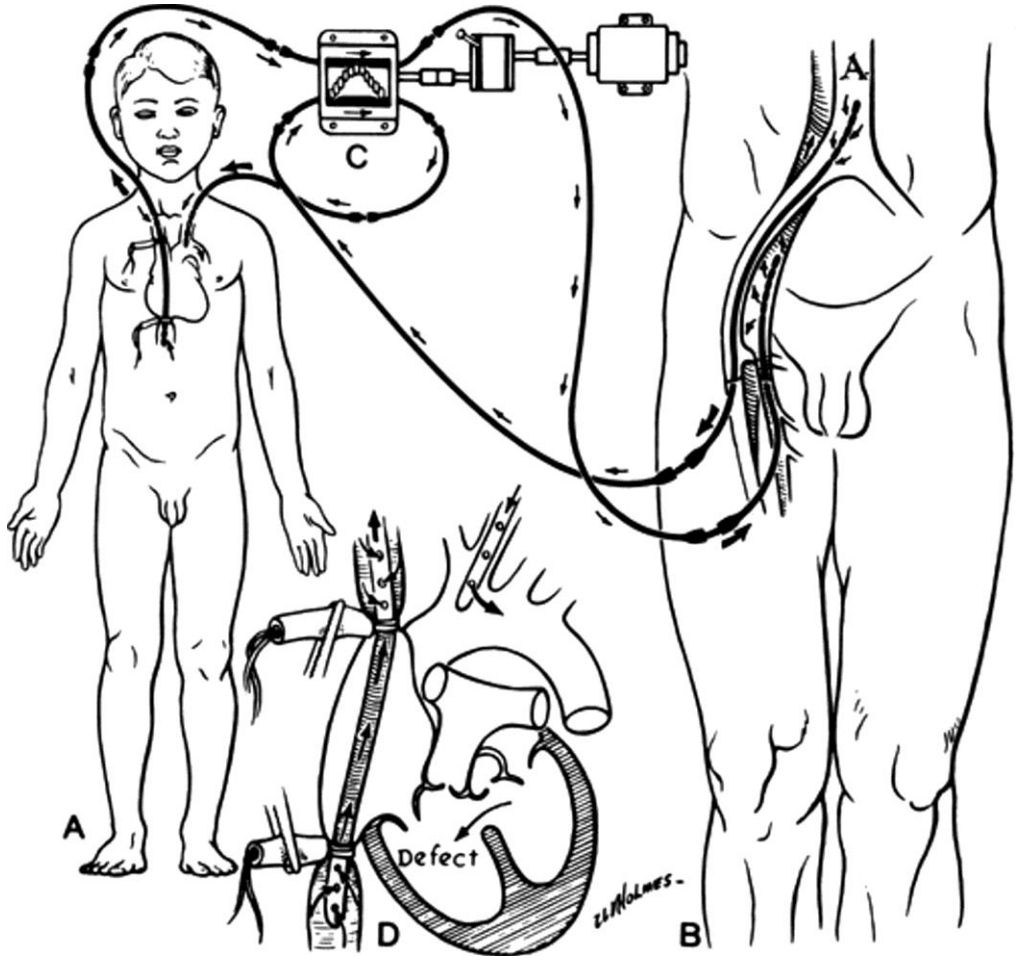
Cross Circulation

Donor Cross Circulation

Lillehei CW, Cohen M, Warden HE, et al

The results of direct vision closure of ventricular septal defects in eight patients by means of controlled cross circulation.

Surg Gynecol Obstet 1955; 101:446



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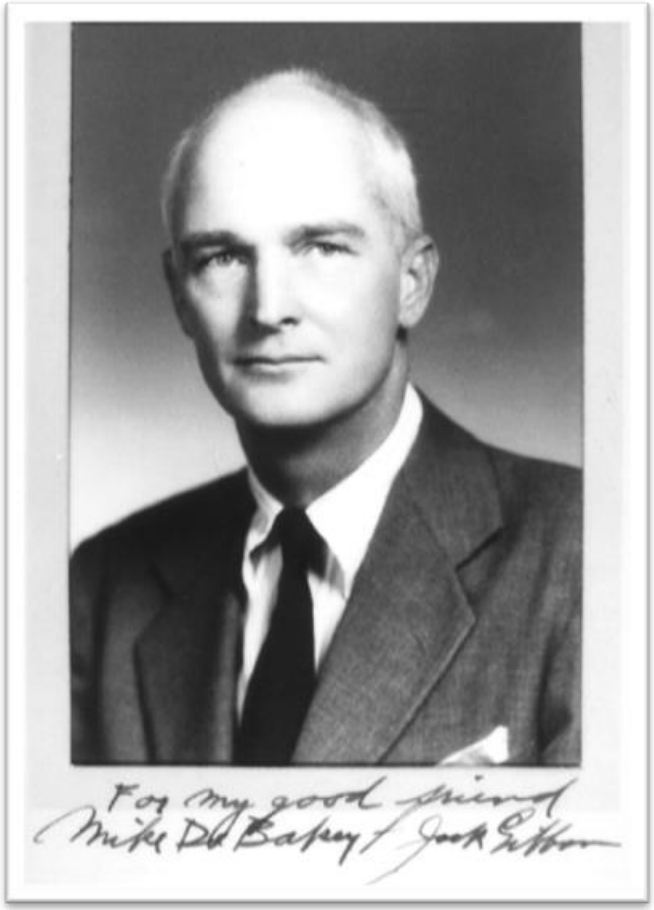
John H. Gibbon, MD
1903 - 1973

Pioneer in the development of extracorporeal circulation



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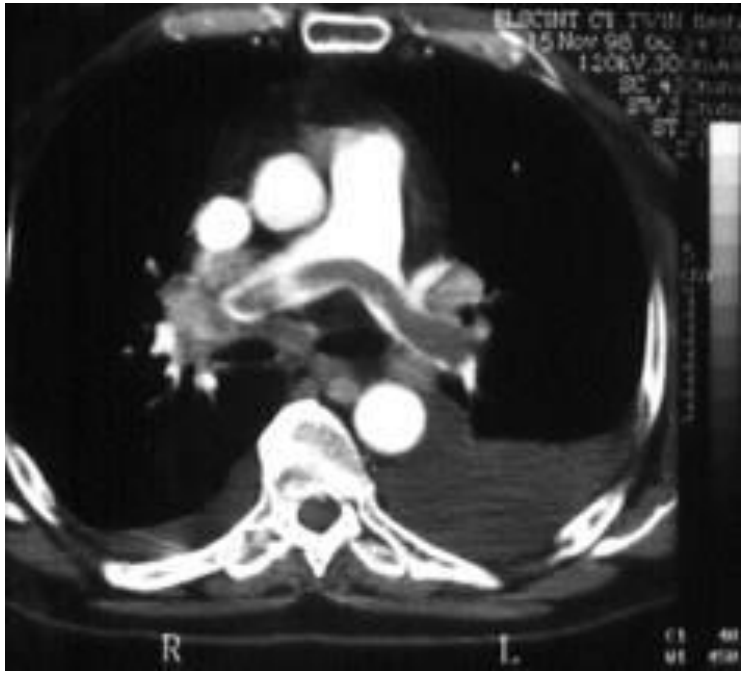
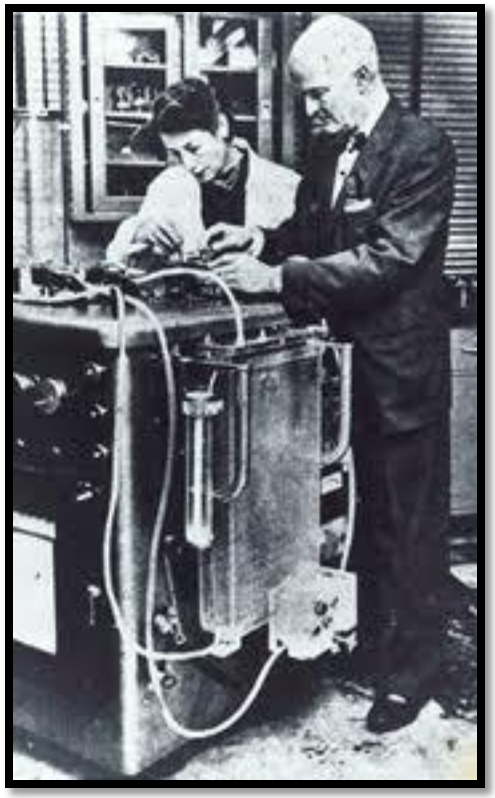
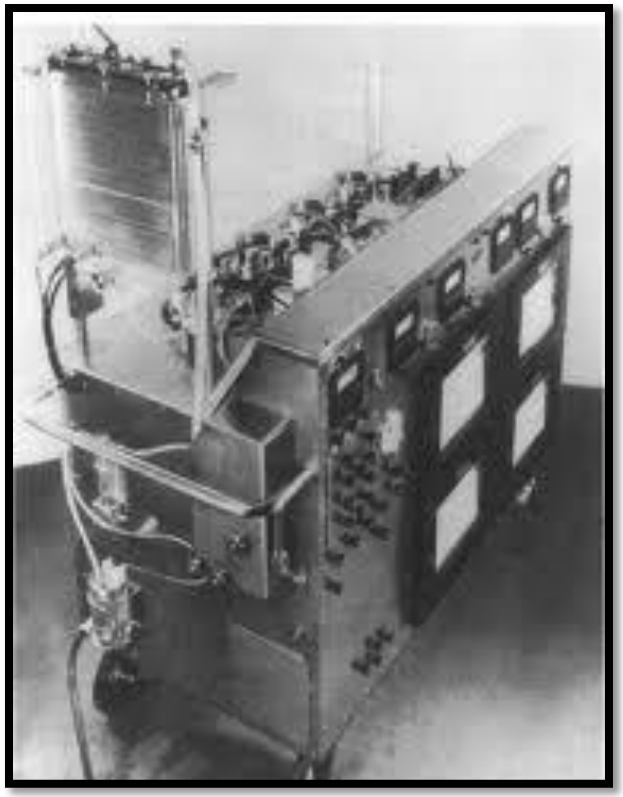
Mass General

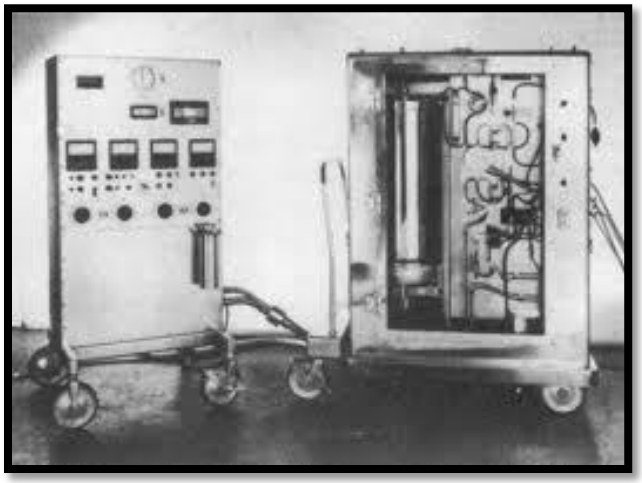
Massive Pulmonary Embolus



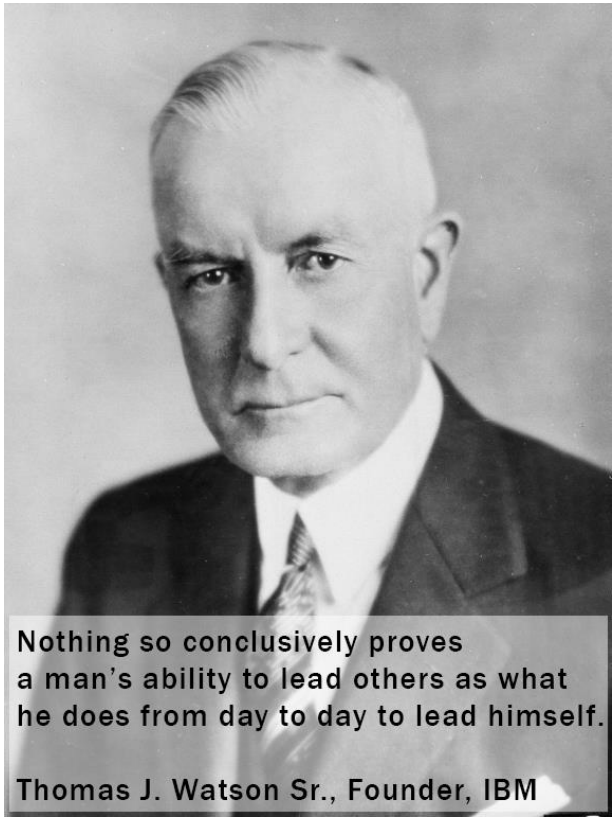
Early Heart Lung Machine



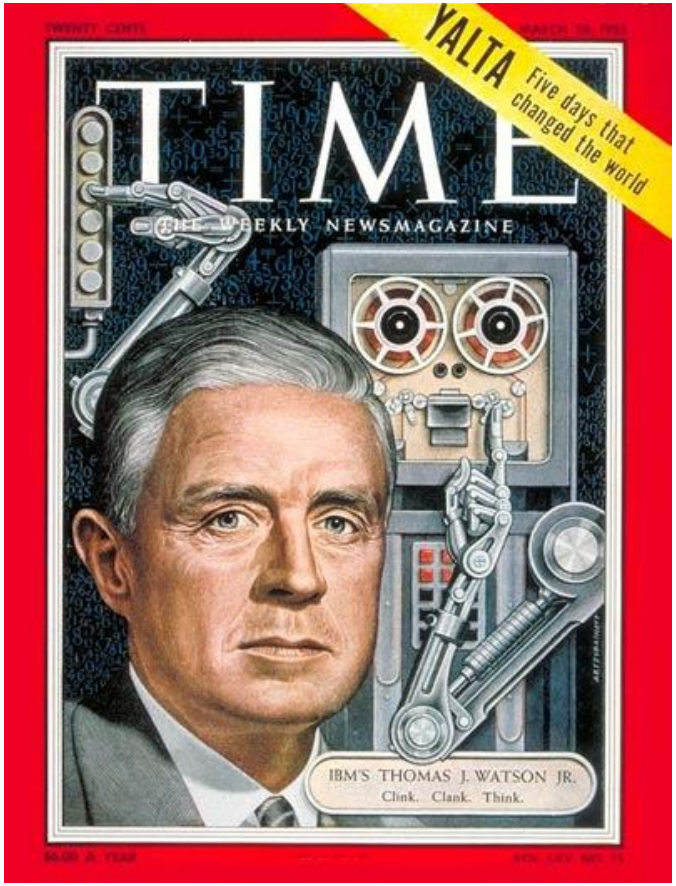




Thomas J. Watson



Thomas J. Watson



"Our work is one of service."

--Thomas J. Watson, Sr

May 16, 1953

Thomas Jefferson University

First successful open heart surgery using cardiopulmonary bypass

Intermountain Heart Institute
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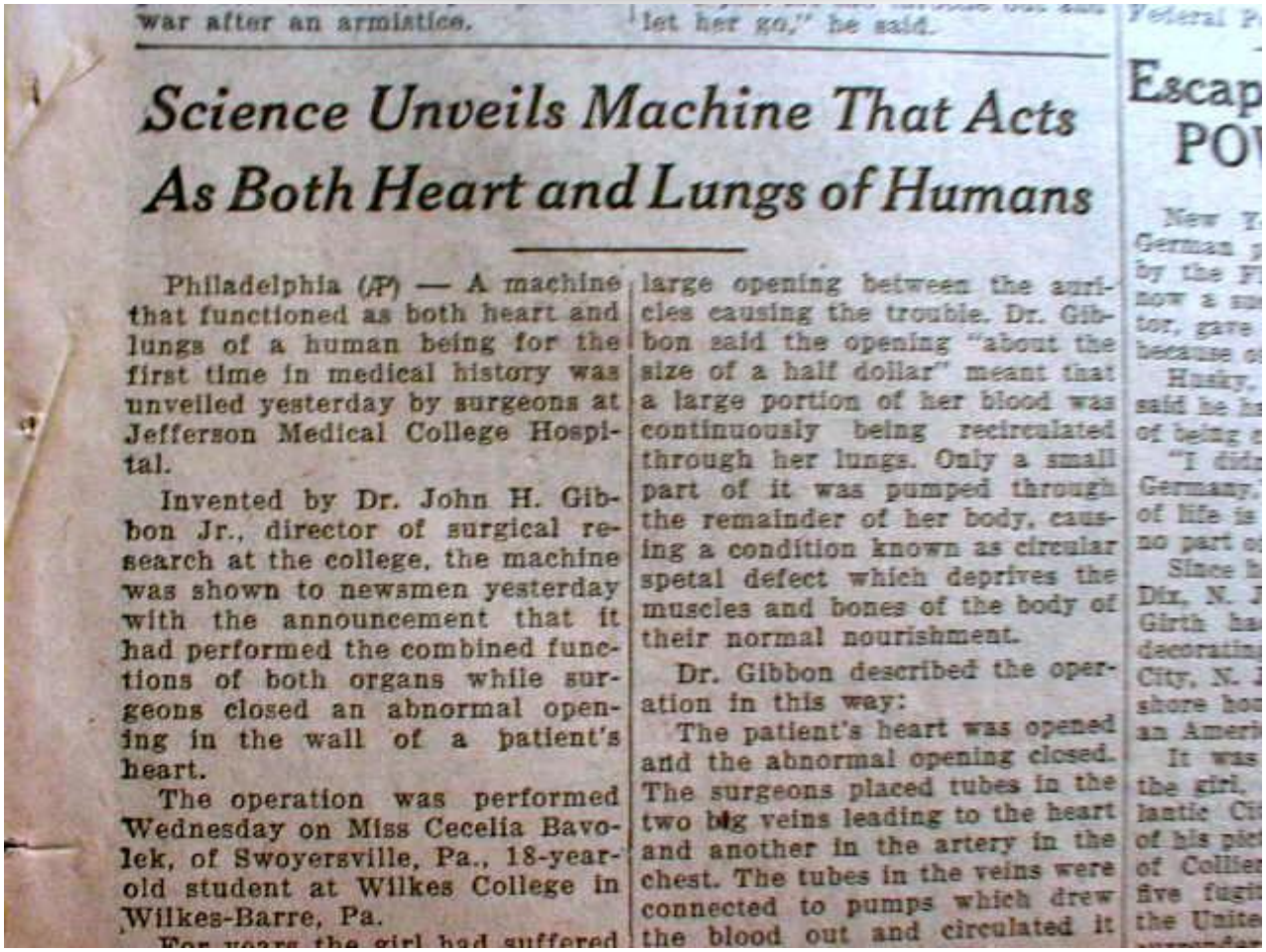
Success



war after an armistice.

let her go," he said.

Science Unveils Machine That Acts As Both Heart and Lungs of Humans

Philadelphia (AP) — A machine that functioned as both heart and lungs of a human being for the first time in medical history was unveiled yesterday by surgeons at Jefferson Medical College Hospital.

Invented by Dr. John H. Gibbon Jr., director of surgical research at the college, the machine was shown to newsmen yesterday with the announcement that it had performed the combined functions of both organs while surgeons closed an abnormal opening in the wall of a patient's heart.

The operation was performed Wednesday on Miss Cecelia Bavolek, of Swoyersville, Pa., 18-year-old student at Wilkes College in Wilkes-Barre, Pa.

For years the girl had suffered

large opening between the auricles causing the trouble. Dr. Gibbon said the opening "about the size of a half dollar" meant that a large portion of her blood was continuously being recirculated through her lungs. Only a small part of it was pumped through the remainder of her body, causing a condition known as circular spetal defect which deprives the muscles and bones of the body of their normal nourishment.

Dr. Gibbon described the operation in this way:

The patient's heart was opened and the abnormal opening closed. The surgeons placed tubes in the two big veins leading to the heart and another in the artery in the chest. The tubes in the veins were connected to pumps which drew the blood out and circulated it

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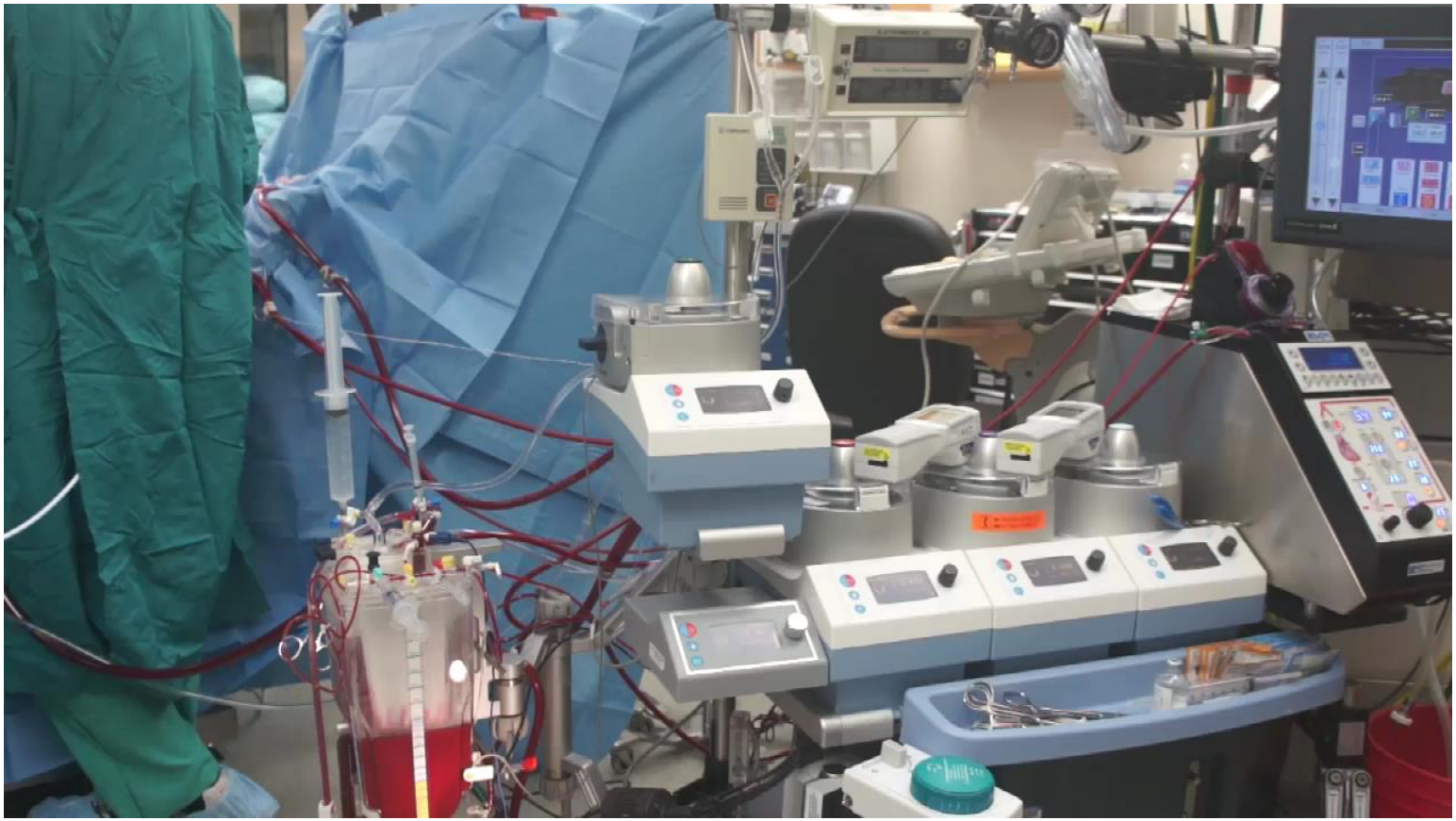
Heart Lung Machine

Modern Cardiopulmonary Bypass



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Heart Transplantation

- "Thus saith the Lord God, 'A new heart also will I give you, and a new spirit will I put within you; and I will take away the stony heart out of your flesh, and I will give you an heart of flesh." '
- Ezekial, chapter 36, verse 26

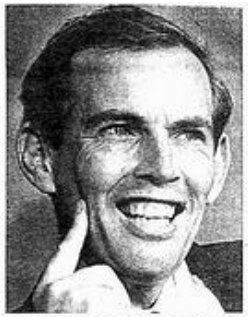
First Heart Transplant 1967

Moments in History

In December, 1967, a young woman, Denise Darvall, was walking across a street in Woodstock to buy a cake when a car struck her. She died in Groote Schuur Hospital and in doing so achieved immortality by becoming the world's first heart donor when Christiaan Neethling Barnard transferred her heart into the chest of Louis Washkansky.

Cape Town has been witness to many historic moments since the day Van Riebeeck anchored in Table Bay. Few, if any, brought more limelight to the city than the heart transplant. For the surgeon, Dr Barnard, soon to be a household name throughout the world, "the heart is merely a pump". But for those who equated the heart with love and death, the transplant seemed close to a miracle.

"Mr Louis Washkansky, the 55-year-old Cape Town man whose life is being sustained today by the heart of a dead 25-year-old woman after the world's first successful heart transplant yesterday, is conscious in Groote Schuur Hospital and in a satisfactory condition." Monday, 4th December 1967



Professor Chris Barnard, leader of the heart-transplant team, in a characteristic pose during one of his many press conferences.

First close-up photograph to be taken of Mr Louis Washkansky, who underwent the world's first heart-transplant operation, was taken by a surgeon using an x-ray photographer's camera at Groote Schuur Hospital. Mr Washkansky, whose condition was given as good, is being assisted to breathe by a respirator. 4.12.1967

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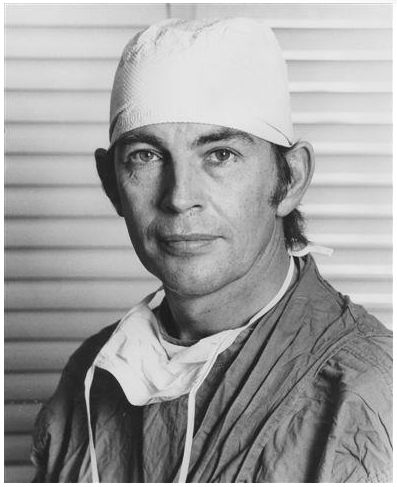
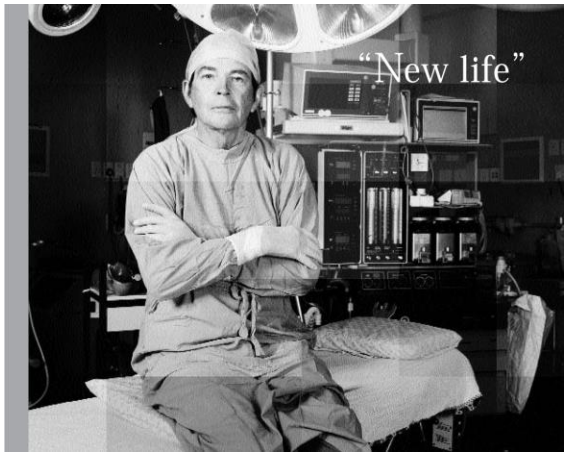
Christiaan N. Barnard, MD





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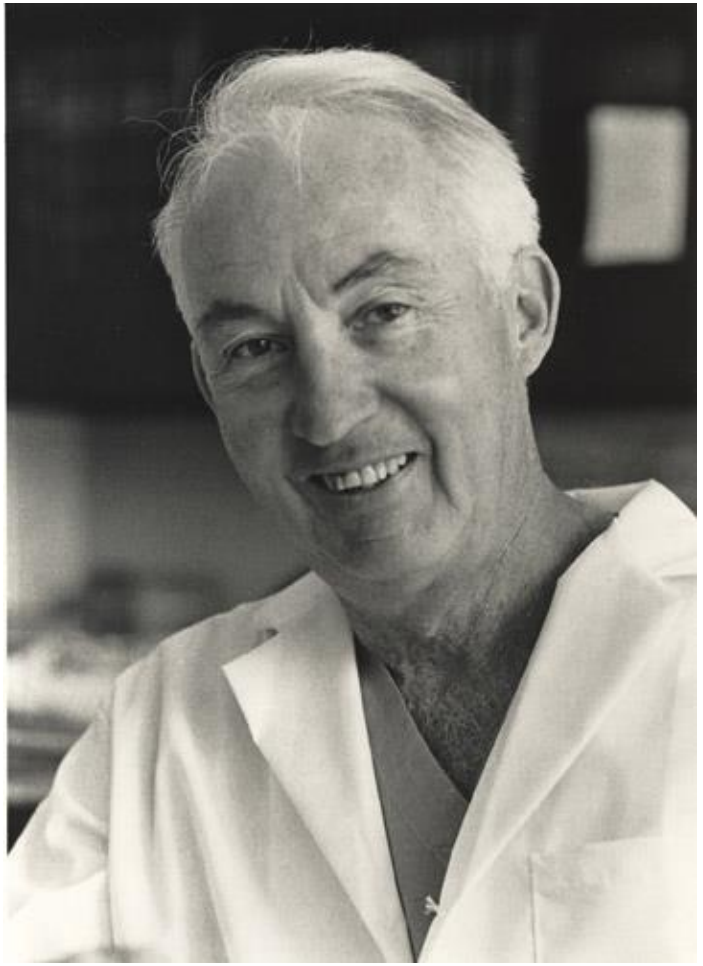
Norman E. Shumway, MD



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First Transplant in US 1968

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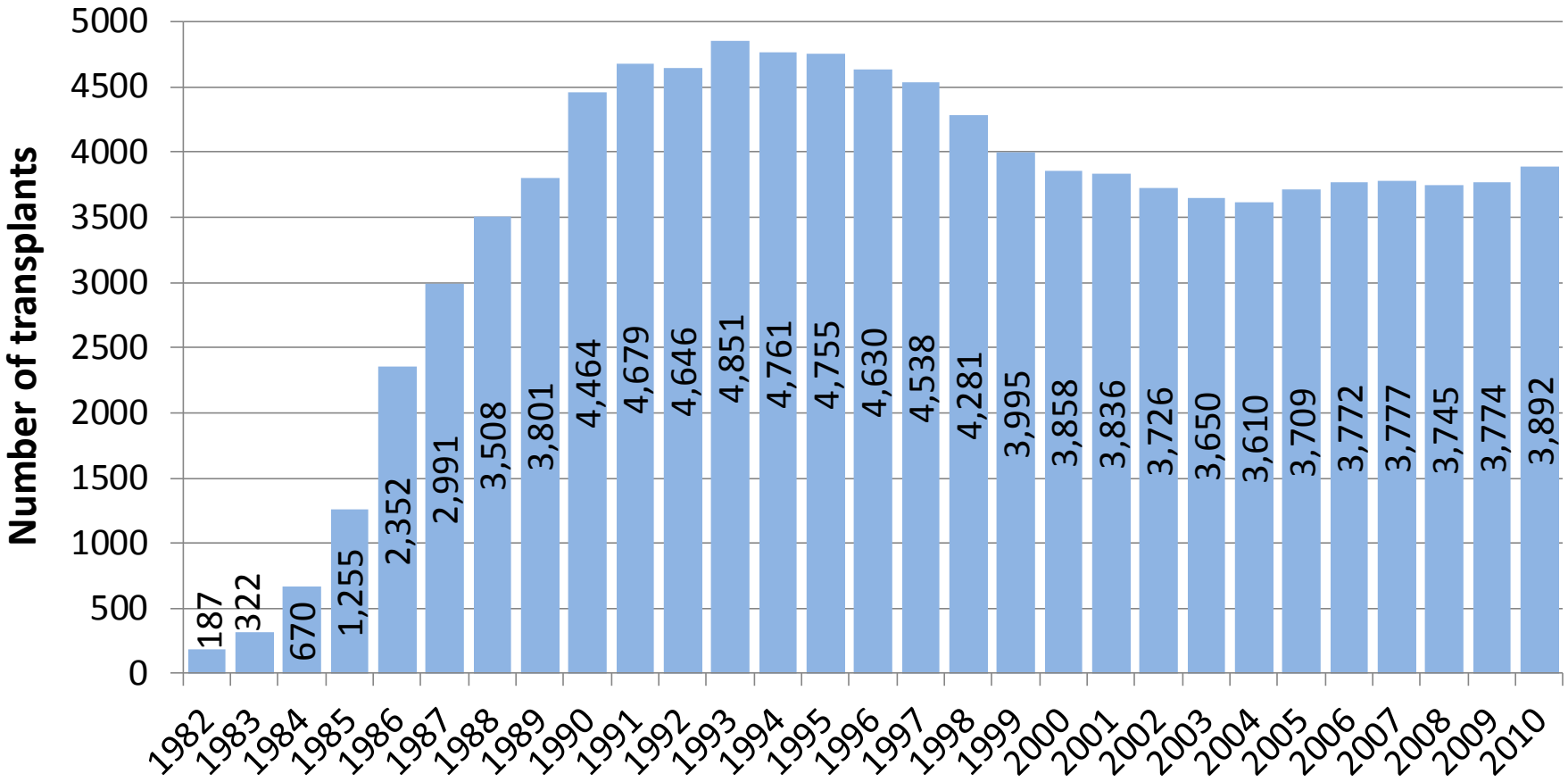
"OK, the old one's in my right hand,
the donor's in my left. Right?"

Heart Transplantation

- First performed in 1967—clinically useful in the early 80s
- Inherent limitations—lack of donors
- ~2000 transplants per year; 3200 listed (many patients die on the waiting list)
- 15-20 transplants at IMC per year
- The majority of transplant recipients in the modern era are "bridged" to the procedure with an LVAD

Heart Transplants Reported per Year



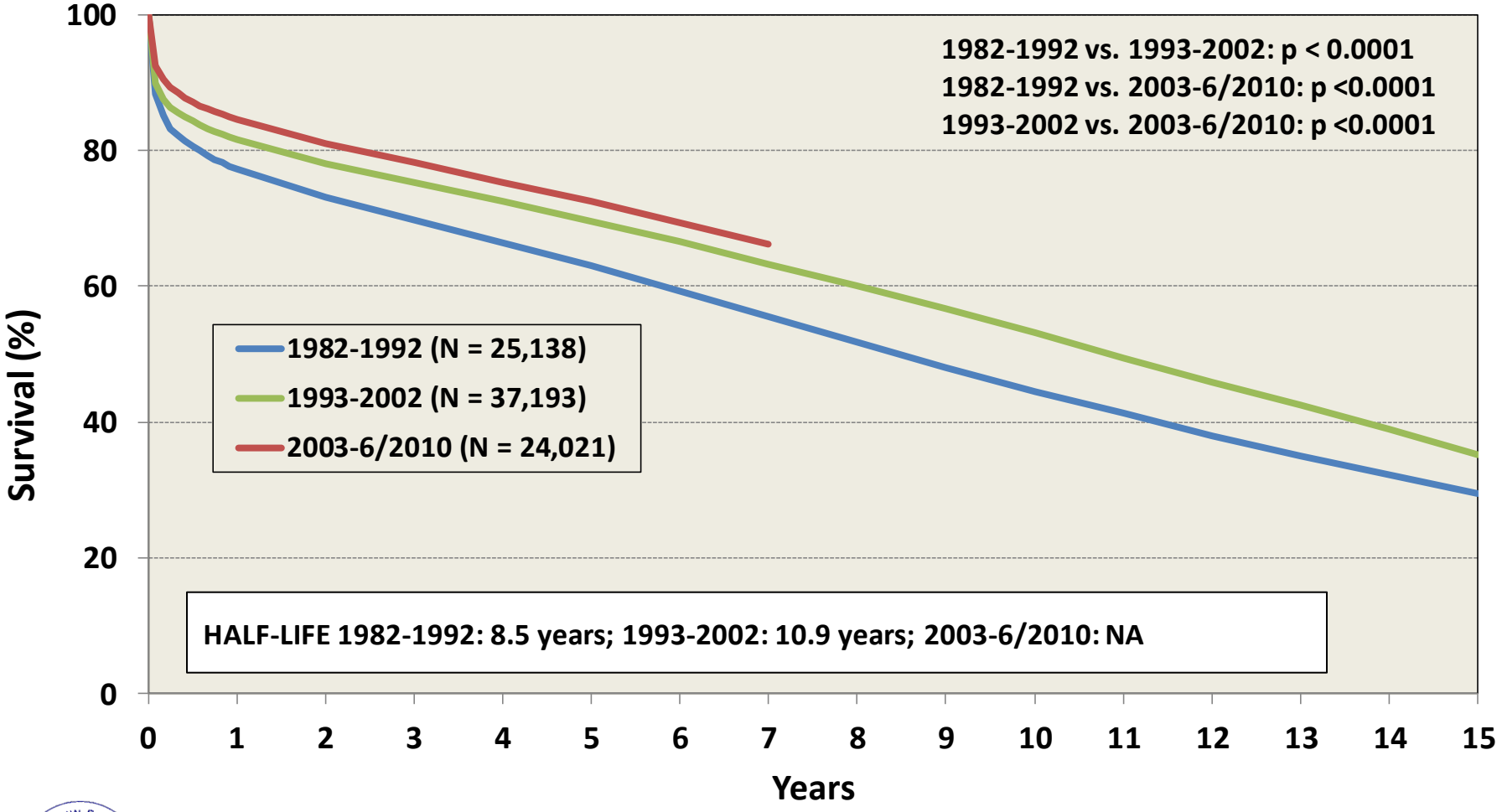
ISHLT 2012

J Heart Lung Transplant. 2012 Oct; 31(10): 1045-1095

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

Kaplan-Meier Survival by Era

(Transplants: January 1982 - June 2010)



ISHLT 2012

J Heart Lung Transplant. 2012 Oct; 31(10): 1045-1095

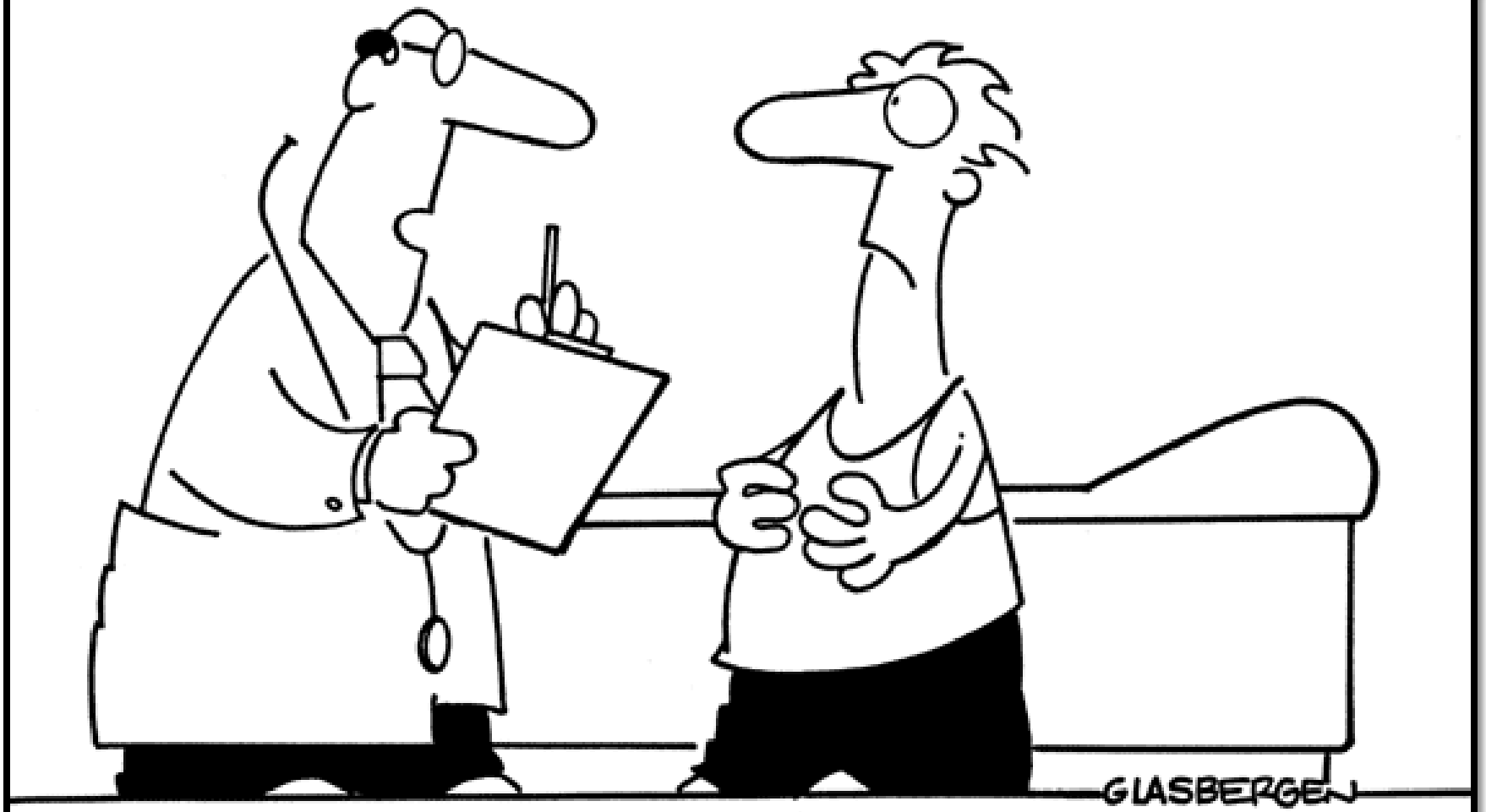
Post-Heart Transplant Morbidity for Adults

Cumulative Prevalence in Survivors at 1, 5 and 10 Years Post-Transplant (Follow-ups: April 1994 - June 2009)

Outcome	Within 1 Year	Total N with known response	Within 5 Years	Total N with known response	Within 10 Years	Total N with known response
Hypertension	73.2%	(N = 24,229)	93.1%	(N = 10,485)	97.4%	(N = 2,238)
Renal Dysfunction	26.8%	(N = 25,254)	31.1%	(N = 12,146)	36.8%	(N = 3,681)
Abnormal Creatinine < 2.5 mg/dl	*18.1%*		*21.0%*		*24.3%*	
Creatinine > 2.5 mg/dl	*7.0%*		*7.3%*		*6.2%*	
Chronic Dialysis	*1.5%*		*2.3%*		*4.8%*	
Renal Transplant	*0.3%*		*0.5%*		*1.5%*	
Hyperlipidemia	58.1%	(N = 25,572)	87.8%	(N = 11,800)	93.3%	(N = 2,659)
Diabetes	27.4%	(N = 25,292)	36.6%	(N = 11,154)	38.5%	(N = 2,401)
Cardiac Allograft Vasculopathy	7.8%	(N = 22,853)	31.0%	(N = 8,197)	51.8%	(N = 1,830)

ISHLT

J Heart Lung Transplant. 2010 Oct; 29 (10): 1083-1141



"Your insurance won't pay to transplant a human heart or even a baboon heart, so we'll be using an artichoke heart."


LIFE
THE 21st CENTURY FAMILY
NEW SHAPES, OLD VALUES
Lisa waits for a heart
50,000 Americans need new hearts. Most will never get one. Who lives? Who dies?
A special report
November 1999/$3.99
DISPLAY UNTIL NOVEMBER 15

The Magnitude of CHF

- 6 million suffer from heart failure: 550,000 new cases per year
- Only form of heart disease increasing in prevalence
- 262,000 deaths per year
- Incidence doubles each decade after 40
- 1 in 5 over age 40 have heart failure
- One year mortality is 28% in men over 75
- Most common cause of hospitalization in patients over 65

Economic Impact of CHF

- Annual cost of $30 billion in U.S.
- Most costly diagnosis in the Medicare population
- More costly than all forms of cancer combined
- 11 million office visits; 3.5 million hospitalizations
- Average total annual cost in Utah of $46 million dollars (79% paid for by the government)*
- $19,843 per hospitalization in Utah*

**Utah Department of Health*

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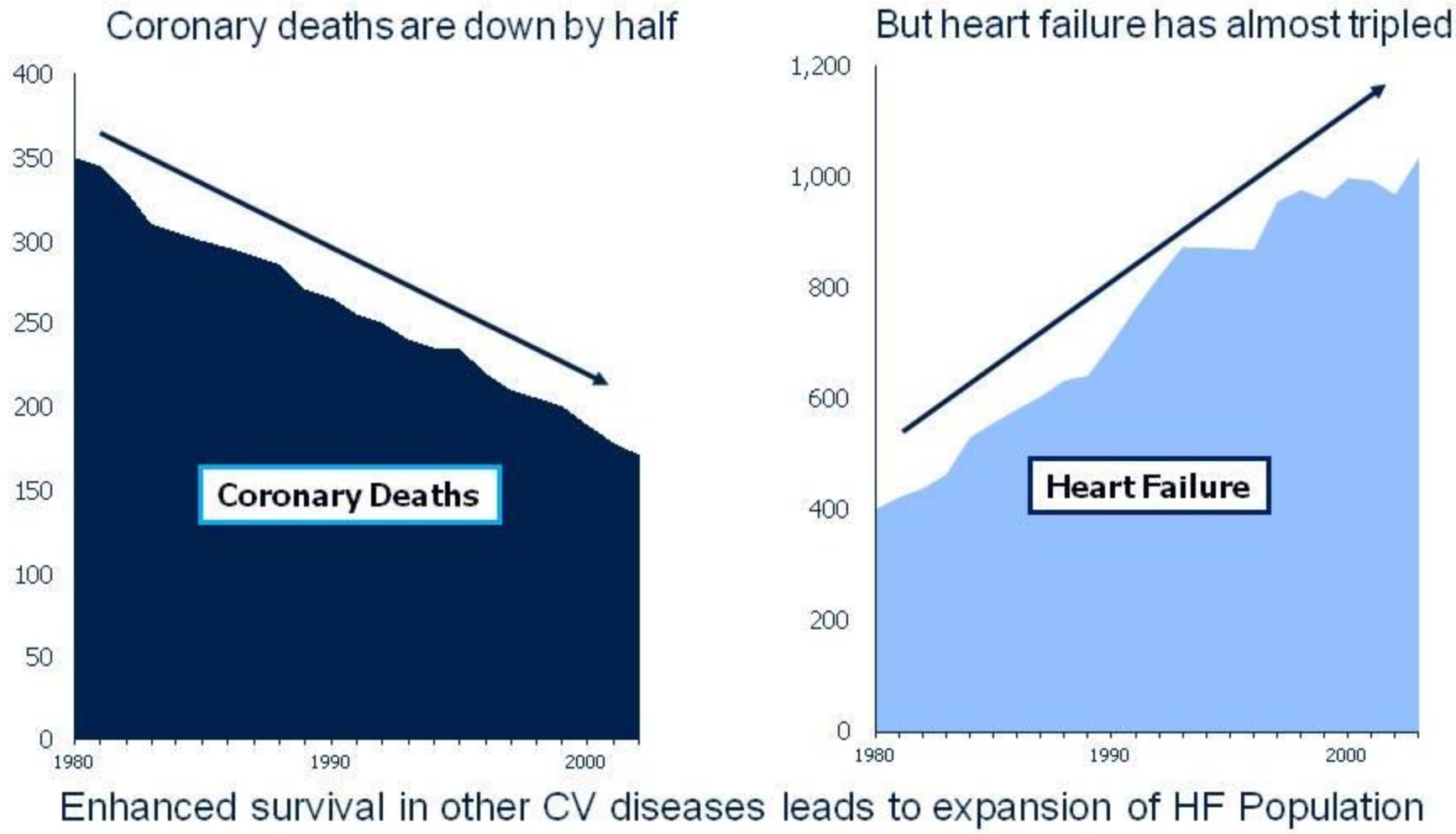
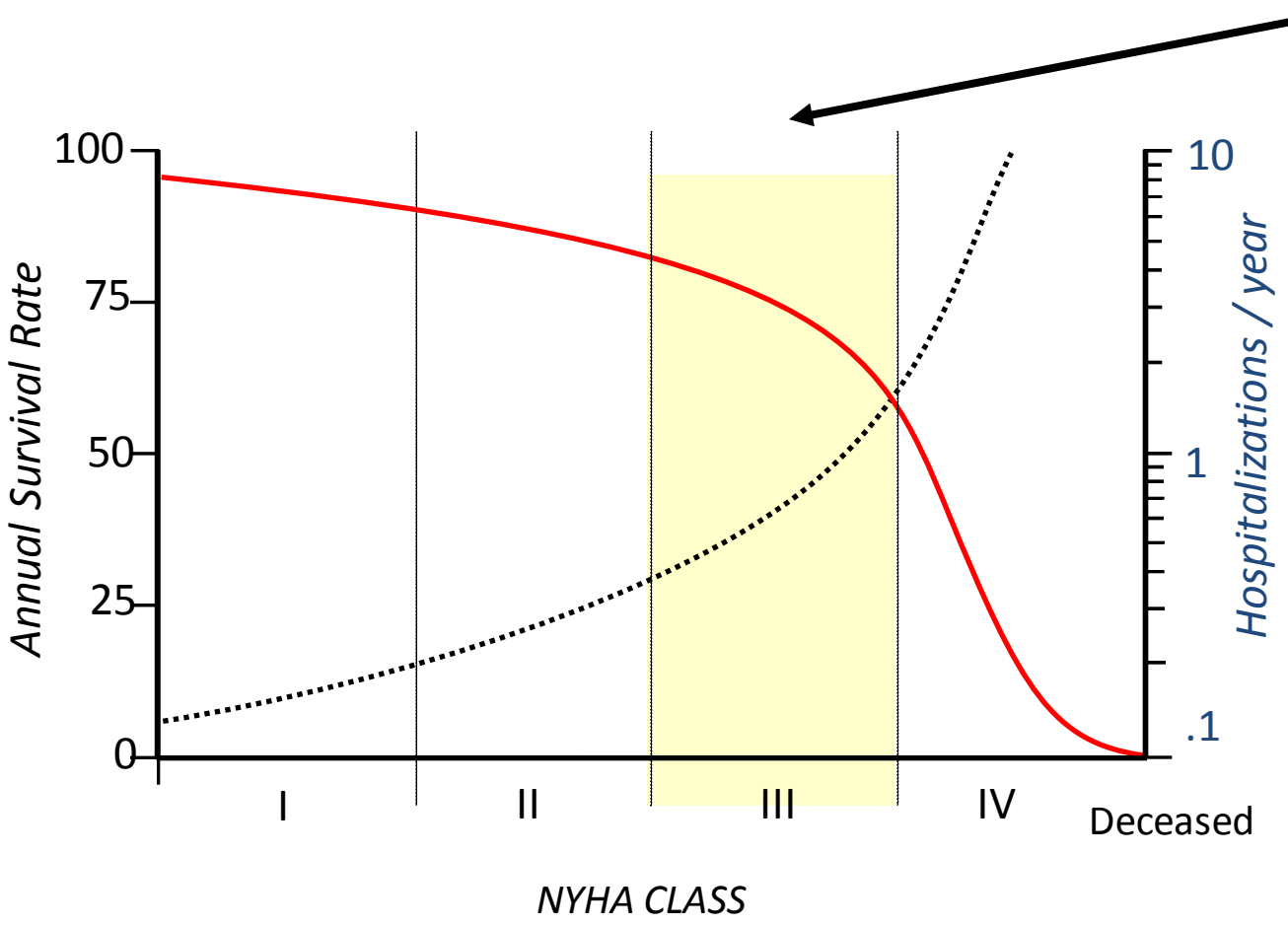
Heart Failure:
The Final Cardiovascular Disease



Source: National Hospital Discharge Survey data. Centers for Disease Control and Prevention/National Center for Health Statistics and National Heart, Lung, and Blood Institute.

Natural History of Heart Failure



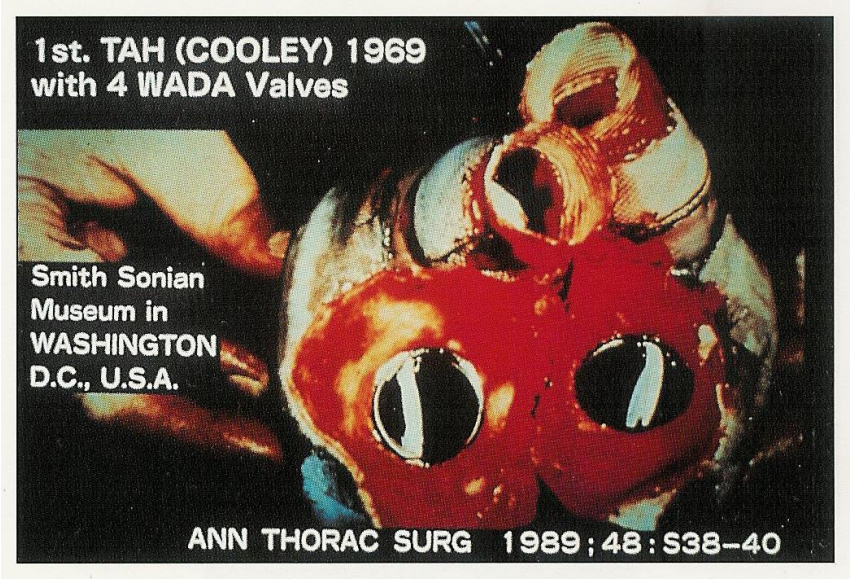
Class III

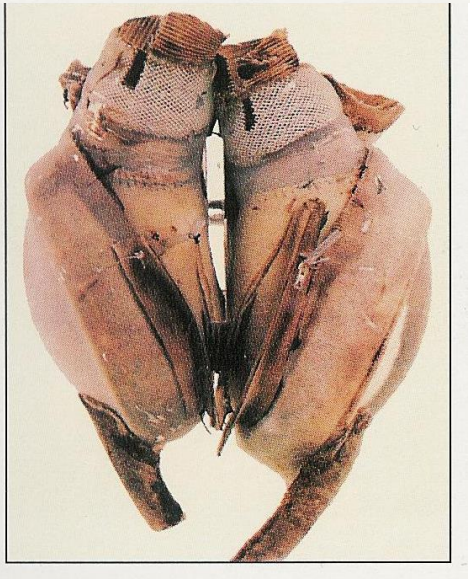
- 25% of HF Patients
- Frequent hospitalizations
- Worsening symptoms despite drug therapy
- Significant opportunity for new therapies

Survival Rate
Hospitalizations

Adapted from Bristow, MR Management of Heart Failure, Heart Disease: A Textbook of Cardiovascular Medicine, 6th edition, ed. Braunwald et al.

Total Artificial Heart





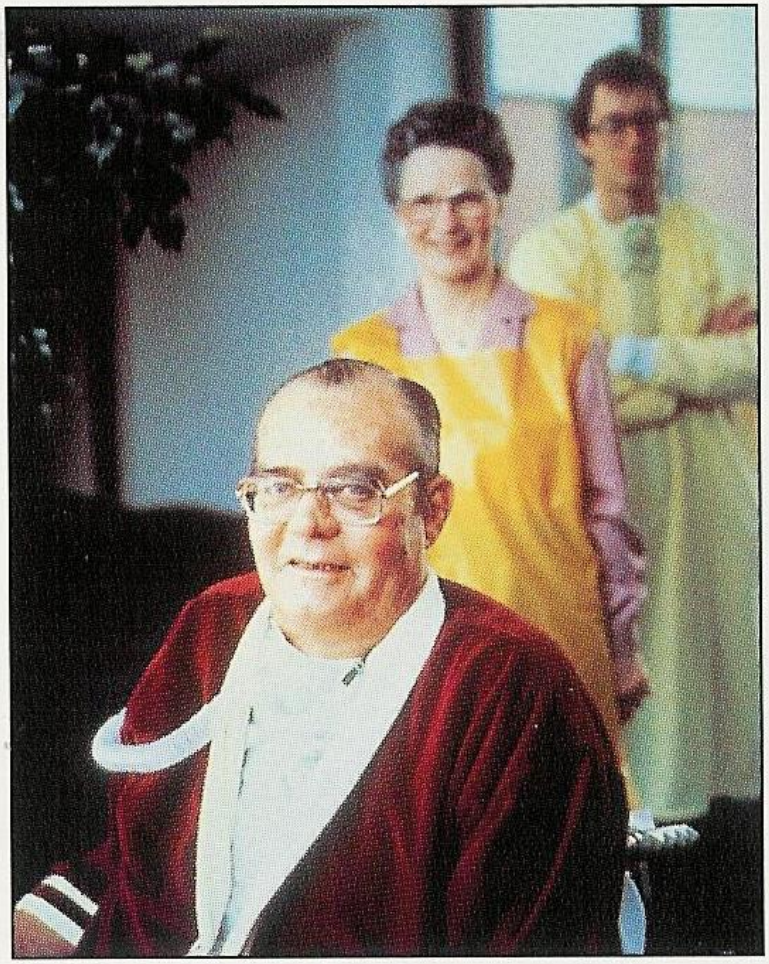
1969 - first artificial heart to be implanted into a human (Dr. Denton Cooley).

The patient was sustained by the device for 3 days, but only lived for 36 hours post transplantation.

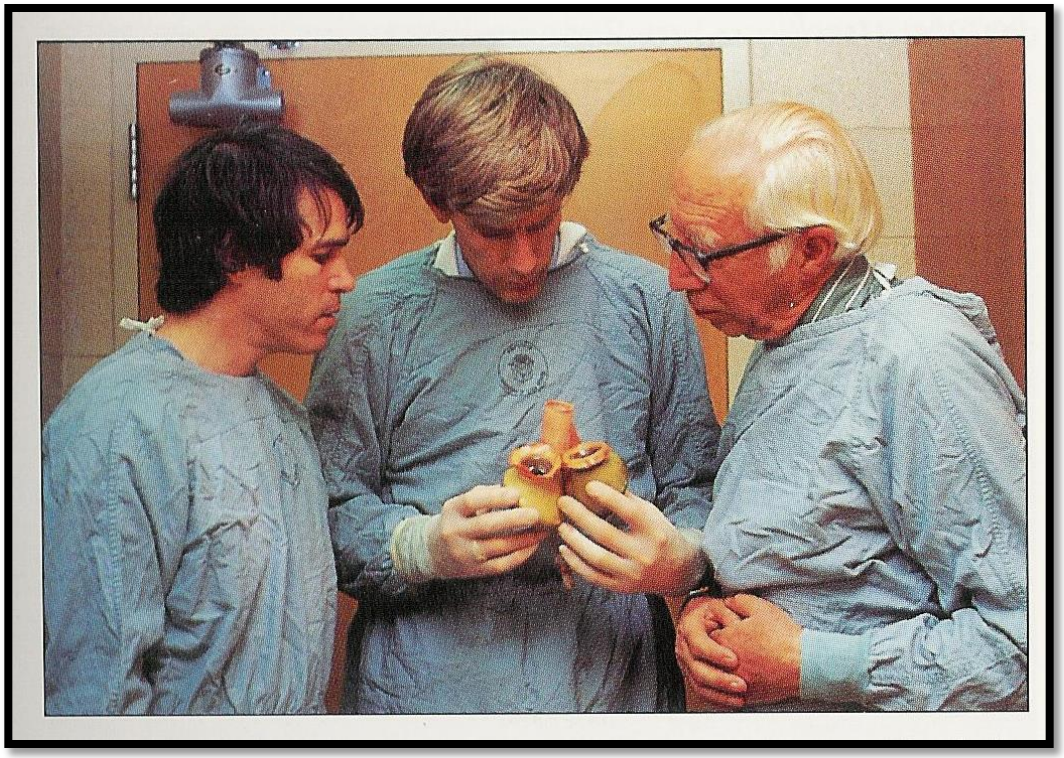
The patient's widow accused Cooley of making her husband the "unfortunate victim of human experimentation."

Barney Clarke

1982 – Barney Clarke with Mrs. Clarke after his initial recovery.

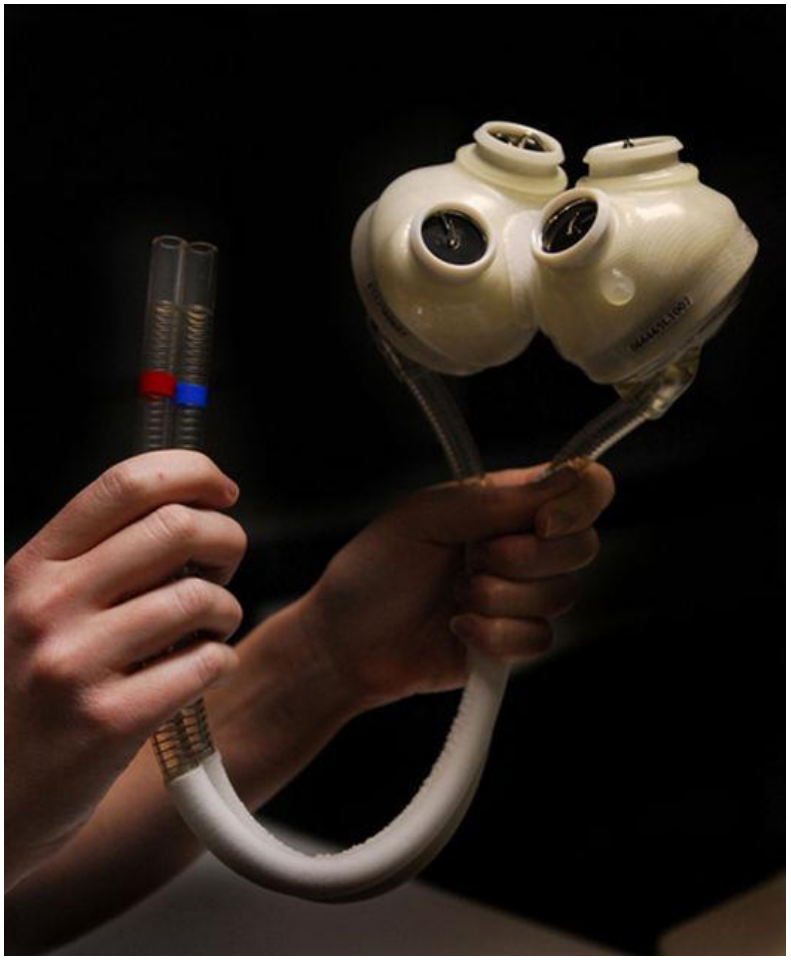


Barney Clarke



Jarvik, DeVries and Kolff examine Clarke's artificial heart after autopsy.

Total Artificial Heart



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REMATCH Summary

- NEJM November 2001
- LVAD vs. optimal medical management
- LDS Hospital - largest enrollment in the country
- Landmark trial leading to FDA approval
- 129 patients with NYHA Class IV CHF ineligible for transplant
- 48% risk reduction of death with LVAD
- 52% vs. 25% survival at 1 year
- 24% vs. 8% survival at 2 years
- Improved quality of life (LVAD patients felt better, less depressed, more mobile and active)

HeartMate II – FDA approved for DT

NEJM, Nov. 2009

FDA approved Jan. 20, 2010

TRIAL SUMMARY:

- Total of 200 patients
- Median age of 62 years (range 26 to 81)
- Mean LVEF of 17%
- 77% of patients receiving IV inotropes
- 2:1 Randomization HM II vs. HM XVE (stopped at mid-study point due to favorable results)
- All 200 patients were followed for at least 2 years or until death, transplantation or device explantation
- QOL improvement to NYHA Class I - II

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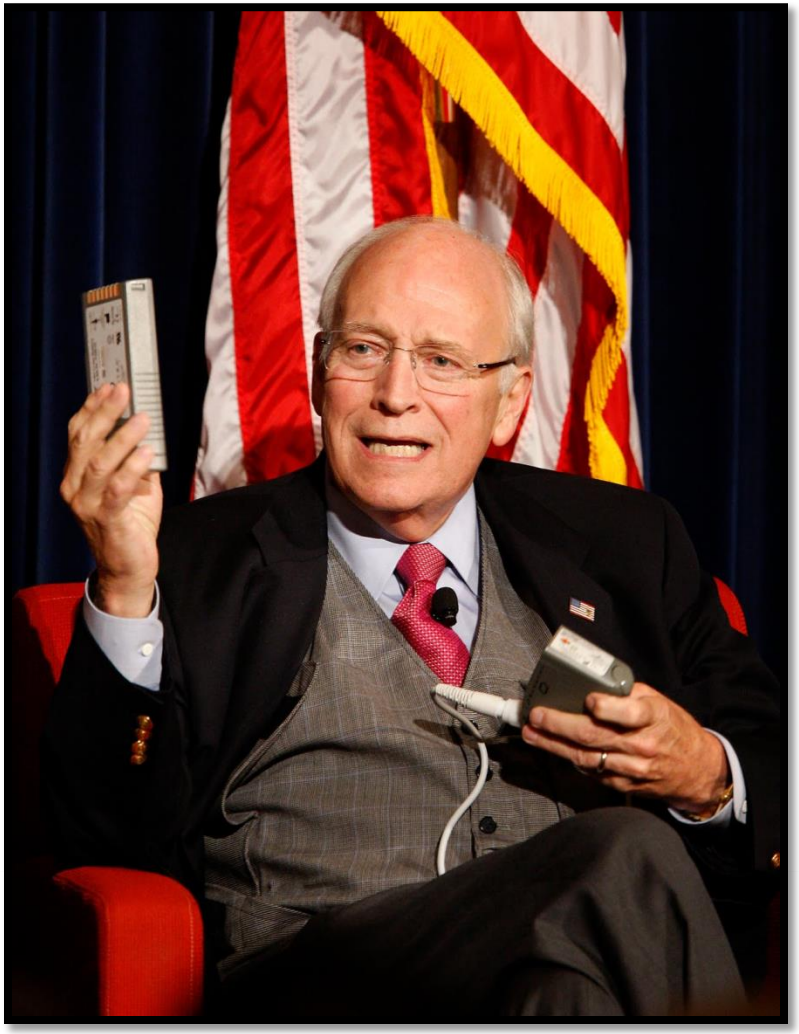
HM II DT – Trial Data

	HM II	HM XVE
Survival @ 2 years	58%	24%
Median duration of support	1.7 years	0.6 years
Relative Risk (95% CI)		
Device repair or replacement	0.06	0.51
Stroke	0.13	0.22
LVAD-related infection	0.48	0.90
Bleeding requiring surgery	0.23	0.29
Rehospitalization	2.64	4.25

Former Vice President Dick Cheney

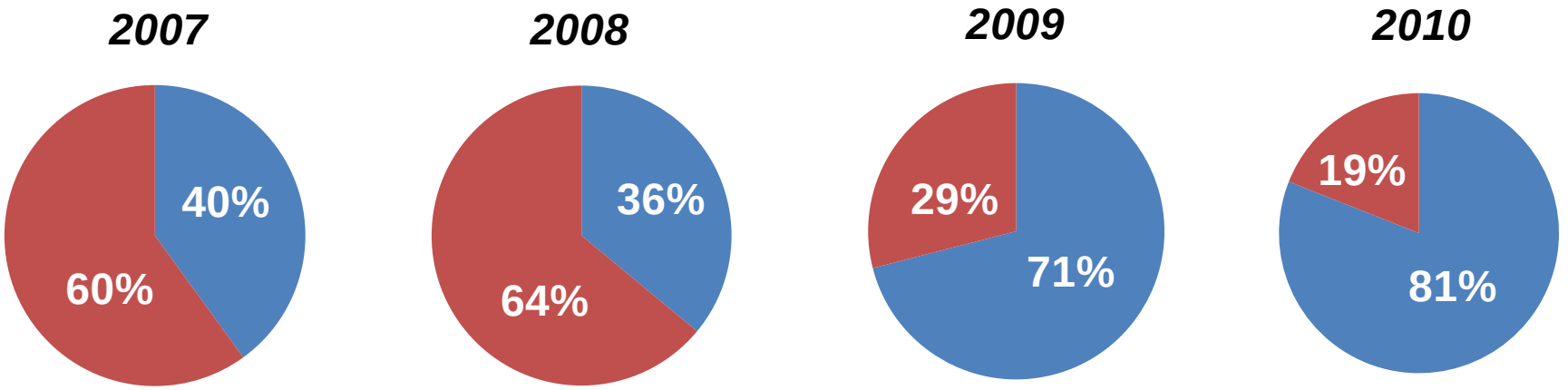


- HeartMate II implant August 10, 2010 as BTT
- 1.5 years of support
- Successful bridge to transplant
- Age 70

"It's brought me back from end-stage heart failure," says Cheney, who has suffered five heart attacks, the first at age 37. "I was in bad shape 14 months ago. Now I'm back to leading a relatively normal life. I fish, hunt a little bit, write books, (am) able to travel."

Bridge to Transplantation (BTT)

An increasing percentage of patients listed for cardiac transplantation require VAD support as a bridge.



OUTCOMES AT OUR CENTER:
HM II Survival to Transplant: 100%

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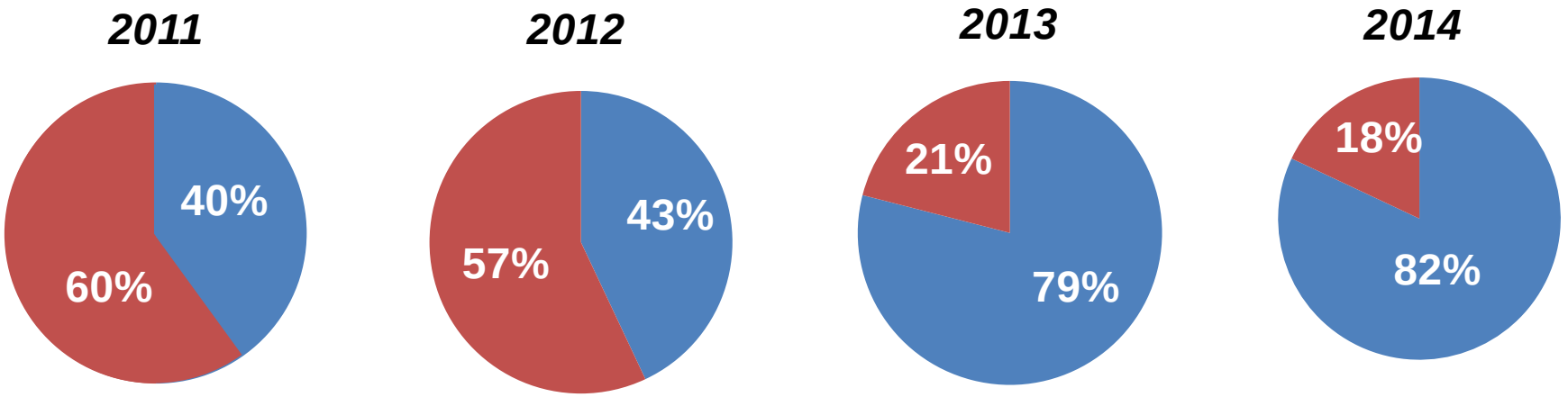
Bridge to Transplantation (BTT)



Bridge requiring VAD/Artificial Heart

Traditional Transplantation

Recent transition to HeartWare HVAD with excellent outcomes as bridge

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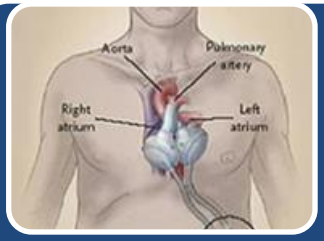
Mechanical Circulatory Support

Short Term / Emergency

- Time frame: hours to days
- Rapid MCS for cardiogenic shock, post cardiotomy failure, or during high-risk Cath Lab procedures



Bridge to Transplant (BTT)

- Time frame: months to years
- Temporary implanted MCS for patients waiting for a donor heart to become available

Destination Therapy (DT)

- Time frame: Permanent (years)
- Long-term implanted MCS for patients who are not eligible for a heart transplant

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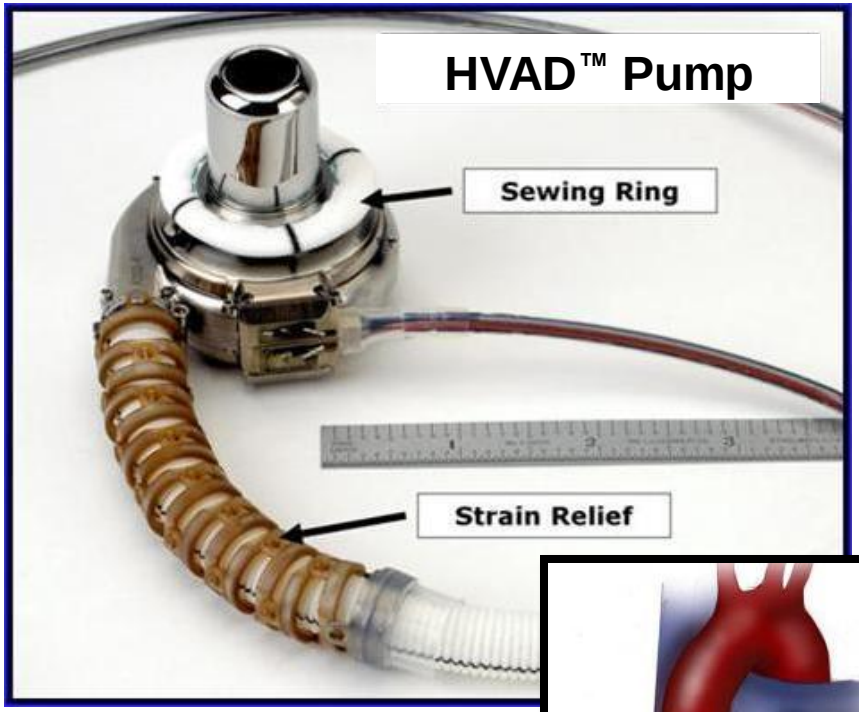
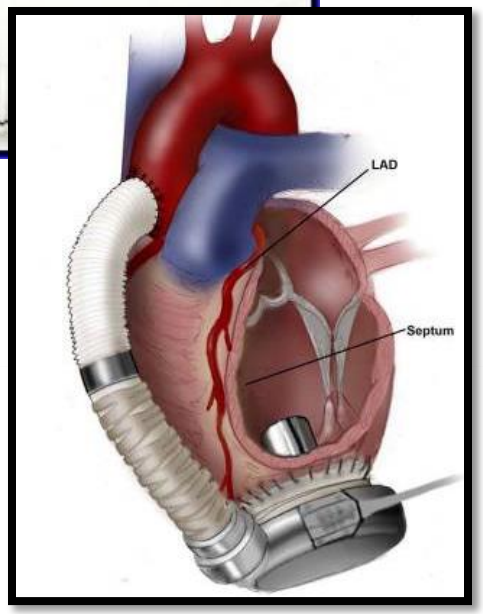
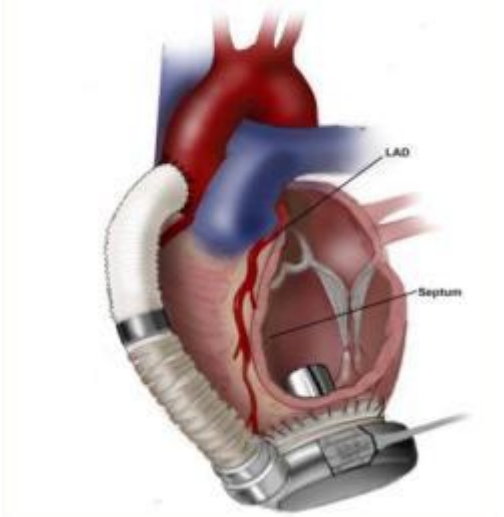
HeartWare HVAD™

- Centrifugal pump
- One moving part
- Short integrated inflow cannula
- 10mm outflow graft
- Dual motor stators
- Thin, flexible driveline
- Sewing ring





HeartWare HVAD



- Inflow cannula integrated with device
- Small pump housing: 2 inch outside diameter, displaced volume of 50 cc
- Magnetically suspended impeller, only moving part (increased durability potential)
- Intrapericardial – no pump pocket
- Requires warfarin (INR: 2.0 - 2.5)
- Approved for use in Europe
- Destination Therapy clinical trial in U.S. (ENDURANCE)
- UAHP: 43 implants to date

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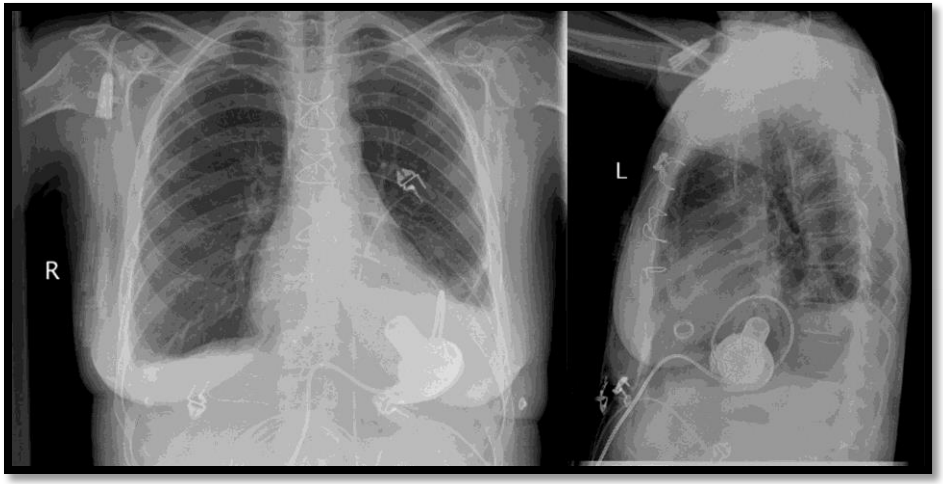
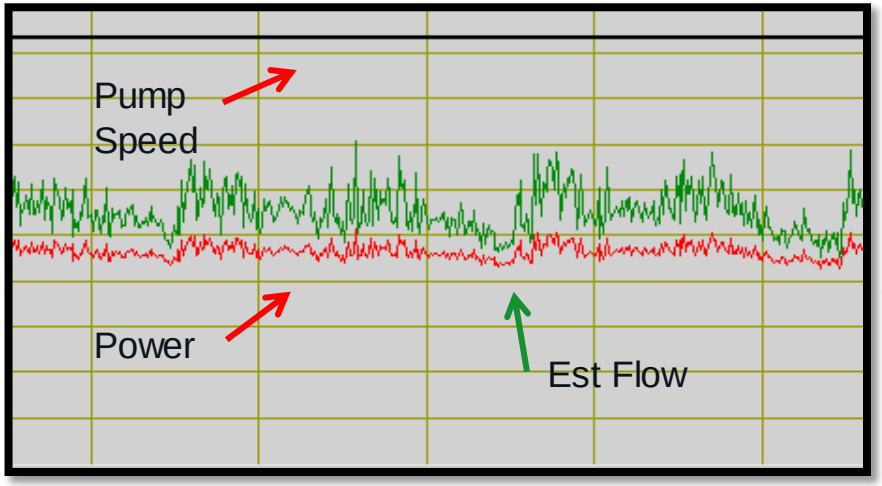
Unique Features

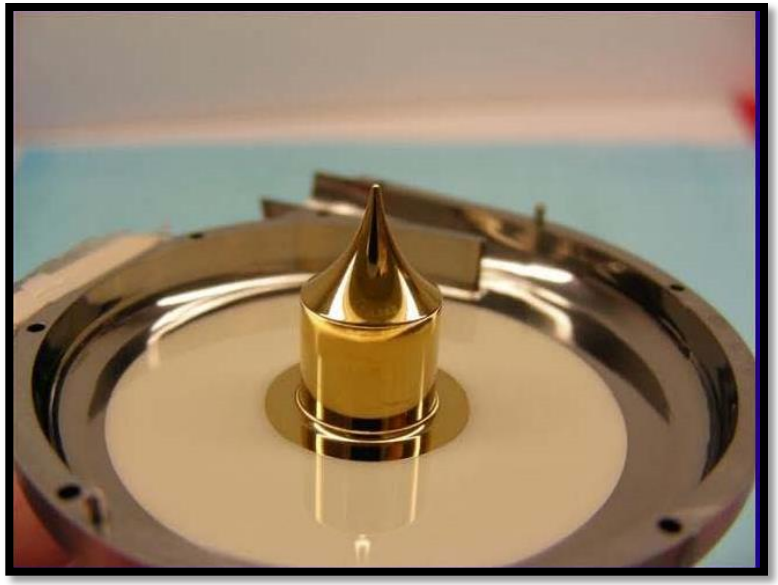
- No abdominal surgery or pump pocket
- Fits in the pericardial space
- Anatomically fits smaller patients
- Less surgery; potentially minimizes blood transfusions
- Novel impeller design enables excellent hemodynamics
- Accurate flow estimation
- Log files enable flow and power waveform analysis





Interior of pump shown after 427 days of support in human patient

IMPELLER



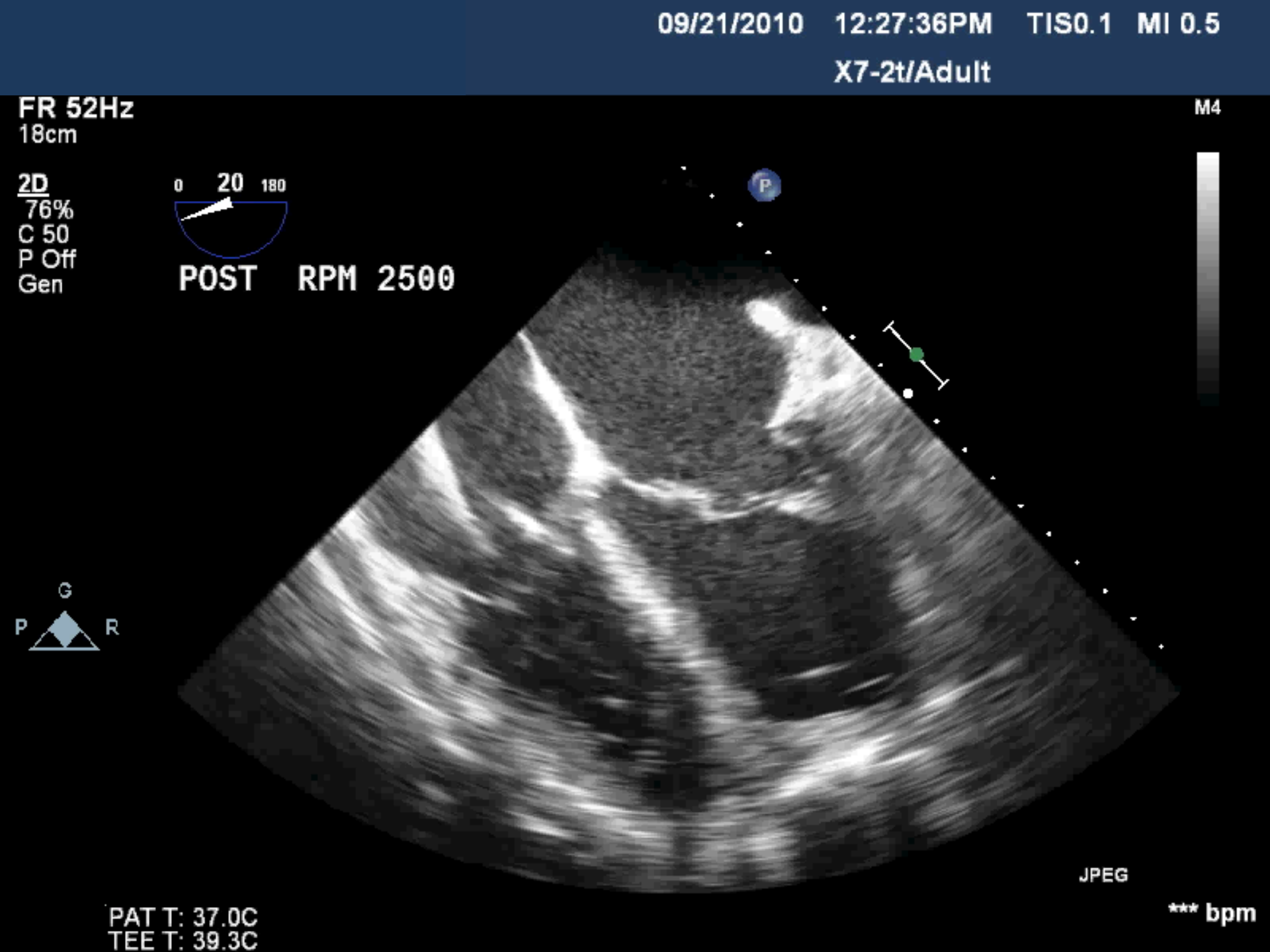
PUMP HOUSING

- Impeller only moving part
- Completely suspended by a combination of passive magnets and hydrodynamic thrust bearings
- Never touches pump housing

HeartWare HVAD

MCS Case Review

- 68 year male with 12 year history of IDC
- Sudden death in August 2009
- Discharged with BiV ICD
- Progressive deterioration to class III/IV
- Multiple hospitalizations over the following year
- Outpatient dobutamine
- Multidisciplinary review to assess candidacy for DT LVAD
- Enrolled in ENDURANCE trial—randomized to receive the HeartWare HVAD
- 3rd HVAD implant in the United States for DT


09/21/2010 12:27:36PM TIS0.1 MI 0.5
X7-2t/Adult
FR 52Hz
18cm
M4
2D
76%
C 50
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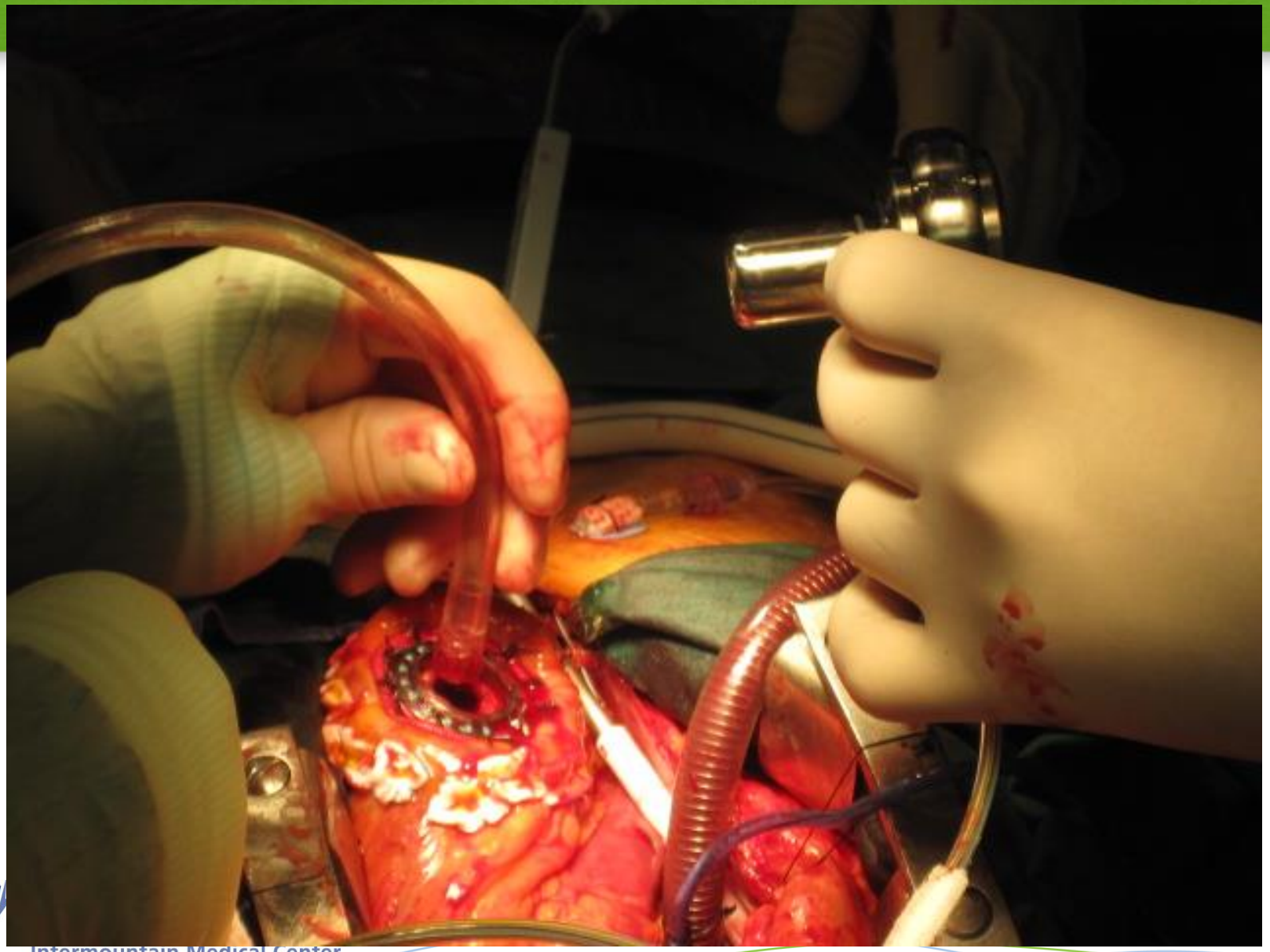

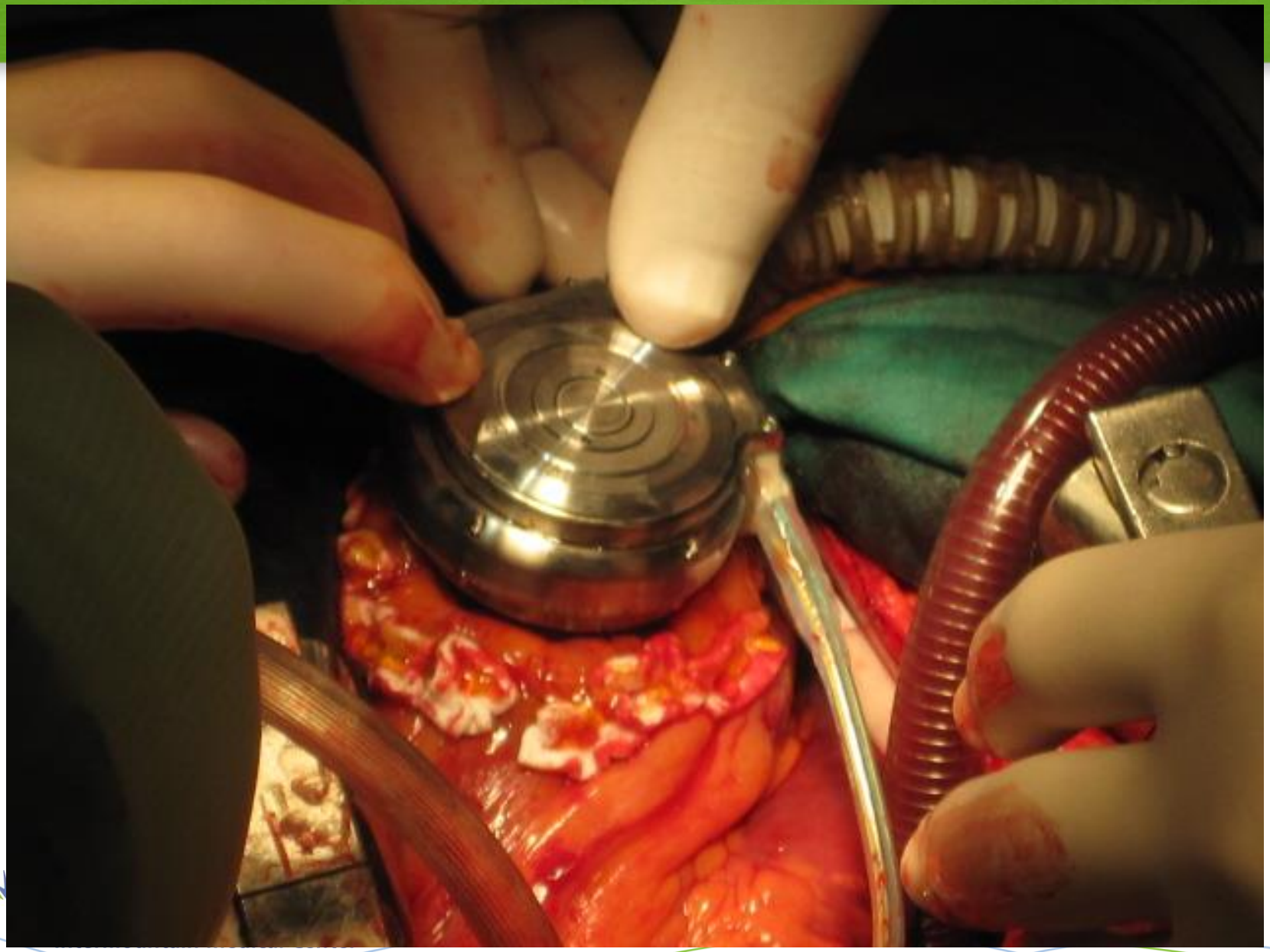

Postoperative Day #1

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3 months later…

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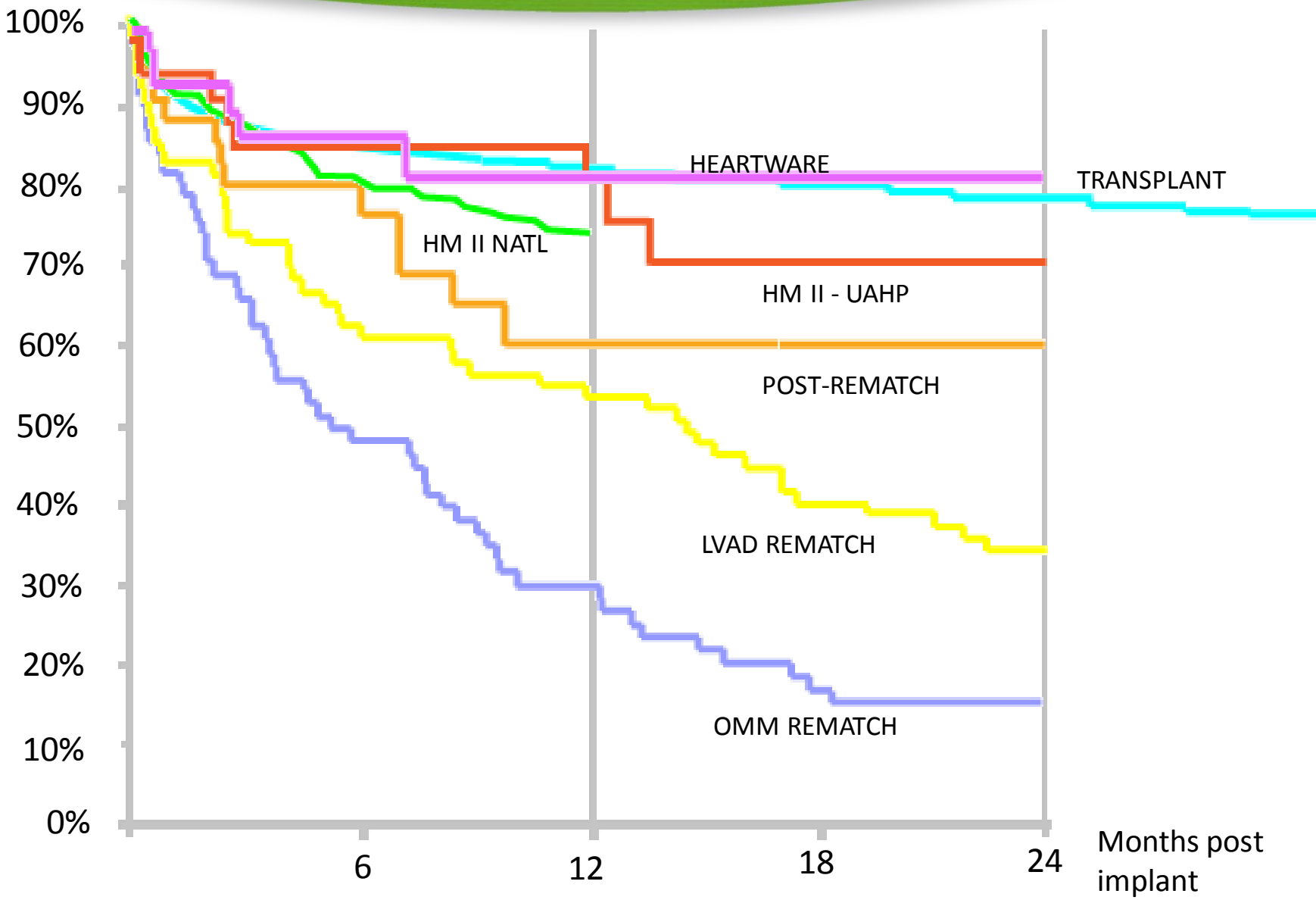
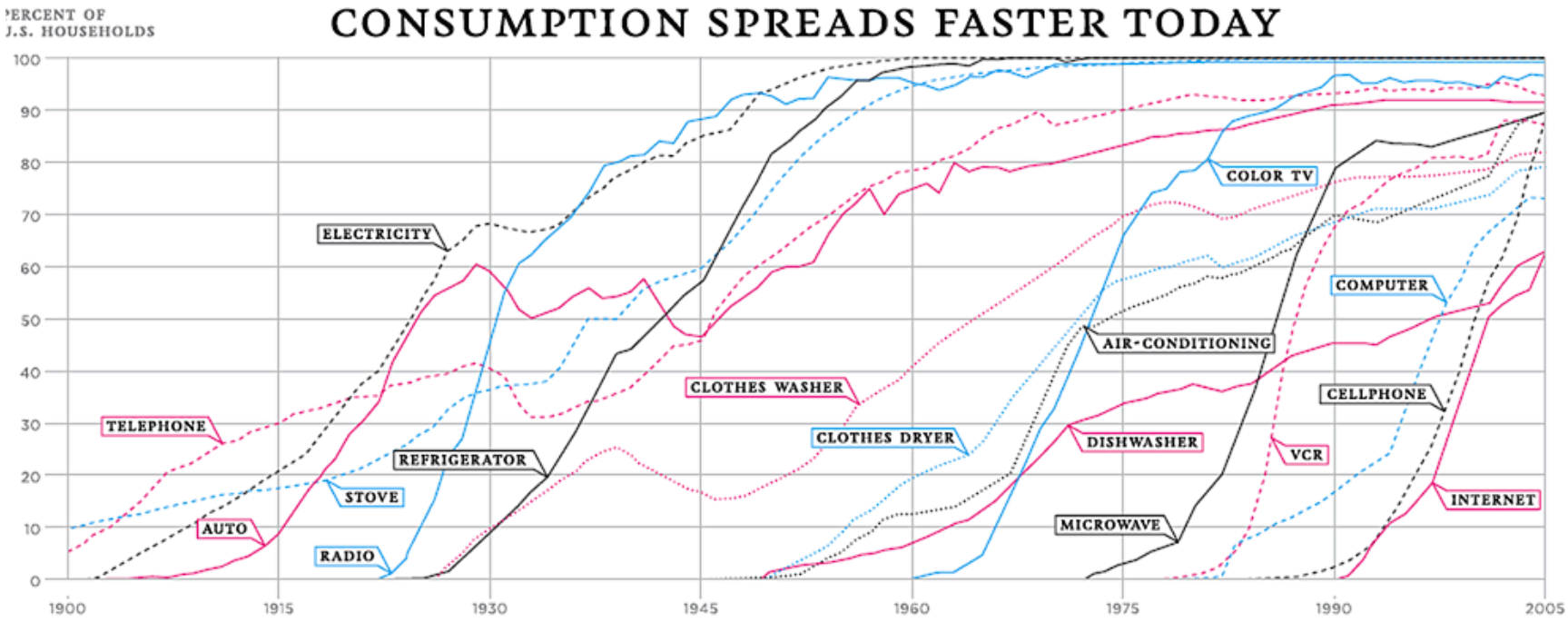
Improvements in Survival



Adoption of Technology



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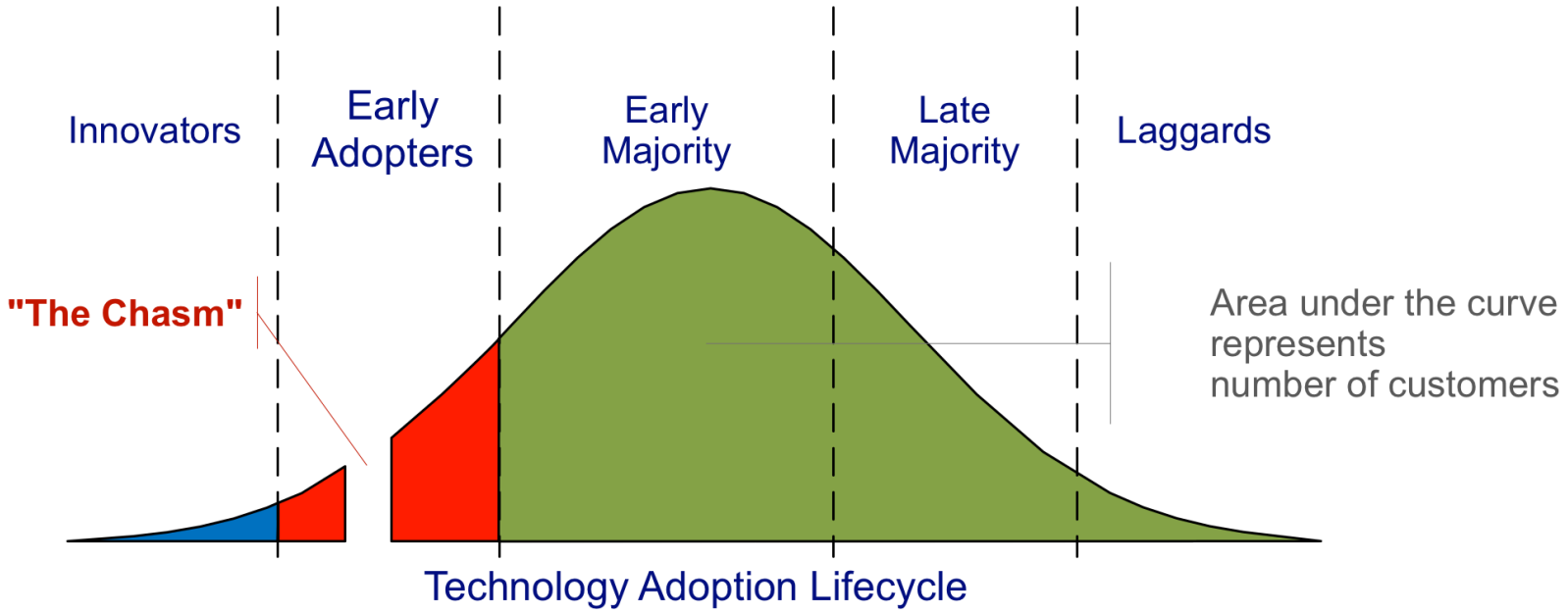
Technology Adoption



Automobile

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Automobile

Automobile

- Ford Model T
- 1908 – 1927
- First affordable automobile
- Mass production
- Moving assembly line: every three minutes
- 20 horsepower 1.7 L 4 cylinder engine
- Top speed ~40 mph

Automobile

- Most influential car of the 20th Century
- Widespread adoption worldwide
- 50% of all cars in 1920
- 1909: 10,666 produced and sold for $825 ($21,650 in 2015)
- 1925: 1.9 million sold for $260 ($3,500 today)

Automobile

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Automobile

Aviation

Aviation

Intermountain® Heart Institute

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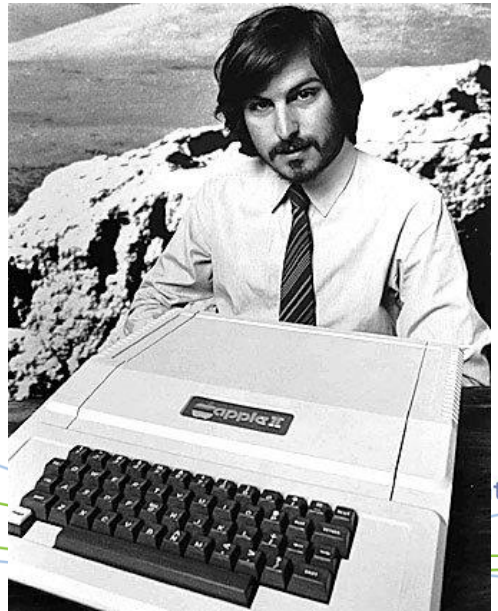
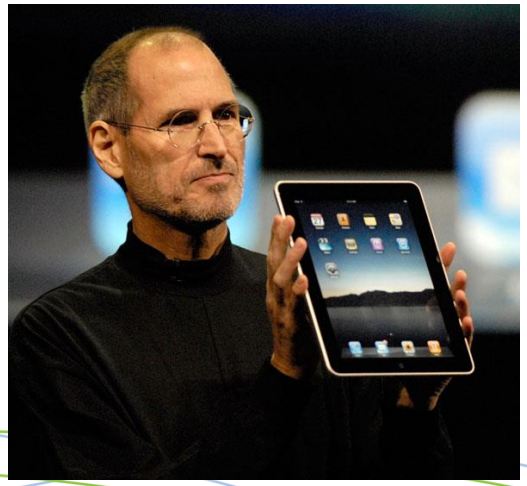
Aviation


APPLE
COMPUTER


apple II



Internet

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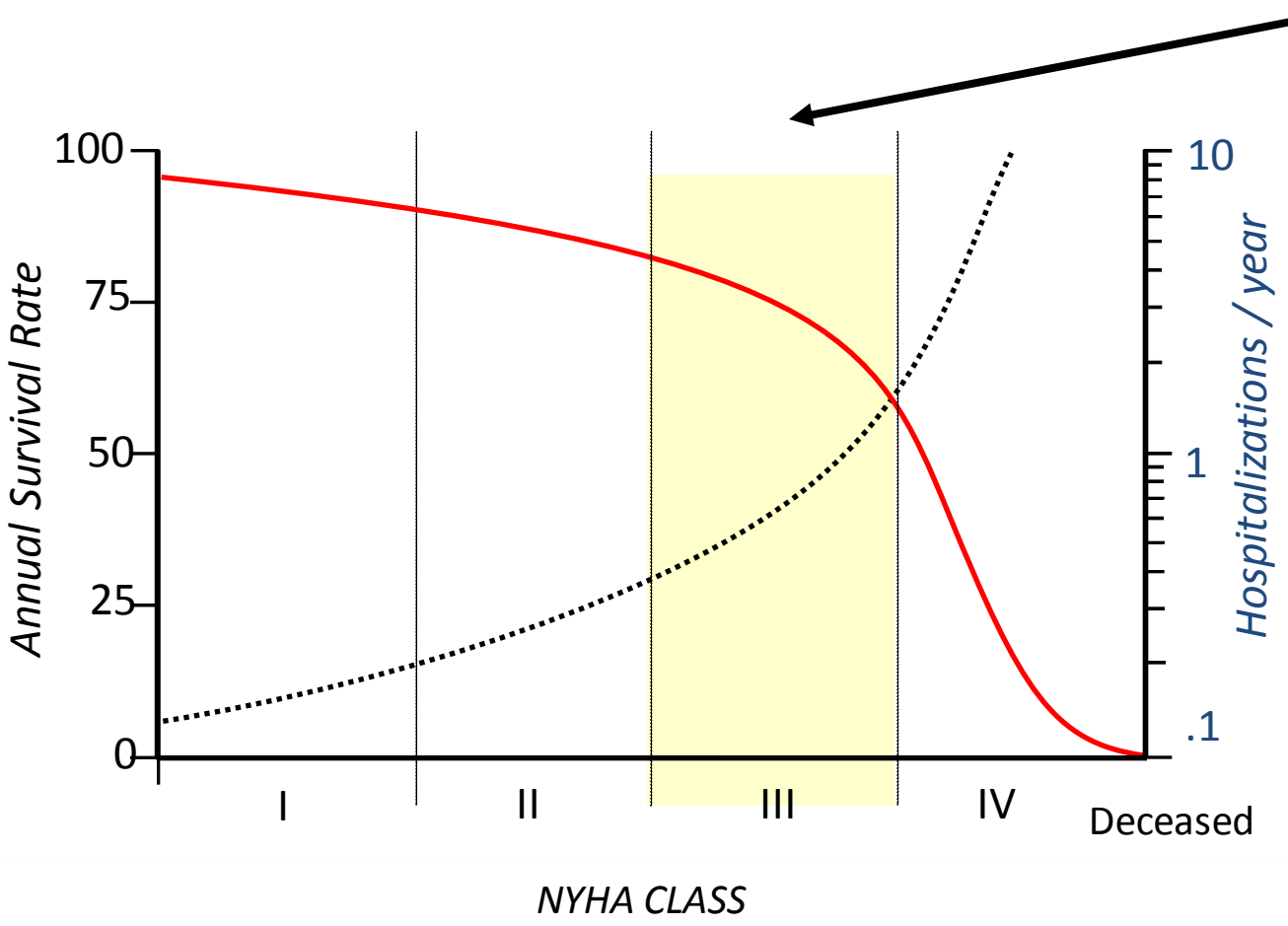
Life Expectancy – Pancreatic Cancer

- Best case scenario
  - Node negative
  - Clear margins at surgical resection (Whipple)
- 20% survival at 5 years for Stage I
- 10% survival at 1 year for all stages

Who and When?



Class III

- 25% of HF Patients
- Frequent hospitalizations
- Worsening symptoms despite drug therapy
- Significant opportunity for new therapies

Survival Rate
Hospitalizations

Adapted from Bristow, MR Management of Heart Failure, Heart Disease: A Textbook of Cardiovascular Medicine, 6th edition, ed. Braunwald et al.

Evaluation Criteria

Consider an evaluation when ***three*** of the following indications are present:

- Class III – IV heart failure symptoms
- Inability to walk < 1 block without dyspnea
- Sodium < 136 mEq/L
- BUN > 40 mg or Cr > 1.8 mg/dL
- ACE/ ARB/ BB intolerance
- Diuretic dose > 1.5 mg/kg/d
- 1 HF admit in the past 6 months
- No clinical improvement with CRT

Steps to Clear the Adoption Chasm

- Viable tool for management of CHF
- Improve patient selection and perioperative management
- Fewer complications and shorter length of stay
- Smaller, less expensive, more durable devices
- 100% success as a bridge to transplantation
- 5 - 10 year DT survival equal to transplantation
- Enhance patient length and quality of life

Contact Information

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Bruce.Reid@imail.org









Increasing the LENGTH and QUALITY of life for patients with heart failure…