From Superstition to Science
From Myth & Magic
To Experimental Design

Throughout human history, the heart has figured enormously—if metaphorically—in nearly every aspect of civilization.
The human heart--the most diverse, most changeable, most versatile part of creation.

Goethe

The heart has long been regarded as the essence of life, the seat of love and affection. Sweetheart, broken-hearted, heartless, heartfelt, soft-hearted, hard-hearted are parts of our vocabulary. Some eat their hearts out, others wear hearts on their sleeve, still others are asked to have a heart, while a few have hearts of gold.

The heart is the first organ that lives.

Michael Servitus
In 1933, Michael DeBakey, while an intern at Charity Hospital in New Orleans, saw a pulsating human heart through a stab wound. “I saw it beating. It was beautiful, a work of art, an awe-inspiring sight. Something that God makes.”
Five thousand years ago, the Egyptians believed that the soul resided within the heart which was the only organ returned to the body after embalming. Before doing so, the heart was placed on a scale and weighed against a symbol of Maat, the goddess of Justice, for the posthumous judgment of Osiris. The brain was discarded as superfluous.
It was here that cultural history originated more than 5,000 years ago. But it was the liver, not the heart, that was regarded as the blood-filled source of the life force.
Ritual slaughter of a ram for examination of its liver.

Model of the liver for comparison with the ram.
For ancient Hebrews, the sign of life was the breath, not the beating heart. “And the Lord God...breathed into his nostrils the breath of life, and man became a living soul.”
Aristotle regarded the heart as a living creature inside its possessor, the first to form in the embryo, the most important organ in the body---both a fact and an image, both real and symbolic, both literal and figurative.
Although Aristotle was not a physician, he dissected over 50 species, and founded the discipline of _comparative anatomy_. He arranged the various zoological forms on the basis of increasing perfection, extending from lower to higher animals—_a prelude to Darwinian evolution._
Rebirth
The Symbol of Healing

The snake sloughs its old skin and is symbolically reborn, hence the association of rebirth with healing. The staff (*caduceum* Latin, *keryx* Greek) exists as two different serpentine images.
The single entwined snake belonged to Aesculapius, the god of medicine.
The double entwined snakes belonged to Hermes, messenger of the gods and prince of thieves.
In ancient Greece, Hippocrates (460-377 BC) replaced supernatural temple medicine with *rational medicine*, a change that coincided with the Golden Age of Athens and the world view of pre-Socratic philosophers.
A Major Step Backward

Galen (131-200 AD) virtually destroyed Hippocratic teaching by forcing medicine to conform to the emerging Christian world view that illness was the work of an all-powerful god. Galen’s principles dominated medicine for 1,500 years, virtually paralyzing innovative thinking.
Avicenna, the most renowned physician in the Arab world, subscribed to the theories of Galen. His *Cannon (Qanun)* served as a reference longer than virtually any textbook in the history of medicine.
Modern medicine dates from the publication of Vesalius’s magnificently illustrated book – *De Humanis Corporis Fabrica* (1543). Vesalius was then 29 years old.
Leonardo da Vinci did his anatomical dissections at night to avoid accusations of heresy. The dissecting room was lighted with candles which made the experience even more macabre. “You will perhaps be impeded by the fear of living through the night hours in the company of corpses, quartered and flayed and frightening to behold.”
Michael Servetus disregarded Galen’s three varieties of spirits, admitting but one—\textit{the vital spirit}--which was contained in red blood flowing into the heart from the lungs.

“The vital spirit is engendered by the mingling of inspired air with the more subtle portion of the blood which the right ventricle of the heart communicates to the left.”
With intuitive genius, Servitus proposed that “within the lungs, we find a new kind of vessels proceeding from the arteries to the veins… extremely minute vessels or capillary arteries.” This was proposed a century before Malpighi discovered the pulmonary capillary circulation.

The date of Servitus’ birth is disputed, but the date of his death is beyond doubt because the Calvinists accused him of heresy, and in 1553, burned him at the stake together with his books. To increase his agony, he was burned slowly.
The Seventeenth Century
William Harvey

*De Motu Cordis* (1628), one of the most celebrated books in the history of medicine
After witnessing the experiments of Hildanus Fabricius of Padua, Harvey demonstrated that veins swell below a ligature, preventing reflux of blood from the heart. This observation served as the basis for *De Motu Cordis et Sanguinis* in which Harvey set forth his concept of the circulation.
Human Arterial Circulation

17th Century

21st Century
From the dawn of cultural history, the magical pulsation of the heart has been one of the enigmas and mysteries of human life. Can hearts of gold pulsate?
On my 40th birthday, a copy of the 28th edition of *Gray’s Anatomy* was inscribed to me by the Editor, Charles Mayo Goss, who taught me anatomy as a medical student, and with whom I maintained close friendship until his death. The inscription read, “*In honor of the 40th anniversary of the birth and in celebration of first beatings of the heart of Joseph Perloff, a fine clinician and scholar from his old professor, Charles Mayo Goss.*”
Death of the Buddha
Death of the Buddha
That the **heart beat is necessary for life** is one of the few dogmas that has enjoyed equal popularity among both cardiovascular physiologists and the lay public. It has long been the conventional wisdom that the embryonic heart begins to beat in order to pump blood for convective transport. However, data from developmental biology have called this seemingly intuitive dogma into question.
The heart cannot function without beating.

But the heart can beat without functioning.
The embryonic heart begins to beat 18 to 21 days after conception. At this stage, the heart has no circulatory function, but if the beat stops, the embryo dies.
Four thousand years ago, the Chinese looked upon the beating heart as the organ that pumped blood throughout the body.

From the Yellow Emperor 2696-2598 BC
The Ancient Art of Feeling the Pulse

For male patient, feel left hand pulse first

25. For female patient, feel the right hand pulse first
Herophilis (344 BC) recognized that the arterial pulse and the heartbeat were synchronous. He constructed a water clock to count the pulse, analyzed its rate and rhythm, was influenced by musical theories, and evolved an entire rhythmical pulse lore.
2000 Years after Herophilis, John Floyer employed a London watch maker who devised a second hand and a lever that stopped the mechanism. The pulse could then be timed precisely.
Seventeenth Century

Francis Bacon, 1st Viscount St Alban

English philosopher, statesman and essayist, and a catalyst of the scientific revolution
18th Century England
A Country Doctor

The Foxglove

William Withering

Digitalis, finger-shaped corollas of the foxglove.
The Foxglove
In My Garden
One of Withering's dying patients took a gypsy’s remedy and survived. Withering hunted down the gypsy and discovered that the vital ingredient of the magic potion was *foxglove*. Withering tried every bit of the plant in all sorts of ways. After experimenting on 163 patients, he found that the best formulation was dried powdered leaf given by mouth.
"...with each movement of the heart, when there is the delivery of a quantity of blood from the veins to the arteries, a pulse takes place and can be heard within the chest."

De Mortu Cordis (1628)
200 Years After Harvey
Rene Laennec 1816
Before the Stethoscope
Mediate Auscultation
A Quire of Paper Rolled Into a Cylinder
The First Stethoscope
Laennec’s discovery of the stethoscope advanced physical diagnostic medicine beyond anything previously imagined.
Rudolph Virchow’s hypothesis that coronary artery atheroma resulted from an inflammatory intimal reaction predated by a century and a half the current focus on inflammation in the pathogenesis of atherosclerosis.
Coronary Artery Disease

Previously regarded as a cholesterol storage disease, coronary atherosclerosis is now considered an inflammatory disorder as Virchow proposed 150 years ago. C-reactive protein is used as a clinical biomarker of an inflammatory process.
Anaesthesia (an without + aesthesia sensation Gr) was a term introduced by Oliver Wendell Holmes. Within a span of just four years (1842 to 1846) anesthesia was born in the United States, and remains among America’s greatest contributions to medicine.
Before Anesthesia
Operations were brief and bloody. The floor of the operating room was covered with sawdust which absorbed the blood, and was swept away at the end of each procedure.

OR 19th Century  Sawdust on the floor
In March 1842, ether was first used during surgery by Crawford W. Long, a modest country practitioner in Jefferson County, Georgia. Seven years elapsed before Long published his observations that received but little attention, although no greater boon has ever come to mankind than the power thus granted to induce temporary but complete insensibility to pain.
Humphry Davy’s self experiments with nitric oxide failed to pursue the application to anesthesia.
The Ether Dome
William Thomas Green Morton used ether anesthesia at the Massachusetts General Hospital in October 1846. Within a month the event was published in the *Boston Medical and Surgical Journal*. In the next month, ether was used in London, and in the succeeding year ether anesthesia was widespread throughout Europe.
Nineteenth Century
Wilhelm Roentgen

A New Kind of Rays
Vacuum tubes from Roentgen’s laboratory
Deusches Museum Munchen

1895
Twentieth Century

The internal structure of the living heart was revealed for the first time.

Four decades after Roentgen discovered his new kind of rays, angiography had its inception with injection of contrast materials into blood vessels of cadavers and animals. In 1937 Castellanos in Havana visualized the right cardiac chambers in infants and children.

Robb and Steinberg at York Hospital introduced angiography in adults.
The Electrocardiogram
Hallmark of Modern Medicine

The early history of electrocardiography (1900-1945) was dominated by Willem Einthoven in the Netherlands, Sir Thomas Lewis in England and Frank N. Wilson in the United States, pioneers that laid the foundation for electrocardiography as a modern clinical science.
1906, Sunao Tawara working in Ludwig Aschoff’s laboratory in Marburg, published in German his epoch-making monograph on the atrioventricular node, now known as the Node of Tawara.
From Electrocardiography to 21st Century Cardiac Electrophysiology

Color Coded Electromechanical Mapping
The Twentieth Century

In 1915, Ernest Henry Starling delivered at Cambridge the prestigious Linacre Lecture that was published in 1918, and was subsequently designated Starling’s Law of the Heart.
“The heart, freed from all its nervous connections, has the power of automatically adjusting the force and extent of its contractions to the task which is set for it by the two factors determining its work, viz: the inflow into the heart from the veins, and the resistance offered to the outflow by the arterial pressure.”
The scroll-like structure of cardiac muscle

The helical heart promotes twisting of cardiac muscle and ventricular ejection, followed by untwisting that promotes filling for the next beat.

Two Hearts Beating as One
The Cardiac Catheter
Werner Forssmann 1929
Nobel Prize in Physiology or Medicine 1956
For their discoveries concerning heart catheterization and pathological changes in the circulatory system

Andre Frederic Cournand
Werner Forssmann
Dickinson W. Richards
We Few, We Very Few

Maude Abbott

Helen Taussig
St Jude
Patron Saint of Hopeless Causes
Before World War II, congenital malformations of the heart were regarded as *hopeless futilities*, an occupation appropriate for the few women in medicine. *Maude Abbott* was advised by William Osler to devote herself to the anatomic specimens in the McGill collection, and *Helen Taussig* was advised to occupy herself with the hopeless futilities in the Harriet Lane Children’s Clinic at Hopkins. *Congenital heart disease in adults was an oxymoron.*
Helen Brooke Taussig

CONGENITAL MALFORMATIONS OF THE HEART

REvised Edition

Volume I
GENERAL CONSIDERATIONS

By HELEN B. TAUSSIG, M.D.

1947
Another Landmark

Ahmanson/UCLA Adult Congenital Heart Disease Center
In 1941 Karl Dussik, an Austrian, first employed ultrasound for medical diagnosis.
Echocardiography
Diagnostic Pathway to the Promised Land
A powerful magnetic field aligns hydrogen atoms in body water.
Surgery for congenital heart disease should be born of hope, not of desperation.
SURGICAL LIGATION OF A PATENT DUCTUS ARTERIOSUS: REPORT OF FIRST SUCCESSFUL CASE
R.E. GROSS
and J. P. HUBBARD
1939
In 1944, Alfred Blalock sutured the end of a subclavian artery to the side of a pulmonary artery in an infant with Fallot’s tetralogy, establishing the now legendary Blalock-Taussig shunt.
A Landmark Operation 1944
The Blalock/Taussig Shunt □
The heart will never be normal, but the life lead can be normal.
2008

Congenital Heart Disease in Adults
3rd Edition

Joseph K. Perloff
John S. Child
Jamil A. Aboulhosn

SaundersElsevier
Cadiac Transplantation
*If I only had a heart*

The Tin Woodman
Cadiac Transplantation

If I only had a heart

The Tin Woodman
1960
Lower and Shumway-- first successful orthotopic cardiac transplantation.

1966
Christiaan Barnard-- first human cardiac transplantation.
For the ancients, the soul resided in the heart---a mystic organ. Death meant that the soul departed from the heart. Where does the soul reside when a heart is transplanted? What have Shumway and Bernard done with our souls?
Thank You