HISTORY OF DIAGNOSIS OF CARDIOVASCULAR DISEASES

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ABSTRACT

BACKGROUND

Access to the anatomy, physiology and pathology of cardiovascular system organs has been made easy by the invention of various tools and techniques.

One third of all deaths globally are due to heart diseases. Future predictions indicate that by the year 2020, heart diseases will be the leading cause of death globally; therefore early diagnosis is needed for a better prognosis.

Tools that are currently central to diagnosis of cardiovascular diseases are: the stethoscope, sphygmomanometer, electrocardiogram, emission techniques like X-rays and echocardiograms. From the early sixteenth through the twenty first century, these devices have been modified to increase their sensitivity and specificity.

For further modification of these devices, understanding the concepts of their discovery in the first place is inevitable.

OBJECTIVES

1. To elucidate the evolutionary understanding of the cardiovascular system
2. To show the historical discovery of some of the devices used in the diagnosis of cardiovascular system diseases

METHODOLOGY

This work was compiled by reviewing books, journals and websites with information on the historic advancement of diagnosis of cardiovascular diseases.

RESULTS

Before the 17th Century, knowledge on the cardiovascular system was much contributed to by Pliny and Galen (a Greek physician and teacher).

This knowledge came to be challenged in the 17th Century by William Harvey. His experiments led to the present understanding of the cardiovascular system, and are considered the greatest achievement of that century.

The discovery of the sphygmomanometer was steered by reverend Hales who watched a horse's arterial blood climb 8 feet six inches high in a glass tube.

Dr. Laennec heard heart sounds better using folds of hard paper and so laid foundations for the discovery of the stethoscope.

The concept of the electrocardiogram began by the observation of bioelectricity by L.Galvan in 1787.

CONCLUSION

Humans always struggle to master their environments. As a problem arises, the need to understand better and modify the present solving techniques or invent new ones arises

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INTRODUCTION

The best treatment or management of any disease condition depends on the accuracy of diagnosis. Since the time of Hippocrates, physicians have based on patients' history, clinical signs and some tests to make their diagnosis[1]. Ancient physicians agreed that the human body is made of fluids one of which is blood and contributes to pathogenesis of diseases[1].

Cardiovascular diseases have always been responsible for illnesses and deaths, and physicians used different methods of diagnosis and treatment which have undergone improvements with time. One example is the puncturing of arteries to measure blood pressure in the seventeenth century which improved to the use of sensors in blood pressure measurement in the twenty first century.

Heart diseases and stroke kill some 17 million people each year, accounting for one third of all deaths globally[2]. By 2020, heart diseases will become the leading cause of both death and disability worldwide2. Interventions that help in early detection of heart diseases and hence better prognosis for patients have been employed and possibly more are needed.

OBJECTIVES

1.To elucidate how our understanding of the cardiovascular system has evolved through centuries to the present day.
2.To show the historical discovery of some of the devices used in diagnosis of cardiovascular diseases

METHODOLOGY

This work was compiled by reviewing books, journals and websites with information on the historic advancement of diagnosis of cardiovascular diseases.

Confusion over the nature of the heart, blood and the role of blood in the body had existed for centuries[3].

- Pliny the elder (AD 23-79) who was the author of a 37-volume treatise entitled "natural history" wrote, "the arteries have no sensation, for they even are without blood, nor do they all contain the breath of life, and when they are cut only the part of the body concerned is paralyzed …The veins spread underneath the whole skin finally ending in very thin threads that blood can't pass except a moisture in form of small innumerable droplets, that is called sweat."
- Galen who was a Greek physician during the second century believed that there were two types of blood; vital blood that was made by the heart and pumped in arteries to carry vital spirits, and nutritive blood that was made by the liver and carried through veins to the organs.
- Galen also believed that blood moved from one ventricle to another through holes in the septum, and that pumping of blood was done by the lungs.
- Greeks believed that the heart was the seat of the spirit.
- Egyptians believed the heart was the centre of emotions and intellect.

The Chinese believed the heart was a centre of happiness.
These beliefs prevailed from the second century until they were challenged by William Harvey during the 17th century.
When Harvey became the court physician, he performed experiments to determine the mechanics of blood flow in humans. He used direct dissection physiological experiments on animals, and he came up with these findings; [4]

- Dissected hearts showed valves which allowed blood to flow in one direction.
- Direct observation of heartbeats showed that ventricles contract together.
- Dissection of the septum of the heart showed that it contains vessels instead of perforations.
- When he removed the heart from a living animal, the heart continued to pump, showing that it's a pumping organ and not a sucking organ as was believed.
- He used mathematical data to show that blood is not consumed in the body.

Harvey's work was challenged for a long time, but gained great acceptance after subsequent researches[4]. His pioneering work is considered the greatest achievement of the 17th century and of Medicine[4]. From his concepts we now have a precise idea and knowledge of circulation and the cardiovascular system.

EXAMPLES OF CARDIOVASCULAR DISORDERS

It's a class of diseases that involve the heart or blood vessels.

1.VALVE PROBLEMS

(a)**Valvular stenosis; this is** narrowing of the opening of the valve that causes blood to flow through with difficulty, hence blood dams up behind the valve. It can be a result of diseases such as rheumatic fever.
(b)**Valvular regurgitation;** occurs when valves become so worn out that they cannot close completely and blood flows back into the atria or ventricles hence drastically reducing the efficiency of the cardiac stroke, with subsequent related consequences.

2.VASCULAR PROBLEMS

Artery

- Atherosclerosis; degenerative disease that results in narrowing of the coronary arteries. This is mostly caused by fatty deposits notably cholesterol in the interior walls of coronary arteries. Narrowing or occlusion of coronary arteries reduces blood supply to heart muscle.
- If the artery remains open to some degree, the problem is noted when the heart is under stress e.g. during exercise.
- If the artery is completely occluded, a section of the heart muscle can no longer get oxygenated blood and begins to die. This is called a heart attack.
- The resulting pain is called angina.
- When walls of systemic arteries become weak, they balloon outwards like a weak spot in the radiator hose; this is called an aneurysm-an extremely dangerous condition.
- When an aneurysm bursts, the blood spills over in body cavities. If an aortic aneurysm bursts, death is almost obvious.

Vein

- Varicose veins; occur when valves in the veins become incompetent and blood pools up in the legs
- Clots can form in the legs, and when they break loose and travel to the lungs, they cause pulmonary embolism and possibly death.

Capillaries

- Edema; when the pre-capillary sphincter is damaged, increase in pressure in the capillaries causes fluid to shift into interstitial spaces (since capillaries have no smooth muscles to control pressure increases), hence fluid builds up in tissues causing edema.
- Since they are fragile and rupture easily, in the skin they result in bruises as when one sustains trauma.

DEVICES USED IN DIAGNOSIS OF CARDIOVASCULAR DISEASES

1. SPHYGMOMANOMETER

People have observed the spurting of blood from injured arteries since time immemorial. In 1733, Reverend Stephen Hales inserted a long glass tube, one sixth of an inch in diameter, upright into an incision in a horse's crural artery[6]. The pumping action of the heart generated a pressure force, causing the blood level to raise in the tube 8 feet 3 inches high[6]. That was the first proof that blood has pressure. Attempts to measure blood pressure continued.[6]

In 1828, Poisseuile developed a mercury manometer that measured blood pressure by directly inserting the cannula into an artery. He used potassium carbonate as an anticoagulant.[7]

In 1847, Carl Ludwig (professor of comparative anatomy) attached a float with a pen writing on a drum buoyed by Poisseuile's mercury manometer and developed the kymograph[7]. Blood pressure measurement required puncturing an artery.

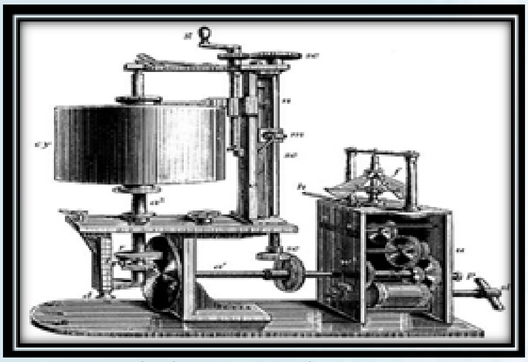

figure 1. Kymograph that required puncturing an artery to measure blood pressure

Vierodt postulated a non-invasive, indirect technique by measuring a counter pressure which would be necessary to cause pulse in artery to cease[7]. He developed the first sphygmomanometer which was very cumbersome and was not applicable for clinical purposes.[8]

In 1860, Etienne Jelus Marey improved Vierodt's apparatus. The arm was enclosed in a glass chamber filled with water connected to a sphygmograph. The pressure was varied by raising the mercury column and the pressure at which no movements were seen in the sphygmograph was taken as the systolic pressure.[7]

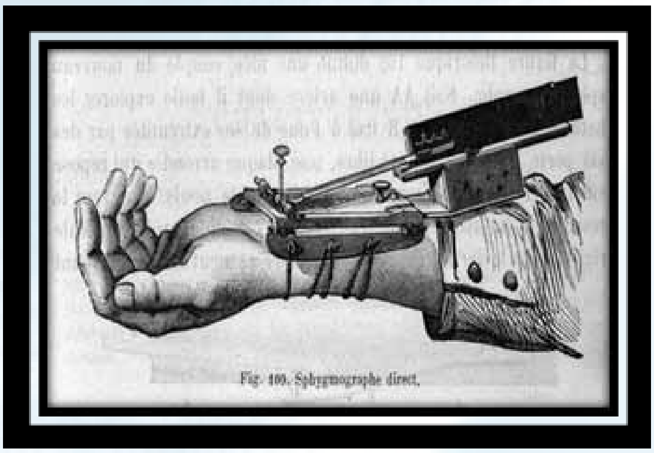

figure 2. Marey's sphygmograph

Samuel Ritter Von Basch finally dispensed the recording of blood pressure by using a column of fluid. An inflatable rubber bulb filled with water around the bulb neck could transmit pressure to the bulb hence the mercury column height could be recorded as systolic pressure[7].This apparatus finally had a very successful clinical application.[8]

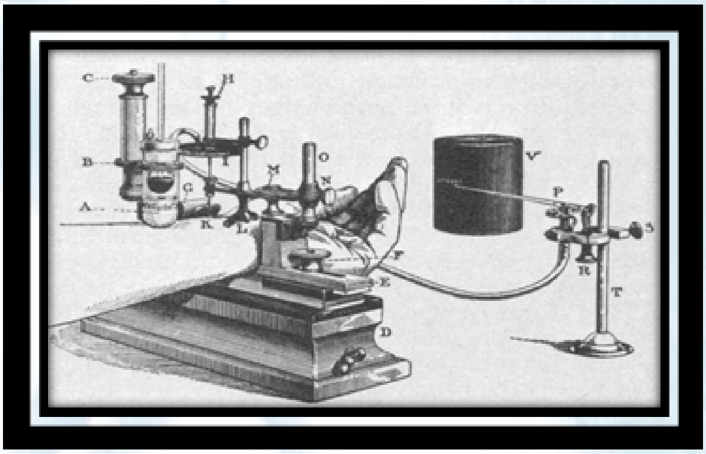

Figure 3. Von basch sphygmomanometer

In 1896, Italian doctor Riva Rocci developed ideas that led to the present day technique, but his device had a thin cuff that gave inaccurate results[7].With time, thick cuffs were developed and more accurate measurements were obtained.[7]

In 1905, Russian surgeon Korotkoff, heard tapping sounds by placing the stethoscope on the cubital fossa distal to the cuff, leading to development of the ausculatory method.[7]

Figure 4. Auscultatory method

Now with the use of strain gauges, photocells, and semiconductors, devices have been improved and blood pressure can be monitored continually by sensors worn on the patient's thumb. New techniques like ambulatory methods have been developed.[7]

figure 5. ambulatory method

2. STETHOSCOPE

Since the time of Hippocrates, physicians listened directly to patients chests as they tried to assess cardiac health[9].The inventor of the stethoscope Rene Theophile-Hyacinthe Laennec also initially relied on this method.[9]

figure 6. Listening to the heart of a patient; head to chest

One day he needed to examine an obese young woman but couldn't put his head on her chest. He rolled a stack of paper into a cylinder with one end on the patient's chest another on his head. He heard the beats even more clearly than before and thereafter manufactured simple wooden tubes for the purpose.

figure.7 Among the earliest stethoscopes

figure 8.current stethoscopes

3.ELECTROCARDIOGRAM

The first exploration of bioelectricity: in 1787, L. Galvan noted that the frog muscle contracted when exposed to an electrical discharging process.[10]

In 1843, Matteuci noted that current could be measured from resting heart muscle[10].

In 1878, Julius Bernstein used the differential rheotome to make the first recorded frog EKG, with electrodes on the opened heart muscle[10].

In 1887, Waller recorded the heart electrical activity by using capillary electrometers on the heart surface without opening the heart and called them CARDIOGRAMS[11].

figure 9. The first recorded Electrocardiogram on the frog's surface, without exposing heart muscle

In 1900, Einthoven developed a string galvanometer that was faster than the capillary electrometer, and was more efficient.[12]

Einthoven designed the first Electrocardiograph composed of a string galvanometer, an arch lamp, a projecting system, a timing system and a falling glass plate camera. It weighed 600 pounds and required five people to operate it. This was in 1915.[12]

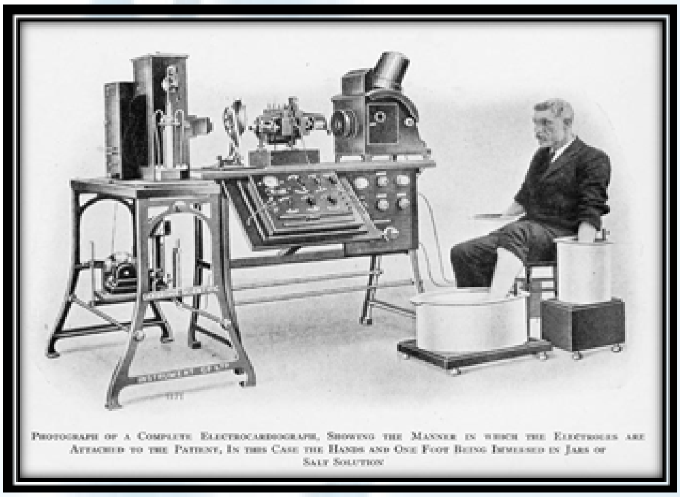

Figure 10. the first Electrocardiogram. It required five people to operate it and weighed 600 pounds.

MODIFICATIONS. Cylinder electrolyte electrodes have been replaced with suction electrodes, string galvanometers were replaced with vacuum tubes, then the cathode ray oscilloscope, and microelectronics e.g. semiconductors[12].

CONCLUSION

Human beings struggle to master their environment. Solutions to their problems begin by identifying the problems. Present day technological developments in the diagnosis of cardiovascular diseases are merely a continuation of concepts developed in the first place by ancient scientists of the fifteenth to the first half of the nineteenth century.

The death rate from cardiovascular diseases being seventeen million people per year worldwide calls for detection of cardiovascular lesions at very early reversible stages of the disease. However, techniques used have to be affordable worldwide and of easy clinical application.

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