The sphygmograph

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The name sounds familiar? But not quite! We all know the sphygmomanometer for measuring blood pressure. The key to determine blood pressure is to measure a pulse accurately. In the 19th century, it was not possible to do so non-invasively. *Sphygmos* is the Greek word for pulse. Sphygmograph is a medical instrument that records graphically the rise and fall of a pulse and its rate. It was invented in 1854 by a German physiologist Dr Karl von Vierordt (1818-1884).[1] It used a system of levers to amplify the radial pulse. By compressing the radial artery proximally using quantified weights, the disappearance of the pulse allowed the systolic blood pressure to be determined. In 1863, Dr Étienne-Jules Marey (1830-1904) made the sphygmograph portable, and used the elastic force of a spring rather than the static force of weights, and also recorded the trace on paper. Dr Marey, a French scientist and physiologist working in Paris, contributed significantly to cardiology and physical instrumentation, and was a pioneer in photography. Later, Dr Heinrich von Recklinghausen (1867-1942), a German physician and scientist from Wurzburg, introduced the first practical sphygmomanometer. Incidentally, he was the son of Dr Friedrich Daniel von Recklinghausen (1833-1910), a German pathologist who was associated with two eponymic diseases: multiple neurofibromatosis (1882) and osteitis fibrosa cystica (1891).

The sphygmograph allowed the mechanical aspect of cardiac contraction and relaxation to be indirectly studied. In 1871, Dr Alfred Henry Garrod from St John's College, Cambridge, UK, presented a treatise on the radial pulse wave form, and described sphygmosystole and sphygmodiastole, corresponding to the cardiac systole and diastole. He demonstrated the isometric period of heart contraction by using the sphygmograph to determine flow, and a simultaneous apex cardiograph to determine the onset of mechanical systole in the left ventricle.[2] Pulse wave analysis has recently received renewed interest as a means to generate a corresponding central aortic waveform, from which the aortic argumentation index and central aortic pressure can be derived.[3] These measurements provide important information about arterial stiffness, a marker of atherosclerosis.

Prior to the invention of electrocardiography, the sphygmograph was the only way to study cardiac arrhythmias. A well-known example was the demonstration of atrial fibrillation by Dr James Mackenzie, MD, FRS, FRCP (1853-1925) using a simultaneous sphygmographic recording of the pulse and jugular venous waveforms.[4] He described a patient with a continuing irregular pulse and absent jugular 'a' wave using this equipment. This was the first recording of atrial fibrillation in history. Dr Mackenzie was a Scottish cardiologist and a pioneer in the field of cardiac arrhythmias, and was knighted by King George IV in 1915. The sphygmograph in the collection of the Hong Kong Museum of Medical Sciences is a Dudgeon's sphygmograph (Fig 1), a modification of the Marey sphygmograph by Dr Robert Ellis Dudgeon (1820-1904), a Scottish physician best known for his practice of homeopathy.[5] The instrument was strapped on the wrist, and the weight on the lever could be adjusted to exert pressure on the radial pulse to produce a

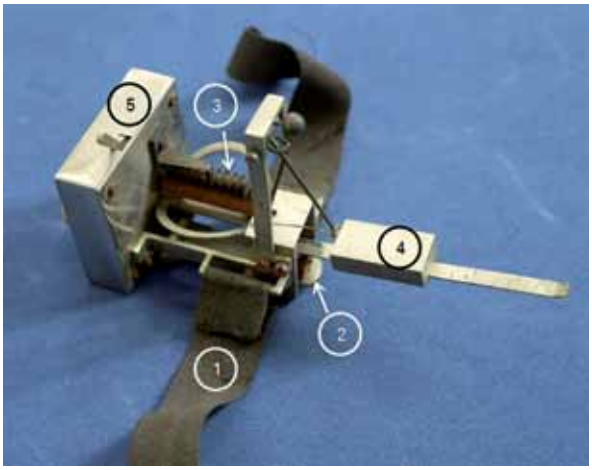

FIG 1. Dudgeon's sphygmograph (length x width x height: 10.5 cm x 3.5 cm x 5.5 cm) donated to the Hong Kong Museum of Medical Sciences by Dr Judith Mackay in 2002

The instrument is strapped onto the wrist of the study subject by a belt (1) with a stud (2) placed on the radial artery, the pressure applied being controlled by a weighted lever (4). The force of the pulse is transmitted to a moving stylus that makes a tracing on a strip of smoked paper placed on top of the roller (3) powered by a wound spring. The spring is housed in a box equipped with an on-off switch (5) that controls the movement of the paper strip

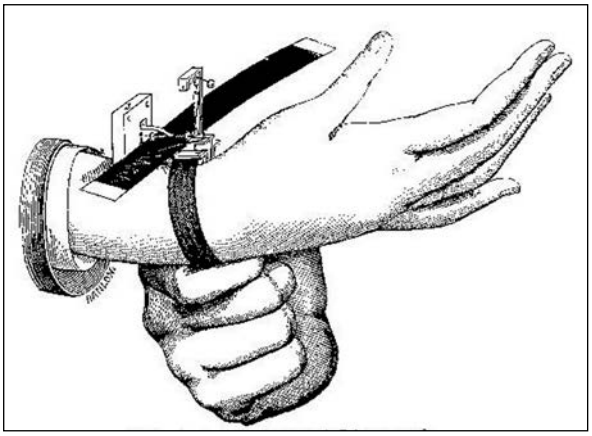

FIG 2. Diagram showing the sphygmograph on the wrist ready for measurement

From the digital copy of the book by Dudgeon,[5] reproduced with permission of the Medical Heritage Library

tracing of the pulse on smoked paper (Fig 2). The device was donated to the Museum by Dr Judith Longstaff Mackay, who in turn received it from Dr Edward Hamilton Paterson on 26 July 1982. Dr Mackay is well known in Hong Kong for her tireless work on anti-smoking and tobacco control for which she has been honoured with awards from many parts of the world including the conferment by Hong Kong Shue Yan University of the degree of Doctor of Social Sciences, honoris causa, in 2015.[6] Dr Paterson (1920-2013) was a Scottish missionary doctor who graduated from the Middlesex Medical School in 1943 and served as senior surgeon and later medical superintendent of the Alice Ho Miu Ling Nethersole Hospital from 1951 until his retirement in 1989.[7] He was best remembered for his foresight in establishing the United Christian Hospital and developing the concept of 'hospitals without walls' by starting, for the first time in Hong Kong, community nursing and training nursing practitioners. In recognition of his contributions, he was conferred the degree of Doctor of Social Sciences, honoris causa, by the University of Hong Kong in 1985.[8] Dr Paterson had this to say in his covering note to Dr Mackay:

> "…I have in my possession an incredibly ancient machine called a Dudgeon's sphygmograph, which produces tracings of the radial pulse wave. It was given [to] me by my father, and I don't know where he got it from, but I gather it was used fairly widely in the days before ECGs [*sic*] were invented. I can remember Samson Wright lecturing about the machine when I was a student, but not long after that time ECGs [*sic*] came into fairly general use, and I'm sure your MOs will never have heard of a sphygmograph."

Dr Samson Wright (1899-1956) was an eminent British physiologist who wrote the world famous textbook *Samson Wright's Applied Physiology*. Without an instrument to measure blood pressure non-invasively and reproducibly, the association of hypertension with stroke and heart diseases would not have been recognised nor treatment of hypertension possible. These all started from the humble beginnings of the sphygmograph. This instrument, on its own, is well worth a visit to the Museum.

On a personal note, when I examined the instrument, to my surprise, the roller sprang to life when I wound the spring, after over 100 years since it was made!

References

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