EDITORIAL

Who was the first to monitor blood pressure during anaesthesia?

The measurement of blood pressure is the single most common clinical examination; its importance in the treatment and prevention of hypertensive cardiovascular disease, and as a predictor of mortality and morbidity cannot be disputed. In acute medicine, such as intensive care and anaesthesia, mandatory blood pressure monitoring has played an important role in improving the outcome. It is fair to say that the progressive advancement in the quality of anaesthesia from its birth 150 years ago to modern times owes a great deal to the vigilant monitoring which includes repeated measurements of blood pressure.

The years 1996 and 1997 have a special importance to anaesthetists: these two consecutive years mark the anniversaries of the introduction of ether and chloroform, and therefore, the birth of the specialty. The inauguration of ether was duly celebrated in 1996 at the 11th World Congress of Anesthesiologists in Sydney, Australia, while 1997 has been marked by the chloroform sesquicentenary [1]. In this atmosphere of celebrations, it seems appropriate to record that 1997 is also the centenary year of the first report on monitoring blood pressure during anaesthesia.

Ether and chloroform became widely used all over the world shortly after their introduction, and remained the only major anaesthetic agents for over 100 years. The mortality associated with chloroform was a matter of great concern, even during the first decade of its introduction. Later, growing concern led to the appointment of a committee by the Royal Medical and Chirurgical Society, who published their report in 1864. This voluminous report mentioned that a haemodynamometer had been used to assess the effect of chloroform on animal hearts during the experiments carried out for the report [2]. This confirms the recognition that close monitoring of the heart during chloroform anaesthesia was a useful observation.

The earliest device capable of recording the pulse was invented during the same decade in which anaesthesia was discovered. A Frenchman had introduced Marey’s Sphygmograph in 1860, and this instrument was improved by many modifications, which soon found a place in clinical practice [3,4]. These novel devices, forerunners of present-day non-invasive blood pressure measuring apparatuses were successfully used by physicians in their clinical practice. Some of the investigations using these devices which were published were well-executed studies in which the actions of various chemicals and therapeutic agents on the heart were investigated and a number of workers obtained the earliest tracings of the pulse. In 1866, the sphygmograph was used by comparing the difference in the sphygmographic tracings of radial arteries from both sides to monitor and confirm the diagnosis of an aneurysm of the right axillary artery [5]. In 1867, the sphygmograph was again used as a prognostic tool during acute pulmonary consolidation [6]. In another study, the pulse tracings were made during the administration of alcohol, a popular therapeutic agent [7].

Towards the last quarter of the nineteenth century, still better and more reliable devices were introduced so that the pulse recordings could be made both in physiological laboratories and at the bedside. One such apparatus, a real object de art of Victorian engineering, was the Dudgeon Sphygmograph and its improved modification by Richardson, which was capable of marking the time intervals while the pulse trace was recorded on smoked paper [8,9]. Other devices which were classified as sphygmometers are worth mentioning: von Boch’s sphygmometer and Potain’s sphygmometer, both of which were introduced towards the latter half of the nineteenth century [10,11]. These instruments were used not only in France, but also in the UK and America. The sphygmometers were portable, easy to use and reasonably accurate instruments which were widely available and popular among physicians who could conveniently use them.
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A SIMPLE AND ACCURATE FORM OF SPIRIGMOMETER FOR CLINICAL USE.

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Two instruments consist of: (1) A closed metal, which is strapped round the arm, by a rubber bag, on a black rubber bag, inflated by a hand pump, with (2) a small stopcock, and 255±259

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exhibited in a hinged magnifying form by means of a cross in which the pressure is judged. This sheet is graduated in millimeters of mercury. The scale, pump, and pressure gauge are all of metal, and the two are connected by a cord. The instrument is used thus: (1) The arm is strapped round the arm, and the pressure gauge is placed under the arm. (2) By means of the pressure, the pressure wave is raised in the rubber bag until the pressure indicated by the index of the pressure gauge becomes of maximal extension. (3) At this point the pressure is taken, and the pressure gauge is reset to zero. This pressure is the mean arterial pressure. The pressure is repeated on the arm of any individual with the arm at a right angle to the body. The pressure is taken in any shape or size. In children the arm can be fitted exactly to the limb, and the pressure is then taken in the mean arterial pressure. The arm is removed from the arm by the index of the pressure gauge, and the pressure is determined when the pressure is raised within 2 to 3 to the arterial pressure. If the pressure very greatly delayed the elasticity of the bag would come into play, and from this an error in the readings would occur. The rubber bag is made of thin and thick. By raising the pressure with the bag and the venous outlets are blocked. This, if continued for long, produces great congestion of the arm and discomfort. For this reason the readings must be taken rapidly. The pressure is never to be maintained on the arm for more than a minute or so. The following is a convenient plan of work: (1) Force up the pressure rapidly till palpation appears. (2) Continue to force up the pressure till palpation disappears or otherwise becomes impossible. (3) Slightly open the valve and allow slow leakage. As the pressure falls, note where the pulse beats, and where the bag is empty as venous blood either by elevation of the limb or by the heart. (4) Repeat the operation and make another reading. (5) Following the plan no pain or discomfort will arise. In studying the effect of exercise, posture, drugs, etc., successive readings must be taken in the above manner, first during normal, and then during the experimental condition. (6) Owing to the effect of position on the circulation, the readings must be taken uniformly, with the arm placed by the side and on the same level as the heart. The muscles of the arm must be relaxed during the observations. The arterial tension is constantly varying slightly, owing to changes in the form of the heart beat and the respiratory oscillations of pressure. Thus the maximal observations may be obtained now at one place and soon at another, a few millimeters higher or lower. The mean of the different readings must be taken just as is done when the mercurial manometer is used in physiological experiments on animals. In conditioned quiet respiration these variations are often not great, and the pressure may be read at each observation within 2 to 3 millimeters. Variations of pressure by 5 to 10 mm. 3rd of the experiment, are physiological, and of no importance.

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Fig. 1. Paper published in the British Medical Journal in 1897.

level of anaesthesia with primitive inhalers fully occupied the thoughts of the single-handed anaesthetist.

The practice of anaesthesia during first 50 years remained totally dependent on the observation of breathing as the sole method of monitoring. A quote from professor James Syme's (1799–1870) lecture illustrates the fact that even the palpation of the pulse

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during anaesthesia was not recognized as a good practice: ‘you never see any one here with his fingers on the pulse while chloroform is given’ [12]. In contrast with this, the picture in the anaesthesia history books of Dr J. T. Clover feeling the pulse while administering ether to a patient is a unique example. No wonder he was credited with exceptional success in his profession!

In 1896, Scipione Riva-Rocci (1863–1936), while he was professor at Turin, described his vertical mercury manometer with a rubber arm cuff to occlude the brachial artery. His extensively researched 30-page paper was published in December 1896 [13]. This classic historical publication has never been translated into English, but there is no mention that Riva-Rocci’s revolutionary apparatus was considered for the measurement of blood pressure during anaesthesia in the summary translations which are available. This apparatus was introduced in America by Harvey Cushing in 1901, who was also responsible for introducing the practice of blood pressure recording on the anaesthetic charts [14].

The first report of blood pressure monitoring during anaesthesia was recorded in a joint publication to the British Medical Journal on 2 October 1897 (Fig. 1). It was a short, one-page article by Leonard Hill and Harold Barnard, describing a new blood pressure measuring device. At the start of the paper, the instrument was described briefly. It consisted of a narrow armlet to occlude the brachial artery, a small bicycle-type metal pump and a metal manometer graduated in mmHg. The construction of the pressure gauge was described as consisting of a metal tambour connected to a needle or a pointer. The pressure changes caused the pointer to move over a round, graduated scale to 200 mmHg. The authors also described a portable, pocket sphygmometer, although the date of its introduction cannot be ascertained accurately. Both of these instruments are in the exhibition at the Wellcome Museum in London.

The following quote from the Hill and Bernard paper offers ample evidence that the authors had carefully monitored the blood pressure of anaesthetized patients:

‘The facility with which the instrument can be used for clinical purposes is illustrated by a series of observations which we have made upon patients placed under the influence of anaesthetics. Before and during administration a series of readings were taken at intervals of time, and from the figures thus obtained curves were plotted out. In 8 cases of anaesthesia with gas and oxygen (sitting posture) the arterial pressure either rose a few millimeters of mercury or remained constant. In 4 cases of anaesthesia with ether the arterial pressure remained or fell a few millimeters of mercury. In 6 cases of anaesthesia with chloroform the sphygmometer indicated an extensive and rapid fall of arterial pressure. This fall equalled 20 to 40 mm. of mercury. The normal arterial pressure in most healthy young men appears to be 110 to 130 mmHg in sitting position.’ [15]

The above quotation offers the first evidence of measurement of blood pressure during surgical anaesthesia. Unfortunately, my efforts to trace details and data on relevant material mentioned in the quote have not been fruitful.

Harold Leslie Barnard (1868–1908) was born in London (Fig. 2). He was the grandnephew of Michael Faraday. Barnard qualified with many distinctions...
After 100 years, it is only justice that the pioneering contributions made by the two doctors who were the first to monitor blood pressure during surgical anaesthesia should be recognized.

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