A METHOD OF RECORDING SYSTOLIC BLOOD PRESSURE

BY

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The method of recording indirect systolic blood pressure described below is a slight modification of a method developed at the Institution of Aviation Medicine, Farnborough (Ernsting, personal communication, 1961). It has been used for recording the systolic blood pressures of volunteers during certain breathing experiments carried out in the Department of Anaesthetics at the Royal College of Surgeons, and of 400 adult patients during dental anaesthesia at the Royal Dental Hospital. It proved satisfactory for these purposes although it has the limitations of all indirect methods of measuring blood pressure.

A piezo-electric crystal pulse detector is placed over the brachial artery above the elbow joint. It is then overlapped by the lower margin of a standard sphygmomanometer cuff which is wrapped round the arm in the usual way. Signals from the pulse detector and the pressure within the cuff are recorded simultaneously.

The cuff is connected to a mercury manometer, the tube of which is made of perspex (fig. 1). Platinum electrodes pass through the perspex at regular intervals and project a short distance into the lumen of the tube. Resistors are connected between adjacent electrodes and these are short-circuited in turn as the column of mercury rises within the tube. By incorporating these resistors in a suitable bridge circuit, movement of the mercury meniscus is represented by a series of "step" deflections of a pen recorder, each complete step being equivalent to the movement of the meniscus between two adjacent electrodes. The width of individual steps on the record can be varied by suitable choice of resistance values, and by this means steps, which are recognizable by their width, can be arranged at key positions for identification purposes. Two such identification steps are shown in figure 4, between 140 and 150 mm Hg.

FIG. 1
The multi-electrode mercury manometer.
In the manometer constructed at the Royal College of Surgeons the electrodes have been placed at intervals corresponding to pressure increments of 2.5 mm Hg. Two additional electrodes have been inserted at the 100 mm Hg and the 200 mm Hg positions. These actuate two relays which are so connected that the full sweep of the recorder pen may be used for each of the three ranges 0–100 mm Hg, 100–200 mm Hg and 200–300 mm Hg. This arrangement ensures that the step deflections are of readable size, despite the large number of electrodes used. The circuit diagram is given in figure 2.

A modified Acos type 43-1 (Cosmocord Ltd.) crystal microphone is used as a pulse detector. Details of construction are indicated in figure 2. A

![Circuit Diagram](https://example.com/circuit-diagram.jpg)

**Fig. 2**
The circuit diagram used in conjunction with the mercury manometer.
Details of the modification to an Acos type 43-1 (Cosmocord Ltd.) crystal microphone to make the crystal pulse detector for use over the brachial artery.

A hole of approximately 2.2 cm diameter is cut out of the centre of the perforated plate which normally protects the light alloy cone. The cone is discarded. In its place sorbo rubber is used to transmit impulses from the brachial artery to the crystal. Three sorbo discs, 0.5 cm thick and of approximate diameters 0.5 cm, 2 cm, and 3 cm are stuck together and mounted so that the smallest disc presses against the central corner of the crystal (in place of the apex of the cone); so that the middle disc lies within the hole cut in the perforated plate; and so that the margin of the largest disc overrides the perforated plate, to which it is stuck. A small wedge of sorbo rubber is introduced between the central corner of the crystal and the base of the microphone. This prevents overloading. The assembly is then mounted in a suitable container, the outer surface of the largest sorbo disc being left exposed. It is advisable to anchor the microphone lead so that no mechanical strain is put on the solder tag connections. When using this pulse detector it is important to place it accurately over the site of the brachial artery. During the course of the observations made during dental anaesthesia it was found to be advantageous to stick an additional button of sorbo rubber to the centre of the outer surface of the largest sorbo disc.

An Ediswan e.e.g. amplifier, with the gain control turned to minimum, was used for amplifying the signals from the pulse detector because this happened to be available. A simpler amplifier could be used. An Ediswan pen recorder was used for recording the cuff pressure steps and the signals from the pulse detector.

Blood pressure recordings are taken by inflating the cuff rapidly to a pressure greater than the systolic pressure and then deflating it slowly. The cuff was inflated with oxygen from a regulated reducing valve and deflated through an adjustable leak by rotation of a two-position lever. This opened and closed appropriate pinch-cocks. When the lever was in the "leak" position it was possible to increase the cuff pressure by means of a standard sphygmomanometer bulb.

The systolic blood pressure may be taken as not less than the cuff pressure indicated by the step write-out at the instant when the brachial arterial pulse is first detected and recorded. A sample record is shown in figure 4. This should be read from right to left. The top record was obtained using a paper speed of about 0.5 cm/sec, which is the speed that has usually been selected. The bottom record was obtained using a paper speed of 6 cm/sec. From above downwards the pens recorded the cuff pressure; the signals obtained from the crystal pulse detector over the brachial artery; a pneumotachograph trace to indicate phase of respiration; and pulse signals derived from a photo-electric pulse detector applied to the lobe of an ear. The top cuff pres-
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FIG. 4

Records of:
1. (top trace). Cuff pressure (note the two wide identification “steps” between 140 and 150 mm Hg).
2. Pulse as obtained from the crystal pulse detector placed over the brachial artery and overlapped by the lower margin of a sphygmomanometer cuff.
3. Respiratory flow rate (pneumotachogram).
4. Pulse, as obtained from a photo-electric pulse detector attached to the lobe of an ear.

Top record was taken with a paper speed of 0.5 cm/sec. Bottom record was taken with a paper speed of 6 cm/sec. A 10-second time signal is superimposed upon the pneumotachograph trace. See text for further details.

The difference between the systolic pressures occurring during inspiration and during expiration may be increased when the subject breathes against resistance. It follows that the rate of deflation of the cuff should be adjusted according to the respiratory rate, especially when accurate measurements are being attempted. This limits the number of blood pressure readings that can be taken within a given time. In addition to the variations in systolic blood pressure which occur during a single respiratory cycle, some subjects show a superimposed cyclical variation over about two or three breaths.

A very small pulse signal is usually detected while the cuff is inflated to a pressure above the systolic pressure. This may be transmitted through the cuff. Whether a very small pulse is being recorded while the cuff is inflated above the systolic pressure, or whether a large pulse is being recorded while the cuff is deflated below the systolic pressure, it can be seen from the bottom record with the faster paper speed, in figure 4, that the start of the recorded pulse always bears a constant time relationship with the pulse signal.
detected at the ear. The maximum response usually occurs after a variable delay. This fact should be considered when deriving the pulse rate from the time of only a few pulses.

The amplitude and the form of the pulses recorded vary from patient to patient. Some of the obvious factors involved are the accuracy with which the crystal detector is placed, the anatomical relations of the brachial artery and the precise anatomy and bulk of the related structures, the tone of the arterial wall, the arterial pulse volume and waveform and the arterial blood pressure. In a few patients the pulse signal was very small and difficult to read. A smaller pulse detector would be needed for use with children. It has been noted that during long experiments there may be a progressive reduction in the amplitude of the pulse recorded. This was most evident with a volunteer who found the repeated blood pressure determinations to be rather unpleasant. This observation could be explained by arterial spasm. It may not be possible to read the pulse record during movements of the arm, but normal recording is resumed immediately the disturbance ceases. This is one of the advantages of using a piezo-electric crystal for pulse detection.

SUMMARY
A method of recording indirect systolic blood pressure is described. A standard sphygmomanometer cuff is used. A crystal pulse detector is placed over the brachial artery beneath the lower margin of the cuff. An Ediswan pen recorder is used for simultaneous display of the pressure within the cuff and the pulse signal detected over the brachial artery. The cuff pressure is indicated in “steps” of 2.5 mm Hg by using a multi-electrode mercury manometer.

The interpretation of the records and the need to adjust the rate of deflation of the cuff according to the respiratory rate are discussed.

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EDITORIAL NOTE

DR. MINNITT’S RESIGNATION

An unfortunate aspect of the commencement of the year 1962 was that it marked the retirement of Dr. Minnitt from the Editorial Executive Committee of this Journal. Dr. R. J. Minnitt has been intimately concerned with the welfare of the Journal since 1933, during which time he has had a very considerable influence on its policy and development. Now that he is becoming less active in its affairs one may hope that his labours have not been without success. His wise counsels will be missed, but it is a comfort to know that he will continue to serve on the Board of Management and Proprietors and we hope that this connection will be maintained for many years to come.

It is not usual to draw attention to changes in the editorial staff and managing personnel, but exceptional mention of this particular event seems justified in view of Dr. Minnitt’s long association with the Journal and of the great contribution he has made to it and, indeed, to anaesthesia in general.