MEASUREMENT OF THE CIRCULATION TIME

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For determining circulation time, the oximetric method with intravenous injection of methylene blue has been widely used. The underlying principle is simple, and enables quite an accurate determination of the circulation time to be made. However, the technique described by certain authors [1-4] has many shortcomings. In repeated determinations, it is impossible to maintain the pressure in the syringe constant during the injection of the solution into the vein, and each time the rate is different; only animals which are pale in colour may be used; considerable amounts of dye (0.2 ml per kg) are used, and after repeated measurements, the concentration in the blood becomes considerable, and leads to the formation of methemoglobin.

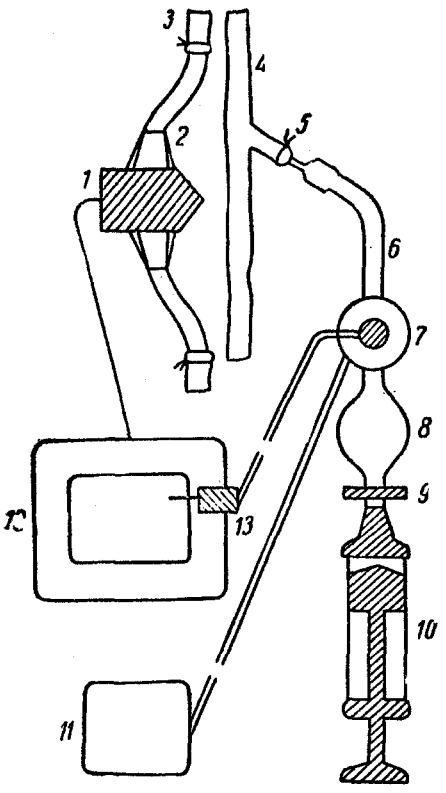

Fig. 1. Diagram of the oximetric method of determining circulation time, using a tank. Description in text.

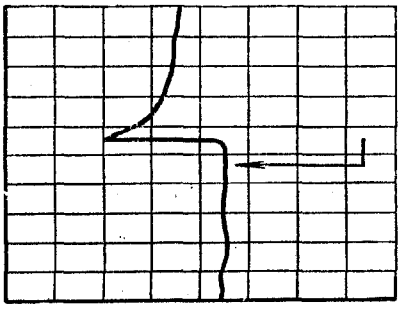

Fig. 2. Oxihemogram. The arrow indicates the beginning of the injection of the dye.

In the method which we propose, these shortcomings have been largely eliminated.

EXPERIMENTAL METHODS AND RESULTS

In experiments on eight adult dogs, we used an 0-36 Soviet oxihemograph (Fig. 1). The sensitive element 1 is placed in the vessel 2 made out of perspex, and having plane parallel sides. The internal height of the vessel is 1 mm, and it is connected by polythene tubes to the central and peripheral ends of artery 3. A blunt-ended needle 5 is connected to the vein 4.

To determine the circulation time, the oxihemograph 12 is switched on, and measurements made in the usual way. After opening clamp 9, 0.2-0.3 ml of a 0.3% methylene blue solution are introduced into the rubber bulb 8 from syringe 10, and the clamp is then again closed. By pressing on the release tap 7, tube 6 becomes open, and

the dye passes rapidly from the expanded balloon into the vein; at the same time the contents of the electrically driven chronometer 11 mounted on the body of the oxihemograph are closed, so that a record is made on the paper [13] strip of the time at which the solution enters the blood.

The time at which the dye appears in the vessel is indicated by a rapid drop in current from the photocell, and the writer of the oxihemograph immediately deviates to the left; it is arranged that this deviation stops the chronometer. The time recorded on the chronometer and on the paper strip of the oxihemograph between the beginning of the methylene blue injection and the onset of deviation of the writer corresponds to the rate of flow of the blood stream in this part of the circulation. The curve of Fig. 2 shows the time of arrival of the dye, and the moment of deviation of the writer. Before the experiment is begun, 500 I.U. per kg of heparin are injected intravenously.

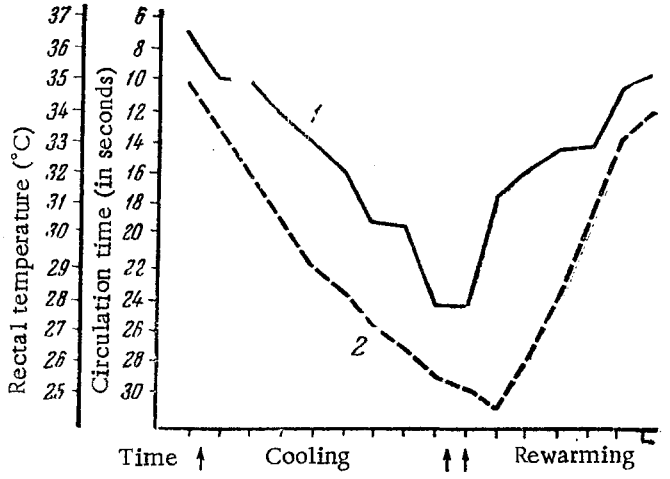

Fig. 3. Curves showing blood flow (1) and rectal temperature (2) against time for different depths of hypothermia, and subsequent warming.

Experiments were made to determine the circulation time in hypothermia. Before cooling, the circulation time was 6-9 seconds, and increased according to the depth of hypothermia (Fig. 3); at a body temperature of 30°, the time was 15-20 seconds, and at 26-25°, it was 23-29 seconds. When the body temperature was restored, the circulation time was gradually reduced.

The proposed method enables the circulation time of animals of any colour to be determined to within a few tenths of a second. For each measurement, the dye is injected under the same pressure into the blood stream, and at a fixed rate. In this way we have avoided the difficulty which sometimes occurs in other methods that there is a time delay caused by a spasm at the site of the injection

SUMMARY

The oximetric principle was used for recording the circulation time. The transducer of the oximeter is placed on a cuvette made of organic glass fixed in the artery. A 3 per cent methylene blue solution is introduced into the vein. The appearance of the stain in the cuvette is accompanied by a photocurrent drop. Oxyhemograph recordings are traced on a paper band. The period from the moment of stain administration up to the start of the curve deviation is the circulation time in the given vascular channel.

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