A SYRINGE FOR TAKING BLOOD SAMPLES FROM ANIMALS IN A LOW-PRESSURE ATMOSPHERE

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The blood pressure of animals in a pressure chamber under conditions of an extremely rarefied atmosphere is considerably lower than atmospheric pressure under ground conditions, which greatly hampers taking samples of their blood. When using the usual syringe it is impossible to overcome this pressure difference. It becomes necessary to equalize the atmospheric pressure over and under the syringe piston. For this purpose the experimenter together with the investigated person or animal is "raised" in altitude in the pressure chamber, and there the blood is sampled under conditions close to ground conditions [2]. However, this method is quite laborious, is connected with some risk, and is not always applicable (at great heights, without special oxygen-supply equipment, etc.). In other cases rather complex devices are used which make it possible to equalize the pressure on both sides of the syringe [1].

For the same purpose I, together with M. P. Chapin, designed a special vacuum syringe, the diagram of which is shown in the figure.

The main element of the syringe is the usual Record Syringe 1 in which rod 3 was lengthened by 3-4 cm and the upper part of the cylinder was made air-tight by rubber chamber 2. In the chamber is a packing gland through which the syringe rod passes. Rubber tube 5, which is equipped with valves or clamps 6 and 7, connects the cavity between piston 4 and chamber 2 with pressure chamber 8 or with the ambient atmosphere. The tip of the syringe is connected with the artery or vein of the animal in the pressure chamber by means of the rubber tube with valve or clamp 9 and probe 10, which passes through the wall of the pressure chamber.

The procedure of blood sampling with such a syringe is as follows. Under local anesthesia, rigid probes (60-70 cm long with an inside volume of 1-2 ml) pre-filled with physiological salt solution containing heparin (2-3 drops of heparin per 10 ml solution) are inserted into the vein and artery of the animal. On the free end of the probe is attached a rubber tube 6-7 cm long closed on the outside with a small plug. The animal is placed in the pressure chamber. The probes are passed out through the opening in the pressure chamber and connected with the syringe (it is desirable to have two syringes so that the sample can be collected from the vein and artery simultaneously). Into the syringe, under the piston, is drawn 2-3 ml of vaseline oil which had preliminarily been kept under vacuum to separate the air bubbles in the outside end of the rubber tube from the blood entering the syringe. Valves (clamps) 6 and 9 are closed, after which the animal can be "raised" in altitude.

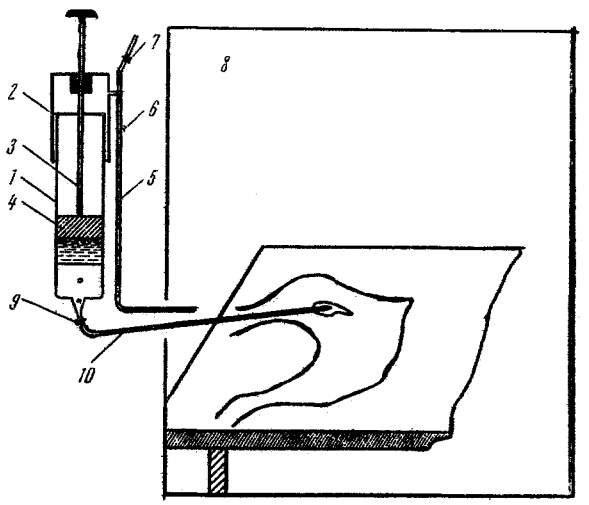

Diagram of syringe for taking blood samples from animals in a low pressure atmosphere. Description in the text.

Before taking the blood from the "dead" space of the probe, the physiological salt solution with the heparin, which was added to prevent coagulation of the blood, is removed. For this purpose valve 7 is closed and 6 is opened; thus the pressure in the cavity under the piston

is balanced with the pressure in the pressure chamber. Valve 9 is opened and the physiological salt solution is drawn from the probe until the appearance of the first portions of blood in the syringe, after which valves 9 and 6 are closed and valve 7 opened (atmospheric pressure at ground level is established over the piston). The syringe is disconnected from the probe and again connected to it only after removal of the collected physiological salt solution from it. Valve 7 is closed and valves 6 and 9 are opened, after which, observing the described sequence of manipulations, the blood is collected, which is then poured into a test tube under vaseline oil and carefully mixed with 2-3 drops of heparin. Into the syringe is collected 2-3 ml of physiological salt solution with heparin and again it fills the "dead" space of the probe. For this purpose it suffices to connect the syringe with the probe, open valves 9 and 7, and the piston under atmospheric pressure will push the solution into the probe. At the end of these manipulations the next sample of blood can be taken.

If the blood is not analyzed immediately, the test tube must be placed in a vessel with crushed ice to prevent the blood itself from consuming the oxygen in it.

This method of sampling blood of animals in a low-pressure chamber requires that the following precautionary measures be observed.

1. Careful air-sealing of the entire system. Otherwise, the outside air is instantaneously sucked into the blood stream and, expanding there, causes the death of the animal with phenomena of acute disorder of cardiac activity. Rapid descent to earth can prevent animal death.

2. The probes and rubber tubes should be sufficiently rigid so that they do not collapse under a pressure of 760 mm, and the tubes, in addition, should easily fill out after the clamps are removed from them (if clamps are used in place of valves).

3. The syringe must always be kept vertical so that the blood does not mix with the oil and air bubbles which are under the oil. Contact between the air bubbles and blood can disturb the quantitative composition of the gases contained in it; turbidity of the oil hampers an accurate determination of the amount of blood collected.

The method, which has been checked out under actual conditions in a pressure chamber, is rather simple and completely reliable. In 38 experiments on 28 dogs we took 300 arterial and venous blood samples of animals at an altitude from 4000 to 30,000 m under conditions of respiration of air, oxygen at ordinary atmospheric pressure, and oxygen at excess intrapulmonary pressure. A subsequent analysis of the blood, carried out together with V. L. Popokov and E. A. Kovalenko on the "Godart" combination analyzer, made it possible to determine in these samples the tension of O_2, CO_2, and the pH. The data obtained showed that the level of pO_2 in the arterial and venous blood is determined by the degree of rarefaction of the atmosphere, by the value of the partial pressure of oxygen in the inspired air, and by the efficiency of compensation of the increasing intrapulmonary pressure when the instruments were used for respiration under an excess pressure. The individual characteristics of the animal are of definite significance. These factors also determine the pCO_2 and pH values in the blood. The level of pCO_2 and pH of dogs to a considerable extent depends on the conditions of heat exchange. With panting (polypnea) the pCO_2 value frequently dropped to 20-19 mm and the pH value increased to 7.50-7.56.

A detailed analysis and a discussion of the obtained results will be given in a special report.

LITERATURE CITED

1. G. G. Sturua, Lab. delo, 6, 57, 1958.
2. A. Eichenholz, R. O. Mulhausen, W. E. Anderson et al., J. appl. Physiol., 1962, Vol. 17, p. 283.