

PROGNOSTIC SIGNS IN EXPERIMENTAL HEMORRHAGIC SHOCK

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Despite a large amount of investigation, criteria have not been found which indicate with certainty the death or survival of animals in secondary hemorrhagic shock. This has handicapped efforts to ascertain the value of various treatments. It was, therefore, the purpose of this investigation to study still other manifestations of shock in the hope that their quantitative measurement would lead to better prognosis.

Methods. Dogs were anesthetized by subcutaneous injection of 5 mg./kg. of morphine sulphate and intraperitoneal injection of 30 mg./kg. of sodium pentobarbital. The animals were bled rapidly from the femoral artery until, within a few minutes, an arterial pressure of 50 mm. Hg was established. This level was maintained for ninety minutes, after which it was lowered to 30 mm. Hg by further withdrawal of blood. This was maintained for forty-five minutes or more, making the total period of hypotension at least one hundred and thirty-five minutes, the average period being one hundred and forty-seven minutes. The withdrawn blood was stored in a bottle-reservoir under controlled pressure and remained connected with the arterial circulation for the duration of the experiment. The quantities of blood removed to produce the desired state of hypotension ranged from 2.6 to 7.7 per cent body weight. Ten to 15 mg. of heparin was used as anticoagulant in the reservoir and connecting tubing in each experiment.

After the hypotensive period, all or part of the blood was reinfused through the same femoral artery at an average rate of 30 ml. per minute, until the dogs' arterial pressure was re-established at about 100 mm. Hg. The amount of blood necessary to accomplish this ranged from 20 to 100 per cent of the withdrawn blood. Kymographic records of arterial pressure, volume of blood in the reservoir, and respiratory rate were obtained for the entire experiment (fig. 1, 2).

Results. Among various prognostic criteria studied the following proved most useful:

1. Any persistent drop of arterial pressure during the hypotensive period, which causes blood to flow back from the reservoir into the animal, must be considered a bad prognostic sign for survival. In particular, the larger the intake of blood by the animals during the last fifteen minutes of the 30 mm. hypotensive period, the smaller their chance for indefinite survival. This sign is critical and should be obtained from continuous kymographic records of both volume in the reservoir and arterial pressure during this period. The correlation factor between

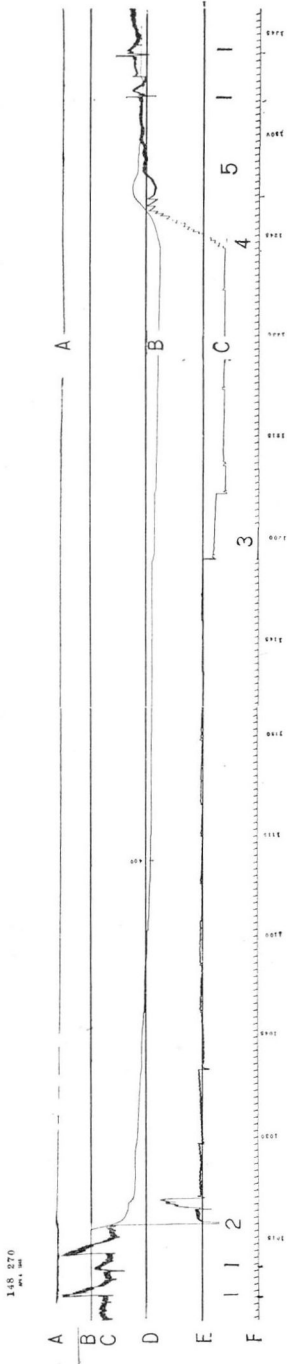


FIG. 1. Kymographic record of experiment 148-270 (April 4, 1946): A. respiration; B. blood volume in reservoir, with base line at 150 mm. Hg; C. arterial pressure; D. 100 mm. Hg line; E. 50 mm. Hg line; F. 0 mm. Hg base line, with time intervals of 1 min. Duration of experiment 3 hrs. and 45 min. Experimental procedures: 1, response of arterial pressure to adrenalin; 2, bleeding to establish arterial pressure of 50 mm. Hg; 3, additional bleeding to establish arterial pressure of 30 mm. Hg. Total time of hypotension: 146 min.; 4, arterial transfusion; 5, ouabain. Prognosis for survival good on account of no intake of blood during hypotensive period, small intake during transfusion, good return of adrenalin response. Result: animal survived and recovered completely.

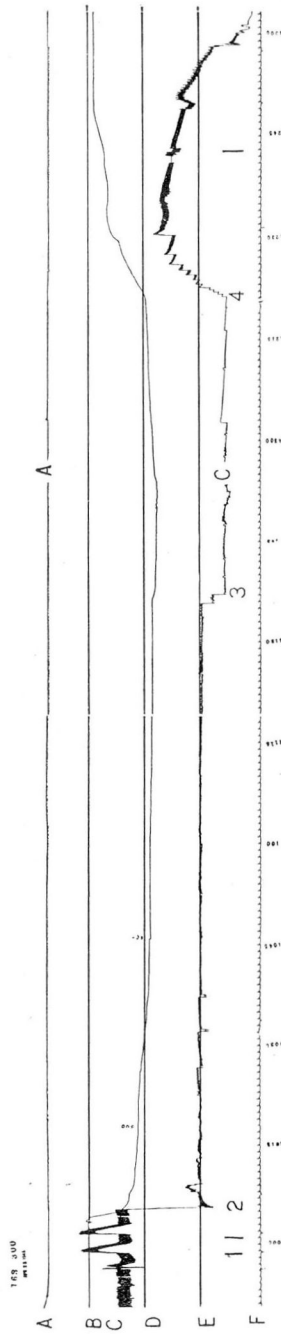


FIG. 2. Kymographic record of experiment 163-300 (April 25, 1946): A. respiration; B. blood volume in reservoir, with base line at 150 mm. Hg; C. arterial pressure; D. 100 mm. Hg line; E. 50 mm. Hg line; F. 0 mm. Hg base line, with time intervals of 1 min. Duration of experiment 3 hrs. and 12 min. Experimental procedures: 1, response of arterial pressure to adrenalin; 2, bleeding to establish arterial pressure of 50 mm. Hg; 3, additional bleeding to establish arterial pressure of 30 mm. Hg. Total time of hypotension: 137 min.; 4, arterial transfusion; 5, ouabain. Prognosis for survival poor on account of considerable intake of blood during latter part of hypotensive period, large intake during transfusion, poor return of response to adrenalin. Result: animal died 30 min. after transfusion.

the intake in milliliters and indefinite survival for our 68 dogs was -0.55 ± 0.07 .

2. The larger the response of arterial pressure to a dose of 0.1 to 0.2 ml. of a 1:10,000 adrenalin solution after reinfusion of blood compared with the response to an identical dose given before bleeding, the better the chance for indefinite survival. The correlation factor between return of adrenalin response and permanent survival was $+0.54 \pm 0.07$.

3. The larger the intake of blood by the animals during arterial reinfusion required to establish an arterial pressure of 100 mm. Hg, the smaller their chance for survival. The average intake of animals with bad prognosis was 50 per cent higher than for those with good prognosis.

On the basis of these three criteria, 26 out of the 68 dogs were given a bad prognosis and 42 a good one. All of the former died from terminal shock within less than ten hours after reinfusion. Ouabain, 0.05 mg./kg., was given shortly after infusion to 12 animals of this group but produced no effect upon their time of survival.

Of the 42 dogs with good prognosis, one group of 28 was given ouabain shortly after infusion; 20 dogs, or 71 per cent of this group, survived indefinitely. Of the remaining 14 dogs which did not receive ouabain only 5, or 36 per cent, survived indefinitely.

For all surviving dogs the amount of blood necessary to re-establish an arterial pressure of 100 mm. Hg after their hypotensive period was about 30 per cent less than the original amount of blood withdrawn. Attempts to infuse the remaining amount of blood led frequently to undesirable symptoms ordinarily observed in overtransfusion.

Summary

A group of 68 mongrel dogs was submitted to severe hemorrhagic shock and subsequent intra-arterial infusion of part or all of the removed blood. Three criteria permitted prediction of the probable fate of the shocked animals. These were: (1) persistently falling arterial pressure during the hypotensive period, causing blood to flow back from the reservoir into the animal indicates small chance for survival; (2) the more nearly normal the pressor response to adrenalin after restoration of arterial pressure the better the chance of survival; (3) the larger the intake of blood during arterial reinfusion to establish normal blood pressure, the smaller the chance of survival. All dogs (26) given a bad prognosis on the basis of these criteria died within less than ten hours. Forty-two dogs were given a good prognosis. Twenty-eight of these were given ouabain after infusion and 20 of them, or 71 per cent, survived indefinitely. The other 14 dogs with good prognosis did not receive ouabain and only 5 of them, or 36 per cent, survived indefinitely.

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