# INTRA-ARTERIAL TRANSFUSION IN THE TREATMENT OF EXPERIMENTAL HEMORRHAGIC SHOCK

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Experiments on the value of intra-arterial transfusion in the treatment of hemorrhagic shock were extended to an evaluation of the same method in extreme emergencies, including resuscitation. In a previous paper[1] we described the production of severe hemorrhagic shock in dogs and subsequent intra-arterial blood transfusion of the shocked animals. As a result of these experiments three criteria for prediction of the probable fate of the animals in shock were established: (1) persistently falling arterial pressure during the hypotensive period indicates small chance for survival; (2) the larger the intake of blood during arterial transfusion to establish normal pressure, the smaller the chance of survival; (3) the more nearly normal the pressor response to adrenalin after transfusion the better the chance of survival.

## Method

The experimental technic for production of shock was described in the previous report. Suffice it to repeat here that the animal is bled rapidly from a femoral artery (fig. 1, A) until an arterial pressure of 50 mm. Hg is established. A canula (A) is connected through one branch with a mercury manometer (B) which permits recording the arterial pressure on a kymograph. The other branch leads to a bottle-reservoir (C) in which the withdrawn blood is stored under controlled pressure (hand pump, D; manometer, E; and sphygmomanometer, F). The 50 mm. Hg level of hypotension is maintained for ninety minutes, after which it is lowered to 30 mm. Hg by further withdrawal of blood. This 30 mm. Hg level is held for forty-five more minutes, making the total time of hypotension at least one hundred and thirty-five minutes. After the hypotensive period, all or part of the blood is reinfused through the same femoral artery. Kymographic records of arterial pressure, venous pressure (catheter, G, in jugular vein; connected to water manometer, H), weight of blood in reservoir (C), respiratory rate (pneumograph and tambour, K), and time intervals (M) of one minute were obtained for the duration of the entire experiment.

Mongrel dogs of an average weight of 11 kg. were used in these experiments. They were anesthetized by subcutaneous injection of 5 mg./kg. of morphine sulfate and intraperitoneal injection of 30 mg./kg. of sodium pentobarbital. In each experiment about 150 ml. of a saline solution containing 15 mg. of heparin was used as an anti-coagulant in the reservoir and connecting tubes. In addition 0.3 mg./10 kg. of heparin was given intravenously before bleeding.

## Criteria

The most valuable criterion for predicting the probable fate of the animal in deep hemorrhagic shock is the phenomenon of a persistently falling arterial pressure during the hypotensive period. This is especially so in the treatment of shock. A persistent drop of pressure may occur at practically any time; in some cases it begins within half an hour after bleeding, in others it may not occur for several hours. Only one of 52 animals survived permanently which were submitted to bleeding and kept at the reduced pressure for one hundred and thirty-five minutes, and in which the arterial pressure showed a persistent tendency to drop during this period. On the other hand, of 63 animals showing no such tendency during the hypotensive period, 47 (74 per cent) survived permanently after transfusion. In deep shock, a persistent tendency of

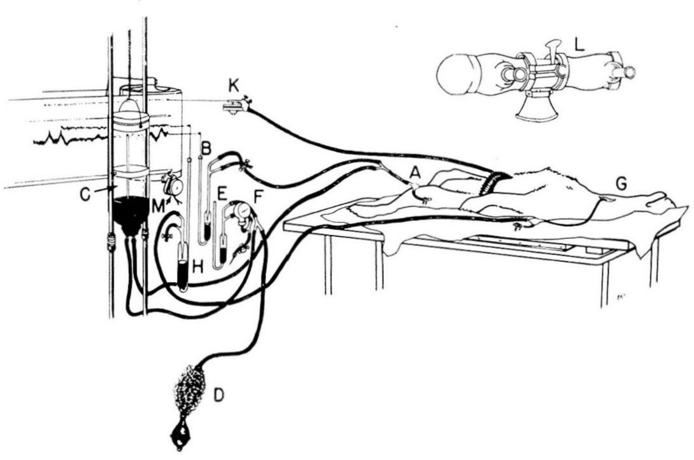



Fig. 1. Experimental bleeding and transfusion apparatus. A. Canula in femoral artery; B. Mercury manometer, recording arterial pressure on kymograph; C. Blood reservoir, connected with A, suspended on spiral spring and equipped with recording pen; D. Hand pump, connected to air tube in reservoir permitting regulation of air pressure in reservoir; E and F. Mercury manometer and sphygmomanometer for controlling air pressure in reservoir; G. Catheter in jugular vein; H. Water manometer, recording venous pressure on kymograph; K. Tambour connected with pneumograph, recording respiration rate on kymograph; L. X-ray tube; M. Timer, recording intervals of one minute.

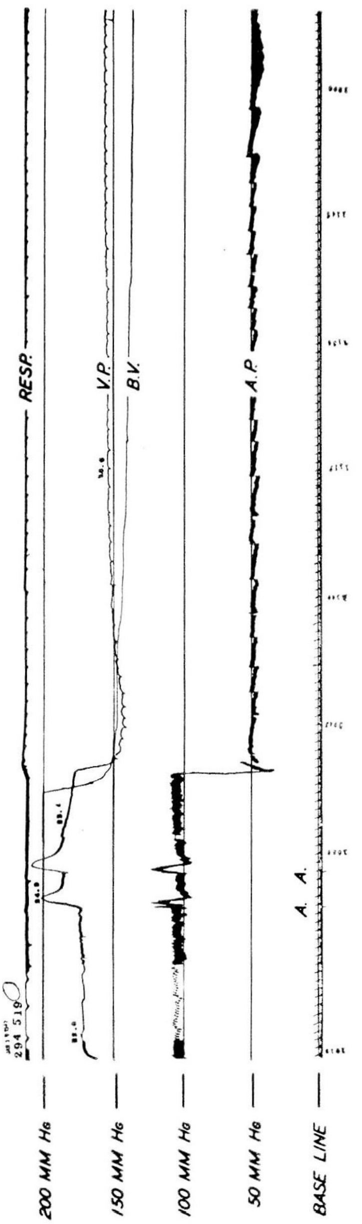
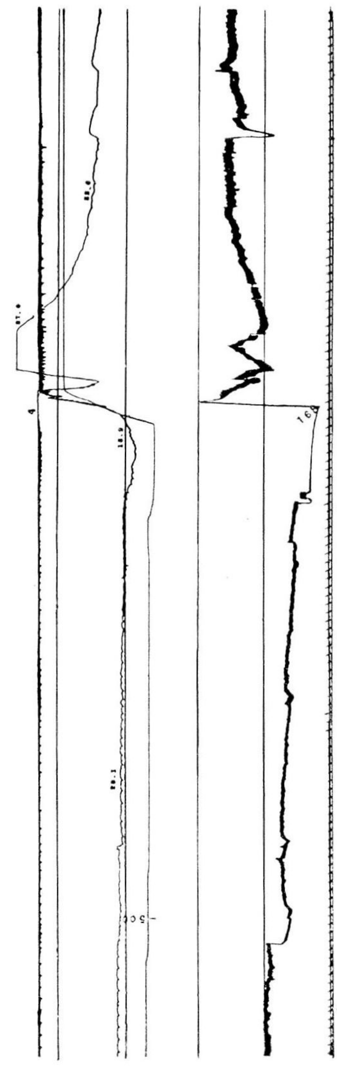



Fig. 2. Resuscitation experiment (294-519, January 15, 1947). Kymographic record (bottom half is continuation of top part) of respiration (RESP.), venous pressure (V.P.), blood volume in reservoir (B.V.) and arterial pressure (A.P.) A. Adrenalin; O. Ouabain; N. Nembutal. Small intervals on base line represent minutes.



arterial pressure to fall off must therefore be considered an emergency and the animal should be transfused at once if it is to be saved. Intra-arterial transfusion is indicated in such an emergency to restore normal arterial pressure and blood volume in the shortest possible time.

## Resuscitation

To evaluate intra-arterial transfusions under extreme conditions in a group of 32 shocked animals, we continued withdrawing blood

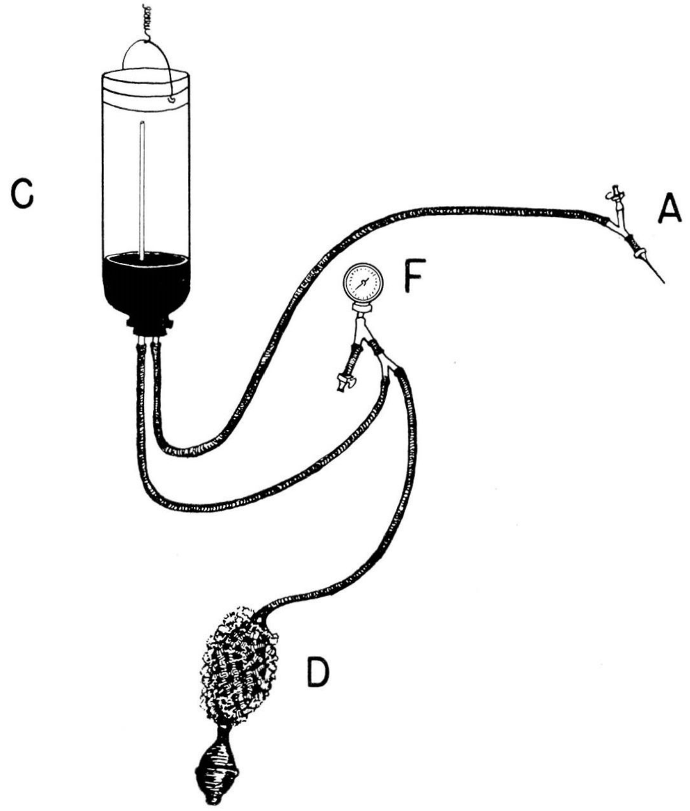



FIG. 3. Practical bleeding and transfusion apparatus. A. Needle for insertion into artery; C. Blood reservoir; D. Hand pump; F. Sphygmomanometer.

after the one hundred and thirty-five minute hypotensive period until circulation and respiration stopped completely, as indicated by electrocardiographic and pneumographic observations. Within two to five minutes after stoppage the blood was reinfused arterially at a rapid rate, ouabain (0.05 mg./kg.) was given intravenously, 0.5 ml. of a 1:10,000 solution adrenalin intra-arterially, and artificial respiration was started.

## Results

Of the 32 animals used in this group for resuscitation 9 (28 per cent) survived indefinitely, 18 (56 per cent) from one to thirty-six hours, with an average of eleven hours, and 5 (16 per cent) could not be resuscitated. Kymographic record of arterial and venous pressures, blood volume in reservoir, and respiration rate for such an experiment is presented in fig. 2.

## Simplified Apparatus

A simplification of the original apparatus of Kohlstaedt and Page[2] for the experimental bleeding and transfusion (fig. 1) is shown in fig. 3. It contains only the essential parts and has no provision for permanent recordings. However, for practical purposes it lends itself well to bleeding, storage, or blood transfusion under controlled pressures.[3]

## Summary

An apparatus is described for treatment of severe experimental hemorrhagic shock by intra-arterial transfusion. The value of this method is demonstrated in the treatment of dogs in hemorrhagic shock and in resuscitation of animals whose circulation and respiration has stopped for a period of several minutes.

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### References

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