SURVIVAL OF DOGS IN THE RECOVERY PERIOD AFTER PROLONGED HYPOVOLEMIC HYPOTENSION

V. L. Kozhura

UDC 616.12-008.331.4-092.9-036.8

The survival rate and completeness of neurological recovery of functions of the CNS in the postresuscitation period were investigated in dogs in relation to the duration of hypovolemic hypotension, the arterial pressure level, and subsequent transfusion therapy. Administration of dextran in the early recovery period after hypovolemic hypotension in animals for 4 h increased the number of surviving dogs and led to complete restoration of functions of the CNS.

KEY WORDS: hypovolemic hypotension; recovery period; transfusion therapy; survival rate.

The mortality after prolonged hypovolemic states remains high despite the use of modern methods of resuscitation and intensive care [4-11].

The object of the investigation described below was to assess the survival rate and completeness of recovery of functions of the CNS in the postresuscitation period in dogs and their relationship to the duration of hypovolemic hypotension, the level of the arterial blood pressure (BP), and subsequent transfusion therapy.

EXPERIMENTAL METHOD

Experiments were carried out on 76 heparinized (100 units/kg) mongrel dogs of both sexes weighing 10-22 kg. After premedication with pantopon or trimeperidine (8 mg/kg), under superficial pentobarbital anesthesia the animals were exsanguinated rapidly (3-5 min) from the femoral artery down to a BP level of 40 or 30 mm Hg. The BP was maintained at 40 mm Hg by repeated small bleedings or by injection of small volumes of blood into the artery for a period of 2 h (group 1, 14 dogs), 3 h (group 2, nine dogs), or 4 h (group 3, 47 dogs). The BP was maintained at 30 mm in six dogs for 2 h (group 4). At the end of these times the removed blood was reinjected in small doses (50-150 ml) into the femoral artery [4] under control of the BP, the pulmonary arterial pressure (PAP), the central venous pressure (CVP) measured in the right atrium or in the inferior vena cava, and the ECG. The BP, PAP, CVP, and ECG were recorded on a polygraph (Sanei, Japan).

Between 30 min and 6 h after the blood loss of the animals exposed to hypotension for 4 h had been made good, dextran (22 dogs) or gelatinol (five dogs) was injected intravenously into the animals in small doses up to a total of 25-30 ml/kg. If breathing stopped, the animals were artifically ventilated. If ventricular fibrillation developed, external cardiac massage of the heart and electrical defibrillation by Gurvich's method [1] were carried out. Indications of adequate management of the recovery period after prolonged hypovolemic states were the heart rate, the presence or absence of disturbances of the cardiac rhythm, and the dynamics of changes in BP, PAP, and CVP. In the case of a considerable increase in PAP or CVP, or the appearance of extrasystoles during reinfusion of the blood or injection of dextran or gelatinol, the volume and rate of injection of the fluids were restricted. On the days following resuscitation (6-30 days) the general behavior and condition of the animals, the absence or presence of paralyses of the

Laboratory of Experimental Physiology of Resuscitation, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Fedorov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 80, No. 10, pp. 39-40, October, 1975. Original article submitted February 20, 1975.

limbs, and the state of hearing and vision of the animals were noted. Restoration of all or most of these functions to normal was used to indicate completeness of recovery of the functional state of the CNS.

EXPERIMENTAL RESULTS

Blood loss leading to hypotension (BP 40 or 30 mm Hg) averaged 45 and 50 ml/kg body weight respectively. During the period of hypovolemic hypotension, 10-20% of the removed blood was reinjected intraarterially in order to maintain the mean BP at the specified level.

The results of these experiments showed that the mortality of the animals increased with an increase in the duration of hypotension and a decrease in the level of the maintained BP. For instance, whereas 14.3% of the dogs died after hypovolemic hypotension (BP 40 mm) lasting 2 h, 50% of the animals with a lower BP (30 mm) died ($P < 0.05$). In dogs exposed to hypovolemic hypotension (BP 40 mm) for 3 and 4 h, the mortality was 22.2 and 55% respectively.

After injection of dextran in the recovery period the mortality was reduced to 22.7% ($P = 0.05$), but all five dogs receiving gelatinol died during the first day of the postresuscitation period. Previous experiments showed that the beneficial effect of dextran after massive blood loss is connected with strengthening of the compensatory powers of the body, removal of the hypovolemia, and restoration of the normal hemodynamics and oxygen balance of the organism [2, 3].

The improvement in the results of resuscitation in these experiments can be considered to have been due to an increase in the effectively circulating blood volume, improvement of the rheological properties of the blood, and restoration of the hemodynamics to a level adequate for the metabolic needs of the organism.

After prolonged hypovolemia death of the animals took place in most cases during the first 12 h after resuscitation, and only occasionally did it occur on the 2nd-3rd day of the postresuscitation period.

Observations on the functional state of the CNS during the posthypoxic period showed that after 2 h of hypovolemic hypotension all the surviving animals were indistinguishable in external appearance and behavior from healthy animals; after hypotension for 3 h incomplete recovery of CNS functions was observed in 14.3% of surviving animals, and after hypotension for 4 h, in 33.3%.

Administration of dextran in the early postresuscitation period after hypovolemic hypotension for 4 h increased the number of animals with complete recovery of CNS functions (recovery was incomplete in only 2 of the 17 dogs).

The duration of the period of hypotension after massive blood loss thus determines not only the final outcome of resuscitation in dogs, but also the completeness of restoration of their CNS functions. The use of dextran in the early postresuscitation period increases the number of surviving animals and helps to secure complete restoration of CNS functions.

LITERATURE CITED

1. N. L. Gurvich, Fibrillation and Defibrillation of the Heart [in Russian], Moscow (1957).
2. E. S. Zolotokrylina and S. S. Chistyakov, Probl. Gematol., No. 8, 32 (1965).
3. V. B. Koziner and N. A. Fedorov, The Mechanism of Action of Dextran [in Russian], Moscow (1974).
4. V. A. Negovskii, A. M. Gurvich, E. S. Zolotokrylina, et al., in: Shock and Terminal States [in Russian], Leningrad (1960), p. 82.
5. V. A. Negovskii, Current Problems in Resuscitation [in Russian], Moscow (1971).
6. I. R. Petrov and G. Sh. Vasadze, Irreversible Changes in Shock and Blood Loss [in Russian], Leningrad (1972), p. 189.
7. E. V. Pashkovskii, L. F. Rachinskii, R. L. Goglozha, et al., Pat. Fiziol., No. 5, 65 (1972).
8. J. W. Crowell, C. E. Jones, and E. E. Smith, Am. J. Physiol., 216, 744 (1969).
9. P. F. Golden and J. A. Jane, J. Trauma, 9, 784 (1969).
10. R. C. Lillehei, J. K. Longerbeam, J. H. Block, et al., Ann. Surg., 160, 682 (1964).
11. C. Wiggers, Physiology of Shock, New York (1950).