

SUMMARY

Evidence is produced that a respiratory disease in cats is due to a virus that forms elementary bodies and that this virus is the same as or closely related to the one causing some of the so-called atypical pneumonias in man. Further work is in progress, and a detailed report of the cat disease and of additional complement fixation tests will be made later.

JAMES A. BAKER

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
PRINCETON, N. J.

CAPILLARY EMBOLI AS A LETHAL FACTOR
IN BURNS¹

IN the course of an extensive series of experiments on shock following thermal trauma in anesthetized cats,² it was noted that a small proportion of the animals succumbed with extreme rapidity within a few minutes of burning. In these cases, respiration stopped suddenly, the heart was slow and irregular and the blood pressure fell precipitately. Artificial respiration usually did not result in recovery, although the heart continued to beat for some time. Hemocoagulation and local fluid loss into the area of the burn were minimal at the time of death. Necropsy in these cats showed pulmonary congestion, subendocardial hemorrhages in the left ventricle and in one instance punctate hemorrhages in the liver and submucous hemorrhages in the duodenum.

Since the sudden death in these experiments could not be explained on the basis of loss of fluid and since the nervous factor had been eliminated experimentally,² the phenomenon was attributed to a toxin. The investigation was carried forward to study the possibility that changes produced by heat in the circulating blood could account for rapid death from burns.

Measurements of subcutaneous temperature in experimental scalds³ show that temperatures of 55 to 65 degrees C. are reached and maintained for several minutes. Citrated cat's blood was heated to 65° C. (149° F.) for one minute; it remained fluid but became dark in color and showed evident hemolysis. Heating of plasma to 56°–65° C. resulted in the formation of a voluminous fine precipitate, presumably fibrinogen. On the other hand, when serum was treated in the same way, no visible change was evident. Fresh coagulable blood heated quickly to 65° C. remained fluid and became incoagulable.

After heating a small amount of citrated cat blood for one minute to 65° C., reinjection intravenously

into the same animal resulted in rapid death. This reaction was similar to the rapid deaths observed following burns. Blood pressure fell markedly and respiration ceased within one to two minutes, but the heart continued to beat for 5 to 10 minutes and artificial respiration was of no avail. As little as 3 to 4 cc of heated blood injected rapidly produced this characteristic fatal outcome. The same phenomenon has been observed repeatedly in cats under nembutal following rapid intravenous injection of 1 to 2 cc of autogenous plasma previously heated to 65° C. for one minute. Intravenous injection of heated serum in much larger amounts had no significant effect. The supernatant of centrifuged heated plasma was also ineffective, indicating that it is the fine precipitate of fibrinogen in heated plasma which possesses the toxic properties.

By very slow intravenous injection of heated plasma, much larger amounts could be introduced without producing rapid death. In one experiment, after injection of 13 cc of heated plasma, blood pressure was low for an hour and respiration became rapid and shallow. The cat survived for four days, during which time it was very weak and unresponsive and made no spontaneous movements. Necropsy showed marked congestion of the lungs, slight renal congestion, a discolored dark gray and softened liver and a gastric ulcer one cm in diameter which had perforated.

The experiments were then extended to study the effect of intravenous injection of heated human plasma and serum into unanesthetized rabbits. Human plasma heated to 56° to 65° C. showed a precipitate similar to that observed in heated cat plasma, while heated human serum was apparently unchanged. Rapid injection through a 22 gauge needle of 2 to 5 cc of heated human plasma into the ear vein of rabbits resulted in rapid arrest of respiration followed by anoxic convulsions with occasional gasping. The heart continued to beat for some time, but artificial respiration was ineffective. All the rabbits injected with heated plasma died within 5 to 10 minutes. The centrifuged precipitate of heated human plasma gave the same reaction, while intravenous injection of as much as 40 cc of the supernatant or of unheated human plasma had no effect. Intraperitoneal injection of heated human plasma was also ineffective. Rapid intravenous injection of heated human serum in amounts up to 40 cc was likewise innocuous to the rabbits.

Necropsy of rabbits which died from injection of heated human plasma or precipitate showed no gross pathology in the internal organs or in the brain other than occasional slight pulmonary congestion. Microscopic examination of the lungs revealed wide-spread and numerous capillary protein emboli.

¹ Aided by a grant from the Graduate School of the University of Minnesota.

² H. Kabat and R. F. Hedin, *Surgery*, 11: 766–776, 1942.

³ H. Pfeiffer, *Virchow's Arch. f. path. Anat.*, 180: 367, 1905.

The precipitate from heated human plasma (presumably fibrinogen) was rendered innocuous simply by homogenizing it in an apparatus capable of breaking up tissue cells. Rapid intravenous injection of 40 cc of the homogenized suspension of the precipitate had no toxic effect on rabbits. This demonstrates conclusively that it is the particle size rather than the chemical constitution of this material which bears the toxic properties.

There is a distinct possibility that capillary emboli may play a role in the constitutional effects of severe burns. Many of the older investigators on pathogenesis of shock and toxemia in burns considered this possibility. Frankel⁴ noted minute capillary thrombi in the liver, spleen and kidneys in burn cases, and

Bardeen⁵ reported that capillary thrombosis in the liver was not infrequent following burns. Billroth⁶ and others supported the embolic theory of the etiology of Curling's ulcer. In experimental burns, Salvio⁷ found that previous defibrination of the blood rendered dogs more resistant to burns. He showed that warming of the mesentery to 55° C. caused adherence of platelets to the walls of small vessels and formation of minute thrombi. Vaccarezza⁸ observed hypocoagulability of the blood following burns in dogs.

HERMAN KABAT
MILTON LEVINE

DEPARTMENTS OF PHYSIOLOGY AND BACTERIOLOGY,
UNIVERSITY OF MINNESOTA, AND ANDERSON
INSTITUTE FOR BIOLOGICAL RESEARCH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR RAPID TUBE FEEDING OF RATS¹

OUR attempts to forcibly feed rats have developed a method permitting one person to feed rats rapidly without recourse to expedients such as gags,^{2,3} holding the tongue,⁴ wrapping the animal in towels⁵ or clipping the teeth.⁶ The method is described here in the hope that it will prove of value to others confronted with this problem.

The equipment required is: (1) a syringe of appropriate size; (2) a 7-inch piece of soft rubber catheter tubing (No. 8 Fr.), one end being cut square and the other beveled; (3) an adapter made by soldering a piece of brass tubing (1 cm long, 2 mm o.d.) to the hub of an old hypodermic needle and inserted into the square-cut end of the catheter tube; (4) a ring stand and burette clamp; (5) a piece of heavy string about 30 inches long having a large securely tied loop at each end.

The feeding is done as follows: The syringe is filled with the desired quantity of the liquid food mixture and is securely clamped to the ring stand in a horizontal position by means of the burette clamp. The rat is grasped in the left hand with the thumb and index fingers about the shoulders and the left foreleg held between the index and middle fingers. The right foreleg is supported by the thumb. With the rat in a

vertical position facing the operator, one loop of the string is caught over the upper incisors, the string is passed over the back of the left hand and between the fourth and little fingers and is fastened by winding it several times about the latter. The tension on the string should be sufficient to hold the head of the animal securely against the palm of the hand. The other loop of the string is now caught over the lower incisors, passed down over the back of the thumb, and fastened by winding around the middle and fourth fingers of the left hand. Tension should be sufficient to hold open the animal's mouth, the extent of opening being controlled by pulling apart the thumb and index fingers which respectively increase the tension on the lower and upper jaws of the animal. The rat is thus effectively suspended by the two strings attached to its jaws. Undue pressure can not be exerted on the animal, for, in order to hold it securely, the thumb and index fingers must be held apart.

With the animal in a vertical position and resting its hind feet on the operator's chest, the wetted tube is inserted into the esophagus with a downward rotating motion. Using a soft rubber tube we have not once, in the course of several thousand feedings, inserted the tube into the trachea. When the tube is pushed down sufficiently (depending on the size of the rat), the adapter is firmly attached to the syringe and the contents of the latter are slowly forced through the tube. The tube is withdrawn and the string attached to the lower jaw is unwound from the fingers.

⁵ C. R. Bardeen, *Johns Hopkins Hosp. Rep.*, 7: 137, 1898.

⁶ T. Billroth, *Wien med. Wchnschr.*, 17: 705, 1867.

⁷ J. Salvio, *Virchow's Arch. f. path. Anat.*, 125: 364, 1891.

⁸ R. A. Vaccarezza, *Comp. rend. Soc. de Biol.*, 86: 1114, 1922.

⁴ E. Frankel, *Deutsche med. Wchnschr.*, 15: 22, 1889.

¹ Aided by a grant from the Rockefeller Foundation and administered by Dr. P. E. Smith.

² R. M. Reinecke, H. A. Ball and L. T. Samuels, *Proc. Soc. Exp. Biol. and Med.*, 41: 44, 1939.

³ C. S. Mathews, E. L. Schwabe and F. E. Emery, *Jour. Lab. and Clin. Med.*, 27: 352, 1941.

⁴ A. E. Pugh and A. W. Tandy, *Jour. Lab. and Clin. Med.*, 24: 80, 1938.

⁵ D. J. Ingle, Personal communication.

⁶ R. M. Reinecke and L. T. Samuels, *Endocrinology*, 30: 687, 1942.