transaminase and co-decarboxylase.[15-18] In the intact normal animal the various compounds of the group presumably are freely interconvertible.[19,20] From these considerations, the hypothesis is suggested that the granulocytosis in pyridoxine-deficient mice is due to the failure on the part of the animals to transaminate, decarboxylate, or otherwise modify unneeded supplies of granulocyte-building substances, and that the animals thereupon utilize these unneeded supplies in producing excess numbers of granulocytes. It is not necessary to assume that the reverse would be true. A further hypothesis may be made that the granulocytosis of a disease state such as human myeloid leukemia may be due to a defect in the absorption or utilization of vitamins of the B_6 group. Although freely interconvertible in the intact animal, this may not be true of them in the diseased animal. Further investigations in mice and in leukemic human beings are in progress to test the validity of these hypotheses. It has been demonstrated that adrenocorticotropic and adrenal cortical hormones will cause granulocytosis and lymphopenia in animals.[21,22] In our histologic material we could not demonstrate evidence of adrenal cortical hyperplasia.

Summary. 1) Pyridoxine deficiency in mice produces granulocytosis and lymphopenia. 2). The leukemia of the Ak mice now being bred in this laboratory is participated in by both granulocytes and lymphocytes. In pyridoxine deficiency the leukemic granulocytosis is more severe and the survival time of the animals is decreased. 3) The hypothesis is advanced that the granulocytosis in pyridoxine-deficient mice is due to the failure on the part of the animals to perform metabolic functions in which pyridoxine derivatives play a catalytic role; thus, supplies of compounds used in the formation of granulocytes accumulate, and, as a result, the animals utilize this plethora in producing excess numbers of granulocytes. The implications of this hypothesis are discussed.

15 Gunsalus, I. C., Bellamy, W. D., and Umbreit, W. W., *J. Biol. Chem.*, 1944, **155**, 685.

16 Lichstein, H. C., Gunsalus, I. C., and Umbreit, W. W., *J. Biol. Chem.*, 1945, **161**, 311.

17 Ames, S. R., Sarma, P. S., and Elvehjem, C. A., *J. Biol. Chem.*, 1947, **167**, 135.

18 Beiler, J. M., and Martin, G. J., *J. Biol. Chem.*, 1947, **169**, 345.

19 Sarma, P. S., Snell, E. E., and Elvehjem, C. A., PROC. SOC. EXP. BIOL. AND MED., 1946, **63**, 284.

20 Junqueira, P. B., and Schweigert, B. S., *J. Biol. Chem.*, 1948, **174**, 605.

21 Valentine, W. N., Craddock, C. G., Jr., and Lawrence, J. S., *Blood*, 1948, **3**, 729.

22 Hills, A. G., Forsham, P. H., and Finch, C. A., *Blood*, 1948, **3**, 755.

Received August 10, 1949. P.S.E.B.M., 1949, **72**.

Device for Measuring Blood Pressure in the Unanesthetized Rat. (17468)

GORDON L. FARRELL AND EVELYN ANDERSON

From the Experimental Biology and Medicine Institute, National Institutes of Health, Bethesda, Md.

The simple technic for measuring blood pressure in the rat described here consists of placing a cuff permanently around the abdominal arorta and vena cava just above their bifurcations and measuring the blood pressure by means of an oscillometer and mercury manometer.

Description of the Apparatus and Its Use. The aortic cuff is shown in Fig. 1. It consists of a latex bulb with a short stem which is fitted on to a piece of plastic tubing, and a plastic shell into which the bulb is inserted.

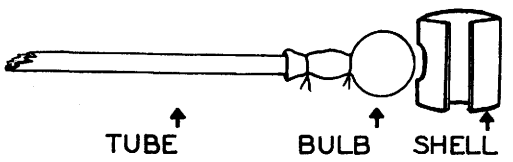

FIG. 1.
The aortic cuff unassembled.

To make the bulb a glass bead 4 mm in diameter with a stem attached is dipped into liquid latex. After drying for 24 hours, the latex is vulcanized by exposure to sulfur chloride fumes for one minute, and then washed under running tap water. After drying, the bulb is powdered and peeled off the mold. The short stem of the bulb is fitted into the end of a 12 cm piece of 18-gauge polyethylene tubing. The tubing is reinforced where it is fitted into the capsule by a 4 mm length of 18-gauge stainless steel tubing. The shell of the cuff consists of a plastic tube (Tenite II) 6 mm long with an inner diameter of 4 mm and an outer diameter of 6 mm. The shell is split lengthwise so that it can be slipped around the aorta. A 3 mm hole is drilled in the shell just opposite the slit and midway between the two ends. The bulb is fitted into the shell, with the tubing brought out through the hole. The bulb should just fill the inside of the shell. The cuff is washed in hot running tap water for 4 hours and then stored in 70% alcohol. Before use, each cuff is tested to withstand an air pressure of 300 mm Hg.

To place the cuff on the aorta the animal is anesthetized with ether and a midline incision is made in the abdomen. The aorta and vena cava are dissected free from the surrounding tissue, but are not separated from each other. Isolating the aorta was found to be difficult because of the danger of tearing the vena cava in the operation. The cuff is placed around both vessels just above their bifurcations. The shell is tightly closed with a strong ligature and secured firmly to the surrounding tissues. The tubing is brought through the posterior wall of the abdominal cavity and carried under the skin to the back of the neck where it is brought to the outside. In this position the tube cannot be disturbed by the animal (Fig. 2). Special care must be taken to prevent moisture from accumulating in the tube or bulb which could falsify pressure readings. There is no evidence that the animal suffers any inconvenience from the cuff. Autopsy examination of the aorta with the cuff *in situ* made 2 to 3 months after inserting the cuff has revealed very little fibrous tissue formation.

FIG. 2.
Rat showing place of exit for the plastic tubing leading from cuff.

Blood pressure readings are made with the use of an improvised oscillometer and a mercury manometer. This apparatus is shown in Fig. 3. The animal is placed in a metal holder (L) or in a 500 cc beaker. There is no struggling since the animal is not uncomfortable or irritated in any way. The tube from the cuff is connected with an oscillometer which consists of a 15 mm length of 1 mm capillary tubing (K) connected with a pressure bottle (G). The capillary tube contains a small drop of colored alcohol which serves as an indicator of the oscillations which are transmitted from the aorta. The pressure bottle G has a mercury manometer attached and it in turn is connected with a bottle of compressed air (A). The cuff is inflated through the capillary oscillometer with air supplied at a steady smooth flow through a hypodermic needle (F) from the reservoir A which has been adjusted to deliver pressures from 0 to 300 mm Hg in about 30 seconds. As the pressure rises in the cuff and oscillometer, the alcohol bead travels toward the cuff and shows distinct oscillations which reach a maximum intensity, gradually decrease, then abruptly diminish. The point of diminution is taken as the endpoint. A manometer reading is made at this point. A small pulsation persists after the endpoint. The pressure in the cuff is quickly released through the side tube H. Three to 5 readings are made at one-minute intervals.

Experimental data. This method for measuring blood pressure in the unanesthetized rat has been tested on a group of 20 normal male rats of the Sprague-Dawley strain which weighed from 105 to 165 g at the beginning of the study. Cuffs were placed around the

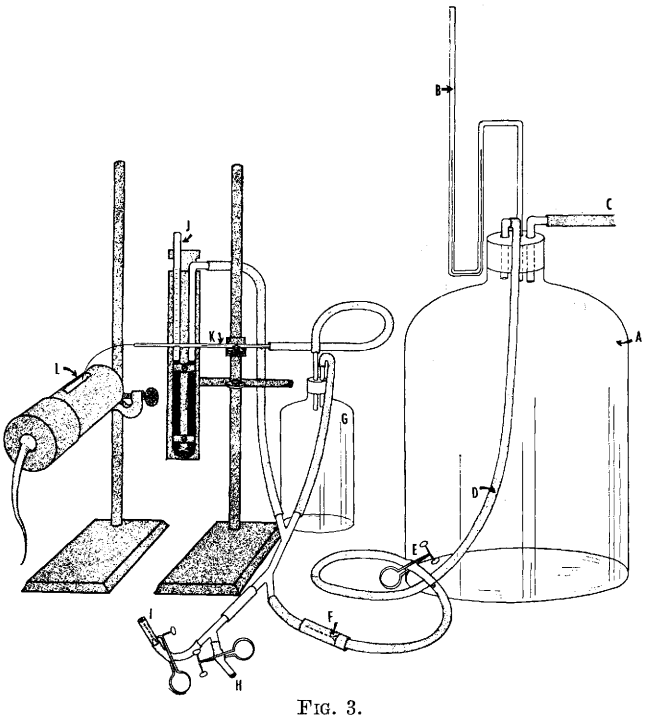

FIG. 3.
Oscillometer and manometer hooked up with pressure bottles.
The oscillometer is connected to the tubing from the animal.

aorta and vena cava a few days before the first readings were made. Afterwards the blood pressure measurements were determined 3 times a week or oftener, over a period of 8 weeks. These readings are shown in Table I. The average of 540 blood pressure readings taken on the 20 normal unanesthetized rats over a 2 month period was 130 mm Hg.

The readings obtained by the cuff method were compared with the systolic pressure in the femoral artery measured intra-arterially by means of a capacitance manometer designed by Noble.[1] These readings were made on rats anesthetized with ether. Immediately after the intra-arterial reading, while the animal was still asleep, blood pressure readings by the cuff method were made. Twenty-nine rats were used for this study. Ten of this group had been made hypertensive by enclosing the left kidney with a latex capsule and removing the right kidney (Abrams and Sobin[2]). The remaining 19 rats were the normal animals which had been used previously for the blood pressure readings recorded in Table I. The comparative data are presented in graph form in Fig. 4. The intra-arterial systolic pressure for a given rat is plotted as the ordinate and the pressure reading by the cuff method as the abscissa. The diagonal line represents perfect agreement. The readings by the 2 methods in both normal and hypertensive animals tend to fall along this line. The average intra-arterial systolic pressure for the 19 normal animals was 121 $\pm$ 15 mm Hg and the reading by the cuff method while the animals were still under ether was 118 $\pm$ 15 mm Hg. Because of the close correlation of the readings by the 2 methods it is assumed that the readings by the cuff method indicate the approximate systolic blood pressures. It has been noted, however, that when the cuff is inflated to the "systolic pressure" reading the aorta may not be com-

[1] Noble, F. W., Third Conference on Factors Regulating Blood Pressure, May 5-6, 1949, Josiah Macy, Jr. Foundation, New York.

[2] Abrams, M., and Sobin, S., PROC. SOC. EXP. BIOL. AND MED., 1947, **64**, 412.

TABLE I.
Systolic Blood Pressures as Determined by the Oscillometric Method on a Group of 20 Adult Male Rats Over a 2-Month Period.

Rat No.	Blood pressure, mm Hg weekly avg 1st	2nd	3rd	4th	5th	6th	7th	8th	Avg for 8-wk period
760	123	129	119	119	117	120	122	121	121
761	125	123	115	120	116	124	124	132	122
762	137	121	124	123	137	137	127	142	131
763	139	134	134	143	136	126	120	133	133
764	140	119	123	128	117	129	129	128	127
765	134	126	133	123	117	131	142	138	131
767	139	126	124	126	111	124	121	126	125
768	128	110	123	129	120	134	141	143	129
769	138	108	132	118	119	130	148	163	134
770	136	129	125	126	113	133	131	133	128
771	141	118	133	127	133	141	135	135	133
772	126	126	115	126	130	130	135	135	128
773	124	116	130	120	120	129	130	133	125
774	121	124	125	137	127	133	132	137	130
775	—	142	130	122	146	134	149	138	137
776	136	133	140	145	137	155	120	—	138
777	120	129	130	131	129	135	—	—	129
778	131	141	145	160	138	—	—	—	143
779	—	124	128	129	141	125	136	133	131
781	—	133	126	113	118	120	122	123	120
Weekly group avg	131	126	128	128	126	131	131	135	

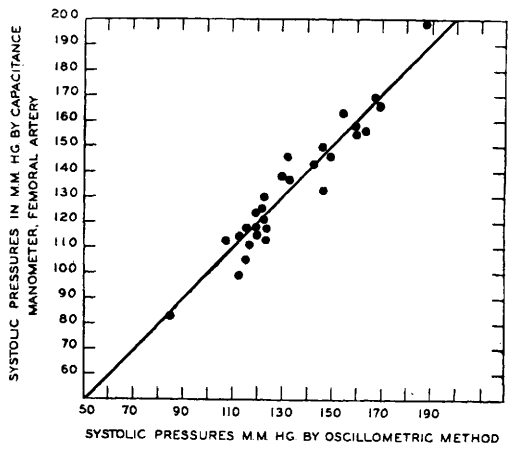

FIG. 4.

Comparison of the intra-arterial pressure by the capacitance manometer with the indirect pressure by the oscillometric method.

pletely occluded, for pulsations are still recorded by the capacitance manometer.

Simultaneous occlusion of the thoracic aorta and inferior vena cava has been shown to increase blood pressure in the dog (Barcroft[3]). However, in our observations no measurable change occurred in the intracarotid pressure when taken simultaneously with the pressure readings made with the cuff on the abdominal aorta and vena cava.

Summary. A device for measuring blood pressure in the aorta of the unanesthetized rat is described. It is simple and permits an unlimited number of readings over a long observation period.

[3] Barcroft, H., *J. Physiol.*, 1931, **71**, 280.

Received Sept. 9, 1949. P.S.E.B.M., 1949, **72**.