

only a short period of time. Concerning the relation of toxic symptoms to dosage, the same authors found that of 7 dogs receiving 1 g/kg of sulfanilamide in capsules by mouth 5 showed toxic symptoms but no mention was made of the concomitant blood levels in these animals.

Conclusions. Sulfanilamide is promptly absorbed from the peritoneal cavity in dogs. Following the intraperitoneal injection of sulfanilamide the levels of concentration of the drug in the peripheral blood are not as high as those reported by other investigators following the oral or subcutaneous administration of smaller doses.

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Catheterization of the Right Auricle in Man.

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Forssmann¹ first used catheterization of the right heart on himself, after exposure of a vein of the arm by a surgeon. Numerous other investigators since have used right heart catheterization for visualization of the right chamber of the heart and pulmonary vascular trees by means of contrast substance.²⁻⁷ The introduction of the Robb and Steinberg method,⁸ however, renders this method unnecessary for the latter purpose. Collection of right heart blood by catheterization of the right auricle for determining cardiac output in man⁹ is mentioned by Grollman,¹⁰ who discredits it because of the possible

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¹ Forssmann, W., *Klin. Wchschr.*, 1929, **8**, 2085.

² Forssmann, W., *Muench. Med. Wchschr.*, 1931, **78**, 489.

³ Egas Moniz, Lopo de Carvalho, and Almeida Lima, *Presse med.*, 1931, **39**, 996.

⁴ Heuser, C., *Rev. Asoc. med. argent.*, 1932, **46**, 1119.

⁵ Conte, E., and Costa, A., *Radiology*, 1933, **21**, 461.

⁶ Ravina, A., *Progres med.*, November 3, 1934, p. 1701.

⁷ Ameuille, P., Ronneaux, G., Hinault, V., DeGrez, and Lemoine, J. M., *Bull. et mem. Soc. med. d. hop. de Paris*, 1936, **60**, 720.

⁸ Robb, G. P., and Steinberg, I., *J. Clin. Invest.*, 1938, **17**, 507.

⁹ Klein, O., *Muench. Med. Wchschr.*, 1930, **77**, 1311.

¹⁰ Grollman, A., *The Cardiac Output of Man in Health and Disease*, Monograph, Williams and Wilkins Co., Baltimore, 1932.

dangers and numerous misleading factors associated with it. In animal experimentation it is widely used and its innocuity established.

Because it is apparently the soundest method for obtaining mixed venous blood for respiratory gas determinations, and because of the numerous problems of hemodynamics it might help solve, a method of right heart catheterization was developed which attempts to overcome objections to former methods. The principal objections included the possibility of venous thrombi and thrombophlebitis that might be associated with introduction of a foreign body in the blood stream, the formation of thrombi within the catheter, and the psychic effects accompanying the procedure with possible alterations in the cardiac output.

The following equipment was used in our method: a specially made 10 gauge Lindeman type of needle; a 3-way stopcock with a Luer lock, tightly fitting adapter; a No. 8 French flexible radiopaque ureteral catheter with 2 holes, one at the rounded tip and another about 1 cm from the tip. The catheter is silk with a smooth varnish finish. A saline reservoir with rubber tubing and clamp for controlling the rate of flow was also used.

Under the strictest asepsis a nick is made in the skin over the median basilic vein of either the right or left arm after a preliminary infiltration with 2% novocain. After applying a tourniquet and fixing the distal portion of the vein with the fingers, the special needle is introduced. The catheter is next introduced into the vein through the needle. The end of the catheter is connected to the saline reservoir by a screw adapter, and a constant flow of saline at the rate of 15 drops per minute allowed to flow through the catheter throughout the procedure. When the catheter has been inserted about 12 cm into the vein, the needle is removed. This is done to prevent the possibility of cutting or shaving the catheter when it is withdrawn or pulled back in manipulation. The further passage of the catheter is done on a horizontal fluoroscopic table, using the fluoroscope in guiding the catheter to the desired position.

Occasionally resistance in passing the catheter may be encountered in the axillary region or at the level of the first rib. This can usually be overcome by drawing the catheter back slightly and placing the arm at a lower level than the table and rotating it inwardly. Several possible false routes may be encountered. It is conceivable that the flexible catheter might find its way into one of the jugular veins, but we have not encountered this. The catheter has on 2 occasions passed into the innominate vein of the opposite side, and occurrence immediately recognized under the fluoroscope. In either case the

TABLE I.
Influence of Right Auricle Catheterization and Arterial Blood Puncture upon Various Respiratory and Circulatory Measurements in 8 Successive Experiments.

Subject	Date	Time	Ventil. l/min	Rate per min	Gas exchange			Pulse per min	Venous pressure, mm	C.I.* l/min sq.m.B.S. Beat	S.V.* cc Beat	Observations
					CO ₂ cc/min	O ₂ cc/min	R.Q.					
G.B. Malignant hypertension, heart failure	10/25/40	Before	9.14	21	201	261	.77	89	132			Catheter in position 15'.
		During	9.38	22	201	275	.73	88	132†	2.29	35.5	" " " "
		During	14.57	29	221	272	.81	95		2.50	37.9	" " " "
P.T. Carcinoma liver (?)	11/27	Before	12.67	19	223	316	.71	115		3.11	42.2	" " " "
		During	11.63	18	194	282	.69	114	80†	2.71	36.2	Intra-auricular pressure = 10 mm change between inspiration and expiration
F.L. Carcinoma stomach	12/20	Before	8.08	21	158	201	.79	79	34	2.92	61.3	Catheter in position 30'.
		During	7.78	22	168	214	.79	66	34	2.72	68.3	15' interval between Exp. 1 and 2
	27	Before	7.44	19	157	200	.79	72				Catheter in position 40'.
		During	8.69	22	191	236	.81	66				15' between Exp. 1 and 2.
31	Before	9.14	25	189	237	.80	66					
	During	8.32	22	167	218	.77	80		3.13	65.0	Catheter in position 25'.	
G.T. Carcinoma stomach	1/14/41	Before	8.95	19	192	225	.85	68		2.80	68.4	
		During	7.92	15	174	191	.91	88		2.66	45.8	Catheter in position 50'.
21	Before	During	8.72	21	178	205	.87	86				20' between Exp. 1 and 2.
		During	8.07	20	158	193	.82	80		2.46	46.6	Catheter in position 60'.
	During	During	6.54	16	156	208	.75	81	30†	2.17	40.6	
		During	7.36	19	175	225	.78	80	30†	2.29	40.8	20' between Exp. 1 and 2.
		During	7.50	19	168	221	.76	88				

*Stroke volume and cardiac index calculated from ballistocardiogram tracings (wave area formula) and cross-section area of the aorta (Bazett's table) using ideal weight.

†Intra-auricular pressure.

tip is withdrawn to the axillary region and further attempts made to pass it to its proper position. When the tip is in the right auricle, if blood is to be collected through the catheter, the tubing of the saline reservoir is first disconnected and a large syringe filled with a little saline is adapted to the 3-way stopcock. Two or 3 cc of blood are drawn into this syringe, thus washing the catheter with right heart blood. Then the valve is turned and the blood for analysis is collected in a second syringe containing mineral oil as an air seal. Fifteen to 20 cc of blood can be collected within 25 seconds by using only the slightest amount of suction. When the blood has been collected, the saline reservoir may be connected again and saline allowed to run slowly into the catheter to keep it open. Duplicate samples may be taken later. Finally, the catheter is withdrawn and examined carefully for any evidence of thrombi.

In our experience we have found no evidence of blood clotting on the smooth outside walls of the catheter. Nor have there been any thrombi seen at the holes of the catheter or within the catheter when it is flushed with saline after being withdrawn. We do not believe that the results are affected by any psychic disturbance. There is no pain involved in the operation, once the needle is in place in the arm vein. The pulse rate does not vary significantly before and during the procedure, and cardiac output determinations as measured by the ballistocardiograph before, during and after the procedure are quite constant.

Table I shows the influence of the catheterization associated with an arterial puncture, in 8 successive passages, upon ventilatory volume and rate, gas exchange and respiratory quotient, pulse rate and cardiac output measured with a ballistocardiograph, and in a few instances upon the venous pressure. The ballistocardiograph used differs slightly in design from that described by Starr, *et al.*,¹¹ and was developed in the Department of Physiology, New York University College of Medicine.

Protocol of Determination of Cardiac Output by Simultaneous Sampling of Right Auricle and Femoral Arterial Blood and Collection of Expired Air (Tissot).*

F.L. Age 61 Weight 53 kg Height 180 cm. Body surface area 1.66 sq.m.
 Carcinoma of stomach.
 Date—12/31/40—not basal.
 Ventilation = 7.77 lit./min., dry gas 0°C, 760 mm Hg.
 CO₂ Output = 2.47 %—192 cc/min.
 O₂ Intake = 2.89 %—225 cc/min.
 R.Q. = .854
 CO₂ Content, vols. %: M.V.B.† = 54.7—art. blood = 51.2—A—V difference = 3.5.

¹¹ Starr, I., Rawson, A. J., Schroeder, H. A., and Joseph, N. R., *Am. J. Physiol.*, 1939, **127**, 1.

O₂ Content, vol. %: M.V.B. † = 10.0 — art. blood = 14.0 — A—V difference = 4.0.

R.Q. from blood: $\frac{\text{CO}_2 \text{ A—V difference}}{\text{O}_2 \text{ A—V difference}} = .875.$

Cardiac Output, lit./min. from

	192	
CO ₂ A—V difference =	—	= 5.49.
	3.5	
	225	
O ₂ A—V difference =	—	= 5.63.
	4.0	

Cardiac Index = 3.35 lit./sq.m. B.S. area.

Heart rate per minute = 70.

Stroke Volume = 79.5 cc.

* Arterial blood sampling starting and ending approximately 15 seconds after mixed venous blood sampling. Total duration of sampling of both bloods 35 seconds. Expired air collected during blood sampling.

† M.V.B. (mixed venous blood) refers to blood drawn directly from the right auricle.

The protocol of one cardiac output determination by simultaneous collection of blood from the right auricle and femoral artery is included herewith. The number of simultaneous determinations of stroke volume measured by this method and compared with estimations from ballistocardiograph tracings is not large enough to warrant a statement concerning the validity of the ballistic method at this time.

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Middle and Old Age in Cholesterol-Fed Rats.*

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Most of the pathological conditions involving cholesterol deposition in tissues are characteristic of middle and old age rather than youth. Previous studies on the effect of cholesterol intake on tissue cholesterol in the rat have been made with comparatively young animals and for comparatively short periods of time.

Cholesterol-fed rats have appeared to be little the worse for their high sterol intake except in that they have developed fatty livers which have contained at least 20 times the normal percentage of

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¹ Okey, R., Gillum, H. L., and Yokela, E., *J. Biol. Chem.*, 1934, **107**, 207.