with the ganglionic blocking agents, chlorisondamine, mecamylamine, pentolinium and hexamethonium. 2. TEA failed to provide protection from mortality due to trauma. 3. Significant protective effects were demonstrable only at certain critical dose ranges. 4. The results provide added support to the observations that blockade of the sympathetic nervous system affords protection from the lethal effects of physical trauma.

1. Levy, E. Z., North, W. C., and Wells, J. A., *J. Pharmacol. and Exp. Therap.*, 1954, v112, 151.

2. North, W. C., and Wells, J. A., *ibid.*, 1951, v103, 356.

3. Zahl, P. A., Hutner, S. H., and Cooper, F. S., *ibid.*, 1943, v77, 143.

4. Hershey, S. G., Zweifach, B. W., and Metz, D. B., *Anesthesiology*, 1954, v15, 589.

5. Harvey, A. M., *J. Physiol.*, 1939, v95, 45.

6. Dutta, N. K., *Brit. J. Pharmacol.*, 1949, v4, 197.

7. Marrazzi, A. S., *J. Pharmacol. and Exp. Therap.*, 1939, v65, 18.

8. Noble, R. L., and Collip, J. B., *Quart. J. Exp. Physiol.*, 1942, v31, 187.

9. Mainland, D., *Canadian J. Res.*, 1948, v261, 1.

10. Trapold, J. H., Plummer, A. J., and Schneider, J. A., *J. Pharmacol. and Exp. Therap.*, 1955, v113, 51.

11. Stone, C. A., Torchiana, M. L., O'Neill, G. Q., and Beyer, K. H., *ibid.*, 1956, v116, 54.

12. Wein, R., and Mason, D. F. J., *Lancet*, 1953, v1, 454.

13. Paton, W. D. M., and Zaimis, E. C., *Brit. J. Pharmacol.*, 1951, v6, 155.

14. Acheson, G. H., and Moe, G. K., *J. Pharmacol. and Exp. Therap.*, 1946, v87, 220.

15. Hambourger, W. E., Cook, D. L., Winbury, M. M., and Freese, H. B., *ibid.*, 1950, v99, 245.

16. Moe, G. K., and Freyburger, W. A., *Pharmacol. Rev.*, 1950, v2, 61.

17. McManus, E. C., Bochey, J. M., and Beyer, K. H., *J. Pharmacol. and Exp. Therap.*, 1953, v108, 364.

Received January 3, 1956. P.S.E.B.M., 1956, v91.

Renal Interstitial Pressure in Normal and in Anuric Man: Based on Wedged Renal Vein Pressure.* (22212)

C. BRUN,† C. CRONE, H. G. DAVIDSEN, J. FABRICIUS, A. TYBJAERG HANSEN, N. A. LASSEN, AND O. MUNCK. (Introduced by R. W. Berliner.)

Department of Medicine III and Central Clinical Laboratory, Kommunehospitalet, and Department of Medicine B and Cardiovascular Laboratory, Rigshospitalet, Copenhagen.

Knowledge of the interstitial pressure of kidneys would be of special interest in patients with acute anuria, as suggested by Peters(1) and Oliver, MacDowell and Tracy (2), that anuria is due to raised interstitial pressure caused by interstitial edema. However, this suggestion has never been substantiated by measurements in man. In dogs suffering from a renal lesion induced by clamping the renal artery for 3 to 4½ hours, the pressure recorded in a needle inserted in the renal tissue was within the normal range(3).

The method of assessing interstitial, or capillary, pressure in human tissues by wedging a cardiac catheter into small venules of an organ has been applied to lungs and liver, but never to kidneys. Such a technic is presented in this report. From the finding of a normal wedged renal vein pressure (WRVP) in acute anuria following shock it is concluded that the anuria in such cases is not caused by raised interstitial pressure.

Methods and material. With patients in the supine position a cardiac catheter No. 7-9 (in a boy of 7 yrs. No. 4) was passed under fluoroscopic guidance into a renal vein, most often the right. After entering the renal vein the catheter was advanced as far as possible into the kidney veins. When the catheter was properly wedged, pressure measurements were performed with a condenser manometer (4) connected with a cathode ray oscillograph and a photographic recorder. At beginning of

* This work has been supported by grants from King Christian X's Foundation and from The Danish State Research Foundation.

† Central Clinical Laboratory, Kommunehospitalet, Ø. Farimagsgade 5, Copenhagen, Denmark.

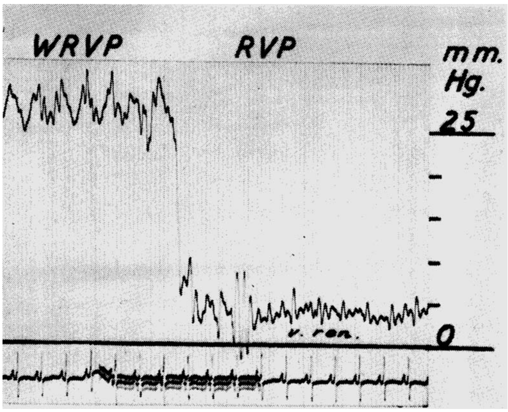

FIG. 1. Abrupt drop in pressure as catheter is withdrawn from a wedged position in renal vein to a free position.

withdrawal the catheter was stretched, followed by a sudden backward movement of the tip when released from the wedged position. Simultaneously with this characteristic slip a sudden and pronounced drop in pressure was seen together with an alteration of the configuration of the curve (Fig. 1). The highest pressure level was taken as the wedged renal vein pressure (WRVP), the lower level representing the renal venous pressure (RVP). In some cases it was impossible to obtain a pressure much higher than that in the main trunk of the renal vein. In other cases an unstable pressure was seen, presumably because the opening at the tip of the catheter was pressed against the wall of a vessel at a venous bifurcation, so that further insertion of the catheter in this position would alter the volume and pressure in the closed tube. It must therefore be emphasized that unless repeated reproduction of a pulsating curve which was stable at a high level and which showed the characteristic drop on withdrawal of the catheter, was obtainable at the oscilloscope, the examination was regarded as a failure. Besides WRVP and RVP, pressure in the right atrium and in the femoral artery were recorded. In all measurements the midaxillary line was used as zero reference. Pressure measurements were incorporated as part of renal function studies, which included renal blood flow in the anuric patients, extraction ratios of PAH and oxygen, and in some cases renal clearances(5). The 9 control subjects were patients with no evidence of renal disease or right sided heart failure. The 4 subjects with anuria or oliguria were patients who had developed acute renal failure after sustained shock following acute barbiturate poisoning (cases 3284, 3312, and 3395) or acute pancreatitis (case 3674). They were examined 5 to 7 days after the initiating shock when the peripheral circulation and blood pressure were normal, and the plasma urea concentration considerably elevated. In 2 cases follow-up studies were made.

Results. In the control group (Table I) WRVP ranged from 14-22 mm Hg, averaging 17.7. RVP ranged from 1.5-11.0, averaging 5.6 mm Hg. The right atrial pressures averaged 3.1 mm Hg, varying from –2-8. Arterial pressure averaged 125/79.

In patients examined during acute renal failure (Table II) the WRVP ranged from 15-30, averaging 20 mm Hg. RVP ranged from 5.5-15.0, averaging 10.5 mm. The right atrial pressures averaged 3.5 mm Hg, varying from 1-7. Arterial pressure averaged 128/76. In cases No. 3395 and 3674 follow-up studies showed no change in WRVP. The WRVP of 15 mm Hg given for case No. 3674 on 9th day of the disease, is from the right kidney. During the same examination a WRVP of 15.5 mm Hg was found in the left kidney.

Discussion. In the human kidney there is one central or internal system of veins—the arcuate veins—which drain the cortex as well as the medulla. Around the bases of the pyramids the arcuate veins anastomose; they unite in large branches—the interlobar veins

TABLE I. Wedged Renal Vein Pressure (WRVP) and Pressure in Renal Vein (RVP), Right Atrium and Femoral Artery in 9 Control Subjects.

Case No.	Sex	Age, yr	WRVP	RVP	Right atrium	Femoral artery
			mm Hg			
3454	♂	16	20.0	3.5	0	120/80
3509	♀	33	16.0	2.5	–2.0	"
3018	♀	19	18.5	1.5	1.0	115/70
1123	♀	30	18.5	5.0	1.0	100/65
3620	♀	32	18.0	6.5	5.5	120/70
3631	♀	40	16.0	3.0	1.0	145/90
3596	♂	27	16.5	11.0	6.0	158/84
3697	♀	46	14.0	8.0	7.0	140/90
3385	♂	7	22.0	9.0	8.0	110/80
Means			17.7	5.6	3.1	125/79

TABLE II. Pressure Measurements in 4 Patients with Acute Renal Failure Examined at Various Stages of the Disease. Symbols as in Table I.

Case No.	Sex	Age, yr	Days after shock	Days after onset of anuria	Urine flow, cc/24 hr	Plasma urea, mg %	24 hr endogenous creatinine clearance, cc/min.	WRVP (mm Hg)	RVP (mm Hg)	Right atrium (mm Hg)	Femoral artery (mm Hg)
3284	♀	41	7	5	170	444	.8	15.0	5.5	1.0	120/80
3312	♂	47	5	3	29	280	.5	30.0	15.0	5.0	162/82
			7	5	15	420	.1	18.0	13.0	—	93/70
3395	♀	27	5	4	85	380	1.0	21.0	9.0	7.0	162/85
			12	11	1740	638	4.8	22.0	10.0	10.0	182/96
			21	20	3020	46	66.0	27.0	3.5	2.0	125/82
3674	♂	51	6	5	700	405	6.0	16.5	10.0	1.0	102/63
			10	9	1680	260	33.0	15.0	10.0	—	122/80

—that run between the sides of the pyramids and the columns of Bertini to the neck of the calices, around which they form a second system of anastomoses much shorter and thicker than those at the base of the pyramids. The interlobar veins join through short thick stems into the main renal venous trunk(6,7). From necropsy studies of human kidneys we have the experience that in most cases a No. 8 cardiac catheter can be easily advanced through an interlobar vein towards its junction with the arcuate veins, the lumen of the interlobar vein being occluded by the catheter.

The pressure at the tip of a catheter occluding an interlobar vein peripherally to the set of anastomoses near the pelvis cannot be lower than the arcuate venous pressure. The pressure in an occluded interlobar vein cannot exceed the pressure in the arcuate veins, as the numerous anastomoses between these vessels are thought readily to drain away the blood which dams up behind the single catheter-blocked interlobar vein.

From these considerations it is reasonable to conclude that the WRVP as measured in this study is equal to the arcuate venous pressure, and hence very near to the pressure in the peritubular capillaries and interlobular veins. Therefore it seems justified that renal interstitial pressure can be assessed from WRVP. It is also seen that arcuate venous pressure is obtained whenever the tip of the catheter blocks the lumen of an interlobar vein between the 2 sets of anastomoses.

The normal value of 18 mm Hg for WRVP was in good agreement with values for arcuate venous pressure as measured by Swann *et al.* by renal vein catheterization in dogs; in these experiments a sudden drop in pressure of the same magnitude as observed in the present investigation (Fig. 1) was found when the catheter was withdrawn from an arcuate vein into an interlobar vein. Similarly, the present value for WRVP is nearly identical with the pressure measured in dogs by inserting a needle into the kidney(8,9,10,11).

It was impossible to demonstrate a raised WRVP in the 4 patients examined in the anuric or oliguric phase of acute renal failure. The follow-up studies in cases 3395 and 3674 deserve special interest, as they clearly demonstrate that the amount of urine excreted is independent of the WRVP.

Summary and conclusion. 1. A method is described for determination of wedged renal vein pressure (WRVP) in man. 2. In 9 normal subjects WRVP averaged 18 mm Hg. It was not possible to demonstrate a raised WRVP in 4 patients with acute anuria following shock, the average WRVP being 20 mm Hg. 3. It is argued that in agreement with experiences from lungs and liver, the interstitial pressure in kidneys equals the WRVP. The results suggest that in patients with acute anuria following shock the anuria cannot be explained by an increased interstitial renal pressure.

1. Oliver, J., MacDowell, M., and Tracy, A., *J.*

Clin. Invest., 1951, v30, 1307.
2. Peters, J. T., *Ann. Int. Med.*, 1945, v23, 221.
3. DeWardener, H. E., *Lancet*, 1955, vI, 580.
4. Hansen, A. T., *Pressure Measurements in the Human Organism*, Teknisk Forlag, Copenhagen, 1949.
5. Brun, C., Crone, C., Davidsen, H. G., Fabricius, J., Hansen, A. T., Lassen, N. A., and Munck, O., PROC. SOC. EXP. BIOL. AND MED., 1955, v89, 687.
6. Morison, D. M., *Am. J. Anat.*, 1926, v37, 53.
7. Brödel, M., *Johns Hopkins Hosp. Bull.*, 1901, v118, 10.
8. Swann, H. G., Hink, B. W., Koester, H., Moore, V., and Princ, J. M., *Science*, 1952, v115, 64.
9. Swann, H. G., Montgomery, A. V., Davis, J. C., Jr., and Mickle, E. R., *J. Exp. Med.*, 1950, v92, 625.
10. Gottschalk, C. W., *Am. J. Physiol.*, 1952, v169, 180.
11. Miles, B. E., and DeWardener, H. E., *J. Physiol.*, 1954, v123, 131.

Received January 4, 1956. P.S.E.B.M., 1956, v91.

Action of Diethylpropanediol and Diethylbutanediol on Isolated Sciatic Nerve and Ileum.* (22213)

SAUL ADAMS† AND I. H. SLATER.‡ (Introduced by H. C. Hodge.)

Division of Pharmacology, Department of Radiation Biology, University of Rochester School of Medicine and Dentistry, Rochester, N. Y.

2,2-diethyl 1,3-propanediol (DEP) is a central nervous system depressant remarkable for its effectiveness in protecting animals against the convulsant action of pentylenetetrazol (Metrazol). Pharmacologically, it has been characterized as an interneuronal depressant with action throughout the neuraxis but with maximal effect in the brain stem (2,3,4). 2,2-diethyl 1,4-butanediol (DEB) which differs from DEP by but one methylene group is a convulsant remarkably similar to metrazol in action(5). It too has its principal action on interneurones throughout the central nervous system with a maximal effectiveness in the brain stem. DEP protects animals from the convulsant action of DEB. The available evidence indicates that this is a non-specific example of pharmacological antagonism since other depressants and stimulants act similarly in combination with the drugs in question.

It seemed of some interest to make a quantitative comparison of the effect of these two compounds on isolated axones and synapses.

Methods. Strength-duration curves were determined for desheathed rat sciatic nerve which was maintained in Tyrode's solution at 36-37°C in a nerve chamber. The nerve was allowed to equilibrate until the curve was reproducible. Increasing concentrations of drug in Tyrode's solution were added and the strength-duration curve was determined at 15 minute intervals until concentrations causing unequivocal depression of the nerve had been added. The nerve was then washed in drug-free Tyrode's solution until a normal level of excitability had been reached. In some experiments the excitability of the nerve was enhanced by calcium ion depletion by using a calcium-free Tyrode's solution and varying concentrations of sodium citrate as suggested by Brink *et al.*(6). As a simple method of evaluating ganglionic transmission, the contraction of the isolated rabbit ileum was used following the method of Feldberg(7). To study simple neuronal pathways in the central nervous system, the segmental reflex was studied in cats in which the spinal cord had been divided at the second cervical vertebra or at both the second cervical and last thor-

* Material in this paper appeared in thesis by Saul Adams in partial fulfillment for the degree of Master of Science at the University of Rochester.

This paper is based on work performed under contract with the U. S. Atomic Energy Commission at The University of Rochester Atomic Energy Project.

† At present on duty with the U. S. Air Force (M.S.C.).

‡ Present address, Lilly Research Laboratories, Indianapolis.