

*Summary.* A selected anterior lobe powder from ox pituitary was used successfully as a standard of reference for one year in an assay procedure employing normal rats. By restricting the biological comparison to the steeper portion of the dose-response curves it was possible to obtain relatively low limits of error.

### 11399 P

#### Application in Man of Method for Continuous Reciprocal Transfusion of Blood.\*†

GARFIELD G. DUNCAN, LEANDRO TOCANTINS and TRACY D. CUTTLE.

*From the Medical Service of the Pennsylvania Hospital, and the Department of Medicine, Jefferson Medical College, Philadelphia.*

Purified heparin, by prolonging the coagulation time of blood, has reduced the technical difficulties and made feasible the continuous reciprocal transfusion of blood in man. Thalhimer, Solandt and Best,<sup>1</sup> using a uremic and a normal dog and employing purified heparin as an anticoagulant, conducted a reciprocal transfusion for 27 hours, reducing the blood urea from high levels to normal without injury to the normal dog. Prinzmetal<sup>2</sup> carried out exchange transfusions in the investigation of arterial hypertension in patients with inoperable cancer. We have been unable however, to find any instance in which the work of Thalhimer *et al.* was applied in man.

Heparin (10,000 Toronto units in 1,000 cc normal saline) was given intravenously at approximately the rate of 40 drops per minute to the normal donor and to the patient for 20 minutes before and throughout the transfusion. An additional 2,000 units were given intravenously to each individual as the transfusion was started, and repeated 30 minutes later. This maintained the blood coagulation time between 20 and 30 minutes. The median basilic veins of the

---

\* The authors are indebted to Dr. William A. Wolff, Chemist to the Pennsylvania Hospital, for valuable suggestions on the chemical aspects of this problem.

† Since this paper was submitted for publication a transfusion was carried out in which 26,770 cc were exchanged in approximately 5 hours. The total nitrogen excretion in the urine increased from 548 mg per hour before to 851 mg per hour during the transfusion.

<sup>1</sup> Thalhimer, W., Soldant, D. G., and Best, C. H., *Lancet*, 1938, **2**, 554.

<sup>2</sup> Prinzmetal, M., Friedman, B., and Rosenthal, N., *Proc. Soc. Exp. Biol. and Med.*, 1936, **34**, 545.

two, a uremic patient and a normal donor, were then connected by a suitable rubber tubing filled with heparin in saline. The tubes passed through a roller pump which milked forward the same quantity of blood in opposite directions. A 400 mm manometer was placed between the pump and the recipient (1B and 2C), thus providing a sensitive indicator of any obstruction in the needle and at the same time a safeguard against undue increasing pressure in the receiving vein (Fig. 1).

Sufficient bicarbonate of soda was given to the donor and the recipient to make the urine alkaline as a preparatory measure. Trials of the apparatus in artificial models gave good results. Two patients with chronic uremia, one as a result of a polycystic disease of the kidneys and the other from chronic glomerular nephritis, have been given continuous reciprocal transfusions from normal donors. In the first patient an exchange of 2,520 cc of blood (including saline and heparin) was made over a period of 2 hours and 50 minutes. On the second patient 7,020 cc of blood, not including saline and heparin, were cross transfused in 47 minutes; during the greater portion of the time 82 cc of blood were delivered in each direction per

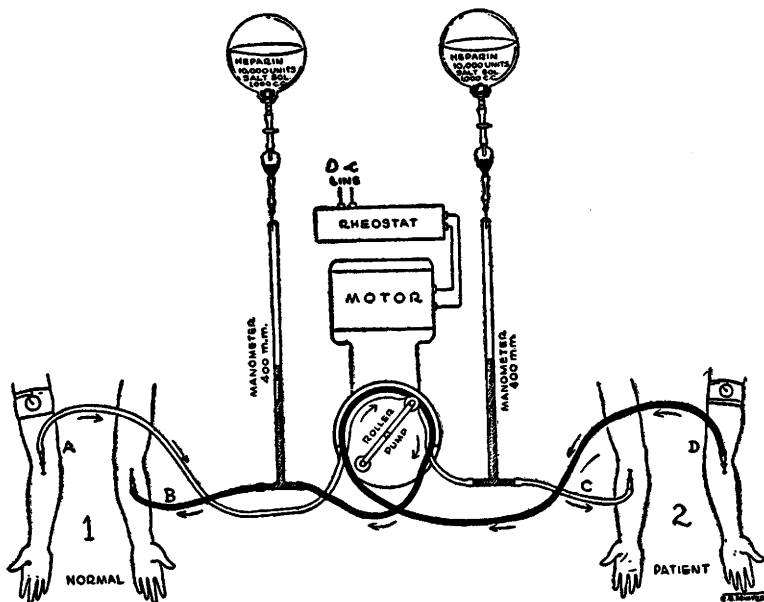


FIG. 1.

Diagram of the apparatus. 1A—delivering vein, 1B—receiving vein of the normal individual. 2D—delivering vein, 2C—receiving vein of the uremic patient. The 2 tubes rest exactly superimposed in a semi-circle around the periphery of the roller pump.

minute. In neither study were there any untoward reactions, except a slight elevation of temperature in one of the normal donors, attributed to a large hematoma having occurred when the needle escaped from the receiving vein.

Clinically both patients seemed improved. In Table I are listed the average hourly excretion of nitrogen in the urine of the two patients and the normal persons, as an example of the metabolic changes induced by the reciprocal transfusions. Further observations by this method, now under way, may help to elucidate obscure points in various metabolic disorders and perhaps make it possible to afford some relief during acute, though transient, incapacitations of the urinary apparatus.

TABLE I.  
Total Nitrogen Excretion (mg per hr) in the Urine of the 2 Uremic Patients and the 2 Normal Donors Before, During and After the Reciprocal Transfusion.

Period	Nitrogen Excretion (mg per hr)							
	Uremic Patient (M.B.)				Normal Donor (A.P.)			
	Total N	Urea N	Uric Acid	Creatinine	Total N	Urea N	Uric Acid	Creatinine
12 hrs prior to transfusion	230	190	5.6	13.5	306	232	3.9	21.4
4 $\frac{5}{6}$ hr including transfusion period	322	229	5.6	16.8	471	428	15.0	32.5
Subsequent 6 hr	301	246	4.6	18.8	342	316	8.0	30.0
6-18 hr after transfusion	253	227	—	15.1	399	356	—	31.4
	Uremic Patient (S.C.)				Normal Donor (E.C.)			
13 hr 55 min prior to transfusion	319	262	2.6	13.5	398	340	1.0	16.5
3 $\frac{3}{4}$ hr including transfusion period	478	339	4.3	16.3	486	412	6.3	—
6 hr following this period	191	118	1.3	10.0	302	173	6.3	30.0
Subsequent 6-19 $\frac{1}{2}$ hr period	262	228	1.9	—	378	239	4.6	20.0