Simultaneous Dialyses Using The Sweden-Kolff Kidney

A Comparison with the Single Patient Use of a Kolff Travenol Unit.

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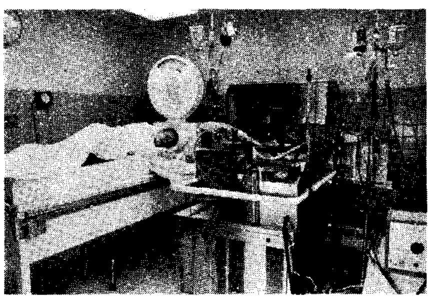
Hemodialysis for treatment of patients in actue renal failure was begun at the University of Minnesota Hospitals in 1954 employing the Kolff Rotating Drum dialyzer until 1958 when a Travenol Twin Coil Artificial Kidney was purchased. In 1963, the program was expanded to include intermittant hemodialysis for preparation and support of patients in our homotransplantation program, and for this purpose a Kiil dialyzer employing a Sweden Freezer 385L. reservoir tank was purchased. Difficulty in assembly and time involved in maintenance of this equipment rendered its use impractical for our limited program, and the Kiil unit saw little use until 1965 when its 385L. reservoir tank was modified to allow simultaneous dialysis of two patients using two Travenol Twin Coils.

This report represents the results of hemodialysis using our modified Sweden-Kolff unit and compares the efficiency of this method with that of the original Travenol Twin Coil unit.



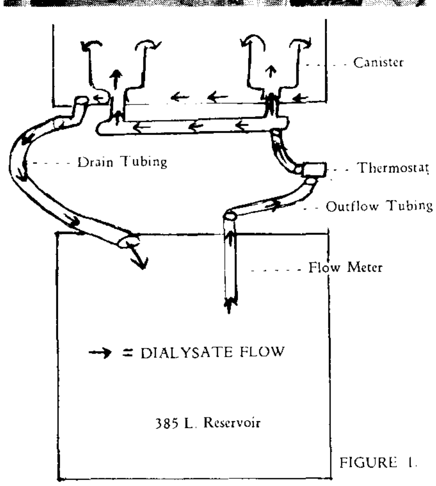


FIGURE 1.

Schematic illustration of the University of Minnesota Modified Sweden Freezer Tank for simultaneous hemodialysis of two patients with the Kolff twin coil dialyzer.

Technical Considerations of the Dialysate Tank

The Sweden Freezer tank has been modified by addition of a stainless steel tank placed on top of the reservoir behind the washer motor. In this upper tank are two cannisters into which the Twin Coils are placed. Dialysate is pumped from the reservoir tank through a flow meter and thermostat to a "Y" coupling which distributes the fluid to the two coils. (See figures 1 & 2). Both coils can be bathed simultaneously, or one side can be stoppered and a single patient dialyzed. In addition a thermostatically controlled heating element has been placed inside the reservoir tank.

Clinical Studies

Since October 1965, approximately 400 hemodialyses have been performed with this modified Sweden-Kolff unit. Through June 1966, a total of 25 patients have been chronically maintained with an average of 24 dialyses per patient using this system. Average length of dialysis was 4 hours. Blood flow through the dialyzer circuit averaged 180 ml./min. (range 140-225 ml./min.) Blood pumps used were the Sigma-motor Finger Type pump (October, 1965 - January, 1966) and Travenol UA14 Roller Type pumps from January, 1966 - June, 1966. Standard bath composition for the 385 L. tank was adjusted from the standard composition of the 100L. Twin Coil tank as follows: lactic acid, 108 cc; dextrose, 1925 gm; sodium chloride, 2195 gm; sodium bicarbonate, 1155 gm; magnesium chloride, 38.5 gm; potassium chloride, 116 gm; calcium chloride, 77 gm. (readjusted because our city water contains 1.5 - 3. 0 mg. calcium). Variations made according to patients' needs included greater concentration of dextrose, lowered sodium, and lowered potassium.

Bath circulation through the dialyzer, determined by a float type flow meter, was 10 L./min. or 5/min. per patient for two simultaneous dialyses. When only one patient was being dialyzed one cannister inflow was covered with a stainless steel cap thus enabling the total 10 L./min. circulation for one coil. With few exceptions the bath was not changed during dialysis. Temperature of the bath was maintained at 37° - 39° C.

Results and Discussion

Fifteen patients were inculded in this study. Criteria for inclusion of a patient were 1)40-70 kilogram weight, and 2) dialyzed on both the Kolff and Sweden-Kolff units.

Table I shows the comparative effects of our methods expressed in percent of predialysis values of urea and creatinine. With simultaneous dialysis of two patients for four hours the BUN and creatinine were respectively reduced to 46% and 51% of the predialysis value. Utilizing the 385 L. tank for dialysis of one patient for four hours average reduction of the urea and creatinine was to 41% and 46% respectively. After 2 or 3 initial dialyses average predialysis value for all patients 120 mg. % for urea and 13.0 mg. % for creatinine.

Studies on urea and creatinine dialysance based on optimal blood flow of 180-220 ml./min. with varying bath flows are summarized in Table II. Increased bath flow effected increased dialysance up to 10 L./min. which was the upper limit of our study.

The difficulty in evaluating hemodialyzers with regard to urea clearance and creatinine clearance has been previously demonstrated. (1) Clearance rates are dependent upon the diffusion gradient across the membrance, bath flow rate, blood flow rate, predialysis blood levels and patient size. (2, 3) In addition the Travenol Twin Coil has a variable internal resistance. Inflow pressures may differ by as much as 65 mm. Hg. (2) These variations may be related to tightness of coil winding or wrinkling of the fiber glass mesh. It has been well documented that optimum blood flow rate for the Twin Coil is 200 ml/min. (3, 4, 5) Kolff's study indicated that a dialysate flow rate of at least 3 L./min. is required, (4) while Meyer et al reported that with a dialysate flow rate of 6-8 L./min. the mean dialysance of urea is 110 ml/min. (2) In two studies Freeman, Maher et al reported optimal dialysance with the Twin Coil at a dialysate flow rate of 9 L./min., (6) with urea dialysance of 130 ml/min, and creatinine dialysance of 100 ml/min. (7)

At 3 L/min. our results show only 83 ml/min. urea dialysance and 66 ml/min. creatinine dialysance, values which are considerably less than those of 102 my/min. and 86 ml/min. obtained at 10 L/min. dialysate flow rates. With simultaneous dialysis of two patients, dialysate to each coil is reduced from the single patient value of 10 L/min. to only 5 L/min. At optimum blood flow this decrease in dialysate rate resulted in a 10 to 15% decrease in clearance through each coil.

Recently we eliminated the flow meter and replaced it with a continuous length of tubing from the dialysate pump to the thermostat. This has increased our dialysate flow to 14 L/min. or 7 L/min. per patient for two simultaneous dialyses.

Effectiveness of dialysis as expressed by percentage predialysis urea and creatinine values with the Twin Coil varies slightly. In an initial study, Freemen, Maher, et al found urea and creatinine reduced to 35% and 46% respectively, (6) while two years later they found urea and creatinine reduced to 41% and 49% respectively. (7) However, duration of dialysis was not given. Our results with the Travenol Twin Coil Kolff unit show average reduction to 36% for urea and 43% for creatinine for a four-hour dialysis.

We have employed the Sweden-Kolff unit for one year and have found many advantages over the Travenol Kolff, principally in economy in time and personnel. Our unit consists of two rooms with limited space on different nursing stations. Utilizing the Travenol unit one nurse and one technician care for a single patient, whereas the same personnel care for two patients undergoing simultaneous dialysis with the Sweden-Kolff unit. Simultaneous dialysis also eliminates double shifts which were necessary with the Travenol unit. The 385L. tank eliminates bath changes except for patients with extremely high urea and creatinine values.

Disadvantages include the difficulty of dialyzing patients together whose chemical requirements vary significantly. These include use of a low sodium bath for a patient with hypertension and a high dextrose bath for a patient with fluid retention. This unit is also more difficult and time consuming to clean than the Travenol unit.

Summary and Conclusions:

Efficiency of the Sweden-Kolff Twin Coil unit utilizing simultaneous dialysis of two patients was compared with the single patient unit. Dialysance studies showed two patient dialysis for four hours to be less efficient due to less than optimal dialysate flow. Five-hour dialysis, begun about three months ago, show the BUN and creatinine reduced to 43% and 49% respectively of pre-dialysis values, clearances only slightly lower than those of the Travenol unit used on a single patient. Studies in progress employing a further increase in dialysate flow rate indicate the possibility of further reducing or eliminating this difference. Where space is limited, utilization of the Sweden 385L. reservoir with Kolff Twin Coils for simultaneous dialyses results in economy in time and personnel.

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COMPARATIVE EFFECTIVENESS OF KOLFF UNIT AND SWEDEN—KOLFF UNIT

TABLE I

Kidney Machine	No. of Dialyses	No. of Hours	(Average Reduction as % of Predialysis Value) % BUN	% Creatinine
Kolff	49	4	36	43
Sweden-Kolff-2 pts	89	4	46	51
Sweden-Kolff-2 pts	20	5	43	49
* Sweden-Kolff-2 pts	6	6	39	47
Sweden-Kolff-2 pts	32	4	41	46
Sweden-Kolff-1 pt	7	5	38	45

* Average weight was 61 kg.; other results - average weight was 53 kg.

TABLE II

EFFECT OF BATH FLOW ON DIALYSANCE

FLOW RATE	BUN	Creatinine
3 L/ min.	83 ml/min.	66 ml/min.
5 L/ min.	95 ml/min.	75 ml/min.
10 L/ min.	102 ml/min.	86 ml/min.

Blood flow rate: 180-220 Ml./Min.