

THE ROLE OF THE ARTIFICIAL KIDNEY IN CORRECTING SERUM ELECTROLYTE ABNORMALITIES IN RENAL FAILURE

Report of Four Representative Cases

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AT the Cleveland Clinic Hospital, from January 1, 1957, to September 20, 1960, a total of 651 dialyses was performed on 258 patients with either acute or chronic renal failure. The Kolff disposable twin-coil artificial kidney was used. Often, the correction of serum electrolyte abnormalities was either a primary or a secondary reason for initiating dialysis. *Table 1* shows the number of patients in whom the serum electrolyte concentrations were either abnormally high or low before dialysis. The possibility of correcting the electrolyte abnormalities with the artificial kidney is well known. *Table 2* summarizes the results^{1,2} of the 64 first dialyses performed for acute renal failure in 1957 and 1958. Serum potassium values were within normal limits after 63 of the 64 dialyses. When serum electrolyte values did not return to within the normal range during the first dialysis, they usually did so, after the second or third dialysis.

Table 1.—*Serum electrolyte data at the onset of 651 dialyses on 258 patients*

Number of determinations	Serum electrolyte	Concentration, mEq./l.
13	Sodium	> 145
57	Sodium	< 125
26	Potassium	> 7.0
25	Potassium	< 3.5
5	Chloride	> 110
150	Chloride	< 90
10	Carbon dioxide content	> 30
238	Carbon dioxide content	< 20

Four representative case reports are presented to illustrate the effectiveness of the disposable twin-coil artificial kidney in correcting electrolyte abnormalities in patients with renal failure. Since each patient had multiple abnormalities in the serum electrolytes, the one or two outstanding deviations are indicated for each case.

This study was prepared under the guidance and sponsorship of W. J. Kolff, M.D., Head of the Department of Artificial Organs.

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Table 2.—*Status of electrolytes in 64 patients with acute renal failure, before and after the first dialysis*

Number of patients with abnormal electrolyte content		Serum electrolyte	Normal range, mEq./l.
Before	After		
24	9	Sodium	130-145
15	1	Potassium	3.5- 5.5
34	3	Chloride	90-110
42	10	Carbon dioxide content	20- 30

Four Representative Case Reports

Case 1. *High serum potassium and low serum carbon dioxide content.* A 15-year-old boy was admitted to the Cleveland Clinic Hospital because of progressive weakness, oliguria, and generalized edema that developed six weeks before admission. For the past year he had a backache and had also lost 40 pounds in weight. Two days after admission he underwent dialysis and ultrafiltration with the twin-coil artificial kidney, and a pronounced improvement occurred in the serum potassium concentration (*Table 3*). Temporary clinical improvement followed, but the glomerulonephritis was beyond recovery, and he died several weeks thereafter.

Case 2. *High serum sodium content.* A 39-year-old woman underwent surgical repair of an interatrial septal defect that had been symptomatic for many years. The post-operative course was normal for five days, and then a fever developed, also generalized edema, oliguria, and signs of toxic psychosis. The cause of distress or renal failure was never explained. The patient had no history of renal disease, hypertension, or other predisposing factors. To control the fever, she was placed under artificial hibernation,³ and to reduce the edema and the high serum sodium content, she was treated with a three-hour dialysis with ultrafiltration. The only explanation for the high serum sodium content may be that dextrose was administered in saline solution instead of in water. The electrolyte concentrations before and after dialysis are listed in *Table 3*. The most remarkable change was the lowering of the serum sodium content; in a patient who is both overhydrated and anuric, it can be accomplished only by dialysis. Diuresis ensued several days after dialysis; by then, the electrolyte values were within normal limits, and her mental condition was greatly improved. The patient was discharged from the hospital and she is now in excellent health.

Case 3. *Low serum sodium and low serum chloride content in the presence of edema.* A 40-year-old man was admitted to the hospital in acute distress. He had a long history of chronic renal insufficiency associated with hypertension, anemia, and azotemia. On the day of admission he underwent dialysis and ultrafiltration with the twin-coil artificial kidney.

After dialysis, an immediate increase occurred in the serum sodium and the serum chloride concentrations (*Table 3*). If correction of the electrolyte abnormality had been attempted without dialysis and ultrafiltration, cardiac failure and pulmonary edema would certainly have resulted. After dialysis his clinical condition improved considerably, although oliguria persisted. To stabilize improvement, he was given four more dialyses before he was discharged, and then 14 additional dialyses on an outpatient basis (through a Teflon arteriovenous shunt fastened in his arm). He was able to engage in most normal activities; the daily urinary output never exceeded 200 ml. The electrolyte values remained within normal limits. Approximately six weeks after his discharge he died suddenly of cardiac failure and pulmonary edema.

Case 4. Low serum potassium and low serum carbon dioxide content. A 30-year-old man was admitted to the hospital in a coma. Twelve years before admission he had been in an automobile accident and had sustained a ruptured bladder for which he underwent a suprapubic cystostomy and later a ureterosigmoid anastomosis. Subsequently, urinary tract infections developed and, in addition, chronic renal insufficiency. Two months before entering the hospital he had back pain, vomiting, weakness, and a low-grade fever. Upon admission to the Cleveland Clinic Hospital, he was comatose, febrile, and acidotic. He underwent dialysis for six hours with the twin-coil artificial kidney. The serum electrolyte values before and after dialysis are shown in *Table 3*. These values remained normal throughout his hospital course, but the fever, because of staphylococcal septicemia and multiple abscesses throughout the body, resisted all therapy, and he died nine days after admission.

Table 3.—*Correction of serum electrolyte values; values before and after the first dialysis on four patients (cases 1-4)*

Serum or plasma determination	First dialysis							
	Case 1		Case 2		Case 3		Case 4	
	Before	After	Before	After	Before	After	Before	After
Sodium, mEq./l.	140	136	172	148	115	129	127	127
Potassium, mEq./l.	9.0	4.5	4.1	4.2	4.5	3.9	2.9	4.6
Magnesium, mEq./l.	—	—	—	—	—	—	1.9	2.5
Chloride, mEq./l.	101	100	133	108	54	83	93	94
Phosphorus, mg./100 ml.	—	—	—	—	18.9	8.5	—	—
Carbon dioxide content, mEq./l.	7.4	17.2	19.5	18.9	18.9	25.9	11	18
Creatinine, mg./100 ml.	22.2	12.7	—	—	23.6	2.2	1.8	1.0
Blood urea, mg./100 ml.	420	220	143	95	—	—	—	—

Conclusion

Six hundred fifty-one treatments with the twin-coil artificial kidney were performed on 258 patients at the Cleveland Clinic Hospital from January 1, 1957, to September 20, 1960. Severe electrolyte disturbances were present before dialysis in nearly one half of the cases. The twin-coil artificial kidney is an effective means of correcting abnormalities of serum electrolytes, whether the values are too high or too low before dialysis.

1. Kelemen, W. A., and Kolff, W. J.: Evaluation of management of acute renal failure with dialysis. *A.M.A. Arch. Int. Med.* 102: 871-880, 1958.
2. Kelemen, W. A., and Kolff, W. J.: Survey of dialyses for acute renal failure at Cleveland Clinic Hospital in 1958. *Cleveland Clin. Quart.* 26: 227-234, 1959.
3. Kolff, W. J.: Artificial hibernation; technic, and observations on seriously ill patients. *Cleveland Clin. Quart.* 22: 109-123, 1955.