

MEDICAL GRAND ROUNDS  
PARKLAND MEMORIAL HOSPITAL  
November 29, 1962

DIALYSIS IN CHRONIC RENAL DISEASE

Case 1. [REDACTED] - Polycystic disease with hypertensive cardiovascular disease.

This 50 year old [REDACTED] had the diagnosis of polycystic kidney disease made in 1943. First seen in this hospital in [REDACTED], 1960 with hematuria, BP then 170/110. Several admissions followed during which time decreasing renal function was noted. By [REDACTED], 1961 his BUN was 150 mg% and he manifested congestive heart failure with increased venous pressure and circulation time. His urine volume remained high (around 2000 cc/day). His 5th admission was [REDACTED] 1962 with acute pulmonary edema. BP 240/110, 2+ peripheral edema.

Lab. results:

	Hgb	BUN	CO <sub>2</sub>	CL	Na	K	Ca
Before dialysis	5.7	175	8.2	100	136	5.4	6.6
After dialysis	7.1	100	25	93	137	4.2	9.9

Dialysis resulted in a 23 pound weight loss. Twenty-four hour urine volume rose from 650 to 1500 ml per day. Dialysis consisted of 31 runs of 2 liters each. He did well until [REDACTED] 1962 at which time, because of return of his signs and symptoms of uremia he was readmitted. He again responded well to dialysis, but died suddenly just after dialysis was completed.

Case 2. [REDACTED] - Hypertensive cardiovascular disease with nephrosclerosis. Long remission after one dialysis.

This 75 year old [REDACTED] woman had been followed as an outpatient since 1957 with hypertensive disease and congestive heart failure. In [REDACTED] 1962 she was admitted with 3+ peripheral edema pulmonary edema, bilateral pleural effusion, mental confusion. BP 180/110. Urine volume prior to dialysis 200 ml per day.

Lab. results:

	Hgb	BUN	CO <sub>2</sub>	Cl	Na	K	Ca	P
Before dialysis	8.0	145	23	86	132	5.1	7.6	8.6
After dialysis	8.7	76	32	94	142	4.7	8.3	4.9

Weight loss as a result of dialysis 7.7 lbs. Urine volume after dialysis 800 ml plus/day. Six months after dialysis patient doing satisfactory.

Case 3. [REDACTED] - Malignant hypertension.

This 37 year old [REDACTED] female first found to have hypertension 5 years prior to admission. Three months prior to admission had the onset of progressive symptoms of malaise, lethargy, nausea, headache, and visual disturbances. For 2 months prior to admission PND, orthopnea, and peripheral edema were present. BP 260/130. Patient confused and anxious; orthopneic. Grade 4 eye grounds (K-W). Loud pericardial friction rub. 2+ peripheral edema. Venous pressure 33 cm - circulation time 22 sec. Urine volume 250 ml/day.

Lab results:

	Hgb	BUN	Creat.	CO <sub>2</sub>	Na	K	P
Before dialysis	5.9	138	10.5	20.1	120	3.7	12.4
After dialysis	9.9	27	4.1	26.9	132	4.6	5.5

Urine volume after dialysis never over 300 ml/day.

Despite an overall good response to dialysis, the patient expired with sudden respiratory arrest 8 days after dialysis.

Case 4. [REDACTED] - Urethral stricture resulting in hydronephrosis, pyelonephritis, hypertensive cardiovascular disease.

This 29 year old man was thought to have a congenital urethral stricture resulting in renal disease. He was first seen by us in late [REDACTED] 1960 with uremia with pericarditis and convulsions. Urine volume was 400 cc daily. He responded well to peritoneal dialysis, his urine volume increasing to 2000-2500 ml per day. Despite advanced renal disease and severe hypertension it was elected to undertake surgery to divert the urinary stream to an ileal pouch. This was carried out [REDACTED] 1961. He withstood the surgery well, but unfortunately, one ureter failed to function after surgery. Despite this, the remaining kidney sustained life for almost six months.

Case 5. [REDACTED] - Neurogenic bladder, hydronephrosis, hypertensive cardiovascular disease, pyelonephritis; repeated dialysis for 12 month period.

This 30 year old man sustained neurogenic bladder as a result of spinal cord trauma. Bladder dysfunction resulted in severe renal disease and insufficiency. First dialysis for uremia characterized by coma and convulsions in [REDACTED] 1962. Table summarizes his course. (see next sheet for Table).

### OUTLINE OF TREATMENT IN CHRONIC RENAL DISEASE

#### Dialysis

- Specifically for uremia or impending uremia.
- To reverse the venous congestive state or reduce edema in congestive heart failure.

#### Alkalization

- Daily administration of alkaline sodium salt.
- Most conveniently done by means of Shohl's Solution:

1 ml of this sol. contains  
1.0 mEq Na<sup>+</sup>.



100-140 gms Citric Acid  
98 grams Na Citrate  
H<sub>2</sub>O qs 1000 cc

- Daily dose varies from 30 to 90 cc per day.
- Doses should be diluted in sweetened water or ginger ale.
- Limitation obviously set by salt retention.

#### Diet

- Balance protein intake against alkaline intake to keep CO<sub>2</sub> content near normal.
  - Frequently requires protein restriction to not over 40 gms per day.

DATE	/61	/61	/61	/62	/62	/62	/62	/62	/62	/62	/62
Hgb	6.6	8.5	4.2	4.4	8.6	8.4	6.4	9.0	8.0	10.3	8.5
BUN	206	51	125	200	100	240	100	85	150	90	87
CO <sub>2</sub> Content	6.6	29	22	21	31	16	34	37	25	33	35
24 hr Urine Vol.	500	1500	-	700	1000	250	400+	500	875	240	50
[Na <sup>+</sup> ] s	120	145	137	138	137	133	138	142	130	141	138
[K <sup>+</sup> ] s	5.5	5.3	5.4	5.3	4.0	6.4	4.6	4.0	4.7	4.4	5.5
Coma and Convulsions		Peritoneal Dialysis	Outpatient visit - Shohl's Sol. & restricted protein intake	CHF Edema Stupor	Peritoneal Dialysis, Blood Trans, Digitalis	Pharyngitis, Coma and convulsions, aspiration pneumonia	Peritoneal Dialysis	Repeated Dialysis & Blood Trans.	Outpatient Visit	Peritoneal Dialysis	Last Peritoneal dialysis. Urine volume failed to increase 4/13/62

- b) Restrict NaCl intake to minimum.
  - 1) NaCl intake results in expansion of ECV and dilution of  $\text{HCO}_3^-$  resulting in hyperchloremic acidosis.

- c) Protein restriction adequately controls serum K concentration.

4. Blood administration.

- a) Usually can be given during periods of dialysis.
- b) Attempt to keep Hct. 28-30%.
- c) Raising Hct. to levels higher than 30% appears unnecessary and the increased Hct. lasts for very short periods of time.

5. Continue digitalis administration as indicated.

- a) Digoxin preferred drug.
- b) Discontinue administration during oliguria.

6. Prophylactic administration of penicillin.

- a) Prevents streptococcal and pneumococcal infection.

PERITONEAL DIALYSIS AS USED IN CHRONIC RENAL DISEASE

1. Use commercially available solutions and peritoneal catheters.

- a) Composition of solution:

Sodium	140 mEq/L
Chloride	101 mEq/L
Calcium	4.0 mEq/L
Magnesium	1.5 mEq/L
Lactate	45 mEq/L
Glucose	15 gms/L

2. For removal of edema, add glucose (as 50% sol.) so that final concentration is from 3 to 5%.

- a) Diabetics that may ordinarily not require insulin will require frequent blood sugar determinations and treatment with insulin to keep blood sugar below 500 mg%.

- b) Cycle dialysis of fluid at 30 min. for rapid removal of edema.

3. If serum potassium 4.0 mEq/L or less, add KCl to dialysis fluid to make final 2 L concentration 4 to 4.5 mEq/L.

4. Add 5 ml 2% procaine to 2 L dialysis fluid to reduce peritoneal pain.

5. Heat unopened liter bottles of dialysis fluid in water bath to near body temperature.

- a) Make additions of glucose, potassium, procaine etc. after bottles are heated just before administration.

6. To specifically remove products of uremia and correct acidosis cycle dialysis fluid every 1 to 1-1/2 hours.



7. Ordinarily, 25-30 two liter runs bring BUN concentration below 100 mg%, corrects acidosis, and removes edema.
8. Recommended that tincture of iodine be used as the only antiseptic agent.
  - a) To swab tops of dialysate bottles before additions are made.
  - b) To prep patient's abdomen prior to insertion of peritoneal tube.
  - c) To bathe connections between peritoneal tube and administration sets as each 2 liters of fluid is given.
9. Recommended that sterile rubber gloves be worn to:
  - a) Prepare bottles of dialysate fluid.
  - b) Break and remake connection between administration set and peritoneal tube.
  - c) Change abdominal dressing.
  - d) Make any adjustment of peritoneal tube.

#### COMPLICATIONS OF PERITONEAL DIALYSIS

1. Bleeding
  - a) Frequently first two or three runs return bloody. Hct. of this fluid usually less than 5%.
  - b) Bleeding may be more active and continuous reducing blood Hct.
  - c) Bleeding apparently occurs from abdominal wall and under no circumstances is it an indication to stop dialysis.
2. Pain
  - a) Usually controlled by the use of procaine in dialysis fluid.
  - b) May rarely require the use of demerol.
  - c) Most always lessens as dialysis continues.
3. Failure of rapid or complete drainage of peritoneal fluid.
  - a) Peritoneal tube very seldom becomes plugged to the extent that fluid cannot be run into peritoneal cavity.
  - b) Early, clotted blood may plug peritoneal tube.
  - c) Best procedure to follow with malfunctioning peritoneal tube is to replace it, either in same hole or new abdominal hole.
4. Leakage around peritoneal tube.
  - a) Does not preclude good dialysis result.
  - b) Leakage usually slows down or stops as dialysis continues.
5. Peritoneal infection.
  - a) Incidence very markedly reduced by making use of good antiseptic technique.
  - b) Abdominal tenderness even with rebound tenderness does not necessarily mean infection.
  - c) Examination of spun sediment of peritoneal fluid discloses, during infection, very many bacteria (too numerous to count) together with many polys.
  - d) Many polys may be seen in dialysate fluid from time to time (giving fluid a slightly cloudy appearance) without other sign of infection and requires no specific therapy.

- e) Cultures of peritoneal fluid always positive with peritoneal infection, but from time to time will be positive without other sign of infection. This requires no treatment; is apparently due to the normal transgression of bacteria across the peritoneal surfaces.
- f) Therapy for peritoneal infection:
  - 1) Chloromycetin - give normal parenteral dose. In addition, add 250 mg to dialysis run.
  - 2) Alter antibiotic therapy to comply with culture and sensitivity studies.
  - 3) Continue dialysis. Use narcotics for peritoneal pain if necessary. Bowel distention usually not a problem if dialysis is continued. Recovery within 24 hours usual (Burnett, W.E., Brown, G. R., Jr., Rosemond, G. P., Caswell, H. T., Buchor, R. B. and Tyson, R.R. The treatment of peritonitis using peritoneal lavage. Ann. Surg. 145:675, 1957).

### SUMMARY

For the present, the role of dialysis in chronic renal disease would seem to be the treatment of uremia. Its use to forestall the uremic syndrome in those patients who have no renal function must be regarded as an entirely experimental technique not applicable to the ordinary treatment unit of the average modern hospital.

Dialysis, when used to help low functioning kidneys reverse the uremic state is a practical, worked-out, therapeutic method that should be universally used within the following limits.

1. All patients with chronic renal disease, regardless of the type of kidney disease, regardless of the attendant so-called complications should be dialyzed at least one time.
2. If a remission of at least one month is forthcoming, then dialysis should be repeated. Within this framework, a program of prophylactic dialysis may be carried out to the great benefit of the patient.
3. It appears that peritoneal dialysis is a safe, efficient and entirely satisfactory method of treatment of these patients. It precludes the problem of vessel shunts, etc., of skilled teams of operators, and of special physical facilities.
4. No single finding in the uremic patient, eg. azotemia, acidosis, urine volume, blood pressure, heart size, can be used as a guide to judge which patient shall benefit by at least a month's remission following dialysis.
5. Some findings in the uremic patient suggest a favorable response to dialysis.
  - a) Relative polyuria prior to dialysis.
  - b) Absence of hypertension.
  - c) Absence of congestive heart failure (not to be confused with the venous congestive state).
  - d) An element of pre-renal dysfunction not related to cardiovascular disease.
    - 1) Obstructive uropathy, common particularly in older males.
    - 2) Acute extracellular volume deficit - frequently due to vomiting.
    - 3) Venous congestive state; resulting from anemia and over-expansion of extracellular volume.
    - 4) Acute infection, particularly kidney infection.

## REFERENCES

1. Alwall, N. and Herner, B.: On the artificial kidney. VI. Acta. med. Scand. 132:572, 1949.
2. Alwall, N.: On the artificial kidney. X. On the after-course of 24 cases treated with dialysis. Acta. med. Scand. Suppl. 229:16, 1949.

A very early report on the use of the artificial kidney in chronic renal disease. Alwall recognized what he called the "vicious cycle" of chronic renal failure, eg. by the presence of uremia, the patient of chronic renal disease may suffer further loss of renal function. The cycle, in some instances can only be broken by dialysis. It should be pointed out, however, that the pre-renal deviations incident to renal failure, and no uremia, per se, are the mechanism of the so-called vicious cycle. Clinical data were given on 16 patients with chronic renal disease. Concluded that dialysis could significantly prolong life in this condition.

3. Merrill, J. P., Smith, S., Callahan, E. J., and Thorn, G. W.: The use of an artificial kidney. II. Clinical experience. J. Clin. Invest. 29:425, 1950.

A very early evaluation of the place of the artificial kidney in the treatment of uremia in chronic renal disease. These authors thought that the following circumstances in chronic renal disease might be indications for the use of artificial kidney:

1. In acute exacerbation of chronic glomerulonephritis.
2. Where proper dietary management is impossible because of continued anorexia, nausea and vomiting.
3. To prepare an uremic patient for surgery where the surgery was to correct a defect that was impairing renal function.

4. Merrill, J. P.: The treatment of renal failure. Grune & Stratton, New York, 1955.
5. Merrill, J. P.: The use of the artificial kidney in the treatment of glomerulonephritis. J. Chron. Diseases 5:138, 1957.
6. Merrill, J. P.: The artificial kidney, Arch. Int. Med. 106:143, 1960.

After Merrill's first report describing results of dialysis in chronic renal disease, there was an apparent change in his mind for the usefulness of this procedure in chronic disease. His views are by far the most conservative of those persons engaged in dialysis programs. Nevertheless, as late as 1960, he upholds his indications for dialysis in chronic renal disease as being those given under reference 3 above.

7. Goldner, F., Gordon, G. L. and Danzig, L. E.: Use of artificial kidney in chronic renal disease. Arch. Int. Med. 93:61, 1954.

The Kolff-Brigham rotating drum kidney was used in these studies. A total of 20 dialyses were carried out in 15 patients. The patients exhibited a wide variety of kidney diseases. Only a small number of long remissions were obtained.

Factors which appeared to predispose to a prolonged remission according to these authors:

1. A general symptomatologic and chemical "plateau".
2. Absence of generalized vascular disease even though hypertension is present.
3. No overwhelming infection nor septicemia.
4. Polyuria.
5. Predialysis serum sodium level above 130 mEq/L.

(Of these, only #2 and #4 are of prognostic value. #3 is perhaps an indication for dialysis. #5, oft-quoted, has little meaning or value).

8. Palmer, R. A., Price, J. D., English, E. T., and Thomas, N.: Clinical trials with the Kolff twin coil artificial kidney. *Canad. M. A. J.* 77:850, 1957.

Here it is reported that dialysis was carried out in two patients with chronic nephritis with good immediate results. Neither patient survived for more than a few days. Interestingly, one patient, 47 years old with known renal disease for 30 years had a relative polyuria prior to dialysis (1800-2000 ml/day). Despite this he became anuric after dialysis. He also developed hyperkalemia during dialysis (Serum  $[K^+]$  4.8 to 7.4 mEq/L). Although not reported, hemolysis may have occurred during dialysis perhaps sufficient to impair renal function.

9. Parsons, F. M. and McCracken, B. H.: The artificial kidney. *Brit. J. Urol.* 29:424, 1957.

With a Kolff-Brigham kidney these authors dialyzed 8 patients with chronic renal disease. Without giving any data, they state that the remission was satisfactory in only one patient. They concluded that there was little indication for the use of the artificial kidney in chronic renal disease.

10. Parsons, F. M.: Hemodialysis; Indications and results. *Postgraduate Med. J.* 35:625, 1959.

It is interesting that as late as 1959, one of the leading proponents of hemodialysis in Europe fails to mention the use of the artificial kidney as a adjunct to therapy in chronic renal disease.

11. Shackman, R. and Milne, M. D.: The use of the artificial kidney. *Brit. J. Urol.* 29:434, 1957.

Without giving data, the role of the artificial kidney in the treatment of chronic renal disease was minimized almost to the point of extinction.

12. Schreiner, G. E.: The artificial kidney. *Heart Bull.* 8:42, 1959.

Advocated dialysis in chronic renal disease only in selected patients; primarily those with a pre-renal deviation. States that remissions are generally too short to warrant the use of the artificial kidney.

13. Doyle, J. E.: Extracorporeal hemodialysis therapy in blood chemistry disorders. pp. 141-158, Charles C. Thomas, Springfield, 1962.

14. Doyle, J. E., Anthone, R., Anthone, S. and McNeill, A. E.: Technic with parallel flow, straight tube blood dialyses. *New York State J. Med.* 59:4149, 1959.

These two reports concern the treatment of patients with chronic renal disease with the McNeill-Collins artificial kidney.

Twenty-five patients were dialyzed. Nineteen of these died during their hospitalization. The average length of survival after dialysis was 2 weeks; the longest was six months.

These authors concluded that dialysis in chronic renal disease should be reserved for those patients that have minimal vascular disease, an obviously reversible uremic state, or require surgery.

15. Aoyama, S. and Kolff, W. J.: Treatment of renal failure with the disposable artificial kidney. *Am. J. Med.* 23:565, 1957.

In this report are included the results of dialysis in 23 patients with chronic renal disease. It was concluded that treatment of patients with malignant hypertension was hopeless. One patient with polycystic disease had an 8 month remission. The average improvement in all patients was 7 weeks, a somewhat longer time than previously reported by other workers dealing with a rather unselected group of patients.

16. Nakamoto, S. and Kolff, W. J.: Chronic uremia due to polycystic renal disease treated with the artificial kidney. Arch. Int. Med. 101:921, 1958.

Dialysis by means of the artificial kidney resulted in long remissions for some patients with polycystic disease having little in the way of vascular disease. As a group then, this type of patient should always be given a trial of dialysis when clinical uremia appears.

17. Kelemen, W. A., Kolff, W. J.: Use of artificial kidney in the very young, very old, and very sick. J.A.M.A. 171:530, 1959.

Although not specifically concerned with chronic renal disease, this paper puts forth an opinion that pertains well to patients with chronic renal disease:

Dialysis should be undertaken:

1. Even though the recoverability of the patient is in doubt.
2. Early, particularly if the patient is extremely ill.
3. When the underlying diagnosis is in doubt and much of the clinical picture is a result of the uremic syndrome.

18. Kelemen, W. A. and Kolff, W. J.: Evaluation of dialysis in treatment of chronic renal failure. Arch. Int. Med. 5:608, 1960.

The most important prognostic sign, according to these authors, is the 24 hour urine volume. If the volume reaches 1500 ml/day prognosis is good and a long remission is to be expected. The degree of azotemia and acidosis were of less prognostic importance. It was noted, however, that patients with a high serum creatinine and phosphorus concentration in general did poorly.

It should be pointed out that the best prognostic sign can usually only be evaluated after dialysis. The urine volume prior to dialysis is not a good prognostic sign, although a high volume is usually accompanied by a longer remission.

19. Grollman, A.: Acute Renal Failure. Charles C. Thomas, Springfield, 1954.
20. Maxwell, M. H., Rochney, R. E., Kleeman, C. R. and Twiss, M. R.: Peritoneal dialysis. J.A.M.A. 170:917, 1959.
21. Doolan, P. D., Murphy, W. P., Wiggins, R. A., Carter, N. W., Cooper, W. C., Watten, R. H. and Alpen, E. L.: An evaluation of intermittent peritoneal lavage. Am. J. Med. 27:831, 1959.
22. Boen, S. T.: Kinetics of peritoneal dialysis, a comparison with the artificial kidney. Medicine 40:243, 1961.

These 4 references form the basis of the clinical practice of peritoneal dialysis as it is now carried out. References 20 and 21 describe methods using special peritoneal catheters that were designed for easy placement and to decreasing the incidence of blockage during draining. Although touched upon in reference 21, reference 22 has the



most data regarding the electrolyte and water movements during peritoneal dialysis.

23. Cleve, E. A., Smith, F. P. and Hensler, N. M.: Peritoneal dialysis in renal failure. Am. J. Med. Sci. 240:319, 1960.

In this study, 4 patients with chronic renal disease were dialyzed. The longest survival time, however, was only 45 days.

They performed peritoneal dialysis in 2 patients immediately following intra-abdominal surgery without ill effect. In all cases, antibiotics were used and there were no infections.

24. McCaughan, J. J., Jr. and McGown, C.: Intermittent peritoneal lavage. Am. J. Surg. 102: 519, 1961.

Reports the use of peritoneal dialysis in 8 patients with chronic renal disease. One patient with chronic glomerulonephritis was carried for 8 months during which time 3 peritoneal dialyses were carried out.

The authors state that by means of repeated peritoneal dialysis, it is conceivable that patients with chronic renal disease may be treated for long periods of time and have a prolongation of life.

25. O'Brien, T. F., Baxter, C. R. and Teschan, P. E.: Prophylactic daily hemodialysis. Trans. Am. Soc. Art. Internal Organs 5:77, 1959.

This work showed: 1) The feasibility of semi-permanent cannulization of artery and vein. 2) Uremia could be prevented in oliguric patient by sufficient dialysis. It was these two concepts that were later elaborated on by other workers first in situations of acute renal failure, then in chronic renal failure.

26. Teschan, P. E., O'Brien, T. F., and Baxter, C. R.: Prophylactic hemodialysis in the treatment of acute renal failure. Ann. Int. Med. 53:992, 1960.

27. Alwall, N., Norvitt, L. and Steins, A. M.: On the artificial kidney. VII. Acta. med. Scand. 132:587, 1949.

First description of external by-pass circulation between artery and vein. Fistula consisted of glass tube. The major drawback was that this A-V shunt required that there be total body heparinization at all times.

28. Quinton, W., Dillard, D. and Scribner, B. H.: Cannulation of blood vessels for prolonged hemodialysis. Trans. Am. Soc. Art. Internal Organs 6:104, 1960.

This is the original report of the technical advance that has allowed prolonged intermittent hemodialysis. The novelty of the method utilized teflon cannulas which could be heat formed to fit the available vessels in the patient's arm. The A-V shunt between the cannulas was also of teflon. The blood flow through the cannulas during dialysis was from 60 to 130 ml/min. The estimated volume of A-V shunt between dialyses was 200 ml/min. The major drawback in the use of teflon as the cannulating material was its almost total lack of flexibility. Often, external pressures to the cannulas caused internal injuries to the cannulized vessels.

29. Scribner, B. H., Caner, J. E. Z., Buri, R. and Quinton, W.: The technique of continuous hemodialysis. Trans. Am. Soc. Art. Internal Organs 6:88, 1960.



This is a description of the dialysis method first used with the indwelling A-V shunts in both acute and chronic renal disease.

Important points:

1. Modified Skeggs-Leonard artificial kidney used.
2. No blood pump used - in an effort to avoid both hemolysis and thrombocytopenia
3. Dialysis bath 300 L volume.
4. Dialysis fluid cooled to between 0° and 4° C. in an effort to reduce heparin requirements and in order to prevent bacterial growth in dialysate fluid.
5. Dialysis period 24 hours. 300 L dialysis bath used for 24 hour period.
6. Emphasized that dialysis could be adequately monitored by specially trained nurses.

30. Scribner, B. H., Buris, R., Canes, J. E. Z., Hegstrom, R. and Burnell, J. M.: The treatment of chronic uremia by means of intermittent hemodialysis: A preliminary report. Trans. Am. Soc. Art. Internal Organs 6:114, 1960. Rosenbloom, J. K., et al., J. Exper. Med. with A-V shunt cannulas for repeated dialyses. Trans. Am. Soc. Art. Internal Organs 7:57, 1961.

The first report of the Seattle group regarding the use of their dialysis method together with the teflon shunts in patients with chronic renal disease. Brief report on 2 patients. Dialysis about every 7 days. Biggest problem seemed to be with the "permanent" indwelling teflon cannulas which frequently became infected and/or thrombosed.

31. Pendras, J. P., Cole, J. J., Tu, W. H. and Scribner, B. H.: Improved technique of continuous flow hemodialysis. Trans. Am. Soc. Art. Internal Organs. 1:27, 1961.

The two major improvements in the dialysis method had to do with the artificial kidney:

1. The Skeggs-Leonard artificial kidney was further modified in order to decrease its internal resistance.
2. The Kiil kidney replaced the Skeggs-Leonard kidney.

Ultimately, the Kiil kidney became standard equipment for this technique.

Comparison of artificial kidneys:

Type of Kidney	Hrs. of dialysis	Total Urea clearance in liters
Skeggs-Leonard	24	53.1
Kiil	24	79.6
Kolff twin-coil	6	54.7
Kolff-Brigham	6	57.6

Thus 24 hours of dialysis at low blood flow rates with the artificial kidney cooled to 0° C is about equal to conventional dialysis of 6 hours duration. Note the over-all superiority of the Kiil kidney.

32. Hegstrom, R. M., Quinton, W. E., Dillard, D. H., Cole, J. J. and Scribner, B. H.: One year's experience with the use of indwelling teflon cannulas and by pass. Trans. Am. Soc. Art. Internal Organs 7:47, 1961.

An early report giving results in four patients with chronic renal disease. The most successful cannulation lasted 8 months; 2 lasted 7 months; one only 4-1/2 months. Malposition and kinking of cannulas was the most common problem. Apparently there were other attempts at cannulation that were not so successful. In any event, these results with teflon cannulas made it imperative to find another material for cannulation.

33. Chisholm, G. D.: The Scribner arteriovenous fistula for hemodialysis. Brit. Med. J. 2:30, 1961.

The teflon cannulas with teflon shunt were used in 10 patients with acute renal failure for 24 dialyses. The only complication was infection at the wound site in one individual that resulted in septicemia. Concluded that the method was of great help in treatment of acute renal failure. No mention of use in chronic disease.

34. Quinton, W. E., Dillard, D. H., Cole, J. J. and Scribner, B. H.: Possible improvements in the technique of long-term cannulation of blood vessels. Trans. Am. Soc. Art. Internal Organs 7:60, 1961.

This is but a mere mention that the Seattle group was trying to adapt silicone rubber for use as the cannulating material. Ultimately, silicone rubber proved far superior to teflon for this purpose.

35. Nakamoto, S., Brandon, J. M., Franklin, M., Rosenbaum, J., Kolff, W. J.: Experience with A-V shunt cannulas for repeated dialyses. Trans. Am. Soc. Art. Internal Organs 7:57, 1961.

A one year's experience in using teflon cannulas. Fourteen patients acute renal failure; 27 patients chronic renal disease. The average clot-free period for patients with chronic renal disease was only 29 days. Other complications included hemorrhage, pressure necrosis of skin, infection and the development of false aneurysms.

36. Sherris, J. C., Cole, J. J. and Scribner, B. H.: Bacteriology of continuous flow hemodialysis. Trans. Am. Soc. Art. Internal Organs 7:37, 1961.

Despite cooling of the 300 liter dialysis bath from 0° to 4° C, bacteria ( $4 \times 10^3$  organisms/ml) frequently exist in the bath at the end of 24 hours of dialysis. Pseudomonas and aerobacter are frequent organisms. Some are psychophiles. One patient developed a positive blood culture from bath organisms during dialysis. On several occasions, the bicarbonate concentration within the bath was lowered to zero by the growth of these organisms. The suggested prevention of this complication is to antiseptically treat dialysis tank with Zephiran solution.

37. Schreiner, G. E.: Note on experiences with long term cannulation of blood vessels. Trans. Am. Soc. Art. Internal Organs 7:66, 1961.

At Georgetown University Hospital again teflon cannulas were used. Cannulas were used in 6 patients. The longest lasted only 34 days; the average for the six patients was 11 days. In 7 instances, infection with septicemia developed. In 6 instances the effectiveness of cannulation was limited by clotting. One patient pulled his catheter out and became a suicide.

38. Welzant, W. R., Merrill, J. P., Crane, C. and Rabelo, A., Jr.: Use of the teflon arteriovenous by pass. Trans. Am. Soc. Art. Internal Organs. 7:125, 1961.

Report of another group's experiences with teflon catheters one year after their introduction. The shunts were used in 5 patients with chronic renal disease. In 4 patients the shunt did not function satisfactorily. In one patient, 2 shunts were used; one lasted 112 days, the other 71 days. One was discontinued because of infection (112 days); the other because of clotting.

It is interesting that after the second shunt failed, the patient was continued with weekly peritoneal dialysis. Following table depicts results of both artificial kidney dialysis and peritoneal dialysis.

	Art. Kidney 71 days 10 dialyses		Peritoneal Dialysis 94 days 5 dialyses	
	Before	After	Before	After
BUN (mg%)	140*	67	166*	90.2
CO <sub>2</sub> mEq/L	12.8	18.1	16.0	26.1
Na mEq/L	135	141	141	147
K mEq/L	5.4	4.9	5.4	4.5
Body wt (Kg)	44.5	43.1	45.2	42.5

\* Numbers are means of dialysis periods.

39. Brandon, J. M., Nakamoto, S., Rosenbaum, J., Franklin, M. and Kolff, W. J.: Experience with periodic, long ( $\pm 20$  hours) dialyses. Trans. Am. Soc. Art. Internal Organs 7:130, 1961.

Again indwelling teflon catheters were used with shunts. A total of 13 patients were considered for intermittent dialysis. Four patients refused. Nine patients were so treated. The Kolff twin coil kidney was used with a blood pump and blood flow rates of from 120 to 150 ml/min. The dialysate was a 300 liter bath cooled to 0°-4° C. Patients were dialyzed every 6 or 7 days. At the time of this paper one patient had been maintained for 4 months, 5 patients for over 3 months and 3 other patients apparently survived for a lesser time.

It is pointed out that even if this method of therapy of chronic renal disease were practical, the vast majority of patients could not be treated because of faulty limitations.

40. Brandon, J. M., Nakamoto, S., Rosenbaum, J. L., Franklin, M. and Kolff, W. J.: Prolongation of survival by periodic prolonged hemodialysis in patients with chronic renal failure. Am. J. Med. 33:538, 1962.

This is a further report of the patients presented in the previous reference. By the time of publication one patient died after 8 months dialysis with a cerebral vascular accident. Another patient continued to have infection around the indwelling catheters and died 7 months after the start of prolonged dialysis. A third patient died an accidental death. Three additional patients were being dialyzed and had been in the program for 12, 10 and 11 months respectively.

41. Hegstrom, R. M., Murray, J. S., Pendras, J. P., Burnell, J. M. and Scribner, B. H.: Hemodialysis in the treatment of chronic uremia. Trans. Am. Soc. Art. Internal Organs 7:136, 1961.

This report covers the first four patients to be treated by this group. At the time of writing, 2 had been treated for 13 months, 2 for 9 months.

The usual signs and symptoms of uremia were for the most part controlled by the weekly dialyses (one patient was dialyzed Q 5 D). However, anemia could only be controlled by repeated transfusions (304 units per month). Hypertension was apparently controlled by decreasing ECV by means of ultrafiltration during dialysis. Two interesting complications developed.

Two patients developed a peripheral neuritis. One patient developed crippling paralysis of his lower extremities. The cause for this neuritis is unknown. No effective therapy has been found.

Two patients developed "mild symptoms of gout" (one of these also had neuritis). The concentration of uric acid in the serum ranged from 4.5 to 14.7 and 3.7 and 12.6 mg% in these two patients.

CONCOMITANT WITH DISTAL MYOCLONUS

including interictal, ictal and postictal

Calculation by Chaparral