PERITONEAL DIALYSIS

THE RESULTS OF ITS USE IN 55 PATIENTS

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For over 80 years experimental workers have made use of the fact that the peritoneum is a semi-permeable membrane which allows water and electrolytes to cross it in accordance with known physical laws. Gantner[5] was the first to try peritoneal dialysis for the treatment of uraemia in animals and in man and his work, and that of other pioneers, has been reviewed by Merrill[10] and by Boen.[3] However, peritoneal dialysis was not generally adopted as a clinical procedure because of various practical difficulties relating to the preparation of suitable dialysing fluid and to efficient methods of recovering it from the peritoneal cavity. In addition, peritonitis proved to be a not infrequent complication.

In the past few years satisfactory fluids have been prepared on a commercial scale, improved peritoneal catheters have been designed, and owing to the use of antibiotics and a system of closed drainage, the incidence of peritonitis has been greatly reduced. These advances have resulted in such a striking increase in the use of peritoneal dialysis (PD) for the treatment of uraemia, that it has to a large extent superseded haemodialysis (HD) in many centres. For example, Burns *et al.* in Boston performed HD on 85 occasions in 1959, 102 in 1960 and 37 in 1961, while the corresponding figures for PD were 3, 12 and 121 respectively.[4] The same trend has occurred in our unit in which HD was performed 52 times in 28 patients in 1962 and 36 times in 20 patients in the first 3 months of 1963, but only 4 times between March 1963 and March 1964, during which period 55 patients were treated by means of PD.

The purpose of this communication is to present our experience of PD and to discuss briefly its advantages and disadvantages.

TECHNIQUE

A firm nylon catheter (Baxter K 128) is used. It is 11 in. long, its tip is sealed and rounded and it has numerous pin-point perforations at its curved distal end. Under local anaesthesia a small incision is made about 1 inch below the umbilicus and the linea alba and the peritoneum are pierced with a suitable trocar and cannula through which the catheter is manipulated into the pelvis. The cannula is then withdrawn, the catheter secured and the skin and subcutaneous tissues firmly sealed with a purse-string suture.

The commercially prepared irrigation fluid (Dianeal, Baxter) contains—per litre—142 mEq. sodium, 1·5 mEq. magnesium, 45 mEq. lactate, 3·5 mEq. calcium, 101 mEq. chloride, and 1·5% glucose, but no potassium. Its osmolality measured by freezing-point depression is 349 mOsm/l. compared with 280 of normal blood. To each litre is added 25 mg. of tetracycline and, during early exchanges when the dialysate may be blood-stained, 500 units of heparin to prevent clotting in the catheter. Potassium is added or not depending on the blood-fluid gradient desired.

Two litres of the solution, previously warmed to body temperature, are run rapidly into the peritoneal cavity via a Y-type administration set. In smaller patients and children this quantity is proportionately reduced, infants requiring 200 - 300 ml. Pain or discomfort during administration may be controlled by the injection into the peritoneal cavity of a solution of a few ml. of 2% procaine. When over-hydration is present, water can be attracted into the abdomen with a solution containing 7% glucose (661 mOsm./l.), but one of intermediate osmolality made up of 1 litre of 1·5% and 1 of 7% glucose produces an adequate and safer rate of water withdrawal.

The fluid is left in the abdomen for 30 - 60 minutes and then siphoned off. The process is repeated using a fresh administration set and making any adjustments in potassium and glucose concentration desired. Strict aseptic precautions are observed throughout. Dialysis may be carried out for many days either continually or diurnally and no harm has resulted from leaving the catheter in position for a week or longer.

THE RELATIVE MERITS OF HAEMODIALYSIS AND PERITONEAL DIALYSIS

Advantages

The artificial kidney, such as the Kolff twin-coil, is a costly apparatus which requires for its efficient operation a fully-equipped 'kidney room' approaching in design a small operating theatre. Each dialysis entails the use of an expensive coil, about 4 units of blood and many other expendables. Vessels have to be cannulated and it is our practice to have an experienced medical attendant present throughout the whole procedure, which, including priming of the coil and postdialysis care, usually lasts about 8 hours. Frequently, multiple dialyses are necessary during the course of treatment of a patient with acute renal failure.

PD, on the other hand, is technically very simple and once the catheter has been positioned the procedure is left to the nursing staff. Dialysis is carried out until diuresis ensues and in this way the clinical and biochemical deterioration which characterizes the interval between one HD and the next is avoided.

During HD severe hypotensive and hypertensive episodes may occur and blood incompatibility and serum hepatitis are possible complications. Furthermore, heparinization carries with it the risk of haemorrhage, especially in patients with cerebral trauma, hepato-renal failure and uraemic bleeding. Although regional heparinization is employed under these circumstances, it is not always easy to control.

One of the most troublesome aspects of HD is that dialysis of low efficiency may result from inadequate rates of blood flow through the coil, due either to circulatory insufficiency or to difficulties related to the catheters in the vessels. The latter applies particularly to infants and small children. Where oliguria follows trauma, the number of peripheral vessels available may be limited because of sepsis, amputations and splints. PD circumvents all these difficulties; nor is it contraindicated after recent abdominal operations.

A further advantage of PD is that patients may throughout the procedure be given modest quantities of food,

including protein, and a reasonable amount of water, with obvious benefit to morale and comfort. Any resulting overhydration is quickly controlled by temporarily substituting a hypertonic irrigation solution. For those unable to take food by mouth the glucose absorbed during PD provides a continuous source of calories.

Disadvantages

PD has several drawbacks. Since the dialysate contains a variable amount of protein—often 1 G/l. and sometimes as much as 2 G—prolonged dialysis may seriously deplete body stores of protein and result in hypoalbuminaemic oedema and also hypotension due to contraction of the plasma volume and this may necessitate intravenous infusions of albumin or plasma. This aspect of PD was recently extensively studied by Berlyne *et al.*[2] Circulatory collapse may also be produced by removing water too rapidly with hypertonic irrigation fluids. Despite the use of prophylactic antibiotics peritonitis may occur, but dialysis need not necessarily be discontinued on this account.

Conclusion

Thus, with the exception of the occasional patient in whom clinical or biochemical situation demands urgent treatment, or in whom PD, once instituted, fails to prevent further deterioration, there seems to be no reason why HD should take preference over PD. Moreover, in patients who have been uraemic for long periods the rapid biochemical alteration brought about by HD is sometimes harmful[7,11] and the more gradual correction that PD brings about is to be preferred.

Like HD, PD can be used in hepatic coma, for the removal of water in cases of intractable anasarca, and in poisoning with barbiturates, glutethamide, aspirin and other drugs. The urgency of the situation will dictate the choice except in the case of infants in whom PD is far superior for the technical reasons already mentioned.

THE KINETICS OF PERITONEAL DIALYSIS

The kinetics of PD have been comprehensively studied by Boen.[3] The irrigation fluid which he used differed slightly in composition from Dianeal; the glucose content was 2% compared with 1·5% and it contained 40 mEq./l. of bicarbonate in place of 45 mEq./l. of lactate.

Using 1·7 l. per exchange, and allowing the fluid to remain in the peritoneal cavity for 15 minutes, Boen achieved a dialysed volume of 3·5 l./hr. and a urea clearance by the peritoneum of 28·5 ml./min. Increasing the stay in the abdomen to 30 minutes and thus reducing the turnover to 2·5 l./hr. resulted in a slight decrease of urea clearance to 26 ml./min. and this he accepted as the most economical rate of dialysis. The urea clearance of the Kolff twin-coil artificial kidney at a flow rate of 200 ml./min. is about 140 ml./min.

The clearance of other substances by PD compared with the 26 ml./min. for urea are stated by Boen to be as follows: potassium 21 ml./min., sulphate 20 ml./min., inorganic phosphorus 16 ml./min., creatinine 15 ml./min. and uric acid 14 ml./min. After a 30-minute stay in the peritoneal cavity, 5 - 12 G of glucose/l. of irrigation fluid was absorbed, which meant that at a dialysed volume of 60 l./day, the patient received between 500 and 720 G of glucose. In one patient, 18 mEq. of bicarbonate was absorbed from 1 l. of fluid in 30 minutes. With a fluid containing 3 - 4% glucose, 4 l. of water in 44 hours and 5·5 l. in 59 hours respectively, were removed in 2 cases of pulmonary oedema.

We estimated the clearance of urea by the peritoneum in a small number of cases and found that it was only 10 ml./min. when using the technique of Maxwell *et al.* and allowing 2 l. of fluid to stay in the peritoneum for 1 hour.[9] Under these circumstances the turnover amounts to little more than 1 l./hr. measured from the start of inflow to the end of outflow. By reducing the stay in the abdomen to 30 minutes there was an increase in turnover to between 1·5 - 2 l./hr. and a corresponding increase in urea clearance to 15 - 17 ml./min. It was found that the time taken to drain the peritoneum was 20 minutes or longer in most cases and seldom as little as 10 - 15 minutes as suggested by Maxwell *et al.*[9] and by Boen.[3] The rate of turnover was largely dependent on this factor and it was only when drainage was brisk that 2 l./hr. could be achieved. The volume of water that could be removed with hypertonic fluid varied between 2 - 4 l./day, which is similar to the amounts mentioned by Boen.

RESULTS

PD was carried out in 55 patients (Table I). Nine were postoperative and post-traumatic cases, 2 were associated with pregnancy and 44 had various medical conditions.

TABLE I. DIAGNOSES AND RESULTS OF TREATMENT OF 55 CASES WITH PERITONEAL DIALYSIS

Diagnosis	*Peritoneal dialysis*		
	Alive	*Dead*	*Total*
Chronic nephritis	–	5	5
Pyelonephritis	3	2	5
Gouty nephropathy	1	–	1
Phenacetin nephropathy	–	3	3
Lupus nephritis	–	2	2
Haemolytic uraemic syndrome of infancy	3	–	3
Hepato-renal failure	2	2	4
Blackwater fever	1	–	1
Obstructive uropathy	1	–	1
Incompatible blood transfusion	–	1	1
Diabetic acidosis with oliguria	2	–	2
Oliguria complicating dehydration	1	1	2
Congestive cardiac failure with oliguria	1	5	6
Oliguria of undetermined aetiology	1	–	1
Diphtheritic myocarditis with oliguria	–	3	3
Carbon tetrachloride poisoning	2	–	2
Barbiturate and aspirin poisoning	2	–	2
Oliguria following surgery or trauma	2	7	9
Oliguria associated with pregnancy	2	–	2
Total	24	31	55

The renal failures following operation occurred after: a complicated repair of a ruptured abdominal aorta (1), a paralytic ileus of undetermined cause (1), the removal of a stag-horn calculus in a remaining kidney (1) and following prostatectomy (1). All 4 of these died. In 5, uraemia followed multiple injuries and of these only the 2 with the least severe lesions survived. Thus 7 of the 9 postoperative and post-traumatic cases died. The 2 obstetric patients recovered, 1 requiring HD in addition to PD.

The medical group treated by PD consisted of 44 patients made up as follows: pyelonephritis 5, gouty nephropathy 1, chronic nephritis with exacerbating factors 5, lupus nephritis 2, haemolytic uraemic syndrome of infancy 3, hepato-renal failure 4, blackwater fever 1, obstructive uropathy 1, incompatible blood transfusion 1, carbon tetrachloride poisoning 2, diabetic acidosis with oliguria 2, phenacetin nephropathy 3, oliguria complicating dehydration from diarrhoea (1 with hypokalaemia) 2, congestive cardiac failure with oliguria and various electrolyte disturbances 6, oliguria of undetermined origin 1, and diphtheritic myocarditis with anuria 3. In addition, 2 patients, 1 with barbiturate and 1 with aspirin poisoning, neither with oliguria, were dialysed. Of this heterogeneous group 20 survived. This is in keeping with the common experience that renal failure due to medical causes has a better prognosis than that following surgery or trauma.

The over-all mortality for all 55 cases, medical, obstetric, postoperative and post-traumatic was 56·4%. In the 90 patients that we treated by means of HD the mortality rate was 60%.

ILLUSTRATIVE CASES

Hepato-renal Failure due to Malaria and Alcoholism

A 32-year-old man, accustomed to drinking one bottle of brandy a week, increased his consumption to one bottle daily while on a fishing holiday during which he contracted malignant tertian malaria. He was admitted to hospital 2 weeks later in a drowsy state with severe jaundice, hepatomegaly, oliguria, proteinuria and bilirubinuria.

The serum bilirubin was 26 mg./100 ml., the blood urea 230 mg./100 ml. and the CO_2 content 11·9 mEq./l. A heavy infestation with *P. falciparum* was found in the blood smears. Liver biopsy showed only malarial pigment in the Kuppfer cells and no evidence of infective hepatitis. He was given chloroquin, oral neomycin, corticosteroids and bowel washouts but developed severe hepatic encephalopathy. The blood urea increased to 350 mg./100 ml. and respiratory alkalosis was evidenced by a pCO_2 of 24 mm.Hg and an arterial pH of 7·51. The urine volume remained below 150 ml./day in spite of adequate hydration and the use of intravenous mannitol.

On the 3rd hospital day PD was begun and continued for 8 days. The dialysate was blood-stained for most of the time. The bilirubin level fell to 7·6 mg./100 ml. on the 4th day of dialysis when diuresis commenced. Confusion and a flapping tremor continued for a further 3 days. The blood urea was 140 mg./100 ml. and the urine output 2,000 ml./24 hrs. when the dialysis was stopped. The patient eventually made a complete recovery.

Diabetic Acidosis with Marked Hyponatraemia and Uraemia

A 32-year-old man who for 5 years had suffered from diabetes, omitted to take his insulin during a week-end holiday. Blurring of vision, thirst, polyuria and drowsiness ensued and he was admitted to another hospital on 6 October 1963 and treated with intravenous dextrose in saline and insulin. Three days later, on 9 October, he was transferred to our unit because of anuria.

On admission he was drowsy, sweating and dehydrated and displayed marked Kussmaul breathing. The blood sugar was 780 mg./100 ml., the blood urea 278 mg./100 ml., serum sodium 104, potassium 4, chloride 66 and the CO_2 content 8·5 mEq./l. The urine on the day of admission measured 105 ml. and contained protein, erythrocytes, leucocytes and casts. Intravenous hypertonic saline, sodium bicarbonate and insulin were administered, and on the following day the urine volume increased to 520 ml., but then fell to 355 ml. the next day when the blood urea was 405 mg./100 ml., serum sodium 122, potassium 4·7, chloride 82 and the CO_2 content 21 mEq./l. 420 ml. of urine were voided on 12 October, and 512 ml. the following day, but despite this he became disorientated and confused and the blood urea continued to rise.

PD was started on 13 October and continued intermittently for 7 days. Great improvement in his mental state was noted on 17 October, by which day the urinary output measured 1,600 ml. At the end of the period of PD the blood urea was 240 mg./100 ml. and the serum electrolytes were normal. The urinary output reached a peak of 5,580 ml. on 2 November. The diuretic phase was punctuated by several hypoglycaemic incidents. Oedema of the legs appeared and was ascribed to depletion of the serum proteins resulting from prolonged dialysis. Recovery was satisfactory.

Severe Salicylism in a Child

A 3-year-old girl developed measles and otitis media. She was admitted in an unconscious state with a respiratory rate of 45/minute. Aspirin poisoning was suspected and the serum salicylate level was found to be 88 mg./100 ml. Her stomach was washed out but only 130 mg. of salicylate were recovered. The blood urea was 54 mg./100 ml. and the CO_2 content 8 mEq./l.

PD was started at once and 4 exchanges of 300 ml. each and 18 of 500 ml. were completed in 36 hours. Since the urinary output was good, 3,000 ml. of 0·2% saline in 5% invert sugar were given intravenously during this period and a brisk diuresis was maintained. The total amount of salicylate removed by dialysis was 550 mg. but the urinary salicylate content was not measured. Unconsciousness gave way to drowsiness and irritability at the 24th hour and by the 36th her mental state was normal. During the period of dialysis 3-hourly serum salicylate levels were 64, 19·3, 37, 20·1 and 4·7 mg./100 ml. respectively. By the morning of the 4th day it was 5·1 mg./100 ml. and on the 5th day it was absent; the blood urea was then 20 mg./100 ml. and the CO_2 content 23 mEq./l.

Malignant Hypertension with Oliguria and Anasarca

A 37-year-old man was admitted to hospital in March 1962 with malignant hypertension for which no cause was found. Treatment with hypotensive agents resulted in rapid control of the hypertension and improvement in the retinopathy. He failed to carry out his treatment after discharge. Apart from severe occipital headaches he was well until September 1963 when he began to deteriorate. He was re-admitted in October 1963 in congestive cardiac failure with extreme anasarca and uraemia. He was confused, his blood pressure was 220/150 mm.Hg and papilloedema was present. The urine output was about 750 ml. daily. The haemoglobin was 9·6 G/100 ml., blood urea 322 mg./100 ml., serum sodium 118, potassium 3·6, chloride 69 and CO_2 content 23·5 mEq./l.

Since there was no response to digitalis, diuretics and hypotensive agents, it was decided to attempt correction of the uraemia and the over-hydration by means of PD with hypertonic solutions and, simultaneously, to treat his hypertension. A cumulative negative balance of water of 13 l. was effected in 8 days. The blood urea was reduced to 210 mg./100 ml. and the serum electrolytes returned to normal. The reduction in the anasarca was striking and the improvement in his mental state considerable. Intravenous salt-free albumin was administered to replace the 113 G of protein lost by peritoneal drainage. Dialysis was continued for a further 4 days with irrigation fluid containing 1·5% glucose, but the urine output fell to low levels and the patient died on the 18th hospital day. Permission for autopsy was refused.

Post-traumatic Oliguric Renal Failure

A 45-year-old goldminer was trapped in a fall of rock on 6 August 1963. When rescued 4 hours later he was shocked and required transfusions of blood and plasma for resuscitation. Twelve hours later a secondary fall in blood pressure occurred but recovery from this was spontaneous.

When seen after 24 hours he was oliguric though well hydrated and normotensive. There were multiple severe bruises and lacerations and massive oedema of the left buttock and upper thigh. In addition, foot drop was present on the affected side with anaesthesia in the distribution of the lateral popliteal nerve. No increase in urine flow resulted from the

intravenous administration of mannitol. The blood urea was 131 mg./100 ml. and the serum potassium 5·6 mEq./l. During the next 2 days the blood urea level increased to 300 mg./100 ml. and exchange resins were necessary to control hyperkalaemia. Because of the rapid rise in blood urea PD was started and continued intermittently over the next 13 days. The blood urea was initially reduced to 145 mg./100 ml., but then rose to about 200 mg./100 ml., at which level it remained throughout the oliguric phase. Serum potassium, after an initial fall to 3·2 mEq./l., was maintained at about 4·5 mEq./l. The CO_2 content increased to a maximum of 32 mEq./l.

Diuresis set in on the 14th day and gradual recovery of renal function ensued. The marked oedema which developed towards the end of the period of PD was associated with a fall in serum albumin level to 1·5 G/100 ml. Mild peritonism was observed on the 10th day of dialysis and culture of the catheter tip after it was removed showed a scanty growth of *K. pneumoniae* and *Staph. albus*. The signs of peritonitis rapidly subsided when dialysis was stopped. Throughout the oliguric phase the patient was alert and able to cooperate with breathing exercises and physiotherapy to the leg.

DISCUSSION

Balslov and Jorgensen[1] have stressed that the outcome of treatment of acute renal failure, whether by dialysis or not, depends to a large extent on the nature of the underlying disease and on the presence or absence of complications. In a series of 305 patients they found those with slight or cured underlying disease and no complications had a mortality rate of 3%, those with slight or cured underlying disease and some complications 52%, those with severe underlying disease 69% and those with severe underlying disease and complications 80%. Of the 55 patients whom we treated with PD a high proportion had severe underlying disease or complications and it is therefore not surprising that the mortality rate was as high as 56%. This figure is not significantly different from the 60% mortality that we obtained in the 90 patients whom we treated with HD. It seems profitless to attempt a detailed comparison between our 2 groups since the numbers are relatively small and the aetiological factors diverse, but the over-all results amply confirm the impression so far gained that the outcome of treatment with PD is on the whole no better than with HD. Our preference for PD, nonetheless, continues because of its technical simplicity and convenience. It seems by any standards to be the better method in infants and children, in patients with circulatory insufficiency and in those in whom heparinization is particularly dangerous.

With PD continued throughout the 24 hours the rate of blood urea reduction averaged about 100 mg./100 ml. per day but with the diurnal method this was only 50 - 70 mg. In some instances the urea level remained fairly constant for several days, or when catabolism was marked, even rose slightly for a time. Such slow correction of the blood urea did not in itself appear to be a drawback, nor did it as a rule reflect an unsatisfactory response to PD by clinical or other criteria. Except in severe cases, it was feasible to dialyse during waking hours only, provided a brisk turnover of irrigation solution could be maintained. On only 2 occasions was it deemed advisable, because of poor clinical response, to augment PD with HD but this additional measure succeeded in only one.

Our experience of PD in patients with post-traumatic renal failure has been small, but it has been possible to successfully treat 2 moderately severe cases by means of PD alone. The opportunity has not so far arisen to test the value of PD in post-traumatic cases with extremely high rates of urea production as instanced by that of Kennedy *et al.*[5] in patients who had an average daily rise of blood urea of 133 mg./100 ml. and required no less than 10 haemodialyses in 25 days. It seems likely that PD could substantially reduce the number and frequency of haemodialyses necessary under these circumstances.

By the use of potassium-free irrigation fluid, high serum potassium was in all instances rapidly reduced to safe levels. This is probably due not only to the diffusion of potassium into the irrigation fluid, but also to correction of the acidosis and to a shift of this cation into the cells in combination with the glucose absorbed. Reduction of serum potassium by means of PD may be so rapid as to constitute a hazard in digitalized patients. In one with a serum potassium of 7·4 mEq./l., dialysis was started with potassium-free fluid with the intention of adding 4 mEq./l. of potassium at the third exchange. Unfortunately, he died early during the second exchange following a brief spell of cardiac arrhythmia, thought to be due to digitalis intoxication, precipitated by too rapid a reduction in the serum potassium level. On the other hand, we have been able to confirm the observation of Boen[3] that when the serum potassium level is initially normal, dialysis with potassium-free fluid does not cause significant hypokalaemia in the first 24 hours.

The irrigation fluid which we employed contains 45 mEq. of lactate. This seems to be a higher concentration than necessary except during early exchanges in severely acidotic patients. It results in restoration of the CO_2 content to normal or near normal levels after 24 hours of dialysis, and over-correction to 30 mEq. or more infrequently occurs after some days. There is room for a fluid with a lower lactate (or bicarbonate) content for the maintenance of PD for periods of longer than a few days, although we have observed no ill-effects resulting from a high serum CO_2 content in these patients.

In some patients serum sodium levels of 150 mEq./l. or more developed during the course of PD. Although no measurements were made, it was our impression that this was more likely to occur when hyperosmotic irrigation solutions were employed and presumably more water relative to electrolytes attracted into the peritoneal cavity. This phenomenon was particularly noticeable in an elderly diabetic patient (not included in this series) who developed marked hyperglycaemia while being dialysed for post-surgical renal failure and whose serum sodium exceeded 150 mEq./l. There was a calculated increase of serum osmolality of 50 mOsm./l., 30 of which could be accounted for by the elevated blood sugar level. In an attempt to minimize the contribution of the hyperglycaemia to the hyperosmolality, insulin was used and this was followed by severe hypoglycaemia when dialysis was stopped for a short period. Hypoglycaemia also occurred in 2 other patients with diabetic ketosis and renal failure when dialysis was stopped, despite a considerable reduction in the insulin dosage.

In the uncomplicated case treated with PD routine, management has been easy, the fluid and food allowance has been liberal and the morale and cooperation of patients usually good. Occasionally dialysis caused considerable abdominal discomfort, so that rest was disturbed and fatigue became apparent, especially when the procedure was carried out continuously. Under these circumstances limiting dialysis to 16 or 18 hours a day provided a welcome respite.

While PD offers a simple and easily manageable means of correcting uraemia and maintaining the patient in a state of relative well-being, the well-recognized principles of treatment of renal failure may not be neglected. During dialysis, particular attention must be given to the fluid balance in view of the large volume of irrigation fluid employed. When continued over several days, total fluid balance can be difficult to achieve and under- or over-hydration may result. Similarly, strict aseptic techniques must be used since infection is a constant hazard which can nullify any advantages gained from this method of treatment.

SUMMARY

Peritoneal dialysis was used in the treatment of 53 cases of renal failure. 1 of aspirin poisoning and 1 of barbiturate poisoning. The survival rate was 44·6%. It has proved to be a safe, convenient and effective method of treatment and the results are comparable to those obtained in 90 cases treated by means of haemodialysis.

Peritoneal dialysis is particularly useful for the treatment of those patients with acute renal failure in whom deterioration is relatively slow, but conservative means alone do not suffice. In cases with more rapid deterioration it may have to be supplemented by haemodialysis. Peritoneal dialysis is especially suited to children and infants in whom rapid correction of biochemical abnormalities can be achieved.

Prolonged dialysis may give rise to hypoproteinaemia which may require correction, and in some patients hypernatraemia occurs during dialysis.

The relative merits of peritoneal dialysis and haemodialysis are discussed.

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REFERENCES

1. Balslov, J. T. and Jorgensen, H. E. (1963): Amer. J. Med., **34**, 753.
2. Berlyne, G. M., Jones, J. H., Hewitt, V. and Nilwarangkur, S. (1964): Lancet, **1**, 738.
3. Boen, S. T. (1961): Medicine (Baltimore), **40**, 243.
4. Burns, R. O., Henderson, L. W., Hager, E. B. and Merrill, J. P. (1962): New Engl. J. Med., **267**, 1060.
5. Gantner, G. (1923): Münch. med. Wschr., **70**, 1478.
6. Goldberg, B., Leonsins, A. J., Fleishman, S. J., Levin, N. W., Van Blerk, P. J. P., Gentin, B., Rubenstein, A. and Stables, D. (1965): S. Afr. Med. J., **39**, 439.
7. Kennedy, A. C., Linton, A. L., Luke, R. G. and Renfrew, S. (1963): Lancet, **1**, 408.
8. Kennedy, A. C., Luke, R. G., Campbell, D. and Cannon, R. N. (1963): *Ibid*., **2**, 1304.
9. Maxwell, M. H., Rockney, R. E., Kleeman, C. R. and Twiss, M. R. (1964): J. Amer. Med. Assoc., **170**, 1917.
10. Merrill, J. P. (1955): *The Treatment of Renal Failure*. New York: Grune & Stratton.
11. Shakman, R., Chisholm, G. D., Holden, A. J. and Pigott, R. W. (1962): Brit. Med. J., **2**, 355.