Current Practice

URINARY TRACT DISEASES

Acute Renal Failure

P. SHARPSTONE,* M.B., M.R.C.P.

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Since uraemia can often be controlled effectively by peritoneal dialysis, many patients with acute renal failure are treated outside specialist renal centres. This article outlines the management of acute renal failure in a regional hospital and gives some indications for referral to a specialist unit. But it is the interests and experience of the clinician involved, rather than the availability of special equipment, that will dictate the need for referral in most cases.

Classification

Classification of renal failure into pre-renal, renal, and post-renal causes is time-honoured and remains fundamental since extrarenal factors can often be corrected but may lead to prolonged or permanent impairment of renal function if this is delayed. The demarcation between pre-renal and intrinsic renal failure, however, is not clear cut and their definition depends on the criteria used. Because the different criteria overlap (see Table) the terms are not used uniformly. In this article oliguria without impairment of renal concentrating ability is defined as physiological. This occurs in dehydration or a modest reduction of renal blood flow. In more severe hypovolaemic or hypotensive states both the excretion of solute and urine volume are reduced. In consequence, waste products of metabolism accumulate in the body and the syndrome of uraemia results. But the renal disturbance here is functional, and if correction of the circulatory disturbance is followed promptly by the restoration of normal renal function it is termed pre-renal failure. When oliguria persists after correcting the precipitating factors the term renal failure is used. In some patients who fulfil this latter criterion mannitol given at an early stage will promote a diuresis and prevent progression to established renal failure (acute tubular necrosis). Incipient and established failure cannot be distinguished by crude tests of renal concentrating ability, such as the urine specific gravity or urea concentration, but only by measuring the ratio of the osmolality of plasma to urine.

Urinary Concentrating Ability and the Response to Treatment in Varieties of Oliguria

Condition	Effect of correction of precipitating factor	Urine specific gravity	Urine plasma urea ratio	Urine plasma osmolality ratio	Effect of mannitol
Physiological oliguria	Reversed	>1022	>10	>2	Reversed
Pre-renal failure		<1022	<10	Incipient renal failure 1·1–2	
Renal failure	Not reversed			Established renal failure <1·1	Not reversed

* Senior Medical Registrar, King's College Hospital, London S.E.5.

Pre-renal Failure

Pre-renal failure occurs in hypovolaemic or hypotensive states from causes such as haemorrhage, plasma loss, dehydration, septicaemic or cardiogenic shock, or overdosage with various drugs.

Renal Failure

Acute Tubular Necrosis

Acute tubular necrosis is a syndrome, resulting from ischaemic or toxic injury to the kidney, characterized by abrupt cessation of renal function and spontaneous recovery, usually within four weeks. Though the term is widely used, it is often a misnomer, since there is no histological evidence of tubular necrosis in many cases. Any of the conditions causing pre-renal failure, particularly if severe or prolonged, may result in acute tubular necrosis. Nephrotoxins which may be responsible include haemoglobin (as in incompatible blood transfusion or blackwater fever) myoglobin (crush injuries) bacterial toxins (*Clostridium welchii* septicaemia), carbon tetrachloride, ethylene glycol, and mercuric chloride. Susceptibility to acute renal failure is increased in pregnancy, cirrhosis of the liver with ascites, advanced cardiac failure, the nephrotic syndrome, severe liver failure, and obstructive jaundice. For example, quite modest blood loss from an antepartum haemorrhage is much more likely to cause renal failure than a haemorrhage of similar magnitude in a non-pregnant patient. A few patients with apparent acute tubular necrosis have in fact bilateral renal cortical necrosis and fail to recover adequate renal function. Pregnancy accidents complicating pre-eclampsia are particularly prone to cause this.

The diagnosis of acute tubular necrosis is usually evident from the circumstances of the onset of the oliguria, though occasionally no definite cause can be determined. After pre-renal factors have been treated mannitol should be tried to distinguish incipient from established renal failure. Oliguria is not invariable in acute tubular necrosis. Normal or even high urine volumes may be seen, particularly after burns or when mannitol has been used, but the output of urinary solute is insufficient and uraemia develops. The diagnosis must be based on measuring the urine urea output as well as the blood urea since the latter may be raised from a rapid rate of urea production with little impairment of renal function. For example, the excretion of as much as 20 g. of urea per 24 hours, in the presence of a raised blood urea, would indicate quite severe renal insufficiency.

Glomerulonephritis

Proliferative, necrotic, and inflammatory vascular lesions of the glomeruli in a variety of diseases may cause acute renal failure. A few patients with post-streptococcal glomerulonephritis remain permanently oliguric. Acute or rapidly progressive glomerulonephritis—usually without evidence of streptococcal aetiology, and leading to end-stage renal failure within a few weeks of onset—affects mostly middle-aged and elderly patients. A similar outcome may result from

the renal leisions of polyarteritis nodosa, systemic lupus erythematosus, scleroderma, subacute bacterial endocarditis, and the syndrome of lung purpura and nephritis.

When oliguric glomerulonephritis is suspected renal biopsy should be performed unless the diagnosis is evident from the extrarenal features of the disease. The histological appearances are rarely specific for a particular disease of this group, but will distinguish glomerulonephritis from other causes of renal failure and give some idea of the severity of the lesion. If uraemia is advanced it should be controlled by dialysis first.

Miscellaneous Causes

Other causes of acute renal failure include: malignant hypertensive nephrosclerosis, acute interstitial nephritis (for example, in Weil's disease or phenindione sensitivity), thrombotic thrombocytopenic purpura, the haemolytic uraemic syndrome of infancy, fulminating acute pyelonephritis, necrotizing papillitis, infusion of low molecular weight dextran and other osmotic diuretics, pre-eclampsia, sulphonamide crystalluria, hypercalcaemia, hyperuricaemia, and bilateral renal arterial or venous thrombosis.

Post-renal Failure

Acute obstruction of the urinary tract—for example, by the impaction of a calculus in the ureter of a solitary kidney—is rare, but chronic obstructive uropathy, like other varieties of chronic renal failure, may present with advanced uraemia and with little or no past history of renal symptoms. Urethral stricture, prostatic hypertrophy, malignant pelvic tumours, retroperitoneal fibrosis, pelvi-ureteric obstruction, and renal calculous disease are the commonest causes. Suggestive features in the history are difficulty in micturition, intermittent polyuria or oliguria, and pain in the back or loins. Examination may show renal swellings or distension of the bladder. Absolute anuria is rare in other varieties of renal failure and is highly suggestive of obstruction. Sometimes, however, none of these features is present. Investigations to exclude obstruction should be carried out in every case unless another cause is obvious. These include catheterization of the bladder, plain *x*-ray films of the abdomen, tomography of the renal areas, cystoscopy, and retrograde pyelography.

Exacerbation of Chronic Renal Failure

This is usually characterized by a previous history of urinary tract or uraemic symptoms or by the stigmata of long-standing renal failure, such as pigmentation, severe anaemia, or osteodystrophy. Nevertheless, when these features are absent differentiation from acute renal failure may be difficult. The most useful investigation is to assess the size of the kidneys by radiology and, if necessary, tomography. Small kidneys indicate long-standing renal disease. Dehydration is often the cause of exacerbation of chronic renal failure and intravenous fluid the mainstay of treatment.

Management

Prophylaxis and Treatment of the Renal Lesion

Pre-renal factors should be corrected as rapidly as possible, whether or not the patient is judged to have established renal failure. The distinction may be impossible prospectively and prompt treatment of circulatory insufficiency may prevent the development of acute tubular necrosis. Oliguria should never inhibit the correction of hypovolaemia. Large volumes of intravenous fluid are often required and can be given with relative safety if the central venous pressure is carefully monitored. The therapeutic value of mannitol has already been mentioned. If oliguria persists, 200 ml. of a 10% solution are given intravenously in 10 minutes. If the urine flow rate increases to over 40 ml./hour further doses are given to maintain a urine output of about 100 ml./hour. Lack of a diuretic response to mannitol (and to a second dose given two hours later) indicates established renal failure, and no more should be given. Mannitol has also been shown to be of prophylactic value. When the development of acute renal failure can be expected—for example, in surgery of the aorta or in patients with deep obstructive jaundice—mannitol infusion should be started before operation. There is no specific treatment for established acute tubular necrosis. Spontaneous recovery occurs (except in the minority of cases with bilateral cortical necrosis) usually within four weeks, if the patient survives until then.

When glomerulonephritis is sufficiently severe to cause oliguria to last more than a few days recovery of useful renal function is exceptional. Nevertheless, dialysis should be continued for at least six weeks, and a few patients have recovered after even longer periods of oliguria. Recently, there have been reports of possible benefit from the use of anticoagulant and immunosuppressive drugs in this condition and their further trial is warranted. Renal biopsy should be done before initiating treatment and referral to a specialist unit may be necessary. Obstruction of the renal tract is usually treated surgically. Uraemia should be corrected by dialysis first.

General Measures

The outcome for patients with acute renal failure is largely determined by the severity of the underlying illness. The mortality ranges from about 15%, when it is due to incompatible blood transfusion or pregnancy accidents, to 70% or more in burns and major trauma. This emphasizes the need for intensive treatment of the underlying disorder as well as of the renal failure. The closest possible collaboration is essential between the various specialists involved in the care of the patient. Many patients are best managed in an intensive care unit. Uraemia reduces the resistance to infection and sepsis is a common cause of death. Though full barrier nursing is not always practical it is an ideal to be aimed at. Infections must be treated promptly and vigorously, but routine antibiotic prophylaxis is undesirable. Antibiotics which are eliminated from the body by renal excretion need not be avoided, provided that the dosage is reduced appropriately. Frequent physiotherapy and intensive nursing care, especially attention to oral hygiene and the prevention of decubitus ulcers, are of crucial importance. In the bustle of activity surrounding the patient with acute renal failure his emotional needs must not be forgotten. Time must be taken to explain, to reassure, and to comfort.

Treatment of Uraemia

The aim is to maintain the volume and composition of the body fluid as nearly normal as possible. The basic daily water requirement of the average adult is 400 ml. This represents the insensible loss less the water produced by tissue catabolism. An amount equivalent to the volume of urine and of any gastrointestinal loss is added, with an additional allowance if there is fever or hyperventilation. The best guide is the weight of the patient, which should fall by about 0·3 kg. daily as a result of loss of tissue mass. Hyponatraemia is usually dilutional in origin and no electrolyte should be given, except to compensate for overt losses. When acute tubular necrosis recovers the 24-hour urine output may increase from 200 ml. to several litres in the course of a few days. Correspondingly large quantities of fluid, sodium, and potassium must be given at this stage to avoid depletion.

Carbohydrate is essential to minimize protein catabolism. The basic daily requirements are met by four bottles of

Hycal (a flavoured liquid dextrose concentrate), which provides 1,700 calories with 400 ml. water. Caloreen, a soluble glucose polymer, is a useful alternative for patients who find Hycal unpalatable. A little first-class protein has been shown to spare the patient's own protein, and the best diet, for patients who can tolerate it, contains 2,000 calories, 16 g. of protein, and 10 mEq. each of sodium and potassium. Supplementary vitamins are necessary. Hyperkalaemia is controlled by the oral or rectal administration of 15 to 30 g. of calcium Resonium, a resin which exchanges calcium for potassium. Its effect is not immediate and life-threatening potassium intoxication must be corrected more rapidly by the intravenous infusion of 100 mEq. of sodium bicarbonate. The control of treatment is made very much easier by a simple chart on which laboratory results, the urine output, and the patient's weight are entered daily.

The rate of rise of blood urea in patients with oliguric renal failure is determined by the rate of endogenous protein catabolism and the quantity of protein ingested. It ranges from 20 mg./100 ml. per day in patients who are well apart from their renal failure and are taking an optimum diet, to 100 mg./100 ml. per day in patients whose renal failure is associated with major trauma, burns, or sepsis. A daily rise of more than 60 mg./100 ml. indicates a hypercatabolic state and, in this situation, hyperkalaemia and acidosis may develop with alarming rapidity. It follows that some patients with non-hypercatabolic renal failure may be maintained in reasonable health for up to two weeks by dietary manipulation alone, whereas patients with hypercatabolic states may die from uraemia within a few days of onset, unless dialysis is used.

Dialysis

In addition to its inherent dangers, uraemia reduces the chances of recovery from the precipitating disease. Dialysis should be looked upon as a means of preventing, rather than treating, uraemia, and should be used early and vigorously. Previous criteria for dialysis, such as a blood urea of 400 mg./100 ml. or a serum bicarbonate of 10 mEq./l. are no longer applicable. Ideally, the blood urea should be maintained below 200 mg./100 ml. at all times. In a severely hypercatabolic patient this may necessitate haemodialysis every day. Once dialysis has been initiated, the diet should be made more liberal; 2,000 ml. of water, 40 g. of protein and 3,000 calories may be given, since the excess water and nitrogenous products are removed by dialysis. Even more protein should be given to the hypercatabolic patient. Many patients cannot take an adequate diet by mouth because of gastrointestinal tract disturbances, such as ileus, peritonitis, or fistulae. Their nutrition should be maintained by intravenous fat emulsions (Intralipid) and amino-acid solutions (Aminosol).

Peritoneal dialysis and haemodialysis each have their own advantages and dangers and there is little to choose between them in most cases. Since peritoneal dialysis does not require specialized equipment it is more widely used. Relative or absolute contraindications to peritoneal dialysis include obliteration of the peritoneal cavity by previous major surgery, recent surgery in which peritoneum has been stripped or intraperitoneal drains left, and severe ventilatory insufficiency. In these circumstances the patient should be referred for haemodialysis. In severely hypercatabolic states continuous peritoneal dialysis may be required for long periods and intermittent haemodialysis is probably preferable. Well-closed recent abdominal wounds, peritonitis, and pancreatitis are not contraindications to peritoneal dialysis. The latter two conditions are themselves benefited by lavage.

Technique of Peritoneal Dialysis

Some minor but useful modifications in technique have been made since peritoneal dialysis was introduced into clinical practice ten years ago. The catheter is inserted by a central stylet, rather than through a cannula, and a purse-string suture is not required. The preferred site is in the midline below the umbilicus, but any site on the anterior abdominal wall may be used provided that the vicinity of operation scars and enlarged viscera is avoided. One-litre dialysate exchanges give a lower incidence of respiratory complications and less pain than the previously customary 2 litres. The reduced efficiency of dialysis is compensated by increasing the frequency of exchanges. A suitable scheme for most patients is to run the fluid in as fast as possible and to start drainage 20 minutes later. The cycle is repeated as soon as drainage is complete, so that two exchanges are made each hour. The dialysate is collected in a disposable plastic urine drainage bag fitted with a spigotted outlet through which it is drained into a measuring cylinder after each exchange. Heparin (1,000 u/l.) is added to the first three exchanges only unless the dialysate remains blood-stained. Antibiotics are not used routinely in the dialysate.

When the serum potassium is normal or low 0·2 to 0·3 g. of potassium chloride are added to each litre. Dialysate containing 1·36% dextrose is sufficiently hypertonic to plasma to ensure a modest negative water balance. The over-hydrated patient requires more rapid removal of water and 500 ml. of this solution should be given concurrently with 500 ml. of solution containing 6·36% dextrose. With this mixture water may be removed from the circulation faster than it can diffuse in from the interstitial fluid and it is possible to cause hypovolaemia, even in the presence of oedema. Use of the 6·36% solution alone is required only to relieve acute pulmonary oedema, and one or two exchanges of solution of this strength usually suffice. Dialysate with a sodium concentration of 130 instead of 141 mEq/l. makes control of hypertension easier and prevents the hypernatraemia which sometimes develops in patients having hypertonic dialysis.

Intraperitoneal sepsis is indicated by turbidity of the dialysate and confirmed by microscopy. Antibiotics are added to the dialysate and the dialysis continued. Chloramphenicol, 50 mg./l. or gentamicin, 5 mg./l. are useful while awaiting the results of bacteriological culture. The incidence of peritonitis is reduced by changing the catheter site at the first sign of local inflammation or leakage and, in any case, after five days.

After an initial period of 36-48 hours of continuous dialysis to bring the uraemia under control, frequent short dialyses are preferable to widely-spaced long dialyses. About 12 hours each day should maintain a stable blood urea in most non-hypercatabolic patients.

FURTHER READING

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