Acute renal failure — 10-year experience of the Johannesburg Hospital renal unit

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Summary

The 10-year experience of Johannesburg Hospital's renal unit in treating acute renal failure (ARF) is described; 290 patients were treated by haemodialysis — 169 drawn from the surgical disciplines, 109 from the medical disciplines and 12 from obstetrics and gynaecology, suffering 55%, 41% and 33% mortality rates, respectively. The mortality rates were found to correlate strongly with the cumulative number of acute insults to renal function accruing as a result of the particular surgical or medical illness ('precipitating event') and culminating in ARF. Age was also shown to have a powerful influence on outcome, the survival rate failing steadily with each decade of life. A plea is made to limit the potential insults to renal function actively, particularly in the elderly, in an attempt to further reduce the high mortality rate with which ARF continues to be stubbornly associated.

Mortality in patients in whom acute renal failure (ARF) develops is acknowledged to be high1 and the observation has repeatedly been made5,6 that it remains high despite intensive medical care and aggressive dialysis therapy.

The 10-year experience of treatment of ARF at Johannesburg Hospital was recently analysed in order to determine epidemiological patterns of ARF in a large general hospital through review of the medical and surgical records of 290 patients who required haemodialysis (HD).

Patients and methods

The records (in microfiche) of patients treated for ARF by HD between 1 January 1975 and 31 December 1984 were scrutinised. During this 10-year period patients received frequent HD, often on a daily basis or 6 days a week, and supplemental total parenteral or enteral nutrition as a matter of policy.4 Patients were frequently admitted to intensive care units where concomitant respiratory failure, if present, was handled by intermittent positive-pressure ventilation. Sepsis was aggressively treated, usually with a regimen incorporating two or more antimicrobial agents.

In the latter years of the study an attempt was made to convert all oliguric patients to the non-oliguric state by therapy with a combination of dopamine (1 - 3 ng/kg/min) and furosemide (250 - 500 mg intravenous bolus, repeated every 6 - 8 hours if necessary),3 in the expectation that high-output ARF would be more easily managed and would carry an improved prognosis.3 An analysis was made of the acute insults consequent upon illness or injury which contributed to the development of ARF. These included: (i) hypotension, defined as a systolic blood pressure < 100 mmHg, or dehydration diagnosed in the presence of a history of fluid and electrolyte loss and clinical signs (e.g. hypotension, poor skin turgor) typical of this state; (ii) sepsis, diagnosed in an appropriate clinical setting when either documented bacteremia or a known focus of infection was present; (iii) pigmentation — haemoglobin was diagnosed by the presence of haemoglobin in the urine on dipstick testing; myoglobinuria when there was clinical evidence of extensive muscle damage, and haemopigment was detected in the urine on dipstick testing in the absence of red blood cells on microscopy; (iv) aminoglycoside nephrotoxicity was diagnosed in the setting of administration of the drug(s) in doses inappropriately high for the patient's serum creatinine level or body mass; (v) severe liver disease was diagnosed when there was documented cirrhosis or when jaundice, obstructive in type, was present before the onset of ARF; and (vi) radiocontrast medium nephrotoxicity was diagnosed when ARF developed within 48 hours of radiological investigation in which contrast material was utilised.

Thus, a patient injured in a motor vehicle accident (MVA) might suffer hypotension as a result of blood loss, peritonitis (sepsis) from a ruptured colon and receive an aminoglycoside antibiotic in appropriately high dose, so accruing three insults to renal function.

Additional factors relating to non-survival of patients with ARF were analysed. Statistical analyses utilised Student's t-test or the chi-square test, as appropriate.

Results

A steady increase occurred in the number of patients treated for ARF in the first 5 years of the study period to reach a more or less steady state of 40 - 50 cases annually during the 1980s (Fig. 1). Mortality rates (Fig. 1) were high and remained so throughout the 10-year period.

The 290 patients (aged 17 - 87 years; mean 54 years) were treated by HD; the male/female ratio was 2.6:1. The overall mortality rate was 49% (142 patients). As shown in Table I, 169 patients were drawn from the surgical disciplines and suffered the highest mortality rate (55%). In 109 patients ARF occurred in a medical setting and of these 41% died. In only 12 patients was ARF related to gynaecological illness or obstetric accident. In 7 of these women ARF complicated septic incomplete abortion. Early hysterectomy, in line with established policy at our hospital, allowed for early stabilisation and full recovery in 3, while in 4 patients surgery was delayed by their relatively late referral; 2 died before hysterectomy could be performed and 2 died despite surgery.

Over the years the number of cases of ARF occurring against a background of medical illness increased until the prevalence of 'medical' ARF exceeded 'surgical' ARF.

In analysing 'precipitating events' preceding the development of ARF, it was found that multiple trauma sustained predominantly
TABLE I. DISTRIBUTION OF CASES OF ARF BETWEEN MAJOR DISCIPLINES

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Patients</th>
<th>Deaths</th>
<th>% mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical disciplines</td>
<td>169</td>
<td>93</td>
<td>55</td>
</tr>
<tr>
<td>Medical disciplines</td>
<td>109</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>Obstetrics/gynaecology</td>
<td>12</td>
<td>4</td>
<td>33</td>
</tr>
</tbody>
</table>

An analysis was made of the cumulative total of acute insults to the kidneys sustained during the course of illness or injury complicated by ARF. The mortality rate correlated strongly with this sum of acute insults, showing a significant increment for each additional acute insult (Fig. 2).

**TABLE II. MAJOR CATEGORIES OF ARF AND ASSOCIATED MORTALITY**

<table>
<thead>
<tr>
<th>Precipitating event</th>
<th>Renal insults</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>Hypotension</td>
<td>42</td>
</tr>
<tr>
<td>Trauma</td>
<td>Hypotension + sepsis</td>
<td>57</td>
</tr>
<tr>
<td>Post-operative</td>
<td>complication</td>
<td>38</td>
</tr>
<tr>
<td>Post-operative</td>
<td>complication</td>
<td>55</td>
</tr>
<tr>
<td>Post-aortic</td>
<td>aneurysmectomy</td>
<td>63</td>
</tr>
<tr>
<td>Medical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Sepsis and hypotension</td>
<td>54</td>
</tr>
<tr>
<td>Other infective illness</td>
<td>Sepsis and hypotension</td>
<td>41</td>
</tr>
<tr>
<td>Hepatorenal syndrome</td>
<td></td>
<td>81</td>
</tr>
</tbody>
</table>

in MVAs accounted for 27% of all cases of surgical ARF, post-operative complications for 43% and aneurysmectomy, whether undertaken under elective or emergency conditions, for a further 22%. The remainder of the surgical patients developed ARF as a complication of burns, acute pancreatitis, radiographic contrast investigations and aminoglycoside nephrotoxicity.

Among medical patients ARF complicated infective illness in the majority (50%); by far the largest number developed ARF as an early complication of severe pneumonia which of itself frequently demanded mechanical ventilatory support. A miscellany of conditions (hepatorenal syndrome implying hepatic and renal failure and occurring as a consequence of chronic liver disease or fulminant hepatitis, uric acid nephropathy, non-traumatic rhabdomyolysis, haemoglobinuria in malaria, drug overdose, myocardial infarction, aminoglycoside toxicity and primary renal disease in the form of glomerulonephritis and drug-related acute interstitial nephritis) accounted for the remainder of medical cases.

ARF supervening in certain clinical settings was associated with a particularly high mortality (Table II): thus of 35 surgical patients whose ARF complicated surgery for repair of aortic aneurysm 22 (63%) died. It must be noted that most patients undergoing abdominal aneurysmectomy were elderly, having a mean age of 67 years (range 52 - 87 years), and as was observed (see below), the older the patient the poorer his or her chance of surviving an illness complicated by ARF. The incidence of ARF following abdominal aneurysmectomy was dramatically reduced after the introduction in 1983 of Swan-Ganz catheterisation by which means meticulous blood pressure control was achieved during the operative and postoperative period. Of 21 patients with the hepatorenal syndrome 17 (81%) died; ARF complicating severe pneumonia occurred in 28 patients, of whom 15 (54%) died.
Age proved a major determinant of mortality, survivors being significantly younger (mean 44.7 years) than non-survivors (mean 52 years) \( (P = 0.0004) \). The mortality rate rose sharply after the third decade and increased steadily thereafter (Fig. 3).

**Fig. 3. After the third decade, mortality rate rose steadily with increasing age.**

During the last 3 years of the 10-year period, there was a noticeable increase in the number of elderly people (aged 60 years and over) requiring acute artificial renal support (Fig. 4). The major causes of ARF in this age category were peri-operative hypotension and/or sepsis, and infective illness of which pneumonia was the most common. This age group also contained the majority of patients whose ARF was due to aminoglycoside nephrotoxicity.

The majority of patients were treated within intensive care units (ICUs). Of 196 patients managed within an ICU 93 (47%) died while of 94 managed within the general surgical or medical wards 49 (52%) died. The mortality rates of these two groups of patients were not statistically significantly different \( (P > 0.5) \). However, if mechanical ventilation was required the mortality rate rose to 58%, significantly higher \( (P < 0.02 < 0.01) \) than the 40% mortality suffered by those in whom ventilatory support was not required.

**Fig. 4. In the latter years of the 10-year period of the study there was an increase in the number of elderly patients requiring HD. This trend is likely to continue.**

**Discussion**

Annually between 40 and 50 patients at Johannesburg Hospital require HD for ARF. A few cases of ARF are treated by peritoneal dialysis but, because most cases are of the hypercatabolic type, the more efficient HD is preferred.

We have noted a steady increase in the number of cases of ARF occurring in a medical as opposed to a surgical setting, a trend which has been noted elsewhere. Conversely, obstetric cases of ARF are becoming increasingly rare. In such patients the mortality rate is low, as might be expected in young, previously healthy women; however, whenever there is sepsis the mortality rate rises and all 4 deaths in this group occurred in women in whom procured abortion was complicated by Gram-negative septicemia. It is probable that these deaths might have been averted had early hysterectomy been undertaken. A woman who develops ARF as a complication of septic abortion should be transferred urgently to a centre offering haemodialysis; there the decision should be made to perform hysterectomy if no significant clinical improvement is evident within 24 - 48 hours. It should be emphasised that the extremely rare occurrence today of ARF as a complication of obstetric accident (e.g. abortion, antepartum or postpartum haemorrhage) is testimony to the ease with which acute tubular necrosis may be averted by early aggressive resuscitation and restoration of renal perfusion. In almost two-thirds of our patients ARF supervened on a background of surgical illness. Sixty per cent of all surgical ARF arose in the postoperative period as a consequence of peri-operative hypotension, with or without concomitant sepsis, and one-third of these operations were abdominal aneurysmectomies. This fact points to the crucial role, in terms of maintenance of renal function, of meticulous intra- and postoperative monitoring to ensure that episodes of hypotension and consequent renal hypoperfusion are avoided.

Multiple trauma, frequently complicated by sepsis, accounted for a quarter of all cases of surgical ARF and was the result of MVAs in most instances, reflecting our unenviable but well-established record as the world's worst motorists.

Our experience, in common with that of renal units around the world, was that ARF was associated with a dauntingly high mortality rate in spite of intensive dialytic, nutritional, antibiotic and, in many cases, ventilatory support. Thus ARF occurring in a surgical setting was associated with a 55% overall mortality rate and that occurring in association with medical illness with a 41% mortality rate.

The relatively high overall mortality rate associated with 'medical' ARF reflects the very high mortality rate of 54% in those patients whose ARF complicated severe pneumonia and that of 81% in those cases of hepatorenal failure. After exclusion of the cases of the hepatorenal syndrome among whom fatalities are expected to be high the mortality rate of 'medical' ARF falls to 35% resembling, but unfortunately not bettering, that reported from overseas units in the 1970s.

We may speculate that the persistently poor survival rate was a reflection of the severe nature of the illness or injury underlying the development of ARF rather than of the metabolic disturbance associated with renal shutdown, especially as this was adequately controlled by dialysis. Our experience provides some justification for this argument. Two-thirds of our patients were considered ill enough to merit management within an intensive care area. And many, among whom the mortality rate was extremely high, had multiple organ failure (e.g. liver failure or respiratory failure) in addition to renal shutdown. The slightly higher mortality rate in those patients not admitted to ICUs was surprising and may indicate that most patients ill enough to develop ARF are indeed ill enough to merit intensive care management.
Addendum

Prevention of ARF after radiological investigation

Implementation of the following protocol will prevent ARF after radiological investigations which employ contrast media in subjects predisposed to this complication owing to existing renal insufficiency.

1. Ensure adequate hydration before investigation by administering 1-2 litres of normal saline intravenously the night before the proposed study.

2. Add furosemide in a dose of 100 mg for each 100 ml of 20% mannitol. Begin an infusion of this mixture 1 hour before the administration of contrast medium at a rate of 20 ml/h. This infusion should be continued throughout the procedure and for about 6 hours thereafter.

3. Replace urine output, volume for volume, with 5% dextrose saline with 30 mmol potassium chloride added per litre.

REFERENCES


