PROSPECTIVE STUDY OF ACUTE RENAL FAILURE IN A GENERAL HOSPITAL

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SUMMARY

A prospective study of acute renal failure (ARF) over a three month period showed that 60 out of 22,033 inpatients developed ARF (Serum creatinine exceeding 0.200 mmol/L). The ARF was oliguric in 22% and nonoliguric in 78%. Poor cardiac output or diminished intravascular volume, nephrotoxins and infections were the main aetiological factors associated with ARF in 85% of cases. Mean peak serum creatinine and blood urea values were higher in the oliguric than the non oliguric group. The oliguric group required dialysis more frequently (53.8% vs 4.3%) and had a higher mortality (53.8% vs 8.5%) than the non oliguric group. Nonoliguric ARF occurs more commonly and has a better prognosis than oliguric ARF.

Acute renal failure is a serious condition with significant mortality[1] and remains a frequent occurence in the setting of large general hospitals.[2,3,4] Previous reports on acute renal failure in Kuala Lumpur comprised patients treated at the Department of Nephrology at the General Hospital Kuala Lumpur, but did not include patients with acute renal failure treated at other departments in the hospital.[4]

This report is based on a prospective study of acute renal failure occurring in the General Hospital Kuala Lumpur over a three-month period to evaluate the clinical spectrum of this disease, and its outcome.

PATIENTS AND METHODS

Acute renal failure is a serious condition with significant mortality[1] and remains a frequent occurence in the setting of large general hospitals.[2,3,4] Previous reports on acute renal failure in Kuala Lumpur comprised patients treated at the Department of Nephrology at the General Hospital Kuala Lumpur, but did not include patients with acute renal failure treated at other departments in the hospital[4].

Oliguria is defined as urine output of less than 400 ml/day, and patients with oliguria persisting for more than 48 hours were classified as having oliguric acute renal failure. If the initial oliguria persisted for less than 48 hours, and is followed by urine output exceeding 400 ml/day, these patients were classified as having non-oliguric acute renal failure.

The daily lists of hospitalised patients with serum creatinines exceeding 0.200 mmol/L were obtained from the Division of Biochemistry and the patients reviewed. Those found to have acute renal failure were included in the study. All patients were seen in their respective wards in the hospital and a review of the charts and case notes made. Prior permission had been obtained from the respective heads of departments to include their patients in the study. Patients under the age of 10 years, those with documented

pre-existing renal failure (S. Creatinine >0.200 mmol/L), obstructive uropathies, parenchymal renal disease, including glomerulonephritis were excluded from the study. The Department of Nephrology was not involved in the management of these patients unless a formal referral had been made.

The serum creatinine was measured by an Autoanalyser. All data were expressed as ± ISEM and statistical analyses were performed using the student 't' Test and chi-square analysis with Yates correction.

RESULTS

Over the 3–month study period, a total of 22,023 patients were admitted to the hospital, and 60 were found to have acute renal failure. The sex and ethnic distribution are shown in table I. the age distribution is shown in table II; 76% were over 40 years and 38% over 60 years. Thirteen (22%) out of the 60 patients were oliguric and 47 (78%) were nonoliguric at the onset of acute renal failure. The clinical presentation grouped under medicine, surgery and obstetrics is shown in table III. It is clear that nonoliguric acute renal failure in all the three groups were more common than the oliguric form.

TABLE 1. Characteristics of patients with acute renal failure

	Sex Distrubution	Ethnic Distribution
Males :	34	Malays: 23
Females:	26	Chinese: 19
		Indians: 16
		Others: 2

TABLE II. Age distribution of patients with acute renal failure

Age	Number of patients
up to 20 years	2
21 – 40 years	12
41 – 60 years	23
< 60 years	

TABLE III. Urinary output at the onset of acute renal failure (ARF) in medical, surgical and obstetric patients.

	Oliguric ARF	Nonoliguric ARF
	Number of patients	Number of patients
Medicine	6	28
Surgery	6	17
Obstetrics	1	2
Total	13	47

The primary event or causes leading to acute renal failure is shown in Table IV. Pre-renal causes were the most common, related mainly to poor cardiac output or diminished intravascular volume. Four of the II patients with decreased cardiac output had suffered a myocardial infarction prior to the onset of acute renal failure. In the group with diminished intravascular volume, seven were severely dehydrated, (in two patients, this was the result of severe diuresis after frusemide therapy), four were due to blood loss and two patients had the hepatorenal syndrome.

In nine patients, acute renal failure occurred following surgery: Blood or fluid loss, or impaired blood flow to the kidneys were the most likely causes of the renal failure. Characteristics of these patients are shown in table V. Septicaemia was clinically diagnosed as the aetiological factor in five patients and

TABLE IV. Primary events leading to acute renal failure (ARF)

	Events or causes leading to ARF	Number of patients	
1.	Pre renal azotaemia		
	a) decreased cardiac output	11)	
	b) diminished intravascular volume	13)	33
	c) post operative	9)	
2.	Infective		5
3.	Toxin induced		
	a) aminoglycosides	8)	13
	b) others	5)	
4.	Obstructive jaundice		3
5.	Miscellaneous		6
	Total		60

TABLE V. Characteristics of patients developing acute renal failure postoperative

Patient	Nature of surgery and clinical course
1.	Laparotomy with oesophageal transection and pyeloroplasty following bleeding of upper gastrointestinal tract.
2.	Cholecystectomy in a patient with Von Willebrand's disease who had generalised bleeding after surgery requiring seven units of blood transfusion.
3.	Resection of abdominal aortic aneurysm.
4.	Herniorraphy followed by laparotomy and bowel resection the following day and a second laparotomy seven days later.
5.	Herniorraphy followed by laparotomy three days later.
6.	Resection of abdominal aortic aneurysm.
7.	Total abdominal hysterectomy for post partum haemorrhage.
8.	Laparotomy with gastrostomy, ileostomy and resection of colon performed.
9.	Resection of abdominal aortic aneurysm.

blood cultures grew Pseudomonas aeruginosa, E. Coli, Staphylococcus aureus streptococcus faecalis in four patients suffering from acute myeloid leukaemia, diabetes mellitus, heroin addiction and infective endocarditis respectively.

Gentamicin therapy was associated with acute renal failure in eight patients (Table VI), and the mean age amongst the eight cases was 61 ± 8 years. Renal failure occurred 12 ± 5 days after starting therapy. Acute renal failure after ingestion of a local fruit called "jering" (Pithecolobium lobatum) occurred in one patient. Ingestion of this fruit and the occurence of acute oliguric renal failure is well known, and has been previously reported.[4,5]

TABLE VI. Aetiology of toxin induced acute renal failure

Aetiological factors	Number of patients
Gentamicin	8
Nonsteroidal anti inflammatory drugs (mefenemic acid)	1
Cis-platinum	1
Weed killer	2
Jering (Pithecolobium lobatum)	1
Total	13

In the miscellaneous group one patient who had severe multiple hornet stings and another patient who had been severely assaulted, developed acute renal failure associated with rhabdomolysis. In two patients, acute renal failure occurred after viral infections. Head injury where a coconut fell on the head, and toxaemia of pregnancy was associated with acute renal failure in two other patients respectively.

Some characteristics of patient with oliguric and nonoliguric acute renal failure are shown in table VII. The majority (II out of 12) of patients with toxin induced acute renal failure were nonoliguric. This is well known to occur in acute renal failure caused by drugs.[1,8,10]. The mean peak serum creatinine and blood urea levels were higher in the oliguric group compared with the nonoliguric group which is consistent with Anderson's report.[2] A high percentage (53.8%) of patients in the oliguric group required dialysis, while only 4% in the nonoliguric group were dialysed.

The overall mortality was 18%, but mortality was 53.8% in the oliguric group and 8.5% in the non-oliguric group. The characteristics of patients who died are shown in table VIII. Five of the seven patients who died in the oliguric group were dialysed, and one of the four patients in the nonoliguric group were dialysed. Of the total of nine patients who were dialysed, there were six deaths. The higher mortality and morbidity among oliguric patients has been previously reported.[2,3,6]

Out of the 60 patients, 38 were admitted to hospital with normal serum creatinine levels, and subsequently developed acute renal failure, while 22 patients were admitted with elevated levels of serum creatinine (Table IX). Eigthteen patients (30%) were referred and managed by the Nephrology service while 42 patients (70%) were managed by other clinical units in the hospital.

TABLE VII. Characteristics of patients with oliguric and nonoliguric acute renal failure

Aetiology of ARF	Oliguric ARF	Nonoliguric ARF	
	Number of patients	Number of patients (%)	
Pre renal causes			
a. decreased cardiac output	1	10	ns
b. diminished intravascular volume	1	12	ns
c. Post operative	3	6	ns
Infective	3	2	ns
Toxin induced			
a. gentamicin	0	8	ns
b. others	1	3	
Obstructive jaundice	0	3	ns
Miscellaneous	4	2	ns
Total	13	47	
Treatment by dialysis	7	2	$P<0.05$
Deaths	7	4	$P<0.05$
Mean peak blood urea (mmol/l)	38 ± 18	23 ± 15	ns
Mean peak serum creatinine (mmol/l)	0.559 ± 0.267	0.329 ± 0.231	ns

ns = not siginificant

DISCUSSION

Oliguria is commonly considered to be characteristic of acute renal failure. However our results show that nonoliguric acute renal failure occurs more commonly than is generally appreciated. The current results supports similar findings by others.[2,3,6,9]

There are several possible explanations for high incidence of nonoliguric acute renal failure. It is now more frequently recognised because of frequent biochemical monitoring of patients with serious illness. The use of drugs, particularly nephrotoxic antibiotics resulting in acute renal failure which is frequently nonoliguric[1,8,10,11] also contributes to the increased incidence. The use of potent diuretics in oliguric patients may convert them into nonoliguric acute renal failure.[2,12] This clinical observation is consistent with experimental studies in which use of diuretics or renal vasodilators may convert acute renal failure into nonoliguric type, and results of studies on the pathophysiology of nonoliguric acute renal failure following cardiac surgery revealed similarities with the experimental model.[13] As the mortality is very much lower in the nonoliguric type as shown in this study and in others[2,3,6] there are obvious advantages in being able to convert the oliguric to nonoliguric acute renal failure. Although the nonoliguric form is associated with less morbidity and mortality than the oliguric acute renal failure, it is still associated with considerable risk of morbidity and mortality.

The main causes of acute renal failure were diminished cardiac output or intravascular volume, which may be associated with surgery, septicaemia and nephrotoxic agents, and this is consistent with the findings of Diamond in a recent review of nonoliguric acute renal failure.[6] Gentamicin was the main

TABLE VIII. Characteristics of 11 patients who died

	Characteristics	Patients with Oliguric ARF	Patients with Nonoliguric ARF
Medical			
	Heroin addict with Staph. aureus septicaemia	1	
*+	Septicaemia with Strep. faecalis endocarditis	1	
	Acute myocardial infarction with pulmonary oedema		1
*	Trauma with rhabdomolysis and pneumonia		1
Surgical			
	50% Burns	1	
*	Septicaemia, three abdominal operations performed	1	
*	Resection of aortic aneurysm	1	
+	Head injury and coma	1	
	Intracranial haemorrhage and GIT bleeding		1
	Obstructive jaundice with carcinoma gall bladder		1
	Total	7	4

* haemodialysis performed

\+ peritoneal dialysis performed

cause of drug-induced acute renal failure, and it is well known that up to 11% of patients receiving this drug showed significant increases in serum creatinine.[11] The mean age of patients with gentamicin induced acute renal failure was 61 ± 8 years, is consistent with the fact that older patients are at greatest risk for nephrotoxicity.[1,11] Contrast media induced acute renal failure was not detected during the study period, although it has been well reported as a cause.[1,2,3] Its incidence however, is known to be variable and relates to differences in risk factors.[1] As it may be nonoliguric, it may not be detected if the renal function were not monitored after the procedure. It was of interest to note that no cases of acute renal failure were detected amongst the 60 patients undergoing open heart surgery with cardio pulmonary bypass during the study period, although its occurance has been well reported,[2,13–15] with an incidence of up to 26%.[14]

Thirty eight (63.3%) out of the 60 patients developed acute renal failure after admission to hospital. Iatrogenic factors if broadly defined to include diminished intravascular volume, post operative cases and exposure to nephrotoxic drugs, would account for 25 (10 out of 13 toxin induced acute renal failures were due to drugs as shown in table VI) out of 38 cases. This makes an. incidence of 65% of acute renal failure acquired in hospital being iatrogenic, which is similar to what was reported by Hon.[3]

TABLE IX. Status of renal function on admission to hospital in patients with acute renal failure

Aetoilogy of ARF	Serum creatinine below 0.120 mmol/l	Serum creatinine 0.120 mmol/l above
	Number of patients	Number of patients
Pre renal causes		
a. decreased cardiac output	6	5
b. diminished intravascular volume	9	4
c. post-operative	6	3
Infective	2	3
Toxin induced		
a. gentamycin	8	–
b. others	3	2
Obstructive jaundice	2	1
Miscellaneous	2	4
Total	38 (63.3%)	22 (36.7%)

The mortality of 18.3% in this study is lower than our previous report of 33.2%.[3] However, that report comprised only of patients managed by the Department of Nephrology, who were generally more severely ill and required dialysis, and excluded patients with acute renal failure treated by other units in the hospital.

The 11 patients who died were severely ill with severe infections. Repeated abdominal surgery, gastrointestinal bleeding and head injury were important factors contributing towards the final outcome. The mortality was much higher among the oliguric than the nonoliguric group, as has been previously observed.[2,3,6]

In considering efforts to prevent acute renal failure, careful selection of drugs, particularly antibiotics, monitoring of renal function and antibiotic blood levels would all be helpful, but it is likely that drug induced acute renal failure will remain an important cause of iatrogenic acute renal failure.

Reduced intravascular volume and postoperative acute renal failure featured prominently despite our better knowledge of fluid and electrolytes than a few decades ago, emphasising the importance of careful fluid and electrolyte management of patients in hospital particularly among those with cardiac and renal disease.

In summary, nonoliguric acute renal failure occurs very much more commonly than is generally realised, and its prognosis is better than oliguric acute renal failure. However, nonoliguric acute renal failure is a serious disease with significant, morbidity and mortality. The common practice of monitoring urine volume as an indicator of renal function may be grossly misleading unless biochemical tests of renal function are monitored as well. Nephrotoxic drugs, diminished intravascular volume including those in postoperative cases, were important causes of acute renal failure acquired in hospital and careful monitoring of renal function and careful management of fluid and electrolyte balance are important in preventing iatrogenic acute renal failure.

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