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Transient azotaemia is associated with a high risk of death in hospitalized patients

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Abstract

Background. There are no suitably powered epidemiological studies of 'transient azotaemia' (TA). The objective of this study was to describe the epidemiology of TA and its independent association with hospital mortality. We hypothesized that TA would be associated with an independent increase in the risk of death.

Methods. We retrospectively studied all patients admitted to a university-affiliated hospital in Australia between January 2000 and December 2002. Patients were excluded if they were <15 years old, were on chronic dialysis, had kidney transplant or if their length of hospital stay was <24 hours. We defined TA as rapidly recovering acute kidney injury (AKI) (return to no-AKI risk, injury, failure, loss, end stage (RIFLE) class within 72 hours of onset). We performed descriptive and comparative statistical analysis of data. The primary outcome of the study was the association between TA and hospital mortality in multivariate logistic regression analysis.

Results. Among 20 126 study patients, 3641 (18.1%) had AKI according to the RIFLE criteria and 1600 had AKI, which recovered during their hospital stay. Recovery of AKI occurred most commonly within 1 day after diagnosis (37.7%, $n = 603$). Furthermore, 1172 patients (73.3%) who recovered from AKI did so within 3 days (TA). After correcting for confounding factors, compared with patients without AKI, patients with TA had a significantly higher odds ratio for hospital mortality (2.26; 95% confidence interval: 1.85–2.76).

Conclusions. Transient azotaemia is common in hospital patients, represents close to a third of all cases of AKI and is independently associated with a significantly higher risk of death.

Keywords: acute kidney injury; acute tubular necrosis; epidemiology; pre-renal azotaemia

Introduction

Acute kidney injury (AKI) is common in hospitalized patients, and its associated mortality is high [1–3]. The causes of AKI are commonly divided into three groups: pre-renal, intra-renal and post-renal [4–6]. Within the group of patients with pre-renal failure, a typical further clinical subdivision is then applied depending on the speed of recovery from AKI. According to this paradigm, such transient azotaemia (TA) represents a separate entity characterized by a rapidly reversible increase in serum creatinine. This rapid reversibility is believed to reflect a functional reduction in glomerular filtration without established structural kidney injury (so-called acute tubular necrosis or ATN), which instead leads to sustained AKI [6]. These two causes have been reported to account for 66% [1] to 75% [2] of all cases of AKI.

Early differentiation of TA from ATN is considered clinically important, and multiple studies have been conducted to deal with the issue of differential diagnosis, using urinalysis, serum and urinary biochemistries and ultrasound [7–18]. These studies argue that TA is a benign condition, which, unlike ATN, does not carry a significant independent association with increased mortality. However, there are no suitably powered epidemiological studies of TA to establish its incidence and possible independent association with outcome.

We hypothesized that TA is common in hospital patients and that it carries an independent association with hospital outcome. We tested these hypotheses using a large database of hospitalized patients from an academic medical centre [3].

Subjects and methods

We screened all patients admitted to the Austin Hospital between January 2000 and December 2002 using the computerized hospital admissions and discharges database. Patients were excluded if they were <15 years old, if they were on chronic dialysis or had kidney transplant or if their length of hospital stay was <24 hours. Demographic information was collected from the database: age, gender, type of admission, intensive care unit (ICU) ad-

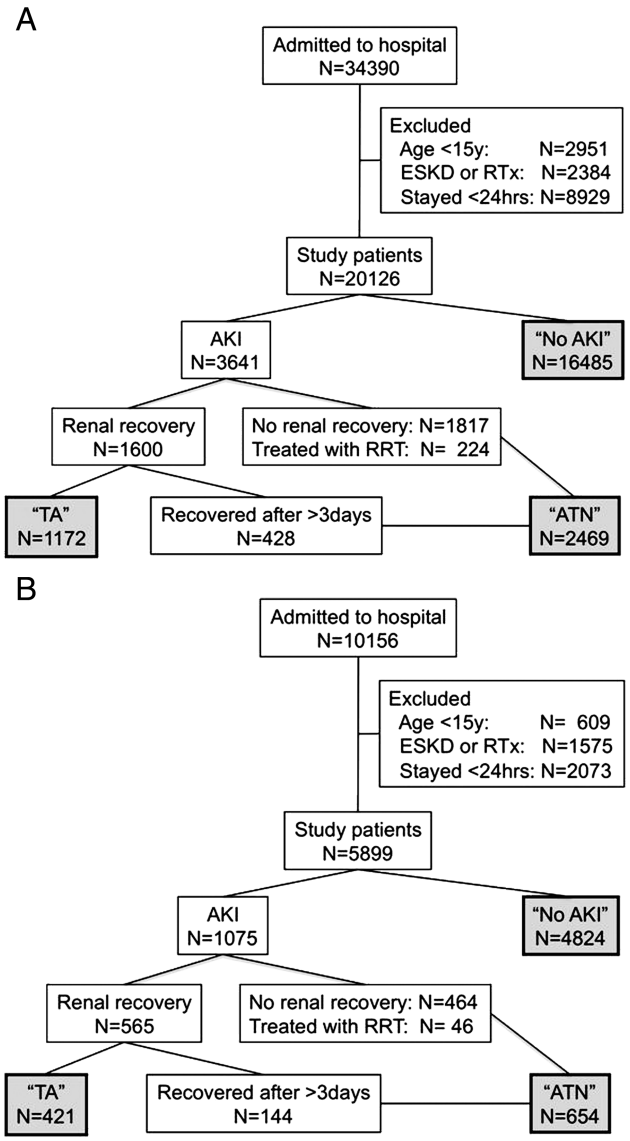

Fig. 1. Patient selection flow diagram for current study (ESKD: end-stage kidney disease, RTx: renal transplantation, AKI: acute kidney injury, RRT: renal replacement therapy, TA: transient azotaemia. **(A)** All study patients and **(B)** patients with more than one admission. The seemingly different numbers are due to the fact that some patients had more than one exclusion criterion).

mission, use of mechanical ventilation, use of renal replacement therapy (RRT), admission units and hospital mortality. If a patient had more than one admission during the study period, only the last admission was included in the study. The study was approved by the Austin Hospital Human Research Ethics Committee. The need for informed consent was waived as the study required no intervention and no breach of privacy or anonymity as such projects are considered quality improvement activities by the Institutional Ethics Committee.

Serum creatinine values for all included patients during their hospital stay were obtained from the central laboratory database. AKI was defined according to the RIFLE criteria [19]. We used the glomerular filtration rate (GFR) criteria only because we could not collect information for urine output. The worst categorical group of the criteria (the highest RIFLE category reached during hospital stay) was chosen from the risk, injury or failure categories. The peak creatinine was defined as the highest creatinine during their hospital admission. The baseline creatinine was defined in two ways as previously described [3]. In brief, for patients who had more than one admission during the study period, the baseline creatinine was defined as that measured at hospital discharge from the previous admission. For patients with only one admission, the baseline creatinine was estimated using the modification of diet in renal disease (MDRD) equation [20], as recommended by the acute dialysis quality initiative workgroup (assuming an average GFR of 75 ml/min in this age group) [3,19].

Included patients were then divided into three groups: 'TA', 'ATN' and 'No-AKI'. Patients were classified in the 'No-AKI' group if, during admission, they did not satisfy any of the RIFLE criteria for AKI. Renal recovery was defined when patients with AKI had creatinine reduced to the 'No–AKI' range during hospital stay without receiving RRT. If renal recovery occurred within 3 days after diagnosing AKI, these patients were classified as having 'TA' as previously described [9,12,18]. The remaining patients with AKI (no renal recovery, received RRT, renal recovery after >3 days) were classified in the 'ATN' group. Figure 1 shows the patient selection flow diagram.

Statistical analysis

Demographic data are presented as medians (25th–75th quartiles) or percentages. The demographics of the three groups were compared with the chi-square test for nominal values and Kruskal–Wallis test for numerical variables. Multivariate logistic regression analysis was conducted for hospital mortality. All variables in Tables 1 and 2 and renal conditions for patients ('No-AKI', 'ATN' and 'TA') were chosen as independent variables in the analysis. 'General medicine' was used as a reference for admission units and 'No-AKI' for renal conditions. The RIFLE criteria and RRT requirement could not be included in the analysis because of their strong colinearity with 'renal conditions'. Because approximately three quarters of patients did not have a known baseline creatinine, sensitivity analyses were conducted by separately studying only patients with more than one admission (measured baseline creatinine available). A commercially available statistical package was used (StatView, Abacus Concepts, Berkeley, CA). A P-value of <0.05 was considered statistically significant.

Results

Among 20 126 study patients, 3641 (18.1%) had AKI. Among these patients, 1600 (43.9%) had AKI which recovered during their hospital stay (Figure 1A and B). The distribution of AKI duration is shown in Figure 2A. Recovery of AKI occurred most commonly within 1 day of diagnosis (37.7%).

Overall, 1172 patients recovered renal function within 3 days (32.1% of all patients with AKI; 5.8% of all admissions) ('TA' group) (Figure 1). Patients whose renal function recovered after 3 days (n = 428), or whose renal function did not recover during their hospital stay (n = 1817) or who were treated with renal replacement therapy (n = 224) were classified in the 'ATN' group (n = 2469). AKI occurred 2 days [1–4] after hospital admission in the 'TA' group and 2 days [1–3] after hospital admission in the 'ATN' group (P = 0.0007). In the 'TA' group, 60.5% of patients had AKI within 2 days after hospital admission, whereas this value was 65.5% in the 'ATN' group. Patients without AKI were classified in the 'No-AKI' group (n = 16 485). The demographics of patients in these three groups are shown in Table 1. Patients with AKI ('ATN' and 'TA') were older, were more likely to have an emergency hospital admission and an ICU admission, more likely to be mechanically ventilated and to be admitted under general medicine than patients with 'No-AKI'. Compared to the 'ATN' group, patients in the 'TA' group were more likely to be surgical patients, to experience readmission, ICU admission and mechanical ventilation (P < 0.0001 for all comparisons).

Table 1. Demographics of patients

	No AKI	ATN	TA	Comparison for three groups	ATN *vs.* TA
Number of patients	16 485	2469	1172		–
Age, years	65 (49–76)	78 (69–85)	75 (65–82)	$P < 0.0001$	$P < 0.0001$
Male gender, %	56.1	48.7	52.4	$P < 0.0001$	$P = 0.040$
Readmission, %	29.3	26.5	35.9	$P < 0.0001$	$P < 0.0001$
Emergency admission, %	55.7	71.9	68.1	$P < 0.0001$	$P = 0.019$
ICU admission, %	12.3	22.3	32.1	$P < 0.0001$	$P < 0.0001$
Mechanical ventilation, %	7.3	15.5	20.9	$P < 0.0001$	$P < 0.0001$
Baseline creatinine, mg/dL	1.0 (0.8–1.1)	0.9 (0.8–1.0)	0.9 (0.8–1.0)	$P < 0.0001$	$P = 0.82$
Operation, %	36.7	22.5	39.6	$P < 0.0001$	$P < 0.0001$
Admission units, %				$P < 0.0001$	$P < 0.0001$
General medicine	19.6	40.2	35.3		
Cardiology	12.9	7.8	5.8		
Gastroenterology	3.1	4.8	4.6		
Haematology	1.6	2.7	2.4		
Neurology	4.9	1.9	2.1		
Oncology	7.6	7.0	6.2		
Renal medicine	0.6	5.7	1.3		
Respiratory medicine	3.6	3.3	4.0		
Stroke unit	2.9	3.2	1.7		
Other medical units	3.7	1.9	1.1		
Cardiac surgery	4.5	4.1	11.8		
General surgery	12.7	5.5	9.8		
Neurosurgery	5.4	1.1	1.4		
Orthopedics	4.6	2.1	3.2		
Thoracic surgery	4.0	1.1	2.2		
Urology	3.0	3.0	2.5		
Vascular surgery	2.7	3.6	3.6		
Other surgical units	2.6	1.1	1.0		

AKI: acute kidney injury, ATN: acute tubular necrosis, TA: transient azotaemia.

Table 2. Demographics of patients with readmission

	No AKI	ATN	TA	Comparison for three groups	ATN *vs.* TA
Number of patients	4824	654	421	–	–
Age, years	70 (55–79)	74 (61–81)	73 (58–81)	$P < 0.0001$	$P = 0.21$
Male gender, %	57.6	55.0	54.9	$P = 0.23$	$P > 0.99$
Emergency admission, %	56.3	69.7	68.6	$P < 0.0001$	$P = 0.74$
ICU admission, %	10.0	23.9	27.6	$P < 0.0001$	$P = 0.20$
Mechanical ventilation, %	5.1	16.5	16.2	$P < 0.0001$	$P = 0.93$
Baseline creatinine, mg/dL	0.9 (0.7–1.2)	1.0 (0.7–1.4)	0.9 (0.6–1.2)	$P < 0.0001$	$P < 0.0001$
Operation, %	28.9	21.3	34.2	$P < 0.0001$	$P < 0.0001$
Admission units, %				$P < 0.0001$	$P < 0.0001$
General medicine	23.9	32.4	37.1		
Cardiology	9.6	5.4	3.1		
Gastroenterology	4.4	9.2	7.8		
Haematology	3.5	5.7	3.1		
Neurology	4.3	2.0	1.9		
Oncology	14.7	14.7	11.2		
Renal medicine	1.1	5.2	1.4		
Respiratory medicine	4.0	4.6	4.3		
Stroke unit	1.6	1.5	1.2		
Other Medical units	2.6	2.4	1.9		
Cardiac Surgery	4.2	2.8	8.8		
General surgery	10.3	5.0	8.8		
Neurosurgery	3.5	0.8	0.5		
Orthopedics	2.4	2.0	2.6		
Thoracic Surgery	3.1	1.2	1.2		
Urology	2.2	2.8	1.9		
Vascular surgery	3.5	1.4	2.6		
Other Surgical units	1.2	1.1	0.7		

AKI: acute kidney injury, ATN: acute tubular necrosis, TA: transient azotaemia.

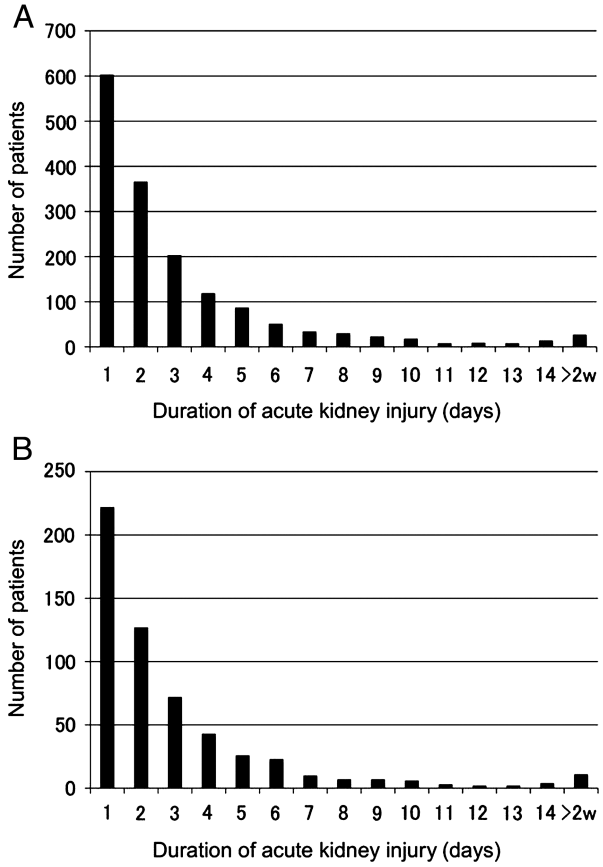

Fig. 2. Number of patients for each duration of AKI in days, showing that most patients had AKI for only 24 hours [**(A)** all study patients (n = 1600), **(B)** patients with more than one admission (n = 565)].

confounding factors, 'TA' was an independent predictor of hospital mortality with a high odds ratio (2.26, P < 0.0001). Because the threshold of 3 days to distinguish TA and ATN was based on the literature and carries no previous validation, multivariate analysis for hospital mortality was repeated for different durations of AKI (1, 2, 3, 4 to 7, 8 to 14 and >14 days). Figure 3 shows the odds ratios for hospital mortality with different durations of AKI. There was an overall trend towards a gradual increase in the odds ratio for hospital mortality as duration of AKI increased but also significant overlap in the 95% confidence intervals (CIs) of the odds ratios for hospital mortality. Even 1 day of TA had a significantly increased odds ratio for hospital mortality (1.93, 95% CI: 1.46–2.56, P = 0.0036).

As part of a sensitivity analysis and to test the robustness of our findings, all above analyses were repeated for patients with more than one admission (for whom a stronger estimate of baseline kidney function was available) (n = 5899, 29.3%) (Figure 1B). In this cohort, we confirmed the findings seen in all study patients, including distribution of days for renal recovery (Figure 2B), patient demographics (Table 2), outcomes (Table 3) and multivariate analysis for hospital mortality (Table 5, Figure 3).

Discussion

We performed a retrospective analysis of a large patient database to describe the epidemiology of 'TA' and its outcome associations in hospital patients. We found that TA is common in hospital patients occurring in ~6% of admissions and that it accounts for almost a third of all cases of in-hospital AKI. We also found that patients with TA had

Table 3. Renal outcome and hospital mortality

	All patients				Patients with readmission			
	No AKI	ATN	TA	ATN *vs.* TA	No AKI	ATN	TA	ATN *vs.* TA
Number of patients	16 485	2469	1172	–	4824	654	421	–
RRT				–				–
CRRT	–	147 (6.0%)	–		–	41 (6.3%)	–	
IRRT	–	11 (0.4%)	–		–	5 (0.8%)	–	
RIFLE classes				P < 0.0001				P < 0.0001
Risk	–	969 (39.2%)	868 (74.1%)		–	302 (46.2%)	305 (72.4%)	
Injury	–	832 (33.7%)	223 (19.0%)		–	182 (27.8%)	84 (20.0%)	
Failure	–	668 (27.1%)	81 (6.9%)		–	170 (26.0%)	32 (7.6%)	
Hospital mortality	719 (4.4%)	718 (29.1%)	174 (14.8%)	P < 0.0001	368 (7.6%)	272 (41.6%)	74 (17.6%)	P < 0.0001

AKI: acute kidney injury, ATN: acute tubular necrosis, TA: transient azotaemia, RRT: renal replacement therapy, CRRT continuous RRT, IRRT: intermittent RRT.

Table 3 shows the outcomes of patients in the three groups. RRT was delivered to 6.4% of patients in the 'ATN' group. The majority of patients in the 'TA' group were in the 'Risk' RIFLE class (74.1%), whereas the RIFLE classes in the 'ATN' group were more equally distributed. Hospital mortality was highest in the 'ATN' group and lowest in the 'No-AKI' group (P < 0.0001).

Table 4 shows the results of multivariate logistic regression analysis for hospital mortality. Even after excluding

significantly higher hospital mortality compared to patients with no AKI and that TA carried an independent association with increased mortality. Furthermore, we found that even 1 day of AKI had a significantly increased odds ratio for hospital mortality.

The concept of TA is similar but not identical to that of 'pre-renal azotaemia' (PRA). However, TA, the term used in this paper, avoids non-verifiable assumptions about aetiology, histopathology and pathogenesis. PRA and acute

Table 4. Multivariate logistic regression analysis for hospital mortality

Variables	Odds ratios (95% CI)	
Age, years	1.036 (1.031–1.041)	$P < 0.0001$
Male gender	1.199 (1.060–1.356)	$P = 0.0038$
Readmission	1.860 (1.636–2.115)	$P < 0.0001$
Emergency admission	1.543 (1.327–1.795)	$P < 0.0001$
ICU admission	3.181 (2.500–4.048)	$P < 0.0001$
Mechanical ventilation	5.007 (3.826–6.552)	$P < 0.0001$
Baseline creatinine, mg/dL	1.514 (1.332–1.722)	$P < 0.0001$
Operation	0.809 (0.665–0.983)	$P = 0.033$
Admission units		
General medicine	1.000 (Reference)	
Cardiology	0.389 (0.288–0.525)	$P < 0.0001$
Gastroenterology	1.298 (0.927–1.816)	$P = 0.13$
Haematology	2.675 (1.921–3.725)	$P < 0.0001$
Neurology	0.829 (0.563–1.222)	$P = 0.34$
Oncology	4.312 (3.545–5.244)	$P < 0.0001$
Renal medicine	0.257 (0.147–0.449)	$P < 0.0001$
Respiratory medicine	1.139 (0.850–1.526)	$P = 0.38$
Stroke unit	2.046 (1.556–2.690)	$P < 0.0001$
Other medical units	0.628 (0.380–1.035)	$P = 0.068$
Cardiac surgery	0.090 (0.060–0.135)	$P < 0.0001$
General surgery	0.514 (0.387–0.682)	$P < 0.0001$
Neurosurgery	1.094 (0.741–1.616)	$P = 0.65$
Orthopedics	1.133 (0.781–1.645)	$P = 0.51$
Thoracic surgery	0.528 (0.318–0.874)	$P = 0.013$
Urology	0.120 (0.048–0.301)	$P < 0.0001$
Vascular surgery	0.368 (0.241–0.561)	$P < 0.0001$
Other Surgical units	0.174 (0.068–0.445)	$P = 0.0003$
Renal condition		
No AKI	1.000 (Reference)	
ATN	6.070 (5.305–6.944)	$P < 0.0001$
TA	2.264 (1.856–2.762)	$P < 0.0001$

CI: confidence interval, RRT: renal replacement therapy, AKI: acute kidney injury, ATN: acute tubular necrosis. Area under the receiver operating characteristic curve: 0.872, Hosmer–Lemeshow goodness-of-fit test: 400.7, $P < 0.0001$.

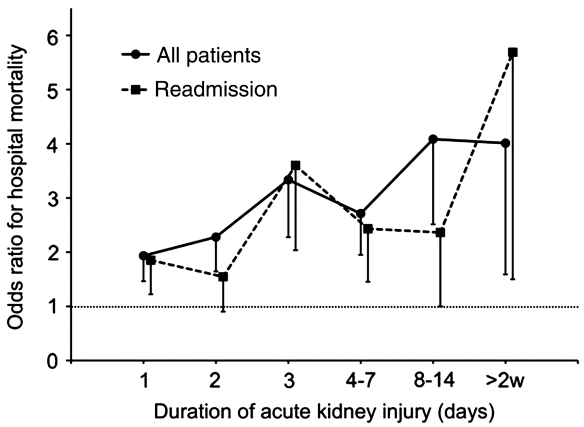

Fig. 3. Odds ratios (with lower 95% CI) for hospital mortality with different durations of acute kidney injury (patients with readmission had baseline information on serum creatinine; AKI of longer duration was associated with increased odds ratio of death).

tubular necrosis (ATN) are well established in the renal literature [4–6] and widely discussed in textbooks of medicine and nephrology [26–28]. In TA, unlike ATN, the loss of GFR is rapidly reversed [4–6]. Although no consensus definition exists of what such 'rapid reversal' should mean, most articles exploring early diagnostic tests (urinalysis, serum and urinary biochemistries and ultrasound), which might help distinguish it from ATN, have used short duration of azotaemia (usually from 24 to 72 hours) as the *de facto* definition to confirm or refute the diagnostic accuracy of such tests [7–18]. Independent of the predictive accuracy of these tests, in the absence of a highly accurate gold standard diagnostic test to identify its presence or of histopathological confirmation, it is, therefore, the clinical course that defines whether TA has or has not occurred. Given these logical defining features, we sought, for the first time, to understand the epidemiological features of such TA and its outcome associations.

Our findings suggest that, epidemiologically, TA is common in hospitalized patients, represents approximately a third of all cases of AKI and carries an independent association with increased hospital mortality. As expected, however, the odds ratio for hospital mortality in ATN patients was much higher than for TA (6.07 *vs.* 2.26). Furthermore, in general terms, although overlap exists, the duration of AKI and its associated odds ratio for mortality exist on a continuum such that as the duration of AKI increases so does the risk of death.

This is the first epidemiological study of TA. Recently, the acute kidney injury network (AKIN) proposed that, given the theoretical and practical difficulties associated with the use of the historical terms 'pre-renal azotaemia' and 'ATN', these terms be discarded and replaced with 'volume-responsive AKI' and 'volume-unresponsive AKI' [21]. Our study does not use such nomenclature to define TA as the same as 'volume-responsive AKI' because we have no information on fluid treatment, because we wish to make no imputation about aetiology and because improved azotaemia after a volume challenge in hospital patients is typically associated with other simultaneous interventions (antibiotics, vasodilators, inotropic drugs). These simultaneous interventions make it impossible to attribute improvements in azotaemia to intravenous fluids alone. For example, we note that many patients with TA in our study were cardiac surgery patients. In these patients, many interventions (fluids, inotropic drugs, vasopressor drugs, diuretics) are often simultaneously applied to patient care in response to increased azotaemia. We also acknowledge that the use of different terms may be a source of controversy and confusion and that there is already some disagreement about this entity and its pathogenesis [25–28]. Accordingly, we sought to avoid any assumptions about aetiology, pathogenesis, histopathology or putative response to treatment of azotaemia as the reason for its transient nature [25–28]. Importantly, although some of our patients might have had other non-pre-renal causes of AKI (urinary tract obstruction, interstitial nephropathy or glomerulonephritis), such conditions are relatively uncommon in hospital patients, and the vast majority of patients who develop AKI in hospital have pre-renal causes as the trigger for renal injury [2].

Our study has both strengths and limitations. It involves all hospital admissions and the assessment of more than 20 000 patients, makes no assumptions and uses a repro-

Table 5. Multivariate logistic regression analysis for hospital mortality among patients with readmission

Variables	Odds ratios (95% CI)	
Age, years	1.029 (1.022–1.037)	$P < 0.0001$
Male gender	1.408 (1.170–1.694)	$P = 0.0003$
Emergency admission	1.273 (1.027–1.580)	$P = 0.028$
ICU admission	2.337 (1.597–3.421)	$P < 0.0001$
Mechanical ventilation	3.866 (2.433–6.142)	$P < 0.0001$
Baseline creatinine, mg/dL	1.493 (1.299–1.715)	$P < 0.0001$
Operation	0.929 (0.688–1.253)	$P = 0.63$
Admission units		
General medicine	1.000 (Reference)	
Cardiology	0.242 (0.139–0.421)	$P < 0.0001$
Gastroenterology	0.957 (0.601–1.523)	$P = 0.85$
Haematology	2.042 (1.344–3.105)	$P = 0.0008$
Neurology	0.795 (0.427–1.479)	$P = 0.47$
Oncology	3.013 (2.304–3.941)	$P < 0.0001$
Renal medicine	0.205 (0.090–0.469)	$P = 0.0002$
Respiratory medicine	1.390 (0.921–2.100)	$P = 0.12$
Stroke unit	1.606 (0.905–2.850)	$P = 0.11$
Other medical units	0.320 (0.122–0.843)	$P = 0.021$
Cardiac surgery	0.047 (0.020–0.111)	$P < 0.0001$
General surgery	0.515 (0.333–0.796)	$P = 0.0028$
Neurosurgery	0.429 (0.157–1.171)	$P = 0.099$
Orthopedics	1.165 (0.619–2.192)	$P = 0.64$
Thoracic surgery	0.319 (0.130–0.786)	$P = 0.013$
Urology	0.157 (0.054–0.455)	$P = 0.0007$
Vascular surgery	0.413 (0.211–0.807)	$P = 0.0097$
Other surgical units	0.221 (0.049–1.002)	$P = 0.050$
Renal condition		
No AKI	1.000 (Reference)	
ATN	6.475 (5.233–8.011)	$P < 0.0001$
TA	2.015 (1.495–2.716)	$P < 0.0001$

CI: confidence interval, RRT: renal replacement therapy, AKI: acute kidney injury, ATN: acute tubular necrosis. Area under the receiver operating characteristic curve: 0.831, Hosmer–Lemeshow goodness-of-fit test: 276.5, $P < 0.0001$.

ducible definition of TA. It presents novel observations on this clinical condition. On the other hand, this is a single-centre retrospective study with limitations in terms of external validity. However, the electronically collected biochemical, clinical and outcome data are not subject to bias and our hospital is a typical tertiary centre in a developed country. Second, the definition of TA and ATN used in this study may appear arbitrary. However, in textbooks of medicine, there is only broad agreement [22–24] but no consensus definition for these renal conditions. As previous studies used duration of AKI <72 hours [9,12,18], to confirm or refute the accuracy of diagnostic tests, we chose to adhere to such published criteria. We further note that changing the definition to include azotaemia of only 24- or 48-hour duration did not materially affect our findings. Third, we did not have baseline values for serum creatinine for many of our patients. This lack of baseline data may have led to the misclassification of patients into the incorrect RIFLE class and thus to incorrect allocation of patients to TA who did not have it or the non-inclusion of patients who did have it. We note, however, that once we performed sensitivity analysis to include only patients for whom baseline creatinine values were available, the results did not change appreciably. Nonetheless, even creatinine levels measured at previous discharge might not provide an accurate baseline value. Finally, some important risk factors for AKI, e.g., diabetes and hypotension, were not available for analysis.

In conclusion, we conducted the first epidemiological study of TA in a large cohort of hospital patients. We found that TA was common, accounted for almost a third of all cases of AKI, and carried an independent and significant risk of increased hospital mortality even when lasting for only 24 hours. Finally, we found that longer duration of azotaemia increased the risk of death. We believe that our findings, by highlighting the association between azotaemia of even 24 hours duration and mortality, suggest the need for specific and focused investigations directed at identifying effective treatments to decrease its incidence in hospitalized patients.

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Conflict of interest statement. None declared.

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Hypertensive retinal changes, a screening tool to predict microalbuminuria in hypertensive patients: a cross-sectional study

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Abstract

Background. Studies have shown that hypertensive retinal changes (HRC) have a moderate accuracy in predicting microalbuminuria (MA) in elderly hypertensive patients (age >65 years). This study is an effort to identify a similar relationship in hypertensive patients aged <65 years.

Methods. Eight hundred and seventy consecutive hypertensive patients (males, 460; females, 410) aged 18–65 years were assessed for their demographic characteristics and other laboratory variables. Patients with diabetes mellitus, metabolic syndrome and overt nephropathy were excluded. Optic fundi were assessed for HRC after pupillary dilatation, which were photographed. MA (albumin–creatinine ratio) was measured as an average of two non-consecutive overnight spot urine samples.

Results. Mean age was 45 ± 13.4 years. Prevalence of MA and HRC was 36.7 and 38%, respectively. MA showed a strong association with HRC ($P < 0.0001$). Logistic regression identified the association between MA, duration of hypertension (HTN) ($P = 0.016$), smoking ($P = 0.012$) and elevated high-sensitivity C-reactive protein (HsCRP) ($P = 0.032$). HRC were associated with duration of HTN ($P = 0.021$) and smoking ($P < 0.0001$). Tests of accuracy for HRC as a predictor of MA showed sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratio of a positive test and likelihood ratio of a negative test of 78%, 86%, 76%, 87%, 5.2 and 0.26, respectively. Area under the receiver operating characteristic curve was 81%. Similarly, the individual grades of HRC had a moderate predictive accuracy. Higher grades had higher predictive accuracy. Inter- and intra-observer correlation in interpreting HRC was acceptable.

Conclusions. HRC of any grade have moderate accuracy in predicting MA and hence can be used as a cost-effective