Acute Kidney Injury in Critically Ill Trauma Patients: A Retrospective Review

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Background: *Acute kidney injury (AKI) in critically ill patients is associated with high mortality rates. Few studies have evaluated the epidemiology of AKI in critically ill trauma patients.*
Material and Method: *Between January 2007 and December 2008, 265 patients who admitted in trauma ICU of the level 1 trauma center were included in this study. Demographic data, mechanism of injury, admission vital signs, GCS, ISS, TRISS, APACHE II scores, ICU mortality, 28-day mortality, ICU length of stay (LOS), hospital LOS, need for dialysis, and mode of dialysis were collected. The AKI patients were classified by RIFLE and AKIN criteria.*
Results: *101 of 265 patients (38.1%) had AKI according to RIFLE criteria and 132 of 265 patients (49.8%) according to AKIN criteria. The mortality rate of patients with AKI was 40.2%. The patients with AKI were increased 28-day mortality (OR 12.8, 95% CI 4.88 to 33.56, p<0.001) and ICU mortality (OR 15.61, 95% CI 5.97 to 40.77, p<0.001). Higher grading of AKI according to RIFLE or AKIN classifications was associated with higher mortality (p<0.001).*
Conclusion: *50% of trauma ICU patients in Thailand develop AKI according to RIFLE and AKIN criteria. AKI in critically ill trauma patients was associated with ICU LOS, hospital LOS and mortality.*

Keywords: *Acute kidney injury, AKI, Critically ill trauma patient*

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Acute renal failure is a common problem in critically ill patients and associated with high mortality[1-4]. The incidence of acute renal failure is very different. It is due to extremely diagnostic criteria for a variety of different definitions[5,6]. The Acute Dialysis Quality Initiative Group, a group that consists of international experts in nephrology and critical care medicine, developed and published a definition and classification of Acute Kidney Injury (AKI) for the patients with loss of renal function. These criteria, which call RIFLE criteria, were classified into 3 grades of severity of AKI, risk (R), injury (I), and failure (F) and two outcome classes-sustained loss (L) of kidney function and end-stage kidney disease (E)[7]. This new definition is intended to early predict the severity of impairment of renal function for decreased of morbidity and mortality in critically ill patients[8,9]. Later, the Acute Kidney Injury Network (AKIN) modified the RIFLE criteria to be the new criteria that called "AKIN criteria" for classified AKI into 3 stages (stage 1, 2, and 3)[10,11]. From previous studied, increased of severity of AKI from RIFLE and AKIN criteria were related to increase of morbidity and mortality. Patients with AKI have a mortality rate from 10 to 100% depending on the population studied[12].

Critically ill trauma patients have an incidence of AKI of about 18 to 50% and of 16 to 54% of mortality rate[13-15]. All of the previous data of AKI in critically ill trauma patients were collected from the western countries, so the epidemiology of AKI in Asia may be different. The difference between type of injury, age of the patients, and race may be the cause of differences in the epidemiology.

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Material and Method

Between January 2007 and December 2008, a retrospective chart review identified all trauma patients admitted to the Trauma ICU (T-ICU) of a level 1 trauma center, the faculty of medicine, Siriraj Hospital, Mahidol University. The patients who have age under 15 years-

old, stay in ICU less than 48 hours, death before 48 hours after admission, and incomplete data collection were excluded from this study. Demographic data, mechanism of injury, admission vital signs, Glascow Coma Scale (GCS) score, Injury Severity Score (ISS), Trauma Injury Severity Score (TRISS), Acute Physiology and Chronic Health Evaluation (APACHE II) scores, ICU mortality, 28-day mortality, ICU length of stay (LOS), hospital LOS, need for dialysis, and mode of dialysis were collected.

The patients with AKI were diagnosed according to RIFLE or AKI criteria. The severity grading of AKI were classified by RIFLE and AKI criteria. After that, all of the patients who included in this study were divided into 2 groups of study, AKI group, and non-AKI group. All of the parameters of AKI group and non-AKI group were compared.

Statistical analysis was performed. Clinical data were reported as mean $\pm$ SD or percent. Chi-square analysis was applied to determine the differences of categorical data and t-test analysis was applied to determine the differences of continuous data of both groups. The SPSS Statistics software version 18.0 was used to perform these analyses. Statistical significance was defined as $p<0.05$.

Results

418 trauma patients were admitted in the Trauma ICU during study period. 154 patients were excluded from this study according to exclusion criteria, 19 patients with age under 15 years old, 31 patients stayed in ICU less than 48 hours, 29 patients died before 48 hours after admission, and 75 patients with incomplete data collection. After exclusion, 265 patients were included in this study. 101 of 265 patients (38.1%) had AKI according to RIFLE criteria and 132 of 265 patients (49.8%) had AKI according to AKIN criteria. The overall incidence of AKI according RIFLE or AKIN criteria is 49.8% (132/265).

The patients with AKI were classified with severity grade according to RIFLE and AKIN criteria. Using the RIFLE criteria, 13.4% of patients were classified as Risk grade, 14.7% Injury grade, and 9.8% Failure grade. Compared with AKIN criteria, 29.4% of patients were classified as grade 1, 10.6% grade 2, and 9.8% grade 3 (Fig. 1).

The patients with AKI according to the RIFLE and AKIN criteria had significant higher heart rate and respiratory rate than normal renal function patients but no difference of age, body temperature, and mean arterial pressure (MAP) (Table 1). The patients with AKI had significant higher ISS, TRISS, APACHE II score, and significant lower GCS score (Table 2). The patients with AKI had significant longer both of ICU and hospital length of stay (Table 3).

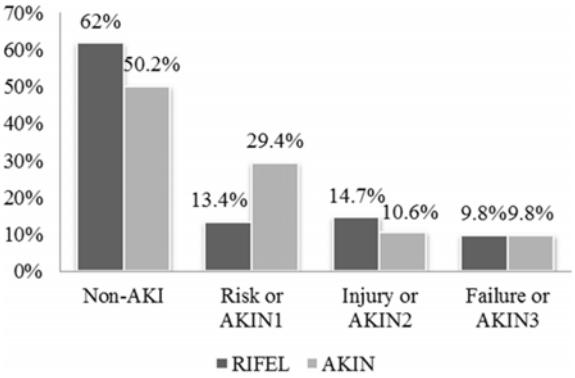

Fig. 1 Distribution of severity grade of AKI according to RIFLE and AKIN criteria.

About 53% of patients with AKI returned to normal renal function, 7% turned to chronic kidney disease (CKD), and 40% of these patients died. The patients with AKI had significant longer 28-day mortality rate (33.3%/3.8%), ICU mortality rate (37.9%/3.8%), and overall mortality rate (40.2%/3.8%) (Table 4). Using the RIFLE and AKIN criteria to classify severity grade of AKI, the higher grades of AKI were significant related with the higher 28-day mortality rate, ICU mortality rate, and overall mortality rate (Fig. 2-4).

In this study, 96% of patients with AKI were treated by medication without dialysis. Just only 4% of these patients were treated with hemo-dialysis, 2% of intermittent hemo-dialysis (IHD), and 2% of continuous renal replacement therapy (CRRT). Pelvic fracture was only significant risk factor for AKI in critically ill trauma patients. Male gender, blunt mechanism of injury, head injury, and chest injury were not significant risk factors for AKI in this study (Table 5).

Discussion

There were no data regarding AKI in critically ill trauma patients in Asian countries, study was the first study which reported the epidemiology of AKI in Thailand and Asia. According to the RIFLE criteria, study has showed the incidence of AKI in critically ill trauma about 38.1% and 49.8% if using the AKIN criteria. The overall incidence of AKI was about 49.8%. The AKI in critically ill trauma patients were associated with increased length of ICU stay, length of hospital stay, 28-day mortality, ICU mortality, and overall mortality. Higher grading of AKI according to RIFLE or AKIN

Table 1. Compared of baseline characteristic between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria

	Criteria	Non-AKI	AKI	*p*-value
Age	RIFLE	45.48±17.55	45.29±25.15	0.94
	AKIN	44.21±17.42	46.61±23.61	0.34
Temperature	RIFLE	36.76±0.94	36.95±1.40	0.18
	AKIN	36.92±0.92	36.74±1.32	0.20
MAP	RIFLE	99.91±22.87	100.62±16.75	0.78
	AKIN	101.15±21.55	99.19±19.89	0.44
Heart rate	RIFLE	88.69±18.04	106.24±18.14	<0.001**
	AKIN	88.12±15.73	102.69±21.13	<0.001**
Respiratory rate	RIFLE	19.80±4.34	18.83±4.79	0.09
	AKIN	20.38±4.32	18.47±4.55	0.001**

** $p<0.05$

Table 2. Compared of severity scores between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria

	Criteria	Non-AKI	AKI	*p*-value
GCS	RIFLE	9.49±4.52	6.67±4.09	<0.001**
	AKIN	10.47±4.30	6.34±3.84	<0.001**
ISS	RIFLE	12.25±5.80	16.45±8.10	<0.001**
	AKIN	11.71±5.61	16.00±7.70	<0.001**
TRISS	RIFLE	9.01±13.33	24.08±22.61	<0.001**
	AKIN	5.35±7.65	24.23±21.93	<0.001**
APACHE II score	RIFLE	11.69±7.46	20.66±7.76	<0.001**
	AKIN	9.96±6.61	20.30±7.46	<0.001**

** $p<0.05$

GCS = glascow coma scale score; ISS = injury severity score; TRISS = trauma injury severity score; APACHE II = acute physiology and chronic health evaluation scores

Table 3. Compared of ICU and hospital stay between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria

	Criteria	Non-AKI	AKI	*p*-value
ICU LOS	RIFLE	8.12±10.75	15.45±14.64	<0.001**
	AKIN	8.68±11.83	13.16±13.49	0.004**
Hospital LOS	RIFLE	20.46±19.60	38.33±35.93	<0.001**
	AKIN	20.59±21.13	34±32.78	<0.001**

classifications was associated with higher mortality. High levels of heart rate, increased of respiratory rate, increased of ISS, increased of TRISS, increased of APACHE II score, and low levels of GCS may associated with AKI.

Several previously studies about AKI in trauma patients were showed highly incidence of AKI[13-15]. Bagshaw et al[13], study from Australia and Canada, reported the multi-center evaluation of early acute kidney injury in critically ill trauma patients and showed the incidence of AKI about 18.1%. This study has the average of age of study group about 62.5 years-old, APACHE II score about 17.5, ICU length of stay 4.2 days, hospital length of stay 20 days, and overall

Table 4. Compared of 28-days, ICU, and overall mortality rate between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria

	Number/total (%)		*p*-value	OR	95% CI
	Non-AKI	AKI			
28-day mortality	5/133 (3.8%)	44/132 (33.3%)	<0.001	12.80	4.88 to 33.56
ICU mortality	5/133 (3.8%)	50/132 (37.9%)	<0.001	15.61	5.97 to 40.77
Overall mortality	5/133 (3.8%)	53/132 (40.2%)	<0.001	17.17	6.58 to 44.80

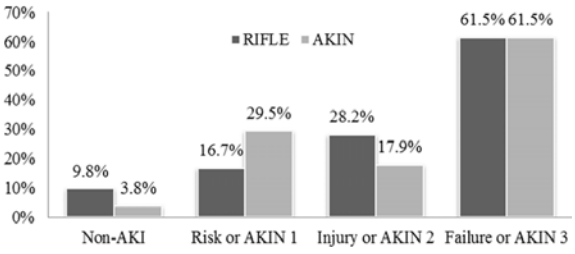

Fig. 2 Compared of 28-day mortality rate between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria.

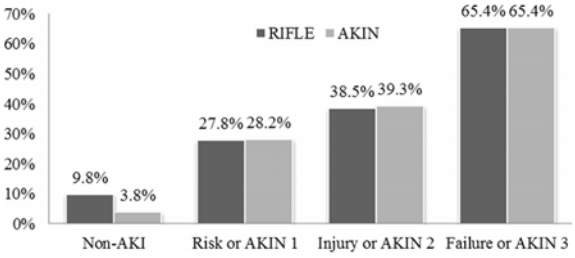

Fig. 3 Compared of ICU mortality rate between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria.

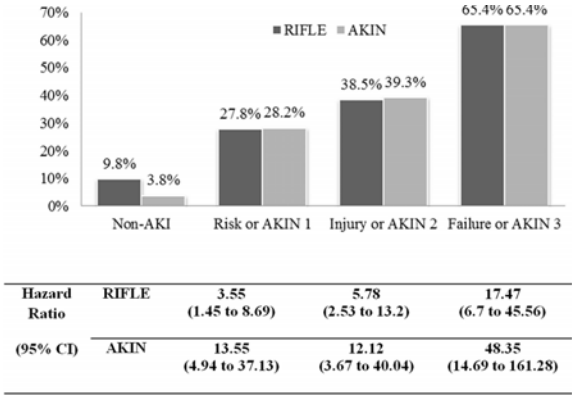

Fig. 4 Compared of overall mortality rate between patients with AKI groups and without AKI groups according to RIFLE and AKIN criteria.

mortality rate about 16.7%. Compare with our study, our study has showed the higher incidence of AKI, APACHE II score, ICU length of stay, hospital length of stay, overall mortality rate, and lower of age of study group. The difference of epidemiology of AKI of both studies may explanation with few reasons. Because our study had a higher APACHE score, which means that our patients were more serious condition. So, our patients had to have higher incidence of AKI. Higher ICU length of stay, hospital length of stay, and overall mortality rate maybe related by higher incidence of AKI or more serious condition or both.

Gomes et al[14] study AKI in severe trauma patients had showed higher ISS score and TRISS score than our study, means that patients in this study have more severe than our patients, but overall mortality was less than our study. These results may be explained by the standard of pre-hospital care or first hours care of the injuries vary by region. In developed countries, it might be the availability of care in these patients is better than the mortality rate in developing country.

Conclusion

About 50% of trauma ICU patients in Thailand develop AKI according to RIFLE and AKIN criteria. AKI in critically ill trauma patients were associated with ICU length of stay, hospital length of stay, and mortality.

What is already known on this topic?

Several previously studies about AKI in trauma patients showed high incidence of AKI. The AKI in critically ill trauma patients were associated with increased length of ICU stay, length of hospital stay, and overall mortality.

What this study adds?

This study was the first study which reported the epidemiology of AKI in Thailand. The AKI in critically ill trauma patients were associated with

Table 5. Risk factor(s) for AKI in critically ill trauma patients

Risk factor	Number/total (%)		*p*-value	OR	95% CI
	Non-AKI (n/133)	AKI (n/132)			
Male gender	75 (56.4%)	86 (65.5%)	0.14	1.44	(0.88 to 2.37)
Blunt mechanism of injury	102 (76.7%)	110 (83.3%)	0.17	1.52	(0.82 to 2.79)
Head injury	55 (41.4%)	68 (51.5%)	0.09	1.50	(0.92 to 2.44)
Chest injury	28 (7.9%)	21 (10.6%)	1.16	0.70	(0.38 to 1.32)
Pelvic fracture	9 (3.4%)	19 (7.2%)	0.04*	2.31	(1.00 to 5.32)

* $p<0.05$

increased 28-day mortality and ICU mortality. Higher grading of AKI according to RIFLE or AKIN classifications was associated with higher mortality. High levels of heart rate, increased of respiratory rate, increased of ISS, increased of TRISS, increased of APACHE II score, and low levels of GCS were associated with AKI.

Acknowledgements

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Potential conflicts of interest

None.

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ภาวะ acute kidney injury ในผู้ป่วยที่ได้รับการบาดเจ็บและมีภาวะวิกฤต: การศึกษาย้อนหลัง

จตุพร ศิริกุล, รณิษฐา รัตนะรัต

ภูมิหลัง: *ภาวะ acute kidney injury (AKI) ที่พบในผู้ป่วยที่มีภาวะวิกฤตนั้นมีความสัมพันธ์กับอัตราการเสียชีวิตที่เพิ่มขึ้น การศึกษาในเรื่อง AKI ในผู้ป่วยกลุ่มที่ได้รับการบาดเจ็บและมีภาวะวิกฤตยังมีอยู่ไม่มาก*

วัสดุและวิธีการ: *การศึกษานี้ทำโดยการรวบรวมข้อมูลของผู้ป่วยจำนวน 265 คน ที่ได้รับการรักษาในหอผู้ป่วยไอซียูของสาขาวิชาศัลยศาสตร์อุบัติเหตุในช่วงเดือนมกราคม พ.ศ. 2550 ถึงเดือนธันวาคม พ.ศ. 2551 โดยข้อมูลทั่วไปของผู้ป่วย, กลไกการบาดเจ็บ, สัญญาณชีพ, GCS, ISS, TRISS, APACHE II scores, อัตราการเสียชีวิตในไอซียู, อัตราการเสียชีวิตที่ 28 วัน, ระยะเวลาในไอซียู, ระยะเวลานอนพักรักษาในโรงพยาบาล, การทำการฟอกไตและชนิดของการฟอกไตได้ถูกรวบรวมเพื่อนำมาวิเคราะห์โดยการวินิจฉัยภาวะ AKI ของผู้ป่วยทำโดยอาศัยเกณฑ์การวินิจฉัยตาม RIFLE และ AKIN*

ผลการศึกษา: *ผลการศึกษาพบว่าผู้ป่วย 101 คนจากผู้ป่วยทั้งหมด 265 คน มีภาวะ AKI ตามเกณฑ์การวินิจฉัยของ RIFLE คิดเป็นร้อยละ 38.1 โดยที่ผู้ป่วย 132 คนจากผู้ป่วยทั้งหมด 265 คน มีภาวะ AKI ตามเกณฑ์การวินิจฉัยของ AKIN คิดเป็นร้อยละ 40.2% ผู้ป่วยที่มีภาวะ AKI จะมีอัตราการเสียชีวิตที่ 28 วันเพิ่มขึ้น (OR 12.8, 95% CI 4.88 ถึง 33.56, p<0.001) และมีอัตราการเสียชีวิตในไอซียูเพิ่มขึ้นเช่นกัน (OR 15.61, 95% CI 5.97 ถึง 40.77, p<0.001) ภาวะ AKI ที่มีความรุนแรงระดับสูงกว่าตามเกณฑ์การวินิจฉัยของ RIFLE และ AKIN จะมีความสัมพันธ์กับอัตราการเสียชีวิตที่เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ (p<0.001)*

สรุป: *ประมาณร้อยละ 50 ของผู้ป่วยที่ได้รับบาดเจ็บและมีภาวะวิกฤตในประเทศไทยจะมีภาวะ AKI ตามเกณฑ์การวินิจฉัยของ RIFLE และ AKIN ภาวะ AKI ในผู้ป่วยที่ได้รับบาดเจ็บและมีภาวะวิกฤตสัมพันธ์กับระยะเวลาในไอซียูระยะเวลาในโรงพยาบาลและอัตราการเสียชีวิต*