RBTI
2008:20:2:115-123

ORIGINAL ARTICLE

Performance of Six Prognostic Scores in Critically ill Patients Receiving Renal Replacement Therapy*

Desempenho de Seis Modelos de Predição Prognóstica em Pacientes Críticos que Receberam Suporte Renal Extracorpóreo

Elizabeth R. Maccariello[1], Carla Valente[2], Lina Nogueira[3], Márcia Ismael[3], Ricardo V. R. Valença[2], José E. S. Machado[2], Eduardo Rocha[4], Márcio Soares[5]

SUMMARY

BACKGROUND AND OBJECTIVES: There is no consensus about which prognostic score should be used in patients with acute kidney injury (AKI). The aim of this study was to evaluate the performance of six prognostic scores in predicting hospital mortality in patients with AKI in need of renal replacement therapy (RRT).
METHODS*:* Prospective cohort of patients admitted to the intensive care units (ICU) of three tertiary care hospitals that required RRT for AKI over a 32-month period. Patients with end-stage renal disease and those with ICU stay < 24h were excluded. Data from the first 24h of ICU admission were used to calculate SAPS II and APACHE II scores, and data from the first 24h of RRT were used in the calculation of LOD, ODIN, Liaño and Mehta scores. Discrimination was evaluated using the area under ROC curve (AUROC) and calibration using the Hosmer-Lemeshow goodness-of-fit test. Hospital mortality was the end-point of interest.
RESULTS: 467 patients were evaluated. The hospital mortality rate was 75%. Mean SAPS II and APACHE II scores were 48.5 ± 11.2 and 27.4 ± 6.3 points, and median LOD score was 7 (5-8) points. Except for Mehta score (p = 0.001), calibration was appropriate in all models. However, discrimination was uniformly unsatisfactory; AUROC ranged from 0.60 for ODIN to 0.72 for SAPS II and Mehta scores. In addition, except for Mehta, all models tended to underestimate hospital mortality.
CONCLUSIONS: Organ dysfunction, general and renal-specific severity-of-illness scores were inaccurate in predicting outcome in ICU patients in need for RRT.
Key Words: acute kidney injury, dialysis, ICU, mortality, prognosis, severity-of-illness scores

RESUMO

JUSTIFICATIVA E OBJETIVOS*:* Não existe consenso sobre qual modelo prognóstico deva ser utilizado em pacientes com disfunção renal aguda (DRA). O objetivo deste estudo foi avaliar o desempenho de seis escores de prognóstico em pacientes que necessitaram de suporte renal.
MÉTODO*:* Coorte prospectiva de pacientes internados nas unidades de terapia intensiva (UTI) de três

1. Nephrologist MD, Hospital Universitário Antônio Pedro, HUFF, Niterói; Multidisciplinary Research Laboratory of the Hospital Universitário Clementino Fraga Filho, UFRJ; NepHro Consultant D'Or Network of Hospitals;, PhD in Nephrology by UNIFESP; Post- Doctorate at *Harvard Medical School*
2. Nephrologist MD, NepHro Consultant D'Or Hospital Network
3. Nurse, NepHro Consultoria, RJ.
4. Associate Professor of Nephrology Faculdade de Medicina Laboratório Multidisciplinar de Pesquisa of the Hospital Universitário Clementino Fraga Filho, UFRJ; D'Or Network of Hospitals; NepHro Consultant, RJ; Post-Doctorate in Nephrology by UFRJ.
5. Physician of the Intensive Care Unit, Instituto Nacional de Câncer; PhD in Internal Medicine by UFRJ, Research scholarship by CNPq, Certified in Intensive Medicine by AMIB, Clinical Researcher of NepHro Consultants, RJ.

*Received from the Hospitals Barra D'Or, Quinta D'Or, Copa D'Or, Rio de Janeiro, RJ

Submitted in April 3, 2008
Accepted for publication in May 6, 2008

Address for correspondence
Elizabeth R. Maccariello, M.D.
Rua Jardim Botânico, 674 – Sala 405
22461-000 Rio de Janeiro, RJ
Phone +55 21 2249-9131; Fax: +55 21 3205-7034
E-mail: emaccariello@yahoo.com.br, emaccariello@hucff.ufrj.br

hospitais terciários que necessitaram de suporte renal por DRA durante 32 meses. Foram excluídos os pacientes crônicos em programa de diálise ou com < 24h de internação na UTI. Os dados das primeiras 24h de UTI foram utilizados no cálculo do SAPS II e do APACHE II, e os dados das primeiras 24h de suporte renal foram utilizados no cálculo dos escores LOD, ODIN, Liaño e Mehta. A discriminação foi avaliada através da área sobre a curva ROC (AUROC) e a calibração através do teste do *goodness-of-fit* de Hosmer-Lemeshow. A letalidade hospitalar foi o desfecho de interesse.

RESULTADOS: Quatrocentos e sessenta e sete pacientes foram incluídos e a letalidade hospitalar foi 75%. Os valores dos escores SAPS II, APACHE II e LOD foram 48,5 ± 11,2, 27,4 ± 6,3, 7 (5-8) pontos, respectivamente. A calibração foi adequada para todos os escores, com exceção do Mehta (p = 0,001). Entretanto, a discriminação foi ruim para todos os modelos, com AUROC variando entre 0,60 para o ODIN e 0,72 para o SAPS II e Mehta. Com exceção do Mehta, todos os modelos subestimaram a letalidade.

CONCLUSÕES: Todos os seis modelos estudados foram inadequados na predição prognóstica de pacientes graves com DRA e necessidade de suporte renal.

Unitermos: hemodiálise, índices de gravidade de doença, insuficiência renal aguda, mortalidade, prognóstico, UTI

INTRODUCTION

Evaluation of prognosis is a routine in medical practice. Selection of patients, type and intensity of treatments, in addition to other decisions related to patient care are influenced by the prognosis[1]. Prognostic scores are comprised of relevant clinical and laboratory variables of patients, associated to the clinical endpoint. Although these methods should not be used for individual prediction, they may be useful in clinical discussions on prognosis, in assessment of the quality of an ICU and, above all, for stratification of patients in clinical studies[1,2]. Nevertheless scores should be validated before routine use in a population of patients.

Various probabilistic models have been proposed for evaluation of the prognosis of patients with acute kidney injury (AKI)[3-8]. However there is no consensus on which model may be most appropriate for these patients[9-12].

This study aimed to evaluate the performance of six probabilistic models (two general severity-of-illness scores[7,8] and two specific scores for patients with acute kidney injury[3-6] and two scores of acute organ dysfunction[13,14]), to predict hospital mortality of large cohort of patients admitted in intensive care units (ICU) with AKI and in need of renal replacement therapy (RRT).

METHODS

Prospective cohort study carried out from December 2004 to July 2007 in clinical and surgical ICU of three private hospitals in Rio de Janeiro, RJ. The Hospital Barra D'Or has 180 beds and four ICU with a total of 42 beds for intensive care. The Hospital Quinta D'Or has 200 beds, with 60 ICU-beds distributed in three units. The Hospital Copa D'Or has 200 beds, with a total of 42 ICU-beds, distributed in five ICU. Individual ICU are comprised of six to 14 beds. Physicians, nurses, physiotherapists, nutritionists and other professionals with experience in care of critically ill patients are found in all units. At least one intensivist, two nurses and five nursing assistants work in on duty regimen (12h) in the units. Decisions related to patient care are taken together by the ICU team and the physicians responsible for the patients. This study was approved by the Ethics Committee of the participating institutions without the need of an informed consent due to its observational nature.

Criteria for Eligibility, Data Collection and Definition of Terms and Variables

During the study, all adult patients (age ≥ 18 years with diagnosis of AKI or acute on chronic kidney injury (ACKI) in need of renal replacement therapy were studied. End-stage renal disease patients on chronic dialysis, those who underwent RRT for reasons other than renal dysfunction or with < 24h admission time at the ICU were excluded. For a diagnosis of ACKI, a glomerular filtration rate (GFR) < 60 mL/min for at least three months[15] was considered. When previous GFR was unknown, it was estimated by the MDRD (*modification of diet in renal disease*) formula[16]. In the case of re-admissions, only the first was considered for analysis.

AKI was classified according to the RIFLE criteria at the time of onset of RRT[17]. Oliguria was defined as urinary output of < 400 mL/day. Decisions for indication, change and interruption of the method of RRT were taken together by the nephrologist and the physicians

in charge of the patient, The RRT methods used were conventional hemodialysis, extended daily dialysis and continuous RRT (CRRT). Methods were selected considering the patient's clinical condition and hemodynamic status. CRRT were used in patients on vasoactive drugs or with a potential for hemodynamic instability[18].

At admission and during ICU stay, demographic, clinical and laboratory data were collected. The following prognostic scores were estimated: the second versions of the Acute Physiology and Chronic Health Evaluation (APACHE II) and Simplified Acute Physiology Score (SAPS II)[8], the Logistic Organ Dysfunction[14], the Organ Dysfunction and Infection[14], the Liaño[3] and Mehta scores[6]. The APACHE II and SAPS II scores were estimated on the first day of admission at the ICU and the scores for organic dysfunction and those specific for patients with AKI were estimated on the first day of RRT according to their original versions. For sedated patients, the Glasgow coma scale (GCS) prior to sedation was considered. When a variable was missing, a zero value or normal values were attributed, according to instructions for the estimate of each prognostic model. In the current study, demographic and physiological variables were obtained for all patients. Among the laboratory variables, normal values were attributed for activated prothrombin time in 102 (22%) and for billirubins in 42 (9%) patients. At clinical exam, billirubins levels were available in all patients with jaundice. Comorbidities were diagnosed according to the criteria of each score. Patients were classified according to the reason for admission as medical, elective surgery and emergency surgery. Criteria of the Consensus Conference of the College of Chest Physicians / Society of Critical Care Medicine were utilized for diagnosis of sepsis[19]. In the ICU under study, criteria for infection diagnosis are usually those of the Centers for Diseases Control[20]. Hospital mortality was the endpoint of interest.

Statistical Analysis

Data were entered in an electronic spreadsheet by a single person. Consistency of data was observed by one author (M.S.) and, at the end of the study, a duplicate check procedure of a randomized sample of 10% of patients was carried out. There was also a final verification of outliers and implausible values. Usual descriptive statistics were used to characterize the population. Continuous variables were presented as mean ± standard deviation or median (interquartile range 25%-75%) according to distribution as appropriate. Assessment of score performances was made through analysis of the discrimination and calibration. Discrimination of scores, that is to say, the capacity of diagnostic scores to differentiate patients who survived from those that died was assed using the receiver operating characteristic curve (AUROC) curve[21]. Analysis of the calibration (agreement between the number of patients observed and those predicted to die in hospital over all severity spectrums) was performed by the "C" statistics of the Hosmer-Lemeshow goodness-of-fit test (GOF)[22]. In this case a high value of $p > 0.05$ was considered as the criterion for a good calibration. Standardized mortality rate (SMR) was also calculated - deaths observed / predicted deaths for each model. Calibration curves were constructed. In them the observed mortality rates ("y" axis) and predicted ("x" axis) were compared; patients (columns) were distributed in deciles of predicted mortality. A two-tailed p value <0.05 was considered as statistically significant. For statistical analyses the SPSS version 11.0 package was used (SPSS Inc., Chicago, IL, USA).

RESULTS

During the study period, 467 patients met the eligibility criteria and were included. Of them, 382 (82%) were admitted in ICU due to medical complications, 49 (10%) at postoperative from elective surgeries and 39 (8%), at postoperative from emergency surgeries. The main demographic and clinical characteristics are shown in table 1 and the main reasons for ICU admission are listed on table 2. The main factors associated to the development of AKI were sepsis (n = 354, 82%), shock/hyperperfusion (n = 333, 71%), contrast/drugs (n = 129, 28%), rhabdomyolysis (n = 22, 5%) and obstruction of the urinary tract (n = 15. 3%). AKI was multifactorial in 385 (82%) patients. On the day of initiating RRT the mean of serum urea concentration was 106 (62-164) mg/dL, median serum creatinine concentration was 1.7 (1.1-2.6) mg/dL and the median urinary output was 860 (406-1500) mL/24h. One hundred and five patients (22%) presented with oliguria. RRT was begun on the first day of ICU admission in 227 (49%) patients. Because of the high frequency of hemodynamic instability, CRRT were used in 83% of patients, 14% of patients were initially treated with extended daily dialysis and 3%

with conventional daily hemodialysis. The In ICU and in hospital mortality rates were 71% and 75%, respectively. Results of performance analyses of the six models are summarized in Table 3. Overall, discrimination was poor to regular for all models. The highest was for SAPS II [AUROC = 0.72 (95% confidence interval (95% CI) = 0.66 – 0.77)] and for the Mehta score [AUROC = 0.72 (95% CI = 0.67 – 0.78)]. Except for the Mehta score, all other models presented good calibration (GOF, $p > 0.05$) and tended to underestimate hospital mortality (SMR > 1). Calibration curves for specific models for AKI, general severity-of-illness and organic dysfunction scores are represented on figures 1a, 1b and 1c respectively.

Table 1 – Main Demographic and Clinical Characteristics (n = 467).

Variables	n (%), Mean ± SD, Median (IIQ)
Age (years)	71.1 ± 15.3
Male gender	241 (52%)
Hospital admission prior to ICU (days - n)	0 (0 – 1)
Impaired functional capacity (Knaus C or D)	186 (40%)
Charlson comorbidity index (points)	3 (1 – 4)
Charlson comorbidity index ≥ 1 point	382 (82%)
SAPS II (upon admission in the ICU. points)	48.5 ± 11.2
APACHE II (upon admission in the ICU. points)	27.4 ± 6.3
LOD on D1 of RRT (points)	7 (5 – 8)
RIFLE classification	
Risk	132 (28%)
Injury	111 (24%)
Failure	224 (48%)
Acute on chronic kidney injury	151 (32%)
RRT on D1 of ICU admission	227 (49%)
During stay in the ICU	
Sepsis	354 (76%)
Mechanical ventilation	379 (81%)
Vasoactive amines	352 (75%)
Duration of ICU stay (days)	18 (8 – 36)
Duration of hospital stay (days)	23 (12 – 48)
Decision to limit treatment	83 (18%)
ICU mortality	333 (71%)
Hospital mortality	351 (75%)

SD = standard deviation. IQI = interquartile interval; ICU= Intensive Care Unit; APACHE = Acute Physiology and Chronic Health Evaluation; SAPS = Simplified Acute Physiology Score; LOD = Logistic Organ Dysfunction.

Table 2 – Main reasons for ICU admission (n=467).

Variables	n (%)
Elective surgical patients	46 (10%)
Gastrintestinal	27
Cardiac	7
Others	12
Emergency surgical patients	39 (8%)
Gastrointestinal perforation or obstruction	11
Complications of former surgeries	10
Cardiac / vascular	9
Others	9
Medical patients	382 (82%)
Sepsis	238
Cardiovascular complications	38
Acute kidney injury	23
Neurological complications	15
Digestive hemorrhage	15
Trauma	10
Others / miscellaneous	43

Table 3 – Area under ROC Curves, "C" Statistics of the Goodness-of-fit Hosmer-Lemeshow test and Standardized Mortality Rates for the SAPS II, APACHE II, LODS, ODIN, Liaño and Mehta Scores (n = 467;Hospital Mortality = 75.2%)

Prognostic Scores	ROC Curves	Goodness-of-fit		Predicted Mortality	SMR
	AUROC (95% CI)	$\chi 2$	p-value	(Mean ± SD)	
SAPS II	0.72 (0.66-0.77)	9.221	0.324	43.2±21.5	1.74 (1.55-1.95)
APACHE II	0.61 (0.55-0.67)	0.632	0.999	63.2±18.5	1.19 (1.09-1.30)
LODS	0.63 (0.58-0.69)	0.250	0.998	35.1±16.9	2.14 (1.87-2.45)
ODIN	0.60 (0.54-0.66)	4.176	0.383	53.1±13.5	1.41 (1.28-1.56)
Liaño	0.62 (0.56-0.67)	12.200	0.142	67.6±5.1	1.11 (1.02-1.21)
Mehta	0.72 (0.67-0.78)	26.260	0.001	78.4±16.5	0.96 (0.89-1.03)

AUROC = area under the ROC curve; CI = confidence interval, SD = standard deviation; SMR = standardized mortality rate, $\chi 2$ = Chi- sq uare, SAPS = Simplified Acute Physiology Score; APACHE= Acute Physiology and Chronic Health Evaluation; LOD = Logisitc Organ Dysfunction; ODIN = Organ Dysfunction and Infection.

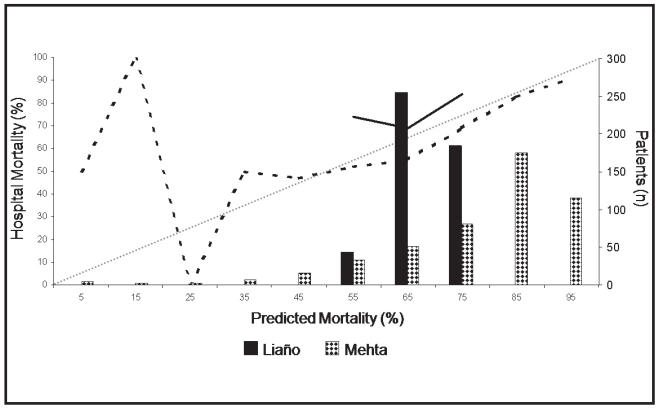

Figure 1a – Specific Models for Patients with kidney injury. Calibration curves for Mehta (black dashed line) and Liaño (solid black line) scores. The diagonal dashed line represents the line of ideal prediction. Columns represent the number of patients in each decile of predicted mortality

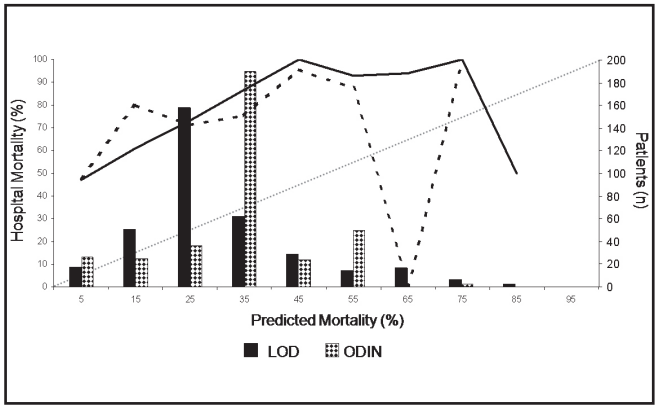

Figure 1c - Organ Dysfunction Scores Calibration curves for ODIN (black dashed line) and LOD (solid black line) The diagonal dashed line represents the line of ideal prediction. Columns represent the number of patients in each decile of predicted mortality.

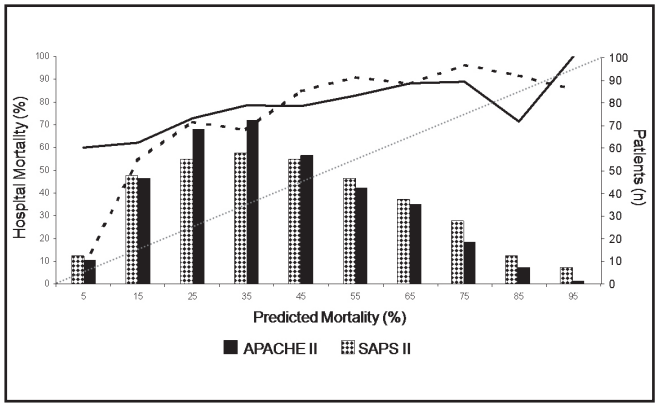

Figure 1b – Severity of Illness Scores (general models) Calibration curves for SAPS II (black dashed line) and for APACHE II (solid black line) scores. The diagonal dashed line represents the line of ideal prediction. Columns represent the number of patients in each decile of predicted mortality.

DISCUSSION

This is the largest, multicentric, prospective study carried out to date, in Brazil on the evaluation of performance of prediction models in patients with AKI treated with RRT during ICU stay. Further, this study is noteworthy for the simultaneous evaluation of six models in this population, among which are the overall prognostic models (SAPSII and APACHE II), models for evaluation of organic dysfunction (LOD and ODIN) and specific models for patients with AKI (Mehta and Liaño). All of the models studied presented different performances, but as a rule, none was suitable for use in this sample of patients.

During the last decades, various prognostic scores were developed and have been proposed for use with

ICU patients. However, these models must be suitably validated before their routine use in a given population of patients. In general, the prognostic models developed as from an overall population of ICU patients have an unsatisfactory performance, when tested in a more specific population[23,24], including patients with AKI[9-12,25-27]. Nevertheless, information on the applicability of such models in patients with AKI requiring RRT is still scarce.

The largest study on the subject was carried out by Uchino et al., using the BEST Studies (Beginning and Ending Supportive Therapy for the Kidney)[9] database. In this study performance of four specific models for AKI (Mehta, Paganini, Chertow and Liaño), in addition to the SAPS II and SOFA scores, were studied in 1742 patients coming from 54 centers in 23 countries. Discrimination was equally poor for all models with AUROC ranging from 0.610 for the Chertow score and 0.698 for the Liaño score. With the exception of the Liaño score (p=0.36) adjustment of calibration was inadequate for all the remaining models ($p < 0.001$).

In this study, APACHE II and SAPS II scores presented regular discrimination and underestimated hospital mortality. These results are similar to those in literature[9-12,25-27]. One of the justifications for these observations was that a possible sub-representation of AKI patients was made in the studies that generated the general scores such as APACHE II and SAPS II. Therefore specific models for patients with AKI were proposed[3-6]. The Mehta and Liaño models were chosen here because they are more widely studied models and generate probabilities of death[3.6]. Results from evaluations of the performance of these scores were very variable. The Mehta score presented a somehow better discrimination and among all other scores presented the SMR [0.96 (95% CI, 0.89-1.03) nearest to the unit. However, its calibration is poor. On the other hand, although calibration of the Liaño score has been adequate, there was a clear underestimation of mortality. This frustration with the use of specific models for AKI was also noted in other studies[6,9,26]. Finally among the models of organ dysfunction, the SOFA score is certainly the most studied[6,9,25,28]. Nevertheless, the SOFA score does not generate probability of death, only counting points, which is why LOD and ODIN scores were chosen[13,14]. Similar to these results, LOD presented a good calibration in a study carried out in four North-American centers, but discrimination was poor[6]. In this study the first validation of ODIN in patients with AKI was carried out. However this score was not advantageous in relation to the LOD and the remaining models, with poor discrimination and a tendency to underestimate mortality.

Performance of prognostic scores of Brazilian patients with AKI was assessed in only three different studies performed in single centers[2,26,27]. Batista et al.[27] evaluated the APACHE II and the Liaño model in 76 patients of one center. Discrimination was reasonable for the two models (AUROC of 0.76 and 0.78 respectively) but calibration was good only for the specific model. D'Avila et al. carried out a somewhat larger study of 280 patients with AKI and need for dialysis[26]. In this study the APACHE II and Liaño scores were also evaluated. Although discrimination was better for the specific score ((AUROC = 0.81 *versus* AUROC = 0.65), adjustment was poor for both models. Lima et al. investigated performance of the APACHE II, SARS, LOD and Liaño scores in 324 patients with AKI[12] Likewise, all models showed to be miscalibrated and to underestimate mortality of that population.

Two measures are basically used to evaluate performance of a model: discrimination, assessed by the calculation of the area below the ROC curve and calibration calculated according to the Hosmer and Lemeshow GOPF statistics[1,2,21,22]. However the number of patients evaluated in a study may change the outcome. As such, considerations must be made regarding the relatively small sample size in most studies. In a very elegant study, Zhu et al. assessed the influence of sample size when analyzing the performance of the *Mortality Probability Models* (MPM) II using computer simulations[29]. The authors proved that the smaller the size of the sample, the better is the model's calibration. On the other hand, evaluation of the model's discrimination was not affected.

However, the present study also presents some limitations. Although this is a multicentric study carried out in an ICU with different characteristics, all three hospitals are located in the same geographic region and RRT was supplied by teams of nephrologists with similar care routines and aspects related to RRT procedures. For this reason caution is needed when extrapolating the herein presented results to other services. Influence of regional effects on performance of prognostic scores was shown in the study that generated SAPS 3[30]. In this study, in addition to the standard equation for the SPAS 3,

specific equations were developed for the different geographical regions of the world participating in the study. In a study with cancer patients in a Brazilian ICU, the specific equation for South and Central America countries was better adjusted than the general SAPS 3 equation[31]. Furthermore occurrence of possible selection biases related to ICU, the admission and discharge must be also taken into account. Differences in admission and discharge criteria, differences in acute or chronic illness of patients and differences in the criteria for orders of not resuscitation and for treatment limitations may alter prognosis. Finally, the mortality rate found in these patients was relatively high when compared to other international studies[6,10,32,33] although it was similar to that of other results observed in Brazilian populations of patients with AKI[12,26,27,33]. Furthermore, this mortality rate may be attributed to the fact that it was studied in an older and certainly rather severely ill population due to high frequencies of comorbidity, sepsis, functional capacity impairment and need for mechanical, ventilation and vasoactive amines.

To conclude, all of the six models under study were inadequate for prognostic prediction of severely ill patients with AKI requiring RRT, including specific models for renal patients. It must be stressed that although prognostic scores may be useful to enhance discussions on prognosis and characterize severity of patients in clinical studies, there is no model for use as an isolated parameter to indicate or guide treatments including ICU admission and discharge policies or beginning and ending of RRT.

APPENDIX
Description of the prognostic scores specific for AKI:*

Mehta Score (6):
Log odds of mortality s = (0.0170 x age (years) + (0.8605 x male gender) + (0.0144 x serum ureic Nitrogen) x (0.3398 x serum creatinine) + (1.2242 x hematologic dysfunction) + (1.1183 x liver dysfunction) + (0.,9637 x respiratory failure) + (0.0119 x heart rate) - (0.4432 x log (urinary output)) – 0.7207

Liaño Score (3):
Probability of death : (0.032 x age (decades) – (0.086 x male gender) + (0.109 x nephrotoxic AKI) + (0.109 x oliguria) + (0.116 x hypotension) + (0.122 x icterítia) + (0.150 x coma) – (0.154 x reduced consciousness) + (0.182 x mechanical ventilation) + 0.210

Description of organ dysfunction scores:*

LOD Score (13)

Measurements of Organic Systems	5	3	1	0	1	3	5
Neurological (Glasgow coma scale)	3-5	6-8	9-13	14-15			
Cardiovascular							
HR (bpm)	< 30			30-139	≥ 140		
or	or			and	or		
SBP (mmHg)	< 40	40-69	70-89	90-239	240-269	≥ 270	
Renal							
Serum urea (g/L)				< 0,36	0,36-0,59	0,60-1,19	≥ 120
or							
Ureic nitrogen (mg/dL)				< 17	17- < 28	28- < 56	≥ 56
and				and	or	or	
Serum creatinine (mg/dL)				< 1.20	120-1.59	≥ 1.60	
				and		or	
Diuresis (L/dia)	< 0.5	0.5-0.74		0.75-9.99		≥ 10	
Respiratory							
PaO_2/FiO_2 in MV or CPAP		< 150	≥ 150	With no ventilation; with no CPAP; with no IPAP			
Hematoligic							
n. of leukocytes (mm^3) x 10^3		< 1.0	1.0-2.4	2.5-49.9	≥ 50		
			or	and			
n. of platelets (mm^3) x 10^3			> 50	≥ 50			
Liver				< 2.0	≥ 2.0		
Bilirrubin (mg/dL)				and	or		
Time of prothrombin (s and %)			(< 25%)	(< 3 > 25%)	≥ 3		

MV — mechanical venti lation; CPAP — continued positive airways pressure; IPAP — intermittent positive airways pressure; HR = Heart rate; SAP = Systolic Arterial Pressure

$$\textbf{Prob} = \frac{e^{logit}}{1 + e^{logit}} \qquad logit = -3.4043 + 0.4173 * \text{LOD Score}$$

Probability of death = $e^{logit}/(1 + e^{logit})$
Logit = – 3.4043 + 0.4173 * LOD Score

ODIN score (14)

Probability of death = $e^{logit}/(1 + e^{logit})$
Logit = –3.59 + (1.09 x respiratory) + (1.19 x cardiovascular) + (1.18 x renal) + (0.86 x hematologic + (0.57 x liver) + (0.99 x neurologic) + (0.53 x infection)

N. ODIN	0	1	2	3	4	5	6	7
Death	2.6%	9.7%	16.7%	32.3%	64.9%	75.9%	94.4%	100%

*Definitions used in each score may be obtained in the original publications.

REFERENCES

01. Rocco JR - Escores Prognósticos em Terapia Intensiva, em: David CM, Goldwasser RS, Nacul FE - Medicina Intensiva: Diagnóstico e Tratamento. Rio de Janeiro, Revinter, 1997;308-336.
02. Rocco JR - Escores Prognósticos em Medicina Intensiva, em: Nácul FE - Medicina Intensiva: Abordagem Prática. Rio de Janeiro, Revinter, 2004;555-562.
03. Liaño F, Gallego A, Pascual J, et al. Prognosis of acute tubular necrosis: an extended prospectively contrasted study. Nephron, 1993;63:21-31.
04. Paganini EP, Halstenberg WK, Goormastic M - Risk modeling in acute renal failure requiring dialysis: the introduction of a new model. Clin Nephrol, 1996;46:206-211.
05. Chertow GM, Lazarus JM, Paganini EP, et al. Predictors of mortality and the provision of dialysis in patients with acute tubular necrosis. The Auriculin Anaritide Acute Renal Failure Study Group. J Am Soc Nephrol, 1998;9:692-698.
06. Mehta RL, Pascual MT, Gruta CG, et al. Refining predictive models in critically ill patients with acute renal failure. J Am Soc Nephrol, 2002;13:1350-1357.
07. Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification system. Crit Care Med, 1985;13:818-829.
08. Le Gall JR, Lemeshow S, Saulnier F - A new Simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. JAMA, 1993; 270:2957-2963.
09. Uchino S, Kellum JA, Bellomo R, et al. Acute renal failure in critically ill patients: a multinational, multicenter study. JAMA, 2005;294:813-818.
10. Metnitz PG, Krenn CG, Steltzer H, et al. Effect of acute renal failure requiring renal replacement therapy on outcome in critically ill patients. Crit Care Med, 2002;30:2051-2058.
11. Halstenberg WK, Goormastic M, Paganini EP - Validity of four models for predicting outcome in critically ill acute renal failure patients. Clin Nephrol, 1997;47:81-86.
12. Lima EQ, Dirce MT, Castro I, et al. Mortality risk factors and validation of severity scoring systems in critically ill patients with acute renal failure. Ren Fail, 2005;27:547-556.
13. Le Gall JR, Klar J, Lemeshow S, et al. The Logistic Organ Dysfunction system. A new way to assess organ dysfunction in the intensive care unit. ICU Scoring Group. JAMA, 1996;276:802-810.
14. Fagon JY, Chastre J, Novara A, et al. Characterization of intensive care unit patients using a model based on the presence or absence of organ dysfunctions and/or infection: the ODIN model. Intensive Care Med, 1993;19:137-144.
15. National Kidney Foundation - K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease; Evaluation, Classification and Stratification. Am J Kidney Dis, 2002;39:S46-S75.
16. National Kidney Foundation - K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease; Evaluation of laboratory measurements for clinical assessment of kidney disease. Am J Kidney Dis, 2002; 39:S7-6-S110.
17. Bellomo R, Ronco C, Kellum JA, et al. Acute renal failure - definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Crit Care, 2004;8:R204-R212
18. Maccariello E, Soares M, Valente C, et al. RIFLE classification in patients with acute kidney injury in need of renal replacement therapy. Intensive Care Med, 2007;33:597-605.
19. Bone RC, Balk RA, Cerra FB, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. Chest, 1992;101:1644-1655.
20. Garner JS, Jarvis WR, Emori TG, et al. CDC definitions for nosocomial infections, 1988. Am J Infect Control, 1998;16:128-140.
21. Hanley JA, McNeil BJ - The meaning and use of the area under receiver operating characteristic (ROC) curve. Radiology, 1982;143:29-36.
22. Hosmer DW, Lemeshow S - Applied Logistic Regression. 2nd, New York, Wiley-Interscience, 2000.
23. Soares M, Fontes F, Dantas J, et al. Performance of six severity-of-illness scores in cancer patients requiring admission to the intensive care unit: a prospective observational study. Crit Care, 2004;8:R194-R203.
24. Chatzicostas C, Roussomoustakaki M, Vlachonikolis IG, et al. Comparison of Ranson, APACHE II and APACHE III scoring systems in acute pancreatitis. Pancreas. 2002;25:331-335.
25. Ahlstrom A, Kuitunen A, Peltonen S, et al. Comparison of 2 acute renal failure severity scores to general scoring systems in the critically ill. Am J Kidney Dis, 2006;48:262-268.
26. d'Avila DO, Cendoroglo Neto M, dos Santos OF, et al. Acute renal failure needing dialysis in the intensive care unit and prognostic scores. Ren Fail, 2004;26:59-68.
27. Batista PB, Cendorogolo Neto M, dos Santos OF, et al. Evaluation of prognostic indexes in critical acute renal failure patients. Ren Fail, 2004;26:545-552.
28. de Mendonca A, Vincent JL, Suter PM, et al. Acute renal failure in the ICU: risk factors and outcome evaluated by the SOFA score. Intensive Care Med, 2000;26:915-921.
29. Zhu BP, Lemeshow S, Hosmer DW, et al. Factors affecting the performance of the models in the Mortality Probability Model II system and strategies of customization: a simulation study. Crit Care Med, 1996;24:57-63.
30. Moreno RP, Metnitz PG, Almeida E, et al. SAPS 3--From evaluation of the patient to evaluation of the intensive care unit. Part 2: Development of a prognostic model for hospital mortality at ICU admission. Intensive Care Med, 2005;31:1345-1355.
31. Soares M, Salluh JI - Validation of the SAPS 3 admission prognostic model in patients with cancer in need of intensive care. Intensive Care Med, 2006;32:1839-1844.
32. Bagshaw SM, Mortis G, Doig CJ, et al. One-year mortality in critically ill patients by severity of kidney dysfunction: a population-based assessment. Am J Kidney, Dis, 2006;48:402-409.
33. Uchino S, Kellum JA, Bellomo R, et al. Acute renal failure in critically ill patients: a multinational, multicenter study. JAMA, 2005;294:813-818.