

Annual Scientific Meeting of the Hong Kong Society of Critical Care
Medicine and the Hong Kong Association of Critical Care Nurses

Assessment of three hospital mortality prediction models in patients admitted to Pamela Youde Nethersole Eastern Hospital intensive care unit

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Introductions

- Predicting outcome is a routine duty of physicians
- Prognostication based on clinical observation is affected by
 - Memory of recent events
 - Inaccurate estimation of relative contribution of multiple factors
 - False beliefs
 - Human limitations like fatigue





Introductions

- Outcome prediction models will always produce the same estimate from a given dataset
- Correctly value the importance of relevant data

Introductions

- Four major applications
 - Performance assessment
 - Predicting and planning of resource utilization
 - Clinical research
 - Individual patient management

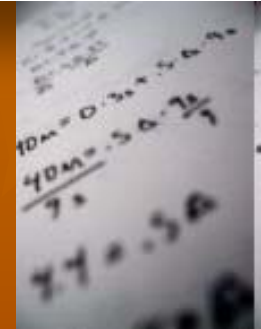
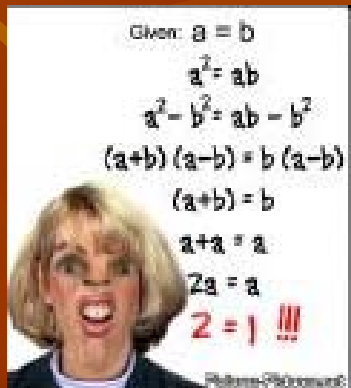


Introductions

- APACHE
 - APACHE II
 - APACHE III
 - APACHE IV
- SAPS
 - SAPS II
 - SAPS III
- MPMII/ III
 - MPM₀
 - MPM₂₄
 - MPM₄₈ & MPM₇₂

Introductions

- Most scoring systems were developed using multivariate regression analysis of large clinical databases to identify the most relevant variables related to mortality
- Prospective validation in other patient populations



Scores



Risk of Death

Mathematical Model
(Goodness of fit model)

Calibration

Hosmer-Lemeshow

$\hat{C}$ statistics

$\hat{H}$ statistics

Test extent of agreement
between expected and observed
death across all subgroups of
patients

Discrimination

ROC

Test the ability to discriminate
live and death

TABLE 259-8. COMPARISON OF SEVERITY MODELS ON A COMMON DATA SET

	Discrimination ROC Area	Calibration GOF (H Statistic)	Sample Size
APACHE II*	0.853	< .0001	12,899
APACHE III	0.848	Not available	12,899
MPM ₀ I	0.766	< .0001	4,605
MPM ₀ II	0.805	0.0143	4,605
MPM ₂₄ I	0.815	< .0001	4,101
MPM ₂₄ II	0.833	.0247	4,101
SAPS I	0.784	Not applicable	4,605
SAPS II*	0.847	.1019	4,605

Castella et al: Crit Care Med 1995; 23: 1327-35

What about APACHE IV

- 104 ICUs in 45 US hospitals
- 131,618 consecutive ICU admissions
- Good discrimination: Area under ROC 0.88
- Good calibration: Hosmer-Lemeshow C statistic = 16.9, $p = 0.08$

Crit Care Med. 2006 May;34(5):1297-310.

Any validation study published among Chinese population?

- Lin CY et al, Chang Gung Memorial Hospital, Taiwan
- To assess the performance of APACHE IV/ APACHE II/ SOFA/ RIFLE among patients on ECMO

Table 3. Comparison of Calibration and Discrimination of the Scoring Methods in Predicting Hospital Mortality

Model	Calibration			Discrimination		
	Hosmer-Lemeshow χ^2	df	p Value	AUROC $\pm$ SE	95% CI	p Value
APACHE IV	6.972	8	0.540	0.922 $\pm$ 0.030	0.863–0.982	<0.001
APACHE III	22.013	8	0.005	0.907 $\pm$ 0.038	0.833–0.981	<0.001
APACHE II	8.114	8	0.422	0.898 $\pm$ 0.033	0.833–0.963	<0.001
SOFA score	8.228	8	0.411	0.870 $\pm$ 0.041	0.790–0.949	<0.001
RIFLE classification	0.807	2	0.668	0.810 $\pm$ 0.053	0.707–0.913	<0.001

APACHE = Acute Physiology and Chronic Health Evaluation; AUROC = area under the receiver operating characteristic curve; CI = confidence interval; df = degree of freedom; RIFLE = risk of renal failure, injury to the kidney, failure of kidney function, loss of kidney function, and end-stage renal failure; SE = standard error; SOFA = Sequential Organ Failure Assessment.

Objective of this study

- To assess the validity of mortality prediction systems in patients admitted to our intensive care unit.
- We included Acute Physiology and Health Evaluation (APACHE) II, APACHE IV and Simplified Acute Physiology Score (SAPS) II in our evaluation.

Methods

- Single centre prospective observational cohort study
- General ICU of regional hospital
- All patients admitted to ICU in 2008 with ICU stay more than 4 hours and age >16 years old

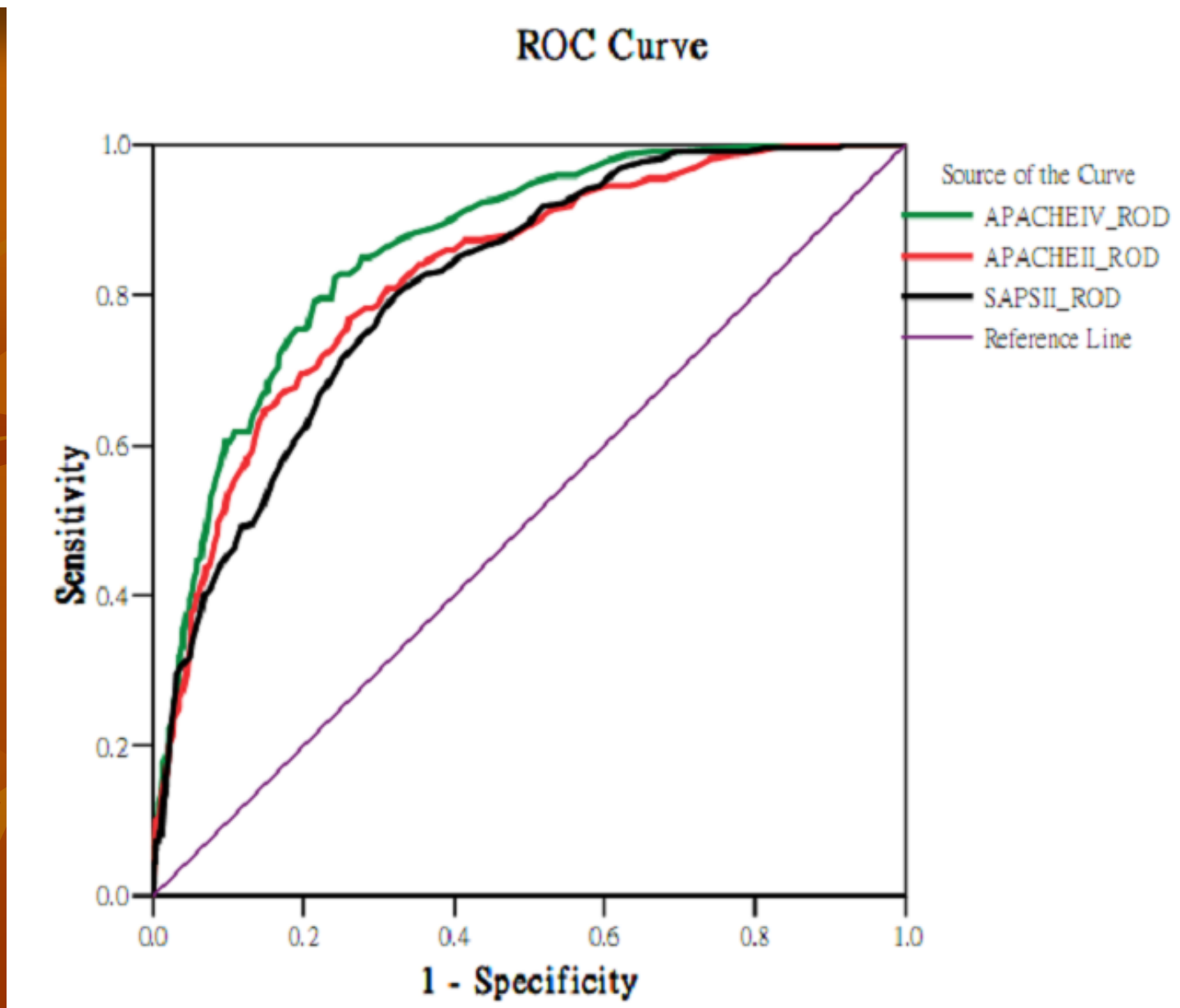
Methods

- The data necessary for mortality prediction were collected prospectively via the Clinical Management System
- Predicted and actual mortality rates, and standardized mortality ratio (SMR) were calculated.
- Discrimination was assessed using receiver operating characteristic (ROC) curves.
- Calibration was assessed using Hosmer Lemeshow goodness of fit C-statistic.

Results

- A total of 1194 consecutive ICU admissions occurred in 2008, of which 1117 met inclusion criteria.

Parameters	N=1117
Age (year +/- SD)	63.4 +/- 16.7
Sex (M:F)	61.9 : 38.1
Admission sources (%)	
1. General ward	500 (44.8%)
2. OT/ recovery room	460 (41.2%)
3. AED	145 (13%)
4. Others	12 (1%)
Operative status (%)	
1. Non-operative	657 (58.8%)
2. Operative	460 (41.2%)
• Emergency	259 (23.2%)
• Elective	201 (18%)
Comorbidities (%)	
1. None	902 (80.7%)
2. Heart failure	6 (0.5%)
3. Respiratory failure	23 (2.1%)
4. Renal failure on dialysis	55 (4.9%)
5. Immunosuppression	46 (4.1%)
6. Metastatic cancer	47 (4.2%)
7. Liver failure	5 (0.4%)
8. Cirrhosis	34 (3.0%)
9. Leukemia/ myeloma	10 (0.9%)
10. Lymphoma	4 (0.4%)
11. AIDS	1 (0.1%)
Disease category (%)	
1. Cardiovascular	98 (8.8%)
2. Respiratory	223 (20%)
3. Gastrointestinal	245 (21.9%)
4. Neurological	235 (21%)
5. Sepsis	104 (9.3%)
6. Metabolic	90 (8.1%)
7. Renal	41 (3.7%)
8. Trauma	37 (3.3%)
9. Others	44 (3.9%)
ICU outcome (%)	
1. Survive	970 (86.8%)
2. Death	147 (13.2%)
Hospital outcome (%)	
1. Home	700 (62.7%)
2. Convalesces	188 (16.8%)
3. Death	229 (20.5%)
ICU length of stay in days (mean +/- SD, median)	4.6 +/- 5.9, 2.4
Hospital length of stay in days (mean +/- SD, median)	25.1 +/- 34.2, 14.0
APACHE II score (mean +/- SD), SMR	19.9 +/- 9.5, 0.62
APACHE IV score (mean +/- SD), SMR	70.1 +/- 34.8, 0.78
SAPS II score (mean +/- SD), SMR	47.9 +/- 17.6, 0.48



Area under ROC curve: APACHE IV 0.862, APACHE II 0.826 and SAPS II 0.812

Hosmer-Lemeshow goodness-of-fit tests for the APACHE IV, APACHE II and SAPS II

Scores	C statistics (χ^2 value)	P value
APACHE IV	22.35	0.004
APACHE II	10.03	0.263
SAPS II	17.14	0.029

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	No. (%)
Mean ICU length of stay, days	3.82
Age, mean, yrs	61.7
16-44	20,408 (17.6)
45-64	58,770 (33.0)
65-84	49,727 (42.8)
>85	7,712 (6.6)
APACHE comorbidities ^a	
None	103,685 (89.1)
Immunosuppression	4,459 (3.8)
Metastatic cancer	3,029 (2.6)
Hepatic failure	1,667 (1.4)
Cirrhosis	1,343 (1.2)
Leukemia/myeloma	916 (0.8)
Lymphoma	612 (0.5)
AIDS	599 (0.5)
Operative status	
Nonoperative	80,700 (69.4)
Postoperative	35,509 (30.6)
Elective	29,056 (25.0)
Emergency	6,453 (5.6)
Severity of illness (ICU day 1)	
Acute physiology score, mean	39.7
APACHE III score, mean	51.4
Prior length of stay, days	0.94
Admission source, location	
before ICU admission	
Emergency room	41,918 (36.1)
Operating/recovery room	35,509 (30.6)
Floor	19,765 (17.0)
Other hospital	6,709 (5.8)
Direct admission	6,619 (5.7)
Intermediate care unit	5,689 (4.9)
Other ICU	NA
ICU readmission	7,545 (6.5%)

Conclusion

- APACHE IV predictions of hospital mortality have good discrimination as compared with other models but it had inadequate calibration.
- Difference of patient's characteristics may be the reason and customization of model should be considered.





Questions/ Comments

