HSOR NEWS
The evidence behind your decisions
Health Services & Outcomes Research, Issue 2011/4

Predicting the admission needs at emergency department's (ED) triage using predictive modeling

INSIDE THIS ISSUE

1. Introduction to predictive modeling

What is predictive modeling?

It is the process of finding previously unknown patterns and trends in historical and current data, and using that information to make prediction on future events.

Core attributes

- It captures relationships between predictors and the predicted outcome from past occurrences.
- It exploits the findings to predict future outcomes.
- A variety of techniques are used: statistics, data mining and game theory, etc.
- It is usually applied to large data sets.

Difference from cause-effect model

- Predictive modeling involves obtaining "honest" estimates of the rule's performance in actual practice, in terms of the discrimination and calibration of the rules.
- Causal effect modeling focuses on measuring the true effect of causal factors on outcomes by confounding the effects from other factors.

Applications in healthcare

- Development of clinical guidelines.
- Targeting patients for disease or population management.
- Healthcare resource allocation and planning.

2. Predicting the admission needs at ED triage

Background and Motivation

- Overcrowding at emergency department (ED) continues to be a problem faced by hospitals in Singapore and in developed countries.
- The reasons for overcrowding may be attributed to heavy workload, shortage of manpower and inpatient beds.

By early prediction of the hospital admission risk at triage, it may help to:

- Initiate admission plans earlier so that bed waiting time can be reduced, and improve patient flow from ED to the ward.
- Aid doctors make decision on whether to admit patients or not, so that consultation time and variation in decision making can be reduced.
- Improve patients' satisfaction through faster admission.

Model development

- Study patients: Patients who visited TTSH ED in year 2007 and year 2008. Patients who died in ED were excluded.
- Data collection: Routinely collected at triage by nurses.
- Method: Stepwise logistic regression for predictor selection and parameter estimation.
- Validation: split validation - 60% for derivation and the remaining 40% for validation of predictive model.

Candidate predictors used

- Demographics (age, gender, and ethnic group)
- Chronic conditions of diabetes (D), hypertension (H), or dyslipidaemia (L)
- Arrival mode (ambulance or walk-in)
- Patient acuity category (PAC1-3)
- Prior hospital admission in preceding 3 months
- Prior ED visit in preceding 3 months

Final predictors identified See Table 1.

Table 1. Final predictors for predicting hospital admission needs

		Odds ratio	95% Confidence interval	
Predictors			**Lower**	**Upper**
Age Group	[25-34]	1		
	<15	0.2	0.1	0.2
	15-24	0.6	0.6	0.7
	35-44	1.3	1.2	1.3
	45-54	1.5	1.5	1.6
	55-64	1.8	1.7	1.9
	65-74	2.5	2.4	2.6
	75-84	3.6	3.4	3.8
	85+	5.3	4.9	5.7
Race group	[Malay]	1		
	Chinese	1.1	1.1	1.2
	Indian	1.2	1.2	1.3
	Others	1.1	1.1	1.2
Arrival mode	[Walk-in]	1		
	Ambulance	1.7	1.7	1.8
PAC	[3]	1		
	1	20.2	19.1	21.4
	2	4.4	4.3	4.6
Prior ED visit in preceding 3 mth	[No]	1		
	Yes	1.2	1.2	1.3
Prior hospital adm in preceding 3 mth	[No]			
	Yes	1.4	1.3	1.5
Chronic conditions	[No]	1		
	D	2.1	1.9	2.4
	H	1.5	1.4	1.6
	L	1.9	1.8	2.0
	DH	2.7	2.4	3.0
	DHL	2.6	2.5	2.7
	DL	2.1	1.9	2.2
	HL	1.9	1.8	2.0

Model performance

- A Receiver Operating Characteristic (ROC) curve measures how accurate a model discriminates between the dichotomous outcomes with a value from 0 (no discrimination) to 1 (perfect discrimination). Here, the area under the ROC curve is 0.849 (95%CI: 0.847-0.851), which shows that the model discriminates well, between patients who are admitted and those who are not.
- The goodness of fit test summarizes the discrepancy between observed values and the values predicted by the model. Here, the test shows that the predicted admissions match the actual admissions well.

Model deployment

- Model may be integrated with existing ED information system, to predict patients' admission needs at triage. Clinical judgement can over-rule the prediction model.
- For each patient presented at triage, their risk of admission is calculated using the formula: if p>=0.7, then patient is predicted to need admission.

$$p = \frac{1}{1 + e^{-(\beta_0 + \sum_{i=1}^{k} \beta_i X_i)}}$$

Sun Yan, PhD in Medical Informatics, and a Biostatistician; She has extensive experience in predictive modeling, statistics and analytics of large observational data. Her current research interests include predictive modeling in health services, evaluation & risk adjustment in observational studies.