University of Dundee
Division of Population Health Sciences

Development and validation of an acute kidney injury prediction score for use in the general population

Samira Bell[1,2], Hilda Hounkpatin[3], Nicosha de Souza[2], Matthew J Johnson[4], Paul Roderick[5], Simon D S Fraser[5], Miles D Witham[6]

[1]Renal Unit, Ninewells Hospital, Dundee, UK, [2]Population Health Sciences Division, Medical Research Institute, University of Dundee, Dundee, DD2 4BF, [3] NIHR CLAHRC Wessex Primary Care and Population Sciences, Faculty of Medicine, University of Southampton, [4]NIHR CLAHRC Wessex Methodological Hub, Faculty of Health Sciences, University of Southampton, [5]Academic Unit of Primary Care and Population Sciences, Faculty of Medicine, University of Southampton,[6]Ageing and Health, Division of Molecular & Clinical Medicine, School of Medicine, Ninewells Hospital, Dundee,DD1 9SY, UK.

Introduction

Acute Kidney Injury (AKI) affects approximately 15% of all hospitalised patients in developed countries with a significant proportion originating in the community. Identifying those patients at increased risk of AKI whilst in the community may facilitate earlier detection and implementation of proactive prevention measures such as medication review and potentially avoid hospital admission.

Aims

To develop and externally validate a simple score to predict the risk of acute kidney injury for use in the general population using routinely collected diagnostic, demographic and biochemistry data.

Methods

Design: Observational cohort using routine NHS data
Development Cohort: all adults with at least one creatinine measurement between 1st January 2004 and 31st December 2012 in the Tayside, alive at 1st January 2010
Validation Cohort: all adults registered with GP practices in Southampton or Portsmouth between 1st January 2013 and 31st December 2014
Main Outcome Measure: AKI defined by NHS England algorithm based on KDIGO criteria
Statistical Methods: Multivariable logistic regression analysis with AKI as the dependent variable. Model was derived using data from in Tayside. Model performance was determined by assessing discrimination (c-statistic) and calibration

Results

- Model developed in 273,450 individuals
- Validation Cohort: 643, 039
- Mean age: 52 ± 18.6
- 4761 (1.7%) individuals had an episode of AKI during the calendar year 2010
- 1619 (34%) of these stage 2 or 3 AKI
- 5724 (0.9%) with AKI in validation cohort
- Calibration, both internal and external, was good at lower risk levels, but risk was overestimated at the highest risk levels.

Model Performance

Model and cohort	AKI 1-3		AKI 2-3	
	c	95% CI	c	95% CI
Tayside 2010 development cohort	0.89	0.80-0.90	0.95	0.95-0.96
Hampshire 2014 cohort	0.81	0.80-0.81	0.85	0.84-0.86

Results (continued)

Covariate	N (%)	OR	95%CI
Age (<20 as index)	4780 (1.7)	1	-
20-29	35994 (13.2)	1.24	0.77-2.00
30-39	36247 (13.3)	1.55	0.97-2.49
40-49	48411 (17.7)	1.56	0.98-2.49
50-59	47340 (17.3)	1.97	1.24-3.14
60-69	45887 (16.8)	2.55	1.61-4.04
70-79	33656 (12.3)	2.89	1.82-4.57
80-89	18118 (6.6)	2.91	1.83-4.62
90 and over	3107 (1.1)	2.78	1.71-4.50
Female sex	151826 (55.5)	1	-
Male sex	121714 (44.5)	1.10	1.04-1.19
eGFR >=60 ml/min/1.73m^2	253233 (92.6)	1	-
eGFR 45-59 ml/min/1.73m^2	13500 (4.9)	1.71	1.55-1.88
eGFR 30-44 ml/min/1.73m^2	5286 (1.9)	1.97	1.76-2.20
eGFR <30 ml/min/1.73m^2	1521 (0.6)	5.75	5.03-6.58

Covariate	N (%)	OR	95% CI
Previous AKI	17138 (6.3)	16.87	15.70-18.13
Liver disease	18887 (6.9)	1.30	1.18-1.43
Heart failure	4860 (1.8)	1.17	1.04-1.31
Myocardial infarction	9274 (3.4)	1.26	1.14-1.39
Stroke	4039 (1.5)	1.30	1.10-1.54
Neurological disease	3537 (1.3)	1.26	1.11-1.44
RAS or RA stent	181 (0.1)	NI	NI
AAA repair	394 (0.1)	2.00	1.45-2.75
Major Urological surgery	565 (0.2	1.73	1.29-2.33
ACEi/ARB	43742 (16.0)	NI	NI
Aldosterone antagonist	2219 (0.8)	NI	NI
Loop diuretic	11767 (4.3)	1.24	1.13-1.35
Non-loop diuretic	17339 (6.3)	0.85	0.77-0.94
NSAID	23218 (8.5)	NI	NI

Risk Score

Covariate	AKI stages 1-3 (4761 events)			
	OR	95%CI	B	Points
Age (<20 as index)	1	-	-	0
20-29	1.99	1.24-3.19	0.687	1
30-39	3.05	1.91-4.88	1.116	2
40-49	3.20	2.01-5.09	1.163	2
50-59	4.96	3.14-7.85	1.602	2
60-69	8.08	5.12-12.74	2.089	3
70-79	11.46	7.27-18.07	2.439	4
80-89	13.47	8.52-21.28	2.600	4
90 and over	13.63	8.46-21.94	2.612	4
eGFR >=60 ml/min/1.73m^2	1	-	-	0
eGFR 45-59 ml/min/1.73m^2	2.77	2.54-3.03	1.020	1
eGFR 30-44 ml/min/1.73m^2	4.80	4.33-5.34	1.570	2
eGFR <30 ml/min/1.73m^2	21.65	19.12-24.50	3.075	4
Diabetes mellitus	2.24	2.07-2.41	0.804	1
Heart failure	2.51	2.27-2.79	0.921	1

Conclusion

Identification of patients in the community at high risk for AKI is key to early identification and prevention of AKI.
We have devised an externally validated simple risk score comprising of four variables from routinely collected data which could be implemented in both primary and secondary care to identify those at risk of future acute kidney injury.

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