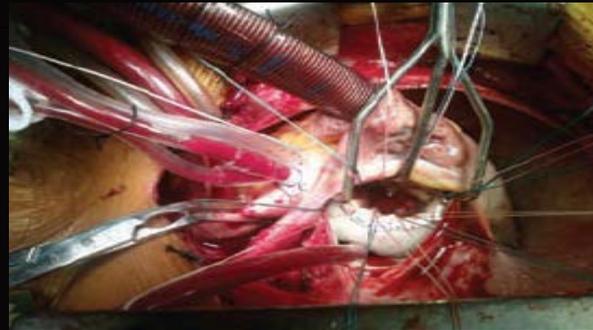




**Comparison of four contemporary
risk scores for predicting
mortality and morbidity after
aortic valve replacement**



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Background

- Prevalence of aortic valve disease increasing (5%/2%)
- Surgical aortic valve replacement is gold standard for severe symptomatic disease
- Recent introduction of TAVI, suitable for selected (moderate-to-)high risk candidates by “Heart Team”
- Risk stratification important for decision-making, especially AVR vs TAVI vs medical in high-risk



Risk models

1. EuroSCORE (1999/2003, all cardiac ops, international)
2. EuroSCORE II (2012, all cardiac ops, international)
3. STS Score (2009, AVR, US, mortality+morbidities)
4. Aus-AVR (2011, AVR, ANZSCTS)

Predictor	β -Coefficients	Additive score	p-value	Odds ratio (95% CI)
Cerebrovascular disease				
Coma	0.805	3	0.002	2.24 (1.34, 3.75)
CVA	0.422	2	0.23	1.52 (0.77, 3.03)
RIND/TIA	0.417	2	0.34	1.52 (0.65, 3.56)
EF grade				
Mild EF: 46–60%	0.233	1	0.31	1.26 (0.80, 1.98)
Moderate EF: 30–45%	0.377	1	0.15	1.46 (0.87, 2.44)
Severe EF: <30%	0.742	3	0.011	2.10 (1.18, 3.73)
NYHA class				
III	0.557	2	0.009	1.75 (1.15, 2.65)
IV	1.129	4	0.001	3.09 (1.84, 5.21)
Prior operation				
Previous CABG	0.959	4	0.001	2.61 (1.50, 4.53)
Previous valve surgery	0.256	1	0.60	1.29 (0.49, 3.38)
Previous other cardiac surgery	1.425	6	0.003	4.16 (1.64, 10.56)
Active infective endocarditis	1.351	5	0.001	3.86 (1.81, 8.26)
Left main disease	0.775	3	0.003	2.17 (1.30, 3.64)
Renal dysfunction (estimated GFR)				
Mild (60–89)	0.789	3	0.10	2.20 (0.86, 5.65)
Moderate (30–59)	0.990	4	0.042	2.69 (1.04, 6.98)
Severe (15–29)	1.873	7	0.002	6.51 (2.02, 20.97)
End-stage kidney disease (<15)	1.909	7	0.001	6.74 (2.25, 20.23)
Age group				
60–69 years	0.576	2	0.23	1.78 (0.69, 4.56)
70–79 years	1.122	4	0.013	3.07 (1.26, 7.46)
80+ years	1.564	6	0.001	4.78 (1.90, 11.98)
Constant	-6.084			

Compare prognostic utility of four risk scores at predicting after AVR:

- Short and long-term mortality
- Post-operative complications (also with each STS complication models)



Methods

- Isolated AVR 2005-2012 at Auckland City Hospital
- Clinical characteristics and outcomes collected, calculated 4 risk scores
- Operative and long-term mortality, morbidities and composite (STS definitions)
- Statistics: multivariate analyses, discrimination (ROC) and calibration tests. Ethics approval attained



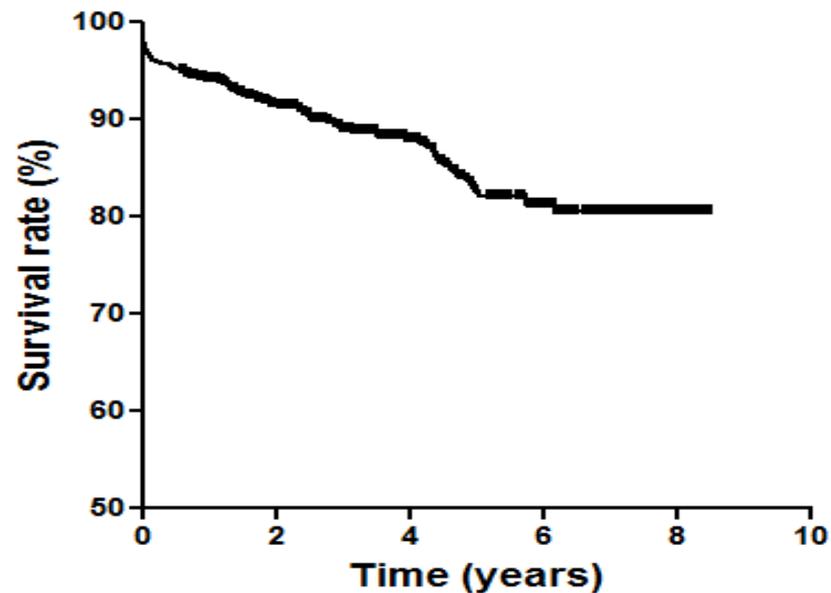
Cohort characteristics (n=620)

- **Demographics:** age 64.8+/-15.5 years, female 34.5%, Maori/Pacific 21.1%, BMI 29.6+/-11.5 kg/m²
- **Presentation:** NYHA II/III/IV 37.3%/27.9%/12.9%, Syncope 6.1%, Unstable angina 2.7%, Critical pre-operative state 3.1%, Inpatient operation 50.6%, Active endocarditis 10.8%
- **Past history:** Cardiac surgery 22.6% (Valve 14.7%, CABG 8.4%), CHF 20.3%, MI 8.7%, AF 19.2%, DM 17.3%, HTN 49.0%, Stroke 6.1%, PVD 6.0%, Resp 19.0%, Dialysis 2.4%
- **Investigations:** AS 75.3%, AR 36.0%, EF<50% 35.0%, MR 8.1%, LMS/3VD 9.2%, CrCl 83+/-40mL/min
- **Operation:** Time 204+/-72min, CPB 112+/-42min, mech 30.6%



Cohort outcomes (n=620)

Outcomes	Observed
Operative mortality	2.9% (18)
Composite morbidity	18.5% (115)
Stroke	1.3% (8)
Renal failure	4.5% (28)
Ventilation>24 hours	11.1% (69)
Mediastinitis	0.8% (5)
Return to theatre	8.1% (50)
Post-op stay >14 days	9.5% (59)



Mean follow-up 3.8+/-2.4 years
1-year 94.2%, 3-year 89.1%,
5-year 82.6%, 7-year 80.5%



Mortality Analyses





Multivariate predictors

Outcomes	Predictors
Operative mortality (odds ratios)	Critical pre-operative state (7.72), atrial fibrillation (3.38), peripheral vascular disease (4.11), mitral stenosis (6.13)
Long-term mortality (hazards ratios)	Critical pre-operative state (3.37), atrial fibrillation (2.36), peripheral vascular disease (2.72), dialysis (4.85), previous stroke (2.62).



Mortality discrimination

Outcomes	EuroSCORE	EuroSCORE II	STS Score	Aus-AVR Score
Operative mortality	0.752* (0.652-0.852)	0.711 (0.607-0.815)	0.715 (0.593-0.837)	0.684 (0.557-0.811)
Long-term mortality	0.707 (0.652-0.761)	0.697 (0.642-0.753)	0.704 (0.650-0.759)	0.713* (0.658-0.768)

Area under curve (95% confidence interval) – all have $P < 0.05$

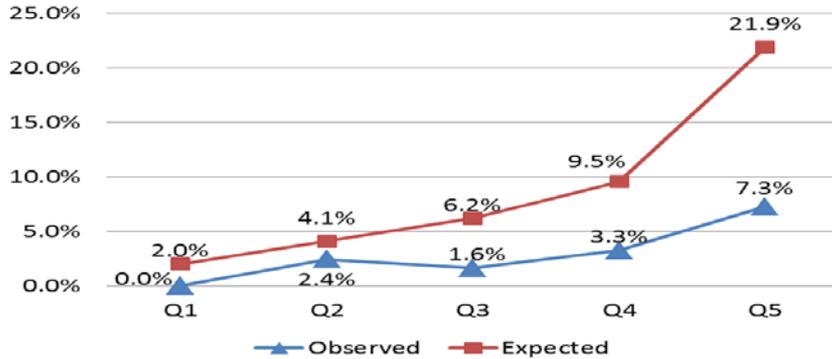


Mortality calibration

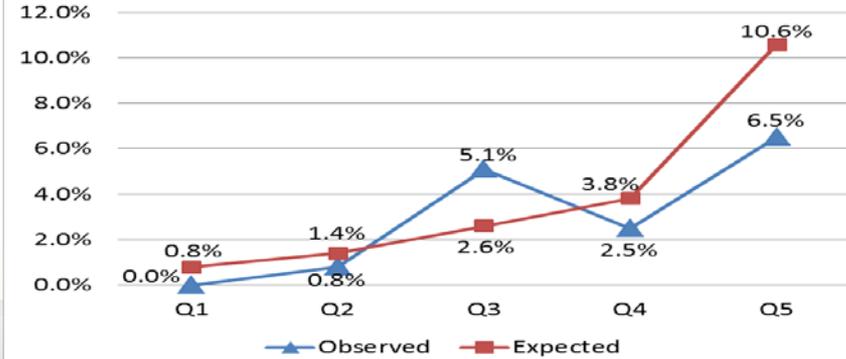
Calibration	EuroSCORE	EuroSCORE II	STS Score	Aus-AVR Score
Observed: 2.9% (18/620)	8.7+/-8.3%	3.8+/-4.7%	2.8+/-2.7%	3.2+/-4.8%
O/E ratio	0.33	0.77	1.05	0.90
T-test (P-value)	<0.001	0.433	1.000	0.869
Brier Score	0.0348	0.0278	0.0276	0.0294
Hosmer-Lemeshow test P-value (χ^2)	0.007 (21.1)	0.125 (12.6)	0.753 (5.0)	0.468 (7.7)

Calibration by quintiles

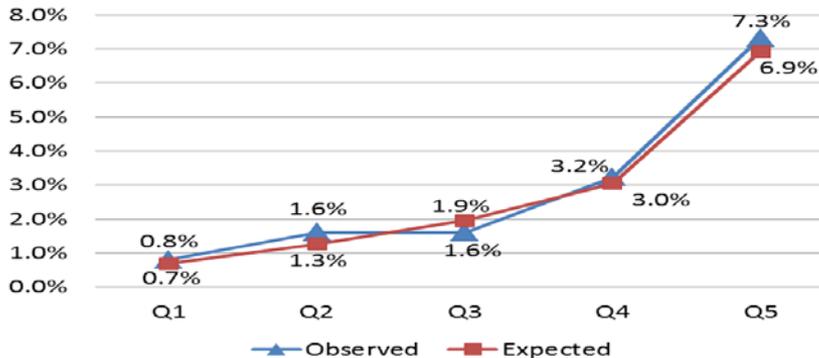
A) EuroSCORE



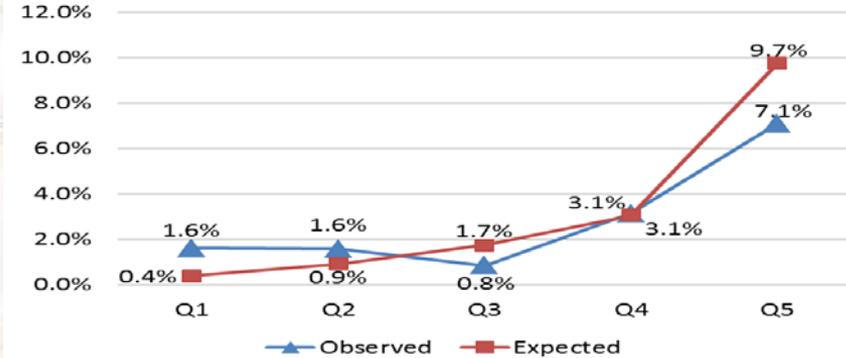
B) EuroSCORE II



C) STS Score

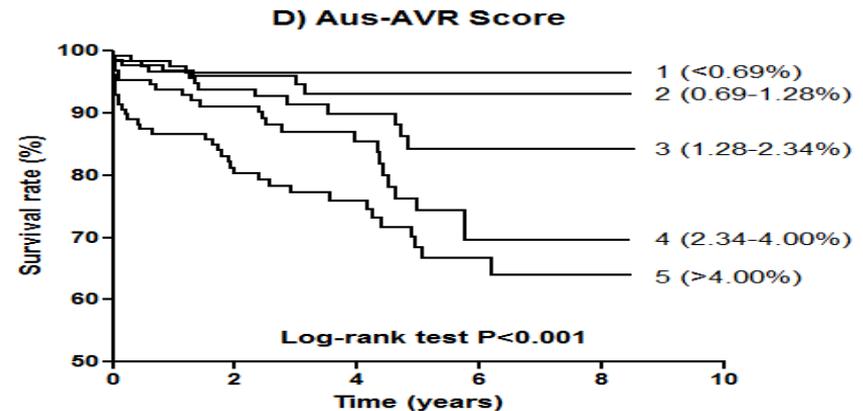
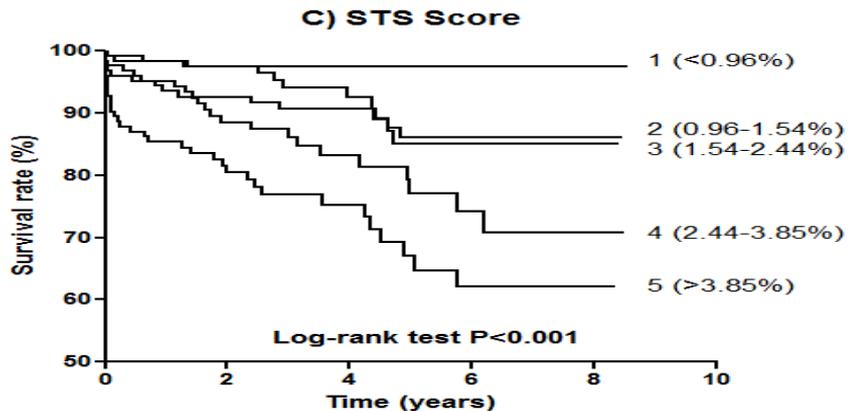
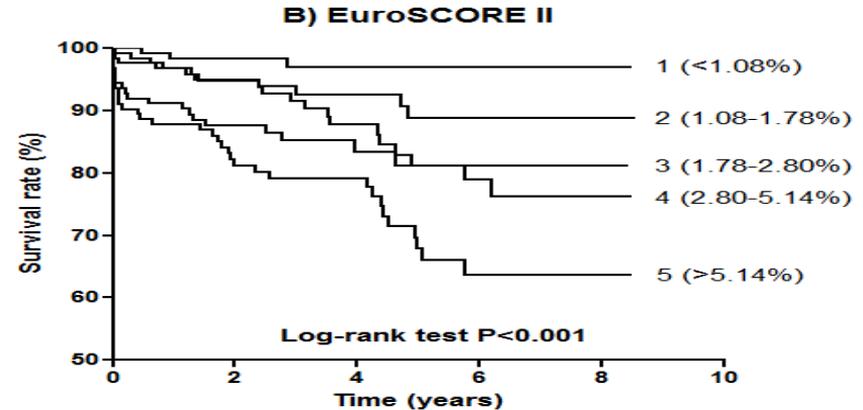
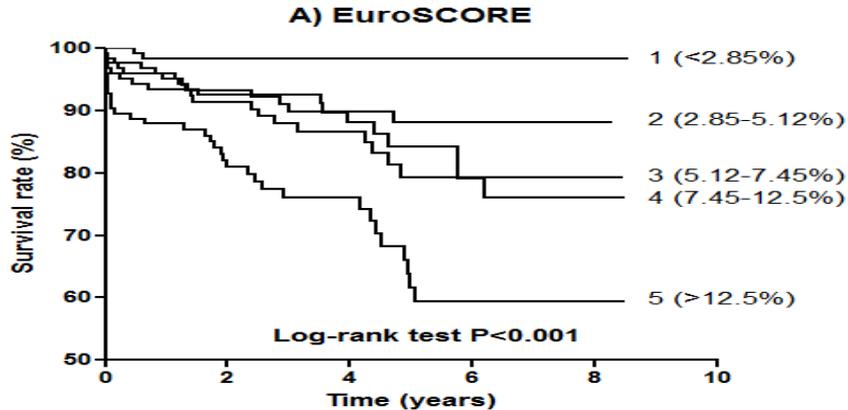


D) Aus-AVR Score





Survival by quintiles





Morbidity Analyses





Multivariate predictors

Outcomes	Predictors
Composite morbidity	Age (1.02), critical pre-operative state (8.98), urgent inpatient surgery (1.62), dialysis (7.89)
Stroke	Age (1.10), syncope (6.07), critical pre-operative state (7.30), history of stroke (7.23)
Renal failure	Male (3.23), critical pre-operative state (6.57), hypertension (3.98), history of stroke (3.90)
Ventilation>24 hours	BMI (0.934), critical pre-operative state (8.21), AF(2.48), active infective endocarditis (2.61), dialysis (4.08), impaired EF (1.47)
Deep sternal wound infection	Critical pre-operative state (12.3), history of CABG (10.5)
Return to theatre	Unstable angina (5.25)
Post-op stay >14 days	Critical pre-operative state (4.43), active infective endocarditis (3.38), impaired EF (1.37)

(All figures are odds ratio)



Morbidity discrimination

Outcomes	EuroSCORE	EuroSCORE II	Aus-AVR Score	STS Score	STS Score [#]
Composite morbidity	0.653	0.649	0.618	0.666*	<u>0.686</u>
Stroke	0.845*	0.770	0.642	0.812	<u>0.845</u>
Renal failure	0.599	0.614	0.599	0.634*	<u>0.695</u>
Ventilation>24 hours	0.727	0.726	0.675	0.735*	<u>0.747</u>
Mediastinitis	0.675	0.748*	0.502	0.666	0.605
Return to theatre	0.556	0.566	0.560	0.577*	<u>0.634</u>
Post-op stay >14 days	0.672	0.675	0.678	0.707*	<u>0.738</u>

Area under curve (bold =P<0.05), #STS complications risk models



Morbidity calibration

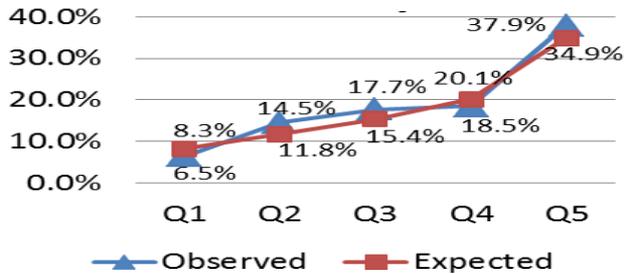
STS complications risk models

Outcomes	Observed	Score	Hosmer-Lemeshow test P-value (χ^2)	Brier Score
Composite morbidity	18.5%	18.1%	0.369 (8.7)	0.0139
Stroke	1.3%	1.3%	0.770 (4.9)	0.0125
Renal failure	4.5%	3.8%	0.666 (5.8)	0.0424
Ventilation>24 hours	11.1%	11.3%	0.811 (4.5)	0.0865
Mediastinitis	0.8%	0.3%	0.778 (4.8)	0.0080
Return to theatre	8.1%	8.6%	0.915 (3.3)	0.0730
Post-op stay >14 days	9.5%	8.1%	0.123 (12.7)	0.0812

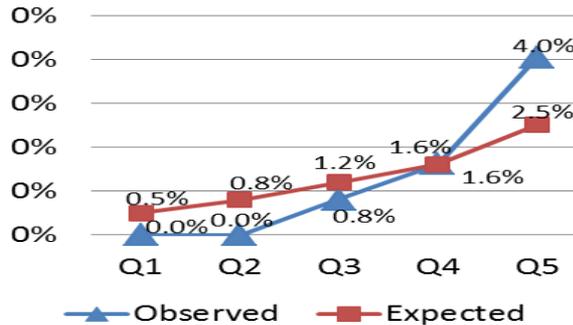


Morbidity by quintiles

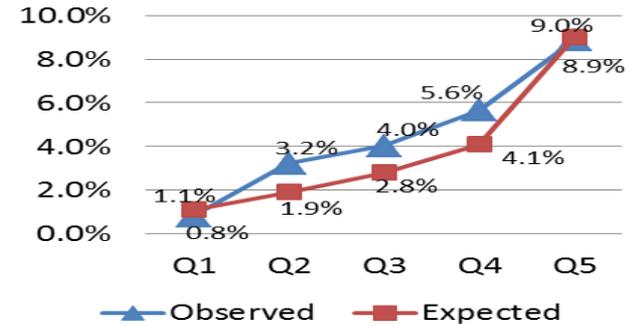
A) Composite morbidity



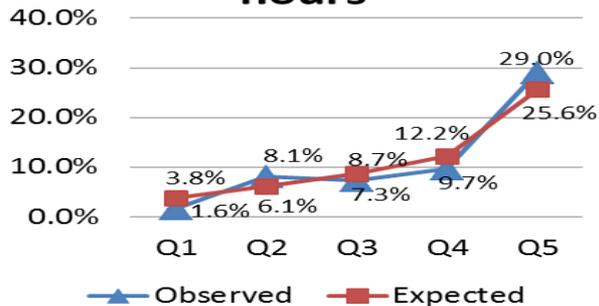
B) Stroke



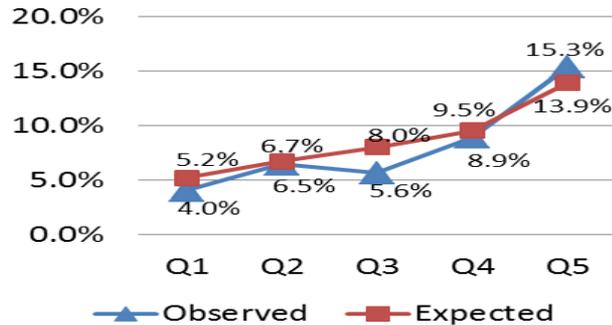
C) Renal failure



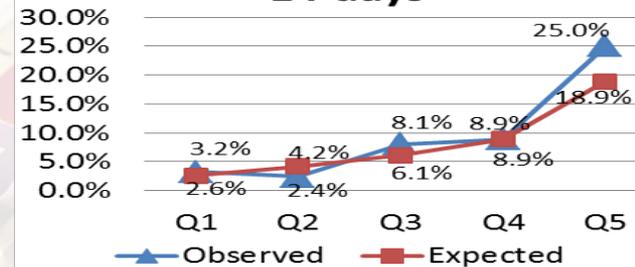
D) Ventilation >24 hours



E) Return to theatre



F) Prolonged hospital stay after operation >14 days





Discussion

- Operative mortality: all can discriminate this, EuroSCORE over-estimates, STS best in high-risk.
- Long-term mortality: all can detect this as score or in quintiles
- Complications: STS Score best amongst 4 scores, complication models even better and well-calibrated
- Room for improvement: AVR specific, mortality+morbidity, consideration of other parameters eg frailty, RV, liver, aorta
- Limitations: single-centre observational study, retrospective calculation, moderate power.



Other studies

Biancari 2014¹: meta-analysis, 5 surgical AVR studies n=8311

- EuroSCORE II: AUC 0.73, O/E 0.94, STS Score: AUC 0.75, O/E 0.84

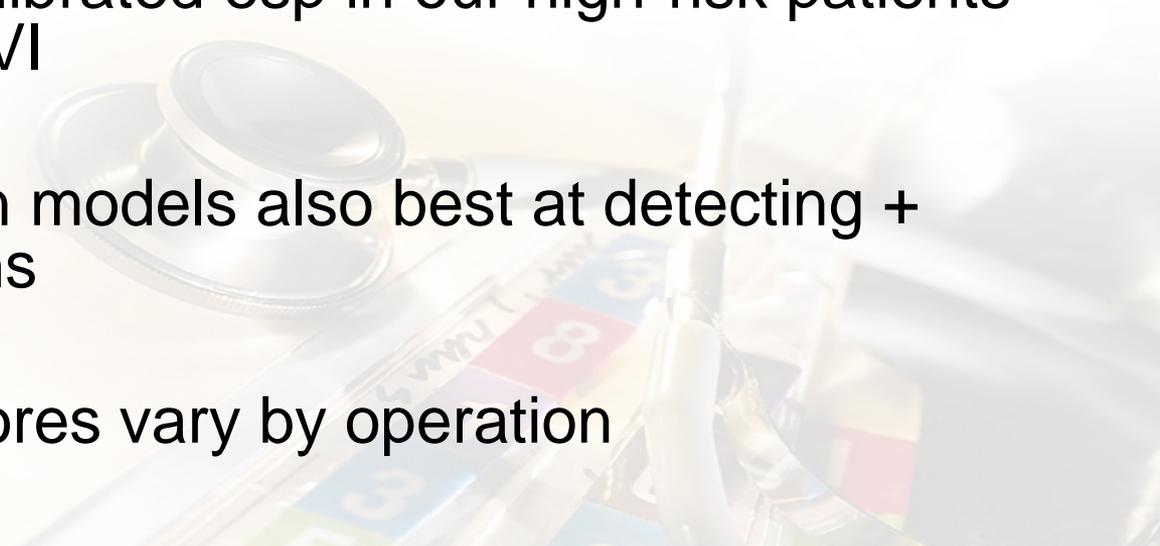
Auckland	EuroSCORE	EuroSCORE II	STS Score	Other
AVR ²	0.752 (0.33)	0.711 (0.77)	0.715 (1.05)	0.684 (0.90) Aus-AVR Score
CABG ³	0.675 (0.36)	0.642 (0.62)	0.641 (0.44)	0.661 (1.7) AusSCORE
AVR+CABG ⁴	0.567 (0.52)	0.669 (0.97)	0.699 (1.17)	
MVR	0.844 (0.32)	0.817 (0.72)	0.850 (0.69)	
Endocarditis ⁵	0.645 (0.52)	0.656 (0.75)	0.699	0.744 (De Feo)

Area under curve (O/E ratio) for operative mortality: bold =P<0.05

1. Biancari F, Juvonen T, Onorati F, Faggian G, Heikkinen J, Airaksinen J, Mariscalco G. Meta-analysis on the performance of the EuroSCORE II and the Society of Thoracic Surgeons Scores in patients undergoing aortic valve replacement. J Cardiothorac Vasc Anesth 2014 Dec;28:1533-9.
2. Wang TK, Choi DH, Stewart R, Gamble G, Haydock D, Ruygrok P. Comparison of four contemporary risk models at predicting mortality after aortic valve replacement. J Thorac Cardiovasc Surg 2015;149:443-8.
3. Wang TK, Li AY, Ramanathan T, Stewart RA, Gamble G, White HD. Comparison of four risk scores for contemporary isolated coronary artery bypass grafting. Heart Lung Circ 2014;23:469-74.
4. Wang TKM, Choi D, Ramanathan T, Ruygrok P. Comparing performance of risk scores for combined aortic valve replacement and coronary bypass grafting surgery. Heart, Lung and Circulation 2016 April accepted.
5. Wang TK, Oh T, Voss J, Gamble G, Kang N, Pemberton J. Comparison of contemporary risk scores for predicting outcomes after surgery for active infective endocarditis. Heart Vessels 2015;30:227-34.



Conclusion

- EuroSCORE over-estimates operative mortality so should no longer be used, while others fit well to contemporary outcomes
 - STS score was best calibrated esp in our high-risk patients – use this for AVR vs TAVI
 - STS score/complication models also best at detecting + calibrating complications
 - Performance of risk scores vary by operation
- 



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Dr David Choi¹ (house officer)

Mr Greg Gamble² (statistician)

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Travel Grants: Cardiac Society of Australia and New Zealand, Auckland Medical Research Foundation, National Heart Foundation, RACP Foundation

- Cardiac Society of New Zealand Annual Scientific Meeting
- Cardiac Society of Australia and New Zealand Annual Scientific Meeting
- World Congress of Cardiology (World Heart Federation)
- Royal Australasian Society of Physicians Congress



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Comparison of four contemporary risk models at predicting mortality after aortic valve replacement

Tom Kai Ming Wang, MBCHB,^a David H. M. Choi, MBCHB,^a Ralph Stewart, MD,^{a,b} Greg Gamble, MSc,^b David Haydock, FRACS,^a and Peter Ruygrok, MD^{a,b}

Objective: Risk stratification for aortic valve replacement (AVR) is desirable given the increased demand for intervention and the introduction of transcatheter aortic valve implantation. We compared the prognostic utility of the European System for Cardiac Operative Risk Evaluation (EuroSCORE), EuroSCORE II, Society of Thoracic Surgeons (STS) score, and an Australasian model (Aus-AVR score) for AVR.

J Thorac Cardiovasc Surg 2015;149:443-8.

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<http://dx.doi.org/10.1016/j.hlc.2014.11.021>

ORIGINAL ARTICLE

ACD

Comparison of Risk Scores for Prediction of Complications following Aortic Valve Replacement

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