

A New Mortality Prediction Model for Australian and New Zealand Intensive Care Units

Eldho Paul

Michael Bailey

David Pilcher

Adult Intensive Care Unit Prognostic Models – Potential uses

National level

- Benchmarking

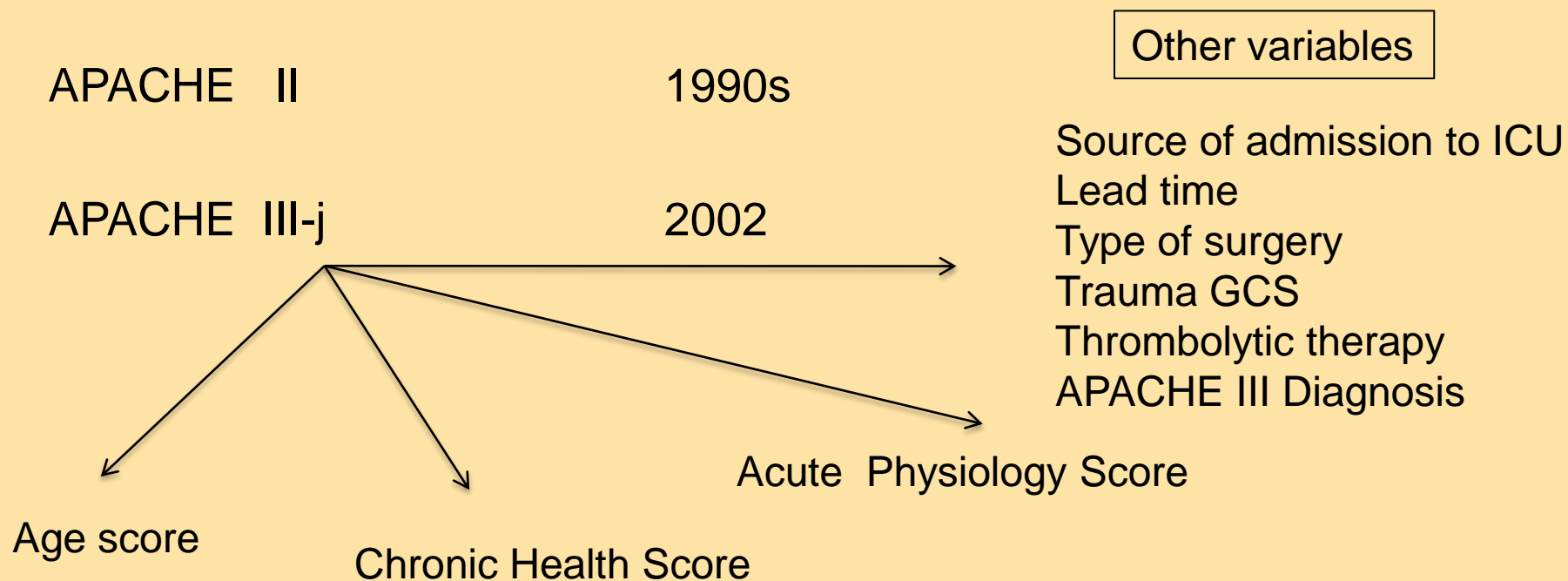
Institution level

- Internal use of quality improvement efforts such as comparing performance of a hospital against the national average
- Institutional self-monitoring for competitive or contractual reasons
- Monitoring by regulatory agencies
- Adjustment of outcomes in clinical trials
- Resource allocation

Acute Physiology and Chronic Health Evaluation (APACHE)

	Year	Dataset (ICU admissions)
APACHE I	1981	805
APACHE II	1985	5,815
APACHE III	1991	17,440
APACHE III-j	2002 →	(Public release)
APACHE IV	2006	110,558

APACHE in Australia & New Zealand



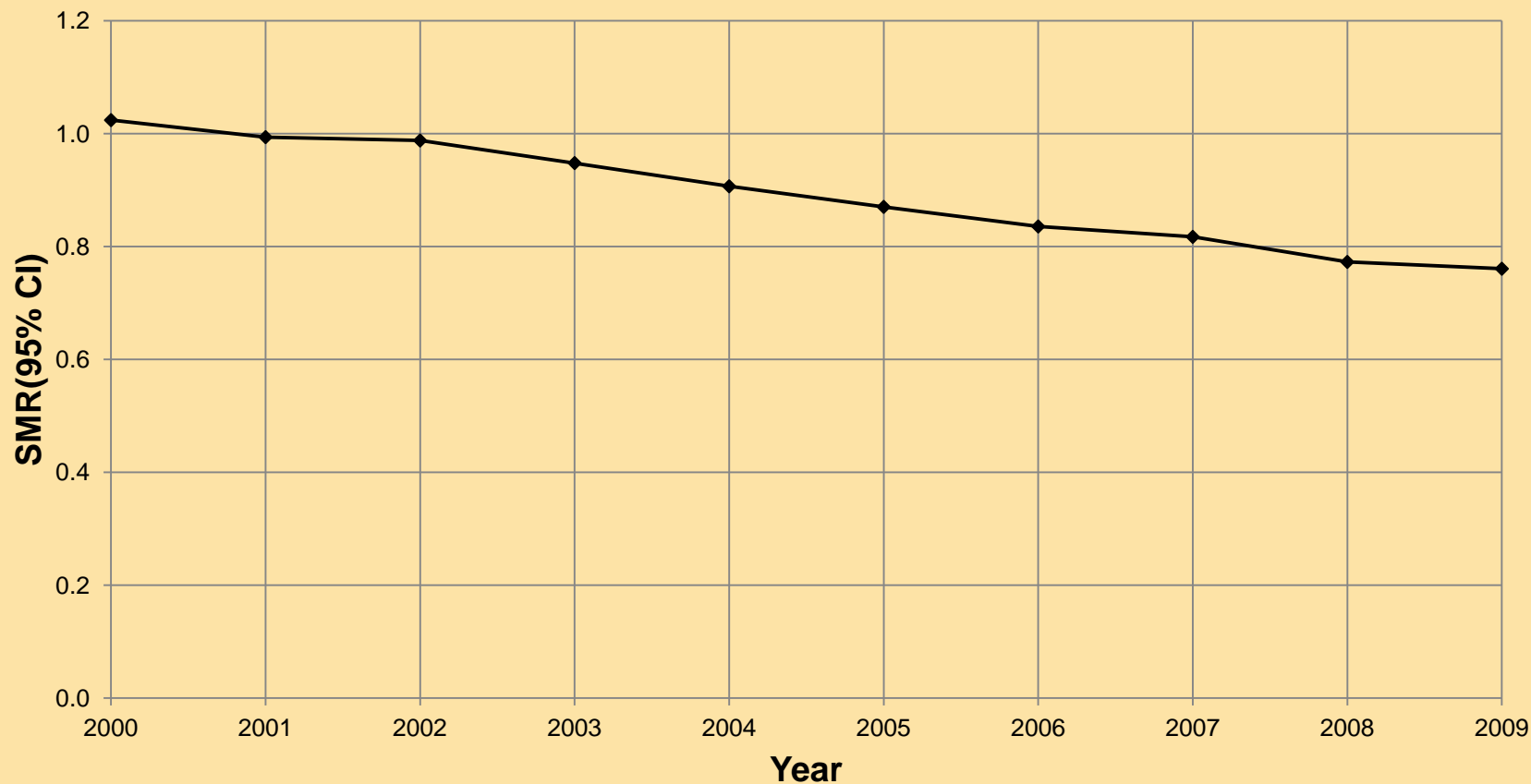
APACHE III-j

Predicted Risk of Death

- Total score = Age score +
Chronic health score +
Acute physiology score +
Scores for other variables
- Logistic regression analysis → Predicted risk of death
- Standardised Mortality Ratio (SMR) =
$$\frac{\text{Observed deaths}}{\text{Predicted deaths}}$$

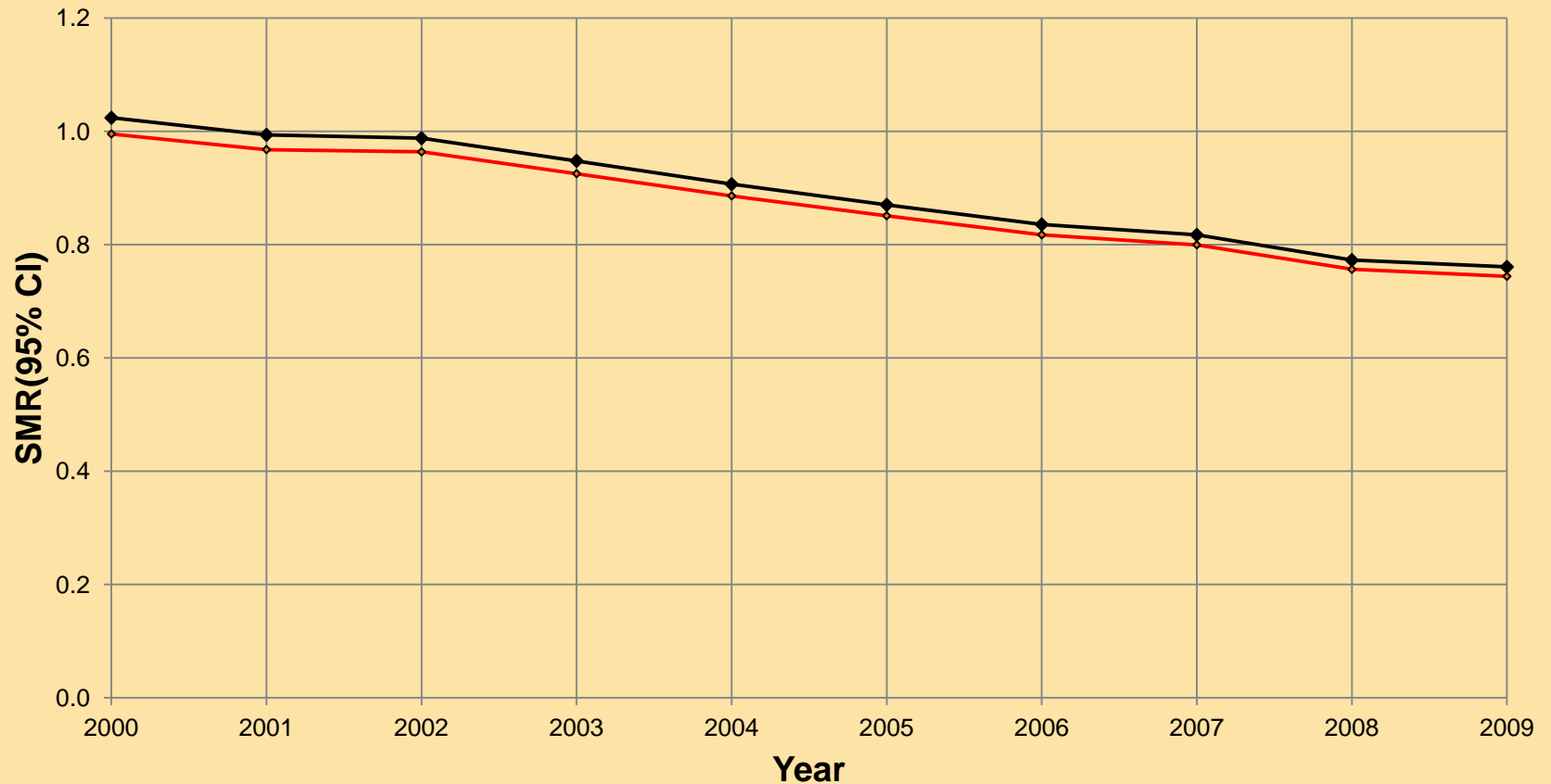
Loss of calibration of APACHE III-j – Time

Standardised Mortality Ratio in ANZ ICUs : 2000-09



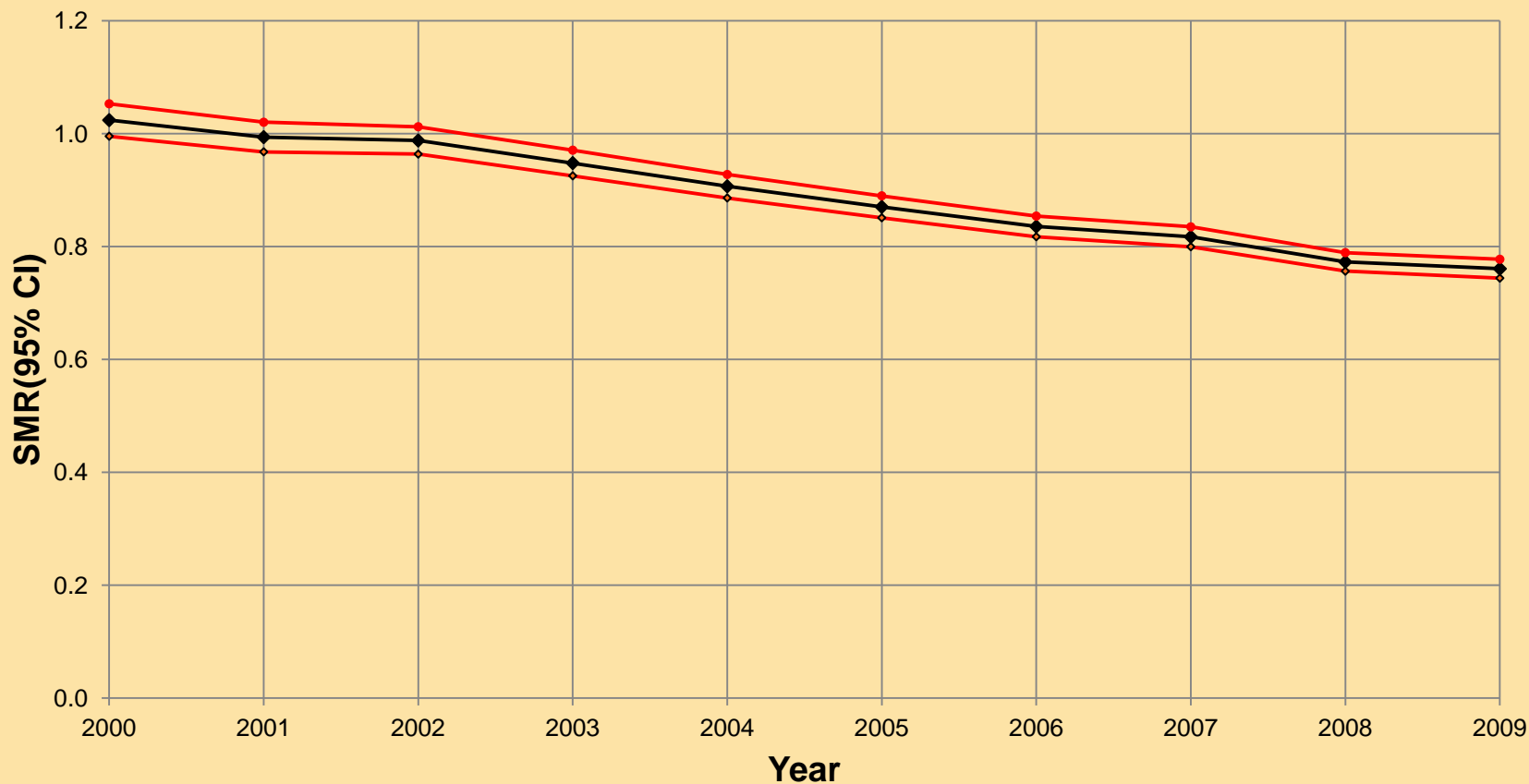
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Loss of calibration

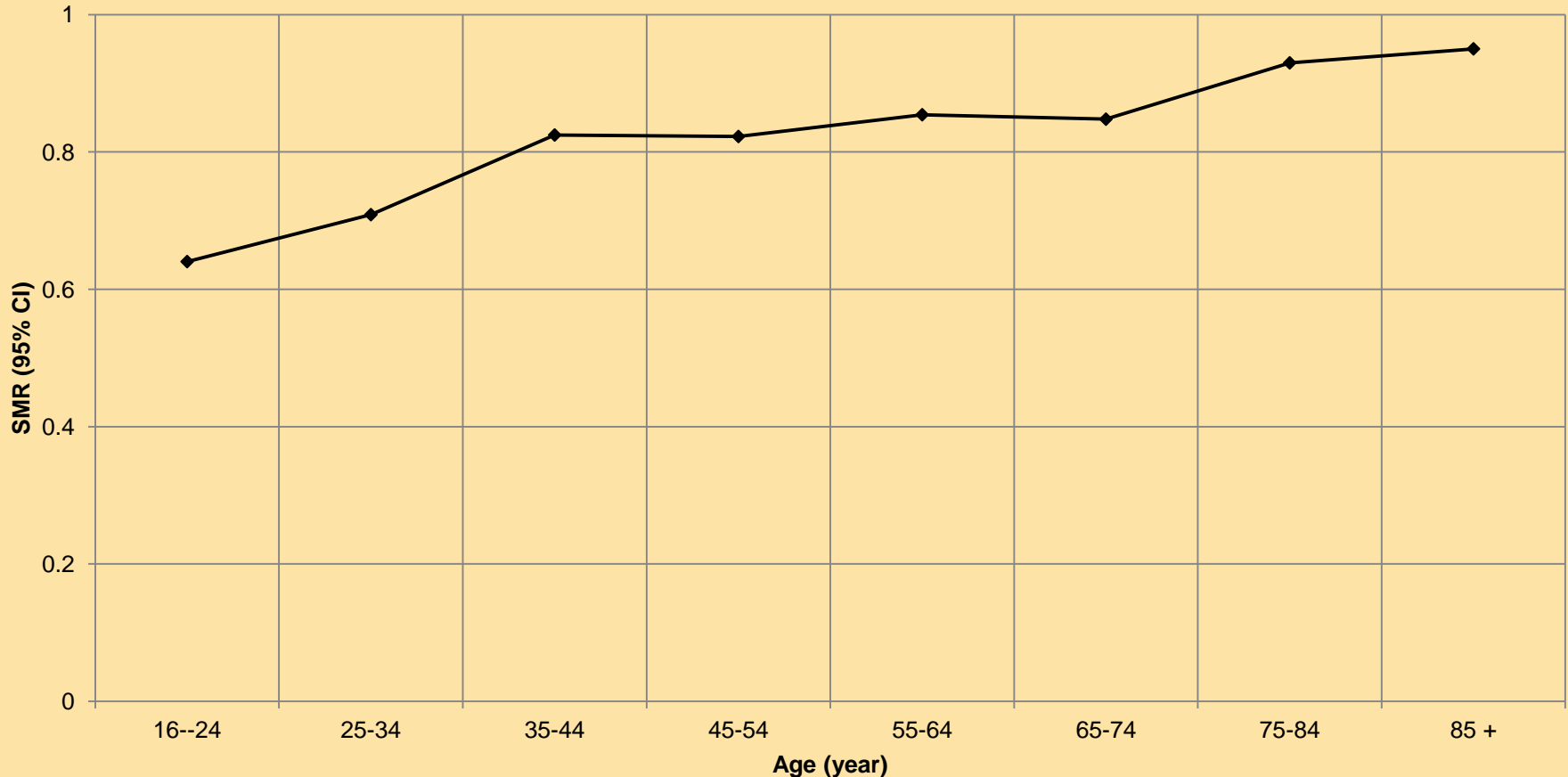
Causes

- Better outcomes
- Change in data quality
- Change in case mix

Continuous methods of monitoring need well calibrated model

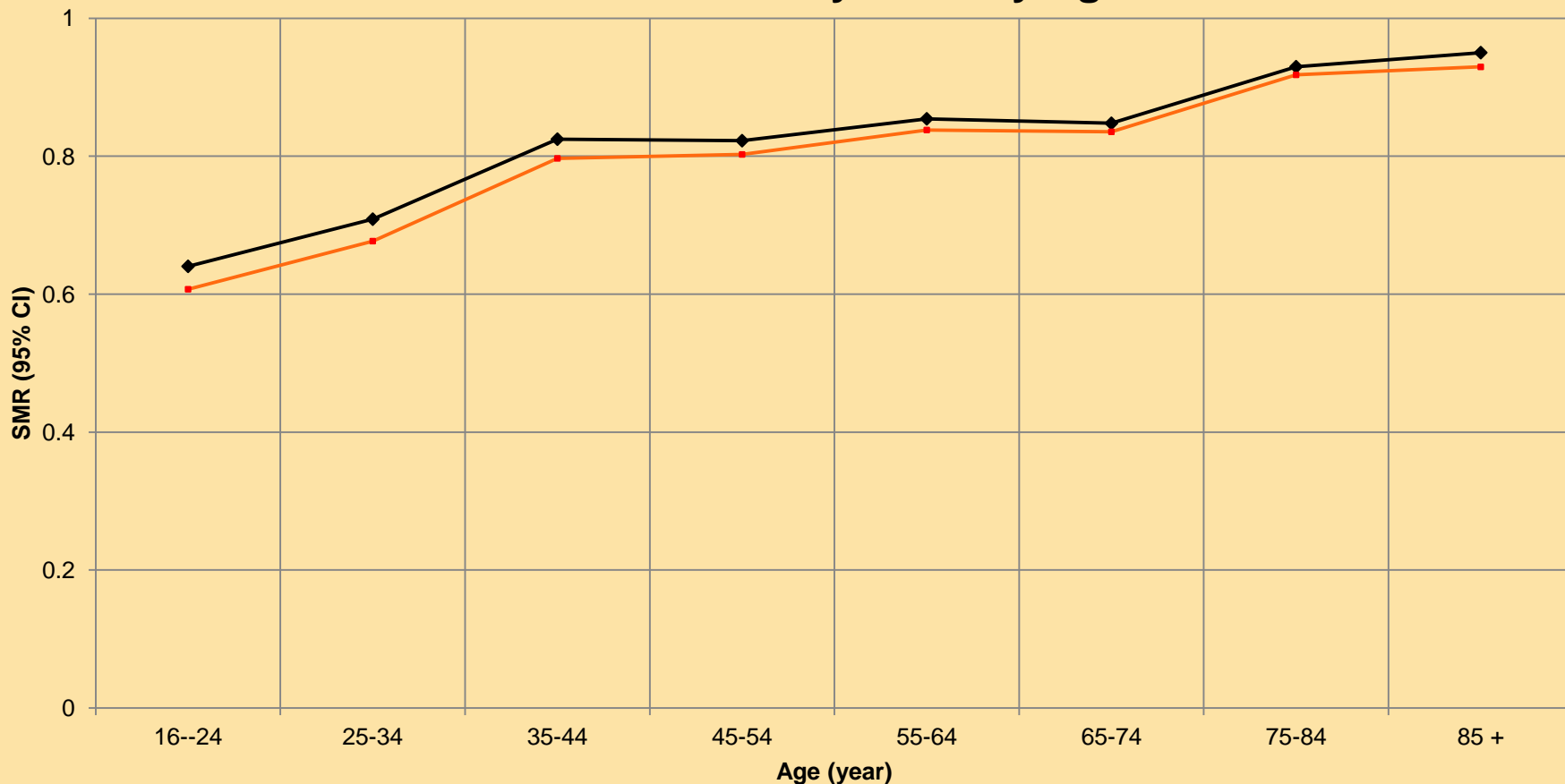
Calibration of APACHE III-j – Age strata

Standardised Mortality Ratio by Age



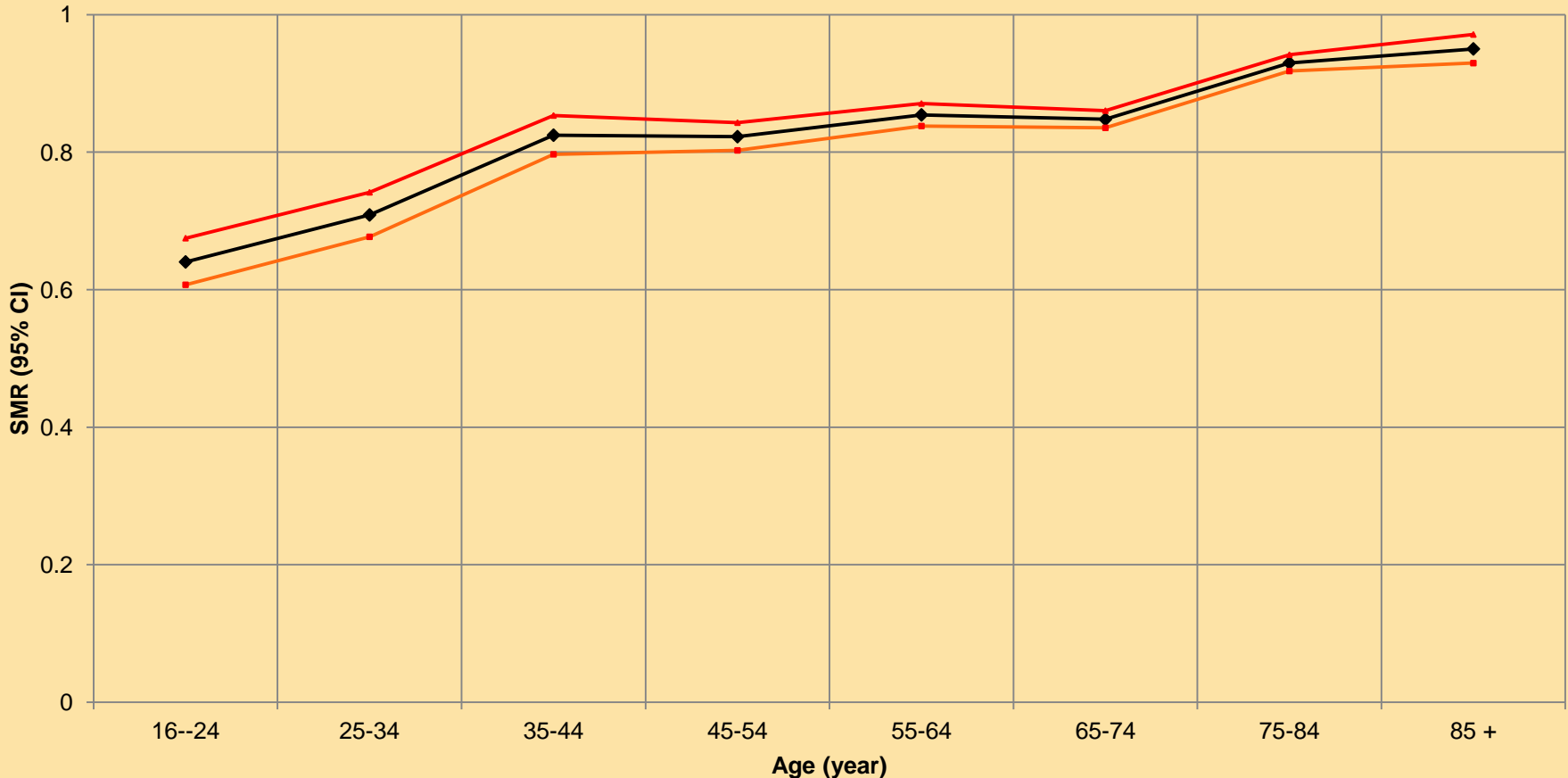
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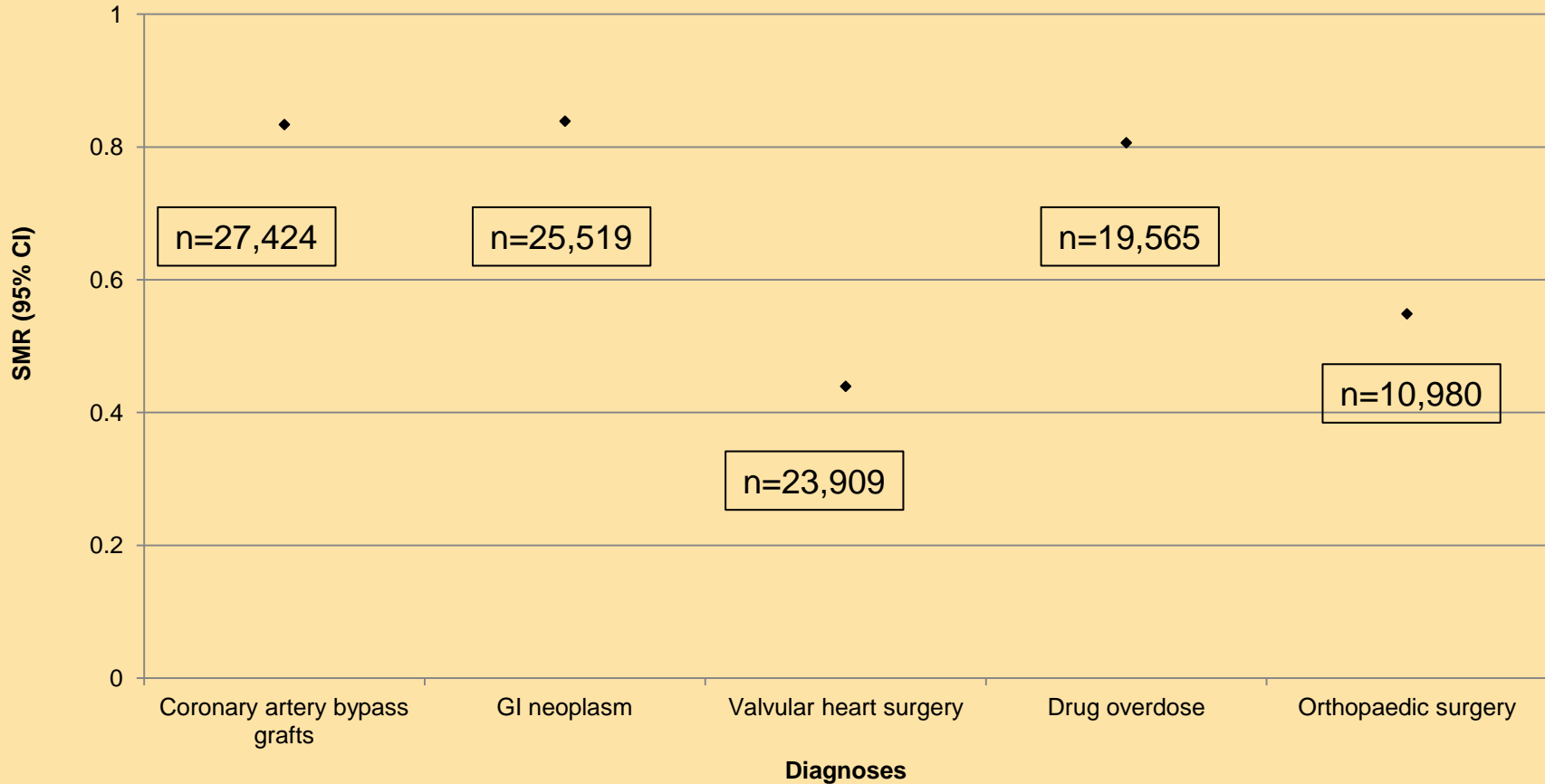
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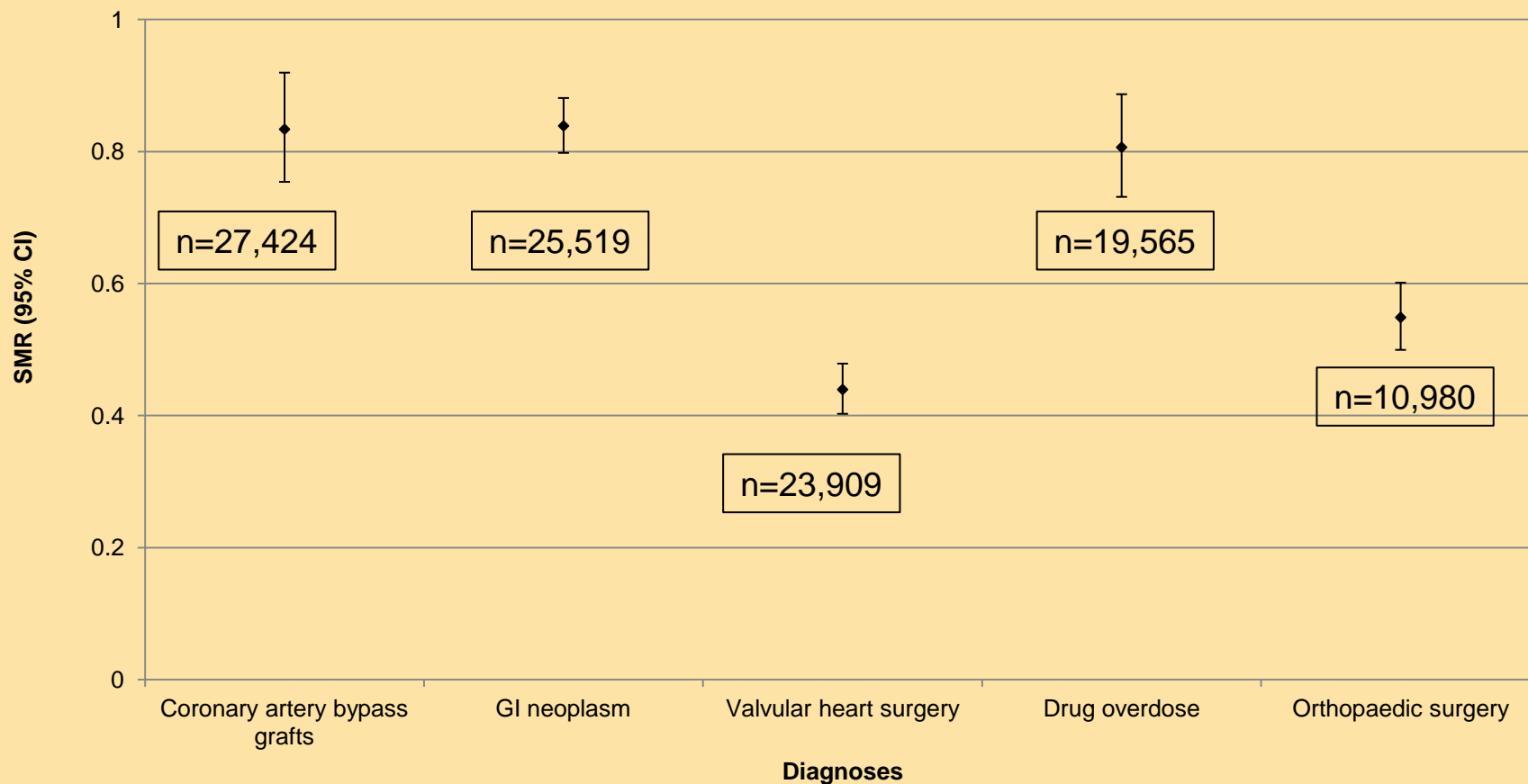
Calibration of APACHE III-j – Diagnoses

Standardised mortality ratio in top 5 diagnoses



Calibration of APACHE III-j – Diagnoses

Standardised mortality ratio in top 5 diagnoses




Aim

- Develop a new mortality risk prediction model for Australian and New Zealand Intensive Care Units
- Assess performance of the new model by applying appropriate statistical methods

Using ANZICS APD, we developed a new mortality prediction model on two-thirds of the data (2/3) and then validated on one-third (1/3).

This was done by

- Re-weighting diagnostic categories
- Re-weighting components of APACHE III-j Score
- Adding new variables



Treatment limitation
Hospital admission source
APACHE II chronic illnesses
Ventilation status

We assessed model calibration by

- Standardised Mortality ratio
- Hosmer-Lemeshow C statistic
- Brier Score
- Calibration curves

We assessed model discrimination by

- area under the receiver operating characteristic curve

ANZICS Adult Patient Database

All admissions
2004 - 2009
(N=542, 429)

N=374,466

N=249,590
Development Cohort

N=124,876
Validation Cohort

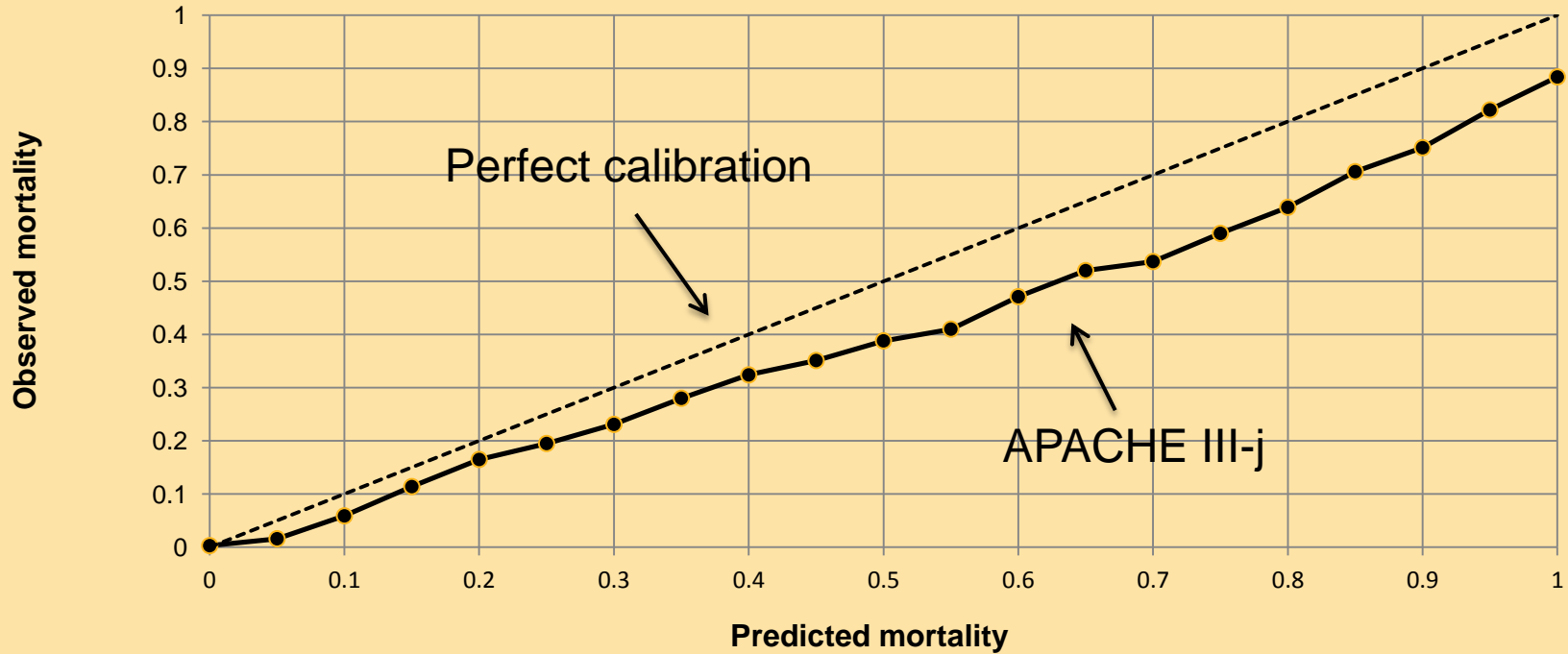
Exclusions

Readmissions to ICU
Age < 16 years
ICU Stay < 4 hours
Unknown Hospital Outcomes
Transferred to other ICUs
Missing APACHE III-j score
Missing APACHE III-j Diagnosis

Results – Model performance

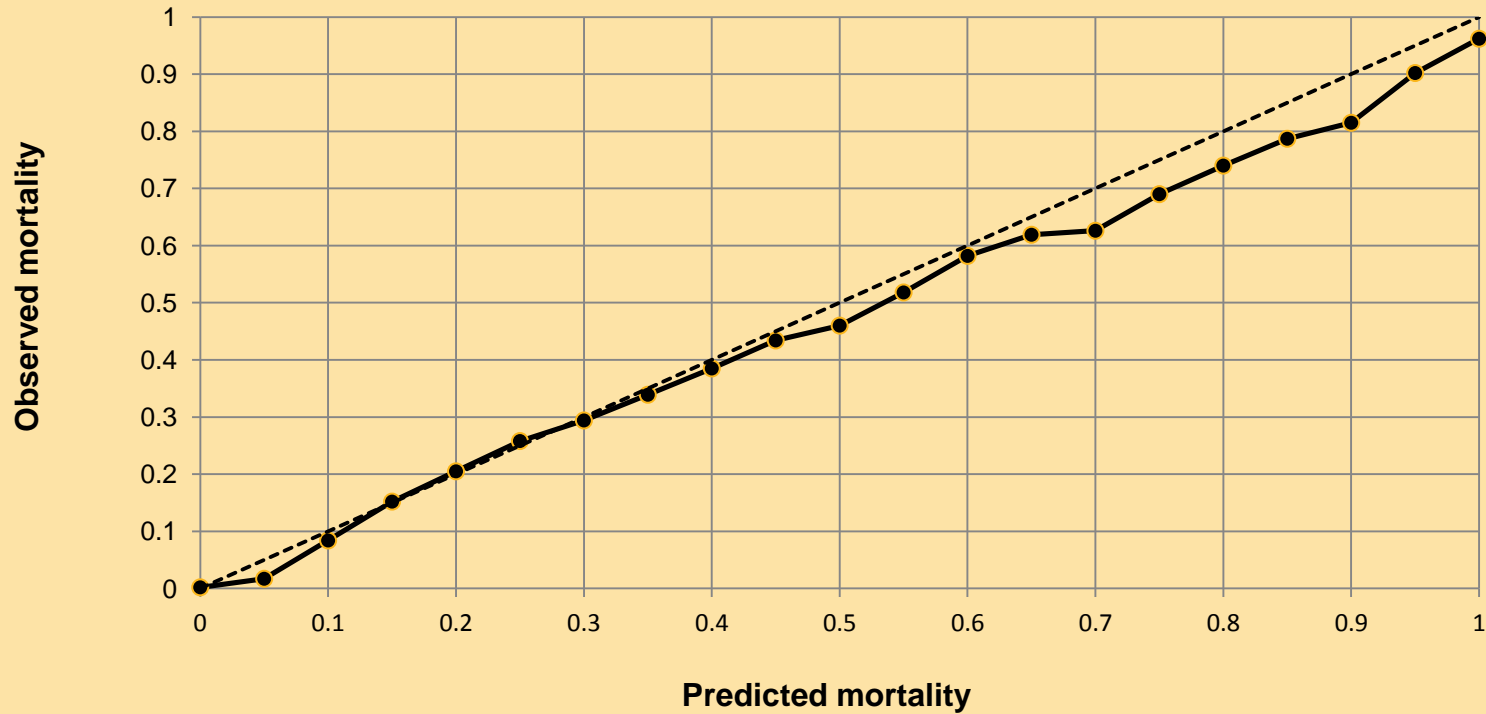
	Ideal value		APACHE III-j	New Model	
Discrimination					
Area under ROC Curve	1	Development	0.890	0.906	“Good Discrimination” Area under ROC > 0.8
		Validation	0.892	0.904	
Calibration					
Hosmer-Lemeshow chi-square	0	Development	2423.19	351.01	
		Validation	1191.28	165.87	
Brier Score	0	Development	0.073	0.065	
		Validation	0.073	0.066	
SMR	1	Development	0.82	1.00	“Good Calibration” SMR = 1
		Validation	0.83	1.01	

Calibration curve of APACHE III-j



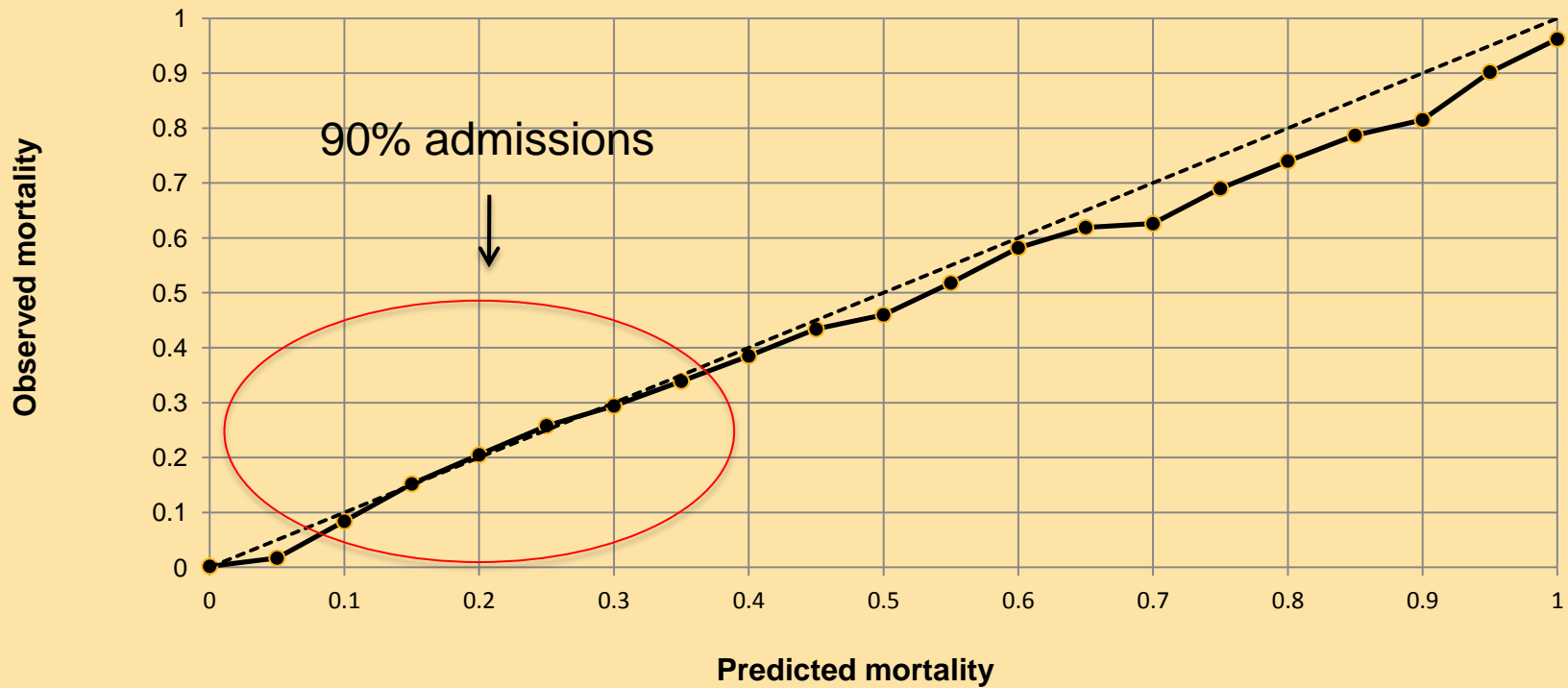
Performance of new model in validation cohort

Calibration curve of new model



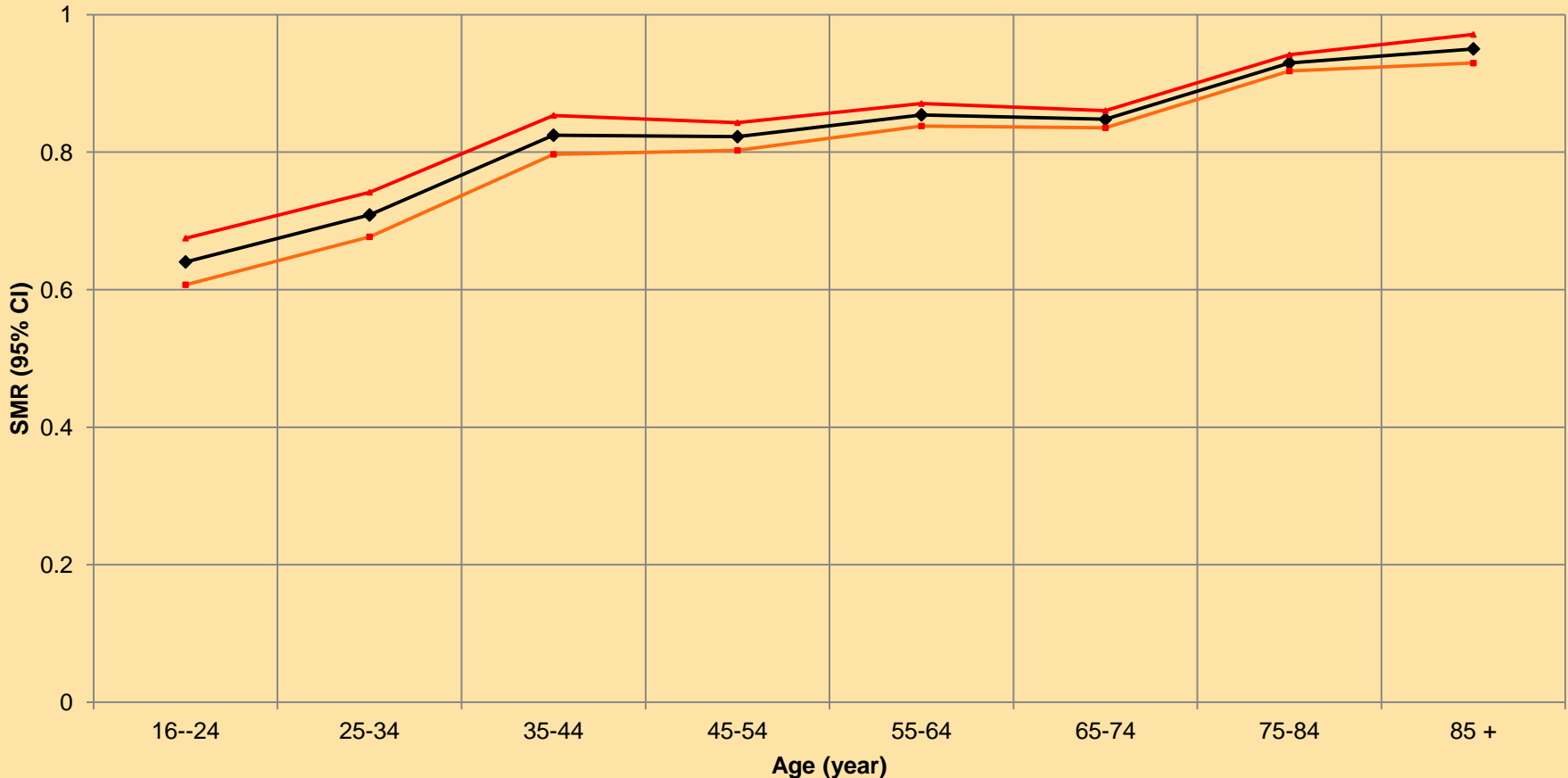
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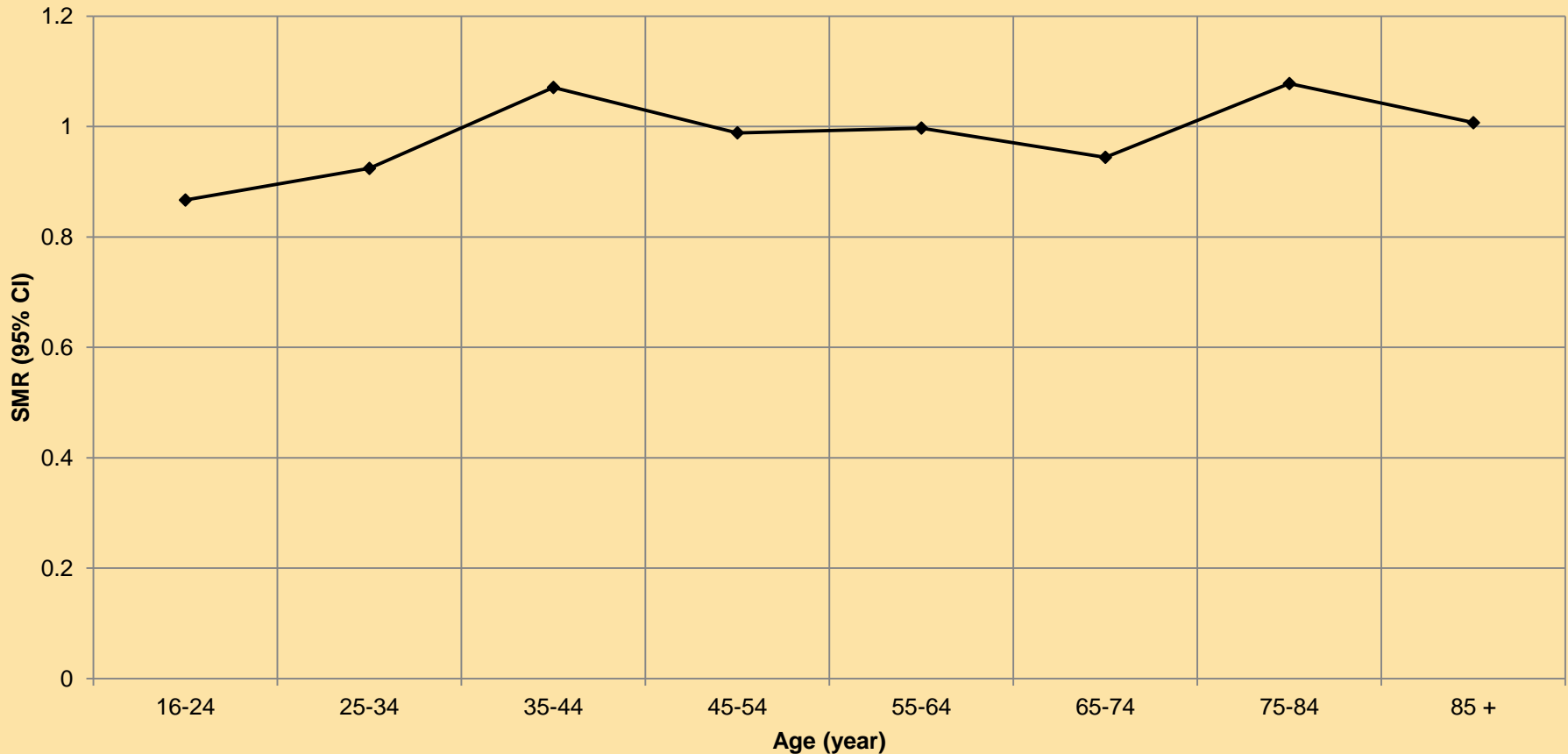
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Standardised Mortality Ratio by Age



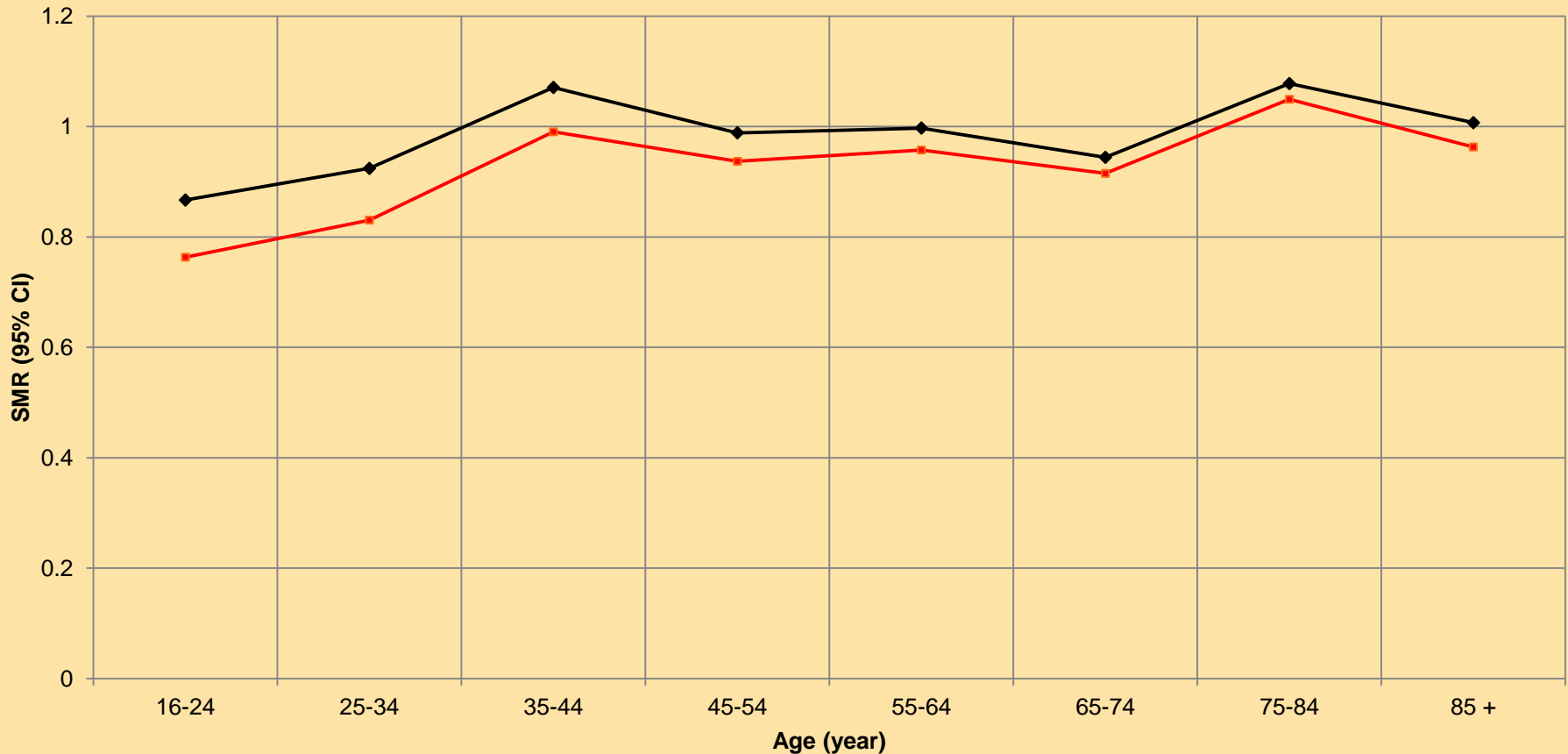
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SMR by Age - Validation cohort



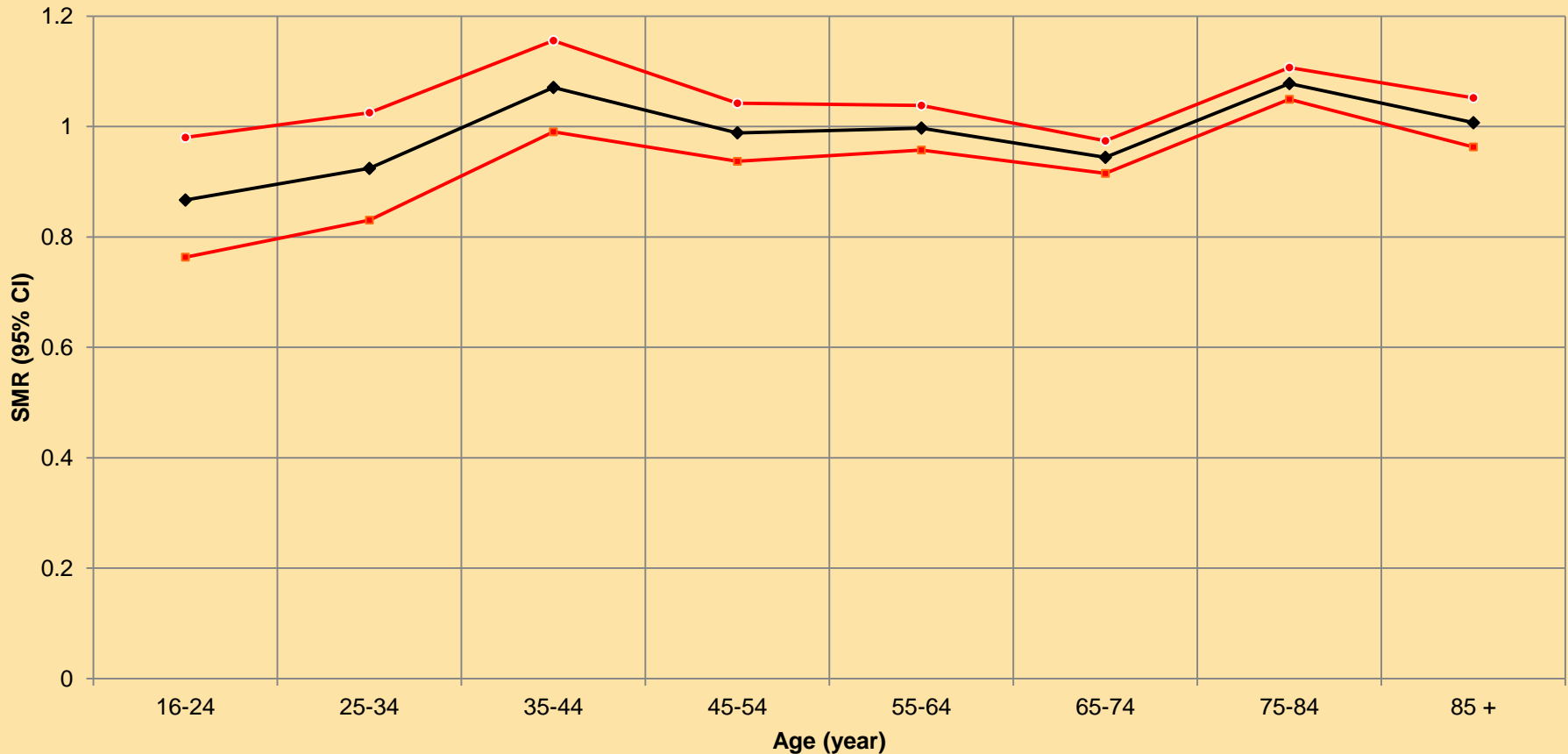
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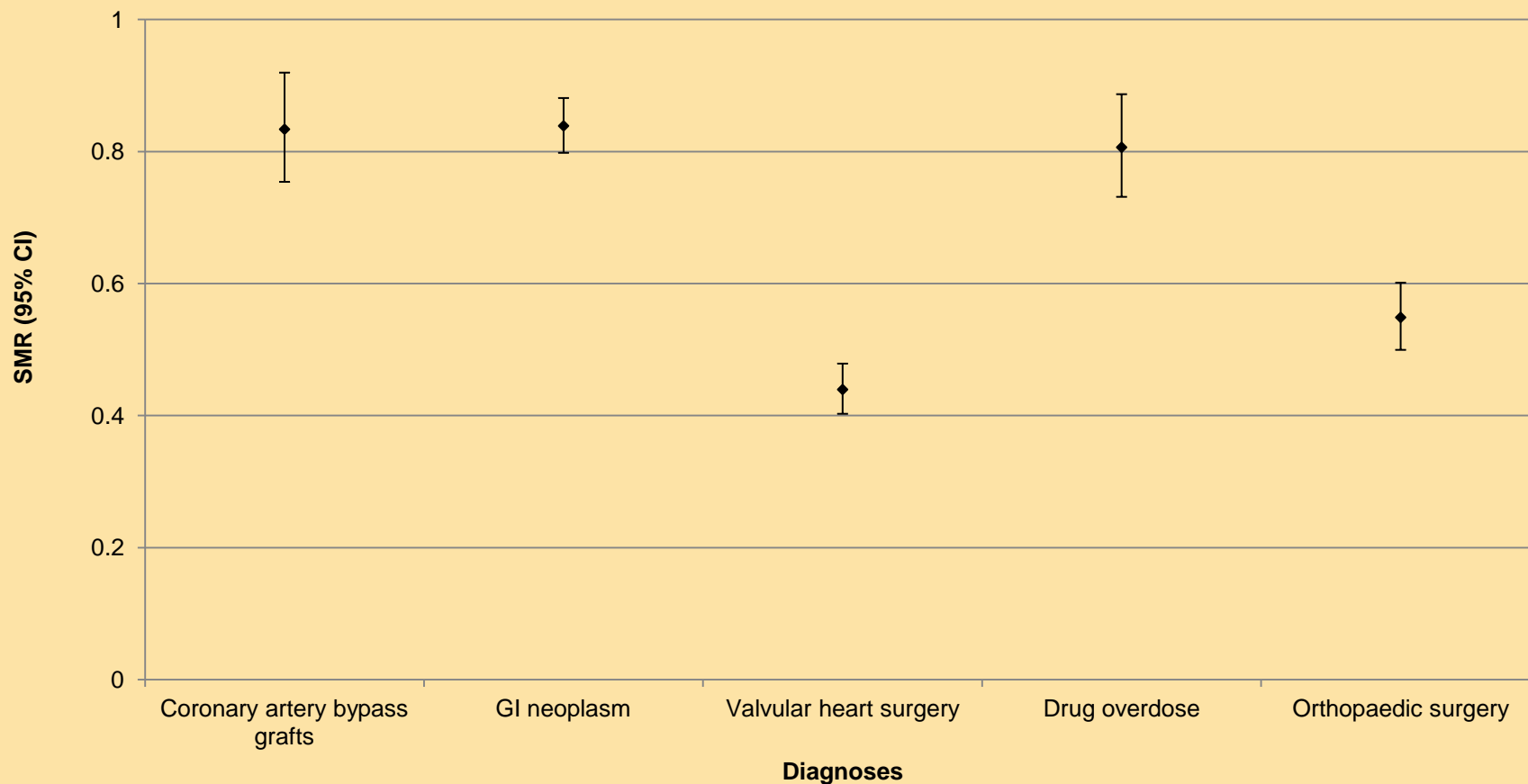
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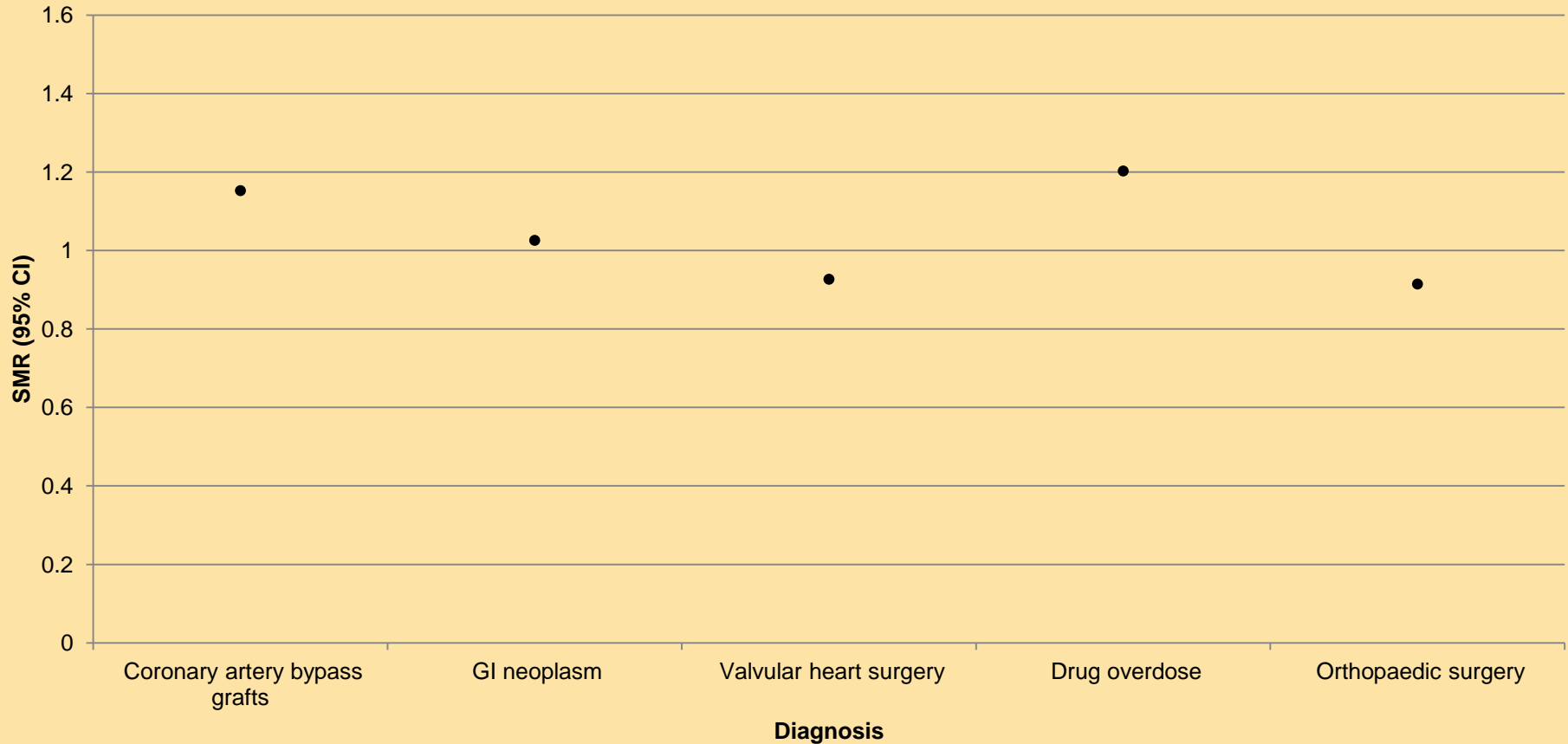
Calibration of APACHE III-j – Diagnoses

Standardised mortality ratio in top 5 diagnoses



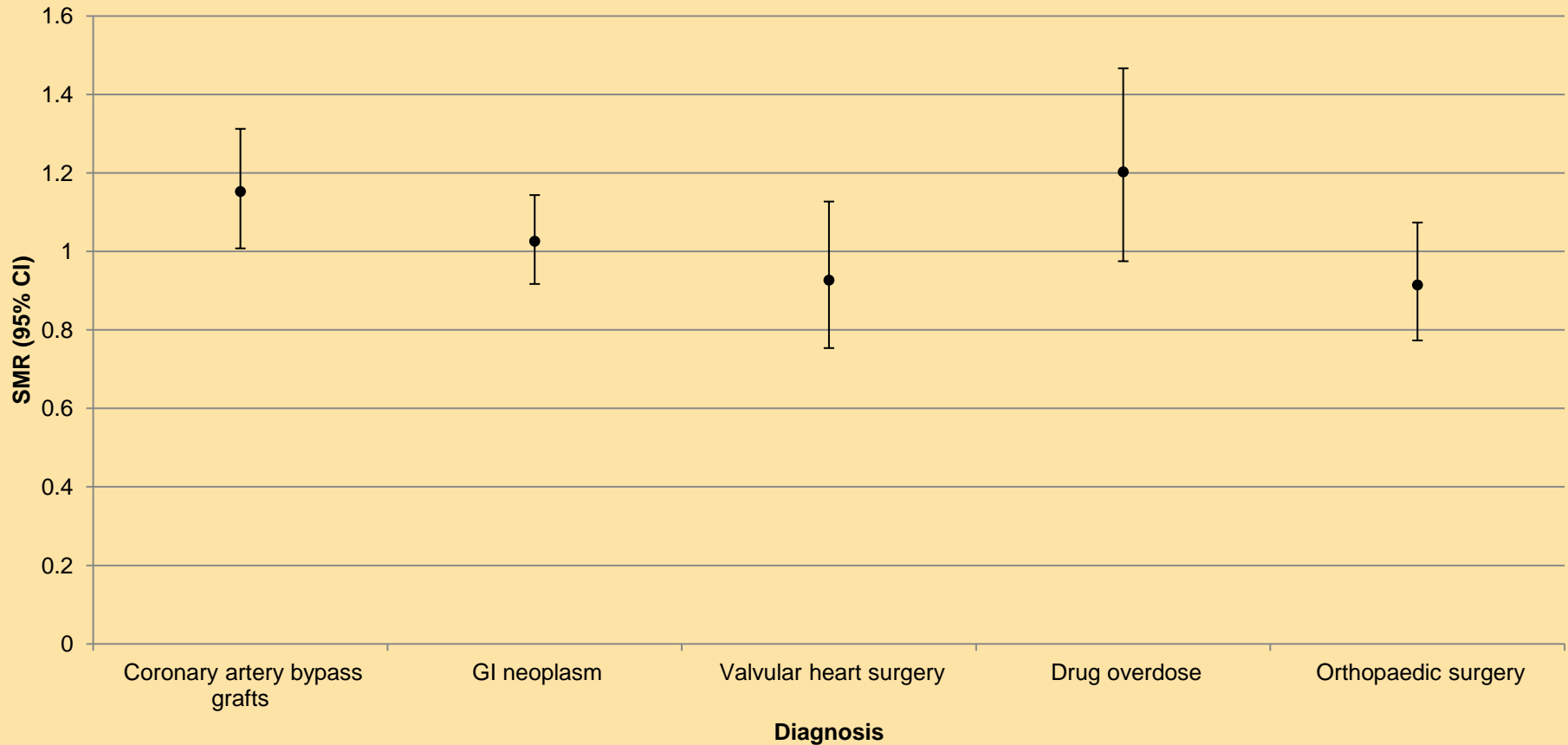
Performance of new model in Validation cohort – Diagnoses

Standardised Mortality Ratio in Top 5 Diagnostic groups



Performance of new model in Validation cohort – Diagnoses

Standardised Mortality Ratio in Top 5 Diagnostic groups



New model has

- Excellent discrimination
- Good calibration

Current priorities

- Write a paper about deficiencies of APACHE III-j and the need for a new model
- Develop and refine the algorithm to compute new predicted risk of death

Future priorities

- Write a paper on development and validation of the new model
- Assess clinical application

Thank you