RISK-STRATIFICATION AND OUTCOME ANALYSIS FOLLOWING CARDIAC SURGERY:

VALIDATION OF 'INTERNATIONAL' METHODOLOGY AND OUTCOME MONITORING

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Introduction

- Risk scores important in cardiac surgery

- Local/Operation Specific Risk scores important for 'local monitoring'

- For International 'benchmarking' need validated risk models that cross boundaries

- International 'benchmarking' important tool to compare outcomes and establish standards

Euroscore: 1999 (European System for Cardiac Operative Risk Evaluation)

- **128 Hospitals**
- **20,000 patients**
- **97 Risk Factors**

Euroscore : Logistic Component 2003

Predicted mortality = $e^{(\beta_0 + \sum \beta_i X_i)} / 1 + e^{(\beta_0 + \sum \beta_i X_i)}$

where

e is the natural logarithm = 2.718281828...

β_0 is the constant of the logistic regression equation = -4.789594

β_i is the coefficient of the variable X_i in the logistic regression equation provided in the table below.

$X_i = 1$ if a categorical risk factor is present and 0 if it is absent

For age, $X_i = 1$ if patient age < 60; X_i increase by one point per year thereafter;

hence for age 59 or less $X_i = 1$, age 60 $X_i = 2$, age 61 $X_i = 3$, and so on.

- Same 13 components

- More Accurate

Bayes Tables: United Kingdom Data

The simple (5-factor) CABG Bayes score

		r^I	n^I	p^{II}	odds^{IV}	LR^V	weight^{VI}
OVERALL		835	33,392	2.5%	0.026	NA	-36.63
Age	<56 years old	84	6,626	1.3%	0.013	0.501	-6.92
	56-60 years old	70	5,250	1.3%	0.014	0.527	-6.41
	61-65 years old	134	6,670	2.0%	0.021	0.799	-2.24
	66-70 years old	183	6,730	2.7%	0.028	1.090	0.86
	71-75 years old	195	4,952	3.9%	0.041	1.598	4.69
	>75 years old	153	2,325	6.6%	0.070	2.747	10.10
Body Surface Area	<1.7 m2	118	2,941	4.0%	0.042	1.630	4.88
	1.70-1.89 m2	201	6,979	2.9%	0.030	1.156	1.45
	1.90-2.39 m2	355	16,490	2.2%	0.022	0.858	-1.53
	>2.39 m2	39	2,284	1.7%	0.017	0.677	-3.90
Ejection fraction	Good EF	317	19,652	1.6%	0.016	0.639	-4.480
	Fair EF	248	8,410	2.9%	0.030	1.185	1.70
	Poor EF	185	2,044	9.1%	0.100	3.880	13.56
Priority	Elective	374	21,098	1.8%	0.018	0.704	-3.52
	Urgent	247	8,142	3.0%	0.031	1.220	1.99
	Emergency	126	914	13.8%	0.160	6.235	18.30
Prior op'ns	None	679	29,278	2.3%	0.024	0.926	-0.77
	One or more	87	1,335	6.5%	0.070	2.718	10.00

The complex (9-factor) CABG Bayes score

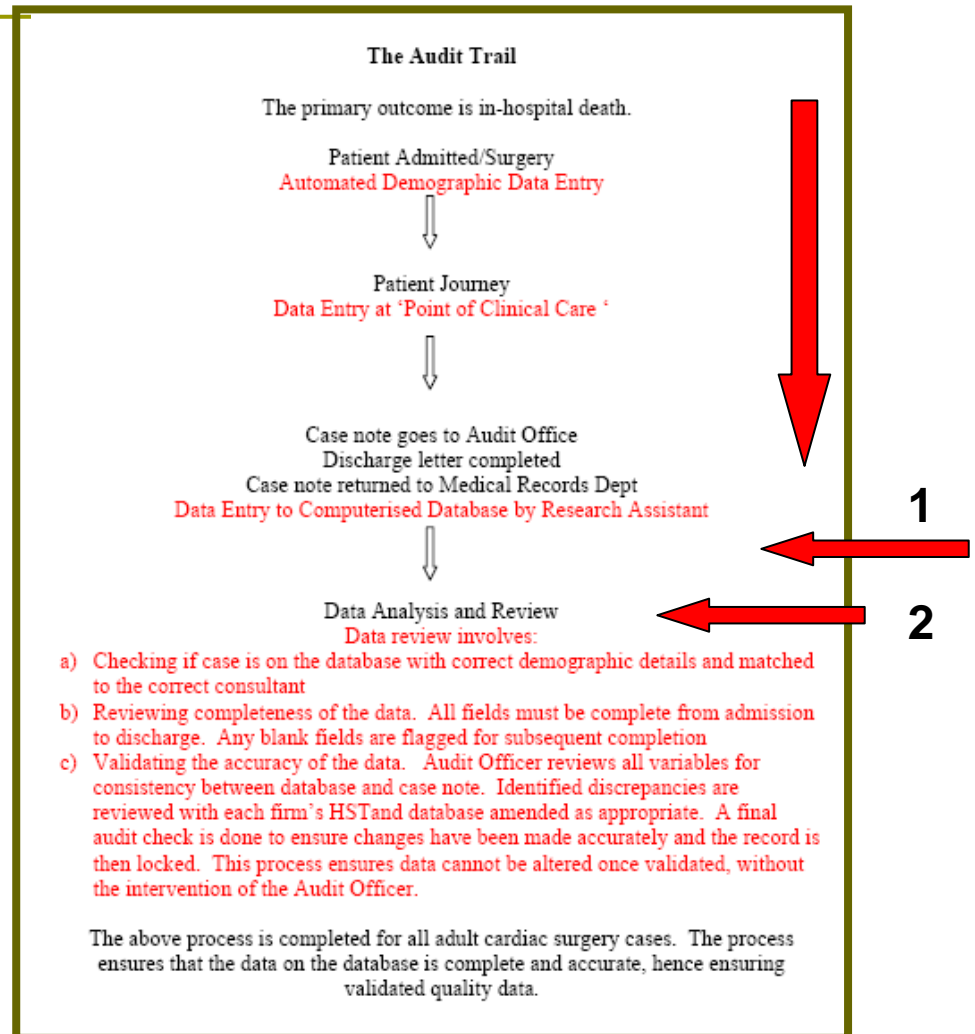|		r^I	n^I	p^{II}	odds^{IV}	LR^V	weight^{VI}
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	>2.39 m2	38	2,280	1.7%	0.017	0.661	-4.14
Diabetes	No	162	5,055	3.2%	0.033	1.291	2.55
	Yes	559	23,486	2.4%	0.024	0.951	-0.51
HT	No	310	14,776	2.1%	0.021	0.836	-1.80
	Yes	462	15,773	2.9%	0.030	1.177	1.63
LMS	No	418	19,431	2.2%	0.022	0.857	-1.54
	Yes	138	3,919	3.5%	0.036	1.423	3.53
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	Urgent	247	8,142	3.0%	0.031	1.220	1.99
	Emergency	126	914	13.8%	0.160	6.235	18.30
Renal disease	Dialysis	12	138	8.7%	0.095	3.713	13.12
	Elevated creatinine	85	1,071	7.9%	0.086	3.361	12.12
	None	463	21,778	2.1%	0.022	0.847	-1.66
Prior op'ns	None	679	29,278	2.3%	0.024	0.926	-0.77
	One or more	87	1,335	6.5%	0.070	2.718	10.00

Aim of Study: 1

- To test the applicability of these 3 commonly used predictive risk models in Hong Kong:

  - additive EuroSCORE,

  - logistic EuroSCORE,

  - complex Bayes score (CABG only)

Methods 1

- Nov 2005 to Jul 2009

- Data prospectively collected all patients (n= 1168) undergoing cardiac surgery

- Demographics, automatically generated risk scores, intra and post-operative variables recorded.

DATA COLLECTION: Principles

☐ Most accurate data collected at the 'point of clinical care'

☐ Professional responsibility of all groups who deliver care

The Audit Trail

The primary outcome is in-hospital death.

Patient Admitted/Surgery
Automated Demographic Data Entry

Patient Journey
Data Entry at 'Point of Clinical Care '

Case note goes to Audit Office
Discharge letter completed
Case note returned to Medical Records Dept
Data Entry to Computerised Database by Research Assistant

1

Data Analysis and Review
Data review involves:
2

a) Checking if case is on the database with correct demographic details and matched to the correct consultant
b) Reviewing completeness of the data. All fields must be complete from admission to discharge. Any blank fields are flagged for subsequent completion
c) Validating the accuracy of the data. Audit Officer reviews all variables for consistency between database and case note. Identified discrepancies are reviewed with each firm's HSTand database amended as appropriate. A final audit check is done to ensure changes have been made accurately and the record is then locked. This process ensures data cannot be altered once validated, without the intervention of the Audit Officer.

The above process is completed for all adult cardiac surgery cases. The process ensures that the data on the database is complete and accurate, hence ensuring validated quality data.

Automated Demographics and Risk Calculation (Dendrite system)

Methods 2

- The Applicability or Predictive Accuracy of the International Predictive Risk Models for our local population is assessed by Receiver Operating Characteristic (ROC) curve (% true positive vs % false positives) and Calibration plots.

Results
ROC curves: Validation of EuroScores in Hong Kong (n=1168)
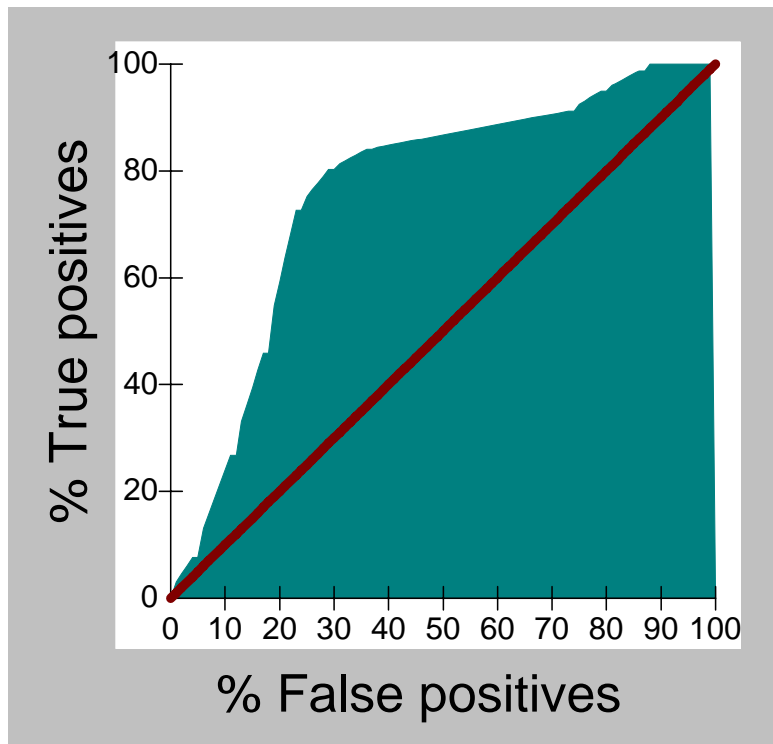
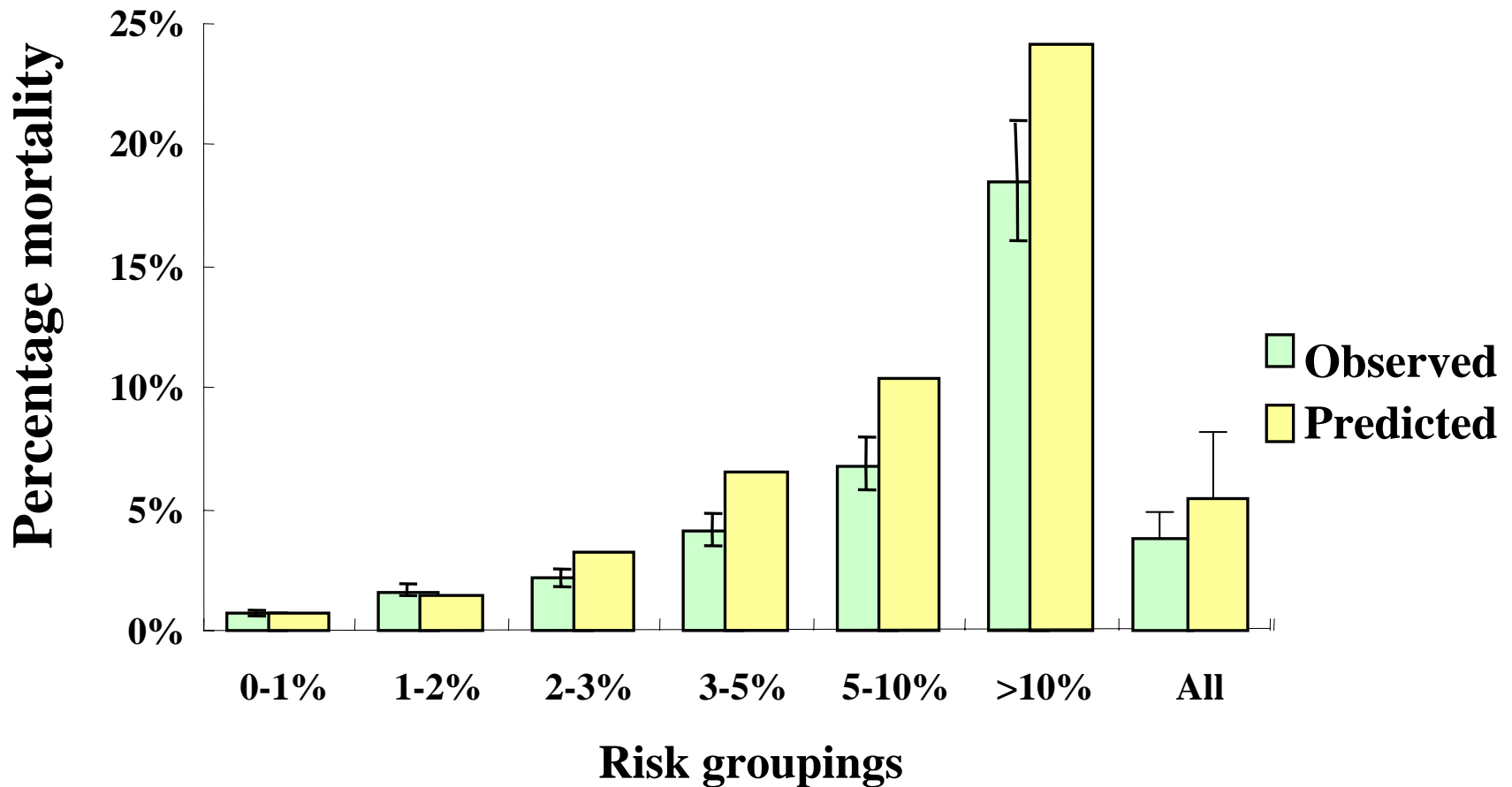- ☐ **Additive Euroscore** ROC Area 0.78
  - ■ Observed v. Predicted mortality:
  2% v. 4.2%

- ☐ **Logistic Euroscore** ROC Area 0.77
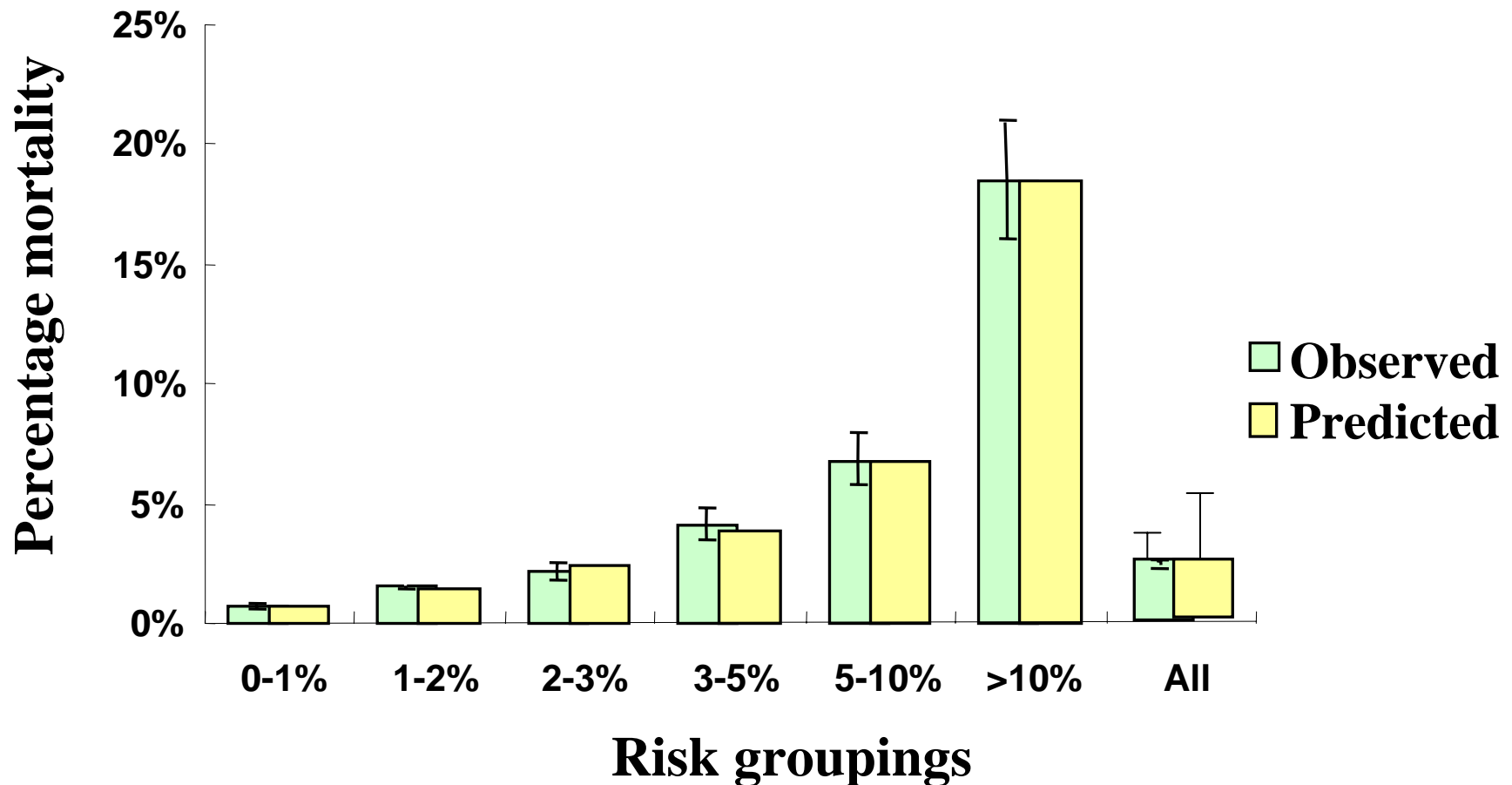 - ■ Observed v. Predicted mortality:
  2% v. 5.2%

Calibration plot: logistic Euroscore: all cases

Results
Calibration plot: Complex 9-factor Bayes score for isolated CABG (ROC 0.82)

Results:1

- International scores performed well in applicability and discriminatory capacity

Aim of Study: 2

- Compare local 'risk-adjusted' outcomes with international data

- International benchmarking

Benchmarking vs UK National Database

Pilot 'International Benchmarking' against National Database
UK National Database 400,000 records
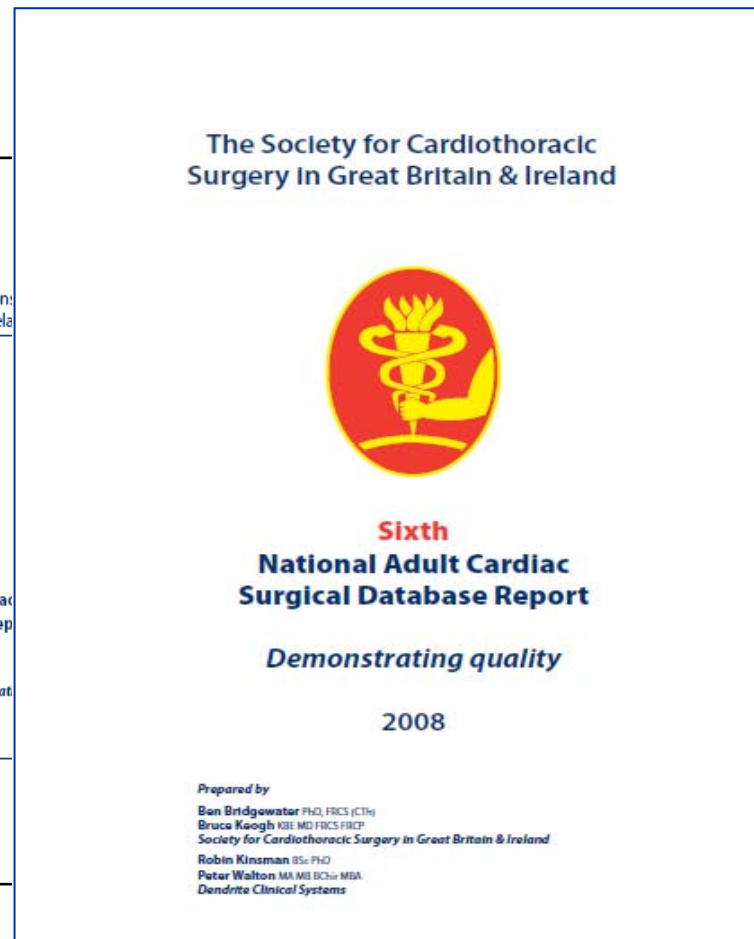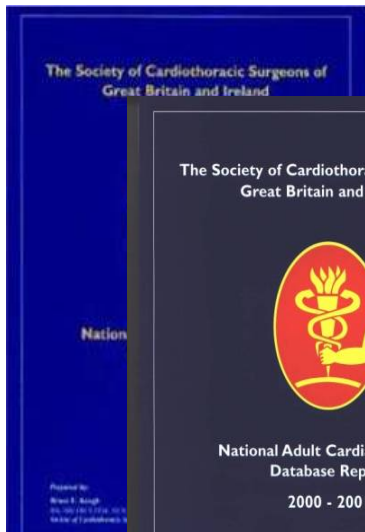
Methods 3: Independent Data Extraction

- Nov 2005 to Jul 2009
- Independent 'remote' data extraction
  - UK Society/Dendrite

- Independent analysis/benchmarking
  - UK Society/Dendrite

Table of contributing centres: United Kingdom and Ireland

City	Hospital	Year of contribution					Total cases
		2004	2005	2006	2007	2008	
Aberdeen	Royal Infirmary	●	●	●		●	2,
Basildon	Basildon Hospital					●	
Belfast	Royal Victoria Hospital	●	●	●	●		2,
Birmingham	Queen Elizabeth Hospital	●	●	●	●	●	4,
Blackpool	Victoria Hospital	●	●	●	●	●	4,
Brighton	Royal Sussex County Hospital	●	●	●	●	●	3,
Bristol	Royal Infirmary	●	●	●	●	●	6,
Cardiff	University Hospital of Wales	●	●	●	●	●	4,
Cork	University Hospital	●	●	●	●	●	2,
Coventry	Walsgrave Hospital	●	●	●	●	●	3,
Dublin	Mater Misericordiae Hospital		●	●	●	●	2,
Dublin	St James's Hospital	●	●	●	●	●	2,
Edinburgh	Royal Infirmary	●	●	●		●	3,
Glasgow	Golden Jubilee Hospital	●	●	●		●	1,
Glasgow	Royal Infirmary	●	●	●	●	●	2,
Glasgow	Western Infirmary	●	●	●	●	●	3,
Hull	Castle Hill Hospital	●	●	●	●	●	4,
Leeds	General Infirmary	●	●	●	●	●	5,
Leicester	Glenfield Hospital	●	●	●	●	●	5,
Liverpool	Cardiothoracic Centre	●	●	●	●	●	8,
London	Guy's & St Thomas's Hospitals	●	●	●	●	●	7,
London	Hammersmith Hospital	●	●	●	●		2,
London	Harefield Hospital	●	●	●	●	●	4,
London	Kings College Hospital	●	●	●	●	●	3,
London	The Heart Hospital	●	●	●	●	●	5,
London	Royal Brompton Hospital	●	●	●	●	●	4,
London	Barts & the London	●	●	●	●	●	8,
London	St George's Hospital	●	●	●	●	●	5,
London	St Mary's Hospital				●	●	
London	Wellington Hospital	●	●	●	●	●	1,
North Cheam	St Anthony's Hospital			●	●	●	
Manchester	Royal Infirmary	●	●	●	●	●	4,
Manchester	Wythenshawe Hospital	●	●	●	●	●	5,
Middlesbrough	James Cook University Hospital	●	●	●	●	●	5,656
Newcastle	Freeman Hospital	●	●	●	●	●	5,199
Nottingham	City Hospital	●	●	●	●	●	3,295
Oxford	John Radcliffe Hospital	●	●	●	●	●	4,570
Papworth	Papworth Hospital	●	●	●	●	●	8,862
Plymouth	Derriford Hospital	●	●	●	●	●	5,218
Sheffield	Northern General Hospital	●	●	●	●	●	5,437
Southampton	Southampton General Hospital	●	●	●	●	●	4,289
Stoke-on-Trent	N Staffordshire Royal Infirmary	●	●	●	●	●	4,833
Swansea	Morriston Hospital	●	●	●	●	●	3,822
Wolverhampton	New Cross Hospital		●	●	●	●	2,994
Totals		**39**	**41**	**42**	**40**	**42**	**184,754**

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19/03/2009

Table of contributing centres: Private and overseas hospitals

Group / Country	Hospital	Year of contribution					Total cases
		2004	2005	2006	2007	2008	
Galway Clinic	1 hospital		●	●	●	●	103
HCA International	2 hospitals	●	●	●	●	●	2,566
Spire	1 hospital				●	●	867
St Anthony's Hospital	1 hospital			●	●	●	340
Wellington Hospital	1 hospital	●	●	●	●	●	1607
Hong Kong	Prince of Wales Hospital			●	●	●	729
Totals		3	4	6	7	7	6,212

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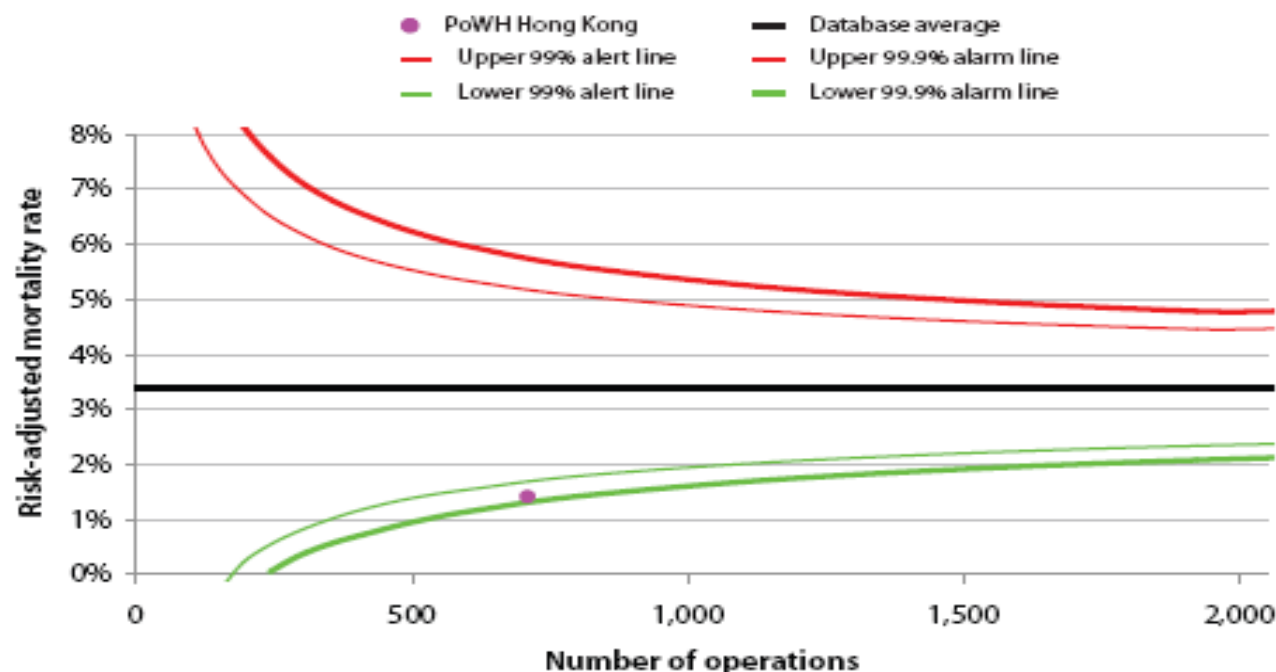# Sixth National Adult Cardiac Surgical Database Report

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Appendices

Funnel plots

We have benchmarked outcomes for all surgery, CABG and isolated AVR surgery against the contemporary recalibrated logistic *EuroSCORE*, as described in appendix **. For simplicity we have simply used 0.5 of the logistic *EuroSCORE* for the *all surgery* comparison. We have used the exact calibration factors of 0.44 and 0.34 respectively for AVR surgery and CABG.

Outcomes at the Prince of Wales Hospital fall comfortably within the control limits for all operative groups, showing satisfactory quality.

All opertions: Risk-adjusted funnel plot on mortality by hospital; risk defined as 50% logistic *EuroSCORE*; financial years 2006-2008

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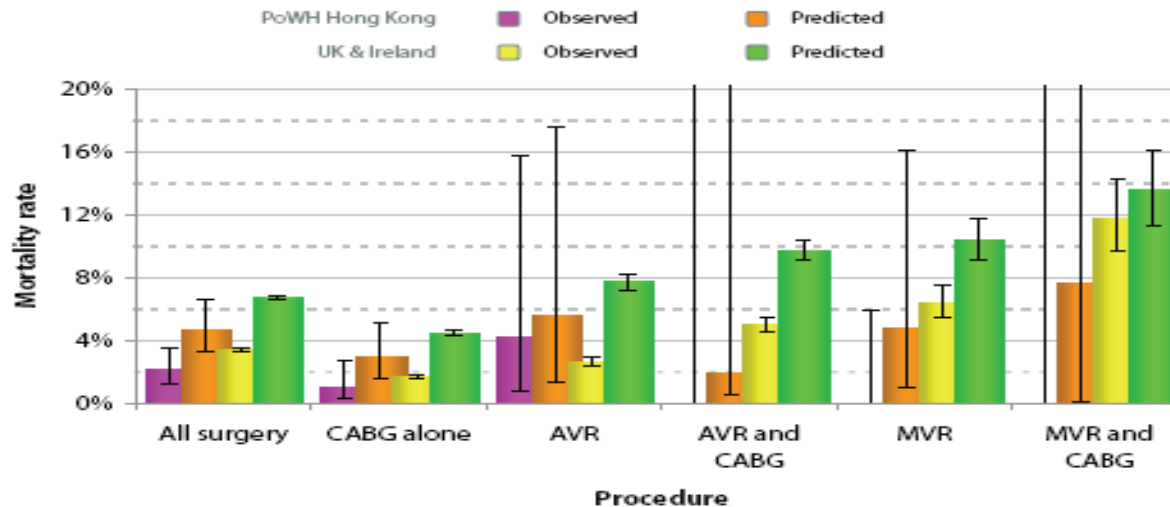**Draft print date:** 02 Apr 2009 02:00 PM

Mortality

There are no significant differences in either observed or predicted mortality (by logistic *EuroSCORE*) between practice in Hong Kong and that in Great Britain and Ireland, for any operative group.

Mortality and procedure for the financial years 2006-2008

		Mortality data					
		Hong Kong			United Kingdom		
		Count	Observed rate	Predicted rate [i]	Count	Observed rate	Predicted rate [i]
Procedure group	CABG alone	404	1.0	2.9	65,396	4.5	4.5.
	AVR	47	4.3	5.6	11,439	7.7	7.7
	AVR and CABG	8	0.0	1.9	8,381	9.7	9.7
	MVR	49	0.0	4.8	2,132	10.3	10.3
	MVR and CABG	5	0.0	7.7	815	13.6	13.6
	All surgery	709	2.1	4.7	110,987	6.7	6.7

i   Predicted as per the logistic *EuroSCORE*

A comparison of observed and predicted, procedure-specific mortality rates in Hong Kong and the UK & Ireland; financial years 2006-2008

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Other post-operative outcomes

In general the other post-operative outcomes seen at the Prince of Wales Hospital are excellent, with a lower incidence of all complications than in the remainder of the SCTS database.

Other post-operative outcomes; the upper numbers represent the crude percentage mortality rate and the lower numbers the count within the sub-group ; financial years 2006-2008

		Outcome					
		Re-operation for bleeding		New post-operative stroke		New post-operative HF / dialysis	
		PoWH HK	UK & I	PoWH HK	UK & I	PoWH HK	UK & I
Operation group	CABG alone	1.5 402	3.3 56,057	1.0 396	1.1 57,632	0.3 400	2.6 56,683
	AVR alone	0.0 47	5.5 9,683	2.1 47	1.7 10,234	0.0 47	3.1 9,970
	AVR & CABG	0.0 8	6.9 7,101	0.0 8	2.7 7,405	0.0 8	5.8 7,187
	MV repair alone	0.0 9	3.8 1,905	0.0 9	1.3 1,942	0.0 9	2.1 1,866
	MVR repair & CABG	33.3 3	6.0 1,141	0.0 2	2.5 1,190	0.0 3	9.0 1,135
	MVR alone	4.2 48	5.3 1,786	0.0 46	2.8 1,875	0.0 49	6.5 1,827
	MVR & CABG	0.0 5	8.5 692	20.0 5	3.7 721	0.0 5	12.2 711
	All	1.9 700	4.7 94,636	1.5 688	1.7 97,170	0.4 690	3.9 95,153

Summary

This analysis describes methodology that will enable any organisation, or group of organisations, in the world to compare their outcomes against a comprehensive national dataset derived from complete coverage of all operations in NHS hospitals in the United Kingdom. There are systematic differences in case-mix between the Prince of Wales Hospital in Hong Kong and the pooled United Kingdom data, but on both crude and risk-adjusted mortality the outcomes are in line with United Kingdom standards, as are the complication rates. These data should provide reassurance for patients, clinicians, managers and commissioners of services at the Prince of Wales Hospital that the cardiac surgery programme is safe, and that the unit is actively looking to monitor and improve its standards.

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in Great Britain & Ireland

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Dendrite Clinical Systems

Conclusion:1

- Using prospective data collection and an automated analysis system, validation of 'internationally' recognized risk-scoring systems for the local population was performed.

- 'International' benchmarking of outcomes using a recognized National Database was achieved
  - Reassurance of standards

Conclusion: 2

- Ability to ensure performance conforms to internationally published and risk-adjusted standards.

- Move towards 'local' and 'international' real-time monitoring of outcomes and quality accounts.

The End