Risk Stratification and Outcome Analysis Following Cardiac Surgery: Validation of scoring systems and implications for quality assurance

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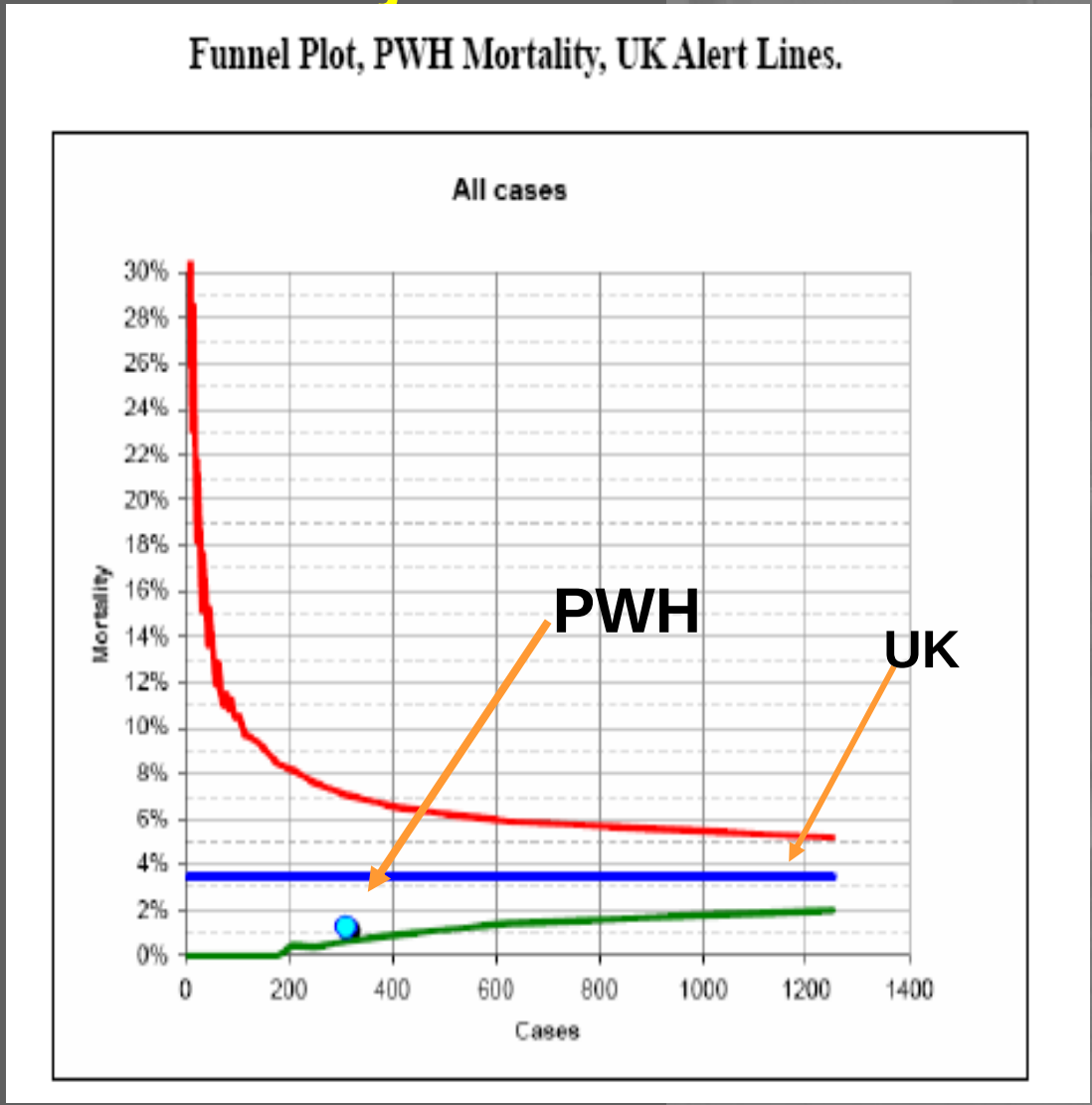
Ideal Surgical Practice

- Accurate reporting of morbidity and mortality
- Validated local risk-stratification models
- Ability to compare outcome with international standards
- Qualities assurance program

Patient Outcomes: Non-Risk Adjusted



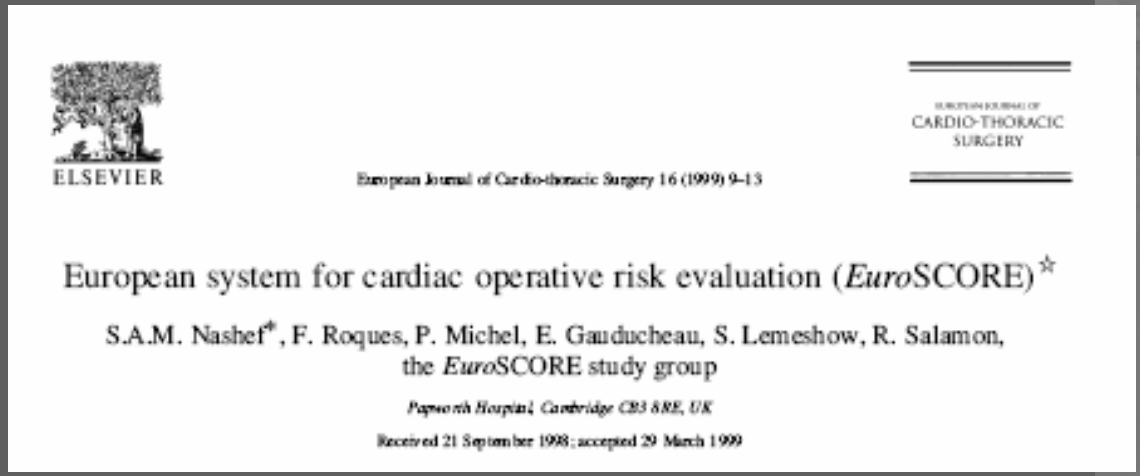
What is ‘Risk Stratification’ ?

- **Risk Stratification** is a method of predicting outcomes based upon severity of illness and co-morbidity of the patient population

How : ‘Risk Stratification (Scoring)’ ?

- Define Quantifiable Variables in Subset
  - Age, LV Function
- Determine Contribution to ‘Risk’ Event
  - Death
- Assess Effect of Combinations of Variables
  - Additive and Logistic
- Generate “Predictive Score”
  - ‘probability’ not ‘certainty’

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



ELSEVIER

European Journal of Cardio-thoracic Surgery 16 (1999) 9–13

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

European system for cardiac operative risk evaluation (*Euro*SCORE)☆

S.A.M. Nashef*, F. Roques, P. Michel, E. Gauducheau, S. Lemeshow, R. Salamon, the *Euro*SCORE study group

Papworth Hospital, Cambridge CB3 8RE, UK

Received 21 September 1998; accepted 29 March 1999

128 Hospitals

20,000 patients

97 Risk Factors

EuroSCORE

- Additive
  - 13 clinical factors
- Logistic
  - Same 13 clinical factors
  - ? More Accurate

Predicted mortality = $e^{(\beta o + \Sigma \beta i\ Xi)} / 1 + e^{(\beta o + \Sigma \beta i\ Xi)}$

where

e is the natural logarithm = 2.718281828...

βo is the constant of the logistic regression equation = **-4.789594**

βi is the coefficient of the variable **Xi** in the logistic regression equation provided in the table below.

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

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

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

Bayes Tables: United Kingdom Data

The simple (5-factor) CABG Bayes score

		r[i]	n[ii]	p[iii]	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
Body Surface Area	>75 years old	153	2,325	6.6%	0.070	2.747	10.10
	<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[ii]	p[iii]	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
Body Surface Area	>75 years old	153	2,325	6.6%	0.070	2.747	10.10
	<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	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
Ejection fraction	Good	317	19,652	1.6%	0.016	0.639	-4.47
	Fair	248	8,410	2.9%	0.030	1.185	1.70
	Poor	185	2,044	9.1%	0.100	3.880	13.56
Priority	Elective	374	21,098	1.8%	0.018	0.704	-3.51
	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

- To validate internationally recognized risk-scoring systems :
  - EuroSCORE
    - Additive
    - Logistic
  - Complex Bayes

  for the local population undergoing cardiac surgery in PWH

To allow continuous quality assurance

Validating Scoring System

- Study of all cardiac surgical patients in consecutive 24 months
- Data entered into commercially available computerized system
- Allow ‘Real-time’ data access and automatic data transfer to *analysis module*
- Audit trail for data collection and validation

Cardiac Surgical Database
Prince of Wales Hospital, Chinese University of Hong Kong
Version 1.0; page 1

Demographics

Hospital number	
Date of birth	dd / mm / yyyy
Gender	○ Male ○ Female

Initial database entry

Admission details

Referring hospital	○ PWH ○ NDH ○ TMH ○ AHNH ○ Others
Referring cardiologist	select from table
Date of referral	dd / mm / yyyy
Date of outpatient clinic	dd / mm / yyyy
Date of admission	dd / mm / yyyy
Date of operation	dd / mm / yyyy
Admission category	○ HA ○ Private
Mode of admission	○ Elective ○ Planned inpatient transfer ○ Emergency
Angina status pre-surgery	○ No angina ○ No limitation of physical activity ○ Slight limitation of ordinary activity ○ Marked limitation of ordinary physical activity ○ Symptoms at rest or minimal activity
Dyspnoea status pre-surgery	○ No limitation of physical activity ○ Slight limitation of ordinary activity ○ Marked limitation of ordinary physical activity ○ Symptoms at rest or minimal activity
Congestive cardiac failure	○ Never ○ In past ○ Now
Symptom status	○ Stable ○ Unstable / recent deter'n
Number of previous MIs	○ None ○ One ○ Two or more ○ Unknown
Interval between surgery and last MI	○ MI <6 hours ○ MI 6-24 hours ○ MI 1-30 days ○ MI 31-90 days ○ MI >90 days

Logistic Euroscore : Calculator

Patient-related factors			Cardiac-related factors		
Age (years)	0	0	Unstable angina[6]	No	0
Gender	Select	0	LV function	Select	0
Chronic pulmonary disease[1]	No	0	Recent MI[7]	No	0
Extracardiac arteriopathy[2]	No	0	Pulmonary hypertension[8]	No	0
Neurological dysfunction[3]	No	0	**Operation-related factors**		
Previous Cardiac Surgery	No	0	Emergency[9]	No	0
Creatinine > 200 µmol/L	No	0	Other than isolated CABG	No	0
Active endocarditis[4]	No	0	Surgery on thoracic aorta	No	0
Critical preoperative state[5]	No	0	Post infarct septal rupture	No	0
Logistic *Euro*SCORE	0				
Note: Logistic is now default calculator	Calculate	Clear			

Validating Scoring System

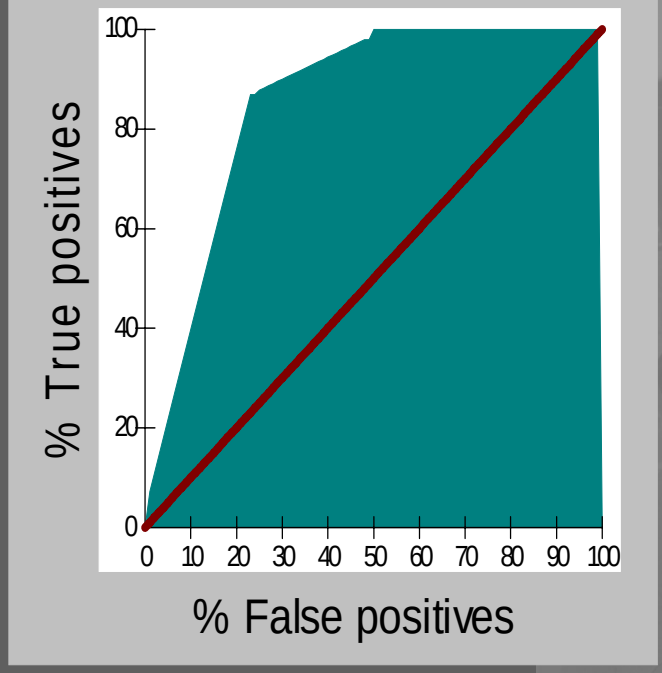
- Data from 612 patients was entered
- Allow calculation of
  - *Additive* and *logistic* EuroSCORE
  - Complex Bayes
- Predictive accuracy for local population was assessed using Receiver Operating Characteristic Curve

Direct Comparison of Risk Scoring Systems: *Testing*

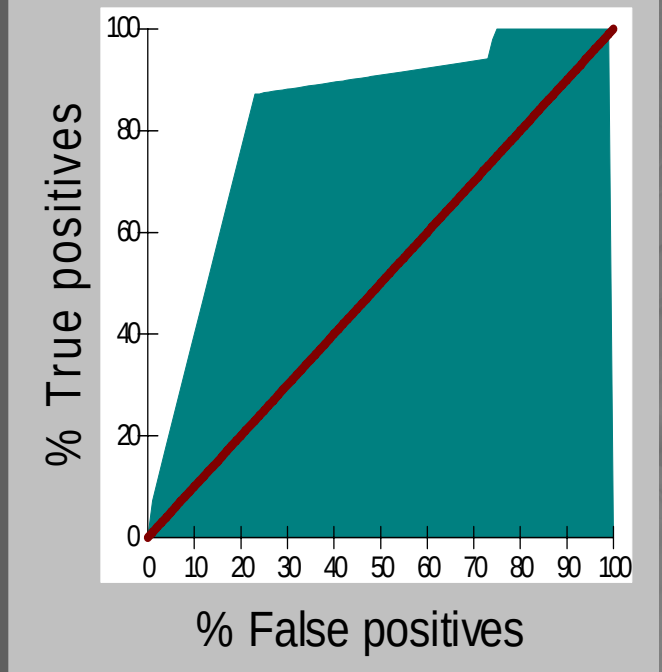
- Receiver Operating Characteristic (ROC) Curves
  - Area represents probability that risk predictor accurately discriminates between death and survival
  - Area of 1 = Perfect Discrimination
  - Area <0.5 = No Discrimination
  - Area >0.7 = Validity in Predictive Accuracy

EuroSCORE

Additive:
0.834

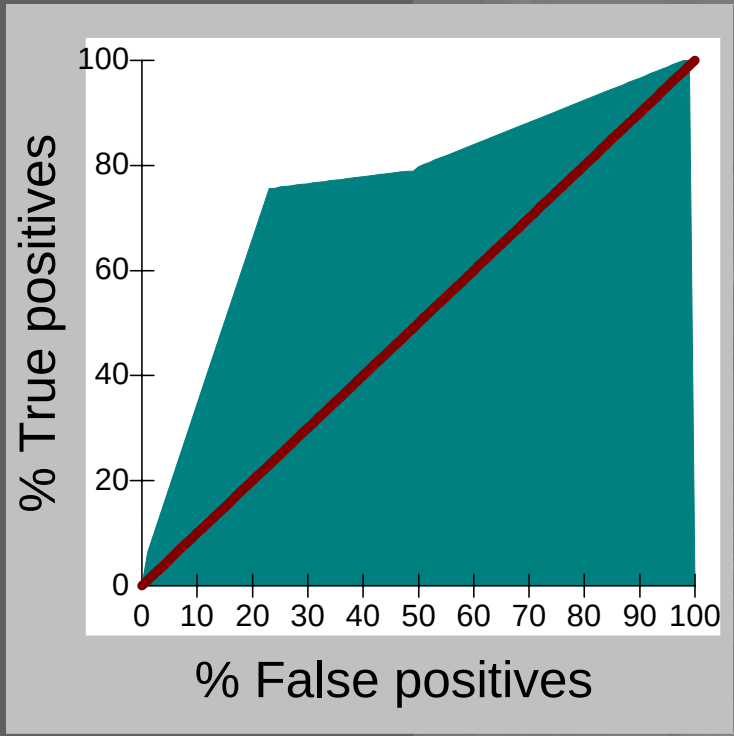


Logistic:
0.805



Complex Bayes:

0.775



Performance Trends Over Time

Risk Adjusted Trends

- Risk-Adjusted *CUSUM* (cumulative events over time)
- Variable Life Adjusted Display Charts (*VLAD)*

$$\frac{\delta_p}{(1-\delta_p)}$$

Initially two hypotheses must be set: the first is H_O, which is the outcome rate that we wish to test. Thi could be set to the level of current practice. The second, alternative hypothesis, H_A defines the deviatio from H_O to be detected. Either increases in the outcome rate or decreases in the outcome rate may b detected; a doubling in the outcome rate would set, a halving in the outcome rate or any other suitabl differences may be chosen. There is an odds ratio associated with each of these hypotheses; the odds ratio associated with H_O is denoted OR_O, and the odds ration associated with H_A is OR_A. Using our previou notation:

$$OR_O = \frac{\delta_O}{\delta_O} \text{ and } OR_A = \frac{\delta_A}{\delta_O}$$

where

δ_O is the probability of the adverse outcome under H_O

δ_A is the probability of the adverse outcome under H_A

If H_A is set such that a doubling in the rate is to be examined, δ_A is clearly 2; if H_A is intended to look for halving in the rate, δ_A is 0.5. The method repeatedly tests H_O against H_A. Under H_O the odds on an adverse outcome for an individual patient, O_{pO} are:

$$O_{pO} = \frac{OR_O \cdot \delta_p}{(1-\delta_p)}$$

The corresponding probability of an adverse outcome for this same patient is:

$$\delta_{pO} = \frac{OR_O \cdot \delta_p}{\left[1-\delta_p + (OR_O \cdot \delta_p)\right]}$$

Under H_A the odds on an adverse outcome for an individual patient, O_{pA} are:

$$O_{pA} = \frac{OR_A \cdot \delta_p}{(1-\delta_p)}$$

And, the corresponding probability of an adverse outcome for this same patient is:

$$\delta_{pA} = \frac{OR_A \cdot \delta_p}{\left[1-\delta_p + (OR_A \cdot \delta_p)\right]}$$

Performance Trends Over Time

- Risk-Adjusted Outcome Trend

Plotting cumulative risk

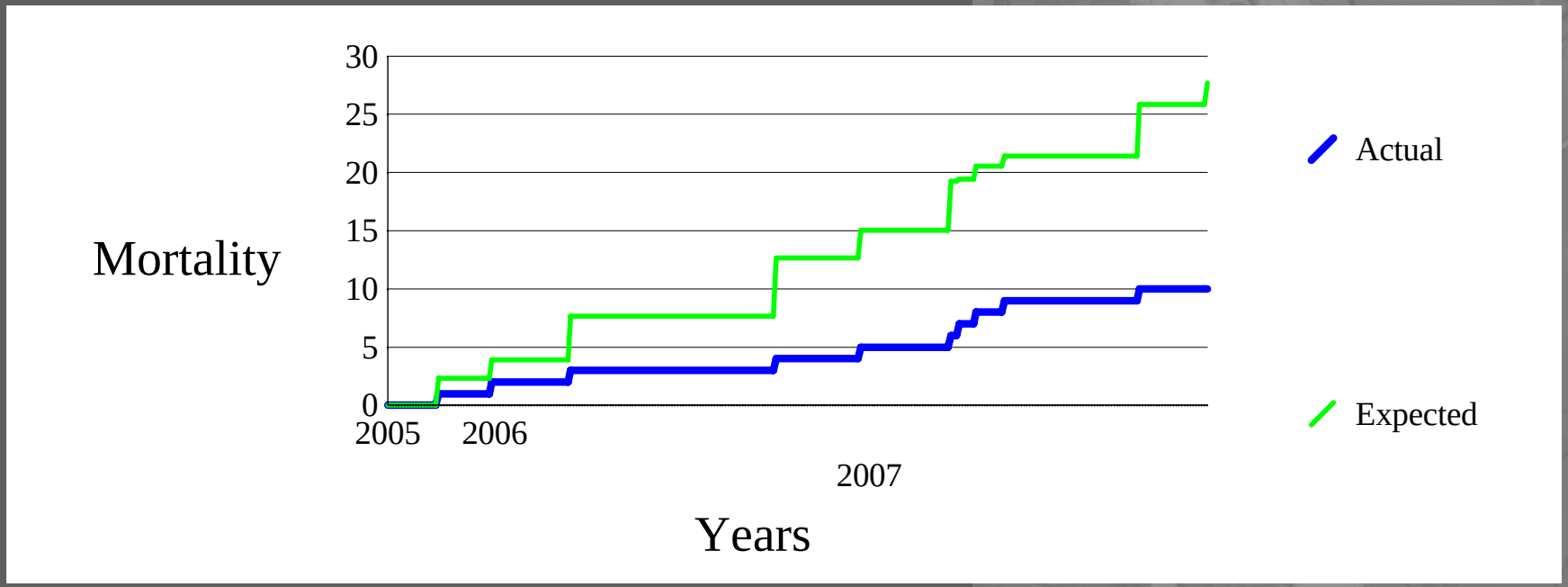
This plot always has an upward trend and illustrates the cumulative risk over the operative sequence. Application and extension of this method can be used to calculate the cumulative risk associated with any group of patients using any suitable risk score. The following equation describes this approach:

$$\rho_n = \sum_{p=1}^{p=n} \delta_p$$

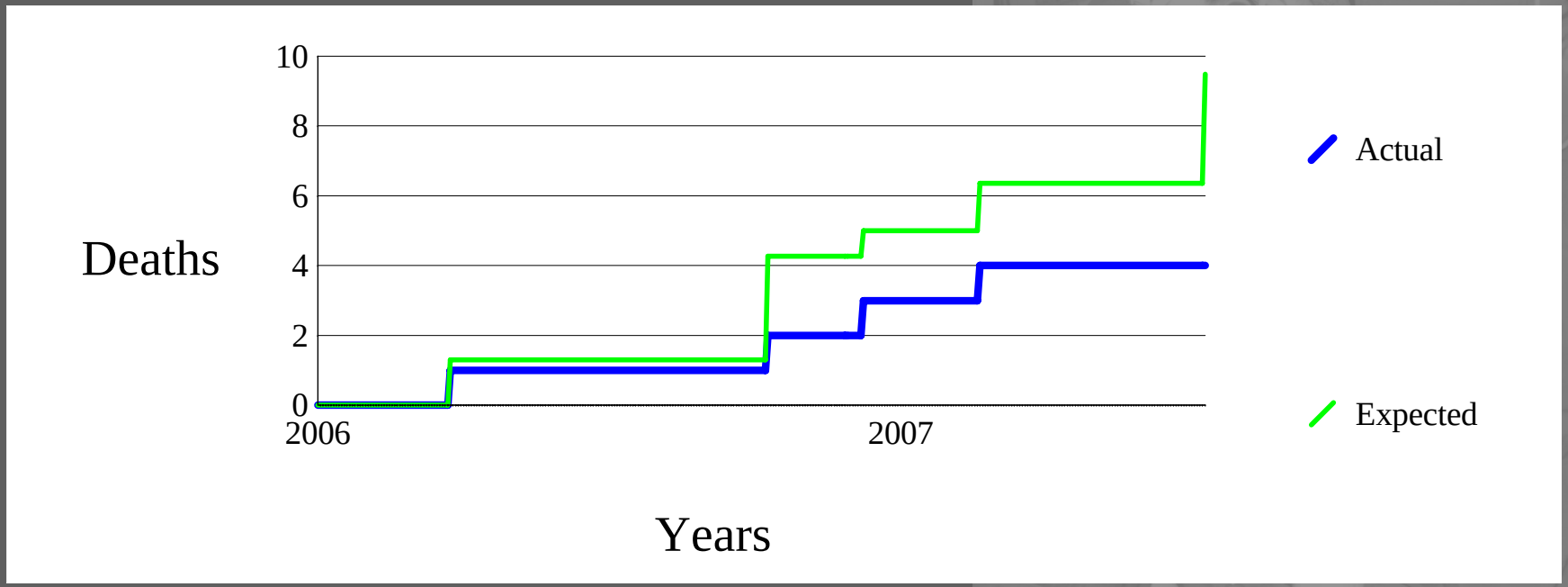
where

p	is the number of operations in the sequence
δ_p	is the predicted outcome rate for the patient at operation number p
ρ_n	is the cumulative risk when the operative sequence is n

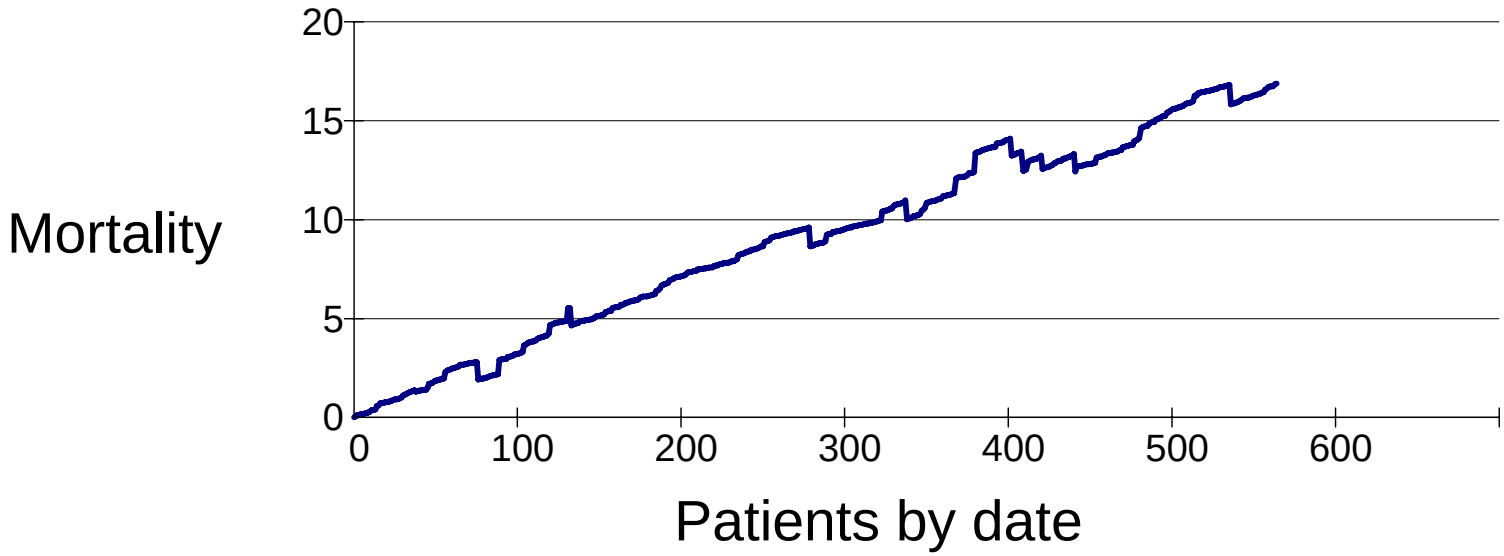
RA-CUSUM 2005-2007
Logistic EuroSCORE: 612pts



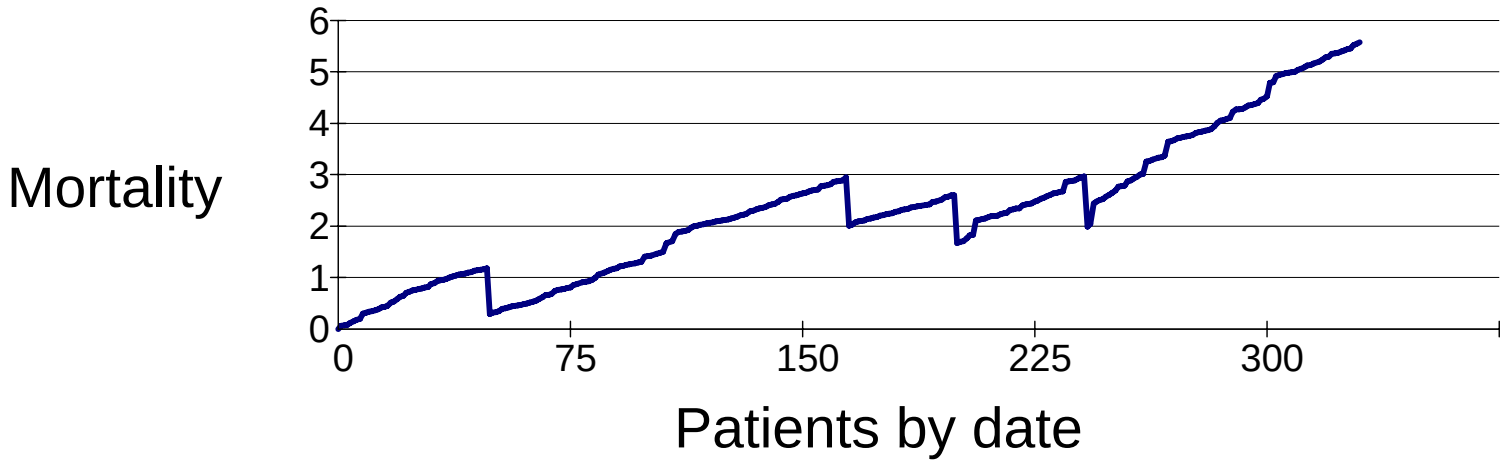
RA-CUSUM for Isolated CABG Complex Bayes



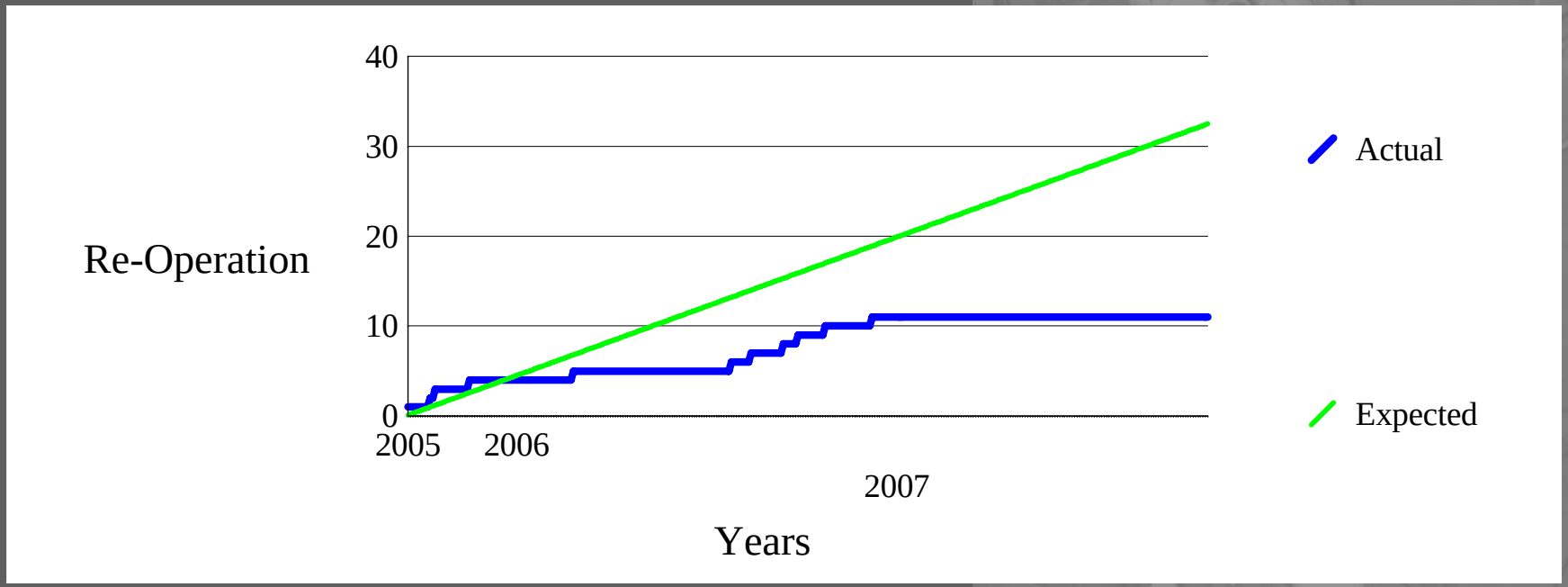
RA-Trends 2005-2007
Logistic EuroSCORE



RA-Trends CABG 2 years Logistic EuroSCORE



Re-operation for bleeding vs 5%



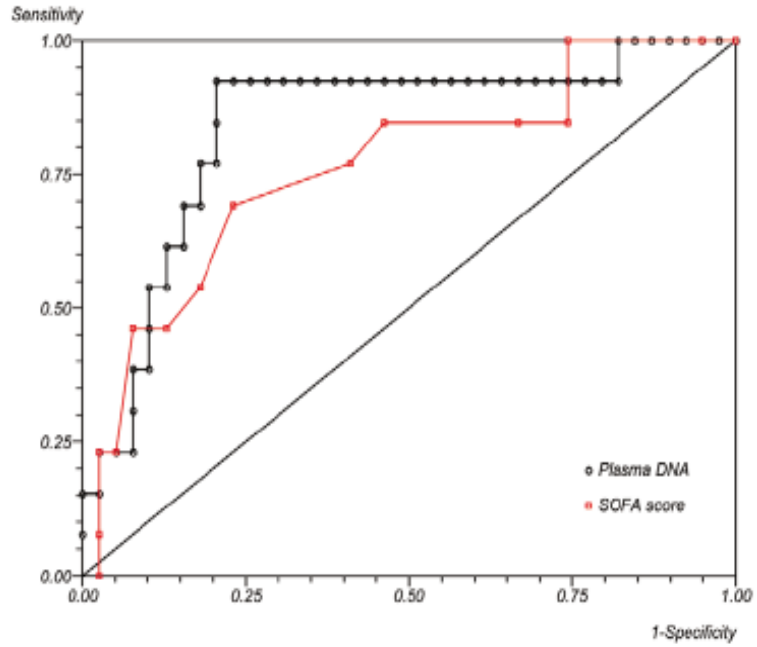
Research

Open Access

Plasma DNA concentration as a predictor of mortality and sepsis in critically ill patients

Andrew Rhodes[1], Stephen J Wort[1], Helen Thomas[2], Paul Collinson[2] and E David Bennett[1]

Figure 2



Receiver operating characteristic curves for plasma DNA and the Sepsis-related Organ Failure Assessment (SOFA) score to predict intensive care outcome. The area under the curve for plasma DNA is 0.84 (95% confidence interval, 0.71–0.97) and that for the SOFA score is 0.76 (95% confidence interval, 0.61–0.92).

- Addition of 'genetic' predictors of outcome following complications

Association Between the TNF-2 Allele and a Better Survival in Cardiogenic Shock*

Olivier Appoloni, MD; Etienne Dupont, MD, PhD; Marleen Vandercruys, RT; Marc Andrien, BS; Jean Duchateau, MD, PhD; and Jean-Louis Vincent, MD, PhD, FCCP

Conclusion

- We have validated the discriminatory ability of internationally recognized scoring systems in cardiac surgical patients in HK population

Conclusion

- Continuous “Real-time” monitoring in risk-adjusted manner
- Quality assurance program to monitor outcomes with internationally published standards

Special Thanks to:

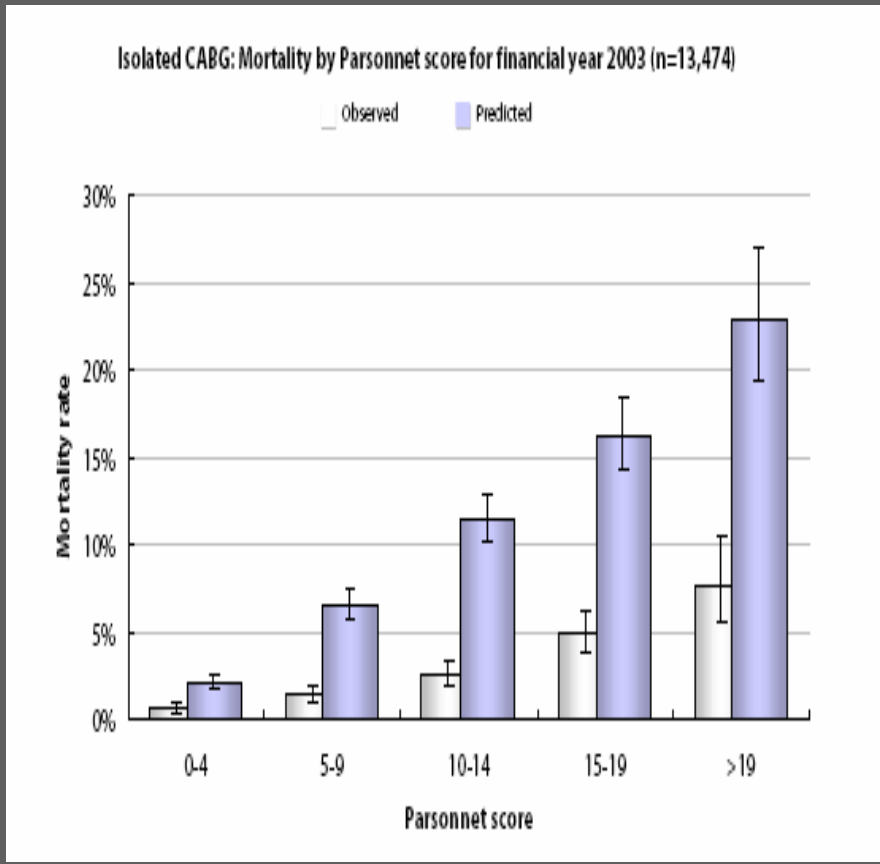
- Professor MJ Underwood and Cardiac surgical team colleagues
- Cardiac Anaesthetists
- Perfusionists
- Dedicated Ward Nurses
- Research Assistants

Parsonnet: Circulation 1989

	Factor	Definition	Score
Patient-related factors	Gender	Female	1
	Morbid obesity	Body Mass Index >35	3
	Diabetes	Any history of diabetes regardless of duration or treatment. Latent diabetes of pregnancy excluded	3
	Hypertension	A history of blood pressure greater than 140/90mmHg on two occasions, or lower if on medication	3
	LV dysfunction	Good (50%)	0
		Fair (30-49%)	2
		Poor (<30%)	4
	Age	70-74 years old	7
		75-79 years old	12
		> 80 years old	20
	Re-operation	Second operation	5
		Third (or more)	10
	Intra aortic balloon pump	Prior to surgery. Do NOT include IABP's inserted prophylactically just prior to surgery because these represent post-operative support.	2
	Left ventricular aneurysm	Aneurysmectomy	5
	Recently failed intervention	Within 24 hours of operation	10
		>24 hours; operation on same admission	5
	Renal	Dialysis dependency	10
	Catastrophic states	*e.g.* s acute structural defect, cardiogenic shock, acute renal failure	10-50
	Other rare circumstances	*e.g.* s paraplegia, pacemaker dependency, congenital heart disease in adults, severe asthma	2-10
Surgery-related factors	Mitral valve surgery	Systolic PA pressure <60 mmHg	5
		Systolic PA pressure ≥60 mmHg	8
	Aortic valve surgery	AV pressure gradient ≤120 mmHg	5
		AV pressure gradient >120 mmHg	7
	CABG at the time of valve surgery		2

Score	Mortality%
0-4	1
5-9	5
10-14	9
15-19	17
>19	31

Parsonnet Score



- Outdated (1985)
- 16 Variables
- Use of Subjective Indices
- Poor prediction in ‘High Risk’
- ‘Over-Predicts’ for Today’s Population

Validation of the EuroSCORE model in Australia☆

Cheng-Hon Yap[a,1,*], Christopher Reid[b,1], Michael Yii[a,1], Michael A. Rowland[c,1], Morteza Mohajeri[d,1], Peter D. Skillington[e,1], Siven Seevanayagam[f,1], Julian A. Smith[g,1]

[a] Department of Cardiothoracic Surgery, St Vincent's Hospital Melbourne, Melbourne, Australia
[b] Baker Heart Research Institute and CCRE Therapeutics, Monash University, Melbourne, Australia
[c] The Alfred Hospital, Melbourne, Australia
[d] The Geelong Hospital, Melbourne, Australia
[e] Royal Melbourne Hospital, Melbourne, Australia
[f] The Austin Hospital, Melbourne, Australia
[g] Monash Medical Centre, Melbourne, Australia

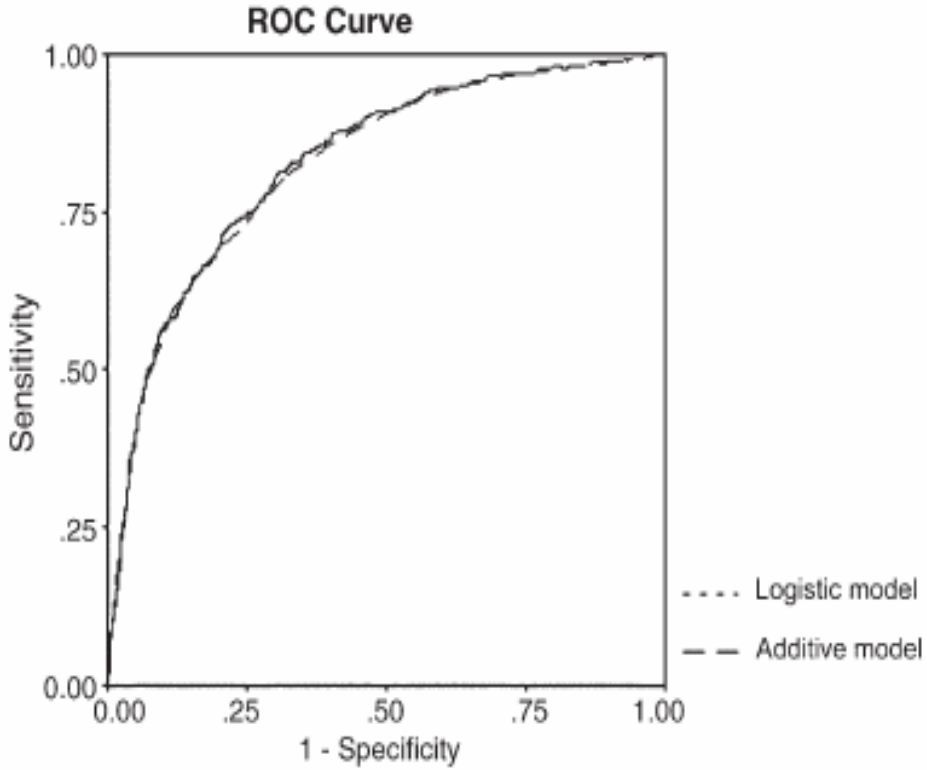
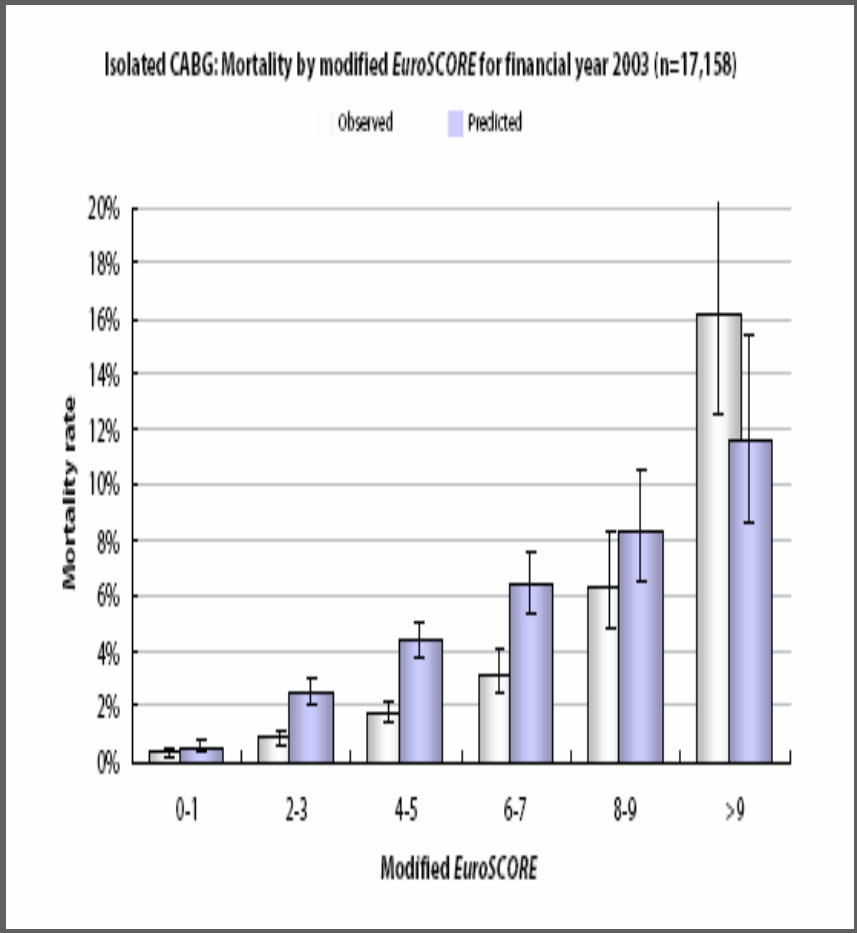


Fig. 1. Receiver operating characteristic (ROC) curves. Area under the curve is 0.83 for the additive and logistic EuroSCORE models when applied to the entire study cohort.

Euroscore: Additive



- Simple additive risk scoring
- 13 clinical factors
- More accurate than Parsonnet
- Least accurate for ‘High Risk’ Groups

Euroscore : Logistic Component

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

where

e is the natural logarithm = 2.718281828...

β_o 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
  - High Risk Groups
- Over-Predicts Risk in This Group

Comparison of 19 pre-operative risk stratification models in open-heart surgery

Johan Nilsson[1*], Lars Algotsson[2], Peter Höglund[3], Carsten Lührs[1], and Johan Brandt[1]

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[2] Department of Cardiothoracic Anesthesiology, Heart and Lung Centre, Lund University Hospital, Lund, Sweden; and
[3] Competence Centre for Clinical Research, Lund University Hospital, Lund, Sweden

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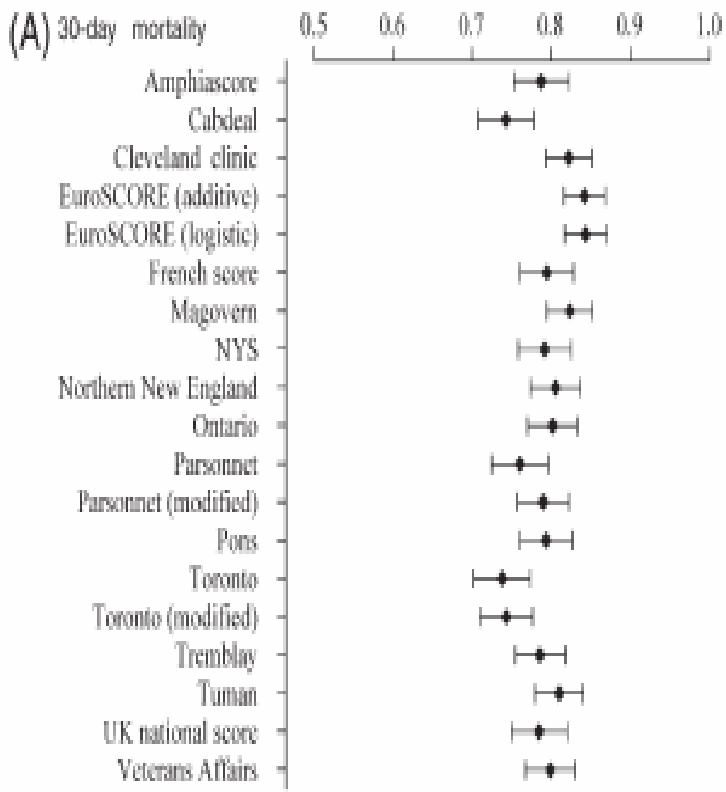
Table 1 Synopsis of original data of 19 risk score algorithms

	Region	Year of data collection	Year of publication	Number of patients (centers)	Risk variables	ROC area
Amphiascore[23]	Netherlands	1997–2001	2003	7282 (1)	8	0.84
Cabdeal[a,24]	Finland	1990–1991	1996	386 (1)	7	0.71
Cleveland clinic[25]	USA	1986–1988	1992	5051 (1)	13	N/A
EuroSCORE (add.)[26]	Europe	1995	1999	13 302 (128)	17	0.79
EuroSCORE (log.)[27]	Europe	1995	2003	13 302 (128)	17	0.79
French score[28]	France	1993	1995	7181 (42)	13	0.75
Magovern[a,29]	USA	1991–1992	1996	1567 (1)	18	0.86
NYS[a,3,30]	USA	1998	2001	18 814 (33)	14	0.79
NNE[a,11]	USA	1996–1998	1999	7290 (N/A)	8	N/A
Ontario[31]	Canada	1991–1993	1995	6213 (9)	6	0.75
Parsonnet[32]	USA	1982–1987	1989	3500 (1)	16	N/A
Parsonnet (mod.)[33]	France	1992–1993	1997	6649 (42)	41	0.70
Pons[34]	Spain	1994	1997	1309 (7)	11	N/A
Toronto[a,35]	Canada	1993–1996	1999	7491 (2)	9	0.78
Toronto (mod.)[a,36]	Canada	1996–1997	2000	1904 (1)	9	N/A
Tremblay[37]	Canada	1989–1990	1993	2029 (1)	8	N/A
Tuman[38]	USA	N/A	1992	3156 (1)	10	N/A
UK national score[a,5]	UK	1995–1996	1998	1774 (2)	19	0.75
Veterans Affairs[a,39]	USA	1987–1990	1993	12 712 (43)	10	N/A

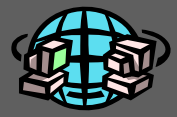
Add, additive; log, logistic; mod, modified; NNE, Northern New England; N/A, not available. Cleveland Clinic risk score algorithm is also known as Higgins score, NNE as American College of Cardiology/American Heart Association (ACA/AHA) score, and Ontario as Provincial Adult Cardiac Care Network (PACCN) score.
[a]Algorithms developed for CABG-only surgery.



Euroscore performed well for overall group and CABG only group

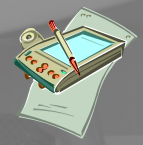
HA Convention 2008

OCR



Internet

Network Workstations



PDA / Data Tablet

Laptop / Standalone PC

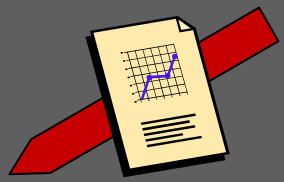
Legacy Database

Link Software

Link Software

Laboratory

Hospital PAS / EPR



SEQUENTIAL OUTCOME ANALYSIS

CUSUM

VLAD

CRAO

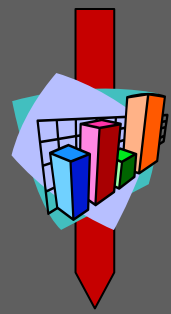
CRAM

RISK MODELLING

Parsonnet & EuroSCORE

Bayes

Neural Networks



ANALYSIS

Basic Analysis

Longitudinal Analysis

REPORTS

Ad-Hoc Reports

Audit Reports

PATIENT REPORTS

Discharge Summary

Operation Notes

Follow Up

Division of Cardiothoracic Surgery, PWH

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

⇩

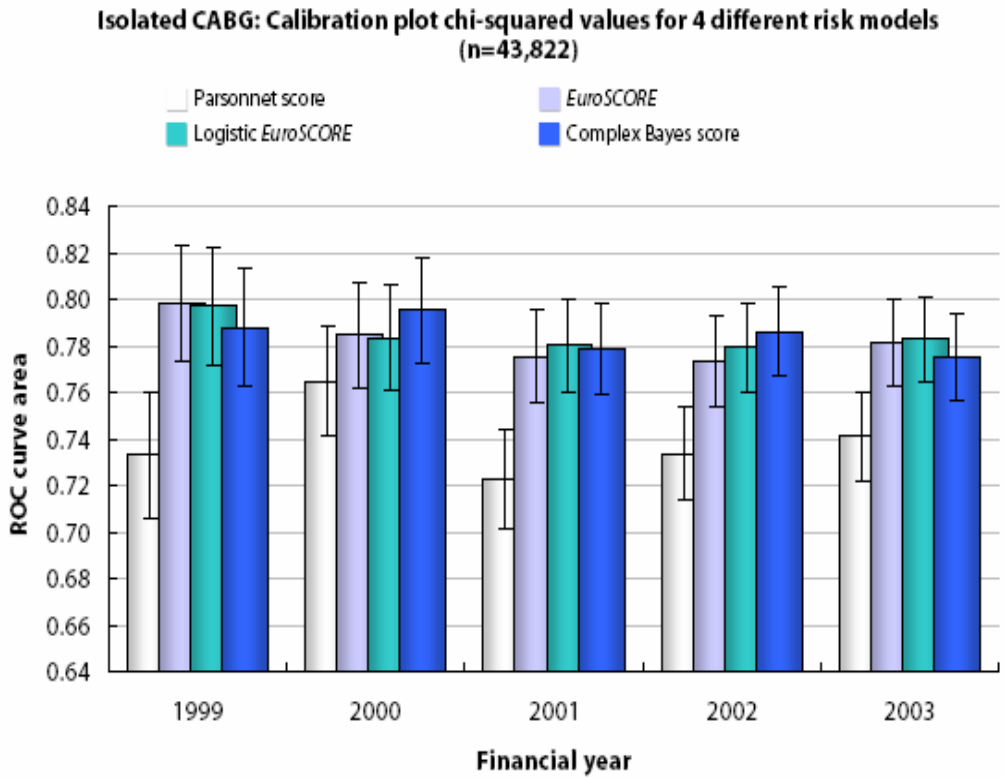
Data Analysis and Review
Data review involves:

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.

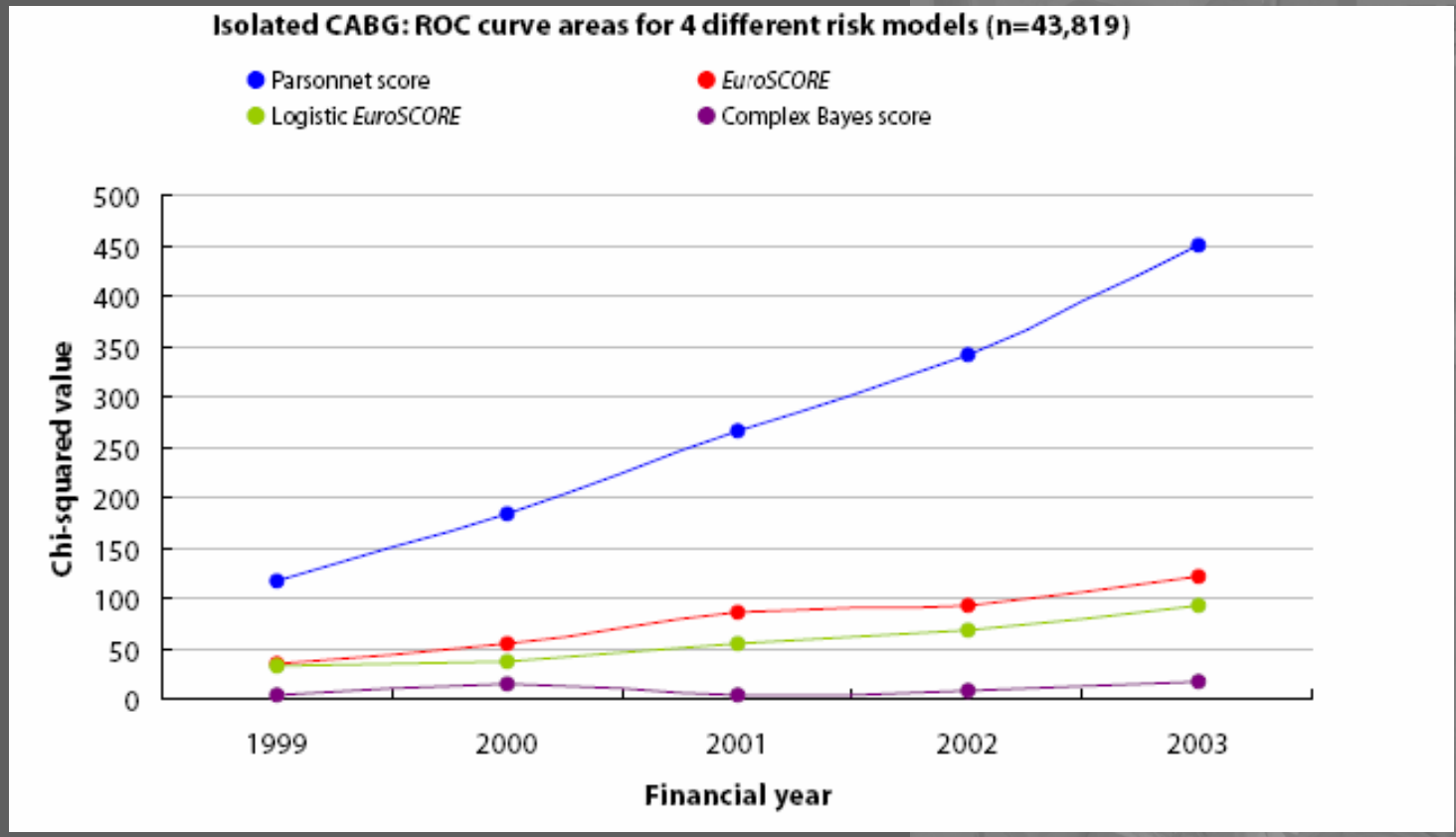
The above process is completed for all adult cardiac surgery cases. The process ensures that the data on the database is complete and accurate, hence ensuring validated quality data.

Summary

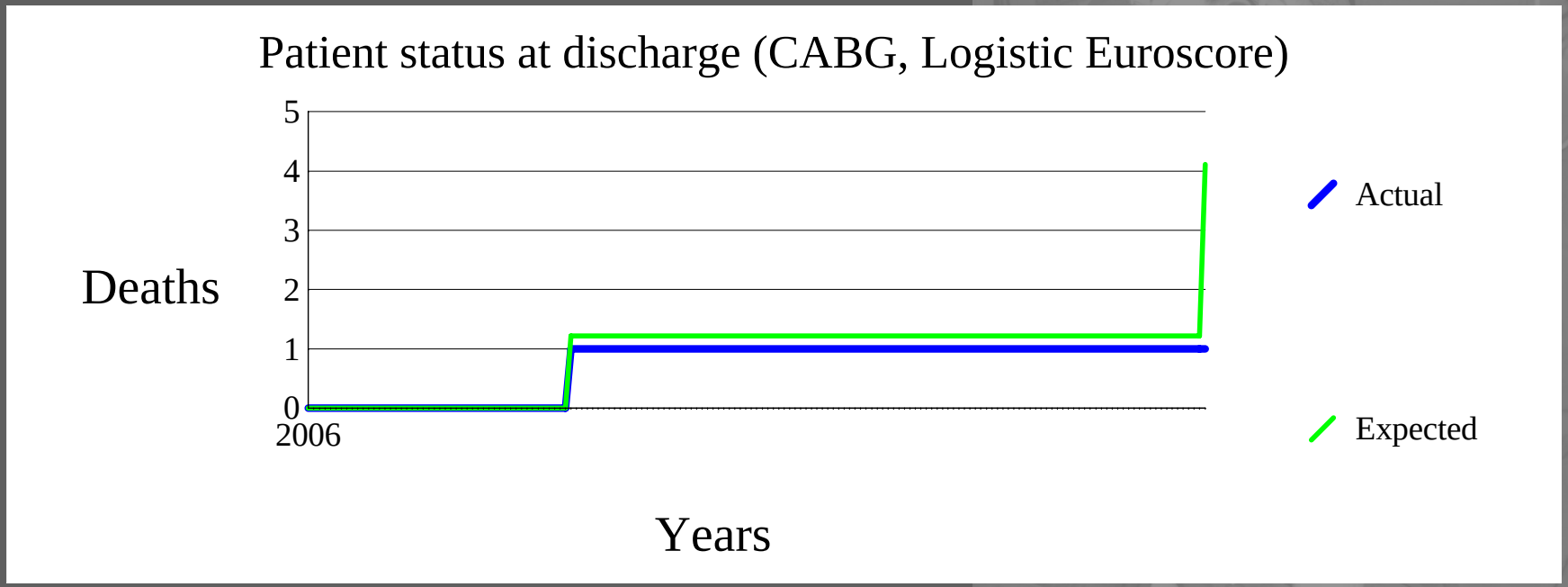
ROC curve areas



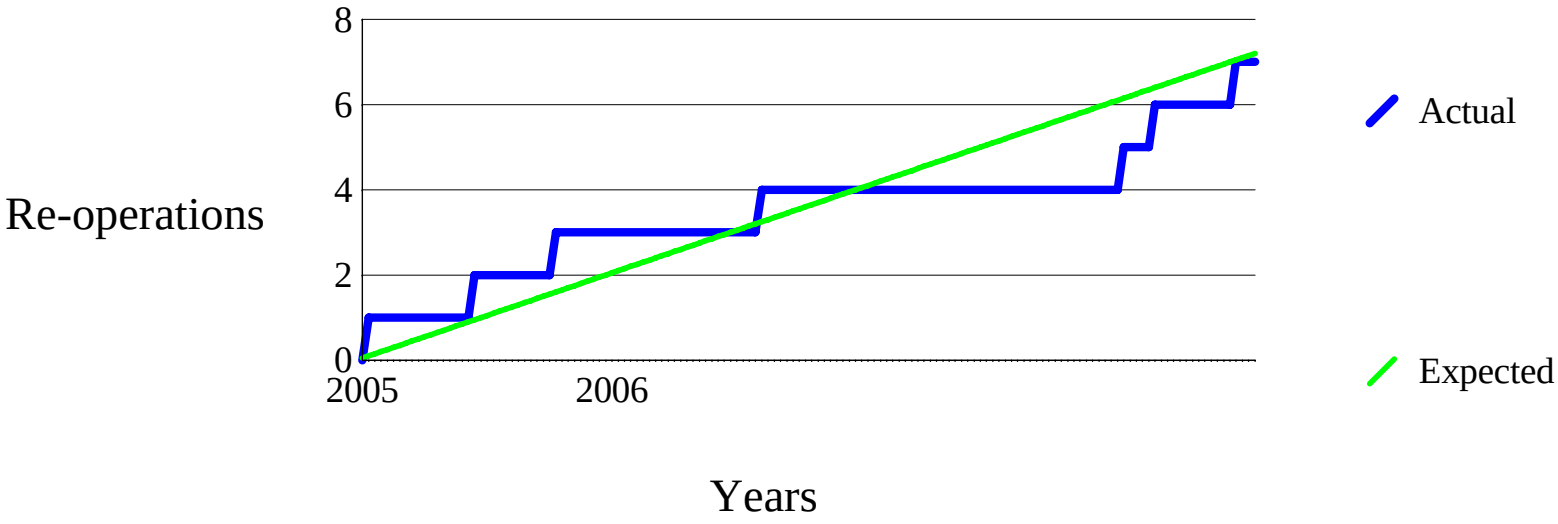
Summary

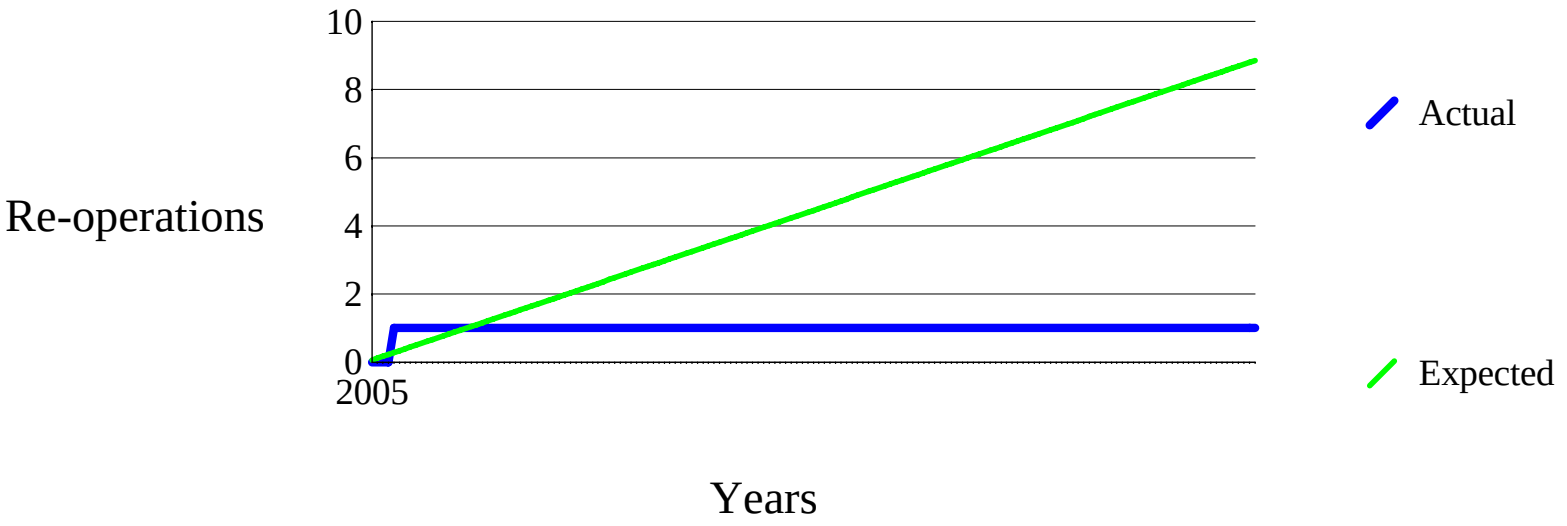

Isolated CABG: ROC curve areas for 4 different risk models (n=43,819)
Parsonnet score
EuroSCORE
Logistic EuroSCORE
Complex Bayes score
Chi-squared value
500
450
400
350
300
250
200
150
100
50
0
1999
2000
2001
2002
2003
Financial year

Isolated CABG



Re-operation Based on 144 Cases Firm A (vs UK 5%)




Re-operation Based on 166 Cases Firm B (vs UK 5%)
Re-operations
10
8
6
4
2
0
2005
Years
Actual
Expected

Risk Comparison

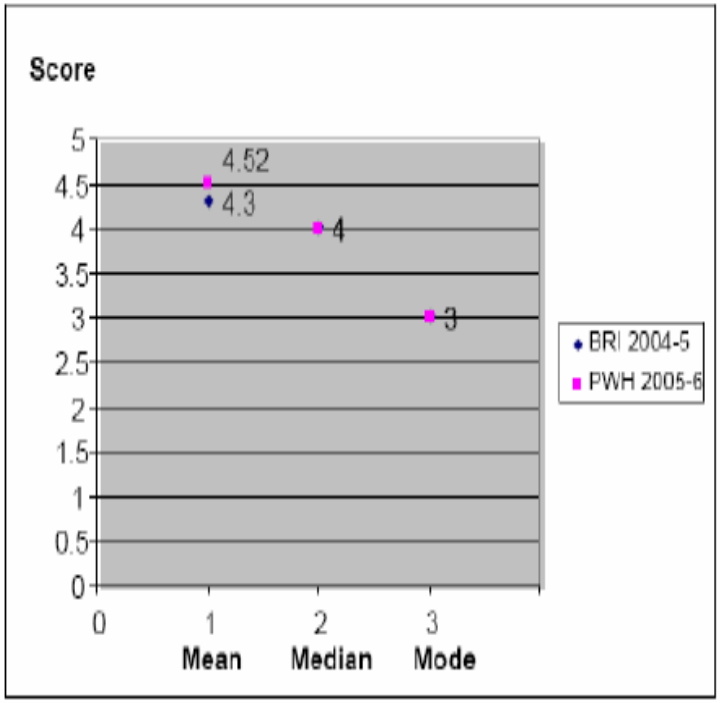
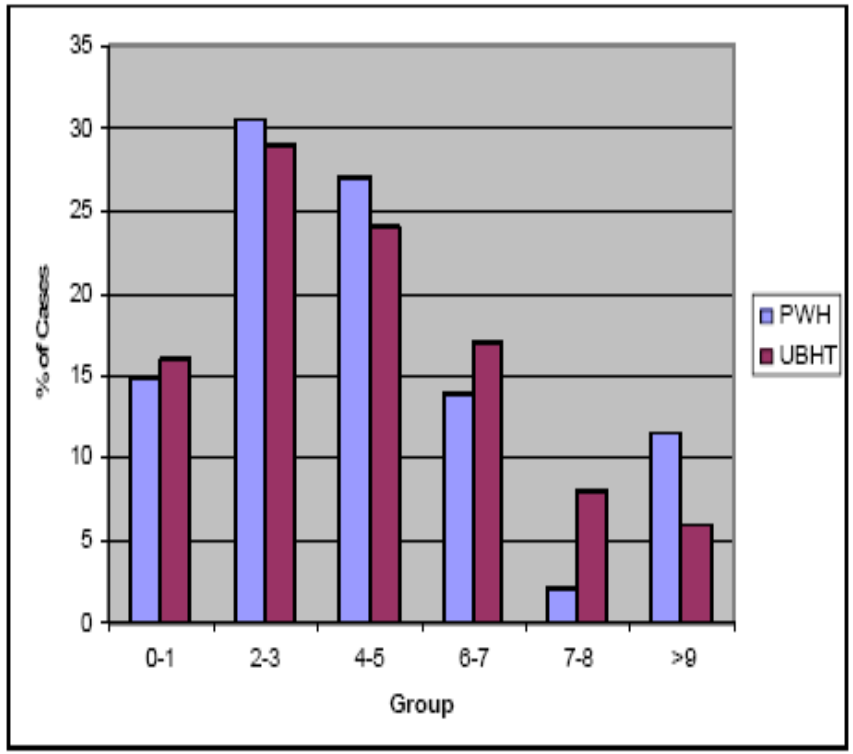


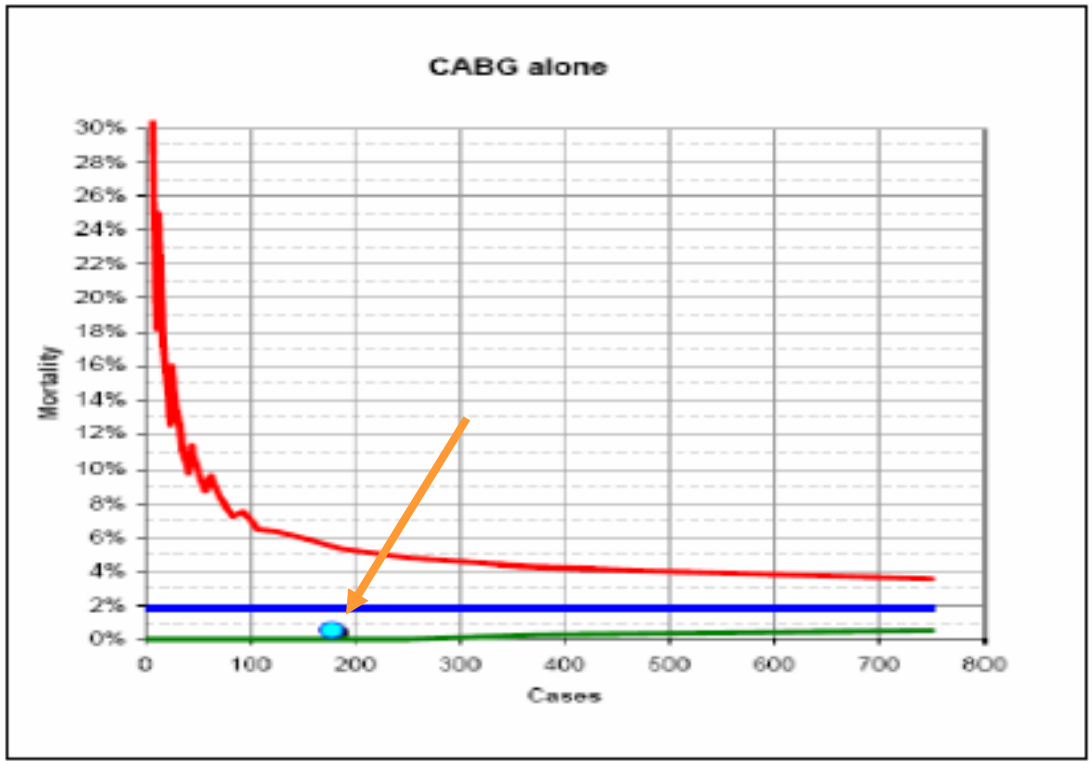
Figure 12. Case distribution within EuroSCORE Groups (%).



From these comparisons we can see that despite case-mix differences, the overall risk-profiles are very similar. (The Median and Mode were identical values).

CABG Outcome

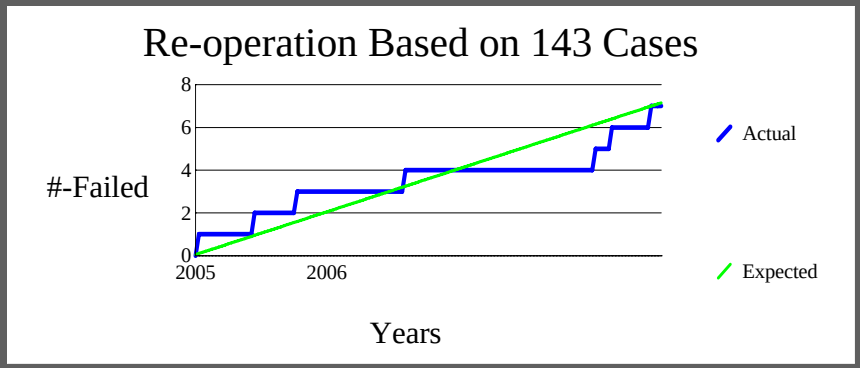
Figure 23. Funnel Plot of crude CABG mortality.

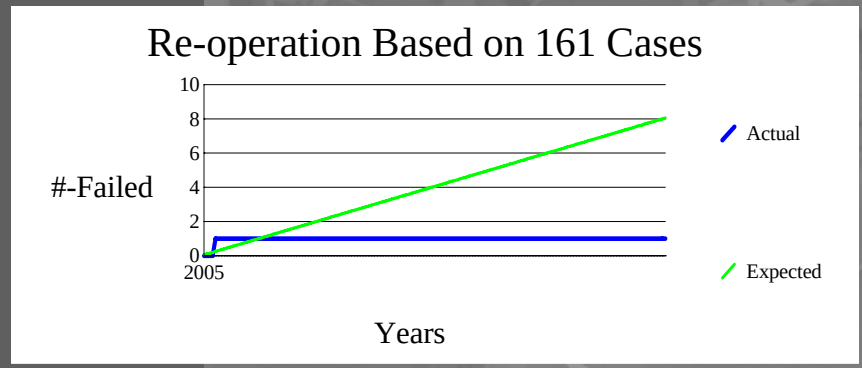


PWH data blue 'dot', UK alert lines (see Figure 6 *explanatory note*).

Risk Models	Total no. of patients	H-L statistic (*P*-value)	ROC area (95% CI)
Parsonnet	4439	94.9 (<0.001)	0.73 (0.68–0.77)
EuroSCORE	4654	37.6 (<0.001)	0.76 (0.72–0.80)
ACC/AHA	4753	130.8(<0.001)	0.76 (0.72–0.81)
UK Bayes	5471	82.1 (<0.001)	0.77 (0.74–0.81)
Simple Bayes	5471	23.7 (0.004)	0.76 (0.72–0.79)
Complex Bayes	5471	42.9 (<0.001)	0.76 (0.73–0.80)

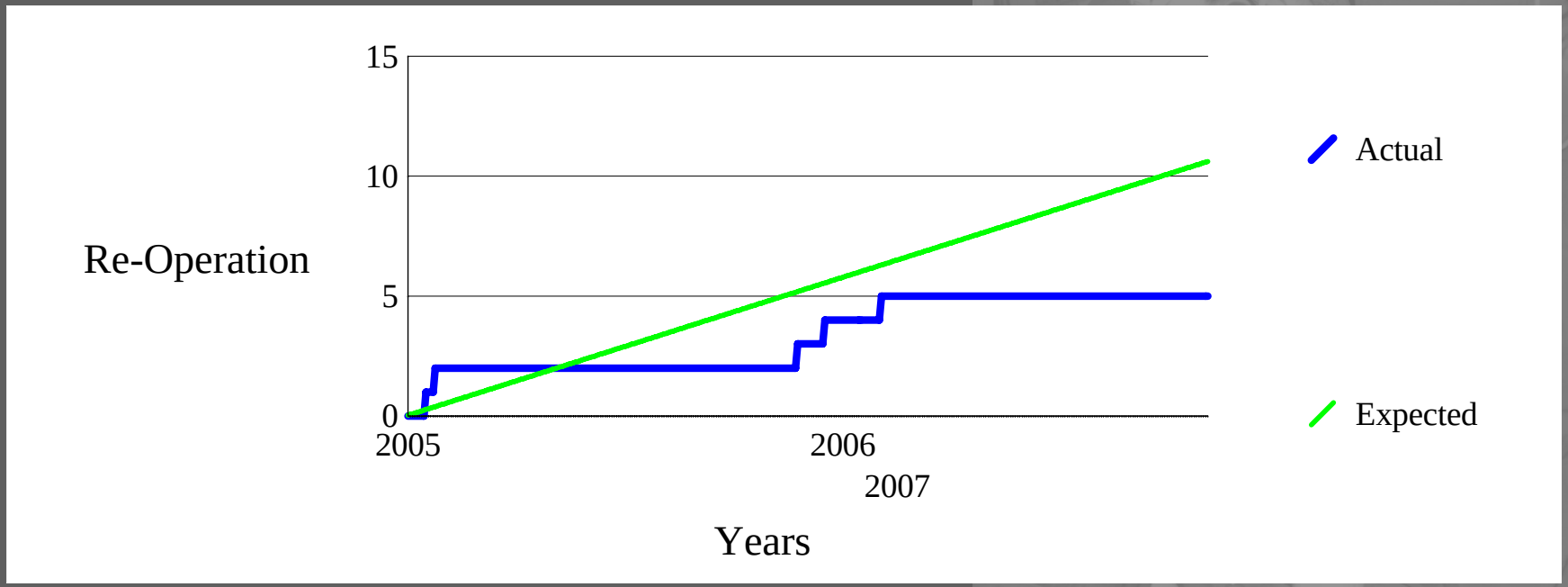
Institution Use of CUSUM Charts



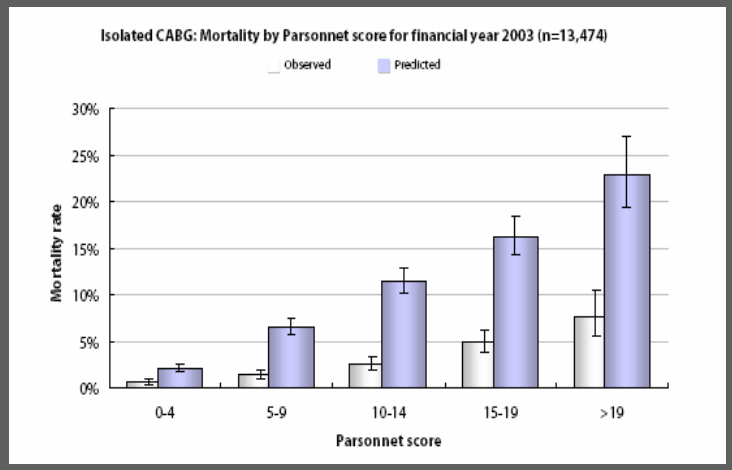


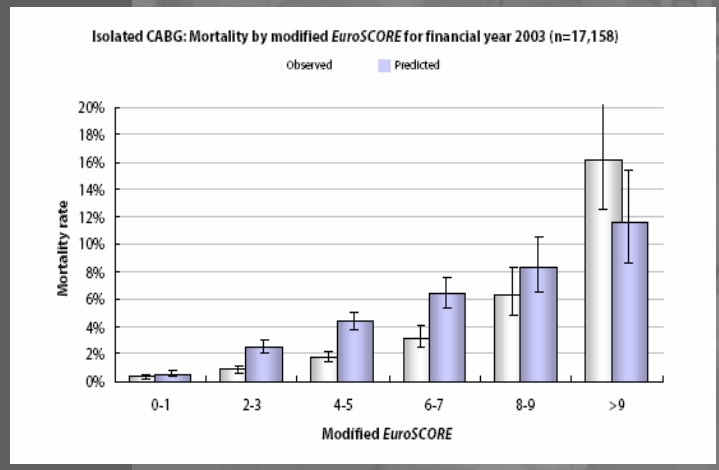
	1/1105-6aaa	1/1105-6mju
Sample Size	143	161
Minimum Answer	0	0
Maximum Answer	15	23
Mean	3.77	5.15
Median	3	4.5
Mode	2	5
Sum	528	783
Standard Deviation	2.74	4.26
25th Percentile	2	2
50th Percentile		4.5
75th Percentile		6.75

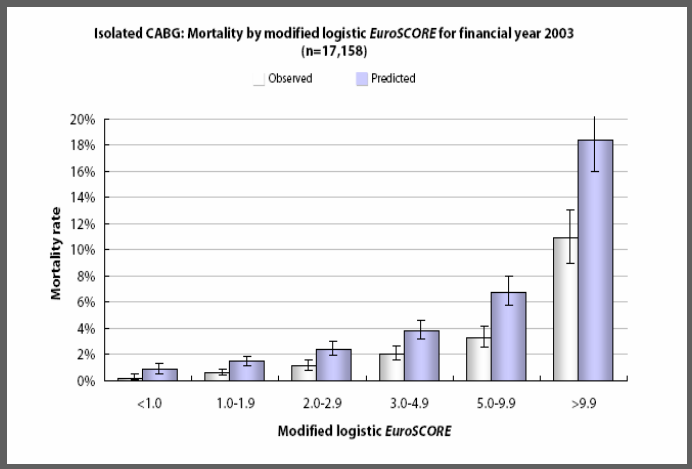
Reoperation for bleeding
All CABG vs 3 %

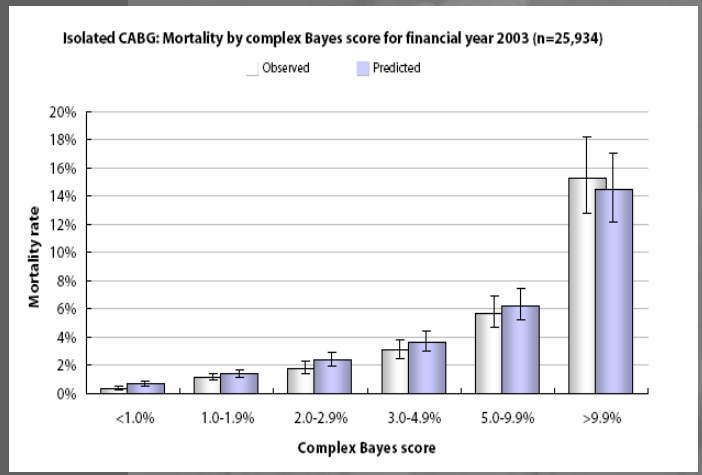


Summary

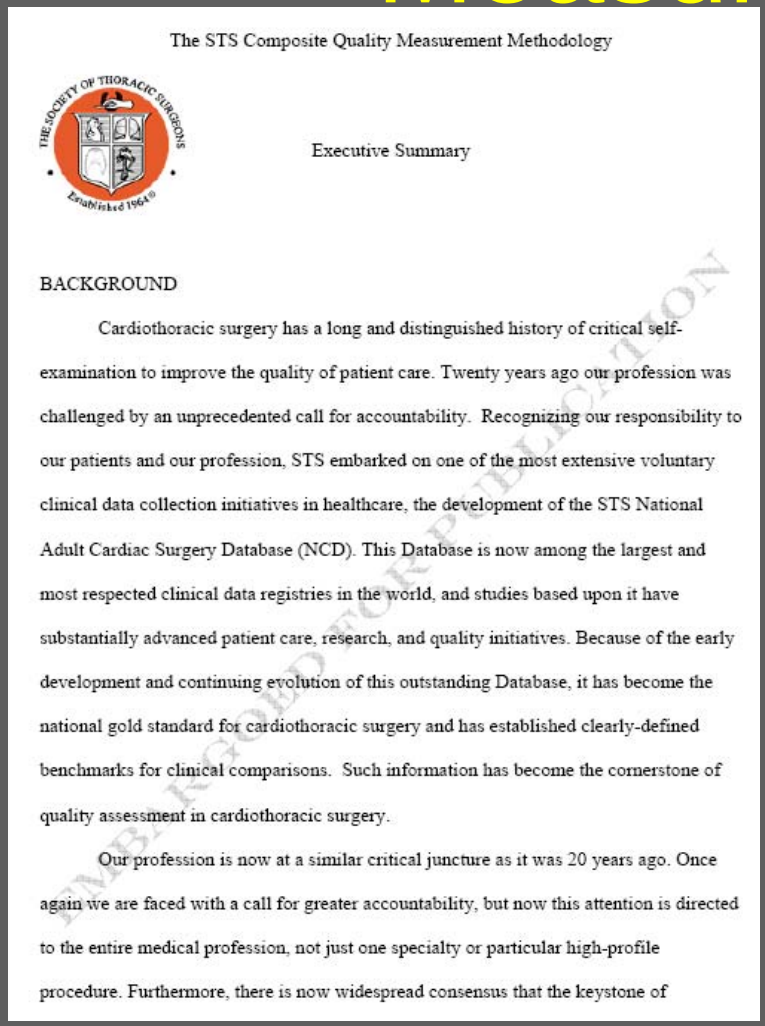

Isolated CABG: Mortality by Parsonnet score for financial year 2003 (n=13,474)
Observed
Predicted
Mortality rate
30%
25%
20%
15%
10%
5%
0%
0-4
5-9
10-14
15-19
>19
Parsonnet score


Isolated CABG: Mortality by modified EuroSCORE for financial year 2003 (n=17,158)
Observed
Predicted
Mortality rate
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
0-1
2-3
4-5
6-7
8-9
>9
Modified EuroSCORE


Isolated CABG: Mortality by modified logistic EuroSCORE for financial year 2003 (n=17,158)
Observed
Predicted
Mortality rate
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
<1.0
1.0-1.9
2.0-2.9
3.0-4.9
5.0-9.9
>9.9
Modified logistic EuroSCORE


Isolated CABG: Mortality by complex Bayes score for financial year 2003 (n=25,934)
Observed
Predicted
Mortality rate
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
<1.0%
1.0-1.9%
2.0-2.9%
3.0-4.9%
5.0-9.9%
>9.9%
Complex Bayes score

Composite Quality Measurements



The STS Composite Quality Measurement Methodology

Executive Summary

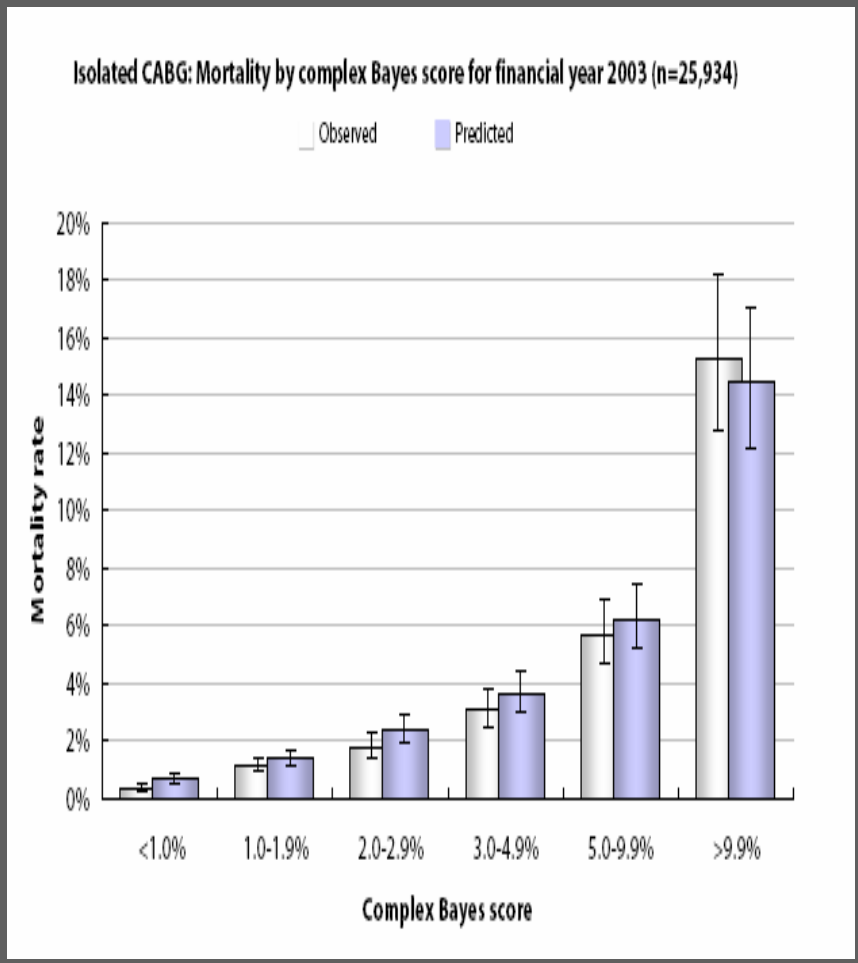
BACKGROUND

Cardiothoracic surgery has a long and distinguished history of critical self-examination to improve the quality of patient care. Twenty years ago our profession was challenged by an unprecedented call for accountability. Recognizing our responsibility to our patients and our profession, STS embarked on one of the most extensive voluntary clinical data collection initiatives in healthcare, the development of the STS National Adult Cardiac Surgery Database (NCD). This Database is now among the largest and most respected clinical data registries in the world, and studies based upon it have substantially advanced patient care, research, and quality initiatives. Because of the early development and continuing evolution of this outstanding Database, it has become the national gold standard for cardiothoracic surgery and has established clearly-defined benchmarks for clinical comparisons. Such information has become the cornerstone of quality assessment in cardiothoracic surgery.

Our profession is now at a similar critical juncture as it was 20 years ago. Once again we are faced with a call for greater accountability, but now this attention is directed to the entire medical profession, not just one specialty or particular high-profile procedure. Furthermore, there is now widespread consensus that the keystone of

- Pre-Operative Medical Care
- Operative care
- Risk-Adjusted Mortality
- Risk-Adjusted Morbidity

Complex Bayes Analysis: Summary



- Complex Bayes very accurate
- Even in ‘High Risk’ Group