Interrogating large clinical databases to improve clinical performance

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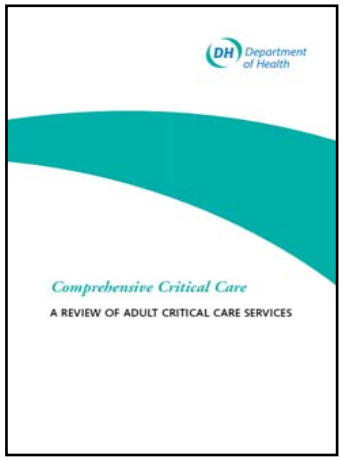
Aims

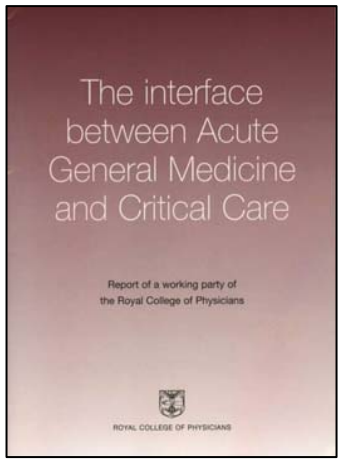
- Early warning scoring systems
- British Thoracic Society Guideline for emergency oxygen use in adult patients
- In-hospital assessment of pain
- Biochemistry Haematology Outcome Model (BHOM)

Reports discussing early warning scores 2000-2007

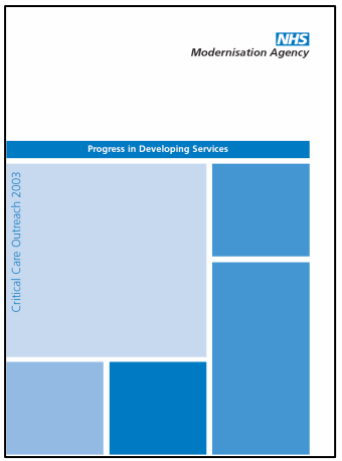
2000



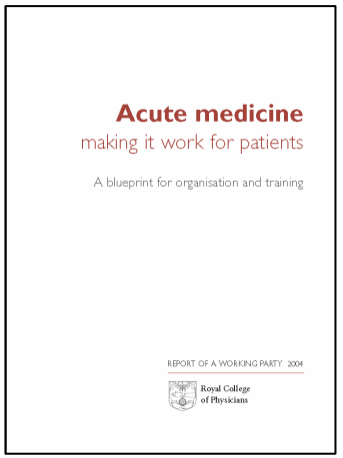
2002



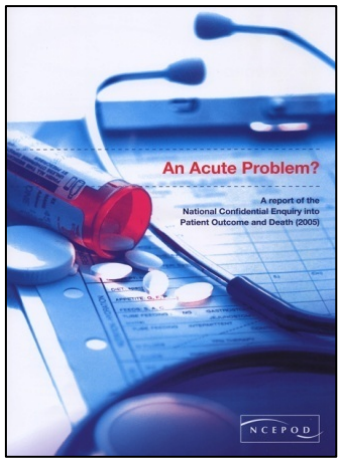
2003



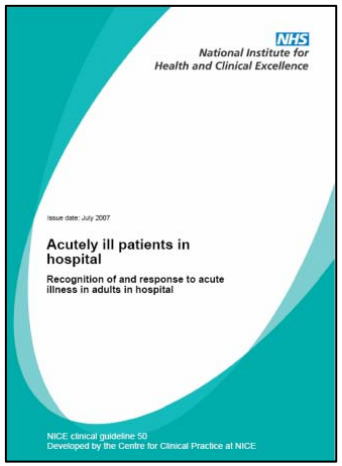
2004



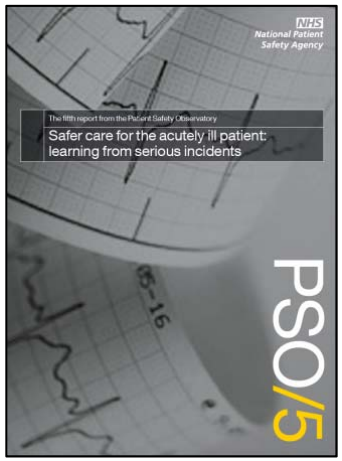
2007



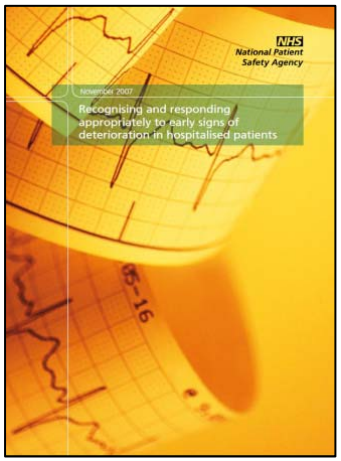
2007



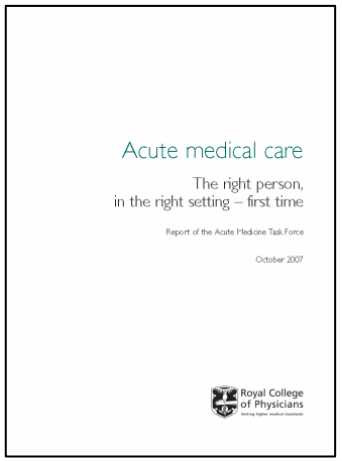
2007



2007

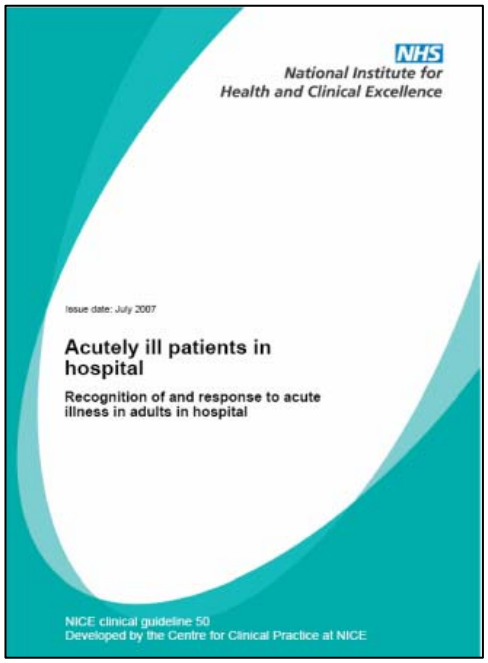


2007



Earl Warning Scores

NICE 2007: early warning scores



"...Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings..."

"... Track and trigger systems should use multiple-parameter or aggregate weighted scoring systems, which allow a graded response..."

"...Multiple-parameter or aggregate weighted scoring systems used for track and trigger systems should measure:

- *heart rate*
- *respiratory rate*
- *systolic blood pressure*
- *level of consciousness*
- *oxygen saturation*
- *temperature..."*

Aggregate-weighted "track and trigger" systems

- periodic measurement of selected basic vital signs
- assign weighted scores to vital signs measurements on the basis of their derangement from an arbitrarily agreed "normal" range.
- trigger value (e.g., ≥3) set locally, depending upon system used.
- total score [Early Warning Score] leads to a graded response

	Points						
	3	2	1	0	1	2	3
HR (bpm)		≤ 40	41-50	51-100	101-110	111-129	≥ 130
sBP (mmHg)	≤ 70	71-80	81-100	101-199		≥ 200	
RR (bpm)		≤ 8		9-14	15-20	21-29	≥ 30
Temp (°C)		≤ 34.9		35-38.4		≥ 38.5	
Neuro (AVPU)				**A**lert	Reacts to **V**oice	Reacts or **P**ain	**U**nresponsive

Variations in parameters in existing EWSs

Year	System	Author and citation	PR	BR	sBP	AVPU	Temp	Urine	Age	S_pO_2	F_iO_2
1997	1	Morgan[25]	●	●	●	●	●				
2000	2	Wright[45]	●	●	●	●	●				
2001	3	Subbe[79]	●	●	●	●	●				
2001	4	Subbe[79]	●	●	●	●	●		●		
2001	5	Fox[33]	●	●	●	●	●	●			
2001	6	Riley[77]	●	●	●	●	●	●			
2001	7	Cooper[41]	●	●	●	●	●	●			
2002	8	Subbe[70]	●	●	●	●			●		
2002	9	Wasson[81]	●	●	●	●	●				
2002	10	Odell[31]	●	●	●	●		●			
2002	11	Carberry[34]	●	●	●	●	●	●			
2003	12	Rees[29]	●	●	●	●	●	●			
2004	13	Rees[27]	●	●	●	●					
2004	14	Priestley[28]	●	●	●	●		●			
2004	15	Ryan[36]	●	●	●	●	●	●			
2004	16	Allen[37]	●	●	●	●	●	●			
2005	17	Goldhill[35]	●	●	●	●	●	●		●	?
2005	18	Chatterjee[38]	●	●	●	●					
2005	19	Heaps[39]	●	●	●	●	●	●			
2005	20	Andrews[40]	●	●	●	●	●				
2005	21	Bakir[73]	●	●	●	●	●		●	●	Air
2006	22	Smith[6]	●	●	●	●	●	●			
2006	23	Paterson[3]	●	●	●	●	●			●	?
2006	24	Lam[26]	●	●	●	●	●				
2006	25	Smith[30]	●	●	●	●	●	●			
2006	26	Gardner-Thorpe[32]	●	●	●	●	●	●			
2006	27	Hancock[43]	●	●	●	●	●				
2007	28	Duckitt[4]	●	●	●	●	●			●	Air
2007	29	Subbe[22]	●	●	●	●			●		
2007	30	Odell[42]	●	●	●	●		●			
2007	31	Barlow[44]	●	●	●	●	●	●		●	?
2007	32	Von Lilienfeld-Toal[82]	●	●	●	●	●				
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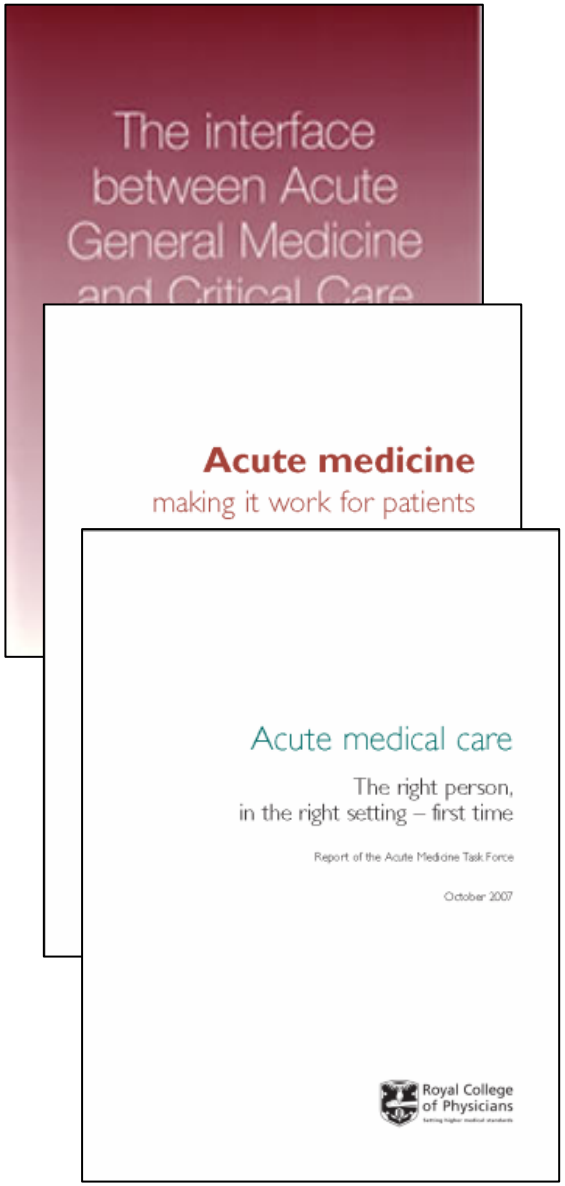
Smith et al. Resuscitation 2008; 77: 170-179.

Royal College of Physicians: early warning scores



"... There is no justification for the continued use of multiple different early warning scores to assess illness severity..."

"...The physiological assessment of all patients should be standardised across the NHS with the recording of a minimum clinical data set resulting in a NHS early warning (NEW) score..."

"...This will provide a standardised record of illness severity and urgency of need, from first assessment and throughout the patient journey..."

"...This NEW score should be familiar to all staff and should be used to trigger the most appropriate response, either in the community or in hospital..."

"...Although many similar systems may exist, the development of a national system would promote clinical communication and facilitate wide adoption..."

VitalPAC system: aims

To develop a PDA-based system to facilitate patient-centric data collection at point and time of delivery of care directly into a database, avoiding need for paper.

Aims

- To improve the vital signs monitoring process
- To improve the legibility and usefulness of the charting of vital signs
- To improve systems used to detect deterioration
- To improve the escalation of care for deteriorating patients
- To audit the "triggering" and "response" processes

Resuscitation (2006) 71, 19–28

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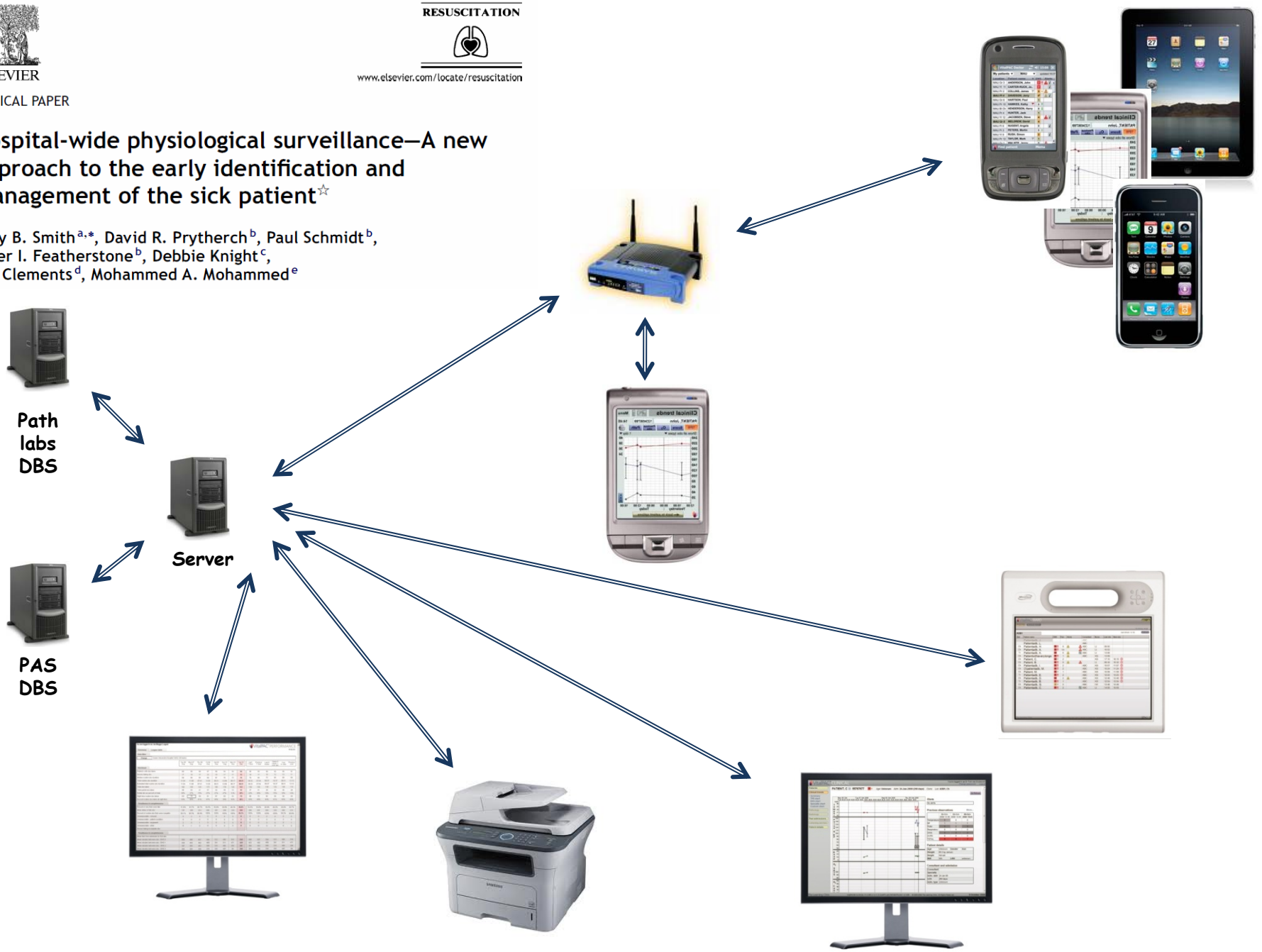
CLINICAL PAPER

Hospital-wide physiological surveillance—A new approach to the early identification and management of the sick patient☆

Gary B. Smith[a,*], David R. Prytherch[b], Paul Schmidt[b], Peter I. Featherstone[b], Debbie Knight[c], Gill Clements[d], Mohammed A. Mohammed[e]



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2002	8	Subbe[70]	●	●	●	●			●		
2002	9	Wasson[81]	●	●	●	●	●				
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2005	21	Bakir[73]	●	●	●	●	●		●	●	Air
2006	22	Smith[6]	●	●	●	●	●	●			
2006	23	Paterson[3]	●	●	●	●	●			●	?
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2006	27	Hancock[43]	●	●	●	●	●				
2007	28	Duckitt[4]	●	●	●	●	●			●	Air
2007	29	Subbe[22]	●	●	●	●			●		
2007	30	Odell[42]	●	●	●	●		●			
2007	31	Barlow[44]	●	●	●	●	●	●		●	?
2007	32	Von Lilienfeld-Toal[82]	●	●	●	●	●				
2007	33	Von Lilienfeld-Toal[82]	●	●	●	●	●	●		●	?

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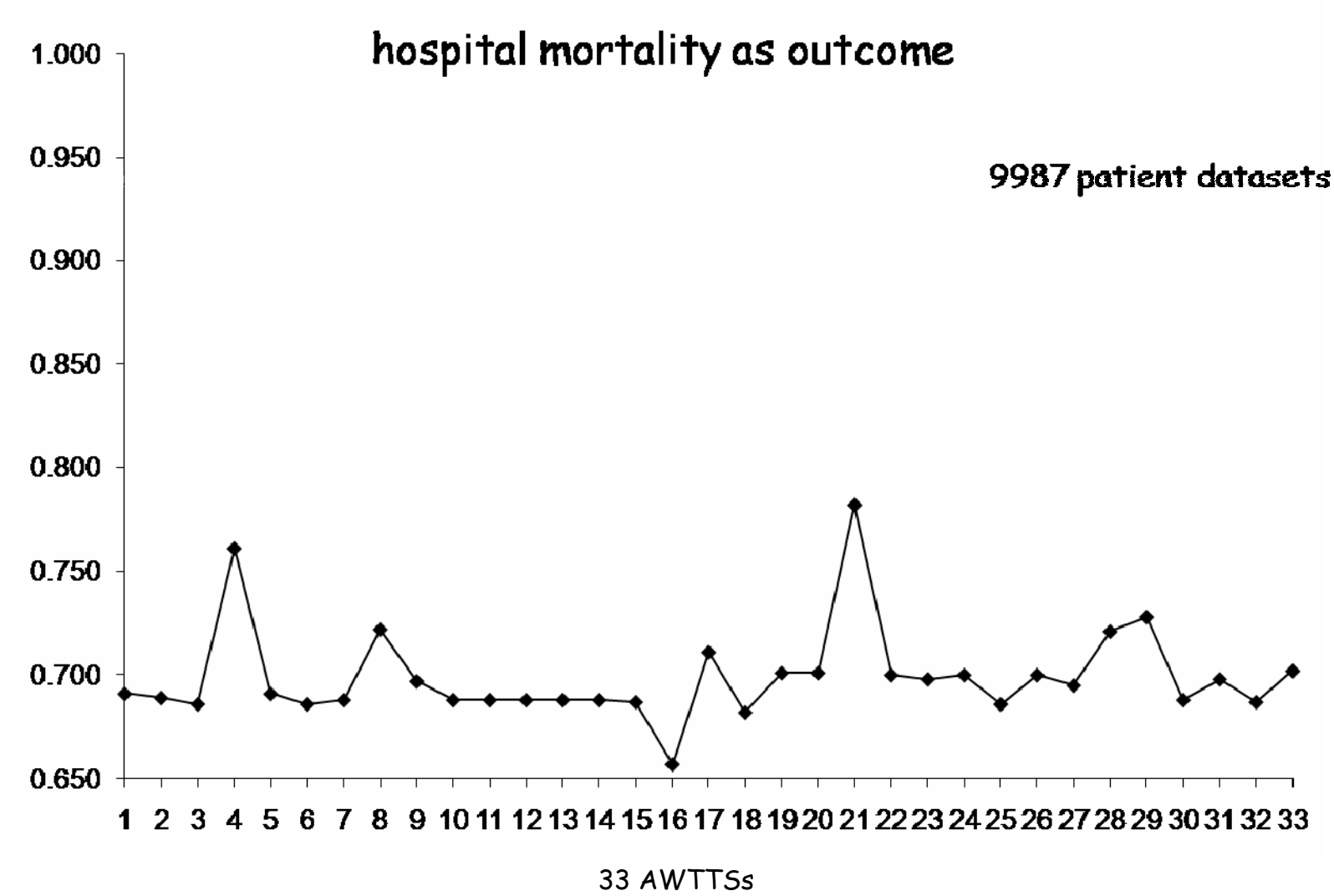
Receiver Operator Characteristics Curves for 33 AWTTS



Smith et al. Resuscitation 2008; 77: 170-179.

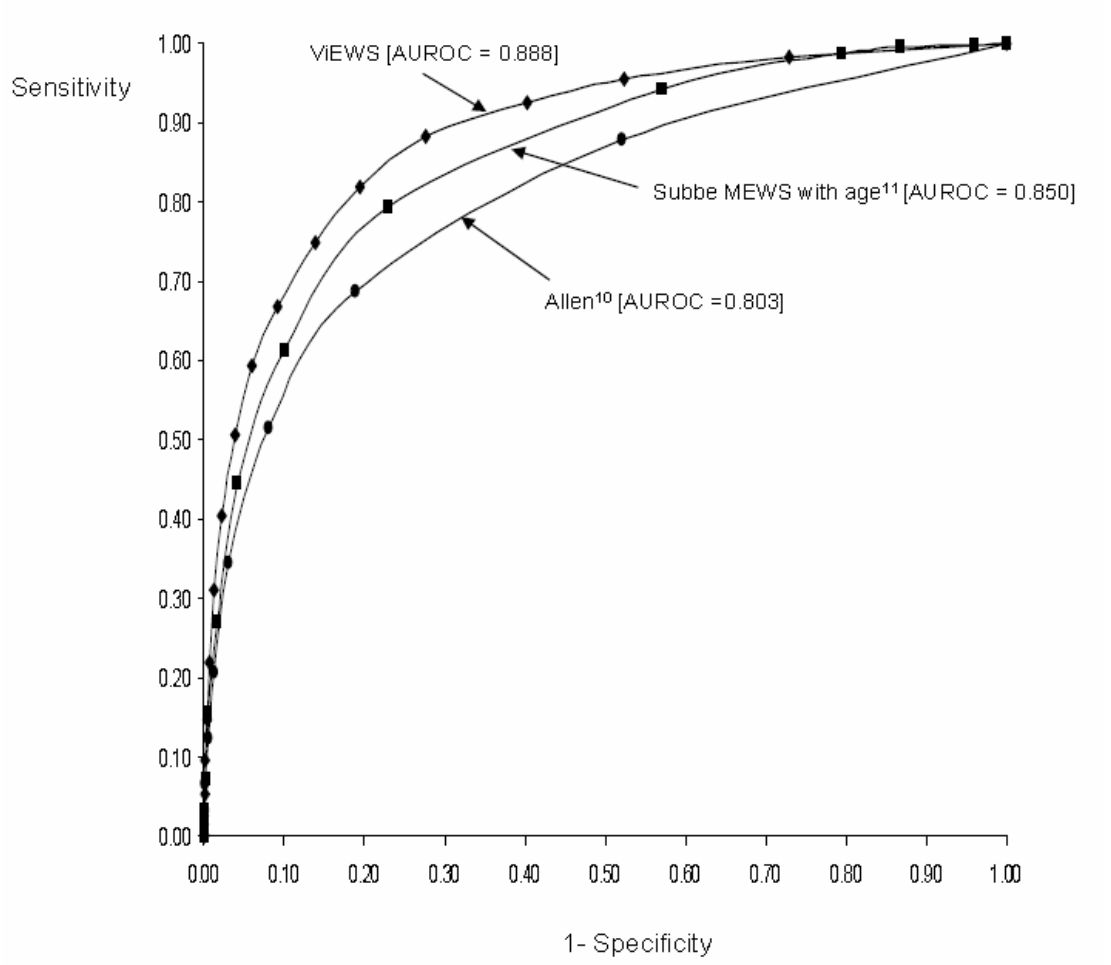
ViEWS

	Score						
	3	2	1	0	1	2	3
Pulse (bpm)		≤ 40	41 – 50	51 – 90	91 – 110	111 – 130	≥ 131
Temp (°C)	≤ 35.0		35.1 – 36.0	36.1 – 38.0	38.1 – 39.0	≥ 39.1	
Systolic BP (mm Hg)	≤ 90	91 – 100	101 – 110	111 – 249	≥ 250		
Resp rate (bpm)	≤ 8		9 – 11	12 – 20		21 – 24	≥ 25
AVPU				A			V, P or U
S_pO_2	≤ 91	92 – 93	94 – 95	≥ 96			
Inspired O_2				On air			Any supplemental O_2

Prytherch et al. Resuscitation 2010; 81: 932-937

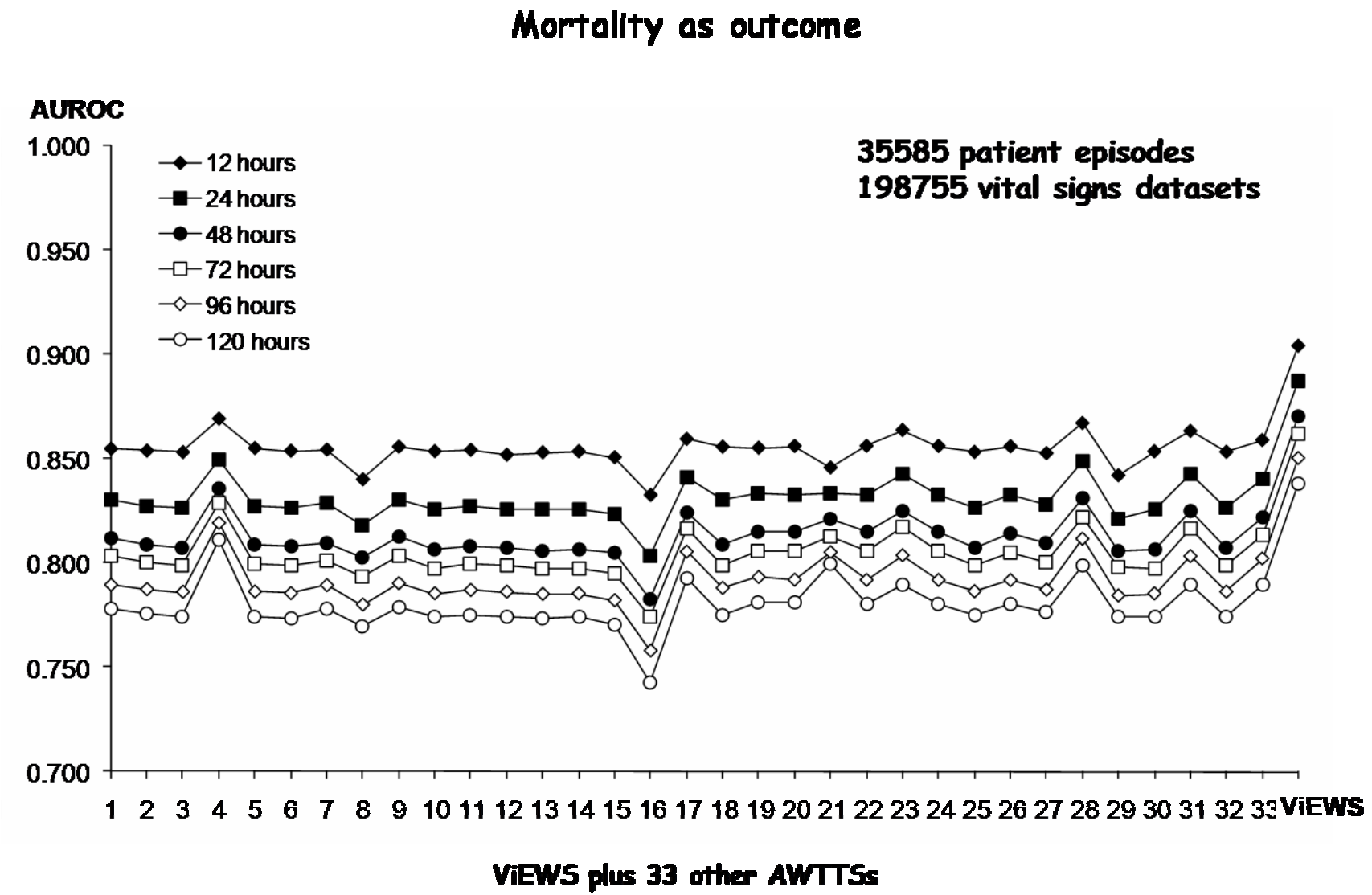
ViEWS: comparison of performance

Mortality at 24 hours post-EWS as outcome



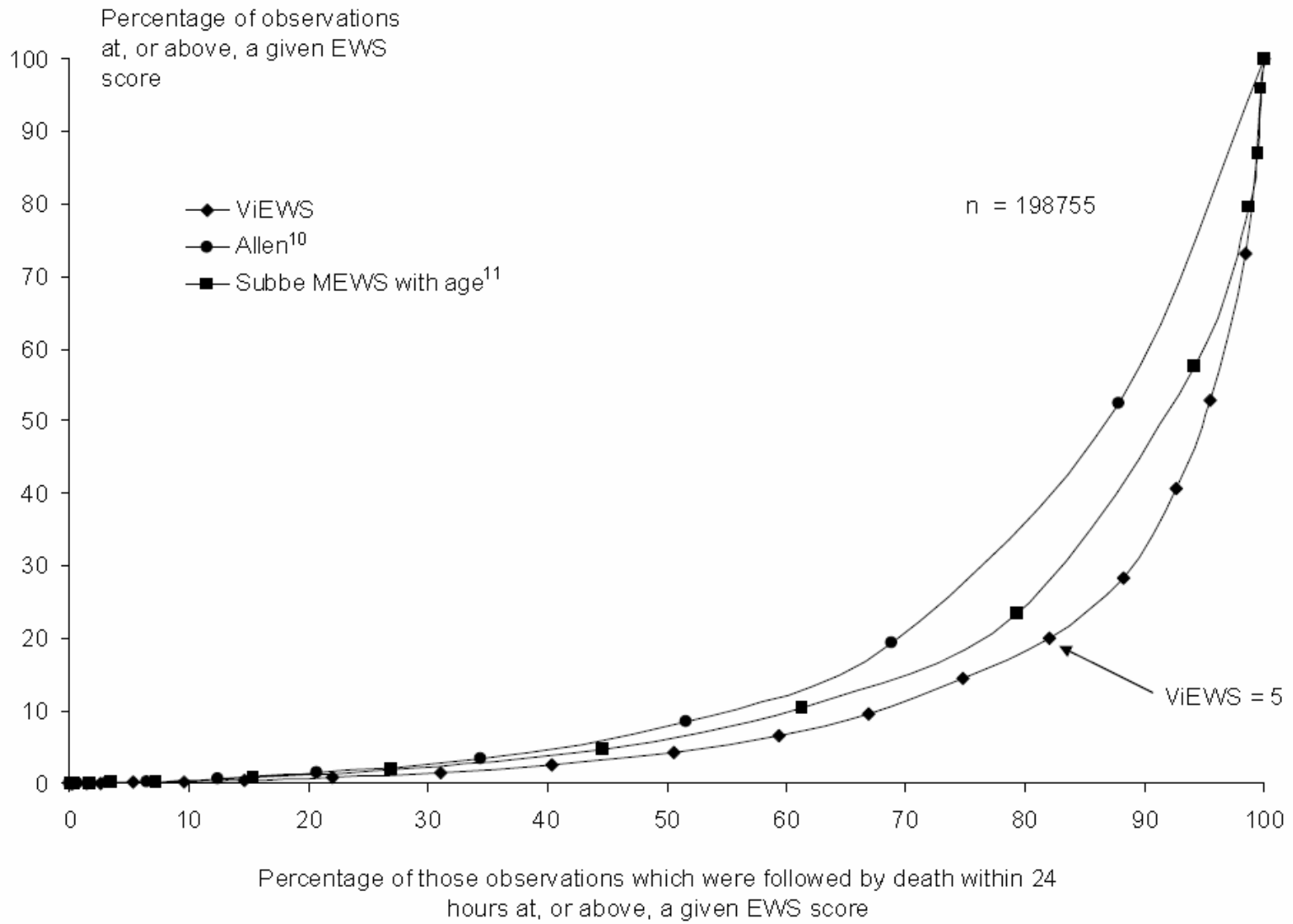
Prytherch et al. Resuscitation 2010; 81: 932–937

Early Warning Scores: comparison of performance



Prytherch et al. Resuscitation 2010; 81: 932-937

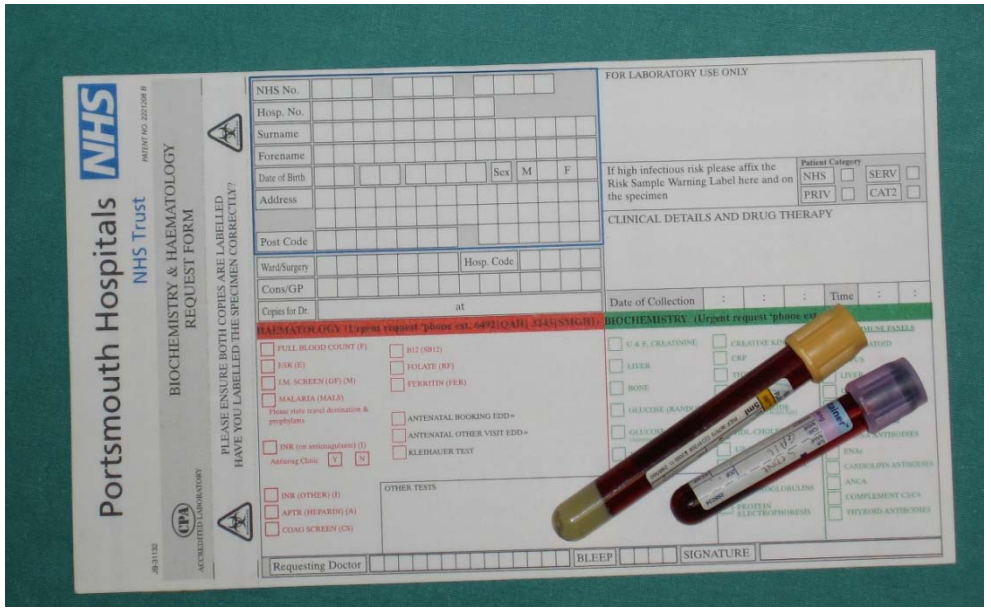
Early Warning Score efficiency chart



Prytherch et al. Resuscitation 2010; 81: 932-937

Are the target SpO2 values recommended by the British Thoracic Guidelines correct?

Can the performance of hospitals be compared using models based on routinely collected clinical laboratory data?



Relevant history

APACHE II, APACHE III, SAPS II, MPM

P-POSSUM

Prytherch DR, Whiteley MS, Higgins B, Weaver PC, Prout WG, Powell SJ. POSSUM and P-POSSUM for predicting mortality.
British Journal of Surgery 1998;85:1217-1220.

BHOM

Prytherch DR, Sirl JS, Weaver PC, Schmidt P, Higgins B, Sutton GL.
Towards a national clinical minimum dataset for general surgery.
British Journal of Surgery 2003;90:1300-1305.

Prytherch DR, Sirl JS, Schmidt P, Featherstone PI, Weaver PC, Smith GB.
The use of routine laboratory data to predict in-hospital death in medical admissions.
Resuscitation 2005;66:203-207.

Prytherch DR, Briggs JS, Weaver PC, Schmidt P, Smith GB.
Measuring clinical performance using routinely collected clinical data.
Medical Informatics and the Internet in Medicine 2005; 30:151-156

BHOM components

Surgical model	Medical model
Urea	Urea
Sodium	Sodium
Potassium	Potassium
Haemoglobin	Haemoglobin
White Blood Cell count	White Blood Cell count
	Albumin
	Creatinine
Age	Age
Gender	Gender
Mode of Admission	Mode of Admission
Bupa Operative Severity Score	

General Medicine BHOM Validation: T2 v T1

Risk (%)	Discharges	Mean Risk (%)	Predicted Deaths	Reported Deaths	χ^2
≥0 to ≤5	1103	1.40	15	13	0.39
>5 to ≤7.5	119	6.16	7	6	0.26
>7.5 to ≤10	85	8.66	7	6	0.28
>10 to ≤12.5	68	11.29	8	10	0.79
>12.5 to ≤15	32	13.67	4	6	0.70
>15 to ≤20	66	17.34	11	12	0.03
>20 to ≤25	50	22.64	11	11	0.01
>25 to ≤33	61	29.20	18	20	0.38
>33 to ≤50	90	40.71	37	36	0.02
>50 to ≤100	93	74.58	69	78	4.24
≥0 to ≤100	1767	10.68	189	198	7.09

$\chi^2 = 7.09$

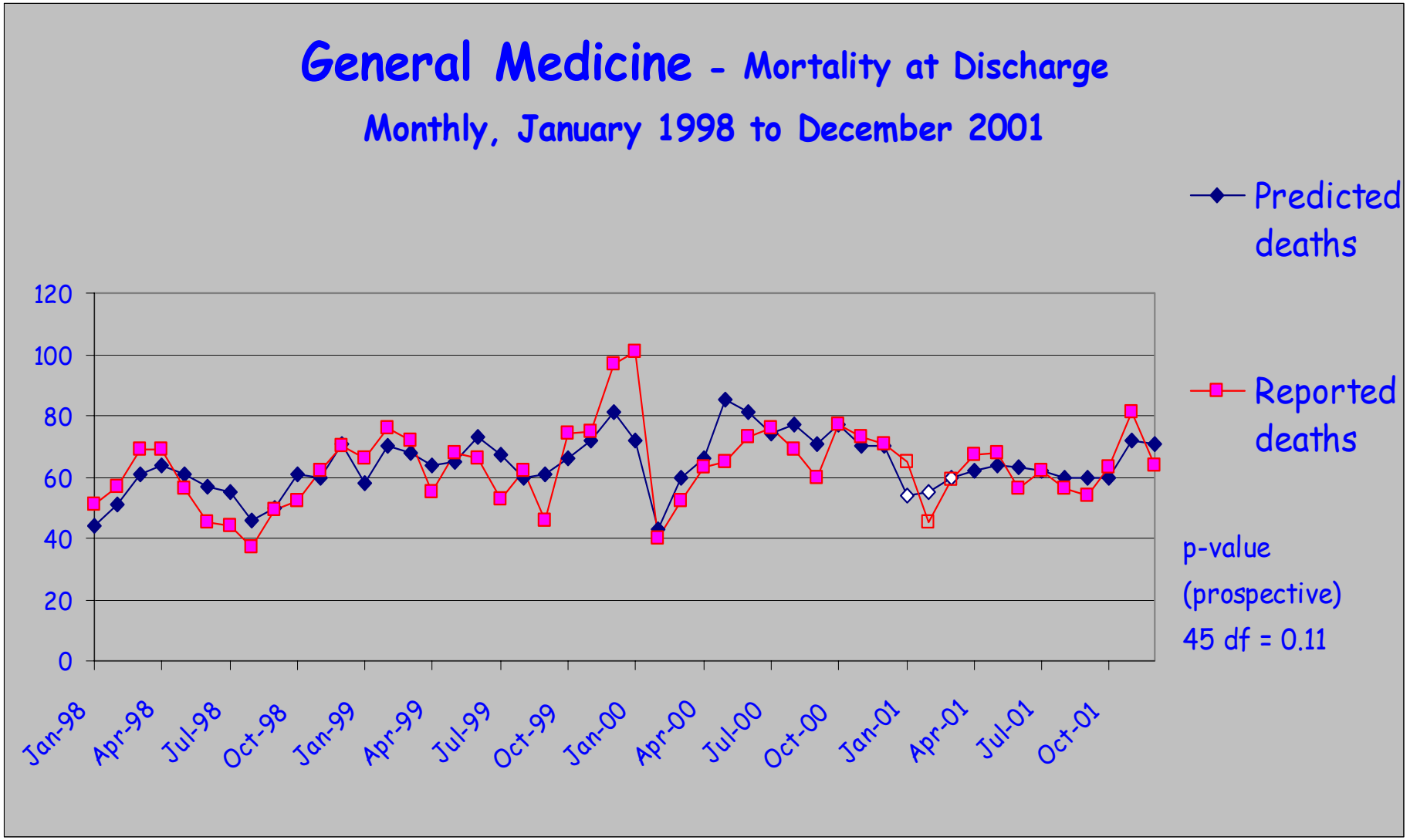
10 d.f

$P = 0.72$

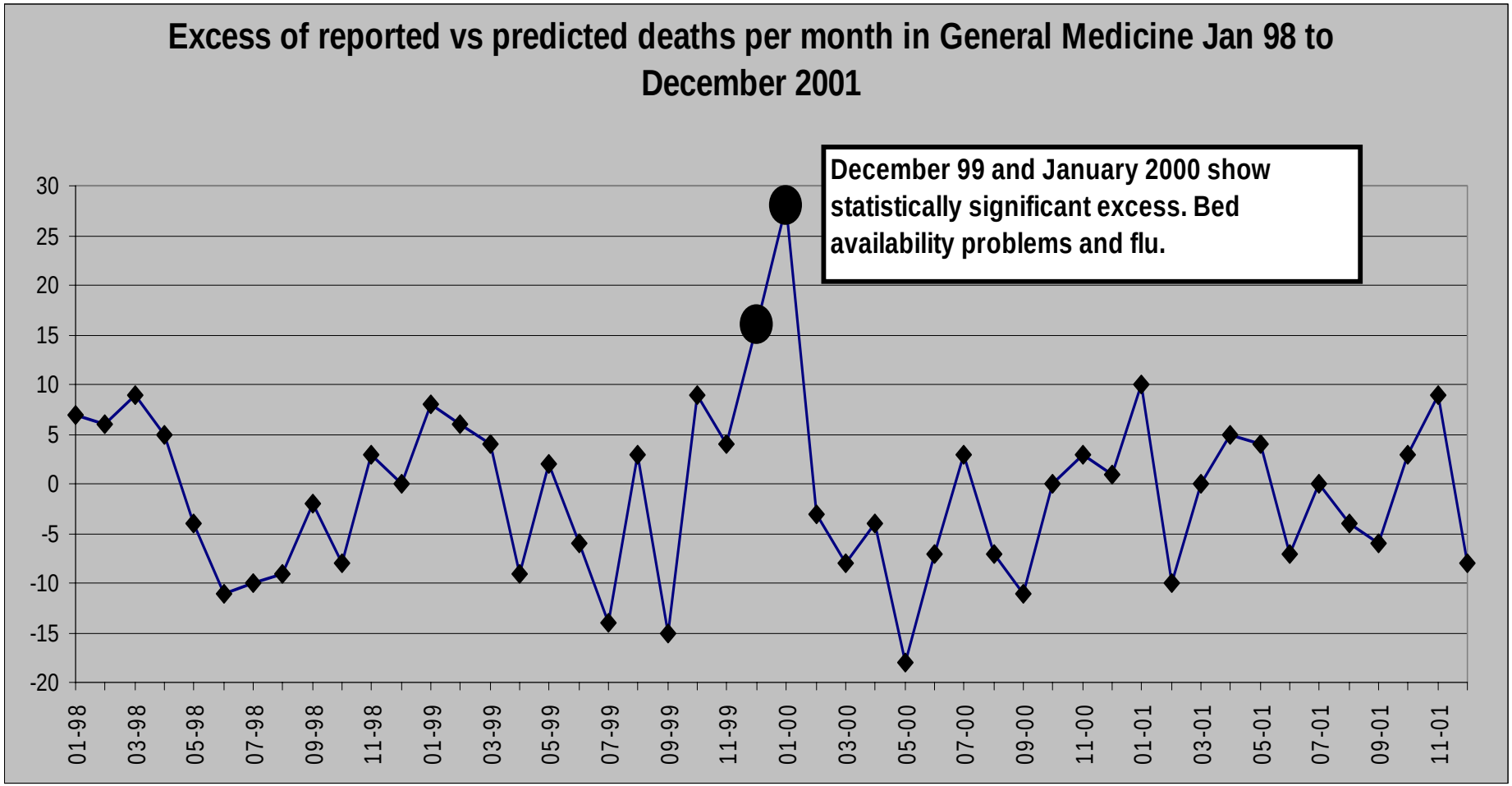
no evidence of lack of fit

c-index=0.92

General Medicine BHOM performance over time



General Medicine BHOM: excess deaths



Key points re BHOM

- Necessary clinical data can be obtained from a single venesection
- Clinical data are used operationally in care of individuals
- All data already stored on hospital core IT systems - no "extra" effort is required to collect data
- Clinical data used are subject to extensive quality assurance
- Case mix adjusted and uses high quality data trusted by clinicians (no coded data) – more likely to win clinical acceptance
- Data immediately available to inform decisions
- Cannot be "gamed"
- Performance and surveillance tool

Summary

- Early warning scoring systems
- British Thoracic Society Guideline for emergency oxygen use in adult patients
- In-hospital assessment of pain
- Biochemistry Haematology Outcome Model (BHOM)