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Audit of Intensive Care Units in Scotland.

Project Director: Miss Fiona MacKirdy

Lead Clinician: Dr Simon J Mackenzie

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STAFF

Fiona MacKirdy, Project Director

Annette Little, Information Officer, NHS Greater Glasgow

Karen Lorenzetti, Statistician, NHS Greater Glasgow

SICSAG STEERING GROUP

Gillian Adey, Consultant, Aberdeen

Simon J Mackenzie, Consultant, Edinburgh

Fiona MacKirdy, Project Director

Louie Plenderleith, Consultant, Glasgow

Alfred J Shearer, Consultant, Dundee

The Steering Group is responsible to the Council of the Scottish Intensive Care Society, of which Dr Jim Dougall (Glasgow) is President.

A. CONTENTS

A. CONTENTS **3**
B. FIGURES **4**
C. TABLES **5**
D. ABBREVIATIONS **6**
E. INTRODUCTION. **7**
F. RESULTS & DISCUSSION **9**
F.1. Intensive care demand. 9
F.2. Source of admissions to Scottish ICUs. 21
F.3. Length of stay and bed usage. 25
F.4. Use of Augmented Care Period (ACP) data to determine levels of organ support and levels of care. 37
Ventilation. *39*
Renal replacement therapy. *46*
Pulmonary artery flotation catheters. *48*
Inotropes/vasopressors. *51*
Summary ACP data. *52*
Levels of care. *53*
F.5. Outcomes monitoring: Case mix-adjusted outcome and Statistical Process Control. 58
F.6. Progress of surveillance of healthcare associated infections, antimicotic prescribing and resistance in ICUs in Scotland. 76
G. ACKNOWLEDGEMENTS. **81**
H. REFERENCES. **82**
I. APPENDICES. **84**
Appendix I. Publications, Reports and Abstracts. 84
Appendix II. List of Scottish adult ICUs and the lead audit consultants during the period of reporting. 87

B. FIGURES

Figure 1. Annual admission rates to Scottish ICUs, 1995 - 2004: a) in cohort of 20 units contributing throughout and b) all participating units. 10
Figure 2. Trends in annual admission rates: 2001-2004. 10
Figure 3. Trends in bed occupancies (%) in Scottish ICUs, 2001 - 2004.Figure 4. Scotland's annual ICU bed occupancies, 1996 - 2004. 15
Figure 4. Scotland's annual ICU bed occupancies, 1996 - 2004. 16
Figure 5. Trends in Scottish ICU winter bed occupancies: December - March. 16
Figure 6. Trends in monthly bed occupancies (all units): 2001-2004. 17
Figure 7. Age distribution of admissions to Scottish ICUs in 2004. 18
Figure 8. Gender variation (Male:Female) in admissions to Scottish ICUs in 2004. 19
Figure 9. Trend over time of the percentage of admissions by source to Scottish ICUs. 22
Figure 10. Trend over time of the number of admissions by source to Scottish ICUs. 22
Figure 11. Rate of admitting patients in to Scottish ICUs from other hospitals. 24
Figure 12. Proportion of admissions to Scottish ICUs from other hospitals: 2002, 2003 & 2004. 24
Figure 13. Lengths of stay in Scottish ICUs, 2004 (Mean & Median). 27
Figure 14. Length of ICU stay, 2004 (median and inter-quartile range). Scottish median = 2 days, IQR 0.91-5.25. 28
Figure 15. Median lengths of ICU stay in Scottish ICUs, 2002 – 2004. 29
Figure 16. Mean lengths of ICU stay in Scottish ICUs, 2002 – 2004. 29
Figure 17. Variation in ICU LOS and admission source (2004). 31
Figure 18. Breakdown of proportions of admissions and bed days by admission source to Scottish ICUs (2004). 32
Figure 19. Variation in ICU LOS and body system responsible for admission (APACHE II-scored patients in 2003). 33
Figure 20. Breakdown of proportions of admissions and bed days by system (APACHE II-scored patients in 2003). 34
Figure 21. Operative and non-operative LOS by system (APACHE II-scored patients in 2003). 35
Figure 22. Variation in ICU LOS and age (2004). 36
Figure 23. Proportion of patients ventilated on the first ACP day during 2004. 40
Figure 24. Proportion of patients ventilated at any time during 2004. 40
Figure 25. Proportion of ventilated patients in 2004 who are ventilated on day 1. 43
Figure 26. Proportion of all patients treated in Scottish ICUs in 2004 who are ventilated, per ACP day. Includes the ACP days in 2004 of patients admitted in 2003 whose stay continued into 2004. 44
Figure 27. Proportion of ACP days in which there is ventilatory support: 2004. Mean = 61.8% of ACP days. 45
Figure 28. Provision of renal replacement therapy in 2004. 46
Figure 29. Provision of renal replacement therapy in 2004. Proportion of patients in Scottish ICUs receiving RRT = 9.9%, utilising 9.8% of ACP days. 47
Figure 30. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 4.8%) or at any time during ICU (mean = 8.3%): 2002. 49
Figure 31. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 3.2%) or at any time during ICU (mean = 5.6%): 2003. 49
Figure 32. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 2.7%) or at any time during ICU (mean = 4.7%): 2004. 50
Figure 33. Proportion of patients receiving inotropes/vasopressors in Scottish ICUs: 2004. 51
Figure 34. Updated ACP dataset. 53
Figure 35. Updated ACP screen: Display of number of days at levels 1, 2 or 3. 54
Figure 36. ACP dataset 1999 – 2005. 55
Figure 37. Levels of care determined from the ACP dataset, 2004. 56
Figure 38. Levels of care determined from the ACP dataset, 2003. 57
Figure 39. Levels of care determined from the ACP dataset, 2002. 57
Figure 40. Illness severity: Median APACHE II scores in 2002. Scottish median: 19 (Inter-quartile range: 15 & 26). 61

Figure 41. Illness severity: Median APACHE II scores in 2003. Scottish median: 19 (Inter-quartile range: 14 & 25).....62
Figure 42. Median APACHE II probabilities in 24 units in 2003. Scottish median: 29 (Inter-quartile range: 12.2-52.5). 63
Figure 43. Mortality within subgroup of admissions in which APACHE II methodology applied: 2003. 63
Figure 44. Case mix adjusted SMRs (APACHE II model) in 24 ICUs in 2003. Mean: 0.983 (95% CIs 0.953-1.012). 64
Figure 45. Scottish SMRs (APACHE II) 1995 – 2003. 66
Figure 46. Non-operative SMRs (APACHE II model) in 22 units in 2003. Mean: 1.046 (95% CIs 1.013-1.080). 67
Figure 47. Post-operative SMRs (APACHE II model) in 17 units in 2003. Mean: 0.840 (95% CIs 0.782-0.897). 67
Figure 48. Scottish SMRs by system (2003). 70
Figure 49. Run Chart from one Scottish ICU, 1998 – 2003. 74
Figure 50. Record of infections identified following HELICS/SICSAG protocol. 77
Figure 51. Daily dataset for pilot study.Figure 52. Blood stream infection dataset.....77
Figure 52. Blood stream infection dataset. 78

C. TABLES

Table 1. Annual admission rates to Scottish ICUs, 1996 – 2004. _____11
Table 2. Number of ICU & HDU funded beds used to calculate occupancies in 2002 - 2004._____13
Table 3. Mean number of funded ICU beds in Scotland during 2001 - 2004._____14
Table 4. Summary demographic characteristics of all admissions to Scottish ICUs in 2002-2004. ___18
Table 5. Gender variation (Male:Female) in admissions to Scottish ICUs in 2002-2004. _____20
Table 6. Source of admissions to Scottish ICUs during 2004. _____23
Table 7. Tabulated median and mean lengths of ICU stay, 2004._____25
Table 8. Tabulated median and mean lengths of ICU stay, 2003._____26
Table 9. Tabulated median and mean lengths of ICU stay, 2002._____26
Table 10. Variation in ICU LOS and admission source (2004). _____32
Table 11. Proportion of patients and workload by system (APACHE II-scored patients in 2003). ___34
Table 12. Variation in ICU LOS and age (2004). _____36
Table 13. Six-year trend in proportion (%) of patients ventilated at any time in Scottish ICUs (1999-2004)._____41
Table 14. Six-year trend in proportion (%) of patients ventilated on 1st ACP day in Scottish ICUs (1999-2004). _____42
Table 15. Six-year trend in ventilation rates (1999-2004). _____43
Table 16. Six-year trend in the rates of delivering RRT (1999-2004). _____47
Table 17. Six-year trend in PAFC utilisation rates (1999-2004). _____48
Table 18. Summary ACP data demonstrating the extent of organ support in each ICU during 2004. Includes patients admitted to ICU in 2003, still in ICU in 2004. _____52
Table 19. Summary demographic characteristics of admissions with APACHE probabilities in 2003. 60
Table 20. Summary demographic characteristics of admissions with APACHE probabilities in 2002. 60
Table 21. Annual variation in APACHE II SMRs. _____65
Table 22. Variation in illness severity by system in all scored patients: 2002. _____68
Table 23. Variation in illness severity by system in all scored patients: 2003. _____69
Table 24. Comparison of SMRs within each system during 2001 – 2003. _____69
Table 25. Post-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2003._____71
Table 26. Post-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2002._____71
Table 27. Non-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2003._____72
Table 28. Non-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2002._____72

D. ABBREVIATIONS

ACP	Augmented Care Period
APACHE	Acute Physiology (age) and Chronic Health Evaluation, version II (III)
BSI	Blood stream infection
CCDG	Critical Care Delivery Group
CVC-RI/CRI	Central venous catheter related infection
DDD	Daily defined doses
DGH	District General Hospital
HAI	Hospital Acquired Infection
HDU	High Dependency Unit
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
HPS	Health Protection Scotland
ICNARC	Intensive Care National Audit and Research Centre
ICU	Intensive Care Unit
ICU/HDU	Combined ICU & HDU
IQR	Inter-quartile range
ISD	Information Services Division, NHS Scotland
LOS	Length of stay
PAFC	Pulmonary artery flotation catheter
PN	Pneumonia
RRT	Renal replacement therapy
SCIEH	Scottish Centre for Infection and Environmental Health
SEHD	Scottish Executive Health Department
SICS	Scottish Intensive Care Society
SICSAG	Scottish Intensive Care Society Audit Group
SMC	Scottish Medicines Consortium
SMR	Standardised mortality ratio
SPC	Statistical process control
TISS	Therapeutic Intervention Scoring System

E. INTRODUCTION.

1. This is the 10th Annual Report of the Scottish Intensive Care Society Audit Group (SICSAG). It follows a similar format to recent years. Reported this year are complete data on intensive care unit (ICU) activity and outcome for 2003 and activity data for 2004. Outcome data for 2004 are not yet complete and will be included in the Annual Report in 2006.

2. To keep the report size manageable, unit-specific graphs and tables are not included but are given electronically to lead audit clinicians in each ICU. Data will complement those for Scotland included in this report. Locally, therefore, staff in each unit will be able to present and report on both local and national data.

3. The Scottish intensive care unit audit has grown from an ICU-only system, totally reliant on the APACHE II methodology [1], into a much more comprehensive audit of critical care activity in Scotland. The audit has been a success, not just in a narrow field, but also, in its contribution to the development of intensive care services, organisation and research in Scotland. It has been a source of information for planning of services by Health Boards, the Scottish Medicines Consortium (SMC), the Scottish Executive Health Department (SEHD) and the Chairs of Critical Care Delivery Groups (CCDGs). The audit infrastructure and the collaboration between ICUs has fostered cooperation between units; it has supported the development of both a trials group and an evidence based medicine/standards group. It has also contributed internationally to the methodologies used in audit and there is an extensive list of publications included in Appendix I. Nonetheless, the resources available are quite limited; the SICSAG is never able to do everything it might wish and must prioritise. Unavoidable staff absences have continued to be an issue and have further constrained what it can do.

4. A steering group supervises the audit on behalf of the Scottish Intensive Care Society (SICS). The present structure of the audit seems to have produced a strong feeling of clinical ownership but is dependent on piece-meal funding which makes

staff recruitment, retention and development particularly challenging. The staffing lacks the critical mass to give long-term security. Closer links have been developed with the Information Services Division (ISD) of NHS Scotland and there has been a decision in principle by SICS Council that the long-term future of the SICSAG would be best secured within that organisation.

5. Since the last Annual Report [2], the audit group has been revising the minimum dataset, including the augmented care period (ACP) definitions, removing extraneous datafields, updating the diagnostic list, as well as piloting the audit of Healthcare Associated Infections (HAI) within a small number of volunteer ICUs. This has meant that there have been several software updates and we will be attempting to ensure that all units are on the same version as quickly as possible. Staffing issues have meant that the rollout of the updated software has not been as quick as would have been liked. Work has been commissioned to make better use of IT solutions.

6. Twenty-seven high dependency units (HDUs) participated for all or part of 2004, collecting a minimum dataset on Ward Watcher (Critical Care Audit Ltd, Yorkshire). Almost all data collection in the HDUs is conducted by nursing staff. No HDU results are included in this report. Only a few HDU consultants have demonstrated any great interest in the audit; the audit group and the local HDU staff greatly appreciate their continued support and advice.

7. The whole audit, including this report, is only possible as a result of the support of ***all*** participating staff in critical care in Scotland. In nearly all units, they bear the burden of data entry without any dedicated staffing. It is important that data are collected in both an accurate and timely manner and the audit group want to pay tribute to the staff who do this.

F. RESULTS & DISCUSSION

In all graphs * identifies District General Hospitals (DGHs) and ^ identifies combined HDU/ICUs during the period identified, unless stated differently. Appendix II contains a list of all participating units and the acronyms used to identify them in the workload and organ support figures.

F.1. Intensive care demand.

8. Figure 1 shows the trend in annual ICU admissions in all units, which have contributed data over the period 1995-2004, and in those 20 that have participated throughout this 10-year period. For the few units that joined the audit in the early months of 1995 the numbers of admissions were annualised for that year. The number of participating ICUs has remained stable since 2001; until then the increase in admissions was partially due to the increase in participating units. Details of each unit's participation are contained in Table 1.

9. Figure 2 and Table 1 demonstrate the annual number of admissions to individual ICUs since 1996. It can be seen that the overall increase in numbers is not evenly distributed across units. This is partly due to changes in available beds. Though there was very little increase in bed complement in 2004, increases made in 2003 were still working through. In particular, this explains the very large increase in admissions to the Royal Infirmary of Edinburgh. The increase in combined intensive care and high dependency care units (ICU/HDUs) that enter patients of both levels of dependency into the audit has made raw admission numbers difficult to interpret.

Figure 1. Annual admission rates to Scottish ICUs, 1995 - 2004: a) in cohort of 20 units contributing throughout and b) all participating units.

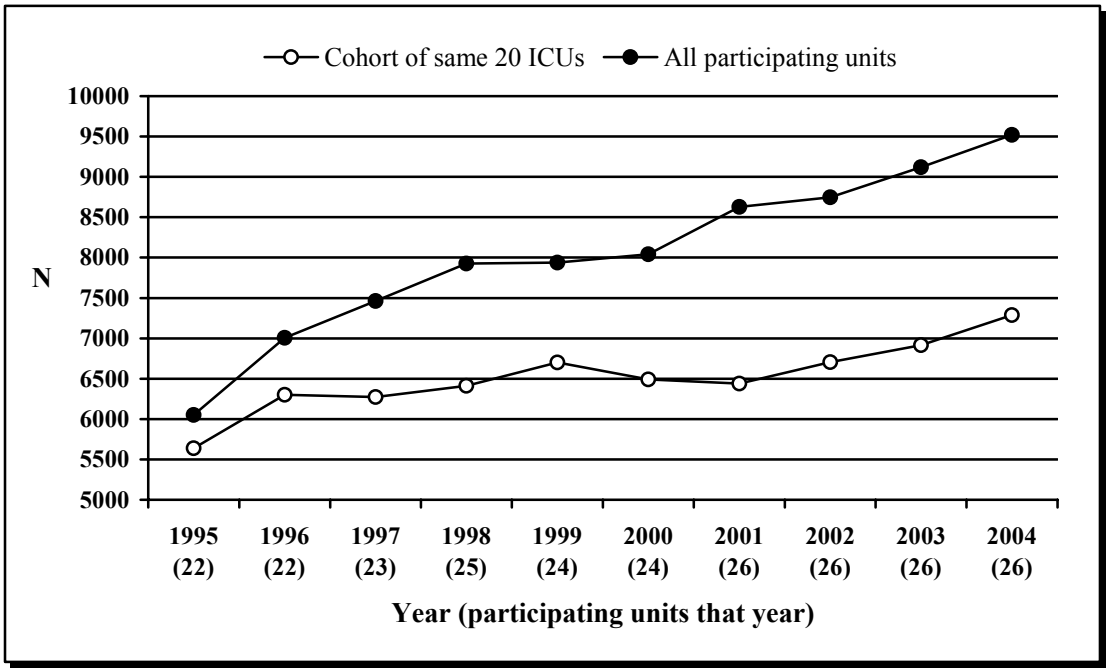


Figure 2. Trends in annual admission rates: 2001-2004.

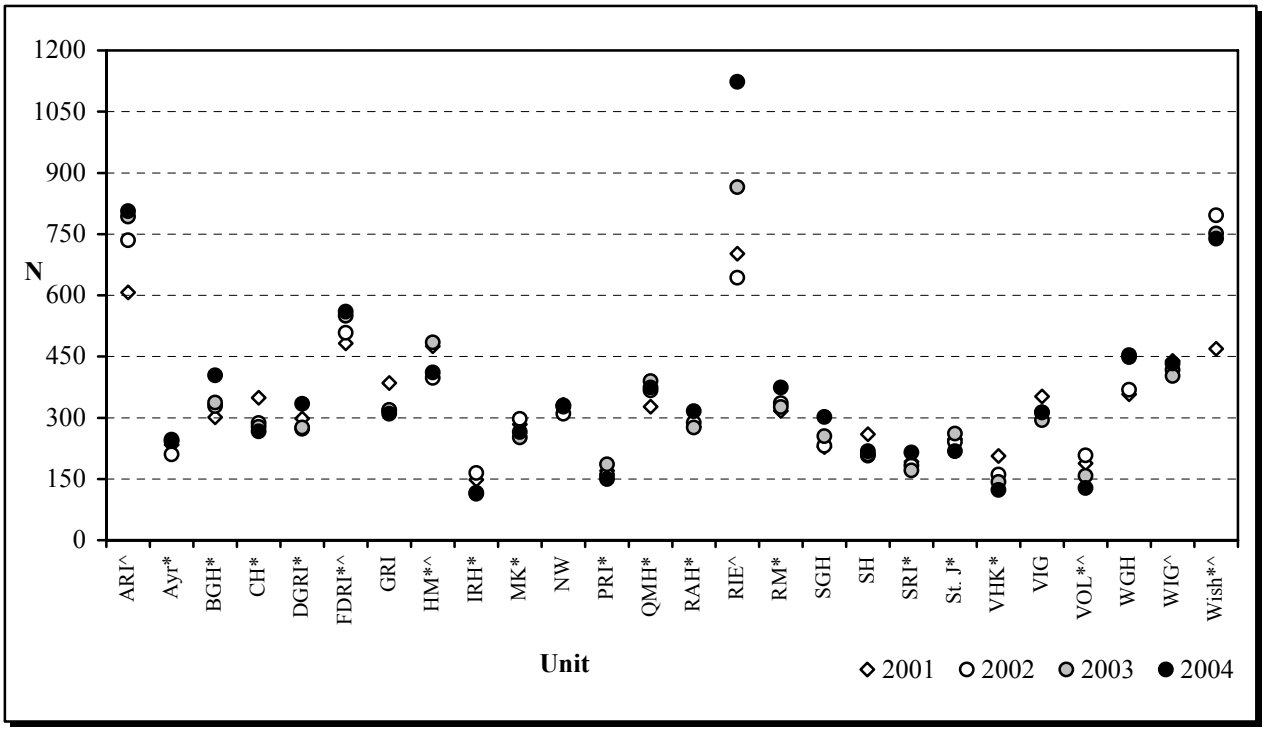


Table 1. Annual admission rates to Scottish ICUs, 1996 – 2004.

Unit	1996	1997	1998	1999	2000	2001	2002	2003	2004
ARI^	531	564	591	606	624	607	735	793	806
Ayr*			335	303	268	234	210	246	242
BGH*	314	298	335	375	322	301	329	337	404
CH*	378	353	350	364	320	349	287	278	267
DGRI*			279	405	392	298	273	276	334
FDRI*^	466	530	*126*			482	508	550	560
GRI		429	436	384	387	385	317	319	310
HM*^				145	504	475	398	485	411
IRH*	196	212	224	188	156	148	165	116	114
MK*	290	268	323	331	334	284	297	252	265
NW	282	277	297	337	339	332	310	330	327
PRI*	236	222	204	190	236	170	159	186	150
QMH*	471	475	549	407	354	327	367	390	374
RAH*	320	387	372	426	359	278	288	276	316
RIE^	600	576	546	651	655	702	643	865	1123
RM*	247	229	262			317	336	326	374
SGH	287	287	245	250	280	228	231	255	302
SH	255	267	225	242	236	260	207	210	218
SRI*	209	161	145	177	219	192	183	171	215
St. J*	236	201	223	260	281	248	241	261	218
VHK*	250	232	329	271	204	206	161	143	123
VIG	321	303	289	318	317	352	313	294	313
VOL*^	203	199	197	247	185	188	208	158	128
WGH	384	316	328	339	383	358	369	449	453
WIG^	403	466	476	456	446	439	417	402	433
Wish*^	183	210	239	266	239	469	796	751	739

FDRI 1998*: Participated January – March 1998.*
GRI 1997*: Participation began in 1997. 344 records were imported into central database, however, data were collected retrospectively on GRI's own database to complete the year's total of 429 admissions.*
HM 1999*: 145 records for participation late in 1999.*

10. Table 2 identifies the fluctuation in funded bed numbers during 2002 – 2004, in some instances monthly. A number of units have now both ICU (level 3) beds and HDU (level 2) beds located in the same unit, as indicated in Table 2. In these units, all consecutive admissions, whether level 3 or level 2, are entered onto the audit software. To determine bed occupancy as accurately as possible, therefore, SICSAG must know the correct number of available funded beds in each unit, whether level 2 or level 3. Obtaining reliable information can be surprisingly difficult and the audit group relies on senior staff in each ICU providing details of any changes, particularly increases in funded beds over the winter months. In the ICU/HDUs, the total numbers of funded beds are used to derive bed occupancy. As some units have to convert 2 HDU beds to accommodate 1 extra ICU admission, this methodology inevitably overestimates bed availability so underestimating bed occupancy.

11. The number of available ICU beds has risen very slightly from 144.5 in December 2003 to 146.8 in December 2004 (Table 2), However, because of the fluctuation of bed numbers, it is necessary to calculate the mean number of funded ICU beds over each year for Scotland to calculate occupancy. There has been an increase in the mean number of ICU beds in Scotland from 112 beds in 1996 to 145.4 in 2004 (Table 3).

12. Trends in annual bed occupancies per unit are demonstrated in Figure 3. Each unit's percentage annual bed occupancy is derived from the mean of the twelve monthly occupancies for each year, based on the total number of funded beds identified to SICSAG (Table 2) for each month. The most noticeable change is seen in the occupancy at Inverclyde Royal Hospital, which has fallen from 83% in 2003 to 51% in 2004 (Figure 3). This, and other units' occupancies are discussed further in section F.3.

Table 2. Number of ICU & HDU funded beds used to calculate occupancies in 2002 - 2004.

Unit	2002	2003	2004
ARI^	10 ICU (Jan-Mar); 12 ICU+4HDU (Apr-Dec)	12 ICU+4HDU	12 ICU+4HDU
Ayr*	4	4	4
BGH*	3 (Jan-Sep); 4 (Oct-Dec)	4 (Jan-Mar & Oct-Dec); 3 (Apr-Sep)	4
CH*	5	5 (Jan-Oct); 5.5 (Nov-Dec)	5.5
DGRI*	6 (Jan-Mar); 4 (Apr-Dec)	4	4
FDRI*^	5 ICU + 3 HDU	5 ICU + 3 HDU	5 ICU + 3 HDU
GRI	7	7	7
HM*^	5 ICU + 2 HDU	5 ICU + 2 HDU	5.25 ICU + 1.75 HDU
IRH*	2	2 (Jan-Apr); 3 (May-Dec)	3
MK*	5 (Jan-Nov); 6 (Dec)	6 (Jan-Mar & Dec); 5 (Apr-Nov)	6 (Jan-Mar & Dec); 5 (Apr-Nov)
NW	7	7	7
PRI*	3	3	3
QMH*	7	7	7
RAH*	4	4 (Jan-Oct); 6 (Nov-Dec)	6
RIE^	12 (Jan-Mar); 11 (Apr-Dec)	12 ICU (Jan-Mar); 11 ICU (Apr); 11 ICU+ 6 HDU (May-Dec)	12 ICU + 6 HDU (Jan-Sept); 13 ICU+ 5 HDU (Oct-Dec)
RM*	7 (Jan-Mar); 6 (Apr-Dec)	6	6 (Jan-Mar); 7 (Apr-Dec)
SGH	5	5	5
SH	5	6	6 (Jan-Oct); 5 (Nov-Dec)
SRI*	4	4	4
St. J*	4	4	5 (Jan-Mar); 4 (Apr-Dec)
VHK*	3	3	3
VIG	5	5	5
VOL*^	2 ICU + 2 HDU	2 ICU + 2 HDU (Jan-Sep); 2 ICU + 1 HDU (Oct-Dec)	1 ICU + 2 HDU
WGH	8	8	8 (Jan-Sept); 9 (Oct-Dec)
WIG^	7 ICU (Jan-Mar); 7 ICU + 2 HDU (Apr-Dec)	7 ICU + 2 HDU	7 ICU + 2 HDU
Wish*^	5 ICU + 7 HDU	5 ICU + 7 HDU	5 ICU + 7 HDU (Jan-Jun); 5 ICU + 6 HDU (Jul-Dec)

Table 3. Mean number of funded ICU beds in Scotland during 2001 - 2004.

HEALTH BOARD	HOSPITAL	Mean number of funded ICU beds			
		2001	2002	2003	2004
Argyll & Clyde	Inverclyde Royal Hospital	2	2	2.7	3
	Royal Alexandra Hospital	4	4	4.3	6
	Vale of Leven DGH	2	2	2	1
	Total for Health Board	***8***	***8***	***9***	***10***
Ayrshire & Arran	Ayr Hospital	4	4	4	4
	Crosshouse Hospital	5	5	5.1	5.5
	Total for Health Board	***9***	***9***	***9.1***	***9.5***
Borders	Borders General Hospital	3	3.3	3.5	4
	Total for Health Board	***3***	***3.3***	***3.5***	***4***
Dumfries & Galloway	Dumfries Royal Infirmary	4	4	4	4
	Total for Health Board	***4***	***4***	***4***	***4***
Fife	Victoria Hospital Kirkcaldy	3.9	3	3	3
	Queen Margaret Hospital	6.1	7	7	7
	Total for Health Board	***10***	***10***	***10***	***10***
Forth Valley	Stirling Royal Infirmary	4	4	4	4
	Falkirk Royal Infirmary	5	5	5	5
	Total for Health Board	***9***	***9***	***9***	***9***
Grampian	Aberdeen Royal Infirmary	9.3	11.5	12	12
	Total for Health Board	***9.3***	***11.5***	***12***	***12***
Greater Glasgow	Glasgow Royal Infirmary	7	7	7	7
	Southern General Hospital	5	5	5	5
	Stobhill Hospital	5	5	6	5.8
	Victoria Infirmary	5	5	5	5
	Western Infirmary	7	7	7	7
	Total for Health Board	***29***	***29***	***30***	***29.8***
Highland	Raigmore Hospital	6.1	6.3	6	6.75
	Total for Health Board	***6.1***	***6.3***	***6***	***6.75***
Lanarkshire	Hairmyres Hospital	5.3	5	5	5.25
	Wishaw (Law) Hospital	5	5	5	5
	Monklands Hospital	5.3	5.1	5.3	5.3
	Total for Health Board	***15.5***	***15.1***	***15.3***	***15.55***
Lothian	Royal Infirmary of Edinburgh	11.3	11.3	11.3	12.25
	Western General Hospital	8	8	8	8.25
	St. John's Hospital	4.3	4	4	4.25
	Total for Health Board	***23.6***	***23.3***	***23.3***	***24.75***
Tayside	Ninewells Hospital	7	7	7	7
	Perth Royal Infirmary	3	3	3	3
	Total for Health Board	***10***	***10***	***10***	***10***
	SCOTLAND	**136.5**	**138.5**	**141.2**	**145.35**

13. The limited increase in funded beds has resulted in a small fall in average occupancy over the last few years from 80% in 2002 to 74% in 2004 (Figure 4). It is important to note that this is measured on a minute-to-minute basis. Nineteen (73%) units had average occupancies of at least 70% during 2004. The fall in occupancy must be interpreted in the light of the increasing numbers of HDU patients entered into the audit, referred to in Paragraph 10. If these were elective surgical patients then a reduction in occupancy would be expected, as elective surgery does not take place at weekends.

Figure 3. Trends in bed occupancies (%) in Scottish ICUs, 2001 - 2004.

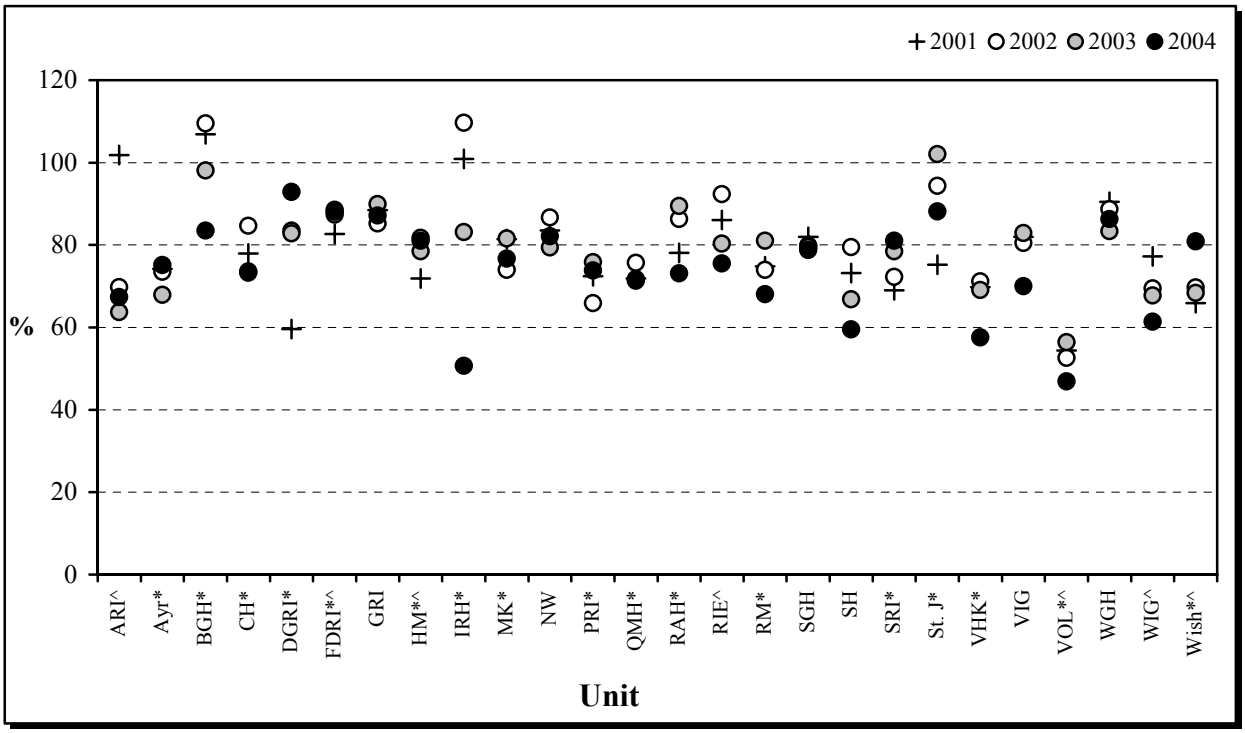
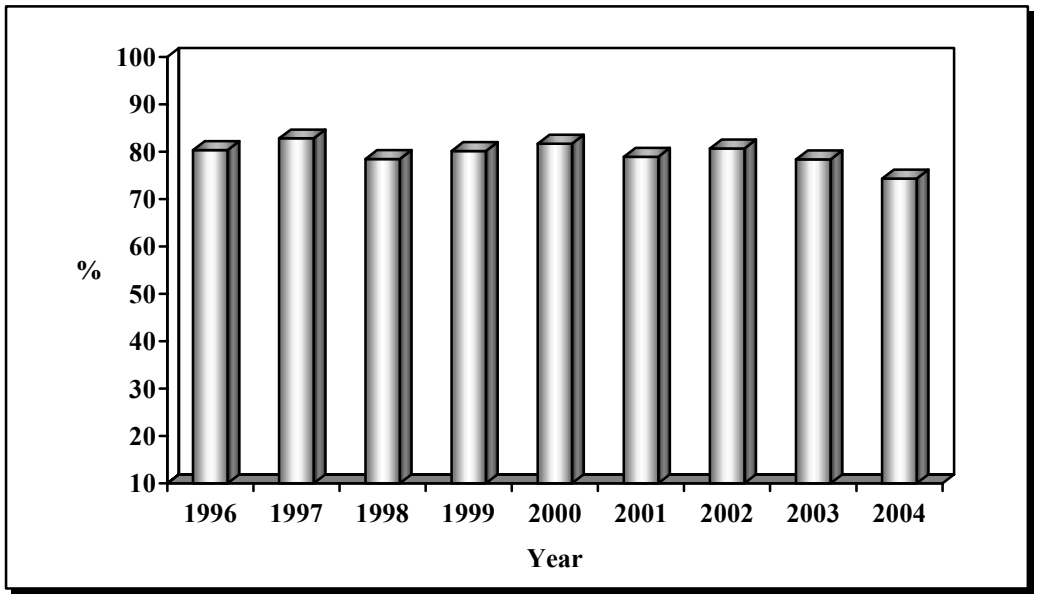


Figure 4. Scotland's annual ICU bed occupancies, 1996 - 2004.



14. The period between December and March is a time when it is thought ICUs are most consistently under pressure. Figure 5 details the trend in winter occupancy from 1996 – 2004. January 2000 remains exceptional. Figure 6, however, demonstrates the continuous pressure on ICU resources throughout the year, though January or February have been the busiest months in four of the last five years.

Figure 5. Trends in Scottish ICU winter bed occupancies: December - March.

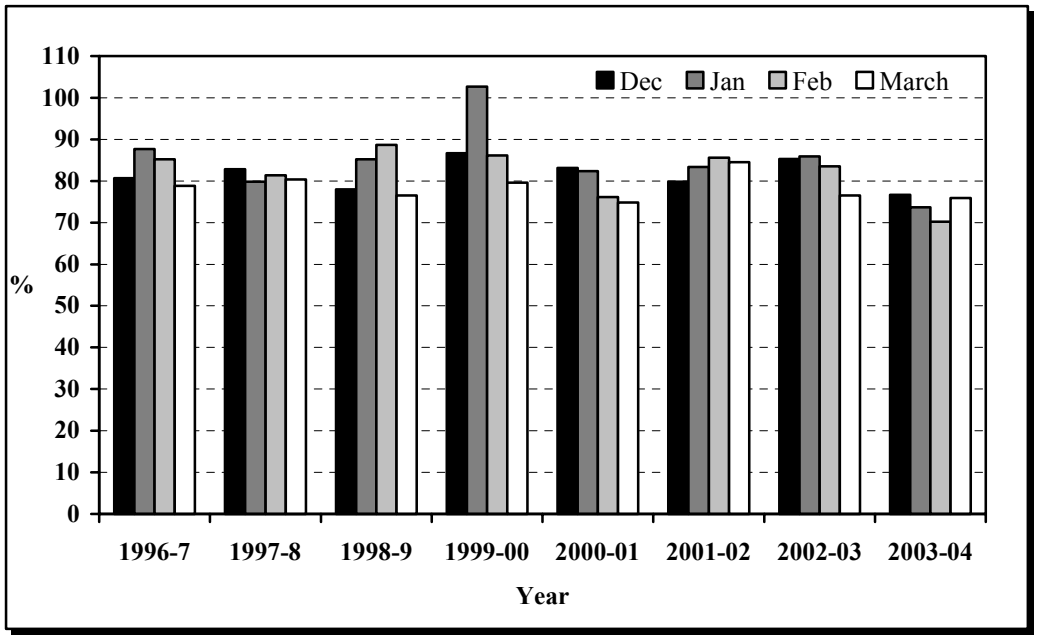
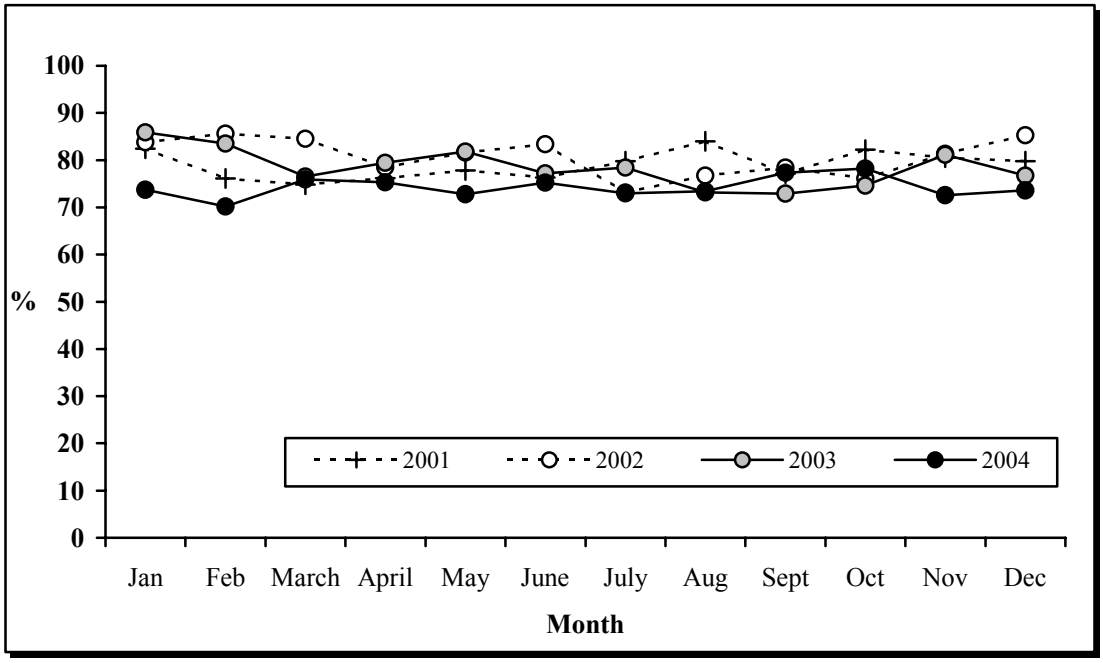


Figure 6. Trends in monthly bed occupancies (all units): 2001-2004.



15. Summary characteristics of admissions during 2002 to 2004 are given in Table 4. There has been little change in this period.

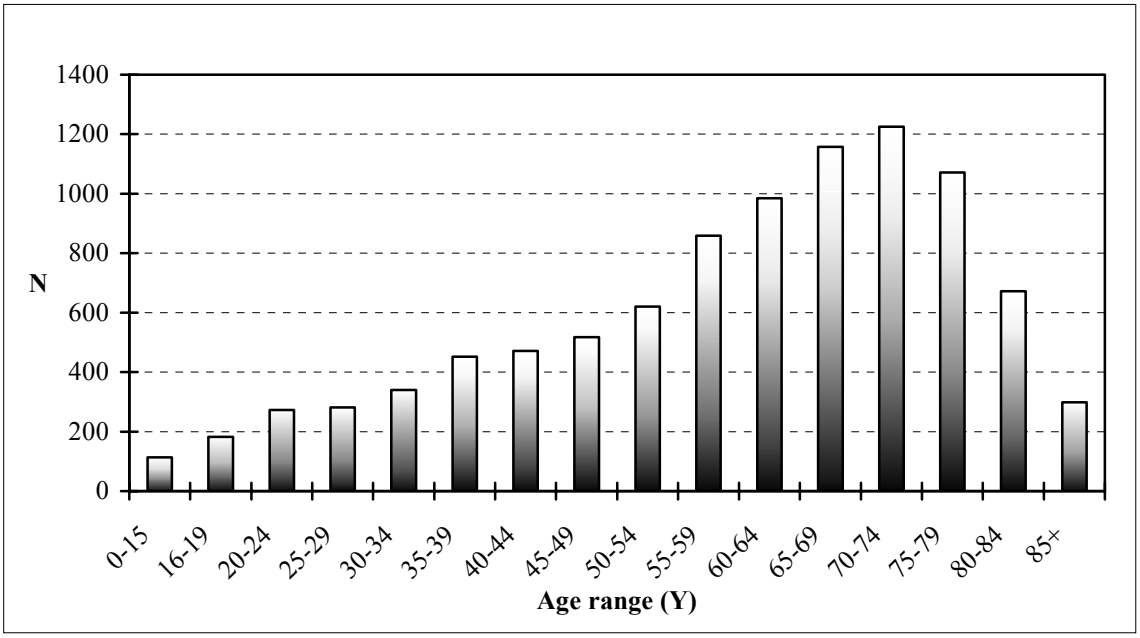
16. In the majority of patients, the ultimate hospital outcome is discharge from the admitting hospital. However, a number of patients are transferred to another hospital either for an increase in care or for step-down care. Where no ultimate hospital outcome is available for an ICU episode on a unit's database, because the patient has been transferred, extensive collaboration between SICSAG and ISD exists to provide record linkage to the Scottish Morbidity Records. This linkage enables the outcome recorded at the end of the continuous in-patient stay in the Scottish Morbidity Record to be used as the ultimate outcome. If the linkage fails, the hospital outcome on the ICU record is used.

Table 4. Summary demographic characteristics of all admissions to Scottish ICUs in 2002-2004.

	All admissions 2002	All admissions 2003	All admissions 2004
N	8748	9119	9519
Operative (%)	41.6	41.2	43.0
Non-operative (%)	58.4	58.8	57.0
Male (%)	55.8	54.5	55.6
Female (%)	44.2	45.5	44.4
Age (y) (Mean)	58.9	59.2	59.0
Age (y) (Range)	0-103	0-102	0-103
Length of ICU Stay (d) (Mean)	5.2	5.0	4.8
Length of ICU Stay (d) (Median)	2.0	2.0	2.0
Length of ICU Stay (d) (Range)	177.7	119.0	201.4
ICU Mortality (%)	21.9	21.3	not available
Hospital Mortality (%)	29.4	29	
Ultimate Hospital Mortality (%)	32.2	32.3	

17. The distribution of admissions by age is shown in Figure 7.

Figure 7. Age distribution of admissions to Scottish ICUs in 2004.



18. For the fist time we have looked at gender variation (Figure 8 and Table 5) Overall, in common with the published literature, Scotland has preponderance of male admissions, but there is surprising variation between units.

Figure 8. Gender variation (Male:Female) in admissions to Scottish ICUs in 2004.

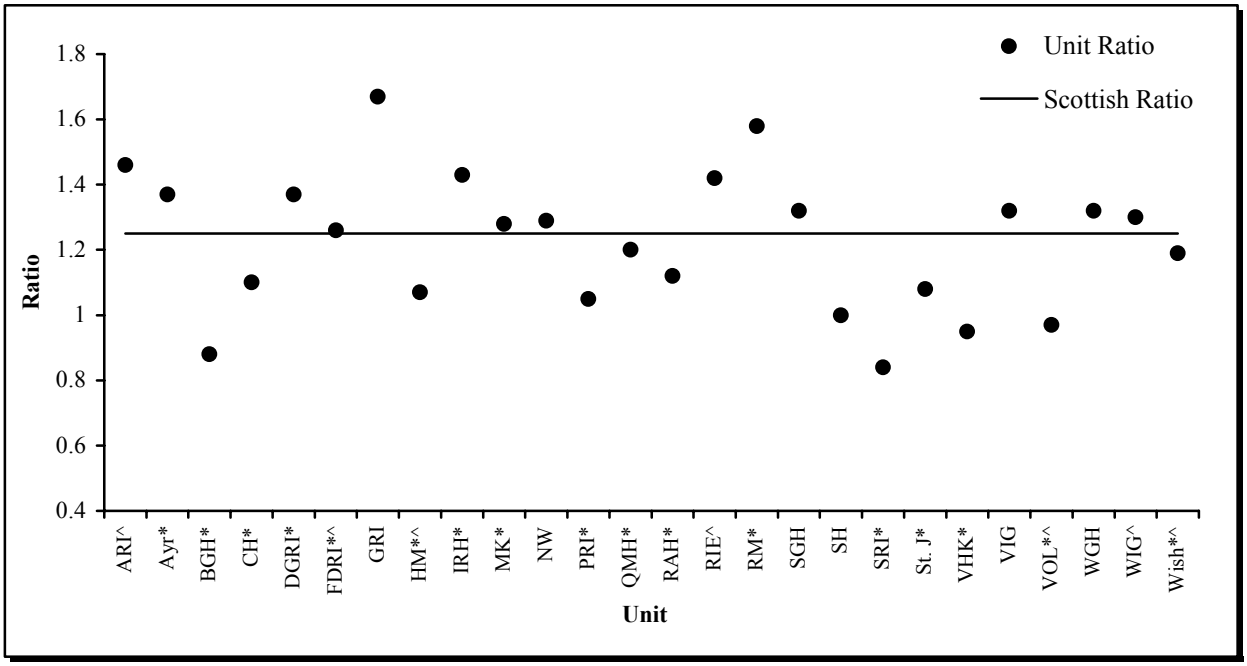


Table 5. Gender variation (Male:Female) in admissions to Scottish ICUs in 2002-2004.

	2002	2003	2004
SRI*	1.03	1.41	0.84
BGH*	1.14	0.77	0.88
VHK*	0.64	0.91	0.95
VOL*^	0.76	0.74	0.97
SH	0.99	1.16	1.00
PRI*	1.15	1.09	1.05
HM*^	1.25	1.10	1.07
St. J*	1.03	1.04	1.08
CH*	1.43	1.28	1.10
RAH*	1.10	1.34	1.12
Wish*^	1.16	0.98	1.19
QMH*	1.27	0.92	1.20
FDRI*^	1.30	1.08	1.26
MK*	1.36	1.60	1.28
NW	1.44	1.32	1.29
WIG^	1.66	1.34	1.30
VIG	1.30	1.51	1.32
SGH	1.26	1.02	1.32
WGH	1.22	1.28	1.32
DGRI*	1.37	1.38	1.37
Ayr*	1.47	1.18	1.37
RIE^	1.44	1.38	1.42
IRH*	1.12	0.93	1.43
ARI^	1.47	1.51	1.46
RM*	1.23	1.31	1.58
GRI	1.54	1.38	1.67
SCOTLAND	1.26	1.20	1.25

F.2. Source of admissions to Scottish ICUs.

19. Previous reports have demonstrated trends over time in the sources from which patients are admitted in to Scottish ICUs. The dataset requires source of admission to be recorded for every admission as follows (datafield = "Admitted from (type)"):

- 01. A&E in this hospital
- 02. Recovery/theatre in this hospital
- 03. Recovery only, in this hospital
- 04. Ward in this hospital
- 05. ICU in this hospital
- 06. HDU in this hospital
- 07. Other intermediate care area (not ICU or HDU) in this hospital
- 08. X-Ray, endoscopy suite, CT scanner or similar in this hospital
- 09. ICU in another hospital
- 10. HDU in another hospital
- 11. Other area in another hospital (not ICU or HDU)
- 12. Normal residence

The sources 03, 04, 07 & 08 above have been amalgamated into the category "Ward this hosp.", in Figures 9 and 10 and Table 6. Source 11 is "Ward other hosp." and 12 is "Home".

20. Figures 9 and 10 show that the reduction in the percentage and absolute numbers of patients admitted to ICU from theatre between 1998 and 2000 has reversed and, in fact, the number admitted from theatre was greatest in 2004. While the relative increase in numbers from ward and HDU in the same hospital has levelled off, admissions from A&E continue to rise. There continues to be a large variation in admission source between hospitals (Table 6).

Figure 9. Trend over time of the percentage of admissions by source to Scottish ICUs.

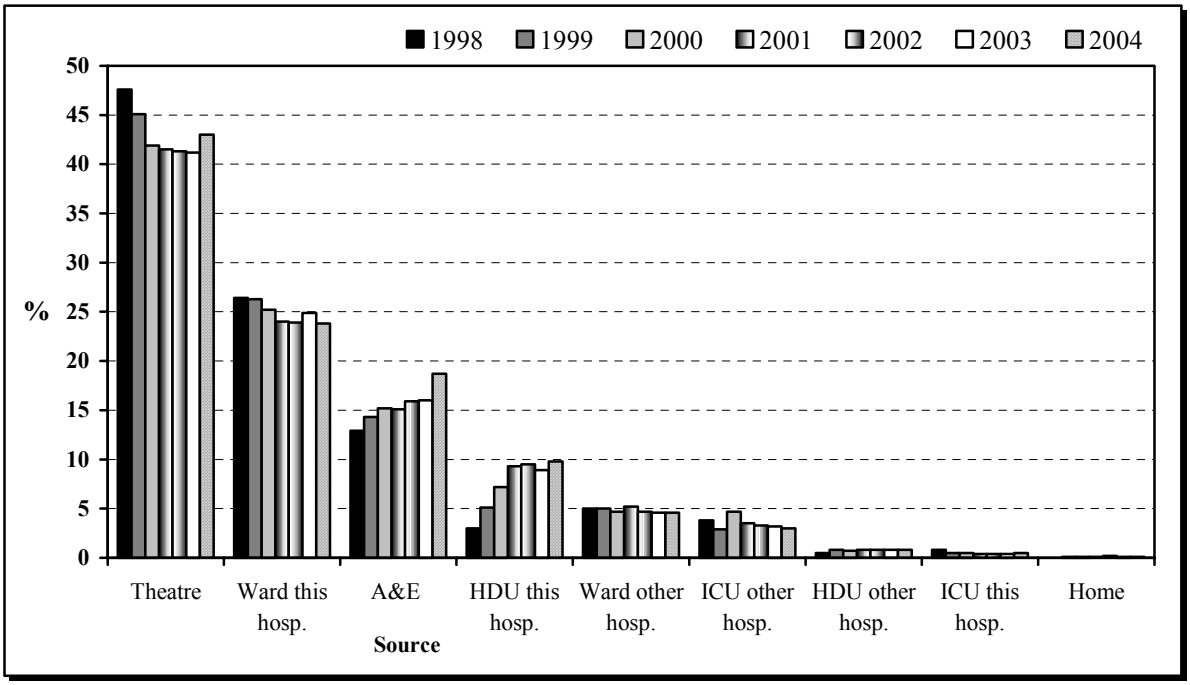


Figure 10. Trend over time of the number of admissions by source to Scottish ICUs.

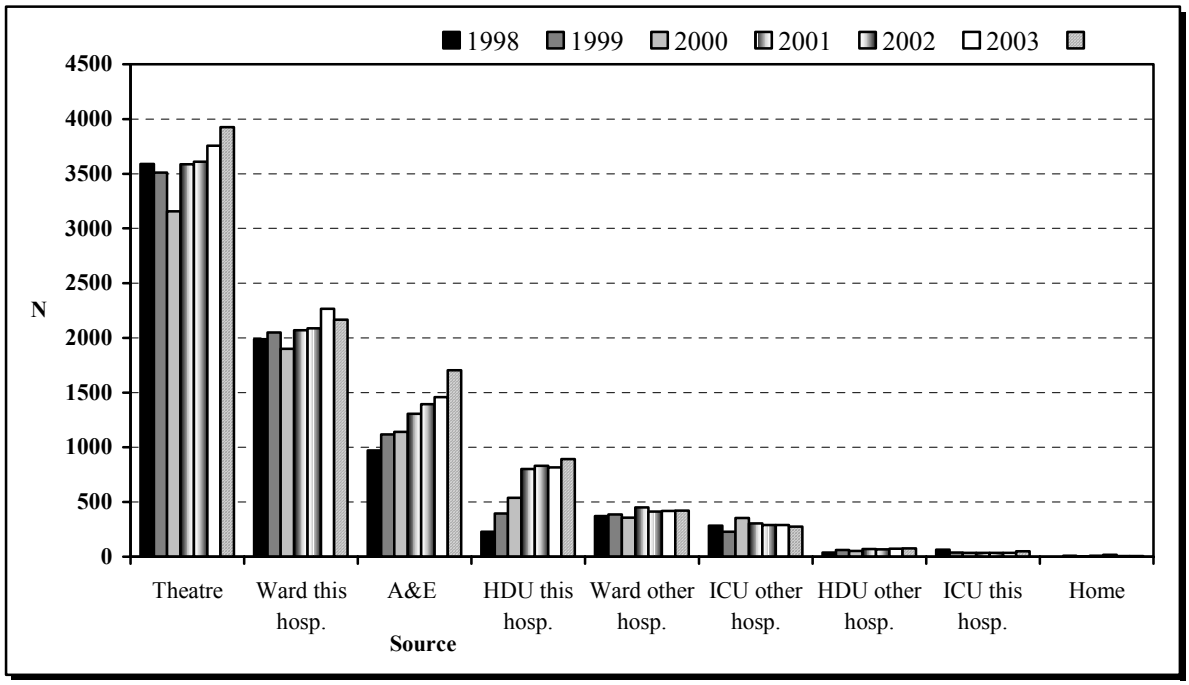


Table 6. Source of admissions to Scottish ICUs during 2004.

	Theatre		Ward this hosp.		A&E		HDU this hosp.		Ward other hosp.		ICU other hosp.		HDU other hosp.		ICU this hosp.		Home	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
ARI^	270	33.5	301	37.3	59	7.3	64	7.9	71	8.8	11	1.4	17	2.1	13	1.6	0	0.0
Ayr*	116	47.9	42	17.4	43	17.8	21	8.7	12	5.0	7	2.9	1	0.4	0	0.0	0	0.0
BGH*	224	55.4	139	34.4	38	9.4	0	0.0	0	0.0	3	0.7	0	0.0	0	0.0	0	0.0
CH*	104	39.0	47	17.6	60	22.5	36	13.5	11	4.1	7	2.6	2	0.7	0	0.0	0	0.0
DGRI*	206	61.7	38	11.4	36	10.8	49	14.7	5	1.5	0	0.0	0	0.0	0	0.0	0	0.0
FDRI*^	309	55.2	123	22.0	85	15.2	10	1.8	4	0.7	9	1.6	2	0.4	15	2.7	3	0.5
GRI	103	33.2	67	21.6	47	15.2	43	13.9	20	6.5	24	7.7	3	1.0	3	1.0	0	0.0
HM*^	210	51.1	98	23.8	49	11.9	33	8.0	6	1.5	13	3.2	1	0.2	1	0.2	0	0.0
IRH*	32	28.1	33	28.9	30	26.3	16	14.0	0	0.0	2	1.8	1	0.9	0	0.0	0	0.0
MK*	106	40.0	75	28.3	53	20.0	22	8.3	6	2.3	2	0.8	1	0.4	0	0.0	0	0.0
NW	148	45.3	72	22.0	54	16.5	41	12.5	2	0.6	9	2.8	1	0.3	0	0.0	0	0.0
PRI*	85	56.7	14	9.3	27	18.0	15	10.0	7	4.7	1	0.7	0	0.0	0	0.0	1	0.7
QMH*	179	47.9	44	11.8	67	17.9	52	13.9	17	4.5	14	3.7	1	0.3	0	0.0	0	0.0
RAH*	129	40.8	74	23.4	63	19.9	33	10.4	6	1.9	9	2.8	2	0.6	0	0.0	0	0.0
RIE^	392	34.9	193	17.2	320	28.5	118	10.5	34	3.0	38	3.4	20	1.8	8	0.7	0	0.0
RM*	162	43.3	77	20.6	55	14.7	58	15.5	14	3.7	2	0.5	6	1.6	0	0.0	0	0.0
SGH	105	34.8	47	15.6	83	27.5	30	9.9	22	7.3	9	3.0	2	0.7	4	1.3	0	0.0
SH	51	23.4	51	23.4	18	8.3	24	11.0	44	20.2	24	11.0	6	2.8	0	0.0	0	0.0
SRI*	91	42.3	42	19.5	41	19.1	25	11.6	7	3.3	9	4.2	0	0.0	0	0.0	0	0.0
St. J*	58	26.6	49	22.5	65	29.8	32	14.7	5	2.3	9	4.1	0	0.0	0	0.0	0	0.0
VHK*	10	8.1	56	45.5	40	32.5	0	0.0	9	7.3	8	6.5	0	0.0	0	0.0	0	0.0
VIG	68	21.7	79	25.2	96	30.7	30	9.6	26	8.3	13	4.2	1	0.3	0	0.0	0	0.0
VOL*^	37	28.9	40	31.3	47	36.7	0	0.0	1	0.8	1	0.8	0	0.0	1	0.8	1	0.8
WGH	148	32.7	88	19.4	60	13.2	87	19.2	50	11.0	19	4.2	1	0.2	0	0.0	0	0.0
WIG^	131	30.3	123	28.4	76	17.6	33	7.6	36	8.3	22	5.1	8	1.8	4	0.9	0	0.0
Wish*^	451	61.0	156	21.1	91	12.3	22	3.0	7	0.9	10	1.4	1	0.1	0	0.0	1	0.1
Scotland	**3925**	**43.0**	**2168**	**23.8**	**1703**	**18.7**	**894**	**9.8**	**422**	**4.6**	**275**	**3.0**	**77**	**0.8**	**49**	**0.5**	**6**	**0.1**

21. Transfers between hospitals were dealt with in great detail in last year's report and this detail will not be repeated this year [2]. It can be seen from Figure 11, that the overall numbers involved have not changed. This is supported by Figure 12, which shows that, while there is considerable variation between hospitals, there has been little change in the proportion admitted form other hospitals between 2003 and 2004.

Figure 11. Rate of admitting patients in to Scottish ICUs from other hospitals.

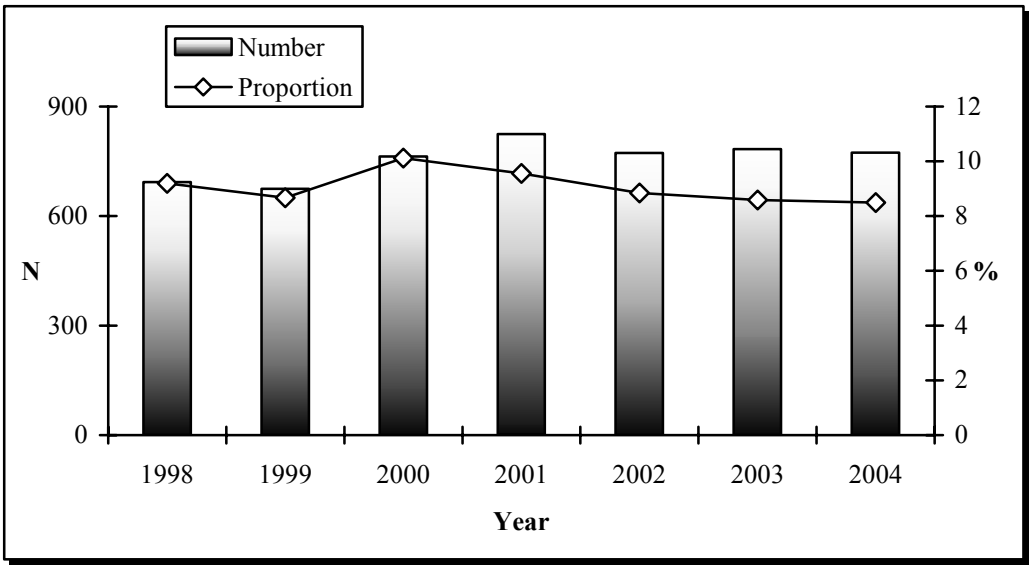
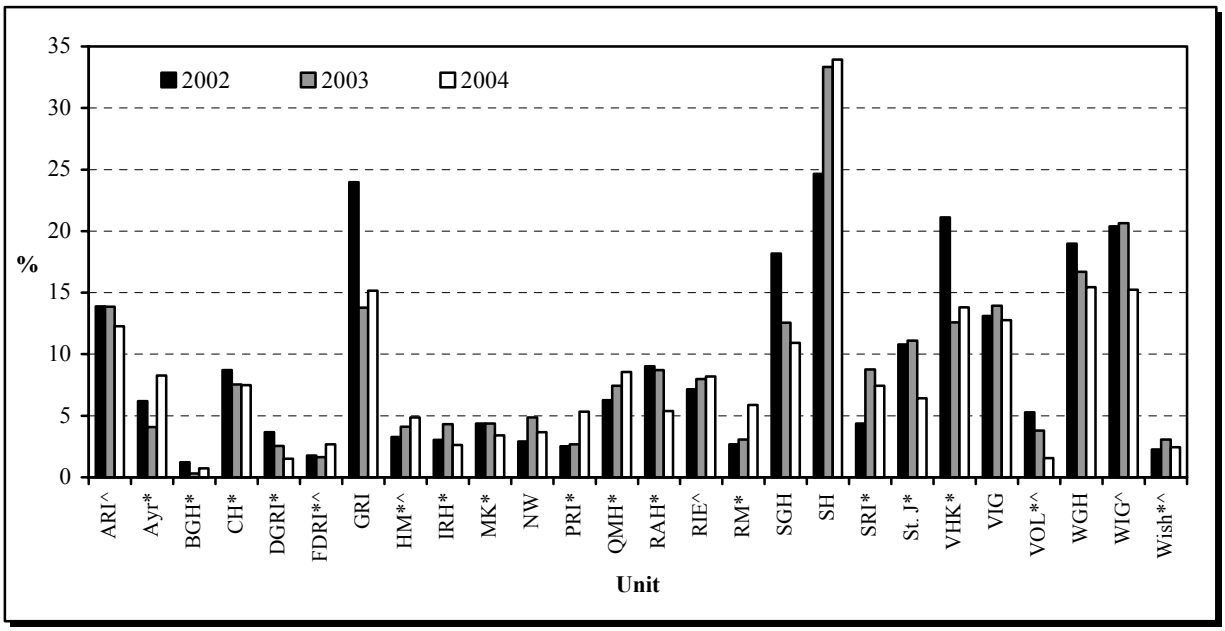


Figure 12. Proportion of admissions to Scottish ICUs from other hospitals: 2002, 2003 & 2004.



F.3. Length of stay and bed usage.

22. Tables 7 to 9 and Figures 13 to 16 show ICU lengths of stay (LOS) in the most recent calendar year, 2004, as well as the two preceding years. Although median LOS is the more appropriate way to describe the data (LOS is not normally distributed), both measures have value. The mean LOS can be heavily influenced by a small number of patients with a prolonged ICU stay. The practical consequences within a unit are to markedly increase occupancy and reduce the number of beds available for new admissions, with potential impact on the service. The effect can be especially marked in smaller units.

23. Median LOS has been stable year-on-year in Scotland, at 2.0 d, while the mean has fallen slightly to 4.8 d in 2004 from 5.2 d in 2002 (Tables 7 to 9).

Table 7. Tabulated median and mean lengths of ICU stay, 2004.

Unit	ICU LOS(d)					
	Median	Lower IQR	Upper IQR	Mean	Minimum	Maximum
ARI^	2.0	0.9	5.4	4.8	0.0	57.8
Ayr*	1.8	0.9	4.5	4.4	0.0	37.0
BGH*	1.2	0.7	2.9	2.9	0.0	32.4
CH*	1.8	0.8	5.0	5.3	0.0	201.4
DGRI*	2.1	0.9	5.0	4.1	0.0	38.5
FDRI*^	2.9	1.0	5.7	4.7	0.0	112.0
GRI	2.6	0.9	8.7	7.1	0.0	110.8
HM*^	2.1	1.1	5.3	4.9	0.0	76.0
IRH*	1.7	0.6	5.0	4.7	0.1	50.3
MK*	1.5	0.7	5.6	5.6	0.1	81.0
NW	2.6	1.0	6.0	6.1	0.0	79.0
PRI*	1.9	1.0	3.4	4.1	0.0	71.5
QMH*	1.8	1.0	4.8	4.8	0.0	51.4
RAH*	1.8	0.8	5.7	4.9	0.0	40.9
RIE^	1.9	0.8	4.1	4.3	0.0	54.4
RM*	1.9	0.9	5.1	4.6	0.0	50.6
SGH	2.1	0.9	6.1	4.7	0.1	39.4
SH	2.6	1.0	8.0	5.9	0.0	58.7
SRI*	2.0	0.9	6.7	5.5	0.0	63.2
St. J*	1.9	0.9	5.9	5.9	0.0	49.1
VHK*	1.8	0.8	3.9	5.4	0.0	71.8
VIG	2.2	0.8	4.9	4.1	0.0	33.9
VOL*^	1.7	0.9	3.8	4.2	0.0	92.5
WGH	2.8	1.0	7.2	5.8	0.1	48.6
WIG^	2.2	1.0	5.7	4.6	0.0	47.8
Wish*^	2.6	1.1	5.1	4.7	0.0	76.8
Scotland	2.0	0.9	5.3	4.8	0.0	201.4

Table 8. Tabulated median and mean lengths of ICU stay, 2003.

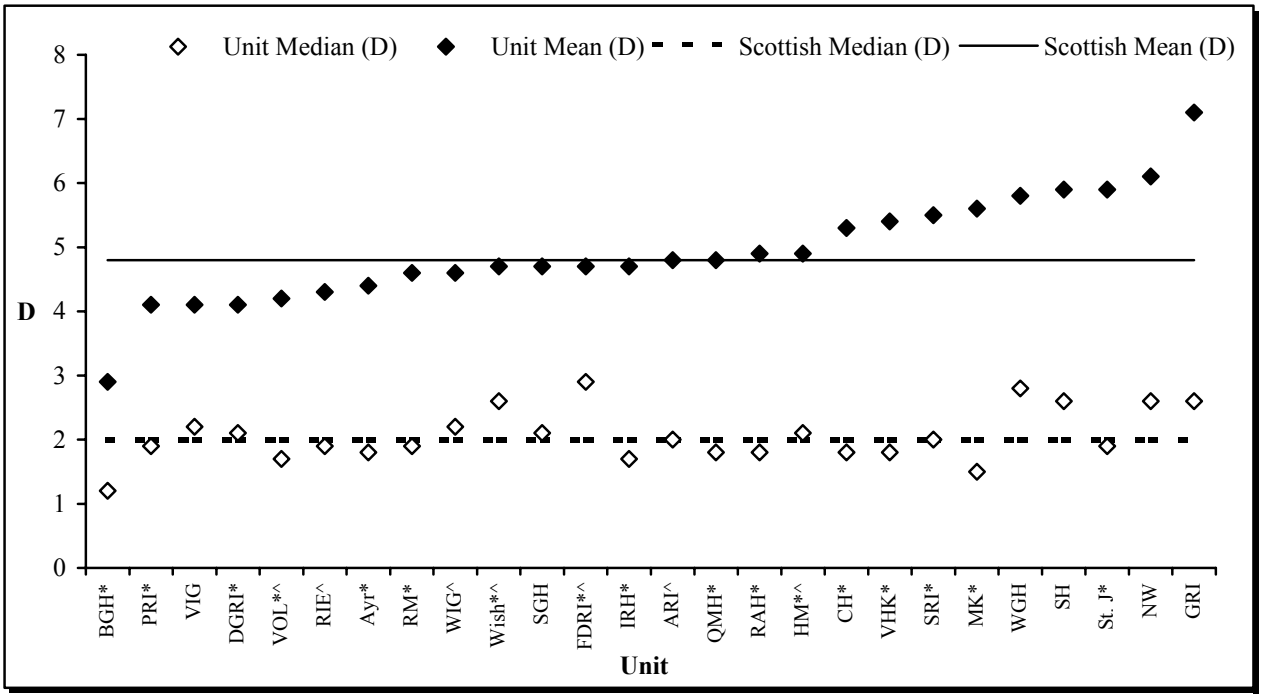
Unit	ICU LOS(d)					
	Median	Lower IQR	Upper IQR	Mean	Minimum	Maximum
ARI^	1.7	0.8	5.1	4.6	0.0	54.8
Ayr*	1.8	0.8	4.0	4.0	0.1	35.0
BGH*	1.4	0.7	3.2	3.8	0.0	51.6
CH*	1.7	0.9	4.6	4.7	0.0	51.5
DGRI*	2.0	0.8	5.3	4.4	0.0	44.8
FDRI*^	2.4	1.0	5.6	4.7	0.0	57.9
GRI	2.9	0.9	8.6	7.3	0.0	117.9
HM*^	1.9	1.0	4.1	4.2	0.0	101.3
IRH*	3.2	1.2	8.3	6.6	0.0	78.0
MK*	1.9	0.9	6.5	6.2	0.0	67.0
NW	2.8	1.3	7.0	6.0	0.0	59.2
PRI*	2.0	0.9	3.8	4.6	0.0	37.3
QMH*	1.7	0.9	4.6	4.7	0.0	98.9
RAH*	2.0	0.8	6.0	5.1	0.0	47.1
RM*	2.1	0.9	6.0	5.2	0.0	56.4
RIE^	1.8	0.8	5.3	5.2	0.0	111.2
SGH	2.1	0.9	6.8	5.6	0.0	62.7
SH	2.8	1.0	8.3	6.6	0.0	107.7
SRI*	2.1	0.9	6.3	6.7	0.0	52.7
St. J*	1.7	0.8	4.8	5.9	0.1	84.7
VHK*	1.8	0.8	3.6	5.3	0.0	71.5
VIG	2.0	0.7	6.5	5.1	0.0	59.2
VOL*^	2.0	1.0	4.8	4.7	0.2	119.0
WGH	2.3	0.9	7.6	5.2	0.0	47.2
WIG^	2.5	0.9	6.2	5.4	0.0	43.4
Wish*^	2.0	1.0	4.0	3.9	0.0	63.0
Scotland	**2.0**	**0.9**	**5.4**	**5.0**	**0.0**	**119.0**

Table 9. Tabulated median and mean lengths of ICU stay, 2002.

Unit	ICU LOS(d)					
	Median	Lower IQR	Upper IQR	Mean	Minimum	Maximum
ARI^	1.9	0.8	4.8	4.7	0.0	82.6
Ayr*	1.8	0.8	4.3	5.1	0.0	48.9
BGH*	1.3	0.6	3.2	3.9	0.0	177.7
CH*	2.0	0.9	6.1	5.5	0.0	103.8
DGRI*	2.0	1.0	5.5	4.8	0.1	53.7
FDRI*^	2.8	1.0	5.9	4.9	0.0	69.2
GRI	3.0	0.9	7.8	6.5	0.0	59.7
HM*^	2.1	1.0	4.8	5.3	0.0	70.3
IRH*	1.3	0.7	5.6	5.3	0.1	80.5
MK*	1.2	0.7	4.1	4.6	0.0	75.2
NW	2.9	1.1	8.8	7.1	0.0	127.2
PRI*	2.1	1.1	4.0	4.5	0.1	52.1
QMH*	1.8	0.8	4.9	5.2	0.0	71.0
RAH*	1.6	0.8	3.9	4.4	0.1	61.0
RIE	1.8	0.8	5.5	6.0	0.0	88.9
RM*	1.8	0.8	4.6	5.0	0.0	108.0
SGH	2.5	0.9	7.4	6.2	0.0	45.0
SH	2.9	0.7	9.3	7.5	0.0	66.6
SRI*	1.8	0.9	4.8	5.7	0.1	69.9
St. J*	1.7	0.8	4.7	5.9	0.0	169.2
VHK*	2.0	1.0	5.2	4.8	0.1	33.1
VIG	2.0	0.8	6.0	4.6	0.0	45.0
VOL*^	2.1	1.0	4.0	3.8	0.1	50.1
WGH	3.9	1.5	10.2	7.2	0.0	84.3
WIG^	2.2	1.0	6.8	5.2	0.0	49.8
Wish*^	2.0	1.0	4.0	3.8	0.0	40.0
Scotland	**2.0**	**0.9**	**5.6**	**5.2**	**0.0**	**177.7**

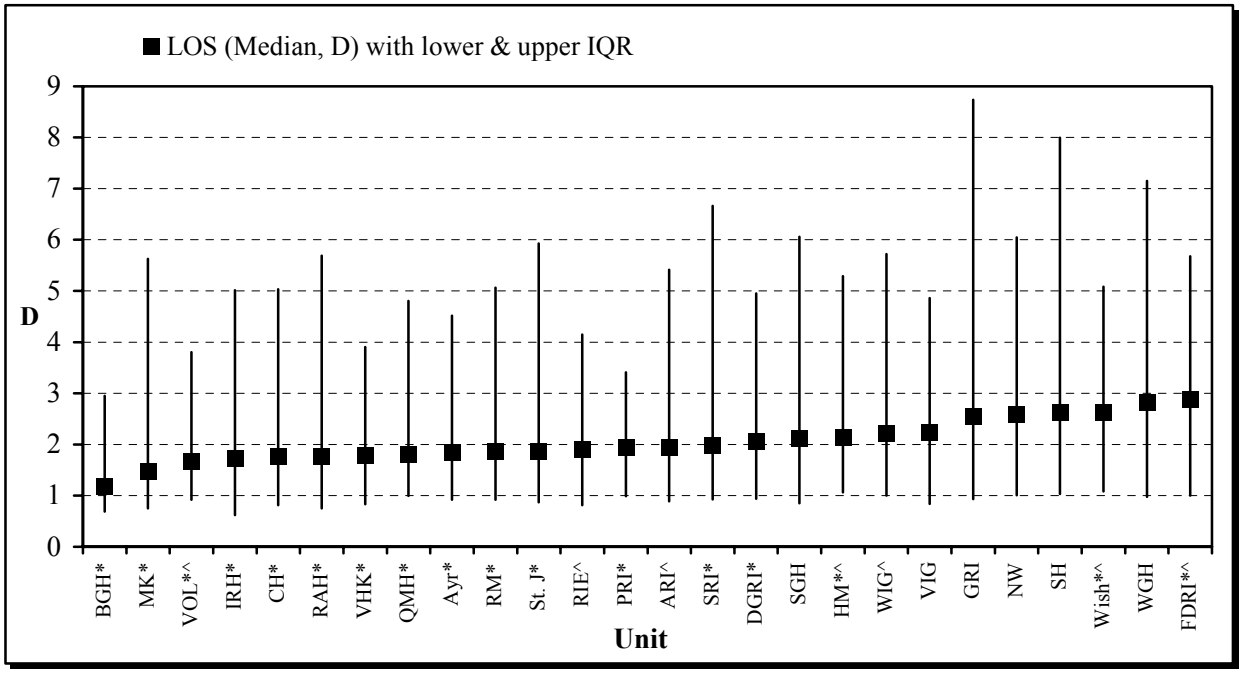
24. Figure 13 demonstrates the variation of LOS between units, the mean ranging from 2.9 d in Borders General Hospital (BGH) to 7.1 d in Glasgow Royal Infirmary (GRI).

Figure 13. Lengths of stay in Scottish ICUs, 2004 (Mean & Median).



25. Figure 14 displays each unit's median LOS and associated inter-quartile ranges. The upper percentile is the point below which 75% of lengths of stay lie in each unit.

Figure 14. Length of ICU stay, 2004 (median and inter-quartile range). Scottish median = 2 days, IQR 0.91-5.25.



26. Figures 15 and 16 and Tables 7 to 9 provide detailed information on each unit's length of stay. The decreases in median and mean lengths of stay at Western General Hospital, Edinburgh (WGH) were discussed in last year's report [2**].**

27. There are differences during the years 2002 to 2004 in a few other units, which are worthy of note. At Inverclyde Royal Hospital's (IRH) ICU, a decrease in bed occupancy, from 83% to 51%, between 2003 and 2004 was highlighted in section F.1. The numbers of admissions in these two years, however, had altered little (116 and 114 in 2003 and 2004 respectively) (Table 1). Instead, the reduction in occupancy may be attributable to the reduced LOS, of almost 2 days on average, observed in this unit for admissions during 2003 and 2004 (mean & median of 6.6 d & 3.2 d *versus* 4.7 d & 1.7 d) (Tables 7 to 8).

Figure 15. Median lengths of ICU stay in Scottish ICUs, 2002 – 2004.

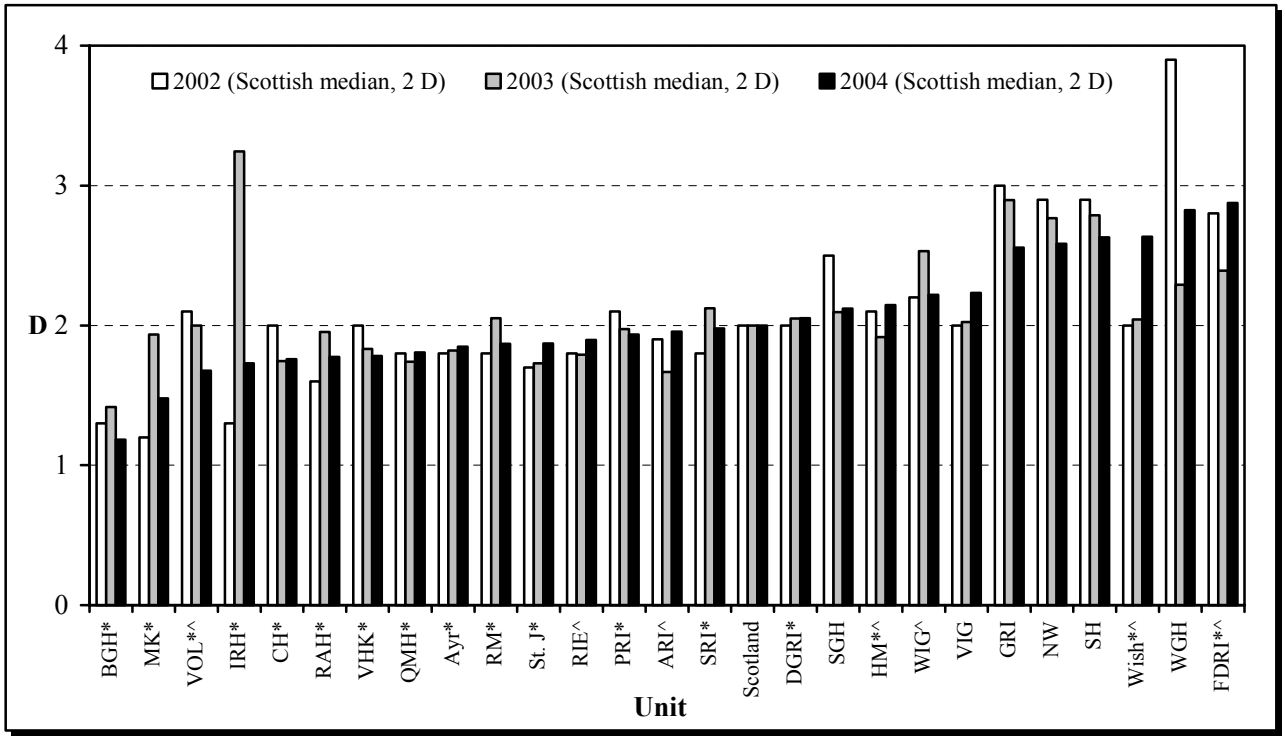
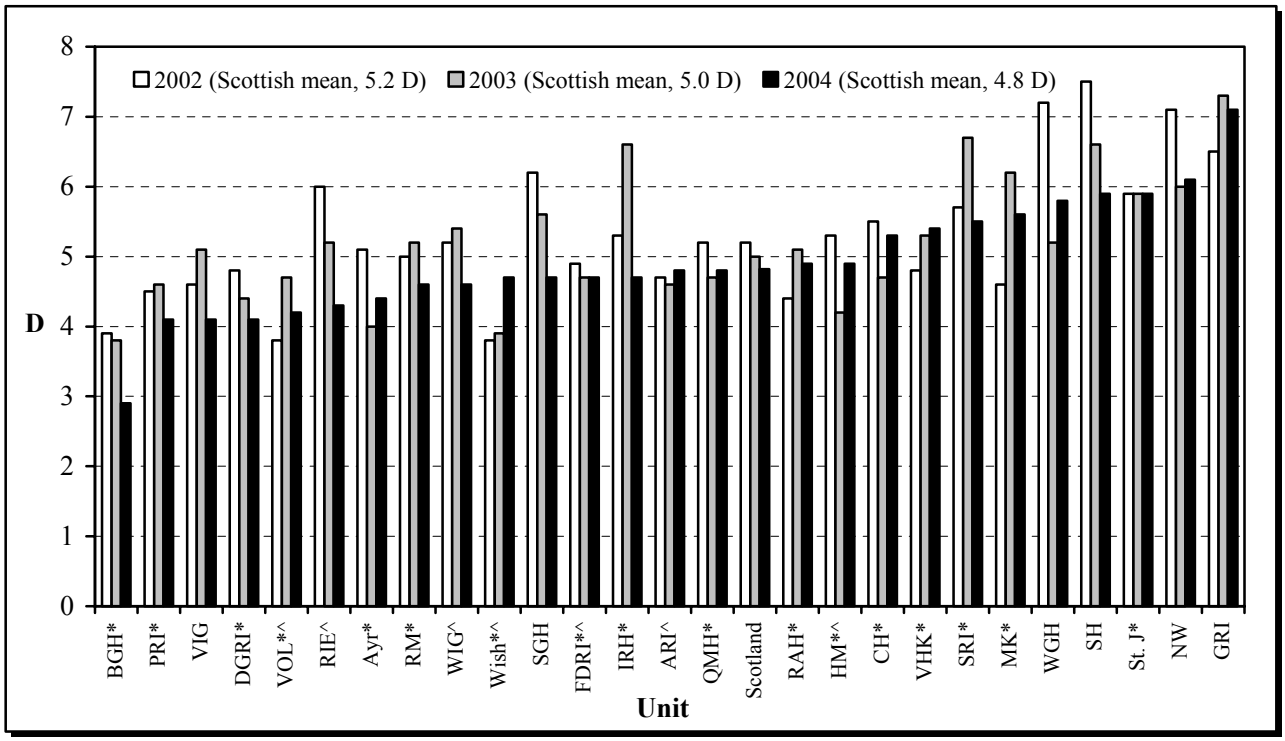


Figure 16. Mean lengths of ICU stay in Scottish ICUs, 2002 – 2004.



28. In Stobhill Hospital, the ICU's admission numbers were 207, 210 & 218 during the years 2002, 2003 and 2004 (Table 1). There has, nevertheless, been a fall in this unit's bed occupancy during the same period, from 79.5% in 2002 to 59.5% in 2004 (Figure 3). This may be attributed partly by an increase in the number of funded beds in these years by approximately 1, to 6 in 2003 and an average of 5.8 in 2004 (Tables 2 and 3), with only a small increase in admissions. Another contributing factor to the reduction in bed occupancy would appear to be a fall in the LOS during the same period (Figures 15 & 16 and Tables 7 to 9). In this unit, admissions during 2004 had an average LOS of 5.9 d (Table 7), 1.6 d less than those admitted in 2002 (Table 9). (Note, bed occupancy includes admissions in the previous year still in ICU whereas the numbers of admissions and the LOS reported in Tables 7 to 9 refer to those admissions in the relevant year only.)

29. In Wishaw, the number of admissions to the ICU/HDU was 796 in 2002. This rate has fallen to 739 in 2004 (Table 1). In the same time period, however, the bed occupancy has risen by approximately 10% to 80.9% in 2004 (69.7% and 68.4% in 2002 and 2003) (Figure 3). There have been corresponding increases in the length of stay of the admissions in this unit over the same time period, from an average of 3.8 d in 2002 (1.4 d less than the Scottish average) to 4.7 d in 2004 (Figure 16 and Tables 7 to 9). The median LOS rose to 2.6 d in 2004 from 2.0 in the two preceding years (Figure 15 and Tables 7 to 9).

30. The ICU in the Borders has seen an increase from an average of 3.3 beds to 4 beds between 2003 and 2004 (Tables 2 and 3). There has also been a decrease in the LOS from a mean of 3.9 d in 2002 to 2.9 d in 2004, 1.9 d less than the national average (Figure 16 and Tables 7 to 9). With the increase in bed numbers and reduced LOS, there has been an associated increase in admissions from 329 to 404 between 2002 and 2004 (Table 1). Even with the increase in admission rate, the annual bed occupancy has now fallen below 96% for the first time since the audit began (112%, 128%, 96%, 102%, 118%, 107%, 110%, 98% and 83.5% *per annum*, from 1996 to 2004 respectively). (Note, the number of funded beds, not the number of physical beds is used to calculate occupancy)

31. It is known from previous years' data that LOS varies with source of admission. This is confirmed in Figure 17 and Table 10, which show patients admitted from A&E have the shortest LOS followed by admissions from theatre, while patients transferred from other ICUs have the longest. The reasons for this are not known but transfers from areas able to provide at least HDU care (ICU or HDU in same or another hospital) have the longest stays, so patients with potentially short stays may have been selected out of this group. This also results in workload, as measured by bed days rather than admission numbers, showing a slightly different pattern. Admissions from theatre generate less workload than their numbers suggest and HDU and A&E admissions change places in importance (Figure 18). The variation in LOS means that differences in case mix could explain the variations in length of stay between units.

Figure 17. Variation in ICU LOS and admission source (2004).

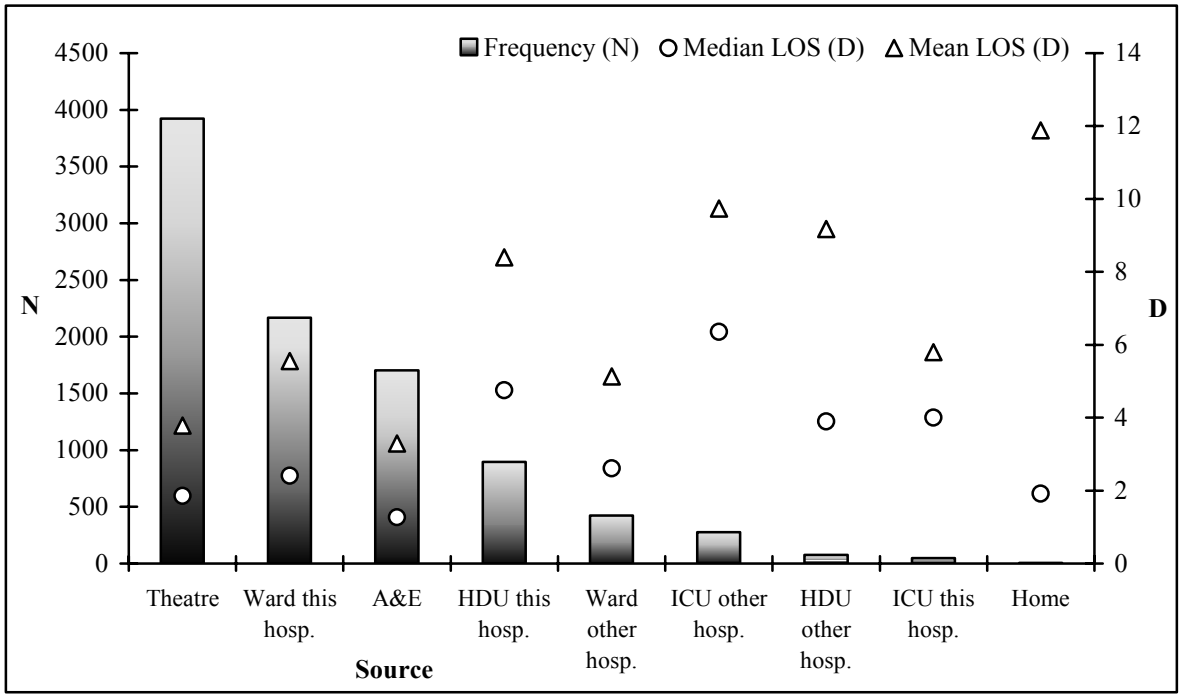
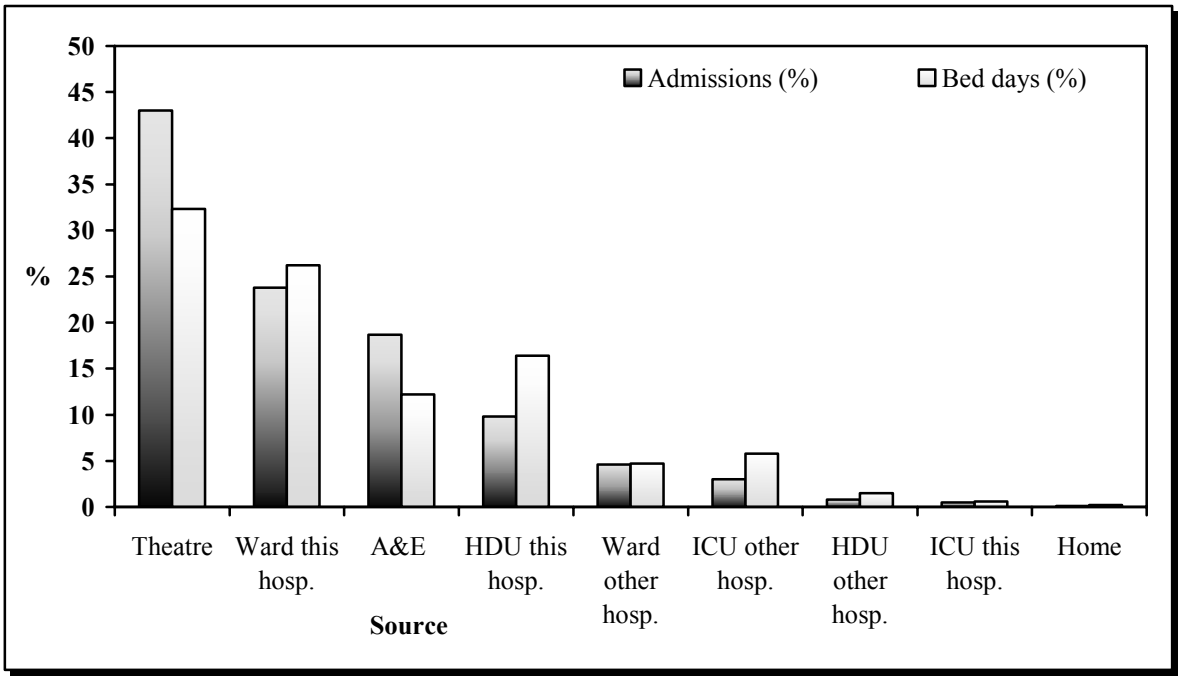


Table 10. Variation in ICU LOS and admission source (2004).
(No LOS available for 1 admission from theatre)

	Number of cases	ICU LOS (days)					
		Median	Lower IQR	Upper IQR	Mean	Minimum	Maximum
Theatre	3924	1.9	0.9	4.0	3.8	0.0	71.5
Ward this hosp.	2168	2.4	0.9	6.1	5.6	0.0	201.4
A&E	1703	1.3	0.6	3.2	3.3	0.0	76.0
HDU this hosp.	894	4.7	1.7	11.0	8.4	0.0	110.8
Ward other hosp.	422	2.6	1.1	6.5	5.1	0.0	42.7
ICU other hosp.	275	6.4	2.6	12.9	9.7	0.0	69.6
HDU other hosp.	77	3.9	2.0	9.4	9.2	0.1	112.0
ICU this hosp.	49	4.0	1.1	8.1	5.8	0.2	26.7
Home	6	1.9	0.2	20.8	11.9	0.1	59.1

Figure 18. Breakdown of proportions of admissions and bed days by admission source to Scottish ICUs (2004).



32. A similar pattern is observed with body system responsible for admission (derived form the APACHE II diagnosis), as demonstrated in Figures 19 and 20 and Table 11. These data illustrate especially that patients with respiratory diagnoses, because of their length of stay, use considerably more resources than would be suggested from their numbers. These results are derived from a subgroup of ICU admissions in 2003, the most recent admissions eligible for severity scoring by the APACHE II methodology.

Figure 19. Variation in ICU LOS and body system responsible for admission (APACHE II-scored patients in 2003).

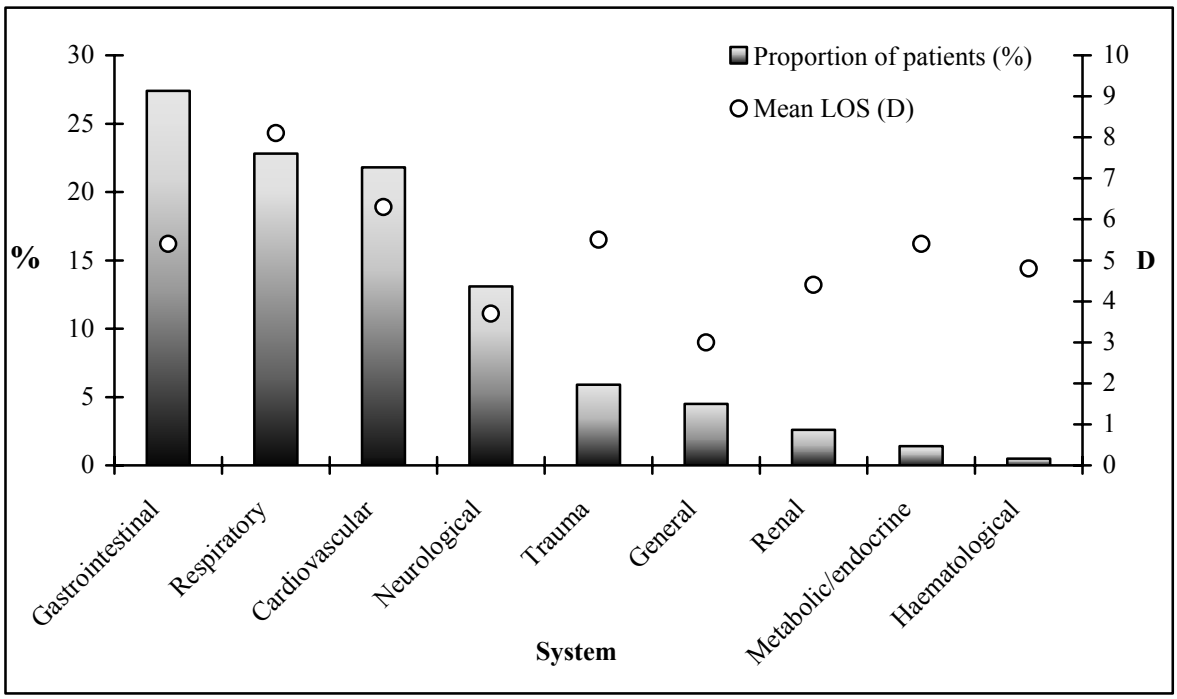


Figure 20. Breakdown of proportions of admissions and bed days by system (APACHE II-scored patients in 2003).

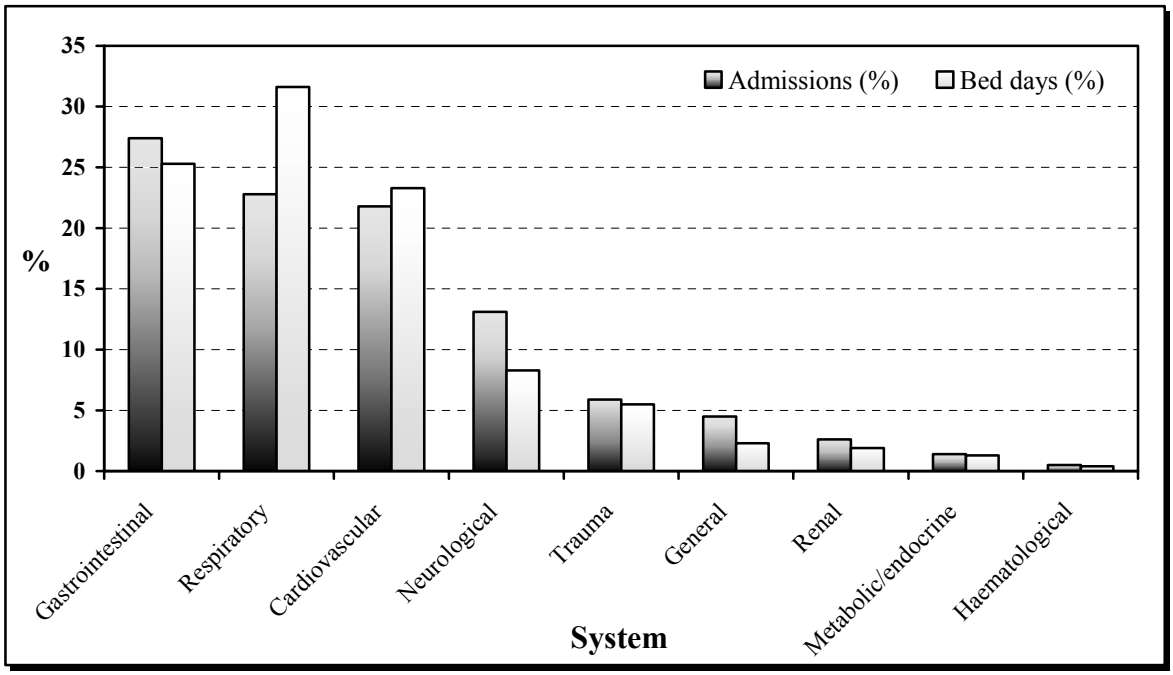


Table 11. Proportion of patients and workload by system (APACHE II-scored patients in 2003).

APACHE Diagnostic System Category	Patients (%)	Mean LOS (D)	Bed days (%)
Gastrointestinal	27.4	5.4	25.3
Respiratory	22.8	8.1	31.6
Cardiovascular	21.8	6.3	23.3
Neurological	13.1	3.7	8.3
Trauma	5.9	5.5	5.5
General	4.5	3.0	2.3
Renal	2.6	4.4	1.9
Metabolic/endocrine	1.4	5.4	1.3
Haematological	0.5	4.8	0.4

33. There are also differences in length of stay between operative and non-operative patients within these diagnostic groups (Figure 21).

34. Admission age also appears to affect length of stay with a peak at 60 – 64 years (Figure 22 and Table 12).

Figure 21. Operative and non-operative LOS by system (APACHE II-scored patients in 2003).

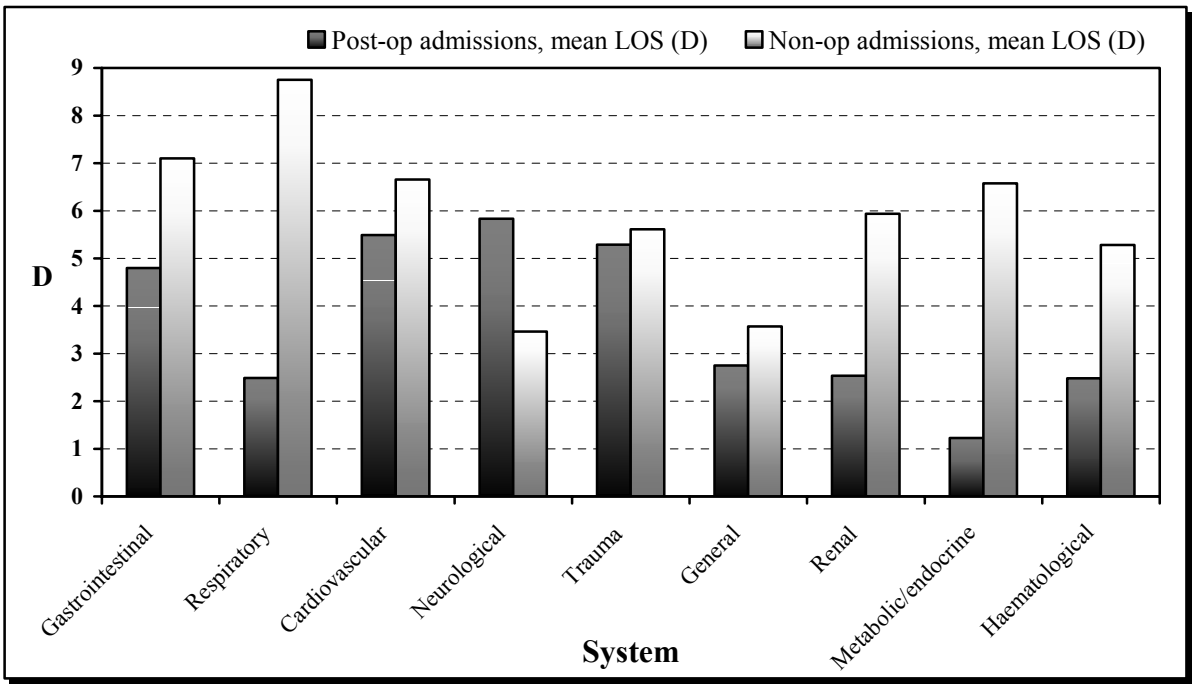


Figure 22. Variation in ICU LOS and age (2004).

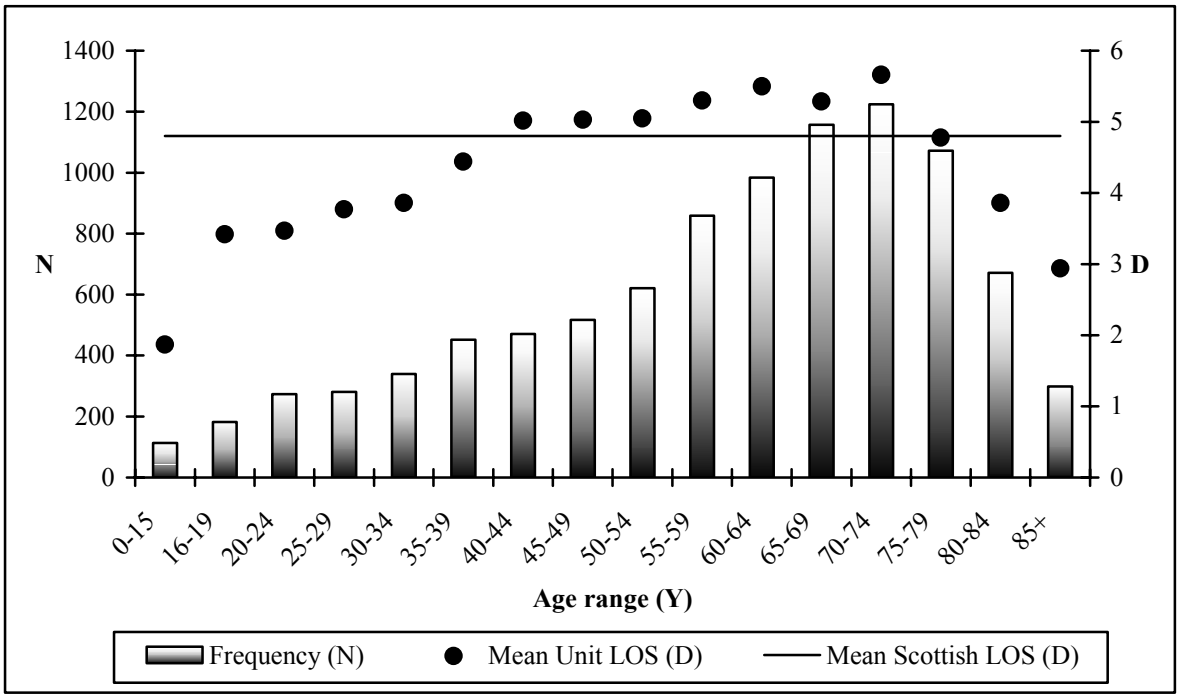


Table 12. Variation in ICU LOS and age (2004).

Age (Y)	Number of cases	ICU LOS (days)					
		Median	Lower IQR	Upper IQR	Mean	Minimum	Maximum
0-15	114	0.7	0.2	1.6	1.9	0.0	59.1
16-19	182	1.4	0.6	3.7	3.4	0.0	69.6
20-24	273	1.4	0.7	3.5	3.5	0.0	54.9
25-29	281	1.6	0.7	3.8	3.8	0.0	76.8
30-34	340	1.6	0.7	3.9	3.9	0.0	201.4
35-39	452	1.8	0.7	4.8	4.4	0.0	66.9
40-44	471	1.8	0.8	5.7	5.0	0.0	71.8
45-49	517	2.0	0.9	5.0	5.0	0.0	81.0
50-54	621	1.9	0.9	5.6	5.0	0.0	112.0
55-59	859	2.3	1.0	6.1	5.3	0.0	79.0
60-64	984	2.7	1.0	6.6	5.5	0.0	92.5
65-69	1157	2.2	1.0	6.0	5.3	0.0	52.9
70-74	1225	2.2	1.0	6.0	5.7	0.0	110.8
75-79	1072	2.1	1.0	5.3	4.8	0.0	57.8
80-84	672	1.9	0.9	4.8	3.9	0.0	33.1
85+	299	1.8	0.9	3.1	2.9	0.0	27.3

F.4. Use of Augmented Care Period (ACP) data to determine levels of organ support and levels of care. ACP data were not available from Borders General Hospital for 2004.

35. The level of organ support is influenced by the patients admitted and to some extent it can be seen as an indicator of severity of illness. It is also affected by the approach of the clinical staff, which may vary over time as new evidence or techniques become available (e.g. changes in use of pulmonary artery catheters) and between units. Some caution is therefore required when using these data as an estimate of workload and staffing requirements. The intervention results described in this section are primarily from ACP data recorded daily between 2002 and 2004. The daily ACP dataset incorporates Yes or No responses to the following fields for every calendar day:

- Intubated
- Connected to a ventilator
- Face Mask CPAP
- Pulmonary artery flotation catheter
- Inotropes/vasopressors
- Filtration/dialysis

36. The first and last ACP days may be for only a few hours in the ICU during that day. The field is marked 'YES' if that intervention has been employed at any time in the 24 hours (midnight to midnight) irrespective of whether it is still occurring at the time data is entered. The intent is to capture the highest level of support during that period. It is important to note that in the combined ICU/HDUS, these figures for interventions are based on all admissions, not just those for level 3 care. SICSAG aims to refine this analysis in future years.

37. The Scottish ACP dataset was developed in 1998 and is similar to that used in England. The intention was primarily to characterise patients according to the interventions required. The Therapeutic Intervention Scoring System (TISS) [3] had been obligatory for the first 3-years of the audit (1995-1997) but it was complex, making it difficult to complete and almost impossible to validate. The Society does not wish to collect data which are not used and hence adopted the simpler ACP system whilst continuing to make TISS available for units to use internally if they wish.

38. With an increase in the number of combined HDU/ICUs and the audit now encompassing HDUs as well as ICUs, the ACP dataset has been modified in order to stratify patients by levels of care, this time based on Levels 1, 2 & 3 as identified in *Better Critical Care* [4]. Pilots of the modifications to the SICSAG dataset have been implemented in some sites, and some issues have been highlighted so that full role out will not now be until 2006.

39. An extensive database of the key ACP interventions has developed since 1999 and collection of these daily intervention data allows us to gain insights into variations in practice, both between units and with time. The following series of figures and tables attempts to convey the level of work conducted in each Scottish ICU during 2002, 2003 and 2004 as well as the 6-year trends of specific interventions. Units are encouraged to examine their practice, not only in relation to the national norm but also in relation to that of comparable units.

Ventilation.

40. Figure 23 demonstrates the proportion of patients ventilated on the first 'ACP day' of ICU care in each unit during 2004. The first ACP day is the time between ICU admission and midnight that day: this may be only a few hours during which some patients are assessed prior to instituting key interventions. There are marked variations and some interesting trends. Both patients and clinical practice may drive the variations. Some units may, for instance, admit patients for a few hours of ventilation, where others would arrange extubation in the recovery room. Traditionally the larger units, mainly in teaching hospitals, had higher ventilation rates. It is important to recognise that collection of data on all admissions to the combined ICU/HDU facilities (marked ^) underestimates the proportion of 'ICU' patients who are ventilated. Reductions in the rates of ventilation in specific ICU/HDUs, for example the Royal Infirmary of Edinburgh, have been described previously in the Annual Report 2004 [2].

41. A similar pattern is seen in Figure 24**,** which displays the rate of ventilation at any time in the ICU stay of admissions during 2004. The variation is wide, ranging from 22.9% in Wishaw (an ICU/HDU) to 94.3% in Glasgow Royal Infirmary. Almost 40% (10) of units ventilate at least 80% of admissions during their ICU stay.

42. Tables 13 and 14 demonstrate the annual variations in each unit from 1999 to 2004. It must be remembered that ^ identifies combined ICU/HDUs during 2004. The percentages themselves demonstrate changes as the status of a number of other units have altered with time. Primarily, these ICU/HDUs became ICUs, with the opening of separate HDUs. For example, Dumfries & Galloway Royal Infirmary, Inverclyde Royal Hospital, Queen Margaret Hospital and Royal Alexandra Hospital.

43. It is not certain that high ventilation rates are a good thing. Although this is the intervention that is most characteristic of ICU, high ventilation rates may suggest pressure on beds with difficulty in admitting patients who need ICU care but not ventilation or alternatively a pressure to discharge very quickly after extubation.

Figure 23. Proportion of patients ventilated on the first ACP day during 2004.

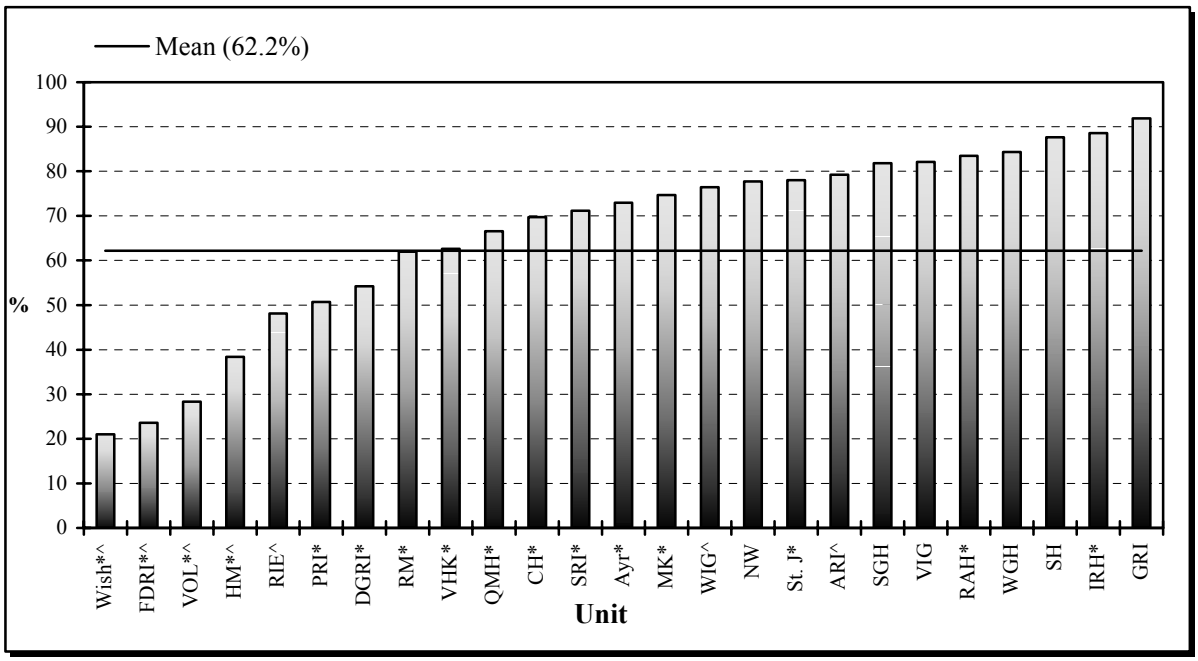


Figure 24. Proportion of patients ventilated at any time during 2004.

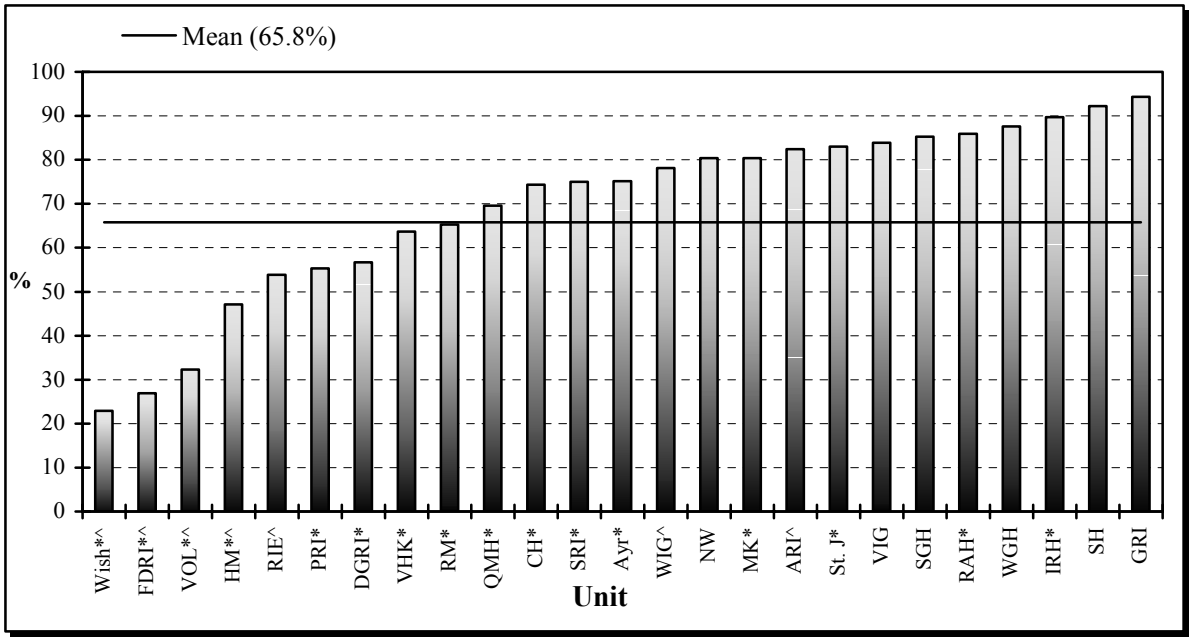


Table 13. Six-year trend in proportion (%) of patients ventilated at any time in Scottish ICUs (1999-2004).

Note, ^ indicates combined ICU/HDU during 2004. The status of other units has changed in the preceding years.

Unit	1999	2000	2001	2002	2003	2004
ARI^	87.9	85.3	85.3	79.4	79.8	82.4
Ayr*	65.2	77.2	77.4	79.8	76.9	75.1
BGH*	50.8	59.5	52.5	49.7	49.2	N/A
CH*	65.4	69.1	75.4	74.4	79.1	74.3
DGRI*	35.8	47.2	58.7	60.6	61.3	56.7
FDRI*^	N/A	N/A	23.3	28.3	24.6	26.9
GRI	91.9	92.0	90.9	92.2	94.4	94.3
HM*^	32.4	35.3	42.5	43.4	43.9	47.1
IRH*	52.1	77.9	85.1	89	91.8	89.7
MK*	83.1	81.1	82	83.5	85.3	80.4
NW	N/A	N/A	88.9	87.7	84.5	80.4
PRI*	49.5	40.3	50	53.5	50.3	55.3
QMH*	54.7	62.6	63	63	62.9	69.6
RAH*	57.5	71.9	80.6	82.4	82.1	85.9
RIE^	89.4	86.0	83.3	82.3	60.4	53.8
RM*	N/A	N/A	N/A	72.9	73.5	65.3
SGH	79.5	79.6	87.7	84.2	86.8	85.3
SH	91.6	89.0	93.1	92.7	88.9	92.2
SRI*	66.7	67.3	67.2	74	71.7	75
St. J*	84.6	78.2	66.1	77.3	74.1	83
VHK*	53.5	73.5	65	66.3	68.5	63.7
VIG	83.3	77.3	85.5	86.8	82.2	83.9
VOL*^	34.0	42.4	39.9	38.4	39.1	32.3
WGH	89.4	89.3	88.5	90.7	89.2	87.6
WIG^	88.2	81.9	84.7	76.1	84.4	78.1
Wish*^	69.5	78.2	44.1	30	26	22.9

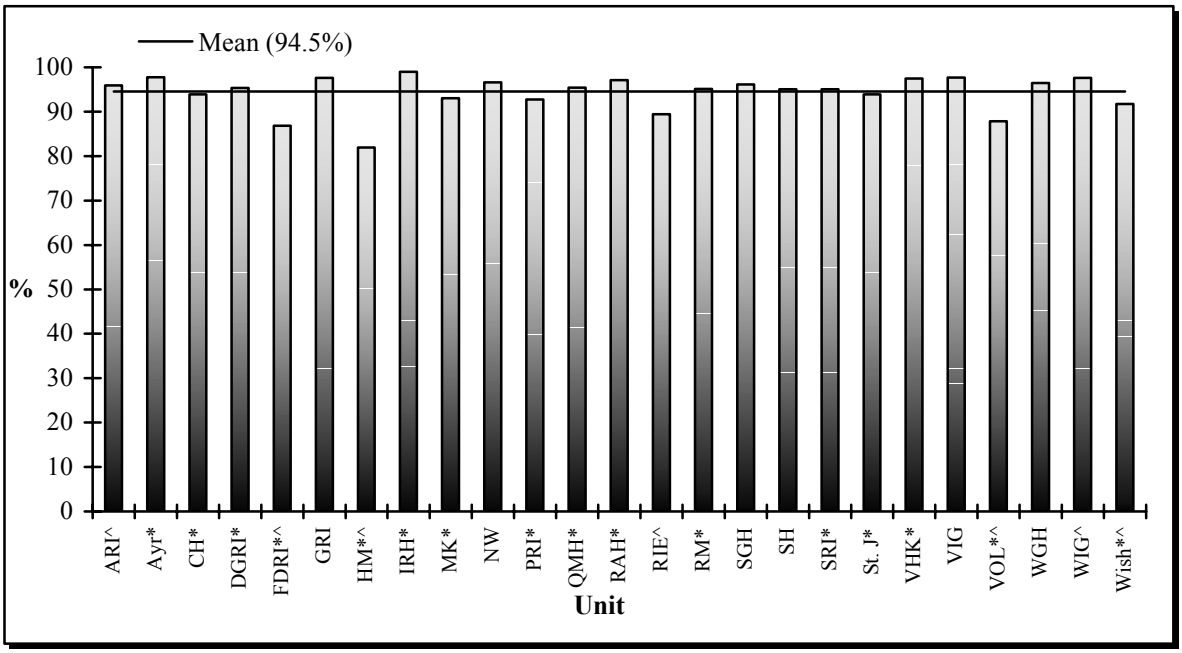
Table 14. Six-year trend in proportion (%) of patients ventilated on 1st ACP day in Scottish ICUs (1999-2004).

Note, ^ indicates combined ICU/HDU during 2004. The status of other units has changed in the preceding years.

Unit	1999	2000	2001	2002	2003	2004
ARI^	82.9	81.1	79.9	75.0	75.7	79.2
Ayr*	61.6	75.0	75.6	75.8	74.0	73.0
BGH*	47.1	53.6	47.2	43.1	43.0	N/A
CH*	62.5	65.3	71.1	68.8	78.1	69.7
DGRI*	31.9	40.6	55.7	54.6	57.8	54.2
FDRI*^	N/A	N/A	21	24.4	21.0	23.6
GRI	90.1	88.6	87.8	88.9	89.6	91.9
HM*^	29.0	28.2	35.4	34.3	37.8	38.4
IRH*	51.1	71.4	81.1	83.9	89.7	88.6
MK*	80.4	78.7	80.6	79.6	81.7	74.7
NW	N/A	N/A	84.9	84.1	82.4	77.7
PRI*	45.3	38.1	47.1	49.0	46.7	50.7
QMH*	50.7	59.5	59.6	59.8	59.0	66.6
RAH*	56.1	70.2	79.5	81.5	79.3	83.5
RIE^	87.9	82.7	79.8	78.9	55.1	48.1
RM*	N/A	N/A	N/A	69.4	69.8	62.0
SGH	74.7	75.7	82.9	80.8	83.0	81.8
SH	87.8	83.9	89.6	87.4	84.7	87.6
SRI*	61.0	63.1	62.5	67.6	68.6	71.2
St. J*	78.1	74.8	62.5	73.7	70.7	78.0
VHK*	50.2	67.2	62.6	62.3	64.8	62.6
VIG	80.8	71.9	79.8	83.9	79.1	82.1
VOL*^	30.8	36.0	34	33.0	33.8	28.3
WGH	84.7	87.5	84.6	88.4	86.0	84.3
WIG^	85.7	80.5	82	73.3	82.8	76.4
Wish*^	65.0	74.9	40.7	25.0	23.3	21.0

44. It is uncommon for patients who are not ventilated on day 1 to be ventilated later on their ICU stay (Figure 25). There is little variation between the units.

Figure 25. Proportion of ventilated patients in 2004 who are ventilated on day 1.



45. Overall, ventilation rates in Scotland have decreased over time (Table 15), with an increase in ICU/HDUs admitting a higher proportion of patients who are never ventilated. It does appear that the figure may now be stabilising.

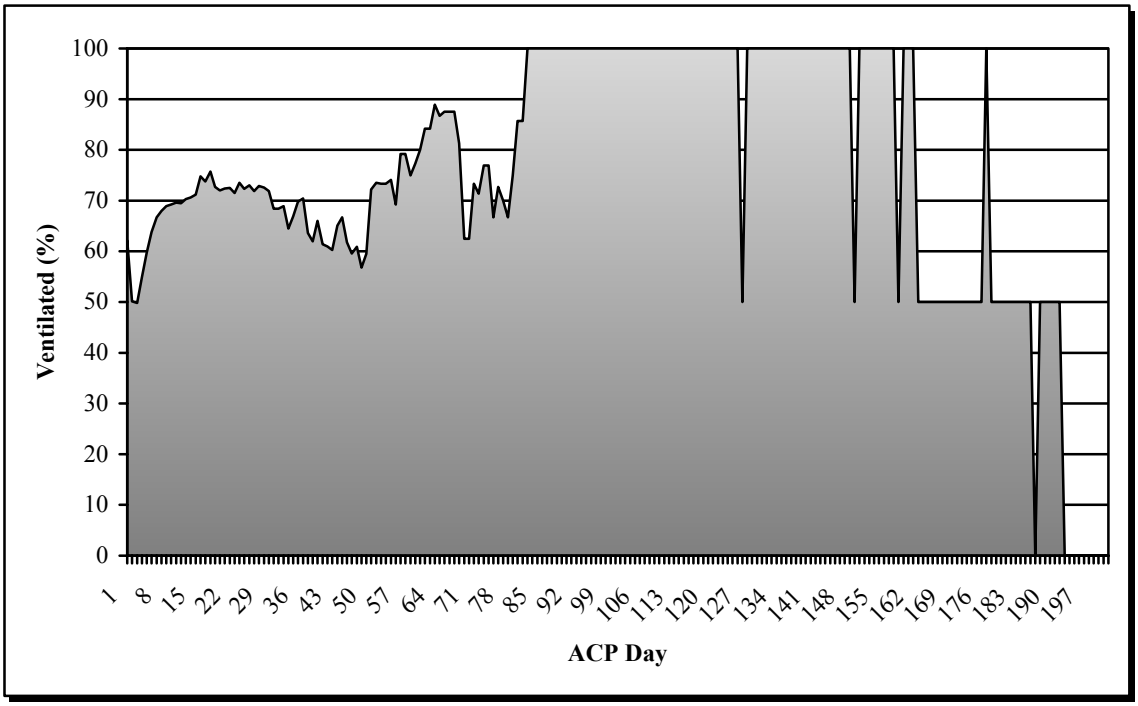
Table 15. Six-year trend in ventilation rates (1999-2004).

Year	Proportion of patients ventilated on 1st ACP day (%)	Proportion of patients ventilated at any time (%)
2004	62.2	65.8
2003	62.4	66.2
2002	63.8	68.1
2001	66.6	70.4
2000	68.2	72.2
1999	67.2	70.6

46. Figure 26 demonstrates the ventilation rates on every ACP day in ICU during 2004. There is a fall in the proportion of patients ventilated over the first couple of days, but the great majority of long-stay patients remain ventilated.

47. The decrease in the proportion of patients ventilated on day 2 may be a real decrease, with patients being prepared for discharge from intensive care (the median length of ICU stay being 2 days (Table 4)). It may reflect short-term ventilation, for example post-operatively. There is also a possibility that staff are recording the last ACP prior to discharge as *not* ventilated when the patient may well have been ventilated for part of that day.

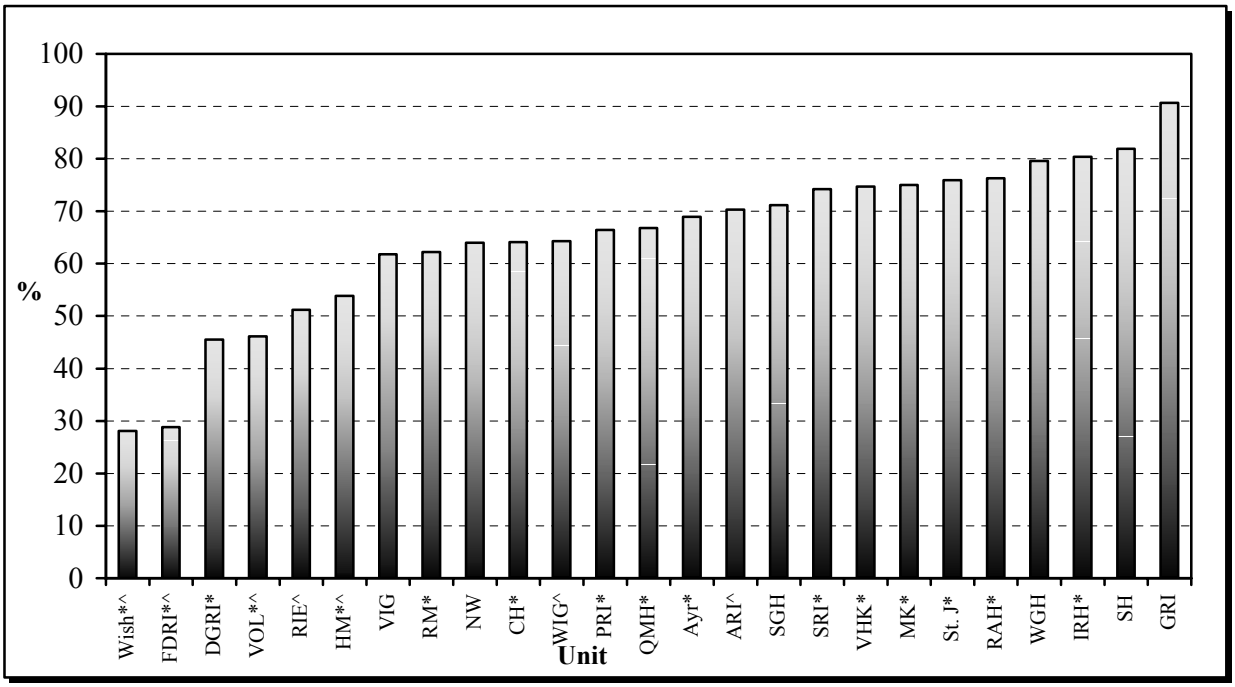
Figure 26. Proportion of all patients treated in Scottish ICUs in 2004 who are ventilated, per ACP day. Includes the ACP days in 2004 of patients admitted in 2003 whose stay continued into 2004.



48. During 2002 and 2003, the proportions of the total number of ACP days on which ventilation was utilised in Scotland were similar at 66.6% and 66.2% [2]. In 2004, this percentage fell to 61.8%.

49. An increase in the number of units providing ventilation during at least 80% of the ACP days had risen from 5 units in 2002 to 11 units in 2003 [2]. In 2004, however, fewer than 5 units provided this intervention on at least 80% of the ACP days (Figure 27).

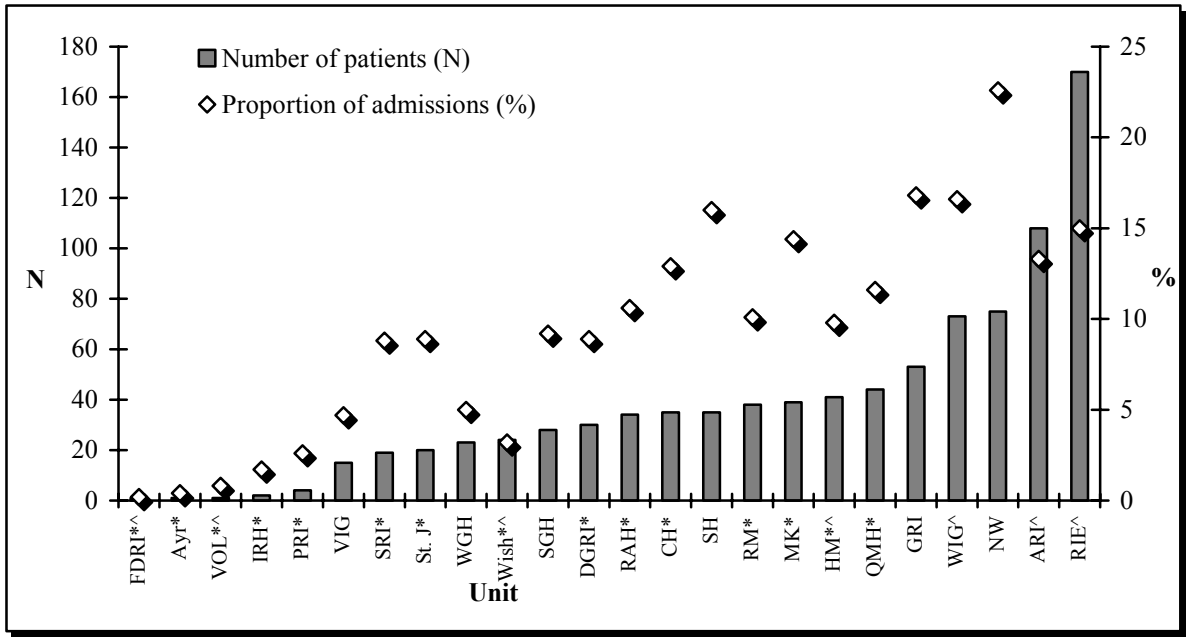
Figure 27. Proportion of ACP days in which there is ventilatory support: 2004. Mean = 61.8% of ACP days.



Renal replacement therapy.

50. As well as identifying the units in which renal replacement therapy (RRT) was provided in 2004, Figure 28 demonstrates the number of patients in these units who had RRT delivered and the proportion they represent of each unit's admissions. There are clear differences here, and this reflects case mix, with a tendency for patients with acute renal failure to be more likely to be seen in hospitals with a renal unit.

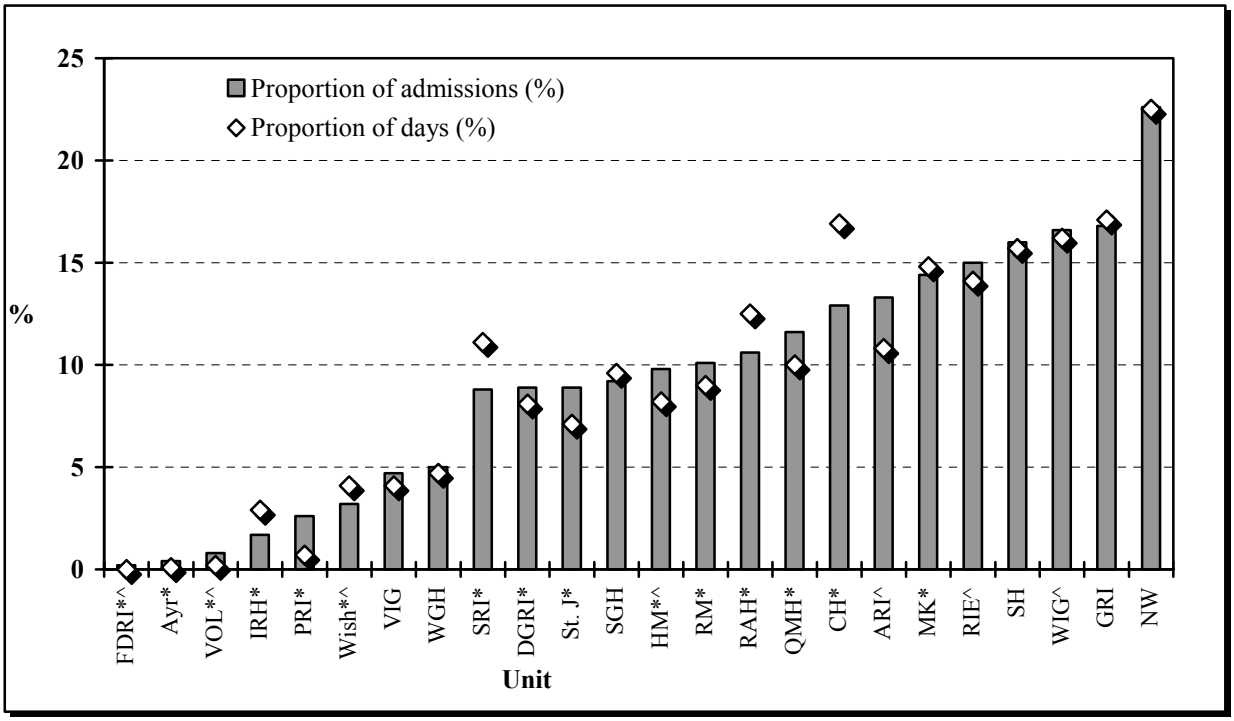
Figure 28. Provision of renal replacement therapy in 2004.



51. The proportion of patients receiving this intervention does not vary greatly within units from one year to another.

52. Figure 29 complements Figure 28 by demonstrating the proportion of total ACP days on which RRT was provided. Variation in the need for RRT amongst units with comparable case mix might arise from differences in the threshold for institution of RRT, the extent to which such support is instituted in patients with poor expectation of survival and the extent to which renal failure occurs during intensive care.

Figure 29. Provision of renal replacement therapy in 2004. Proportion of patients in Scottish ICUs receiving RRT = 9.9%, utilising 9.8% of ACP days.



53. Since 1999, there has been a 2.9% increase in the absolute proportion of patients given RRT in Scottish ICUs (Table 16) and this represents a relative increase of around a third.

Table 16. Six-year trend in the rates of delivering RRT (1999-2004).

Year	Proportion of patients with RRT (%)	Proportion of ACP days of RRT (%)
2004	9.9	9.8
2003	9.4	10.3
2002	8.6	8.9
2001	8.1	8.5
2000	7.6	8.8
1999	7.0	9.1

Pulmonary artery flotation catheters.

54. The use of pulmonary artery flotation catheters (PAFCs) has been controversial. Results of the PACMAN trial, a randomised controlled clinical trial assessing pulmonary artery catheters, conducted by the Intensive Care National Audit and Research Centre in London (ICNARC), have been inconclusive [5]. Alternative tools for assessing cardiac indices are increasingly used and alterations to the minimum ACP dataset will attempt to address this issue.

55. It is probable that variation in the approach to patient management, both within and between units, is responsible for a great deal of the variation in use of PAFCs.

56. Over the years there has been striking variation in the utilisation of PAFCs between comparable units. Table 17 confirms the diminished use of this monitoring tool. In Scotland in 2001, there were still 8 units which monitored over 10% of their patients using PAFCs, 5 of which utilised it in over 20%. The use of PAFCs in 2002, 2003 and 2004 is demonstrated in Figure 30 to 32. In the most recent year, 2004, only 1 unit monitored between 10% and 20% of patients in this manner.

Table 17. Six-year trend in PAFC utilisation rates (1999-2004).

Year	Proportion of patients with PAFC on 1st ACP day (%)	Proportion of patients with PAFC at any time (%)
2004	2.7	4.7
2003	3.2	5.6
2002	4.8	8.3
2001	6.7	10.9
2000	9.0	14.5
1999	10.0	15.0

Figure 30. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 4.8%) or at any time during ICU (mean = 8.3%): 2002.

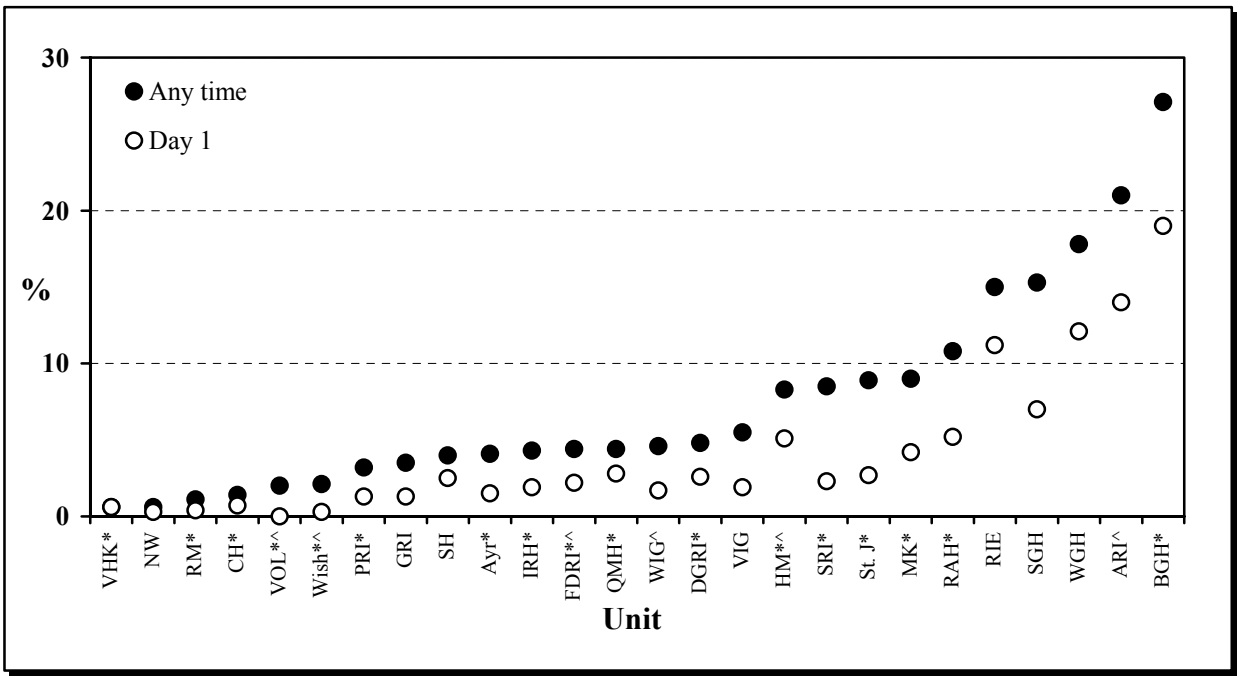


Figure 31. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 3.2%) or at any time during ICU (mean = 5.6%): 2003.

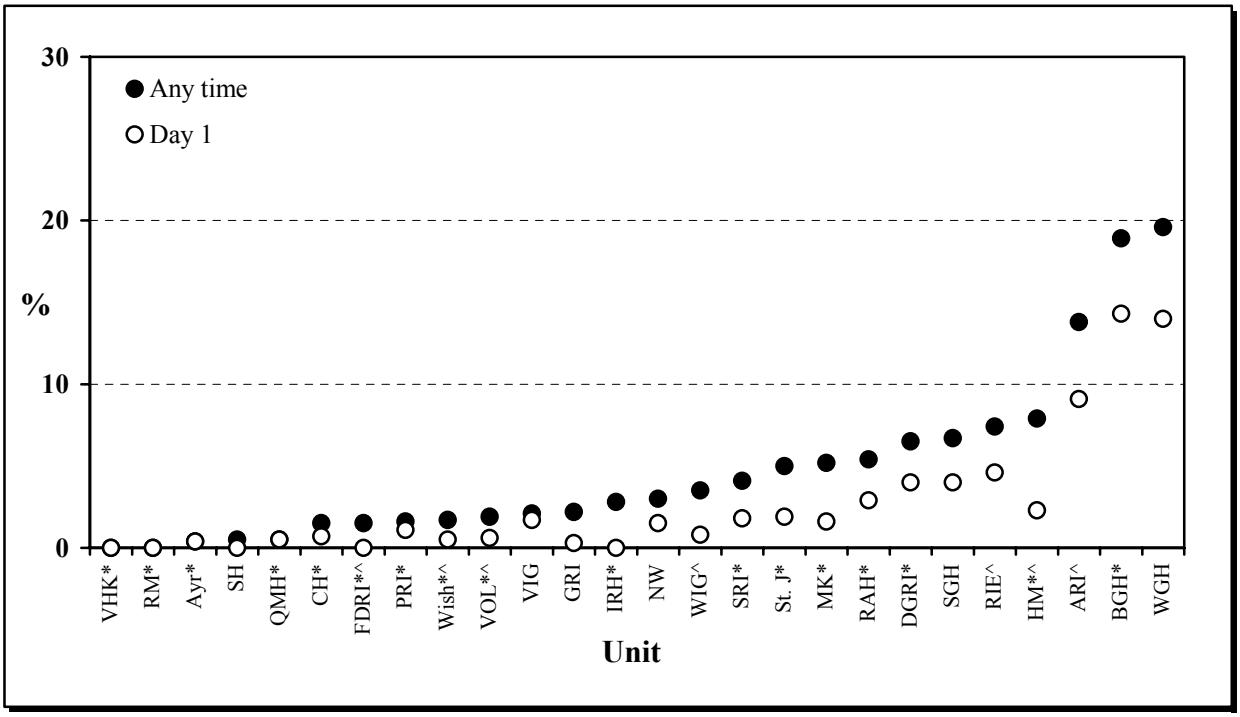
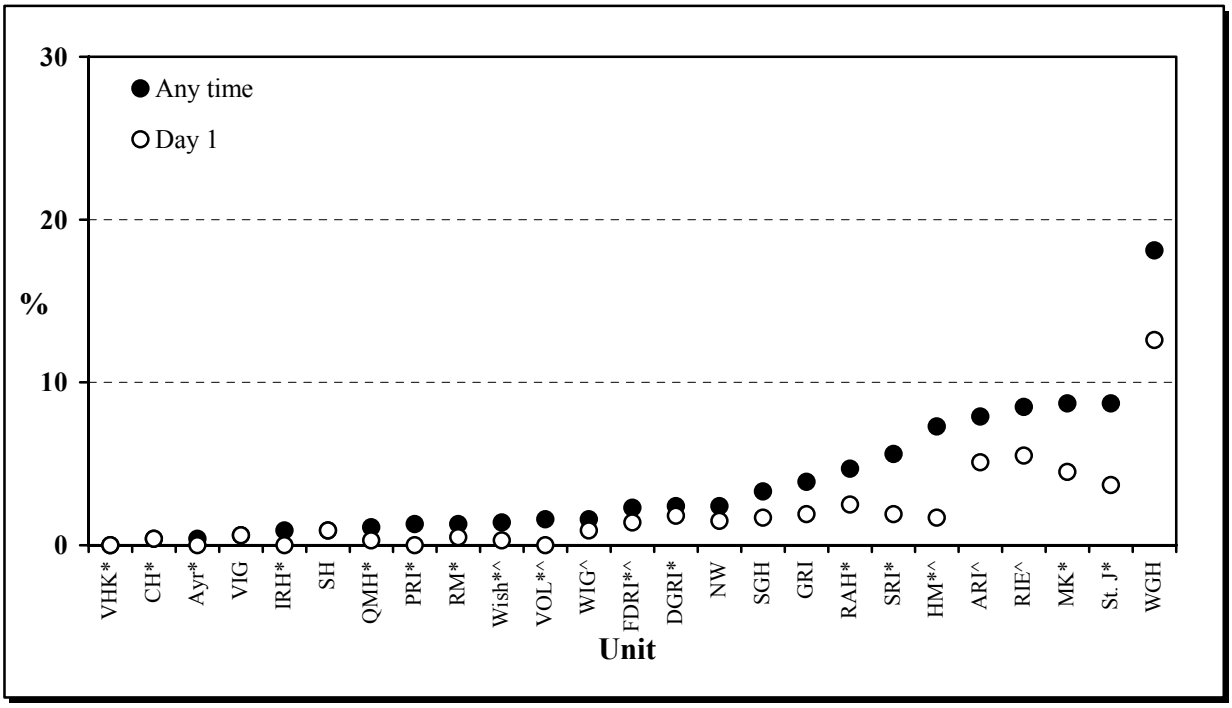


Figure 32. Proportion of patients with PAFC *in situ* on 1st day of ICU (mean = 2.7%) or at any time during ICU (mean = 4.7%): 2004.

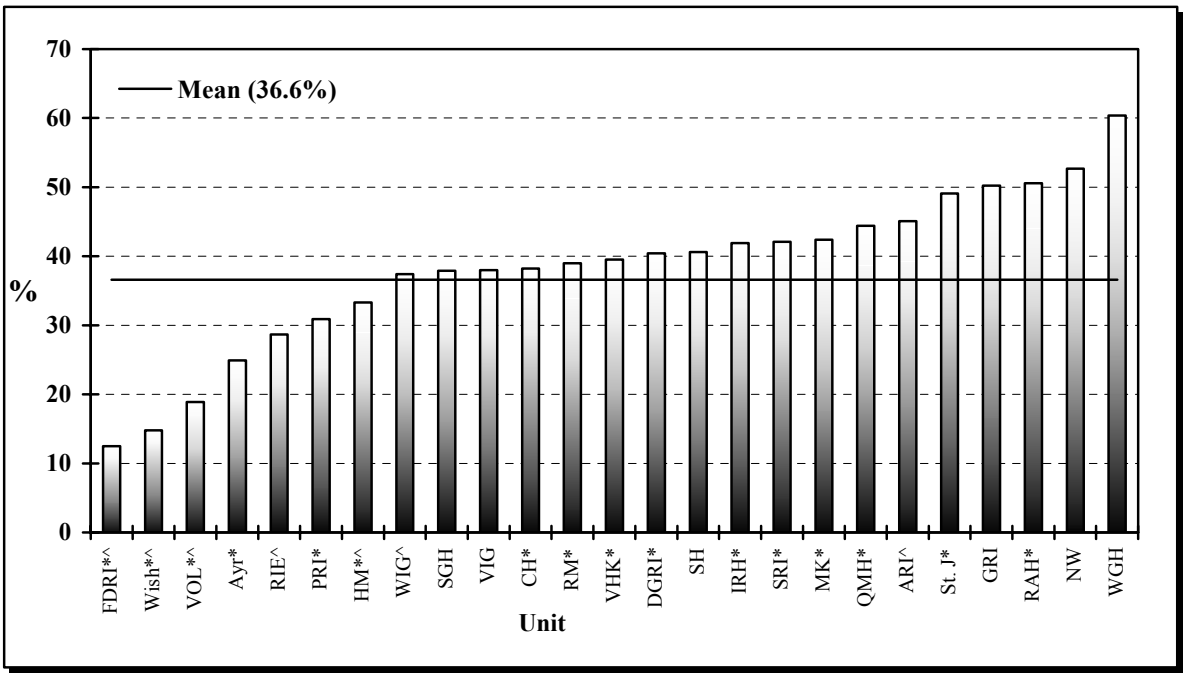


Inotropes/vasopressors.

57. Presented in Figure 33 are data demonstrating the extent to which inotropes/vasopressors are utilised during the intensive care period. On average, approximately 37% of admissions to Scottish ICUs received this therapeutic intervention in 2004.

58. There is wide variation in the use of inotropes/vasopressors, from 12.5% in Falkirk Royal Infirmary to 60.4% at the Western General Hospital in 2004. The units with the least usage are, as expected, the combined ICUs/HDU. These variations reflect the different case mix of admissions and may also reflect differing approaches to management. In the combined units, these figures reflect the proportion of inotropes/vasopressors administered to all admissions, whether HDU or ICU patients.

Figure 33. Proportion of patients receiving inotropes/vasopressors in Scottish ICUs: 2004.



Summary ACP data.

59. Summary data of various key interventions and / or therapies that were utilised in 25 of the 26 adult, general ICUs in Scotland during 2004 are tabulated in Table 18.

Table 18. Summary ACP data demonstrating the extent of organ support in each ICU during 2004. Includes patients admitted to ICU in 2003, still in ICU in 2004.

	ACP Days, all admissions														
Unit	**Total Days**	**Ventilator days**		**Intubation days**		**Tracheostomy days**		**Mask CPAP days**		**PAFC days**		**Inotrope days**		**RRT days**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
ARI^	4739	3330	70.3	2207	46.6	1589	33.5	323	6.8	165	3.5	1121	23.7	514	10.8
Ayr*	1312	904	68.9	685	52.2	294	22.4	36	2.7	2	0.2	192	14.6	1	0.1
CH*	1737	1114	64.1	730	42.0	579	33.3	57	3.3	1	0.1	353	20.3	294	16.9
DGRI*	1691	769	45.5	589	34.8	297	17.6	125	7.4	20	1.2	399	23.6	137	8.1
FDRI*^	3162	912	28.8	604	19.1	516	16.3	55	1.7	32	1.0	209	6.6	1	0.0
GRI	2528	2292	90.7	1912	75.6	419	16.6	32	1.3	38	1.5	586	23.2	433	17.1
HM*^	2484	1339	53.9	1099	44.2	409	16.5	65	2.6	80	3.2	542	21.8	204	8.2
IRH*	653	525	80.4	417	63.9	100	15.3	49	7.5	3	0.5	150	23.0	19	2.9
MK*	1751	1313	75.0	1054	60.2	385	22.0	103	5.9	49	2.8	447	25.5	260	14.8
NW	2413	1545	64.0	1374	56.9	460	19.1	235	9.7	26	1.1	619	25.7	544	22.5
PRI*	965	641	66.4	348	36.1	317	32.8	48	5.0	7	0.7	168	17.4	7	0.7
QMH*	2179	1456	66.8	1146	52.6	407	18.7	50	2.3	5	0.2	622	28.5	217	10.0
RAH*	1913	1459	76.3	1263	66.0	298	15.6	31	1.6	26	1.4	543	28.4	239	12.5
RIE^	6094	3120	51.2	2356	38.7	929	15.2	200	3.3	154	2.5	1016	16.7	862	14.1
RM*	2015	1254	62.2	958	47.5	391	19.4	90	4.5	12	0.6	563	27.9	181	9.0
SGH	1731	1233	71.2	1075	62.1	210	12.1	94	5.4	24	1.4	343	19.8	167	9.6
SH	1477	1210	81.9	998	67.6	239	16.2	47	3.2	3	0.2	251	17.0	232	15.7
SRI*	1386	1029	74.2	641	46.2	449	32.4	37	2.7	24	1.7	345	24.9	154	11.1
St. J*	1583	1201	75.9	682	43.1	657	41.5	44	2.8	38	2.4	435	27.5	112	7.1
VHK*	751	561	74.7	345	45.9	253	33.7	15	2.0	0	0.0	135	18.0	0	0.0
VIG	1570	970	61.8	811	51.7	292	18.6	64	4.1	6	0.4	335	21.3	65	4.1
VOL*^	633	292	46.1	171	27.0	144	22.7	23	3.6	7	1.1	89	14.1	1	0.2
WGH	3031	2414	79.6	1743	57.5	848	28.0	97	3.2	224	7.4	1136	37.5	141	4.7
WIG^	2434	1566	64.3	1380	56.7	325	13.4	95	3.9	12	0.5	391	16.1	394	16.2
Wish*^	4147	1166	28.1	883	21.3	483	11.6	37	0.9	24	0.6	490	11.8	169	4.1
Scotland	**54379**	**33615**	**61.8**	**25471**	**46.8**	**11290**	**20.8**	**2052**	**3.8**	**982**	**1.8**	**11480**	**21.1**	**5348**	**9.8**

Levels of care.

60. A more complete picture of the variation in dependency and organ support has been made in past reports, by aggregating the days on which each patient receives one or more key interventions, i.e., ventilation, renal replacement therapy or cardiovascular support. The audit group has received requests to demonstrate resource utilisation by the dependency levels: 3 (most dependent), 2 and 1 (least dependent). A modified ACP dataset has been developed over the last couple of years and has been installed in approximately 20 ICUs and HDUs at time of reporting. Key interventions in the new dataset are mapped to the levels of dependency, 1, 2 and 3. Thus, there is one dataset suitable for ICUs, HDUs and combined ICU/HDUs, which is demonstrated in Figures 34 & 35. It will be some time before every one of the 55 critical care units has the new software and therefore, reporting on the success of the mapping and the application of levels of care within the units will be, at the earliest, in the Annual Report 2006.

Figure 34. Updated ACP dataset.

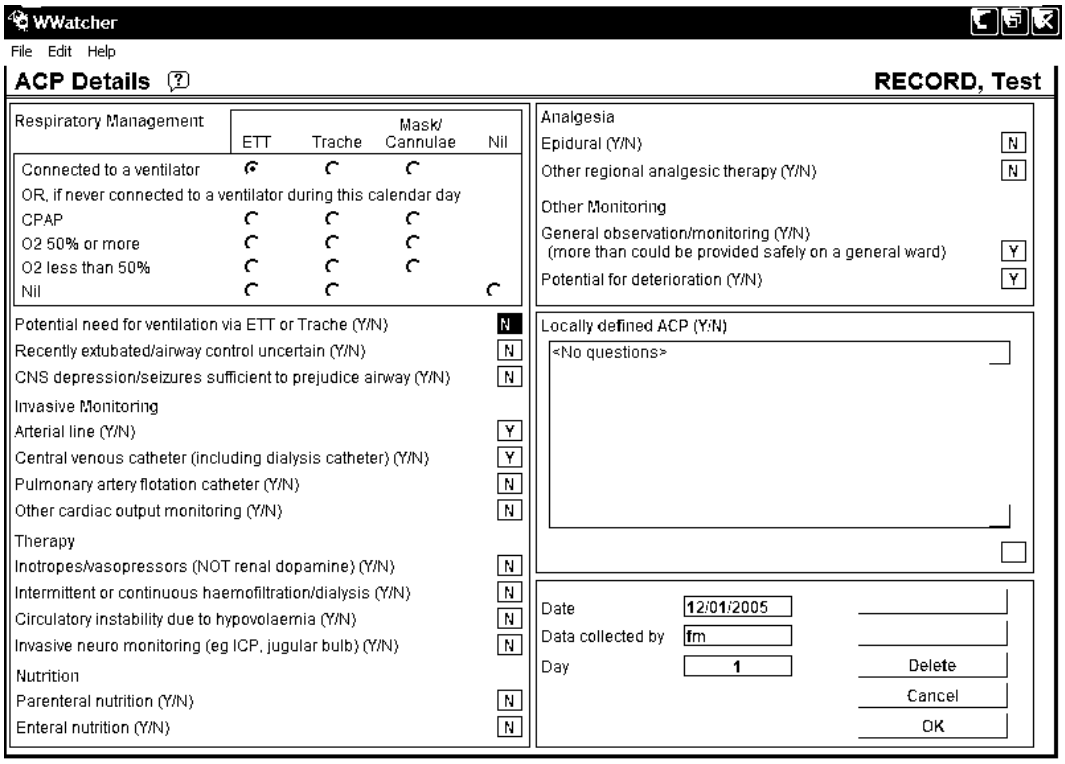
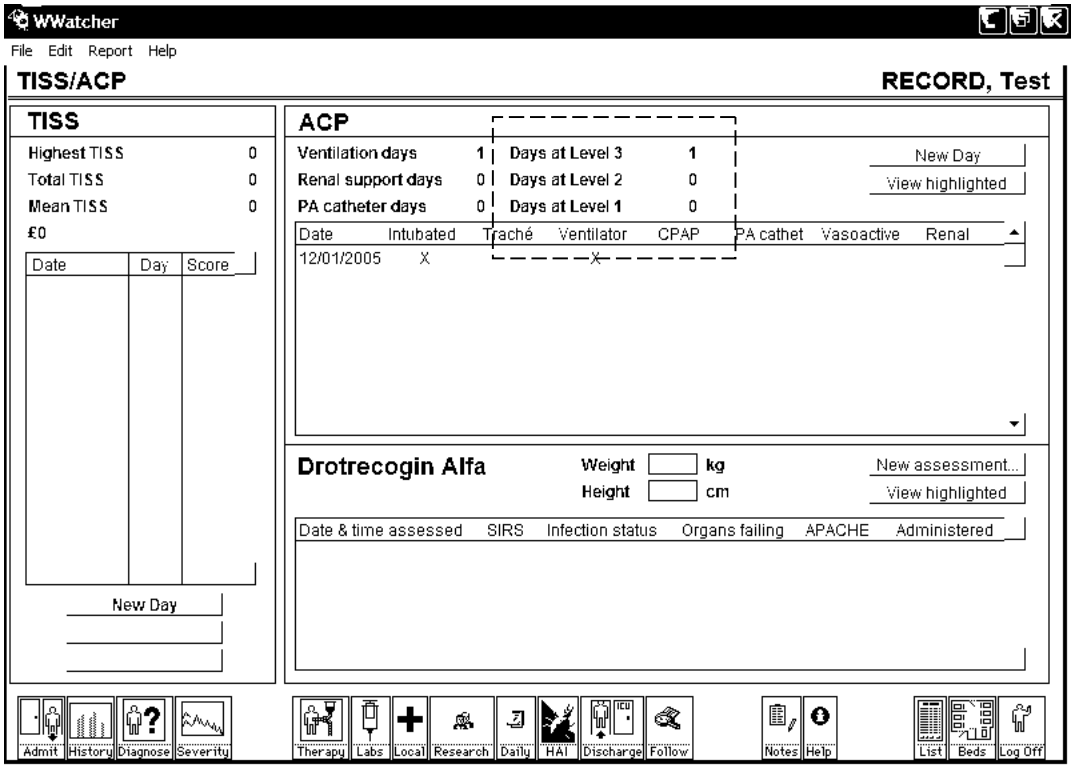


Figure 35. Updated ACP screen: Display of number of days at levels 1, 2 or 3.



61. Once more, in preparation for displaying this type of data in the future, we have attempted to map the current ACP dataset to levels of care in this report, which is demonstrated in Figure 36. The daily ACP records for every admission were used to determine the proportions of each level of care for each unit, using the classifications:

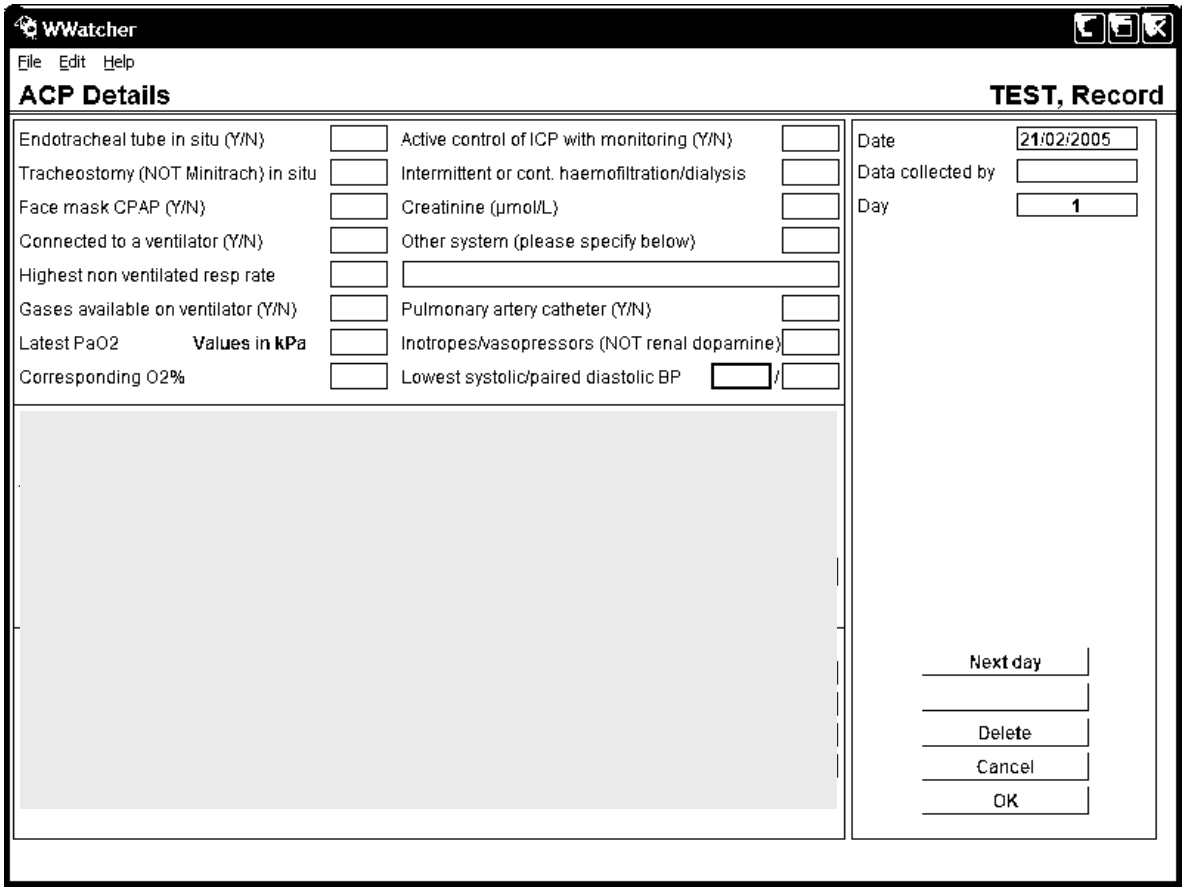
Level 3: - Advanced respiratory support (ventilator plus intubation or ventilator plus tracheostomy.
- Any two other organs supported

Level 2: - One organ support (other than advanced respiratory support)

Level 1: - No organ support

62. In England, the ACP dataset allows a patient who has had no organ support (level 1) but who cannot be safely looked after in a general ward, or is at risk of deteriorating, to be categorised as level 2. The current Scottish ACP dataset does not account for this, therefore, the results will likely overestimate the proportion of level 1 days, particularly in the combined ICUs/HDU.

Figure 36. ACP dataset 1999 – 2005.



63. In Figure 37, the units are ordered from left to right by highest to lowest proportion of level 1 days. The combined ICU/HDUs generally have the lowest proportion of level 3 days. The extent of their level 2 days is likely to be underestimated. The consistently high proportion (~90%) of ACP days devoted to level 3 care at Glasgow Royal Infirmary is noteworthy.

Figure 37. Levels of care determined from the ACP dataset, 2004.

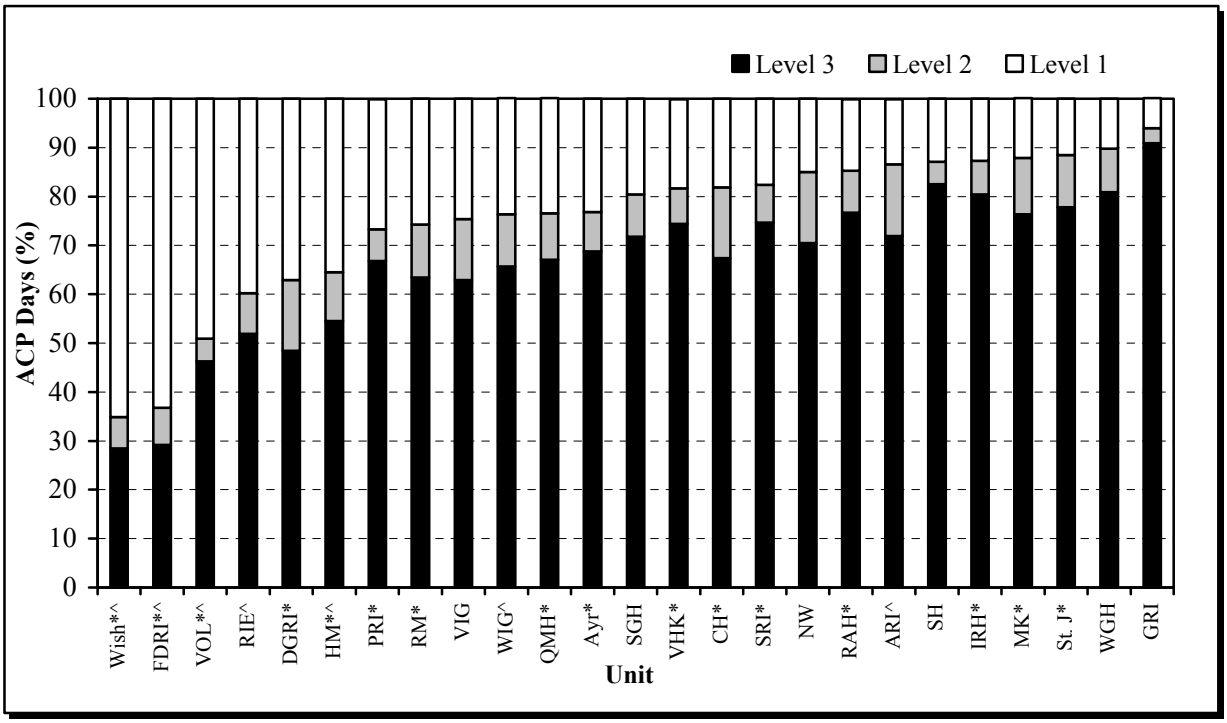


Figure 38. Levels of care determined from the ACP dataset, 2003.

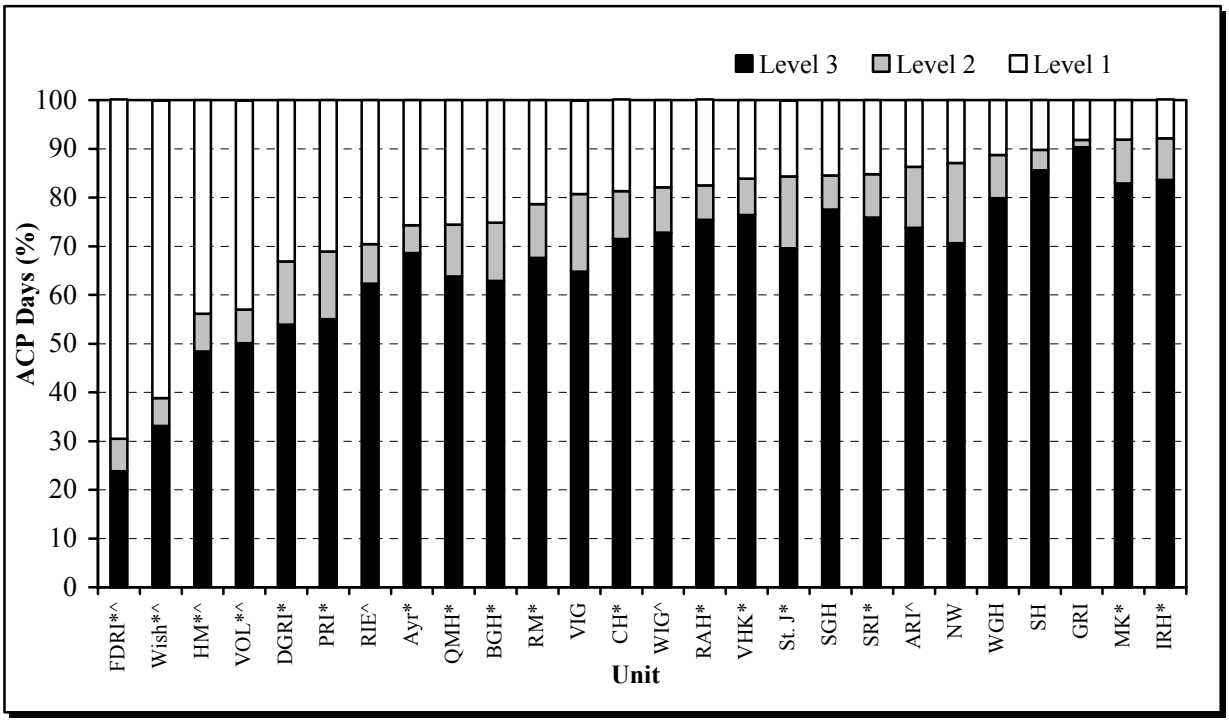
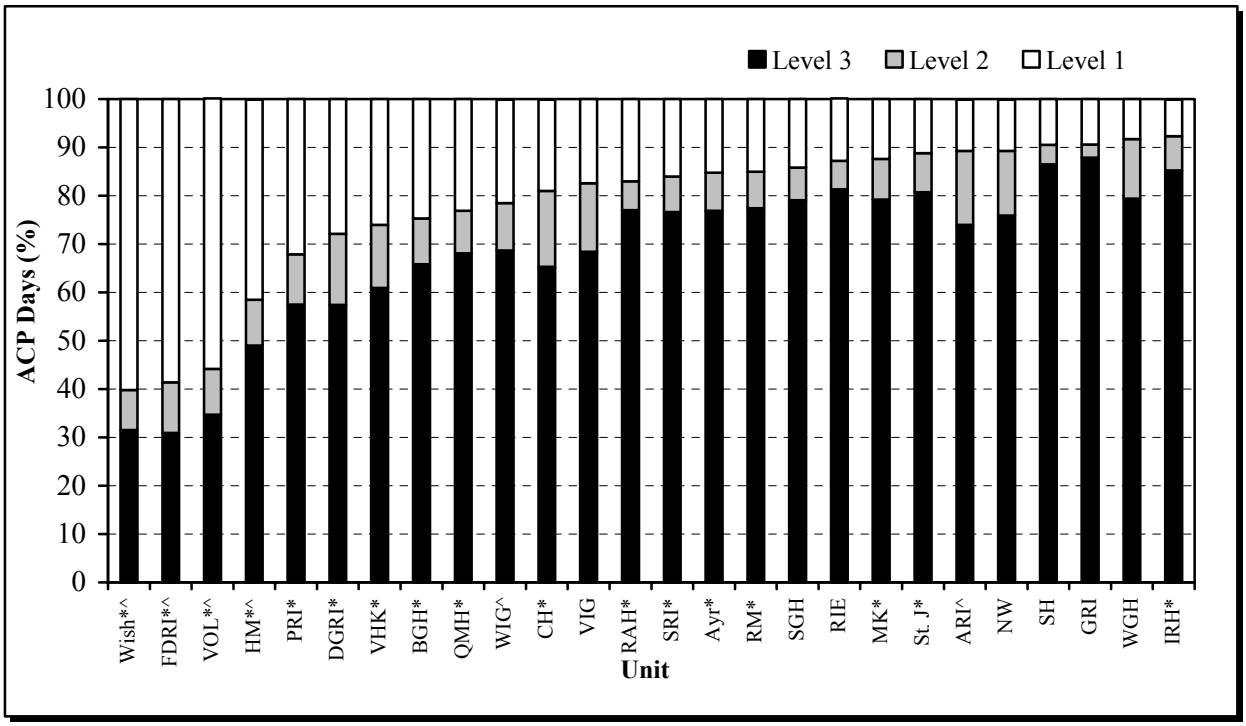


Figure 39. Levels of care determined from the ACP dataset, 2002.



F.5. Outcomes monitoring: Case mix-adjusted outcome and Statistical Process Control.

64. We continue to use the APACHE II scoring system [1] to attempt to adjust mortality for variation in case mix. Each ICU enters raw data values into identical software, which then calculates scores and mortality probabilities. The APACHE II score is derived from 12 acute physiological variables, age points and chronic health points. The higher the score, the greater the severity of the acute illness. This score, combined with a weighting for diagnosis, enables the expected number of hospital deaths to be calculated for each unit. Dividing the observed mortality by the expected mortality generates a standardised mortality ratio (SMR), an attempt to enable comparison of different units with different case mix. The ultimate outcome from the acute hospital episode is used.

65. As mentioned in Paragraph 16, extensive collaboration with ISD enables the outcome recorded at the end of the continuous in-patient stay on the Scottish Morbidity Records to be used as the ultimate outcome for patients for whom no hospital outcome is available on a unit's database. This helps avoid apparent differences in performance between units due to patient transfer. This is a labour-intensive process requiring extensive data validation where each linkage has to be confirmed to ensure correct outcome status. This process undoubtedly improves the accuracy of the data but requires extensive work and a time delay in producing reports. The time taken to do this explains why outcome data are only available to 2003. This work is also providing ISD with a process of external validation of the morbidity records being returned and linked. If the linkage fails, the hospital outcome on the ICU record is used.

66. The uses and limitations of applying standardised mortality ratios in this way must be kept in mind:

- They were developed on what are, by present standards, relatively small data sets.
- They are most accurate in the system or population on which they were developed: international comparisons have been difficult to interpret.

- They do not fully adjust for case mix. As an example, we have previously demonstrated how the mortality of patients with a neurological diagnosis may be under-estimated [6] and the mortality of patients admitted from theatre appears to be over estimated compared to patients admitted from wards. This means that a unit with relatively more ward patients will appear to perform less well than a unit with mainly theatre admissions.
- They are more susceptible than is often appreciated to treatment effects. This includes, but is not limited to, 'lead time bias'- the effect of resuscitation prior to ICU admission [7]. Changes in ICU management strategies since the systems were developed may have increased this effect.

67. APACHE II is applicable to the majority of patients admitted to ICUs in Scotland however there are exclusions: age less than 16, length of stay less 8 hours and primary burn injury.

68. As in previous years, the outcome data for individual units are published on an anonymised basis. In future these data will not be anonymised. The same letter code identifies an individual unit throughout this section of the Report. The code will be given to the lead audit clinician in that unit and to relevant Trust staff on request. As a result of the time required for the data linkage mentioned above the most recent outcome data relates to 2003. Figures and tables of earlier data are included where necessary for comparison.

69. During 2003, 24 of the 26 ICUs provided severity data. Borders General Hospital, Falkirk Royal Infirmary, Queen Margaret Hospital and Raigmore Hospital were unable to participate in this aspect of the study for either all or part of the years 2002 and 2003.

70. Summary characteristics of those admissions in 2003 with APACHE mortality probabilities are given in Table 19 (2003). For comparison, the data for 2002 is also displayed (Table 20**)**. As patients with a length of stay of less than 8 hours are

excluded, the median and mean lengths of stay are longer than those for all patients (Table 4).

Table 19. Summary demographic characteristics of admissions with APACHE probabilities in 2003.

24 SITES	Predicted Patients
N	6144
Operative (%)	38.2
Non-operative (%)	61.8
Length of ICU Stay (d) (Mean)	5.9
Length of ICU Stay (d) (Median)	2.3
Length of ICU Stay (d) (Range)	0.33 to 119
ICU Mortality (%)	22.8
Hospital Mortality (%)	31.2
Ultimate Hospital Mortality (%)	33.9
APACHE II Score (Mean)	19.6
APACHE II Probability (%)	34.2
SMR *(95% lower & upper CIs)*	0.983 *(0.953-1.012)*

Table 20. Summary demographic characteristics of admissions with APACHE probabilities in 2002.

23 SITES	Predicted Patients
N	5503
Operative (%)	36.7
Non-operative (%)	63.3
Length of ICU Stay (d) (Mean)	6.1
Length of ICU Stay (d) (Median)	2.4
Length of ICU Stay (d) (Range)	177.7
ICU Mortality (%)	24.8
Hospital Mortality (%)	33.1
Ultimate Hospital Mortality (%)	35.8
APACHE II Score (Mean)	19.7
APACHE II Probability (%)	34.0
SMR *(95% lower & upper CIs)*	1.052 *(1.021-1.083)*

71. The mean and median scores in Scotland for 2003 are 19.6 & 19 respectively and are unchanged from 2002. The median APACHE II scores (plus inter-quartile ranges) are given for each ICU in Figure 40 and 41 for 2002 and 2003. Although these scores give some indication of severity of illness, the expected mortality is also influenced by diagnostic coefficients and is not directly proportional to the APACHE II score.

Figure 40. Illness severity: Median APACHE II scores in 2002. Scottish median: 19 (Inter-quartile range: 15 & 26).

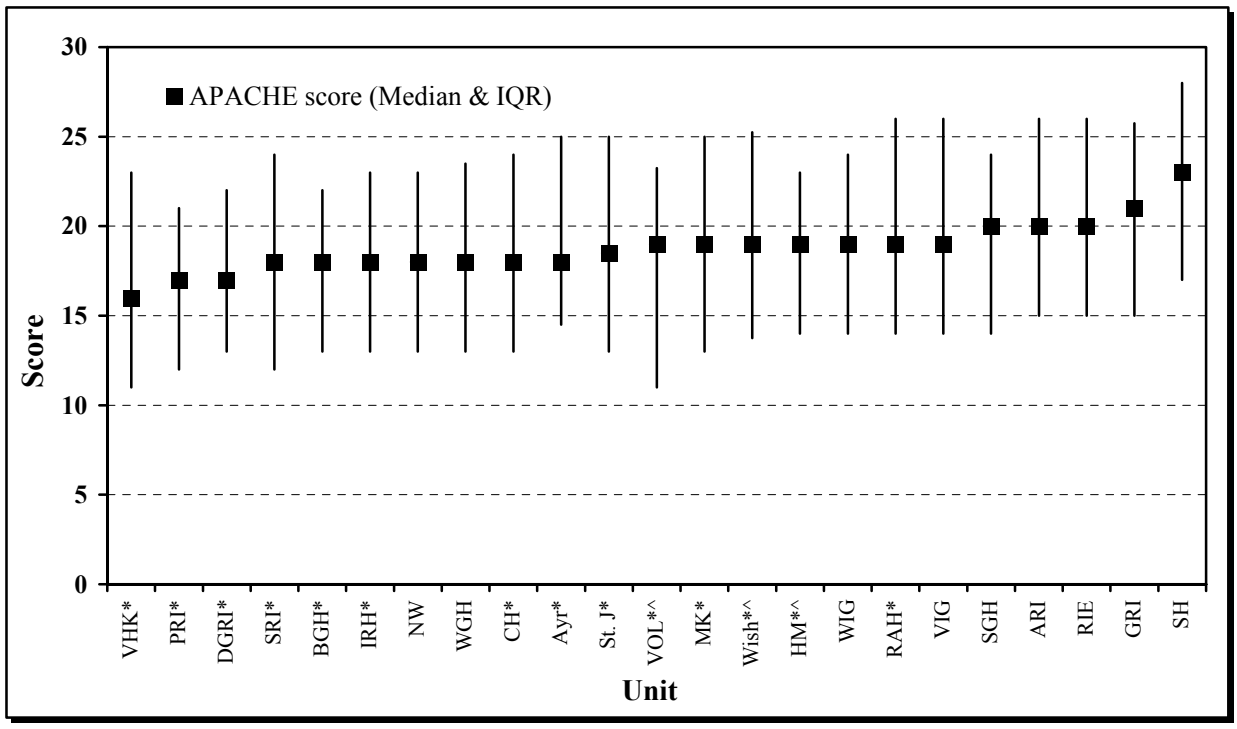
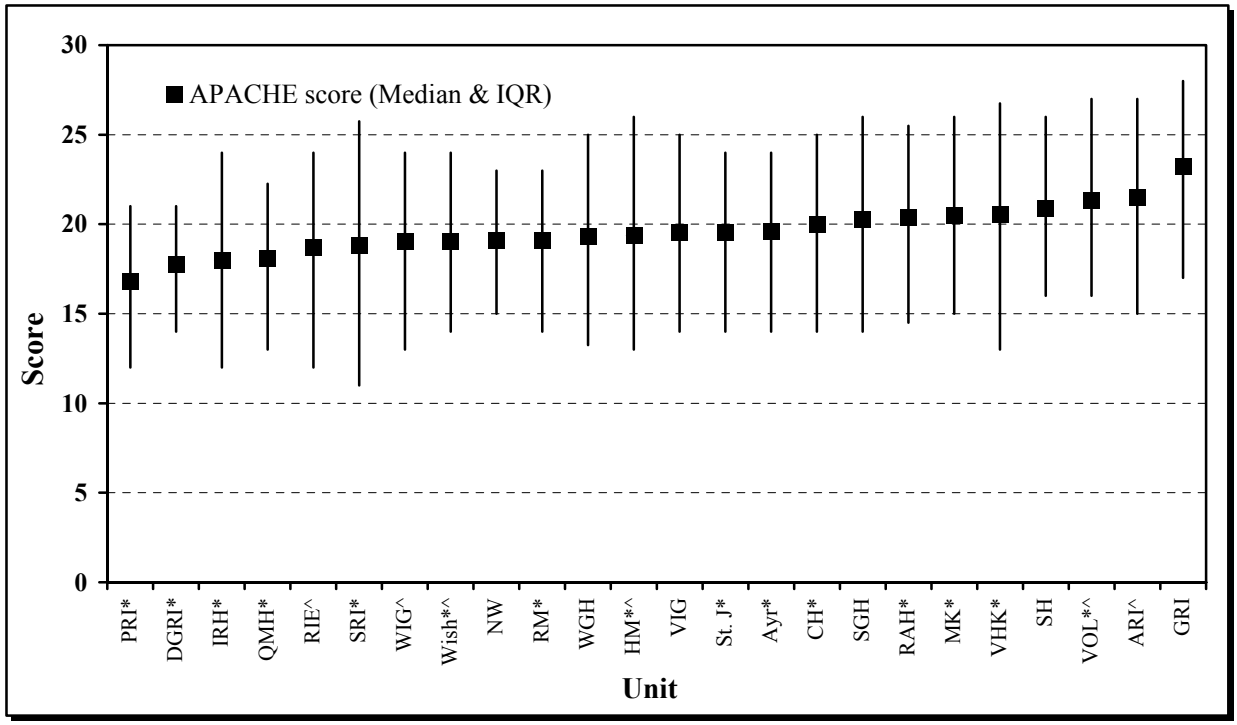


Figure 41. Illness severity: Median APACHE II scores in 2003. Scottish median: 19 (Inter-quartile range: 14 & 25).



72. Figure 42 shows the expected hospital mortalities for severity scored admissions to the 24 ICUs in 2003. The expected mortality varies from 21% in Unit I to 43% in Unit B.

73. Figure 43 demonstrates the unadjusted mortality, ranging from 19% in Unit A to 46% in Unit X. Overall 11% of severity scored patients discharged alive from ICU died without leaving hospital. There is a difference, however, in the post-ICU attrition rates between units, with more than half of the patients in units I and W dying after ICU. Note that these figures make no correction for the known difference in expected mortality between units so cannot be used to compare units' performances.

Figure 42. Median APACHE II probabilities in 24 units in 2003. Scottish median: 29 (Inter-quartile range: 12.2-52.5).

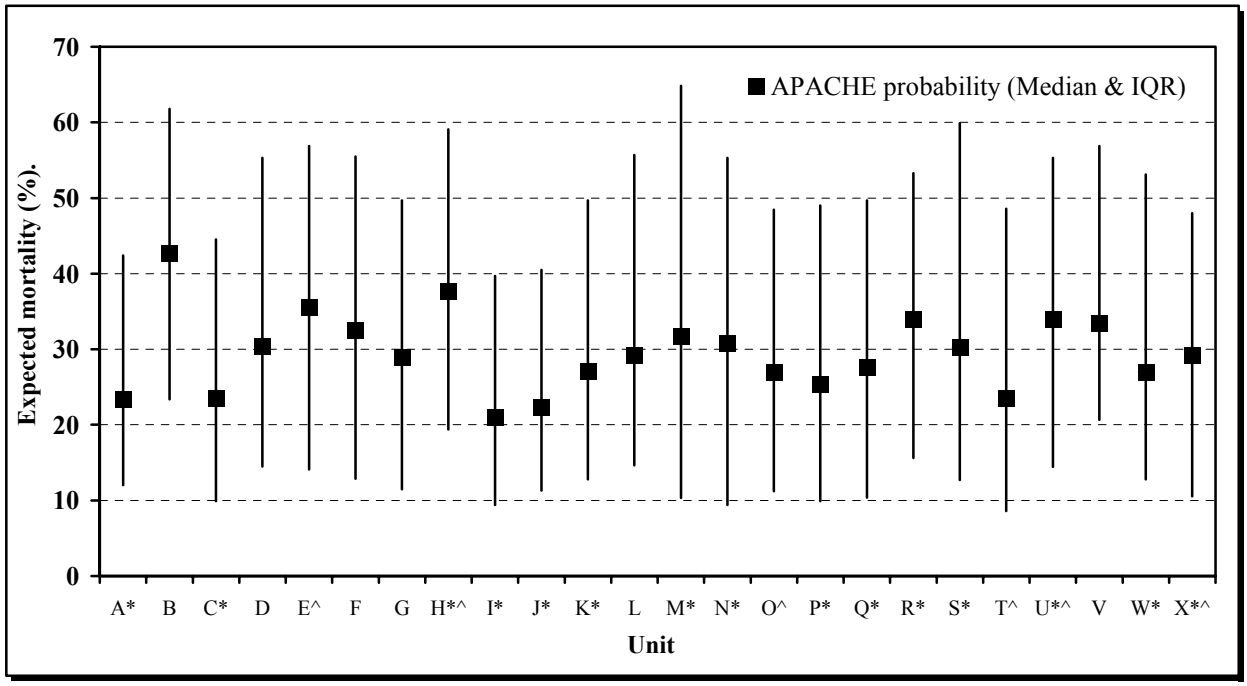
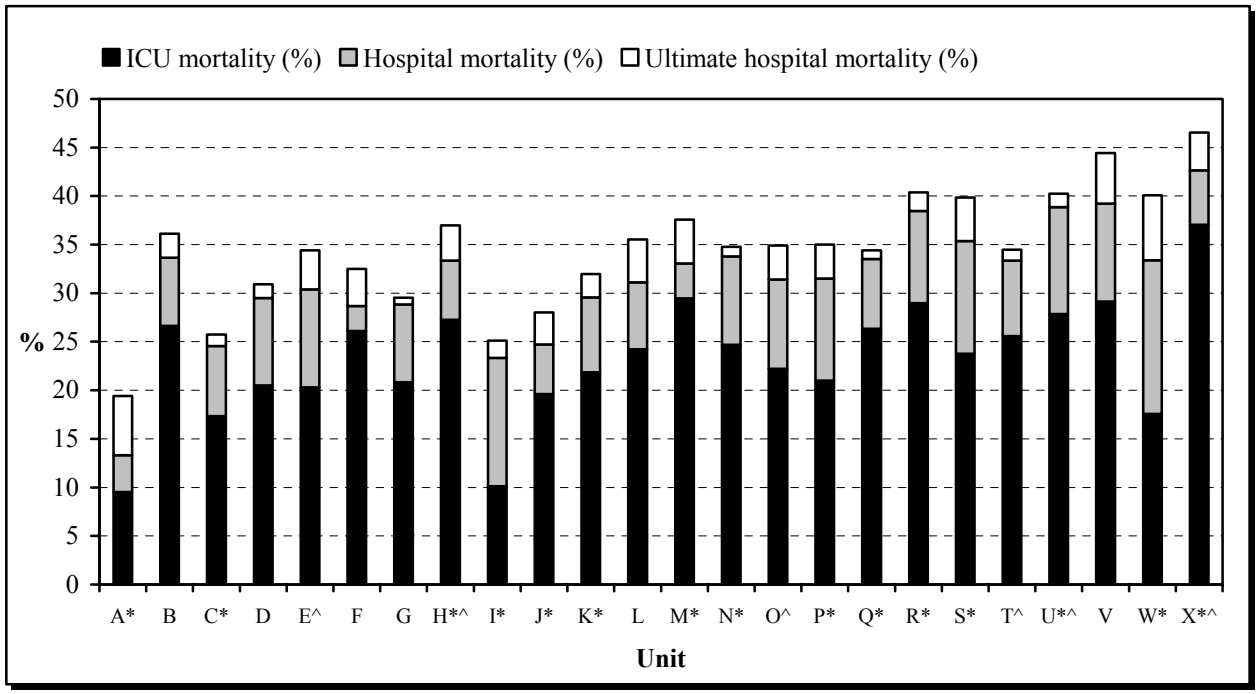


Figure 43. Mortality within subgroup of admissions in which APACHE II methodology applied: 2003.



74. The best comparator available is the case mix adjusted SMR. Figure 44 contains the SMRs and the associated lower and upper confidence intervals for the 24 units in 2003. These must be interpreted in light of the comments at the start of this section.

75. Comparison of Figures 43 and 44 demonstrates that the ultimate hospital mortality rate and SMR do not correlate. There is much less variation in SMR than there is in a raw mortality not corrected for case mix.

76. Figure 44 reveals that the upper 95% confidence intervals of units A and B fall below the lower 95% confidence interval of the Scottish SMR for 2003. The lower 95% confidence interval of unit X lies above the upper 95% confidence interval for the Scottish SMR. The units are ordered by the 2003 SMR in Figure 44 and in Table 21**,** which also shows individual unit's SMRs since 2000. It can be seen that there are changes in the ranking order of each unit year-on-year, as would be expected if the performance of units were similar.

Figure 44. Case mix adjusted SMRs (APACHE II model) in 24 ICUs in 2003. Mean: 0.983 (95% CIs 0.953-1.012).

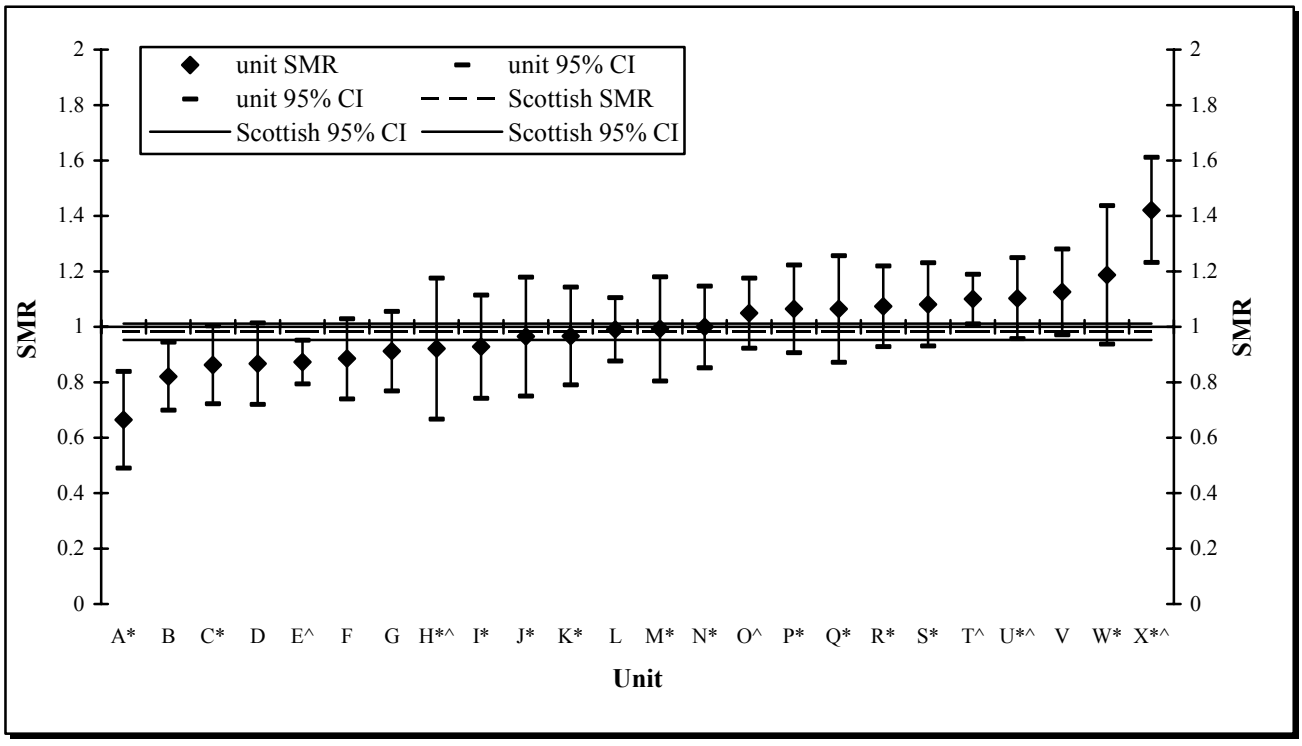
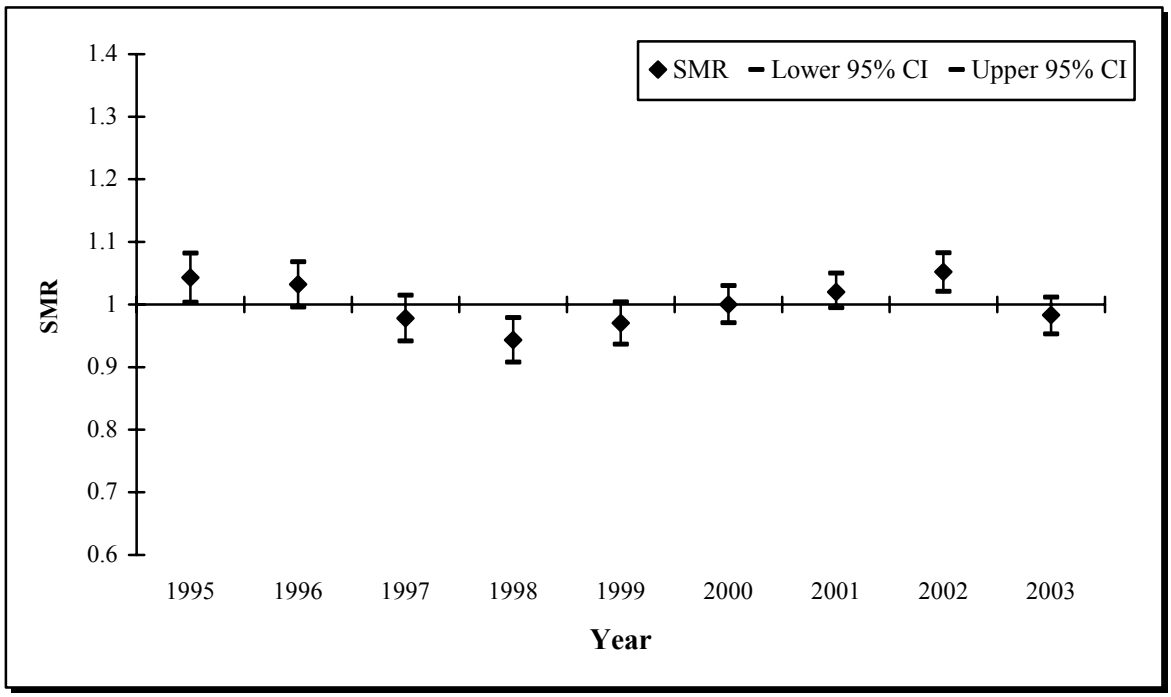


Table 21. Annual variation in APACHE II SMRs.

	2000			2001			2002			2003		
Unit	**SMR**	**95% LCI**	**95% UCI**	**SMR**	**95% LCI**	**95% UCI**	**SMR**	**95% LCI**	**95% UCI**	**SMR**	**95% LCI**	**95% UCI**
A*	-	-	-	-	-	-	-	-	-	0.665	0.490	0.839
B	0.914	0.820	1.01	1.09	0.970	1.21	1.071	0.932	1.210	0.821	0.699	0.944
C*	0.857	0.669	1.05	1.10	0.921	1.27	-	-	-	0.863	0.723	1.003
D	0.996	0.858	1.13	0.907	0.781	1.03	0.926	0.788	1.065	0.867	0.720	1.014
E^	0.992	0.891	1.09	0.941	0.852	1.03	0.924	0.837	1.012	0.873	0.794	0.952
F	1.08	0.907	1.25	1.11	0.936	1.27	1.118	0.953	1.282	0.885	0.740	1.029
G	1.41	1.26	1.56	1.19	1.05	1.33	1.089	0.932	1.247	0.912	0.769	1.055
H*^	0.895	0.609	1.18	1.08	0.809	1.35	1.202	0.909	1.494	0.921	0.667	1.176
I*	0.784	0.638	0.931	0.829	0.675	0.984	0.871	0.702	1.040	0.928	0.742	1.114
J*	0.746	0.573	0.919	1.13	0.931	1.33	0.786	0.575	0.998	0.965	0.750	1.179
K*	1.00	0.855	1.15	0.986	0.812	1.16	0.998	0.809	1.187	0.967	0.791	1.143
L	1.16	0.998	1.31	1.18	1.05	1.30	1.204	1.066	1.341	0.991	0.876	1.105
M*	1.08	0.898	1.26	0.860	0.683	1.04	0.729	0.496	0.962	0.993	0.805	1.180
N*	0.888	0.739	1.04	1.01	0.869	1.15	0.734	0.583	0.884	1.000	0.852	1.147
O^	1.06	0.937	1.19	1.13	1.013	1.25	1.061	0.940	1.182	1.050	0.923	1.176
P*	0.847	0.627	1.07	0.892	0.712	1.07	1.133	0.959	1.306	1.065	0.906	1.223
Q*	0.920	0.736	1.10	0.760	0.576	0.943	0.922	0.732	1.112	1.065	0.872	1.257
R*	0.959	0.817	1.10	1.01	0.853	1.17	1.077	0.929	1.224	1.074	0.928	1.220
S*	1.08	0.926	1.22	1.06	0.922	1.21	1.100	0.956	1.245	1.081	0.931	1.231
T^	1.10	1.00	1.19	1.17	1.08	1.27	1.222	1.125	1.319	1.100	1.010	1.190
U*^	0.911	0.759	1.06	0.879	0.757	1.00	1.104	0.942	1.267	1.103	0.957	1.250
V	1.08	0.946	1.21	0.922	0.792	1.05	1.062	0.918	1.206	1.126	0.971	1.281
W*	1.14	0.916	1.36	1.01	0.785	1.24	1.622	1.389	1.855	1.187	0.938	1.437
X*^	1.14	0.936	1.34	1.16	0.979	1.34	1.224	1.052	1.395	1.421	1.232	1.611
Y*^	-	-	-	0.985	0.780	1.19	-	-	-	-	-	-
Z*	0.829	0.681	0.977	0.895	0.718	1.07	1.124	0.952	1.297	-	-	-
Scotland	**1.00**	**0.971**	**1.03**	**1.02**	**0.995**	**1.05**	**1.052**	**1.021**	**1.083**	**0.983**	**0.953**	**1.012**

77. The annual Scottish SMRs for the 9-year period, 1995 to 2003, are displayed in Figure 45. The variation is from 0.944 in 1998 to 1.052 in 2002. The confidence intervals for each year overlap at least one other year's. The SMR for 2003 fell below 1.00 and the upper confidence level did not overlap the lower confidence interval of the 2002 SMR.

Figure 45. Scottish SMRs (APACHE II) 1995 – 2003.



78. Figures 46 and 47 present case mix adjusted outcomes for patients admitted directly to ICU from any area other than theatre and those admitted directly to ICU post-operatively. Only units in which there were 70 or more cases within either subgroup were included in these analyses. In Scotland, 62% of scored patients are non-operative admissions (Table 19). The data continue to demonstrate a higher SMR for non-operative admissions than post-operative admissions.

Figure 46. Non-operative SMRs (APACHE II model) in 22 units in 2003. Mean: 1.046 (95% CIs 1.013-1.080).

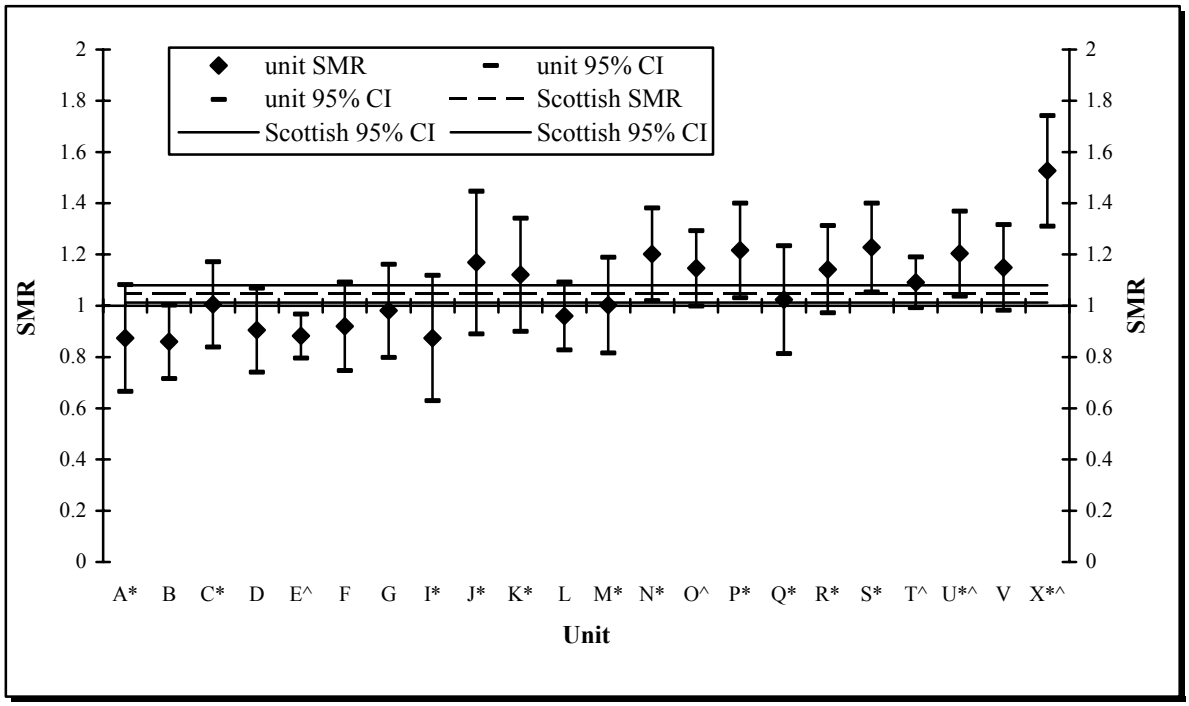
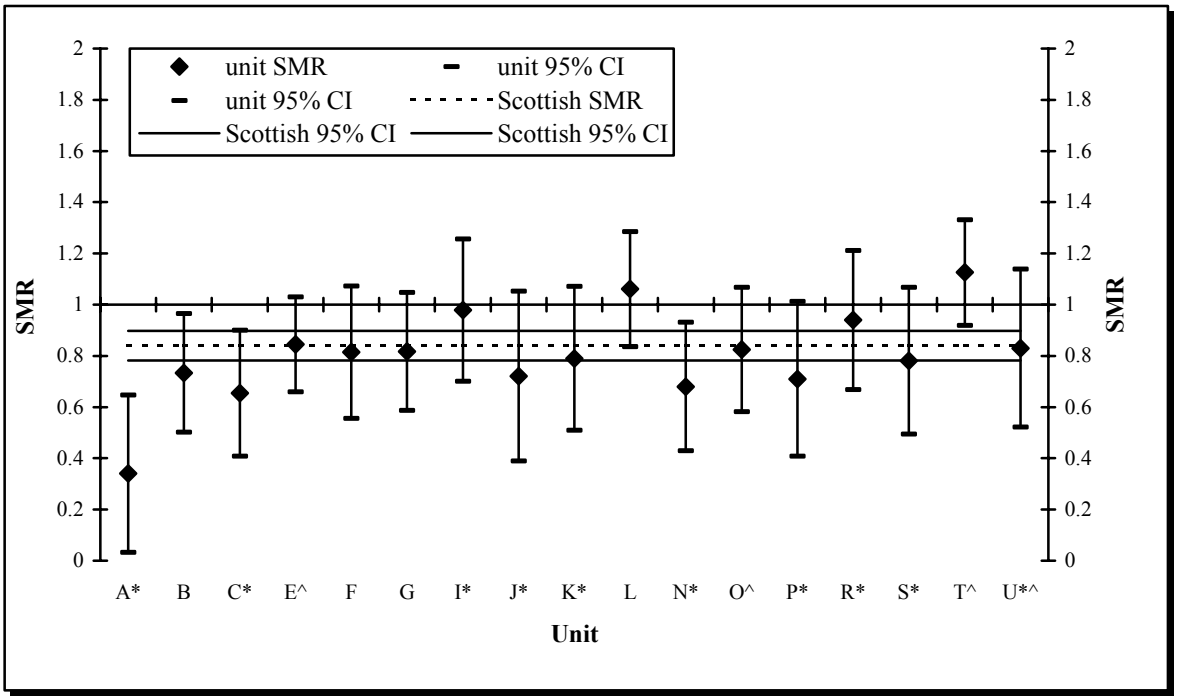


Figure 47. Post-operative SMRs (APACHE II model) in 17 units in 2003. Mean: 0.840 (95% CIs 0.782-0.897).



79. Using the APACHE diagnostic classification, patients can be grouped according to the primary organ system failure leading to ICU admission. Tables 22 and 23 illustrate the consistent variation in the proportions of patients within these nine categories during 2002 and 2003. The majority of patients (70%) fall into only three categories, gastrointestinal, respiratory and cardiovascular and the SMRs within each are similar year-on-year (Table 24 and Figure 48). Neither mortality probability nor SMR are given for Haematological classifications of which there were few cases. Two categories, however, are worthy of note: neurological and trauma. In both 2002 and 2003, the proportions of patients, the severity scores and the mortality probabilities for each category are similar. The ultimate hospital mortalities are less, however, resulting in SMRs very close to 1. Neurological SMRs have been consistently high throughout the audit, a result attributed to the failure of APACHE II to adequately adjust for neurological admissions in whom sedation prevents adequate GCS assessment. The SMR for 2003 is, however, the lowest observed in the neurological system's category (Table 24).

Table 22. Variation in illness severity by system in all scored patients: 2002.

APACHE Diagnostic System Category	Proportion of patients (%)	APACHE II		Ultimate Hospital Mortality (%)	2002		
		Score	Probability (%)		SMR	95% LCI	95% UCI
Gastrointestinal	24.7	18.7	39.3	35.1	0.892	0.833	0.952
Respiratory	24.3	20.3	33.5	37.8	1.128	1.061	1.194
Cardiovascular	21.1	23.9	46.8	50.2	1.071	1.020	1.123
Neurological	13.9	18.0	22.6	29.3	1.293	1.188	1.398
Trauma	6.8	13.8	11.9	18.1	1.516	1.260	1.771
General	4.5	14.7	19.9	13.2	0.663	0.439	0.886
Renal	2.7	20.7	28.4	27.7	0.974	0.749	1.198
Metabolic/endocrine	1.7	23.0	29.0	32.6	1.124	0.853	1.396
Haematological	0.2	23.8	-	50.0	-	-	-

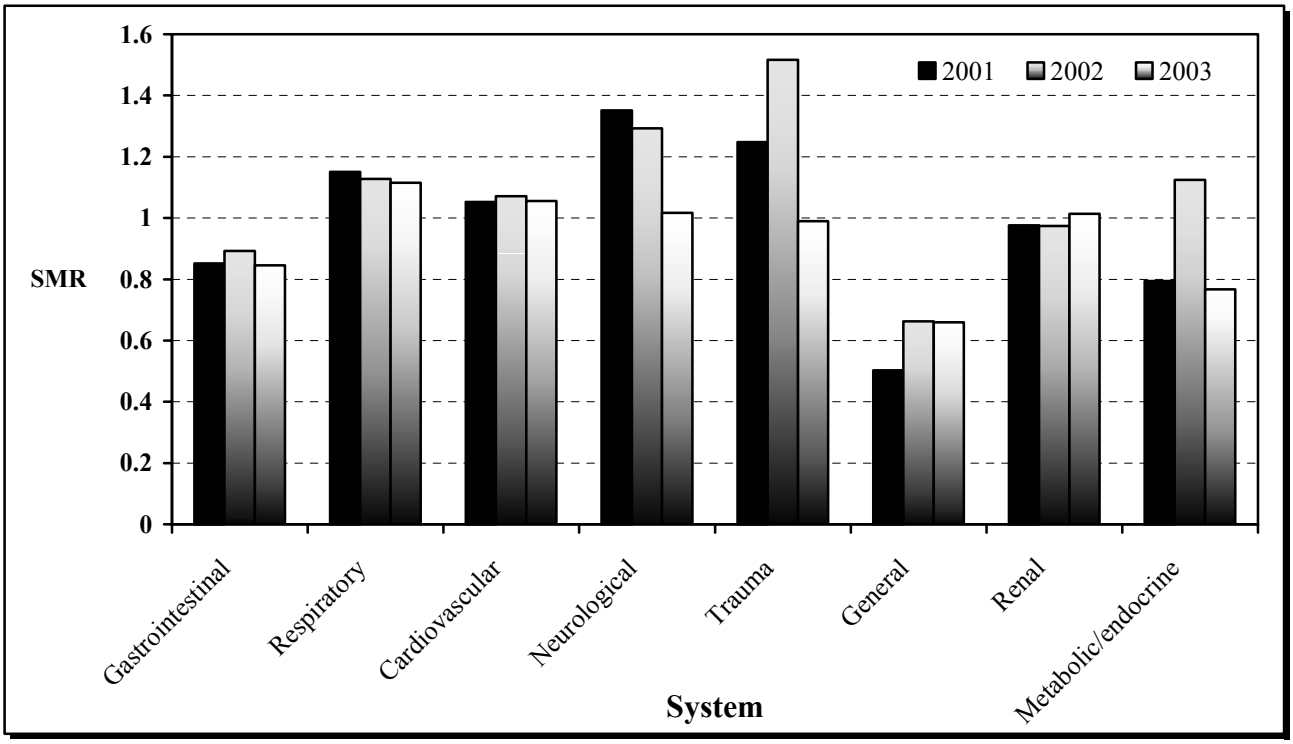
Table 23. Variation in illness severity by system in all scored patients: 2003.

APACHE Diagnostic System Category	Proportion of patients (%)	APACHE II		Ultimate Hospital Mortality (%)	2003		
		Score	Probability (%)		SMR	95% LCI	95% UCI
Gastrointestinal	27.4	18.7	39.1	33.0	0.845	0.792	0.897
Respiratory	22.8	20.4	33.7	37.6	1.115	1.051	1.180
Cardiovascular	21.8	23.2	45.1	47.7	1.056	1.007	1.106
Neurological	13.1	18.0	22.0	22.4	1.017	0.914	1.120
Trauma	5.9	14.0	12.5	12.3	0.990	0.740	1.240
General	4.5	14.9	21.0	13.9	0.659	0.455	0.864
Renal	2.6	21.0	28.7	29.1	1.014	0.798	1.231
Metabolic/endocrine	1.4	21.0	26.7	20.5	0.767	0.482	1.053
Haematological	0.5	24.1	-	53.1	-	-	-

Table 24. Comparison of SMRs within each system during 2001 – 2003.

APACHE Diagnostic System Category	2001			2002			2003		
	SMR	95% LCI	95% UCI	SMR	95% LCI	95% UCI	SMR	95% LCI	95% UCI
Gastrointestinal	0.852	0.799	0.905	0.892	0.833	0.952	0.845	0.792	0.897
Respiratory	1.151	1.087	1.216	1.128	1.061	1.194	1.115	1.051	1.180
Cardiovascular	1.052	1.004	1.1	1.071	1.02	1.123	1.056	1.007	1.106
Neurological	1.351	1.257	1.445	1.293	1.188	1.398	1.017	0.914	1.120
Trauma	1.248	1.037	1.458	1.516	1.26	1.771	0.990	0.740	1.240
General	0.503	0.311	0.695	0.663	0.439	0.886	0.659	0.455	0.864
Renal	0.976	0.759	1.194	0.974	0.749	1.198	1.014	0.798	1.231
Metabolic/endocrine	0.794	0.468	1.12	1.124	0.853	1.396	0.767	0.482	1.053
Haematological	-	-	-	-	-	-	-	-	-

Figure 48. Scottish SMRs by system (2003).



80. To help assess the case mix of the post-operative and non-operative subgroups, the diagnostic classifications of each are presented in Tables 25 to 28 for both 2002 and 2003. Where there were less than 70 cases within a subgroup, no probability or SMR data have been presented.

81. In 2003, gastrointestinal diagnoses accounted for over half of the post-operative admissions (N=1233) but only 12% of non-operative admissions (N = 452) (Tables 25 and 27). Over a third of non-operative admissions were admitted with respiratory diagnoses and remained in ICU, on average, for almost 9 days. These data are similar to those for 2002 (Table 28).

82. The SMR in 2003 for post-operative Gastrointestinal diagnoses was 0.77 (Table 25) compared to 1.15 for non-operative Respiratory diagnoses, with no overlap of confidence intervals (Table 27).

83. Although the neurological SMR in post-operative admissions remains high (Tables 25 and 26), there has been a significant reduction in the non-operative subgroup (Tables 27 and 28), from 1.251 (CI 1.142-1.361) in 2002 to 0.944 (CI 0.839-1.050) in 2003. The proportion of patients, the APACHE scores and probabilities for the non-operative neurological subgroup were almost identical in both years. There was an associated reduction in mean LOS of 0.9 d in the 2 years.

84. The results demonstrated in this section illustrate the limitations of the APACHE system in adjusting for case mix. Apparent differences in performance between units may, in fact, be partly due to differing proportions of patients from groups with different SMRs.

Table 25. Post-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2003.

APACHE Diagnostic System Category	Proportion of patients (%)	Mean LOS (d)	APACHE II		Ultimate Hospital Mortality (%)	SMR	95% LCI	95% UCI
			Score	Probability (%)				
Gastrointestinal	52.5	4.8	17.7	34.8	26.8	0.771	0.702	0.839
Cardiovascular	19.0	5.5	19.0	25.4	27.6	1.088	0.949	1.226
General	8.2	2.8	14.2	14.6	11.9	0.818	0.499	1.137
Trauma	6.7	5.3	13.2	9.9	11.4	1.149	0.712	1.586
Respiratory	6.0	2.5	15.0	16.8	7.1	0.425	0.078	0.772
Neurological	3.6	5.8	14.7	17.8	32.1	1.803	1.381	2.225
Renal	3.0	2.5	17.2	23.6	12.7	0.537	0.165	0.909
Metabolic/endocrine	0.8	1.2	10.4	-	0.0	-	-	-
Haematological	0.2	2.5	19.2	-	20.0	-	-	-

Table 26. Post-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2002.

APACHE Diagnostic System Category	Proportion of patients (%)	Mean LOS (d)	APACHE II		Ultimate Hospital Mortality (%)	SMR	95% LCI	95% UCI
			Score	Probability (%)				
Gastrointestinal	49.3	4.7	17.7	35.1	30.2	0.860	0.783	0.937
Cardiovascular	19.1	5.6	19.7	27.4	29.4	1.072	0.931	1.214
General	8.7	2.7	14.2	13.9	10.8	0.776	0.431	1.121
Trauma	7.9	5.1	13.5	10.9	12.0	1.101	0.691	1.512
Respiratory	6.9	2.5	15.0	17.5	13.7	0.782	0.454	1.109
Neurological	4.0	5.8	16.3	22.6	37.0	1.639	1.280	1.998
Renal	3.5	3.0	17.0	23.2	12.7	0.546	0.167	0.925
Metabolic/endocrine	0.5	3.7	14.5	-	0.0	-	-	-
Haematological	0.1	10.5	27.5	-	50.0	-	-	-

Table 27. Non-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2003.

APACHE Diagnostic System Category	Proportion of patients (%)	Mean LOS (d)	APACHE II		Ultimate Hospital Mortality (%)	SMR	95% LCI	95% UCI
			Score	Probability (%)				
Respiratory	33.2	8.8	21.0	35.6	41.0	1.151	1.086	1.217
Cardiovascular	23.5	6.7	25.3	55.0	57.7	1.049	0.998	1.101
Neurological	19.0	3.5	18.3	22.5	21.2	0.944	0.839	1.050
Gastrointestinal	11.9	7.1	21.4	50.6	49.8	0.984	0.904	1.063
Trauma	5.5	5.6	14.7	14.4	13.0	0.907	0.602	1.211
Renal	2.3	5.9	24.2	32.9	42.5	1.294	1.028	1.559
General	2.1	3.6	16.6	36.4	18.5	0.508	0.248	0.768
Metabolic/endocrine	1.8	6.6	23.9	-	26.1	-	-	-
Haematological	0.7	5.3	25.0	-	59.3	-	-	-

Table 28. Non-operative admissions: variation in illness severity and length of ICU stay within each diagnostic category, 2002.

APACHE Diagnostic System Category	Proportion of patients (%)	Mean LOS (d)	APACHE II		Ultimate Hospital Mortality (%)	SMR	95% LCI	95% UCI
			Score	Probability (%)				
Respiratory	34.6	9.0	21.0	35.4	40.6	1.148	1.080	1.216
Cardiovascular	22.3	5.7	26.0	56.6	60.7	1.071	1.017	1.125
Neurological	19.7	4.4	18.2	22.6	28.3	1.251	1.142	1.361
Gastrointestinal	10.2	8.7	21.7	51.3	49.0	0.956	0.865	1.046
Trauma	6.2	6.7	13.9	12.7	22.5	1.781	1.455	2.107
Metabolic/endocrine	2.4	5.4	24.1	30.0	36.6	1.219	0.941	1.497
Renal	2.3	6.3	24.2	33.3	41.6	1.249	0.973	1.526
General	2.0	2.1	16.1	-	19.4	-	-	-
Haematological	0.3	4.7	23.1	-	50.0	-	-	-

Statistical Process Control.

85. In the last 2 Annual Reports [2,8] it was proposed to assess the feasibility of applying Statistical Process Control (SPC) techniques to assess quality of intensive care provision. This is a system introduced by Walter Shewhart as a quality improvement tool within the manufacturing industry many years ago; a technique that has been recently applied to healthcare processes. Indeed, it is a technique now advocated for quality improvement in the NHS [9,10]. Shewhart recognised that there are two types of process variation: random (common) causes and assignable (special) causes. Common cause variation is ever present and does not indicate differences in the quality of a process. If there is only common cause variation present in a process, the process is "in control". If special cause variation is present, the process is "out of control", unstable and unpredictable.

86. The Clinical Indicators Support Team at NHS Quality Improvement Scotland use SPC in outcomes monitoring within the NHS in Scotland. Further information on the use and construction of control charts, produced by the team, can be found online [11,12]. Sytsma and Manley, Ferris State University, have produced a reasonably straightforward explanation of control charts, which can also be found online [13].

87. This year, individual control charts will be distributed to each unit. One unit's control chart is given in as an example in Figure 49. This type of chart displays the observed mortality rate over time plotted against the mortality rate as predicted by APACHE II for that population. Upper and lower limits of the expected mortality are plotted too. This type of chart differs from classical control charts by using the APACHE II predicted mortality rather than a unit's historical data as the baseline. The Audit Group will continue to explore the use of process control with the Clinical Indicators Support Team as a tool for monitoring outcomes.

88. When reviewing charts, out of control periods can be indicated by, amongst others,

- ***the observed mortality rate lying outside the upper or lower limits***

In Figure 49, Nov-88, the observed mortality of 0.531 is above the upper limit of the expected mortality.

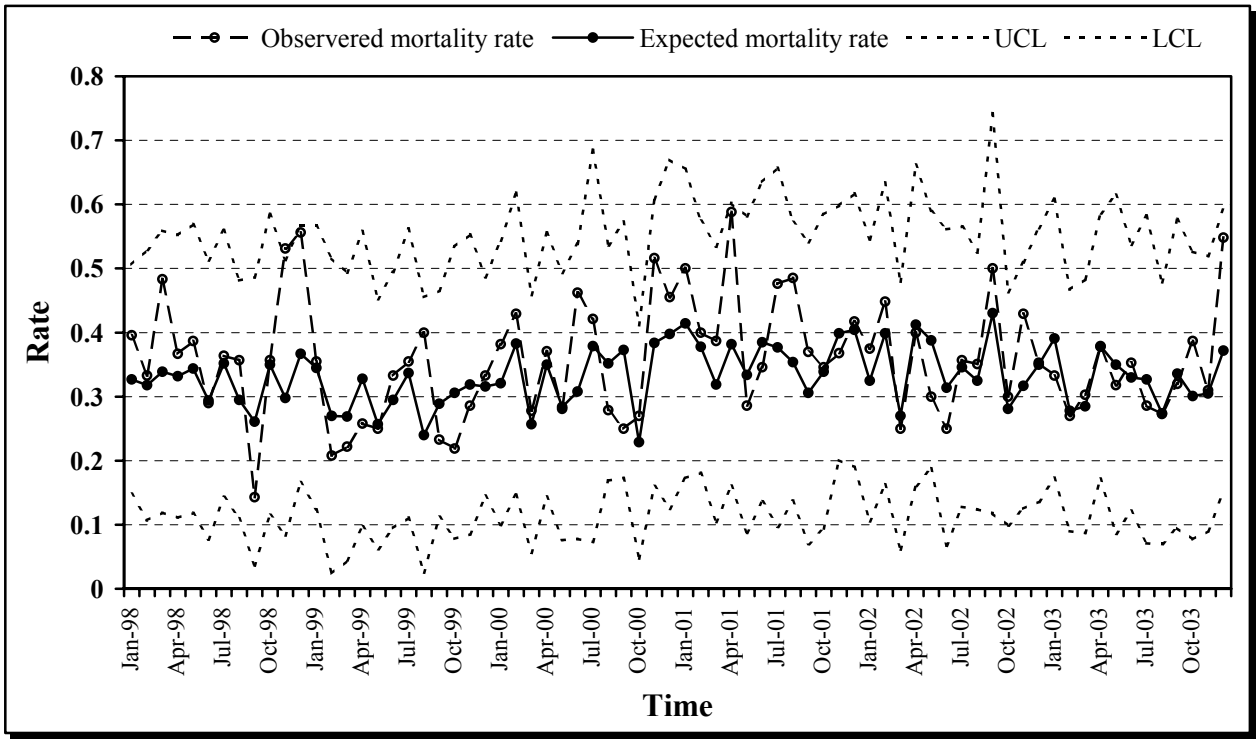
- ***8 consecutive data points (observed mortality) lying above (bad) or below (good) the centre line (predicated rate)***

There are 7 points lying above the predicted rate between Oct-00 and Apr-01 in Figure 49, hence, not quite out of control.

- ***5 data points steadily rising***

Between Nov-00 and Apr-01, 4 points steadily rise, again, not quite out of control.

Figure 49. Run Chart from one Scottish ICU, 1998 – 2003.



89. The major benefit of these charts is that they allow units to monitor their own progress without comparison to others. Units themselves can produce them once hospital outcome is known, rather than waiting for the annual report. This should enable problems to be identified earlier or the benefits of changes of management assessed. A database, which can produce charts from Ward Watcher data, can be obtained from SICSAG.

F.6. Progress of surveillance of healthcare associated infections, antimicotic prescribing and resistance in ICUs in Scotland.

90. There has been significant progress made with the surveillance of intensive care-associated infections.

91. In June 2002 a subgroup of the Advisory Group on Infection, set up by the Scottish Executive Health Department to advise it on surveillance of healthcare associated infection (HAI) and antibiotic resistance, recommended that surveillance of healthcare associated infection, antibiotic resistance and prescribing be piloted in ICUs in Scotland. Since then, there has been extensive collaboration between SICSAG, the Health Protection Scotland [HPS, previously known as the Scottish Centre for Infection and Environmental Health (SCIEH)], microbiologists, infection control nurses and clinicians in Scottish hospitals to work towards the development of an electronic surveillance system, maximising the data already collected routinely on the national ICU audit software.

92. Following discussions involving HPS, SICSAG and the Hospitals in Europe Link for Infection Control through Surveillance (HELICS) it was noted that there was considerable overlap between the ICU audit data that are already collected routinely and the HELICS dataset. Currently, several European countries contribute data on HAI in ICUs.

93. It was proposed that the pilot surveillance of hospital-acquired infection in Scottish ICUs, recommended by the Advisory Group on Infection, be conducted utilising the HELICS model rather than the American one, that it be facilitated by SICSAG and that the dataset be incorporated into the audit software.

94. A provisional dataset was presented to all interested parties at a meeting in the Victoria Infirmary on 28th April 2004, following which several changes were suggested. This dataset has been incorporated into the upgrade of Ward Watcher, as demonstrated in Figures 50 to 52.

Figure 50. Record of infections identified following HELICS/SICSAG protocol.

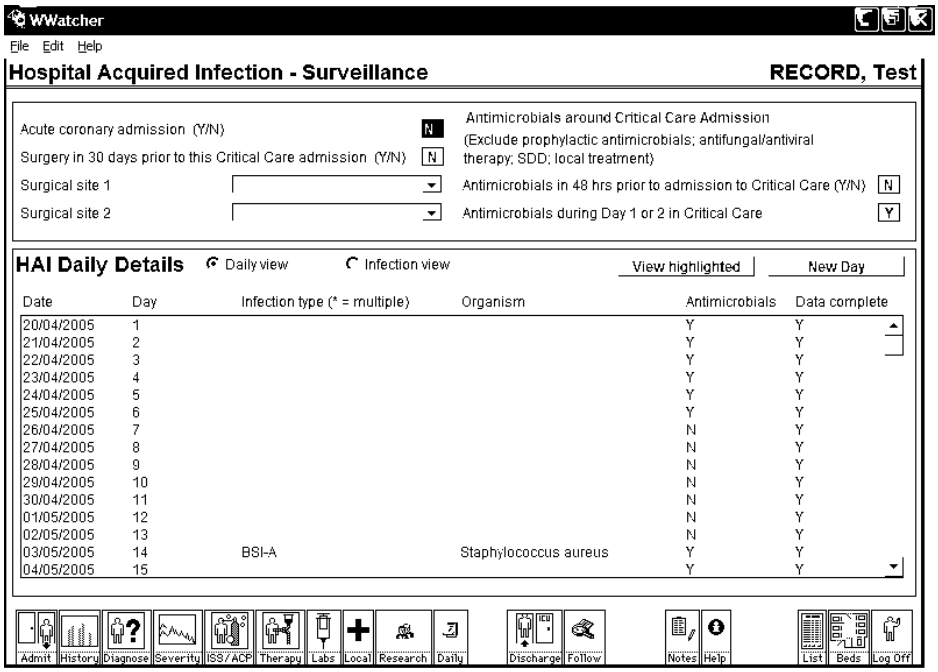


Figure 51. Daily dataset for pilot study.

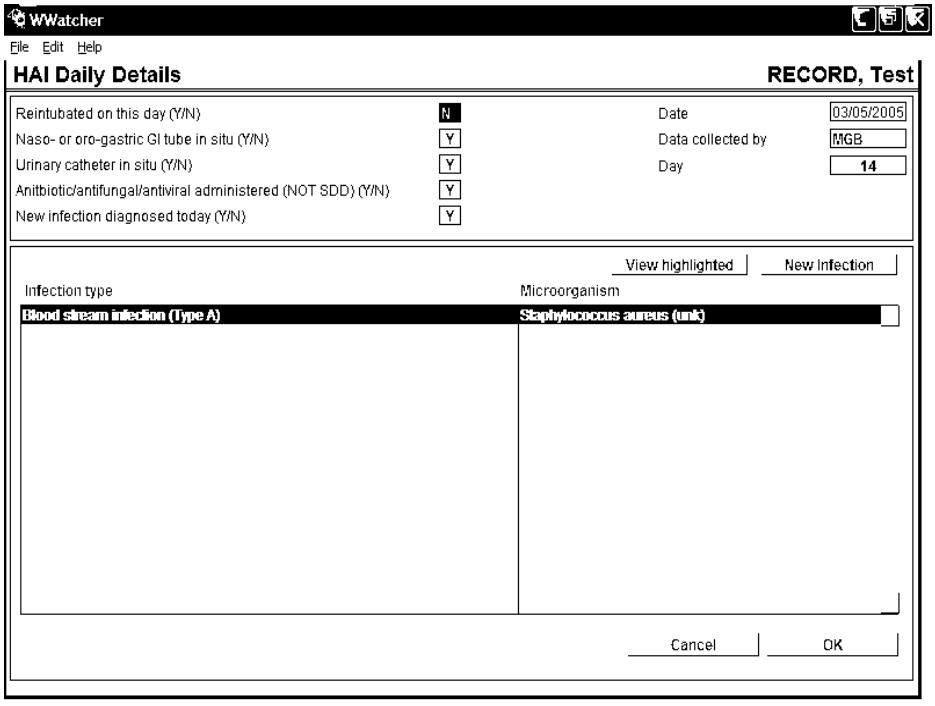
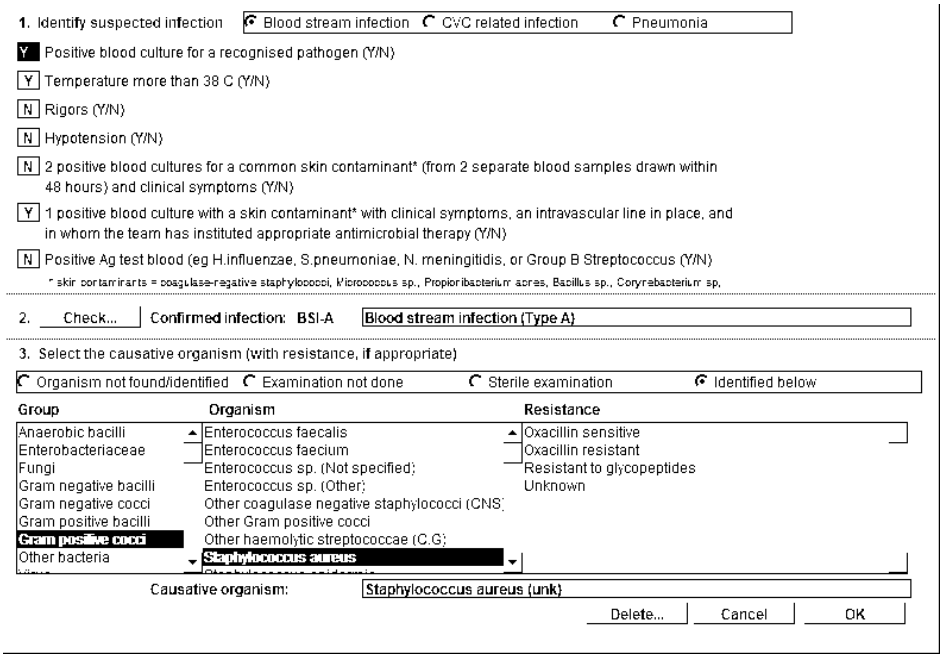


Figure 52. Blood stream infection dataset.



95. The dataset has been run as a pilot program by 5 ICUs for periods of 2 to 3 months. The objectives being to evaluate

- Ward Watcher as a tool for collecting HAI surveillance data in the ICU
- the applicability of the HELICS methodology for surveillance of HAI in ICUs in Scotland
- the resources required to collect HAI surveillance data
- the feasibility of accessing Daily Defined Doses (DDD) data from ICU pharmacists throughout Scotland

The data have been analysed. Some preliminary results and feedback from the ICUs involved, is presented below.

96. During the pilot period, data were collected on all ICU admissions regardless of length of stay. Data were collected on pneumonia (PN), blood stream infection (BSI) and CVC-related infection (CVC-RI). The pneumonia definition was adapted to allow the diagnosis of pneumonia without consecutive chest X-rays. This was a pragmatic decision as it appeared few ICUs performed chest X-rays frequently enough to meet this criterion.

97. All pilot sites have the ability to report PN3-5. Only some sites provide the quantitative microbiological results required for PN1-2. Sputum and non-quantitative lower respiratory tract specimens are used most frequently for diagnosing pneumonia, thus PN4 will be most frequently diagnosed.

98. Both BSI and CVC-RI definitions can be easily applied by all sites. Similar limitations in the provision of quantitative data mean that the CVC-RI may be limited to CRI3 (non-quantitative results) at many sites.

99. A total of 386 patients were admitted to the 5 pilot sites, 52% (199) of whom stayed in ICU for at least 2 days. The following figures relating to infections are preliminary and subject to change following quality checking by HPS:

- 44 infections were diagnosed using the criteria (BSI = 11.4%, PN = 68.2%, CVC = 20.5%)
- for all pilot sites, the overall infection rate was 30.5 infections (95% CI 22.2-40.9) per 1000 patient days.

100. The feedback from the pilot sites was largely positive. Pilot participants reported that the definitions were easy to apply. Data collection was felt to be easy and straightforward and not time-consuming – approximately 5 minutes per patient per day. Some minor improvements were suggested that would improve the system.

101. Once installed in all units wishing to participate, it is intended to perform Scotland-wide surveillance. This would run for a 3 or 6-month period and could be repeated at some point in the future.

102. The Scottish Adult Critical Care Pharmacists Network has collated DDD data relating to antibiotics from all ICUS in Scotland. This provides data on how much antibiotic is dispensed in a unit. It is limited to prescription rather than actual use of the antibiotic. Data on DDD were collated for the pilot sites over the pilot period for their unit. In due course it is hoped that this will mature into a system that will be able to track antibiotic use and antimicrobial resistance patterns for ICU in Scotland

103. A full report on the results of the pilot will be published shortly.

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I. APPENDICES.

Appendix I. Publications, Reports and Abstracts.

PUBLICATIONS

Walsh TS, Garrioch M, Maciver C, Lee RJ, MacKirdy F, McClelland DB, Kinsella J, Wallis C, for the Audit of Transfusion in Intensive Care in Scotland (ATICS) Study Group. Red cell requirements for intensive care units adhering to evidence-based transfusion guidelines. *Transfusion* 2004; **44**(10):1405-1411.

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Appendix II. List of Scottish adult ICUs and the lead audit consultants during the period of reporting.

Unit ID	Intensive Care Unit	Lead Audit Consultant
ARI	Aberdeen Royal Infirmary	Dr G Adey
Ayr	Ayr Hospital	Dr I Taylor
BGH	Borders General Hospital, Melrose	Dr NP Leary
CH	Crosshouse Hospital	Dr R White
DGRI	Dumfries & Galloway Royal Infirmary	Dr D Williams
FDRI	Falkirk & District Royal Infirmary	Dr H Robb
GRI	Glasgow Royal Infirmary	Dr MG Booth
HM	Hairmyres Hospital, East Kilbride	Dr D Allen / Dr V Watson
IRH	Inverclyde Royal Hospital, Greenock	Dr F Munro
MK	Monklands Hospital, Airdrie	Dr R MacKenzie
NW	Ninewells Hospital, Dundee	Dr AJ Shearer
PRI	Perth Royal Infirmary	Dr S Winship
QMH	Queen Margaret Hospital, Dunfermline	Dr R Savage / Dr P Nicholas
RM	Raigmore Hospital, Inverness	Dr I Skipsey / Dr S Hunter
RAH	Royal Alexandra Hospital, Paisley	Dr S Madsen
RIE	Royal Infirmary of Edinburgh	Dr B Cook
St. J	St. John's Hospital, Livingston	Dr M Fried
SRI	Stirling Royal Infirmary	Dr M Worsley
SH	Stobhill Hospital	Dr C Miller / Dr D Ure
SGH	General ICU, Southern General Hospital	Dr G Imrie
VOL	Vale of Leven DGH, Alexandria	Dr WR Easy
VHK	Victoria Hospital, Kirkcaldy	Dr C Wilson
VIG	Victoria Infirmary, Glasgow	Dr JC Howie
WGH	Western General Hospital, Edinburgh	Dr C. Wallis
WIG	Western Infirmary, Glasgow	Dr L Plenderleith
Wish	Wishaw General Hospital (Law Hospital until mid 2001)	Dr N Willis