Scottish Intensive Care Society Audit Group

ANNUAL REPORT 2000

An Audit of Intensive Care Units in Scotland.

Clinical Effectiveness Programme 99/50

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(A) INTRODUCTION & SUMMARY

1. Once again the Annual Report is being published on the Scottish Intensive Care Society's web site. The web site is a means of communication, which saves publication costs and allows a considerable volume of information to be conveyed. More importantly, it offers improved access for health care professionals and the capacity to provide relevant links to other web-based publications. It also allows downloading of graphical data in a form which facilitates local presentation and discussion. Our use of the web, as a means of communication, remains in its infancy. It offers a medium for debate which, as a group, we have yet to take up with any conviction. Suggestions on how we can improve the report in particular and the web site in general, will be very welcome.

2. A web site questionnaire currently offers the opportunity to comment on the strengths and weaknesses of the audit, in particular, how it could be adapted to better meet your needs, whether as a nurse, doctor, profession allied to medicine, or health service administrator. This type of feedback is an important element in continuing to refine the audit, both for those who are required to enter data and those responsible for ongoing funding.

3. At the time of writing, funding support from the Clinical Resource and Audit Group (CRAG) is secured through to April 2002. Although ongoing support for the audit is strongly supported in *Better Critical Care* (1), a means of securing ongoing funding has yet to be identified. Identifying the mechanism of "exit" from CRAG funding will be a priority for the forthcoming year.

4. While the Annual Report represents an important summary of data feedback, many of the important issues were discussed at our annual audit meeting in October. A summary of this meeting can be viewed on-line, in the Society's newsletter. A further meeting was organised by the Society in November to debate important issues raised in *Better Critical Care*(1), with presentations being given by members of the Working Group. This meeting was extremely well attended by nursing and medical staff involved in both intensive care and high dependency care. Again, a summary of this meeting can be viewed on-line, in the Society's newsletter.

5. *Better Critical Care*(1) was published in September 2000. The Short-Life Working Group was invited to take a broad view of critical care services, but with particular emphasis on dealing with winter pressures. This was inevitable, given the difficulties experienced in dealing with the exceptional increase in acute medical admissions(2) in general , and the consequent increase in ICU admissions, seen during the period between December 1999 and January 2000. The report from which these data are derived can be accessed on the SHOW website. (http://www.show.scot.nhs.uk/).

6. Trust-level Critical Care Delivery Groups (CCDGs) have been given responsibility for establishing local winter "coping" strategies. This involves, where necessary, providing

safe transfer of critically ill patients to the most appropriate intensive care unit (ICU), and the development of local escalation policies. By the time of publication of this report it is anticipated that there will be a comprehensive National ICU Bed Bureau, which should greatly facilitate identification of the most appropriate ICU for transfer. Setting up the National Bed Bureau has been rendered possible by initial funding from GGHB and CRAG funding of the national audit software. More recently we have been greatly assisted by Mr C Knox (Head of Computing and I.T. Strategy), in linking ICUs via the NHSnet. To better inform those units which implement an escalation policy, only where there are few, if any, beds available in the system, we have displayed on the web site, a regularly updated trend in national ICU bed occupancy and bed availability.

7. Once again we provide comparative data on ICU occupancy. These data are of particular value to the Trusts' Critical Care Delivery Groups, which have the responsibility for ongoing assessment of the adequacy of provision of critical care beds.

8. Case mix adjusted mortality is presented both in terms of 5-year trends and variation across individual ICUs. Once again the most striking feature is the very narrow range of standardised mortality ratios. These data are provided in an anonymised form, with an ICU's identity made available to its own staff and the relevant Director of Medical Services.

9. The ability to compare case mix adjusted ICU lengths of stay would be complimentary to comparisons of standardised mortality ratios, in providing an insight into variations in effectiveness of ICU care. We have recently published an evaluation of the length of stay prediction generated by the Acute Physiology Age and Chronic Health Evaluation model (APACHE III)(3,4). This was found to have limited applicability to a Scottish population. In the current report we describe the relationship between length of ICU stay and severity of illness as measured by APACHE II(5) mortality probability. We have used these "length of stay v mortality probability" plots to examine trends in ICU length of stay over the last 5 years in Scotland. More importantly, we have provided plots for each ICU. In the forthcoming year we intend to work with Dr Saxon Ridley to develop a robust prediction of length of ICU stay, based on his previously published work in this area(6).

10. In the 1998 report(7) we provided outcomes for patients with renal and respiratory failure. In the 1999 report(8) we surveyed variations in the provision of renal support. In the last year, we have used data collected on a daily basis to examine the impact of variations in the timing of commencing renal dialysis. This was presented to the Annual Meeting of the Scottish Renal Association in November 2000 (Appendix I). A group under Ian Grant's direction is now analysing data on patients with the Adult Respiratory Distress Syndrome (ARDS) in conjunction with AstraZeneca. A presentation of interim data analysis was made at the recent meeting of the Intensive Care Society & Riverside Group in London and was awarded first prize (Appendix II). For the first time, in the forthcoming year, we intend to extend data collection to assessment of quality of life following hospital discharge, in the ARDS patients.

11. A recent study(9) from Ninewells Hospital reported an association between workload and outcome. As a first step in evaluating this observation we have examined the variation in standardised mortality ratio, in relation to the monthly variation in ICU occupancy across Scotland.

12. As a means of further refining our understanding of nursing workload, the System of Patient Related Activity (SOPRA) will be available on Ward Watcher (Critical Care Audit Ltd, Yorkshire) as an alternative to the Therapeutic Intervention Scoring System(10) (TISS). This system was discussed and presented at the annual audit meeting and is being welcomed by the nurses who attended.

13. Discussions with the Information and Statistics Division (ISD) are ongoing in relation to developing a Scottish Morbidity Record (SMR01) for intensive care, derived from the audit database. Simon Mackenzie has taken the lead role in this, along with the ongoing development of the ICU diagnostic list. The Society's dataset has always recorded a diagnosis using the classification published with the APACHE III system. This requires the admitting clinician to choose the single most significant diagnosis at the time of ICU admission from a fairly limited list. This diagnosis is essential for the calculation of APACHE-based probabilities but does not adequately describe the patient for clinical purposes or for more detailed audit. Most ICU patients have multiple diagnoses and as a minimum it is necessary to know the underlying problem as well as the precipitant of ICU admission. These are often different but both may be relevant to prognosis (e.g. pulmonary embolism in a patient with colonic carcinoma).

14. Ward Watcher has always allowed the recording of additional diagnoses but this was non-standardised and, in practice, only a few units used it. A standard classification was introduced in 1999 and the diagnoses at hospital admission and at ICU admission are now recorded for all patients. Six additional diagnoses can be recorded for each patient at the clinician's discretion. Entries are made from a pre-programmed hierarchical list. This does not have browser functionality but is as intuitive as possible. The number of diagnoses available is finite to aid data entry, but in 2000 the program has been modified to allow free text entry of uncommon diagnoses.

15. While continuing to provide descriptive data of ICU activity and outcomes, it is important that the audit evolves towards a system, which more clearly encourages ongoing improvement of intensive care provision. Recent publications from our group have summarised the performance of available audit tools in terms of both prediction of mortality(11) and length of ICU stay(3) and have clarified the most appropriate use of the Glasgow Coma Score (GCS) within the severity scoring systems(12). We have recently summarised our views on how ICU audit systems may be used to deliver real health gain(13). To this end, the Society has set up a research group which seeks to take advantage of the common audit database, to undertake multi-centre clinical studies. We believe that, in the future, the audit should seek to facilitate local evaluation of critical care services by the Clinical Standards Board for Scotland. We commend the Scottish Intensive Care Society to consider creation of a Standards Group, which would present Scottish ICU staff with recommendations on best practice, based on best available

evidence. Limited availability of high level evidence constrains guideline development. It is, therefore, of considerable interest that the Scottish Intercollegiate Guidelines Network is establishing a group to examine this problem in the context of postoperative care.

16. *Better Critical Care*(1) echoed the Department of Health document Comprehensive Critical Care(14) in proposing a broader definition of critical care, encompassing not only intensive care and high dependency care, but also care of "at-risk" patients in general wards. The audit group undertook a review of high dependency services for the working group. While almost all acute hospitals have high dependency units (HDUs), they are predominantly surgical. There is, as yet, limited development of medical HDU facilities. *Better Critical Care*(1) commended the extension of the ICU audit to HDU audit. Given the current predominance of surgical HDUs, the leading role taken by the Scottish Audit of Surgical Mortality (SASM) in encouraging the development of HDU care, and the availability of a model of case mix adjustment for surgical HDU patients(15),(16), we believe this could best be pursued in conjunction with SASM. This proposal is subject, in the first instance, to approval from CRAG. We have indicated that this could be taken forward without additional national funding, on the assumption that all of the system costs would be met by individual Trusts, as of April 2001.

17. *Better Critical Care*(1) also highlighted a number of concerns around nurse training, and set a challenge in proposing increased flexibility as a key factor in dealing with ICU "winter pressures". A first step in addressing these issues has been taken with the publication of "*Continuing Professional Development Portfolio - A Route to Enhanced Competence in Critical Care Nursing*" by the National Board for Nursing in Scotland (17).

B) RESULTS & DISCUSSION

B.1. INTENSIVE CARE DEMAND

18. A list of letter codes for each unit, relevant to this section are given in Appendix III. Throughout the graphs, asterisks identify District General Hospitals.

19. As in previous years we provide an overall picture of the trend in ICU bed demand and data which allows each ICU to compare its activity with a Scottish benchmark. In this section, as well as later sections, we have analysed not only all participating ICUs, but also a subset of 20 ICUs who have submitted data throughout the period 1995-99. Trend data, which include all units currently participating, is less valuable for year-on-year trend analyses, as it includes a variable composition of ICUs.

20. Figure 1 demonstrates the pattern of ICU occupancy on a month-by-month basis, with individual plots of the years from 1996 to 1999 inclusive. Figure 2 allows a comparison of the year 1999 with the mean for the preceding years. Once again, the trend of

increased activity in the period from December to February is apparent. As everyone is aware, we had to cope with exceptional demand for a period during the winter of 1999/2000. Figure 3 shows the occupancies for January to March over a 6-year period. In fact, only during January 2000 was occupancy exceptional, the February/March period was no different from previous years. This peak in activity from late December through January mirrors data on Acute Hospital Admissions(2) (Figure 4). Once again the peak was much more pronounced than in the two previous years (Figures 5 & 6) and of relevance to ICU activity, respiratory conditions were a particular feature. (Data provided by ISD, previously published in the Winter Pressures Group Report(2)).

21. Figures 7 - 31 allow each intensive care unit to examine its monthly pattern of occupancy over the period of data collection.

22. Figure 32 demonstrates the pattern of average ICU bed occupancy over the 5-year period from 1995 to 1999. Occupancy was maintained at a very high level through the period 1996 to 1999, in spite of a modest increase in ICU bed capacity during that period.

23. Figure 33 shows the range of bed occupancies in those 20 units who contributed data for the entirety of the period from January 1995 to December 1999. Individual year's occupancies for each unit are colour coded and the units have been ordered from left to right according to their mean occupancy during the study period.

24. Figure 34 shows 1999 occupancies for all ICUs contributing data in that year, along with the mean for the previous years in which they contributed data. Examining the ICUs with the highest average occupancies, it is gratifying to find that the majority have, during the study period, or subsequently, expanded their ICU bed provision. Thus Borders General Hospital (Unit W) reduced it's occupancy to 100% with the addition of one further funded ICU bed in 1999, while Aberdeen maintained very high occupancy in spite of increasing its ICU beds by 20% during the study period and is currently undergoing major expansion. The Glasgow units which all featured in the top 50% in terms of occupancy, were all expanded by one additional bed during 2000, with the exception of the Royal Infirmary. This unit identifies the problem of the difficulties in expansion of provision once a unit is maximally expanded on its current site.

25. The forthcoming Building Note for Intensive Care Units (SHBN27) will recommend that consideration be given to the potential for future expansion of beds when commissioning a new ICU. None of the foreseeable factors in health care indicate anything other than a progressive increase in demand for critical care beds.

26. Intensive care bed occupancy is a consequence of admission rate and average length of stay. Figure 35 shows a comparison of ICU mean length of stay, for all admitted patients, comparing 1999 with the mean for 1996-98. Figure 36 shows the variation in annual ICU admission rates per bed for the years 96-99. As expected the highest rates occur in units with the shortest lengths of stay. The relationship between severity of illness and average length of stay is discussed

B) RESULTS & DISCUSSION

B.2. ORGAN SUPPORT

27. Bed occupancy provides an incomplete picture of ICU workload. This can be augmented by categorising patient care according to the level of organ support. For approximately 2 years we have entered data on each patient on a daily basis (the Augment Care Period (ACP) data), which indicates whether one or more key critical care interventions were being undertaken. Thus individual patient days can be categorised by the number of organ systems which are being supported, up to a maximum of three. There is no implication that the absence of any one of these interventions on a given day represents inappropriate placement in an ICU. Indeed, it is inevitable that, even where the provision of high dependency facilities is adequate, some at-risk patients may be admitted to intensive care who do not ultimately require active intervention. In addition, some patients, during the course of recovery, will be monitored while confirming their ability to cope without support. However, overall figures may be used to assess appropriate nurse:patient ratios for an individual ICU, and/or the potential to augment ICU beds with a greater HDU provision. Figure 37 displays the proportion of ICU days on which patients were ventilated during April 1999-March 2000. Figure 38 further refines this by adding the proportion of days on which either cardiovascular or renal support was given in conjunction with ventilation (Resp+1) or all three systems were being supported (Resp+2). It also identifies the days on which cardiovascular or renal support were being given in the absence of respiratory support (nonResp+1) and the minuscule number of occasions on which both cardiovascular and renal support were being given without respiratory support (nonResp+2).

28. This analysis may underestimate the proportion of days of organ support as it gives equal weighting to the final day where less than 24 hours of care is given and interventions are likely to be reduced. Nevertheless, the overall percentage of ACP days in which ventilation is required is 70%. Not surprisingly, the 5 units in which 80% or more of the days involve ventilatory support, are teaching hospitals. Neither is it surprising that the 3 units ventilating less than 50% of the time are flexible ICU/HDUs.

B) RESULTS & DISCUSSION

B.3. THE USE OF ICU LENGTH OF STAY AS AN OUTCOME MEASURE

29. The letter code for an individual ICU can be obtained from the local ICU audit co-ordinator. A list of these valued individuals, who are responsible for organising the real work, is given in Appendix III.

30. We have recently published an evaluation of the APACHE III prediction of ICU length of stay(3). This was found to be of limited value and is no longer available for use in Scotland, as our access was limited to the period of our APACHE III evaluation.

31. We have previously demonstrated that there is a complex but entirely understandable relationship between severity of illness and ICU length of stay. The relationship is parabolic, with ICU length of stay being shortest in the most severely ill patients and in the least severely ill patients (Figure 39). The basis for this becomes clearer when ICU survivors and ICU non-survivors are examined separately. Though our recent publication(3) utilised APACHE III(4) predicted mortality as a measure of severity of illness, as can be seen from Figure 40, a similar relationship applies for the predicted mortality, using APACHE II. For ICU non-survivors there is a progressive decrease in the ICU length of stay with increasing predicted mortality. For ICU survivors there is a progressive increase in ICU length of stay with increasing predicted mortality. Linear regression analysis produced r2 of 0.96 and 0.94 for survivor and non-survivor plots respectively (mean length of stay v mean mortality probability). Figure 40 includes a frequency distribution of survivors and non-survivors, indicating where patient numbers are sufficiently high for the relationship to be expected to be consistent. This is particularly relevant to subsequent plots for individual ICUs where numbers are much smaller.

32. We have, in previous years, published the average length of stay for each ICU and accompanied this with a measure of severity of illness such as the mortality probability. On this occasion, we have provided a set of plots (Figures 41-65), which allow each unit to compare its pattern of length of stay in relation to severity of illness and survivor status. It is important to resist the temptation to over-interpret these comparisons, particularly where they relate to small patient numbers. Variations in ICU length of stay may arise for a variety of reasons. Where an individual intensive care unit has a satisfactory standardised mortality ratio, a length of stay in ICU survivors which was lower than expected might arise from either more effective care or through discharge of patients at higher levels of dependency. Conversely, variations in length of stay of non-survivors, in the presence of a satisfactory standardised mortality ratio, may arise from differences in the readiness with which the futility of intensive care is recognised.

33. We have attempted to examine whether there are any discernible trends in the patterns of length of stay of survivors (Figure 66) and non-survivors (Figure 67). The frequency distribution of patient numbers refers to average annual numbers. Somewhat to our surprise, remarkable stability in these patterns, year-on-year for the last five years, is demonstrated. Longer lengths of ICU stay, in comparably sick patients, do not explain the gradual increase in the requirement for ICU beds over this period.

34. There is some debate about the most pertinent way to describe ICU length of stay. Wiseman(18) suggested that there is no single appropriate statistical descriptor and that, where possible, both mean and median data should be provided. Nonetheless, as regards the impact of variations in length of stay on ICU bed demand, the most relevant measure is the mean length of stay. Consequently, in this presentation we have used mean length

of stay exclusively for individual ICU plots. Figure 68 shows the relationship when median length of stay is used. The flatter relationship is expected, given the skewed distribution of length of stay to the left. This observation was also made when evaluating the APACHE III prediction(3).

35. These analyses do not examine the impact of factors incorporated into the mortality probability, which may have a relatively greater impact on length of stay, such as age, chronic co-morbidity, source of admission, diagnostic category and the GCS component of the acute physiology score. Thus examination of data from the Western General Hospital (Edinburgh), unit W, suggests that patients with a neurological diagnosis will have a longer length of ICU stay for a given severity of illness. Given the interim nature of these data, we have retained the method of anonymity used in standardised mortality ratio (SMR) presentations. It remains our intention to develop a model to predict ICU length of stay. We are collaborating with Dr. Saxon Ridley who has previously published in this area(6).

B) RESULTS & DISCUSSION

B.4. STANDARDISED MORTALITY RATIOS AS AN OUTCOME MEASURE

36. The letter code for an individual ICU can be obtained from the local ICU audit co-ordinator.

37. For these data and all subsequent mortality data, we have used ultimate hospital outcome by using data linkage to Scottish Morbidity Records (SMR01), wherever ultimate hospital outcome has not been recorded on the local ICU database. We are currently revising our customised model of APACHE II. This will use the list of APACHE III diagnoses and will incorporate the pre-sedation GCS, which, we have demonstrated, improves the performance of the APACHE method(12). It will also use ultimate hospital outcome generated as detailed above. It was anticipated this would be completed for this report, however, we have had to do further work to ensure accurate data linkage with the Scottish Morbidity Records.

38. Use of the original APACHE II model(5) impacts particularly on units which have a large number of patients with neurological diagnoses, where relatively high SMRs are generated. It also requires that, given the significant difference in standardised mortality ratios seen between operative and non-operative patients, we continue our previous practice of giving SMRs for operative and non-operative groups both together and separately.

39. Our preference for the APACHE II methodology to generate standardised mortality ratios is based on our comparison of the performance of available scoring systems on the

Scottish database(11). It remains the case that the Simplified Acute Physiology Score(19) (SAPS II) performed almost as well as APACHE II. Consequently, in this report, we provide SMRs from both APACHE II and SAPS II for individual intensive care units.

40. A cohort of 20 ICUs has contributed data on severity of illness over a 5-year period from 1995 to 1999. This has allowed us to examine the trend in SMRs utilising the APACHE II methodology. Figure 69 shows the trend in the annual Scottish SMR for APACHE II. The trend is towards a minimal reduction in SMR over this period. We have examined the trend in non-operative and operative SMRs independently (Figures 70 and 71). A downward trend in SMRs is only evident in the non-operative admissions.

41. Utilising data from these same 20 units, we have examined the pattern of SMRs on a month-by-month basis over a 5-year period. This was undertaken as a first stage in investigating the relationship between ICU activity and patient outcome. It was stimulated by a recent publication from Ninewells Hospital(9), which indicated an association between periods of increased ICU activity and poorer outcomes. Figure 72 show the variations in SMR on a month-by-month basis for each year and for the 5-year period overall. More detailed plots for each year are available (Figures 73-77). There is remarkably little variation in the SMR and no pattern to suggest an association with variations in workload. A similar analysis, using SAPS II to generate the SMRs, showed a similar lack of effect. Figure 78 shows a plot of monthly variations in both occupancy and SMR for the period from January 1996 to March 2000, i.e. including the period of exceptional demand last winter. Again even during the period of exceptional demand in January 2000, the SMR is within the normal range. A caveat applies to the data from December 1999 to March 2000: data linkage with ISD is not complete for this period, we would, therefore, expect a modest increase in the SMRs for these months.

42. Although there is no evidence in these preliminary data to support a relationship between ICU activity and patient outcome, it is our intention, in the forthcoming year, to examine this in greater detail.

43. The subsequent series of figures allows individual ICUs to examine their case mix adjusted outcomes, using both APACHE II and SAPS II. In all graphs a District General Hospital (DGH) is indicated by an asterisk beside the unit letter. For those 20 units which contributed data throughout the period 1995-99 we provide APACHE II SMRs (overall, operative and non-operative) for each year (Figures 79-93) and for the entire 5-year period (Figures 94-96). For units who contributed data during 1998-99, a similar set of graphs is produced for individual years (Figures 97-98) and for the entire 2-year period (Figures 99-101). Figure 102 shows SAPS II data for the entire period 98-99.

44. There is remarkably little variation in case mix adjusted outcomes in Scottish ICUs, particularly where the entire 5-year period of data collection is analysed, regardless of the method of case mix adjustment.

45. Tables 1 & 2 provide the numerical data on which the APACHE II analyses are based. Tables 3 & 4 demonstrate the variation in rank order of Scottish ICUs, year-on-

year.

Table 1. Annual standardised mortality ratios (95% confidence intervals)

Unit	1995	1996	1997	1998	1999
A*	-	-	-	0.602 (0.408-0.796)	0.754 (0.586-0.922)
B*	0.931 (0.718-1.14)	0.895 (0.700-1.09)	0.728 (0.538-0.917)	0.650 (0.477-0.823)	0.791 (0.622-0.961)
C*	1.14 (0.951-1.34)	0.934 (0.770-1.10)	0.872 (0.704-1.04)	0.584 (0.410-0.758)	0.848 (0.693-1.00)
D*	-	-	-	0.786 (0.659-0.912)	0.758 (0.613-0.903)
E*	1.22 (1.04-1.41)	1.08 (0.926-1.23)	1.05 (0.878-1.21)	0.799 (0.649-0.949)	0.894 (0.747-1.04)
F*	1.01 (0.841-1.19)	1.02 (0.848-1.20)	1.03 (0.845-1.12)	0.766 (0.631-0.902)	0.943 (0.789-1.10)
G*	1.08 (0.861-1.3)	1.25 (1.02-1.47)	1.13 (0.954-1.30)	0.880 (0.726-1.03)	0.825 (0.693-0.956)
H	0.922 (0.783-1.06)	0.766 (0.605-0.928)	0.935 (0.781-1.09)	0.920 (0.759-1.08)	0.850 (0.714-0.985)
I*	0.828 (0.594-1.06)	1.21 (0.990-1.43)	0.869 (0.66-1.08)	1.10 (0.893-1.31)	0.763 (0.591-0.935)
J	1.12 (0.939-1.31)	1.01 (0.84-1.18)	1.05 (0.872-1.22)	0.827 (0.668-0.987)	1.02 (0.849-1.19)
K	1.04 (0.905-1.18)	0.913 (0.792-1.04)	0.833 (0.716-0.949)	0.953 (0.837-1.07)	0.937 (0.821-1.05)
L	-	-	-	0.952 (0.848-1.06)	0.948 (0.848-1.05)
M	0.942 (0.779-1.10)	0.927 (0.780-1.08)	0.890 (0.742-1.04)	1.05 (0.892-1.21)	0.879 (0.738-1.02)
N*	1.07 (0.827-1.32)	0.774 (0.510-1.04)	0.807 (0.552-1.06)	0.940 (0.717-1.16)	0.983 (0.772-1.19)
O*	1.18 (0.897-1.46)	1.15 (0.925-1.28)	0.973 (0.742-1.20)	0.896 (0.646-1.15)	1.04 (0.786-1.30)
P*	1.23 (1.00-1.45)	1.02 (0.808-1.23)	1.015 (0.818-1.12)	0.996 (0.802-1.19)	0.984 (0.787-1.18)
Q*	0.958 (0.724-1.19)	0.976 (0.773-1.18)	0.972 (0.783-1.16)	0.890 (0.701-1.08)	1.08 (0.916-1.24)
R*	0.845 (0.598-1.09)	1.37 (1.10-1.64)	1.30 (1.07-1.54)	0.989 (0.737-1.24)	1.02 (0.776-1.27)
S*	0.702 (0.492-0.911)	0.896 (0.716-1.08)	1.024 (0.874-1.17)	0.990 (0.836-1.14)	1.10 (0.920-1.28)
T	0.873 (0.728-1.02)	0.970 (0.833-1.11)	1.06 (0.896-1.23)	0.980 (0.811-1.15)	1.10 (0.960-1.24)
U	1.16 (1.04-1.29)	1.18 (1.07-1.28)	1.01 (0.904-1.12)	1.04 (0.93-1.15)	1.08 (0.978-1.17)
V	1.09 (0.959-1.21)	1.07 (0.949-1.19)	0.963 (0.837-1.09)	1.18 (1.06-1.30)	0.972 (0.839-1.10)
W	1.20 (1.06-1.35)	1.29 (1.15-1.43)	1.20 (1.05-1.36)	1.21 (1.06-1.36)	1.17 (1.04-1.31)
Mean	1.04 (1.00-1.08)	1.03 (0.996-1.07)	0.978 (0.942-1.01)	0.944 (0.908-0.979) [20 units];	0.971 (0.934-1.00) [20 units];
				0.926 (0.894-0.958) [23 units].	0.951 (0.921-0.982) [23 units].

Table 2. Overall standardised mortality ratios (95% confidence intervals)

Unit	1995-1999	1998-1999
A*	-	0.691 (0.564-0.818)
B*	0.786 (0.703-0.869)	0.720 (0.599-0.841)
C*	0.866 (0.791-0.942)	0.725 (0.610-0.841)
D*	-	0.773 (0.677-0.869)
E*	0.880 (0.813-0.946)	0.846 (0.741-0.951)
F*	0.922 (0.815-1.03)	0.848 (0.746-0.950)
G*	0.930 (0.876-0.984)	0.850 (0.749-0.950)
H	0.935 (0.867-1.00)	0.881 (0.777-0.985)
I*	0.935 (0.863-1.01)	0.907 (0.774-1.04)
J	0.942 (0.849-1.03)	0.920 (0.803-1.04)
K	0.967 (0.891-1.04)	0.945 (0.863-1.03)
L	-	0.950 (0.878-1.02)
M	0.982 (0.896-1.07)	0.961 (0.855-1.07)
N*	0.987 (0.910-1.06)	0.962 (0.809-1.12)
O*	0.993 (0.933-1.06)	0.965 (0.787-1.14)
P*	1.00 (0.923-1.08)	0.990 (0.852-1.13)
Q*	1.00 (0.934-1.07)	0.995 (0.872-1.12)
R*	1.04 (0.931-1.15)	1.00 (0.829-1.18)
S*	1.04 (0.951-1.13)	1.04 (0.920-1.15)
T	1.05 (0.998-1.11)	1.05 (0.947-1.16)
U	1.09 (1.04-1.14)	1.06 (0.986-1.13)
V	1.10 (0.984-1.21)	1.08 (0.989-1.17)
W	1.22 (1.15-1.28)	1.19 (1.09-1.29)
Mean	0.991 (0.975-1.01)	0.939 (0.917-0.961)

Table 3. Annual variation in rank order of APACHE II SMRs (lowest to highest) of 20 ICUs participating throughout 1995-1999

1995	1996	1997	1998	1999	Overall
S*	H	B*	C*	I*	B*
I*	N*	N*	B*	B*	C*
R*	B*	K	F*	G*	H
T	S*	I*	E*	C*	N*
H	K	C*	J	H	K
B*	M	M	G*	M	M
M	C*	H	Q*	E*	F*
Q*	T	V	O*	K	I*
F*	Q*	Q*	H	F*	S*
K	J	O*	N*	V	Q*
N*	P*	U	K	N*	G*
G*	F*	P*	T	P*	E*
V	V	S*	R*	J	J
J	E*	F*	S*	R*	T
C*	O*	E*	P*	O*	O*
U	U	J	U	U	P*
O*	I*	T	M	Q*	V
W	G*	G*	I*	S*	U
E*	W	W	V	T	R*
P*	R*	R*	W	W	W

Table 4. Annual variation in rank order of APACHE II SMRs (lowest to highest) of 23 ICUs participating throughout 1998-1999

1998	1999	Overall
C*	A*	A*
A*	D*	B*
B*	I*	C*
F*	B*	D*
D*	G*	E*
E*	C*	F*
J	H	G*
G*	M	H
Q*	E*	I*
O*	K	J
H	F*	K
N*	L	L
L	V	M
K	N*	N*
T	P*	O*
R*	J	P*
S*	R*	Q*
P*	O*	R*
U	U	S*
M	Q*	T
I*	S*	U
V	T	V
W	W	W

B) RESULTS & DISCUSSION

B.5. HIGH DEPENDENCY UNIT PROVISION

46. The audit group conducted a telephone questionnaire in April 2000 to assess the provision of high dependency care beds across Scotland. The survey was done to provide information for the working party, which produced the *Better Critical Care*(1) document. A review of the information received during the initial survey has led to small differences between the graphs here and those in the *Better Critical Care* document. As well as identifying the number of HDUs, and their bed complement, the survey assessed the extent of the variation in nursing provision and the range of critical care interventions, which each unit could provide. This information is particularly relevant to discussions on the development of guidelines on admission and discharge from HDU. Figure 103 shows the types of HDUs which were identified. Table 5 identifies the location of the HDU beds identified at that time. The most striking feature is the lack of availability of HDU beds for non-surgical patients. Almost every acute hospital had high dependency facilities available for surgical patients, the exceptions being the Western Infirmary Glasgow and the Southern General in Glasgow. The latter has since opened a new HDU. No such comprehensive provision exists for non-surgical patients, with less than half of the hospitals having routine access to HDU beds for non-surgical patients. Most of the credit for driving the HDU provision must go to SASM, which has consistently raised the issue over a number of years. No comparable demand has come from General Medicine.

47. Figure 104 identifies the number of units capable of providing each of 11 critical care interventions. All are able to provide transduced monitoring of central venous and intra-arterial pressures, and the majority is able to infuse inotropes and care for patients with tracheostomies. Few are able to care for intubated or ventilated patients, use pulmonary artery catheters or undertake renal support. Figure 105 displays the distribution of units according to the number of interventions which can be undertaken. As expected, those providing all interventions, or all but one, are HDU beds housed within combined ICU/HDUs. Nevertheless, there is a considerable range of capability. It follows that, while such variation exists, it is very difficult to specify either guidelines on admission and discharge or nurse:patient ratios. The majority of HDUs have nurse patient ratios of 1:2 (Figure 106). This is an evolving situation. Consequently, local guidelines will require regular review by the Critical Care Delivery Group.

Table 5. Location & type of HDU beds, April 2000

HOSPITAL	HDU Beds (n)
Aberdeen Royal Infirmary, Neuro	4
Aberdeen Royal Infirmary, Surgical	9
Aberdeen Royal Infirmary, Vascular	10
Ayr Hospital, Surgical	5
Belford Hospital, Fort William, Surgical	2
Borders General Hospital, Melrose, in ICU	1
Caithness General Hospital, Wick, Medical	3
Crosshouse Hospital, Kilmarnock, Medical	4
Crosshouse Hospital, Kilmarnock, Surgical	12
Dumfries & Galloway Royal Infirmary, in ICU	2
Dumfries & Galloway Royal Infirmary, Medical	8
Falkirk Royal Infirmary, Medical	5
Falkirk Royal Infirmary, Surgical HDU/ICU	4
Gartnavel General Hospital, Glasgow, Mixed	6
Glasgow Royal Infirmary, Surgical	12
Hairmyres Hospital, East Kilbride, Surgical	4
Inverclyde Royal Hospital, Surgical	4
Law Hospital, Carluke, Surgical	10
Lorn & Islands Hospital, Oban, Medical	6
Monklands Hospital, Airdrie, Surgical	6
Ninewells Hospital, Dundee, Surgical	6
Ninewells Hospital, Dundee, Neuro	2
Perth Royal Infirmary, Surgical	2
Queen Margaret Hospital, Dunfermline, Surgical	4
Raigmore Hospital, Inverness, Surgical	6
Royal Alexandra Hospital, Paisley, HDU/ICU	2

Royal Infirmary of Edinburgh, Mixed	15
Southern General Hospital, Glasgow,	4
Neurosurgical in NITU	
St. John's Hospital, Livingston, Mixed	6
Stirling Royal Infirmary, Mixed	4
Stobhill Hospital, Glasgow, Mixed	6
Town & County Hospital, Wick, Medical	3
Vale of Leven DGH, Alexandria, HDU/ICU	2
Victoria Hospital, Kirkcaldy, Surgical	4
Victoria Infirmary, Glasgow, Surgical	8
Western General Hospital, Edinburgh, Surgical	8
Western Isles Hospital, Stornoway, Medical	6
Orkney	0
Shetland	0
Southern General Hospital, Glasgow, Surgical	0
Western Infirmary, Glasgow, Surgical	0

B) RESULTS & DISCUSSION

B.6. THE BED BUREAU

48. In keeping with the commitment given in last year's annual report(8), we have established a comprehensive ICU electronic bed bureau. Following recent discussions at the annual audit meeting we will modify the software in the forthcoming year. We will attempt to distinguish ICU and HDU patients in combined ICU/HDU, and we will seek agreement on imposing mandatory data entry, as a prerequisite to gaining access to bed bureau information. These changes will facilitate audit of the system and allow a more precise description of ICU bed availability at any given time. Finally, the display of the trend in ICU bed occupancy and availability (Figure 107), currently accessed from the web site, will become available via the bed bureau, with real-time update.

B) RESULTS & DISCUSSION

B.7. RESEARCH

49. The setting up of an independent research group is seen as an important mechanism of taking maximal advantage of a comprehensive audit system. The expectation is for the group to organise multi-centre trials, so contributing to the evidence upon which standards and clinical guidelines can be based. The audit group will continue to analyse audit data as a means of contributing to our understanding of critical care processes. In the last year the audit group have had publications in both Critical Care Medicine(11),(12) and Anaesthesia(3),(19). We have, over the last 12 months, conducted a survey of ARDS patients in conjunction with AstraZeneca. Approximately 8% of ICU patients met the criteria for ARDS. ICU mortality was 53%. Initial results were presented as a poster at the American Lung Association/American Thoracic Society International Conference, Toronto, May 2000(21) and a more recent free paper presentation won first prize at the Intensive Care Society & Riverside Group Meeting in December 2000 (Appendix II).

C) CONCLUSIONS

50. Intensive care in Scotland is a good-news story. In terms of both case mix adjusted mortality and profiles of ICU length of stay, there remains remarkable consistency across the full range of ICU facilities. There has been an ongoing expansion of ICU beds, with increases in ICU beds occurring predominantly in areas where we have identified a shortfall in provision. Implementation of the recommendations in *Better Critical Care*(1) would ensure this continues to be the case.

51. There was inadequate time available to Trusts to fully implement the *Better Critical Care*(1) recommendations, in time for this winter. In particular, it was not realistic to expect sufficient nurses to be recruited to take up the challenge of increasing flexibility across critical care areas. However, we anticipate that, in the forthcoming year, there will be further planned expansion of critical care beds and nursing establishment. We also encourage Critical Care Delivery Groups to address the shortfall in HDU beds available to non-surgical patients.

52. Our long standing collaboration with the Scottish Renal Registry, our proposed collaboration with SASM on HDU audit, and our aspiration to develop a Scottish Morbidity Record (SMR01) generated from the audit database, indicate an intention to increasingly integrate our work with other national audits and agencies.

53. Continued support for the national audit is a key element in encouraging progressive improvement in critical care services. In England there is an aspiration to achieve comprehensive national audit, and establish functional ICU networks. In Scotland we have a national ICU network in all but name, driven by individuals from a multidisciplinary background, and underpinned by a comprehensive national audit. All this is being achieved at a fraction of the cost which will be required to establish comprehensive audit and ICU networks in England.

D) ACKNOWLEDGEMENTS

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Information and Statistics Division in providing record linkage.

Mr C Knox, Head of Computing and IT Strategy, Scottish Executive.

Mr B Millar, Critical Care Audit Ltd.

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F) APPENDICES

APPENDIX I

The outcome for patients requiring renal replacement therapy in Scottish ICUs for 1999.

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The Scottish Intensive Care Society collects data from all Scottish ICUs that provide renal support. Data were available from 18 of the 20 Scottish ICUs that provide renal replacement therapy (RRT). Of the 529 cases that received RRT, 52.1% were male. The mean age was 58.7(SD 8.7) and the mean APACHE II1 score was 25.1(SD 8.7). The ICU mortality was 50.1% and the hospital mortality was 60.3%. The standardised mortality ratio by APACHE II was 1.13 (95% C.I. 1.06-1.2). The hospital mortality was 70% (253/316) for patients requiring RRT and inotropes and 65% (298/458) when both RRT and mechanical ventilation were required. For patients on RRT, inotropes and ventilation, the mortality was 71.6% (165/231). The day that RRT was first required had no bearing on outcome. There was a 57% (120/210) mortality when first filtered or dialysed on day 1, 58.6% (61/104) mortality on day 2, 57.4% (50/87) mortality on day 3 and a 36.4% (16/44) mortality when RRT was first initiated after day 7. There was a lower mortality for those patients who first received RRT at higher plasma creatinine concentrations. This was related to a lower requirement for organ support (Table 1.).

Table 1. Relationship of outcome to creatinine on day of first RRT.

Creatinine (mmol/L)	< 200	200-299	300-399	400-499	500-599	> 600
Number	37	62	68	49	39	33
Mortality (%)	70.2	77.4	70.5	61.3	33.3	30.3
Ventilation (%)	94.5	96.7	95.5	85.7	69.2	69.7
Inotropes (%)	72.9	80.6	80.8	57.1	48.7	45.4

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APPENDIX II

A prospective, observational study of ARDS in a cohort of patients in Scottish Intensive Care Units

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* Scottish Intensive Care Society Audit Group (SICSAG), Anaesthetic Department, Victoria Infirmary, Glasgow, G42 9TY. ~Departments of Public health and Midwifery Studies, University of Glasgow. #Robertson Centre For Biostatistics, University of Glasgow

Acute Respiratory Distress Syndrome (ARDS) has been recognised for over 30 years, yet epidemiological data are still relatively sparse, and published mortality figures vary widely1,2. The Scottish Intensive Care Society is currently assessing the incidence of ARDS in its adult Intensive Care Unit (ICU) population, the underlying condition, treatment regimens, mortality and outcome in terms of pulmonary function and quality of life post discharge. 23 adult general ICUs participated. Ward Watcher software (Critical Care Audit Ltd) identified all patients with ARDS (American European Consensus definition). Prospective daily data collection was undertaken locally and validated by our research nurse. The influence of the covariates was explored using univariate and multivariate logistic regression. 375 patients were diagnosed with ARDS in the 8-month study period. The incidence of ARDS in the ICU population was 8.1%. ICU mortality among ARDS patients was 53.1% (95% Confidence Intervals (CI) 43% - 58.2%), dramatically higher than the overall Scottish ICU death rate of 19.3%. Mean APACHE II was 21.95 (CI 21.2 - 22.7), significantly higher than the mean for the whole Scottish ICU population of 19.3. Univariate analysis found that significant factors associated with death in ICU were age (Odds Ratio (OR) increasing by 15% for every 5 years increase in age), APACHE II score (each unit increase increasing OR by 9%), SAPS II score (each unit increase increasing OR by 6%). Admission from ICU/HDU or from a ward doubled the odds of death compared with admission from theatre. Admission variables which increased OR were systolic blood pressure (SBP) less than 90mmHg (OR 2.53), cardiac dysrhythmia (OR 2.42), acute renal failure (OR 3.93) and immunosuppression (OR 3.24). Length of ICU stay was strongly negatively predictive of death - 89% of those with an ICU stay £ 5 days died (OR 11.8). Each day spent in hospital before admission to the ICU increased the OR by 4%. Multivariately, age, SAPS II, SBP < 90mmHg, days in ICU and days in hospital prior to ICU are all jointly predictive of death. Extrapulmonary origin of lung injury did not significantly alter mortality. In an unselected, general ICU population, whose overall outcome is comparable with published series (SMR = 0.95), the mortality from ARDS is substantially higher than that reported in some individual series which claim recent improvement in ARDS outcome1. Further study into the process of intensive care is required to explain the apparently selective poor mortality from ARDS.

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APPENDIX III

List of units, lead audit consultants' names and letters to identify units' workload graphs (up to Figure 38).

Unit ID	Intensive Care Unit	Lead Audit Consultant
S	Aberdeen Royal Infirmary	Dr G Adey
F	Ayr Hospital	Dr I Taylor
W	Borders General Hospital, Melrose	Dr NP Leary
G	Crosshouse Hospital	Dr R White
C	Dumfries & Galloway Royal Infirmary	Dr D Williams
X	Falkirk Royal Infirmary	Dr D Simpson
U	Glasgow Royal Infirmary	Dr J Kinsella
Z	Hairmyres Hospital, East Kilbride	Dr B Cook
H	Inverclyde Royal Hospital, Greenock	Dr F Munro
N	Law Hospital, Carluke	Dr N Willis
D	Monklands Hospital, Airdrie	Dr R MacKenzie
I	Ninewells Hospital, Dundee	Dr AJ Shearer
K	Perth Royal Infirmary	Dr FD Magahy
Q	Queen Margaret Hospital, Dunfermline	Dr P Curry
Y	Raigmore Hospital, Inverness	Dr I Skipsey
E	Royal Alexandra Hospital, Paisley	Dr S Madsen
J	Royal Infirmary of Edinburgh	Dr SJ Mackenzie
V	St. John's Hospital, Livingston	Dr M Fried
B	Stirling Royal Infirmary	Dr M Worsley

M	Stobhill Hospital	Dr C Miller
T	Surgical ICU, Southern General Hospital	Dr P Oates
A	Vale of Leven DGH, Alexandria	Dr WR Easy
L	Victoria Hospital, Kirkcaldy	Dr C Wilson
R	Victoria Infirmary, Glasgow	Dr A Dell
P	Western General Hospital, Edinburgh	Dr IS Grant
O	Western Infirmary, Glasgow	Dr L Plenderleith

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Figure 5. (Data from ISD) Scotland: Winter Admissions, Oct 1998-Mar 1999. Emergency Admissions: % emerg with resp infection, %emerg with other conditions and emerg as % total admissions and elect as % total admissions

Figure 6. (Data from ISD) Scotland: Winter Admissions, Oct 1997- Mar 1998 Emergency Admissions: emerg with resp infection, %emerg with other conditions and emerg as % total admissions and elect as % total admissions

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Figure 89. Scottish ICU operative SMRs: 1995 (20 units in 1995-99). Mean: 0.820, 0.752-0.888.

Figure 90. Scottish ICU operative SMRs: 1996 (20 units in 1995-99). Mean: 0.864, 0.798-0.930.

Figure 91. Scottish ICU operative SMRs: 1997 (20 units in 1995-99). Mean: 0.775, 0.712-0.839.

Figure 92. Scottish ICU operative SMRs: 1998 (20 units in 1995-99). Mean: 0.774, 0.711-0.837.

Figure 93. Scottish ICU operative SMRs: 1999 (20 units in 1995-99). Mean: 0.778, 0.715-0.841.

Figure 94. Scottish ICU SMRs: 1995-99 (20 units in 1995-99). Mean: 0.991, 0.975-1.01.

Figure 95. Scottish ICU non-operative SMRs: 1995-99 (20 units in 1995-99). Mean: 1.10, 1.09-1.12.

Figure 96. Scottish ICU operative SMRs: 1995-99 (20 units in 1995-99). Mean: 0.801, 0.772-0.830.

Figure 97. Scottish ICU SMRs: 1998 (23 units in 1998-99). Mean: 0.926, 0.894-0.958.

Figure 98. Scottish ICU SMRs: 1999 (23 units in 1998-99). Mean: 0.951, 0.921-0.982.

Figure 99. Scottish ICU SMRs: 1998-99 (23 units in 1998-99). Mean: 0.939, 0.917-0.961.

Figure 100. Scottish non-operative ICU SMRs: 1998-99 (23 units in 1998- 99). Mean: 1.05, 1.02-1.07.

Figure 101. Scottish operative ICU SMRs: 1998-99 (23 units in 1998-99). Mean: 0.750, 0.709-0.790.

Figure 102. SAPS II Scottish ICU SMRs: 1998-99 (23 units in 1998-99). Mean:1.11, 1.08-1.13.

Figure 103. Classification of HDUs.

Figure 104. Interventions provided in Scottish HDUs.

Figure 105. Variation in level of interventions in different HDUs. Maximum number of interventions = 11.

Figure 106. Nurse:patient ratios in HDUs.

Figure 107. Trend in occupied ICU beds. Last updated 18/01/2001.