An Audit of Intensive Care Units in Scotland

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A) EXECUTIVE SUMMARY.

1. This report is the result of an ongoing financial commitment by the Department of Health to support evaluation of the quality of intensive care and the adequacy of bed provision in Scotland, and encourage progressive improvement in patient care. The provision of central funding, rather than requiring successful negotiation with individual Trusts as in England, has led to data being available for almost every intensive care unit in the country. It follows that we are able to provide a comprehensive national review. The successful implementation of the audit has required a commitment by both medical and nursing staff to take on data collection as a part of their routine work, thus avoiding the cost of dedicated data collectors.

2. The data collected since 1995 allows the evaluation of trends in both workload and patient outcome. A 3-year period of data collection also allows more confident analysis of the true extent of variation in patient outcomes across the

full range of hospitals. Our data clearly demonstrate that analysis of variation in patient outcomes annually is of limited value.

3. We have demonstrated that there is no significant difference in patient outcomes across the full range of Scottish intensive care units (ICUs). There is no indication of superior outcomes being produced by large teaching hospitals when compared with the smaller units found in District General Hospitals. This conclusion is based not only on assessment of overall patient outcomes, but on a detailed evaluation of outcomes in the most demanding patient group i.e. those requiring multiple organ support (e.g., ventilation and dialysis). Most importantly outcome for patients receiving intensive care is superior to that which would be predicted by internationally validated models of mortality prediction. Over the 3-year period of evaluation approximately 200 fewer patients died than would have been predicted.

4. The assessment of adequacy of ICU bed provision demonstrates a consistent increase in demand over the period of study. There is considerable variation in adequacy of provision between Health Boards, with Grampian, which has the lowest number of ICU beds per 100,000 population, demonstrating extreme pressure on beds. Nonetheless there is no clear relationship between pressure on beds and provision as measured by beds/100,000, due to the considerable cross boundary flow which occurs in the central belt. Detailed evaluation of bed requirement in Greater Glasgow Health Board (GGHB), performed in conjunction with their Public Health Department, has suggested a requirement for a further 4 beds to reduce refusals to an acceptable level[†]. This suggests Boards with even higher levels of occupancy require a similar or higher percentage increase in provision. The ease with which additional intensive care beds can be created will vary between hospitals. In some cases, this may simply require employment of additional nursing staff to take advantage of additional capacity which currently exists. In others, where physical space is limited, considerable capital expenditure might be required. We will be offering to collaborate with other Health Boards to facilitate assessment of the most appropriate level of provision.

   [†] Murray, S. Assessment of need for general intensive therapy beds in Glasgow. GGHB

5. There will always be a requirement to transfer ICU patients to deal with the considerable variations in demand, which are seen at an individual hospital level. The specialist nature of intensive care, with its requirement for both specialist equipment and specialist nursing, precludes the ability to readily match such fluctuations. It is not necessarily a failure of provision when such transfers are required. The West of Scotland Health Boards support a specialist transfer team to ensure that no patient is put at risk by the need for transfer. This will be supported by an electronic Bed Bureau early in 1999, which has been funded by GGHB. The Bed Bureau will provide an immediate indication of the most suitable ICU for

transfer, when this is required. After a trial period in the GGHB hospitals, we will offer this service throughout Scotland.

6. The current audit represents an important example of collaboration between the Department of Health, Health Boards, nursing and medical staff in attempting to promote increasing quality of intensive care provision.

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B) INTRODUCTION

7. Since publication of our Audit Report in August 1997 the SICS National Audit project has undergone a number of important changes. In particular there has been a move to change from an Apple platform to a PC system under Windows 95 or NT. This hardware transition has been effected through funding by individual ICUs and to date 21 out of 23 units, currently using Ward Watcher, use a PC-based system. One unit continues to successfully download data from its own software. Nonetheless, it is our intention to continue to provide support to units, who through choice or financial constraint, choose to continue to use Apple-based systems. Two additional units began data collection in January 1998 and another ceased contributing in April 1998. One unit has not provided data for the Audit. Twenty-four adult general units currently contribute data (Appendix I).
8. The major change in the data collection has involved simplification of the physiology data entry with disappearance of the APACHE III data fields. In relation to identification of active treatment, while this report will continue to use definitions derived from APACHE III and based on first 24-hours TISS entry, subsequent reports will be based on the small list of active interventions which we are attempting to collect daily on a comprehensive basis.
9. As regards data validation we have, over the last 12 months, concentrated on confirmation of diagnosis and interventions while placing less emphasis on validation of the first 24-hour physiology data. We accept that we will have to continue to do this on an intermittent basis. Diagnostic validation has allowed us to examine areas of specific interest such as multiple organ failure and acute asthma, as a means of attempting to understand variation in intensive care process.
10. Problems in providing good information on outcome from a relatively simple diagnostic group such as asthma, further emphasises the extent to which the APACHE-based diagnostic categories, while appropriate for generating mortality predictions, are not the best way of describing critical illness in a meaningful way. To this end a subgroup has been working over the last 9 months to produce a better list of diagnoses. This was presented at the Annual Audit Meeting, October 1998, and was positively received.
11. Between July 1997 & June 1998, the Society was in receipt of research funding from CRAG which allowed Mark Livingston to work on the customisation of the available severity of illness scoring systems. We have previously documented variations in standardised mortality ratios (SMR) seen in important subgroups for available scoring systems. Customisation of these methodologies, using Scottish

data, has led to a significant improvement in model performance, particularly for APACHE II and SAPS II. This report will, therefore, provide information on the customised APACHE II model which, we believe, provides the best available method of examining variation in mortality *within* Scotland.

12. Our re-evaluation of the APACHE III prediction of length of stay has led us to believe there is a potential to develop a better prediction from our own database. This work was started by Mark and was taken on by John Norrie, a statistician from the Department of Biostatistics at Glasgow University. A prediction of length of stay would be an important and complementary method of examining outcome, which at the present time is based exclusively on mortality prediction and SMR.

13. Funding from GGHB has allowed the development of a Bed Bureau based on the current platform. This system has been trialed over the last month and should be operational in GGHB early in 1999. It is our intention to pilot this for a 1-year period and thereafter offer it to hospitals throughout Scotland. Clearly, this development is dependent on ongoing funding of the current project. To this end we have been in discussion with CRAG and have secured a guarantee of funding through to April 1999.

14. We have now submitted a paper to support ongoing funding for a further 2 years. This has been submitted on a commissioned basis and has been accepted in principle. In particular it has required ‘re-focusing’ of the project, placing greater emphasis on improving mechanisms which should promote improvement in quality of care and less emphasis on comparison of overall outcomes. We intend to address this in a number of ways. We will continue to evaluate outcome in important patient subgroups as we have done previously for patients requiring respiratory and renal support. In the first instance this will involve examination of outcome in patients who develop the adult respiratory distress syndrome (ARDS). Support for this study is being given by Zeneca Pharmaceuticals. It is hoped that we may evolve consensus guidelines on management from this study. We also propose to undertake a series of studies, which would involve randomisation for specific interventions. Suggestions thus far have included nutritional supplements, steroids for ARDS, not to mention collaboration with the Intensive Care National Audit and Research Centre (ICNARC) on a pulmonary artery catheter study. Lastly, we are discussing mechanisms of reviewing ICU deaths along the lines pioneered by the Scottish Audit of Surgical Mortality (SASM). We have also undertaken to evaluate the impact of ICU bed refusals. This will be facilitated by the electronic Bed Bureau.

15. Lastly, in a significant departure from previous practice, appendix I gives a key to identification of individual unit’s data in relation to workload. However, we have retained anonymity for standardised mortality ratio data, in which a different letter code has been used.

C) <u>RESULTS FROM ANALYSIS OF DATA COLLATED DURING 1995-1997 INCLUSIVE</u>

i) ICU DEMAND

16. The size of our database collected over 3 complete years allows us to examine trends in ICU utilisation. Therefore, this report will concentrate on the years 1995-1997 inclusive, the years for which we have complete data. Summary characteristics are provided in Table 1.

Table 1. Summary characteristics of admissions between 01/01/95 & 31/12/97.

	All patients	Scored patients	Predicted patients
n	20,738	16,256	15,437
Operative (%)	49	-	-
Non-operative (%)	51	-	-
Male (%)	55	-	-
Female (%)	45	-	-
Age (y) *(range)*	58.2 *(0 - 99)*	59.2 *(16-99)*	59.1 *(16 -99)*
Mean length of ICU stay (d)	4.3	5.03	4.92
Median length of ICU stay (d)	1.83	2.06	2.02
Range of ICU stay (d)	0 - 142	-	-
ICU mortality (%)	19.0	19.4	19.3
Hospital mortality (%)	26.7	29.0	28.5
APACHE II score	-	18.4	18.3
APACHE II prediction (%)	-	-	30
SMR *(95% CIs)*	-	-	0.95 *(0.93 - 0.97)*

17. Concern continues to be expressed around the episodic requirement for ICU beds. There is a presumption that there are periods of increased ICU bed demand, reflecting the pattern of increased acute medical admissions, during the winter months. Intensive care occupancy is found to be consistently high in the period December – March at which time it is in excess of 80%. In 1997 the mean occupancy was consistently 90% in these months, indicating that in units with the greatest overall occupancy, demand will be excessive (Figure 1).

18. Figure 2 demonstrates a consistent increase in overall bed occupancy with, however, the increase between 1996 & 1997 being less striking than the preceding year-on-year increase. The given annual occupancies are the means of the monthly occupancies per annum.

19. Figure 3 demonstrates the year-on-year pattern of occupancy for each ICU, with considerable variation in occupancy across the ICUs being evident. Bed occupancy is based on our *understanding* of the number of funded beds. This is particularly difficult in HDU/ICUs where units may have flexible use of beds accommodating a large number of HDU patients or a small number of ICU patients. In general we believe this leads to an underestimate of occupancy. **In the following graphs the HDU/ICUs have, therefore, been asterisked.**

Analysis by Health Board

20. It is quite clear from these data that a number of ICUs are under considerable pressure on beds. We have analysed these data by Health Board, as they are the funding agencies. Detailed analysis of bed requirement within GGHB, undertaken in conjunction with the Public Health Department, suggests a requirement for 4 additional beds. Data are currently being released to Argyll & Clyde Health Board to allow it to undertake a similar analysis.

21. Table 2 shows that a number of Health Boards have even greater pressure on beds than GGHB and would suggest that they require an even greater percentage increase in ICU bed provision than that indicated in the Glasgow assessment. It should again be emphasised that data from Boards such as Argyll & Clyde, which have a flexible use of beds in predominantly HDU/ICU facilities, probably underestimates ICU occupancy. It should be remembered that comparison of bed provision in relation to beds/100,000 population cannot take account of cross-boundary flow, which for some Boards may be considerable.

22. Our report structure to date has used overall occupancy to estimate bed demand. Normally the NHS uses occupancy at midnight. The extent to which this is the most appropriate census point can be clarified from Figure 4 which shows the

distribution of admission and discharge times, of ICU patients, throughout the 24-hours. It is clear from this that a midnight census does represent a point of relatively low flux. Nonetheless, patients continue to be admitted between midnight and 0800h, which would appear to be the point of least change.

23. We have made an assessment of occupancy based on midnight census for a 3-month period in 1997 (Figure 5) which shows a lower level of occupancy than our more thorough analysis of occupancy.

Table 2. ICU bed numbers and occupancy by Health Board. Data from 1997.

Health Board	Population	ICU bed number	HDU beds	Beds per 100,000	Occupancy (%)
Grampian	532,800	7.5		1.41	97.00
Argyll & Clyde **(occupancy=60% on 11 beds)**	432,800	7	4	1.62	93.75
Borders	106,000	2		1.89	127.50
Highland	208,300	4		1.92	88.20
Lanarkshire*	561,200	11		1.96	72.00
Ayrshire & Arran*	377,200	9		2.39	75.10
Tayside	395,600	10		2.53	82.30
Lothian Health	764,600	19.5		2.55	87.70
Fife	351,600	9	1	2.56	87.75
Dumfries	147,900	4	2	2.70	-
GGHB*	912,500	26.5		2.90	77.20
Forth Valley	273,900	8	4	2.92	62.70
Total for Scotland	5,136,600	117.5		2.28	86.47

* Lanarkshire: Hairmyres - no occupancy data; Ayrshire & Arran: Ayr Hospital - no occupancy data; GGHB: assumes 5 beds at surgical ICU & excludes neurosurgical ICU at the Southern General Hospital.

24. One concern, which has been expressed in numerous occasions around trends in ICU workload, is the perception that we increasingly admit an elderly population. Figure 6 demonstrates the distribution of admissions in relation to age annually. This shows remarkable consistency over the 3-year period. When we examine

Figure 7, the relation between percentage mortality and age without attempting to correct for case-mix, as expected, this demonstrates an increase in mortality with increasing age.

25. Figures 8 & 9 show trends in admission rates and length of stay. Over the three years these show remarkable consistency within a given ICU. However, there are considerable differences in admission rates and average length of stay across the range of ICUs.

26. We have previously demonstrated a non-linear relationship between severity of illness and length of stay. This is shown in Figure 10 using APACHE II predicted mortality. The superimposed population distribution demonstrates that for the great majority of patients (mortality 50% or less) there is a broadly linear relationship, where length of stay increases with severity of illness. Differences in average length of stay seen in different ICUs may relate predominantly to variation in severity of illness.

27. Figure 11 examines the mean length of stay in each ICU compared with each unit's mean severity of illness, calculated for the 3-year period using APACHE II. The mean length of stay was calculated for patients only in whom a mortality prediction was generated. This figure demonstrates that some of the variation seen in length of stay can be explained by variation in severity of illness. In Table 3 it is notable that length of stay is particularly high in the Western General Hospital (Edinburgh) which takes neurological patients. The longest average length of stay is seen in Falkirk Royal Infirmary. This is predominantly explained by a very high average severity of illness in its scored patients. As an HDU/ICU facility, this presumably results from Falkirk's exclusion of all but the sickest patients from scoring. As previously stated, we are currently developing a prediction of length of stay which will incorporate severity of illness.

Table 3. Mean mortality prediction and length of stay in each unit.

Unit	A	B	C	D	E	F	G	H
Mortality Prediction (%)	19.5	24	23.1	27.7	24.4	29.3	26.4	31.4
Length of stay (d)	4.18	3.78	3.79	4.24	3.7	6.98	5.46	3.39
Unit	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
Mortality Prediction (%)	28.5	29.4	29.6	30.6	31.1	30	33.6	32.2
Length of stay (d)	4.77	5.3	4.8	4.8	4.19	5.37	4.55	4.7
Unit	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	
Mortality Prediction (%)	31.6	32.1	34.3	36	33.2	36.6	44.5	
Length of stay (d)	6.83	4.61	5.05	5.14	5.01	4.86	8.46	

28. The proportion of patients having active interventions using APACHE III definitions (for the last time) shows minimal change (Figure 12). Figure 13 demonstrates this trend for individual units.

29. Figure 14 demonstrates the variation in mean APACHE II scores across the ICUs, the most striking observation being the relative consistency of this score in any given unit over the 3-year period.

30. Analysis of the data provided in Figures 8, 9 & 13 should allow each ICU to assess the extent to which there is pressure on beds and whether this could be better alleviated by either increased ICU or HDU provision. We have examined this issue in greater detail in the GGHB ICUs in conjunction with Dr. S. Murray. Figures 15 a & b give a breakdown of patient population according to patient exclusions, active interventions and an arbitrary level of severity of illness set at an APACHE II of 10 or more. It can reasonably be assumed that exclusions above a minimum level of 5% reflect patients excluded on the basis of being recovery/HDU. This analysis gives a clearer picture of bed pressure and possible

solutions. In particular it emphasises the relatively small contribution which 'HDU-type' patients make to occupancy due to their shorter length of stay. Thus, the surgical ICU at the Southern General Hospital, which has the largest number of HDU-type admissions (reflecting its absence of a separate high dependency unit) still has a very small proportion of its occupied bed days represented by such patients. In general none of the Glasgow units could have pressure on beds significantly alleviated by the provision of additional HDU beds. It must be emphasised that an analysis of this type gives an overall indication of potential HDU use. It cannot be presumed that an individual patient who neither has active interventions in the first 24-hours or an APACHE II score less than 10 should not be in intensive care. It should be noted that in this detailed analysis of GGHB hospitals and in the preceding Scottish data, 5 beds have been allocated to the Southern General. This is the number which is provided to us by GGHB. However, the unit believes it is only funded for 4. This would have a considerable effect on occupancy calculations for this unit (increasing to 83%). We intend to repeat this analysis nationally, and in the future we will utilise the daily interventions to add greater clarity.

ii) CASE MIX ADJUSTED OUTCOME

31. Figure 16 shows the SMR distributions with upper and lower 95% confidence intervals (UCI & LCI) for the units per annum. These graphs emphasise the problems in demonstrating how any change in practice could be assessed year-on-year with reference to SMRs, in as much as individual unit SMRs and their place in these 'league tables' change dramatically year-on-year. The best example is unit K which moves from having the second lowest SMR in 1995, into the highest SMR in the following year. Similarly unit T with the highest SMR in 1995 is no longer significantly different in the subsequent 2 years.

32. Figure 17 shows the combined SMRs for the 3-year period. There is evidence of a unit holding its rank order position quite dramatically (unit F). This unit has given permission to be identified to illustrate one effect of case mix: it is the Western General Hospital, Edinburgh in which there is a large intake of neurosurgical patients. Patients often arrive intubated, sedated and ventilated thus precluding accurate assessment of their Glasgow Coma Scores during the first 24-hours of intensive care, as required by the scoring systems such as APACHE II. We have been aware of this problem for some time and Simon Mackenzie has demonstrated that the failure of the APACHE II system to assign points for neurological disease is most readily dealt with by using the Glasgow Coma Score obtained prior to ICU admission. These data have been presented at the ICS Winter meeting and won the Free Paper competition in 1997. A summary of this is incorporated into the Appendix II.

33. Figure 18 demonstrates that the case mix adjusted outcome of patients admitted to both District General Hospitals and teaching hospitals is comparable.

34. Due to the significant difference in SMRs for operative and non-operative admissions, which we have previously described, the SMR distributions for operative and non-operative admissions are being presented separately (Figure 19). The examination of the non-operative SMRs identifies 2 units with SMRs which are statistically significantly lower than the Scottish population as a whole for a 3-year period and 1 unit which has a SMR that is significantly higher at the 5% level. A review of Figure 16 demonstrates that this high SMR was due to the results in the first year of data collection only. In subsequent years, this unit's rank order is in the middle of the pack. Comparison of these data with that of post-operative admissions shows only 1 unit with an SMR significantly lower than the population as a whole and only one with an SMR statistically higher than the population as a whole. Whilst confidentiality is maintained, this data is reported anonymised the individual units, the Trust and their respective HBs ARE AWARE OF THE IDENTITY . OF THESE OUTLIERS.

35. The improvements seen with the Scottish customised APACHE II model are evident in Figure 20 where we have displayed the SMRs, by source of admission, and Figure 21, by primary system failure at admission. These figures demonstrate a better uniformity of fit, i.e. less variation in SMRs across diagnostic and admission categories. We have used this model to examine individual unit SMRs and this is presented in Figure 22. Clearly customisation has further reduced inter-ICU variation with no unit statistically significantly different from the population as a whole. Notably the Western General dramatically changes its rank order.

36. Over the last 12 months, partly prompted by a request from the Acute Services Review, we examined the outcome of patients requiring respiratory and renal support in Scottish ICUs. Preliminary analysis of this work was presented at the Annual Audit Meeting in November 1997. A further update was presented at the ICS Spring meeting 1998. We are now able to provide the most accurate data available on variation in mortality in this important subgroup. This includes all general ICUs in Scotland which provide on-site renal support. We have, in addition, documented which categories of patients go on to require chronic renal support in collaboration with the Scottish Renal Registry and Audit System. A more detailed description of this work is included in Appendix III. This study emphasised the importance of encouraging accurate data entry and the requirement to undertake validation, particularly where the results appear, on first examination, to be incongruous. On this occasion using data from TISS scores, mortality in patients both ventilated and dialysed in ICU was found to be 48.3%

which was far lower than previously observed for this category of patient. We surmised that this was due to incorrect TISS data entry and so undertook a detailed case-by-case validation, which resulted in an ultimate hospital mortality of 61.1%. This increased to 65.3% when data from 5 units who did not collect TISS data were included. An overall survival of 35% of patients in this high-risk group represents a very satisfactory outcome when compared with published data. There was considerable variation in numbers of patients who required the support. Nonetheless, there was no evidence of any relationship between volume and outcome.

37. South Thames (West) Region has, from the outset, used an identical database and we now have a collaborative arrangement that allows comparison of the outcomes between Scotland and the South Thames (West) Region. Tabulated data for both areas are included in Appendices IV & V. Once again it is quite clear, from these tables, that for the key outcomes the Scottish ICUs are cast in a favourable light.

D) CONCLUSION

38. This report is the result of an ongoing financial commitment by the Department of Health to support evaluation of the quality of intensive care and the adequacy of bed provision in Scotland, and encourage progressive improvement in patient care. The provision of central funding, rather than requiring successful negotiation with individual Trusts as in England, has led to data being available for almost every intensive care unit in the country. It follows that we are able to provide a comprehensive national review. The successful implementation of the audit has required a commitment by both medical and nursing staff to take on data collection as a part of their routine work, thus avoiding the cost of dedicated data collectors.

39. We are now in a position to provide ongoing quality assurance of intensive care facilities in Scotland. In collaboration with Health Boards we hope to improve the matching of ICU provision and demand where, during times of excessive demand, the provision of a national Bed Bureau should optimise utilisation of available resources.

40. The database, which we continue generate, represents an important audit and research resource. We intend to use this facility to support a progressive improvement in the quality of intensive care provision.

41. Finally, we are indebted to the Clinical Resource and Audit Group (CRAG) for ongoing financial support and to the medical and nursing staff of the individual intensive care units, particularly those listed in Appendix I who have co-ordinated their unit's contribution.

Appendix I.

Key to units in workload graphs. Table of participants in the study.

Unit ID	Intensive Care Unit	Lead Audit Consultant	Participation in Audit
A	Perth Royal Infirmary	Dr FD Magahy	1995
B	Inverclyde Royal Hospital, Greenock	Dr M Simmons	1995
C	Queen Margaret Hospital, Dunfermline	Dr P Curry	1995
D	Victoria Hospital, Kirkcaldy	Dr C Wilson	1995
E	Stirling Royal Infirmary	Dr M Worsley	1995
F	Western General Hospital, Edinburgh	Dr IS Grant	1995
G	Raigmore Hospital, Inverness	Dr I Skipsey	1995
H	Borders General Hospital, Melrose	Dr NP Leary	1995
I	St. John's Hospital, Livingston	Dr M Fried	1995
J	Law Hospital, Carluke	Dr D MacLean	1995
K	Surgical ICU, Southern General Hospital	Dr J MacDonald	1995
L	Crosshouse Hospital	Dr R White	1995
M	Victoria Infirmary, Glasgow	Dr A Dell	1995
N	Aberdeen Royal Infirmary	Dr G Adey	1995
O	Royal Alexandra Hospital, Paisley	Dr S Madsen	1995
P	Monklands Hospital, Airdrie	Dr D Clough	1995
Q	Ninewells Hospital, Dundee	Dr AJ Shearer	1995
R	Western Infirmary, Glasgow	Dr L Plenderleith	1995
S	Glasgow Royal Infirmary	Dr J Kinsella	Commenced January 1997
T	Vale of Leven DGH, Alexandria	Dr WR Easy	1995
U	Royal Infirmary of Edinburgh	Dr SJ MacKenzie	1995
V	Stobhill Hospital	Dr C Miller	1995

W	Falkirk Royal Infirmary	Dr D Simpson	Ceased April 1998
	General adult ICUs not included in report		
	The Ayr Hospital	Dr I Taylor	Commenced January 1998
	Dumfries & Galloway Royal Infirmary	Dr D Williams	Commenced January 1998
	Hairmyres Hospital, East Kilbride	Dr B Cook	No data

Appendix II.

THE USE OF PRE-SEDATION GCS IMPROVES THE PERFORMANCE OF APACHE III WHEN THE GCS CANNOT BE ASSESSED

SJ Mackenzie, BM Livingston, FN MacKirdy, JC Howie

Objectives: The GCS is an important component of the APACHE III (APIII) score. When the GCS cannot be assessed because of sedation, APACHE assumes that the score is 15. The objective of this study was to study the effect of using a pre-sedation GCS in this situation (as is done in SAPS) on the performance of APIII.

Methods: The APIII score, predicted and actual hospital mortality were recorded for 10 326 patients admitted to 22 Scottish ICUs during 1995-6. When the GCS could not be assessed because of sedation, it was assigned a normal value. Scorers also recorded the pre-sedation GCS for such patients. The APIII score and mortality prediction were then recalculated using these values, producing an alternative database. The calibration and discrimination of the two databases were compared using the Hosmer-Lemeshow statistic and area under the ROC curve respectively.

Results: The GCS could be assessed in 5202 patients but 5124 were recorded as being sedated. When the GCS of the sedated patients was assumed to be normal APIII demonstrated good discrimination but relatively poor calibration. When the pre-sedation GCS was used both discrimination ($p<0.001$) and calibration improved. When patients who were sedated or had a neurological diagnosis were analysed separately similar improvements were seen.

	Area under ROC curve			Hosmer-Lemeshow Chi Sq		
	All pts	Sedated	Neuro	All pts	Sedated	Neuro
APIII	0.8446	0.8098	0.8568	331.65	484.24	76.41
Alternative	0.8519	0.8156	0.8753	126.89	148.44	13.96

Conclusion: When it is not possible to record the GCS in an ICU patient it may be preferable to use a pre-sedation value rather than assume that the GCS is normal.

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Appendix III.

OUTCOME IN PATIENTS REQUIRING COMBINED RENAL AND RESPIRATORY SUPPORT IN SCOTTISH ICUS OVER A 2-YEAR PERIOD.

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Objectives: To define the mortality and morbidity for combined renal and respiratory failure in Scottish ICUs, with widely varying levels of dialysis activity, and to identify the requirement for chronic renal replacement therapy, following discharge, in these patients.

Design: A retrospective audit of patients in 15 out of 16 ICUs in Scotland which undertake dialysis. Patients having dialysis and ventilation were identified from daily entry of Therapeutic Intervention Scoring System data (TISS). Outcome was identified by survival at ultimate hospital discharge and severity of illness on first admission to the ICU determined by the Acute Physiology and Chronic Health Evaluation score (APACHE II). All patients identified as having both ventilation and dialysis had this confirmed by case-note review. Linkage with the Scottish Renal Registry & Audit System enabled follow-up of all survivors to determine the requirement for chronic renal support following discharge.

Subjects: For a two year period between 1995 and 1997 we validated 998 recorded incidences of renal support in intensive care to determine the extent of combined renal and respiratory failure (defined by the need for both dialysis and ventilation)**.**

Results: Following the validation process 615 patients, in 15 ICUs, were identified as having received both respiratory and renal support. The ultimate hospital mortality of this group, of 64.3%, compares with a predicted mortality (based on the first 24 hours in ICU) of 52.5%. With the exception of one unit which dialysed only one patient, mortality varied between 50% and 74.3% with no obvious relationship between observed mortality or standardised mortality ratio (SMR) and volume of patients dialysed. Of the 4 most common admission diagnoses, septic shock and pneumonia resulted in the worst outcome. The duration of dialysis made no difference to the observed outcome. Seventy-eight patients who received renal and respiratory support in ICU had chronic renal impairment documented in their case-notes prior to acute hospital admission. Within this subgroup 19, out of 61 patients who were not receiving any form of chronic renal replacement therapy (CRRT) prior to their acute episode, went on to require CRRT following ultimate hospital discharge (Table 1). The ultimate hospital mortality rate within the 17 patients who were receiving CRRT prior to admission was 70.5%. Of those with no documented renal impairment, 6 required CRRT following discharge, accounting for 2% of survivors within this group.

Table 1.		**Renal status pre-ICU**	
Summary characteristics	**No renal impairment.**	**Renal impairment, no CRRT.**	**Renal impairment, CRRT.**
n	537	61	17
ICU mortality	276 (51.4%)	16 (26.2%)	4 (23.5%)
Ult. Hosp mortality	353 (65.7%)	30 (49.1%)	12 (70.5%)
SMR (95% CIs)	1.28 (1.20-1.36)	-	-
***CRRT post-ICU**	6 (1.9% of hosp. survivors)	19 (64.3% of hosp. survivors)	5 (100% of hosp. survivors)

Conclusion: Scottish ICUs demonstrate a wide range of dialysis activity. In spite of this, overall mortality for patients with combined renal and respiratory failure is as good as that previously quoted.[1-2] There is no obvious relationship between volume of patients dialysed and outcome. This suggests that no improvement in quality of patient care for this high-risk group could be produced by further centralisation of care for such patients.

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Funding from the Clinical Resource and Audit Group (CRAG)