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Predicting death and readmission after intensive care discharge

Authors:

Alison J Campbell, MB ChB, MRCP, FRCA[1]

Jonathan A Cook, BSc, PhD[2]

Gillian Adey, MB ChB, FRCA[3]

Brian H Cuthbertson MB ChB, FRCA, MD[2]

1. Department Anaesthesia, Western Infirmary, Glasgow, G11 6NT

2. Health Services Research Unit, Health Sciences Building, University of Aberdeen, Foresterhill, Aberdeen, AB25 2ZD

3. Intensive Care Unit, Aberdeen Royal Infirmary, Foresterhill, Aberdeen, AB25 2ZN

Short title:

Predicting death and readmission after intensive care

Summary

Background: Despite initial recovery from critical illness many patients deteriorate after discharge from the intensive care unit. We examined prospectively collected data in an attempt to identify patients at risk of readmission or death after intensive care discharge.

Method: This was a secondary analysis of clinical audit data from patients discharged alive from a mixed medical and surgical (non-cardiac) intensive care unit.

Results: Four hundred and seventy five patients (11.2%) died in hospital after discharge from the intensive care unit. Increasing age, time in hospital before intensive care admission, Acute Physiology, Age and Chronic Health Evaluation II (APACHE II) and discharge Therapeutic Intervention Scoring System (TISS) scores were independent risk factors for death after intensive care discharge. Three hundred and eighty five patients (8.8%) were readmitted to intensive care during the same hospital admission. Increasing age, time in hospital before intensive care, APACHE II score and discharge to a high dependency unit were independent risk factors for readmission. One hundred and forty three patients (3.3%) were readmitted within 48 hours of intensive care discharge. APACHE II scores and discharge to a high dependency or other intensive care unit were independent risk factors for early readmission. The overall discriminant ability of our models was moderate with only marginal benefit over the APACHE II scores alone.

Conclusion: We identified risk factors associated with death and readmission to intensive care. It was not possible to produce a definitive model based on these risk factors for predicting death or readmission in an individual patient.

Keywords: Intensive Care; Models, statistical; Complications, death; Complications, morbidity

Introduction

Despite initial recovery from critical illness requiring intensive care unit (ICU) admission many patients remain at risk of subsequent deterioration and death. This may result in readmission to ICU or death on another ward or during the ICU readmission. Early identification of patients at the highest risk would allow resources to be targeted appropriately and prevent avoidable morbidity and mortality. ICU readmission rates have been advocated as a marker of ICU quality on the basis that early readmissions (within 48hrs) may indicate premature discharge or discharge to an inappropriate clinical area.[1 2] Although using readmission rates as a quality indicator remains controversial [3] early readmissions are certainly a group who merit special attention. They have disproportionately high hospital mortality [4-7] and include patients in whom deterioration could probably have been avoided. Some may have been discharged prematurely from ICU due to either clinical resource limitations or poor discharge planning.[5 6] Similarly some deaths after ICU may be preventable.[8] Interventions aimed at reducing readmission or death after ICU requires timely identification of patients at highest risk. At present there is no validated scoring system to predict readmission or death after ICU discharge.

We aimed to determine whether we could utilise prospectively collected clinical data to identify which patients are at high risk of readmission or death after ICU discharge. Identification of these patients before they leave the ICU might allow these patients to be kept in ICU for a further period, to triage the patient to an appropriate level of ongoing care or to focus efforts in identifying early signs of deterioration.[9]

Patients and Methods

Local research ethics committee approval was not required as the study was a secondary analysis of routinely collected and anonymised clinical audit data. We analysed the existing Scottish Intensive Care Society Audit Group database of all admissions to a single mixed medical-surgical ICU over a ten year period from Jan 1995 – Jan 2005. The ICU in Aberdeen operates as a closed unit led by consultants in intensive care medicine. There are no strict protocols governing admission and discharge policies. Patients from all adult medical and surgical specialties are accommodated with the exception of cardiac surgery patients who are cared for in a separate unit. A small number of postoperative cardiac patients requiring a prolonged stay for non-cardiac complications are transferred from the cardiac intensive care unit. Data are collected prospectively using Ward Watcher™ software (Critical Care Audit Ltd, Yorkshire, UK). Data recorded include patient age, sex, hospital and ICU admission diagnosis, severity of illness scoring (APACHE II and Simplified Acute Physiology Score (SAPS II)), date and time of unit and hospital admission and discharge and patient outcome up to hospital discharge. The study cohort comprises adult (>16 years) patients admitted during this period. These patients were considered as a derivation cohort to attempt to identify factors associated with death and readmission to the intensive care unit. In order to study the number of patients readmitted rather than the number of readmissions, only the first ICU admission during the same hospital admission was analysed. Patients who died during their first ICU admission were excluded from analysis because they are not at risk of readmission or death after ICU. Patients who were recorded as discharged for palliative care or expected to die (as assessed by their consultant in intensive care medicine) were also excluded from the main analysis (Figure 1). These patients and those who died in ICU are included only in the presentation of baseline data.

Three different outcome groups were examined: patients who died after ICU discharge; patients who were readmitted within 48 hours of ICU discharge (early readmissions); patients who were readmitted at any time during the same hospital admission. Patients falling into more than one of these poor outcome groups are included in each category since their outcome could not be identified prospectively. Data relating to each outcome category should therefore be interpreted independently. APACHE II [10] and SAPS II scores [11] were calculated using standard methods during the first 24 hours of the first ICU admission. SAPS II has been found to have the best overall performance and APACHE II to have the best calibration when various severity of illness scoring systems were tested in a large Scottish ICU database to predict hospital mortality.[12] Daily Therapeutic Intervention Scoring System (TISS) scores [13] were recorded over each 24 hour period during ICU admission.

Data analysis

Data are presented as median (interquartile range) or as the number of cases and the proportion as appropriate. The association of individual factors was assessed separately in a simple logistic regression model for each of the outcomes in turn. We then used a multivariable logistic regression to evaluate the relationship between potential variables and outcome.

Gender and age were included in the multivariable analyses. Other predictor variables were included in multivariable logistic regression model if they were associated with ICU readmission or death with a p-value ≤ 0.2 in the simple logistic regression analysis. An *a priori* decision was made that variables with more than 5% missing data or with obvious co-linearity were not entered into multivariable logistic regression model. SPSS version 14 was used for analysis. A base case analysis which included only the APACHE II score was also performed for each outcome.

Calibration and discrimination of the prediction model were assessed using Hosmer and Lemeshow goodness of fit test and the area under the curve (AUC) respectively. Nagelkerke R^2 statistic was also calculated.

Results

Over a ten year period there were 6208 adult (≥ 16years) admissions, of which 5725 were index admissions (first admission in a single episode of hospital admission). One thousand one hundred and ninety patients died during their first ICU admission. One hundred and fifty nine were recorded as discharged for palliative care or were expected not to survive. Four thousand three hundred and seventy six adult patients were thus discharged alive from ICU without being recorded as expected to die or for palliative care (Figure 1). Patient characteristics are shown in Table 1. An outline of patient characteristics is presented in two year time slots to allow an assessment of potential changes over the ten year study period (Table 2). Both case mix and ICU management have evolved over the ten year period, but no specific changes in policy have been implemented.

Patient Outcomes

Four hundred and seventy five patients (11.2%) of the study cohort died after ICU discharge. Hospital length of stay in those who died after initial discharge from ICU was similar to those who survived to hospital discharge (14 (5-27) vs. 13 (7-27) days). Three hundred and eighty five patients (8.8%) were readmitted to ICU during the same hospital admission. Hospital mortality in those who were readmitted at any time was 40.2% and hospital length of stay after initial discharge from ICU was 32 (18-51) days.

The subgroup of readmissions who were readmitted within 48hours was also examined. One hundred and forty three patients (3.3%) were readmitted within 48 hours of ICU discharge. Hospital mortality in these early readmissions was 27.7% and hospital length of stay after initial discharge from ICU was 31 (15-47) days. Hospital mortality in those who were not readmitted was 8.4% and hospital length of stay after ICU discharge was 13 (7-24) days.

Factors associated with death, readmission, or readmission within 48hrs are shown in tables 3 to 5.

Reason for readmission

Admitting diagnoses were grouped according to whether it was the same pathology as original admission or a new diagnosis. Diagnoses were further grouped on the basis of organ system involved. Admitting diagnosis for both initial and readmission were available for 121/ 143 patients (85%). Forty nine % were readmitted for the same or related diagnosis and 51% for a different diagnosis. Twenty eight % of the total was readmitted with a new diagnosis of chest infection (initial admitting diagnosis not respiratory infection); 2.5% with new sepsis (not chest); 2.5% after in-hospital cardiac arrest; 3% with new acute respiratory distress or acute lung injury; 4% with fluid overload and 2% with cardiac failure. Between them these diagnoses accounts for 42% of the 49% of readmissions for new diagnoses. The remaining 7% were for miscellaneous reasons.

Multivariable logistic regression analysis

Admitting specialty was excluded from the multivariable analysis because of more than 5% missing data (28% missing). This was not recorded routinely until 1998. SAPS II scores and total TISS scores were excluded because of expected co-linearity with APACHE II scores and ICU length of stay respectively. Factors associated with death or ICU readmission on multivariable analysis are shown in tables 6 to 8.

Discrimination ability was moderate for the three models: AUC of 0.74, 0.67 and 0.62 for predicting death after ICU discharge, early readmissions and readmissions respectively. Based upon the Hosmer and Lemeshow goodness of fit test, there was no evidence of poor calibration for any of the three logistic regression models. However, discrimination ability based only upon the APACHE score were: AUC of 0.69, 0.63 and 0.59 respectively suggesting limited gain from using the full

model. The highest Nagelkerke R^2 statistic was 0.162 for death after ICU discharge. Because of their limited usefulness, prospective validation of these models was not considered to be warranted.

Discussion

A significant minority of patients deteriorate after discharge from intensive care. In our study 8.8% of initial survivors were readmitted to ICU and 11.2% died in hospital after ICU discharge. These are consistent with data from other units.[6] Not all of these deaths and readmissions will be preventable. A few patients discharged from ICU, although not expected to die, will have been assessed as unsuitable for readmission in the event of deterioration. Despite this, some will inevitably have been readmitted and subsequently died. These patients are not reliably detected by our data collection system and will contribute to the post-ICU and readmission mortality figures. However, identification of other high risk patients before they leave ICU may allow extra resources to be targeted towards them. This may include delayed discharge; discharge to a high dependency or other "step-down" unit; or more aggressive follow-up on the wards.

Early readmissions may be particularly important. Within this group there may be a number of problems which might be attributed to premature discharge from ICU and which could have been prevented.[2 6] Undoubtedly other factors will also impinge on the early readmission rate, including local high dependency facilities, quality of care on the ward after ICU discharge and the presence of ICU follow-up services. Whatever the reason for their deterioration and readmission it is clear that patients readmitted to ICU are at much higher risk of subsequent death than those who are not readmitted.[4-6] It would be useful to be able to identify those at risk of readmission before initial ICU discharge.

Not surprisingly our data show that death after ICU is independently associated with increasing illness severity, age and time in hospital before ICU admission. Time in hospital before ICU may reflect a failure to respond to treatment on a general ward or late referral to ICU.[4] It is tempting to speculate that this might be amenable to earlier intervention, perhaps facilitated by early warning systems and hospital outreach teams. For readmissions overall, the risk factors are similar and also include discharge to an HDU. This last factor may reflect illness severity at discharge or an earlier recognition of deterioration because of higher levels of monitoring. Only surgical HDU facilities exist in our hospital and it is possible that surgical patients are discharged earlier in their recovery phase because a higher level of step down care is available. The only factors associated with early readmissions are severity of illness at ICU admission and discharge to an HDU. Our findings are consistent with previous studies.[5-7 14] Better predictive models might be produced by including more patient variables at the time of ICU discharge. Status at discharge would seem a more relevant factor and is also when we might have the opportunity to intervene. Higher TISS scores at discharge have been found in other studies to be associated with an increased risk of readmission and death but we did not confirm this finding in our patients.[2 15 16] While discharge TISS score was statistically associated with death in our study, the difference between scores in those who died and survived (29 vs. 28) is not clinically useful. We do not currently collect other measures of illness severity at the time of patient discharge.

Other factors associated with death or readmission after ICU have been identified but none have yet translated into a useful predictive model for individual patients.[6] A US study in a medical ICU found the acute physiology score component of APACHE II at ICU discharge to be the independent risk factor most associated with readmission to ICU.[4] This data is not collected routinely in our unit at present.

Another study showed proximity of extubation to time of discharge and the need for organ support on the day of discharge to be independently associated with readmission.[2] These might indicate unresolved organ failure and premature discharge or substandard care after ICU discharge. Premorbid functional status and several severity of illness related factors such as delirium and muscle weakness might also be relevant in determining outcome. None of these are currently recorded in our clinical audit system.

If discharges are indeed premature, would delaying discharge make any difference? A model developed in the UK suggested that about a third of ICU patients are at increased risk of death after ICU and that delaying their discharge by 48 hours might reduce their risk of death.[9] Decisions on discharge from ICU are currently based on clinical judgement rather than objective criteria. The effect on mortality and readmission of introducing a discharge policy based around a "physiological discharge score" is unlikely to be straightforward but deserves further investigation. We do know that night-time discharge, used as an indicator for premature discharge, is associated with poorer outcome.[16 17] Our findings did not note any influence of night-time discharge, perhaps because the absolute number of night-time discharges in our unit was very small. Other potentially relevant organisational factors not considered in our study include ICU bed occupancy and the level of ward care. Increasing length of stay in ICU or increasing the provision of high dependency care have been suggested as strategies for improvement.[16] Each of these solutions has major resource implications so cost-effectiveness needs to be demonstrated by prospective study. Case by case analysis might be valuable in identifying avoidable readmissions and deaths. This has been studied elsewhere to assess quality of care before admission to intensive care and found several cases of suboptimal care but rather fewer cases of preventability.[18] A study of 97 early readmissions to a surgical

ICU concluded that most (63%) initial discharges were appropriate, 22% of readmissions were preventable, 11% of readmissions may have been anticipated and 5% might have been prematurely discharged.[5] Other studies report that up to 40% of readmissions may have been associated with premature discharge.[6] Such results are not easily extrapolated to different units because of differing patient and organisational factors, particularly between countries. One strategy for obtaining local information is the development of follow-up teams who monitor patients after ICU discharge, can provide early warning of deterioration and perhaps suggest interventions to prevent further deterioration.[19] One study of a critical care outreach team found preliminary evidence of benefit in both survival and reduced readmission rates, [20] although this is not a universal finding.[21] Effective and aggressive follow-up may actually increase readmission rate. As the mortality of patients deteriorating after ICU discharge is so high, some clinicians may elect to readmit at an early stage to avert further deterioration. This may be clinically appropriate but will confound the use of readmission rate as a quality marker. Caution must therefore be exercised when interpreting comparative data on readmission rates.

The above studies and our results give some insight into the problem of unexpected deterioration after ICU discharge. Different hospitals, particularly in different countries have different case-mixes, different step-down arrangements and different organisational factors such as numbers of transfers between hospitals, each of which might affect readmission rates. This makes comparisons and identification of common predictors more difficult.[3 4 6] Nonetheless, readmission rates and unexpected deaths may be a relevant quality marker, particularly at a local level.

Conclusions

Risk of death after ICU is independently associated with increasing illness severity at time of ICU admission, age and time in hospital before ICU admission. Risk factors for readmission to ICU are similar and also include discharge to an HDU. Risk factors for early readmissions are severity of illness at ICU admission and discharge to an HDU. Prognostic models based on these risk factors had moderate discrimination ability, but only performed slightly better than models based only upon APACHE score at ICU admission. We conclude that our routinely collected data cannot be used to produce models that are more clinically useful in predicting death or readmission than admission APACHE II scores alone. In future, the most logical area on which to focus efforts to predict outcome might be on physiological variables at discharge. This could be based around the same acute physiological score components included in the APACHE II score, not currently collected at the time of discharge from our unit. Follow-up of patients after discharge provides the ideal opportunity to study reasons for deterioration and to assess the likely preventability of each readmission or unexpected death. Only when we have answered these questions will we be able to target our resources best at those at highest risk of poor outcome despite a good response to treatment of their initial illness.

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Fig 1. Flow diagram of patients included in study cohort.

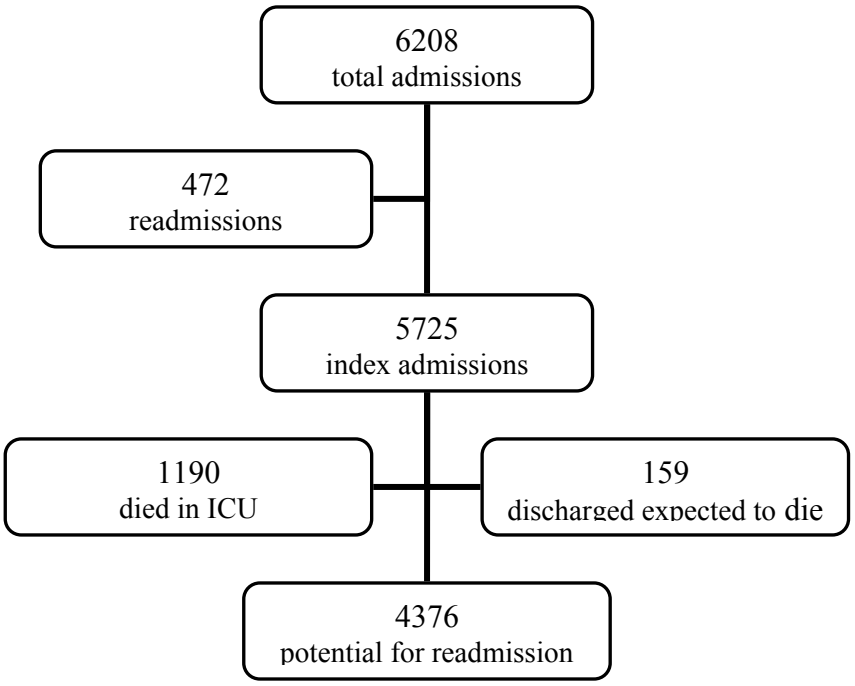

Table 1 - Patient characteristics for all ICU admissions during study period. Data are presented as median (interquartile range) or as percentages.

Abbreviations: ICU- Intensive Care Unit; LOS- Length of stay.

	All patients	**Died in ICU**	**Survived ICU**
Patient number	5725	1190	4535
Male sex	3324 (58.1)	672 (56.5)	2652 (58.5)
Age (years)	63 (46-73)	66 (54-74)	61 (44-72)
APACHE II	19 (14-25)	28 (23-33)	18 (13-23)
APACHE II mortality prediction	29 (12-53)	64 (42-80)	23 (10-42)
SAPS II	38 (27-52)	59 (47-72)	34 (24-45)
Surgery on or prior to admission	2903 (52.0)	355 (30.6)	2548 (57.6)
ICU LOS (days)	2 (1-5)	2 (1-7)	2 (1-5)
Hospital LOS after ICU discharge (days)	10 (1-21)	-	13 (7-27)
ICU mortality	1190 (20.8)	-	-
Hospital mortality	1775 (31.0)	-	585 (13.3)
Unit APACHE II standardised mortality rate for study period	0.87 - 0.96		

Table 2- Patient characteristics presented in two-year time slots over the study period. Data are presented as medians (interquartile range) and cases (percentages).

Abbreviations: CPR- cardiopulmonary resuscitation: ICU- intensive care unit: N/A- information not available.

Year	**<1997**	**1997-8**	**1999-2000**	**2001-02**	**>2003**
Number of patients	875	1023	1094	1226	1496
Age (years)	63 (48-72)	61 (44-72)	63 (47-72)	63 (47-73)	63 (46-73)
Male sex	514 (58.7)	578 (56.5)	606 (55.4)	724 (59.1)	895 (59.8)
CPR in 24h before initial ICU admission	111 (12.8)	95 (9.3)	127 (11.6)	132 (10.8)	143 (9.6)
Surgical admitting specialty	N/A	269 (64.5)	678 (62.0)	761 (62.1)	885 (59.2)
ICU mortality	151 (17.3)	166 (16.2)	246 (22.5)	278 (22.7)	347 (23.2)
Hospital mortality	255 (29.1)	266 (26.0)	366 (33.5)	416 (33.9)	469 (34.2)
APACHE II score	18 (13-23)	18 (13-24)	20 (14-26)	20 (15-27)	20 (14-27)

Table 3 - Simple logistic regression of patients who died after ICU discharge with those who survived to hospital discharge. Data are presented as medians (interquartile range) and cases (percentages). Abbreviations: OR- odds ratio; CPR- cardiopulmonary resuscitation; ICU- Intensive Care Unit; HDU- High Dependency Unit. * Variable with less than 95% of data available.

	Died N=475	**Alive N=3779**	**Unadjusted OR (95% CI)**	**P-value**
Age (years)	70 (60-76)	59 (42-71)	1.04 (1.03-1.05)	<0.001
Male sex	290 (61.1)	2211 (58.5)	1.11 (0.91-1.35)	0.288
Days in hospital before ICU admission	2 (0-7)	1 (0-3)	1.03 (1.02-1.03)	<0.001
CPR in 24h prior to initial ICU admission	51 (10.8)	217 (5.8)	1.98 (1.43-2.72)	<0.001
Surgical admitting specialty*	205 (61.2)	1824 (67.2)	0.77 (0.61-0.97)	0.028
Surgery on admission or prior to ICU	263 (56.3)	2169 (58.9)	0.90 (0.74-1.09)	0.290
APACHE II	22 (17-27)	17 (13-22)	1.09 (1.08-1.11)	<0.001
SAPS II	43 (33-54)	33 (23-43)	1.05 (1.04-1.05)	<0.001
Days of mechanical ventilation	2 (1-6)	2 (1-3)	1.04 (1.03-1.05)	<0.001
Highest TISS	42 (36-48)	37 (30-44)	1.05 (1.04-1.06)	<0.001
Total TISS	124 (65-314)	74 (45-172)	1.0011 (1.0008-1.0014)	<0.001
Mean TISS	35 (31-38)	32 (28-37)	1.05 (1.04-1.06)	<0.001
Discharge TISS	29 (24-35)	28 (23-34)	1.013 (1.003-1.023)	0.010
Unit stay (days)	3 (1-9)	2 (1-5)	1.03 (1.02-1.04)	<0.001
Night discharge	13 (2.7)	105 (2.8)	0.99 (0.55-1.77)	0.958
Discharge to HDU or other ICU	161 (33.9)	1233 (33.6)	0.99 (0.81-1.21)	0.897

Table 4 - Simple logistic regression of patients who were readmitted to ICU at any time during index admission with patients who were not readmitted to ICU. Data are presented as median (interquartile range) and cases (percentages) as appropriate. Abbreviations: OR- odds ratio; CPR- cardiopulmonary resuscitation; ICU- Intensive Care Unit; HDU- High Dependency Unit. * Variable with less than 95% of data available.

	Readmitted to ICU N=385	**Not readmitted to ICU N=3981**	**Unadjusted OR (95% CI)**	**P-value**
Age (years)	66 (54-73)	60 (43-71)	1.0`2 (1.01-1.02)	<0.001
Male sex	245 (63.6)	2323 (58.4)	1.25 (1.01-1.55)	0.045
Days in hospital before ICU admission	1 (0-6)	1 (0-3)	1.02 (1.01-1.02)	0.001
CPR in 24h prior to initial ICU admission	30 (7.8)	242 (6.1)	1.30 (0.88-1.93)	0.190
Surgical admitting specialty *	213 (71.0)	1889 (65.9)	1.27 (0.97-1.64)	0.078
Surgery on admission or prior to ICU	233 (61.3)	2252 (58.0)	1.15 (0.92-1.42)	0.213
APACHE II	20 (16-24)	17 (13-22)	1.05 (1.03-1.06)	<0.001
SAPS II	37 (28-48)	33 (23-43)	1.02 (1.01-1.02)	<0.001
Days of mechanical ventilation	2 (1-5)	2 (1-3)	1.03 (1.01-1.04)	<0.001
Highest TISS	41 (35-47)	37 (31-44)	1.03 (1.02-1.04)	<0.001
Total TISS	111 (65-274)	75 (45-176)	1.001 (1.000-1.001)	<0.001
Mean TISS	34 (30-38)	32 (28-37)	1.04 (1.02-1.05)	<0.001
Discharge TISS	28 (24-35)	28 (23-34)	1.008 (0.997-1.019)	0.136
Unit stay (days)	2.9 (1-7.5)	2 (1-5)	1.02 (1.01-1.04)	<0.001
Night discharge	10 (2.6)	109 (2.7)	0.95 (0.49-1.83)	0.871
Discharged to HDU/ICU	161 (42.0)	1293 (33.4)	0.69 (0.56-0.86)	0.001

Table 5 - Simple logistic regression of patients readmitted to ICU within 48hrs with patients who were not readmitted within 48hrs. Data are presented as median (interquartile range) and cases (percentages) as appropriate. Abbreviations: OR- odds ratio; CPR- cardiopulmonary resuscitation; ICU- Intensive Care Unit; HDU- High Dependency Unit. *Variable with less than 95% of data available.

	Readmitted within 48h N=143	**Not readmitted with 48h N=4223**	**Unadjusted OR (95% CI)**	**P-value**
Age (years)	66 (51-73)	61 (44-72)	1.011 (1.001-1.020)	0.028
Male sex	96 (67.1)	2472 (58.5)	1.45 (1.02-2.06)	0.041
Days in hospital before ICU admission	1 (0-5)	1 (0-3)	1.00 (0.99-1.02)	0.603
CPR in 24h prior to initial ICU admission	13 (9.1)	259 (6.1)	1.53 (0.85-2.74)	0.156
Surgical admitting specialty *	78 (67.8)	2024 (66.3)	1.07 (0.72-1.59)	0.744
Surgery on admission or prior to ICU	79 (56.4)	2406 (58.4)	0.92 (0.66-1.30)	0.647
APACHE II	20 (16-24)	17 (13-22)	1.04 (1.02-1.07)	<0.001
SAPS II	36 (28-48)	34 (24-44)	1.01 (1.00-1.03)	0.001
Days of Mechanical ventilation	2 (1-5)	2 (1-4)	1.01 (0.99-1.04)	0.315
Highest TISS	40 (33-46)	38 (31-45)	1.015 (0.999-1.031)	0.072
Total TISS	109 (59-253)	76 (47-184)	1.0004 (0.9998-1.0010)	0.209
Mean TISS	33 (30-38)	32 (28-37)	1.01 (0.99-1.04)	0.242
Discharge TISS	28 (23-35)	28 (23-34)	1.00 (0.98-1.02)	0.931
Unit stay (days)	2 (1-7)	2 (1-5)	1.01 (0.99-1.03)	0.339
Night discharge	3 (2.1)	116 (2.7)	0.76 (0.24-2.42)	0.640
Discharged to HDU or other ICU	68 (48.2)	1136 (33.7)	0.55 (0.39-0.76)	<0.001

Table 6 - Multivariable logistic regression of death after initial ICU discharge before hospital discharge. Data presented as adjusted odds ratios (95% confidence intervals). With continuous variables, odds ratio refers to odds associated with a unit increase in the predictor variable. Nagelkerke R^2 statistic was 0.162. Hosmer and Lemeshow goodness of fit test was not significant at 5%, p=0.103. AUC was 0.74. Abbreviations: CPR - cardiopulmonary resuscitation; OR- odds ratio.

	Adjusted OR (95% CI)	**p-value**
Age (years)	1.03 (1.02-1.04)	<0.001
Male sex	1.24 (1.01-1.53)	0.043
Days in hospital before ICU admission	1.02 (1.01-1.03)	<0.001
CPR in 24h prior to initial ICU admission	1.21 (0.85-1.73)	0.295
APACHE II	1.06 (1.04-1.08)	<0.001
Days of mechanical ventilation	0.97 (0.92-1.03)	0.300
Mean TISS	1.03 (1.02-1.05)	<0.001
Discharge TISS	1.01 (1.00-1.02)	0.064
Unit stay	1.04 (1.00-1.09)	0.046

Table 7 - Multivariable logistic regression of readmission at any time after initial ICU discharge and before hospital discharge. Data presented as odds ratios (95% confidence intervals). With continuous variables, odds ratio refers to odds associated with a unit increase in the predictor variable. Nagelkerke R^2 statistic was 0.046. Hosmer and Lemeshow goodness of fit test was not significant at 5%, p=0.216. AUC was 0.65. Abbreviations: CPR: cardiopulmonary resuscitation; ICU - Intensive Care Unit; HDU- High Dependency Unit; OR- odds ratio.

	Adjusted OR (95% CI)	**p-value**
Age (years)	1.01 (1.00-1.02)	0.010
Male sex	1.23 (0.98-1.54)	0.070
Days to unit	1.01 (1.00-1.02)	0.011
CPR in 24h prior to initial ICU admission	0.91 (0.59-1.39)	0.653
APACHE II	1.03 (1.01-1.05)	<0.001
Days of mechanical ventilation	0.96 (0.91-1.02)	0.232
Mean TISS	1.02 (1.01-1.04)	0.006
Discharge TISS	1.01 (1.00-1.02)	0.146
Unit stay	1.05 (1.00-1.10)	0.052
Discharged to HDU or other ICU	1.37 (1.10-1.72)	0.005

Table 8 - Multivariable logistic regression of readmission within 48 hours of initial ICU discharge. Data presented as odds ratios (95% confidence intervals). With continuous variables, odds ratio refers to odds associated with a unit increase in the predictor variable. Nagelkerke R^2 statistic was 0.02. Hosmer and Lemeshow goodness of fit test was not significant at 5%, p=0.269. Area under curve was 0.62. Abbreviations: CPR - cardiopulmonary resuscitation; ICU - Intensive Care Unit; HDU - High Dependency Unit; OR- odds ratio.

	Adjusted OR (95% CI)	**p-value**
Age (years)	1.01 (0.99-1.02)	0.360
Male sex	1.38 (0.96-1.99)	0.083
CPR in 24h prior to initial ICU admission	0.96 (0.49-1.88)	0.900
APACHE II	1.04 (1.01-1.07)	0.012
Highest TISS	1.00 (0.99-1.02)	0.737
Discharged to HDU or other ICU	1.66 (1.18-2.35)	0.004