

**British Intensive Care Society
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Oral Presentations

- 1 C H Collins, Royal Devon & Exeter Hospital
- 2 M P Carroll, Southampton General Hospital
- 3 P D McDonagh, Mater Hospital, Dublin
- 4 M Y Rady, N W Injury Research Centre, M/c Univ.
- 5 S P Davies, Charing Cross Hospital, London
- 6 M S Nielsen, Southampton General Hospital
- 7 M Singer, Middlesex Hospital, London
- 8 I S Grant, Western General Hospital, Edinburgh
- 9 W Kox, Charing Cross Hospital, London
- 10 R J Winter, Bristol Royal Infirmary
- 11 S Ridley, Western Infirmary, Glasgow
- 12 E B Faragher, UHSM
- 13 P Allsop, University Hospital, Nottingham
- 14 C A Carter, Royal Hallamshire, Sheffield

Poster Presentations

- 1 R R Macmillan, Whiston Hospital
- 2 P J D Andrews, Western General, Edinburgh
- 3 M P Shelly, ICU, UHSM
- 4 C Clarke, ICU, UHSM
- 5 C E Harris, ICU, Whiston Hospital
- 6 M D J Donaldson, St Bartholomew's Hospital, London
- 7 I H Lewis, Southampton General
- 8 D N Sutton, Southampton General
- 9 J G de Courcy, Southampton General
- 10 M White, Mater Hospital, Dublin
- 11 D J Wright, Western General Hospital, Edinburgh
- 12 N R Coad, ICU, University Hospital, Nottingham
- 13 M Singer, St George's Hospital, Tooting, London
- 14 E H S Yau, St Bartholomew's Hospital, London
- 15 A R Manara, Addenbrooke's Hospital, Cambridge
- 16 R D Griffiths, Whiston Hospital

Oral Presentations

1

A PROTOCOL FOR INCREASING ORGAN DONATION FROM CEREBROVASCULAR DEATHS IN A DISTRICT GENERAL HOSPITAL. C H Collins, T G Peest, H N Riad, M G S Golby. There is a shortage of donor organs for transplantation in the UK. Recent audit of intensive care units (ICU) suggest that few potential donors in them are missed. However, such studies underestimate the pool of potential organ donors by not considering deaths outside ICU.

In a District General Hospital serving 303,000 people, deaths from cerebrovascular accidents (CVA) in a 12 month period were analysed retrospectively. 8 patients who died in general wards were identified as potential organ donors. A working party then devised a protocol for managing these potential donors, and transferring them to the ICU until organ retrieval can be arranged.

The essential elements of the protocol are: i) identify patients who are terminally ill with CVA, who are expected to die within 48 hours and who are suitable organ donors, ii) the consultant physician to refer patients to consultant in intensive care to check bed availability, iii) relatives fully informed and permission for organ donation requested prior to transfer to ICU.

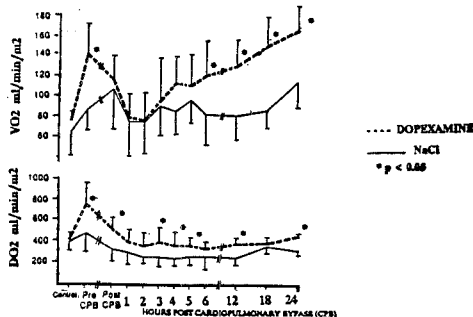
Results: In the first 19 months using the protocol organs were retrieved from 8 patients (1 heart, 2 sets of heart valves, 2 livers and 16 kidneys) who would not have become organ donors without its use. In the 3 years preceding introduction of this protocol the number of organ donors was 6 per year. This donor rate of 19.8/million/year was high for a hospital with no neurosurgical unit (the national average was then 21.7). During use of our new protocol this basic donor rate did not change. Of patients admitted to ICU with severe brain injury because they required either treatment or support until a diagnosis could be made, 10 (5 trauma, 5 CVA) later became donors.

The current national rate of organ donation has fallen to 14.6 per million population per year. Our ICU in 19 months had an overall donor rate of 37.5/million/year. If the results of our protocol were repeated nationally a further 16.7/million/year would be added to the national rate.

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3

DOPEXAMINE HYDROCHLORIDE AUGMENTS TISSUE PERFUSION IN PATIENTS UNDERGOING CARDIAC SURGERY. PD McDonagh, M White, D Phelan. Impaired tissue oxygenation relative to demand correlates with increased morbidity and mortality. Peri-operative lactic acidosis reflects inadequate tissue perfusion in major surgical operations. We compared haemodynamics and tissue perfusion indices in low risk patients (LVEF > 0.5) undergoing coronary artery by-pass grafting (CABG). Patients were randomly allocated to two groups. Group I received prophylactic Dopexamine infusion 2/ug/kg/min; Group II Saline. CI, DO₂, VO₂ and Lactate were measured at determined intervals. Significant increases in serum lactate (p < 0.05) occurred in both groups. However CI, DO₂ and VO₂ were significantly higher in Group I and were associated with a more rapid decline in serum lactate.



This study shows an oxygen deficit relative to requirement occurs in cardiac surgery and suggests that augmentation of CI and DO₂ using Dopexamine results in improved VO₂ and tissue perfusion in the post operative period.

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2

RESPIRATORY FAILURE TREATED WITH NASAL INTERMITTENT POSITIVE PRESSURE VENTILATION.

M Carroll* JH Conway* J Bott^o RA Hitchcock* J Moxham^o RC Godfrey* ST Holgate*.

It is desirable to avoid full intubation and ventilation in patients with respiratory failure due to acute exacerbations of airways disease. Consequently we have evaluated the use of nasal intermittent positive pressure ventilation (NIPPV) applied through a tight fitting mask to assist ventilation in 7 patients (5 males) mean age 59 years (range 32-71) all with FEV₁ < 1.5lt and a >10 year history of respiratory symptoms. The patients were in respiratory failure due to an acute exacerbation of their pre-existing airways disease. Arterial blood gases on admission, on air, range between 3.45-8.30 kPa (mean 6) for PO₂ and 9.07-13.58 kPa (mean 10.5) for PCO₂. Despite the severity of their conditions such acutely ill patients tolerated the NIPPV well and achieved partial reversal of their respiratory failure: PO₂ 10.15 kPa (mean 13); PCO₂ 5.8-9.9 kPa (mean 7.5). The significant increase in PO₂ (p<0.05) occurred without increase in PCO₂. Indeed there was a significant decrease in PCO₂ (p<0.05).

We conclude that it is possible to use NIPPV to treat respiratory failure in the acutely ill.

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4

THE RELATIONSHIP BETWEEN SHOCK INDEX AND CARDIAC FUNCTION AND OXYGEN TRANSPORT IN HAEMORRHAGIC SHOCK.

MY Rady; RA Little; JD Edwards; E Kirkman. When measured alone heart rate HR and arterial pressure are of limited value in the assessment of circulatory failure in shock states (CR Shippy, PL Appel & WC Shoemaker. Crit Car Med. 12: 107, 1984). The shock index (SI, the ratio of HR to systemic systolic arterial pressure) was used in the estimation of blood loss following haemorrhage in man (M Allgower & C Burri. Deutsche Med Woch 43: 1, 1967). However, little experimental work has been done to examine the relationship of SI to cardiac function and oxygen transport. This has now been investigated in a porcine model of haemorrhage. The study was conducted on 22 anaesthetised immature domestic swine (16-27 kg). General anaesthesia was induced with ketamine (20 mg/kg) and maintained with O₂-N₂O (FIO₂ 0.5) and isoflurane (1.5%). Bilateral femoral arterial cannulae (arterial pressure monitoring and bleeding) and a 7F thermidilution pulmonary artery catheter were inserted. Animals were bled at a rate of 0.75 ml/kg.min until 30 ml/kg had been removed. Haemodynamic and oxygen transport variables were measured before, during and 30 min after haemorrhage. SI and indices of cardiac function (cardiac index, r=-0.73; stroke volume, r=-0.75 and left ventricular stroke work r=-0.75) and oxygen transport (oxygen delivery, r=-0.68; mixed venous oxygen saturation, r=-0.72 and base excess, r=-0.54) were significantly correlated. Oxygen consumption increased until SI reached a critical value (>3), whereupon it fell sharply. In conclusion SI may provide a non-invasive means of monitoring inadequate left ventricular function; cardiac index and oxygen transport in haemorrhagic shock, and therefore may be used in the early assessment and therapy of hypovolaemic shock.

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5

CLEARANCE STUDIES IN PATIENTS WITH ACUTE RENAL FAILURE TREATED BY CONTINUOUS ARTERIOVENOUS HAEMODIALYSIS.
S P Davies, E A Brown, W Kox.

Continuous arteriovenous haemodialysis (CAVHD) is now an established technique for the treatment of acute renal failure on the ICU. We measured clearances of a range of solutes in patients treated by CAVHD using Hospal AN695 0.43 m² filters and Fresenius 1.5% peritoneal dialysis fluid at dialysate flow rates (Qd) of 1 and 2 l/hr.

Results:-

(Mean ± SEM)	Clearance (ml/min)	
	Qd 1 l/hr	Qd 2 l/hr
Urea	22.02 ± 0.46	33.46 ± 0.81
Creatinine	20.15 ± 0.48	29.43 ± 0.80
Phosphate	20.68 ± 0.70	28.26 ± 1.12
Urate	16.49 ± 0.54	22.21 ± 0.75
B ₂ microglobulin	6.58 ± 0.65	6.62 ± 0.78
Cefuroxime	13.97 ± 2.34	16.22 ± 3.35
Ceftazidime	13.11 ± 1.15	15.24 ± 1.47
Ciprofloxacin	16.31 ± 1.89	19.93 ± 1.11
Vancomycin	11.70 ± 1.88	15.58 ± 2.07

Clearances of all small solutes were higher at a Qd of 2 l/hr than at 1 l/hr. Increasing the dialysate flow rate did not significantly increase clearance of B₂ microglobulin (MW 11,800), rather, this correlated with ultrafiltration rate (r = 0.75, p < 0.001).

These studies confirm that clearances of small MW solutes, including a number of antibiotics, are high with CAVHD. Removal of larger solutes depends primarily on convection and therefore clearances of these are likely to be low with this form of renal replacement therapy.

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7

PILOT STUDY OF PENTOXIFYLLINE IN HUMAN MULTI-ORGAN FAILURE

M Singer, D Tighe, ED Bennett

Pentoxifylline (PTF) is a putative treatment of multi-organ failure (MOF). Animal studies have shown encouraging results though it has yet to be tested in patients. A pilot study was therefore undertaken to elucidate cardio-respiratory responses to PTF in patients with established MOF (including ARDS).

PTF was given to 9 patients (age range 16-61y, median 35y) with 2-5 organ failure (median 3) and APACHE II scores of 14-32 (median 23). Doses ranged from 0.125-1.0 mg/kg/hr. Two patients died within 12 hours from their underlying disease. Data for the remaining 7 is shown below as mean ± s.e. † p < 0.05

HOUR	0	2	12
Mean Arterial Pressure mmHg	71±6	61±6 †	72±4
Mean Pulmonary P. mmHg	34±5	28±3	32±5
PA Wedge Pressure mmHg	14±3	11±1	14±3
Cardiac Index l/min/m ²	3.7±0.5	3.8±0.6	4.5±0.5 †
SVR Index dyne/sec/cm ⁵ /m ²	1338±230	957±50 †	1104±123
PVR Index dyne/sec/cm ⁵ /m ²	554±197	523±204	372±101
DO ₂ ml/min/m ²	415±59	432±75	614±78 †
VO ₂ ml/min/m ²	121±13	119±12	139±10 †

At 1-2 hours there was an initial and sudden vasodilatation; rapid fluid infusion, up to 1 litre, was needed to restore cardiovascular stability. This effect appeared greater at higher doses. From 10 hours reductions were seen in PVRI with improvements in CI, DO₂l and VO₂l; this was maintained at 12 hours. PTF may be beneficial in MOF therapy; early administration may prove more efficacious though care should be exercised with its usage.

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6

TOTAL SERUM AMYLASE AND AMYLASE ISOENZYMES IN THE CRITICALLY ILL.

M S Nielsen, P B Randalls, R Boswell, P Rogers.

Acute pancreatitis may precipitate the need for intensive care or may arise as a complication of some other critical illness. The diagnosis is difficult in patients who are sedated and paralysed and, if CT scanning or ultrasonography are impracticable, then much reliance may be put on total serum amylase levels. These can be misleading as 50% of serum amylase activity may come from non-pancreatic sources. This study prospectively examined total amylase and amylase isoenzyme activity in 202 consecutive adult admissions to a general intensive care unit.

Method. Samples were taken on the day of admission and analysed using the Phadebas IsoAmylase Test (Pharmacia Diagnostics AB, Sweden). Using this method the normal ranges are as follows: total amylase (TA) 90-325 u/l, pancreatic amylase (PA) < 200 u/l, non-pancreatic amylase (NPA) < 240 u/l.

Results. There were 149 surgical and 53 medical patients. On the basis of findings at either laparotomy or post-mortem, 8 patients were known to have pancreatic injury at the time of blood sampling. In only 3 of these did PA levels exceed 200 u/l (range 215-655 u/l). In only 2 of these 8 was TA elevated to a clinically significant level (>1000 u/l), at 2110 and 1210 u/l (PA 655 and 135 u/l respectively). 13 patients (5 surgical, 8 medical) had TA levels > 1000 u/l. In only 6 did PA activity exceed 200 u/l (range 600-2220 u/l) and in 9/13 over 60% of TA was non-pancreatic in origin (normal = 50%).

Conclusion. Total serum amylase and amylase isoenzyme levels are unreliable as indicators of pancreatic injury in the critically ill.

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8

HAEMODYNAMIC RESPONSE TO HAEMOFILTRATION.

I.S. Grant, S.J. Mackenzie, G.R. Nimmo, I.R. Armstrong.

Intermittent high volume pump-driven haemofiltration has logistical advantages over continuous techniques and may be acceptable in critically ill patients provided solute and fluid removal can be achieved without unacceptable haemodynamic effects. We prospectively studied the cardiorespiratory effects of haemofiltration in 12 patients with multiple organ failure. Cardiorespiratory status was optimised before haemofiltration using a Gambro AK10 system was commenced. The patient's cardio-respiratory parameters were studied before and 1 hour after the start of haemofiltration during which time fluid and inotrope infusion rates were kept constant. The results are shown in the table. All values are mean ± S.D.

	Baseline	1 hr. post HF	Significance
HR	104 ± 16.7	105 ± 13.5	NS
MAP	81 ± 17.6	79 ± 11.7	NS
CI	4.6 ± 1.6	3.8 ± 1.2	NS
SVR	667 ± 107	832 ± 258	p < 0.05
CVP	13.3 ± 4.8	13.1 ± 5.9	NS
PCWP	13.6 ± 3.6	13.3 ± 5.3	NS
DO ₂	624 ± 152	510 ± 133	p < 0.05
VO ₂	145 ± 28.8	130 ± 21.7	NS
Qs/Qt	32 ± 12	31 ± 14	NS

There was a significant increase in SVR and a significant decrease in DO₂. MAP was well maintained despite a mean fluid removal of 716 ml (0-1700). High volume pump-driven venovenous haemofiltration is well tolerated in respect of cardiorespiratory function in patients with multiple organ failure who have received adequate prior resuscitation. In particular, vascular responsiveness to fluid removal is maintained.

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9

THE EFFECT OF ENOXIMONE AND ADRENALINE ON OXYGEN DELIVERY AND CONSUMPTION. A CROSS OVER STUDY.

W. Kox and C. Brydon

Patients in hyperdynamic septic shock frequently require inotropic support to maintain adequate tissue oxygenation. Enoximone, a relatively new inotropic agent (Phosphodiesterase inhibitor) and vasodilator, may be a useful drug in preventing oxygen debt. In addition, its different site of action compared to beta adrenergic agents could make it a useful adjuvant to those inotropes.

Ten patients in septic shock requiring inotropic support (MAP < 60 mmHg) were treated with adrenaline (0.04-0.4 µg/kg/min) or enoximone (5 µg/kg/min) or both drugs together. Cardiac index (CI), mean arterial pressure (MAP), wedge pressure (PCWP), total peripheral (TPR) and pulmonary vascular resistance (PVR), oxygen delivery (DO₂), oxygen consumption (VO₂) and blood lactate (Lac) were measured before and 1 hour after the start of the inotrope infusion.

	Pre	Adr	En	Adr/En
CI	3.6±1.8	4.0±1.7	4.7±2.0	4.7±1.7
MAP	57±7	80±9**	66±9**	73±12*
WP	14±3	18±4**	13±2	17±4*
TPR	1243±606	1737±890**	1007±469*	1246±657
PVR	256±120	331±167*	201±104**	276±134
DO ₂	480±245	563±256*	636±273**	680±267*
VO ₂	136±40	140±31	156±40**	182±43**
Lac	2.7±1.4	3.2±1.6**	1.8±1.0	2.8±1.7

* p < 0.05, ** p < 0.01

Results show that enoximone alone or in combination with a beta adrenergic inotrope may be beneficial in the provision of oxygen to the tissues and in preventing oxygen debt in patients in septic shock.

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11

CAUSES OF DEATH AFTER DISCHARGE FROM ITU S Ridley and J Purdie.

There is little data concerning the causes of death in patients discharged from ITU. This study aimed to (a) report the primary cause of death in survivors of ITU and (b) investigate whether the cause of death was related to ITU admission diagnosis.

All patients discharged from ITU between June 1985 and December 1988 were studied. The APACHE score on admission, age and diagnosis were recorded for all patients. Details of survivors were sent to the Registrar General for Scotland who issued copies of death certificates for those patients died between discharge and 1st January 1990; thus patients were followed for 1 to 4.5 years. Chi-squared and Wilcoxon rank sum tests were used for statistical analysis.

Between July 1985 and December 1988, 780 patients were discharged from the ITU. Up to 1st January 1990, 181 were known to have perished; although the Registrar General could only provide copies of 157 death certificates. The details of these patients are shown below:

	Median	Range	10th	90th	centile	Diagnosis	Number
Age (yrs)	65	16-88	45	77		Trauma	3
APACHE	15	5-33	8	24		Cardiovascular	30
						Respiratory	71
						Gastrointestinal	33
						Miscellaneous	20

The commonest causes of death after ITU was malignancy (49 patients) and respiratory failure (31 patients). The admission diagnosis and the primary cause of death were identical in 38 patients, 95% of whom died within one year of discharge (median 48 days, 10th & 90th centile 1 & 304 days). There was no significant variability between the diagnostic groups with respect to the proportion of matched deaths in any particular category; overall 24% of patients in each diagnostic group died from the same condition that precipitated their ITU admission. However there was significant variability between the post discharge mortality of the various diagnostic groups (P < 0.05). High mortality was observed in patients with gastrointestinal pathology (48%) and respiratory failure (37%) while mortality for acute conditions such as trauma and poisoning was low (6% and 8%, respectively).

In conclusion, in this group of ITU survivors, the commonest causes of death after ITU discharge are malignancy and respiratory failure. There is significant variation in the post discharge mortality of different diagnostic categories. The ITU diagnosis and primary cause of death were identical in approximately 25% of patients, 95% of whom died within one year of discharge.

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10

APACHE II SCORING AFTER THE FIRST 48 HOURS

R J Winter, S W Willatts, D P Coates.

Two hundred and thirty patients admitted to the Intensive Therapy Unit at the Bristol Royal Infirmary who were expected to stay for at least 48 hours, were scored using the APACHE II scoring system (Knaus 1985) on a daily basis. While there was a significant difference between the scores in the patients dying (either on the unit or following discharge to the ward) and those surviving to leave hospital, there was no upper limit for scores in surviving patients. However, patients who had failed to reduce their APACHE II score to below 20 by day 3 also failed to leave hospital alive. Scores above 20 on day 3 were uniformly associated with a fatal outcome irrespective of the score on day 1.

APACHE II SCORES

Day 3 of Unit stay

	Died in Unit	Died in Ward	Home
SCORE < 20	34	41	131
SCORE <= 20	14	1	0
TOTALS	48	51	131

Reference. Knaus WR, Draper EA, Wagner DP, Zimmerman JE. (1985) APACHE II: A severity of disease classification system. Crit Care Med. 13:818-829.

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12

THE RELATIONSHIP BETWEEN OXYGEN UPTAKE AND DELIVERY IN ADULT RESPIRATORY DISTRESS SYNDROME (ARDS): A STATISTICAL RE-EVALUATION. EB Faragher, JA Morris, P Nightingale, JD Edwards, AJ Mortimer and MP Shelly

Little consensus of opinion exists as to the form of the relationship between oxygen delivery (DO₂) and oxygen consumption (VO₂) in ARDS. In a review of the literature some studies have found no correlation, whilst others have reported a strong linear relationship; a critical level of DO₂ above which there is a plateau of VO₂ has even been suggested.

In an effort to elucidate the cause of this confusion, data from 20 patients with ARDS were evaluated assuming 6 different relationships between DO₂ and VO₂. Multiple linear regression analysis indicated that between-patient variation was by far the dominant factor irrespective of which relationship was assumed. An algebraic evaluation of the known mathematical coupling between DO₂ and VO₂ revealed an underlying complex relationship involving arterial and mixed venous oxygen saturation, cardiac output and body surface area. These findings have considerable implications for the statistical analysis of the DO₂/VO₂ relationship and dramatically highlight the dangers inherent in combining data from several patients into a single analysis. Improved statistical methods for pooling data to obtain a statistical relationship between haemodynamic variables, and with an increased predictive power for an individual patient, must involve a patient-dependent factor (eg. body surface area). No statistical justification for a plateau level of VO₂ has been found in this or other studies.

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13

AUDIT: A COMPUTERIZED DATABASE TO FACILITATE CLINICAL AUDIT AND WARD MANAGEMENT IN THE INTENSIVE CARE UNIT.

P. Allsop, S. Howlin, A.J. Byrne and A. Hutchinson

Data collection and processing are becoming increasingly more important^{1,2a,2b}. The Nottingham Intensive Care Database enables the collection, storage and processing of data having the inbuilt features of disease classification, calculations, automatic reports and search facilities.

Input includes, patient identifiers, demographic data, diagnoses, admission features (date, time, consultant, source), variables for APACHE II, Injury Severity Score, Admission Severity Score, Trauma Score, Nursing Dependency Category, surgical data, ventilatory data, monitoring, lines, major therapeutic manoeuvres, complications on ITU, outcome and discharge details. Patient records can be tagged for audit and research.

Calculations include APACHE II and outcome prediction³.

Output to screen and hard-copy is designed for both clinical and ward management. It includes simple lists, patient summaries, graphical output, search and sort facilities, case mix complexity, bed occupancy and admission rates.

System requirements IBM compatible, dBase IV.

1. Intensive Care in the United Kingdom: Report from the King's Fund Panel. *Anaesthesia* 1989; vol 44, p 428-31.

2a. Core specification, Case Mix Management System:

2b. Core information Requirements for Acute Resource Management: Pub NHS Management Board.

3. APACHE II: A severity of disease classification system. W A Knaus et al, *Crit Care Med* 1985; vol 13, p 818-29.

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14

A SOFTWARE INDEPENDENT INTENSIVE CARE DATABASE.

C. A. Carter, S. P. Gerrish

The purpose of this study was to design an Intensive Care database that could be used by those with little or no experience of computing and would run 'stand alone', i.e. without requiring the database programming language, on an IBM PC or compatible. dBase IV (Ashton Tate) was chosen as the development language.

The program records personal, referral, diagnostic, treatment and outcome related information and specifically addresses the problems of data security and integrity. The system administrator can set file and record access privileges to prevent unauthorised viewing and or editing of data. Data integrity is ensured by forcing the user to select from a menu of allowable options whenever possible. This technique also ensures consistency of terminology. The available options in the menus can be configured by the system administrator to suit local needs. Diagnoses and complications are recorded using a modification of the W.H.O. ICD-9 codes which allows adequate description but prevents patients being categorised into very small subgroups. The database supports user defined search criteria to locate individual and groups of patients. The criteria are set using a menu system therefore requiring no knowledge of the database language syntax, and can be set using any combination of data in the database. In addition to single dimensional analysis, two dimensional analysis is possible, allowing patients to be cross referenced on two sets of variables.

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Poster Presentations

1

WORK LOAD ASSESSMENT, A SIMPLIFIED APPROACH.
RR Macmillan, RD Griffiths, C Harris, ST Atherton, B Rimmer

Medical audit is intended to measure the quality of care and direct changes in practice that enhance quality. Nurse staffing levels are a major determinant of quality and these levels should correlate with work load. The methodology for determining work load is both poor and complex. Observer bias may affect nursing dependency scores. There is a clear need to be able to compare activity between units and changes that occur due to developments within a particular unit. Ventilated patients are labour intensive. Most modern ventilators have a clock and monthly records of the number of ventilator hours can be acquired within a matter of minutes. These figures could be a useful standard value when investigating patterns of work load. As can be seen there is no direct association between the number of patients and the number of ventilator hours on this ICU over a 6 month period.

Month	No pats	Vent Hrs	Deaths
Sept	24	1277	3
Oct	23	558	6
Nov	39	885	9
Dec	27	1865	5
Jan	25	2225	3
Feb	20	1897	2

The annual number of admissions has been suggested as a criteria to estimate the viability of an Intensive Care Unit, we believe this hypothesis needs to be tested.

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3

OXYGEN DELIVERY AND UPTAKE IN CRITICALLY ILL SURVIVORS AND NON-SURVIVORS

MP Shelly, P Nightingale, AJ Mortimer and JD Edwards

Various studies have demonstrated patterns of oxygen delivery and uptake in subsets of critically ill patients, particularly postoperative patients and those with septic shock. We investigated the pattern in a general Intensive Care Unit patient population.

Patients admitted between 1.9.88 and 31.8.89 who had a pulmonary artery catheter inserted were included. Initial haemodynamic measurements were analysed and patients subdivided into hospital survivors and non-survivors. Haemodynamic records of 113 patients were analysed; there was a 67% mortality (76/113). Preliminary results showed no difference between survivors and non-survivors regarding oxygen delivery (DO₂); mean (SD) 626 (235) vs 516 (269) ml/min.m² and oxygen consumption (VO₂) 117 (27) vs 125 (39) ml/min.m². Cardiac index was significantly higher in survivors; 3.97 (1.39) vs 3.18 (1.59) l/min.m² p<0.05. There was no correlation between VO₂ and DO₂ in survivors (correlation coefficient 0.32) but non-survivors demonstrated supply dependent oxygen consumption (correlation coefficient 0.57).

This study demonstrates a different pattern of oxygen delivery and uptake in surviving and non-surviving patients admitted to a general intensive care unit. This may reflect a high incidence of sepsis in the non-survivors.

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2

INTRAHOSPITAL TRANSPORT FOLLOWING SEVERE BRAIN INJURY

P.J.D.Andrews, I.R.Piper, N.M.Dearden, J.D.Miller.

Patients with brain injury undergoing neuro-intensive care (NIC) often require transport within the hospital for investigations that can only be performed out with the Intensive care unit, such as CT and MRI scans. We report here a prospective clinical study in which multi-modality monitoring was used to determine the effect of intrahospital transport on the incidence, type and severity of secondary physiological insults (occurring after injury) in brain injured patients.

Secondary physiological insults were assessed prospectively in 50 head injured patients requiring intrahospital transfer; 35 were transported from the ICU (mean duration 133 minutes, range 40-420 minutes) and 15 from the Accident and Emergency department (mean duration 123 minutes; range 31-271 minutes). Physiological variables were documented every minute in the four hours before transfer (ICU group only), during transport and for four hours after transfer. Pre-transfer insults were predictive of further insults both during and after transport. There was significant correlation between increased frequency of insults post-transfer (compared to pre-transfer) and high Injury Severity Score (P<0.01). A greater proportion of the patients transported from the Accident department had secondary insults post-transfer (P<0.001). Treatment of raised intracranial pressure (ICP) in the two hours before transport prevented post-transfer ICP insults, in all cases and post-transport insults in 60% of patients. Detection and treatment of raised intracranial pressure is therefore recommended before embarking upon transfer.

The importance of adequate resuscitation prior to moving the patient, particularly in patients with multiple injury, is emphasised.

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4

IS THE THE ADULT RESPIRATORY DISTRESS SYNDROME UNCOMMON IN ENGLAND?

C Clarke, P Nightingale, JD Edwards, AJ Mortimer.

Estimates of the incidence of ARDS vary. Confusingly the reported incidence in England (1) is lower than that in the United States (2). This difference may in part be due to the use of varying diagnostic criteria. As part of a continuing study of ARDS we have investigated its incidence and outcome on a general ICU.

In a 10 month period, 259 patients from all medical and surgical services except cardiothoracic and neurosurgical were admitted to our ICU. Diagnostic criteria for ARDS were a) recognised risk factor b) need for mechanical ventilation c) an inspired oxygen concentration of 50% or more to maintain an arterial oxygen tension of 8 kPa d) measured shunt fraction (Qsp/Qt) of at least 30% e) characteristic radiographic changes. Forty patients have been analysed to date. The mean age was 45 (19-78) and mean APACHE II score was 22 (8-50). Mortality in the series was 62.5%. The mean maximum Qsp/Qt was 40 (30-51) in survivors and 46 (32-61) in non-survivors (p 0.05). The causes of death were sepsis and treatment withdrawal with no patient dying of persistent hypoxia. The 3 patients with multiple organ failure present on admission all died. The incidence of ARDS in our ICU population is 15.4%, considerably higher than reported in the UK literature and falling within the range defined by various incidence studies in the United States.

1. Webster NR, Cohen AT, Nunn JF: Adult respiratory distress syndrome-how many cases in the UK? Anaesthesia 1988; 43:923

2. Fowler AA, Baird M, Eberle D, et al: Adult respiratory distress syndrome: Risk with common predispositions. Ann Intern Med 1983;98:593

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5

Intestinal Permeability in the Critically-ill

Harris C E, Griffiths R D, Shakil O, Freestone N, Billington D, Atherton S, Macmillan RR.

Sepsis and bacteraemia remain an important cause of morbidity and mortality in the critically ill. For a long time the G.I. tract has been recognised as a source of pathogens (Atherton et al, Lancet 1978;ii;968-9). We used a differential sugar absorption test (D.S.A.) to explore whether disturbances in G.I. permeability occur in the critically ill, as increased intestinal permeability has been associated with infection in burned patients (Zeigler et al, Arch Surg 1988;123;1313-9). Eleven critically ill patients admitted for non gastrointestinal problems were studied, APACHE, TISS and sepsis (Elubute et al, Br.J.Surg 1983;70;29-31) scores were recorded daily. Three patients were studied twice with an interval of approximately 7 days between tests. The D.S.A. test comprised 5 gm lactulose and 2 gm mannitol with 22.3 gm glucose in 100 ml water given nasogastrically. Urine samples were taken at 2, 5, 10 and 24 hours after administration of the test solution. To prevent bacterial consumption of the sugars, 20% chlorhexidine was added to the urine catheter bags. Mannitol was measured in the urine using gas chromatography and lactulose was measured using an enzymatic technique.

The results of the five hour recovery of sugars in 14 studies compared with those from 10 normal controls were:

	mannitol(%)	lactulose(%)	L/M ratio
patients (n=14)	12.05 (8.6)	1.72 (1.3)	0.25 (0.3)
controls (n=10)	26.17 (7.7)	0.37 (0.3)	0.015 (0.01)

The lactulose/mannitol (L/M) ratio was significantly different between patients and controls ($p < 0.05$). The use of the L/M ratio corrects for variables unrelated to intestinal permeability, such as gastric emptying or renal function. In some cases abnormal L/M ratios were observed as early as 24 hours after the onset of illness even in the absence of obvious sepsis. Our findings indicate that increased intestinal permeability occurs in I.C.U. patients and it is hoped that further study will show whether this correlates with the incidence of sepsis.

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7

A WITHIN PATIENT COMPARISON OF TWO DIFFERENT CHARCOAL HAEMOPERFUSION COLUMNS FOR ACUTE PHENOBARBITONE POISONING
 I.H.Lewis, M.S. Nielsen and J. Henry

Charcoal haemoperfusion may be indicated in acute phenobarbitone poisoning, particularly in association with very high plasma levels (Vale, A, ABC of Poisoning, Eliminating poisons. Brit. Med. J., 1984, 289: 366-369).

A 42 year old woman was admitted to hospital on two separate occasions as a result of self-poisoning with phenobarbitone. On both occasions she was deeply unconscious with circulatory and respiratory failure. Plasma phenobarbitone levels were also similar at the time of admission (192 mg/l on the first and 220 mg/l on the second). Haemoperfusion was instituted during both admissions. On the first admission a Haemocol column (Smith and Nephew Pharmaceuticals Ltd.) was used and on the second a DHP-1 column (Kuraray Co. Ltd., Japan) was used in preference. It was felt that the carbon bead formulation of the DHP-1 column may offer superior absorption characteristics.

Repeated samples were taken for plasma phenobarbitone estimations on both admissions. These were taken from the extracorporeal circuit, both pre-column and post-column.

The results showed a similar reduction in plasma levels of phenobarbitone over the course of 10 hours with a clinical improvement at similar plasma levels. Mean clearance of drug by the DHP-1 column (109 ml/minute) was almost twice that of the Haemocol (59 ml/minute) for the 2 hour period over which they were compared.

These results support the superior performance of the DHP-1 in vivo, but the similar decline in plasma levels on each occasion suggest that other mechanisms of phenobarbitone clearance played an important role.

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6

LACK OF EFFECT OF ACTH (1-24) IN PORCINE ESCHERICHIA COLI SEPTICAEMIA. M.D.J. Donaldson, C.J. Vesey, M. Wilks, J.D. Watson and C.J. Hinds.

Previous work has shown that ACTH(1-24) rapidly and dose-dependently improves circulatory and respiratory function, as well as increasing survival in experimental models of haemorrhagic shock (Bertolini A. et al, Life Sci 1986; 39: 1271). It is postulated that this effect may be due to physiological antagonism of excessive endogenous opioid activity. In this study we investigated the haemodynamic and metabolic effects of intravenous ACTH(1-24) in porcine E. coli septicaemia. We have previously demonstrated beneficial effects of buprenorphine and naloxone in this model (Donaldson et al, Circ Shock 1988; 25: 209). Animals were anaesthetised with alpha-chloralose and infused with live E. coli over two hours. One hour after starting the infusion a significant fall in cardiac index, mean arterial pressure and pH had occurred, together with a significant rise in mixed venous blood lactate and packed cell volume. Animals were then randomly divided into two groups and received either a bolus of ACTH(1-24) 160ug/kg or an equivalent volume of normal saline, and were monitored for a further three hours.

Treatment with ACTH(1-24) failed to produce any significant changes in cardiac index, mean arterial pressure, pH, mixed venous blood lactate or packed cell volume compared with the control group, nor was there any difference in survival three hours after treatment was given.

In conclusion, ACTH(1-24) did not influence either haemodynamic or metabolic variables nor short-term survival in this model of porcine E. coli septicaemia.

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8

HEAD DOWN TILT: JUGULAR VEIN DIAMETER AND CEREBRAL FUNCTION. DN Sutton, M Nevin, SPK Linter.

Head down tilt of 15-30° is recommended for facilitating internal jugular vein (IJV) cannulation. Reports neither quantify the effects of tilt, nor morbidity. Two studies were carried out to investigate the effect of tilt on IJV diameter and cerebral function.

METHODS: 1. IJV Diameter. Ultra-sound was used to measure IJV diameter in two groups of patients of 5° tilts from level to 30°. Group 1 comprised awake, spontaneously breathing volunteers, Group 2 ventilated patients with no evidence of raised central venous pressure.

2. Cerebral Function. 35 sedated patients presenting for coronary artery grafting were studied using a Cerebral Function Analysing Monitor (CFAM). Continuous recordings were made when level, and when tilted at 30° during IJV cannulation.

RESULTS: 1. IJV Diameter. In the spontaneously breathing group, IJV diameter increased from 5.6mm to 11.7mm (100% increase), with an almost linear increase for each increment of tilt. In the ventilated group, the initial diameter was 8.5mm, increasing to 15mm (80% increase), but with 90% of the change in diameter occurring in the first 10° of tilt, and thereafter little change up to 30°.

2. Cerebral Function. 5 patients showed alterations in CFAM traces at a tilt of 30°. These changes consisted of an opening of the amplitude envelope with a sudden switch to slow wave activity, consistent with episodes of cerebral hypo-perfusion.

DISCUSSION: In the spontaneously breathing group, the linear increase in IJV diameter suggests that a steep head down tilt would facilitate IJV cannulation. However, 14% of the spontaneously breathing patients studied with CFAM showed significant deterioration in cerebral function, and this could be deleterious in patients with already obtunded perfusion, in addition to other hazards such as cardiac dysfunction and haematoma formation etc. In the ventilation group, the initial IJV diameter is 50% greater, but little benefit is gained from tilts steeper than 10°.

CONCLUSIONS: Ventilated patients undergoing IJV cannulation require only 10° of head down tilt. In spontaneously breathing patients, benefit is gained from steeper tilts; this may expose the patient to hazards and can cause cerebral function impairment.

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9

HAEMOGLOBIN OXYGEN AFFINITY IN CRITICALLY ILL PATIENTS

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There is increasing interest in the concept of tissue oxygen delivery. One determining factor is the position of the oxygen dissociation curve which may be defined by the P_{50} .

P_{50} was measured by five point tonometry in 40 consecutive patients admitted to a general intensive care unit. All patients required mechanical ventilation. A normal range for the method was derived in 30 normal volunteers. Ten repeated measurements in one volunteer established the precision of the method. Blood samples were drawn into heparinised syringes and promptly equilibrated at 37°C in an IL237 tonometer with gas at high PO_2 and PCO_2 of 4kPa. PO_2 was then reduced keeping PCO_2 constant and five samples withdrawn over a range of PO_2 from 1.2kPa to 20.5kPa. Samples were analysed for PO_2 and oxygen saturation using an IL 1303 blood gas analyser and linked IL 283 co-oximeter and these values plotted. P_{50} values were determined by interpolation.

The precision of the method was excellent, the coefficient of variation being 2.1%. The reference range for the method used, in the normal controls, was 3-3.5 kPa (Mean 3.27 \pm 2 S.D. and rounded)

The majority of patients had P_{50} values within the reference range. Eight had values above the range, most commonly associated with metabolic acidosis. Two had values below the range, both having had massive transfusions. Recently transfused patients (n=10) had a mean P_{50} significantly lower than non-transfused patients (3.07 vs 3.41, $p < 0.05$) but there was no statistically significant correlation with the total volume of blood transfused.

These results suggest that pathologically increased haemoglobin oxygen affinity is not a common problem in general intensive care patients.

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11

CRITICAL INCIDENTS IN THE INTENSIVE THERAPY UNIT.

D.J. Wright, S.J. Mackenzie

A critical incident in the Intensive Therapy Unit (ITU), is an occurrence which might have led or did lead to an undesirable outcome. By definition it is caused by an error made by staff or failure of equipment and is preventable.

We asked medical and nursing staff in a 6 bedded general ITU to record details on a specially designed form over a 12 month period. During this time 244 patients were admitted to the unit.

144 reports were completed which described 136 critical incidents and these have been analysed. Twenty six (19%) were equipment failures in which ITU personnel did not play a contributing part. This low incidence is similar to that found in studies of critical incidents in anaesthesia. The remaining 110 incidents could be broadly considered under the headings of problems with ventilation (44), problems with vascular lines (21), problems with drug administration and prescription (19) and miscellaneous (26).

A frequently occurring factor in the generation of incidents was poor communication between staff. Regular checking and recording was important in the early detection of incidents and thus in preventing them from having serious outcome.

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10

SPUTUM SCORING FOR DIAGNOSIS OF I.C.U. PNEUMONIA

M. White, D. Phelan, J. Gallagher.

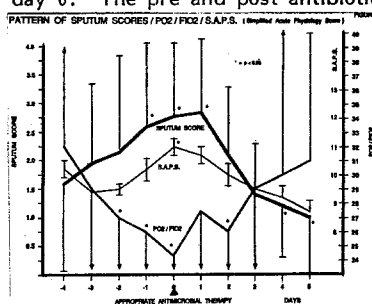
The diagnostic indices of nosocomial pneumonia in intubated Intensive Care Unit (I.C.U.) patients lack sensitivity and specificity. The value of cough and expectoration, seen as cardinal features of pulmonary disease, is questioned. This study evaluated a mechanism of scoring sputum as an index of Ventilator Associated Pneumonia (VAP).

METHOD: All patients admitted to the I.C.U. over a 4 month period who were intubated for > 4 days were prospectively studied upon endotracheal intubation or placement of tracheostomy or cricothyroid minitracheostomy tube. Tracheal suctioning was performed 2 hourly and as required. The sputum score - a composite graded system based on sputum volume and purulence was calculated hourly. Pneumonia was diagnosed and antimicrobial therapy commenced by independent clinicians using standard clinical and radiological criteria. Sputum score was related to gas exchange (pO_2/FiO_2), severity of illness (Simplified Acute Physiology Score (SAPS) leucocyte count and course of antimicrobial therapy.

RESULTS: 20 patients were studied. Time of commencement of appropriate antimicrobial therapy is indicated as day 0. The pre and post antibiotic sputum scores are

depicted and related to gas exchange (pO_2/FiO_2) and SAP score.

COMMENT: The sputum score provides an early diagnostic index of VAP and is a useful marker of response to antimicrobial therapy. It is practical and repeatable and is now incorporated into routine nursing procedures.



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12

INTENSIVE CARE AUDIT: A SIMPLE CLINICAL SEVERITY SCORE AS A PREDICTOR OF OUTCOME.

N.R. Coad A. Moors P. Allsop and A. Hutchinson

APACHE II is a widely used system which is an accurate predictor of in hospital mortality of patients admitted to ICU. This study was designed to evaluate the use of a simple severity score and to compare this with APACHE. 365 admissions to a general ICU were studied. Following admission patient details including the severity score: 1. Expected to die 2. Likely to die, 3. Even chance, 4. Likely to live, 5. Expected to live were collected in a database together with APACHE scores. Eventual outcome was also collected. The overall mortality was 27%. A close correlation between expected and actual outcome using APACHE was confirmed. The Table shows the nos., mortality, and APACHE scores median (10th, 90th centile) in each severity group

severity	No	Mortality(%)	APACHE
1	37	93	18 (8-32)
2	36	58	20 (10-25)
3	76	36	16 (9-22)
4	89	14	13 (6-23)
5	119	4	9 (3-16)

These results confirm the usefulness of APACHE but more interestingly they confirm the high predictability of a simple severity score, despite the wide range of APACHE scores within each group. This study confirms that clinical judgement should retain an important place when assessing likely outcome.

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13

ESOPHAGEAL DOPPLER ASSESSMENT OF LEFT VENTRICULAR FILLING

M Singer, ED Bennett

Measurement of descending aortic blood flow by oesophageal Doppler is a simple and reliable non-invasive technique for continuous monitoring of changes in cardiac output (Crit.Care Med.17:447,1989). It can estimate absolute volumetric cardiac output and provide further information on left ventricular (LV) function. The systolic flow time (FT) of the velocity waveform was affected by alterations in LV filling. This finding was studied in more detail using concurrent pulmonary artery wedge pressure (WP) and cardiac output (CO) measurements during: (i) fluid challenge in hypovolaemic patients (baseline WP<8mmHg, n=21); (ii) preload reduction in patients (n=18) with baseline 'normal' filling (baseline WP:10-15mmHg, post-reduction WP<10); and (iii) progressive preload reduction by intravenous nitrates in patients with LV failure (baseline WP>20mmHg, n=11). The effect of heart rate on FT can be corrected (FT_{corr}) using Bazett's formula, i.e.dividing FT by the square root of the electrocardiographic R-R interval (=cycle time).

Fluid repletion always increased WP, FT_{corr} and CO. Preload reduction to sub-optimal filling levels resulted in falls in WP, FT_{corr} and CO. Conversely, preload reduction in patients with LV failure showed an initial fall in WP but an increase in CO and FT_{corr}. Further preload reduction in 6 of these patients eventually resulted in falls in CO and FT_{corr}. The highest CO achieved corresponded with the longest FT_{corr}.

Left ventricular filling can be assessed non-invasively by the oesophageal Doppler waveform parameter of FT_{corr}. This has application in both diagnosis and management.

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15

FAILURE TO DEMONSTRATE ENTEROHEPATIC CIRCULATION OF NALBUPHINE IN CRITICALLY ILL PATIENTS.

A.R. Manara and G.R. Park.

Nalbuphine exhibits properties that are considered advantageous for a postoperative analgesic. However, the disposition of opioids is altered in critically ill patients and the pharmacokinetic data available for nalbuphine are limited to healthy individuals.

The elimination of nalbuphine was studied in twelve critically ill patients with normal renal function following orthotopic liver transplantation. Plasma, urine, bile and nasogastric fluid samples were collected and analysed for nalbuphine using high pressure liquid chromatography.

The mean (range) elimination half life was 230 min (59.5-493.3), the apparent volume of distribution at steady state was 3.9L/kg (1.55-9.00) and the clearance 17.5 ml/kg/min (6.5-36.0). The amount of nalbuphine excreted in urine ranged from 0.17-6.82% (mean 2.14%) of the total dose administered. The mean elimination half life is similar to that reported in healthy volunteers but this reflected a decrease in both the clearance and the volume of distribution in our patients, probably due to the effects of surgery, anaesthesia and deranged liver function.

An important finding was the high concentration of nalbuphine measured in nasogastric fluid in the presence of low biliary concentrations, suggesting gastrointestinal clearance of the drug. This means that enterohepatic circulation which has been described with other opioids, does not occur with this drug. Future pharmacokinetic studies in critically ill patients should address the possibility of drug clearance by the gastrointestinal tract.

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14

LONG TERM PROGNOSIS AND QUALITY OF LIFE FOLLOWING INTENSIVE CARE FOR LIFE-THREATENING MEDICAL COMPLICATIONS OF HAEMATOLOGICAL MALIGNANCY.

EHS Yau, CJ Hinds.

Hospital mortality rates are high (in the region of 80%) when patients with haematological malignancy develop an acute illness of sufficient severity to warrant admission to an intensive care unit, although for some of these patients intensive care is life-saving (Lloyd-Thomas et al, Br Med J 1988; 296: 1025). There is only limited information, however, on the long term prognosis of those who do survive to leave hospital and the quality of life of survivors has not been assessed. The objective of this study was to evaluate the long term outcome in such patients.

The case notes of all adults admitted to the intensive care unit over the last ten years with life threatening medical complications of haematological malignancy were reviewed retrospectively. 93 patients were admitted during this period of whom 22 (24%) were discharged from the hospital. The median survival time of these patients was 36 months and 9 patients are still alive up to 8 years after discharge from hospital. The quality of life of the 7 patients who are still alive more than one year after discharge from the hospital was assessed using the Nottingham Health Profile, the Hospital Anxiety and Depression Scale and the Perceived Quality of Life Scale. These measures indicate that the quality of life of the surviving patients is generally good, and in some is excellent. 5 have returned to full time work and all seven stated that under the same circumstances they would be prepared to undergo intensive care treatment again.

We conclude that although mortality rates are high in critically ill patients with haematological malignancy, selected cases may survive long term with a good quality of life. This emphasises the importance of attempting to identify those patients most likely to benefit from intensive care.

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16

MUSCLE CARNITINE IN THE CRITICALLY-ILL PATIENT

RD Griffiths, AJM Wagenmakers, P McClelland, IT Campbell, JH Coakley and TR Helliwell.

L-carnitine is necessary for the transport of long chain fatty acids into mitochondria. L-carnitine is synthesised in the liver with muscle containing more than 95% of the body store. Excess carnitine excretion in the urine occurs in patients in negative nitrogen balance presumably due to muscle breakdown. Carnitine is absent from usual parenteral feeds. Deficiency of L-carnitine is described during chronic intermittent haemodialysis. We questioned whether carnitine deficiency could contribute to the muscle necrosis we have previously documented (Helliwell et al. Brit. J. Hosp. Med. 42:140,1989).

54 percutaneous muscle biopsies were taken from 28 patients with a range of critical illnesses (21 in renal failure, 20 septic). Total acid-soluble muscle L-carnitine was measured with a radio-isotopic enzymatic assay after alkali hydrolysis.

L-carnitine content (umol/g wet wt)

	Normal	Non ICU patients	Patients week 1	Patients week 3
mean	2.95	2.62	4.02	3.41
SD(n)	±0.55(12)	±0.70(22)	±1.19(28)	±1.30(9)

In most patients L-carnitine levels were high initially and fell later. There was a significantly consistent decline in carnitine seen after the first few days in patients with renal failure (R=0.41, n=24, p<0.05), and muscle necrosis (R=0.8, n=9, p<0.01). However only in two biopsies with extensive necrosis were the concentrations of L-carnitine significantly below normal. These muscles were oedematous and had lost considerable fibre structure. Deficiency of L-carnitine may not present a problem. Increased L-carnitine accumulation probably reflects the changes in metabolic demand while the subsequent decline is secondary to damage and necrosis and not its cause.

Muscle Research Centre, Department of Medicine, University of Liverpool, L69 3BX, UK. With the Intensive care units at Whiston and Royal Liverpool Hospital and Depts of Anaesthesia and Pathology. We acknowledge the support of Sigma Tau.