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IDENTIFICATION OF FUTILITY IN INTENSIVE CARE

Summary

Rising costs of intensive care and the ability to prolong the life of critically ill patients creates a need to recognise early those patients who will die despite treatment.

We used changes in a modified APACHE II score (organ failure score) to make daily predictions of individual outcome in 3600 patients. 137 patients were predicted to die and of these, 131 (95.6%) died within 90 days of discharge from hospital (sensitivity 23.4%, specificity 99.8%); a false-positive diagnosis rate of 4.4%. 2 of the 6 survivors have subsequently died but 4 are alive with good quality of life. Patients predicted to die stayed 1492 days in intensive care and incurred 16.7% of total intensive care expenditure and 46.4% of the cost of all patients that died. Median survival after a prediction to die was 2 days, accounting for 62% of intensive care patient days in this patient group, giving an effective intensive care cost per survivor of UK pounds 129 651.

If used prospectively, this algorithm has the potential to indicate the futility of continued intensive care but at the cost of 1 in 20 patients who would survive if intensive care were continued

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Introduction

Advances in intensive care have made it possible to prolong the lives of patients with little expectation that they will survive.[1] In some patients, death occurs after a considerable time in the intensive care unit (ICU) or after going to a general ward;[2,3] others may die soon after leaving hospital.[4] Futile treatment is not only costly but also, more importantly, prolongs suffering for patients and families.[5]

Predictive models to identify patients in ICU who will die[6] depend on physiological data obtained at the time of admission or in the first 24 hours. Models such as APACHE II and III,[7,8] SAPS II,[9] and MPM,[10] estimate the probability of death in hospital and allow comparison with actual mortality. Although these models have been validated in the USA, Europe, and elsewhere[11] and appear to calibrate well to different environments and discriminate between patients who survive and those who die, they do not predict outcome in an individual.

We describe a dynamic scoring system based upon daily organ failure scores--APACHE II scores corrected for the duration and number of organs in failure--with an algorithm designed to make daily predictions of individual outcome.

Patients and methods

A patient-management system (Riyadh Intensive Care Program [RICP]; Medical Associated Software House Ltd, London, UK) was used to process data on all patients admitted for more than 8 hours to the 13-bedded adult ICU at Guy's Hospital, London, UK, from May 1990 to Sept 1993. Data were collected prospectively by two specially trained members of staff to provide daily APACHE II scores and the number of organ systems in failure.[12] Specific diagnostic categories were assigned and checked by two intensive care consultants (DB, MS). In all cases, the Glasgow Coma Score was assumed to be normal (15) unless structural brain damage was present or sedation and muscle relaxants had been stopped for at least 7 days.

An algorithm within the system calculated daily organ-failure scores from daily APACHE II scores for each patient with coefficients derived from mortality rates associated with the number and duration of organ systems in failure[12,13] to make individual predictions of death or uncertain outcome. The values of, and changes in, these defined scores that triggered predictions of death had been derived from trend analysis of a cohort of ICU patients described and studied elsewhere.[13,14]

Daily predictions of outcome were not available to the attending physicians and nurses and did not influence treatment. Patients were deemed to have been predicted to die if a fatal prediction was recorded at any time during their ICU stay, even if subsequent predictions were uncertain. Accuracy of a fatal prediction was defined as being a death in hospital (in the ICU, in a general ward, or in another hospital), or within 90 days of hospital discharge.

Records of patients predicted to die who subsequently survived were reviewed. Patients were excluded from analysis if predictions of death were triggered by iatrogenic events (eg, pneumothorax associated with central venous access, inappropriate or inadvertent extubation, discontinuation of continuous renal support in the face of persisting oligoanuric acute renal failure). The quality of life of those patients predicted to die who survived for more than 90 days out of hospital was assessed 6 months after hospital discharge by the Nottingham Health Profile.[15]

Resource use and cost per patient day were derived from individual daily scores with the Therapeutic Intervention Scoring System (TISS)[16,17] recorded by the nursing staff. At Guy's Hospital, the value of one TISS point has been calculated from the [CU running expenditure divided by the number of TISS points accrued during a given period.[18] The TISS point value was constant over the study period at UK pounds 27.00.[15]

Results

3702 patients were admitted to ICU during the 40 months of the study; 3600 stayed more than 8 hours and had daily predictions of outcome recorded (table 1). These patients required 11 216 patient days of intensive care with a mean daily TISS score of 31.0 points per patient day. Cost of

intensive care was UK pounds 10 037 505 and the 560 deaths that occurred accounted for 3393 patient days and 36.8% of the ICU budget (table 2).

Of the 139 patients predicted to die, 2 had their predictions changed. One was inadvertently scored on admission as having a chronic health problem (New York Heart Failure Classification grade IV) when in fact he had recent-onset acute pulmonary oedema as a result of accelerated hypertension; the other deteriorated after elective interruption of renal replacement therapy because of haemorrhage associated with thrombocytopenia (the resulting increases in serum creatinine and potassium led to a prediction of death).

A 10% random sample of records of patients predicted to die and who subsequently went on to die were reviewed. No errors in data collection or evaluation of chronic health status were found and none of the predictions were related to an iatrogenic event.

Of the remaining 137 patients predicted to die, 115 patients died in the ICU, 13 on the general wards, and 2 after transfer to other hospitals (table 3). 1 patient died after 87 days at home, giving an overall sensitivity for the prediction of death of 23.4% (table 4). 6 patients survived, giving a false positive diagnosis rate of 4.6%. 2 have subsequently died (at 548 and 131 days after discharge); 4 are alive with good subjective functional health status (table 5). Those patients predicted to die had a median ICU-stay of 5 days (range 1-98 days) but after a prediction of death, there was a wide range in the length of stay (median 2, range 0-91 days) before death or ICU discharge (table 6). 62% of ICU patient days occurred after a prediction of death.

Patients predicted to die accounted for 1492 patient days (13.3%) and cost UK pounds 1 635 082 (16.7% of total ICU expenditure; 46.4% of costs incurred by nonsurvivors), giving a cost per survivor in this group (total cost of all patients predicted to die [UK pounds 1 635 082]/number of survivors [6]) of UK pounds 272 513. Cost calculated from the day of prediction of death to actual death in ICU (excluding costs of stay on general wards) was UK pounds 777 910, representing ICU cost per survivor of UK pounds 129 651.

Discussion

The RICP algorithm uses daily individual physiological data instead of data obtained at admission or in the first 24 hours of the ICU. Little or no emphasis is placed on specific diagnostic category (other than diabetic ketoacidosis which is treated as a special case) since organ failure score represents standard daily APACHE II scores corrected only for the number and duration of organ systems in failure. The model assumes a physiological threshold which, once breached, is associated with certain death; it does not generate a probability.

Conceptually, this is quite different from systems which are designed to allocate probabilities of survival or death based on static analysis of group data. The RICP algorithm assumes that individual mortality threshold varies according to age and previous chronic ill-health. Surgery and other interventions may produce transient physiological disturbances that breach the threshold but these are often readily reversible, eg, the patient who improved when put back on renal support. Accurate data collection and entry are crucial and particular attention needs to be given to the Glasgow Coma Score since it is so heavily weighted in the APACHE II score. We assumed that patients had normal neurological function unless they had obvious brain damage.

The original APACHE II validation used hospital discharge as the end-point as did the first description of RICP. After studies on outcome after cardiopulmonary resuscitation,[20,21] however, it has become clear that some patients die soon after hospital discharge; accordingly we took 90 days

after hospital discharge as our survival end-point.

Our results suggest that predictions of death based upon the algorithm within the RICP are highly specific but not particularly sensitive; only 23% of hospital deaths were identified by the system with little potential impact on reducing ICU stay in those patients who died early on, in contrast to initial reports of 50% sensitivity when RICP was first developed. Others have reported a sensitivity as low as 14-8%[22] with the implication that the system would save few ICU bed days. One factor might be that amongst patients not predicted to die there may be some in whom an error in scoring resulted in the failure to predict death. Correcting for this would increase the sensitivity, but the main point of interest remains the number of patients who survive following a prediction to die. Whilst it might be possible for RICP to make more accurate predictions of death by introducing new discriminant variables (eg, cardiac output or gastric intramucosal pH), this should not be at the expense of increasing the false positive diagnosis rate.

Another consideration is the local practice of withdrawing treatment. The report of RICP from Cardiff[22] was associated with a treatment-withdrawal rate of 55%, whereas in Riyadh where it was developed, treatment was seldom if ever withdrawn. At Guy's Hospital, during the study, withdrawal of treatment was at the discretion of two consultants in intensive care in consultation with the patient's relatives and the admitting physician or surgeon, and accounted for 20% of all deaths. Early treatment withdrawal reduces the time available for the system to detect a deteriorating physiological state and predict death, but if this deterioration has not yet occurred, it begs the question of why treatment is withdrawn in the first place. Clinicians identify different groups of hopelessly ill patients using criteria other than deteriorating physiology. These include age, perceived premorbid functional health status, admission diagnosis, and the intensity of treatment required to maintain stability. Nevertheless, unlike the RICP, there is little information concerning sensitivity, specificity, and rate of false-positive diagnoses with a clinical approach.

The use of any predictive system in ICU will have costs and benefits. Costs, apart from the purchase of the system and staff wages are false predictions of death; benefits are a reduction in the suffering of those for whom treatment is futile. Less importantly, there would also be better use of resources, as less would be expended on patients who subsequently die.

Discussion about the degree of predictive error that is deemed "acceptable" reflects the value placed upon an individual human life in particular cultures or societies. Moreover, attitudes appear to differ between the withdrawal of treatment, compared with its initiation, and this is particularly the case concerning patient selection for major surgery. Some patients are denied potentially lifesaving procedures (albeit with a high risk) and many are denied any access to intensive care.[23] Nevertheless, wherever resources are limited, expenditure on one group of patients necessarily prevents expenditure on another. From our study, it is expensive to treat patients predicted to die in the ICU (UK pounds 129 651 per survivor).

How might such a system be used in practice? A prediction of death would not necessitate withdrawal of treatment by the physician responsible; it would simply draw attention--like any other diagnostic test--to the patient's poor prognosis and after checking for data entry errors, the situation could be discussed in a more informed fashion with the patient's family and treatment withdrawn only if and when a consensus was reached that this was in the patient's best interest. Use of such a system to influence decisions to withdraw treatment might cost the lives of 1 in 20 patients who would otherwise survive with a reasonable quality of life. Whilst this model may require some further refinement and validation in other settings, we believe the challenge remains to identify hopelessly ill

patients who cannot benefit from further intensive care.

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Table 1: **Details of study cohort**

	All	Predicted to die	90-day post-hospital discharge survival following prediction to die
Numbers of patients			
All	3600	137	6
Males	2462	90	5
Females	1138	47	1
Mean age (years)	58.5	61.2	64.2
Significant categories			
Non-operative	1212	99	4
Post-operative-elective	2137	19	2
-emergency	251	19	0
Source of admission			
Operating theatres	2366	38	2
Recovery	22	2	0
Ward transfers	416	41	2
Hospital transfers	341	44	2
Emergency room admissions	455	12	0
APACHE II (first 24 h following admission to ICU) mean (SD)	14.8 (6.35)	25.9 (6.79)	28.3 (6.28)
Risk of death (derived from above) mean % (SD)	15.01 (17.52)	47.51 (25.47)	42.57 (28.04)

Table 2: **Cost and ICU stay of study cohort**

	Number of patients	Total patient days	Total ICU costs (UK pounds)
Admissions	3 600	11 216	10 037 505
All deaths	560	3 393	3 693 801
Predicted to die	137	1 492	1 635 082

Table 3: **Outcome for patients predicted to die**

Patient outcome	Number of patients
Died in ICU	115
Died in wards at Guy's Hospital	13
Died in wards at another hospital	2
Died within 90 days following hospital discharge	1
Survived 90 days following hospital discharge	6
Total	137

Table 4: **Accuracy of predictions in study cohort**

	Actual dead	Actual alive	Total
Number of patients			
Predicted to die	131	6	137
Outcome uncertain	429	3034	3463
Total	560	3040	3600

Sensitivity	23.4%
Specificity	99.8%
False-positive diagnosis rate	4.4%

Table 5: **Nottingham Health Profile Scores at six month assessment for patients surviving following prediction to die (%)**

Patient no	Energy	Pain	Emotional reaction	Sleep	Social Isolation	Physical mobility
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	12.9	0	34.3	0	0
4	24	0	9.8	12.6	0	0
5	0	0	0	0	0	0
6	0	8.96	0	34.3	0	0

(Scores are percentage for each dimension of the assessment--low scores represent subjective perception of good quality of life.)

Table 6: **Costs and ICU stay for patients predicted to die**

For patients predicted to die	Effective cost per survivor (UK pounds)	ICU stay (days) median (range)	ICU cost (UK pounds) median (range)
From admission to ICU death or ICU discharge	272 513	5 (1-98)	7457 (702-82 437)
From prediction to ICU death or discharge	129 651	2 (0-91)	1566 (0-72 798)

References

1 Ridley S, Jackson R, Findlay J, Wallace P. Long term survival after intensive care. BMJ 1990; 301: 1127-30.

- 2 Rowan KM, Kerr JH, Major E, McPherson K, Short A, Vessey MP. Intensive Care Society's APACHE II study in Britain and Ireland--I: variations in case mix of adult admissions to general intensive care units and impact on outcome. BMJ 1993; 307: 972-77.
- 3 Rowan KM, Kerr JH, Major E, McPherson K, Short A, Vessey MP. Intensive Care Society's APACHE II study in Britain and Ireland--II: outcome comparisons of intensive care units after adjustment for case mix by the American APACHE II method. BMJ 1993; 307: 977-81.
- 4 Murray LS, Teasdale GM, Murray GD, et al. Does prediction of outcome alter patient management? Lancet 1993; 341: 1487-91.
- 5 Ruark JE, Raffin TA. Initiating and withdrawing life support. N Engl J Med 1988; 318: 25-30.
- 6 Chang RSW. Individual outcome prediction models for intensive care units. Lancet 1989; i: 143-46.
- 7 Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13: 818-29.
- 8 Knaus WA, Wagner DP, Draper EA, et al. The APACHE III prognostic system. Risk prediction of hospital mortality for critically ill hospitalized adults. Chest 1991; 100: 1619-36.
- 9 Le Gall JR, Lemeshow S, Saulnier E Development of a new scoring system, the SAPS II, from a European/North American Multicenter Study. JAMA 1993; 270: 2957-63.
- 10 Lemeshow S, Teres D, Klar J, Avrunin JS, Gehlbach SH, Rapoport J. Mortality probability models (MPM II) based on an international cohort of intensive care unit patients. JAMA 199:3; 270: 2478-86.
- 11 Sirio CA, Tajimi K, Tase C, et al. An initial comparison of intensive care in Japan and the United States. Crit Care Med 1992; 20: 1207-15.
- 12 Knaus WA, Draper EA, Wagner DP, Zimmerman J. Prognosis in acute organ system failure. Ann Surg 1985; 202: 685-93.
- 13 Chang RWS, Jacobs S, Lee B. Predicting outcome among intensive care unit patients using computerised trend analysis of daily APACHE II scores corrected for organ system failure. Int Care Med 1988; 14: 558-66.
- 14 Chang RWS, Jacobs S, Lee B, Pace N. Predicting deaths among intensive care unit patients. Crit Care Med 1988; 16: 34-42.
- 15 Hunt SM, McKenna SP, McEwen SP, Williams J, Papp E. A quantitative approach to perceived health status. J Epid Comm Health 1980; 34: 281-86.
- 16 Cullen DJ, Civetta JM, Briggs BA, Ferrara LC. Therapeutic intervention scoring system: a method for quantitative comparison of patient care. Crit Care Med 1974; 2: 57-60.
- 17 Keene RA, Cullen DJ. Therapeutic intervention scoring system: update 1983. Crit Care Med 1983; 11: 1.
- 18 Chang RWS, Beale R, Smithies M, Bihari D. A preliminary cost performance evaluaton of HA-1A (Centoxin) with an addendum on its demise. Clinical Intensive Care 1993; 4: 208-16.

- 19 Smithies MN, Bihari DJ, Chang RWS. Scoring systems and the measurement of ICU cost effectiveness. Reanimation Urgences 1994; 3 (2): 495-97.
- 20 Bedell SE, Delbanco TL, Cook EF, Epstein FH. Survival after cardiopulmonary resuscitation in the hospital. N Engl J Med 1983; 309: 567-76.
- 21 Gulati RS, Bhan GL, Horan MA. Cardiopulmonary resuscitation of old people. Lancet 1983; ii: 267-69.
- 22 Jacobs S, Arnold A, Clyburn PA, Willis BA. The Riyadh Intensive Care Program applied to a mortality analysis of a teaching hospital intensive care unit. Anaesthesia 1992; 47: 775-80.
- 23 Campling EA, Devlin HB, Hoile RW, Lunn JN. The report of the National Confidential Enquiry into Perioperative Deaths 1991/1992. NCEPOD, 1993.

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