

## ORIGINAL ARTICLES

## Analysis of intensive care populations to select possible candidates for high dependency care

J V Pappachan, B W Millar, D J Barrett, G B Smith

### Abstract

**Objectives**—To identify the proportion, and range across intensive care units, of intensive care patients who might potentially be managed on a high dependency unit (HDU) using three different classification systems.

**Methods**—8095 adult patients admitted to 15 intensive care units in the south of England between 1 April 1993 and 31 December 1994 were studied. Patients were identified as potential HDU admissions if their APACHE III derived risk of hospital mortality was  $\leq 10\%$ , if they were categorised as a low risk monitor (LRM) patient using the Wagner risk stratification method, or if they did not require advanced respiratory support (ARS).

**Results**—4146 patients (51.2%) had an APACHE III derived risk of hospital death of  $\leq 10\%$ , 1687 (20.8%) were classified as LRM, and 3860 (47.7%) did not receive ARS. The values for each intensive care unit ranged from 32.8–63.3% (APACHE III group), 7.2–29.9% (LRM group), and 14.4–68.2% (ARS group). No matter which of the three methods was used, there were significant differences between the 15 units ( $p < 0.0001$ ) with regard to the number of potential HDU patients identified within the scored population.

**Conclusions**—The percentage of intensive care patients who might be more appropriately managed in a HDU varies considerably between hospitals, and depends upon both local circumstances and the method used to define a high dependency patient. However, whichever method is used, it appears that significant numbers of patients of low dependency status currently fill intensive care beds in the units studied. If these analyses are correct, the perceived national shortage in intensive care beds might be improved by the development of HDUs.

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**Keywords:** high dependency care; intensive care; triage; patient selection

In the USA and the UK critically ill patients appear to have a better outcome if admitted to intensive care units directly from the accident and emergency (A&E) department,<sup>1,2</sup> in comparison with those from general wards. In the UK in particular, some critically ill patients will be admitted to general wards from the A&E department because of the lack of high dependency or intensive care beds.

Opinions vary concerning the use and provision of high dependency or intensive care beds.<sup>3-12</sup> At present only approximately 15% of UK hospitals possess a high dependency unit (HDU),<sup>13,14</sup> yet studies from individual hospitals have suggested that up to 40% of patients currently admitted to an intensive care unit might be more appropriately managed in a HDU if one was available.<sup>3,9,10,12,15</sup> Although these estimates generally rely upon subjective assessments of the need for HDU care, several objective methods have been described.<sup>3,11,16,17</sup>

Kilpatrick *et al* have suggested that patients may be safely nursed on a HDU if their predicted hospital mortality, derived using the acute physiology and chronic health evaluation II (APACHE II) scoring system,<sup>18</sup> is  $\leq 10\%$ .<sup>3</sup> This mortality prediction assumes that the patient is managed on an intensive care unit and may not be valid if the patient is nursed on a HDU instead.<sup>19</sup>

Wagner *et al* have described an alternative method which uses a risk stratification system.<sup>16</sup> Intensive care unit admissions are categorised into active treatment, high risk monitor (HRM), and low risk monitor (LRM) groups; the distinction between HRM and LRM is made using the predicted risk of receiving active intensive care unit type treatment ( $>10\%$  for the HRM group and  $<10\%$  for the LRM group). Wagner *et al* suggest that LRM patients, who by definition have low intervention and low mortality rates, could be appropriately placed in a HDU. Some of the active treatment modalities, identified as requiring intensive care unit admission in the USA, can, in our opinion, be managed in a less dependent area in the UK and, therefore, Wagner's technique may not be transferable. In the UK, patients who do not require advanced respiratory support (ARS)—for example nasotracheal or orotracheal intubation, mechanical ventilatory support (excluding mask continuous positive airways pressure (CPAP) and

Department of  
Intensive Care  
Medicine, Portsmouth  
Hospitals NHS Trust,  
Queen Alexandra  
Hospital, Portsmouth  
PO6 3LY  
J V Pappachan  
G B Smith

Critical Audit Ltd,  
St George's Hospital  
Medical School,  
Cranmer Terrace,  
London  
B W Millar

School of  
Mathematical Studies,  
University of  
Portsmouth,  
Portsmouth  
D J Barrett

Correspondence to:  
Dr Smith, Director of  
Intensive Care Medicine.

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Table 1 The list of 31 unique intensive care type interventions referred to by Wagner.<sup>16</sup> Numbers 1 to 4 represent ARS as defined by the authors

1. Controlled ventilation with intermittent or continuous muscle relaxants	17. Pressurised blood transfusion
2. Controlled ventilation with or without PEEP	18. Haemodialysis, stable patient
3. Assisted respirations or intermittent mandatory ventilation	19. Haemodialysis, unstable patient
4. Nasotracheal or orotracheal intubation	20. Atrial or ventricular pacing
5. Induced hypothermia	21. Intra-aortic balloon assist
6. Barbiturate anaesthesia	22. Vasoactive drug infusion
7. Continuous arterial drug infusion	23. Continuous antiarrhythmic infusion
8. Ventriculostomy	24. After cardiac arrest (48 hours)
9. Mannitol infusion	25. Cardioversion
10. Treatment of seizures	26. Emergency cardiocentesis
11. Treatment of metabolic encephalopathy	27. Complex metabolic balance
12. Spontaneous PEEP or CPAP	28. Balloon tamponade of varices
13. Active treatment of metabolic balance	29. Nasogastric lavage
14. Fresh tracheostomy (within 48 hours)	30. Emergency endoscopy
15. Emergency bronchoscopy	31. IV replacement of excess fluid loss (>6 l/day)
16. Emergency operative procedure	

non-invasive, for example mask, ventilation)—are often nursed on HDUs.

We postulated that the number of intensive care unit patients who might be classified as

Table 2 Demographic data for the scored patients in the South West Thames database in the period studied and the corresponding values for the North American APACHE III database

Patient characteristics	South West Thames database	American APACHE III database
No of patients	8095	17440
Sex (%)		
Male	58.7	44.8
Female	41.3	55.2
Age in years (mean and range)	60.3 (16–101)	59 (16–113)
<45 (%)	20.5	23.2
45–65 (%)	29.7	28.8
66–85 (%)	46.8	42.7
>85	2.9	5.3
Severe comorbidities before admission (%)	7.9	13.0
Operative status (%)		
Non-operative	55.3	57.7
Operative		
Elective	27.0	33.3
Emergency	17.7	9.0
Severity of illness (average first day)		
APACHE III score	56.2	50
≤ 10% predicted risk of death (%)	51.0	63
> 90% predicted risk of death (%)	2.3	2.3
Outcome (%)		
Average ICU mortality	17.6	9.2
Length of stay (days)		
Average ICU length of stay	4.8	4.9
Treatment level (%)		
Active treatment	71.0	54.0
HRM	8.2	11.0
LRM	20.8	35.0
Patients not receiving advanced respiratory support (%)	50.0	*

\*No data available. ICU = intensive care unit.

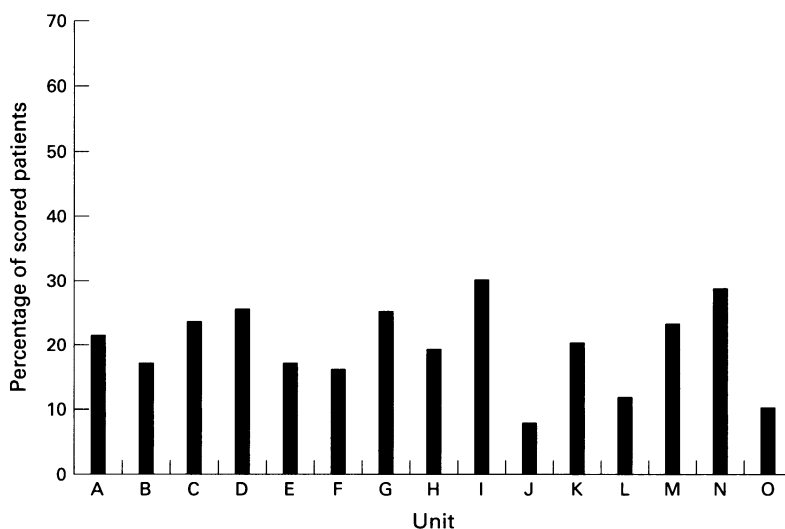


Figure 1 Percentage of scored patients with a ≤10% risk of hospital mortality as assessed by the APACHE III predictive algorithm.

potential HDU admissions would vary between units and might depend upon the classification method employed. The aim of this retrospective observational study was to estimate the proportion of intensive care patients from 15 units that might have been cared for on a HDU by using the three methods outlined above.

## Methods

All admissions to 15 intensive care units (labelled A to O) in the Western Division of the South Thames Regional Health Authority and the Portsmouth Health District were studied between 1 April 1993 and 31 December 1994. Four of these units (J, K, N, and O) were pure general intensive care units while the remaining 11 served as mixed intensive and coronary care units with patients from both categories being nursed in the same floor area. In 10 of these, coronary care patients were managed by general physicians, whereas in the remaining unit (I) the intensive care unit consultants took responsibility for the management of all patients on the unit. The coronary care unit patients admitted to unit I were included in the APACHE III analysis.

An identical system of data collection (Ward Watcher © software) and central analysis (Critical Audit Ltd) was used in all intensive care units. An assessment of risk of hospital death was made for each patient using the APACHE III scoring system<sup>20</sup> unless they (a) were aged under 16 years; (b) had a diagnosis of primary burns injury; (c) died within four hours of intensive care unit admission; or (d) had been admitted to intensive care units A–H and J–O because either a separate coronary care or theatre recovery unit did not exist or was not available in the hospital concerned.

For each patient scored using the APACHE III system, demographic data including age, gender, diagnosis, reason for admission (that is, medical, elective surgical, or emergency surgical), pre-existing co-morbidity, intensive care unit length of stay, hospital length of stay, and actual hospital outcome were recorded. Data were further analysed by Critical Audit Ltd, using algorithms supplied by Apache Medical Systems Inc, to subdivide admissions into active treatment, HRM, and LRM groups. Table 1 lists active treatment tasks as defined by Wagner *et al.*<sup>16</sup>

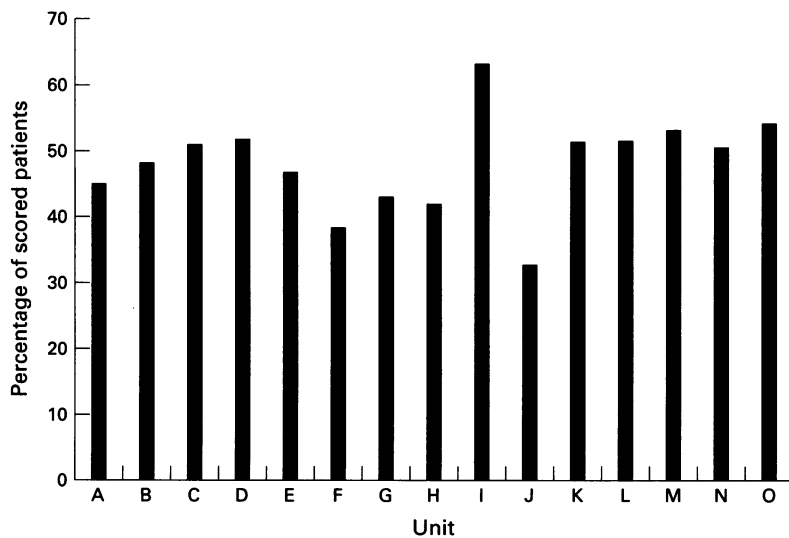


Figure 2 Percentage of scored patients in the LRM group.

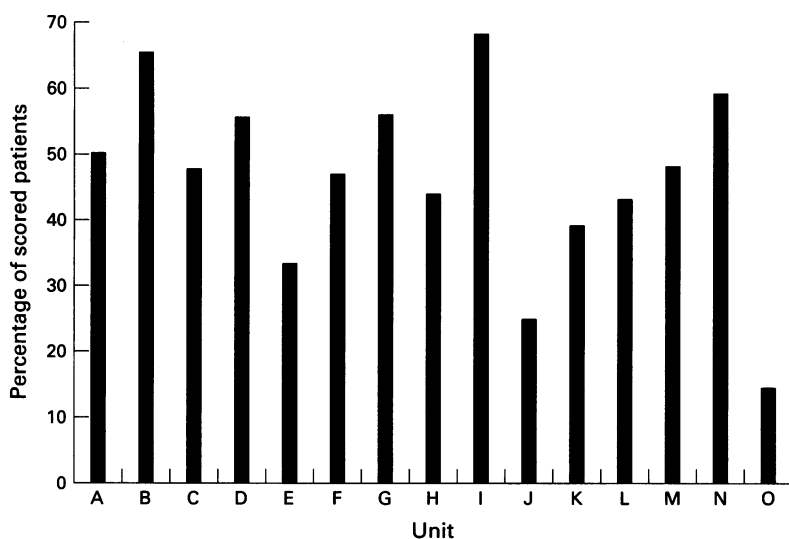


Figure 3 Percentage of scored patients not receiving ARS.

We then identified those scored patients who required ARS. This was defined as the need for mechanical ventilatory support (excluding mask CPAP and non-invasive, for example mask, ventilation), nasotracheal or orotracheal intubation.

The number of intensive care units admissions in each centre which might have been cared for in an HDU environment were then quantified using three different criteria: (a) those with a  $\leq 10\%$  risk of mortality using the APACHE III system (Apache III group); (b)

those with a  $< 10\%$  risk of requiring intensive care unit type interventions as described by Wagner *et al*<sup>16</sup> (LRM group); and (c) those not receiving ARS.

### Results

A total of 15 717 patients were admitted to the 15 intensive care units studied. Altogether 7622 patients were excluded from APACHE III analysis; of these 89.7% (6837) had been admitted to the unit because either a separate coronary care or theatre recovery unit did not exist or was not available in the hospital concerned. The percentage of patients excluded varied between 10.3% (unit K) and 83.6% (unit A).

Eight thousand and ninety five patients (51.5%) had a prediction of hospital mortality derived using the APACHE III system and this group can be regarded as representing the "true" intensive care population. The means of the raw and derived data from the group are shown in table 2.

Overall, the percentage of the 8095 scored intensive care unit patients who might have been suitable for HDU care was 51.2% (APACHE III group), 20.8% (LRM group), and 50.0% (ARS group). The values for each intensive care unit are shown in figs 1–3 and ranged from 32.8–63.3% (APACHE III group), 7.2–29.9% (LRM group), and 14.4–68.2% (ARS group). The rank order of units varied depending upon the method used to identify potential HDU patients. Unit J admitted the lowest number of potential HDU patients when admissions were ranked on the basis of APACHE III risk of mortality and LRM. In contrast, unit I admitted the highest number of potential HDU patients when admissions were ranked using any of the three methods.

Individual data from each of the 15 intensive care units are shown in table 3.

There were statistically significant differences between the 15 intensive care units with respect to the percentage of scored patients admitted for medical reasons (mean 55.3%, range 37.5%–78.7%;  $p < 0.0001$ ) and after elective (mean 27%, range 11.3%–40.6%;  $p < 0.0001$ ) and emergency operations (mean 17.7%, range 10%–34.4%;  $p < 0.0001$ ). For the purpose of this analysis we used the definitions of medical and surgical admissions in the APACHE III scoring system.<sup>20</sup> We also showed

Table 3 Details of admissions to the 15 intensive care units studied describing the numbers admitted and scored, the number with a hospital mortality as predicted by APACHE III of  $\leq 10\%$ , those in the LRM group, and those not receiving ARS

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Admissions	1217	658	667	1454	572	1628	234	884	1488	445	435	1399	1981	1461	1194
Excluded	1018	242	188	957	253	1033	106	683	223	58	45	890	1565	174	187
Scored	199	416	479	497	319	595	128	201	1265	387	390	509	416	1287	1007
No in LRM group	43	71	112	126	53	94	32	38	378	28	77	58	96	371	100
%	21.5	17.0	23.4	25.3	16.6	15.8	25.0	18.9	29.9	7.2	19.7	11.4	23.0	28.8	9.9
No with $\leq 10\%$ risk of hospital mortality	90	201	244	259	149	229	55	84	801	127	202	264	222	651	547
%	45.2	48.3	50.9	52.1	46.7	38.5	43.0	42.0	63.3	32.8	51.8	51.9	53.4	50.6	54.3
No not receiving ARS	100	273	229	277	106	279	72	88	863	95	153	219	200	761	145
%	50.3	65.6	47.8	55.7	33.2	46.9	56.2	43.8	68.2	24.5	39.2	43	48.1	59.1	14.4

a significant difference between the numbers of patients excluded from APACHE III analysis in each unit ( $p < 0.0001$ ). In addition, no matter which of the three methods was used, there were significant differences between the 15 units ( $p < 0.0001$ ) with regard to the number of potential HDU patients identified within the scored population.

### Discussion

The inappropriate placement of high dependency patients in intensive care beds may lead to an increase in costs, greater numbers of patient transfers between intensive care units, delays in transferring critically ill patients from A&E units, and the cancellation of major routine surgery.<sup>6-8</sup> However, most methods of identifying HDU patients from within the intensive care unit population are subjective which may make categorisation invalid. A small number of publications suggest specific objective criteria,<sup>3 11 16 17</sup> but these may also produce differing estimates.

Henning *et al* used an acute physiology score  $\leq 10$ ,<sup>17</sup> but this technique fails to recognise the important contribution of diagnosis to the risk of mortality. Furthermore it lacks discrimination because there is considerable overlap in the degree of physiological derangement between ward and intensive care patients.<sup>21 22</sup> Kilpatrick *et al* used an APACHE II derived mortality prediction of  $\leq 10\%$  as the arbiter for selection of HDU patients.<sup>3</sup> This technique may overestimate the true number of patients who could safely be transferred from an intensive care unit,<sup>5</sup> because the APACHE II predictive equation assumes that subsequent care will be in an intensive care unit and not an HDU.<sup>19</sup> Wagner *et al*<sup>16</sup> described a risk stratification method which, if employed in the UK, might underestimate the number of HDU patients within an intensive care unit, because some of the interventions considered to require intensive care unit admission in the USA could be managed safely in a less dependent area. Moreover, some are esoteric and are infrequent treatment modalities on a general adult intensive care unit in the UK.

Other publications have used the number and chronicity of failing organs, or the requirement for organ support, as indicators of the need for HDU or intensive care unit admission.<sup>11 23-25</sup> Common to all is the view that patients requiring ARS (mechanical ventilation with or without intubation) should be admitted to an intensive care unit. For this reason, we proposed that patients who do not require ARS might be suitable for high dependency, rather than intensive, care. Nevertheless, we recognise fully that a small number of patients, requiring only basic respiratory support, might need intensive care unit admission for other reasons.

All three methods tested in our study are flawed as arbiters of the requirement for intensive care over time. The APACHE III method and the LRM technique of Wagner *et al* estimate the need for intensive care based on the severity of illness within the first 24 hours of intensive care unit admission. The third method used in our study stratified patients

according to their need for ARS at any point during intensive care unit admission and may therefore have overestimated the true requirement for intensive care facilities. These flaws may be corrected when augmented care period data become available.<sup>26</sup> This method, recently devised by the NHS Executive, is likely to provide information regarding the number of intensive care unit bed days occupied by high dependency patients.

We have shown that the percentage of intensive care unit patients who might be better managed in a HDU varies considerably between hospitals and with local circumstances. However, this figure also depends heavily upon the method used to define a high dependency patient. Overall, 4146 (51.2%) intensive care admissions had a risk of hospital mortality of  $\leq 10\%$ , 1687 (20.8%) fell into the LRM category, and 3860 (47.7%) did not require ARS. Using these figures, the number of scored intensive care unit patients who would be classed as high dependency patients ranges from 1687 to 4146. Alarming, this would classify between 59% and 75% of our original population of 15717 patients (7622 of which were not scored) as potential HDU admissions. Equally concerning is the discovery that six of the 15 intensive care units studied (that is units A, B, E, G, H, and M) appear to admit fewer than 200 "true" intensive care patients per annum and are clearly already working predominantly as HDUs, if one adopts the classification proposed by the Intensive Care Society.<sup>24</sup> At the other end of the spectrum, unit O scored 1007 of 1194 patients (84.3%) admitted during the study period, and, of these, 862 (85.6%) required ARS.

It is estimated that, in the UK, approximately 10 000 transfers of critically ill patients occur annually, many simply because of a lack of intensive care facilities in the base hospital.<sup>27</sup> In addition, many patients requiring postoperative intensive care have surgery postponed because intensive care beds are unavailable.<sup>28</sup> Possibly more worryingly, the proportion of intensive care patients who are admitted directly from A&E is significantly smaller than in the USA (23.5% *v* 35.8%)<sup>2</sup> and this may be a contributing factor to the apparent excess hospital mortality observed when intensive care practice in southern England is compared with that in the USA.<sup>2</sup> This admission of ill patients from an A&E department to a general ward may be the understandable result of an absence or relative deficiency of high dependency or intensive care beds in a hospital, but it is recognised that such patients may receive substandard care which may contribute to increased morbidity and mortality.<sup>29</sup>

The finding that approximately 50% of scored patients in 15 intensive care units in the south of England might require only high dependency care could suggest that the UK possesses adequate numbers of intensive care beds, but that their correct use is often hampered by a lack of high dependency facilities. The solution almost certainly involves a combination of actions. Intensive care beds,

which are used predominantly for high dependency care, should be reclassified and restaffed as high dependency beds. In addition, intensive care beds should be redistributed to those hospitals that already cancel a significant number of major acute surgical procedures and/or undertake many interhospital transfers because of a lack of local intensive care resources, after ensuring that these are not the same hospitals that fill intensive care beds with HDU patients. There may also need to be an expansion of HDUs to cater for the significant number of patients on the general wards who might also benefit from this level of care<sup>4</sup> and who have not been considered by our study.

We would like to thank the Directors and staff of the intensive care units of the South West Thames Intensive Care audit group for their permission to use data from their units.

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