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A simplified acute physiology score for ICU patients

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We used 14 easily measured biologic and clinical variables to develop a simple scoring system reflecting the risk of death in ICU patients. The simplified acute physiology score (SAPS) was evaluated in 679 consecutive patients admitted to eight multidisciplinary referral ICUs in France. Surgery accounted for 40% of admissions. Data were collected during the first 24 h after ICU admission. SAPS correctly classified patients in groups of increasing probability of death, irrespective of diagnosis, and compared favorably with the acute physiology score (APS), a more complex scoring system which has also been applied to ICU patients. SAPS was a simpler and less time-consuming method for comparative studies and management evaluation between different ICUs.

The purpose of the acute physiology score (APS or APACHE) is to facilitate multicenter studies and reliable outcome comparisons in patient groups of similar pathology. APS is calculated from 34 physiologic measurements. A value of 0 to 4 is assigned to each variable according to its degree of abnormality, and the APS is the sum of the assigned weights for all measurements recorded. Although APS is generally accepted as a reliable estimate of severity of illness in individual patients,[1] variations in the mean number of data collected per patient may introduce a systematic bias in patient scoring[2] because missing values are interpreted as normal. It seems appropriate, therefore, to select a standardized subgroup of routinely available measurements which would give unbiased results.

METHODS

The simplified acute physiology score (SAPS) variables were specifically selected to evaluate, directly or indirectly, the majority of systemic failures encountered in ICU patients (Table 1). All the SAPS data were collected during the first 24 h after ICU admission. Variables reflected simple and routine ICU measurements. For variables measured repeatedly during this period, only the most abnormal value was used.

Thirteen values, plus age, were selected. Age was considered because we thought it would be an important predictive factor. Like the other variables, it was assigned a range of 0 to 4. However, in order to be certain that we had not underestimated its importance, SAPS was also recalculated using a double weight for age (0 to 8).

A fixed value of 3 was assigned to ventilated patients, rather than the alveolar-arterial oxygen tension difference ($P[A-a]O_2$) value used in APS. All remaining variables were scored from 0 to 4.

The APS and SAPS were calculated in each of 679 unselected patients from eight ICUs, using data collected in the first 24 h after admission. Forty percent of patients had undergone surgery, whereas 30% were hospital transfers. Receiver operating characteristic (ROC) curves were drawn for APS, SAPS, SAPS recalculated with $P(A-a)O_2$ in ventilated patients, and SAPS recalculated with a double-weight value for age. An ROC curve[3] depicts the relation between true positives (number of predicted deaths/number of deaths) and false positives (number of predicted deaths/number of survivors) for each score. This method compares scores without fixing arbitrary cut-off points. The sensitivity (proportion of true positives) and the specificity (1 minus proportion of false positives) were calculated for the two scores at the cut-off point giving the best Youden index,[4] i.e., the fewest false positives for the most true positives.

RESULTS

A good correlation was found between ICU mortality and SAPS. Mortality increased from 0 to 80% with increasing SAPS (Table 2). Sensitivity and specificity were 0.56 and 0.82, respectively, for APS at a cut-off of 14 points and 0.69 and 0.69 for SAPS at a cut-off of 12 points. The predictions of SAPS and APS differed in 126 patients. The correct prediction was given by SAPS in 81 patients and by APS in 45 patients ($p < .001$). There was no significant difference between ROC curves for each score (Fig. 1).

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TABLE 1. Scoring values for the 14 variables of SAPS

Variable SAPS Scale	4	3	2	1	0	1	2	3	4
Age (yr)					≤45	46–55	56–65	66–75	>75
Heart rate (beat/min)	≥180	140–179	110–139		70–109		55–69	40–54	<40
Systolic blood pressure (mm Hg)	≥190		150–189		80–149		55–79		<55
Body temperature (°C)	≥41	39.0–40.9		38.5–38.9	36.0–38.4	34.0–35.9	32.0–33.9	30.0–31.9	<30.0
Spontaneous respiratory rate (breath/min)	≥50	35–49		25–34	12–24	10–11	6–9		<6
or									
Ventilation or CPAP								Yes	
Urinary output (L/24 h)			>5.00	3.50–4.99	0.70–3.49		0.50–0.69	0.20–0.49	<0.20
Blood urea (mMol/L)	≥55.0	36.0–54.9	29.0–35.9	7.5–28.9	3.5–7.4	<3.5			
Hematocrit (%)	≥60.0		50.0–59.9	46.0–49.9	30.0–45.9		20.0–29.9		<20.0
White blood cell count (10^3/mm^2)	≥40.0		20.0–39.9	15.0–19.9	3.0–14.9		1.0–2.9		<1.0
Serum glucose (mMol/L)	≥44.5	27.8–44.4		14.0–27.7	3.9–13.9		2.8–3.8	1.6–2.7	<1.6
Serum potassium (mEq/L)	≥7.0	6.0–6.9		5.5–5.9	3.5–5.4	3.0–3.4	2.5–2.9		<2.5
Serum sodium (mEq/L)	≥180	161–179	156–160	151–155	130–150		120–129	110–119	<110
Serum HCO_3 (mEq/L)		>40.0		30.0–39.9	20.0–29.9	10.0–19.9		5.0–9.9	<5.0
Glasgow coma score					13–15	10–12	7–9	4–6	3

TABLE 2. Relation between SAPS and ICU mortality rate

SAPS	No. of Patients	Mortality Rate (%)[a]
4	64	—
5–6	56	10.7 ± 4.1
7–8	75	13.3 ± 3.9
9–10	103	19.4 ± 7.8
11–12	106	24.5 ± 4.1
13–14	70	30.0 ± 5.5
15–16	81	32.1 ± 5.1
17–18	43	44.2 ± 7.6
19–20	28	50.0 ± 9.4
≥21	53	81.1 ± 5.4

[a] Mean ± SD.

Respiratory rate in spontaneously breathing patients, or a fixed value of three points in ventilated patients, adequately replaced $P(A-a)O_2$ values and thus did not modify SAPS efficiency. As anticipated, age proved to be an important predictive factor; most deaths in low scores were old patients, whereas survivors in the high scores were young. The double weighting for age did not improve SAPS efficiency.

The SAPS was far less time-consuming. A trained data collector or ICU nurse took only about 1 min to collect the relevant data, compared to 6 min for APS. Although at least seven values were unavailable in 70% of APS patients, the data were complete in 50% of SAPS patients and a maximum of three values was missing from each of the remaining 50%.

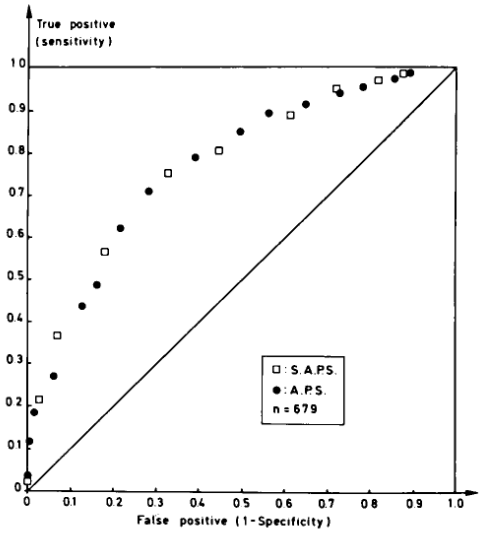

FIG. 1. Receiver operating characteristic (ROC) curves drawn at different cut-off values for SAPS and APS. There is no significant difference between the two curves.

DISCUSSION

The APACHE or APS proposed by Knaus et al.[5] has proved to be adequate in multicenter and international studies. However, because it is both complex and time-consuming, it is not used routinely by many ICU teams.

In an attempt to simplify APS, we initially tried a discriminant analysis of the 34 variables, to test their influence on mortality with a multiple linear regression. Several subgroups of five or six variables had the same discriminant power. However, each of these subgroups reflected only one or two physiologic systems. We therefore selected the 13 most easily measured variables, found in 90% of patients in the APS survey.[2] These variables covered most physiologic systems.

SAPS may have a wider application in replacing

specific scoring systems. A recent study[6] using APS and SAPS to evaluate patients with gastrointestinal disease and hepatic failure showed an excellent correlation with mortality. The similarity of the two ROC curves for SAPS and APS is a strong argument for the simpler scoring system. Moreover, retrospective studies[7] using SAPS have shown that all requisite variables, including the Glasgow coma score, one venous blood sample and a clinical evaluation, are readily obtainable from medical records in most ICUs. Because fewer biologic measurements are necessary for SAPS than for APS, SAPS causes less discomfort to the patient and is less expensive.

However, SAPS has its limitations. It is calculated from the worst value during the first 24 h of ICU admission, a period when unforeseen events may be the major determinant of outcome. This could explain deaths of patients with a low SAPS.

APS and SAPS were both designed specifically to classify patients into groups of comparable probability of death. Whereas one can confidently predict a 40% mortality for a patient subgroup with a SAPS of 17, it is impossible to identify individual survivors or nonsurvivors. SAPS and APS should not, therefore, be used for individual prognosis or treatment decisions.

CONCLUSION

A simple standardized scoring system such as SAPS, valid for a majority of pathologies, would largely eliminate the need for specific scoring systems, thereby facilitating inter-ICU comparisons of treatment and management. Although SAPS cannot replace highly specific scoring systems such as those used for burn patients or patients with myocardial infarction, it is an efficient indicator of mortality over a wide range of pathologies. However, further prospective multicenter studies are required to test the reliability of SAPS in specific pathologies. Although it is possible to improve a score by changing the variables, modifying weights, and including information on previous health status or diagnosis, this also complicates the score and hence prohibits its routine application. However, although no score is without limitations, the SAPS has the advantage of being simple, inexpensive, and reliable.

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