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Short- and long-term outcomes of older patients in intermediate care units

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Abstract *Objective:* To evaluate short- and long-term outcomes of elderly patients (≥ 65 years) treated at an intermediate care unit (IMCU) and to identify outcome predictors. *Design and setting:* Prospective observational study in the IMCU of a university teaching hospital. *Participants:* We studied 412 patients over 8 months, classified into three groups: under 65 years (control group, $n = 158$), 65–80 ($n = 186$), and > 80 ($n = 68$). *Measurements:* At admission: APACHE II, TISS-28 first day, Charlson Index, diagnosis, and prior Barthel Index. Outcome measures: in-hospital mortality, length of stay, discharge destination, and 2-year mortality and readmissions. Data analysis included multivariate logistic regression and receiver operating characteristics area under the curve (ROC AUC). *Results:* No statistically significant differences between groups were observed in hospital mortality (14.1%), discharge to a long-term facility (2.7%), or 2-year readmissions (1.2 ± 2.1). However, hospital stay was longer in patients aged 65–80 years (14 vs.10 days) and 2-year mortality was higher in those 65 or over (34% vs.10.6%). In the overall series in-hospital mortality was predicted by APACHE II, first-day TISS-28, and diagnosis (ROC AUC 0.81), and 2-year mortality by Charlson Index and age (ROC AUC 0.77). In the elderly patients 2-year mortality was predicted by Charlson and Barthel indices (ROC AUC 0.70). *Conclusions:* Illness severity and therapeutic intervention at admission to IMCU were predictors of short-term mortality, whereas the strongest predictor of long-term mortality was comorbidity. Our results suggest that comprehensive assessment of elderly patients at admission to IMCUs may improve outcome prediction.

Keywords Prognosis · Aged · Aged, 80 years and over · Prospective studies · High-dependency unit

Introduction

Intermediate care units (IMCUs), also called step-down units or high-dependency units, attempt to provide appropriate resources to a subset of critically ill patients who do not require all the resources of a full intensive care unit (ICU) but need more care than that available in general wards [1]. An increasing number of elderly patients are being treated in these units [2, 3], but little is known about their previous functional status, comorbidity, severity of illness, and short- and long-term outcomes. This information is important in clinical practice when deciding whether to resuscitate, to initiate major organ support (e.g., mechanical ventilation, renal dialysis), and to transfer the patients to an ICU. Some studies in critical care units suggest that increasing age contributes to poorer outcome [4, 5], whereas others show that severity of the illness at admission is a better prognostic indicator [6, 7]. Nevertheless, studies addressing this subject in IMCUs are scarce. De Silva et al. [8] reported that increased age in a high-dependency unit was associated with poorer outcome in terms of physiological dysfunction measured by the Logistic Organ Dysfunction System score. Brooks [9] found, however, that older and sicker patients reported higher levels of satisfaction with their resulting quality of life. More recently, Ip et al. [10] concluded from their study of 150 unselected critically ill medical patients older than 70 years that high-dependency care for elderly patients is worthwhile.

The primary objective of this study was prospectively to evaluate short- [11] and long-term mortality in elderly patients admitted to an IMCU in comparison with younger patients. We also assessed other outcomes such as length of hospital stay, discharge destination, and hospital readmissions. It was hypothesized that prognosis in elderly patients depends more on severity of illness, comorbidity, previous functional status, and therapeutic intervention than on chronological age.

Methods

Setting

Hospital de la Santa Creu i Sant Pau comprises a 600-bed acute care center, a 30-bed ICU, and a 20-bed IMCU. The multidisciplinary IMCU is adjacent to the ICU. Patients are admitted to the IMCU from the emergency department, acute hospital wards, ICU, or directly from other hospitals. All patients in the sample required high-dependency care that could not be provided in a general ward, including intensive nursing care (e.g., hourly observation, continuous electrocardiographic monitoring), and active intervention (e.g., inotropic agents, noninvasive mechanical ventilation) or invasive monitoring (e.g., arterial or central venous catheter). Organ support such as invasive mechanical ventilation and renal dialysis was performed occasionally, mainly in patients receiving chronic therapy and those awaiting a ICU bed. More complex forms of life support were not usually provided.

Patients

We prospectively studied 412 patients admitted to the IMCU during daytime hours on weekdays between March and October 2000 (mean age 64.6 ± 17.5 years, 158 aged under 65 and 254 aged 65 or over; 65% men). Admissions were from the emergency department in 80.1% of cases, hospital wards in 8%, ICU in 6.6%, and other hospitals in 5.3%. Patients were categorized according to their age as follows: under 65, 65–80, and over 80 years; there were no statistically significant differences between the three age groups in admission source. Table 1 shows patients' baseline characteristics and diagnoses. It was not possible to enroll all patients because of logistic

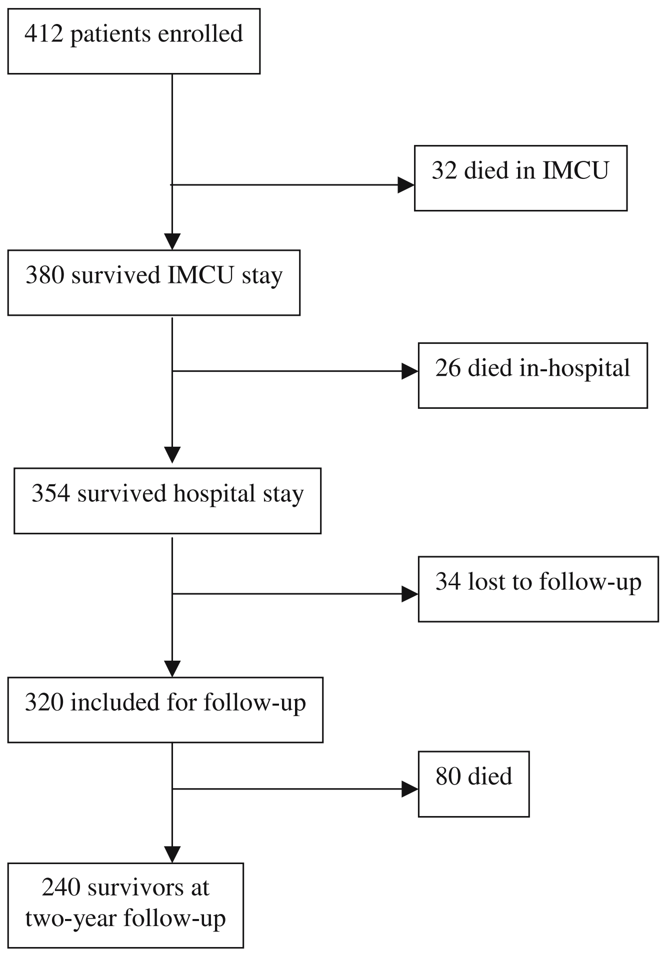

Fig. 1 Follow-up process

Table 1 Patient characteristics

	< 65 years ($n = 158$)	65–80 years ($n = 186$)	≥ 80 years ($n = 68$)	p
Age (years)				≤ 0.001
Mean ± SD	47.1 ± 14.1	73.0 ± 4.5	85.0 ± 3.3	
Median	51	73.2	84.5	
95%CI	44.9–49.3	72.4–73.7	84.2–85.9	
Barthel Index				≤ 0.001
Mean ± SD	95.2 ± 17.6	89.6 ± 19.4	79.7 ± 29.5	
Median	100	100	95	
95%CI	92.4–98.0	86.8–92.5	72.6–86.8	
Charlson Index				≤ 0.001
Mean ± SD	1.5 ± 2.1	2.1 ± 1.8	2.1 ± 1.7	
Median	1	2	2	
95%CI	1.2–1.9	1.9–2.4	1.7–2.5	
APACHE II				≤ 0.001
Mean ± SD	9.8 ± 5.9	14.1 ± 5.7	15.1 ± 6.7	
Median	9	13	13	
95%CI	8.8–10.7	13.3–15.0	13.4–16.7	
APACHE II without age points				0.285
Mean ± SD	8.1 ± 5.8	8.8 ± 5.7	8.9 ± 6.7	
Median	7	8	7	
95%CI	7.1–9.0	8.0–9.6	7.3–10.6	
TISS-28, first day				0.013
Mean ± SD	18.7 ± 8.1	20.5 ± 7.9	20.2 ± 6.9	
Median	17	19	18	
95%CI	17.4–20.0	19.3–21.6	18.5–21.9	
Diagnosis (%)[a]				
Coronary syndrome	22.2	24.2	20.6	0.814
Heart failure	6.3	16.1	14.7	0.013
Gastrointestinal bleeding	1.9	5.4	5.9	0.193
Trauma	12.7	2.2	5.9	≤ 0.001
Stroke	12.0	10.8	8.8	0.811
Respiratory disease	3.8	5.9	4.4	0.680
Sepsis	7.0	7.5	7.4	1.000
Overdose	11.4	2.2	0	≤ 0.001
Postsurgery	5.1	8.1	11.8	0.193
Other	17.7	17.7	20.6	0.833

[a] See explanation in the ESM

constraints; at nights and on weekends there was only a single staff physician on duty and a high turnover in nursing shifts. Patients admitted several times during the study were followed only on their first admission. Age, sex, in-hospital mortality, and length of stay of the included patients were compared with the other 1,183 patients treated in the IMCU in 2000 who were not included in the study, and we found no statistically significant differences (see Table E1, electronic supplementary material, ESM). The follow-up process is outlined in Fig. 1.

Data collection

Data collected at the time of IMCU admission by the attending physician were: age, sex, origin, Acute Physiology and Chronic Health Evaluation (APACHE) II score [12], ability to perform basic activities of daily living 15 days prior to hospital admission, comorbidity, and diagnosis. The principal diagnosis or main reason for IMCU admission was coded as one of ten diagnostic categories: coronary syndrome, heart failure, gastrointestinal bleeding, trauma, stroke, respiratory disease, sepsis, overdose, postsurgery, or other (see explanation of the diagnostic coding in the ESM). Data about ability to perform basic activities of daily living were self-reported and gathered from information obtained at a structured interview conducted at the IMCU admission between patients, and/or their relatives, and the attending physician. The Therapeutic Intervention Scoring System (TISS-28) [13] was administered by the attending nurse. Evaluation at admission followed predetermined protocols, and all staff involved in the study had been trained in this. A separate group of trained clinician-researchers (O.H.T., E.F. and V.L.) conducted a detailed review of hospital records for IMCU and in-hospital mortality, length of IMCU and hospital stay for survivors, and discharge destination.

Two years later readmissions and postdischarge mortality were determined from medical records and/or telephone questionnaire. Thirty-four patients (8.3%) were lost to follow-up.

Measurements

Severity of illness was measured using the APACHE II scoring system [12], which was designed to characterize severity of illness in critical care patients. This includes three types of data collected during the first 24 h after admission: worst value for physiological variables, age, and the presence of severe chronic illness. Scores can range from 0 to 71, with higher scores indicating more severe illness. Therapeutic intervention was determined in the first 24 h after admission using TISS-28 [13]. This scoring system enables quantitative comparisons of patient care and can help in allocating resources. Points are assigned for specific interventions in the critical care unit over a 24-h period and range from 1 to 4. Higher values are given for more specialized, critical or life-sustaining activities. Dependency in basic activities of daily living was scored using the Barthel Index [14], which measures the capacity to perform ten basic activities and gives a quantitative estimation of the patient's level of dependency, scoring from 0 (totally dependent) to 100 (totally independent). This index has been proposed as the standard for clinical and research purposes [15]. The Charlson Index was used as a comorbidity index. It scores from 1 to 6 for 18 specific medical diagnoses, representing increasing levels of illness. Scores have been shown to be correlated with long-term survival following acute medical illness [16].

Analyses

Descriptive statistics for continuous variables were expressed as mean ± standard deviation, 95% confidence interval (CI) for the mean, and median. The Kruskal-Wallis test was used to compare groups, and Fisher's exact test and the χ^2 test were used for categorical variables. Spearman rank correlation coefficient was applied to determine significant correlations between parameters. Multiple logistic regression with forwards stepwise selection was used to determine prognostic factors of hospital mortality, length of stay, long-term destination at discharge, and 2-year readmission and mortality, adjusted for patients' characteristics (APACHE II, TISS-28 first day, Charlson score, Barthel Index, diagnosis, age, and sex). Colinearity was examined using a variance inflation factor [17] and condition indexes. Age was centered on its mean to reduce collinearity [17]. The entry criterion for the multivariate model was $p \leq 0.05$. We defined cutoff points for the length of stay variables to create a binary dependent variable: 3 days for IMCU stay and 12 days for hospital stay. These cutoff points were chosen because they were the median values for the variables. Furthermore, based on our clinical experience, these levels corresponded to usual stays vs. longer and/or complicated IMCU and hospital stays. The receiver operating characteristics (ROC) area under the curve (AUC) was used to assess models discrimination. Tests were two-tailed, and statistical significance was set at the $p \geq 0.05$ level. The SPSS/Win statistical package (version 10.5) was used for all the analyses (SPSS, Chicago, Ill., USA).

Results

Table 2 shows the outcomes in each of the three age groups. No differences between groups were observed in IMCU length of stay (3.6 ± 6.3 days, 95% CI 2.9–4.2, median 3) or number of readmissions 2 years later (1.2 ± 2.1, 95% CI 1–1.4, median 0). There were also no statistically significant differences in outcomes, including IMCU mortality (7.8%), in-hospital mortality (14.1%), and discharge to a long-term care center (2.7%; data not shown). However, differences in hospital length of stay and 2-year mortality did differ significantly. As indicated in Table 2, it is of interest that 2-year mortality clearly differed between younger (< 65) and older patients (≥ 65; (10.6% vs. 34%, $p \leq 0.001$), but between the two older age groups ($p = 0.302$). Hospital stay was longer for patients aged 65–84 years (14 vs.10 days, $p = 0.004$).

Multivariate logistic regression studies

Results of multivariate logistic regression studies and the ROC AUC are shown in Table 3. For IMCU and in-hospital mortality the logistic regression model showed APACHE II and TISS-28 first day as strong predictors ($p \leq 0.01$). Diagnosis was also included in the model, and the diagnosis of stroke was a significant predictor ($p \leq 0.03$). The only protective factor for IMCU mortality was the Barthel Index ($p = 0.048$). Mortality 2 years after discharge was predicted by the Charlson Index and age ($p \leq 0.001$). These models showed good discrimination (ROC AUC 0.77–0.88). Good discriminant performance was also shown by the prediction model for discharge to a long-term facility (ROC AUC 0.80). Higher independence in activities of daily living measured by Barthel Index was a protective factor for discharge to a long-term facility ($p = 0.003$), whereas a higher score in TISS-28 first day was a predictor for discharge to a long-term facility ($p = 0.047$).

The analyses were repeated in the elderly patients (≥ 65 years), and similar results were found. However, when 2-year mortality was analyzed, age was not sig-

Table 2 Outcomes

	< 65 years	65–80 years	≥ 80 years	p
IMCU length of stay (days)				0.163
Mean ± SD	3.1 ± 3.2	4.3 ± 8.8	2.9 ± 2.3	
Median	2	3	2	
95% CI	2.6–3.6	2.9–5.6	2.3–3.5	
In-hospital length of stay (days)				0.017
Mean ± SD	13.9 ± 14.2	18.2 ± 19.7	13.6 ± 13.7	
Median	10	14	9	
95% CI	11.6–16.3	15.1–21.3	9.9–17.3	
Readmissions at 2 years				0.203
Mean ± SD	1.3 ± 2.4	1.3 ± 1.8	0.9 ± 1.8	
Median	0	1	0	
95% CI	0.8–1.7	1.0–1.6	0.4–1.5	
IMCU mortality (%; $n = 32/412$)	5.1	8.1	13.2	0.112
In-hospital mortality (%; $n = 58/412$)	10.1	15.1	20.6	0.105
Long-term facility (%; $n = 11/354$)	1.4	3.2	7.5	0.097
Two-year mortality (%; $n = 80/320$)	10.6	33.5	37.5	≤ 0.001

Table 3 Results of the logistic regression analyses (*OR* odds ratio)

Predictors	OR (95% CI)	p	AUC (95%CI)
IMCU mortality			0.88 (0.82–0.93)
APACHE II	1.17 (1.09–1.24)	≤ 0.001	
TISS-28	1.08 (1.03–1.13)	0.002	
Barthel Index	0.98 (0.97–0.99)	0.048	
Diagnosis[a]	–	0.021	
Stroke	8.90 (2.20–36.3)	0.002	
In-hospital mortality			0.81 (0.75–0.87)
APACHE II	1.10 (1.05–1.15)	≤ 0.001	
TISS-28	1.08 (1.04–1.12)	≤ 0.001	
Diagnosis[a]	–	0.017	
Stroke	3.47 (1.31–9.16)	0.012	
Long-term facility at discharge			0.80 (0.68–0.92)
Barthel Index	0.97 (0.96–0.99)	0.003	
TISS-28	1.08 (1.00–1.16)	0.047	
Two-year mortality (after discharge)			0.77 (0.71–0.82)
Charlson Index	1.47 (1.27–1.71)	≤ 0.001	
Age	1.05 (1.02–1.07)	≤ 0.001	
Two-year mortality (including in-hospital mortality)			0.79 (0.74–0.84)
Age	1.03 (1.01–1.05)	0.001	
APACHE II	1.06 (1.01–1.10)	0.008	
Barthel Index	0.99 (0.98–1.00)	0.051	
Charlson Index	1.35 (1.18–1.54)	≤ 0.001	
TISS-28	1.05 (1.02–1.09)	0.001	

[a] Only variables significantly related to the dependent variable; details on the other nine categories of the variable diagnosis are given in the ESM

nificant. We found 2-year mortality after discharge to be predicted by the Charlson Index ($p = 0.001$) and Barthel Index ($p = 0.020$; ROC AUC 0.70). Table 4 compares the results of logistic regression analyses in patients aged under 65 and those aged 65 years or older. Models for IMCU and in-hospital length of stay, and 2-year readmissions showed only fair to moderate discrimination (see Tables E2 and E3, ESM).

Discussion

Our results emphasize the importance of comprehensive assessment for IMCU patients to estimate prognosis more accurately and to avoid decisions based on age. Among the variables that we examined the indicators which maximized prognostic sensitivity and specificity were severity of illness and therapeutic intervention at admission for

Table 4 Results of the logistic regression analyses by age

Predictor	OR (95% CI)	*p*	AUC (95%CI)
Patients < 65 years			
IMCU mortality			0.91 (0.78–1.03)
APACHE II	1.36 (1.17–1.57)	≤ 0.001	
In-hospital mortality			0.88 (0.80–0.97)
APACHE II	1.15 (1.03–1.27)	0.008	
TISS-28	1.10 (1.02–1.18)	0.017	
Charlson Index	1.34 (1.05–1.71)	0.011	
Long-term facility at discharge			0.98 (0.95–1.00)
Barthel Index	0.91 (0.82–1.02)	0.107	
TISS-28	1.35 (0.92–1.97)	0.123	
Two-year mortality (after the discharge)			0.80 (0.67–0.93)
Charlson Index	1.73 (1.33–2.26)	≤ 0.001	
Two-year mortality (including in-hospital mortality)			0.83 (0.74–0.91)
APACHE II	1.12 (1.04–1.21)	0.003	
Charlson Index	1.67 (1.33–2.10)	≤ 0.001	
Patients ≥65 years			
IMCU mortality			0.84 (0.77–0.92)
APACHE II	1.13 (1.05–1.22)	0.001	
TISS-28	1.06 (1.00–1.13)	0.026	
Barthel Index	0.98 (0.96–0.10)	0.034	
Diagnosis[a]	–	0.049	
Stroke	7.51 (1.63–34.52)	0.010	
In-hospital mortality			0.79 (0.71–0.87)
APACHE II	1.10 (1.03–1.16)	0.004	
TISS-28	1.07 (1.02–1.12)	0.003	
Diagnosis[a]	–	0.007	
Stroke	4.35 (1.37–13.88)	0.013	
Long-term facility at discharge			0.60 (0.40–0.81)
Barthel Index	0.98 (0.96–1.00)	0.058	
Two-year mortality (after discharge)			0.70 (0.62–0.77)
Charlson Index	1.37 (1.15–1.65)	0.001	
Barthel Index	0.98 (0.97–0.99)	0.020	
Two-year mortality (including in-hospital mortality)			0.72 (0.66–0.79)
APACHE II	1.06 (1.01–1.11)	0.027	
Barthel Index	0.98 (0.97–0.99)	0.013	
Charlson Index	1.25 (1.06–1.48)	0.007	
TISS-28	1.05 (1.01–1.09)	0.012	

[a] Only variables significantly related to the dependent variable; details on the other nine categories of the variable diagnosis are given in the ESM

short-term outcomes while the strongest predictor of long-term mortality was comorbidity. The only outcome in which age showed an impact was long-term mortality. This effect was not observed in the elderly subgroup (those 65 years old or over).

IMCU mortality in our study was 7.8% and in-hospital mortality 14.1%. Although mortality was higher in older patients, the differences were not statistically significant. The mortality rate during hospitalization is comparable to the 17.6% reported by Porath et al. [18] in a medical IMCU with similar mean disease severity as measured by APACHE II (12.9 vs. 12.6 in our study). However, to our knowledge, mortality rates in elderly patients in IMCUs have not been reported previously, with the exception of the unselected group of critical patients 70 years old or over reported by Ip et al. [10] in a medical geriatric high-dependency unit. They found mortality 1 month after discharge from the hospital to be 48%.

Severity of illness scoring systems have been established to predict outcomes, specifically in ICU patients [12]. Ip et al. [10] reported a close correlation between APACHE II and short-term mortality in elderly patients treated in a medical high-dependency unit. In accordance with this finding, our study confirms APACHE II as an independent predictor for short-term mortality in adults.

Originally designed as a measure of illness severity, TISS has proven a reliable measurement of resource use in ICU patients. It has been used in IMCUs to differentiate between intensive care and high-dependency patients and to identify nursing skill requirements [19]. Wakefield et al. [20] reported that higher intervention TISS scores were significantly associated with 30-day mortality in a surgical high-dependency unit. In our study TISS-28 first day was also a predictor of short-term mortality.

The 2-year cumulative mortality rate in our series was 33.5% (20.9% in patients < 65 years and 45.6% in those ≥ 65 years). The only study to date on long-term outcomes in a high-dependency unit reported a 6-month cumulative mortality of 49.6% in medical patients of a similar age, but severity was higher than in our population (mean age 65 ± 16 years, mean APACHE II score 17.8 ± 8). Age was suggested as an important predictor, but only univariate analysis was performed [21]. Previous multivariate analyses of long-term mortality after ICU discharge have identified predictors such as age [5, 6, 7, 20], severity of illness [5, 7, 22, 23, 24], diagnosis [5, 7], prior functional status [6, 23, 24, 25], comorbidity [25], and immunocompromised state [23]. However, the value of chronological age as a predictor is controversial because some authors have found no association with long-term mortality in adults [24] or very elderly patients [22], and others have stated that the contribution of age in predicting survival is relatively low compared with the contribution of acute physiology or diagnosis [7]. In our study there were significant differences between younger and elderly (≥ 65 years) IMCU patients regarding long-term survival after discharge, but not between the two elderly groups (65–84 vs. ≥ 85 years). Thus in the overall series comorbidity and age were independent predictors for long-term mortality after discharge; however, age was not a significant predictor among elderly patients. In this population 2-year mortality was predicted by comorbidity and a lower Barthel Index. The importance of functional status for long-term survival in the elderly population has already been clearly established [6, 23, 24, 25].

Higher independence in activities of daily living measured by the Barthel Index was a protective factor not only for 2-year mortality but also for discharge to a long-term facility. To our knowledge, there are no studies in IMCU addressing the value of preadmission functional status as an outcome measure. However, in critical care units poor functional status has been reported to be related to poor short-term [4, 23, 26] and long-term [6, 24, 25] outcome and to lower chance of being discharged home [26]. In contrast in the very elderly population, Kass et al. [22] reported that preadmission functional status was not correlated with ICU or with 1-year mortality rates.

Our study has certain limitations. First, the study population was limited to a single community hospital with a relatively small number of patients. Multicentric studies in IMCUs are difficult because of the marked variations in the roles and capabilities of IMCUs internationally and even within individual hospitals. Second, our study population was heterogeneous, including postoperative and posttraumatic groups who carry a better prognosis [12]. For this reason we entered the possible confusing variable "diagnosis" in our analyses. From a practical viewpoint we were interested in the prognosis of the elderly patients as a group and in the conditions in which they were attended at IMCUs rather than the prognosis of the different subgroups of elderly patients. Third, because of logistic constraints it was not possible to enroll all the patients during the study period, and this may introduce a bias. Nevertheless, we compared our patients with the nonstudy patients admitted to the IMCU throughout 2000 (Table E1, ESM) and observed no statistically significant differences. Thus we consider our sample representative of the patients admitted to the IMCU. Furthermore, the observational study design could have introduced a preadmission bias: perhaps only the elderly patients with suspected good-prognosis were admitted to IMCU. To avoid this bias we adjusted outcomes not only for severity of illness, therapeutic intervention, and diagnosis but also for comorbidity and functional status. Finally, decisions such as admission to the ICU or initiation of organ support depended on the decision of the attending physician, thus having an impact on patient outcome. Moreover, information on the aggressiveness of treatment delivered after hospital discharge was not available; the oldest patients and those with higher dependency in activities of daily living may have received less aggressive treatment.

The strengths of our study, on the other hand, include its prospective design, the attempt to standardize a complete evaluation of patients admitted to IMCU, the detailed characterization of our patients in the different age groups, and, especially, the long-term follow-up of patients admitted to IMCU with a high degree of completeness (91.7%).

In conclusion, the contribution of age in predicting prognosis in elderly patients is relatively small compared with that of the four indices analyzed (APACHE II, first-day TISS-28, Charlson Index, Barthel Index). Such information may aid physicians in clinical decision making without overestimating risk related to chronological age. Future studies are required to evaluate prognosis in IMCUs, to examine how older age affects outcomes, and to provide objective analysis in this complex group of patients.

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