Mortality and Outcomes in Very Elderly Patients 90 Years of Age or Older Admitted to the ICU

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BACKGROUND: We evaluated the clinical characteristics and factors associated with mortality in very elderly patients ≥ 90 y of age admitted to the ICU. METHODS: We evaluated age-specific rates of admission and mortality in 16,935 subjects ≥ 18 y old and retrospectively analyzed the clinical data of 155 (0.92%) subjects ≥ 90 y old admitted to the ICU from January 2003 to July 2012. The clinical mortality index was defined as the ICU mortality rate associated with clinical risk factors including poor nutrition, do not resuscitate (DNR) order, pneumonia, chronic renal failure, cancer, mechanical ventilation, use of a vasopressor, and admission from a ward. RESULTS: The mortality rate of ICU subjects ≥ 90 y of age was 32.3%. A Cox's regression hazard model revealed that high glucose ($P = .006$), poor nutrition ($P = .001$), high Simplified Acute Physiology Scoring II scores ($P < .001$), DNR order ($P = .002$), and vasopressor treatment ($P = .03$) were independent predictive factors of mortality in subjects ≥ 90 y of age admitted to the ICU. An increasing number of clinical risk factors was associated with progressively higher mortality rates. All subjects with more than 5 risk factors died. CONCLUSIONS: The very elderly subjects (≥ 90 y) admitted to the ICU had a higher mortality rate compared with subjects of other ages. High Simplified Acute Physiology Scoring II scores, poor nutritional status, high glucose, use of vasopressors, and DNR orders should be considered as important predictors of mortality in very elderly ICU patients. The level of ICU treatment should be carefully considered in very elderly patients presenting with 5 or more risk factors. *Key words: elderly; outcomes; critical care; mortality; nutritional status.* [Respir Care 2015;60(3):347–355. © 2015 Daedalus Enterprises]

Introduction

The world population is aging due to declines in both mortality and childbirth rates.[1-3] Older people require more medical services than younger people because of the higher rates of functional impairment and chronic morbidity.[1-4] Consequently, the number of very elderly patients admitted to the ICU with acute illnesses is increasing.[1-3] A study in Australia and New Zealand found an annual increase of 5.6% in the number of ICU patients over 85 y.[1] Although age is thought of as a strong prognostic factor for critical care, some studies have included other predictive factors such as severity of illness, reason for admission, and underlying condition as well.[1,5-11] However, in elderly patients admitted to the ICU, life-sustaining treatments are more often withdrawn and invasive treatments tend to be avoided.[12,13] Thus, analysis of the outcomes and prognoses of very elderly patients admitted to the ICU is important in terms of the provision of information to the medical team, patients, and families for advanced care planning and decision-making. ICU treatment is expensive and must be effective, given the limited healthcare resources available.

The definition of "very elderly" patients is also unclear. Various studies consider very elderly subjects as people > 80 or 85 y of age.[1,6-10] Given the increasing proportion

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of older patients receiving medical services, the age criterion for very elderly patients is expected to increase. We considered subjects 90 y of age or older to be very elderly.

Because techniques and interest in critical care are developing and expanding rapidly, the ICU survival rate of older patients is increasing, and the quality of life, as well as functional and cognitive impairment, of older patients after ICU care should be considered.[1,2] The aim of this study was to evaluate clinical characteristics and factors including biological, nutritional, and therapeutic interventions associated with mortality in very elderly subjects admitted to the ICU.

QUICK LOOK

Current knowledge

The world population is aging due to declines in mortality and childbirth rates. Older people require more medical services than younger people because of the higher rates of functional impairment and chronic morbidity. Consequently, the number of very elderly patients admitted to the ICU with acute illnesses is increasing. In older patients admitted to the ICU, life-sustaining treatments are more often withdrawn and invasive treatments tend to be avoided, complicating evaluations of mortality in this group.

What this paper contributes to our knowledge

Very elderly subjects (age ≥ 90 y) admitted to the ICU had a higher mortality rate compared with subjects of other ages. High Simplified Acute Physiology Scoring II results, poor nutritional status, high glucose, use of vasopressors, and do not resuscitate orders were important predictors of mortality in very elderly ICU subjects. The level of ICU treatment should be carefully considered in the very elderly patient presenting with 5 or more risk factors.

Methods

Setting and Subjects

The study was performed in a 558-bed university teaching hospital in Seoul, Republic of Korea. It contains a medical ICU (16 beds) and a surgical ICU (30 beds) and receives 1,750 patients/y. The hospital has no specific criteria for ICU admission. Hospital personnel try to obtain information on pre-hospital disability, underlying disease, and wishes of patients and their family before admission. However, even when this information is absent, the patient is admitted. Our institutional review board approved the data analyses.

Variables

We assessed the demographics of very elderly subjects admitted to the ICU using clinical records. Gender, age, body mass index, the nature of any pre-hospital care, admission source, comorbidities, nutritional status, and level of acuity were recorded on admission. We also analyzed the clinical course in terms of ICU stay, hospital days, do not resuscitate (DNR) orders, use of vasopressors, duration of mechanical ventilation support, and transfer out of the ICU to other hospitals or healthcare centers.

The primary outcome of the present study was ICU mortality. We analyzed comorbidities, pre-hospital status, admission source, cause of admission, nutritional status, Simplified Acute Physiology Scoring II (SAPS II), and Acute Physiology and Chronic Health Evaluation (APACHE) II as possible risk factors predicting ICU mortality.

Acuity level on admission was calculated using the APACHE II[14] and SAPS II[15] results from the first day in the ICU. Calculation of the individual severity of illness was based on the worst physiological values recorded within the first 24 h in the ICU. The APACHE II score consists of 12 physiological variables and 2 disease-related variables, and the SAPS II result is the sum of scores for 13 physiological variables, type of admission, and 3 underlying diseases.[14,15]

Nutritional status was assessed according to a single anthropometric value (body mass index) and 3 routine laboratory tests (serum albumin, serum cholesterol, lymphocyte count), which are known to be simple parameters associated with nutritional status.[5,16-22] Poor nutrition was defined as having at least 3 of the following: body mass index < 18.5 kg/m^2, serum albumin < 3.0 g/dL, serum cholesterol < 130 mg/dL, and total lymphocyte count $< 1{,}000$/mm^3.[5,16-22]

Subjects ≥ 90 y of age who were admitted to the ICU and for whom DNR orders were in effect received all indicated medical treatments except for cardiopulmonary resuscitation.

Statistics

Descriptive data are expressed as medians with interquartile range (IQR), and frequencies are expressed as numbers (%). In the univariate analysis, the chi-square test or Fisher exact test was used for categorical variables, and continuous variables were compared using the Mann-Whitney *U* test. Factors found to be significantly associated with survival were analyzed further with a Cox proportional hazard model to adjust for the potential

confounding effect of each factor. Hazard ratios with 95% CI are used to report the results. The 14 variables were included in Cox's regression analysis because all were associated with $P < .05$ on univariate analysis. However, we excluded lymphocyte count and serum albumin and cholesterol levels from multivariate analysis, because the definition of poor nutrition included these variables. In the final multivariate model, a P value of $< .05$ was considered to indicate significance. Cumulative survival curves were derived using the Kaplan-Meier method with reference to poor nutrition, DNR order, and the use of vasopressors.

The clinical mortality index was defined as the ICU mortality rate caused by number of clinical risk factors with $P < .05$ according to univariate analysis, excepting laboratory data and acuity scores. These risk factors represented baseline characteristics upon ICU admission (poor nutrition, a DNR order, admission due to pneumonia, chronic renal failure, and cancer) and ICU treatment-related factors (the need for mechanical ventilation, use of a vasopressor, and admission from a hospital ward).

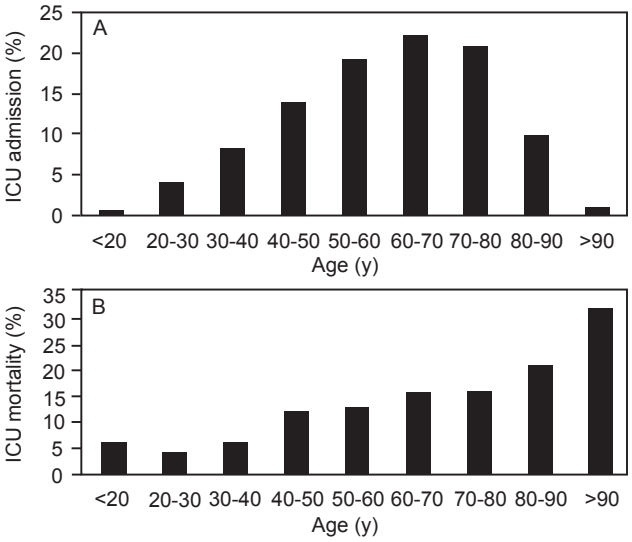

Fig. 1. Admission rates (A) and mortality (B) of subjects admitted to the ICU according to age.

Results

Age-Specific Rates of Admission and Mortality

We evaluated the admission and mortality rates, over time, in 16,935 subjects 18 y of age or older, and we retrospectively analyzed the clinical data of 155 (0.92%) subjects 90 y of age or older admitted to the ICU from January 2003 through July 2012. We excluded patients who were transferred to other hospitals, who were discharged against medical advice, or who had changed their place of residence.

The ICU admission rate in the seventh decade was highest among those examined. The proportion of subjects $\geq$ 80 y of age admitted to the ICU was 10.9%, and that of subjects $\geq$ 90 y of age admitted to the ICU was 0.9%. The proportion of ICU admission decreased according to age above 70 y (Fig. 1A). However, ICU mortality of subjects increased as the age of subjects admitted to the ICU increased. Mortality in subjects 90 y of age or older admitted to the ICU was 32.3%. This was much higher than the 14.9% rate for all subjects admitted to the ICU age 18 y or older (Fig. 1B).

Demographics of Subjects ≥ 90 y of Age Admitted to the ICU

Table 1 presents the demographics and clinical courses of very elderly subjects admitted to the ICU. The median age of subjects $\geq$ 90 y admitted to the ICU was 92 y (IQR, 91–94 y). Before admission, 124 subjects lived at home, but 31 subjects had been cared for in other hospitals or healthcare centers. A total of 112 ICU admissions (72%) were from the emergency room. The principal reason for ICU admission in very elderly subjects was pneumonia (16%). The median SAPS II and APACHE II scores on ICU admission were 37 (IQR, 28–50) and 14 (IQR, 11–22).

Clinical Courses of Subjects ≥ 90 y of Age Admitted to the ICU

The median durations of hospital and ICU stays of subjects $\geq$ 90 y of age admitted to the ICU were 10 (IQR, 5–21) and 5 (IQR, 3–9) d. DNR orders were recorded for 36 subjects (23%) at a median ICU time of 4 d (IQR, 1–12). Twenty-eight (18%) subjects were transferred to other hospitals or healthcare centers due to conservative treatment (Table 2).

Prognostic Factors in Subjects Age ≥ 90 y Admitted to the ICU

In the univariate analysis (Table 3), body mass index did not differ significantly between survivors and nonsurvivors. The laboratory variables on admission including lymphocyte count, albumin, and cholesterol levels were lower in nonsurvivors compared with levels in survivors. Glucose, blood urea nitrogen, creatinine, and C-reactive protein levels were higher in nonsurvivors. The median SAPS II and APACHE II scores of nonsurvivors were higher than those of survivors. The clinical course of very elderly subjects showed the following difference: among nonsurvivors, we found more DNR orders, greater use of

Table 1. Baseline Characteristics of Subjects ≥ 90 y of Age Admitted to the ICU

Variable	All Subjects (N = 155)
Sex (male)	50 (32)
Age (y)	92 (91–94)
Body mass index (kg/m^2)	20.2 (17.8–23.2)
Comorbidity	
Hypertension	75 (48)
Diabetes	19 (12)
Ischemic heart disease	12 (8)
Chronic lung disease	12 (8)
Cerebral disease	10 (7)
Cancer	9 (6)
Chronic renal disease	7 (5)
Chronic liver disease	6 (4)
Pre-hospital care	
Home	124 (80)
Healthcare center or other hospital	31 (20)
Admission source	
Emergency room	112 (72)
Ward	20 (13)
Operating room	18 (12)
Out-patient department	5 (3)
Acuity score on admission	
SAPS II	37 (28–50)
APACHE II	14 (11–22)
Nutritional score	1 (0–2)
Poor nutrition	71 (46)

Data are presented as median (interquartile range) or number (%).
SAPS II = Simplified Acute Physiology Score II
APACHE II = Acute Physiology and Chronic Health Evaluation II

Table 2. Clinical Course of Subjects ≥ 90 y of Age Admitted to the ICU

Variables	All Subjects (N = 155)
Cause of admission	
Pneumonia	25 (16)
Heart failure	18 (12)
Acute coronary syndrome	18 (12)
Cerebral infarction	15 (10)
Brain hemorrhage	15 (10)
Gastrointestinal bleeding	13 (8)
Femur fracture	12 (7)
Biliary infection	8 (5)
Urinary tract infection	5 (3)
Bowel obstruction	4 (2)
Peritonitis	4 (2)
Others	18 (13)
Hospital days (d)	10 (5–21)
ICU stay (d)	5 (3–9)
DNR order	36 (23)
Duration from admission to DNR (d)	4 (1–12)
Vasopressor	49 (32)
Mechanical ventilation	51 (33)
Duration of mechanical ventilation (d)	5 (2–13)
Transfer to healthcare center or other hospital	28 (18)
ICU mortality	50 (32)
Hospital mortality	52 (34)

Data are presented as median (interquartile range) or number (%).
SAPS II = Simplified Acute Physiology Score II
APACHE II = Acute Physiology and Chronic Health Evaluation II
DNR = do not resuscitate

mechanical ventilation, and greater use of vasopressors than in survivors.

The Cox's regression hazard model revealed that 2 laboratory values, including high blood glucose level (P = .006, hazard ratio = 1.007, 95% CI 1.002–1.011), and poor nutrition (P = .1, hazard ratio = 14.918, 95% CI 2.998–74.243), and one acuity score as a high SAPS II scores (P < .001, hazard ratio = 1.140, 95% CI 1.076–1.208) were independent predictors of mortality in subjects ≥ 90 y of age admitted to the ICU. Two clinical factors, that is, having a DNR order in effect (P = .002, hazard ratio = 7.456, 95% CI 2.210–26.221) and vasopressor use (P = .03, hazard ratio = 8.049, 95% CI 1.257–51.529) (Table 4), were associated with mortality of subjects ≥ 90 y of age admitted to the ICU.

In terms of the clinical mortality index of ICU subjects ≥ 90 y of age, 51 subjects (33%) presenting with no risk factors at all survived. Mortality rates increased as the number of risk factors rose. All subjects with more than 5 risk factors died (Table 5).

The Kaplan-Meier survival curves showed that subjects who were poorly nourished, who had DNR orders, who had more than 3 risk factors, and who used vasopressors experienced low survival (Fig. 2).

Discussion

We found that mortality of very elderly subjects admitted to the ICU is associated with high blood glucose level, poor calculated nutritional status, high SAPS II score, having a DNR order in effect, and vasopressor use. Mortality rate increased as the number of risk factors rose.

The cumulative proportion of and mortality in subjects 90 y of age or older admitted to the ICU were 0.92% and 32.3% in our study. There are few data about ICU mortality in patients ≥ 90 y of age, because patients older than 90 y were very rare in the past. Most studies about outcomes in very elderly subjects in the ICU were evaluated with people 80 or 85 y of age and older.[1,7-10,23,24] In a large cohort from Australia and New Zealand,[1] the cumulative proportion of ICU admissions and the ICU mortality rates of subjects ≥ 90 y old were 0.88% and 12.0% lower than

Table 3. Univariate Analysis of Factors Related to Mortality of Subjects ≥ 90 y of Age Admitted to the ICU

Variable	Survivors (n = 105)	Nonsurvivors (n = 50)	P
Sex (male)	29 (28)	21 (42)	.07
Age (y)	92 (91–94)	92 (90–95)	.32
Body mass index (kg/m^2)	21.0 (17.9–23.2)	19.7 (17.8–23.5)	.72
Comorbid conditions			
Hypertension	55 (52)	20 (40)	.14
Diabetes	12 (11)	7 (14)	.72
Chronic renal failure	2 (2)	5 (10)	.02
Cancer	3 (3)	6 (12)	.02
Health care center or other hospital before admission	21 (20)	10 (20)	>.99
Admission source			
Emergency room	74 (70)	38 (76)	.47
Ward	8 (8)	12 (24)	.004
Operating room	18 (17)	0 (0)	.002
Cause of admission			
Pneumonia	11 (11)	14 (28)	.006
Heart failure	13 (12)	5 (10)	.67
Cerebral infarct	13 (12)	2 (4)	.10
Acute coronary syndrome	12 (11)	6 (12)	.92
Brain hemorrhage	9 (9)	6 (12)	.50
Laboratory finding			
BUN (mg/dL)	20 (15–31)	30 (21–44)	< .001
Creatinine (mg/dL)	0.9 (0.8–1.3)	1.3 (1.00–1.6)	< .001
CRP (mg/dL)	51 (14–125)	119 (51–172)	.001
Glucose (mg/dL)	119 (93–145)	159 (114–278)	< .001
Lymphocyte (cells/μL)	1,145 (742–1,550)	742 (470–1,140)	< .001
Albumin (g/dL)	3.4 (3.0–3.7)	2.7 (2.4–3.5)	.02
Cholesterol (mg/dL)	146 (110–171)	114 (77–135)	.001
Poor nutrition	39 (37)	32 (64)	.002
Acuity score on admission			
SAPS II	30 (26–39)	58 (44–71)	< .001
APACHE II	12 (10–16)	24 (21–30)	< .001
ICU stays (d)	6 (3–10)	4 (2–10)	.09
DNR order	4 (3)	32 (64)	< .001
Mechanical ventilation	15 (14)	36 (72)	< .001
Vasopressor	9 (9)	40 (80)	< .001

Total number of subjects was 155. Data are presented as median (interquartile range) or number (%).
BUN = blood urea nitrogen
CRP = C-reactive protein
SAPS II = Simplified Acute Physiology Score II
APACHE II = Acute Physiology and Chronic Health Evaluation II
DNR = do not resuscitate

ours. The various admission and mortality rates found for very elderly subjects of other studies are probably attributable to differences in study design, geographic/cultural variations, and differences in the study populations, including the definition of very elderly subjects, severity of the acute illness, and treatment intensity.[1,7-10,23,24]

Table 4. Multivariate Analysis of Factors Related to Mortality of Subjects ≥ 90 y of Age Admitted to the ICU

	Hazard Ratio	95% CI	P
Comorbidity			
Chronic renal failure	1.040	0.245–4.405	.96
Cancer	5.060	0.972–26.340	.05
Cause of admission: pneumonia	2.057	0.518–8.166	.31
Source of admission: ward	1.526	0.489–4.759	.47
Laboratory finding			
BUN (mg/dL)	0.993	0.958–1.030	.70
Creatinine (mg/dL)	0.579	0.269–1.246	.16
CRP (mg/dL)	1.002	0.994–1.010	.56
Glucose (mg/dL)	1.007	1.002–1.011	.006
Poor nutrition	14.918	2.998–74.243	.001
Acuity score on admission			
SAPS II	1.140	1.076–1.208	< .001
APACHE II	1.015	0.911–1.132	.79
DNR order	7.456	2.120–26.221	.002
Mechanical ventilation	1.628	0.509–5.213	.41
Vasopressor	8.049	1.257–51.529	.03

Total number of subjects was 155.
BUN = blood urea nitrogen
CRP = C-reactive protein
SAPS II = Simplified Acute Physiology Score II
APACHE II = Acute Physiology and Chronic Health Evaluation II
DNR = do not resuscitate

Table 5. Clinical Mortality Index of Subjects ≥ 90 y of Age Admitted to the ICU

	Subjects (n, %)	Mortality Rate (%)
0 risk factors	51 (33)	0
1–2 risk factors	56 (36)	21
3–4 risk factors	35 (23)	71
5–8 risk factors	13 (8)	100

Risk factors are as follows: poor nutrition, DNR order, cause of admission [pneumonia, chronic renal failure, cancer], mechanical ventilation, vasopressor use, admission from ward).
Total number of subjects was 155.

There is a broad consensus in the literature that chronological age is associated with higher rates of ICU mortality.[1,23] Our data showed a tendency for higher ICU mortality with age, but we did not find a relationship between age and ICU mortality in very elderly subjects, consistent with other studies indicating advanced age alone does not preclude successful ICU outcomes even in very elderly subjects.[5,9,10] Although 32.3% of very elderly subjects admitted to our ICU died, this means that 70% survived. Therefore, ICU admission or treatment for very elderly patients must be carefully considered. It is not appropriate to refuse ICU admission or restrict treatment to patients simply because they are ≥ 90 y old.

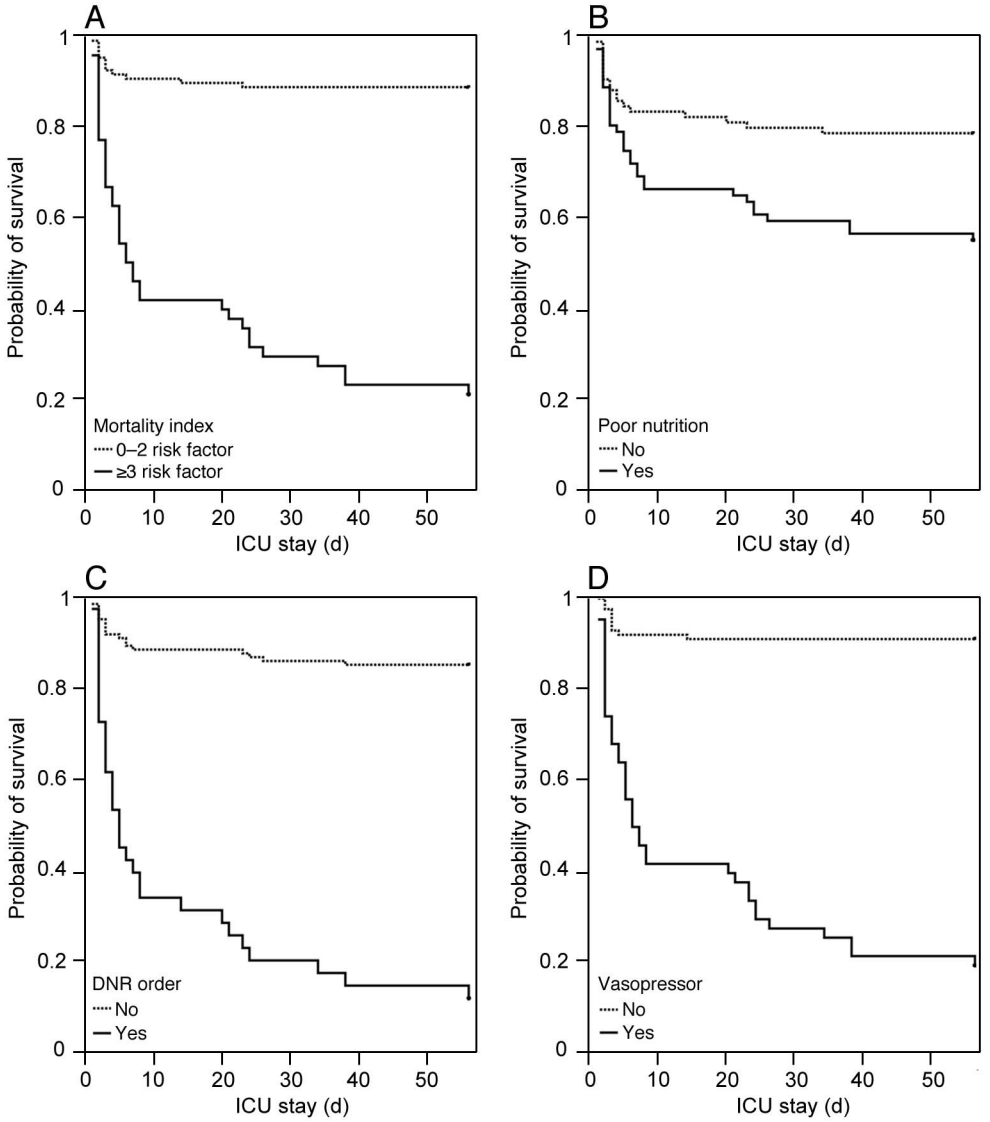

Fig. 2. Kaplan-Meier survival curves showing the effects of high mortality index (A), poor nutrition (B), do not resuscitate (DNR) orders (C), and vasopressor use (D) in 155 very elderly subjects admitted to the ICU.

In the present study, independent predictors of mortality in very elderly subjects admitted to the ICU included high SAPS II, a high serum glucose level, the use of a vasopressor, poor nutritional status, and DNR orders.

Because the general prognosis in ICU patients is principally dependent upon the severity of their illness at admission, severity scores including SAPS II and APACHE II were independent predictors of outcome in previous studies of very elderly subjects admitted to the ICU.[1,7-9,11,24] Although the severity of an acute illness is an important prognostic factor in ICU mortality, physiological state and presence of comorbid illness are also likely to be important determinants in very elderly patients, who frequently present with several comorbidities and generally poor functional activity.

Higher glucose levels in ICU patients also suggested the presence of uncontrolled infections with delay in recovery from wound healing and infectious status.[25] The use of a vasopressor in ICU patients was associated with poor critical status and hemodynamic instability.

The prognostic role of nutritional status has been established in older patients admitted to acute care and geriatric rehabilitation units.[16,17,26] Various nutritional markers, individually or collectively, are associated with prognosis in older patients, but confounding remains uncertain.[5,17,18,20,26-32] Several methods used to assess nutritional or functional status require complex scoring systems, or additional measurements such as skin fold or arm circumflex; in contrast, the nutritional index employed in the present study comprised only body mass index scores and

simple biochemical parameters routinely measured in patients admitted to the ICU. This nutritional score can be easily used to predict the progress of very elderly patients admitted to the ICU. In addition, clinicians need to become more concerned about nutritional support for very elderly patients with poor nutrition scores.

A large number of very elderly subjects (23%) had DNR orders in effect, and many of these subjects died. Whether high mortality in very elderly ICU subjects with DNRs in effect is attributable to active or passive therapeutic limits imposed by clinicians, or to genuinely poor prognoses, remains uncertain. Other studies suggested that the very elderly subjects admitted to the ICU receive less aggressive treatment, including mechanical ventilation, compared with younger subjects, despite similar illness severity scores.[13] Thus, evaluation of predictors of ICU mortality in very elderly patients may be useful in the determination of treatment intensity and triage decisions by clinicians, families, and patients.

We developed a clinical mortality index by including several risk factors that were significant in a univariate analysis, excepting simple laboratory data or acuity scores. We selected these 8 risk factors because they are easily measurable and highly applicable to the clinical setting represented by an ICU. Five risk factors (poor nutrition, chronic renal failure, cancer, pneumonia, and admission from wards) represent the baseline and clinical characteristics upon admission. The remaining factors (active DNR orders, use of a vasopressor, and mechanical ventilation) are treatment-related factors. Very elderly subjects in the ICU presenting with chronic renal failure or cancer exhibited higher mortality rates. Previous studies of subjects with end-stage renal disease in the ICU reported higher mortality and readmission rates due to comorbidities and poor general health.[33,34] In critical cancer subjects, greater age was associated with increased mortality, especially for subjects $>$ 60 y of age.[35] The main predictors of mortality in elderly subjects with cancer admitted to an ICU were more severe organ failure and uncontrolled cancer.[35] Mortality rates were higher in subjects admitted from wards. Admission to an ICU from a ward suggests that the severity of the illness might not have been fully assessed, or there was failure to respond to prior therapy.[36] Very elderly subjects with pneumonia exhibited higher mortality rates in the present study. A previous cohort study of critically ill subjects with pneumonia reported increased age to be independently associated with higher rates of both short- and long-term mortality following ICU admission.[37] In pneumonia subjects $>$ 60 y of age, each additional decade of age was associated with a 24% increase in ICU mortality.[37]

All of the subjects in the present study presenting without any prognostic factors survived; in contrast, none of the subjects with 5 or more prognostic factors survived. The presence of an increasing number of clinical risk factors was associated with progressively higher mortality rates; moreover, the number of clinical risk factors in an individual subject was an accurate predictor of mortality. We suggest that, if a patient presents with 5 or more risk factors, physicians should discuss the level of treatment with the patient and/or their family members. If the patient presents with no risk factors, physicians should consider applying full supportive treatment. Mortality index data should provide useful guidance to clinicians, patients, and families regarding the critical care of very elderly patients.

We found that 18% of subjects $\geq$ 90 y of age admitted to the ICU were transferred to other hospitals or healthcare centers for conservative treatment. It is difficult for very elderly patients to recover fully from disease and to return to daily life. Quite a few patients experience complications after ICU treatment. Such conditions should be of concern before ICU treatment commences, and clinicians should seek to minimize disability and to explain the likelihood of any infirmity to both patients and families.

The current work has several limitations. First, this was a single-center study. Thus, translating these results to other ICUs must be done with caution due to differences in culture/geographical policies or study populations. Second, the study duration was very long, and technological features of critical care, or clinical perspectives on very elderly patients, may have changed during the study. Thus, patient management and clinical decision-making might have varied over time. Third, we did not study the characteristics and mortality rates in very elderly patients who were admitted to the hospital but not to the ICU, and we did not study young patients admitted to the ICU. However, the goal of this study was to help clinicians in their decision-making role with regard to very elderly patients admitted to the ICU. Fourth, although we demonstrated that poor nutritional status was an independent predictor of ICU mortality, other measures of nutritional status—including mid-arm circumflex, skin fold, delayed hypersensitivity, and various questionnaires—were not applied. However, the variables representing nutrition scores in this study were relatively simple and routinely checked parameters, so they might be useful in estimating nutritional status of ICU patients in future studies. Finally, our study enrolled a greater proportion of female subjects. It is surmised that females outlive males, but the mortality rate did not differ between females and males. However, the sex imbalance in our sample could have affected the identified predictors of mortality. Prospective multi-center cohort studies on very elderly ICU subjects will lack the limitations of this retrospective study.

Conclusions

The proportion of very elderly patients 90 y of age or older admitted to the ICU is increasing. Evaluating the outcomes and risk factors in this group has become important in terms of the effective use of restricted healthcare resources and decision making by clinicians, families, and patients. The very elderly subjects (≥ 90 y old) admitted to the ICU had higher rates of mortality. Important predictors of mortality included SAPS II, high glucose levels, use of vasopressors, poor nutritional status, and DNR orders. The mortality index comprising the actual number of the following clinical risk factors was an accurate predictor of mortality. If a very elderly patient admitted to the ICU presents with 5 or more risk factors, physicians should discuss the level of treatment with the patient and/or family members.

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