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Prognosis of patients aged 80 years and over admitted in medical intensive care unit

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Abstract *Objective:* To determine the prognostic indicators of long-term survival after admission to a medical intensive care unit (MICU) for patients aged 80 years and over. *Design:* Prospective cohort study. *Setting:* A 14-bed MICU in a 970-bed, acute care, tertiary, university hospital in Paris, France. *Patients:* A total of 233 patients aged 80 years and over discharged from a MICU during a 2-year period. *Measurements and main results:* Severity at admission was estimated using the Simplified Acute Physiology Score. The underlying condition was classified using the MacCabe classification. The functional status was assessed using the Knaus classification. The outcome after MICU discharge was determined after a median 2-year follow-up. The functional outcome was assessed by telephone interviews, employing the Instrumental Activities of Daily Living (IADL). The in-MICU mortality was 19.5% including death occurring during the 2 days following discharge. The long-term survival rates for patients admitted to the MICU were 59% at 2 months, 33% at 2 years, and 29% at 3 years. The multivariate analysis identified two prognostic factors of death after discharge: presence of an underlying fatal disease (HR 1.7; 95% CI 1.1–2.6) and severe functional limitation (HR 1.7; 95% CI 1.2–2.6). The IADL was excellent or good for 56% of the surviving patients. *Conclusion:* Long-term survival after MICU is mainly related to the underlying condition, whereas known factors for in-MICU survival do not influence long-term prognosis.

Keywords Elderly · Intensive care units · Prognosis · Risk factors · Survival · Multivariate analysis

Introduction

The population of Western countries is getting older. The proportion of people 60 years and over in the French population increased from 19% in 1990 to 20.5% in 2000 and is projected to reach 26.8% by 2020 [1]. With aging, comorbidities, cognitive function, and disabilities appear as important components of the health status [2, 3]. People over 80 years have an increased number of comorbidities. The geriatric conditions, including frailty and disability, often lead to a loss of independence which also has to be considered [3]. As in the United States, the growth of the elderly population in France will lead to a higher health care expenditure [4, 5, 6].

According to the latest French census in 1999, the proportion of the population over 80 years was 4% but is expected to increase to more than 7% in the next 20 years. The increase in the population aged 65 years and over as well as the increase in the life expectancy translate into an increase in admission to intensive care units (ICU) of patients aged 65 years and over either in Europe or in the United States [7, 8]. More than a half of all ICU days concern patients over 65 in the United States [9]. In the Euricus I study that includes 89 units of 12 European countries, the proportion of patients over 80 was 8.3%

[10], and in the second Euricus study which included 39 units, the proportion was 15.6% (personal data).

Given the high cost of acute care and the increasing number of oldest old patients potentially requiring ICU admission, it is necessary to assess the short-term outcome but also long-term survival and functional autonomy after admission to a medical intensive care unit (MICU).

The effect of age per se on short-term prognosis is a matter of debate. Some studies suggest that the higher mortality observed for the elderly in an ICU is in fact related to the severity of the acute illness [11, 12, 13, 14].

Factors influencing long-term survival have been studied less [15, 16, 17, 18], yet they may contribute to the decision to admit into a MICU a patient older than 80. Ely et al. [19] showed that age was a predictive factor of in-hospital death in patients developing acute lung injury, but the recovery seemed similar for patients aged over 70 years old than for younger patients, even though they were less likely to be discharged from ICU without ventilator support. The authors suggest that the relative bad prognosis of old patients could be related to the underlying condition.

The primary objective of this study was to assess prognostic factors of long-term survival of patients over 80 years, referred to as oldest old patients, together with an estimation of the functional status after MICU discharge, in order to help the decision making process regarding the admission policy.

Materials and methods

We carried out a prospective study using data from the 14-bed MICU of the Saint-Antoine Hospital (Paris, France). Patients over 80 years account for 11.2% of all hospital stays with a length of stay almost twice that of younger patients. Patients are admitted to the MICU from the emergency room, outpatient clinics, or medical wards. Admissions are classified as follows: emergency, when the patient is admitted directly from the emergency room or through the French emergency rescue squad (SAMU); or referrals when the patient is transferred from other departments or other hospitals. Our admission policy is quite liberal. Published recommendations of admission to ICU [20] are often applied. Whenever possible, ICU physicians perform direct patient consultation, in order to assess the indication of ICU admission taking into account organ dysfunction together with underlying disease as well as patient's and family's wishes.

We studied survival and long-term outcome of patients aged over 80 years old discharged from the MICU during the period 1 January 1998, to 31 December 1999. We collected standard clinical and biological data on admission. We also recorded Glasgow Coma Scale [21], severity of illness at admission according to the Simplified Acute Physiology Score II (SAPS II) [22], and immune status (immune deficiency included HIV infection, ongoing malignancy, radiation, or chemotherapy, high doses or chronic use of corticosteroids, immunesupressive drugs). Life expectancy was estimated using the MacCabe classification: class 1 for none or nonfatal underlying disease; class 2 for ultimately fatal disease (death expected in a 5-year period); and class 3 for rapidly fatal disease (death expected in 1 year) [23, 24]. The functional status was assessed using the Knaus classification [25] (A for no limitation, B slight functional limitations, C severe functional limitations, D for bed-ridden patients). The diagnosis were coded with the International Classification of Diseases, 10th revision (ICD-10). Indications for MICU admission were defined according to the major organ dysfunction and classified into seven categories: acute respiratory failure without cardiac failure; renal failure and metabolic disorders; acute pulmonary cardiogenic edema; shock; coma; cardiac arrest; and miscellaneous. Only comorbidities with known impact on length of stay according to the French diagnosis related group (DRG) system were considered as associated diagnosis. We also computed the length of MICU stay, the length of mechanical ventilation, and the total OMEGA score, which summarizes the therapeutic, diagnostic, and nursing workload in the MICU [26, 27, 28]. We considered the ratio of the total omega score to the length of the ICU stay as a proxy for daily workload. We ensured data quality [29]. Patients were either discharged to wards in the same hospital or to another acute-care hospital or to a nursing care unit or directly home. We obtained information regarding the total length of stay and final discharge location of patients discharged to our hospital. Patients discharged from the MICU were contacted for follow-up interviews between December 2000 and February 2001. We collected information concerning the health and living conditions of patients either by telephoning the patient or his/her relatives, or by contacting the referring physician, or other hospital administrations or the townhall registry. Once living status and location were determined, the functional status was assessed by using the questionnaire validated by Lawton on Instrumental Activities of Daily Living [30]. This simple questionnaire was completed after a phone call. The scale is 0 (no limitation) to 4 (difficulties in all activities: phone; transportation; ability to take medication; budget management). Of patients who were known to be alive, 56% responded to the IADL questionnaire.

Survival curves with a 95% confidence interval were computed using the Kaplan-Meier method. The first survival analyses identified predictive variables of long-term survival after MICU admission and the second identified predictive variables of long-term survival after MICU discharge. In this last analysis, survival was measured from the first day after discharge. Patients alive at the time they were contacted were censored at that time. The log-rank test was used in the univariate analysis to study the association between survival and each previously described variable. For multivariate analysis, only variables with a p value under 0.2 were entered into a Cox proportional hazards model [31] and selected using a stepwise selection procedure. Hazard ratios (HR) and 95% confidence intervals (95% CI) were computed from the estimated parameters of the final regression model. Examination of the proportionality assumption indicated no significant time risk factor interactions for any variable in the model. To evaluate the stability of the regression models, we studied the median and interquartiles (25th–75th percentile) of its estimated parameters when fitted to 200 random samples obtained with the bootstrap method [32]. We also studied the selection frequency of all variables by fitting a stepwise regression model to these 200 random samples. Statistical analysis was performed using SAS software V8 (SAS Institute, Cary, N.C.).

Results

During the period 1998 to 1999, 233 patients aged 80 years and over were discharged from the MICU. Eighteen patients were admitted several times; therefore, 256 ICU stays were registered in the study period, accounting for 15.9% of all MICU discharge during this period.

A comparison of the characteristics of young patients vs older patients admitted to the MICU is shown in Table 1. Among the 233 old patients, 71.2% were

Table 1 Characteristics of the patients and intensive care unit stays according to age. *MICU* medical intensive care unit

	Patients aged ≥80 years	Patients aged <80 years	Diff	Significance (*p*)
No. of patients	233	1224		
Age in years (SD, range)	86.1 (3.8, 80–101)	52.5 (17.31, 15–79)	33.6 (15.9)	<0.0001
Female n(%)	140 (60.1%)	473 (38.7%)		<0.001
MacCabe classification [23] n(%)				0.02
None or nonfatal underlying disease	173 (74%)	895 (73%)		
Ultimately fatal disease (≤5 years)	51 (22%)	226 (18%)		
Rapidly fatal disease (≤1 year)	8 (3%)	102 (8%)		
Knaus classification [25] n(%)				<0.001
No functional limitation	26 (11%)	613 (50%)		
Slight limitation	106 (45%)	361 (29%)		
Severe limitation	89 (38%)	221 (18%)		
Bed-ridden patient	12 (5%)	28 (3%)		
Immunosuppression[a] n(%)	11 (4.7%)	183 (14.9%)	10.2%	<0.0001
Simplified acute physiology score II (SD, range) [22]	45.1 (18.9, 20–111)	32.8 (21.2, 0–140)	12.3 (20.8)	<0.0001
Cumulative workload: total Omega score (SD, range) [26][a]	72.5 (88.8, 4-644)	70.42 (181.5, 4–4975)	2.1 (170.1)	0.786
Daily workload: Omega per day (SD, range)	11.6 (9.1, 4–67)	11.0 (7.9, 4–59)	0.62 (8.1)	0.329
Length of MICU stay (SD, range)	6.3 (5.8, 1–35)	5.7 (9.3, 1–236)	0.59 (8.8)	0.204
Invasive mechanical ventilation n(%)	105 (45.5%)	476 (38.9%)	6.6%	0.01
Length of mechanical ventilation (SD, range)	5.5 (5.8, 1–29)	5.3 (6.7, 1–57)	0.2	0.78
Death rate (%)	16.3	13.3	2	0.25
Mode of discharge of the survivors n(%)				<0.001
Wards	133 (69%)	591 (56%)		
Other hospitals or institutions	40 (21%)	209 (17%		
Home	21 (11%)	261 (21%)		
Readmissions n(%)				0.92
No	214 (92%)	1122 (92%)		
One or more	19 (8%)	102 (8%)		

[a] Immune deficiency included HIV infection, ongoing malignancy, radiation or chemotherapy, high doses or chronic use of corticosteroids, immunosuppressive drugs
[b] Omega score is made up 47 diagnostic and therapeutic items

admitted from the emergency department or through the French emergency rescue squad. The mean age was 86±3.8 years (range 80–101 years). The mean number of related diagnoses was 3.4±2.3 (range 0–10). Indications for MICU admission were mainly respiratory insufficiency (44%), acute pulmonary edema (12%), kidney failure and metabolic disorders (11%), shock (9%), coma (7%), cardiac arrest (5%), and miscellaneous (12%). The in-MICU mortality was 16%; 42 patients died during their last MICU hospitalization and 8 patients died within 2 days after their last MICU discharge (6 of them died in medical wards in our hospital, 1 at home, and 1 in a nursing care unit). Including these 8 patients in the in-MICU mortality, it reached 19.5%. Among the 233 patients, 195 were discharged from their first MICUs hospitalization and 192 survived more than 2 days after their first MICU discharge. The characteristics of oldest old patients according to the outcome of their first MICU stay are shown in Table 2.

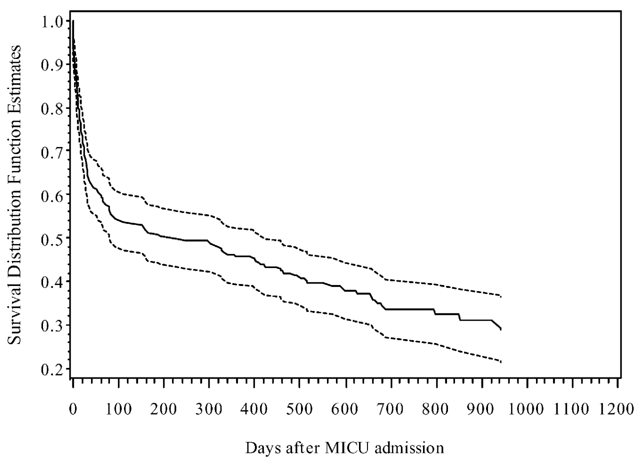

Fig. 1 Kaplan-Meier survival curve after medical intensive care unit (*MICU*) admission. *Dashed lines:* 95% confidence interval

Long-term survival analysis after MICU admission

We only took into account the first admission when patients were admitted several times to the MICU (233 observations). In order to identify predictor variables of long-term survival present in the medical record, we only used variables available in the 72 h following admission to MICU.

Figure 1 shows long-term survival from the day of MICU admission. Survival rates were 59% at 2 months,

Table 2 Characteristics of MICU patients according to their first MICUnit stay outcome

Variable	Survivors	Non-survivors (including death occurring during the 2 days following discharge)	Significance (p)
No. of patients	192	41	
Age in years (SD, range)	86.2 (3.8, 80–99)	85.8 (3.8, 80–101)	NS
Immunosuppression[a]	5.2%	2.4%	NS
Women (%)	60.4	53.7	NS
No. of related diagnoses (SD, range)	3.2 (2.2, 0–10)	4.2 (2.7, 0–10)	<0.05
Simplified Acute Physiology Score II (SD, range) [22]	40.6 (12.7, 20–92)	66.1 (27.5, 29–111)	<0.001
Glasgow Coma Scale (SD, range)	13.3 (2.8, 3–15)	10 (5.1, 3–15)	<0.001
Cumulative workload: total Omega score (SD, range) [26][b]	66.4 (87.4, 4–644)	101.3 (90.6, 15–436)	<0.05
Daily workload: Omega score per day (SD, range)	9.2 (5.2, 4–44)	23.2 (13.6, 4–67)	<0.001
Length of stay (SD, range)	6.3 (5.5, 1–35)	6.4 (6.9, 1–29)	NS
Mechanical ventilation (%)	38	82	<0.001
Length of mechanical ventilation (SD, range)	6 (6.3, 1–29)	4.2 (4.4, 1–18)	0.09

[a] Immune deficiency included HIV infection, ongoing malignancy, radiation or chemotherapy, high doses or chronic use of corticosteroids, immunosuppressive drugs
[b] Omega score is made up 47 diagnostic and therapeutic items

Table 3 Prognostic factors of death for all oldest old patients admitted in ICU (univariate analysis)

Variable	Reference value for quantifying risk	p value	Hazard ratio	95% hazard ratio confidence limits	
Underlying fatal disease[a]	Yes	<0.0001	2.209	1.563	3.121
Any alteration of consciousness[b]	Yes	<0.0001	1.935	1.398	2.677
Mechanical ventilation	Yes	0.0002	1.878	1.354	2.604
Severe functional limitation[c]	Yes	0.0005	1.779	1.288	2.458
Shock	Yes	0.0070	1.981	1.205	3.258
Simplified Acute physiology score II [22]	>39	0.0153	1.502	1.081	2.086
Origin of the patient	Transfer	0.0791	1.361	0.965	1.921
Age (years)	>85	0.0988	1.320	0.949	1.835
No. of related diagnoses	>2	0.3854	1.154	0.835	1.596
Gender	F	0.7380	1.058	0.762	1.468

[a] Defined with a MacCabe score [23] indicating the presence of either ultimately or rapidly fatal disease
[b] Defined with a Glasgow Coma Scale score [21] below 15
[c] Defined with a Knaus classification [25] indicating severe or total functional limitation

33% at 2 years, and 29% at 3 years. The median survival time was 231 days after admission. The mean survival time was 13 months.

Table 3 shows the results of the log-rank test for each of the selected variables. The multivariate analysis showed five independent poor long-term prognosis factors: the presence of an underlying fatal disease (HR=2.1, 95% CI: 1.5–3, p<0.0001); initial altered consciousness (HR=1.5, 95% CI: 1.1–2.5, p=0.03); the need for mechanical ventilation (HR=1.9, 95% CI: 1.4–2.8, p<0.001); older age (age >85 years; HR=1.4, 95% CI: 1–2, p=0.04); and diagnosis of shock (HR=2.7, 95% CI: 1.5–4.3, p=0.0004). If no, one or two bad long-term prognosis factor was present, the median of survival was 463 days, whereas it dropped to 32 days when more than two factors were present (p<0.0001). The variables selected in our models were those that were the more often selected when the same regression procedure was applied to 200 bootstrap samples. The parameter estimates of the final regression model were always included in their interquartile whenever this model was fitted to these 200 bootstrap samples.

Long-term survival analysis after MICU discharge

We wanted to investigate if variables present from the medical record and variables characterizing MICU stay were predictor of long-term survival after discharge. Of the 233 patients, 192 patients were discharged from their first hospitalization and survived more than 2 days after discharge. Survival rates were 71% at 2 months, 41% at 2 years, and 35% at 3 years. The median survival time was almost 1.5 years (500 days) after discharge. The mean survival time was 16 months. The univariate prognostic analysis selected seven variables (Table 4). The median survival time is about 600 days longer for patients with no or unfatal underlying disease or good functional status. The factors implicated in in-MICU mortality (such as SAPS II) did not contribute to the long-

Table 4 Prognostic factors of death for oldest old survivors after ICU discharge (univariate analysis)

Variable	Reference value for quantifying risk	*p* value	Hazard ratio	95% hazard ratio confidence limits	
Severe functional limitation[a]	Yes	0.0008	1.911	1.307	2.793
Underlying fatal disease[b]	Yes	0.0020	1.958	1.279	2.996
Any alteration of consciousness[c]	Yes	0.0151	1.622	1.098	2.395
Shock	Yes	0.0431	1.913	1.020	3.586
Age (years)	>85	0.0580	1.459	0.987	2.155
Origin of the patient	Transfer	0.0611	1.471	0.982	2.202
High daily workload[d]	Yes	0.0984	1.376	0.942	2.010
Length of mechanical ventilation	>1 day	0.1195	1.351	0.925	1.971
Gender	F	0.3924	1.185	0.803	1.749
Length of MICU stay	>4 days	0.4163	0.855	0.585	1.248
Simplified Acute Physiology score II [21]	>39	0.4269	1.166	0.799	1.701
High cumulative workload[e]	Yes	0.5235	1.131	0.774	1.653
No. of related diagnoses	>2	0.6362	1.096	0.750	1.600

[a] Defined with a Knaus classification [25] indicating severe or total functional limitation
[b] Defined with a MacCabe score [23] indicating the presence of either ultimately or rapidly fatal disease
[c] Defined with a Glasgow Coma Scale score [21] below 15
[d] Defined as an Omega score per day above 9.5
[e] defined as a total Omega score above 38 [26]

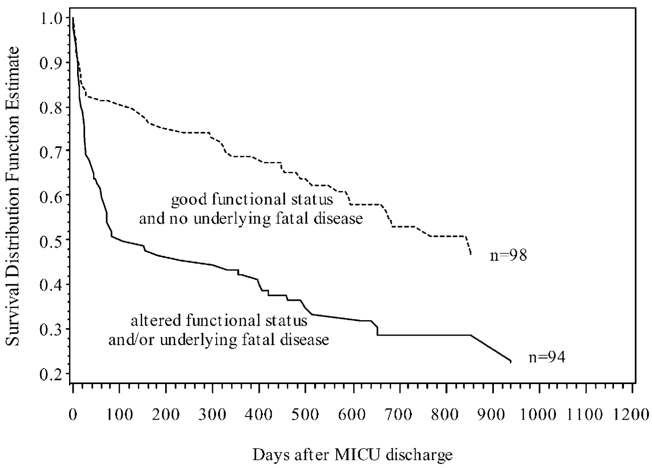

Fig. 2 Long-term survival curves of MICU survivors according to the number of risk factors (presence of an underlying fatal disease and altered functional status). *Dashed line*: no risk factor, *straight line*: one or two risk factor

term prognosis. On the contrary, the factors related to patient status, such as age or underlying diseases were important contributors of post-MICU survival.

The multivariate analysis found two bad prognostic factors: functional limitations (HR=1.7, 95% CI: 1.2–2.6, $p<0.01$) and presence of an underlying fatal disease (HR=1.7, 95% CI: 1.1–2.6, $p=0.02$). As shown in Fig. 2, if no risk factor are present, the median of survival was 851 days while it dropped to 106 days when it was present ($p<0.006$).

The variables selected in our models were those that were the more often selected when the same regression procedure was applied to 200 bootstrap samples. The parameter estimates of the final regression model were always included in their interquartile whenever this model was fitted to these 200 bootstrap samples.

Eighty-three patients were alive when contacted between December 2000 and February 2001, their mean age was 88 years. Half of those patients were contacted more than 687 days after MICU discharge. The mean time between MICU discharge and the date of contact was close to 2 years (689 days, SD 250 days). Among the survivors, 80% were living at home and 20% were living in a nursing home. The IADL scale could be computed for 56% of the patients. More than 50% of these patients returned to a good functional status (IADL equal to 0 or 1), and less than 10% were completely unable to care for themselves and to perform everyday tasks.

Discussion

The decision to admit an oldest old patient to a MICU is difficult. The willingness of the patient and his/her family is certainly an important consideration. The referring physician who knows well the past medical history is also an important contributor in the decision making process; however, in several circumstances, the ICU physician is alone in making the decision. Our work was designed to look for long-term survival factors that could help the ICU physician in this difficult task. The statistics of all Western countries population underline the urgent need for such information since the proportion of oldest old will nearly double in the next 20 years [1, 3, 33].

We chose the age cut-off value of 80 years for defining oldest old patients since several geriatric studies have stressed that the number of co-morbidities increases with age and the autonomy decreases [2, 34]. Evidently age per se is a risk factor for long-term mortality [2], but the risk of death increases with the number of co-morbidities [3] and the difficulty in instrumental activity and low cognitive function [3, 35]. In the study by Inouye et al., after adjustment on severity, three factors increased the relative risk of death 2 years after hospital discharge: impairment in instrumental activities of daily living; mini-mental status <20; simplified geriatric scale >7 [35].

The relatively good short-term prognosis is probably related to a selection bias with only old patients in good condition being admitted: old patients were rarely classified MacCabe 3 and only 4.7% were immunosuppressed compared with 14.9% for the patients younger than 80 years. The mortality of elderly is often higher than that of younger patients [19, 36]; however, when adjusted for covariates, older age has a modest detrimental effect on survival [17, 37].

When an oldest old patient is admitted to an MICU, the treatment intensity seems to be the same as that for younger patients. Although it has been shown that ventilator support and aggressive care were economically worthwhile for older patients [38], previous studies have found that older age was associated with lower hospital costs and resource intensity and higher rates of decisions to withhold life-sustaining treatments [36, 39, 40].

We confirm previously described factors influencing the in-MICU mortality [41]. Other studies have documented that in-MICU, mortality of old patients was mainly related to the initial severity and the need for mechanical ventilation [42, 43, 44, 45]. Interestingly enough, age and sex were not different for the dead and survivors in the MICU. Few oldest old patients were discharged directly home (11 vs 21% for younger patients), indicating that these patients deserve special attention in order to prevent secondary complications.

In the multivariate analysis of survival after discharge, two poor prognostic factors were identified: presence of an underlying fatal disease and strong limitations of functional status. In grouping these two factors, it can be shown that patients with no risk factor have a relatively good long-term prognosis with a median of survival of more than 2 years while patients with more than one factor have a significantly worse prognosis with a median of survival of 3 months. We believe that the mean survival time is not strongly reduced if the patient survives ICU stay. Our results need to be compared with the life expectancy of the general population in France which is 6.4 years for women and 5.2 for men at the age of 85 years [46].

Severe incapacity, defined as the need of help in dressing and in cleansing and confined to a bed or an armchair, involves 10% of women and 7% of men over 80 years in the general population and increases, respectively, to 20 and 15% for people over 85 years in France [47]. According to a French investigation [48], 56% of the oldest old patients living in the community had relatively good functional status. Oldest old patients discharged from a MICU have similar autonomy. Moreover, only 20% lived in a nursing home, whereas the others were at home. These figures are also very similar to those reported by the National Institute of Statistics in 1999, in France, with about 80% of people aged 80 years and older living at home [48]. Although collected in a small population of surviving patients, the relatively good IADL suggests that long-term functional status is preserved in old patients. This good result could be explained by a selection of old patients in good condition, who are able to recover well after ICU stay. The analysis reported in this paper provides information on factors that could help physician in making the decision to admit an old patient in intensive care; however, this piece of information obviously needs to be integrated into a broader view of health care, taking into account the patient and his or her family's wishes.

Conclusion

Long-term survival after MICU is mainly related to the underlying condition, whereas known factors for in-MICU survival do not influence long-term prognosis. Our results suggest that well-selected oldest old patients benefit from MICU admission with an acceptable life expectancy and substantial autonomy. Many oldest old patients survived intensive care and returned to good functional status.

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