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"Oldest old" patients in intensive care: prognosis and therapeutic activity

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„Oldest old" Patienten und intensivmedizinische Betreuung: Prognose und therapeutischer Aufwand

Zusammenfassung. *Hintergrund:* Patienten, älter als 84 Jahre werden im englischen medizinischen Sprachgebrauch als „oldest old" bezeichnet. Angesichts wachsender ethischer Diskussionen und der zunehmenden Limitierung der finanziellen Mittel im Bereich der intensivmedizinischen Betreuung ist es Ziel der präsentierten Untersuchung einen deskriptiven Überblick über die Prognose und den therapeutischen Aufwand von „oldest old" Patienten auf Intensivstationen im Vergleich zu Patienten jüngeren Alters zu geben.

Patienten und Methoden: 3069 Patienten, die innerhalb eines Zeitraumes von 7 Jahren an einer Intensivstation zur Aufnahme gelangten, wurden in 4 Altersgruppen unterteilt: jünger als 65 Jahre (48%), 65 bis 74 Jahre (26%), 75 bis 84 Jahre (22%) oder älter (5%; „oldest old"). Zuweisungsdiagnose, Länge des Intensivaufenthaltes, Schweregrad der Erkrankung, gemessen anhand des „simplified acute physiology score (SAPS)-II", Ausmaß des Therapieaufwandes, gemessen anhand des „simplified therapeutic intervention scoring systems (TISS)-28", und Vitalstatus zum Zeitpunkt der Entlassung wurden dokumentiert.

Ergebnisse: Die Mortalität von Intensivpatienten im Alter von 85 Jahren oder älter war signifikant höher als jene von Patienten jünger als 65 (OR der Mortalität: 1,8, $p < 0.001$). Insgesamt hatten Patienten, die nicht überlebten höhere SAPS-II-Werte (auch nach Ausschluss der Punkte für Lebensalter), während sich höhere mittlere Tages-TISS-Werte nur bei verstorbenen Patienten jünger als 85 fanden. Es zeigte sich ein negativer Zusammenhang zwischen mittleren Tages-TISS-Werten und dem Lebensalter (r = –0,03; $p < 0{,}001$) und signifikant niedere TISS-Tages-Werte bei „oldest old" Patienten im Vergleich zu den Patientengruppen jüngeren Alters ($p < 0{,}001$). „Oldest old" Patienten hatten einen signifikant kürzeren mittleren Krankenhausaufenthalt (median: 2; Interquartilenabstand [IQA] 1–3, $p < 0{,}001$) als die Patientengruppen jüngeren Alters.

Schlussfolgerung: Bei „oldest old" Patienten ist der Faktor Lebensalter ein wichtiger und eigenständiger Prediktor der Mortalität, aber der akute Schweregrad der Erkrankung ist noch stärker mit der Mortalität assoziiert. Zusammenfassend ist das Lebensalter per se ungeeignet als entscheidendes Kriterium für die Zuteilung von ICU-Ressourcen.

Summary. *Objective:* In view of ethical considerations and the limited resources in intensive care medicine, the present investigation aims to give a descriptive overview of the prognosis and therapeutic activity for the oldest age group of elderly patients admitted to an intensive care unit (ICU) in comparison with younger ICU patients.

Patients and Methods: 3069 patients admitted to the ICU during a seven-year period were categorized into four age groups: under 65 years (48%), 65 to 74 years (26%), 75 to 85 years (22%) and 85 years or older (5%). Type and reason for ICU admission, length of ICU stay, severity of illness as measured by the simplified acute physiology score (SAPS)-II, level of provided care as measured by the simplified therapeutic intervention scoring system (TISS)-28, and vital status at the date of ICU discharge were recorded.

Results: The ICU mortality rate of patients aged 85 years or older was significantly higher than in patients under 65 (OR of mortality: 1.8, $p < 0.001$). Non-survivors had higher SAPS II levels (even when excluding age points) in all age groups, but higher daily average TISS points only in patients under 85. The daily average TISS score was negatively correlated to age (r = –0.03; $p < 0.001$) and was significantly lower in the oldest group when compared with all the younger groups ($p < 0.001$). The oldest patients had a significantly shorter length of stay (median: 2; interquartile range [IQR] 1–3, $p < 0.001$) than the younger patient groups.

Conclusions: Within the very elderly population, age is an important and independent predictor of mortality, but acute severity of illness is even more strongly associated with mortality. Consequently, age alone may be an inappropriate criterion for allocation of ICU resources.

Key words: Intensive care, patients of very old age, prognosis, therapeutic activity.

Several studies have described the impact of age on the prognosis of critically ill patients but few have focused on this issue in the very elderly, i.e. patients aged 85 years or more [1–6]. Demographically, people over 85 years constitute the most rapidly growing age group in the general population and this is reflected in the increasing mean age of patients admitted to intensive care units (ICUs) in both Europe and the USA [7–9]. Both age and severity of illness are correlated with the change of survival rates of ICU patients [10–12], but whether age per se or the severity of the underlying acute illness has the most impact on short-term outcome is still unclear. Moreover, the definition of the term 'elderly' has varied between 60 and 80 years of age [13–16].

Beyond ethical considerations of the appropriateness of intensive care in patients reaching the natural end of their lifespan, there are also resource limitations and advanced age might constitute a criterion in triage decisions. Since intensive care facilities are limited and rationing of critical care beds is a common necessity in western countries, the appropriateness of admission of very elderly patients with questionable prognosis is the subject of daily debates in ICUs.

Apart from anecdotal experiences of intensivists, the appropriate approach to the care of elderly patients should be based on analysis of inherent prognostic limitations, at the same time avoiding the phenomenon of self-fulfilling prophecy. The present investigation aims to analyze the prognosis and treatment of critically ill patients with respect to different age groups, and with special focus on the very elderly.

Patients and methods

The study population consisted of all patients consecutively admitted to the 10-bed medical ICU in the 800-bed tertiary-care community hospital Krankenanstalt Rudolfstiftung (Vienna, Austria) during the period 10 May 1997 – 9 May 2004. A chi-squared test revealed that readmission (less than 10%) was independent from age group ($p = 0.49$), therefore only data from first ICU admissions were included in the analysis. Data collection was prospective and included the following items: demographic data (age, sex, type and reason for ICU admission, comorbidities, length of ICU stay); diagnosis according to the international classification of disease (ICD) versions 9 and 10; severity of illness as measured by the simplified acute physiology score (SAPS)-II [17]; level of provided care as measured by the simplified therapeutic intervention scoring system (TISS)-28 [18]; and outcome data, including vital status at the dates of ICU discharge and hospital discharge. As part of the SAPS-II, the following data were recorded during the first 24 hours of ICU stay: age, type of admission, three underlying disease variables, and the most disturbed value out of 12 physiologic variables, including the Glasgow coma score. We also calculated a modified version of the SAPS-II, excluding the parameter of age (SAPS without age adjustment). Data for the TISS-28 were recorded daily until ICU discharge. We have presented the sum of TISS divided by the number of days of ICU stay; thus TISS was adjusted for length of stay.

This observational study without any intervention in patients was performed in accordance with the Declaration of Helsinki and the European Good Clinical Practice Guidelines.

Statistics

For comparison purposes, patients were stratified into four age groups (under 65 years ('younger age'), aged 65–74 ('old'),

Table 1. Source of ICU admission and reason for ICU admission

	Overall N (%)	Group 1 <65 years (n = 1475) N (%)	Group 2 65–74 years (n = 788) N (%)	Group 3 75–85 years (n = 664) N (%)	Group 4 ≥85 years (n = 142) N (%)
Source of admission*					
from within the same hospital	1732 (57)	805 (55)	468 (60)	391 (59)	68 (49)
from home	683 (22)	296 (20)	162 (21)	172 (26)	53 (38)
from a different hospital	456 (15)	259 (18)	120 (15)	72 (11)	5 (4)
from a public place	169 (6)	103 (7)	28 (4)	25 (4)	13 (9)
Reason for ICU admission**					
cardiovascular disease	917 (32)	356 (26)	253 (35)	248 (41)	60 (45)
neurosurgery	615 (22)	394 (29)	124 (17)	80 (13)	17 (13)
others***	482 (17)	219 (16)	143 (20)	103 (17)	17 (13)
respiratory failure	418 (15)	176 (13)	126 (18)	98 (16)	18 (14)
neurologic disease	396 (14)	220 (16)	73 (10)	83 (14)	20 (15)

Values are given as number of patients (%); *missing data, n = 29; **missing data, n = 241; ***including metabolic disease, shock, renal disease, sepsis, trauma, gastrointestinal disease, hematologic disease, pregnancy, surgery other than neurosurgery.

aged 75–84 (‘very old’) and aged 85 or over (‘oldest old’). Continuous data are presented as median, IQR from the 25th to 75th percentile, and compared between groups using Wilcoxon rank-sum tests, or, when showing normal distributions, as mean +/- standard deviation (SD), with *t*-tests for group comparisons. Categorical variables are presented as N (%) and compared using chi-squared tests. Pearson’s linear correlation coefficient was used to assess association between variables. Mortality was analyzed using logistic regression models. Results from univariate and multivariable logistic regression analysis are given as crude and adjusted odds ratios (OR) for ICU mortality, 95% confidence intervals (95% c.i.) and p-values. The relative importance of prognostic factors in explaining variation in mortality was assessed by comparing their partial R-squared values [19]. The partial R-squared value of a prognostic factor is defined as the percentage by which the total variance of mortality can be reduced if that prognostic factor is included in a multivariable logistic regression model. All p-values are based on two-tailed tests of significance. A p-value of <0.05 was considered significant.

Results

During the seven-year period of the study a total of 3069 patients (1306 females, 1763 males) were admitted to the ICU. The mean age of patients was 62.9 years (range 13–95); 1475 patients (48%) were under 65 years of age (‘younger age’; Group 1), 788 patients (26%) were aged 65–74 years (‘old’; Group 2), 664 patients (22%) were 75–85 years (‘very old’; Group 3) and 142 patients (5%) were 85 years or older (‘oldest old’; Group 4).

Sex was equally distributed in Groups 2, 3 and 4 but in the youngest group there were significantly more males than females (917 versus 558, p<0.001).

Table 1 summarizes source of ICU admission and reason for ICU admission. In all age groups most patients were transferred to the ICU from other departments of the hospital. The oldest patients were more likely than the other age groups to be admitted from their home or from a public place.

The most frequent reason for admission was cardiovascular disease, followed by neurosurgery, ‘others’, respiratory failure and neurologic disease.

The median length of ICU stay for all patients was three days (IQR 2–8). There was no difference in length of ICU stay between survivors and non-survivors (median: 3; IQR 2–8 and median: 3; IQR 1–9; p = 0.09). The oldest patients (Group 4) had significantly shorter length of stay (median: 2; IQR 1–3, p<0.001) than those in Group 1 (median: 3; IQR: 2–8, p<0.001), Group 2 (median: 3; IQR 2–10, p<0.001) and Group 3 (median: 3; IQR 2–8, p<0.001). After admission the average duration until death was 20 days in Group 1, 14 days in Group 2, 10 days in Group 3 and 4 days in Group 4 (median values, Kaplan-Meier estimates).

Overall, the mean SAPS-II was 44.9±21.2, the age-excluded SAPS was 33.7±21.2 and the daily average TISS score was 28.4±10.2. Patients who died had significantly higher SAPS-II levels (59.8±18.4 versus 36.2±17.6, p<0.001), age-excluded SAPS (47.2±18.4 versus 25.8±17.6, p<0.001) and daily average TISS points (33.5±10.4 versus 25.4±8.8, p<0.001) than the survivors. Patients referred to the ICU in 1997 had an average (SD) age-excluded SAPS II score of 27.4 (17.7) compared with 37.7 (19.9) in 2004 (average increase per year 1.2, p<0.001). Table 2 shows the severity of illness in the different age groups, as measured by the SAPS-II, a modified SAPS without age adjustment, and the level of treatment as measured by the daily average TISS score.

The daily average TISS score was negatively correlated to age (r = –0.03; p<0.001) and both the total and the daily average TISS scores were significantly lower in the oldest group (Group 4) when compared with all younger patient groups (p<0.001 each; data not shown for the total TISS score). When the daily average TISS score of survivors and non-survivors was compared within each age group, we found significantly higher scores among non-survivors in all but the oldest group (Group 1: 35.6 vs 25.5, p<0.001; Group 2: 34.7 vs 25.5, p<0.001; Group 3: 32.0 vs. 25.1, p<0.001; Group 4: 24.2 vs 24.3, p = 0.95). Daily average TISS scores among non-survivors in Group 4 were significantly lower than those of non-survivors in all other groups (p<0.001). For the patients overall there was a positive correlation between severity of disease and the daily average level of treatment (r = 0.56; p<0.001). Comparison of the SAPS without age adjustment showed that patients in Group 1 had significantly lower values than patients in the other age groups (ANOVA and Tukey post-hoc test). There were no significant differences in age-unadjusted SAPS II between Groups 2, 3 and 4.

The combined ICU mortality rate of all patients was 27.3%. The ICU mortality rate of the four subgroups increased with age from 24.7% to 27.7%, 30.8% and 36.6% respectively. The mortality rate of the oldest patients aged 85 or over (Group 4) was significantly higher than in patients of Group 1 (OR: 1.8, p<0.001) and Group 2 (p<0.03) but did not differ significantly from patients in Group 3 (p = 0.1784). Results changed only marginally after adjusting for age-excluded SAPS-II and source of

Table 2. SAPS-II, age-excluded SAPS and TISS score in the different age-groups

	SAPS-II (mean±SD)	SAPS without age adjustment (mean ±SD)	Daily average TISS score (mean ±SD)
Group 1; <65 years (n = 1475)	37.7±20.1	30.9±19.3	28.3±10.4
Group 2; 65–74 years (n = 788)	49.4±20.4	35.6±20.3	29.3±10.5
Group 3; 75–85 years (n = 664)	53.4±19.4	36.8±19.3	28.4±9.7
Group 4; ≥85 years (n = 142)	55.5±18.0	37.5±18.0	24.3±7.8

Values are given as mean ±SD.

admission (Table 3). During the period studied, ICU mortality decreased from 26.6 % in 1997 to 21.9% in 2004 (p = 0.75), in contrast to the increasing severity of illness (see SAPS II). Regarding the source of admission, patients admitted to the ICU from within the hospital had higher mortality rates than patients admitted from a public place (p = 0.04; OR: 1.5), even after adjusting for other effects (p = 0.02; OR: 1.7; Table 3).

The age-excluded SAPS-II score had greater impact on variation of mortality (partial R-squared, 4.7%) than either age group (partial R-squared, 0.2%) or source of admission (partial R-squared, 0.02%). The partial R-squared value of age group was significantly lower than that of the age-excluded SAPS-II score (p < 0.001) and not significantly higher than that of source of admission (p = 0.48).

Discussion

In this study we found considerable differences in the prognosis and treatment efforts in a subgroup of very old patients, aged 85 years or more, admitted to the ICU when compared with a younger cohort of ICU patients.

A number of investigators have examined the effect of age on the outcomes of ICU patients [20–23], but few of these reports have concentrated on the very oldest patients and those that did are limited by a small sample size or a missing adjustment for baseline severity of disease. The present report analyzes a large sample size of more than 3000 patients and, for the first time, the investigation was conducted over a period of more than five years.

In the present study, patients aged 85 years or more constituted 5% of all ICU patients. This finding differs from results of an earlier investigation by Chelluri et al. who reported that the oldest patients were only 1% of a similar number of ICU patients [2]. This difference probably relates to changing patient characteristics in intensive care medicine during recent years: the oldest age group is the most rapidly growing age category in the general population and this is reflected in the growing increase of this age group in ICUs. In addition, the shorter follow-up period and the different geographic location of the earlier study might have contributed to the different results. Our data corroborate the more recent Euricus I study that included 89 ICUs in 12 European countries, in which the proportion of patients over 80 years was 8.3% [19]. In the future even higher rates of very old patients will constitute a growing challenge for appropriate medical and ethical decisions relating to questions about ICU admission and treatment limitations.

The relatively high ICU mortality rate of 36.6% that we found in the oldest patients was significantly higher than the rate in patients under 65 (24.7%) and in those aged 65–74 (27.7%), but did not differ in a statistically significant way from the mortality rate in those aged 75–84 (30.8%). Interestingly, the physiologic state of patients had a higher impact on mortality than age alone: the SAPS II without points for age contributed more than the respective age group to the variation in mortality. In particular, in patients aged 85 or over we found a higher ICU mortality rate in addition to increased severity of illness when compared with those aged 65–84 years.

One limitation of this analysis might be related to the relatively small number of patients in the oldest age group. Another point of discussion is the narrow age interval between the age groups that might have inhibited the

Table 3. Predictors of ICU mortality. Crude and adjusted odds ratios estimated by logistic regression

Variable	Crude			Adjusted Age + SAPS without age adjustment + source of ICU admission		
	odds ratio	95% c.i.	p-value	odds ratio	95% c.i.	p-value
Age						
Group 4 (≥85yrs) vs. Group 1 (<65 yrs)	1.7	[1.2; 2.5]	**0.004**	1.5	[1.0; 2.2]	0.041
Group 4 vs. Group 2 (65–74 yrs)	1.5	[1.0; 2.2]	**0.044**	1.5	[1.0; 2.2]	0.063
Group 4 vs. Group 3 (75–85 yrs)	1.3	[0.9; 1.9]	0.25	1.3	[0.8; 1.9]	0.27
Age-excluded SAPS	1.03	[1.02; 1.03]	**<0.001**	1.03	[1.02; 1.03]	**<0.001**
Source of admission						
from a different hospital	0.9	[0.7; 1.1]	0.45	1.0	[0.8; 1.3]	0.98
from a public place	0.9	[0.6; 1.3]	0.70	0.9	[0.6; 1.3]	0.48
from home	1.1	[0.9; 1.3]	0.26	1.05	[0.9; 1.3]	0.67
from within the same hospital (ref.)						

Odds ratios refer to the odds of ICU mortality in comparison with the respective reference group (age and source of ICU admission) or in comparison of two patients differing by one unit in age-excluded SAPS. Crude odds ratios were estimated by regarding one factor at a time. Adjusted odds ratios were computed using a multiple model including all factors simultaneously and can be interpreted as the ratio of the odds of surviving between two patients that differ in only one factor. Missing data were excluded from the univariable and multivariable models (complete case analysis). The variables selected for the multivariable model of Table 3 were chosen on the basis of their clinical relevance and availability in the data base. There were no additional candidate variables.

demonstration of statistically significant differences. On the other hand, similar age classifications have been used in other studies in the literature [1–4], thus facilitating comparison with our results.

Earlier reports revealed a significant decrease in cardiovascular admission diagnoses and an increase in pulmonary disease with increasing age among patients aged 65 or over [24], whereas in the present investigation reasons for admission did not differ between patients in different age groups. Reasons for admission to ICU in a particular hospital inevitably reflect the overall structure of the hospital. In the present study, patients were admitted from all departments of the hospital, but predominantly from internal medicine, neurosurgery and neurology. In addition, the ICU served as an emergency center for patients who were referred directly by emergency ambulance services. This is an important point because these ICU admissions are not subject to the discretion of the attending intensivist, in contrast to admissions from within the hospital. To give an example, a 90-year-old patient already admitted to a general ward might be the subject of a ‘do not admit to the ICU’ decision when deteriorating, whereas an emergency ambulance service will bring a similar patient for ICU admission in any case. In our opinion this organizational variable is one explanation of why the oldest patients have a shorter ICU length of stay. Some patients who are brought to the ICU via the emergency ambulance service may be considered as inappropriately admitted to the ICU and discharged to a general ward as soon as possible; this process might be more frequent in very aged patients. Another explanation of the shorter mean length of ICU stay in the oldest patients could be related to the higher short-term mortality (patients in the oldest age group died after a median duration of four days, whereas younger patients died after 20, 14 and 10 days, respectively).

The present results show that both the total and the daily average TISS scores in elderly patients were significantly lower than in younger ones and that the daily treatment effort decreased in association with increasing age. However, interpretation of this finding is not as easy at it first appears. A study of more than 80 000 patients showed that the need for treatment during the first 24 hours, as determined by the TISS score within this period, was significantly lower in patients over 75 years, even if their mortality rate and scores of disease severity were higher than those of younger patients [25]. The authors speculated that the unexpectedly higher level of treatment activity in the younger age group could reflect over-treatment of these patients. The TISS score was provided during the very first 24 hours only, whereas our data report on the total therapeutic effort determined by the sum of daily TISS scores during the entire ICU stay, in addition to the daily average TISS score. However, our data show an interesting detail: in contrast to other age groups, the TISS score in the oldest patients did not differ between survivors and non-survivors. This observation might reflect an approach that is based on a limited therapeutic effort which is provided to give a chance of physiologic stabilization but is not intensified in case of missing a response in the oldest patients. This approach might be particularly justified in these patients, who may have at least a fair level of function and independency in daily life. To be picked up from public places by emergency ambulance services can indicate that a fair level of treatment activity would be appropriate in these very elderly patients. In fact, a public place as source of admission is associated with a better prediction for survival than other sources of admission to the ICU. Unfortunately our database does not include outcome data on levels of functioning and independency and therefore no firm conclusions on the justification of medical effort in very old patients can be drawn in this context.

In general, our study is limited by the fact that we do not provide follow-up data and therefore our data do not provide estimates on quality of life or patients‘ personal preference after discharge from ICU. We are aware that the missing information on level of functioning and independency limits the conclusions of the study. Earlier studies justified the adoption of intensified treatment measures in older patients with severe sepsis, as they increased survival rates of those patients [26]. Furthermore, costs associated with gained quality-adjusted life years in older patients were shown to range within generally accepted limits for other potentially life-saving treatments [27].

In conclusion, within the very elderly population, age by itself appears to be an independent outcome predictor in patients admitted to our ICU, but acute severity of illness is even more strongly associated with mortality. Thus, age alone may be an inappropriate criterion for allocation of ICU resources and the very old should not be denied critical care simply based on age.

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