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ORIGINAL ARTICLE

Outcome of older persons admitted to intensive care unit, mortality, prognosis factors, dependency scores and ability trajectory within 1 year: a prospective cohort study

Claude Level[1] · Eric Tellier[2] · Patrick Dezou[3] · Karim Chaoui[1] · Aissa Kherchache[4] · Philippe Sejourné[5] · Anne Marie Rullion-Pac Soo[5]

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Abstract

Background The outcome and functional trajectory of older persons admitted to intensive care (ICU) unit remain a true question for critical care physicians and geriatricians, due to the heterogeneity of geriatric population, heterogeneity of practices and absence of guidelines.

Aim To describe the 1-year outcome, prognosis factors and functional trajectory for older people admitted to ICU.

Methods In a prospective 1-year cohort study, all patients aged 75 years and over admitted to our ICU were included according to a global comprehensive geriatric assessment. Follow-up was conducted for 1 year survivors, in particular, ability scores and living conditions.

Results Of 188 patients included [aged 82.3 ± 4.7 years, 46% of admissions, median SAPS II 53.5 (43–74), ADL of Katz's score 4.2 ± 1.6, median Barthel's index 71 (55–90), AGGIR scale 4.5 ± 1.5], the ICU, hospital and 1-year mortality were, respectively, 34, 42.5 and 65.5%. Prognosis factors were: SAPS 2, mechanical ventilation, comorbidity (Lee's and Mc Cabe's scores), disability scores (ADL of Katz's score, Barthel's index and AGGIR scale), admission creatinin, hypoalbuminemia, malignant haemopathy, cognitive impairment. One-year survivors lived in their own home for 83%, with a preserved physical ability, without significant variation of the three ability assessed scores compared to prior ICU admission.

Conclusion The mortality of older people admitted to ICU is high, with a significant impact of disabilty scores, and preserved 1-year survivor independency. Other studies, including a better comprehensive geriatric assessment, seem necessary to determine a predictive "phenotype" of survival with a "satisfactory" level of autonomy.

Keywords Older persons · Intensive care unit · Survival · Ability and ADL scores · Comprehensive geriatric assessment · Ethics

Introduction

"To be alive is also to be made of memory"
Philip Roth, Patrimony. To my parents.

The number of older people in the world is constantly increasing as a result of intricate phenomenae such as the fall in the birth-rate, the baby-boom of the post-war period, medical progress and the improvement of social protection [1]. All those factors combined have resulted in a progressive lengthening of life expectancy, and a constant growth in the age structure pyramid since the Sixties in Western countries, including France [1, 2]. In parallel, the number of older persons admitted to intensive care unit (ICU) increases, with a proportion of up to 50% for patients aged 65 years and

✉ Claude Level
sylvie.tandt@wanadoo.fr

1 Intensive Care Unit, Jean Rougier Hospital, 335, Président Wilson's Street, 46000 Cahors, France

2 Emergency Department, Pellegrin Hospital, 33000 Bordeaux, France

3 Geriatric Medical Unit, Nerac Hospital, 47600 Nerac, France

4 Intensive Care Unit, Saint Esprit Hospital, 47000 Agen, France

5 Department of Medical Computing, Saint Esprit Hospital, 47000 Agen, France

over, and on average about 35% of admissions for patients older than 70–75 years [3].

Identifying the factors associated with a poor outcome should be obvious to all physicians involved in ICU, essentially to guide clinical decisions and early discussion of care goals [4]. However, short- and long-term outcomes of older people admitted to ICU still remain a real question for ICU physicians and geriatricians, as well as functional trajectory which is not well known before and after critical illness. In French studies, octogenarians mortality varies from 17 to 50% in ICU, 28 to 62% in hospital and about 70% after 1 year ICU discharge [3]. In international studies, ICU mortality is about 25% for patients known as "scheduled surgery", and about 45–55% for patients known as "medical" or "unscheduled surgery" [1]. For 6–12 months outcome, octogenarians mortality rate is also very high, variable from 50 to 89% for "medical" and unscheduled surgery patients, and about 50–60% for the scheduled surgery patients [5, 6].

After critical illness, little is known about functional decline and disability in older persons. Indeed, critical illness may create functional disability and further compromise preexisting frailty, premorbid organ reserve, organ dysfunctions, and development of post-critical illness, physical incapacity, functional and/or cognitive decline, and dysautonomy [6]. A few studies have, however, shown that 1-year physical capacity and quality of life seem to be acceptable for survivors, and that functional trajectory in the year following ICU admission is strongly influenced by pre-ICU conditions and ability [6–8]. One of the difficulties to evaluate the level of autonomy is due to the heterogeneity of geriatric people and non-systematic standardized scores. Furthermore, little is known about comprehensive geriatric assessment (CGA) for emergencies and ICU patients [9]. In general practice, it is recognized that CGA allows a significant reduction in functional decline and an improvement of the mental status without additional costs but also without survival improvement [10]. This concept and, in particular, ability assessment with validated scores is not yet a part of the everyday routine of ICU and emergency services [9, 11]. The absence of expert consensus and guidelines explains partly the difficulties of adapted treatment, ethical course and also the heterogeneity of practices. Faced with a structural deficit that includes administrative closing of beds in hospital, nursing staff reduction, saturation point of "downstream" services, medical teams are also forced to make choices that will impact on the oldest and frailest patients [11–14]. "Upstream" strategies of anticipation, based on a CGA from emergency units nevertheless seem essential for a more adapted plan of care without abandonment, age discrimination or, on the opposite, unreasonable obstinacy. All those considerations, and their associated ethical questions should encourage and foster a better knowledge, a more systematic assessment of older patients, to avoid the dual pitfall of either under-use or over-use of the ICUs, through enhanced cooperation with geriatric departments [13].

The objective of this study is, firstly, to determine the mortality and prognosis factors, including ability scores, for older persons admitted to intensive care unit, and, secondly, to describe the outcome, in particular the functional trajectory for 1-year survivors.

Methods

Study population

The study was performed at Saint Esprit Hospital, a non-university tertiary care hospital based in Agen, France (400 hospital beds, and a yearly volume of 186,000 hospitalization-days and 29,000 in-patients). The ICU includes 12 beds, and a care team of five physicians, 36 nurses, 24 auxiliary nurses, physiotherapists and dieticians, as well as a hospital mobile geriatric care team and mobile palliative care experts. The study is observational, without modification of the usual care protocols, and in particular without additional invasive procedure. Confidentiality and medical secret were fully respected when informing patients and family. Consent was given by the hospital management director, as well as the People Protection and Ethics Committee of the district.

Data collection from admission to ICU discharge

Period of inclusion was from 1 March 2014 to 1 March 2015, and the follow-up was performed for 1 year after hospital discharge, until 1 March 2016. All patients aged 75 years and over admitted to ICU were included in the study, with no predefined criteria, according to a comprehensive geriatric assessment including reason for ICU admission, severity of illness (SAPS II), health status (McCabe's score, Knauss's classification, Charlson's score, Lee's score), cognitive impairment (preexisting in medical file, MMSE or hetero-evaluation from relatives with short IQ CODE.), nutritional status (BMI, albuminemia) and functional status (ADL of Katz's score, Barthel's index, AGGIR scale).

One-year follow-up

Data for 1-year outcome was systematically assessed over a standardized telephone consultation with survivors, the objective of which was to evaluate ability scores, the need for assistance or nursing care at home, and disorders expressed by the patient such as sleep disorders (yes/no), memory disorders (yes/no) and mood disorders (mini GDS > 1). When the patient was unable to answer, information was provided by the primary care physician or home relatives.

Table 1 (continued) [e]Acute kidney injury score according to KDIGO 2012 classification not documented

Statistical analysis

The main aim was to describe not only the short-term (ICU and hospital) but also the 1-year outcome, prognosis factors and functional trajectory for people 75 years and older admitted to ICU according to a comprehensive global geriatric assessment. ICU mortality, intensity of care and procedures in ICU were also compared to younger people < 75 years admitted over the same period. Results are reported as mean ± SD if normally distributed, and as median with interquartile range (IQR) otherwise. Population characteristics were initially studied using the tests of Fisher, Student and *U* of Mann–Whitney (threshold for significance $p<0.05$). In a second phase, an analysis of survival was performed, using the Cox model of proportional risks.

Results

During the 1-year study period, 402 patients were admitted to ICU [mean age 68.4 ± 16 (16–98), sex-ratio 1.63, median SAPS II 51 (41–73), mean length of stay 7.6 ± 11.5 days, median 4 days [3–10]).

One hundred and eighty-eight patients aged 75 years and over were included in the study (46% of the admissions, sex ratio 1.5, median SAPS II 53.5 (43–74), mechanical ventilation 84%, including endotracheal procedure in 51% and non invasive ventilation in 33%, catecholamine in 60.6%, renal replacement therapy in 10.5%). The characteristics of illness severity and reasons for ICU admission are shown in Tables 1 and 2. The complete data represent 188 full observations of 60 variables (no missing data).

Clinical course and short-term outcome in ICU and hospital

The median ICU and hospital length of stay were respectively 5 days [2–9] and 17 days [12–39]. ICU and hospital mortality were, respectively, 34% ($n=64/188$) and 42.5% ($n=80/188$). Some geriatric syndromes are also noted, in particular, confusion for 50% (ICU-CAM score), swallowing disorders for 8.6%, and pressure ulcers for 9.6% at ICU admission (median Norton's score 15 IQR [12–20], risk if < 16). At ICU discharge, the incidence of pressure ulcer was 25%, considering the high proportion of diabetic 32.5%, and bedridden patients 7.5% (significant correlation with the length of stay > 9 days, and use of vasopressors OR 4, IQR 2–7.9, $p<0.001$), but not with age ($p=0.2$), BMI ($p=0.8$) or albumin ($p=0.07$). Compared to younger patients < 75 years admitted to ICU over the same period, the median SAPS 2 was not significantly different (53.5 vs 48, $p=0.27$), mortality was significantly higher (34.5 vs 20.5%, $p=0.02$), the withdrawal decisions were significantly higher (27 vs 4%, $p<0{,}001$) while the intensity of care was significantly lower (Table 3).

Outcomes and predictors for 1-year mortality

Mid- and long-term survival follow-up was available for the 108 hospital survivors, with a 6 month and 1-year mortality, respectively, of 52.5% ($n=99/188$) and 65.5% ($n=123/188$). The Kaplan–Meier survival curve is illustrated on Fig. 1. Mortality predictor factors (univariate and multivariate analysis) are summarized in Table 4. In the analysis of patients treated with mechanical ventilation (84%, $n=158$), when comparing the subgroup without ventilation support to those treated with endotracheal ventilation (ETV 51%, $n=96$) or non-invasive ventilation (NIV 33%, $n=62$), the relation between mechanical ventilation and outcome was stronger, with a significant difference for 1-year mortality, respectively, 50, 59.5 and 76.9% ($p=0.004$). In those three subgroups, there were no differences in age, comorbidity [Charlson score, Lee score, McCabe's score, Knauss's classification), and dependency scores (ADL of Katz's score, Barthel's index, AGGIR scale], but a significant difference in SAPS2 (33.7 [18.5–46.5] vs 31.9 [19.3–43], vs 49.3 [31–66.3], $p<0.001$) and albumin (0.24.1 vs 28.3 vs 23.2 g/l, $p<0{,}001$). In multivariate logistic regression adjusted with albumin, the impact of mechanical ventilation support persists for 1-year mortality (ETV OR = 3.2 [1.5–7], NIV OR = 1.6 [0.6–4]).

Characteristics and outcome for 1-year survivors (Table 5)

One-year survival was 34.5% [mean age 82.4 ± 5.1 years, median SAPS II 43 (35–51), significantly lower vs 1-year dead patients 64 (48–82), $p<0.001$]. The near totality of patients (98.5%) was transferred after ICU discharge to a medical or surgical care unit, while 33% of them were admitted to follow-up and rehabilitation care unit. At 1-year follow-up, 83.1% of survivors lived in their own home, with a preserved physical ability (mean ADL of Katz's score 4.61 ± 1.5, median 4.5 [3.5–5.5], no significant variation compared to previous ICU admission − 0.5 [− 1 to 0]; mean Bathel's index 70.5 ± 19.5, median 82 (65–92), no significant variation compared to previous ICU admission − 8 [− 16 to 0]; mean AGGIR scale 4.85 ± 1.35, median 3 [1.5–3], no significant variation compared to previous ICU admission − 1 [− 1 to 0]).

Table 1 Characteristics at admission in ICU ($n=188$)

General characteristics	
Age (mean ± SD, years)	82.3 ± 4.7
Female % (*n*)/sex ratio	39.9 (75)/1.5
Nursing residence % (*n*)	14.3 (27)
Home % (*n*)	85.7 (161)
Type of admission (%)	
Emergencies	51
Medical emergency service	8
Hospital	41
Medical unit	26.6
Surgical unit	14.4
Health status, pre-existing medical conditions and comorbidity	
Drugs (n = mean ± SD)	7.4 ± 3.6
Cardiac failure[a] %	47.9
Hypertension %	73.9
Cardiac rhythm disease %	39.4
Coronary disease %	25
Arteriopathy %	10
Chronic respiratory disease[b] %	33.5
Diabetes	32.5
Chronic kidney disease[c]	31
Malignant haemopathy[d] %	7.5
Cancer %	17.6
Cirrhosis %	2.7
Stroke %	11
Cognitive impairment[d] %	12
Nutritional status	
BMI (kg/m^2) median [IQR]	25 [23–30]
Albumin (g/l)/prealbumin (g/l) median [IQR]	25 [19–29]/0.14 [0.03–0.2]
Swallowing disorders (assessed by standardized functional test) (%)	8.6
C-reactive protein (mg%), mean (median) [IQR]	86 (35.3) [12–129]
Admission creatinin[e] (μmol/l), mean (median) [IQR]	149.7 (115) [71–178]
GFR (Cockroft ml/mn), mean (median) [IQR]	46 (39.7) [25.5–64]
Charlson's score (mean ± SD)	7.3 ± 2.2
Lee's Index (mean ± SD)	14 ± 4
Mac Cabe's classification (%)	
0: underlying disease. none or non-fatal	11.20
1: underlying disease expected to cause death within 5 years	64.4
2: underlying disease expected to cause death within 1 year	24.5
Knaus's chronic health status score (%)	
A: Normal health status	8
B: Moderate activity limitation	46.3
C: Severe activity limitation due to chronic disease	38.3
D: Bedridden patient	7.5
Ability scores	
Katz's ADL score (mean ± SD)	4.2 ± 1.6
Barthel's index (median IQR)	71 [55–90]
AGGIR scale (mean ± SD)	4.5 ± 1.5

[a]According to the European Society of Cardiology 2008 (guidelines for heart failure's diagnosis, clinical syndrom, history of pulmonary oedema and/or sytolic or diastolic dysfunction in echocardiography)

[b]According to the American Thoracic Society guidelines 2011 (clinical and gazometric or spirometric criteria for COPD, asthma and ILD)

[c]According to KDIGO 2012 (clinical practice guideline for Chronic Kidney Disease, GFR < 60 ml/min/1.73 m^2)

[d]Etiology and evolution undocumented

Table 2 Illness severity and admission diagnosis

SAPS II	
Median, IQR	53.5 [43–74]
Corrected for points related to age[a] (median, IQR)	37.5 [25–56.5]
Admission category	
Medical % (*n*)	93 (174)
Surgical % (*n*)	7 (14)
Unscheduled	4 (8)
Scheduled	3 (4)
Main symptoms and admission diagnosis (%)	
Acute respiratory failure	24.5
ARDS or pneumonia with severe hypoxemia	11
Acute COPD exacerbation	13
Pulmonary embolism	0.5
Infectious disease	24
Septic shock	18
Severe sepsis	6
Cardiovascular failure	20
Congestive heart failure, cardiogenic shock, cardiogenic oedema	11
Cardiac arrest	6
Others (coronary artery disease, rythm disturbance)	3
Haemorragic and other shock	6
Acute kidney failure	7
Others metabolism disorders (diabetic ketaoacidosis, dysnatremia, Dyskaliemia)	3,6
Neurological (coma, stroke, status epilepticus)	7,7
Trauma	2.7
Suicide	2
Others	2.5

[a]Patient aged 75–79 years: – 16 points; patient aged 80 and over: – 18 points

Discussion

This study confirms the important mortality for older people admitted to ICU (34% in ICU, 42.5% in hospital, 52.5% at 6 months and 65.5% at 1-year follow-up, Fig. 1). In the ICE CUB 1 French cohort study, covering 2646 patients aged 80 years and over, immediate mortality is 33%, and 51% at 6 months [14]. In a recent study, Peigne et al. also demonstrated that ICU mortality (38% for octagerians) increased with age between 40 and 80 years, as well as SAPS2 and whatever the intensity of care and organ failure treatment [15]. In a prognostic model for 6-month mortality in elderly survivors of critical illness, Baldwin et al. demonstrated that disability and morbidity are strong variables for outcome, as well as patient preferences regarding resuscitation and advanced directives [16]. In a recent study, Ducos et al. showed that age > 70 years and SAPS2 were both correlated to limitation or withdrawal of life-sustaining treatment, but that age > 70 years alone was not an independent factor for mortality in ICU [17]. Otherwise, functional status seems to be a very strong predictor of 1-year mortality, from 43% to 67.5% for severely disabled older people [8]. In our study, the 1-year mortality predictors are:

- SAPS2 ($p < 0.001$, multivariate analysis)
- Ability scores: ADL of Katz's and Barthel's index score (univariate analysis, respectively $p = 0.02$ and $p = 0.04$) and AGGIR scale (multivariate analysis $p = 0.009$)
- Co-morbidity (Lee's score $p = 0.002$, Mac Cabe's $p = 0.004$, multivariate analysis)
- Mechanical ventilation ($p < 0.02$, univariate analysis, $p < 0.004$ multivariate analysis, OR 3.6 for endotracheal ventilation, OR 1.6 for non invasive ventilation)
- Admission creatinine (167 micromol/l vs 117micromol/l, $p < 0,004$ univariate analysis)
- Admission albumin < 25 g/l ($p = 0.03$, univariate analysis)
- Hospitalization 6 months prior to ICU admission ($p = 0.03$, univariate analysis)
- Type of admission and provenance (p = 0.007, multivariate analysis)
- Cognitive impairment and malignant haemopathy ($p = 0.01$, multivariate analysis).

Table 3 Intensity of care, mortality and procedures in ICU

Procedures and treatments for 188 patients > 75 years				
Oxygenotherapy % (*n*), (l/mn, median, IQR)				75 (142), (5.5 [3–10])
Mechanical ventilation				
Endotracheal % (*n*)				51 (96)
Non-invasive % (*n*)				33 (62)
Catecholamines % (*n*)				60.6 (114)
Arterial catheter % (*n*)				53 (101)
Central venous catheter % (*n*)				66 (124)
Renal replacement therapy % (*n*)				10.5 (20)

	All	≥ 75 years	< 75 years	*p* value (Fisher's test)
Mortality and intensity of care for patients aged > 75 and over vs < 75 years				
Admission into ICU % (*n*)	100 (402)	46 (188)	54 (214)	–
Median SAPS II	51	53.5	48	$p=0.27$
Mortality % (*n*)	24.5 (99)	34 (64)	20.5 (44)	$p=0.023$
Mechanical ventilation				
Endotracheal % (*n*)	69 (276)	51 (96)	83 (180)	$p=0.002$
Non-invasive *n* % (*n*)	52 (209)	33 (62)	66 (147)	$p<0.001$
Cathecholamines % (*n*)	48 (192)	35 (66)	59 (126)	$p=0.005$
Renal replacement therapies % (*n*)	21 (87)	10.5(20)	31 (67)	$p<0.001$
Withholding and withdrawing life-sustaining treatment % (*n*)	15 (60)	27 (51)	4 (9)	$p<0.001$

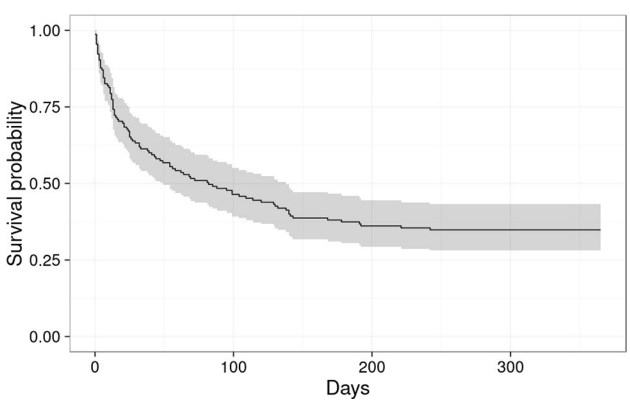

Fig. 1 Survival from ICU admission. Kaplan–Meier survival curve ($n=188$)

All these results are in agreement with previous publications and reviews of literature [8, 11–21]:

Considering the requirement of mechanical ventilation, previous studies have already shown that invasive ventilatory support is associated with hospital and 1-year mortality, but also longer length of weaning, and risk of disability, strongly correlated with age > 75 years [22–26]. Denutrition has also been previously published as an important predictor in-ICU mortality and mortality at 6 months [27].

Non-invasive ventilation is also the first choice of ventilatory technique in diseases such as COPD, cardiogenic pulmonary edema, obesity, hypoventilation, and immunosuppression pneumonia, which have also a high prevalence in the elderly, offering the advantages of the same physiological effects than invasive ventilation, without the risks correlated with the use of an artificial airway (barotraumatism, ventilator-acquired pneumonia) and sedative drug-related complications [28]. In our study, there was a significant difference in 1-year mortality when we compared the patients treated with endotracheal vs non-invasive ventilation (59.5 vs 76.9%, $p=0.004$), confirming previous studies that also demonstrated the benefit of NIV in the elderly [28, 29]. In a recent study in older patients > 75 years with acute hypercapnic respiratory failure, NIV is associated with a decrease of the rate of endotracheal intubation and a higher in-hospital 6 and 12 months survival rate [29].

This non-invasive strategy is also an adequate alternative for the patients considered as poor candidate for intubation (end-stage chronic cardio-pulmonary disease, advanced solid cancer, palliative situation or "do not intubate" order) [28]. In any case, when the benefit of ICU is uncertain, an ICU trial encouraging a first line non-invasive treatment may be an alternative choice to non-adapted invasive treatment. Such a strategy should indeed be proposed and implemented until all the following information is available: individual advanced directives and wishes, family and primary care physician opinions, patient reality based on global geriatric assessment and ethical reflexion process. The ultimate goal of this approach is to avoid a reduction in the chance of

Table 4 Univariate and multivariate analysis for factors associated to 1-year mortality

Variables	RR 95% CI	*p* value
Univariate analysis		
Age (years)		0.65
[75–78]	1	
[78–82]	1.3 [0.77–2.22]	
[82–86]	1.2 [0.72–1.99]	
> 86	1.1 [0.65–1.86]	
Male sex	1.55 [1.06–2.25]	0.02
SAPS 2[a]	1.03 [1.02–1.04]	< 0.01
Hospitalization 6 month prior ICU admission	1.53 [1.03–2.25]	0.03
Type of admission and provenance		0.002
Emergency unit	1	
Nursing home	4.52 [1.75–11.63]	
Medical unit	1.69 [1.04–2.73]	
Surgical unit	1.23 [0.67–2.25]	
Emergency mobile medical team[b]	3.4 [11.7–2.73]	
Geriatric unit	4.77 [1.14–20.02]	
Mechanical ventilation	2.65 [1.37–5.23]	< 0.002
Albumin < 25 g/l	1.74 [1.21–2.54]	0.03
Chronic kidney disease	1.51 [1.01–2.27]	0.05
Lee's score	1.07 [1.03–1.11]	< 0.001
ADL of Katz's score	0.88 [0.8–0.98]	0.02
Barthel's index	0.99 [0.98–1]	0.04
Mac Cabe's score 1	0.99 [0.5–2.01]	< 0.001
Mac Cabe's score 2	2.35 [1.22–4.96]	
Cognitive impairment	2.02 [1.18–3.45]	0.01
Malignant haemopathy	3.22 [1.7–6]	< 0.001
Multivariate analysis		
Age (ans)		0.31
[75–77]	1	
[78–81]	1.76 [0.94–3.31]	
[82–85]	1.13 [0.62–2.07]	
> 86	1.34 [0.70–2.54]	
SAPS 2	1.04 [1.03–1.05]	< 0.001
Type of admission		0.007
Emergency unit	1	
Nursing home	4.27 [1.63–11.21]	
Emergency mobile medical team[b]	3.04 [1.42–6.48]	
Geriatric unit	3.76 [0.84–16.75]	
Medical unit	1.32 [0.8–2.17]	
AGGIR scale	1.3 [1.07–1.58]	0.009
Lee's score	1.07 [1.03–1.12]	0.002
Mac Cabe's score 1	1.7 [0.74–3.92]	0.004
Mac Cabe's score 2	4.35 [1.57–12]	
Cognitive impairment	2.29 [1.15–4.57]	0.01
Malignant haemopathy	3.37 [1.68–6.76]	< 0.001

[a]Global or corrected for points related to age

[b]SAMU in France

Table 5 Characteristics and functional trajectory for 1–year survivors ($n=65$)

General characteristics of survivors within 1 year ($n=65$)	
Age (years. mean ± SD)	82.4 ± 5.1
SAPS II (mean, median, IQR)	45.4 (43) [35–51]
Place of life % (*n*)	
Home	83.1 (54)
Nursing residence	16.9 (11)
Abiltiy scores (median, IQR)/variation prior ICU admission	
ADL of Katz's score	4.5 [3.5–5.5]/− 0.5 [− 1 to 0]
Barthel's score	82 [65–92]/− 8 [− 16 to 0]
AGGIR scale	3 [1.5–3]/− 1 [− 1 to 0]
Auxiliary of life % (*n*)	34 (22)
Numbers of hours per week (mean ± SD)	5.5 ± 3.3
Nurse coming at home for primary care % (*n*)	30 (20)
Numbers of hours per week (mean ± SD)	4.5 ± 3.8
Physiotherapy % (*n*)	16 (11)
Complaints and disorders % (*n*)	
Sleep	24.6 (16)
Mood (miniGDS > 1)	21.5 (14)
Memory	18.5 (12)
Trajectory before return home or nursing residence % (*n*)	
Hospitalization in medical or surgical unit after ICU discharge	98.5 (64)
Follow-up and rehabilitation care unit admission	34(22)

	Survivors ($n=65$)	Non survivors ($n=123$)	*p* value
Comparison of survivors and non survivors within 1 year			
Age (years, mean ± DS)	82.4 ± 5.1	82.2 ± 4.6	0.86
Female sex (%)	47.7	33.3	0.018
Length of stay (days,median, IQR)			0.32 0.52
ICU	5 [2–8]	5 [3–11]	
Hospital	17 [12–44]	18 [11.5–30.5]	
Albumin (g/l, median,IQR)	26 [20.9–32.1]	24.7 [18.6–28.1]	0.04
Renal function			
Admission creatinin (µmol/l, mean, median, IQR)	117 (85) [59–151]	167 (124) [83–180]	<0.004
ICU discharge creatinin (µmol/l, mean, median, IQR)	100 (81) [60–125]	143 (104) [65–185]	0.049
SAPS II (median, IQR)	43 [35–51]	64 [48–82]	< 0.001
ADL of Katz's score (mean ± SD)	4.6 ± 1.5	3.9 ± 1.6	0.003
Barthel's index (median, IQR)	82 [65–92]	65 [50–85]	0.006
AGGIR Scale (mean ± SD)	4.85 ± 1.3	4.2 ± 1.6	0.007
Charlson's score (mean ± SD)	6.6 ± 1.7	7.7 ± 2.3	0.001
Lee's score (mean ± SD)	12.3 ± 3.8	15 ± 1.5	< 0.001
Mac Cabe's score (*n*)			
0	12	9	0.03
1	49	72	0.03
2	4	42	< 0.001
Hospitalization prior to 6 months % (*n*)	52 (34)	87 (107)	0.02
Cognitive impairment % (*n*)	3 (2)	20 (25)	0.02

survival, inadequate renunciation linked to “silent ageism” or again futile aggressive therapy and obstinacy [11–13].

In any case, if critical illness carries substantial risks of death, it also provides disablement process, resulting in functional limitations, disability, chronic critical illness, loss of autonomy and poor quality of life and well being [7, 9]. In our study, it is clearly shown that disability is also a very strong outcome predictor, according to the significant convergence of the three studied scores in univariate and multivariate analysis (ADL of Katz’s score, Barthel’s index and AGGIR scale). To date, the link between ability score and outcome is, however, the subject of controversy according to different previous studies, with a difficulty in synthesis partly explained by the heterogeneity of the used scores.

In the study of Roch et al. [20], the functional autonomy evaluated by the score of Knauss and the index of Karnofsky is not associated to a significant degree with mortality. Tabah et al. [30] did not find any relation between ADL of Katz’s score and 1-year mortality for octogerians, but with a very small number of survivors. In the study of Somme et al. [5], it is shown that 3-month mortality depends on the age (OR 2.25 for the patients > 85 years) but also on the presence of one type of daily living dependency at admission to ICU (OR 1.74). In the French cohort study ICE CUB 1 [14], disability was associated with the refusal of admission, but the impact on mortality was not evaluated. Recently, Ferrante et al. highlighted that the functional trajectory and the outcome were particularly poor for older people with high level of premorbid disability [8].

To date, it is clear that functional assessment is not yet included in ICU culture, without ability score in routine use. Otherwise, this assessment is not always concordant with the family evaluation, often underestimated for patients refused for ICU admission and, on the contrary, overestimated for admitted patients [1, 13]. In daily practice in ICU, the original version of ADL of Katz’s score is probably the easiest to use in ICU including only six basic items to assess locomotion, transfers, preparing, food intake, toilet and continence (score 0 means completely dependent, and score 6 means completely independent) [31]. Barthel’s index includes ten items and is more time-consuming, but its main advantage is that it is also validated to follow the functional advances in ICU or after discharge into rehabilitation unit [32]. AGGIR scale is not strictly an ability score (originally used for the allocation of dependency-related allowances for older people in France), but it also easily provides information about autonomy capacities (physical, mental, domestic and social), classifying the elderly into homogeneous groups (from GIR1 meaning dependency in all daily activities, to GIR 6 meaning total functional autonomy). In a study among 31,603 patients still alive after the 2003 Paris heat wave, dependency and GIR groups were identified as independent factors of mortality for community and nursing home patients [33]. To our knowledge, no other study has previously described the relevance of those three combined ability scores for older persons in ICU. In our study, frailty was not evaluated by a specific score, but an important point for intensive care physicians is to remember, first, the link between frailty, sarcopenia, functional dependency and mortality in the short, mid and long term, for medical and surgical patients [6, 11–13] and, second, that frailty indicators are associated with the disability and disablement process such as “domino effect pathologies” [6]. In a recent French study, mortality at 6 months was significantly higher for older patients with frailty phenotype based on an assessment with Fried’s score and Rockood’s score [34].In another study, frailty is also already identified as an independent risk factor of non-invasive ventilation failure and mortality [35]. In our opinion, frailty score should also be routinely included in ICU as part of an integrated strategy to avoid failure of treatment and improve plan care based on the reality of the patient. For 1-year survivors, this study also describes a preserved ability, living for 83% in their own home (median ADL of Katz’s score 4.5 [3.5–5.5], median Barthel’s index 82 [65–92], median AGGIR scale 3 [1.5–3], non-significant variation compared to previous ICU admission, respectively, − 0.5 [− 1 to 0], − 8 [− 16 to 0] and − 1 [− 1 to 0]). The need for assistance or nursing care at home was, respectively, 34 and 30%, with a low intervention time compared to the INSEE report (43 h per week for all AGGIR scales according to the 2016 findings of the French National Institute of Statistics and Economic Studies). Our results are in agreement with previous studies and reviews of literature [36, 37]. In the study of Tabah et al., 80% of the 1-year octogenarian survivors are self-sufficient in ADL [30]. In the study of Roch et al., quality of life assessed by the SF36 score is globally impacted by physical health, but pain, emotional wellness and social function remain preserved [20]. In the study of Sacanella et al., 1-year survivors have a functional status and a quality of life similar to the general population, but a twofold increase in geriatric syndrome was noted [38].

Another cohort also demonstrated that 88% of 1-year survivors had a satisfactory health-related quality of life, at least comparable to that of the age- and sex-matched general population [39]. One last study demonstrated on the other hand a significant deterioration based on Barthel’s index, without recovery at 1-year follow-up, with moderate to severe dependency for 20.3% of 1-year survivors [40]. To our knowledge, no multicentric and international study is published to determine a profile of survival and maintenance of a favorable functional autonomy after critical illness.

Conclusion

In this study, the 1-year mortality of older people admitted to ICU was 65.5%, while survivors' ability remained preserved (83% live at home, with maintained autonomy in ADL). Predictive factors identified were mainly SAPS2, co-morbidity (Lee and Mac Cabe's scores), mechanical ventilation, admission creatinine, admission albumin < 25 g/l, and also ADL of Katz's score, Barthel's index and AGGIR scale which were all significantly associated with 1-year outcome.

A more systematic comprehensive geriatric assessment (CGA), including, in particular, disability, frailty and morbidity scores, as well as cooperation and learning with geriatricians, should be promoted and adapted in ICU, for a more efficient strategy, plan of care, follow-up and improvement of the pathway of care within hospital [13]. Indeed, CGA driven by a systematic geriatric opinion in ICU has already shown, especially for unscheduled ortho-geriatrics surgery, a significant improvement of care and decrease in mortality [41, 42]. All those results and comments justify the relevance and the challenge of a specialist geriatric line for intensive care medicine, particularly ability evaluation with validated scores for activities in daily living. Further and larger multicenter studies are necessary with regard to quality of life, and to try to determine a profile or predictive "phenotype" of survival and maintenance of a favorable functional autonomy after ICU experience [43].

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Compliance with ethical standards

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Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval The study is observational and all the procedures were included in our protocols of usual care, in accordance with the ethical standards of the institutional research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent The confidentiality and medical secret was also fully respected with individual and family informed consent. Consent for this study was also given by the hospital management director, as well as the People Protection and Ethics Committee of the district.

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