CLINICAL INVESTIGATION

Frailty and survival in elderly intensive care patients in Norway

Finn H. Andersen[1,2] | Øystein Ariansen Haaland[3] | Pål Klepstad[4,2] |
Hans Flaatten[5,6]

[1]Department of Anesthesiology and
Intensive Care, Ålesund Hospital, Helse
Møre and Romsdal Health Trust, Ålesund,
Norway

[2]Department of Circulation and Medical
Imaging, Norwegian University of Science
and Technology, Trondheim, Norway

[3]Department of Global Public Health and
Primary Care, University of Bergen, Bergen,
Norway

[4]Department of Intensive Care, Clinic of
Anesthesia and Intensive Care, St. Olavs
Hospital, Trondheim, Norway

[5]Department of Intensive Care, Anesthesia
and Surgical Services, Haukeland University
Hospital, Bergen, Norway

[6]Department of Clinical Medicine, University
of Bergen, Bergen, Norway

Correspondence
Finn H. Andersen, Helse Møre and Romsdal
Health Trust, Ålesund hospital, Department
of Anesthesiology and Intensive Care, 6026
Ålesund, Norway.
Email: finn.andersen@ntnu.no

Background: Today, 10%-15% of Norwegian intensive care patients are ≥80 years. This proportion will increase significantly over the next 20 years, but it is unlikely that resources for intensive care increase correspondingly. Thus, it is important to establish which patients among elderly people will benefit from intensive care. The main objective of the study was to investigate the relationships between geriatric scoring tools and 30-day mortality.

Methods: The study included 451 Norwegian patients ≥80 years who were included in two prospective European observation studies (VIP (very old intensive care patient)1 of VIP2). Both studies included clinical frailty scale (CFS) while VIP2 also obtained the geriatric scores, comorbidity and polypharmacy score (CPS), Short Form of Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), and Katz Activity of Daily Living score (Katz ADL).

Results: Survival after 30 days was 59.9%. Risk factors for 30-day mortality were increasing Sequential Organ Failure Assessment (SOFA) score (odds ratio (OR) 1.30; confidence interval (CI) 95% 1.22-1.39) and (CFS) > 3 (CFS 4: OR 1.96 (CI 95% 1.01-3.81); CFS 5-9: OR 1.81 (CI) 95% 1.12-2.93)). Data from VIP2 showed that CFS was the only independent predictor of 30-day mortality when these scores were tested in multivariate analyses separately together with age, SOFA, and gender (OR 1.21 (95% CI 1.03-1.41)).

Conclusions: Elderly intensive care patients had a 30-day survival rate of 59.9%. Factors strongly associated with 30-day mortality were increasing SOFA score and increasing frailty (CFS). Other geriatric scores had no significant association with survival in multivariate analyses.

1 | BACKGROUND

Currently, 10%-15% of the Norwegian intensive care patients are aged 80 years or older.[1-5] This proportion will increase significantly over the next 20 years, but it is unlikely that resources for intensive care will increase correspondingly, as the hospitals have limited economic resources and limited access to specialized health personnel.

Intensive care patients over 80 years of age have a reduced long-term prognosis with a 1-year survival of about 40%.[6-10] Thus, elderly patients are in danger of being less prioritized in future intensive care medicine. Recent examples of such prioritization were seen in overfilled ICUs in countries like China, Italy, and Spain during the outbreak of COVID-19. Therefore, it is important to find patient groups among elderly people who could benefit from intensive care,

and conversely, if there are particular groups who have little or no benefit from such treatment. This is both an ethically and health-politically important issue.

Advanced age, comorbidity, and disease severity at ICU admission predict partially the risk of death, but traditional intensive care scoring tools are inaccurate when applied in elderly ICU patients.[10,11] Hence, it is conceivable that other geriatric factors are more important for outcome than acute illness characteristics, and that geriatric scoring tools, therefore, may perform better than traditional intensive care scoring tools. That was the research question of two large European studies, VIP1[12] of VIP2.[13] However, intensive care medicine is differently organized in European countries, leading to a different patient population among countries. Thus, results from international studies cannot directly be transferred to each national context. We, therefore, present the specific result from the Norwegian population.

Based on a Norwegian cohort of intensive care patients aged 80 years or older at the time of ICU admission, we have studied the association among frailty, cognitive failure, comorbidity, the general health condition, and 30-day mortality.

2 | METHODS

2.1 | Design of study population

Data presented in this paper are based on two prospective observational studies (VIP1[12] and VIP2[13]), which included intensive care patients ≥80 years in Europe. Norwegian participants from these studies were merged into one study population. Outcome in the studies was ICU survival and survival 30 days after ICU admission.

In total, 18 Norwegian ICUs participated in the VIP studies, where 12 were local hospitals and 6 were university hospitals (VIP1: 14 ICUs (4 university hospitals and 10 local hospitals); VIP2: 14 ICUs (5 university hospitals and 9 local hospitals)).

Inclusion criteria in both studies were acute ICU admissions of patients ≥80 years of age. VIP1 included also elective ICU admissions, but since this is not common practice in Norway, we considered the inclusion criteria as similar in both studies. In VIP1, each participating ICU could choose to either include all patients within a time period of 3 months (October 2016–February 2017), or the first 20 patients within the same time period. In VIP2, each participating ICU could choose to either include all patients within a 6-month period (May 2018–February 2019) or the first consecutive 20 patients during the same time period. The 30-day mortality follow-up was on July 15th, 2019. Information on ICU admission triage decisions was not collected in either of the studies.

VIP1 and VIP2 were coordinated by the *Health Services Resource and Outcome (HSRO)* section of the *European Society of Intensive Care Medicine (ESICM)*. National coordinators were responsible for recruitment of ICUs. Information about the studies was published on a dedicated website (www.vipstudy.org). Patient data entry was enabled through an electronic case report form (eCRF), with data

Editorial Comment

Traditional intensive care scoring tools are inaccurate when applied in elderly intensive care patients. Recently, interest in frailty has increased in intensive care medicine through the scoring tool "Clinical Frailty Scale" (CFS), especially regarding intensive care for elderly patients. This study showed that cognitive deficit and functional decline, in addition to frailty, were strongly associated with 30-day mortality among intensive care patients aged 80 years and above. On the other hand, comorbidity and polypharmacy, measured with comorbidity and polypharmacy score (CPS), showed no strong association with survival.

storage on a server in Århus, Denmark. Both studies were registered in ClinicalTrial.gov (NCT03134807 (VIP1); NCT0337069 (VIP2)).

2.2 | Data collection

For all patients in both studies, we collected demographic data (age, sex, and place of living before hospital admission), ICU length of stay (ICU-LOS), ICU treatment (vasoactive medication, mechanical ventilation (invasive and non-invasive), and renal replacement treatment (RRT)), and life-sustaining treatment (LST) limitation (withhold/withdrawal) during the ICU stay. The frailty status before the actual critical illness was scored with clinical frailty scale (CFS)[14] by either a physician or a nurse. Sources for CFS scoring were patients, proxies, or patient records. The following definitions for CFS were used: not frail = CFS 1-3, vulnerable = CFS 4, and frail = CFS ≥ 5. SOFA (Sequential Organ Failure Assessment) score was used for assessment of severity of illness.[15] The primary reason for ICU admission was grouped according to a list consisting of the following 11 categories: respiratory failure, circulatory failure, combined respiratory/circulatory failure, sepsis (severe sepsis in VIP1 and sepsis in VIP2), multitrauma without head injury, multitrauma with head injury, isolated head injury, postemergency surgery, intoxication, non-traumatic cerebral failure, and other causes (Table 1).

In VIP2, there was also collected information on place of living before hospital admission, duration of ICU treatment, and geriatric syndromes. For collection of data regarding the geriatric syndromes, the following scores were used: comorbidity and polypharmacy score (CPS[16] ; comorbidity), Short form of Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE[17] ; cognitive function), and Katz Activity of Daily Living score (Katz ADL[18] ; daily activity). IQCODE was scored by proxies, while Katz ADL also could be scored based on information from the patient. High degree of comorbidity was defined as CPS ≥15.[19] Cognitive decline was defined as IQCODE >3.5, which corresponds to a Mini Mental State evaluation of ≥22.[20] Disability was defined as Katz ADL ≤4, corresponding to a patient

TABLE 1 Data variables for VIP1 and VIP2

Data	VIP1 & VIP2	VIP2
Age, sex	X	
Length of stay (ICU and after 30 d)	X	
Reason for ICU admission (11 categories)	X	Except elective surgery
Severity of illness (SOFA)	X	
Frailty (Clinical Frailty Scale)	X	
Place of living before hospital admission		X
ICU treatment: mechanical ventilation, vasoactive medication, tracheostomy, and renal replacement therapy	X	
Hours of ICU treatment		X
Life-sustaining treatment limitation (withhold/withdrawal)	X	
Scores of comorbidity, cognitive failure, and daily activities		X
Survival (ICU and after 30 d)	X	

dependency in at least one of the following domains: bathing, dressing, toileting, transferring, continence, and feeding.

Information about life-sustaining treatment (LST) limitation (withholding/withdrawal) was collected during the ICU stay, and the time (days) until LST limitation decision was counted from ICU admission.

2.3 | Statistics

Patient characteristics were analyzed as percentages for categorical variables, while continuous variables were measured as means with standard deviation if the distribution was symmetrical, and medians with quartiles if the distribution was skewed. The main analysis was performed with logistic regression with 30-day mortality as outcome variable, and age, sex, severity score (SOFA), and frailty (CFS) as exposure variables. Information about geriatric scores (CPS, IQCODE, or Katz ADL) was not available in VIP1. Thus, we performed five different regression analyses with data from VIP2 (N = 238) to compare these geriatric scores with CFS. Missing observations was handled with the use of R-package mice for the generation and analysis of 100 imputated data set. Principal component analysis (PCA) was used for age, SOFA score, CFS, Katz ADL, CPS, and IQCODE. PCA is a technique that can be used to visualize the association between variables in a data set with many variables. In a data set with only two variables, one may plot them against each other, but because we have six variables, we would need a six dimensional plot. However, with PCA we may still plot these variables using only two axes, but the cost is that some nuances are lost. This cost can be described as "explained variance." The six-dimensional plot mentioned earlier would have 100% explained variance. Missing information in the PCA analyses was imputed by using the R-packages FactoMineR and missMDA to regularized iterative PCA.

2.4 | Ethics

Both VIP1 and VIP2 included patients who usually lacked the ability to give an informed consent, and the ethical committees waived the need for consent at inclusion. Survivors later received information about the studies and were given the possibility to decline participation in the studies. Both studies were approved by the *Regional Committee of Medical and Health Research Ethics in Central Norway* (VIP1: REC West 2016/806; VIP2: REC South-East 2018/87).

3 | RESULTS

In total, 451 patients from Norway were included in VIP1 and VIP2 (VIP1: N = 215; VIP2: N = 236). Median age was 85 years, and 51.9% were women. Respiration and/or circulatory failure and sepsis were the main reasons for ICU admission in 67.1% of the cases. The percentage of patients admitted to university hospitals was 28.6%. The majority of patients lived in their own homes before hospital admission (81.3%; of whom 9.7% lived with their family) (Table 2).

Invasive mechanical ventilation was given to 30.4% of the patients, while 36.6% received non-invasive mechanical ventilation. Median length of stay in the ICU (ICU-LOS) was 48.0 hours (2.0 days). Vasoactive medication was given to 61.9% of the patients, while 5.3% received renal replacement treatment. Mean SOFA score was 6,8.

More than half of the patients were counted as frail (CFS ≥5; 51.9%), while 33.9% were counted as non-frail (CFS 1-3) and 14.2% as vulnerable (CFS 4). Median CFS was 5.0. Regarding the other geriatric scores, 22.9% had a high degree of comorbidity (CPS >15), 35.1% had a cognitive failure (IQCODE value >3.5), and 24.4% had a disability (Katz <4).

In total, 60.3% of the patients received LST limitation decisions during the ICU stay. Of patients who died within 30 days, treatment was withheld in 66.9% and withdrawn in 44.2%. Median time to decision of withhold was 1 day and withdrawal 2 days.

ICU survival was 82.0%, while 30-day survival was 59.9%. Among patients who died within 30 days after ICU admission, 55.2% survived the ICU stay. Predictors of 30-day mortality were higher SOFA score (OR 1.30; CI 95% 1.22-1.39) and CFS >3 (CFS 4: OR 1.96 (CI 95% 1.01-3.81); CFS 5-9: OR 1.81 (CI 95% 1.12-2.93)) (Table 3). We found no significant differences between patients with a CFS of 4 and CFS 5-9. Among patients in the group CFS 5-9, 152 of 234 patients had values 5 or 6.

Table 4, containing data from VIP2, shows that IQCODE was the geriatric score that was most strongly associated with the 30-day mortality. However, CFS was the single independent predictor for 30-day mortality when the geriatric scores were tested in separate

TABLE 2 Status of patient characteristics 30 d after admission to the ICU

Data variables	Number	All	Dead	Survivors	P-value
Patients	—	451	181	270	—
Age, median (IQR)	451	85 (6)	85 (6)	85 (6)	.31[d]
Female, n (%)	451	234 (51.9)	83 (45.9)	151 (55.9)	.05[b]
Living status before hospital admission, n (%)[e]	236				
Home		169 (71.6)	71 (73.2)	98 (70.5)	.76[b]
Home with family		23 (9.7)	5 (5.2)	18 (12.9)	.08[b]
Nursing home		34 (14.4)	17 (17.5)	17 (12.2)	.34[b]
Other ward at the hospital		7 (3.0)	4 (4.1)	3 (2.2)	.45[c]
Other		3 (1.3)	0 (0.0)	3 (2.2)	.27[c]
Reason for admission, n (%)	451				
Respiratory failure		101 (22.4)	42 (23.2)	59 (21.9)	.82[b]
Circulatory failure		97 (21.5)	42 (23.2)	55 (20.4)	.55[b]
Combined respiratory and circulatory failure		0 (9.5)	22 (12.2)	21 (7.8)	0.17[b]
Sepsis		62 (13.7)	25 (13.8)	37 (13.7)	1.00[b]
Multitrauma without head injury		16 (3.5)	5 (2.8)	11 (4.1)	.61[c]
Multitrauma with head injury		9 (2.0)	7 (3.9)	2 (0.7)	.03[c]
Isolated head injury		8 (1.8)	3 (1.7)	5 (1.9)	1.00[c]
Non-traumatic cerebral failure		14 (3.1)	6 (3.3)	8 (3.0)	1.00[b]
Postemergency surgery		59 (13.1)	21 (11.6)	38 (14.1)	.53[b]
Other reason		42 (9.3)	8 (4.4)	34 (12.6)	.01[b]
University hospital, n (%)	451	129 (28.6)	67 (37.0)	62 (23.0)	.002[b]
Invasive ventilation					
n (%)	451	137 (30.4)	80 (44.2)	57 (21.1)	<.001[b]
Time (h), mean (SD)[e]	70	76.2 (88.6)	57.1 (63.7)	103.3 (110.7)	.05[a]
Non-invasive ventilation (NIV)					
n (%)	451	165 (36.6)	80 (44.2)	85 (31.5)	.01[b]
Time (h), mean (SD)[e]	87	18.5 (21.8)	14.8 (16.9)	21.5 (24.9)	.14[a]
Tracheostomy, n (%)[e]	236	5 (2.1)	0 (0.0)	5 (3.6)	.08[c]
Vasoactive medication					
n (%)	451	279 (61.9)	127 (70.2)	152 (56.3)	.004[b]
Time (h), mean (SD)[e]	160	53.4 (69.0)	51.0 (61.5)	55.4 (74.8)	0.68[a]
Renal replacement therapy					
n (%)	451	24 (5.3)	14 (7.7)	10 (3.7)	0.10[b]
Time (h), mean (SD)[e]	14	88.2 (96.8)	74.8 (74.9)	112.4 (134.6)	0.59[a]
SOFA score, mean (SD)	451	6.8 (3.5)	8.5 (3.5)	5.7 (3.1)	<0.001[a]
CFS, median (IQR)	451	5.0 (3.0)	5.0 (3.0)	4.0 (3.0)	0.04[d]
CFS 1-3 (not frail), n (%)		153 (33.9)	51 (28.2)	102 (37.8)	0.04[b]
CFS 4 (vulnerable), n (%)		64 (14.2)	29 (16.0)	35 (13.0)	0.44[b]
CFS 5-9 (frail), n (%)		234 (51.9)	101 (55.8)	133 (49.3)	0.21[b]
Geriatric scoring tools					
CPS, median (IQR)[e]	236	12.0 (7.0)	12.0 (7.0)	11.0 (6.5)	0.91[d]
High degree of comorbidity (CPS >15), n (%)		54 (22.9)	22 (22.7)	32 (23.0)	1.00[b]
IQCODE, median (IQR)[e]	171	3.3 (1.0)	3.4 (1.0)	3.2 (0.6)	0.08[d]
Cognitive failure (IQCODE >3,5), n (%)		60 (35.1)	28 (40.6)	32 (31.4)	0.28[b]
Katz, median (IQR)[e]	213	5.0 (3.0)	5.0 (3.0)	6.0 (2.0)	0.06[d]
Functional disability (Katz <4), n (%)		52 (24.4)	24 (28.2)	28 (21.9)	0.37[b]

(Continues)

TABLE 2 (Continued)

Data variables	Number	All	Dead	Survivors	P-value
LST limitation					
Withhold of therapy					
n (%)	451	189 (41.9)	121 (66.9)	68 (25.2)	<0.001[b]
Days from ICU admission to withhold, median (IQR)	117	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)	0.52[d]
Withdrawal of therapy					
n (%)	451	83 (18.4)	80 (44.2)	3 (1.1)	<0.001[b]
Days from ICU admission to withdrawal, median (IQR)	44	2.0 (3.0)	2.0 (3.0)	1.5 (0.6)	0.48[d]
Hours in the ICU, mean (SD)	451	88.8 (97.3)	75.8 (97.3)	97.4 (183.6)	0.10[a]
Survival, n (%)					
ICU	451	370 (82.0)	100 (55.2)	100	—
30 d	451	270 (59.9)	0 (0.0)	100	—

Abbreviations: CFS, Clinical frailty scale; CI, confidence interval; CPS, Comorbidity and polypharmacy score; ICU, intensive care unit; IQCODE, Short form of Informant Questionnaire on Cognitive Decline in the Elderly; IQR, interquartile range: Katz ADL, Katz activity of daily living score; LST, life-sustaining treatment; OR, Odds ratio; SD, standard deviation; SOFA, Sequential organ failure assessment.

[a]t-test,

[b]chi-square-test,

[c]Fisher's exact test,

[d]Wilcoxon rank-sum test,

[e]Only in VIP2 cohort.

TABLE 3 Risk of death 30 d after ICU admission

	OR (95% CI)	P-value
Age	1.03 (0.98-1.09)	.2
Sex	0.80 (0.53-1.22)	.3
SOFA	1.30 (1.22-1.39)	<.001
CFS		
1-3	1 (ref.)	—
4	1.96 (1.01-3.81)	.046
5-9	1.81 (1.12-2.93)	.016

Abbreviations: CFS, Clinical frailty scale; CI, confidence interval; OR, Odds ratio; ref., reference category; SOFA, Sequential organ failure assessment.

multivariate analyses with age, SOFA, and sex (OR 1.21 (95% CI 1.03-1.41)). When all the scores were included in a multiple regression analysis, we found no significant impact in the model. Figure 1 shows the different variables in the PCA relative to the first two principal components. These two components contribute with a total of 40.53% + 17.64% = 58.17% explained variance. As mentioned, including six dimensions would yield 100% explained variance. In other words, the first two principal components can be said to approximate the full data set very well. The angles between the arrows show the degree of correlation between the variables (0° means 100% positive correlation, 90° means no correlation, while 180° means 100% negative correlation). The length of the arrows shows how much weight each variable has on each principal component.

Katz ADL and IQCODE have more points because these variables lacked several observations that had to be imputed. Because IQCODE was scored by proxies, and Katz ADL was scored by proxies or patients, we believe that the missingness was random in the sense that the score itself was not the reason for the missingness. As seen, CFS and the other geriatric scores are correlated with each other, while CFS has the longest arrow, and this finding corresponds well with the regression analyses.

4 | DISCUSSION

In this Norwegian cohort of ICU patients ≥80 years, we found that 82.0% survived the ICU stay and that 30-day survival was 59.9%. Factors strongly associated with 30-day mortality were higher SOFA score and higher frailty (CFS). Other geriatric scores for comorbidity, daily activity, and cognitive function had no significant association with survival in multivariate analyses. In our Norwegian cohort, we found more LST limitation decisions compared with the total European cohort in the VIP studies.

A survival rate after 30 days of around 60% correlates well with the total results from the rest of Europa (VIP1 62.0%[21] ; VIP2 61.1%[13]). When comparing our results with other Norwegian cohorts regarding ICU patients ≥80 years, we found similar results with a hospital survival of just below 60%.[6,8,22] Survival for elderly patients is, therefore, as expected, lower than for younger patients,[22] but nevertheless we should consider offering ICU treatment for elderly as a group. Initiating ICU treatment should, therefore, be based

TABLE 4 Risk of death 30 d after ICU admission (VIP2)

	CFS		KATZ ADL		CPS		IQCODE		All	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Age	1.02 (0.95-1.10)	.545	1.03 (0.96-1.10)	.425	1.04 (0.97-1.11)	.284	1.02 (0.95-1.09)	.664	1.01 (0.94-1.09)	.763
Sex	0.92 (0.51-1.64)	.775	0.97 (0.54-1.72)	.911	0.97 (0.55-1.73)	.93	0.97 (0.55-1.74)	.93	0.95 (0.53-1.70)	.852
SOFA	1.34 (1.21-1.49)	<.001	1.33 (1.20-1.48)	<.001	1.33 (1.20-1.47)	<.001	1.34 (1.21-1.48)	<.001	1.34 (1.21-1.49)	<.001
CFS	1.21 (1.03-1.41)	.02							1.15 (0.94-1.42)	.179
KATZ ADL			1.17 (0.99-1.38)	.073					1.05 (0.83-1.31)	.705
CPS					1.01 (0.96-1.06)	.727			0.98 (0.93-1.04)	.559
IQCODE							1.68 (0.98-2.88)	.062	1.31 (0.68-2.54)	.42

Note: Results from five different regression analyses. All analyses include age, sex, and SOFA score. The first includes CFS, the second includes KATZ ADL, the third includes CPS, the fourth includes IQCODE, and the fifth includes all of them.

Abbreviations: CFS, Clinical frailty scale; CI, confidence interval; CPS, Comorbidity and polypharmacy score; IQCODE, Short form of Informant Questionnaire on Cognitive Decline in the Elderly; Katz ADL, Katz Activity of Daily Living score; OR, Odds ratio; SOFA, Sequential organ failure assessment.
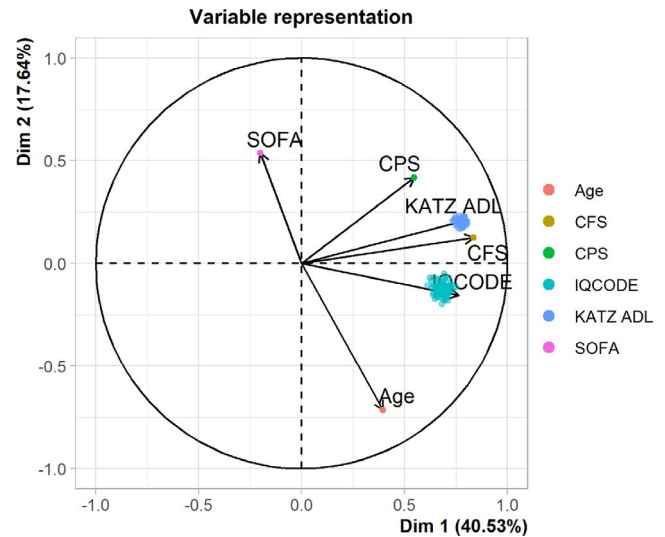
FIGURE 1 Principal component analysis was performed for age, SOFA score, CPS, Katz ADL, CFS, IQCODE and CPS. The first principal component (Dim 1) explains 40.53% of the variation between the variables, while the second principal component (Dim 2) explains 17.64%. Together, these two components contribute with a total of 58.17% explained variance. The angles between the arrows show correlation between the variables (90 degrees for 0 correlation, 0 degrees for perfect positive correlation, and 180 degrees for perfect negative correlation). The length of the arrows shows how much weight a variable has on each component. For Katz ADL and IQCODE, information on some of the patients was missing. The point clouds illustrate the uncertainty this has caused for the estimate of the arrows

on an individual basis for patients aged 80 years or older, preferably on the basis of established risk factors for poor outcome.

The term "frailty" has been established in geriatrics decades ago, and is evaluated in two different ways; a phenotypical model[23] and a cumulative deficit model.[24,25] Recently, interest in frailty has increased in intensive care medicine through the simple scoring tool "Clinical frailty scale" (CFS), especially regarding intensive care for elderly patients. One reason for the emergence of the CFS might be due to its visual simplicity. The scoring tool has also correlated well with clinically important outcomes in large studies.[26,27] In our study, we found that the majority of the patients were categorized as frail. Increasing frailty showed to be a strong prognostic factor for 30-day mortality, which again corresponded to the main conclusions from both VIP studies. A Canadian study has also found that frailty correlates with health-related quality of life.[28]

Since frailty showed strong correlation with survival in VIP1, other geriatric variables were tested in VIP2. Findings from our study were that cognitive deficit and functional decline, in addition to frailty, were strongly associated with 30-day mortality, but that CFS was a better predictor than the other scores. However, registration of cognitive deficit and functional decline did not provide additional prognostic value when CSF was used. All of these factors performed better than age alone. Comorbidity and polypharmacy, measured as CPS, showed on the contrary no correlation with

survival.[13] It is important to recognize that this applies to 30-day mortality. Decisions on not to start ICU treatment are not based on short-term survival alone. Cognitive impairment, disability, and other comorbidities can be good reasons to expect such a poor functional outcome that it is not appropriate to expose the patient to advanced medical treatment.

There are large variations in the degree of LST limitations in Europe.[29,30] Of patients who died within 30 days in the VIP1 and VIP2 studies, 24.3% and 49.2%, respectively, had decisions to withhold LST, while in 34.6% and 34.4% of cases, respectively, LST was withdrawn.[21] In our Norwegian study, we have somewhat higher figures, with 66.9% (withholding) and 44.2% (withdrawal). A substudy from VIP1 supports our findings.[31] It showed that in countries with a high gross domestic product (GDP) there was a higher degree of LST limitation, while it was lower in countries where religion is high. It was also found that patients admitted to ICUs in the northern part of Europe, and especially in the Nordic countries, had a higher proportion of LST limitation. Hence, Norwegian ICUs have a greater degree of LST limitation of intensive care patients aged 80 years or older compared with the rest of Europe. Intuitively, one would think that this could be related to a relatively low intensive care capacity in Scandinavia compared to many other countries in Europe, defined as the number of intensive beds per 100 000 inhabitants, where Norway in 2014 had 8.0 and Germany had 29.2 (most intensive beds per capita in Europe).[32] However, despite that difference in ICU capacity, that factor was not crucial to the degree of LST limitations.[31]

There are currently no clinical guidelines on how to choose which of the oldest patients will be offered intensive care, a so-called "triage". Traditional severity scores are not intended for individual use in triage, and are validated for a general intensive population, not for the elderly people. Based on data from VIP1, an attempt was made to create a model for predicting death within 30 days after admission to the intensive care unit.[33] Even after including many variables in the model, it was not possible to accurately predict who will die within 30 days. In anticipation of better models, many will rely on a so-called "Time Limited Trial" where elderly, critically ill patients are admitted to the ICU, and then are given advanced medical treatment for a few days to see if they respond to the measures during this "trial period".[6,34] At the same time, more information is gathered about comorbidity, cognitive function, frailty, and level of function, as well as whether the treatment is in line with the patient's and relatives' suitable view of advanced intensive care. Treatment limitation, either not stepping up or ending treatment, will be a decision made by the treatment team. Based on our study and the other VIP studies, as well as several other studies, using the "Clinical frailty scale", as part of the assessment of further treatment level, will be very useful in such contexts.

This study has several strengths. Prospective data have been obtained from both local and university hospitals in Norway, where all parts of the country were represented. Information was also obtained from relatives regarding cognitive function and functional status. There are also some limitations. Firstly, we cannot rule out a certain form of selection bias, as we have no information about those patients who were not admitted to ICUs. The patients' care-givers may think that the patient in any case will not be accepted for intensive care treatment due to a full ICU capacity and, therefore, probably will not be prioritized, a so-called "hidden triage." Also, no information was obtained about the selection process of which patients were accepted for intensive care by an ICU physician, and which were rejected. Such a process is often referred to as the "ICU triage." Furthermore, we cannot rule out information bias regarding misclassifications of the scores. However, a recent substudy of the VIP2 study showed a high reliability in the scoring of CFS.[35] Secondly, we have no data on decisions on treatment limitation after the intensive care unit. Thirdly, there will be a difference in patient populations between hospitals that have intermediate units and those hospitals that have intermediate patients and postoperative monitoring patients also admitted to the intensive care unit. Fourthly, we used a composite score for comorbidity, which do not identify specific chronic diseases as risk factors.

5 | CONCLUSION

In this study of intensive care patients aged 80 years or older, we found a 30-day survival rate after ICU admission of 59.9%. Factors strongly associated with 30-day mortality were increasing severity scores (SOFA) and increasing frailty (CFS). Other geriatric scores for comorbidity, daily activities, and cognitive function were not significantly associated with survival in multivariate analyses. Using the clinical frailty scale as a measure of frailty can be an important tool for treatment decisions.

ORCID

Finn H. Andersen https://orcid.org/0000-0003-3775-7325
Hans Flaatten https://orcid.org/0000-0001-9186-3482

REFERENCES

1. Ihra GC, Lehberger J, Hochrieser H, et al. Development of demographics and outcome of very old critically ill patients admitted to intensive care units. *Intensive Care Med*. 2012;38:620-626.
2. Reinikainen M, Uusaro A, Niskanen M, Ruokonen E. Intensive care of the elderly in Finland. *Acta Anaesthesiol Scand*. 2007;51:522-529.
3. Bagshaw SM, Webb SA, Delaney A, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. *Crit Care*. 2009;13:R45.
4. Boumendil A, Aegerter P, Guidet B, Network CU-R. Treatment intensity and outcome of patients aged 80 and older in intensive care units: a multicenter matched-cohort study. *J Am Geriatr Soc*. 2005;53:88-93.
5. Flaatten H, de Lange DW, Artigas A, et al. The status of intensive care medicine research and a future agenda for very old patients in the ICU. *Intensive Care Med*. 2017;43:1319-1328.
6. Andersen FH, Flaatten H, Klepstad P, et al. Long-term outcomes after ICU admission triage in octogenarians. *Crit Care Med*. 2017;45:e363-e371.
7. Docherty AB, Anderson NH, Walsh TS, Lone NI. Equity of access to critical care among elderly patients in Scotland: a National Cohort Study. *Crit Care Med*. 2016;44:3-13.

8. Andersen FH, Flaatten H, Klepstad P, Romild U, Kvale R. Long-term survival and quality of life after intensive care for patients 80 years of age or older. *Ann Intensive Care*. 2015;5:53.

9. Somme D, Maillet JM, Gisselbrecht M, Novara A, Ract C, Fagon JY. Critically ill old and the oldest-old patients in intensive care: short- and long-term outcomes. *Intensive Care Med*. 2003;29:2137-2143.

10. Vallet H, Schwarz GL, Flaatten H, de Lange DW, Guidet B, Dechartres A. Mortality of older patients admitted to an ICU: a systematic review. *Crit Care Med*. 2021;49:324-334.

11. Guidet B, Vallet H, Boddaert J, et al. Caring for the critically ill patients over 80: a narrative review. *Ann Intensive Care*. 2018;8:114.

12. Flaatten H, De Lange DW, Morandi A, et al. The impact of frailty on ICU and 30-day mortality and the level of care in very elderly patients (≥ 80 years). *Intensive Care Med*. 2017;43:1820-1828.

13. Guidet B, de Lange DW, Boumendil A, et al. The contribution of frailty, cognition, activity of daily life and comorbidities on outcome in acutely admitted patients over 80 years in European ICUs: the VIP2 study. *Intensive Care Med*. 2020;46:57-69.

14. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ*. 2005;173:489-495.

15. Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. *Intensive Care Med*. 1996;22:707-710.

16. Evans DC, Cook CH, Christy JM, et al. Comorbidity-polypharmacy scoring facilitates outcome prediction in older trauma patients. *J Am Geriatr Soc*. 2012;60:1465-1470.

17. Jorm AF. The Informant Questionnaire on cognitive decline in the elderly (IQCODE): a review. *Int Psychogeriatr*. 2004;16:275-293.

18. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. *J Am Geriatr Soc*. 1983;31:721-727.

19. Stawicki SP, Kalra S, Jones C, et al. Comorbidity polypharmacy score and its clinical utility: a pragmatic practitioner's perspective. *J Emerg Trauma Shock*. 2015;8:224-231.

20. Mackinnon A, Mulligan R. Combining cognitive testing and informant report to increase accuracy in screening for dementia. *Am J Psychiatry*. 1998;155:1529-1535.

21. Flaatten H, De Lange DW, Morandi A, et al. The impact of frailty on ICU and 30-day mortality and the level of care in very elderly patients (>/= 80 years). *Intensive Care Med*. 2017.43(12):1820–1828.

22. Andersen FH, Kvale R. Do elderly intensive care unit patients receive less intensive care treatment and have higher mortality? *Acta Anaesthesiol Scand*. 2012;56:1298-1305.

23. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol Ser A: Biol Sci Med Sci*. 2001;56(3):M146-M157.

24. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. *Scientific World J*. 2001;1:323-336.

25. Flaatten H, Clegg A. Frailty: we need valid and reliable tools in critical care. *Intensive Care Med*. 2018;44:1973-1975.

26. Bagshaw SM, Stelfox HT, McDermid RC, et al. Association between frailty and short- and long-term outcomes among critically ill patients: a multicentre prospective cohort study. *CMAJ*. 2014;186:E95-102.

27. Le Maguet P, Roquilly A, Lasocki S, et al. Prevalence and impact of frailty on mortality in elderly ICU patients: a prospective, multicenter, observational study. *Intensive Care Med*. 2014;40:674-682.

28. Bagshaw SM, Stelfox HT, Johnson JA, et al. Long-term association between frailty and health-related quality of life among survivors of critical illness: a prospective multicenter cohort study. *Crit Care Med*. 2015;43:973-982.

29. Sprung CL, Cohen SL, Sjokvist P, et al. End-of-life practices in European intensive care units: the Ethicus Study. *JAMA*. 2003;290:790-797.

30. Sprung CL, Ricou B, Hartog CS, et al. Changes in end-of-life practices in european intensive care units from 1999 to 2016. *JAMA*. 1999;2019:1-12.

31. Guidet B, Flaatten H, Boumendil A, et al. Withholding or withdrawing of life-sustaining therapy in older adults (≥ 80 years) admitted to the intensive care unit. *Intensive Care Med*. 2018;44:1027-1038.

32. Rhodes A, Ferdinande P, Flaatten H, Guidet B, Metnitz PG, Moreno RP. The variability of critical care bed numbers in Europe. *Intensive Care Med*. 2012;38:1647-1653.

33. Lange DW, Brinkman S, Flaatten H, et al. Cumulative prognostic score predicting mortality in patients older than 80 years admitted to the ICU. *J Am Geriatr Soc*. 2019;67:1263-1267.

34. Guidet B, de Lange DW, Flaatten H. Should this elderly patient be admitted to the ICU? *Intensive Care Med*. 2018;44:1926-1928.

35. Flaatten H, Guidet B, Andersen FH, et al. Reliability of the Clinical Frailty Scale in very elderly ICU patients: a prospective European study. *Ann Intensive Care*. 2021;11:22.