Severity-Adjusted ICU Mortality Only Tells Half the Truth—The Impact of Treatment Limitation in a Nationwide Database

Mark Kaufmann, MD[1]; Andreas Perren, MD[2–4]; Bernard Cerutti, MPH, PhD[3]; Christine Dysli, BSN[5]; Hans Ulrich Rothen, MD, PhD[5]; on behalf of the Swiss Society of Intensive Care Medicine

Objectives: The influence of different forms of treatment limitation on mortality rate in the ICU is not known despite the common use of the latter as a quality indicator. The aim of the present study was to assess the prevalence of treatment limitation and its influence on ICU mortality rate. Primary outcomes were prevalence of treatment limitation and its influence on severity-adjusted ICU mortality rate. Secondary outcomes included the association of limitation with age, sex, type of admission, diagnostic group, treatment intensity, and length of ICU stay.

Design: Retrospective, observational study.

Setting: All Swiss adult ICUs.

Interventions: None.

Patients: A total of 166,764 patients were admitted to an ICU in 2016 and 2017. Of these, 9139 were excluded because of readmission or invalid coding.

Measurements and Main Results: Of 157,625 ICU patients, 20,916 (13.3%) had a fully defined treatment limitation. Among this group, treatment limitation was defined upon ICU admission in 12,854 (61%), the decision to limit treatment was based on the patient's advance directives in 9,951 (48%), and in 15,341 (73%), there was a decision to deliberately withhold certain treatment modalities. The mortality odds ratio for the group with a treatment limitation, considering relevant cofactors, was 18.1 (95% CI 16.8–19.4).

Conclusions: Every seventh patient in a Swiss ICU has some kind of treatment limitation, and this most probably affects the severity-adjusted mortality rate. Thus, mortality data as a quality indicator or benchmark in intensive care can only meaningfully be interpreted if existence, grade, cause, and time of treatment limitation are taken into account. (*Crit Care Med* 2020; 48:e1242–e1250)

Key Words: end-of life; ethics; intensive care; outcomes assessment; quality indicators

Mortality rate remains one of the most frequently assessed outcome variables in intensive care medicine. Accordingly, this measure is routinely used as a major primary endpoint in cohort studies and benchmarking analyses (1–3), and it must be frequently reported to the government, funding authorities, and organizations that focus on quality. The reduction of a complex clinical process—dying—to a simple outcome, namely the mortality rate, is tempting especially if the variable is easy to measure. Although death is a definite endpoint, there are several well-established factors confounding mortality rate (4). A relatively unknown aspect, however, is the potential influence of the decision to limit therapeutic measures in the context of shared decision-making. First, the overall proportion of ICU patients with any form of treatment limitation is only known for selected patient groups and not for samples including all ICU patients of an entire health system or country. Second, it is unclear whether the high mortality rate of ICU patients with treatment limitations is merely an expression of disease severity or whether it is independently influenced by decisions to limit or withhold life-sustaining treatments (5–8).

In 2013, the Swiss Academy of Medical Sciences published medical-ethical guidelines on intensive care treatment and possible limitation of such measures (9). These are elements of a structured approach in decision-making and were subsequently integrated into the Minimal Dataset of the Swiss Society of Intensive Care Medicine (MDSi), a mandatory ICU registry (10). Accordingly, frequency, timing, type, and consequences of a treatment limitation can now be analyzed in the light of this complete nationwide dataset.

The aim of this study was to assess the prevalence of decisions to limit life-sustaining therapy in patients cared for in any of the ICUs in Switzerland and to explore its impact on

[1]Department for Anesthesia, Surgical Intensive Care, Prehospital Emergency Medicine and Pain Therapy, University Hospital Basel, Basel, Switzerland.

[2]Intensive Care Unit, Department of Intensive Care Medicine–Ente Ospedaliero Cantonale, Ospedale Regionale Bellinzona e Valli, Bellinzona, Switzerland.

[3]Faculty of Medicine, University of Geneva, Geneva, Switzerland.

[4]Faculty of Biomedical Sciences, Università Svizzera Italiana, Lugano, Switzerland.

[5]Department of Intensive Care Medicine, Bern University Hospital, Inselspital Bern, Bern, Switzerland.

DOI: 10.1097/CCM.0000000000004658

severity-adjusted ICU mortality rate. We hypothesized that this latter measure is significantly influenced by the existence of a treatment limitation. Such an association would limit the usefulness of mortality rate as an outcome measure for benchmarking and quality analysis.

METHODS

Patients and Study Design

The Swiss ICU-Registry (MDSi—Minimal Dataset for ICUs) has recently been described (10). It contains a set of data for every patient admitted to an ICU in Switzerland, such as information on origin and type of admission, severity of acute illness, diagnostic group and intervention before admission to the ICU, daily process variables, and discharge details including ICU mortality rate but no further detailed information on comorbidity. In 2015, the MDSi was supplemented by three key elements (timing, reason, degree) related to any treatment limitation in critically ill patients (9). Data are collected prospectively and are validated during the upload procedure into an anonymous central database, and quality of data is monitored (10, 11).

An analysis of the data was approved by the Ethics Committee of Northwestern and Central Switzerland (EKNZ UBE-15/47).

Switzerland has a population of 8.4 million with 216 acute care hospitals, encompassing 24,427 hospital beds and 950 ICU beds. Records of all patients admitted to any of the 88 certified ICUs in Switzerland between January 1, 2016, and December 31, 2017 and greater than or equal to 16 years old at admission were eligible for further study. Exclusion criteria were readmission to the same ICU, an invalid coding of the limitation, or an erroneous Simplified Acute Physiology Score (SAPS) II (10).

Any treatment limitation is coded upon discharge from the ICU and includes three dimensions (9):

1) Point in time of treatment limitation. At admission: During the process of admission to an ICU/During course: During the ICU stay.
2) Degree of treatment limitation. Change to palliation: Withholding and withdrawal of intensive care and intensification of palliative care/Limited content: Limited intensive care is only to be administered in special cases, for example, if the medium- and long-term prognosis must be assumed to be poor. Serious comorbidities, age-related health impairments, and other factors indicative of a poor medium- and long-term prognosis can justify the limitation of intensive care from the outset/Limited duration: Intensive care of limited duration is applied in cases where the long-term prognosis is poor or unclear; the level of intensive care is not, however, restricted. In cases where the prognosis is essentially favorable in the short term but poor in the longer term, intensive care of limited duration may be indicated to tide the patient through temporary organ dysfunction or failure.
3) Reason for treatment limitation. Advance directive: Advance care planning or advance health directive, obtainable in written form, orally, or otherwise clearly documented/Representative's wish: Only applicable if patient's advance directives unknown or not obtainable/Medical reason: Ineffective care. Ineffectiveness is marked by a deterioration in the condition of a patient receiving full intensive care. Treatment offers little or no likelihood of benefit in cases where there is no reasonable prospect of the patient being able to return to an appropriate living environment.

A cessation of therapeutic measures in the event of a hopeless prognosis and occurring during the final dying process, also referred to as "shortening of the dying process", was not considered a treatment limitation.

The type of admission to the ICU was coded depending on whether it was planned or unplanned and if it was postinterventional or not. To assess severity of acute illness, SAPS II was used, with data collected during the first 24 hours of stay in ICU (12). To characterize resource use and intensity of treatment at the patient level, the following variables were used: length of stay (LOS) in the ICU, nine equivalents of nursing manpower use score (NEMS) (13) for every nursing shift, the relative number of nursing shifts with mechanical ventilation, and the relative number of nursing shifts with renal replacement therapy. The type of ICU (tertiary ICU vs all other ICUs) was defined in accordance with the classification used for postgraduate training of medical specialists in Switzerland (10, 14). Geographic location was assigned according to definitions of major regions, as used by the Swiss Federal Statistical Office (15).

Statistical Analysis

Data were summarized as means and SDs and as numbers and percentages for categorical variables. The ICU mortality rate of the groups with and without a treatment limitation was compared based on SAPS II (12) (taken as a continuous variable) and additional factors such as age (taken as a continuous variable), sex, characteristics of the ICU (tertiary ICU vs other ICUs), region, main diagnostic group, and type of admission (elective or unplanned, postinterventional or not, and the interaction between these two factors). Logistic regressions were used to explore the association between the mortality, and the different covariates mentioned above. Results are presented as odds ratios (ORs) and 95% CIs. The effect of the different covariates was tested with chi-square test based on the difference of deviance of the model with and without the investigated covariate.

Potential additional comparisons between two groups for continuous variables were made using Student's *t* tests. All analyses were done using R Version 3.5.2 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Patients

Of a 2-year total of 166,764 patients, 5.5% were excluded for various reasons (**Fig. 1**). Of the remaining 157,625 patients, 86.7% had unrestricted therapy, and 13.3% had a fully defined

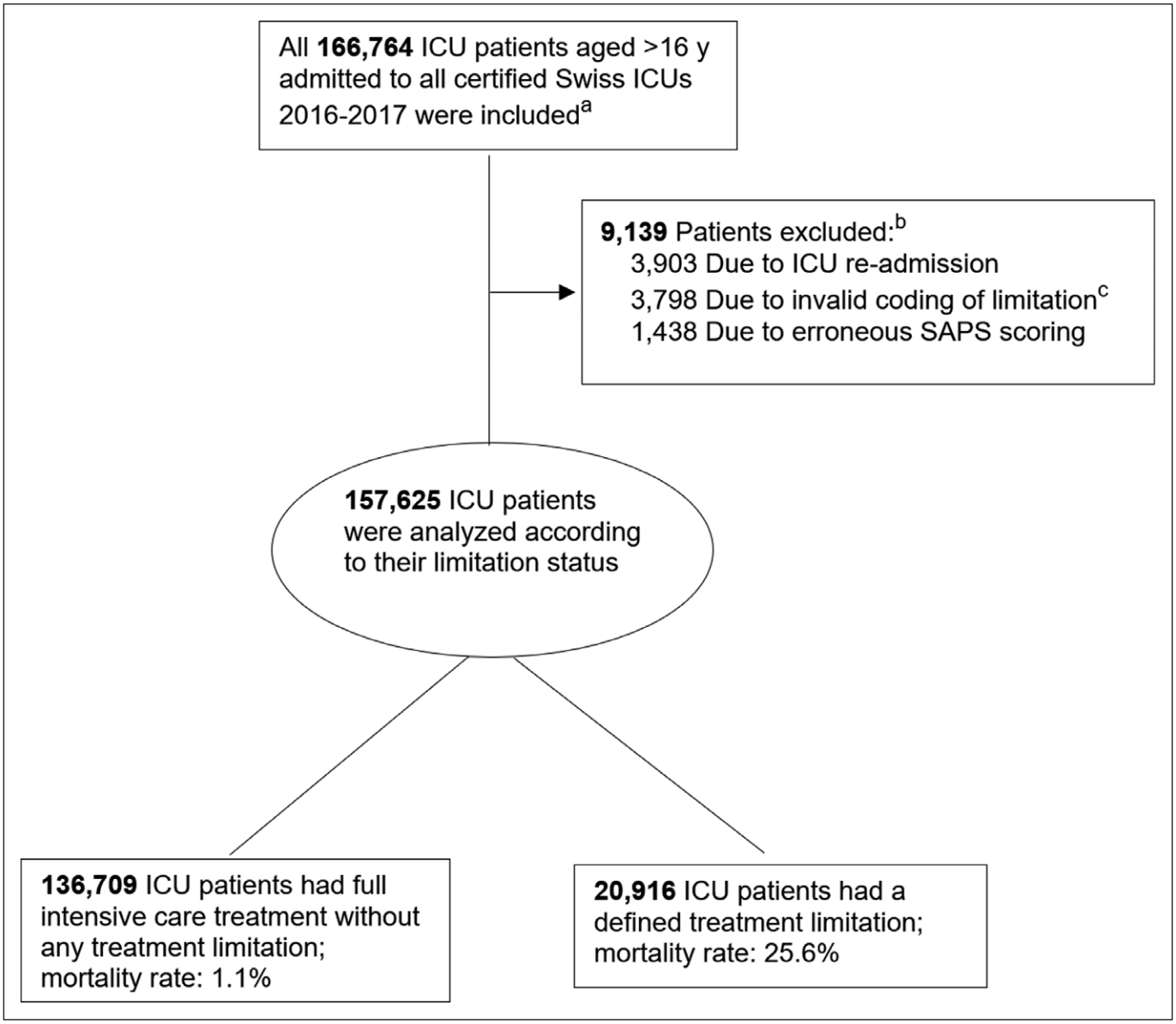

Figure 1. Patient enrollment. [a]Date of patient admission to an ICU between January 1, 2016, and December 31, 2017. Nationwide, all 166,764 patients in need of intensive care are covered; the ICU mortality rate in this population was 4.6%. [b]Sequential exclusion of the three patient groups according to the listing; these 9,139 patients had an ICU mortality rate of 8.6%, the remaining population of 157,625 patients (mortality rate, 4.4%). [c]A valid coding of limitation includes point in time of the decision, degree, and reason of treatment limitation. SAPS = Simplified Acute Physiology Score, y = years.

treatment limitation (**Table 1**). Details of excluded patients are given in **Tables S1** and **S2** (Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

Treatment Limitation

The detailed recording of the different elements of a treatment limitation is given in **Figure 2** and **Table S3** (Supplemental Digital Content 1, http://links.lww.com/CCM/F855). The decision for treatment limitation was more often made on ICU admission than during ICU stay (61% vs 39%). The main causes for treatment limitation were the patient's advance directives or a medical reason with 48% and 41%, respectively. Withholding intensive care was more frequent than a change of the therapy target to palliation (73% vs 24%, respectively); restricted treatment duration was rare (Table S3, Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

Patients with a treatment limitation differed in many aspects from those without a limitation regardless of their survival, as shown in Table 1 and Table S3 (Supplemental Digital Content 1, http://links.lww.com/CCM/F855). The SAPS II score was higher, length of stay longer, and treatment intensity higher. Cardiovascular and metabolic diseases as the main diagnostics were underrepresented in the group with a treatment limitation, whereas patients with pulmonary diseases were overrepresented (11% and 8% vs 20%, respectively) (Table 1). Tertiary ICUs had a lower treatment limitation rate (12.1% *vs* 14.3%, $p < 0.001$) (**Fig. S4**, Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

TABLE 1. Patient Characteristics According to Limitation Status

Variable	Patient Group	All Patients	Patients Without Treatment Limitation	Patients With Treatment Limitation	OR (95% CI) and *p*[a]
Outcome, *n* (%)	All patients	157 625	136,709 (87)	20,916 (13)	
	Survivors	150,730 (96)	135,165 (99)	15,565 (74)	OR 30.1[b] (28.4–31.9)
	Nonsurvivors	6,895 (4)	1,544 (1)	5,351 (26)	
Gender, *n* (%)	Female all	63 722	53,991 (85)	9,731 (15)	
	Female survivors	61,010 (96)	53,413 (99)	7,597 (78)	OR 25.9[b] (23.6–28.6)
	Female nonsurvivors	2,712 (4)	578 (1)	2,134 (22)	
	Male all	93,903	82,718 (88)	11,185 (12)	
	Male survivors	89,720 (96)	81,752 (99)	7,968 (71)	OR 34.2[b] (31.7–36.9)
	Male nonsurvivors	4,183 (5)	966 (1)	3,217 (29)	
Admission, *n* (%)	Scheduled	51,392 (33)	48,398 (94)	2,994 (6)	OR 3.3 (3.2–3.4)
	Unplanned	106,233 (67)	88,311 (83)	17,922 (17)	
Age, yr, mean (SD)	All patients	65.2 (16.8)	63.4 (16.7)	76.1 (12.3)	< 0.0001
	Survivors	64.8 (16.8)	63.3 (16.7)	77.5 (11.7)	< 0.0001
	Nonsurvivors	71.5 (13.5)	69.4 (14.5)	72.2 (13.1)	< 0.0001
Length of stay ICU, d, mean (SD)	All patients	2.5 (4.7)	2.3 (4.3)	3.8 (6.6)	< 0.0001
	Survivors	2.4 (4.4)	2.2 (4.3)	3.3 (5.6)	< 0.0001
	Nonsurvivors	5.1 (8.5)	4.7 (8.1)	5.2 (8.6)	0.033
Simplified Acute Physiology Score II (points), mean (SD)	All patients	32.0 (17.3)	29.7 (15.6)	47.1 (20.0)	< 0.0001
	Survivors	30.5 (15.5)	29.3 (15.0)	40.9 (15.4)	< 0.0001
	Nonsurvivors	64.8 (21.4)	63.0 (22.4)	65.1 (21.1)	0.072
Nine Equivalents of Nursing Manpower Use Score (13)/shift (points), mean (SD)	All patients	20.8 (7.5)	20.3 (7.0)	24.2 (9.4)	< 0.001
	Survivors	20.2 (6.5)	20.1 (6.6)	21.0 (6.0)	< 0.001
	Nonsurvivors	33.9 (13.7)	36.1 (19.7)	33.3 (11.2)	< 0.001
Ventilation ratio/shift, mean (SD)	All patients	0.17 (0.29)	0.14 (0.27)	0.32 (0.39)	< 0.001
	Survivors	0.14 (0.26)	0.14 (0.26)	0.20 (0.31)	< 0.001
	Nonsurvivors	0.69 (0.40)	0.69 (0.46)	0.69 (0.39)	0.78
Renal replacement ratio/shift, mean (SD)	All patients	0.02 (0.10)	0.01 (0.09)	0.04 (0.16)	< 0.001
	Survivors	0.01 (0.08)	0.01 (0.08)	0.02 (0.10)	< 0.001
	Nonsurvivors	0.11 (0.27)	0.12 (0.27)	0.11 (0.27)	0.31
Main diagnostic group, *n* (%)	Cardiovascular	51,217 (33)	45,822 (89)	5,395 (11)	
	Gastrointestinal	19,671 (13)	17,136 (87)	2,535 (13)	
	Metabolic	9,299 (6)	8,579 (92)	720 (8)	
	Neurologic	24,704 (16)	21,030 (85)	3,674 (15)	
	Respiratory	18,777 (12)	15,006 (80)	3,771 (20)	
	Trauma	8,740 (6)	7,572 (87)	1,168 (13)	
	Other	25,217 (16)	21,564 (86)	3,653 (14)	

OR = odds ratio.

[a]*p* test of comparison between groups (with or without treatment limitation).

[b]Mortality odds ratio (treatment limitation odd divided by without treatment limitation odd).

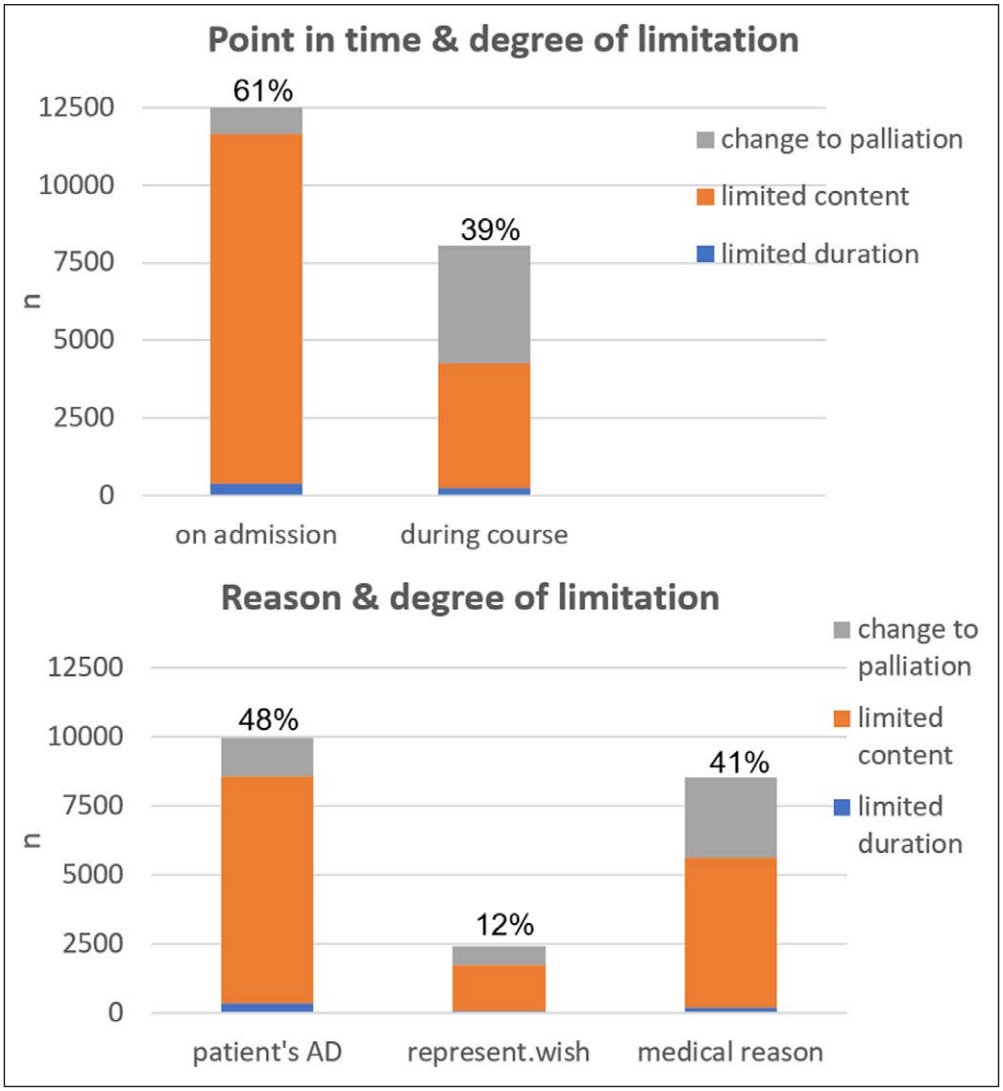

Figure 2. Details of treatment limitation. Treatment limitation: point in time of a decision (at admission to the ICU, during ICU stay), degree of limitation (treatment limited in duration, treatment limited in content, change to palliation), and reason for limitation (patient's advance directive [AD]s, representative's wish, medical reason).

Mortality

Overall, the relative ICU mortality rate was significantly higher in patients with a treatment limitation compared with those without a limitation (26% vs 1%) (Table 1). However, in the group with a decision to limit treatment, three of four patients survived their ICU stay. Significant differences were observed between patients with and without a treatment limitation independent of their SAPS II (**Fig. 3** and **Figs. S1–S3**, Supplemental Digital Content 1, http://links.lww.com/CCM/F855). As an example, an ICU mortality rate of 50% was observed for a SAPS II of 67 points in the group of patients with treatment limitations as compared to a SAPS II of 103 points in the group without treatment limitation. Treatment limitations decided during the course of treatment were more frequently associated with mortality than those decided upon ICU admission (50.1% vs 10.8%; OR 8.25; 95% CI 7.68–8.87). Likewise, a treatment limitation due to medical reasons was more often followed by death compared with a pre-existing limitation based on a patient's advance directives. A change to palliation was associated with death in the ICU in 66.9% of patients. There were significant differences between ORs of the various diagnostic groups (**Table 2** and **Fig. S5**, Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

The difference in mortality rate between patients with and without a treatment limitation was confirmed in a multivariate analysis including age, sex, SAPS II, the type of intervention (elective or unplanned, postinterventional or not), the type of ICU, the region, and diagnosis, with an adjusted OR of 18.1, 95% CI 16.8–19.4 (Table 2).

DISCUSSION

Our study reveals a remarkably high rate of treatment limitations in this Western European country. Indeed, a decision to limit treatment was documented in almost every seventh patient admitted to an ICU. In this nationwide dataset, the rate is higher than has been previously presented (5, 6, 16), but it is nonetheless in accordance with recent data for Western Europe (8, 17). Furthermore, in the present study, ICU mortality rate is clearly related to limitation status. In four of five patients not surviving their ICU stay, a prior decision to limit treatment had been made. Furthermore, in a multivariate analysis, considering several well-known risk factors such as type of admission, age, diagnostic group, and severity of acute illness, the presence of a treatment limitation was by far the leading factor associated with ICU mortality. This has important implications for the interpretation of ICU mortality as a quality measure. If these findings are confirmed by others, adding a statement related to treatment limitation might also be considered for the Consolidated Standards of Reporting Trials guidelines (18, 19), as end-of-life decisions are not yet routinely reported in critical care trials (20, 21) and hospital quality measures (7, 22).

In general, healthcare systems and intensive care, in particular, are often measured according to accessibility, quality of care, and cost (23). Mortality rate represents a commonly used surrogate to assess quality of care. However, it is generally agreed that raw mortality rate cannot be used for this purpose, and a number of scores have been developed to

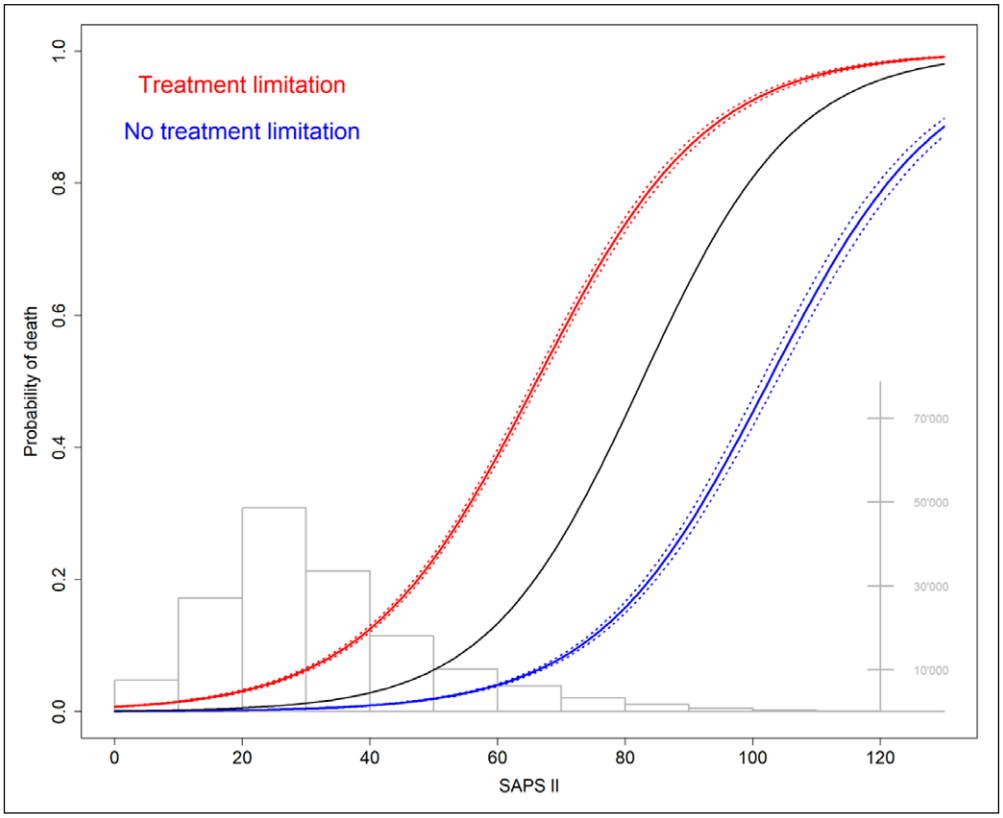

Figure 3. Mortality as a function of treatment limitation adjusted by Simplified Acute Physiology Score (SAPS) II fitted with a logistic regression model. The *black curve* represents the fitting for all patients ($n = 157{,}625$), and the *red* and *blue curves*, the fitting for the patients respectively with and without limitation. The *dotted lines* indicate the 95% CI for the lines fitted using logistic regression. The superposed histogram shows the density distribution of the data. The probability of death if there is a treatment limitation is given by $\frac{e^{-2.8385+(SAPS-28)\times 0.0745}}{1+e^{-2.8385+(SAPS-28)\times 0.0745}}$, and if there is no treatment limitation by $\frac{e^{-5.5505+(SAPS-28)\times 0.0745}}{1+e^{-5.5505+(SAPS-28)\times 0.0745}}$.

allow for risk adjustment of this measure. Standardized mortality rates can be calculated to match specific patient groups or different ICUs using such scores (3, 24, 25). Risk adjustment has also been used to assess the variability in resource use between ICUs (26, 27). As shown in the present study, a decision to limit treatment is made rather frequently in Switzerland, and such limitations are strongly associated with ICU mortality rate. This suggests that the mortality rate (i.e., one of the most commonly used outcome variables in critical care medicine) is markedly influenced by practice guidelines related to medical decision-making, life-sustaining care, and patient preferences. Indeed, considering these and other factors in addition to differing sociocultural and religious backgrounds, there is no limit to the variety of end-of-life practices worldwide which in turn might be a relevant cofactor for ICU mortality (16, 21, 28–31).

Complementary to published studies, our data allow for an in-depth analysis of several dimensions of the decision to limit treatment in critically ill patients. Not unexpectedly, the probability of a treatment limitation increased with advancing age and with increasing severity of acute illness, as assessed by SAPS II. One third of all decisions were made during the ICU stay, and in half of these decisions, a change to palliation was established. This suggests that in Swiss ICUs, palliative care was often initiated during a patients' ICU stay and was not just left over to the subsequent medical team caring for the patient. Half of all decisions to limit treatment were based on a patient's advance directives, roughly 40% were made due to medical reasons. This suggests that there might still be a tendency toward a paternalistic approach (32), although a revised law on the protection of children and adults was put into effect in Switzerland in 2013. These new laws give more emphasis on patient self-determination and the role of a patient's relatives in decision-making (9). In addition, as also suggested by others, better information and sensitizing of the public and early integration of advanced care planning during an illness trajectory may help to better respect patients' needs and preferences related to treatment and end-of-life care and thus patient autonomy (33–37).

Finally, a decision to limit the duration of treatment was chosen only rarely. This finding is rather unexpected, as such a decision could be helpful in "buying" time to observe the clinical course of a patient and for further decision making (37–40).

SAPS II (12) was used to adjust for the risk of mortality related to acute disease. Although the performance of this score has probably decreased over time (41), it remains one of the components used to calculate the diagnosis-related group and billing of services in Switzerland and in other countries. Comparing ICU mortality in patients with similar SAPS II shows a significantly higher mortality rate in patients with a treatment limitation. The difference in mortality rate has also been confirmed in a multivariate analysis considering all relevant cofactors, both in the whole sample of this study and also in the subgroup of tertiary ICUs. Patients with a decision to limit therapy are almost 20 times more likely to die during their ICU stay compared with those without such a limitation. Despite this, looking at the whole group with therapy limitations, three of four patients survived, underscoring that not every patient with a decision to limit therapy will inevitably die during their hospital stay (6, 8).

Our study has several limitations. First, our focus on ICU mortality rate due to the definition of the MDSi inevitably underestimates the consequences of a treatment limitation.

TABLE 2. Multivariate Analysis of Factors Associated to ICU Mortality

Group	*n*	Mortality, %	Unadjusted OR	95% CI	Adjusted OR[b]	95% CI
Female	63,722	4.3	1.00			
Male	93,903	4.5	1.05	1.00–1.10	1.08	1.01–1.15
Simplified Acute Physiology Score II of 28[a] (12)			1.00			
Score increased by 1			1.09	1.08–1.09	1.08	1.08–1.08
Age of 65[a]			1.00			
Age increased by 1			1.03	1.03–1.03	0.98	0.98–0.98
No treatment limitation	136,709	1.1	1.00			
Treatment limitation	20,916	25.6	30.10	28.4–31.9	18.1	16.8–19.4
Tertiary ICU	79,539	5.3	1.00			
Nontertiary ICU	78,086	3.4	0.64	0.60–0.67	0.92	0.86–0.99
Elective	51,392	1.7	1.00			
Unplanned	106,233	5.7	1.36	1.23–1.52	1.16	0.99–1.37
Not postinterventional	70,681	5.6	1.00			
Postinterventional	86,944	3.4	0.24	0.21–0.28	0.78	0.65–0.94
Postinterventional and unplanned (interaction factor)	45,065	5.5	3.93	3.40–4.55	1.23	1.01–1.49
Region BfS 1	23,011	5.6	1.00			
Region BfS 2	28,983	3.8	1.19	1.13–1.25	0.49	0.44–0.55
Region BfS 3	24,644	4.4	0.91	0.86–0.96	0.79	0.71–0.88
Region BfS 4	33,499	5.0	0.82	0.78–0.86	1.47	1.33–1.62
Region BfS 5	22,144	3.6	1.01	0.96–1.07	0.86	0.76–0.97
Region BfS 6	15,339	3.3	1.06	1.00–1.12	0.73	0.63–0.83
Region BfS 7	10,005	4.9	0.75	0.70–0.81	1.04	0.88–1.22
Diagnostic group						
Cardiovascular	51,218	4.7	1	1		
Gastrointestinal	20,555	3.6	0.77	0.71–0.84	0.66	0.59–0.74
Metabolic	9,456	1.2	0.25	0.21–0.30	0.26	0.21–0.33
Neurologic	24,499	3.3	0.68	0.63–0.74	0.63	0.57–0.70
Respiratory	18,714	6.5	1.41	1.32–1.52	1.01	0.92–1.11
Trauma	9,481	3.8	0.81	0.72–0.90	0.87	0.75–0.97
Other	23,702	5.3	1.13	1.05–1.21	0.79	0.72–0.87
All	157,625	4.4				

BfS = Swiss Federal Statistical Office, OR = odds ratio.

[a]Taken as a continuous variable.

[b]Adjusted by age, sex, Simplified Acute Physiology Score II, treatment limitation, type of ICU, region, diagnostic, planned or unplanned admission, postoperative admission, the interaction between these two last factors.

Region BfS (15): 1) Region Lake Geneva, 2) Espace Mittelland, 3) Northwestern Switzerland, 4) Zurich Region, 5) Eastern Switzerland, 6) Central Switzerland, 7) Ticino, southern Switzerland.

It is likely that limitation measures also have an influence on subsequent in-hospital mortality and length of treatment (42). Unfortunately, due to data safety and patient confidentiality restrictions, data from the MDSi cannot be systematically linked to other databases. Therefore, information on hospital mortality and long-term outcome could not be included in

the present study. Thus, the extent to which the importance of treatment limitation as the leading factor associated to ICU mortality diminishes over time awaits further analysis (43).

Second, MDSi only includes data of patients admitted to an ICU. Thus, information related to patients not admitted to an ICU is lacking. Indeed, only very limited data exist on advanced care planning of patients admitted to an acute care hospital in Switzerland (35, 36). On the other hand, the rate of treatment limitation in our study is rather similar to the one observed in other studies (8, 17). Accordingly, even if our data do not allow for a generalizability to all patients admitted to acute care hospitals, they still may be valid for patients admitted to many ICUs throughout the world. Further studies performed in other socioeconomical environments would be needed to strengthen this association.

Third, exclusion of patients readmitted to an ICU could lead to an underestimation of ICU mortality, as such patients typically have a higher mortality rate (44).

Fourth, in our study an abandonment of measures in the event of hopelessness, which only takes place during the final dying process, is not considered a limitation. A forgoing of therapeutic measures in dying patients is a deeply humane measure and—at least according to definitions of data in MDSi—not a broadly evaluated and substantiated procedure in the sense of a therapy limitation. The distinction between the final dying process and a late limitation is to some extent a matter of judgment. In this respect, there may be some variability in interpretation from ICU to ICU that cannot be analyzed in the present dataset.

Fifth, based on predefined criteria, 5.5% of all patients admitted to an ICU were excluded. However, general characteristics of these patients are relatively consistent with the included patients (Table 1; and Table S1, Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

Sixth, the variables for multifactorial analysis (SAPS, age, nursing effort, gender, type of ICU, type of admission, geographic region) do not contain information on comorbidity and functional status before admission. These elements are not included in the dataset and reduce the explanatory power of the analysis.

Finally, patients with treatment limitations overall had a longer LOS, a higher ventilation ratio/shift, and a higher renal replacement ratio/shift. This may be due to the higher severity of illness in this group as reflected by the SAPS II score (Table S3, Supplemental Digital Content 1, http://links.lww.com/CCM/F855).

CONCLUSIONS

Our data show that every seventh patient admitted to an ICU in Switzerland has some kind of treatment limitation, which most probably has a strong impact on the severity-adjusted mortality rate. Thus, mortality data as a quality indicator or benchmark in intensive care can only be meaningfully interpreted if the existence, grade, cause, and time of treatment limitation are taken into account.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (http://journals.lww.com/ccmjournal).

Supported, in part, by the Swiss Society of Intensive Care Medicine.

The authors have disclosed that they do not have any potential conflicts of interest.

For information regarding this article, E-mail: Mark.Kaufmann@usb.ch

REFERENCES

1. Rubenfeld GD, Angus DC, Pinsky MR, et al: Outcomes research in critical care: Results of the American thoracic society critical care assembly workshop on outcomes research. The members of the outcomes research workshop. *Am J Respir Crit Care Med* 1999; 160:358–367
2. Shojania KG, Forster AJ: Hospital mortality: When failure is not a good measure of success. *CMAJ* 2008; 179:153–157
3. McClean K, Mullany D, Huckson S, et al: Identification and assessment of potentially high-mortality intensive care units using the ANZICS centre for outcome and resource evaluation clinical registry. *Crit Care Resusc* 2017; 19:230–238
4. Kahn JM, Kramer AA, Rubenfeld GD: Transferring critically ill patients out of hospital improves the standardized mortality ratio: A simulation study. *Chest* 2007; 131:68–75
5. Ferrand E, Robert R, Ingrand P, et al; French LATAREA Group: Withholding and withdrawal of life support in intensive-care units in France: A prospective survey. French LATAREA group. *Lancet* 2001; 357:9–14
6. Azoulay E, Metnitz B, Sprung CL, et al; SAPS 3 investigators: End-of-life practices in 282 intensive care units: Data from the SAPS 3 database. *Intensive Care Med* 2009; 35:623–630
7. Walkey AJ, Weinberg J, Wiener RS, et al: Association of do-not-resuscitate orders and hospital mortality rate among patients with pneumonia. *JAMA Intern Med* 2016; 176:97–104
8. Lobo SM, De Simoni FHB, Jakob SM, et al; ICON investigators: Decision-making on withholding or withdrawing life support in the ICU: A worldwide perspective. *Chest* 2017; 152:321–329
9. Swiss Academy of Medical Sciences: Intensive-Care Interventions (Medical Ethical Guidelines). Available at: https://www.samw.ch/dam/jcr:99239135-d7e9-4dbd-bcc8-7d55511641ea/guidelines_sams_intensiv_care_2013.pdf. Accessed June 9, 2020
10. Perren A, Cerutti B, Kaufmann M, et al; Swiss Society of Intensive Care Medicine: A novel method to assess data quality in large medical registries and databases. *Int J Qual Health Care* 2019; 31:1–7
11. Previsdomini M, Cerutti B, Merlani P, et al: SwissScoring–A nationwide survey of SAPS II assessing practices and its accuracy. *Swiss Med Wkly* 2014; 144:w14090
12. Le Gall JR, Lemeshow S, Saulnier F: A new simplified acute physiology score (SAPS II) based on a European/North American multicenter study. *JAMA* 1993; 270:2957–2963
13. Reis Miranda D, Moreno R, Iapichino G: Nine equivalents of nursing manpower use score (NEMS). *Intensive Care Med* 1997; 23:760–765
14. Swiss Society of Intensive Care Medicine: Minimal Dataset of the Swiss Society of Intensive Care Medicine (MDSi). Available at: https://www.sgi-ssmi.ch/de/datensatz.html. Accessed June 9, 2020
15. Swiss Federal Statistical Office: Major Regions in Switzerland. Available at: https://www.media-stat.admin.ch/web/apps/glossary/index.php?n=glo-657-en. Accessed June 9, 2020
16. Sprung CL, Cohen SL, Sjokvist P, et al; Ethicus Study Group: End-of-life practices in European intensive care units: The Ethicus Study. *JAMA* 2003; 290:790–797
17. Lautrette A, Garrouste-Orgeas M, Bertrand PM, et al; Outcomerea Study Group: Respective impact of no escalation of treatment, withholding and withdrawal of life-sustaining treatment on ICU patients' prognosis: A multicenter study of the outcomerea research group. *Intensive Care Med* 2015; 41:1763–1772
18. Moher D, Schulz KF, Altman D; CONSORT Group (Consolidated Standards of Reporting Trials): The CONSORT statement: Revised recommendations for improving the quality of reports of parallel-group randomized trials. *JAMA* 2001; 285:1987–1991
19. Schulz KF, Altman DG, Moher D; CONSORT Group: CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. *J Clin Epidemiol* 2010; 63:834–840

20. Messika J, Gaudry S, Tubach F, et al: Underreporting of end-of-life decisions in critical care trials: A call to modify the consolidated standards of reporting trials statement. *Am J Respir Crit Care Med* 2018; 197:263–266
21. Callaway CW, Donnino MW: Testing epinephrine for out-of-hospital cardiac arrest. *N Engl J Med* 2018; 379:787–788
22. Quill CM, Ratcliffe SJ, Harhay MO, et al: Variation in decisions to forgo life-sustaining therapies in US ICUs. *Chest* 2014; 146:573–582
23. Deloitte: 2016 Global Health Care Outlook: Battling Costs While Improving Care. Available at: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-2016-health-care-outlook.pdf. Accessed June 6, 2020
24. Kramer AA, Higgins TL, Zimmerman JE: Comparing observed and predicted mortality among ICUs using different prognostic systems: Why do performance assessments differ? *Crit Care Med* 2015; 43:261–269
25. Kashyap R, Singh TD, Rayes H, et al: Association of septic shock definitions and standardized mortality ratio in a contemporary cohort of critically ill patients. *J Crit Care* 2019; 50:269–274
26. Rapoport J, Teres D, Lemeshow S, et al: A method for assessing the clinical performance and cost-effectiveness of intensive care units: A multicenter inception cohort study. *Crit Care Med* 1994; 22:1385–1391
27. Rothen HU, Stricker K, Einfalt J, et al: Variability in outcome and resource use in intensive care units. *Intensive Care Med* 2007; 33:1329–1336
28. Wunsch H, Harrison DA, Harvey S, et al: End-of-life decisions: A cohort study of the withdrawal of all active treatment in intensive care units in the United Kingdom. *Intensive Care Med* 2005; 31:823–831
29. Mark NM, Rayner SG, Lee NJ, et al: Global variability in withholding and withdrawal of life-sustaining treatment in the intensive care unit: A systematic review. *Intensive Care Med* 2015; 41:1572–1585
30. Park SY, Phua J, Nishimura M, et al; Asian Collaboration for Medical Ethics (ACME) Study Collaborators and the Asian Critical Care Clinical Trials (ACCCT) Group: End-of-life care in ICUs in East Asia: A comparison among China, Korea, and Japan. *Crit Care Med* 2018; 46:1114–1124
31. McPherson K, Carlos WG 3rd, Emmett TW, et al: Limitation of life-sustaining care in the critically ill: A systematic review of the literature. *J Hosp Med* 2019; 14:303–310
32. Curtis JR, Vincent JL: Ethics and end-of-life care for adults in the intensive care unit. *Lancet* 2010; 376:1347–1353
33. Taylor DM, Ugoni AM, Cameron PA, et al: Advance directives and emergency department patients: Ownership rates and perceptions of use. *Intern Med J* 2003; 33:586–592
34. Kon AA, Davidson JE, Morrison W, et al; American College of Critical Care Medicine; American Thoracic Society: Shared decision making in ICUs: An American college of critical care medicine and american thoracic society policy statement. *Crit Care Med* 2016; 44: 188–201
35. Krones T, Budilivschi A, Karzig I, et al: Advance care planning for the severely ill in the hospital: A randomized trial. *BMJ Support Palliat Care* 2019 Jan 21. [online ahead of print]
36. Slankamenac K, Rütsche N, Keller DI: Availability of advance directives in the emergency department. *Swiss Med Wkly* 2020; 150:w20184
37. Kerckhoffs MC, Senekal J, van Dijk D, et al: Framework to support the process of decision-making on life-sustaining treatments in the ICU: Results of a Delphi study. *Crit Care Med* 2020; 48:645–653
38. Lecuyer L, Chevret S, Thiery G, et al: The ICU trial: A new admission policy for cancer patients requiring mechanical ventilation. *Crit Care Med* 2007; 35:808–814
39. Elmer J, Torres C, Aufderheide TP, et al; Resuscitation Outcomes Consortium: Association of early withdrawal of life-sustaining therapy for perceived neurological prognosis with mortality after cardiac arrest. *Resuscitation* 2016; 102:127–135
40. Shrime MG, Ferket BS, Scott DJ, et al: Time-limited trials of intensive care for critically ill patients with cancer: How long is long enough? *JAMA Oncol* 2016; 2:76–83
41. Granholm A, Møller MH, Krag M, et al: Predictive performance of the simplified acute physiology score (SAPS) II and the initial sequential organ failure assessment (SOFA) score in acutely ill intensive care patients: Post-hoc analyses of the SUP-ICU inception cohort study. *PLoS One* 2016; 11:e0168948
42. Chen YY, Connors AF Jr, Garland A: Effect of decisions to withhold life support on prolonged survival. *Chest* 2008; 133:1312–1318
43. Starks H, Curtis JR: Is withholding life support associated with a premature death? If so, what does this mean for ICU practice? *Chest* 2008; 133:1298–1300
44. Kramer AA, Higgins TL, Zimmerman JE: Intensive care unit readmissions in U.S. hospitals: Patient characteristics, risk factors, and outcomes. *Crit Care Med* 2012; 40:3–10