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Long-term Survival of Critically Ill Patients Stratified According to Pandemic Triage Categories

A Retrospective Cohort Study



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BACKGROUND: The COVID-19 pandemic has led to unprecedented demand for ICUs, with the need to triage admissions along with the development of ICU triage criteria. However, how these criteria relate to outcomes in patients already admitted to the ICU is unknown, as is the incremental ICU capacity that triage of these patients might create given existing admission practices.

RESEARCH QUESTION: What is the short- and long-term survival of low- vs high-priority patients for ICU admission according to current pandemic triage criteria?

STUDY DESIGN AND METHODS: This study analyzed prospectively collected registry data (2007-2018) in 23 ICUs in Victoria, Australia, with probabilistic linkage with death registries. After excluding elective surgery, admissions were stratified according to existing ICU triage protocol prioritization as low (age \geq 85 years, or severe chronic illness, or Sequential Organ Failure Assessment [SOFA] score = 0 or \geq 12), medium (SOFA score = 8-11) or high (SOFA score = 1-7) priority. The primary outcome was long-term survival. Secondary outcomes were in-hospital mortality, ICU length of stay (LOS) and bed-day usage.

RESULTS: This study examined 126,687 ICU admissions. After 5 years of follow-up, 1,093 of 3,296 (33%; 95% CI, 32-34) of “low-priority” patients aged \geq 85 years or with severe chronic illness and 86 of 332 (26%; 95% CI, 24-28) with a SOFA score \geq 12 were still alive. Sixty-three of 290 (22%; 95% CI, 17-27) of patients in these groups followed up for 10 years were still alive. Together, low-priority patients accounted for 27% of all ICU bed-days and had lower in-hospital mortality (22%) than the high-priority patients (28%). Among nonsurvivors, low-priority admissions had shorter ICU LOS than medium- or high-priority admissions.

INTERPRETATION: Current SOFA score or age or severe comorbidity-based ICU pandemic triage protocols exclude patients with a close to 80% hospital survival, a $>$ 30% five-year survival, and 27% of ICU bed-day use. These findings imply the need for stronger evidence-based ICU triage protocols. CHEST 2021; 160(2):538-548

KEY WORDS: comorbidity; disaster preparedness; ICU; pandemic; SOFA score; triage

FOR EDITORIAL COMMENT, SEE PAGE 398

ABBREVIATIONS: ANZICS = Australian and New Zealand Intensive Care Society; NSW = New South Wales; SOFA = Sequential Organ Failure Assessment; VAED = Victorian Admitted Episode Dataset

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Take-home Points

Study Question: What is the short- and long-term survival of low- vs high-priority patients for ICU admission according to current pandemic triage criteria?

Results: After 5 years of follow-up, 33% of “low-priority” patients aged > 85 years or with severe chronic illness, and 26% with a SOFA score \geq 12 were still alive.

Interpretation: Current SOFA score or age or severe comorbidity-based ICU pandemic triage protocols exclude patients with considerable short- and long-term survival, implying the need for stronger evidence-based ICU triage protocols.

The ongoing COVID-19 pandemic has led to unprecedented global demand for ICU resources, which has overwhelmed some hospital and critical care services.¹ This situation has led to challenging decisions about which patients (both COVID-19 and/or non-COVID-19) to admit to the ICU, attracting significant media attention.² Similar recent outbreaks of communicable diseases, including avian (H5N1) influenza,³ severe acute respiratory syndrome,⁴ and pandemic (H1N1) influenza,⁵ have prompted the development of various ICU triage protocols.

Prior to this pandemic, the two most widely promulgated ICU triage protocols were developed separately in Minnesota and in Ontario, Canada, in 2006,^{6,7} and subsequently adapted in 2009 by the state government of New South Wales (NSW), Australia, to produce a mandatory ICU pandemic response policy directive.⁸ These triage protocols involve a tiered response to ICU bed allocation, prioritizing access on the basis of perceived survival prospects, including age, chronic comorbidities, and acute severity of illness scoring. Moreover, the Sequential Organ Failure Assessment (SOFA) scoring system has also been used for this purpose.⁹ In particular, the Ontario and NSW protocols rank the admission for patients with a SOFA score \leq 7 as highest priority for ICU admission, SOFA scores of 8 to 11 as intermediate priority, and patients aged > 85 years, or severe comorbidities, or SOFA score \geq 12, as not for

ICU admission. A 2012 Australian prospective evaluation study in eight ICUs simulating pandemic scenarios reported that application of these triage protocols might successfully increase ICU bed capacity by 23%.¹⁰

More recently, however, the validity of this approach has been challenged.^{11,12} Although extreme age, severe comorbid disease, and higher SOFA scores correlate with worse outcomes in both COVID-19 and non-COVID-19 diseases, the ability of such scoring systems to discriminate survivors from nonsurvivors, and the relationship of comorbidities and SOFA scores to long-term outcomes, is unclear.¹³ In addition, given that overall median admission SOFA scores are low with COVID-19 critical illness, a proposed threshold of \leq 7 has been challenged as unhelpful.¹⁴⁻¹⁶ These observations have prompted a recent consensus group rapid guideline directive (“We recommend against the use of the SOFA score for ICU triage of patients with COVID-19”),¹² raising questions about the best approach to triage during high-level ICU demand situations. Importantly, however, this controversy remains heavily opinion based, as there is limited literature on the hospital outcomes of patients (with or without COVID-19) who would be excluded from the ICU under SOFA-based triage conditions. Perhaps even more importantly, the correlation of age, comorbidities, and SOFA score thresholds proposed in triage protocols with short-term (hospital), medium-term (5 years), and long-term (10 years) mortality is unknown.

Accordingly, we conducted a multicenter retrospective cohort study to examine the short-, medium-, and long-term survival of patient groups who might receive tiered prioritization of access to the ICU under current protocolized pandemic triage situations. The aim of the current study was to describe the outcomes and resource utilization of each group under normal working conditions, with the goal of informing the validity of such categorizations. In particular, we hypothesized that the longer term outcomes observed in low prioritization groups would be comparable to those of other high-risk, high-intensity cohorts, which currently receive advanced support as a matter of standard health care policy, such as dialysis patients.

Materials and Methods

This retrospective population-based cohort study was conducted by using the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database, a clinical high-quality registry run by the ANZICS

Centre for Outcome and Resource Evaluation.¹⁷ All public hospital ICUs in the state of Victoria, Australia, contributed during the study period. Data included demographic, diagnostic, biochemical, physiological, and chronic health parameters from the first 24 h of ICU admission, required for calculation of severity of illness scores and

information on patients' outcomes. The Centre for Victorian Data Linkage performed probabilistic matching, linking de-identified registry data to individual admission episodes recorded in the Victorian Admitted Episode Dataset (VAED). The VAED is an administrative dataset containing coded diagnostic (*International Classification of Diseases, Tenth Revision*) and procedural information, demographic data, and outcomes of all hospitalizations in Victoria. The data are submitted to the local Department of Health and Human Services by all public hospitals. These data also contain information from the Victorian Death Registry, which records the date and cause of all deaths that occur in the state of Victoria, Australia. Any death certificate that is written in the state is logged into this dataset. Deaths that occur outside of Victoria are not included. Ethics approval was provided by The Alfred Hospital Human Research Ethics Committee (77/20).

To model potential admissions to ICU during a pandemic, all patients aged ≥ 16 years admitted to a Victorian ICU between July 1, 2007, and June 30, 2018, were included. Exclusion criteria were elective surgery, palliative care, or organ donation as a reason for admission, as these patients would be excluded from triage considerations. Recurrent hospitalizations were included to best mirror a "pandemic event" at a specific time, which may have involved readmitted patients at that time point. Demographic data were recorded, including age, sex, diagnosis (defined by using Acute Physiology and Chronic Health Evaluation III-j diagnosis codes), medical treatment limitation order, and illness severity scores (Acute Physiology and Chronic Health Evaluation II and III-j scores,¹⁸ and probability of death derived from the Australian and New Zealand Risk of Death [ANZROD] model).¹⁹ We only included data for those patients ultimately admitted to the ICU, as distinct from patients considered for ICU admission.

The maximum SOFA score in the first 24 h of admission to the ICU was calculated, based on dysfunction in the six relevant organ systems (respiratory, cardiovascular, renal, neurologic, hepatic, and hematologic) consistent with past definitions.⁹ We categorized five groups of patients, who might be differentially prioritized for ICU admission using previously published pandemic protocols, based on age or severe comorbidities, or acute illness severity defined by degree of organ dysfunction (definitions are given in e-Table 1).^{6,8}

Results

After excluding elective surgical patients and those with missing SOFA or outcomes data, there were 159,533 hospital episodes over the study period, which included one or more admissions to the ICU. Overall, 126,687 admission episodes (79%) in 102,799 discrete patients at 23 Victorian ICUs were listed in the ANZICS Adult Patient Database and could be linked to the VAED, with a growth in admissions over time (e-Fig 1, e-Table 2). Compared with "unlinked" admissions, those included in the study had lower rates of ICU and hospital mortality and longer lengths of stay, although the differences were small (e-Table 3).

Patient ages were similar in the severe SOFA score ≥ 12 , intermediate SOFA score 8 to 11, and mild organ dysfunction SOFA 1 to 7 score groups; patients were older in the severe comorbidity or older cohort, and younger in the SOFA score = 0 cohort (Table 1). Use of invasive mechanical ventilation and renal replacement

Consistent with prior pandemic protocols, three groups potentially considered likely to receive low prioritization for ICU admission were those with: (1) age ≥ 85 years or

one or more of the following comorbidities: dementia, chronic cardiovascular disease, chronic respiratory disease, metastatic cancer, hepatic failure, or severe immune suppressive disease; (2) severe organ dysfunction (SOFA score ≥ 12); or (3) very low illness severity (SOFA score = 0 [no organ failure]). The medium ICU prioritization group was defined as those with a SOFA score of 8 to 11 (intermediate organ dysfunction), and the high ICU prioritization group was defined as those with a SOFA score of 1 to 7 (mild organ dysfunction).

The primary outcome considered was long-term survival. Additional outcomes examined were in-hospital mortality, length of stay in the ICU and in the hospital, and ICU bed-day usage. ICU bed-day usage was estimated for all patients and separately for survivors and for those who died in the hospital.

Data were analyzed with Stata version 16.1 (StataCorp). Data are reported as number (%) for categorical variables and median (interquartile range) for continuous variables. Mean values are included where appropriate for estimates of predicted mortality and resource use such as length of stay. In-hospital mortality was calculated for all available patient admissions. Survival up to 10 years is presented as Kaplan-Meier curves with patients stratified into prioritization categories and also (to examine the effect of age) into four age groups: < 55 years, 55 to 69 years, 70 to 84 years, and ≥ 85 years. For patients who had multiple admissions to the ICU, survival time was calculated from the date of their first admission to the ICU with censoring at July 31, 2018. Multivariable Cox regression analyses were performed, adjusting for site as a random effect, age, admission diagnosis, admission following medical emergency response, treatment limitations on ICU presentation, cardiac arrest occurring in the hospital, and ICU setting (regional, metropolitan, or tertiary). A two-sided *P* value of .05 was used to indicate statistical significance.

therapy was more prevalent in those with the highest SOFA scores but similar between the elderly or severe comorbidity group and those with mild organ dysfunction (SOFA scores 1-7).

Hospital mortality (56%) was greatest for patients with a SOFA score ≥ 12 (e-Fig 2). In the elderly or comorbidity group who would receive triage-based low ICU prioritization, in-hospital mortality was 22% and lower than the 28% mortality seen in those with intermediate organ dysfunction (SOFA score 8-11) (Table 2). In all groups, younger patients had lower in-hospital and long-term mortality rates (e-Fig 3, Table 3).

Survival data to 5 years were available for 28,740 patients in total, including 3,296 patients aged ≥ 85 years or with one or more severe comorbidities and 332 patients with a SOFA score ≥ 12 . Of these, 1,093 patients in the elderly/severe comorbidity group (33%; 95% CI, 32-34) and 86 patients with a SOFA score ≥ 12 (26%; 95% CI,

TABLE 1] Baseline Demographic Characteristics and Interventions

Prioritization Group	Elderly/Severe Comorbidity Patients ^a (n = 29,103)	Severe Organ Dysfunction: SOFA Score ≥ 12 (n = 2,784)	Intermediate Organ Dysfunction: SOFA Score 8-11 (n = 14,754)	Mild Organ Dysfunction: SOFA Score 1-7 (n = 73,719)	No Organ Dysfunction: SOFA Score 0 (n = 6327)
	Low	Low	Medium	High	Low
Age, median (IQR), y	72 (60-84)	62 (48-73)	61 (47-73)	59 (42-72)	51 (35-67)
Male sex	16,485 (57%)	1,769 (64%)	8,958 (61%)	41,384 (56%)	3,182 (50%)
Diagnostic category					
Cardiac surgery	296 (1%)	11 (0.4%)	167 (1%)	1,177 (2%)	18 (0.3%)
Cardiac (medical)	4,764 (16%)	839 (30%)	3,114 (21%)	7,873 (11%)	889 (14%)
GI surgery	3,081 (11%)	145 (5%)	892 (6%)	6,521 (9%)	454 (7%)
Neurologic	1,703 (6%)	246 (9%)	1,755 (12%)	7,867 (11%)	426 (7%)
Medical (other)	4,013 (14%)	515 (18%)	3,021 (20%)	15,834 (21%)	1,516 (24%)
Other	2,793 (10%)	113 (4%)	918 (6%)	7,070 (10%)	590 (9%)
Respiratory	5,313 (18%)	180 (6%)	1,109 (8%)	7,249 (10%)	1,064 (17%)
Sepsis	6,253 (21%)	615 (22%)	2,811 (19%)	12,152 (16%)	583 (9%)
Trauma	887 (3%)	120 (4%)	967 (7%)	7,976 (11%)	787 (12%)
APACHE II score median (IQR)	20 (15-26)	34 (27-40)	25 (19-31)	14 (9-19)	8 (5-11)
APACHE III-j score median (IQR)	66 (51-85)	122 (98-142)	87 (66-108)	50 (36-66)	29 (21-38)
Predicted mortality ANZROD mean, median (IQR)	21.7%, 12.2% (4.8%-30.7%)	53.4%, 57.1% (25.9%-80.6%)	27.6%, 17.9% (5.1%-45.8%)	7.9%, 3.1% (1.1%-8.7%)	2.1%, 1.0% (0.4%-2.4%)
Cardiac arrest prior to ICU	1,811 (6%)	822 (30%)	2,557 (17%)	2,900 (4%)	69 (1%)
Mechanical ventilation	12,106 (42%)	2,577 (93%)	11,374 (77%)	34,711 (47%)	852 (13%)
Renal replacement therapy	1,657 (6%)	741 (27%)	2,012 (14%)	3,007 (4%)	18 (0.3%)

All data are numbers of admissions, not discrete patients. APACHE = Acute Physiology and Chronic Health Evaluation; ANZROD = Australian and New Zealand Risk of Death; IQR = interquartile range; SOFA = Sequential Organ Failure Assessment.

^aPatients aged > 85 years, or with dementia, chronic cardiovascular disease, chronic respiratory disease, metastatic cancer, hepatic failure, or immune suppressive disease.

TABLE 2] In-hospital Outcomes

Prioritization Group	Elderly/Severe Comorbidity Patients (n = 29,103)	Severe Organ Dysfunction: SOFA Score ≥ 12 (n = 2,784)	Intermediate Organ Dysfunction: SOFA Score 8-11 (n = 14,754)	Mild Organ Dysfunction: SOFA Score 1-7 (n = 73,719)	No Organ Dysfunction: SOFA Score 0 (n = 6,327)
	Low	Low	Medium	High	Low
Death in ICU	3,860 (13%)	1,376 (50%)	3,221 (22%)	3,293 (5%)	30 (0.4%)
Death in hospital	6,298 (22%)	1,547 (56%)	4,125 (28%)	5,666 (8%)	78 (1%)
Length of stay in ICU, d ^a					
All admissions	3.7, 2.3 (1.1-4.1)	5.6, 2.8 (1.0-7.3)	5.5, 3.2 (1.6-6.7)	3.6, 2.0 (1.1-3.9)	1.9, 1.2 (0.8-2.1)
Surviving admissions	3.4, 2.2 (1.1-4.0)	7.9, 5.2 (2.3-9.8)	5.8, 3.4 (1.7-6.9)	3.4, 2.0 (1.0-3.8)	1.8, 1.2 (0.8-2.1)
Nonsurviving admissions	4.4, 2.6 (1.1-5.2)	3.8, 1.6 (0.7-4.5)	4.9, 2.9 (1.2-5.9)	5.9, 3.6 (1.7-7.1)	3.7, 2.1 (0.9-4.5)
Length of stay in hospital, d ^a					
All admissions	13.1, 8.6 (4.5-16.1)	11.8, 5.6 (1.3-15.2)	14.2, 8.5 (3.3-18.2)	12.6, 7.7 (3.8-15.1)	7.4, 4.4 (2.2-8.2)
Surviving admissions	13.7, 9.3 (5.2-16.7)	19.3, 13.1 (6.0-25.7)	16.5, 10.9 (5.1-21.1)	12.6, 7.8 (3.8-15.1)	7.3, 4.3 (2.2-8.1)
Nonsurviving admissions	10.8, 5.9 (2.3-14.2)	5.9, 2.1 (0.8-6.9)	8.3, 4.0 (1.5-9.5)	12.9, 7.3 (3.0-15.7)	16.5, 8.5 (3.4-18.3)

All data are numbers of admissions, not discrete patients. SOFA = Sequential Organ Failure Assessment.

^aMean, median (interquartile range).

24-28) were alive at 5 years. An additional 290 patients combined from these groups had 10-year survival data, with 63 (22%; 95% CI, 17-27) alive at 10 years (Figs 1, 2). A total of 64 of 170 patients aged < 55 years (38%; 95% CI, 30-45) with a SOFA score ≥ 12 were alive at 5 years (Fig 2, e-Fig 4).

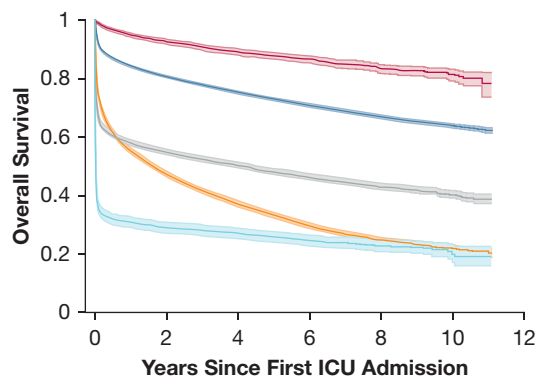
On Cox regression analysis, all patient categories had an increased risk of death compared with the group with a SOFA score = 0. After adjusting for confounders, the elderly or comorbidity group had a survival similar to that of the intermediate organ dysfunction cohort (SOFA score = 8 to 11) (Table 4).

TABLE 3] In-hospital Mortality Stratified According to Prioritization Group and Age Group

Prioritization Group	Elderly/Severe Comorbidity Patients (n = 29,103)	Severe Organ Dysfunction: SOFA Score ≥ 12 (n = 2,784)	Intermediate Organ Dysfunction: SOFA Score 8-11 (n = 14,754)	Mild Organ Dysfunction: SOFA Score 1-7 (n = 73,719)	No Organ Dysfunction: SOFA Score 0 (n = 6,327)
	Low	Low	Medium	High	Low
< 55 y (n = 47,147)	17% (839/4,914)	44% (440/1,009)	19% (1,045/5,586)	4% (1,221/32,101)	0.4% (15/3,537)
55-69 y (n = 35,607)	21% (1,714/8,149)	61% (552/902)	29% (1,307/4,500)	8% (1,680/20,459)	2% (31/1,597)
70-84 y (n = 37,160)	24% (2,266/9,267)	64% (555/873)	38% (1,773/4,668)	13% (2,765/21,159)	3% (32/1,193)
≥ 85 y (n = 6,773)	22% (1,479/6,773)	NA ^a	NA ^a	NA ^a	NA ^a
Total (N = 126,687)	22% (6,298/29,103)	56% (1,547/2,784)	28% (4,125/14,754)	8% (5,666/73,719)	1% (78/6,327)

NA = not applicable; SOFA = Sequential Organ Failure Assessment.

^aAll patients aged ≥ 85 years are included in the category of elderly/severe comorbidity.



No. at risk	0	2	4	6	8	10	12
High comorbidities	22,963	8,607	4,588	2,230	937	263	0
SOFA 0	5,090	3,712	2,441	1,470	729	220	0
SOFA 1-7	57,305	36,935	25,296	15,940	8,136	2,675	0
SOFA 8-11	11,590	4,895	3,403	2,177	1,061	333	0
SOFA ≥ 12	2,352	520	385	250	119	25	0

Figure 1 – Kaplan-Meier survival curves for all prioritization groups. Red: low prioritization group, “no organ dysfunction” (SOFA score = 0); blue: high prioritization group, “mild organ dysfunction” (SOFA score = 1-7); gray: medium prioritization group, “intermediate organ dysfunction” (SOFA score = 8-11); aqua: low prioritization group, “severe organ dysfunction” (SOFA score ≥ 12); and orange: low prioritization group, “elderly/severe comorbidity patients.” SOFA = Sequential Organ Failure Assessment.

ICU bed-day usage varied substantially according to group, with the greatest proportion (55%) occupied by admissions in the mild organ dysfunction SOFA score category 1 to 7, and 27% occupied by the three groups of low prioritization patients (3% by patients with severe organ dysfunction [SOFA score ≥ 12], 2% with no organ dysfunction [SOFA score = 0], and 22% by elderly/severe comorbidity patients) (e-Table 4, Fig 3). Elderly or severe comorbidity patient admissions had a length of stay similar to that in the ICU of the highest prioritization group (SOFA score 1-7) (Table 2). Nonsurvivors in all low prioritization categories had shorter ICU lengths of stay than nonsurvivors from the medium or high prioritization categories.

Discussion

Main Findings

In this retrospective population-based cohort study, we found that 33% of low-priority admissions based on SOFA scores or advanced age or high comorbidity were still alive at 5 years, and 22% were alive at 10 years. Their in-hospital mortality was also less than the mortality of admissions with a SOFA score of 8 to 11. Patient admissions with severe or absent organ dysfunction only accounted for 5% of all ICU bed-days during the study period, with a further 22% of bed-days occupied by patients with advanced age or high comorbidity.

Relationship to Prior Literature

Limited prior literature has assessed the appropriateness of SOFA scoring for those patients who might need to be triaged to an ICU during a pandemic, regardless of whether they present with viral respiratory critical illness or with any other condition deemed to require ICU admission. However, concerns have recently been raised relating to subjectivity in aspects of the scoring system and variability in performance in different disease states.¹¹ Whether SOFA scores at ICU admission robustly correlate with outcome from patients admitted to the ICU during the COVID-19 pandemic is currently not well understood; however, early reports describe comparatively low SOFA scores at admission in patients critically ill with COVID-19¹⁵ and provide no data on non-COVID-19 patients admitted to the ICU during such time. A previous Australian study suggested that utilization of the NSW and Ottawa protocols could increase ICU bed availability by 23% and 53% at admission, respectively.¹⁰ Our results build on these findings by showing that based on implementation of these recommended triage guidelines, bed availability in Victoria ICUs could be increased by one-quarter. However, this increase would be at the expense of not admitting many patients who have medium- and long-term survival comparable to other high-risk patient groups offered costly organ support therapies (eg, chronic hemodialysis).

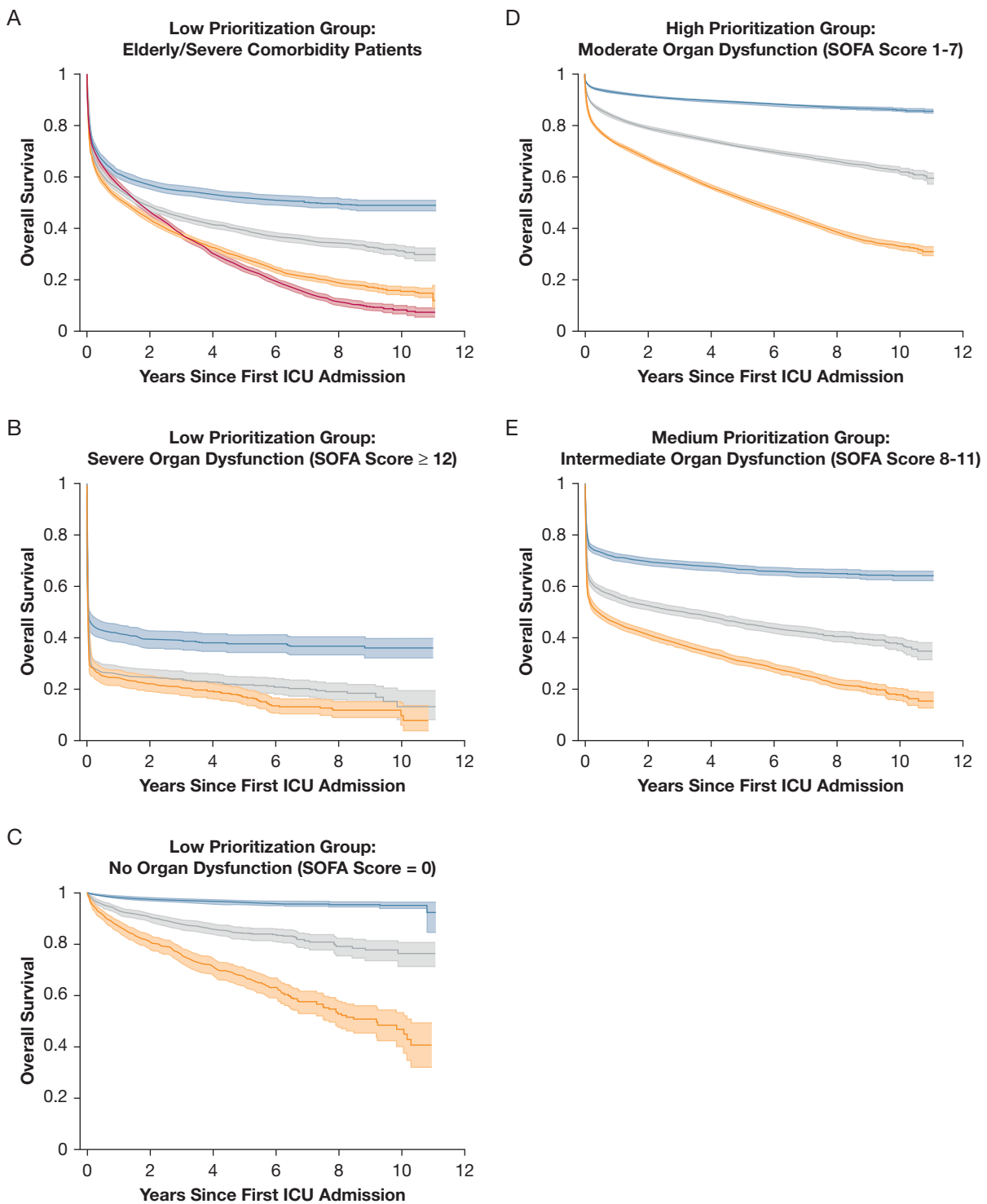


Figure 2 – Kaplan-Meier survival curve stratified according to age (blue, < 55 years; gray, 55-69 years; orange, 70-84 years; and red, ≥ 85 years). SOFA = Sequential Organ Failure Assessment.

The long-term outcome of high-risk, low-priority patients in the current study has to be considered in the context of other conditions, which are widely agreed to justify organ support treatment at high cost

likely exceeding that of 15 days in the ICU. For example, a Canadian cohort of 7,841 patients undergoing dialysis who were of equivalent age (60-69 years) had a 10-year survival of 24%. Patients in

TABLE 4] Cox Proportional Hazards Model for Factors Associated With Survival

Parameter		Hazard Ratio	95% CI
Prioritization group			
Low	No organ dysfunction (SOFA score 0)	1.00	Reference group
High	Mild organ dysfunction (SOFA 1-7)	1.81	1.65-1.99
Medium	Intermediate organ dysfunction (SOFA 8-11)	3.71	3.36-4.10
Low	Severe organ dysfunction (SOFA score \geq 12)	7.42	6.64-8.28
Low	Elderly/severe comorbidity patients	3.56	3.23-3.92
	Age	1.03	1.03-1.03
	Male	1.15	1.13-1.18
	Treatment limitation on admission to ICU	2.43	2.35-2.51
	Admission after medical emergency call	1.12	1.08-1.15
	Cardiac arrest in preceding 24 h prior to ICU admission	1.73	1.65-1.81
	Ventilated on day 1 of ICU	1.44	1.41-1.48
Diagnosis on admission to ICU			
	Cardiac surgery	1.00	Reference group
	Cardiac (medical)	3.40	2.96-3.90
	GI surgery	2.91	2.53-3.35
	Neurologic	4.40	3.82-5.05
	Medical (other)	3.20	2.78-3.68
	Other	2.35	2.04-2.70
	Respiratory	3.41	2.96-3.92
	Sepsis	3.56	3.10-4.09
	Trauma	2.06	1.78-2.38
Hospital type			
	Rural/regional ICU	1.00	Reference group
	Metropolitan ICU	1.46	1.20-1.76
	Tertiary ICU	1.38	1.12-1.69

All variables were significant, $P < .001$. NA = not applicable; SOFA = Sequential Organ Failure Assessment.

our study with a SOFA score \geq 12 and a median age of 62 years had a 10-year survival of 20%. The current study cohort with either a severe comorbidity or older age (median age, 72 years) had a 10-year survival of 22%. This survival was significantly greater than for Canadian patients of equivalent age started on chronic dialysis (6% of men and 8% of women aged \geq 70 years surviving at 10 years).²⁰ Five-year survival was also comparable: 27% of men and 30% of women aged \geq 70 years commenced on dialysis are alive at 5 years vs 33% of the current study patients with severe comorbidity or older age. Overall, these data suggest comparable outcomes with a common, intensive organ-support intervention deemed acceptable in a developed health care setting, with annual US Medicare expenditure averaging \$90,000 per patient.²¹

Our findings reinforce recent concerns raised about SOFA scoring.^{12,22} Unfortunately, there are limited proposed alternative triage models with sufficient detail for implementation.^{13,23} The National Institute for Health and Care Excellence in the United Kingdom has recommended the Clinical Frailty Scale be used for this purpose, with a scale cutoff of \geq 5 (“mild frailty”) in patients aged \geq 65 years.²⁴ We have previously shown, however, that only a weak association exists between mortality and such frailty in critically ill patients with pneumonia, although there are data linking frailty with overall poorer outcomes following ICU admission, particularly in older patients.²⁵⁻²⁷ Some jurisdictions have advocated for a combination of frailty, SOFA scoring, comorbid disease, and age in COVID triage decisions.²⁸ Other consensus groups have similarly recommended combining premorbid performance

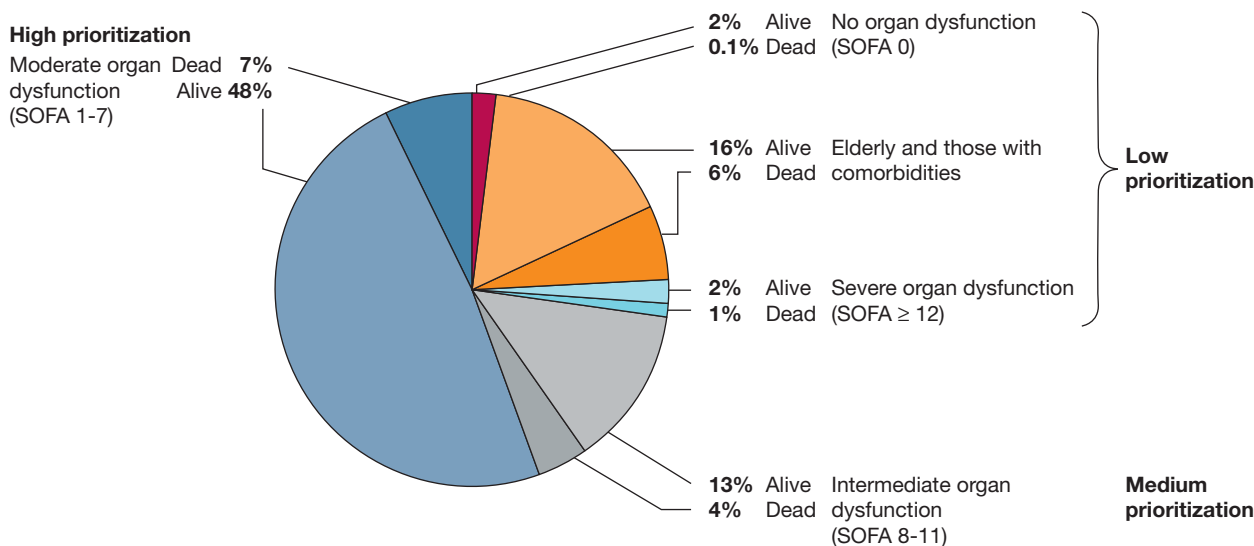


Figure 3 – Proportion of total ICU bed-days occupied by each prioritization group, subgrouped according to in-hospital survival status. SOFA = Sequential Organ Failure Assessment.

status, comorbidities, and organ failures in prioritizing ICU resource allocation.²⁹ Further research is thus required to examine potential long-term survival and bed-day needs in different triage categories of patients incorporating these additional aspects of priority assessment.

Clinical Implications

This study implies that a significant proportion of low-priority patients, based on high level of organ dysfunction, or advanced age or severe comorbidity, have long-term survival compared with that of other high-intensity organ support therapy such as dialysis. Short lengths of stay were observed for admissions associated with mortality in these groups, implying that a large reduction in ICU bed-days “wasted” on patients who would ultimately go on to die is not realized by such a low prioritization strategy. Finally, our findings imply that a more complex assessment of ICU admission candidates, which might involve a risk score based on a combination of frailty, age, comorbidities, organ dysfunction, and admission diagnosis, is needed to inform triage decisions.

Strengths and Limitations

Strengths of this study include the reporting of long-term follow-up data, providing a novel perspective on patient survival at different SOFA thresholds, or older age or comorbidities beyond the index hospitalization. The database used was comprehensive and large in scale, covering the majority of the Victorian population. This study also captured 11 years of ICU admissions,

including the inter-pandemic period between the 2009 H1N1 influenza and the current COVID-19 pandemic, thus reflecting contemporary ICU admission practices in a modern health care setting under normal conditions of resource constraint. The current patient population, therefore, is likely reflective of those patients who would be subject to triage (and potential exclusion from the ICU) under pandemic-induced increases in ICU demand. Conversely, ICU referral and admission patterns may change during a pandemic. Thus, repeating our study in a health care setting experiencing resource exhaustion would be important. Future research could also seek to repeat this investigation in a population of all hospital patients being considered for the ICU, rather than those already admitted. Availability of illness severity and outcome data would, however, be challenging in such a study design.

We were also unable to estimate what the outcomes would have been for patients not admitted to the ICU. A minority of patients were unable to be linked to the VAED database, and thus follow-up data for these patients were unavailable. Overall, however, magnitude of differences between missing and included patients was small. We were not able to measure the impact of deaths recorded outside of Victoria, although we note that interstate and overseas migration during the study period affected < 3% of the resident population (and < 1% of the population aged ≥ 50 years).³⁰ We were not able to account for potential differences in treatment between cohorts following hospital discharge, nor adjust for socioeconomic factors influencing survival. We did

not include patients admitted to private hospitals, nor can we account for potential changes in ICU practice over the study period. We were also unable to calculate repeated SOFA scores during the patients' course in the ICU, relevant to some of the triage policies examined, which advocate for reassessment during the patient's ICU stay. Literature exists, however, challenging the utility of interim SOFA score reviews.³¹ In common with the triage policies being examined, we chose to analyze patients aged ≥ 85 years and those with severe comorbidities grouped within the same cohort, although long-term survival is clearly affected by advanced age at presentation. Finally, repeated admissions affected 20% of the current cohort; however, we chose to analyze data at admission level (rather than discrete patients) as not to progressively exclude patients previously admitted to the ICU over the study period. This

approach would have resulted in biasing the admitted cohort over time in terms of triage criteria assessment.

Interpretation

Current ICU pandemic triage guidelines based on SOFA scoring or older age or the presence of severe comorbidities have major limitations. In particular, many patients in such low-admission prioritization categories go on to have a long-term survival similar to that of patients on chronic dialysis, a likely acceptable outcome. Given these findings, future ICU triage research should focus on stratifying long-term survival outcomes for patients, accounting for a more detailed combination of premorbid functional status, comorbidities, and organ dysfunction severity scoring.

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