ABCDEF Bundle and Supportive ICU Care Practices for patients with COVID-19 infection: An international point prevalence study ~The ISIIC Study~

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Research

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Abstract

Background

Although the number of patients with COVID-19 infection is increasing and concerns for their long-term disabilities are increasing, there is a lack of data about the delivery of the ABCDEF-bundle and supportive care in Intensive Care Units (ICUs). The aim of this study is to investigate the implementation of the ABCDEF-bundle and supportive care provided to patients with COVID-19 infections in ICUs.

Methods

This was a world-wide two-day point prevalence study, on June 3 and July 1, 2020. A total of 212 ICUs in 38 countries (166 ICUs on Day 1 and 212 on Day 2) participated. Clinicians in each participating ICU completed web-based online surveys. The implementation rate for elements of the ABCDEF-bundle, other supportive ICU care measures and implementation associated structures were investigated.

RESULTS

Data for 262 patients was collected during the two-day study. Of patients included, 124 (47.3%) underwent mechanical ventilation (MV) and 12 (4.6%) patients were treated with extracorporeal membrane oxygenation (ECMO). The proportion of patients with implementation of each element was: Element A (regular pain assessment) 45%; B (both spontaneous awakening and breathing trials) 28%; C (regular sedation assessment) 52%; D (regular delirium assessment) 38%; E (early mobility and exercise) 47%; and F (family engagement and empowerment) 16%. The implementation of element E for patients on MV was 16% and ECMO was 17%. Supportive care, such as providing protein throughout the ICU stay (under 1.2g/kg for more than 50% of the patients) and introduction of an ICU diary (25%) was inadequate. A higher implementation rate of elements A and D were recognized in ICUs with specific protocols for ICU care and lower numbers of ICU beds exclusively for patients with COVID-19 infection. Element E was implemented at a higher rate in ICUs with more ICU beds for patients with COVID-19 infection.

CONCLUSIONS

This worldwide two-day point prevalence study found low implementation of the ABCDEF-bundle. Specific protocols and the number of ICU beds reserved for patients with COVID-19 infections might be key factors to deliver appropriate supportive care.

Trial registration: UMIN, UMIN000040405. Registered 14 May 2020, https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000046103

Introduction

It is clear that evidence-based and supportive Intensive Care Unit (ICU) care synchronized with treatment of the underlying disease should be the standard of care to prevent weakness and disabilities in patients after resolution of their critical illness [1–3]. The implementation of ICU care, along with the ABCDEF bundle [1], PADIS guideline [2], and nutrition guidelines [3, 4], have been shown to be key elements for patients in ICUs not only to improve mortality and morbidity [5] but also to rehabilitate their functional abilities and health related quality of life [6]. A variety of guidelines recommend incorporation of these evidence-based approaches to ICU care into clinical practice [1–3], according to the local situation and available resources [7, 8].

However, the novel coronavirus pandemic (SARS-CoV-2) rapidly changed ICU practice internationally [9]. Challenges include an inadequate number of beds to meet the staggering increase in the number of patients with COVID-19 infections [10] and unbalanced interprofessional staff resources to meet the demand [11]. These challenges may lead to patients not receiving the same quality of clinical care, resulting in poorer outcomes including increased mortality [12]. In addition to increased ICU mortality in patients with COVID-19 infections, recent evidence has highlighted the severe physical disabilities and prolonged symptoms during recovery from COVID-19 infection that limits patients' daily activities and quality of life after discharge from the hospital [13–16]. Thus, an enhanced recovery program which optimizes evidence-based ICU care and patient recovery is essential [15–18]. Although, many studies and guidelines propose a way to conduct ICU care including the ABCDEF bundle [19–22] and providing adequate nutrition [23, 24] for patients with COVID-19 infections in this pandemic, data demonstrating implementation of these aspects of care in the ICU is insufficient. There are serious concerns regarding second waves in many countries, and these data are essential to improve future patient outcomes and minimize disabilities.

Therefore, we conducted an international, internet-based, 2-day point prevalence survey, aiming to investigate the implementation of the ABCDEF-bundle, the PADIS guideline and other supportive care provided to patients with COVID-19 infections in ICUs, with consideration of the specific ICU structure.

Materials And Methods

Design and Setting

This was a worldwide two-day point prevalence study of evidence-based ICU care for critically ill patients in ICUs with COVID-19 infections, which was approved by the ethics committee of the Saiseikai Utsunomiya Hospital (2020-07) as the central institution, registered in UMIN (ID: 000046103), and followed the STROBE cross sectional guidelines (Supplemental Table 1). Surveys were performed on June 3rd and July 1st 2020. This project was led by the Japanese Society of Intensive Care Medicine; JSICM collaborating with World Federation of Intensive and Critical Care; WFICC, European Society of Intensive Care Medicine; ESICM, Indian Society of Critical Care Medicine; ISCCM, and other networks (Appendix 1).

Surveys were anonymous and the information collected did not include specific data which could identify the facility or individual, therefore ethical approval at each participating facility was omitted according to the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan [25]. This

ethical policy was explained to all clinicians, and only ICUs for which participants agreed after referring to the ethics policies in their regions and countries participated. If there was difficulty in participation based on this ethical policy, clinicians could decide to participate after obtaining ethical approval. Under this policy, the registration process for each participating site and surveys were managed online using Google Forms (Google, Inc).

The Study Process

Participating ICUs were recruited by distributing information about the study and an invitation letter to members of JSICM, WFICC, ESICM, and ISCCM via their own networks between May 16 and July 1 2020. Social networking services and a web-based advertisement were also used (eAppendix). All ICUs in the world were eligible, regardless of whether they had patients with COVID-19 infections at the time and there were no exclusion criteria based on the structure of the facility or ICU.

After registration, all representatives were requested to answer a pre-survey to obtain basic information about the hospital/ICU. Only those who completed the pre-survey were enrolled as participating sites. One day before each of the survey dates, participating representatives received the URL for the survey of baseline characteristics of patients and daily ICU care provided to patients with COVID-19 infections in the participating ICU on the survey date. Patients considered to be in a terminal state and receiving palliative care, were excluded.

Data collection

The questionnaires and response sheets for both surveys are shown in Appendix 2. The facility registration number was used to link the basic information of the participating hospital/ICU with the data for baseline characteristics of the patients and daily ICU care. The operational definitions of the ABCDEF bundle, composed of elements A, B, C, D, E, and F, were cited from a previous study (Supplemental Table 2) [5]. Other ICU care, such as nutrition, an ICU diary, and physical restraints are defined in Supplemental Table 2.

Study outcomes

This primary outcome of this study was the implementation of each element of the ABCDEF bundle. The following data were examined: classification of professionals with primary responsibility for the bundle, the presence of a target goal for pain and sedation management, the prevalence of delirium on the survey dates, the highest mobility level according to the ICU Mobility Scale [26], the implementation of nutrition therapy, interventions to promote sleep, an ICU diary, the use of physical restraints, the route and amount of energy and protein in nutrition, assessment tools used for pain, sedation, and delirium, agents used for pain, sedation, delirium, and sleep, the reason why element B was not implemented, non-pharmacological interventions to control delirium and promote sleep, classifications of professionals delivering mobilization/rehabilitation, devices used during rehabilitation, barriers which prevent sitting on the edge of the bed or more, and the visiting habits for family members.

The association between the implementation of ICU care and the ICU structure, including the presence of specific protocols, the frequency of multidisciplinary and/or multi-professional rounds, the nurse to patient ratio, the number of ICU beds exclusively for patients with COVID-19 infections, the presence of dedicated physiotherapists, the ability of physiotherapists to enter the room of patients with COVID-19 infections, and visiting hours were also evaluated.

Data analysis

Non-normally distributed continuous data and categorical data, without missing data, are presented as medians with interquartile range (IQR) and numbers or percentages respectively. The chi-squared test and Fisher's exact test were used for categorical data appropriately.

In the analysis of the implementation of ICU care, patients were classified into three groups: no mechanical ventilation (MV) or extracorporeal membrane oxygenation (ECMO), undergoing MV, and undergoing ECMO. The highest mobility level and the energy and protein provided per day were evaluated according to three phases of critical illness: the early period in the acute phase (ICU days 1 to 3), the late period in the acute phase (ICU days 4 to 7), and after the acute phase (ICU days 8 to 14 and from 15) [3, 4].

All statistical analyses were conducted using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan) [27], which is a graphical user interface for R. Statistical tests were two sided and statistical significance was set at $p < 0.05$.

Patient and public involvement

This study did not involve patients or the public directly in terms of development and implementation of the study, or preparation of the manuscript. However, the findings will be widely and immediately disseminated to the public through official (press release and institutional websites), personal, and social communication tools necessitated by the rapid global progression of COVID-19.

Results

Characteristics of Participating Hospitals and ICUs

A total of 166 and 212 ICUs were enrolled on the first and second survey dates respectively (Supplemental Fig. 1 and Supplemental Table 3). The majority of the respondents were intensivist physicians (Supplemental Table 4). There was no difference in basic structure of the hospital/ICU between the two dates (Table 1) at each site. Most ICUs were medical-surgical mixed ICUs with a 1:2 nurse to patient ratio and had less than 5 beds assigned for patients with COVID-19 infections. Intensivists, physicians, and nurses were generally allowed to enter the rooms of patients with COVID-19 infections. About 40% of ICUs used written protocols for ICU care and 60% of the ICUs performed multidisciplinary/-professional rounds daily. Visiting hours were reduced or banned during the COVID-19 pandemic (Supplemental Table 5).

Table 1
Participating hospitals and ICUs

Parameter	ICUs Participating in the first survey (n = 166)	ICUs Participating in the second survey (n = 212)
Basic information for hospitals with participating ICUs ^a		
Type, n (%)		
University hospital	58 (36%)	75 (35%)
University affiliated hospital	34 (20%)	48 (23%)
Community hospital	60 (36%)	71 (34%)
Others	14 (8%)	18 (8%)
Number of (beds), n (%)		
$x < 200$	10 (6%)	19 (9%)
$200 \leq x < 400$	29 (17%)	40 (19%)
$400 \leq x < 600$	41 (25%)	48 (23%)
$x \geq 600$	86 (52%)	105 (50%)
Beds exclusively for patients with COVID-19 infection, n (%)		
$x < 10$	61 (37%)	71 (35%)
$10 \leq x < 20$	34 (20%)	41 (19%)
$x \geq 20$	71 (43%)	100 (47%)
Basic information for participating ICUs		
Type of ICU, n (%) ^b		
Medical-Surgical mixed ICU	140 (84%)	169 (80%)
Medical ICU	11 (7%)	26 (12%)
Surgical ICU including cardiac surgery	7 (4%)	9 (4%)
Other types of ICU ^c	8 (5%)	8 (4%)
Nurse-to-patient ratio, n (%)		
1:1	22 (13%)	35 (17%)
1:2	133 (80%)	151 (71%)
1:x ($x \geq 3$)	11 (7%)	26 (12%)
Number of ICU beds, n (%)		
$x < 10$	43 (26%)	59 (28%)
$10 \leq x < 20$	75 (45%)	90 (42%)
$x \geq 20$	48 (29%)	63 (30%)
ICU beds exclusively for patients with COVID-19, n (%)		
$x < 5$	101 (61%)	113 (53%)
$5 \leq x < 20$	43 (26%)	66 (31%)
$x \geq 20$	22 (13%)	33 (16%)
Professionals who may enter rooms of patients with COVID-19 under infection control regulations, n (%)		
Intensivists	157 (95%)	202 (95%)

Data are presented as number (%)

ICU: intensive care unit

a In 5 instances two different ICUs in the same hospital participated in this study.

b One ICU is managed as a tele-ICU by another hospital or ICU

c Among both 8 other types of ICUs, 5 are pediatric ICUs.

Parameter	ICUs Participating in the first survey (n = 166)	ICUs Participating in the second survey (n = 212)
Physicians other than intensivists	134 (81%)	169 (80%)
Nurses	166 (100%)	212 (100%)
Physiotherapists	93 (56%)	122 (58%)
Respiratory Therapists	48 (29%)	68 (32%)
ICUs with dedicated intensivists, n (%)	159 (96%)	205 (97%)
Role of dedicated intensivists in the ICU, n (%)		
Intensivists have primary responsibility for patient care	88 (53%)	120 (57%)
Intensivists provides mandatory consultations	43 (26%)	48 (23%)
Intensivists available for consultation	28 (17%)	37 (17%)
ICUs with dedicated physiotherapists, n (%)	78 (47%)	108 (51%)
ICUs with dedicated respiratory therapists, n (%)	44 (27%)	65 (31%)
ICU structure associated with evidence-based and supportive ICU care		
ICUs with a written Pain management protocol, n (%)	73 (44%)	98 (46%)
ICUs with a written Spontaneous Awakening Trials management protocol, n (%)	60 (36%)	83 (39%)
ICUs with a written Spontaneous Breathing Trials management protocol, n (%)	70 (42%)	91 (43%)
ICUs with a written Sedation management protocol, n (%)	88 (53%)	115 (54%)
ICUs with a written Delirium management protocol, n (%)	66 (40%)	82 (39%)
ICUs with a written Mobilization / Rehabilitation management protocol, n (%)	73 (44%)	93 (44%)
ICUs with a written Sleep management protocol, n (%)	21 (13%)	30 (14%)
Frequency of multidisciplinary rounds for patients with COVID-19 in the ICU, n (%)		
Daily	100 (60%)	135 (64%)
At least once a week	9 (5%)	10 (5%)
Not applicable	57 (34%)	67 (32%)
Visiting hours/day for patients with COVID-19 in the ICU (hours), n (%)		
No visiting hours	142 (86%)	182 (86%)
0 < x < 6	21 (13%)	26 (12%)
6 ≤ x < 24	1 (1%)	2 (1%)
No limitation on visiting hours	2 (1%)	2 (1%)
Data are presented as number (%)		
ICU: intensive care unit		
a In 5 instances two different ICUs in the same hospital participated in this study.		
b One ICU is managed as a tele-ICU by another hospital or ICU		
c Among both 8 other types of ICUs, 5 are pediatric ICUs.		

Baseline patient characteristics

There were 135 and 127 patients in ICUs on the first and second survey dates respectively (Table 2), with equal distribution of age groups. Most patients were male (68%). Racial mix included mostly and Asian (45%) and white (39%). The median ICU length of stay was 9 [5–35] days. Of a total of 262 patients, 47.3% (n = 124) patients underwent MV and 4.6% (n = 12) patients were treated with ECMO. There was no statistically significant difference between the first and second survey days for these characteristics, except for the use of MV ($p < 0.001$), the number of patients who underwent prone positioning ($p = 0.002$), and its duration ($p < 0.05$) (Table 2).

Table 2
Baseline patient characteristics

	Total patients (n = 262)	Patients in the first survey (n = 135)	Patients in the second survey (n = 127)
Demographics			
Age (years), n (%)			
x < 50 ^a	69 (26%)	27 (20%)	42 (33%)
50 ≤ x < 60	69 (26%)	24 (18%)	45 (35%)
60 ≤ x < 70	62 (24%)	37 (27%)	25 (20%)
70 ≤ x < 80	46 (18%)	35 (26%)	11 (9%)
x ≥ 80	16 (6%)	12 (9%)	4 (3%)
Gender (male), n (%)	177 (68%)	96 (71%)	81 (64%)
Race, n (%)			
Asian	118 (45%)	63 (47%)	55 (43%)
White	103 (39%)	54 (40%)	49 (39%)
Hispanic	10 (4%)	4 (3%)	6 (5%)
Black	7 (3%)	5 (4%)	2 (2%)
Other	24 (9%)	9 (7%)	15 (12%)
BMI (kg/m ²), n (%)			
x < 18.5	19 (7%)	8 (6%)	11 (9%)
18.5 ≤ x < 25	118 (45%)	58 (43%)	60 (47%)
25 ≤ x < 30	79 (30%)	41 (30%)	38 (30%)
30 ≤ x < 35	27 (10%)	14 (10%)	14 (11%)
x ≥ 35	19 (7%)	14 (10%)	4 (3%)
ICU length of stay (days), median [IQR]	9 [5–35]	24 [7–50]	6 [4–10]
Ambulatory independence prior to ICU admission, n (%)	222 (85%)	118 (87%)	104 (82%)
ICU treatment provided on the survey date			
Respiratory assistance, n (%)			
No respiratory device	20 (8%)	12 (9%)	8 (6%)
Oxygen, such as nasal cannula, face mask, reserved face mask, and others	89 (34%)	37 (27%)	52 (41%)
Nasal high flow cannula	22 (8%)	10 (7%)	12 (9%)
Non-invasive ventilation	33 (13%)	9 (7%)	24 (19%)
Mechanical ventilation	124 (47%)	86 (64%)	38 (30%)
ECMO	12 (5%)	11 (8%)	1 (1%)
Patients receiving continuous / intermittent renal replacement therapy, n (%)	38 (15%)	22 (16%)	16 (13%)

Data are presented as median [interquartile range] or number (%)

ICU intensive care unit, IQR interquartile range, BMI body mass index, ECMO extracorporeal membrane oxygenation

a Of 69 patients, 2 patients are under 20 years old.

b Percentages are calculated by dividing by the number of patients without mechanical ventilation and ECMO. The number of patients without mechanical ventilation and ECMO as total, the first survey, and the second survey are 137, 48, and 89 respectively.

c Percentages are calculated by dividing by the number of patients on mechanical ventilation. The number of patients on mechanical ventilation as total, the first survey, and the second survey are 124, 86, and 38 respectively.

d Percentages are calculated by dividing by the number of patients on ECMO. The number of patients on ECMO as total, the first survey, and the second survey are 12, 11, and 0 respectively.

	Total patients (n = 262)	Patients in the first survey (n = 135)	Patients in the second survey (n = 127)
Patients receiving continuous neuromuscular blocking agents, n (%)	38 (15%)	25 (19%)	13 (10%)
Patients receiving continuous vasoactive drugs, n (%)	65 (25%)	42 (31%)	23 (18%)
Patients receiving continuous analgesics, n (%)	118 (45%)	45 (33%)	73 (57%)
Patients receiving continuous use of sedatives, n (%)	102 (39%)	59 (44%)	43 (34%)
Patients receiving prone positioning, n (%)	57 (22%)	19 (14%)	38 (30%)
Prone positioning without mechanical ventilation and ECMO, n (%) ^b	35 (26%)	6 (13%)	29(33%)
Prone positioning on mechanical ventilation, n (%) ^c	22 (18%)	13 (15%)	9 (24%)
Prone positioning on extracorporeal membrane oxygenation, n (%) ^d	2 (17%)	2(18%)	0 (0%)
Scheduled total hours of prone positioning (hours), n (%)	(n = 57)	(n = 19)	(n = 38)
0 < x < 6	26 (46%)	5 (26%)	21 (55%)
6 ≤ x < 12	9 (16%)	4 (21%)	5 (13%)
12 ≤ x < 18	17 (30%)	8 (42%)	9 (24%)
18 ≤ x < 24	3 (5%)	1 (5%)	2 (5%)
24 (all day long)	2 (4%)	1 (5%)	1 (3%)
Data are presented as median [interquartile range] or number (%)			
ICU intensive care unit, IQR interquartile range, BMI body mass index, ECMO extracorporeal membrane oxygenation			
a Of 69 patients, 2 patients are under 20 years old.			
b Percentages are calculated by dividing by the number of patients without mechanical ventilation and ECMO. The number of patients without mechanical ventilation and ECMO as total, the first survey, and the second survey are 137, 48, and 89 respectively.			
c Percentages are calculated by dividing by the number of patients on mechanical ventilation. The number of patients on mechanical ventilation as total, the first survey, and the second survey are 124, 86, and 38 respectively.			
d Percentages are calculated by dividing by the number of patients on ECMO. The number of patients on ECMO as total, the first survey, and the second survey are 12, 11, and 0 respectively.			

Implementation of the ABCDEF bundle

Implementation of the ABCDEF bundle was primarily by intensivists (58%), followed by nurses and a multidisciplinary/-professional team (Table 3). The implementation of each element of the bundle is shown in Fig. 1 and Table 3. Among the different patient groups, there were significant differences in implementation of elements A, C, D, and E. The implementation rates included: element A, *regular pain assessment*, (45%); element B, *both spontaneous awakening and breathing trials*, (28%); element C, *regular sedation assessment*, (52%); element D, *regular delirium assessment*, (38%); element E, *early mobility and exercise*, (47%); element F, *family engagement and empowerment*, (16%). The details associated with implementation of each element are shown in Supplemental Table 6. Most patients undergoing MV and ECMO were managed with a target for pain control and sedation by using of fentanyl and benzodiazepines. The Numerical Rating Scale, Critical-care Pain Observation Tool, and Behavioral Pain Scale were used as Pain assessment tools, the Richmond Agitation- Sedation Scale for sedation assessment, and the Confusion Assessment Method for ICU to monitor delirium. The most common reason why spontaneous awakening trials (Element B) were not performed was respiratory instability, followed by the absence of a protocol. Overall, 11% of patients were diagnosed with delirium. Non-pharmacological interventions, such as orientation, optimizing sleep conditions, and mobilization, were more frequently performed than pharmacological interventions to control delirium. While 75% of the patients without MV or ECMO could mobilize to the level of standing, the implementation of element E for the patients on MV or ECMO was less than 20%. The mobility level increased gradually over during the ICU stay, while the median level in patients undergoing MV remained IMS 0, the level of passive exercise in bed (Fig. 2). The barriers preventing increased mobility to sitting at the edge of the bed or higher were primarily respiratory factors, such as desaturation or an excessive respiratory rate, followed by consciousness factors. The involvement of intensivists in mobilization (20%) was less frequent than nurses (60%) or physiotherapists (56%). The cycle-ergometer and electrical neuromuscular stimulation were rarely used. Electronic devices, using a monitor to facilitate meetings, were used for 40% of the patients. The full implementation of all elements of the ABCDEF bundle was achieved for only 1% of the patients (Supplemental Table 7).

Table 3
Implementation of the ABCDE bundle and other supportive measures for patients with COVID-19 infections

Variables	Total patients (n = 262)	The patients without mechanical ventilation and ECMO (n = 137)	The patients on mechanical ventilation (n = 124)	The patients on ECMO (n = 12)
Person with primary responsibility for implementing the ABCDEF bundle				
Intensivist, n (%)	151 (58%)	71 (52%)	79 (64%)	4 (33%)
Nurse (include nurse managers, directors, and critical care nurse specialists), n (%)	112 (43%)	76 (55%)	36 (29%)	3 (25%)
Multidisciplinary rounds / conference / team, n (%)	92 (35%)	58 (42%)	33 (27%)	5 (42%)
Respiratory Therapist, n (%)	63 (24%)	48 (35%)	15 (12%)	0 (0%)
Physician other than intensivists, n (%)	41 (16%)	27 (20%)	14 (11%)	0 (0%)
Physiotherapist, n (%)	21 (8%)	13 (9%)	8 (6%)	0 (0%)
No one has responsibility for implementing the bundle, n (%)	7 (3%)	4 (3%)	3 (2%)	1 (8%)
Implementation of each element of the ABCDEF bundle				
Patients receiving element A , n (%) ^a	118 (45%)	42 (31%)	75 (60%)	
The presence of a target goal to control patient's Pain , n (%)	136 (52%)	49 (36%)	86 (69%)	10 (83%)
Patients receiving element B ^a				
Spontaneous Awakening Trial during continuous sedation, n (%) ^{a, b}	29 (28%)	4 (19%)	25 (32%)	
Spontaneous Breathing Trial on mechanical ventilation, n (%) ^c			35 (28%)	
Patients receiving element C , n (%) ^a	136 (52%)	45 (33%)	90 (73%)	
The presence of a target goal to control patient's Sedation , n (%)	157 (60%)	49 (36%)	107 (86%)	12 (100%)
Patients receiving element D , n (%) ^a	100 (38%)	37 (27%)	62 (50%)	7 (58%)
Patients diagnosed with delirium, n (%)	30 (11%)	9 (7%)	21 (17%)	2 (17%)
Patients receiving element E , n (%) ^a	124 (47%)	103 (75%)	20 (16%)	2 (17%)
The highest mobility level according to the ICU Scale, median [IQR] ^d	2 [0–6]	5 [3–8]	0 [0–1]	0 [0–2]
Patients receiving element F , n (%) ^a	42 (16%)	23 (17%)	19 (15%)	1 (8%)
The implementation of other essential ICU care				
Patients receiving standardized Nutrition support, n (%) ^e	259 (99%)	136 (99%)	122 (98%)	12 (100%)
feeding tube, n (%)	149 (57%)	39 (28%)	110 (89%)	10 (83%)

Data presented as number (%) or median [interquartile range]

ICU intensive care unit, IQR interquartile range

a Operational definitions of each element of the ABCDEF bundle are shown in Supplemental Table 3.

b Percentages are calculated by dividing by the numbers of sedated patients. All the number of sedated patients were 102. The number of sedated patients without mechanical ventilation and extracorporeal membrane oxygenation are 21. The number of sedated patients on mechanical ventilation or extracorporeal membrane oxygenation are 79 or 10 respectively.

c Percentage is calculated by dividing by the number of the patients on mechanical ventilation, or 124.

d Highest exercise / rehabilitation level performed at the survey date is assessed based on the ICU Mobility Scale (Hodgson C, et al. Heart and Lung. 2014; 43:19–24). IMS 0: Nothing (lying in bed, passive exercise), 1: sitting in bed, exercises in bed, 2: passively moved to chair (no standing), 3: sitting over edge of bed, 4: standing, 5: transferring bed to chair, 6: marching on spot (at bedside), 7: walking with assistance of 2 or more people, 8: walking with assistance of 1 person, 9: walking independently with a gait aid, 10: walking independently without a gait aid.

e There are 19 patients who received nutrition via multiple routes. Of them, 15 patients received nutrition via enteral and oral nutrition, 2 patients received via enteral and total parenteral nutrition, and 2 patients received via oral and parenteral nutrition.

Variables	Total patients (n = 262)	The patients without mechanical ventilation and ECMO (n = 137)	The patients on mechanical ventilation (n = 124)	The patients on ECMO (n = 12)
oral, n (%)	113 (43%)	105 (77%)	0 (0%)	1 (8%)
total parenteral nutrition, n (%)	16 (6%)	5 (4%)	12 (10%)	2 (17%)
Estimated energy in nutrition provided within last 24 hours (kcal/day)				
x < 1000	24 (9%)	12 (9%)	12 (10%)	2 (17%)
1000 ≤ x < 1500	118 (45%)	76 (55%)	42 (34%)	3 (25%)
1500 ≤ x < 2000	105 (40%)	45 (33%)	60 (48%)	6 (50%)
x ≥ 2000	15 (6%)	4 (3%)	10 (8%)	1 (8%)
Estimated protein in nutrition provided within last 24 hours (g/kg/day)				
<1.2 g/kg	157 (60%)	82 (60%)	75 (60%)	7 (58%)
≥1.2 g/kg	105 (40%)	55 (40%)	49 (40%)	5 (42%)
Patients receiving a regular standardized Sleep assessment, n (%)	86 (33%)	34 (25%)	51 (41%)	6 (50%)
Patients receiving ICU Diary , n (%)	65 (25%)	50 (36%)	15 (12%)	1 (8%)
Patients placed in Physical Restraints at any time on the survey date, n (%)	58 (22%)	23 (17%)	35 (28%)	5 (42%)
Data presented as number (%) or median [interquartile range]				
ICU intensive care unit, IQR interquartile range				
a Operational definitions of each element of the ABCDEF bundle are shown in Supplemental Table 3.				
b Percentages are calculated by dividing by the numbers of sedated patients. All the number of sedated patients were 102. The number of sedated patients without mechanical ventilation and extracorporeal membrane oxygenation are 21. The number of sedated patients on mechanical ventilation or extracorporeal membrane oxygenation are 79 or 10 respectively.				
c Percentage is calculated by dividing by the number of the patients on mechanical ventilation, or 124.				
d Highest exercise / rehabilitation level performed at the survey date is assessed based on the ICU Mobility Scale (Hodgson C, et al. Heart and Lung. 2014; 43:19–24). IMS 0: Nothing (lying in bed, passive exercise), 1: sitting in bed, exercises in bed, 2: passively moved to chair (no standing), 3: sitting over edge of bed, 4: standing, 5: transferring bed to chair, 6: marching on spot (at bedside), 7: walking with assistance of 2 or more people, 8: walking with assistance of 1 person, 9: walking independently with a gait aid, 10: walking independently without a gait aid.				
e There are 19 patients who received nutrition via multiple routes. Of them, 15 patients received nutrition via enteral and oral nutrition, 2 patients received via enteral and total parenteral nutrition, and 2 patients received via oral and parenteral nutrition.				

Implementation of other supportive ICU care

Most patients, even while undergoing MV or ECMO, received nutrition therapy with 1000–2000 kcal/day as their total energy intake via feeding tube or oral intake (Table 3). Protein greater than 1.2 g/kg/day was supplied to less than 50% of patients at any time during the ICU stay (Fig. 2). The implementation of sleep assessment, ICU diary and physical restraints were 33%, 25%, and 20% respectively. About half of the patients received either non-pharmacological or pharmacological interventions to promote sleep (Supplemental Table 8).

Association between ICU structure and implementation of the ABCDEF bundle

In ICUs with protocols for pain and sedation management, more patients received elements A and C, while fewer patients received element E in the ICU with the protocol for mobilization/rehabilitation (Table 4). Daily multidisciplinary rounds and a 1:1 nurse to patient ratio did not improve the rate of implementation of the bundle and nutrition therapy. With a 1:2 nurse to patient ratio, elements D, E, and nutrition therapy were more frequently implemented.

Table 4
Association between ICU structure and implementation of the ABCDEF bundle

ICU structure	Total patients	Presence of a specific written protocol for each element	Absence of a specific written protocol for each element	P-value	Multidisciplinary rounds: Daily	Multidisciplinary rounds: At least once a week	Multidisciplinary rounds: Not applicable	P value	Nurse to patient ratio in the ICU: 1:1	Nurse to patient ratio in the ICU: 1:2	Nurse to patient ratio in the ICU: 1:3
Patients receiving element A	118/262 (45%)	62/102 (61%)	56/160 (35%)	< 0.001	95/224 (42%)	3/4 (75%)	20/34 (59%)	0.12	18/45 (40%)	79/161 (49%)	21/38 (55%)
Patients receiving element B (SAT)	29/102 (28%)	16/48 (33%)	13/54 (24%)	0.38	26/85 (31%)	0/3 (0%)	3/14 (21%)	0.62	7/29 (24%)	14/53 (26%)	8/20 (40%)
Patients receiving element B (SBT)	35/124 (28%)	17/63 (27%)	18/61 (30%)	0.84	27/101 (27%)	1/3 (33%)	7/20 (35%)	1.0	8/30 (27%)	19/64 (30%)	8/27 (29%)
Patients receiving element C	136/262 (52%)	97/174 (56%)	39/88 (44%)	0.09	117/224 (52%)	3/4 (75%)	16/34 (47%)	0.74	24/45 (53%)	87/161 (54%)	25/45 (56%)
Patients receiving element D	100/262 (38%)	34/83 (41%)	66/179 (37%)	0.59	76/224 (34%)	4/4 (100%)	20/34 (59%)	< 0.001	16/45 (36%)	73/161 (45%)	11/20 (55%)
Patients receiving element E	124/262 (47%)	21/81 (26%)	103/181 (57%)	< 0.001	111/224 (50%)	1/4 (25%)	12/34 (35%)	0.24	9/45 (20%)	93/161 (57%)	22/39 (56%)
Patients receiving element F					37/224 (17%)	1/4 (25%)	4/34 (12%)	0.69	4/45 (9%)	28/161 (17%)	10/18 (56%)
Patients receiving Nutrition support (protein > 1.2 g/kg/day)					92/224 (41%)	3/4 (75%)	10/34 (29%)	0.16	10/45 (22%)	76/161 (47%)	19/34 (56%)
Data presented as number (%), ICU intensive care unit,											

As more ICU beds were assigned exclusively to patients with COVID-19 infections, elements A and D were less frequently implemented, whereas element E and nutrition therapy were more frequently implemented. There was no ICU structure which lead to the implementation of elements B and F. The presence of dedicated physiotherapists and ability of physiotherapists to enter the rooms of patients with COVID-19 infections did not improve the implementation of element E. The number of visiting hours was limited in both patients who received element F and those who did not. (Supplemental Table 9).

Discussion

This worldwide two-day point prevalence study demonstrated an overall low rate of implementation of the ABCDEF bundle, inadequate protein intake, and rare use of ICU diaries for patients with COVID-19 infections. This study also showed better implementation of evidence-based and supportive ICU care in ICUs using specific protocols and with a defined number of ICU beds exclusively assigned to patients with COVID-19 infections. Structural elements such as daily multidisciplinary/-professional rounds and a 1:1 nurse to patient ratio, did not lead to greater implementation.

The delivery of elements of the bundle to patients with COVID-19 infections was lower than that shown in nationwide and international prevalence surveys conducted before the pandemic (Supplemental Table 10) [5, 28]. The ABCDEF bundle is a strong evidence-based approach to ICU care that prevents ICU patients from developing physical, cognitive, and mental disabilities, termed the post-intensive care syndrome (PICS) [29], which has long lasting effects even after intensive care and hospital discharge. Many studies have suggested that each element of the bundle has its own role to prevent PICS [1, 5, 6, 8] and synchronized implementation would provide further benefits [30]. Despite ongoing research about the specific outcomes of patients who survive COVID-19 infections (NCT04360538, NCT04508712), it is likely that these patients have problems similar to survivors of other critical illnesses. The findings of this study call for urgent efforts to incorporate the ABCDEF bundle of care into routine clinical practice, especially as many countries are dealing with serious concerns for a second wave of COVID-19 infections. The serious disabilities and persistent symptoms after COVID-19 infection [13–16] raise serious concerns about the long-term outcomes associated with PICS induced by COVID-19 infection [17, 18].

Relatively high rates of implementation for elements A, C, and D for patients undergoing MV might reflect the need for intense management of pain, sedation, agitation, and delirium to stabilize symptoms induced by COVID-19 infection, such as strong spontaneous breathing and coughing [31, 32], and to prevent exacerbation of pulmonary injury by self-inflicted lung injury [33–36]. This study also shows a relatively low prevalence of delirium potentially because of deep sedation with the use of benzodiazepines. This could also affect the implementation and intensity of mobilization.

As previously reported [37, 38], MV and ECMO were major barriers to implementation of element E for patients with COVID-19 infections. The complicated pathophysiology of the pulmonary illness with two different phases of acute lung injury caused by COVID-19 infection, which need different ventilation strategies to avoid exacerbation of lung injury [33–36], could limit aggressive mobilization of patients. The variety of neurological complications, such as weakness and fatigue after the acute phase of the disease, often reported as complications associated with COVID-19 infections recently [13–16, 39] and recognized as barriers to mobilization, could also inhibit the implementation of element E. More research is needed to develop the most efficient approach to early rehabilitation of patients with COVID-19 infections and a high risk for developing PICS.

This study showed that energy via enteral nutrition was provided to most of patients, while the protein intake did not reach the target level at any time during the ICU stay. Although many guidelines and statements, including those specifically related to COVID-19 infection, recommended nutrition therapy to provide adequate energy and protein to preserve skeletal muscle and function [3, 4], the protein intake did not often reach the target (1.2 g/kg/day) after or even before the pandemic. The failure to provide sufficient protein and the absence of nutritionists under strict infection regulations might hinder providing enough protein. Protocol-driven nutrition strategies focusing on providing enriched protein, high-protein enteral formulas (> 20%) [40], and sometimes the addition of amino-acid parenteral nutrients in case of digestive complications of COVID-19 infection[41], must be considered.

The ICU diary is used to supplement the patient's memory in the ICU, and helps mitigate anxiety, depression, and post-traumatic stress disorder [42]. Just 20% of ICUs provided diaries, which is low compared to ICUs from Scandinavia [43]. In order to introduce ICU diaries while considering limitations imposed by serious infections, a novel strategy, such as electrical ICU diaries shared online or video based ICU diaries, might be beneficial [44].

The introduction of protocols, especially for pain and sedation management, could provide an ICU with a systematic and resource-conserving approach that would facilitate delivery of evidence-based ICU care [5, 8, 11]. However, these results show that a protocol for mobilization did not facilitate implementation of element E possibly because of the several complicated mechanisms of lung injury and different ventilation strategy in the various phases of the illness [33–36]. A mobilization protocol for other patient populations might apply to patients with COVID-19 infections. In this setting, the aggressive involvement of intensivists, which was lower in this study, and a specialized mobilization program for patients with COVID-19 infections, considering the severity and phases of the lung injury, might facilitate the delivery of safe and efficient rehabilitation with appropriate considerations of risk [45]. Incorporating the dedicated use of ergometers and electrical muscle stimulation into the protocol may also promote rehabilitation.

Controlling the number of ICU beds might allow adjusting the workload of the staff appropriately [46, 47]. Although more ICU beds for patients with COVID-19 infections may increase the burden and responsibility of medical staff making it difficult to implement evidence-based and supportive ICU care, as seen in the poor levels of implementation of elements A and D, it could be lead to greater implementation of element E and nutrition. Assigning more beds, or centralization, could benefit patients by providing multidisciplinary/-professional and structured interventions by trained and experienced staff [48, 49]. The effectiveness of centralization according to the local resources and staffing capacity under a standardized or specialized protocol should be investigated.

Daily multidisciplinary/-professional rounds and a 1:1 nurse to patient ratio, which were regarded as important aspects of care [19], might consume excessive time and resources in an ICU. Optimizing distribution of resources according to the clinical needs might be key factors for the implementation of evidence-based and supportive ICU care.

This study has acknowledged strengths and limitations. Although data were collected from many countries around the world, including locations considered to be COVID-19 infection “hotspots”, the relative proportion of data from Japan could introduce bias and limit the generalizability of the results to ICUs in other countries. The limited number of patients also limits applying the results in other ICUs. Second, surveys were conducted at two time points, one month apart, to include more data. However, as evidence and recommendations for the care of patients with COVID-19 infection has been changing, the policies for ICU care might have changed. For example, an increased number of patients receiving prone positioning on the second survey and the decrease in its duration may be partially due to a recent paper which showed the positive effect of short-term prone positioning [50]. Third, because of the nature of a point prevalence study, a causal relationship for facilitating or limiting factors for ICU care could not be definitively demonstrated. Finally, a variety of key information and possibly confounding factors which could affect the implementation of evidence-based ICU care, such as extubation rate related to spontaneous breathing trials, the consciousness level of patients receiving sedatives during mobilization, frailty, and complications related to COVID-19 infection were not investigated. In order to validate these results and understand the influence of evidence-based ICU care on the long-term outcomes of patients with COVID-19 infections, further investigation and verification are necessary.

Conclusion

This worldwide, two-day point prevalence study revealed a low implementation rate of elements of the ABCDEF bundle, inadequate protein supply, and low rate of use of ICU diaries in patients with COVID-19 infections. The introduction of specific protocols and controlling the number of beds exclusively for patients with COVID-19 infections in an ICU may facilitate the delivery of evidence-based and supportive ICU care during the pandemic.

Abbreviations

ICU
Intensive care unit
SARS-CoV-2
Severe acute respiratory syndrome coronavirus 2
COVID-19
coronavirus disease 2019
UMIN

University Hospital Medical Information Network
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
JSICM
Japanese Society of Intensive Care Medicine
WFICC
World Federation of Intensive and Critical Care
ESICM
European Society of Intensive Care Medicine
ISCCM
Indian Society of Critical Care Medicine
URL
Uniform Resource Locator
IQR
Interquartile range
MV
Mechanical ventilation
ECMO
Extracorporeal membrane oxygenation
IMS
ICU mobility Scale
PICS
Post intensive care syndrome

Declarations

Ethics approval and consent to participate: The study protocol was approved by the Ethics Committee of the Saiseikai Utsunomiya Hospital (No 2020-07). The ethics committee confirmed that the informed consent from the patient was waived because of the nature of this study.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests for the submitted work. There are several potential conflicts of interests for some authors outside of this submitted study. KN reports personal fees from Abbott Laboratory, Nestle, TERUMO, GETINGE, Asahi Kasei Pharma, Ono Pharmaceutical, Japan Blood Products Organization, Nihon Pharmaceutical, Otsuka Pharmaceutical, Pfizer, Toray, and Baxter, and grants from Asahi Kasei Pharma outside the submitted work. HK receive a salary from Japanese Society for Early Mobilization (Non-profit Society) as a chair (full time) outside the submitted work. EWE reports grants from VA/NIH, personal fees from Pfizer, Orion, Lilly, personal fees from Masimo, grants from kohler, outside the submitted work. IS reports personal fees from Abbott Laboratory, Teijin Pharma, Nestle and Nihon Pharmaceutical. NO reports grants from Asahi Kasei Pharma, Ono Pharmaceutical, Baxter, Maruishi Pharmaceutical, Torii Pharmaceutical, Teijin Pharma, Shionogi Pharmaceutical, and Fuso Pharmaceutical, outside the submitted work.

Authors' contribution: KL, KN, HK contributed equally to this paper. Study conception and design: KL, KN, HK, PN, EWE, and SRK. Statistical analysis, or interpretation of data: KL, KN, HK, PN, EWE, SRK, and KT. Drafting the manuscript: KL, KN, HK, PN, EWE, SRK, and KT. Critical review and revision of the manuscript for important intellectual insight: KN, HK, PN, EWE, SRK, KT, SI, AKL, and ON. Study supervision: PN, EWE, SRK, KT, SI, AKL and ON. Recruitment the participating ICUs in overseas countries: ME, PN, EWE, SRK, KT, SI, AKL, JK, and ON. All authors drafted the manuscript for important intellectual content, contributed to revision of the final version of the manuscript, approved the final version submitted, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. KN and ON are the guarantors of the study. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. All authors approved the final version of the manuscript.

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Figures

Figure 1

The implementation of each element of the ABCDEF bundle SAT spontaneous awakening trials, ECMO extracorporeal membrane oxygenation Statistical comparisons were conducted between two groups in elements A, B, and C, and between three groups in elements D, E, and F. a Among 12 patients on ECMO, 11 underwent mechanical ventilation at the same time and one patient was not on mechanical ventilation and received ECMO. b The group of Element B: (spontaneous breathing trial) were excluded from this figure because spontaneous breathing trials were only conducted for patients undergoing mechanical ventilation.

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Figure 2

Highest mobility level and nutrition therapy provided according to the phase of critical illness (max 15 words) (A) the highest mobility level of all patients, (B) the highest mobility level of patients undergoing mechanical ventilation, (C) the proportion of patients receiving the provided total energy (kcal/day), (D) the proportion of patients receiving the provided protein (g/kg)

Figure 2

Highest mobility level and nutrition therapy provided according to the phase of critical illness (max 15 words) (A) the highest mobility level of all patients, (B) the highest mobility level of patients undergoing mechanical ventilation, (C) the proportion of patients receiving the provided total energy (kcal/day), (D) the proportion of patients receiving the provided protein (g/kg)

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