Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Australian Critical Care xxx (xxxx) xxx

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Research paper

Nutrition delivery across hospitalisation in critically ill patients with COVID-19: An observational study of the Australian experience

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ARTICLE INFORMATION

Article history:
Received 21 August 2022
Received in revised form
28 February 2023
Accepted 6 May 2023

Keywords:
COVID-19
Critical illness
Intensive care
Nutrition

ABSTRACT

Background: Data on nutrition delivery over the whole hospital admission in critically ill patients with COVID-19 are scarce, particularly in the Australian setting.

Objectives: The objective of this study was to describe nutrition delivery in critically ill patients admitted to Australian intensive care units (ICUs) with coronavirus disease 2019 (COVID-19), with a focus on post-ICU nutrition practices.

Methods: A multicentre observational study conducted at nine sites included adult patients with a positive COVID-19 diagnosis admitted to the ICU for >24 h and discharged to an acute ward over a 12-month recruitment period from 1 March 2020. Data were extracted on baseline characteristics and clinical outcomes. Nutrition practice data from the ICU and weekly in the post-ICU ward (up to week four) included route of feeding, presence of nutrition-impacting symptoms, and nutrition support received.

Results: A total of 103 patients were included (71% male, age: 58 ± 14 years, body mass index: 30±7 kg/m^2), of whom 41.7% (n = 43) received mechanical ventilation within 14 days of ICU admission. While oral nutrition was received by more patients at any time point in the ICU (n = 93, 91.2% of patients) than enteral nutrition (EN) (n = 43, 42.2%) or parenteral nutrition (PN) (n = 2, 2.0%), EN was delivered for a greater duration of time (69.6% feeding days) than oral and PN (29.7% and 0.7%, respectively). More patients received oral intake than the other modes in the post-ICU ward (n = 95, 95.0%), and 40.0% (n = 38/95) of patients were receiving oral nutrition supplements. In the week after ICU discharge, 51.0% of patients (n = 51) had at least one nutrition-impacting symptom, most commonly a reduced appetite (n = 25; 24.5%) or dysphagia (n = 16; 15.7%).

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https://doi.org/10.1016/j.aucc.2023.05.001

Please cite this article as: Chapple LS, Nutrition delivery across hospitalisation in critically ill patients with COVID-19: An observational study of the Australian experience, Australian Critical Care, https://doi.org/10.1016/j.aucc.2023.05.001

Conclusion: Critically ill patients during the COVID-19 pandemic in Australia were more likely to receive oral nutrition than artificial nutrition support at any time point both in the ICU and in the post-ICU ward, whereas EN was provided for a greater duration when it was prescribed. Nutrition-impacting symptoms were common.

1. Introduction

Recovery for critically ill patients with coronavirus disease 2019 (COVID-19) is substantially impaired. At 6 months, 73% of Australians admitted to an intensive care unit (ICU) with COVID-19 are alive, yet 39% have a new disability, and 11% are unable to work due to poor health.[1] Furthermore, three-quarters of patients experience persistent symptoms including loss of strength (22%) and fatigue (19%).[1] Data also suggest that patients admitted to the ICU with COVID-19 have weight loss during the ICU admission, which correlates with a longer ICU length of stay.[2] It is plausible that the muscle and weight loss that occurs in patients following admission to the ICU with COVID-19 infection may worsen functional recovery, and protein delivery to meet base level recommendations from international guidelines[3–5] has been proposed as a potential therapy aimed at ameliorating this muscle loss.

Patients with COVID-19 admitted to the ICU are at high nutritional risk, based on the observed physiological response to COVID-19 and the presence of nutrition-impacting symptoms. In the ICU, patients with COVID-19 commonly exhibit high fevers,[6–8] increased energy utilisation up to 200% of predicted values,[9] and impaired glucose utilisation.[10] Patients experience a number of symptoms that are likely to impact nutritional intake including a loss of taste (dysgeusia) and smell (dysosmia) (34–59%),[11,12] reduced appetite (>50%),[13] and gastrointestinal (GI) symptoms including diarrhoea, nausea, and vomiting (10%).[7,14] Patients admitted to the ICU with COVID-19 also experience persistent hypermetabolism at levels greater than those observed in general ICU patients.[9] This cohort of patients is therefore particularly susceptible to nutritional deficits.

While a number of guidelines to support nutrition management of the critically ill patients with COVID-19 exist,[15] to date, few studies on the quantification of nutrition delivery and practices in these patients have been published, particularly in an Australian context. Furthermore, limited data exist on nutritional intake after ICU discharge in patients diagnosed with COVID-19. As significant nutritional deficits in other cohorts of ICU survivors have been demonstrated,[16,17] it is hypothesised that patients admitted with COVID-19 will have similar nutritional deficits after ICU discharge. Therefore, the primary aim of this study was to describe nutrition delivery practices in critically ill patients admitted to Australian ICUs with COVID-19, with a focus on post-ICU nutrition practices.

2. Methods

This multicentre observational study was conducted at nine sites in Australia (participating sites listed in Supplemental Table S1). All sites were public hospitals with eight being within a metropolitan area and one in a regional area. The Alfred Health Human Research Ethics Committee approved the study under the National Mutual Acceptance scheme for single ethical review for multicentre clinical trials (Approval number 63512), and individual site governance was obtained.

This study included linked data from an existing observational study investigating clinical care of patients with COVID-19 (Short Period Incidence Study of Severe Acute Respiratory Infection [SPRINT-SARI] (https://www.anzics.com.au/current-active-endorsed-research/sprint-sari/). SPRINT-SARI is a hospital-based surveillance database in Australian ICUs and includes all patients admitted to the ICU with clinically suspected or proven (polymerase chain reaction [PCR] positive) acute novel coronavirus infection.

2.1. Patient population

Patients were eligible if they met all the following inclusion criteria:

1. Enrolled in SPRINT-SARI
2. COVID-19 PCR positive
3. Admitted to an ICU for >24 h
4. Discharged to an acute ward after ICU

Patients were excluded if they were discharged to an acute ward on ICU discharge for palliative care measures.

2.2. Study processes

Patients were screened at ICU discharge if admitted to the participating site and enrolled in SPRINT-SARI between 1st March 2020 and 1st March 2021. For eligible patients, the SPRINT-SARI patient identification number was recorded in the case report form to allow for data linkage on study completion. All study data were collected by the site investigators, and deidentified data were entered into Research Electronic Data Capture (REDCap) central database for analysis.

2.3. Data collection

Data and baseline characteristics extracted from the SPRINT-SARI database included the following: (i) sex; (ii) age; (iii) Acute Physiology and Chronic Health Evaluation (APACHE) II score; (iv) presence of GI symptoms on ICU admission (abdominal pain, vomiting/nausea, diarrhoea, loss of smell/taste); (v) comorbidities on admission (obesity or malnutrition judged by clinical staff); (vi) estimated height; and (vii) estimated weight. Body mass index was calculated from estimated height and weight. Clinical data extracted from the SPRINT-SARI database included the following: (i) mode of respiratory support received on day 1 to day 14; (ii) ICU readmissions; (iii) ICU and hospital length of stay; (iv) hospital discharge destination (discharged alive, transfer to other facility, death, palliative care, unknown); (v) ICU and hospital mortality; and (vi) the ability to self-care at hospital discharge compared to preillness (same as before, worse, or better).

Data were collected on nutrition practices at three time points: (i) in the ICU; (ii) weekly in the post-ICU acute care ward up to week 4; and (iii) at hospital discharge.

Data collected in the ICU included the following: (i) mode of nutrition (days receiving enteral nutrition [EN], parenteral nutrition [PN], or oral nutrition); (ii) time to commence nutrition from ICU and hospital admission; (iii) EN route of feeding (nasogastric

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versus nasojejunal); (iv) caloric and protein prescriptions as per dietitian assessment (collected at initial assessment only); and (v) mode of nutrition at ICU discharge.

Data collected in the post-ICU ward included the following: (i) bodyweight; (ii) mode of nutrition (days receiving EN, PN, or oral nutrition); (iii) caloric and protein prescriptions as per dietitian assessment; (iv) presence of nutrition-impacting symptoms; and (v) presence of documentation that would raise concerns about nutritional status. In patients consuming nutrition orally, data regarding the type of diet received and use of oral nutrition supplements (ONSs) were also collected.

At hospital discharge, data were collected on the following: (i) bodyweight; (ii) the mode of nutrition at discharge; and (iii) nutrition interventions provided on hospital discharge.

2.4. Data analysis

Continuous data are presented as mean ± standard deviation (SD) for normally distributed data and median (interquartile range [IQR]) for nonnormally distributed data. Categorical data are presented as counts (n) and percentages (%). No formal sample size calculation was performed, with all patients admitted who met inclusion criteria at the participating sites over the 12-month study period included in the study. Data regarding the daily mode of feeding was collected in the ICU, with the primary mode of nutrition defined as the one that was used the most frequently per patient. Comparisons between patients receiving mechanical ventilation (MV) at any point up to day 14 in the ICU and those who did not receive MV were performed using Chi-square or Fisher's exact test as appropriate for categorical variables and Wilcoxon rank-sum or Student's t-test for continuous variables. A two-sided p value less than 0.05 was chosen to indicate statistical significance. All analyses were performed with the SAS software version 9.4 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Patient demographic and clinical characteristics

A total of 103 patients were included: 73 (71%) were male, with a mean age of 58 ± 14 years and a mean body mass index of 30 ± 7 kg/m^2, and 43 (42%) patients had received MV by day 14 (Table 1). GI symptoms and nutritional status on ICU admission are reported in Table 1. When compared to non−mechanically ventilated patients, patients receiving MV had a higher illness severity score, had a longer ICU and hospital length of stay, and were more likely to lose weight in the ICU (Supplemental Table S2).

3.2. Nutrition therapy in the ICU

Oral nutrition was received by the majority of patients in the ICU (n = 93; 93%), whereas 43 (42%) patients received EN and 2 (2%) received PN at any time point (Table 2). EN was delivered for a greater duration of time in the ICU (17[12−30] days, 69.6% feeding days) than oral nutrition and PN (3[2−5] days, 29.7% feeding days, and 5[4−6] days, 0.7% feeding days), respectively. All patients receiving EN were fed gastrically, with no use of nasojejunal feeding reported. EN was more common in patients receiving MV than in non−mechanically ventilated patients (41 (95%) vs 2 (3%); $p < 0.001$), whereas oral nutrition was more common in non−mechanically ventilated patients (34 (79%) vs 59 (100%); $p < 0.001$) (Supplemental Table S3). Mean calorie and protein prescriptions were 2000 ± 398 kcal and 101 ± 17 g, respectively. At ICU discharge, the majority of patients (n = 83; 81%) were consuming diet via the oral route, whereas 19 (19%) patients were receiving EN, and no patient was receiving PN (Table 2).

Table 1
Baseline characteristics and clinical outcomes.

	No. of patients	Mean ± SD unless otherwise indicated
Age[a], years	103	58 ± 14
Sex[a] (F), n (%)	103	30 (29%)
APACHE II score within 24 h of ICU admission, median [IQR]	102	11 [8−15]
Weight[a] (kg)	100	87 ± 22
Height[a] (cm)	99	170 ± 11
BMI[a] (kg/m^2)	99	30 ± 7
Weight loss in the ICU (from weight in the ICU to first weight after ICU discharge) (kg), median [IQR]	65	0 [0−5.7]
GI symptoms on ICU admission[a,b], n (%)	103	
Diarrhoea		29 (28%)
Vomiting/nausea		22 (21%)
Loss of smell/taste		12 (12%)
Abdominal pain		12 (12%)
Comorbidities on ICU admission[a], n (%)	103	
Obesity		25 (24%)
Malnutrition		0 (0%)
Respiratory support received on D1 ICU adm[a], n (%)	103	
Mechanical ventilation		25 (24%)
High-flow nasal cannula oxygen therapy		38 (37%)
Noninvasive ventilation		1 (1%)
Nil respiratory support		49 (48%)
Respiratory support received at any time point to D14[a], n (%)	103	
Mechanical ventilation		43 (42%)
High-flow nasal cannula oxygen therapy		54 (52%)
Noninvasive ventilation		4 (4%)
Nil respiratory support		37 (36%)
ICU length of stay[a] (days), median [IQR]	102	6 [3−17]
Destination on ICU discharge[a,c], n (%)	103	
Ward		101 (98%)
Other hospital		1 (1%)
Rehabilitation		1 (1%)
Hospital length of stay[a] (days), median [IQR]	101	16 [10−31]
Ability to self-care at hospital discharge[a], n (%)	103	
Same as before illness		49 (48%)
Worse		29 (28%)
Better		12 (12%)
Unknown		13 (13%)
Destination on hospital discharge[a], n (%)	103	
Discharge home		81 (79%)
Transfer to another facility (rehabilitation)		16 (16%)
Transfer to other facility (acute hospital)		3 (3%)
Death		1 (1%)
Unknown		2 (2%)

BMI: body mass index, D: day, ICU: intensive care unit, IQR: interquartile range, SD: standard deviation.
[a] Data obtained from SPRINT-SARI.
[b] Based on clinical staff definition.
[c] Based on the current ICU admission.

3.3. Nutrition therapy in the post-ICU ward

Nutrition data were available for 100 patients in the first week following ICU discharge, and for 43, 23, and 10 patients in weeks 2, 3, and 4, respectively. In the first week after ICU discharge, mean

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Table 2
ICU nutrition data.

	No. of patients	Mean ± SD unless otherwise indicated
Mode of nutrition in ICU, patients, n (%)	102	
Oral		93 (91%)
EN		43 (42%)
PN		2 (2%)
Duration of feeding mode in the ICU, days, median [IQR]	102	
Oral		3 [2–5]
EN		17 [12–30]
PN		5 [4–6]
Feeding days for each mode of nutrition, n (%)	102	
Oral		404 (29.7%)
EN		948 (69.6%)
PN		10 (0.7%)
Time to commence nutrition from ICU adm (hours), median [IQR][a]		
Any route	102	5 [1–19]
Oral	93	6 [1–136]
EN	43	20 [9–72]
PN	2	283 [144–421]
Time to commence any nutrition from ICU adm (hours), median [IQR][a]	102	4.5 [0.9–18.8]
Time to commence EN from ICU adm (hours), median [IQR][a]	43	20.1 [8.5–71.9]
Route of feeding tube in enterally fed patients, n (%)	43	
Nasogastric		43 (100%)
Nasojejunal		0 (0%)
Dietetic input, mean ± SD		
Caloric prescription (kcal/day)	53	2000 ± 398
Caloric prescription (kJ/day)	53	8360 ± 1664
Protein prescription (grams/day)	53	101 ± 17
Mode of nutrition at ICU discharge, patients, n (%)	102	
Oral		83 (81%)
EN		19 (19%)
PN		0 (0%)

EN: enteral nutrition, ICU: intensive care unit, IQR: interquartile range, PN: parenteral nutrition, SD: standard deviation.
[a] Data obtained from SPRINT-SARI.

calorie and protein prescriptions were 2252 ± 385 kcal and 97 ± 17 g, respectively.

Most patients were consuming nutrition orally in the first week following ICU discharge (n = 95, 95%), whereas artificial nutrition support was received by 20 (20%) patients (n = 19 receiving EN and n = 1 receiving PN). Of the patients receiving oral nutrition in the first week after ICU discharge, the most common type of diet was a general diet in 65 (68%) patients, whereas 19 (20%) patients received a modified texture diet. Other diet prescriptions are presented in Table 3. Oral nutrition supplements were prescribed to 38 of 95 (40%) patients in week 1 following ICU discharge, and to seven of nine (78%) patients by week 4. In the first week following ICU discharge, 52% of patients (n = 49/95) receiving oral nutrition were considered to have adequate oral intake as per the clinical documentation, and 37% of them were deemed to have inadequate intake (n = 35/95).

In week one following ICU discharge, 51 (51%) patients had documentation of at least one nutrition-impacting symptom. The most common symptoms reported were reduced appetite in 25 patients (25%), dysphagia in 16 patients (16%), and diarrhoea in 14 patients (14%).

In the first week following ICU discharge, 38 patients (38%) had at least one documented factor that may affect nutritional intake or status. This increased to 70% of patients (n = 7/10) at week 4. In week one, the most common factors reported to affect nutrition intake included inadequate energy or protein intake in 23 patients (23%), nutrition-impacting symptoms in 19 patients (19%), and significant weight loss in 14 patients (14%). By week 4, the most common reason was significant weight loss in 30% of patients (n = 3/10).

3.4. Nutrition therapy on hospital discharge

At hospital discharge, 11 (11%) of patients were prescribed ONS. Data on ICU and hospital length of stay, discharge location, and ability to self-care at hospital discharge are presented in Table 1.

4. Discussion

This is the first study to our knowledge to quantify both ICU and post-ICU nutrition practices in adult patients admitted to an Australian ICU with COVID-19, and it is the only study to our knowledge to document nutrition practices in critically ill patients with COVID-19 who did not receive MV in the ICU. In our study, oral intake was received by more patients at any time point in the ICU, whereas EN was the predominant feeding mode (70% feeding days). Nutrition-impacting symptoms were documented frequently in the post-ICU ward, with reduced appetite being the most common.

4.1. Route of feeding in the ICU

In our cohort, only 42% of patients received EN, 2% received PN, and 91% received oral intake at any time point in the ICU, with higher rates of artificial feeding in patients receiving MV. Studies in ICU patients typically report higher rates of EN; one of the largest analyses of prospectively collected data in 2776 critically ill patients from 146 Australian ICUs reported that 85% of patients received EN.[18] However, our study, as most other ICU studies, only included patients who were receiving MV, as supported by the high rates of EN in the MV cohort (95% received EN). Point prevalence data from the Nutrition Day survey in 9777 patients (of whom 47% were on MV on the study day) from 46 countries and 880 ICUs reported that 40% of patients admitted to the ICU were enterally fed by day 5.[19] Similarly, a point prevalence survey conducted by our group in 2018 included 539 patients from 38 ICUs across Australia and New Zealand, in which 39% of patients received EN (unpublished data). In our current study, only patients who were alive at ICU discharge and were receiving active medical treatment were included, we observed much lower rates of MV (42% MV by day 14) than in an Australian dataset from the same time period (58% MV; n = 119/204; 27 February to 30 June 2020),[20] which may explain the low rates of artificial nutrition support observed.

Of the patients receiving EN in our study, no patient was fed postpylorically. The need for postpyloric feeding was highlighted as an important consideration early during the pandemic,[21] potentially related to the fear of a greater aspiration risk with reduced respiratory reserve[22] and frequent use of prone positioning for these patients (27% of Australian patients),[20] with concerns of feeding intolerance with gastric feeding in the prone position.[23] From an international perspective, in a qualitative survey in the United States, 11% (22/199) of critical care clinicians reported using postpyloric feeding as the first line therapy; however, this survey did not quantify the number of patients with a clinical need for postpyloric feeding.[22] The low rates of postpyloric feeding observed in practice in our cohort may be due to the inconclusive evidence on the effect of gastric feeding on outcomes in critically ill patients,[24] a preference for alternate strategies to manage GI dysfunction such as prokinetic therapy, a lack of access to this feeding mode, or concerns regarding safety of their placement: these were not quantified in our study.

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Table 3
Post-ICU nutrition data.

	Week 1 (n = 102)	Week 2 (n = 44)	Week 3 (n = 24)	Week 4 (n = 10)	At hospital discharge (n = 102)
Mean ± SD unless otherwise indicated					
Bodyweight, kg	n = 67	n = 17	n = 17	n = 6	n = 27
	82 ± 21	81 ± 17	82 ± 18	85 ± 15	86 ± 25
Method used to obtain bodyweight	n = 66	n = 17	n = 17	n = 6	–
Measured	38 (58%)	16 (94%)	15 (88%)	5 (83%)	
Estimated	1 (1%)	0 (0%)	0 (0%)	1 (17%)	
Reported	27 (41%)	1 (6%)	2 (12%)	0 (0%)	
Dietetic input	n = 47	n = 19	n = 14	n = 9	–
Caloric prescription (kcal/day)	2252 ± 385	2176 ± 452	2375 ± 439	2351 ± 365	
Calorie prescription (kJ/day)	9413 ± 1609	9096 ± 1889	9928 ± 1835	9827 ± 1526	
Protein prescription (grams/day)	97 ± 17	94 ± 18	95 ± 19	93 ± 16	
Mode of nutrition, patients, n (%)	n = 100	n = 43	n = 23	n = 10	n = 102
Oral	95 (95%)	38 (88%)	21 (91%)	9 (90%)	98 (97%)
EN	19 (19%)	7 (16%)	5 (22%)	3 (30%)	3 (3%)
PN	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Number of days below routes were provided, median [IQR]					–
Oral	7 [5–7]	6 [2–7]	7 [3–7]	7 [6,7]	
EN	4 [3–7]	7 [7–7]	7 [4–7]	7 [6,7]	
Patients with the below diet prescribed, n (%)	n = 95	n = 38	n = 21	n = 9	–
General/regular diet	65 (68%)	20 (53%)	6 (29%)	1 (11%)	
High energy	17 (18%)	9 (24%)	7 (33%)	4 (44%)	
High protein	8 (8%)	3 (8%)	1 (5%)	1 (11%)	
Soft/bite-sized	13 (14%)	9 (24%)	8 (38%)	4 (44%)	
Minced and moist	3 (3%)	1 (3%)	0 (0%)	2 (22%)	
Smooth pureed	3 (3%)	2 (5%)	2 (10%)	0 (0%)	
Thickened fluids of any consistency	3 (3%)	3 (8%)	2 (10%)	2 (22%)	
Other	5 (5%)	2 (5%)	1 (5%)	0 (0%)	
If oral, number of patients who	n = 95	n = 38	n = 21	n = 9	–
were prescribed ONS, n (%)	38 (40%)	20 (53%)	16 (76%)	7 (78%)	
Documentation regarding adequacy of oral intake in patient notes:	n = 95	n = 38	n = 21	n = 9	–
Adequate	49 (52%)	23 (61%)	13 (62%)	4 (44%)	
Not adequate	35 (37%)	8 (21%)	5 (24%)	4 (44%)	
Nil documentation	11 (12%)	7 (18%)	3 (14%)	1 (11%)	
Number of patients who had nutrition-impacting symptoms documented:	n = 100	n = 43	n = 23	n = 10	–
	51 (51%)	18 (42%)	10 (44%)	4 (40%)	
Reduced appetite	25 (25%)	7 (16%)	6 (25%)	3 (30%)	
Dysphagia	16 (16%)	8 (18%)	7 (29%)	3 (30%)	
Diarrhoea	14 (14%)	3 (7%)	0 (0%)	0 (0%)	
Constipation	6 (6%)	1 (2%)	0 (0%)	0 (0%)	
Nausea	5 (5%)	1 (2%)	2 (8%)	1 (10%)	
Taste/smell changes	3 (3%)	0 (0%)	2 (8%)	0 (0%)	
Feeding assistance required	1 (1%)	0 (0%)	0 (0%)	0 (0%)	
Vomiting	0 (0%)	1 (2%)	0 (0%)	0 (0%)	
Other	8 (8%)	2 (5%)	0 (0%)	0 (0%)	
Number of patients with documented factors that may affect nutritional intake or status:	n = 100	n = 43	n = 23	n = 10	–
	38 (38%)	16 (37%)	8 (35%)	7 (70%)	
Inadequate energy/protein intake	23 (23%)	5 (11%)	3 (13%)	2 (20%)	
Nutrition-impacting symptoms	19 (19%)	4 (9%)	4 (17%)	2 (20%)	
Significant weight loss	14 (14%)	6 (14%)	2 (8%)	3 (30%)	
Elevated nutritional needs	13 (13%)	4 (9%)	2 (8%)	1 (10%)	
Evidence of fat/muscle wasting	6 (6%)	6 (14%)	3 (13%)	1 (10%)	
Inappropriate route of feeding	2 (2%)	0 (0%)	0 (0%)	0 (0%)	
Other	1 (1%)	1 (2%)	0 (0%)	0 (0%)	
Number of patients with nutrition interventions provided on hospital discharge:	–	–	–	–	n = 102
Dietary education					18 (18%)
Dietitian referral					12 (12%)
Oral nutrition supplements					11 (11%)
Enteral nutrition					2 (2%)
Other					4 (4%)

EN: enteral nutrition, ICU: intensive care unit, IQR: interquartile range, ONS: oral nutrition supplement, PN: parenteral nutrition, SD: standard deviation.

4.2. Route of feeding after ICU discharge

At ICU discharge, oral intake was the primary route of feeding (81%), with less than 20% of patients receiving EN. In the cohort receiving MV, 44% of patients were enterally fed at ICU discharge. This is a substantially lower rate of EN than that reported in a similar study of ICU survivors admitted with COVID-19, in which 66% of patients were receiving exclusive or supplementary EN at ICU discharge.[25] These differences are likely to reflect the population recruited, with Terblanche's study only including patients who were expected to receive >48 hr of artificial nutrition in the ICU. These data demonstrate that patients receiving noninvasive forms

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of respiratory or no respiratory support in the ICU are less likely to receive artificial nutrition support either in the ICU or in the post-ICU ward. While little is known about non–mechanically ventilated patients after ICU discharge, this is supported by previous observational data that report rates of EN delivery in less than 10% of non–mechanically ventilated patients in the ICU.[26,27]

4.3. Oral nutrition support

Of the 95% of patients prescribed oral intake in the first week after ICU discharge, 40% were also prescribed ONS. These rates of ONS prescription are lower than those reported in the study by Terblanche et al. for survivors of an ICU admission for COVID-19, which showed 73% of patients received ONS.[25] The reasons for this are multifactorial. Without quantifying dietary intake, it cannot be ascertained if the lower prescription of the ONS was due to a reduced *need* for ONS or alternatively a lower *prescription* in a population that may have benefited. At hospital discharge, ONS was prescribed for 11% of patients in our study, suggestive of a continued improvement in nutritional intake over the hospital admission, diminishing the need for nutrition intervention.

4.4. Nutrition-impacting symptoms

At ICU admission, the most common nutrition-impacting symptoms were diarrhoea and nausea/vomiting, reported in 28% and 21% of patients, respectively, whereas loss of taste/smell was reported in 12% of patients only. In non-ICU hospitalised patients with COVID-19, rates of diarrhoea and nausea/vomiting are lower (~10%) and that of loss of taste/smell is higher (34–59%). Lower rates of loss of taste/smell may occur due to resolution of symptoms over the course of the disease trajectory, with symptoms largely resolved by the time the patient was admitted to the ICU from the ward. Higher rates of diarrhoea and nausea/vomiting observed in our cohort may be a result of general ICU medical care (e.g., antibiotic therapy) and are similar to a general ICU population where rates of diarrhoea have varied from 3.3% to 78%.[28]

In our study, nutrition-impacting symptoms were documented in 51% of patients after ICU discharge. Interestingly, while taste/smell changes were reported in 21% of patients on ICU admission, this was only documented for 3% of patients in the post-ICU ward and is in keeping with the hypothesis of symptom resolution over the hospital admission. Reduced appetite has been reported in ICU patients previously: in a group of non–mechanically ventilated ICU patients, lack of appetite was reported in 29% of patients,[26] and in mechanically ventilated patients, 'no appetite' was reported in 38% of patients one week after extubation.[29] Similarly, Nematy et al. reported lower self-reported hunger sensations in ICU survivors in the post-ICU ward than in healthy volunteers (24.7 vs 40.9; $p = 0.04$), using a visual analogue score.[30] In a group of ICU survivors at 3 months following ICU admission, appetite had improved, but it was still low in more than 50% of patients.[31]

Our rates of dysphagia were lower than those observed in other studies in ICU survivors: in a systematic review, Skoretz et al. report that up to 62% of ICU survivors experience dysphagia.[32] Patients that receive MV are more likely to experience dysphagia, with higher rates in those who have prolonged MV, explaining the lower rates in our study.

4.5. Weight changes

While our overall cohort did not lose weight in the ICU, patients who were on MV had a mean weight loss in the ICU of 3.7 kg. This is much lower than a mean weight loss of 7.9 kg reported in the 453-patient study conducted in critically ill patients with COVID-19 by Terblanche et al., despite similar clinical characteristics between cohorts (age, sex, APACHE, ICU length of stay).[25] The reason for greater weight loss in the UK cohort is unclear; it may be related to a higher number of patient admissions in the UK site (453 patients included from 7 months of recruitment compared to 103 patients in 12 months in our study), impacting feeding adequacy and dietetic service delivery. Our data may be limited by the use of estimated or reported, as opposed to measured, weights.

4.6. Strengths and limitations

This is the first study in our knowledge to document nutrition practices, including the route of feeding and nutrition-impacting symptoms in patients admitted to Australian ICUs with COVID-19 and the first to quantify nutrition practices in critically ill patients with COVID-19 receiving forms of respiratory support other than MV. Data were collected from nine ICUs across Australia, providing generalisability to other Australian sites. Given the workforce pressures experienced by sites during the recruitment period, data variables were designed to be collected rapidly and retrospectively and hence nutritional intake was not quantified, and the quality of data may have been compromised, including estimations of weight and height as opposed to obtaining measured values.

5. Conclusions

In survivors of an admission to an Australian ICU for COVID-19, most patients received nutrition orally both in the ICU and in the post-ICU ward; however, EN was used for the greatest proportion of feeding days and in mechanically ventilated patients. In the post-ICU ward, nutrition-impacting symptoms are common, and a high number of patients require dietetic interventions on hospital discharge.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

L Chapple and E Ridley were responsible for conceptualisation, data curation, formal analysis, methodology, project administration, and original draft. L Ballantyne, L Campbell, C Dux, S Ferrie, K Fetterplace, V Fox, M Jamei, and E Osland were responsible for project administration, investigation, and writing – review and editing. K Ainscough, A Burrell, and A Nichol were responsible for data curation, resources, and writing – review and editing. V King was responsible for project administration and writing – review and editing. A Serpa Neto was responsible for formal analysis and writing – review and editing. M Summers was responsible for project administration, investigation, and writing – review and editing. A Marshall and A Udy were responsible for formal analysis, methodology, and writing – review and editing. All authors reviewed and approved the final version of the manuscript.

Conflict of interest

Four authors (Chapple, Ridley, Marshall, and Udy) hold leadership positions with *Australian Critical Care*. Chapple and Ridley are Editors, Marshall is the Editor-in-Chief, and Udy is a member of the Editorial Board. Consistent with ACC policies, the authors are excluded from any decision-making processes in relation to this submission. The manuscript was managed from submission through to final decision by Assoc Prof Tom Buckley, Editor.

Please cite this article as: Chapple LS, Nutrition delivery across hospitalisation in critically ill patients with COVID-19: An observational study of the Australian experience, Australian Critical Care, https://doi.org/10.1016/j.aucc.2023.05.001

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.aucc.2023.05.001.

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Please cite this article as: Chapple LS, Nutrition delivery across hospitalisation in critically ill patients with COVID-19: An observational study of the Australian experience, Australian Critical Care, https://doi.org/10.1016/j.aucc.2023.05.001