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ARTICLE

Nutritional support practices at an intensive care unit in Johannesburg, South Africa

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Objectives: Nutritional support is a fundamental component of holistic patient care in the intensive care unit (ICU). There is a paucity of local data pertaining to nutritional support practices at ICUs in South Africa. The aim of this study was to determine nutritional support practices at an academic hospital ICU in Johannesburg, South Africa.
Methods: In this cross-sectional, descriptive and retrospective study, a simple random sampling method was utilised to select 50 data collection days from a three-month period (1 August–31 October 2018). Data relevant to the study were extracted from the ICU charts of patients who received formulae-based enteral and/or parenteral nutrition on the selected days. Charts were categorised into acute phase days (≤ 72 hours from ICU admission) and recovery phase days (> 72 hours from ICU admission).
Results: A total of 387 ICU charts were included in the final sample, comprising 114 acute phase and 273 recovery phase days. Overall, enteral nutrition was prescribed on 296 (76.5%) chart days while parenteral nutrition was prescribed on 111 (28.7%) chart days. The median daily fluid balance was approximately 600 ml positive. Target protein and calorie intake was achieved on 67 (17.3%) and 110 (28.4%) chart days respectively.
Conclusion: Although protein and calorie intake was suboptimal in comparison with the recommended targets, it is in keeping with general international trends. Regular audits, training of staff, attention to minimising feeding interruptions and encouraging the timely initiation of enteral nutrition are recommended interventions that may be useful in achieving nutritional targets.

Keywords: enteral nutrition, parenteral nutrition, ICU nutrition, protein intake, calorie intake, fluid balance

Introduction

Nutritional support is a fundamental component of holistic patient care in the intensive care unit (ICU) and therefore warrants diligent consideration.[1] Various factors including patient pathophysiology, underlying comorbidities, baseline nutritional status, genetic factors and severity of illness may influence nutritional requirements.[2,3]

Both under- as well as overfeeding have been associated with adverse patient outcomes in the ICU. Underfeeding occurs in approximately half of ICU patients and has been associated with a loss of muscle mass, an increase in hospital length of stay and an increase in overall mortality.[4] Approximately one-fifth of patients in the ICU are overfed. Overfeeding has been associated with azotaemia, metabolic acidosis, hypercapnia, hypertonic dehydration, hyperglycaemia, hyperlipidaemia, increased infection risk, hepatic steatosis and an increase in mortality.[5,6]

Despite recent advances in the field of clinical nutrition, there remains uncertainty and a lack of consensus with regard to nutritional support practices in the critically ill.[7] Although local and international guidelines have advocated the enteral above the parenteral route of nutrition and have recommended specific protein and energy targets,[8–11] the Trial of the Route of Early Nutritional Support in Critically Ill Adults (CALORIES) study did not report a mortality benefit in ICU patients who were exclusively enterally fed compared with those who were exclusive parenterally fed during the first few days of ICU admission.[12] Furthermore, the Permissive Underfeeding or Standard Enteral Feeding in Critically Ill Adults Trial (PermiT) showed that permissive underfeeding (i.e. administering only 40-60% of the caloric goal while maintaining protein intake goals) was not inferior to standard enteral feeding goals.[13] Additionally, the Energy-Dense versus Routine Enteral Nutrition in the Critically Ill (TARGET) trial showed that energy dense nutrition (1.5 kcal/ml) did not improve 90-day mortality or other secondary outcomes amongst ventilated patients in the ICU when compared with routine (1 kcal/ml) enteral nutrition.[14]

Updated nutritional support guidelines have been published both locally and internationally. These include the 2016 South African National Department of Health (nDoH) enteral and parenteral nutrition practice guidelines,[8,9] the 2016 American Society of Parenteral and Enteral Nutrition (ASPEN) ICU guidelines,[10] and the 2019 European Society of Parenteral and Enteral Nutrition (ESPEN) ICU guidelines.[11] There is, however, a paucity of local data describing nutritional support practices amongst ICU patients in South Africa. Hence, the aim of this study was to describe and evaluate nutritional support practices in an adult ICU ward at an academic hospital in Johannesburg, South Africa.

Methodology

In this cross-sectional and descriptive study, data were obtained by retrospectively reviewing the medical records (ICU charts) of patients thwhoat were admitted to an adult general ICU. The hospital has over a thousand beds with six distinct ICU sections. The adult general ICU has a capacity of 12 ICU beds. Permission to conduct the study was obtained from the hospital

management, while ethics clearance was granted by the Human Research Ethics Committee of the University of the Witwatersrand (certificate no. M170453).

A simple random sampling method was used to select 50 data collection days from a three-month period (August 1–October 31 2018). Each of the dates during the three-month period was written on an individual piece of paper, and all were folded prior to being placed in a hat. Fifty papers (days) were thereafter selected by an independent individual who was blinded to the study aims and objectives. The charts of these patients managed in the ICU on the 50 selected days were retrieved from the medical records department. Only the charts of patients who received formulae-based enteral and/or parenteral nutrition were included in the study.

For the purpose of this study, the acute phase was defined as the first 72 hours of ICU admission while the recovery phase was defined as stay in the ICU beyond 72 hours. The recommended daily protein and calorie intake was based on the 2016 ASPEN guidelines,[10] which were in use at the study site during the period of data collection. Data were collected by four of the study investigators, who, prior to initiating data collection, received training from the study supervisors on the methods and principles of data abstraction from medical records. Where data were missing, incomplete or conflicting, the attending dietitian and ICU nursing sisters were consulted in an attempt to resolve these issues where possible. Issues that could still not be resolved were then discussed among the study investigators and resolved by consensus.

The process of data collection was periodically monitored by the study supervisors. Inter-rater reliability was assessed after the completion of data collection. Data from a sample of 17 randomly selected medical records was re-abstracted by an independent researcher with previous experience in data abstraction from medical records and compared with data obtained by the study investigators. The overall Cohen's kappa coefficient (κ) was 0.81, indicating that the degree of inter-rater reliability was acceptable.

Collected data included patient age, patient weight, total fluid intake, total fluid output, type of feed administered, volume of feed administered, route of administration, the number of feeding interruptions and causation thereof, any medication/fluids that provided additional energy sources such as dextrose and propofol, patient diagnoses and the presence of organ dysfunction. To maintain patient confidentiality, collected data did not include any patient-identifying information. Furthermore, the data were stored in a password-protected computer that was accessible only to the study investigators.

All data were captured and analysed in Microsoft® Excel® (Microsoft 365, Version 16.0.13029.20232; Microsoft Corp, Redmond, WA, USA). All the included variables were categorised into acute-phase and recovery-phase days. The protein and calorie content of the various types of nutritional support administered, the volume of nutritional support administered per chart day and the weight of the patient were used to calculate the daily protein and calorie intake in g/kg/day and kcal/kg/day respectively. Categorical variables were described using frequency and percentage, while continuous variables such as daily fluid intake, daily fluid output, daily protein intake and daily calorie intake were described using the median and interquartile range (IQR).

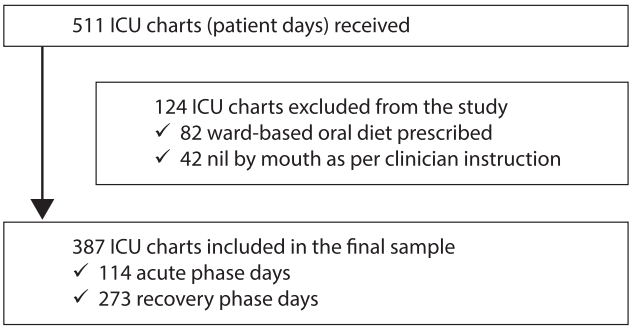

Figure 1: Exclusion and final sample for analysis.

Results

A total of 387 ICU charts (patient days), comprising 114 acute phase days and 273 recovery phase days, were included in the final sample for analysis. Figure 1 describes the details of how the final study sample was achieved.

The median age of the study subjects was 49 years (IQR 35.5–60.0 years). Table 1 provides a summary of the various types and brands of nutritional support and their route of administration. Overall, enteral nutrition (EN) was prescribed on 296 (76.5%) and parenteral nutrition (PN) on 111 (28.7%) chart days. EN alone was prescribed on 231 (59.7%) chart days that comprised 69 (60.5%) acute-phase and 162 (59.3%) recovery-phase days. PN alone was prescribed on 46 (11.9%) chart days that comprised 10 (8.7%) acute-phase and 36 (13.2%) recovery-phase days. The combination of EN and PN together was prescribed on 65 (16.8%) chart days. Fresubin Original® was the most frequently prescribed enteral feed during the acute phase ($n = 34$, 29.8%), whereas Fresubin Supportan® was the most frequently prescribed enteral feed during the recovery phase ($n = 89$, 32.6%). Additional nutrition in the form of 5% dextrose and propofol was also administered.

Table 1: Summary of the various types and brands of nutritional support and their route of administration

Type of feed	Acute phase ($n = 114$) (n, %)	Recovery phase ($n = 273$) (n, %)
Enteral	69 (60.5)	162 (59.3)
Diben ®	4 (3.5)	0
Diben 1.5 HP ®	1 (0.9)	3 (1.1)
Fresubin 1200 Complete ®	25 (21.9)	37 (13.6)
Fresubin HP Energy ®	10 (8.8)	18 (6.6)
Fresubin Original ®	34 (29.8)	4 (1.5)
Fresubin Supportan ®	16 (14.0)	89 (32.6)
Nutrison Low Sodium ®	12 (10.5)	57 (20.9)
Survimed ®	3 (2.6)	42 (15.4)
Parenteral	10 (8.7)	36 (13.2)
ITN 8010A/XA ®	1 (0.9)	6 (2.2)
ITN 8807A/XA ®	3 (2.6)	30 (11.0)
Nutriflex ®	8 (7.0)	27 (9.9)
Enteral and parenteral	22 (19.3)	43 (15.8)
5% dextrose solution	21 (18.4)	93 (34.1)
Propofol	12 (10.5)	29 (10.6)

Totals are greater than 100% as some patients received more than one item concurrently.

Table 2: Summary of the median daily fluid intake and fluid output

Factor	Acute phase ($n = 114$) (median, IQR)	Recovery phase ($n = 273$) (median, IQR)
Nutritional support administered (ml/day)	1065.1 (615.7–1 330.4)	1558.6 (1 135.2–1 875.8)
*Other fluids administered (ml/day)	1200.1 (369.6–1 736.3)	796.6 (181.4–1 376.5)
Fluid output (ml/day)	1533.6 (900.4–1 990.1)	1710.2 (1 065.9–2 097.5)
Fluid balance (ml/day)	622.5 (−77.7–993.4)	584.5 (34.3–1 136.2)

IQR = interquartile range.
*Other includes all other fluids such as maintenance fluids, resuscitation fluids, blood, blood products and medications.

The median (IQR) volume of nutritional support administered, the volume of other fluids administered and the fluid output of the study sample are described in Table 2. Of note, the median (IQR) daily fluid balance was 622.5 ml (−77.7–993.4 ml) positive in the acute phase and 584.5 ml (34.3–1136.2 ml) positive in the recovery phase.

Table 3 provides a summary of the percentage of the recommended protein and calorie targets that were achieved. In comparison with the ASPEN recommendations, target protein intake (80–110% of recommended) was only achieved on 67 (17.3%) chart days, while it was above (overfeeding) the recommended target on 71 (18.4%) and below (underfeeding) the recommended target on 249 (64.3%) chart days. Target calorie intake (80–110% of recommended) was achieved on 110 (28.4%) chart days, while it was above the recommended target on 87 (22.5%) and below the recommended target on 190 (49.1%) chart days.

Table 4 provides a summary of the overall and disease-specific median protein and calorie intake of the study sample. In comparison with the ASPEN recommended targets, the median protein and median calorie intake was below the recommended range for most categories. Subjects with renal disease who were not being dialysed received 41.7% (0.5/1.2 g.kg/day) and 55.6% (13.9/25 kcal/kg/day) of the target protein and calorie intake in the acute phase respectively, and 75.0% (0.9/1.2 g/kg/day) and 84.4% (21.1/25 kcal/kg/day) of the target protein and calorie intake in the recovery phase respectively. Subjects with renal disease who were being dialysed received 40.0% (0.6/1.5 g.kg/day) and 47.2% (11.8/25 kcal/kg/day) of the target protein and calorie intake in the acute phase respectively, and 40.0% (0.6/1.2 g/kg/day) and 55.6% (13.9/25 kcal/kg/day) of the target protein and calorie intake in the recovery phase respectively. Subjects with hepatic failure received 75.0% (0.9/1.2 g.kg/day) and 79.6% (19.9/25 kcal/kg/day) of the target protein and calorie intake in the acute phase respectively.

Table 3: Summary of the percentage of the recommended protein and calorie targets achieved.

Factor	Acute phase ($n = 114$) (n, %)	Recovery phase ($n = 273$) (n, %)
Percentage of recommended daily protein target achieved:*		
0–50%	46 (40.4)	72 (26.4)
> 50–80%	37 (32.5)	94 (34.4)
> 80–110%	17 (14.9)	50 (18.3)
> 110%	14 (12.3)	57 (20.9)
Percentage of recommended daily calories target achieved:*		
0–50%	38 (33.3)	44 (16.1)
> 50–80%	32 (28.1)	76 (27.8)
> 80–110%	23 (20.2)	87 (31.9)
> 110%	21 (18.4)	66 (24.2)

*Recommended daily protein and calorie targets are based on the 2016 American Society of Parenteral and Enteral Nutrition (ASPEN) guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient.[10]

A summary of the frequency, type and duration of enteral feeding interruptions among the study sample is provided in Table 5. Feeding intolerance was the most common reason for enteral feeding interruptions in both the acute ($n = 16$, 61.5%) and recovery ($n = 25$, 53.2%) phases. The median (IQR) duration of interruption was longest in pre-surgical patients during the acute phase (10.5 hours [5.50– 13.7 hours]).

Discussion

To our knowledge, this is the first study of this nature to be conducted in a South African setting. It is well established that EN is preferred over PN in the ICU.[10] Compared with PN, EN is more physiologic, promotes gut immune function, maintains gut integrity by preventing villous atrophy, is associated with a reduction in septic and metabolic complications and is associated with a shorter ICU length of stay.[15, 16]

In this study, enteral nutrition was prescribed on 76.5% of chart days, PN was prescribed on 28.7% of chart days and both EN and PN were concurrently prescribed on 16.8% of chart days. Comparatively, in the 'nutritionDay ICU' study, which was a yearly one-day cross-sectional audit that was conducted between 2007 and 2013 and comprised 9 777 patients from 880 ICU units across 46 countries, an enteral tube was present in 59% of patients while 52% had both an enteral tube and a parenteral line in place.[17] In contrast, in a study that analysed 379 584 nutritional prescriptions across 59 hospitals in China, approximately two-thirds of patients received their protein and lipid requirements via the parenteral route.[18] The Early versus Late Parenteral Nutrition in Critically Ill Adults (EPaNIC) trial, which was a multicentre randomised study that compared the late initiation of PN (> 8 days) with the early initiation of PN (≤ 48 hrs) as a supplement to insufficient EN among 4 650 adults in the ICU, found that the late initiation of PN was associated with fewer complications and a more rapid recovery.[19] Furthermore, a meta-analysis of 26 studies that included over 2 000 patients showed that the receiving PN was not associated with a reduction in mortality compared with receiving no nutritional support, but there was a reduction in the number of complications in the subset of malnourished patients receiving PN.[20]

In the current study, the median daily fluid balance was approximately 600 ml positive per day during both the acute and recovery phases of ICU admission. As insensible water loss is regarded as approximately 600–800 ml/day,[21] this figure can be considered acceptable, particularly as fluid overload in critically ill patients has been associated with poor outcomes. A study conducted in Poland showed that a fluid balance exceeding 1 000 ml/day in the initial 72 hours of ICU admission was independently associated with higher mortality.[22] Several other studies have also reported that fluid overload in critically ill patients was associated with adverse clinical outcomes.[23–26]

Table 4: Summary of the overall and disease-specific median protein and calorie intake

Variable	*n*	Protein intake (g/kg/day) (median, IQR)	Recommended protein intake (g/kg/day)^	Percentage of recommended protein intake^^	Calorie intake (kcal/kg/day) (median, IQR)	Recommended calorie intake (kcal/kg/ day)^	Percentage of recommended calorie intake^^
Acute phase (*n* = 114):							
Overall	114	0.7 (0.4–1.0)	NA	NA	15.7 (9.1–22.2)	NA	NA
General:*							
BMI ≤ 30 kg/m^2**	56	0.9 (0.5–1.2)	1.2–2.0	75.0%	19.0 (11.8–26.4)	25–30	76.0%
BMI 30.1–39.9 kg/m^2***	4	0.5 (0.3–1.7)	~2.0	25.0%	12.3 (6.0–37.5)	11–14	111.8%
Renal disease:							
With no dialysis***	43	0.5 (0.3–0.7)	1.2–2.0	41.7%	13.9 (7.0–19.3)	25–30	55.6%
With dialysis***	6	0.6 (0.3–0.9)	1.5–2.5	40.0%	11.8 (6.8–20.1)	25–30	47.2%
Hepatic failure****	5	0.9 (0.5–1.1)	1.2–2.0	75.0%	19.9 (11.7–23.9)	25–30	79.6%
Acute pancreatitis***	0	0	1.2–2.0	NA	0	25–30	
Recovery phase (*n* = 273):							
Overall	273	0.9 (0.6–1.1)	NA	NA	21.1 (14.4–26.4)	NA	NA
General:							
BMI ≤ 30 kg/m^2*	131	0.9 (0.6–1.1)	1.2–2.0	75.0%	21.6 (14.5–27.2)	25–30	86.4%
BMI 30.1–39.9 kg/m^2**	16	0.6 (0.3–0.8)	~2.0	30.0%	16.5 (7.2–17.3)	11–14	150.0%
Renal disease:							
With no dialysis**	118	0.9 (0.6–1.2)	1.2–2.0	75.0%	21.1 (14.3–26.3)	25–30	84.4%
With dialysis**	6	0.6 (0.5–0.6)	1.5–2.5	40.0%	13.9 (13.0–16.1)	25–30	55.6%
Hepatic failure***	0	0	1.2–2.0	NA	0.0	25–30	NA
Acute pancreatitis**	2	1.0#	1.2–2.0	83.3%	25.2#	25–30	100.8%

IQR = interquartile range.
^Based on the 2016 American Society of Parenteral and Enteral Nutrition (ASPEN) guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient.[10]
^^Calculated by dividing the median protein or calorie intake by the lower limit of the recommended protein or calorie intake respectively.
*Encompasses all other diagnoses besides renal disease, hepatic failure and acute pancreatitis.
**Calculation based on adjusted bodyweight (ABW).
***Calculation based on ideal bodyweight (IBW).
****Calculation based on dry/usual body weight (UBW).
#Unable to calculate the IQR due to insufficient number of subjects.

Table 5: Summary of the frequency, type and duration of enteral feeding interruptions

Factor	Acute phase	Recovery phase
Overall number of interruptions (*n*)	26	47
Pre-surgery (*n*, %)	8 (30.8)	13 (27.7)
Pre-extubation (*n*, %)	1 (3.8)	2 (4.3)
Feeding intolerance (*n*, %)	16 (61.5)	25 (53.2)
Other (*n*, %)	1 (3.8)	7 (10.5)
Overall duration of interruptions (hours) (median, IQR)	8.6 (5.1–13.2)	5.0 (3.1–8.3)
Pre-surgery (median, IQR)	10.5 (5.5–13.7)	5.6 (4.3–13.5)
Pre-extubation (median, IQR)	3.3#	6.5#
Feeding intolerance (median, IQR)	6.5 (3.1–10.4)	4.4 (3.1–8.6)
Other (median, IQR)	7.0#	6.3 (3.3–9.2)

#Unable to calculate the median or IQR due to insufficient numbers.

In this study, the target daily protein and calorie intake was achieved in only 17.3% and 28.4% of chart days respectively. These were above target on 18.4% and 22.5% of chart days and below target on 64.3% and 49.1% of chart days respectively. A recent study conducted in mechanically ventilated patients in Australia showed that although overfeeding was associated with an increase in minute ventilation, more frequent episodes of diarrhoea and greater insulin requirements, there were no differences in the duration of mechanical ventilation, length of stay and mortality.[27] In adequately nourished patients, excessive nutrition has been shown to be associated with higher rates of hyperglycaemia and sepsis.[28] Although the large proportion of patients who were underfed in our study may seem concerning, a meta-analysis found no differences in overall mortality, length of stay, duration of mechanical ventilation or infection rate between underfed and fully fed ICU patients, while there were lower rates of gastrointestinal complaints in the underfed group. Subgroup analysis also showed lower rates of mortality in moderately underfed (received 46–72% of energy requirements) compared with fully fed patients.[29] Another recent study conducted in Iran reported that ICU and hospital mortality was significantly higher in patients who received < 80% of their target protein and calorie requirements.[30]

In the current study, the disease-specific recommendations for protein and energy intake were below the ASPEN recommended targets for almost all categories. For patients with renal disease, the median protein intake was between 40.0% and 75.0% and the median calorie intake was between 47.2% and 84.4% of the recommended targets, while in patients with hepatic failure the median protein intake was 75.0% and the median calorie intake was 79.6% of the recommended targets. Studies evaluating nitrogen balance in ICU patients with acute kidney injury (AKI) requiring dialysis demonstrated that protein intake should be between 1.5 and 2.5 g/kg/day.[31] The ASPEN guidelines recommend that protein intake should not be restricted in ICU patients with AKI requiring dialysis and suggest that these patients should receive up to 2.5 g/kg/day of protein while patients not receiving dialysis should receive 1.2–2.0 g/kg/day of protein. The guidelines also recommend that in patients with hepatic failure, protein intake should be determined in the same manner as for the general ICU patient; however, dry bodyweight should be used in place of ideal bodyweight when calculating the target intake. The guidelines also recommend that the daily calorie intake for patients with either renal or hepatic dysfunction should be the same as for the general ICU patient with a body mass index (BMI) < 30 kg/m^2 (i.e. 25–30 kcal/kg/day). Again, the dry bodyweight should be used in place of ideal bodyweight when calculating the target intake in patients with hepatic failure.[10]

Interruptions to enteral feeding have been reported as one of the commonest causes of underfeeding in the ICU.[30] A study conducted in Lithuania reported that haemodynamic instability (20%), feeding intolerance (17%) and surgical procedures (32%) were the most common reasons for interruptions in EN.[32] Comparatively, in this study, feeding intolerance accounted for over half of the 73 episodes of enteral feeding interruptions, while surgical procedures accounted for over a quarter of episodes. Some authors have recommended that a volume-based feeding (VBF) regimen be implemented over the standard rate-based feeding (RBF) regimen, where a precalculated volume of EN is prescribed over a 24-hour period (e.g. 1200 ml/24 hours) instead of prescribing an hourly rate (e.g. 60 ml/hour), thereby allowing the rate to be adjusted over the course of the day to compensate for any feeding interruptions.[33,34] However, not all studies have reported outcome benefits with this approach.[35]

Based on the above findings, it is important to incorporate interventions that have been proven to improve local ICU nutritional support practices. These interventions could include the conducting of regular in-unit audits,[36] implementing staff training programmes,[37] attention to minimising feeding interruptions[30] and encouraging the timely initiation of enteral nutrition.[38] Future studies should aim to investigate ICU nutritional support practices on a national level as well as evaluate the effectiveness of interventions that may be implemented in this regard.

Limitations

As this was a single centre study and nutritional practices are dependent on clinical experience and facility-specific protocols, which are likely to vary, the findings of this study may not necessarily reflect nutritional support practices at other facilities in South Africa. Another limitation is that we did not compare data between adequately nourished, under-nourished and over-nourished subjects. Furthermore, mortality and outcome data were not collected. Additionally, a retrospective chart review study design holds less weight than a prospective study.[39] As such, this study is subject to known limitations that include spurious findings, missing data and conflicting data. Despite the aforementioned limitations, it is hoped that the findings of this study will serve to increase vigilance and thereby improve nutritional support practices at ICU facilities locally and abroad.

Conclusion

Based on the findings of this study, it is evident that protein and calorie intake were suboptimal in comparison with the recommended targets. However, findings of this study are in keeping with general international trends. There is a need to implement interventions to optimise ICU nutritional support targets. Regular audits, training of staff, attention to minimising feeding interruptions and encouraging the timely initiation of enteral nutrition are recommended interventions that may be useful in achieving nutritional targets.

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