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CASE REPORT

Enteral Nutrition Support for Mechanically Ventilated, Morbidly Obese Patient with Abdominal Compartment Syndrome (ACS): A Case Report from a Medical Intensive Care Unit (ICU)

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Abstract

Abdominal compartment syndrome (ACS) is said to occur when intra-abdominal pressure (IAP) is greater than 20 mmHg in association with new organ failure. This pressure can decrease blood flow to nerve and muscle cells, leading to ischemia and organ dysfunction. Challenges in providing enteral nutrition for abdominal compartment syndrome (ACS) patients include the increased risk for developing gastrointestinal symptoms such as diarrhea, constipation and distention. There are limited reports available on the nutritional management of ACS patients in the ICU, especially those with morbid obesity condition, to guide dietitians in providing nutritional support for these patients. Here, we report the enteral nutrition management of a mechanically ventilated, morbidly obese patient with ACS in a critical care setting by adopting post-pyloric feeding, using pro-kinetic agents and implementing PO_2/FiO_2 ratio calculation for prescription of most suitable enteral formula.

Keywords Critical Care Nutrition; Nutrition Support; Intensive Care Unit; Enteral Nutrition; Abdominal Compartment Syndrome

Introduction

Intra-abdominal hypertension (IAH) is defined by the World Society on Abdominal Compartment Syndrome (WSACS) as a persistent intra-abdominal pressure greater than 12 mmHg. In addition, abdominal compartment syndrome (ACS) is said to occur when intra-abdominal pressure (IAP) is greater than 20 mmHg in association with new organ failure.[1] The pressure can decrease blood flow to nerve and muscle cells, leading to ischemia and organ dysfunction. Studies have been suggested that the incidence of ACS and IAH, when associated with septic shock, can be as high as 30% to 85% respectively.[2] Both ACS and IAH are growingly recognized complications impacting 30–50% of intensive care unit (ICU) patients and have mortality rates of 70–80% if left untreated.[3-5]

Some of the most common early clinical manifestations of IAH and ACS in critically ill

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patients including abdominal distention, oliguria, elevated peak respiratory pressures and difficulty in ventilating. Because of its simplicity and low cost, bladder pressure measurement has been considered as the gold standard to measure IAP.[2,6–7]

Studies have been shown that IAH can affect the central nervous system by raising intra-cranial pressure and also decreasing renal function. Malbrain et al.[3] reported that IAH could independently cause acute kidney injury (AKI). The effect of IAH on gastrointestinal organs leads to decreased gut perfusion. This change can lead to bowel ischemia and edema to infectious risk associated with mucosal hyperpermeability.[8]

The provision of nutrition care to the mechanically ventilated patients in the ICU, most commonly through enteral nutrition, is known to present with numerous challenges due to multidisciplinary and heterogeneous medical condition, severity of illness and specific individual needs.[9] Furthermore, the presence of obesity in mechanically ventilated patients increases the complexity of care. The more severe the obesity, the more demanding the routine of nursing care and diagnostic or therapeutic interventions can be due to patients' physical condition. Similarly, providing enteral nutrition to the obese-mechanically ventilated patients can also be complicated as these patients are prone to develop stress-induced hyperglycemia.[10] Obese-critically ill patients also have altered metabolic processes when compared to their non-obese counterpart.[11–12]

In terms of providing enteral nutrition for IAH/ACS patients, the challenges including the increase risk for developing gastrointestinal symptoms such as diarrhea, constipation and distention. The use of opiate sedation may contribute to decrease gastric motility.[13] Additionally, in critically ill patients, there is an increased risk of developing serious metabolic complications due over feeding including hypercapnia, hyperglycemia, azotemia, hepatic steatosis and metabolic acidosis among others.[14-15]

There are limited reports available on the nutritional management of ACS patients in the ICU especially those with morbid obesity condition to guide dietitians in providing nutritional support for these patients. Here, we report the enteral nutrition management of a mechanically ventilated, morbidly obese patient with ACS in a critical care setting by adopting post-pyloric feeding, using pro-kinetic agents and implementing PO_2/FiO_2 ratio calculation for prescription of most suitable enteral formula.

Client History

A 53-year-old African American female with severe chronic obstructive pulmonary disease (COPD) presented to the Emergency Department with progressive symptoms of severe shortness of breath and swelling of lower extremities. She had a known past medical history of severe oxygen dependent COPD. In the last 12 months, she had multiple hospitalizations for COPD exacerbations.

Upon presentation, she was afebrile with elevated white blood cell count. Chest x-ray showed bilateral atelectasis while her ECG revealed sinus tachycardia with no acute ischemic changes. She was then admitted with initial diagnosis of acute respiratory failure and subsequently transferred to the medical intensive care unit (MICU) for ventilator support. In MICU, she was intubated, sedated and received fluid resuscitation. During the next 24 hours, she had periods of low urine output and subsequently developed non-oliguric acute kidney injury (AKI) with worsening metabolic acidosis. Noticeable increase in bladder pressure and abdominal distension revealed a diagnosis of abdominal compartment syndrome. In the meantime, progressive hypercapnea and auto-PEEP had led to the decision to chemically paralyze her with the neuromuscular blocking agent (NMBA), *cisatracurium*. She was then maintained on a continuous infusion of *cisatracurium*. Shortly following paralysis, bladder pressure decreased and she had urine output of more than 300 ml. During the next few days, her creatinine level returned to normal. She continued to receive other non-surgical therapy to control IAP by gastric decompression and soapsuds enema.

The patient was kept nothing by mouth (NPO), following sedation and intubation in the ICU. Bedside placement of a naso-jejunal feeding tube was done within 72 hours after admission using electromagnetically guided placement device

(EMPD) and dietitian was consulted on Day 3 for enteral nutrition initiation.

Nutrition Care Process:

Nutrition Assessment

Patient was morbidly obese (BMI of 40.6 kg/m^2) with admission weight of 100.8 kg. Her ideal body weight (IBW) for her height of 157.5 cm was 50 kg. She was at 202% of her IBW and 110% of her usual body weight (UBW) during presentation at the hospital with no reported weight loss prior to admission. This was supported by her last documented weight available on hospital electronic record (91 kg) indicating 10% weight gain in 10 months.

Information on food/nutrition-related history was obtained mainly from the nutrition screening form upon admission and the medical record. Prior to admission, the patient was not reported to follow a weight loss diet or any other therapeutic diet for her morbid obesity condition and other nutrition-related clinical diagnoses. The patient was kept NPO following sedation and intubation in the ICU.

Biochemical assessment revealed elevated levels of blood urea nitrogen (BUN), serum creatinine and phosphorus related to AKI resulted from ACS. Other electrolytes and CO_2 level were within normal limits (Table 1). In order to determine the patient's lung function, partial pressure of oxygen/fraction of inspired oxygen (PO_2/FiO_2) ratio was calculated (PO_2, 93.6 mmHg; FiO_2, 40% from arterial blood gas analysis and ventilator setting respectively). Calculation of PO_2/FiO_2 ratio (<300 mmHg) revealed a status of acute lung injury (ALI).

Table 1 Biochemical data

Parameter	Reference range	Day 3	Day 6	Day 10	Day 20	Day 23
Sodium (mmol/L)	135–145	137	152	138	141	139
Potassium (mmol/L)	3.5–5.2	5.2	5.6	5.1	4.6	3.7
Chloride (mmol/L)	98–109	98	108	95	104	100
Carbon dioxide, CO_2 (mmol/L)	23–34	27	37	39	29	30
Blood urea nitrogen (mg/dL)	8–20	40	41	32	NA	14
Creatinine (mg/dL)	0.70–1.20	3.31	0.85	0.54	0.31	0.29
Magnesium (mEq/L)	1.3–1.9	NA	2.1	2.4	3.0	1.5
Phosphorus (mg/dL)	2.4–4.5	6.8	2.8	3.2	2.3	NA
Albumin (g/dL)	3.5–5.0	3.6	3.3	3.5	NA	NA
White blood cell (Thou/cu mm)	4.0–11.0	17.8	13.8	20.7	11.9	6.7
Glucose (mg/dL)	70–200	148	224	149	122	133

NA= Not Available

Energy needs were initially estimated based on Penn 2003b[16] formula at 1681 kcal per day using admission weight. Protein needs were calculated at 110 g per day (2.0 g/kg IBW/day) based on ASPEN recommendation for critically ill adults with BMI between 30–40 kg/m^2.[17] Fluid needs were not specified and were based on physician order due to the critical condition of patient requiring fluid resuscitation.

Nutrition Diagnosis

Patient had increased energy and protein needs from her critical illness. However, enteral nutrition support was not initiated within 24–48 hours due to hemodynamic instability. Patient was at risk of malnutrition in acute setting with delayed initiation of feeding. The nutrition diagnosis during initial assessment was “Inadequate protein and energy intake related to medical condition, intubation and altered gastrointestinal function as evidenced by patient on ventilator, estimated nutrient needs not met, current NPO status and unable to initiate feedings to rule out ileus”.

Nutrition Intervention and Prescription

Nasojejunal feeding of Oxepa®,[18] a concentrated enteral formulation with anti-inflammatory lipid profile and antioxidants was recommended to be initiated at 20 mL/hour continuously over 24 hours with slow feeding rate advancement as tolerated by the patient to the goal rate of 40 mL/hour. Healthy Shot®, a liquid high protein supplement was also recommended to be given twice daily via feeding tube in order to meet the patient’s high protein needs providing in total of 1640 kcal and 108 g protein per day. The use of additional modular protein supplements to ensure adequate delivery of protein is a common practice.[18] In addition, Healthy Shot® was the only liquid modular protein supplement available at the facility for enteral feeding use, thus, it was chosen to be given to patient in order to meet her high protein needs (Table 2).

Nutrition Monitoring/Evaluation and Outcome

Parameters monitored for this patient included electrolyte profile, enteral nutrition tolerance, enteral nutrition intake, gastrointestinal profile, glucose/endocrine profile, renal profile, protein profile and CO_2 levels (Table 1). Upon follow up, elevated CO_2 and glucose levels were seen (Day 6) indicating possible overfeeding. Permissive hypocaloric feeding was then introduced, revising the energy requirement at 1109–1411 kcal (11–14 kcal/kg actual body weight per day) based on obese, critically ill adults guidelines[18] while maintaining the same high protein needs. Permissive hypocaloric feeding is defined as intentional delivery of less non-protein nutrients than what is normally required daily. The concept of permissive hypocaloric feeding is based on the rationale that higher nutrient intake is detrimental from a metabolic and functional perspective. Studies with obese patients have demonstrated that a hypocaloric feeding regimen can promote nitrogen equilibrium and minize negative nitrogen balance without causing weight loss.[19]

The goal rate for Oxepa® was modified to 35 mL/hr with Healthy Shot® order of twice daily remained as previously prescribed. To optimize bowel management, pro-motility agents, Reglan and erythromycin were also recommended. On Day 21, patient was transferred to ICU step down unit and was discharged on Day 32 to a long term acute care facility with a feeding tube regimen using Glucerna 1.2®, a calorically dense diabetes-specific formula planned for better carbohydrate intake control in view of the patient having a chronic COPD. Energy needs for discharge plan was calculated using the Mifflin-St. Jeor formula (x1.2 factor) with protein needs of 2.0 g/kg IBW per day (1850 kcal, 100 g protein per day). The formula is commonly used in clinical practice and it is the most reliable, predicting Resting Metabolic Rate (RMR) within 10% of measured in non-obese and obese individuals than any other equation and it also had the narrowest error range.[20] The recommended goal rate was 65 mL/hr providing 1880 kcal, 94 g protein and 179 g carbohydrate. Table 3 summarizes enteral nutrition prescriptions for this patient throughout her hospitalization.

Table 2 Nutrition facts for nutrition intervention prescriptions

Nutrition facts	Oxepa® (1000 mL)	Healthy Shot® (75 mL)	Glucerna 1.2® (237 mL)
Calories (kcal)	1500	100	285
Protein (g)	62.7	24	14.2
Total carbohydrate (g)	105.3	1	27.1
Total fat (g)	22.2	0	14.2
Water (mL)	186	NA	192
Vitamin A (IU)	2840	NA	1840
Beta-carotene (mg)	1.2	NA	0.63
Vitamin D (IU)	100	NA	82
Vitamin E (IU)	75	NA	9.2
Vitamin K (mcg)	20	NA	24
Vitamin C (mg)	205	22.5	62
Folic acid (mcg)	200	NA	76
Thiamin (mg)	0.75	NA	0.29
Riboflavin (mg)	0.85	NA	0.33
Vitamin B6 (mg)	1.0	NA	0.38
Vitamin B12 (mcg)	3.0	NA	1.2
Niacin (mg)	10	NA	3.8
Choline (mg)	150	NA	105
Biotin (mcg)	150	NA	57
Panthothenic acid (mg)	5.0	NA	1.9
Sodium (mg)	310	80	265
Potassium (mg)	465	NA	480
Chloride (mg)	400	NA	305
Calcium (mg)	250	78	190
Phosphorus (mg)	250	NA	190
Magnesium (mg)	100	NA	76
Iodine (mcg)	38	NA	29
Manganese (mg)	1.3	NA	0.38
Copper (mg)	0.50	NA	0.38
Zinc (mg)	5.7	NA	2.9
Iron (mg)	4.5	0.7	3.5
Selenium (mcg)	18	NA	14
Chromium (mcg)	30	NA	38
Molybdenum (mcg)	38	NA	19
L-carnitine (mg)	43	NA	NA
Taurine (mg)	75	NA	NA

NA= Not Available

Table 3 Enteral nutrition prescriptions

Hospitalization Day	Energy Needs (kcal/day)	Protein Needs (g/day)	Enteral Formula Prescription		
			Oxepa®	**Healthy Shot®**	**Glucerna 1.2®**
Day 1 (MICU admission)	Feeding not yet initiated				
Day 3 (Initial RD consultation)	1681 (Penn 2003b)[16]	110 (2.0 g/kg IBW/day)[17]	Start rate: 20 mL/hour Goal rate: 40 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 6 (Day 5 post EN initiation)	1109-1411 (11-14 kcal/kg ABW per day)[17]	110 (2.0 g/kg IBW/day)[17]	35 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 21 (Transferred to ICU step down unit)	1109-1411 (11-14 kcal/kg ABW per day)[17]	110 (2.0 g/kg IBW/day)[17]	35 mL/hour	75 mL bd	-
			Energy: 1460 kcal/day Protein: 101 g/day		
Day 32 (Discharged plan)	1850 (Mifflin St. Jeor)[20]	100 (2.0 g/kg IBW/day)[17]	-	-	65 mL/hour
					Energy: 1880 kcal/day Protein: 94 g/day

MICU = Medical Intensive Care Unit
RD = Registered Dietitian
bd = twice a day
EN = Enteral Nutrition

Discussion

ACS commonly occurs in critically ill patients. Among other gastrointestinal effects from this syndrome, gut hypo-perfusion that may lead to bowel ischemia together with decreased gastric motility as part of IAH pathophysiology and the impact from opiate sedation are of major concerns in providing a successful enteral feeding. In this report, there were three major nutrition concerns. Firstly, in a patient with IAH, enteral feeding itself can aggravate bowel ischemia or worsen IAH due to fermentation and bowel distention and gastrointestinal symptoms.[21] Secondly, possibility of feeding intolerance secondary to decreased gastric motility from opiate sedation.[13] Thirdly, increased risk of developing serious metabolic complications if over feeding occurs.[14,15]

Overall, our patient was able to tolerate the hypo-caloric, high protein enteral feeding regimen despite several feeding interruptions due to medical condition and procedures.

In conclusion, provision of enteral nutrition support for ACS patients requires careful attention and aggressive measures such as adopting post-pyloric feeding to maximize the delivery of enteral feeding. Hill et al.[8] previously reported a low percentage of possibility for exclusive enteral nutrition support via nasogastric among these patients, thus, post-pyloric feeding should be considered. It is also beneficial to use pro-kinetic agents to optimize bowel management in managing ACS cases. Furthermore, in mechanically ventilated patients, PO_2/FiO_2 ratio calculation is useful for possible prescription of formula suitable for lung impairment.

Conflict of Interest

The authors of this paper declare there is no conflict of interest regarding this research.

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