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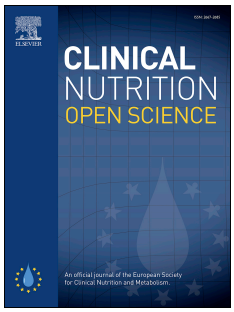

The dietetic practice of prescribing amino acid-based formulas in paediatrics patients without cow's milk allergy: a single centre retrospective study

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The dietetic practice of implementing amino acid-based formulas in infants and children without food allergies: A retrospective study within a paediatric tertiary centre

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The dietetic practice of prescribing amino acid-based formulas in paediatrics patients without cow's milk allergy: a single centre retrospective study

Abstract

Background & Aims: Although there is a comprehensive pathway for prescribing amino acid-based (elemental) formulas (AAF) in paediatric patients with cow's milk allergy (CMA), there is a paucity of evidence-based practice for prescribing AAFs in patients without CMA. Gastrointestinal symptoms are some complications that can occur in enteral tube-fed patients, to mitigate these symptoms an AAF may be prescribed. AAFs contain macronutrients that have been enzymatically hydrolysed, requiring minimal digestion and promoting optimal absorption. The primary aim of this retrospective study was to ascertain the dietetic practice of prescribing AAFs to enteral tube-fed paediatric patients without CMA. Secondary outcomes measured weight change at 1 month and 6 months after AAF was prescribed and the incidence of hypophosphatemia at 6 months. **Methods:** This is a single-centre, retrospective review of paediatric patients prescribed an AAF at a tertiary paediatric hospital between July 2023 and July 2024. Ethical approval was granted by ANONYMISED Audit, Quality Improvement and Service Evaluation Committee: registration number GOSH2024/3834. Inclusion criteria were patients aged between 0 and 16 years old who had been prescribed an AAF as part of their enteral nutrition, providing at least 80% of their estimated energy requirements for any condition other than allergic disease. Exclusion criteria were patients with confirmed immunoglobulin (Ig)E or non-IgE mediated CMA or multiple food allergies, eosinophilic gastrointestinal disease, and Food protein-induced enterocolitis syndrome. Data were collected on demographics, anthropometrics, feed regimens, gastrointestinal symptoms, proton pump inhibitor use and serum phosphate concentration **Results:** 203 children were prescribed an AAF during the data collection period, of these, 154 of 203 (76%) patients had no allergies. Patients with gastrointestinal symptoms were the most common reason for commencing an AAF, 76 of 154 (49%) patients. The median age of patients prescribed AAF was 5.5 (IQR 1.3-9.8) years old. Patients displaying upper or lower gastrointestinal symptoms were the most common reason dietitians prescribed an AAF, 76 of 154 (49%) patients. 44 of 154 (28%) patients prescribed an AAF had a neurological impairment as a primary diagnosis. Dietitians prescribed AAFs as a first-line formula to transition patients off parenteral nutrition in 26 of 154 (17%) patients. 23 of 154 (15%) patients were prescribed an AAF after developing mucositis post high-dose chemotherapy. AAF was also prescribed in patients post cardiac and gastrointestinal surgery, protein-losing enteropathy, and gastrointestinal dystonia. The mean weight-for-age Z-score significantly improved in patients prescribed AAF from -3.7 (1.6SD) at baseline to -2.5 (1.5SD) at 6 months (p-value 0.001). After 6 months of receiving an AAF, there was no increased probability of hypophosphatemia in patients prescribed proton pump inhibitors. (p-value 0.84). **Conclusions:** This single-centre retrospective study found that paediatric dietitians reserved the prescription of AAFs for patients with complex neurological and gastrointestinal conditions. The most common reason for dietitians to prescribe AAFs was to mitigate upper and lower gastrointestinal symptoms in patients already established on enteral formulas. This review found that medically complex patients receiving AAFs for 6 months achieved expected weight gain while under the supervision of a dietitian. Our study was unable to substantiate an increased probability of hypophosphatemia in patients prescribed proton pump inhibitors and an AAF. All paediatric patients with complex medical conditions who need long-term enteral nutritional support require close nutritional monitoring.

Keywords

Amino acid-based formula; enteral nutrition; gastrointestinal symptoms; neurological impairment; parenteral nutrition; proton pump inhibitor; hypophosphatemia

Highlights

- AAFs are reserved for the most medically complex paediatric patients
- Expected weight gain was achieved in patients who were on AAF for six months
- There was no increased probability of hypophosphatemia in patients on AAF for 6 months

1. Introduction

Amino acid-based (elemental) enteral formulas (AAFs) contain macronutrients that have been enzymatically hydrolysed, requiring minimal digestion. AAFs are usually lactose, gluten and fibre-free.[1] A consequence of the hydrolysed macronutrients is an increase in osmolality, the osmolality is inversely related to the molecular size of nutrients in solution the more extensive the protein is hydrolysed, the higher the osmolality of these formulas.[2] The osmolality of human milk is approximately 300 mOsm/kg^3 compared to 350-500 mOsm/kg^3 of AAFs.[3] AAF offers complete nutrition that provides all necessary macronutrients and micronutrients essential for normal growth. [4]

The main benefit of AAFs is their absence of residual allergenicity, making them a safe treatment option in infants with severe cow's milk allergy (CMA), who do not respond to a maternal dairy-free diet or an extensively hydrolysed formula. [5, 6] Around 5% of infants are highly sensitive to cow's milk protein and require an AAF.[7] Infants with the most severe CMA who require AAF are likely to remain on an AAF throughout early childhood, the continued use of a nutritionally complete AAF is recommended to support growth and development. [8] Although there is a comprehensive pathway for prescribing AAF for infants with CMA there is a paucity of evidence-based practice for implementing AAFs in paediatric patients without CMA. AAFs contain easily absorbable free amino acids and medium-chain triglycerides, which may be beneficial for patients with maldigestion and malabsorption.[9]

Gastrointestinal symptoms are some of the complications that can occur in enteral tube-fed patients. [10] Up to 85% of paediatric patients with severe neurological impairment have feeding disorders and require enteral tube feeding; gastrointestinal symptoms associated with neurological impairment include dysmotility and pain associated with feeding (feed-induced dystonia).[11] The Gastrointestinal and nutritional problems in neurologically impaired patients have been recognised as an integral part of their disease, often leading to growth failure and worsened quality of life for both patient and caregivers.[12] The enteric nervous system includes more nerve cells than the spinal cord, and therefore unsurprising, neurological impairment may affect the complex integrated capacities underlying feeding and nutrition. [13] A recent survey of clinicians and family caregivers identified feeding tolerance and formula selection as the top-ranked research priority for children with neurological impairment.[14]

In paediatric units, the standard practice may be to implement an AAF in the most severely medically compromised children, however, there is a gap in identifying all paediatric patients regardless of disease severity, who could benefit from an AAF in tube-fed patients.[15] The primary aim of this retrospective study was to ascertain the dietetic practice of prescribing AAFs to enteral tube-fed

paediatric patients without CMA. Secondary outcomes measured weight change at 1 month and 6 months after AAF was prescribed and the incidence of hypophosphatemia at 6 months.

2. Material and Methods

2.1. Study design and subjects

This single-centre, retrospective study of paediatric patients (infants, children and adolescents) prescribed an AAF (inpatient and outpatients) at our tertiary hospital between July 2023 and July 2024. Our review was registered with Great Ormond Street Hospital Audit, Quality Improvement and Service Evaluation Committee: registration number **2024/3834.** Consent was obtained from patients who remained under the care of Great Ormond Street Hospital; a waiver of consent was granted to patients lost to follow-up, as the anonymised data was deemed low-risk and did not include biological material. Inclusion criteria were paediatric patients aged between 0 and 16 years old receiving an AAF as part of their enteral nutrition, providing at least 80% of their estimated energy requirements for any condition other than allergic disease. Exclusion criteria were patients with confirmed immunoglobulin (Ig)E or non-IgE mediated CMA or multiple food allergies, eosinophilic gastrointestinal disease, and Food protein-induced enterocolitis syndrome.

2.2. Allergy confirmation

A confirmed CMA was diagnosed by a paediatric allergist and documented in our hospital's electronic patient medical records system (EPIC, Madison, WI, USA). A diagnosis of an Immunoglobulin (Ig)E-mediated food allergy was defined as an immediate reaction, which may affect multiple organ systems, typically up to 2 hours after cow's milk ingestion. A diagnosis of mild-to-moderate non-IgE-mediated cow's milk allergy was confirmed by following a cow's milk elimination trial and subsequent home reintroduction, with close monitoring of symptoms as outlined in the National Institute Clinical Excellence (NICE) guidelines. Oral food challenge is the gold standard for diagnosis of food allergy and is an accurate and sensitive test.[16]

2.3. Data Collection

Patients prescribed an AAF were identified by searching the hospital's Electronic Dietetic Manager 3000 system (Mead Johnson - Nutramigen Puramino; Nestle Health Science - SMA® Alfamino®, Alfamino® Junior; Nutricia - Elemental Extra 028, Neocate LCP, Neocate Junior, Neocate Syneo). Patients were then categorised as either allergy or non-allergy. Clinical and dietetic information was collected from the hospital's electronic patient records (EPIC). Data were collected at the time AAF was prescribed on demographics (age, sex and primary diagnosis), feed regimens, percentage (%) Total Energy Intake, feeding route and mode of feeding [continuous or bolus] and gastrointestinal symptoms (gastro-oesophageal reflux, vomiting, abdominal discomfort, constipation and loose stools). Proton pump inhibitor prescription data were extracted from EPIC electronic medical notes.

Anthropometric measurements (weight-for-age Z-score and height-for-age Z-score) were collected at the time AAF was prescribed and again 1 month and 6 months after AAF was prescribed. The nutrition status weight-for-age and height-for-age were assessed using Z-scores. [15] Moderate overweight and obesity were identified if the weight-for-age Z-score was between +2 and +3 or above +3 standard deviation (SD), respectively. Conversely, underweight was identified as moderate and severe underweight if the Z-scores were between -2 and -3 or below -3 (SD), respectively. [16]

Serum phosphate concentration data were extracted from EPIC laboratory, 6 months after AAF was prescribed. The normal serum phosphate level in children is between 0.9 – 1.2mmol/l (4.0 to 7.0

mg/dL),[17] hypophosphatemia was defined as one recorded episode of serum phosphate concentration below 0.8mmol/ l (3.5mg/dl)[18]

2.4. High-risk feeding protocol (local guidelines)

Some paediatric patients are at high risk for malnutrition and gut disease, and standardisation of feeding protocols has been shown to decrease some of this risk. [17,18[19]]. An inter-professional feeding task force developed our local high-risk feeding protocol that highlights perceived at-risk patients for developing serious gut disease. At our specialist hospital, if human milk is unavailable an AAF is used as a first-line formula for patients placed on a high-risk feeding protocol. High-risk patients include those prescribed prostaglandins or octreotide, post-cardiac surgery, and very low birth weight.

2.5. Statistical Analysis

Continuous data were tabulated using descriptive statistics – mean and standard deviation [SD] and median and interquartile range. A Chi-square test was used to compare count data between allergy and non-allergy groups with infant and follow-on AAF groups to their expected counts within each group; and between patients receiving proton pump inhibitors and patients not receiving proton pump inhibitors with hypophosphatemia. Comparative paired T-Test and analysis of variance (ANOVA) were used to compare the change in weight-for-age Z-score from baseline, 1 month and 6 months; a p-value <0.05 was deemed significant. Statistical analysis was performed with RStudio: R version 4.3.2 (2023-10-31)—the R Foundation for Statistical Computing.

3. Results

Over the one-year data collection period, 203 paediatric patients were prescribed an AAF. Of these, 154 of 203 (76%) patients did not have CMA and 49 of 203 (24%) patients had a confirmed CMA. Of the 154 patients prescribed AAF without CMA, 80 (52%) were female, the median age patients were prescribed an AAF was 5.5 years (IQR 1.3, 9.8) years old. The most common primary diagnosis for patients prescribed an AAF was neurological impairment in 44 of 154 (28%), followed by gastrointestinal disease in 35 of 154 (22%) children (Table 2). Almost 50% of patients on AAF were gastrostomy fed, compared to 51 of 154 (33%) fed via nasogastric tube and 36 of 154 (22%) received AAF into the jejunum. Most children were on a hydrolysed formula before an AAF was commenced, 64 of 154 (42%).

The median age of paediatric patients prescribed AAF for CMA was 3.2 years (0.8,6.2 IQR). The most common primary diagnosis for patients prescribed AAF was immunological, in 31 of 49 (63%) patients. Most patients prescribed AAF for CMA consumed the formula orally, 41 of 49 (83%). Most patients were on human milk before AAF was prescribed, 35 of 49 (71%) patients. The number of patients prescribed a proton pump inhibitor was similar for Non-CMA and CMA, 119 of 154 (78%) and 42 of 49 (85%), respectively.

Table 1. Demographic, clinical and feeding data for patients prescribed an amino acid-based formula (AAF) with and without cow's milk allergy.

	Non-CMA N=154	CMA N=49
Sex		
Female, n (%)	80 (52)	23 (46)
Male, n (%)	74 (48)	26 (54)
Median Age, years (IQR)	5.5 (1.3, 9.8)	3.2 (0.8,6.2)
Primary Diagnosis		
Neurological impairment, n (%)	44 (28)	0
Gastrointestinal disease/ surgery, n (%)	35 (22)	10 (20)
Prematurity, n (%)	21 (13)	0
Cancer, n (%)	20 (13)	0
Cardiac, n (%)	11 (7)	0
Neuromuscular - spinal muscular atrophy, n (%)	10 (6)	0
Congenial Hyperinsulinemia, n (%)	7 (4)	2 (4)
Metabolic (galactosaemia), n (%)	4 (3)	0
Dermatology/ Epidermolysis bullosa, n (%)	2 (1)	7(14)
Immunology/ Allergy	0	31 (63)
Feeding Route AAF delivered		
Gastrostomy, n (%)	67 (43)	2 (4)
Gastrostomy with jejunal extension, n (%)	15 (10)	1 (2)
Nasogastric tube, n (%)	51 (33)	5 (10)
Nasojejunal tube, n (%)	21 (14)	
Oral	0	41 (83)
Feeding Method		
Continuous, n (%)	122 (79)	4 (8)
Bolus, n (%)	32 (21)	45 (92)
Percentage of Total Energy Intake from AAF, % (SD)	84 (11)	73 (13)
Feed/ formula before AAF		
Human Milk, n (%)	33 (21)	35 (71)
Infant Formula milk, n (%)	12 (7)	0
Whole protein/ Polymeric, n (%)	14 (9)	1 (2)
Extensively hydrolysed, n (%)	30 (19)	9 (18)
Partially hydrolysed, n (%)	34 (22)	4 (8)
Parenteral Nutrition, n (%)	26 (13)	0
Patients prescribed proton pump inhibitor when AAF commenced, n (%)	119 (78)	42 (85)

CMA: Cow's Milk Allergy; IQR: Interquartile range; SD: standard deviation

The most frequently prescribed AAF was Neocate Junior followed by Neocate LCP, 85 (42%), and 67 of 203 (33%), respectively (Table 1). During the data collection period, 15 patients transitioned from an infant AAF to a follow-on AAF. There was a significant difference in count data between patients with and without CMA: chi-square 8.28 (p-value 0.003) (Table 2).

Table 2. Variety and number of patients prescribed an amino acid formula by dietitians with and without cow's milk allergy.

	Cow's Milk Allergy N=49	Non-Allergy N=154	Total N=203	p-value
Infant Amino Acid Formula				
SMA Alfamino, n (%)	6	20	26	
Neocate LCP, n (%)	9	49	58	
Neocate Syneo, n (%)	0	6	6	
Nutramigen Puramino, n (%)	0	8	8	
Total	15	83		
Follow- On Amino Acid Formula				
Neocate Junior, n (%)	25	60	85	
Elemental 028 Extra, n (%)	5	5	10	
Alfamino Junior, n (%)	4	6	10	
Total	34	71		0.003[a]*

[a]Chi square analysis; *statistically significant

Patients displaying upper or lower gastrointestinal symptoms were the most common reason dietitians prescribed an AAF, in 76 of 154 (49%) patients (Table 3). An AAF was prescribed as the first-line formula to transition medically complex patients off parenteral nutrition, in 26 of 154 (17%) patients. AAF was prescribed in 23 of 154 (15%) patients who had developed mucositis post high-dose chemotherapy. AAFs were also prescribed in patients post gastrointestinal surgery, protein-losing enteropathy and gastrointestinal dystonia (Table 3).

Table 3. The primary reason the dietitian implemented an amino acid formula.

The primary reason for starting AA	N (%)
Upper GI symptom (reflux/vomiting)	40 (26)
Lower GI symptom (constipation/diarrhoea)	36 (23)
Weaning off Parenteral Nutrition	26 (17)
Mucositis post high-dose chemotherapy	23 (15)
Post Gastrointestinal Surgery	19 (12)
'High-Risk Feeding' protocol	6 (9)
Protein-losing enteropathy	2 (1)

Gastrointestinal Dystonia	2 (1)

Patients prescribed an AAF by the dietitians were severely underweight, with a mean weight-for-age Z-score of -3.7 (1.6SD) and a mean height-for-age Z-score of -2.3 (1.5SD). Patients who continued with an AAF gained significant weight over 6 months (n=62), mean weight-for-age Z-score -2.5 (1.5SD) (Table 4).

Data were available for 62 patients who had been prescribed AAF for 6 months, date for the other 92 patients were not available due to:

- 12 patients were transitioned to a blended diet for enteral tube feeding.
- 15 patients were transitioned to a commercial whole protein Food Based Formula (14% food-derived ingredients from rehydrated food – [Nestle Health Science - Compleat paediatric])
- 11 patients weaned on to solid food no longer requiring enteral nutrition.
- 54 patients were transferred to the local care team and unable to follow up.

Table 4. Anthropometric change of patients prescribed an amino acid-based formula over the data collection period.

	Baseline N=154	1 month N=139	6 months N=62	p-value
Weight for age Z-score (SD)	-3.7(1.6)	-3.2 (1.5)	-2.5 (1.5)	0.001[a]*
Height for age Z-score (SD)	-2.3 (1.5)		-2.0 (1.4)	0.09

[a] Analysis of Variance – paired data; * statistically significant

After 6 months of patients receiving an AAF, serum phosphate concentration was available for 62 of the 154 (40%) patients, there was no increased probability of hypophosphatemia for these patients who were prescribed proton pump inhibitors: Chi-square test = 0.042; p-value = 0.84 (Table 5).

Table 5. Probability of hypophosphatemia in patients prescribed an amino acid-based formula for 6 months (n=62) and proton pump inhibitor.

	Proton Pump Inhibitor	No Proton Pump Inhibitor	*Row Totals*	*p-value*
Hypophosphatemia	3 (3.16) [0.01]	1 (0.84) [0.03]	4	
No Hypophosphatemia	46 (45.84) [0.00]	12 (12.16) [0.00]	58	
Column Totals	49	13	62	0.84[a]

[a]Chi-square test

4. Discussion

There is a paucity of evidence-based practice for paediatric patients prescribed AAFs without CMA.[15] This single-centre retrospective study found dietitians regularly prescribed AAFs in paediatric patients with a neurological impairment. Dietitians reserved the prescription of AAF for the most medically complex patients who had upper and lower gastrointestinal symptoms. Furthermore, our study found that some patients with complex gastrointestinal symptoms who required parenteral nutrition were prescribed an AAF to transition off parenteral nutrition. Our study did not find an increased probability of developing hypophosphatemia in patients who had been receiving an AAF and proton pump inhibitors for 6 months.

Our review aligns with findings from a national survey that monitored the use of AAF beyond CMA, stating that, AAFs are commonly used in a range of children with complex medical conditions, most of whom are receiving feeds via the enteral route. The authors reported the primary aim for implementing an AAF was to improve feed tolerance, stating this was standard practice for many dietitians.[20] The mechanisms by which AAF improves feeding intolerance remain unclear, especially when you consider a consequence of its elemental composition increases its osmolality, which can exacerbate gastrointestinal diseases.[20] AAF may promote gastric emptying due to the nitrogen content of AAF typically consists of free amino acids and the lipid content consists of medium-chain triglycerides, which passively diffuse into the portal system, with or without additional long-chain triglycerides; additionally, the carbohydrate content of AAF consists of monosaccharides (dextrose, glucose, or maltose) or easily digestible saccharide polymers, such as maltodextrins. [4] To avoid reducing the beneficial absorptive properties of AAFs it is essential not to concentrate the formula over an osmolality of 450 mOsm kg(-1).[21]

Considering these unique properties of AAFs, it is unsurprising they are the preferred choice to wean patients off parenteral nutrition, parenteral nutrition is crucial to treat patients who cannot be fully fed by oral or enteral route.[22] AAFs have been reported to decrease the duration of parenteral nutrition and reduce the risk of nosocomial infections and parenteral nutrition-associated complications. [23] Although this may be standard practice in some centres, there is limited evidence to support this practice. In contrast, studies have reported the implementation of a standard whole protein (polymeric) enteral formula, harnessing progressive increments of enteral volume in parallel with a gradual reduction of parenteral nutrition, advancing to full calories, and administering enteral feed continuously as opposed to boluses. [24, 25]

Our retrospective study found that patients prescribed AAF were significantly underweight. However, significant weight gain was recorded in patients who continued an AAF for 6 months. Similar findings were reported in a multi-centre study, infants were randomised to receive either an extensively hydrolysed infant formula at (2.8 g protein/100 kcal) (Control) or one of two investigational formulas: extensively hydrolysed casein formula at (2.4 g protein/100 kcal (EHF)) or AAF at 2.4 g total protein equivalents/100 kcal.[26] The new AAF ensured normal growth in subjects affected by IgE-mediated CMA. The authors concluded that this AAF constitutes a suitable safe option for the management of infants affected by CMA.[27] In another multicentre randomised control trial that compared the growth (daily weight gain) of infants consuming a new AAF or a commercially available AAF. A total of 119 subjects completed the study, the mean daily weight gains were 27.26 ± 4.92 g/day for the Control group and 27.42 ± 6.37 g/day for new AAF (P = 0.8812). There were no significant differences in weight change or formula intake between groups. [28] Another study demonstrated AAF hypoallergenic infant formulas at 2.4 g protein/100 kcal were safe, well-tolerated, and associated with appropriate growth in healthy-term infants from 14 to 120 days of age. [29] We were unable to find large studies that had growth data on paediatric patients prescribed AAF for non-allergy reasons, apart from Crohn's disease,

which no longer endorses the need for AAF. This further emphasises the paucity of evidence in this area. [30]

Our study reports that AAFs were commonly prescribed in patients with a neurological impairment. The combined terms 'neuro-gastroenterology and motility' have been coined to encompass components of the enteric neuro-musculature and their modulating influences, representing one of the fastest-growing areas in gastroenterology clinical practice and research. [12] Our results align with a descriptive study of children that reported an association between the prescription of an AAF and benefits with severe feeding difficulties and shortfalls in growth and development with a wide range of complex medical conditions. [15] In neurologically impaired children who are unresponsive to conventional anti-reflux treatments (proton pump inhibitors), an AAF may bring an immediate and sustained improvement in long-standing gastrointestinal symptoms and esophagitis.[31] Proton pump inhibitors (PPIs) are common medications within the practice of gastroenterology. These drugs, which act through the irreversible inhibition of the hydrogen/potassium pump (H+/K+-ATPase pump) in the gastric parietal cells, are used in the treatment of several acid-related disorders.[31] However, the ubiquitous use of PPIs in patients with neurological impairment for the management of gastroesophageal reflux disease and associated feeding intolerance has been associated with decreased intestinal absorption of phosphate. [32]

Generally, proton pump inhibitors are well tolerated, our study did not report any abnormal phosphate levels in patients who had been receiving an AAF for 6 months. [33] Clinicians should be aware of the potential association with hypophosphatemia and bone disease in children on long-term proton pump inhibitors and AAFs, particularly those with medically complex conditions receiving formula as their sole source of nutrition. Although findings implicate that the hypophosphatemia resulted from reduced mineral bioavailability from the formula, an underlying mechanism remains unclear. [32] Another study reported a significantly higher prevalence of hypophosphatemia among infants with congenital heart disease after the introduction of AAFs. Lower phosphate levels were associated with lower weight-for-age Z scores. [34] Although AAFs have been associated with hypophosphatemia, there is no data to suggest a causal link. All patients with complex medical conditions who need long-term enteral nutritional support require close nutritional monitoring no matter the type of formula.

Furthermore, the long-term reduction of gastric acid secretion from the action of PPIs can increase the risk of an imbalance in gut microbiota composition by reducing the gut pH.[35] The evidence indicates that PPIs which are widely used in gastroenterology clinical practice likely through their acid-antisecretory effects, can modify the host microbiota in each segment of the gastrointestinal tract and can contribute to dysbiosis development; this dysbiosis can, in turn, facilitate the onset of certain gastrointestinal disorders.[36] Of note, proton pump inhibitors are ineffective in reducing the symptoms related to gastroesophageal reflux disease in infants but are effective in older children, where histological remission can be seen. [29]

An interesting and promising development in paediatric dietetic practice has been the increased use of blended diets in enterally-fed children with complex neuro-gastrointestinal symptoms. In our study, 27 of 154 (18%) patients transferred from an AAF to either a blended diet or Food Based Formula. An increasing amount of evidence has reported that patients on blended tube feeds/Food-based Formulas have improved tolerance of their feed with a reported decrease in reflux, constipation, and diarrhoea. [32-34] The Dietitians Interested in Special Children (DISC) professional group has estimated that up to 20% of its members' paediatric home enteral feeding caseload receive some form of blended diet. [34] Many caregivers desire a blended tube feed instead of commercial formula for their child, stating a blended diet is more physiologically normal, reflecting familiar family foods, and ultimately improving gastrointestinal symptoms.[36] A blended diet may provide a solution for some children

gastrostomy fed who display gastrointestinal symptoms on standard enteral formulas.[37] Enteral formula selection can be challenging and is not always guided by clinical evidence or clinical practicality. It is important to carefully evaluate the most appropriate enteral formula in conjunction with the available supporting clinical evidence. Until clinical evidence guides us otherwise, a whole protein standard formula should be the product of choice for the majority of patients requiring enteral feeding.[38]

4.1. Limitations

Retrospective studies have several limitations owing to their design, which are dependent on the review of records and documentation and therefore the results are ungeneralisable rather than stating causation. The primary aim of this study was to ascertain why dietitians prescribe AAF in paediatric patients without CMA, we can only allude to a potential association that AAFs are prescribed in the most medically complex paediatric patients with neurological and gastrointestinal conditions. Similarly, due to the number of patients lost to follow-up at 6 months, we were unable to capture data for 92 of the 154 patients and therefore, we can only infer that patients who were prescribed an AAF for 6 months achieved expected weight gain and that there was not an increased probability of hypophosphatemia and PPI. A strength of this study is its reasonable sample size from a single-centre study, and that data was collected from several dietitians from numerous different specialities within a tertiary paediatric hospital.

5. Conclusions

This single-centre retrospective review found that paediatric dietitians reserved the prescription of AAFs for patients with complex neurological and gastrointestinal conditions. The most common reason for dietitians to prescribe AAFs was to mitigate upper and lower gastrointestinal symptoms in patients already established on enteral formulas. Our review found that AAFs were used to transition patients off parenteral nutrition, and patients with chemotherapy-related mucositis. This review found that weight-for-age Z score significantly increased in medically complex patients who had been receiving AAFs for 6 months. Our study was unable to substantiate a relationship between hypophosphatemia, proton pump inhibitors and AAFs. All paediatric patients with complex medical conditions who need long-term enteral nutritional support require close nutritional monitoring.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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