



Role of Enteral Feeding Pumps in Precision Enteral Nutrition

Fatemeh Babaie ¹ and Zahra Ghasemi ^{1,*}

¹Department of Pharmacoconomics and Pharma Management, School of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran

*Corresponding author: Department of Pharmacoconomics and Pharma Management, School of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
Email: matinaghasemi@gmail.com

Received 2022 November 21; Accepted 2022 December 12.

Abstract

Initiating early nutritional feeding in hospitalized patients will decline patients' complications, shorten hospital length of stay and costs, and improve health outcomes. Over the years, with the emergence of the enteral feeding pumps, the process of enteral feeding has become easier with higher accuracy and safety. Enteral feeding pumps provide the ability to combine methods like continuous feeding during the overnight and bolus feeding during the day to make the feeding process more adaptable to patients' status. Nowadays, prescriber's knowledge regarding individualized nutrition for each patient according to their specific needs has been increased, and enteral feeding had shifted to home care settings. The need for precision enteral nutrition programs according to differences in human phenotype, genotype, food preferences, and health status becomes more apparent. Personalized nutrition programs can reduce the prevalence and risk of disease-related malnutrition and improve patients' quality of life in home care settings. In this way, feeding pumps facilitate the personalized feeding process by making it unique and improved.

Keywords: Enteral Feeding Pumps, Enteral Nutrition, Precision Enteral Nutrition, Personalized Nutrition

1. Context

Malnutrition is considered a common health problem in hospitals and health care settings, among patients suffering from chronic diseases and cancers, critically ill patients, Traumatic Brain-Injured (TBI) patients with dysphagia, and so forth (1, 2). From a global point of view, malnutrition affects approximately 30 - 50% of hospitalized patients, and it is generally estimated to be 31% during hospital admission and 36% in pre-discharged patients (3, 4). Around 33 million patients suffered from malnutrition in Europe, and governmental spending cost up to €170 billion in 2011 (5).

At this point, it seems rational to initiate nutritional feeding in patients who will benefit the most, especially with higher hospital length of stay, whether through Enteral nutrition (EN) or parenteral nutrition forthwith. In addition, the exact time of starting nutrition and estimating needed energy intake will be decisive criteria. If this handling happens properly, they can significantly decline patients' complications, shorten the length of hospital stay and costs, and improve health outcomes (3, 6, 7).

2. Evidence Acquisition

The enteral pathway is a direct way of feeding through the gastrointestinal (GI) tract when a patient is unable to

receive food orally. Enteral nutrition has defined as the delivery of food, nutrition, or liquid formulations via a tube, catheter, or stoma to the stomach, duodenal, or jejunum, which would improve the patient's quality of life (QoL) (8, 9). There are four common methods for EN: "Bolus feeding," which is used 4 - 6 times per day and lasts for 5 - 10 minutes via syringe or gravity drip. "Intermittent feeding" with or without a feeding pump for 4 - 6 times per day over 20 - 60 minutes, "cyclical feeding" by an enteral feeding pump for overnight or daytime, and "continuous feeding" with an enteral feeding pump over 24 hours (10, 11). Choosing the most appropriate method highly depends on the patient's medical condition, tolerance, and mobility, relative risks to benefits, feeding tube location, availability of enteral feeding pump, cost, and type of needed nutrition (11). As the European Society for Clinical Nutrition and Metabolism (ESPEN) has suggested, EN for chronic disease is considered a medical treatment, and standard of care for nutrition support in which the nutrition team will do its management, whether in hospitals or home care settings (12, 13).

Over the years, with the emergence of the enteral feeding pumps, which enabled the medical team to program patients' feeding in continuous, intermittent, or cyclical feeding types, many changes occurred in the feeding methods of patients. It obtains many benefits, such as the reduc-

tion of GI discomforts, reduction of complications related to syringe feeding, increase in feed tolerance, and enhancement of feeding accuracy (12, 14). When a small amount of feeding is preferred for frequent times, even overnight, or high caloric feeds are needed, enteral feeding pumps are the best choice, and they have less patient overnight disturbance due to their planned continuous or interval feeding programs (12). Feeding pumps deliver a steady and adjusted feeding flow rate, which is ideal for maintaining gut integrity in critically ill patients and suitable for patients with duodenal or jejunal feeding (15).

To compare the advantages and disadvantages of syringe Vs. pump feedings, only bolus Vs. continuous feeding is compared together in Table 1. It is noteworthy that some of the disadvantages mentioned for pumps have been eliminated over time, including patient's mobility, by designing a backpack to place the pump, feeding supply, and necessary accessories, or using a pole clamp for the feeding pump to attach it to a patient wheelchair (12).

Economic evaluation studies are more focused on using enteral tube feeding outcomes rather than feeding pumps (5, 18), only a cost analysis study which was about comparing open and closed feeding systems, highlighted that the closed delivery systems have reduced nursing time and increased their satisfaction (19). This will be more worthwhile in hospital and intensive care units with limited nurses' time or in-home care settings where the nursing costs will be significant.

Enteral feedings have been undertaken in-home care settings as developments happened in supported services. Therefore, the charge for equipment and feed has shifted from hospitals to other settings and from hospital nurses to patients' relatives and community nurses (14).

A dominant primary indication of home enteral nutrition (HEN) is for neurological patients and patients with cancers (20). More than that, HEN is considered a preferable and safe option for patients with chronic conditions with malnutrition risk, multiple sclerosis patients, elders and children with nutritional problems, and conditions with dysphagia including Parkinson's, TBI, stroke, or dementia (21-23). Dysphagia occurs in 61% of TBI patients with a high risk of malnutrition, which leads to protein and energy deficits (2, 24). At this point, starting early nutrition to support these patients, until dysphagia rehabilitation or improving the level of awareness is considered crucial (2).

Home enteral nutrition improves patients' clinical outcomes and QoL and has shown a decrease in healthcare costs (25, 26). Although the actual prevalence of HEN is unclear, it has been reported in the UK at a growing rate of 42.78% for ten years. It is expected due to advances in technology, the prevalence of using enteral feeding pumps

will be increased. So, it seems valuable to inform manufacturers to begin training and expanding their scale of business to provide HEN equipment such as pumps and feeding tubes (14, 23, 27).

Challenges exist in HEN feedings since there are some gaps and question marks between nutrition recommendations and care standards between health care workers or home care providers (27). Most nutrition recommendations have been categorized based on gender and age, but still, there are some differences in absorption, metabolism, and nutritional requirements raised from different human genomes that emerged in the need for personalized nutrition (PN) programs (28-30). It is believed a wide range of commercial enteral formulas available for HEN makes it possible to treat personal nutrition and achieve the desired goal of receiving the energy and protein needed because of their predictable nutrient levels and suitable physical properties (31).

Individualized nutrition approaches according to personalized phenotype, genotype, food preferences, and health status can reduce the prevalence and risk of disease-related malnutrition and improve patients' QoL even in in-home care settings (28, 32). On the other hand, the intuitive operation of enteral feeding pumps, their anti-free-flow protection, automatic priming, adjustable rate, and volume according to the patient's condition, and alarm conditions during any blockage, have enabled their handling more convenient for patients' home caregivers and made them easier to prescribe PN with commercial or homemade nutrition. Also, using their combination methods with the ability to plan for continuous feeding at night and interval feedings during the day make them more adaptable to patients' life (12, 15).

3. Conclusions

As mentioned, initial and early nutrition support will decrease morbidity and mortality in a different range from critically ill to neurosurgery patients. In addition, feeding pumps facilitate the feeding process by making it unique and improved. On the other hand, according to pump specifications and their leading role in HEN, it is suggested to consider the reimbursement of pumps, and other enteral products to provide and facilitate HEN for a range of patients (12).

Table 1. Enteral Feeding with Feeding Pump Vs. Syringe or Gravity Drip

Syringe or Gravity Drip for Bolus Feeding		Feeding Pump for Continuous Feeding	
Advantages	Disadvantages	Advantages	Disadvantages
Easy administration and inexpensive (11, 16); Limits feeding time (11, 16); Patient is free to move (11, 16); Closely resembles normal eating patterns (More physiological) (11, 16); More muscle protein synthesis and GI hormone secretion (11, 16)	Increased risk of aspiration (11, 16); Hypertonic, highfat, or highfiber formulas may delay gastric emptying Limits or result in osmotic diarrhea (11, 16); Needs for intensive nursing observation (17)	High accuracy and safety (15); May improve tolerance (11, 16); Reduce the risk of aspiration, especially in gastroparesis patients (11, 15, 16); Continuous feeding decreases the gastrointestinal tract secretions (17); Increased time for nutrient absorption (11, 16); Less needed nursing staff (10); Wide choice of enteral feeds (10); Adjusted flow and volume rate (12); Feeding in small volumes for different periods (12); Combination of methods, e.g. overnight continuous feeding and bolus feeding during the day (12)	More expensive (11, 16); May restrict mobility (11, 16)

Footnotes

Authors' Contribution: All authors contributed equally to this article.

Conflict of Interests: The authors have no conflict of interest.

Funding/Support: The funder of this article is Darman Ara Company (P.J.S).

References

- Inciong JFB, Chaudhary A, Hsu HS, Joshi R, Seo JM, Trung LV, et al. Hospital malnutrition in northeast and southeast Asia: A systematic literature review. *Clin Nutr ESPEN*. 2020;39:30–45. [PubMed ID: 32859327]. <https://doi.org/10.1016/j.clnesp.2020.06.001>.
- Cook AM, Peppard A, Magnuson B. Nutrition considerations in traumatic brain injury. *Nutr Clin Pract*. 2008;23(6):608–20. [PubMed ID: 19033220]. <https://doi.org/10.1177/0884533608326060>.
- van Vliet IMY, Gomes-Neto AW, de Jong MFC, Jager-Wittenaar H, Navis GJ. High prevalence of malnutrition both on hospital admission and predischarge. *Nutrition*. 2020;77:110814. [PubMed ID: 32442829]. <https://doi.org/10.1016/j.nut.2020.110814>.
- Sauer AC, Goates S, Malone A, Mogensen KM, Gewirtz G, Sulz I, et al. Prevalence of Malnutrition Risk and the Impact of Nutrition Risk on Hospital Outcomes: Results From nutritionDay in the U.S. *JPEN J Parenter Enteral Nutr*. 2019;43(7):918–26. [PubMed ID: 30666659]. <https://doi.org/10.1002/jpen.1499>.
- Freijer K, Bours MJ, Nuijten MJ, Poley MJ, Meijers JM, Halfens RJ, et al. The economic value of enteral medical nutrition in the management of disease-related malnutrition: a systematic review. *J Am Med Dir Assoc*. 2014;15(1):17–29. [PubMed ID: 24239013]. <https://doi.org/10.1016/j.jamda.2013.09.005>.
- Gostynska A, Stawny M, Dettlaff K, Jelinska A. Clinical Nutrition of Critically Ill Patients in the Context of the Latest ESPEN Guidelines. *Medicina (Kaunas)*. 2019;55(12). [PubMed ID: 31810303]. [PubMed Central ID: PMC6955661]. <https://doi.org/10.3390/medicina55120770>.
- Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr*. 2003;22(3):235–9. [PubMed ID: 12765661]. [https://doi.org/10.1016/s0261-5614\(02\)00215-7](https://doi.org/10.1016/s0261-5614(02)00215-7).
- Harkness L. The history of enteral nutrition therapy: from raw eggs and nasal tubes to purified amino acids and early postoperative jejunal delivery. *J Am Diet Assoc*. 2002;102(3):399–404. [PubMed ID: 11902373]. [https://doi.org/10.1016/s0002-8223\(02\)90092-1](https://doi.org/10.1016/s0002-8223(02)90092-1).
- Ojo O, Keaveney E, Wang XH, Feng P. The Effect of Enteral Tube Feeding on Patients' Health-Related Quality of Life: A Systematic Review. *Nutrients*. 2019;11(5):1–16. [PubMed ID: 31083338]. [PubMed Central ID: PMC6566785]. <https://doi.org/10.3390/nu11051046>.
- Bear DE, Hart N, Puthuchery Z. Continuous or intermittent feeding: pros and cons. *Curr Opin Crit Care*. 2018;24(4):256–61. [PubMed ID: 29877877]. <https://doi.org/10.1097/MCC.0000000000000513>.
- Ichimaru S, Amagai T. Intermittent and Bolus Methods of Feeding in Critical Care. *Diet Nutr Crit Care*. 2014;1:1–17. https://doi.org/10.1007/978-1-4614-8503-2_139-1.
- Bischoff SC, Austin P, Boeykens K, Chourdakis M, Cuerda C, Jonkers-Schuitema C, et al. ESPEN guideline on home enteral nutrition. *Clin Nutr*. 2020;39(1):5–22. [PubMed ID: 31253350]. <https://doi.org/10.1016/j.clnu.2019.04.022>.
- Kozeniecki M, Fritzsche R. Enteral Nutrition for Adults in the Hospital Setting. *Nutr Clin Pract*. 2015;30(5):634–51. [PubMed ID: 26203073]. <https://doi.org/10.1177/0884533615594012>.
- Liley AJ, Manthorpe J. The impact of home enteral tube feeding in everyday life: a qualitative study. *Health Soc Care Community*. 2003;11(5):415–22. [PubMed ID: 14498838]. <https://doi.org/10.1046/j.1365-2524.2003.00444.x>.
- White H, King L. Enteral feeding pumps: efficacy, safety, and patient acceptability. *Med Devices (Auckl)*. 2014;7:291–8. [PubMed ID: 25170284]. [PubMed Central ID: PMC4146327]. <https://doi.org/10.2147/MDER.S50050>.
- Ichimaru S. Methods of Enteral Nutrition Administration in Critically Ill Patients: Continuous, Cyclic, Intermittent, and Bolus Feeding. *Nutr Clin Pract*. 2018;33(6):790–5. [PubMed ID: 29924423]. <https://doi.org/10.1002/ncp.10105>.
- Delsgoglio M, Pichard C, Singer P. How to choose the best route of feeding during critical illness. *Clin Nutr ESPEN*. 2020;37:247–54. [PubMed ID: 32359752]. <https://doi.org/10.1016/j.clnesp.2020.03.019>.
- Elia M, Stratton RJ. A cost-utility analysis in patients receiving enteral tube feeding at home and in nursing homes. *Clin Nutr*. 2008;27(3):416–23. [PubMed ID: 18417257]. <https://doi.org/10.1016/j.clnu.2008.02.004>.
- Phillips W, Roman B, Glassman K. Economic impact of switching from an open to a closed enteral nutrition feeding system in an acute care setting. *Nutr Clin Pract*. 2013;28(4):510–4. [PubMed ID: 23736686]. <https://doi.org/10.1177/0884533613489712>.
- Folwarski M, Klek S, Zoubek-Wojcik A, Szafranski W, Bartoszewska L, Figula K, et al. Home Enteral Nutrition in Adults-Nationwide Multicenter Survey. *Nutrients*. 2020;12(7):1–9. [PubMed ID: 32674453]. [PubMed Central ID: PMC7400937]. <https://doi.org/10.3390/nu12072087>.
- Alsaeed D, Furniss D, Blandford A, Smith F, Orlu M. Carers' experiences of home enteral feeding: A survey exploring medicines administration challenges and strategies. *J Clin Pharm Ther*. 2018;43(3):359–65. [PubMed ID: 29351363]. [PubMed Central ID: PMC6849733]. <https://doi.org/10.1111/jcpt.12664>.
- Cawsey SI, Soo J, Gramlich LM. Home enteral nutrition: outcomes relative to indication. *Nutr Clin Pract*. 2010;25(3):296–300. [PubMed ID: 20581325]. <https://doi.org/10.1177/0884533610368702>.
- Ojo O. The challenges of home enteral tube feeding: a global perspective. *Nutrients*. 2015;7(4):2524–38. [PubMed ID: 25856223]. [PubMed Central ID: PMC4425159]. <https://doi.org/10.3390/nu7042524>.

24. Chapple LS, Deane AM, Heyland DK, Lange K, Kranz AJ, Williams LT, et al. Energy and protein deficits throughout hospitalization in patients admitted with a traumatic brain injury. *Clin Nutr*. 2016;**35**(6):1315–22. [PubMed ID: 26949198]. <https://doi.org/10.1016/j.clnu.2016.02.009>.
25. Boland K, Maher N, O'Hanlon C, O'Sullivan M, Rice N, Smyth M, et al. Home enteral nutrition recipients: patient perspectives on training, complications and satisfaction. *Frontline Gastroenterol*. 2017;**8**(1):79–84. [PubMed ID: 28133532]. [PubMed Central ID: PMC5256397]. <https://doi.org/10.1136/flgastro-2016-100736>.
26. Klek S, Hermanowicz A, Dziwiszek G, Matysiak K, Szczepanek K, Szybinski P, et al. Home enteral nutrition reduces complications, length of stay, and health care costs: results from a multicenter study. *Am J Clin Nutr*. 2014;**100**(2):609–15. [PubMed ID: 24965306]. <https://doi.org/10.3945/ajcn.113.082842>.
27. Martin K, Gardner G. Home Enteral Nutrition: Updates, Trends, and Challenges. *Nutr Clin Pract*. 2017;**32**(6):712–21. [PubMed ID: 28437132]. <https://doi.org/10.1177/0884533617701401>.
28. Kohlmeier M, De Caterina R, Ferguson LR, Gorman U, Allayee H, Prasad C, et al. Guide and Position of the International Society of Nutrigenetics/Nutrigenomics on Personalized Nutrition: Part 2 - Ethics, Challenges and Endeavors of Precision Nutrition. *J Nutrigenet Nutrigenomics*. 2016;**9**(1):12–27. [PubMed ID: 27286972]. <https://doi.org/10.1159/000446347>.
29. Hesketh J. Personalised nutrition: how far has nutrigenomics progressed? *Eur J Clin Nutr*. 2013;**67**(5):430–5. [PubMed ID: 23093344]. <https://doi.org/10.1038/ejcn.2012.145>.
30. de Roos B. Personalised nutrition: ready for practice? *Proc Nutr Soc*. 2013;**72**(1):48–52. [PubMed ID: 23199675]. <https://doi.org/10.1017/S0029665112002844>.
31. Klek S, Szybinski P, Sierzeaga M, Szczepanek K, Sumlet M, Kupiec M, et al. Commercial enteral formulas and nutrition support teams improve the outcome of home enteral tube feeding. *JPEN J Parenter Enteral Nutr*. 2011;**35**(3):380–5. [PubMed ID: 21527600]. <https://doi.org/10.1177/0148607110378860>.
32. Dorner B, Friedrich EK. Position of the Academy of Nutrition and Dietetics: Individualized Nutrition Approaches for Older Adults: Long-Term Care, Post-Acute Care, and Other Settings. *J Acad Nutr Diet*. 2018;**118**(4):724–35. [PubMed ID: 29576092]. <https://doi.org/10.1016/j.jand.2018.01.022>.