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Transition to Ready to Hang Enteral Feeding System: One Institution's Experience

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Healthcare costs in the United States are soaring. Efforts to improve patient care, safety, and outcomes are ongoing goals particularly when they also result in a reduction in the cost of care. Enteral feeding is the primary means of providing nutrition support to patients who cannot meet their needs orally; nursing time and supply costs to administer that care are substantial. One major academic medical center recently converted from an open system (OS) to a closed, or "ready to hang" (RTH) system for enteral feeding. This article reviews that transition from an OS to RTH and documents the costs, nursing perceptions, and lessons learned in the process.

INTRODUCTION

Healthcare costs in the United States are the highest in the world[1] and have become a major concern in recent years. At the same time, undiagnosed and untreated malnutrition in the hospital setting is an often undetected contributor to the growing cost of medical care in this country, as it can lead to further health complications and increased length of stay.[1] Thus, efforts to advance nutrition care should be emphasized as a means to improve patient outcomes and decrease the cost of healthcare. Nutrition care practices and protocols should be reevaluated routinely to ensure that resources are used effectively and efficiently.

Enteral feeding is the primary means of providing nutrition support to patients who cannot meet their needs orally. Enteral nutrition (EN) is a cost-effective way of delivering nutrition support,[2] has inherent benefits to the gastrointestinal (GI) tract, and is the standard of nutrition care over parenteral nutrition.[3] Thus, anything that can be done to improve the efficiency, safety, and delivery of EN is a worthwhile goal.

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Open Vs. Ready to Hang System

EN delivery is available in two main systems: an open system (OS) or a "ready to hang" system (RTH), also sometimes called a "closed system." Using an OS, formula from cans or bottles is "bolused" into a feeding tube with a syringe, or poured into a feeding bag, then administered via a feeding tube into the stomach or intestine using a feeding pump or gravity drip. RTH comes in a sterile, pre-filled formula container (typically 1 liter) that is spiked by the feeding tube, and then fed to the patient via a feeding pump.[4] Boluses can also be delivered using RTH by setting the feeding pump to deliver boluses at predetermined times. Both systems have advantages and disadvantages in several areas, including cost, ease of use, and nursing time required.

COST

Factors to consider when evaluating the cost difference between an OS and RTH include actual cost of the formula and tubing, nursing labor, transportation to hospital units, storage, and waste.

OS has been used for many years to deliver EN to patients. Based on current pricing contracts between the Medical Center and formula companies, OS costs less compared to the same volume of a RTH formula.[4,5] OS is also convenient when a small volume of formula is needed, as is the case with bolus feeding or in the pediatric population,[4] yet it can lead to increased labor and equipment cost.[4-8] According to nursing procedures at some facilities, including the hospital in question, only the amount of formula that will be infused within 4 hours (although in the real world, we know how hard this is to achieve) is to be hung at one time in an OS. So nurses must refill feeding bags frequently, up to 6 times per day.[9] The tedious protocol (see Table 1) may also occasionally lead to missed EN if the nurse is unable to refill the bag in a timely manner when it runs out. Additionally, OS requires more handling than the RTH prior to administration, potentially increasing the risk of bacterial contamination.[4-8,10-13] Proper prevention methods to decrease the chance of bacterial contamination in the OS increase nursing time.[7] The additional time used to ensure an OS system is safe could be spent conducting other nursing tasks.

RTH, also known as a closed system, was developed with the express purpose to reduce the nursing time required to administer EN and to decrease the risk of bacterial contamination by requiring less handling.[5,7] Most studies cite an increased amount of nursing time related to an OS as compared to a RTH;[4-6] in fact, Luther et al.[6] estimated that administering formula using the OS doubles the required nursing time when compared to RTH in a hospital intensive care unit due to the additional steps required to administer the OS (See Table 1). Per manufacturer guidelines, RTH containers are approved to hang for up to 48 hours, yet available tubing sets are only approved to hang for 24 hours; hence, all RTH formula containers must be discarded at 24 hours as they cannot be spiked more than once.[7,8] Regardless, 24 hours is a significant improvement over every 4 hours — or up to 6 times per day — if a patient is on a continuous feeding regimen. Although RTH formula has a higher cost when compared to the same volume of OS formula,[4,5,7] cost savings may be realized through decreased nursing time, a potential decrease in nosocomial infection, and improvement in delivery of EN to patients.[4] Actual practices at individual hospitals should be evaluated to determine if transition to a RTH from an OS achieves these goals.

Handling of EN

Contamination of EN

Contamination of EN can occur during preparation if modular supplements (such as protein powder/liquid) are added to the formula, when the feeding is transferred to the administration container, during assembly of the feeding system, and during administration to the patient.[5,7,11] Clean technique and proper hand washing should always be used to prepare and deliver formula in both an OS and RTH.[2]

Potential risk reduction from nosocomial infection from contamination of EN influences some clinicians in the selection of an OS vs. RTH. Whereas only the formula itself is sterile in an OS (not the bag it hangs in), the entire RTH system is sterile because it is not exposed to the outside environment; it is therefore associated with a decreased risk of contamination.[13,14] However, prospective trials demonstrating this perceived benefit are not available. *C. difficile* infection is one of the most life-threatening infections associated with hospitalized patients, especially those on EN.[17,18] Any measures that can be taken to prevent bacterial contamination and a culture of safe practices surrounding the use of EN should be the goal.

Both OS and RTH EN formulas are sterile when packaged, however, once administration has begun, retrograde movement of bacteria from the GI tract via

Table 1. Steps required for Open vs. Ready-to-Hang System before enteral product can be infused[9]

Open System	RTH System
Equipment required: • Bag • Tubing • Number of cans for a 4 hour infusion	**Equipment required:** • 1 liter RTH • Tubing
Required steps: 1. Thoroughly wash hands with soap and water before handling container or feeding set. 2. Obtain specified number of can/s of feeding formula for a 4 hour period and an enteral pump feeding bag. 3. Fill in information on feeding bag label (i.e., patient name, room, date, start time, expiration time, and rate). 4. Clean the top of the can of feeding formula with alcohol swab to reduce risk of cross contamination. 5. Ensure that the clamp on the feeding bag is closed. 6. Open the top of the feeding bag. 7. Open the can of formula. 8. Fill the feeding bag with enough formula for 4 hours. • Any additional formula can be covered and stored in the refrigerator with another completed label for 8-12 hours; discard opened and unused formula within 8-12. 9. Securely close the top of the feeding bag. 10. Follow pump priming and operation directions provided with feeding set 11. Refill feeding bag with formula every 4 hours as needed. 12. Repeat above steps up to 6 times per day as needed. 13. Change all feeding supplies at least every 24 hours.	**Required steps:** 1. Thoroughly wash hands with soap and water before handling container or feeding set. 2. Obtain Ready-To-Hang container and appropriate safety screw connector feeding set. 3. Fill in information on label (i.e., patient name, room, date, start time, expiration time, and rate). 4. Turn container upside down, shake vigorously using twisting motion for at least 10 seconds. 5. Holding the RTH container firmly, remove the dust cover from the Safety Screw Cap and remove the dust cover from the Safety Screw connector set. 6. Insert the Safety Screw connector set into the port on the RTH Safety Screw Cap and push down on the Safety Screw connector until you feel the inner foil puncture. 7. Turn the Safety Screw connector clockwise until it is securely fastened. 8. Close clamp on set, invert container and suspend, using hanging feature on bottom of container. 9. Follow pump priming and operation directions provided with feeding set. 10. Discard opened, unused formula at 24 hours (since tubing cannot hang longer). 11. Change all ancillary feeding supplies (flushing syringes, adapter covers, etc.) at least every 24 hours.

the feeding tube is possible in both systems,[7,12] as the GI tract is a source of a myriad of microbes.[7] Studies have shown that retrograde movement of bacteria in EN feeding systems is very slow, and while bacterial contamination has been found in the distal portions of the feeding tube closest to the patient, bacteria did not reach the feeding container over a 48 hour hang time.[7,12]

Storage

RTH formula containers should not have long-term exposure to light as some nutrients in the formula such as riboflavin, vitamin B6, and vitamin A are photosensitive. Recommended storage of RTH containers is on covered shelves or in a closed cabinet prior to use to avoid vitamin degradation. The opaque packaging of the OS protects the formula from light during storage.

Volume of EN Delivered

Others have reported an association between longer hang times in the RTH and increased percentage of prescribed EN actually received by the patient.[19,21] Perhaps because of the longer hang time, Atkins and Phillips[20] found that, on average, an OS provided patients with 74% (range 43-104%) of the ordered EN volume compared to 84% (range 59-101%) with RTH at one major academic medical center. Though small, (n=60), this study suggests that the RTH may provide patients with a greater volume of their nutrient needs, and confirms results found in other studies.[19,21]

Product Waste

Formula waste can be a significant cost regardless of which system is used, and the limited research in this

Table 2. Total Cost of Each System Over an Eight Month Period

Enteral Supplies	After switch to RTH	If continued with OS
Formula	$56,501.55	$49,920.52
Tubing and bags	$52,795.99	$54,549.64
Total cost	$109,297.54	$104,470.16
Cost difference of switching over 8 month period = $4,827.38 and per month = $603.42		

Table 3. Cost Comparison of Feeding Sets Used for OS and RTH Systems over Eight Months

UVA Description	Description of Feeding Set	Quantity Used	Price/Unit	Total Cost	% Total Cost of RTH ($109,287.54)
Open System					
Bag Feeding Pump 1000 ml	Single bag and tubing for EN	559	$2.26	$1,262.18	1%
Bag Feeding Pump Flush 1000 ml	EN tubing and bag + tubing and bag for water flushes	809	$4.62	$3,740.85	3%
Closed System					
Set Feeding Pump Screw Spike	Spike and tubing for RTH	3,374	$1.70	$5,739.20	5%
Bag Feeding Pump Flush Spike	**Spike and tubing for RTH + bag and tubing for water flushes**	**10,715**	**$3.92**	**$42,053.76**	**38%**

Table 4. Nursing Survey: Ready-to-Hang versus Open System

On a scale of 1-3 (3 being the best), rate each system						
	Ready to Hang			Tube Feeding in Bags		
Nursing Time Required	1	2	3	1	2	3
Ease of Use	1	2	3	1	2	3
Tube Feeding Waste	1	2	3	1	2	3
Which system do you prefer? Additional Comments:	Ready to Hang			Tube Feeding in Bags		

Table 5. Results of Nursing Survey (n = 92)

Parameter	Mean (3 = best)	
	RTH	OS
Nursing time required	2.83	1.75
Ease of use	2.87	1.86
Tube feeding waste	2.16	2.21

area is mixed. Some studies have shown that the RTH leads to decreased formula waste because the EN can hang longer and thus the full volume is delivered to the patient.[2,4,7] However, others have noted that RTH can lead to increased formula waste if the entire volume of the container is not used within the recommended hang time or if hospital culture is difficult to change from years of switching all bags, tubing, etc. at a certain time each day regardless of expiration time of hanging formula.[4] Further studies are needed to determine whether one feeding system generates less wasted formula than another.

Cost Analysis

To evaluate the difference in cost between the OS and RTH, purchasing data for an eight month period after transition from the OS to RTH was obtained from the hospital storeroom purchasing department. A small inventory of OS supplies and formulas continued to be purchased even after the transition to the RTH system since not all formulas are available in RTH containers and because OS containers are used for teaching those patients discharged home on the bolus feeding method. Total cost for formula and supplies for both the OS and RTH systems during the 8 month study period was $109,297.54. For practical purposes of this descriptive study, it was assumed that the same actual volume of formula would have been purchased had the OS alone been used during the study period, the expenses for formula and related supplies would have been $104,470.16. Therefore, RTH cost $4,827.38 more over the 8 month period than would have been spent on the OS system. Since the study period was 8 months, the monthly average increase in overall cost is $603.42 (see Table 2).

Feeding supply costs were also factored in. Total expenses for feeding supplies after the transition to the RTH system, including the cost of bags and tubing required to deliver water flushes as well as the remaining OS products (excluding enteral formula), during the 8 month period were $52,795.99. Had the OS continued to be used, the money that would have been spent on the equivalent tubing and bags would have been $54,549.64 (see Table 2), for a difference of $1,753.65 in favor of RTH. Overall, considering cost of formula and supplies, the OS would have cost the Medical Center $3,073.73 less during the 8 months under consideration. On the other hand, nursing time with each system, a considerable expense, was not

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Table 6. Lessons Learned and Opportunities for Improvement

1. Identify procedures to minimize waste of formula and supplies and improve processes.
2. Proper labeling of EN is essential to ensure that feeding sets do not exceed the approved hang time.
    - Ensure nurses understand that RTH can, and should, hang for up to 24 hours if needed.
3. Collaborate with interdisciplinary teams to brainstorm ways to improve compliance with recommended hang times.
    - One idea is to create a color-coded labeling system that indicates the date and time that RTH expires.
4. Ensure that the RTH is allowed to hang for the full 24 hours.
    - Nocturnal feeding schedules that exceed one liter volume will require use of 2 RTH units.
    - The remaining volume in the second RTH container does not need to be discarded at the end of the nocturnal feeding–it can be capped and restarted the following evening as long as the total hang time does not exceed 24 hours
5. Evaluate the cost and usage of individual items.
    - In this facility the "Bag Feeding Pump Flush Spike" contributed 38% of our total cost of RTH (see Table 3).
        - Evaluate which patients truly need the water flush/feed bag combo
            - Use in:
                - Continuously fed patients
    - Daytime cycled patients (nurses have little time to stop during the day to run in and give flushes q 4 hours or so; giving water flushes at night while our patients are trying to sleep will rob our patients of precious rest).
            - Avoid using in:
                - Bolus fed patients
                - Nocturnal-fed patients as nursing can give a bolus before hook-up and after overnight TF run; during the day the pump is off, so automatic flushes will not be given — nurses will have to go in and give flushes via bolus method.
                - Bags will need to be clearly identified and nursing educated to quickly identify differences in feeding bag selection.

    → Fun fact regarding feed-flush bags: The pump delivers about 30 mL of water per minute; so 150 mL would have TF off for ~ 5 minutes, 300 mL ~ 10 minutes each time the water flush goes in.
6. Nurse frustration with finding appropriate tubing and supplies was a concern.
    - Partnering with the supply chain to organize and replenish supplies in clean holding so they are well-labeled and easy to find may alleviate confusion associated with tubing and feeding sets.
    - Also, the feeding sets are packaged very similarly making it difficult for busy nurses to identify and grab the correct one.
7. The Future:
    - Encourage manufacturers to make packaging of feeding bags clearly distinctive to help our very busy nursing staff.
    - Evaluate whether the use of RTH decreases the incidence of C. difficile infection in EN fed patients.
    - Implore enteral feeding companies to develop a tubing set that can hang for 48 hours so the full benefit of RTH can be realized contributing to the cost and time saving efficacy of RTH.

factored into the cost differences. An interesting finding was the total expenditure on the feed/flush bags vs. the feed bag alone (see Table 3).

Nursing Satisfaction Survey An Unexpected, but Important Finding

Cost analysis is an important component of evaluating the transition to a RTH, but also important is the effect on nursing satisfaction. A nursing satisfaction survey (see Table 4) was distributed on six hospital units (n=92). Survey results showed nurses perceive that RTH requires less time to prepare, hang, and manage when compared to OS, which is consistent with other studies[6,21] (see Table 5). Nurses also reported that RTH was easier to use, and they perceived formula waste to be comparable between systems. Overall, respondents overwhelmingly preferred the RTH over the OS system: 88% compared to 12%. Nurses play a vital role in patient care, therefore anything that makes their job easier, takes less time, and improves nursing satisfaction is always a worthy goal.

Open text comments left on surveys and visits to nursing units also provided valuable feedback. Nurses reported confusion about which tubing sets to use and the appropriate hang time of RTH EN. Additionally, they reported that the appropriate feeding sets were sometimes difficult to find. Based on these comments, the clinical nutrition team was able to provide improved guidance for nursing staff and in the future expect to see a decrease in costs based on improved selection of appropriate tubing and more efficient use of RTH.

Limitations and Lessons Learned

Actual nursing time associated with delivery of EN was not quantified, making it impossible to attach a monetary value to the nursing time required. The number of patients receiving EN and volume ordered and delivered were not recorded for the RTH or OS. Amount of wasted formula and supplies due to administration error, confusion about hang times, expiration, labeling errors, or other unknown factors were not evaluated because data was based on retrospective purchasing information. However, total costs spent by an institution on supplies required to deliver EN should be measured and tracked, especially related to administration error and supply management. Evaluating data obtained from the purchasing department, as in this study, provides a place to start.

Comments recorded on the nursing satisfaction survey and visits to the unit supply room's revealed opportunities for education and process improvement. In the future, observing actual delivery of EN using the RTH and conducting a root cause analysis of systemic issues needed to improve delivery will be used to improve EN practices. Designing clean supply rooms so all supplies are located in a standardized location on all units with clear labeling is important at all healthcare facilities. Nursing education should be delivered in regular intervals in collaboration with both the nutrition and nursing staff, to include overcoming the barriers identified in this project as well as factors identified via other means related to EN feeding (see Table 6).

CONCLUSION

When considering the advantages and disadvantages of an OS or RTH EN feeding system, the most important factors to consider are patient outcomes, ease of use, safety, and cost. Review of the literature reveals that both the OS and RTH can be safely delivered to patients when proper procedures are followed. A RTH may also provide patients with a greater percentage of their nutrient needs, ultimately leading to improved nutritional status and improved patient outcomes, but this will require further study. Although a RTH is more expensive per unit of volume when compared to the OS, it is possible that if the RTH saves nursing time, it may in fact be significantly less expensive due to savings on labor costs. Other factors that need to be considered are whether there is a decrease in infectious risk and waste. Although insufficient evidence exists to determine if a RTH is superior to OS in terms of cost, it clearly increases nursing satisfaction, and has been shown to increase delivery of EN which could also decrease hospital costs by reducing the incidence of malnutrition. ■

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