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Medication administration via feeding tube for older adults

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ABSTRACT

Older adults are particularly vulnerable to medication administration errors, especially when malnutrition coexists with polypharmacy, highlighting the need for tailored healthcare approaches in this population. In this narrative review, it is aimed to emphasis the importance of medication administration via feeding tube in older adults and provide the list of appropriate administration of common medications in older adults. Feeding tubes used primarily for enteral nutrition and water administration, however when the patient needs medication administration feeding tubes considered as an administration route even though feeding tubes generally not design for medication administration. Therefore, this approach is prone to administration errors. Appropriate administration of medication is important in order to provide optimum pharmaceutical treatment for the older patients, prevent negative outcomes, complications and adverse medication events. However, appropriate administration of medication via feeding tube is challenging due to limited evidence and generally based on best practice. Pharmacists play an important role in providing comprehensive information regarding medication characteristics, the suitability of dosage forms, potential drug interactions, physicochemical stability, and appropriate administration techniques. The recommendations should be made for individual patients and medications with the contribution of multidisciplinary nutrition support team in order to maintain comprehensive evaluation of patient.

Keywords: medication administration, drug administration, feeding tube, enteral nutrition, older adults

Introduction

Medication administration via feeding tubes is critical process in clinical practice, especially for older adults who are unable to take medications orally due to dysphagia, neurological disorders, or other medical conditions affecting swallowing.[1,2] Comorbidities, geriatric syndromes, and polypharmacy should be taken into consideration while managing treatments of older adults, because aging is an unavoidable process, along with changes in pharmacokinetic/pharmacodynamic parameters.[1] Polypharmacy which is defined as the routine use of at least 5 medication continues to be a significant global problem for the health of the older adults.[3] The polypharmacy rates in older adults vary widely in between 40-90%[3,4] and dysphagia is estimated to affect 15-40% of adults aged 60 years and above, with significant consequences for their health status and overall quality of life. [2] Optimizing medication treatment with specific actions such as appropriate administration of medications, deprescribing and regular monitoring should be one of the main duties for healthcare workers.[1] The majority of patient harm and deaths in the medication incident reports are related with inappropriate administration of medications.[5] In general, medication errors that result in patient harm are estimated to occur in 1–2% of hospitalized patients and of all types of medication errors, medication administration errors are hard to recognized which require special attention.[5]

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Older adults generally are at increased risk of malnutrition due to many factors such as chronic diseases, loss of appetite, poor diet or swallowing problems.[6,7] These factors can be observed up to 25% of those living in the community, up to 62% of those hospitalized, and 85% of those living in nursing homes.[7] Malnutrition in older adults has a major concern similar with other life-threatening diseases due to increased rates of infections, sarcopenia, frailty, length of hospital stays and mortality.[6]

Combination of malnutrition and polypharmacy in older adults can lead to medication administration errors and in order to provide optimum healthcare services special attention should be given in this patient group. In this review, it is aimed to emphasis the importance of medication administration via feeding tube in older adults and provide the list of appropriate administration of common medications in older adults.

Swallowing Problems and/or Need of a Feeding Tube

In the process of aging, patients become frailer and complex. Awareness about specific diseases, malnutrition risk, malnutrition, xerostomia and swallowing problems can help to determine the appropriate medical or nutritional treatments.[8,9] Advanced dementia, neurological disorders, stroke or head and neck cancers are commonly seen conditions that require modification in the medical treatment due to swallowing difficulties and eventually mostly require feeding tube for both medical and nutritional treatment.[8,10,11] As more people are being diagnosed with swallowing difficulties, the prevalence of feeding tube use linked to these issues may rise.[12] However, choosing appropriate medications for these conditions and knowledge about safe administration of medications are generally underestimated during the medical treatment process.[10,12]

Main Points

- Safe and individualized medication administration via feeding tubes is important for older adults.
- Age-related changes in gastrointestinal, hepatic, and renal functions require detailed examination.
- Pharmacists can make valuable contributions within the multidisciplinary nutrition support teams in terms of medication adminstration via feeding tube.

Swallowing difficulties can impact quality of life (QoL), hydration, nutrition, and medication administration.[12] Studies showing that almost 15% of the community dwelling older adults experiencing difficulty with swallowing oral dosage forms.[11] In addition to altering the texture of fluid and food intake medication administration must also be considered when the swallowing difficulty detected.[12] Those who have difficulty swallowing or need to administer medications via feeding tube may need to crush or suspend the solid dosage forms, open capsules or switch to liquid dosage forms. Inappropriate modifications in the process of altering dosage type can cause inadequate medical treatment or advers effects. Some solid dosage forms due to its nature can not be crushed such as extended-release formulation, enteric coated tablets or medication with carcinoid properties. Sometimes the bitter taste also can play a role for not altering the dosage type. Another concern related with altering the dosage type is tube clogging. Some medications do not dissolve into fine particles when crushed and increasing the risk of clogging a feeding tube.[12,13] Cost of certain dosage forms besides the stability, bioavailability, viscosity, particle size or toxicity also be considered when it comes to change the dosage type.[12,13]

When the patient has swallowing difficulties, but the feeding tube was not placed, crushed solid dosage forms, liquids or opened capsules generally crushed and suspended with combination of liquid and thickener products. Studies indicating that thickened liquids can impact gastric emptying rate and therefore the absorption rate of medications. It should be taking into consideration Xanthan gum will have a different impact than starch-based thickeners on some medications.[12]

European Society of Clinical Nutrition and Metabolism (ESPEN), suggest that if oral intake is expected to be impossible for more than three days or expected to be below half of the energy requirements for more than one week, despite interventions to ensure adequate oral intake for older adults, feeding tube shall be offered.[6] When the patient has feeding tube, all the medications should be carefully evaluated in terms of appropriate and safe administration.[3,14,15]

On the other hand, polypharmacy itself can be associated with malnutrition or dysphagia.[3,16] Due to some side effects of some medications such as loss of appetite, dry mouth, nausea, and vomiting, malnutrition or dysphagia can occur in a long-term period.[15,17] Therefore, both polypharmacy and nutritional status need to be taken into account in clinical practice concomitantly.

Physiological Changes in Aging and Their Impact on Drug Administration

Significant physiological changes associated with aging have a direct impact on the efficacy and safety of administering medications via feeding tubes. The deterioration of gastrointestinal function is among the most significant changes. The dissolution, absorption, and transit time of drugs administered via enteral tubes can be changed by decreased intestinal motility, delayed gastric emptying, and decreased gastric acid production (hypochlorhydria).[18,19] Drug selection and dosage decisions may become more difficult as a result of these alterations, which may also affect the bioavailability of medications, especially those that need an acidic environment for best absorption.[20]

A reduction in liver and kidney function, which affects drug metabolism and excretion, is another significant age-related change. Age-related decreases in liver mass and blood flow frequently lead to a decline in hepatic first-pass metabolism, while a decrease in glomerular filtration rate causes a decline in renal clearance.[21,22] These modifications raise the possibility of drug accumulation and toxicity, particularly when medication is administered through enteral tubes in liquid or crushed tablet form, bypassing some of the barriers that oral intake modifies absorption. Therefore, when selecting drug formulations and routes for older adults undergoing enteral nutrition therapy, age-related pharmacokinetic shifts must be taken into account.[22,23]

Furthermore, the volume of distribution for many medications is altered by age-related changes in body composition, such as decreased lean body mass, increased fat mass, and decreased total body water. This may also have an impact on the pharmacologic profile of drugs given through a feeding tube. For instance, hydrophilic drugs may exhibit lower peak concentrations, whereas lipophilic drugs may have longer half-lives.[24] All of these age-related physiological changes highlight how crucial customized medication planning, careful observation, and multidisciplinary teamwork are important to ensure older adults receive safe and efficient enteral medication therapy.[22]

Medication Administration via Feeding Tube

Older adults often experience polypharmacy and multiple comorbidities, which increase their vulnerability to adverse drug events, drug-drug and drug-nutrient interactions, and altered pharmacokinetics.[3] The administration of medications through feeding tubes adds layers of complexity, including considerations related to the physical and chemical compatibility of drugs with feeding tube materials, potential tube occlusions, and changes in drug absorption and efficacy.[14]

Feeding tubes are used primarily for enteral nutrition and water administration, however when the patient needs medication administration feeding tubes considered as an administration route even though feeding tubes generally not design for medication administration. Therefore, this approach is prone to administration errors.[11,13,14,25,26]

There are some concerns about medication administration via feeding tube such as tube clogging, loss of dose, medication-nutrient interaction, reduction of the medication efficacy or increase of the medication toxicity.[14,25,26] When older adults have polypharmacy, inappropriate medication administration via feeding tube and medication interactions, which occur 20–40% of the time, can result in adverse medication events.[27]

Medication administration errors as a part of medication related problems can be seen more frequently in patients with feeding tube.[28] In a study conducted in England, the risk of a medication administration error was significantly higher in patients with enteral tubes than in patients without (56% vs 25.3%, $p<0.001$) and mostly caused by inadequate flushing of the tube.[9] In another study conducted in care facilities almost one-third of the dosage form modifications performed inappropriately and this leads to increased risk of medication administration errors.[11]

American Society for Parenteral and Enteral Nutrition (ASPEN) and one study underline that inappropriate administrations of medications may lead to severe negative outcomes, increase morbidity and mortality.[14,28] Appropriate administration of medication is important in order to provide optimum pharmaceutical treatment for the patients, prevent negative outcomes, complications and adverse medication events.[11,14,26] In general, most oral medications are not designed for modifying the dosage type and feeding tube administration.[14,27,29] Inappropriate administrations of medications may result physical and chemical incompatibilities, precipitation, flocculation, adsorption, color changes, chelation and medication-nutrient interactions, changes in drug bioavailability and medication loss.[14,27,29] Medication loss while crushing

is a neglected issue by many practitioners. Medication loss is frequently observed when solid dosage forms are crushed in a container and transferred to syringe for feeding tube administration.[30] One study showing that crushing tablets with a mortar and pestle and transfer was associated with 5.5–13.3% loss of tablet weight[30], in another study it is reported that at least 5–10% of every dose is not delivered to the patient while crushing and administrating the medication via feeding tube.[31] Practitioners generally not rinsing the device that used for crushing and lead to medication loss.[31] The following recommendations are derived from the work of Boullata et al., as part of the ASPEN publication, which aims to ensure the safety of the entire enteral nutrition process through evidence-based practices and expert consensus.

Practice Recommendations by ASPEN[32]:

- Establish comprehensive policies and standardized procedures such as checklists, bundles and protocols to guarantee safe enteral medication preparation and delivery by all departmental staff.
- Ensure the prescriber's order clearly specifies the drug name, dosage, formulation, administration route (such as enteral), and the type of access device (e.g., nasoduodenal tube).
- Each medication prescribed for enteral use must be reviewed by a pharmacist to ensure it is safe, stable, and appropriate for the intended route.
- Establish and implement nursing procedures that promote safe handling and delivery of all medications.
- Avoid mixing medications directly into enteral feeding formulas.
- Do not mix medications; administer each separately through the appropriate route of access.
- Use liquid formulations only when they are suitable for enteral administration.
- Follow the pharmacist's instructions when preparing approved immediate-release solid dosage forms for enteral administration.
- Ensure that enteral medications are measured and prepared using suitable instruments only.
- Before administering any medication, pause enteral feeding and flush the feeding tube with at least 15 mL of water. Dilute solid or liquid medications as appropriate and administer them using a clean oral syringe of at least 20 mL in size. Following administration, flush the tube again with a minimum of 15 mL of water, considering the patient's fluid status. If additional medications are to be given, repeat the same steps for each. Conclude the process with a final flush of at least 15 mL of water.
- Resume enteral feeding promptly to prevent any negative impact on the patient's nutritional status. Feeding should be withheld for 30 minutes or longer only when a medication-nutrient interaction is present in order to prevent altered drug bioavailability.

Appropriate administration of medication via feeding tube is challenging due to limited evidence and generally based on best practice.[9] Making a list can be helpful but not easy due to different excipients in every commercial medication, condition of patient, different ingredients of nutrition products.[33] In order to make comprehensive research about which medication can be given via feeding tube, some factors should be known such as distal tip of feeding tube, the internal diameter and length of the tube, enteral nutrition product information, medication preparation (dosage form liquid or solid, crushing of solid form and dilution), volume restriction, the size of the oral syringe, medication-nutrient interaction and patient conditions (such as the length of a patient's functional bowel).[14,34,35]

During medication administration via feeding tube, in order to avoid the drug-nutrient interactions, enteral nutrition infusion should hold temporarily (30 minutes or more for some medication).[35]

In general liquid medications may easily administered via feeding tube. However even the medications with low viscosity should further diluted with sterile water prior to the administration.[26] The volume of dilution is determined by viscosity and osmolality of the liquid dosage form, the internal diameter and length of the tube, and the location of the distal tip.[26] For liquid medication containing sorbitol amount should be checked due to risk of diarrhea when daily intake over 20g.[14,25,36]

Special attention should be given to the enteral nutrition products, because those characterized by a high protein concentration, especially containing caseinates, interact with numerous drugs, and, due to the high viscosity,

cause tube clogging.[37] Some solid dosage forms such as conventional tablets are suitable for administration via feeding tube on the other hand due to alteration of medication effectiveness or clogging risk, modified-release, film coated or enteric coated tablets are not suitable for crushing.[14,25,26,37,38] It is hard to assure accurate doses with the soft gelatin capsules administration and it is generally not recommended to administer injectable medications via feeding tube due to different design comparing to oral tablets.[26] The information's about some medications administration via feeding tube is shown in Table 1.

Tube obstruction is under responsibility of pharmacist and nurse together. Pharmacist should carefully evaluate all the medications for tube administration and nutritional product formulation to avoid or minimize tube obstruction.[37] One study shown that the risk of feeding tube occlusion is 4.8 times more likely in patients who has more than five medications and 5.3 times more likely when the medication doses number is more than 13 daily. Furthermore, it is reported that if the patient administered the medications via feeding tube for longer than 10 days, they become 2.6 times more susceptible for feeding tube occlusion.[9] In another study it is reported that tube occlusion incidence varies between 12.5 to 45% and mostly caused by wrong medication preparation or administration techniques.[27] Among medications that cause tube obstruction, it is mostly by crushed modified released tablets (10%).[14] In order to avoid tube obstruction and possible interactions solid dosage forms should crushed separately and administer separately with adequate water. Rinsing of the crushing device plays an important role not only to prevent drug loss but also to prevent chemical interactions between remaining medications in the crushing device and new medication.[33] It should be noted that stopping nutrition infusion and flushing the tube before and after every medication is the key component for tube obstruction prevention as well as possible medication-nutrient interaction.[13,26,28] It is best to avoid feeding tube occlusion rather than trying to open clogged ones due to negative outcomes such as delayed administration of nutrients and medications, lack of therapeutic benefits, increased health related costs and even hospitalization.[14,26] The use of warm water to open the clogged feeding tubes is recommended in most cases. Besides the warm water alternating pressure with syringe with an appropriate syringe size, sodium bicarbonate and water mixture or for some conditions pancreatic enzymes, sodium bicarbonate and water mixtures may be preferable.[39]

Role of a Clinical Pharmacist in the Clinical Nutrition Support Team

A multidisciplinary approach was essential to optimize the effectiveness and safety of clinical nutrition treatment. It has been demonstrated that clinical nutrition support teams enhance patient outcomes, safety, and the quality of healthcare organizations. The key members of a nutrition support team are usually a physician (director), a dietician, a pharmacist and a nurse.[40] Pharmacists have a well-established position in nutrition support teams. Medication delivery presents special difficulties for patients undergoing nutrition therapy. All medications frequently need to be given intravenously or through enteral feeding tubes, which necessitate stability and compatibility assessments by pharmacists.[41] When it comes to the changed pharmacokinetics, pharmacodynamics, and bioavailability of drugs, pharmacists have additional problems from common comorbidities which require entire nutrition support team to get involved.[41] When administering medication via a feeding tube, the clinical pharmacist is responsible for controlling many parameters besides medication's characteristics such as the length of the patient's functional bowel region, the internal diameter and length of the tube, the composition of the tube, the routine flushing regimen, the distal end position of the feeding tube and the content of the feeding formula.[36] The clinical pharmacist role throughout the entire process to ensure the safety and effectiveness of both nutritional and pharmaceutical treatments. This includes oversight of the product used, evaluation of the selected medications, monitoring of the route and techniques of administration, assessment of the clinical response, and management of potential complications.

Conclusion

Enteral nutrition treatment plays an important role for those who has malnutrition, however one of the important aspects of enteral nutrition treatment is the need of medication treatment concomitantly. Appropriate medication administration via feeding tube should be provided in order to maintain safe and effective treatment of both nutritional and pharmaceutical. Pharmacists may provide the information's about characteristics of medications, appropriateness of dosage forms, interactions, stability or administration techniques. The recommendations should be made for individual patients and medications with the contribution of multidisciplinary nutrition support team in order to maintain comprehensive evaluation of patient.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Acarbose	Tablet	Tablets are suitable for crushing and suspending with water.	Interaction with nutrients should be considered.
Acetylsalicylic acid	Tablet	Enteric-coated tablets generally not suitable for crushing.	Administer after nutrients.
Aciclovir	Tablet Suspension Injection	Tablets can be dispersed in 50 ml of water. Feeding tube administration of suspension should be avoided due to lack of data.	A specific site of absorption is not documented.
Alendronate	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known. Tablet must be taken on empty stomach.
Allopurinol	Tablet	Tablets are suitable for crushing and suspending with water.	Careful monitoring for malnourished patients is needed due to the risk of toxicity.
Amiodarone hydrochloride	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals.
Amlodipine	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals. Administration via jejunum is not known.
Ampicillin+sulbactam	Tablet Suspension Injection	Feeding tube administration of tablets should be avoided due to lack of data.	Administer without regard to meals.
Apixaban	Tablet	Tablets can be crushed and may be suspended in 60 mL of water.	Administer without regard to meals
Atorvastatin	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals.
Betahistine dihydrochloride	Tablet	The tablets are very soluble in water and can be crushed also.	Administration via jejunum is not known.
Candesartan cilexetil	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administer without regard to meals.
Captopril	Tablet	Tablets are suitable for crushing and suspending with water.	The presence of nutrients in the GI tract reduces absorption by 30–40%.
Carvedilol	Tablet	The tablets will disperse in 10 mL of water if shaken for 5 minutes	The absorption rate decreases in jejunum.
Cholestyramine	Sachet	Contents of one sachet should be mixed with 120–180 mL fluid.	Administer without regard to meals.
Cilazapril	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Ciprofloxacin	Tablet	Tablets are suitable for crushing and suspending with water.	Avoid dairy products within 1-2 hours of ciprofloxacin.
Citalopram	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Clarithromycin	Tablet Granule	Feeding tube administration of tablets should be avoided due to lack of data. Granules can be suspended and administered via feeding tube.	Can be administered into jejunum.
Clopidogrel	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Co-amoxiclav (amoxicillin+clavulonic acid)	Tablet Suspension Injection	Feeding tube administration of tablets should be avoided due to lack of data. Suspension should be diluted 1:1 or 1:1/2 with water.	Administer without regard to meals.
Colchicine	Tablet	Tablets will disperse in 10 mL of water.	Administration via jejunum is not known.
Dabigatran	Capsule	Do not break or open capsules. Opening capsule will lead to 75% increase in absorption and serious adverse reactions.	Administration via jejunum is not known.
Dapagliflozin	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Dexamethasone	Tablet	Tablets will disperse in 10 mL of water.	Tablets may contain lactose.
Diclofenac	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Parenteral formulation is available.
Digoxin	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Tablets may contain lactose. Absorption of digoxin is slowed and reduced by concurrent intake of high-fiber, plasma levels should be monitored. Can't be administered via jejunum.
Diltiazem hydrochloride	Tablet	Feeding tube administration of modified release tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Domperidone	Tablet Capsule Oral suspension	Tablets are suitable for crushing and suspending with water. Oral suspension dosage form should be diluted 1:1 or 1:1/2 with water.	Suspension contains sorbitol.
Donepezil	Tablet Oro-dispersible tablet	Tablets are suitable for crushing and suspending with water. Tablets will disperse in 10 mL of water. Oro-dispersible tablets are not suitable for administration via an enteral feeding tube.	Administration via jejunum is not known.
Duloxetine hydrochloride	Capsule	Contents of capsule can be added to 50 mL of water. Do not crush the microgranules.	Nutrients decreases absorption by 11%, however this is not considered clinically relevant.
Edoxaban	Tablet	Tablets may crush and mixed with 60 to 90 mL water. Suspension should be administered immediately.	Administration via jejunum is not known.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Empagliflozin	Tablet	Feeding tube adminstration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Enalapril maleate	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals.
Escitalopram	Tablet	Feeding tube adminstration of tablets should be avoided due to lack of data.	Administer without regard to meals.
Esomeprazole	Tablet Capsule	Tablets can be dissolved in water. Enteric-coated microgranules shouldn't be crushed.	Hold the feeding 1 hours before and after medication administration.
Ezetimibe	Tablet	Tablets will disperse in 10 mL of water if shaken for 5 minutes.	Administer without regard to meals.
Famotidine	Tablet	Tablets are suitable for crushing and suspending with water.	Administration via jejunum is not known.
Fenofibrate	Tablet Capsule	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Fluoxetine	Capsule	Capsules can be opened and the contents mixed with water.	Administer without regard to meals.
Fluvastatin	Tablet	Modified-release tablets are not suitable for crushing.	Administration via jejunum is not known.
Furosemide	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Food reduces the bioavailability of furosemide by 30%. Can be administered into jejunum.
Gabapentin	Capsule Oral solution	Contents of capsule can be added to 10 mL of water.	Administer without regard to meals.
Galantamine	Capsule Oral solution	Modified-release capsules are not suitable for crushing. Oral solution is sugar free; does not contain sorbitol, can be mixed with water.	Administration via jejunum is not known.
Gliclazide	Tablet	Tablets will disperse in 10 mL of water quickly. Modified release tablets are not suitable for crushing.	Administration via jejunum is not known.
Glipizide	Tablet	Modified-release tablets are not suitable for crushing.	Administration via jejunum is not known.
Granisetron	Tablet	Tablets are suitable for crushing and suspending with water.	May contain lactose. Administer without regard to meals.
Haloperidol	Tablet Oral drops	Feeding tube administration of modified release tablets should be avoided due to lack of data. Oral drops can be administered.	Administer without regard to meals.
Ibuprofen	Tablet Capsule Oral solution	Tablets are suitable for crushing and suspending with water. Oral solution dosage form should be diluted 1:1 or 1:1/2 with water.	Peak plasma concentrations are reduced and delayed when administered with nutrients.
Irbesartan	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administer without regard to meals.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Lansoprazole	Capsule	Microgranules of capsule can be added to 10 mL of 8.4% sodium bicarbonate.	Nutrients decreases the bioavailability by about 50%, hold the feeding 1 hour before and after medication administration. Administration into jejunum is not known.
Levetiracetam	Tablet Solution	Tablets are suitable for crushing and suspending with water. Oral solution dosage form should be diluted 1:1 or 1:1/2 with water.	Can be administered via jejunum.
Levodopa+Benserazid	Capsule Dispersible tablet	Feeding tube adminstration of capsule should be avoided due to lack of data. Dispersible tablets will disperse in 10 mL of water if shaken.	Protein amount in the diet should be calculated. 1–2 hour break might needed due to nutrient-drug interaction.
Levodopa+Carbidopa	Tablet	Conventional tablets disperse in 10 mL of water quickly.	Protein amount in the diet should be calculated. 1–2 hour break might needed due to nutrient-drug interaction.
Levodopa+Karbidopa	Tablet Intestinal gel	Tablets will disperse in 10 mL of water if shaken for 5 minutes. Modified-release tablets are not suitable for administration via enteral feeding tube. Intestinal gels are suitable for feeding tube.	Protein amount in the diet should be calculated. 1–2 hour break might needed due to nutrient-drug interaction.
Levofloxacin	Tablet	Film-coated tablets can be crushed but it takes few minutes for the coating to dissolve when placed in the water.	1–2 hour break might needed due to nutrient-drug interaction. Tablets can be administered via jejunum.
Levothyroxine sodium	Tablet	Tablets are suitable for crushing and suspending with water.	Can be administered via jejunum. Protective equipment must be used during the crushing process.
Linagliptin	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Lisinopril	Tablet	Tablets disperse in 10 mL of water within 2 minutes.	Administration via jejunum is not known.
Lorazepam	Tablet	Tablets are suitable for crushing and suspending with water.	Administration via jejunum is not known.
Losartan potassium	Tablet	Film coated tablets are suitable for crushing and suspending with water.	-
Memantine hydrochloride	Tablet Oral solution	Feeding tube administration of tablets should be avoided due to lack of data. Solution should be added to water then drawn into enteral syringe.	Solution contains sorbitol.
Metformin hydrochloride	Tablet Modified release tablet	Tablets are suitable for crushing and suspending with water. Modified released tablets are not suitable for enteral feeding tube administration.	Avoid administering tablets via jejunum.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Metildopa	Tablet	Tablets are suitable for crushing and suspending with water.	
Metoclopramide hydrochloride	Tablet Oral solution	Tablets can be crushed, but use of a liquid preparation is recommended.	Administration via jejunum is not known.
Metoprolol tartrate	Tablet Modified release tablet	Tablets are suitable for crushing and suspending with water. Modified released tablets are not suitable for enteral feeding tube administration.	Can be administered via jejunum.
Metronidazole	Tablet	Tablets are suitable for crushing and suspending with water.	Nutrients reduces the bioavailability this medication. Admini stration via jejunum is not known.
Mirtazapine	Tablet Orodispersible tablet Oral solution	Feeding tube administration of tablets or orodispersible tablets should be avoided due to lack of data. Solutions may be diluted with water prior to administration.	Administer without regard to meals.
Naproxen sodium	Tablet	Tablets are suitable for crushing and suspending with water.	Absorption is delayed but not reduced by nutrients
Nebivolol	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administer without regard to meals.
Olanzapine	Tablet Orodispersible tablet	Feeding tube administration of tablets should be avoided due to lack of data. Orodispersible tablet can be disperse in water.	Administer without regard to meals.
Olmesartan medoxomil	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Food has minimal effect on absorption of Olmesartan medoxomil
Omeprazole	Capsule	Capsules can be opened and the contents mixed with water.	Can be administered via jejunum.
Ondansetron	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Food has minimal effect on the bioavailability of ondansetron.
Pancreatin admixtures	Capsule Tablet	Capsules can be opened and the contents mixed with water, apple juice or sodium bicarbonate solution. Enteric-coated, sugar-coated tablets; must be swallowed whole.	The pharmacological response is based on the interaction with food.
Pantoprazole	Tablet	Tablet can be crushed and dissolved in at least 10 mL of 8.4% sodium bicarbonate.	Administration via jejunum is not known.
Paracetamol	Tablet	Conventional tablets can be crushed/ suspended with water. Modified release tablets are not suitable for crushing.	Administer without regard to meals.
Perindopril arginine	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Perindopril should be taken before food.
Phenytoin sodium	Capsule	Contents of capsule can be added to the water.	Administration via jejunum is not known.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Pioglitazone	Tablet	Tablets are suitable for crushing and suspending with water.	Administration via jejunum is not known.
Piracetam	Tablet Capsule Oral solution	Feeding tube administration of tablets or capsules should be avoided due to lack of data.	Administration via jejunum is not known.
Prasugrel	Tablet	Tablets are suitable for crushing and suspending with water.	Administration to jejunum may result in reduced bioavailability of prasugrel
Pravastatin	Tablet	Tablets are suitable for crushing and suspending with water.	Nutrients may reduce the systemic bioavailability of the drug by 35–40%. Avoid administering to the jejunum.
Pregabalin	Capsule	Capsules can be opened and the contents mixed with water.	Administer without regard to meals. Can be administered via jejunum.
Quetiapine	Tablet	Film-coated tablets are poorly soluble in water. Manufacturer recommends crushing and mixing in yogurt. Flush the tube with 25 mL of sterile water prior and 50 ml of sterile water after administration.	Hold tube feeds for 30 minutes before administration.
Quinapril	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Peak plasma concentration may be delayed by approximately 30 minutes with nutrients.
Rabeprazole	Tablet	Do not crush. Not suitable for enteral tube administration.	Administration via jejunum is not known.
Ramipril	Tablet	Tablets will disperse in 10 mL of water.	Administration via jejunum is not known.
Risperidone	Tablet	Tablets will disperse in 10 mL of water if shaken for 5 minutes.	Administration via jejunum is not known.
Rivaroxaban	Tablet	Tablets are suitable for crushing and suspending with 50 mL of water.	Avoid administration distal to the stomach; a decrease in the AUC and Cmax (29% and 56%, respectively) was observed when rivaroxaban was delivered to the proximal small intestine; further decreases may be seen with delivery to the distal small intestine.
Rivastigmine	Capsule	Feeding tube administration of capsules should be avoided due to lack of data.	Administration via jejunum is not known.
Rosuvastatin	Tablet	Tablets will disperse in 10 mL of water if shaken for 5 minutes.	Administration via jejunum is not known.
Sertraline	Tablet	Tablets are suitable for crushing and suspending with water.	Administer without regard to meals. Administration via jejunum is not known.
Simvastatin	Tablet	Tablets are suitable for crushing and suspending with water.	Administration via jejunum is not known.

Table 1. Medication Administration via Feeding Tube[9,26,42]

Active Ingredient	Dosage Forms	Information for Administration via Feeding Tube	Additional Information
Sodium valproate	Tablet Oral solution	Modified released tablets/capsules are not suitable for enteral feeding tube administration. Solutions may be diluted with water prior to administration.	Nutrients may delay the absorption of valproate.
Spironolactone	Tablet	Tablets will disperse in 10 mL of water if shaken for 5 minutes.	Can be administered via jejunum.
Tamsulosin	Capsule Tablet	Modified-release preparation; do not crush. Not suitable for enteral tube administration.	Administration via jejunum is not known.
Telmisartan	Tablet	Tablets are suitable for crushing and suspending with water.	Food delays absorption and significantly reduces telmisartan absorption
Ticagrelor	Tablet	Tablets are suitable for crushing and suspending with water.	Crushed tablets comparing to the whole tablets may result in increased concentrations of ticagrelor
Tramadol	Capsule Tablet	Modified released tablets/capsules are not suitable for enteral feeding tube administration.	Administration via jejunum is not known.
Trandolapril	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Trazodone hydrochloride	Tablet	Modified released tablets/capsules are not suitable for enteral feeding tube administration.	Administration via jejunum is not known.
Trimethoprim + sulfamethoxazole	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Valsartan	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Nutrients decreases the AUC by 40% and peak levels by 50%.
Verapamil hydrochloride	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Vildagliptin	Tablet	Feeding tube administration of tablets should be avoided due to lack of data.	Administration via jejunum is not known.
Warfarin sodium	Tablet	Tablets are suitable for crushing and suspending with water.	There is nutrient-drug interaction with warfarin. Can be administered via jejunum. Protective equipment must be used during the crushing process.

Author contribution

The authors declare contribution to the paper as follows: Study conception and design: BKÇ, CB, KD, MH; data collection: BKÇ, CF; analysis and interpretation of results: BKÇ, CB; draft manuscript preparation: BKÇ, CB, KD, MH. Supervision KD, MH All authors reviewed the results and approved the final version of the article.

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Conflict of interest

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