Appropriateness of Long-Term Medications Administered in Tube-Fed Geriatric Patients in Home Health Care; Cross Sectional Observational Study

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Abstract

Background:

Medication delivery via enteral feeding tube require a specific precaution. As many medications are incompatible to be administered via feeding tube. Some medications are not acceptable to be crushed owing to the risk of obstruct the feeding tube, diminish drug efficacy or drug toxicity. While others will interact with the feeding formula and limit its absorption. this study aims to evaluate the prevalence of medication errors that occur during the administration of oral drugs using enteral feeding tubes in geriatric population in home health care.

Methodology

This is a cross sectional observational study conducted in ministry of health governmental hospital in Makkah city, Saudi Arabia. Oral drug administration was examined in 46 individuals in 2020. Demographic information, medical records and pharmaceutical prescription information regarding each patient was evaluated. The errors including improper dosage form and drug-nutrient interaction were measured per various guidelines.

Result:

A significant proportion of investigated populations had inappropriate drug administration. The majority of patients (86.9 percent) got improper dosage form by enteral feeding tube mainly gastrointestinal medicines. While drug-nutrient interaction was prominent in 36.9 percent of the patients with highly prevalent among neurological medicines. All patients' caregiver obtained guidance by doctors and nurses solely. Gender, age, hospital, Type of ET, and educator were not associated with significant differences in appropriateness of dosage form or administration time.

Conclusion:

health care practitioners should display greater attention when choosing drugs dosage type for tube-fed patients and medication administration timing.

Introduction

It's getting more frequent for people to suffer from dysphagia as they grow older, and this is mostly because of neurological diseases. In a systematic review conducted in 2021, dysphagia was found to be prevalent in 35.9% of elderly individuals in nursing homes^(1,2). Aspiration, recurrence of pneumonia, and death can occur in extreme cases of swallowing difficulties⁽³⁾. To feed and provide medication, the majority of this group must rely on an enteral feeding tube.

Drug delivery through enteral feeding tube is challenging and fraught with medication errors. Medication errors are failures in the treatment process that injure the patient or put them at risk for harm⁽⁴⁾.

Pharmacological dosage forms and drug-nutrient interactions should be taken into account when prescribing medicine to these individuals in order to reduce these errors.

Splitting or crushing modified release forms, including extended release and delayed release forms, is never permitted. Extended-release tablets are meant to provide a steady-slow release of the drug over an extended period of time. It is possible that crushing this form may change this feature, resulting in hazardous peaks and subtherapeutic troughs⁽⁵⁾. In one fatality case, the patient was administered crushed extended release nifedipine, which led in severe hypotension and inability to establish compensatory tachycardia owing to the concomitant administration of labetalol. The patient died as a consequence⁽⁶⁾. Crushed prolonged-release isosorbide mononitrate tablets were given to an old patient through a percutaneous endogastric tube (PEG), resulting in the elderly patient experiencing ischemia symptoms and an ECG alteration, which were relieved when a sustained release tablet was substituted with three daily doses of a short-acting nitrate ⁽⁷⁾.

Crushing delayed release preparations, including enteric coated medications, may modify their characteristics because they are created to delay the release of pharmaceuticals that are inactivated by stomach contents, to minimize stomach discomfort, or to delay the onset of action at a specific site within the gastrointestinal system^(5, 8–10).

Enteral nutrition has an effect on the absorption of a variety of drugs, and patients should be evaluated for inadequate clinical response or drug levels, especially those taking phenytoin, carbamazepine, or levodopa. Thus, synchronizing medicine delivery with enteral nourishment is crucial to prevent drug-nutrient interactions and enhance clinical response and absorption.^(10, 11).

Regarding all of these adverse effects, several organizations give numerous recommendations as a resource for actively reducing the aforementioned medication errors, such as "Oral dose forms that should not be crushed" from the "Institute for Safe Medication Practices (ISMP)" and "Guidebook on Enteral Medication Administration" from the "American Society for Parenteral and Enteral Nutrition (ASPEN)"⁽¹²⁾

The drugs provided to patients with enteral feeding tubes have not been monitored in any researches conducted in our area. The goal of this research is to determine the appropriateness of medicine prescription and drug-nutrient interactions in enterally tube-fed elderly patients, as well as to identify risk factors for such errors.

Methodology

Study area/setting:

The research was conducted in Makkah, Saudi Arabia, at a number of major hospitals.

Study subjects:

The trial was eligible to all geriatric patients 65 years of age and older who were registered in home health care and had enteral feeding tubes.

Hospitalized patients and caregivers who don't answer the phone are both excluded.

Study design:

This is an observational cross-sectional research design.

Sample size:

Patients enrolled in home health care at Makkah's main hospitals from April 2020 to January 2020 were included in the study's population.

- Tertiary center including King Abdullah Medical City (KAMC)
- Secondary center including King Faisal Hospital (KFH), King Abdul-Aziz Hospital (KAAH), AL-Noor Specialized Hospital (NSH), and Hera General Hospital (HGH)

Sampling Technique:

Convenience sample of patients who meet the eligibility criteria.

Study tool and data collection method:

Once the study was approved by Institutional Review Board committee, we compiled a list of all patients who met the inclusion criteria. The data of those patients were collected using a self-administered data collection form that prepared by the primary author and validated by three biostatisticians.

The final version of the data collection form had three sections:

First section:

- Personal information "patient name, age, phone number"
- Type of feeding tube "nasogastric tube, percutaneous endoscopic gastrostomy tube, etc."
- The most recent prescription "drug name, dosage form, dose, frequency, and route of administration"

These data were gathered from patients' files

Second section: By contacting the patients' caregivers through the phone and after taking their agreement to participate in the study, they were asked about:

- The health care providers who was responsible for the education about drug administration (Physician, nurse, pharmacist... etc.)
- Medication preparation method includes "crushing, dispersing, opening capsules, and so on."

- The timing of medication administration and its relation to feeding time.
- The brand name of the medications by asking them to send pictures of the medications.

Third, after completing the first and second sections, each drug was evaluated for its preparation appropriateness and potential drug-nutrient interaction by using:

- The Institute for Safe Medication Practices' (ISMP) Oral Dosage Forms That Should Not Be Crushed publication⁽¹²⁾.
- Lexicomp and Micromedex.
- Medication leaflet.
- Handbook of drug administration via enteral feeding tubes
- Guideline for the administration of medicines to adult via enteral tubes within NHS Grampian
- Handbook of drug-nutrient interaction.
- Literature review for some medications.

Outcomes:

Primary outcome:

Proportion of inappropriate medications prescription and administration in enterally fed geriatric patients.

Secondary outcomes:

- To estimate the percentage of inappropriate medication dosage form and/or administration time in geriatric patients who are on enteral feeding tubes.
- To explore the most common medications that frequently administered inappropriately among enterally fed geriatric patients.

Data analysis:

The Statistical Package for Social Sciences SPSS, version 26, was used to input and analyze the data. Nominal data were summarized using descriptive statistics such as frequencies and percentages, whilst numerical variables were described using the mean and standard deviation. Figures were utilized to convey some of the most significant results. In order to determine the relationship between the determinants and the outcome variables, inferential statistics such as the chi-squared and Fisher exact tests will be used. Any P-value less than 0.05 was deemed to be an indicator of a statistically significant relationship or difference between the two variables.

Results

A total of 46 patients were included in this study and more than half of the patients were females (57.8%). The mean age is 77.4 ± 7.7 and about 56.5% of the patients aged >75 years old. The majority of

patients recruited from secondary hospitals while other patients recruited from tertiary hospital.

Pharmacists have no responsibility in educating patients' caregivers about medication administration. 84.8 percent and 15.2 percent of patients, respectively, received instruction from physicians and nurses. The demographic and clinical characteristics of patients receiving medicine through enteral feeding tube are summarized in Table 1.

Table (1): Demographic general health characteristics of the respondents

Characteristics		
Gender	Male 43%	Female 56.5%
Age	65 – 75 (43.5%)	> 75 (56.5%)
Hospital	Tertiary (13%)	Secondary (87%)
Type of Enteral tube	NGT (73.9 %)	PEG (26.1%)
Educator	Doctor (84.8%)	Nurse (15.2%)

During the trial period, a total of 231 administrations were recorded for all participants. Amlodipine capsule, omeprazole enteric coated tablet, clopidogrel film coated tablet, aspirin enteric coated tablet, and atorvastatin tablet were five of the most frequently used oral medications throughout the research period. Each patient received an average of five prescriptions. Seven distinct oral medicinal formulations were employed, including Film coated tablets (41.1%), tablet (25.1%), delayed release tablet (21.6%), extended-release tablets (9.1%), capsule (2.6%), and chewable tablet (0.43%). Table (2) summaries all medication administered in our patients.

Table (2): Distribution of medications administered vin patients with enteral feeding

Drug	No. of patients	percent (%)	Drug	No. of patients	percent (%)
Total medications = 231					
HTN medications			Gastro-intestinal medications		
Amlodipine	21	45.6	Pantoprazole	6	13.0
Valsartan	7	15.2	Omeprazole	19	41.3
Valsartan + HCT	1	2.2	Esomeprazole	10	21.7
Perindopril	6	13.0	Mebeverine	1	2.2
Indapamide	1	2.2	Metoclopramide	1	2.2
Hydralazine	1	2.2	Neurological medications		
Hydrochlorothiazide	1	2.2	Levetiracetam	10	21.7
DM medications			Phenytoin	3	6.5
Metformin	9	19.5	Sodium valproate	3	6.5
Gliclazide	3	6.5	Levodopa/carbidopa	5	10.9
Linagliptin	2	4.3	Baclofen	4	8.6
Glibenclamide	1	2.2	Memantine HCL	4	8.6
Cardiac medications			Pregabalin	1	2.2
Atorvastatin	14	30.4	Piribedil	1	2.2
Aspirin	14	30.4	Psychiatric medications		
Metoprolol	3	6.5	Carbamazepine	1	2.2
Rosuvastatin	12	26.1	Amitriptyline	2	4.3
Isosorbide dinitrate	1	2.2	Escitalopram	2	4.3
Bisoprolol	4	8.6	Quetiapine	2	4.3
Carvedilol	1	2.2	Alprazolam	1	2.2
Spironolactone	2	4.3	Anti-Coagulant medications		
Atenolol	2	4.3	Apixaban	5	10.9
Digoxin	2	4.3	Clopidogrel	15	32.6
Furosemide	2	4.3	Rivaroxaban	1	2.2
Other drugs					
Vitamin D3	4	8.6	Folic acid	2	4.3

Levothyroxine	4	8.6	Sodium bicarbonate	1	2.2
Tamsulosin	4	8.6	Finasteride	3	6.5
Ferrous sulphate	5	10.9	Ferric Hydroxide	1	2.2

Table (3) illustrates prevalence of tube-fed patients with inappropriate dosage forms. Regardless of pharmaceutical type, a large number of patients (86.9 percent) got an unsuitable dosage form, with the majority 45.7 percent receiving wrong formulations of one medicine only. According to prescription type, inappropriate dosage form occurred most often with gastrointestinal medicines, with 73.9 percent of patients receiving inappropriate dosage form.

Table (3): Tube-fed patients with Inappropriate drug dosage form

Characteristics	Frequency	Percent (%)
Patients with inappropriate dosage form regardless of type of medication	40	86.9
Patients with inappropriate dosage form of 1 medication	21	45.7
Patients with inappropriate dosage form of 2 medications	17	36.9
Patients with inappropriate dosage form of 3 medications	1	2.2
Patients with inappropriate dosage form of 4 medications	1	2.2
Patients had no inappropriate dosage form or no data	6	13
Patients with inappropriate dosage form based on the type of medication		
Hypertensive drugs	1	2.2
Cardiac drugs	14	30.4
Diabetic drugs	4	8.7
Gastro-intestinal drugs	34	73.9
Neurological drugs	4	8.7
Psychiatric drugs	1	2.2
Anti-coagulant drugs	0	0.0
Miscellaneous drugs	4	8.7

Patients with Inappropriate administration time via enteral feeding tube are presented in table (4). Risk of drug-nutrient interactions were prevalent in 36.9 percent of the individuals studied, with majority of them has one potential drug-nutrient interaction. Drug-nutrient interactions were quite prevalent among neurological medicines, occurring at a rate of 21.7% of patients. The most frequently prescribed oral drugs that has inappropriate dosage form or inappropriate administration time are summarized in (Table 5)

Table (4): Drug-nutrient interactions of medications that were administered via enteral feeding tube

Characteristics	No. of patients	Percent (%)
Patients with drug-nutrient interaction regardless of type of medication	17	36.9
Patients with drug-nutrient interaction of 1 medication	11	23.9
Patients with drug-nutrient interaction of 2 medications	4	8.6
Patients with drug-nutrient interaction of 3 medications	2	4.3
Patients had no drug-nutrient interaction or no data	29	63
Drug-nutrient interactions based on the type of medication		
Hypertensive medications	6	13.0
Cardiac medications	1	2.2
Diabetic medications	0	0.0
Gastro-intestinal medications	1	2.2
Neurological medications	10	21.7
Psychiatric medications	0	0.0
Anti-coagulant medications	0	0.0
miscellaneous medications	7	15.2

Table (5): The most frequently drugs that has inappropriate dosage form or drug-nutrient interaction

Reason of inappropriateness		Drug	Frequency	Percentage
Dosage form	Enteric coated tablet	Omeprazole	19	41.3%
		Aspirin	14	30.4%
	Extended-release tablet	Tamsulosin	4	8.6%
		Gliclazide	3	6.5%
Drug-nutrient interaction		Levodopa/Carbidopa	4	8.6%
		Phenytoin	3	6.5%

Non-availability of data was an important limitation of this study as the complete data about appropriateness of dosage form were only available for 19.5% of the patients. More data were available for assessment of drug-nutrient interactions as 69.5% of the patients had adequate data.

Table (6) and (7) demonstrated the association between respondents' characteristics and inappropriate dosage form and administration time via enteral feeding tube. Gender, age, hospital, type of ET and educator were not associated with significant differences in appropriateness of dosage form. Although inappropriateness was more prevalent in patients with PEG versus NGT, the differences were not statistically significance. Similarly, patients' characteristics were not significant determinants of the reported drug-nutrient interactions. The small sample size of the included patients could be the reason behind inability to detect significant differences.

Table (6): Association between respondents' characteristics and inappropriate dosage form of medications administered via enteral feeding tube

Characteristics	Inappropriate dosage form		P value
	No reported inappropriate dosage form or no data	Inappropriate of dosage form	
Gender			
Male	2	18	0.591
Female	4	22	
Age			
65-75	5	15	0.101
76-85	1	18	
> 85	0	7	
Hospital			
KAMC	0	6	0.459
KAAH	2	7	
KFH	1	14	
NSH	1	8	
HGH	2	5	
Type of ET			
NGT	6	28	0.119
PEG	0	12	
Educator			
Doctor	5	34	0.916
Nurse	1	6	

Table (7): Association between respondents' characteristics and drug-nutrient interactions of medications administered via enteral feeding tube

Characteristics	Drug-nutrient interactions		P value
	No interactions or no data	Drug-nutrient interactions	
Gender			
Male	10	10	0.108
Female	19	7	
Age			
65 – 75	13	7	0.794
76 – 85	11	8	
> 85	5	2	
Hospital			
KAMC	4	2	0.072
KAAH	7	2	
KFH	6	9	
NSH	5	4	
HGH	7	0	
Type of ET			
NGT	23	11	0.276
PEG	6	6	
Educator			
Doctor	24	15	0.618
Nurse	5	2	

Discussion

Our study's findings indicated that almost all of the study's patients received medicine incorrectly, either owing to an inappropriate dosage form or an improper drug administration time relative to feeding time. 40 of the 64 patients (86.9%) had medicine that should not have been crushed, and 36.9% had drugs delivered at an inopportune time. Tracey et al. observed that only 43% of the patients they analyzed got at least one medicine that should not be crushed⁽¹³⁾. Another study found that 70% of patients received their drug incorrectly, with just 30 percent of patients receiving their medications in an incorrect dosage form, and 40% of patients receiving prescriptions that needed to be adjusted with feeding time⁽¹⁴⁾. Both prevalence's were lower than the one we obtained.

Similarly, to that reported by Mandana et al. Gastro-intestinal medications were the most common category of wrong dose preparation specifically proton pumps inhibitors (PPI) including omeprazole and pantoprazole. Crushing proton pump inhibitor will lead to decrease its efficacy as it is a delayed release tablet that is sensitive to gastric acid⁽¹⁵⁾. While in contrast to other studies reported by Barbosa et al., and Presoti et al., They reported that the most frequently used drug was captopril. It seems that in these studies, proton-pump inhibitors are mostly used in their liquid dosage form (injectable dosage forms or oral suspensions)^(16, 17).

Regarding medicines that must be adjusted for feeding time, 8.7% and 6.5% of participants, respectively, received levodopa and phenytoin inappropriately. In a study done in 2020, 11.5 percent and 3.8 percent of patients in the emergency unit were given these two drugs incorrectly, respectively⁽¹⁸⁾. Heineck et al. observed in another research that around 8.3% of the group investigated need adjustment time with phenytoin administration⁽¹⁹⁾. As levodopa absorption is impaired by high protein levels in the enteral formula, and phenytoin has a narrow therapeutic index, further measures must be taken when administering both drugs simultaneously with enteral feeding. It is advisable to administer these drugs two hours prior to or following the feeding^(11, 20).

Although physicians' and nurses' knowledge were not assessed in our research, it seems to be insufficient in terms of precautions required when administering medications by ET, since all of our patients' caregivers received instruction from solely physicians and nurses and virtually all had medication errors due to incorrect dosage form or administration timing. In 2017, Demirkan et al. observed that regardless of the drug's characteristics or appropriateness for delivery through feeding tube, physicians and nurses were still inclined to prescribe it. While the majority of pharmacists were aware of the precautions required when administering drugs by ET, physicians and nurses seemed to lack significant information on the matter⁽²¹⁾.

Due to the high prevalence of enteral tube drug administration in the elderly population, which accounts for the majority of patients receiving home health care, initiatives are needed to reduce the risk of medication errors. Many studies have shown that a variety of methods, such as a thorough training program for medication administration through an enteral feeding tube with useful protocols for medical practitioners, strengthening the involvement of clinical pharmacists and dietitians in the home health care and hospital settings, and a software application for ordering and giving medicines that may notify staff to the presence of potential risk with ET administration and interaction, can significantly reduce the risk of errors in drug administration^(13, 22–26). On the other hand, for a considerable number of prescriptions, administration instructions for modifying medications to increase their consumption were missing. Pharmaceutical companies should give particular instructions for coping with this issue.

This study is limited by small sample size of tube-fed patients enrolled in home health care and inability to observe patients' caregivers at home during Coronavirus disease (COVID) outbreak.

Additional researches are required to examine health care professionals' knowledge about medication administration in patients with ET, observe nurses' practice in tube-fed elderly patients in geriatric facilities, assess factors that could significantly impact on the risk of inappropriateness, and assess the improvement in medication errors after implementation of initiatives in our region.

Conclusions

because of the altered effectiveness and safety profiles of feeding-tube-administered pharmaceuticals, health care professionals should exhibit more caution when selecting medications dosage form for tube-fed patients and medication administration timing. A constant and mutually beneficial cooperation between health-care providers will ensure reasonable medication usage and enhance patient care using enteral feeding tubes.

Abbreviations

ET

enteral tube

NGT

Nasogastric tube

PEG

percutaneous endoscopic gastrostomy

ISMP

Institute for Safe Medication Practices

ASPEN

American Society for Parenteral and Enteral Nutrition.

KAMC

King Abdullah Medical City

KAAH

King Abdulaziz Hospital

KFH

King Faisal Hospital

NSH

Alnoor Specialty Hospital

HGH

Hera General Hospital.

Declarations

Ethics approval and consent to participate

The current research was approved by Institutional Review Board committee of Makkah Health Affairs General Directorate, ministry of health, Saudi Arabia according to ICH GCP guideline and the registration number is H-02-K-076-1020-391. All methods were performed in accordance with the relevant guidelines and regulations. Subjects (or their guardians) have taken their verbal informed consent that approved by the committee.

Consent for publication

Not applicable.

Availability of data and materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Ibtihaj Bifari collects the data, design, and write the manuscript. Nisrin Bifari helped analyzed data and revise the manuscript. Yusuf Alharbi revised the manuscript and approved the final version of the manuscript.

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