



Medication Administration through Enteral Feeding Tubes in Mechanically Ventilated Critically Ill Patients: Evaluation of the Potential Medication Errors

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ABSTRACT

Background: Oral medication administration through enteral feeding tubes is a challenging issue in critically ill patients, which can lead to medication error. Patients admitted to the intensive care unit may not have the ability to swallow oral medications for various reasons such as lack of consciousness, or the need for mechanical ventilation. Improving the quality of drug administration through enteral feeding tubes is essential. The present study aimed at evaluation of the prevalence of medication errors that occur during the administration of oral medications through enteral feeding tubes in mechanically ventilated critically ill patients.

Methods: This study was a cross-sectional observational study conducted in Golestan Educational Hospital, Ahvaz, Iran. Oral medication administration was evaluated in 50 patients within three months; demographic information, medical records and medicine prescribing information about each patient was examined. The errors were measured according to the Handbook of Drugs Administration via enteral feeding tubes.

Results: Errors occurred in percentage of total prescriptions as follows: Drug-drug interaction 26%, wrong preparation 22.3%, incorrect dosage form 12.1%, wrong time error 11.6%, drug-food interaction 6.7%, improper dose error 5.5%, wrong route 3.8%, extra dose 0.9%, omission 0.2%, deteriorated drug 0.2%, and unordered drug 0.0%. In our study, it was found that most of the drugs were administered in solid dosage forms, and almost 33% of them could be substituted for injection or oral liquid formulations.

Conclusion: Our study indicated the high frequency of drug preparation errors in mechanically ventilated critically ill patients. Close teamwork between pharmacists or pharmacotherapists, physicians, and nurses can result in the appropriate administration of medications by an enteral feeding tube.

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Introduction

Oral medication administration through enteral feeding tubes is a challenging issue in critically ill patients, which

can lead to medication error (1, 2). Patients admitted to the intensive care unit may not have the ability to swallow oral medications for various reasons such as lack of consciousness,

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or the need for mechanical ventilation. Enteral feeding tubes are commonly used to administer both nutritional support and oral forms of medications in this group of patients. Improving the quality of drug administration through enteral feeding tubes is essential (2).

Several medication errors can occur during enterally drug administration. The most critical issues include physicochemical incompatibilities, drug-nutrient interactions, or the use of incorrect administration techniques, increased risk of tube obstruction, increased toxicity or reduced efficacy due to alteration in drug formulation. Some drug interactions can have significant impacts on the patient's clinical state, and some dosage forms such as controlled-release tablets, enteric coated tablets, and tablets containing cytotoxic drugs cannot be crushed (3-5).

The patients hospitalized in the intensive care unit receive more drugs than the patients in other wards. Therefore, the likelihood of drug-drug and drug-food interactions in these patients may be higher than other patients (6). Pharmacists play a vital role in this regard and should provide the entire patient's necessary information not only about the drugs and their formulation but also about the clinical situation of the patient and should have sufficient knowledge about the types of feeding tubes and enteral dietary (7-9).

The aim of this study is to evaluate the potential medication errors in mechanically ventilated critically ill patients.

Methods

This study was a cross-sectional observational study conducted from March to June 2017, in Golestan Educational Hospital, Ahvaz, Iran. The Institutional Review Board and the Medical Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1395.808) approved the study. Oral medication administration was gathered from 50 patients' medical records within three months in intensive care units (ICU) and neonatal ICU; information about each patient was examined. The errors were measured according to the Handbook of Drugs Administration via enteral feeding tubes (22).

The reviewed items include patients' demographic information, type of medicine and frequency of prescribing, time to receive medication and nutrition through an enteral feeding tube, drug-drug interactions, and drug-nutrient interaction, specifying the appropriate pharmaceutical form, proper preparation of medications, and failure to flushing tube before and after drugs administration. Also, the performance of nurses in the preparation and prescribing of drugs was observed. The data were analyzed using SPSS software (Version, 20, SPSS Inc., Chicago, IL, USA).

Results

During the study period, 50 patients with a mean \pm standard deviation (SD) age of 41.8 ± 22.7 years (ranging

from 1 to 88 years) were evaluated.

Table 1. Demographic data.

Gender	Frequency	Valid percent (%)
Female	10	20%
Male	40	80%
Age distribution		
Age (year)	Frequency (%)	Descriptive Statistics
20>	11 (22%)	Mean \pm SD: 41.8 ± 22.7 Min: 1 Max: 88
20-40	18 (36%)	
40-60	10 (20%)	
60-80	9 (18%)	
80<	2 (4%)	
Weight distribution		
Weight (Kg)	Frequency (%)	Descriptive Statistics
50>	4 (8%)	Mean \pm SD: 76.01 ± 23.3 Min: 4.5 Max: 165
50-70	12 (24%)	
70-90	23 (46%)	
90<	11 (22%)	
Height distribution		
Height (cm)	Frequency (%)	Descriptive Statistics
150>	3 (6%)	Mean \pm SD: 169.2 ± 16.4 Min: 70 Max: 182
150-170	19 (38%)	
170<	28 (56%)	
Duration of hospitalization		
Duration (days)	Frequency (%)	Descriptive Statistics
>10	36 (72%)	Mean \pm SD: 11.6 ± 2.34 Min: 6 Max: 14
<10	14 (28%)	
Diagnosis		
Underlying disease	Number	Frequency (%)
Head trauma	9	18%
Multiple trauma	3	6%
Subarachnoid hemorrhage /Subdural hemorrhage	9	18%
Intracerebral hemorrhage	10	20%
Hydrocephalus	4	8%
Other	15	30%
Health status		
Health status	Frequency	Valid percent (%)
Duration of ICU stay	1	2%
Transfer to ward	13	26%
Duration of hospitalization	15	30%
Discharge from hospital	3	6%
Death	18	36%

The patients' diagnoses were head trauma (18%), multiple trauma (6%), and subarachnoid hemorrhage/subdural hemorrhage (18%), intracerebral hemorrhage (20%), Hydrocephalus (8%), and others (30%). The length of ICU stay varied from 6 to 14 days (11.6 ± 2.34 days). The need for mechanical ventilation or having swallowing difficulty varied from 1 to 14 days (8.4 ± 3.4 days). Overall, 7039 administrations for all patients were recorded during the study period. The mean number of drugs prescribed for each patient was 93.3 (from 2 to 369). Five of the most commonly used oral drugs during the study period consisted of pantoprazole tablet, levetiracetam tablet, phenytoin capsule, calcium salt tablet, and nimodipine tablet. On average, each patient received 13.4 types of drugs. Seven different oral pharmaceutical preparations were used, including tablets (60.4%), syrups (24.3%), capsules (8.4%), effervescent tablets (4.2%), oral solutions or edible vial (1.5%) powders (0.9%), and oral drops (0.3%). Also, 13 (33.3%) out of 39 different solid drugs (except effervescent tablets and powders) could be substituted for liquid or injectable forms. Preparation and administration errors occurred in 21 types of drugs, while 82% of patients (41 patients) experienced these errors during their hospital stay. The most common error was the wrong dose preparation including 22.3% of all administrations (Table 1). The frequencies of the wrong form and wrong time are 12.1% and 11.6%, respectively. The unordered drug was not observed.

The results of our study showed that most of the drugs administered in solid dosage forms and almost 33% of them could be switched for oral liquid formulations.

The sixteen most frequently prescribed oral drugs are non-crushable or can interact with enteral nutrition (Table 2).

Discussion

The results of our study showed that most of the drugs administered in solid dosage forms and almost 33% of them could be switched for oral liquid formulations. Barbosa et al. reported that 72.7% of the studied cases also received intravenous medications, and it was possible that some of the drugs could be substituted for intravenous formulations (11). Silva et al. concluded that among 49 drugs prescribed in solid oral pharmaceutical forms, 17 (34.7%) were also available in the oral liquid form, implying that at least 290 prescriptions (21.8%) could have reduced the risk of catheter obstruction (12).

Among the administered medicines, pantoprazole was the most frequently prescribed one with the highest percentage of wrong dose preparation. Pantoprazole is sensitive to gastric acid; therefore, crushing tablets and administering the pieces through the NG tube have the possibility of degradation, leading to decreased efficacy (13). Our results are inconsistent with those of Barbosa et

al., Presoti et al. and Silva et al. studies. They reported that the most frequently used drug was captopril (11, 12, and 14). It seems that in these studies, proton-pump inhibitors are mostly used in their liquid dosage form (injectable dosage forms or oral suspensions), while in our country, oral suspension does not exist, and only pantoprazole is used in injectable dosage form, which is much more expensive compared to its oral dosage forms, and its use is not cost-effective for hospitals. Digoxin and phenytoin were administered for 8.21% and 51.11% of patients. In another similar study conducted at a university hospital in Southern Brazil, the frequency of administrations of these two drugs was 9.8% and 6.3%, respectively (15). These drugs, especially phenytoin, should be administered cautiously. Enteral feeding can decrease phenytoin absorption and hence reduces its serum concentrations (16). It is suggested that the serum concentrations of drugs with narrow therapeutic indices should regularly be monitored, especially in the case of administration through a feeding tube (17).

Crushing sodium valproate enteric-coated tablets are considered an error in some studies since valproate is an irritant for gastric mucosa and can cause nausea and vomiting. Therefore, its tablets should not be crushed for use through a nasogastric (NG) tube (13). We can use sodium valproate syrup instead of crushing tablets; however, using syrup will not eliminate nausea and vomiting. Thus, we did not consider crushing sodium valproate enteric-coated tablets as an error in this study. For extended released products, it is recommended that the doses be 8–20% higher than non-extended release (ER) products; therefore, crushing them leads to the sudden release of high doses of valproate, which can produce higher serum concentrations and effects than expected (18).

In-hospital education of nurses by clinical pharmacists can significantly increase their knowledge and profession regarding medication preparation, tube flushing, recognizing drug-drug or drug-feed interactions, and identifying dosage forms characteristics (19). Pharmacists can help the treatment team by providing useful information on selecting the correct drug, dosage form, and route of administration. Furthermore, pharmacists can decrease some drug-drug interactions by administering them separated by an appropriate time interval (generally 2–4 h) (20, 21).

Our study indicated that the frequency of drug administration and preparation errors in patients who could not use solid forms of drugs in the ICU understudy was high. Close cooperation between medical teams, including pharmacists or pharmacotherapists, physicians, and nurses can lead to appropriate administration of medications by an enteral feeding tube.

The main difficulty in this study was the low number of patients with swallowing problems as well as the

Table 2. Prescribed oral drugs.

NO.	Drug	Labeled for administration by an enteral feeding tube	Number of medication (%)	Number of patients (%)
1	Pantoprazole	No, since it is enteric coated or sustained released or should be crushed and dissolved in 8.4% sodium bicarbonate	369 (5.2%)	45 (90%)
2	Phenytoin	Yes, but the presence of food can reduce the absorption rate by 50%-75%	301 (4.2%)	38 (76%)
3	Levetiracetam	Yes, but the presence of food can reduce the absorption rate by 50%-65%	261 (3.7%)	29 (58%)
4	Calcium salt	Yes, but the tube should be adequately flushed to ensure that the calcium supplement does not come into contact with the feed	182 (2.5%)	26 (52%)
5	Captopril	Yes, but the presence of food can reduce the absorption rate by 30%-40%	144 (2%)	16 (32%)
6	Atorvastatin	Yes, but should be administered quickly, since it is sensitive to light	135 (1.9%)	15 (30%)
7	Nimodipine	Yes, but should be administered quickly, since it is highly sensitive	133 (1.8%)	18 (36%)
8	Warfarin	Yes, but there is evidence of a physicochemical interaction between enteral feed and warfarin	83 (1.1%)	9 (18%)
9	Hydrochlorothiazide	Yes, but food can increase its absorption rate	72 (1.02%)	12 (24%)
10	Levothyroxine	Yes, but after crushing the tablet, disperse in water and protection of the solution from light. Concomitant administration with EN may reduce its absorption, especially if it is rich in fiber. It is recommended to stop the EN 1 h before and two h after administration. Monitor serum concentrations of the drug. Inhalation of crushed tablets should be avoided. Standard precautions apply 13	52 (0.7%)	4 (8%)
11	Furosemide	Yes, but food reduces the bioavailability of furosemide by 30%	48 (0.68%)	8 (16%)
12	Ciprofloxacin	Yes, but the concomitant administration Of EN may reduce its absorption. It is recommended to stop the EN, especially dairy products one h before and two h after administration. Replace ciprofloxacin with another quinolone or use the injectable solution	42 (0.52%)	4 (8%)
13	Nitroglycerine	No, since it is sustained release	37 (0.52%)	5 (10%)
14	Metronidazole	Yes, but food reduces the bioavailability of metronidazole	25 (0.3%)	2 (4%)
15	Carbamazepine	Yes, but powder of the crushed tablet can adhere to the tube and a less-than-optimal dose is absorbed	12 (0.17%)	1 (2%)
16	Levofloxacin	Yes, but stop feed one h before the dose and Restart feed two h after dose	11 (0.15%)	2 (4%)

continuous transfer of patients under review to other departments for surgery and other medical procedures.

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