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

Mandana Izadpanah1*, Negin Amraie2, Farhad Soltani3, Leila Kouti1, Sepideh Sayyadi2, Maryam Aghakouchakzadeh1, Maryam Hariri4

1 Department of Clinical Pharmacy, School of Pharmacy, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
2 Student Research Committee, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
3 Department of Anesthesiology and Critical Care Medicine, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
4 Pharm D., Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

Keywords: Critical Illness; Medication Errors; Enteral Feeding Tube

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.

J Pharm Care 2019; 7(3): 49-53.

*Corresponding Author: Dr Mandana Izadpanah
Address: Department of Clinical Pharmacy, School of Pharmacy, Ahvaz Jundishapur University of Medical Sciences, Golestan Blvd., Ahvaz, 61357-33184, Iran. Tel: +986113738378, Fax: +986113738381.
E-mail: mandana.i@gmail.com
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 ± 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 |
|------------|---------------|------------------------|
| 20–24      | 11 (22%)      | Mean ± SD: 21.5±2.7    |
| 25–40      | 18 (36%)      | Min: 20                |
| 41–60      | 10 (20%)      | Max: 60                |
| 61–80      | 9 (18%)       |                        |
| 81–100     | 2 (4%)        |                        |

**Weight distribution**

| Weight (Kg) | Frequency (%) | Descriptive Statistics |
|-------------|---------------|------------------------|
| 48–50       | 4 (8%)        | Mean ± SD: 50.0±3.0    |
| 51–60       | 12 (24%)      | Min: 45                |
| 61–70       | 23 (46%)      | Max: 70                |
| 71–90       | 11 (22%)      |                        |
| 91<         | 2 (4%)        |                        |

**Height distribution**

| Height (cm) | Frequency (%) | Descriptive Statistics |
|-------------|---------------|------------------------|
| 150–160     | 3 (6%)        | Mean ± SD: 157.0±15.0  |
| 161–170     | 19 (38%)      | Min: 150               |
| 171<        | 28 (56%)      | Max: 175               |

**Duration of hospitalization**

| Duration (days) | Frequency (%) | Descriptive Statistics |
|-----------------|---------------|------------------------|
| >10             | 36 (72%)      | Mean ± SD: 11.6±2.3    |
| <10             | 14 (28%)      | Min: 6                 |
|                 |               | Max: 14                |

**Diagnosis**

| Underlying disease | Number | Frequency (%) |
|--------------------|--------|---------------|
| Head trauma        | 9      | 18%           |
| Multiple trauma    | 3      | 6%            |
| Subarachnoid hemorrhage | 9 | 18% |
| /Subdural hemorrhage |         |               |
| 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 separately 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.

References

1. Btaiche IF, Chan LN, Pleva M, Kraft MD. Critical illness, gastrointestinal complications, and medication therapy during enteral feeding in critically ill adult patients. Nutr Clin Pract 2010;25(1):32-49.

2. Gorzoni LG, Della Torre A, Pires SL. Drugs, and feeding tubes. Rev Assoc Med Bras 2010;56(1):17-21.

3. Bankhead R, Boullata J, Brantley S, et al. Enteral nutrition practice recommendations. J Parenter Enteral Nutr 2009;33(2):122-67.

4. Wohlt PD, Zheng L, Gunderson S, Balzar SA, Johnson BD, Fish JT. Recommendations for the use of medications with continuous enteral nutrition. Am J Health Sys Pharm 2009;66 (16):1458-67.

5. Matsuba CST, Gutiérrez MGR, Whitaker IY. Development and Evaluation of Standardized Protocol to Prevent Nasoenteral Tube Obstruction in Cardiac Patients Requiring Enteral Nutrition with Restricted Fluid Volumes. J Clin Nurs 2007;16(16):1872-77.

6. Wick JY. The ins and outs of medication delivered by enteral tube. Consult Pharm 2006; 21(8):659-62.

7. Catalán E, Padilla E, Hérvas F, et al. Fármacosorales que no debenser triturados. Enferm Intensiva 2001;3(12):146-50.

8. Boullata JI. Drug administration through an enteral feeding tube. Am J Nurs 2009;109(10): 34-42.

9. Sánches AIG, Almagro CGM, Aranzana MC, et al. Atenciónfarmacéutica en pacientes con nutrición enteral. Farm Hosp 2006;30(1):44-8.

10. Van den Bemt PMLA, Cusell MBI, Overbeeke PW, et al. Quality improvement of oral medication administration in patients with enteral feeding tubes. Qual Saf Health Care 2004;13(15):44-7.

11. Barbosa AP, de Paula SL, Barbosa DS, da Cunha DF. Oral drug administration by enteral tube in adults at a tertiary teaching hospital. E SPEN J. 2012;7:e241–4.

12. Silva MJ, Cava CE, Pedroso PK, Futuro DO. Evaluation of the profile of drug therapy administered through enteral feeding tube in a general hospital in Rio de Janeiro. Braz J Pharm Sci 2011;47:331–7.

13. Emami S, Hamishahekar H, Mahmoudpoor A, Mashayekhi S, Asgharian P. Errors of oral medication administration in a patient with enteral feeding tube. J Res Pharm Pract 2012;1:37–40.

14. Presoti AR, do Nascimento MM, Marques LA. Prescription of drugs to be administered through feeding tubes in a Brazilian hospital: Profile and qualification. J Gen Pract 2013;1: 112.

15. Heineck I, Bueno D, Heydrich J. Study on the use of drugs in patients with enteral feeding tubes. Pharm World Sci 2009;31:145–8.

16. Bauer LA. Interference of oral phenytoin absorption by continuous nasogastric feedings. Neurology 1982;32:570–2.

17. White R, Bradnam V. Handbook of Drug Administration via Enteral Feeding Tubes. London: Pharmaceutical Press; 2015.

18. McAsley JW, Lott RS, All dredge BK. Seizure disorders. In: All dredge BK, Corelli RL, Ernst ME, Guglielmo BJ, Jacobson PA, Koda-Kimble MA, et al., editors. Applied Therapeutics: The Clinical use of Drugs. Philadelphia, PA: Wolters Kluwer/Lipincot William and Wilkins; 2013. pp. 1387–418.

19. Dushhi-Khavidaki S, Badri S, Eftekharzadeh SZ, Keshkarkar A, Khalili H. The role of clinical pharmacist to improve medication administration through enteral feeding tubes by nurses. Int J Clin Pharm 2012;34:757–64.

20. Abbasinazari M, Zareh-Toranzeshi S, Hassani A, Sistanizad M, Azizian H, Panahi Y. The effect of information provision on reduction of errors in intravenous drug preparation and administration by nurses in ICU and surgical wards. Acta Med Iran 2012;50:771–7.

21. Sohrevardi SM, Jaraizadeh MH, Mirzaei E, Mirjalili M, Tafii AD, Heydari B. Medication Errors in Patients with Enteral Feeding Tubes in the Intensive Care Unit. Journal of Research in Pharmacy Practice 2017;6(2):100-105.

22. White, R. and V. Bradnam, Handbook of drug administration via enteral feeding tubes. 2015: Pharmaceutical Press.