

The role of clinical pharmacist to improve medication administration through enteral feeding tubes by nurses

Simin Dashti-Khavidaki · Shirinsadat Badri ·
Seyedeh-Zahra Eftekharzadeh · Abbasali Keshtkar ·
Hossein Khalili

Received: 11 February 2012 / Accepted: 2 July 2012 / Published online: 12 July 2012
© Springer Science+Business Media B.V. 2012

Abstract *Background* As a common practice, medications are given in addition to nutrients through enteral catheters especially in critically ill patients. Nurses are primarily responsible to administer medications in this manner. The correct drug delivery via enteral tubes requires special skills. *Objective* This study was designed to evaluate effectiveness of clinical pharmacist-led educational program in progressing nurses' knowledge and practice regarding medications delivery via enteral

catheters. *Setting* This study has been performed in two teaching hospital affiliated to Tehran University of Medical Sciences. *Methods* This is a case–control, interventional study. At first, a knowledge and practice questionnaire regarding drug administration through enteral feeding tube by intensivists nurses was prepared. This questionnaire was filled by each nurse at pre-intervention phase of the study. Then, the clinical pharmacists provided educational programs including preparing evidence-based booklet and classes for case group nurses. Nurses in case and control groups were evaluated again after 3 months. At pre- and post-intervention phases nurses were observed regarding their practice to administer drugs via enteral tubes as well. *Main outcomes* Mean scores of knowledge and practice questions as well as percent of nurses with correct answers were compared between pre- and post-intervention phases in case and control groups. *Results* The mean scores of knowledge and practice questions significantly increased in the case group but decreased or remained unchanged in the control group. In contrast to control group, the percent of nurses with correct answers to each domain of knowledge and practice questions increased significantly in the case group. *Conclusion* This study showed that nurses did not have sufficient baseline knowledge about rules of drug administration via enteral feeding tubes; however, integrated educational program by clinical pharmacists that focus on promoting correct administration of drugs via enteral feeding catheters significantly improved knowledge and practice of nurses. A theory–practice gap was found in this study that may be related to the authority of physicians not nurses in ordering rules for medication administration through enteral catheters.

S. Dashti-Khavidaki (✉) · H. Khalili
Department of Clinical Pharmacy, School of Pharmacy,
Tehran University of Medical Sciences, P.O. Box: 14155/6451,
1417614411 Tehran, Iran
e-mail: dashtis@sina.tums.ac.ir

S. Dashti-Khavidaki
Nephrology Research Center, Imam Khomeini Hospital
Complex, Tehran University of Medical Sciences,
Tehran, Iran

S. Badri
Clinical Pharmacist, School of Pharmacy,
Isfahan University of Medical Sciences, Tehran, Iran

S.-Z. Eftekharzadeh
Department of Clinical Pharmacy, School of Pharmacy,
Tehran University of Medical Sciences, Tehran, Iran

A. Keshtkar
Department of Epidemiology, Osteoporosis Research Center,
Endocrine and Metabolism Research Faculty, Shariati Hospital,
Tehran University of Medical Sciences, Tehran, Iran

A. Keshtkar
Golestan Research Center of Gastroenterology and Hepatology,
Golestan University of Medical Sciences, Gorgan, Iran

Keywords Clinical pharmacy · Drug administration ·
Enteral feeding tube · Iran · Knowledge · Nurse

Impact of findings on practice

- Clinical pharmacists may play pivotal role to increase nurses' knowledge regarding correct drug administration through enteral feeding tubes.
- Clinical pharmacists can improve nurses practice regarding drug administration via enteral catheters.

Introduction

Enteral nutrition is essential in the care of patients who are unable to eat. Nurses usually administer medications in addition to nutrients through enteral catheters [1–3]. Correct delivery of oral drugs through enteral tubes requires special skills, including medication preparation, tube flushing, and assessing for potential complications. There are two ways for preparing solid dosage form to be administered through enteral feeding catheters, dispersing and crushing. Dispersing method is used if the tablet disperses completely within 2 min [4]. Regular sugar-coated or film-coated tablets can generally be crushed; conversely, controlled-release (CR) and enteric coated (EC) tablets could not be grinded. Crushing these two types of dosage forms disturb their characteristics and may result in toxicities [5] or treatment failure [6]. Other dosage forms that should not be crushed include sublingual tablets or capsules, drugs sensitive to light or humidity, potential carcinogenic drugs, effervescent tablets, and soft-gel capsules with liquid inside [6]. Crushed tablets are the frequent cause of enteral tubes obstruction [1, 6, 7]. The rate of catheter occlusions are related to the number of solid medications given through these tubes [1, 8]. Liquid dosage forms are often appropriate alternatives, however, their sorbitol content may cause diarrhea [4, 7]. Syrups and elixirs with a pH of less than 5 may congeal certain formula [9, 10]. Errors also may occur due to inappropriate time interval between drug and meal administration. Catheters should be rinsed before and after each drug administration to prevent drug-food incompatibilities [11–13]. Another consideration is the location of the end of the tube and the main absorption site of the drug to avoid bypass drug absorption site [2, 9].

Nurses' knowledge related to enteral medication administration is essential to achieve optimal patient outcomes. This study was designed to determine the effectiveness of clinical pharmacist-led educational program in progressing the nurses' knowledge and practice regarding medications administration via enteral tubes.

Methods

This case–control study was carried out to compare nurses' knowledge and practices regarding drug delivery via enteral

feeding catheters before (pre-test) and after (post-test) implementation of the educational program by clinical pharmacist.

Study population

Registered nurses (RNs) in four ICUs of two hospitals were enrolled in the study. One hospital considered as case (intervention) and the other as control group. In the studied wards, nursing practice was primarily based on individual past experiences and consultation with colleagues, with older nurses teaching procedures to the younger RNs.

Procedure

This study was conducted in five separate steps: developing the questionnaire, pilot study, assessment of baseline knowledge and practice of nurses (pre-test), implementation of educational program, and finally evaluation of knowledge and practice of nurses again with a 3 months interval (post-test).

Questionnaire

A 37-item (19 yes/no and 18 multiple-choice questions) questionnaire was developed following an extensive literature review and mainly based on the findings of the same study by Hanssens et al. [14]. The questionnaire focused on the RNs' knowledge (30 items) and self-reported practice (7 items) in four different categories:

1. Medication preparation (solid drug crushing, dissolving, dilution) (6 items knowledge, 3 items practice)
2. Tube flushing before, between, and after medications' administration; restoring patency to occluded tubes (2 items knowledge, 2 items practice)
3. Recognizing drug–drug/drug–feed interactions (4 items knowledge, 2 items practice)
4. Recognizing dosage forms (Codes used by manufacturers for CR medications, purpose of synthesis, and the consequences of crushing these preparations) (18 items knowledge)

Furthermore, a 20-item, yes/no questions checklist was developed to extensively evaluate the practice of nurses regarding drugs administration through enteral tubes by observer. Criteria selected for the checklist was also based on evidence in the literature review.

1. Medication preparation (8 items)
2. Tube flushing pre, between, and post medication delivery; restoring patency to occluded tubes (4 items)
3. Recognizing drug–drug/drug–feed interactions (6 items)
4. Recognizing dosage forms (2 items)

Demographic information including age, sex, years of experience as an RN, and educational level of nurses were also collected.

Pilot study

To ascertain reliability, validity, and clarity of the questionnaire, a pilot test–retest study was conducted in 12 ICU-nurses of a teaching hospital that was not considered for main research. These nurses commonly administered enteral medications. There was a two weeks interval between test and re-test courses. Both courses were done in the same participants. Cronbach's alpha coefficient of more than 0.65 and kappa coefficient of more than 0.6 were considered as measures of internal consistency for the knowledge and practice questions respectively. Only minor revisions were made to the questionnaire based on the results of the pilot study.

Assessment of baseline knowledge and practice: pre-test

In order to assess baseline knowledge and practice regarding drug delivery through enteral tubes, the questionnaires were filled by all nurses in both case and control groups before the implementation of the educational program. Before distribution of the questionnaires, brief information sessions were held by the investigator clinical pharmacist, informing participants about the study objectives and participation requirements. The RNs were instructed to answer the questionnaire in relation to their knowledge and routine practice. Also, to evaluate the baseline nurses' practice, bedside disguised observations of the nurses regarding enterally medication administration were performed. All observations were recorded to pre-defined checklist questionnaire.

Implementation of educational program

A clinical pharmacist-led educational program was designed to reduce errors when administering medication through enteral tubes. In the case group, the following interventions were gradually implemented over a period of 1 month:

- An evidence-based, referenced booklet on the appropriate medication administration technique and dosage forms suitable for enteral feeding tubes, was prepared by the clinical pharmacist and educated to the enrolled nurses during one training session.
- A detailed working instruction was prepared containing proper materials for enterally administration of most highly used drugs in the ward. This working instruction was communicated to all nurses on the intervention

wards in daily ward visits by clinical pharmacist for 1 month.

Enrolled nurses in the control group did not receive any educational program or material.

Assessment of the influence of the educational program: post-test

Three months after completing the educational module, the nurses in both case and control groups took another test, which consisted of the same questions as the first test. Additionally, bedside observations of nursing practice regarding enteral drug administration were carried out in the two groups.

Measures

Study outcomes included RNs' knowledge and practice regarding medication administration through enteral tubes that is presented as the percentage of correct answers to questions and mean scores of each domain of the questionnaire at pre- and post-intervention phases of the study. Also, the frequency of medication administration errors was computed by dividing the number of observed errors by the total number of observations.

Data analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 13. Homogeneity or internal consistency of the knowledge and reliability of practice questions were assessed with Cronbach's alpha and kappa coefficients.

Independent sample *t* test was used to compare RNs in the two studied groups regarding age, years of practice as an RN, and level of education. To compare mean scores of questionnaires in pre- and post-phases of the study in each group, paired *t* test was used. Mc Nemar's test was performed to compare percent of nurses with correct answers in pre- and post- intervention phases in each group. A *p* value of <0.05 was considered statistically significant.

Ethics

The RNs' participation in the study was voluntary. They responded questionnaires anonymously. The study protocol was approved by local ethics committee of Tehran University of Medical Sciences.

Results

During pre-test phase of the study, 31 and 36 subjects in the case and control groups respectively, completed the questionnaire

and were observed for their practice regarding medication administration via enteral feeding catheters. The mean age of the participants in both groups was 32 years old. Women were predominant in both groups. Almost all participants in both groups had Bachelor degree in nursery science. The mean time of activity as a nurse was longer in the control group (Table 1). In post-intervention phase of the study 25 nurses in the case and 33 in the control groups completed the questionnaire and were observed for their practice. The reasons for drop-outs in the case group were maternity leave (three nurses) and transfer to another hospital (three nurses). Three patients were excluded in the post-intervention phase in the control group due to transfer to another hospital (one nurse), maternity leave (one nurse), and retirement (one nurse). At the initiation of the study, nurses in the case and control groups had comparable knowledge and practice regarding drug administration through enteral feeding tubes except in the recognizing dosage forms domain in the knowledge questions ($p < 0.001$) and tube flushing domain in the practice questions ($p = 0.001$) that were significantly better in the control group. Mean (median) scores and percent of patients with correct answers in each domain of questions have been compared between two groups in Table 2 through 5.

Table 1 Sex, age, level of education, and years of practice as a nurse in the case and control groups at the initiation of the study

	Case group	Control group	<i>p</i>
Sex (percent of females)	90.3	80.6	0.26
Age (years) (mean \pm SD)	32.1 \pm 4.4	32.7 \pm 3.3	0.52
Master degree (percent)	100 %	91.7 %	0.24
Years of practice as nurse (mean \pm SD)	5.5 \pm 3.3	7.3 \pm 3.3	0.03

Table 2 Mean and median scores of different domains of knowledge questions in the case and control groups, pre- and post-educational intervention

Knowledge question domain	Case group			Control group			<i>p</i> for comparing case and control group	
	Pre-intervention	Post-intervention	<i>p</i>	Pre-intervention	Post-intervention	<i>p</i>	Pre-intervention	Post-intervention
Medication preparation ^a	2.6 (3)	3.6 (4)	0.004	2.7 (2.5)	2.2 (2)	0.003	0.85	<0.001
Tube flushing ^b	1.1 (1)	1.3 (1)	0.57	0.9 (1)	0.7 (1)	0.32	0.11	0.08
Recognizing drug–drug/drug-feed interactions ^c	2.2 (2)	2.8 (3)	0.06	1.9 (2)	1.9 (2)	0.42	0.17	0.001
Recognizing dosage forms ^d	7.9 (8)	11 (11)	<0.001	9.8 (10)	10.2 (11)	0.5	<0.001	0.13

Data are presented as Mean (median)

^a Maximum score in this domain was 6

^b Maximum score in this domain was 2

^c Maximum score in this domain was 4

^d Maximum score in this domain was 18

Knowledge analysis

Mean and median scores of knowledge significantly increased in the case group in following domains: medication preparation, tube flushing, recognizing drug–drug/drug-feed interactions, and recognizing dosage forms. Mean and median scores of these domains remained without significant changes in the control group. Conversely, RNs knowledge regarding solid drug crushing decreased significantly in the control group.

Table 3 Shows number and percent of RNs with proper knowledge regarding different domains including medication preparation, tube flushing, recognizing drug interactions, and dosage forms. Percent of RNs with correct answers increased significantly in all domains in the case group. In contrast, these percents decreased or did not change significantly in the control group.

Practice analysis (self-reported questions)

In contrast to the control group, mean (median) of scores in question domain regarding tube flushing increased significantly in the intervention group (Table 4).

Number and percent of RNs with acceptable practice regarding drug administration via enteral tubes have been shown in Table 5. As seen, percentage of nurses with correct answer in question domains regarding their practice related to tube flushing and recognizing drug-interactions have increased in the case group.

Practice analysis (assessment by investigator observation)

Table 6 shows percent of RNs with correct performance according to the investigator observation in the case and control groups in pre- and post-intervention phases.

Table 3 Number (percent) of nurses with correct answers in different domains of knowledge questions in the case and control groups, before and after educational intervention

Knowledge question domain	Case group			Control group			<i>p</i> for comparing case and control group	
	Pre-intervention N = 31	Post-intervention N = 25	<i>p</i>	Pre-intervention N = 36	Post-Intervention N = 33	<i>p</i>	Pre-intervention	Post-intervention
Medication preparation	10 (32.3)	15 (60.0)	0.09	8 (22.2)	1 (3.0)	0.02	0.36	<0.001
Tube flushing	7 (22.6)	8 (32.0)	1.0	8 (22.2)	8 (24.2)	1.0	0.97	0.51
Recognizing drug–drug/drug-feed interactions	14 (45.2)	17 (68.0)	0.15	7 (19.4)	8 (24.2)	1.0	0.03	0.001
Recognizing dosage forms	6 (19.4)	17 (68.0)	<0.001	23 (63.9)	21 (63.9)	1.0	<0.001	0.73

Table 4 Mean and median scores of different domains of practice questions in the case and control groups, before and after educational intervention

Knowledge question domain	Case group			Control group			<i>p</i> for comparing case and control group	
	Pre-intervention	Post-intervention	<i>p</i>	Pre-intervention	Post-intervention	<i>p</i>	Pre-intervention	Post-intervention
Medication preparation ^a	1.4 (1)	1.3 (1)	0.45	1.6 (1)	1.7 (1)	0.33	0.50	0.08
Tube flushing ^b	0.9 (1)	1.3 (1)	0.03	1.4 (1.5)	1.3 (1)	0.33	0.001	0.94
Recognizing drug–drug/drug-feed interactions ^c	0.7 (1)	0.8 (1)	0.42	0.4 (0)	0.5 (0)	0.1	0.09	0.05

^a Maximum score in this domain was 3

^b Maximum score in this domain was 2

^c Maximum score in this domain was 2

Table 5 Number (percent) of nurses with correct answers in different domains of practice questions in case and control groups, before and after educational intervention

Knowledge question domain	Case group			Control group			<i>p</i> for comparing case and control group	
	Pre-intervention N = 31	Post-intervention N = 25	<i>p</i>	Pre-intervention N = 36	Post-intervention N = 33	<i>p</i>	Pre-intervention	Post-intervention
Medication preparation	2 (6.5)	1 (4)	0.11	8 (22.2)	8 (24.2)	0.22	0.07	0.04
Tube flushing	4 (12.9)	10 (40)	0.11	18 (50)	14 (42.4)	0.13	0.001	0.85
Recognizing drug–drug/drug-feed interactions	1 (3.2)	3 (12)	0.63	1 (2.8)	0 (0)	1.0	0.72	0.08

There are some faults in this evaluation due to the lack of solid drugs for tube administration and lack of proper liquid replacement formula at the time of observation that make exact comparing of pre- and post-test phases impossible.

Percent of medication errors that observed in the case group decreased from 43 % (268 error in 616 observed practice) in the pre-test phase to 27 % (115 errors in 425 observed practice) in the post-intervention phase.

Discussion

Medication administration through enteral tubes is basically nurses' responsibility [1–3] and usually done based on tradition and outdated information [15]. Many medication errors have been made at the administering stage, especially when medication has to be delivered through enteral feeding tubes. These errors include the grinding of dosage forms that should not be crushed and errors with

Table 6 Percent of nurses with correct observed practice in different domains of drug administrations through enteral catheters in the case and control groups, before and after educational intervention

Observed practice	Case group		Control group	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Medication preparation	10.74	11.80	12.98	11.65
Tube flushing	17.6	59.37	25	25
Recognizing drug–drug/ drug-feed interactions	5.85	24.35	14.48	7.15

respect to the administration technique (e.g. not rinsing the tube before, between, and after drug delivery) [4, 16]. This study was designed to first assess the knowledge and practice of acute care nurses regarding drug administration via enteral tube and secondly evaluate the role of educational programs provided by clinical pharmacist in improving the nurses' knowledge and practice in this scope.

We found that more than half of the nurses had insufficient baseline knowledge about solid dosage forms characteristics and rules of drug administration through enteral tubes, which are consistent with the findings of some other researchers [7, 14]. Our results were comparable to the findings of others who reported that majority of nurses stated giving EC and CR dosage forms via enteral tube when liquid ones were not available [7, 9, 17]. Additionally we found that integrated intervention program by clinical pharmacists that focuses on promoting correct administration of drugs via enteral feeding catheters significantly increased knowledge of nurses especially in the aspects of medication preparation, tube flushing, recognizing drug–drug/drug-feed interactions, and recognizing dosage forms characteristics. This finding is similar to the results of Van den Bemt et al. and Hanssens et al. [4, 14]. Based on the results of the present study, education programs by clinical pharmacists also improved questionnaire-based practice of nurses. Although percent of nurses who correctly answered practice questions increased in some domains, however, based on disguised observation these improvements were not really achieved. There was a theory–practice gap in our study that means the available theories did not actually use completely by nurses. This failure may be related to the authority of physicians not nurses in choosing dosage forms or ordering rules for medication administration through enteral catheters in Iran. The major limitation of similar studies was lack of such observations to clarify this theory–practice gap [14].

During an interventional study by Hanssens et al. at first nurses' knowledge and practice regarding drug administration via enteral tubes were assessed by a questionnaire. This questionnaire evaluated responders' knowledge regarding

the purpose of CR drugs preparation, codes used for CR medications, the consequence of crushing these products, and their interactions with enteral feeds or feeding tubes. Then, pharmacists provided a training program covering these aspects for nurses. This program significantly increased nurses' knowledge in recognizing CR codes, correct crushing of solid drugs, possible drug-feed/drug-feeding tube interactions, and correct drug administration via feeding tubes. Hanssens' study suffers from lack of control group, assessment of nurses' practice just by questionnaire and not by direct disguised observation, and very short time interval between pre- and post-education questionnaire assessment. Additionally, just 32 % of nurses who completed the questionnaire before and after the intervention were the same; therefore, this study cannot evaluate exactly the influence of training program in the same subjects [14]. All of their limitations were considered in our study to be avoided.

Idzinga et al. designed a before-after study to document all types of medication errors that happened by nurses. One of these mistakes was error in drug administration via enteral feeding tubes. In this study errors were detected by disguised observer that followed personnel when preparing and administering medications. After the initial evaluation, pharmacists provided training program. This program includes consultation regarding patients who received their medication through enteral tubes, advising suitable formulations or proper administration technique, and providing nurses a “medication through tube box” that contained proper materials for tablets crushing and suspending. Frequency of pre- and post-intervention errors was compared as outcome. The major limitations of this study were lack of control group and short interval between two phases of the study. Additionally observed nurses were only partly the same in the post-intervention period compared to the pre-intervention phase. In the pre-intervention phase of the study, a medication error rate of 64.5 % was reported that reduced to 30 % during post-intervention phase [16]. In our study medication errors regarding drug administration through enteral catheters reduced from 43 % in the pre-intervention phase to 27 % in the post-intervention period.

In two Dutch hospitals a multidisciplinary program was implemented to reduce errors of drug administration through enteral tubes. This program included introducing guidelines, educating nurses, patient visit by pharmacist for medication review and providing necessary comments for drug delivery via enteral tubes, placing contraindications of medication administering via enteral tubes in pharmacy computer and “do not crush icon” on unit dose of the special drugs. They assessed medication errors during drug administration and number of tube obstruction as outcomes before and after the intervention. They reported significant decrease in tube obstruction and administration error per nurse. The important limitation of this study was also the lack of control group [4].

Another descriptive study assessed nurses’ knowledge concerning proper medications administration through nasogastric and enteral tubes using a questionnaire [2]. Approximately 37 % of nurses stated that they disregard the dosage forms provided by the pharmacy at the time of drug administration through enteral tubes. About 65 % of nurses considered physicians as the main responsible of choosing dosage form and location of the end of the tubes for drug administration via enteral tubes. About 25 % believed that there is no difference in administering different dosage forms via those tubes. 51 % of nurses administered all drugs at the same time and with the same syringe [2].

To appropriately administer medication through enteral tubes, nurses need to have sufficient knowledge regarding drug dosage forms characteristics, available dosage forms of a specific drug, and correct handling techniques of drugs. Nurses and pharmacists collaboration increases the rate of using liquid dosage forms instead of solid ones when liquid forms are available. This replacement decreases the rate of enteral tube obstruction [1].

In another study, nurses were observed when preparing and administering drugs via enteral feeding catheters. In about 78 % of cases nurses diluted drugs by tap water. Tap water is not recommended for the drug preparation due to possible chemical incompatibility. More than 90 % of nurses mixed, grinded, and administered simultaneously all medications that were prescribed at the same time. Additionally, most nurses stopped enteral nutrition dripping at the moment of drug administration not 30 min before and after that, as recommended by literatures. In this study, more than 75 % of the assistants washed tube just after drug administration [18].

More than 66 % of nurses in Philips’ study administered tablets that did not grinded to fine powder via enteral tube. More than one-third stated that EC medications would be administered through enteral tubes. More than 20 % administered extended release tablets by this route. About 44 % specified using solid forms when liquid form was not

available on the unit even when available in the hospital pharmacy. About half of the nurses never flushed enteral tubes between medications delivery. Factors mostly affecting the practice of these nurses regarding medication administration via enteral tubes were experience, medication information, hospital policy, pharmacists’ advice, senior or more experienced nurses, and undergraduate education, respectively [3].

The best results in questionnaire-based assessment of nurses’ practice regarding drug administration through enteral tube are related to Schmieding et al. study. About 35 % of nurses stopped feeding for 30 min after giving medication, and 47 % of nurses would independently order a medication in liquid form if it had to be inserted through nasogastric tube. About 67 % of nurses called the pharmacy to get information about medication crushing [15].

Limitations of the study

The major limitation of this research was the lack of outcome assessment such as tube obstruction and patients’ morbidity or mortality.

Conclusion

Correct administration of medications via enteral feeding catheters remains a matter of concern. This study showed that in-hospital education of nurses by clinical pharmacists significantly improved nurses’ knowledge especially in the aspects of medication preparation, tube flushing, recognizing drug–drug/drug-feed interactions, and recognizing dosage forms characteristics. For the safety of patients, basic general knowledge concerning medications characteristics and key points regarding drug administration through enteral feeding tubes should be universalized for academic courses of nurses. Their in-hospital education programs should also include enteral medication administration. Evidence-based protocols should be provided, although, guidelines do not guarantee to change practice without an active implementation strategy.

Due to the role of physicians as major decision-maker in medication administration via enteral feeding tubes, this type of educational programs should be included in their undergraduate course and in-hospital seminars as well. In summary, correct administration of drugs via enteral catheters needs close collaborations between medical teams including physicians, pharmacists, and nurses.

Acknowledgments The authors wish to thank Dr Gita Salimi, pharmacist; Miss Hamidafar, head-nurse of intensive care unit, Imam Khomeini Hospital Complex, Tehran; and Miss Fatemeh Rabepoor educational supervisor nurse, Imam-Reza Hospital, Eslamshahr, Tehran for their invaluable helps.

Funding This study was part of a Pharm.D thesis supported by Tehran University of Medical Sciences.

Conflicts of interest The authors declare no conflict of interest.

References

1. Seifert CF, Johnston BA. A nationwide survey of long-term care facilities to determine the characteristics of medication administration through enteral feeding catheters. *Nutr Clin Prac.* 2005;20:354–62.
2. Mota ML, Barbosa IV, Studart RM, Melo EM, Lima FE, Mariano FA. Evaluation of intensivists-nurses' knowledge concerning medication administration through nasogastric and enteral tubes. *Rev Latino-Am Enfermagem* 2010;18(5):888–94.
3. Phillips NM, Endacott R. Medication administration via enteral tubes: a survey of nurses' practices. *J Adv Nurs.* 2011;. doi: [10.1111/j.1365-2648.2011.05688.x](https://doi.org/10.1111/j.1365-2648.2011.05688.x).
4. Van den Bemt PM, Cusell MB, Overbeeke PW, Trommelen M, Van Dooren D, Ophorst WR, Egbert ACG. Quality improvement of oral medication administration in patients with enteral feeding tubes. *Qual Saf Health Care.* 2006;15:44–7.
5. Schier JG, Howland MA, Hoffman RS, Nelson LS. Fatality from administration of labetalol and crushed extended-release nifedipine. *Ann Pharmacother.* 2003;37:1420–3.
6. Estoup M. Approaches and limitations of medication delivery in patients with enteral feeding tubes. *Crit Care Nurse.* 1994;14:68–79.
7. Belknap DC, Seifert CF, Petermann M. Administration of medication through enteral feeding catheters. *Am J Crit Care.* 1997;6(5):382–92.
8. Bnson DW, Griggs BA, Hamilton F, Hiyama DT, Bower RH. Clogging of feeding tubes: a randomized trial of a newly designed tube. *Nutr Clin Prac.* 1990;5:107–10.
9. Phillips NM, Nay R. A systematic review of nursing administration of medication via enteral tubes in adults. *J Clin Nurs.* 2008;17:2257–65.
10. Cutie AJ, Altman E, Lenkel L. Compatibility of enteral products with commonly employed drug additives. *J Parenter Enteral Nutr.* 1983;7:186–91.
11. Engle KK, Hannawa TE. Techniques for administering oral medications to critical care patients receiving continuous enteral nutrition. *Am J Health Syst Pharm.* 1999;56(14):1441–4.
12. British association for Parenteral and enteral nutrition (BAPEN). 2004 Administering drugs via enteral tubes: a practical guide. Available at; http://www.bapen.org.uk/res_drugs.html. Accessed 24 June 2007.
13. White R, Bradnam V. Handbook of drug administration via enteral feeding tubes. London: RPS publishing of Royal Pharmaceutical Society of Great Britain; 2007.
14. Hanssens Y, Woods D, Alsulaiti A, Adheir F, Al-Meer N, Obaidan N. Improving oral medicine administration in patients with swallowing problems and feeding tubes. *Ann Pharmacother.* 2006;40:2142–7.
15. Schmieding NJ, Waldman RC. Nasogastric tube feeding and medication administration: a survey of nursing practice. *Gastroenterol Nurs.* 1997;20(4):118–24.
16. Idzinga JC, de Jong AL, van den Bemt LA. The effect of intervention aimed at reducing errors when administering medication through enteral feeding tubes in an institution for individuals with intellectual disability. *J Intellect Disabil Res.* 2009;53(11):932–8.
17. Seifert CF, Johnston BA, Rojas-Fernandez C. Drug administration through enteral feeding catheters. *Am J Health Syst Pharm.* 2002;59(4):378–9.
18. Heydrich J, Heineck I, Bueno D. Observation of preparation and administration of drugs by nursing assistants in patients with enteral feeding tube. *Braz J Pharm Sci.* 2009;45(1):117–20.