Title: Drug Administration via Enteral Feeding Tubes in Residential Care Facilities for Individuals with Intellectual Disability: An Observational Study

Authors: Joos, Elke, Els Mehuys, Jan Van Bocxlaer, Jean Paul Remon, Myriam Van Winckel, Koen Boussery

In: *Journal of Intellectual Disability Research* 59 (3): 215–225

DRUG ADMINISTRATION VIA ENTERAL FEEDING TUBES IN RESIDENTIAL CARE FACILITIES FOR INDIVIDUALS WITH INTELLECTUAL DISABILITY: AN OBSERVATIONAL STUDY

Running Head: Drug administration via feeding tube in institutions

Keywords: intellectual disability, residential care facility, medication, enteral feeding tube, gastrostomy, guidelines

Elke Joos [1] (MSPharm), Els Mehuys [2] (MSPharm PhD), Jan Van Bocxlaer [3] (MSPharm PhD) Jean Paul Remon [4] (MSPharm PhD), Myriam Van Winckel [5] (MD PhD) and Koen Boussery [6] (MSPharm PhD).

[1] Pharmaceutical Care Unit, Faculty of Pharmaceutical Sciences, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. E-mail: elke.joos@ugent.be Tel: +32 92648073. Fax: +32 92648197.

[2] Pharmaceutical Care Unit, Faculty of Pharmaceutical Sciences, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. E-mail: els.mehuys@ugent.be Tel: +32 92648043. Fax: +32 92648197.

[3] Department of Bioanalysis, Faculty of Pharmaceutical Sciences, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. E-mail: jan.vanbocxlaer@ugent.be Tel: +32 92648130. Fax: +32 92648197.

[4] Pharmaceutical Care Unit, Faculty of Pharmaceutical Sciences, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. E-mail: jeanpaul.remon@ugent.be Tel: +32 92648054. Fax: +32 92228236.

[5] Department of Paediatrics, Ghent University Hospital, De Pintelaan 185, B-9000 Ghent, Belgium. E-mail: myriam.vanwinckel@uzgent.be Tel: +32 93323966. Fax: +32 93323875.

[6] Pharmaceutical Care Unit, Faculty of Pharmaceutical Sciences, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. E-mail: koen.boussery@ugent.be Tel: +32 92648110. Fax: +32 92648197.

Corresponding author:

E Joos, Pharmaceutical Care Unit, Ghent University, Harelbekestraat 72, B-9000 Ghent, Belgium. Tel: +32 92648073. Fax: +32 92648197. E-mail: elke.joos@ugent.be

Acknowledgements:

The authors would like to thank the participating institutions and their staff members. The authors would also like to thank Liesbeth Bogaert for her help in data collection.

ABSTRACT

Background

The administration of oral medication to patients with an enteral feeding tube (EFT) is challenging. Compliance to guidelines concerning medication administration via EFT has been investigated extensively in the hospital setting. However, studies in residential care facilities (RCFs) for individuals with intellectual disability (ID) are very limited. Therefore, the present study aimed to collect direct observational data on drug administration practices to residents with EFT in multiple RCFs.

Method

This cross-sectional, observational study was conducted in six Belgian RCFs for individuals with ID. Observations of medication preparation and administration through EFT were carried out in two randomly selected units per participating RCF, on two days per unit during all daytime drug rounds, using a direct observation method. Afterwards, the recorded observations were compared with international guidelines on drug preparation and administration through EFT.

Results

In total, 862 drug preparations and 268 administrations in 48 residents with EFT were witnessed. Mixing together multiple drugs, not diluting liquid formulations with at least an equal amount of water, not shaking suspensions/emulsions before use, and not selecting the most appropriate dosage form were the most common deviations from medication preparation guideline recommendations. For medication administration, not flushing the EFT with at least 15mL water was the most common deviation. We also observed high variability in working methods regarding medication preparation and administration via EFT, even between staff members of the same unit.

Conclusion

This study found that current guidelines concerning medication preparation and administration through EFT are often not followed in Belgian RCFs for individuals with ID. Further research aimed at understanding why current guidelines are not followed seems warranted.

INTRODUCTION

Feeding problems are highly prevalent in people with intellectual disabilities (ID). Severe/profound ID is often associated with problems regarding feeding skills (e.g. motor coordination and muscle tone) and with an increased aspiration risk (Gal et al. 2011). Therefore, this population often depends on an enteral feeding tube (EFT) for both feeding and the administration of drugs (Gal et al. 2011;White and Bradnam 2007). The administration of oral medication through the feeding tube is however challenging and may present some pitfalls. Firstly, when no appropriate liquid dosage form is available, solid dosage forms are often crushed and suspended in an amount of water to enable drug administration through the EFT (Bankhead et al. 2009;Williams 2008). However, not all oral solid dosage forms are suitable for crushing. In case of sustained release formulations (when administered through gastrostomy as well as jejunostomy), crushing leads to an immediate release of the total drug dose, which is higher than the total drug dose in regular immediate release formulations (Bankhead et al. 2009;White & Bradnam 2007). This may cause drug toxicity, as was demonstrated by a case in which a crushed sustained release nifedipine tablet led to a patient fatality (Schier et al. 2003). In case of enteric coated formulations (when administered through gastrostomy), crushing may result in loss of drug efficacy or irritation of the gastric mucosa (depending on the reason for enteric coating) (White & Bradnam 2007). Secondly, inappropriate drug formulations may cause tube obstructions; e.g. the administration of bulk-forming laxatives or inadequately crushed tablets, or the administration of a “cocktail” of several oral dosage forms, possibly together with feeding, is associated with an increased risk for tube clogging (White & Bradnam 2007;Williams 2008). Thirdly, concurrent administration of oral medication and enteral feeding may lead to drug-nutrient interactions; e.g. concurrent administration of enteral feed and phenytoin leading to a reduced phenytoin absorption and therapeutic effect (Boullata and Hudson 2012;Lourenco 2001;White & Bradnam 2007;Wohlt et al. 2009). Similarly, mixing together multiple drugs for administration through EFT may result in physicochemical incompatibilities (Bankhead, Boullata, Brantley, Corkins,

Guenter, Krenitsky, Lyman, Metheny, Mueller, Robbins, & Wessel 2009;White & Bradnam 2007). These unwanted and often unforeseen risks with drug administration through the EFT, can lead to patient harm or even death (Schier et al. 2003). Besides, administering a drug via an EFT usually falls outside the terms of the drug's product license, resulting in the prescriber, dispenser and administrator becoming liable for any harm that occurs from taking the medication (White & Bradnam 2007).

To reduce these risks, guidelines for the administration of medication through EFT have been issued. These include careful selection and preparation of appropriate dosage forms, withholding feeding during drug administration, separate administration of drug doses and adequate flushing of the EFT (Bankhead et al. 2009;White & Bradnam 2007). However, research investigating whether these special precautions are actually followed in residential care facilities (RCFs) for individuals with ID is limited to two studies from the Netherlands. *Van den Bemt et al.* studied the frequency of drug administration errors in one RCF for residents with ID (with and without EFT) (van den Bemt et al. 2007). They found that errors were common and that drug administration via EFT was a determinant associated with errors (odds ratio 189.66; 95% confidence interval). In a follow-up study, the same authors evaluated the effect of an intervention program designed to reduce errors when administering medication through EFT (Idzinga et al. 2009). This program showed to be effective, although the proportion of administration errors after the intervention was still considered high (in particular the EFT related preparation errors). In the hospital setting, compliance to guidelines concerning drug administration via EFT has been studied more extensively (Bertsche et al. 2010;Ech-chaouy et al. 2007;Heydrich et al. 2009;Kelly et al. 2011;Lonergan et al. 2010;Triki et al. 2012;van den Bemt et al. 2006). These studies all observed deviations from guidelines to a certain extent (e.g. mixing several drugs together, crushing of modified-release formulations, not flushing EFTs,…) (Ech-chaouy et al. 2009;Kelly et al. 2011;Triki et al. 2012;van den Bemt et al. 2006). Moreover, a recent study investigating the role of the clinical pharmacist in improving medication administration through EFT, found that most nurses did not have sufficient knowledge about rules of drug administration via

EFT (Dashti-Khavidaki et al. 2012). In RCFs for people with ID, medication is mainly administered by non-medically trained staff (e.g. educators) (Joos et al. 2013), which may lead to even more errors. In addition, residents with ID are especially at risk for medication errors due to their high medication use (Idzinga et al. 2009) and the fact that they may not be aware of errors because of their cognitive impairment (van den Bemt et al. 2007).

Therefore, the present study aimed to collect direct observational data on drug administration practices to patients with EFT in several RCFs for people with ID.

METHODS

STUDY DESIGN AND SETTING

This cross-sectional, observational study was conducted from March to June 2012 in RCFs for individuals with an ID in Belgium. We approached six randomly selected RCFs with at least 10 residents with EFT. All six agreed to participate. The RCFs included in this study are relatively large campus-style accommodations. They offer (semi-) residential care to people with mild to profound ID (often associated with other disabilities), who cannot be cared for at home. These RCFs provide medical, pedagogic, psychological and social services, and are often linked to special schools. Approval for the study was granted by the local Ethical Committee. All directors of the RCFs and the observed staff members gave written informed consent. For the observed residents we used an opt-out arrangement (i.e. residents' parents or guardian were offered the opportunity to opt-out of study participation by signing an opt-out form) (Junghans et al. 2005;Vellinga et al. 2011).

DATA COLLECTION

Observations of medication administration through EFT were carried out in two randomly selected units of the participating RCFs. A unit is a living group of approximately 10 residents, where daily care and support is provided by educators and/or caretakers and/or nurses. A direct observation method (Allan and Barker 1990;Barker et al. 2002) was used with two observers witnessing preparation and administration of drugs through EFT on two random days per unit, during all daytime drug rounds (from 6 am to 9 pm). The observers wrote down exactly what the nurses did during the preparation and administration of medication. Data recorded included resident codes, drug product, dosage form, amount of drug, and all procedures related to medication preparation (e.g. tablet crushing) and administration (e.g. stopping enteral feeding). Afterwards, the recorded observations were compared with international guidelines on drug preparation and administration through EFT (Bankhead et al. 2009;Boullata 2009;British Association for Parenteral and Enteral Nutrition 2013;White & Bradnam 2007). An expert panel of three pharmacists (E.J., E.M., K.B.) selected the

A.S.P.E.N. guidelines (Bankhead et al. 2009;Boullata 2009), and the Handbook of Drug Administration via Enteral Feeding Tubes by (White & Bradnam 2007) as guideline standards. As these guidelines do not provide a concrete advice concerning the dilution of medication before administration through the EFT, a literature review on this topic was undertaken that identified several extra recommendations (American Society of Consultant Pharmacists 2013;British Association for Parenteral and Enteral Nutrition 2013;Wohlt et al. 2009). All recommendations agree on the necessity of diluting (American Society of Consultant Pharmacists 2013;Bankhead et al. 2009;Boullata 2009;British Association for Parenteral and Enteral Nutrition 2013;White & Bradnam 2007;Wohlt et al. 2009), but there seems to be inconsistency regarding the amount of liquid used. For liquid medication, the recommendations vary from 'dilute as appropriate' (Bankhead et al. 2009;Boullata 2009), over 'dilute with an equal amount' (British Association for Parenteral and Enteral Nutrition 2013), or 'with 10-30mL' (American Society of Consultant Pharmacists 2013), to 'dilute with at least with 30mL' (Wohlt et al. 2009). Therefore, the expert panel decided to select the minimal, concrete advice available in these guidelines as guideline standard, i.e. 'dilute with an equal amount'. For dilution of solid medication, 'dilute with at least 10mL' was chosen as the minimal, concrete advice. The guidelines for respectively medication preparation and medication administration are detailed in Table 1 and 2 (first column). In addition, the following resident characteristics were collected: age, sex, weight, severity of ID, type and size of EFT, and type of enteral feeding regimen.

DATA ANALYSIS

Descriptive data analysis was performed using Microsoft Excel 2010. All data were processed anonymously.

RESULTS

The parents of one resident opted out of study participation. A total of 11 nurses and 28 educators/caretakers were observed during the study period. Altogether 862 drug preparations and 268 administrations (one administration is defined as one administration moment to one resident, independent of the number of drugs administered at that moment) in 48 residents with EFT were witnessed. Resident characteristics are displayed in Table 3. Residents received multiple medications via EFT, with a median of six per resident (range 1-14). We also noticed that there were differences in working methods during medication preparation and administration, not only between the RCFs, but also between units in the same RCF, and sometimes even within the same unit.

Medication preparation

About 55% of the prepared drugs (470/862) were solid dosage forms (Table 4), with 1.7% (15/862) being non-crushable (i.e. sustained release formulations for administration through gastrostomy as well as jejunostomy, and enteric coated formulations for administration through gastrostomy). These formulations included sustained release formulations of valproic acid (n=4) and carbamazepine (n=3), and enteric coated formulations of omeprazole (n=4), esomeprazole (n=2) and pantoprazole (n=2). Valproic acid (121/862), baclofen (70/862) and levetiracetam (58/862) were the three most frequently prepared drugs (Table 5).

Table 1 summarizes all recommendations found in literature relating to medication preparation procedures, as well as the frequency of their relevance and their implementation in our observations. Mixing together multiple drugs was the most common deviation from guidelines. About two thirds (69%, 599/862) of the prepared drugs were mixed together before administration, which generated 165 cocktails. These cocktails were combinations of 2 drugs (53/165, 32%), 3 drugs (47/165, 28%), 4 drugs (19/165, 12%), or ≥5 drugs (46/165, 28%; max. 8 drugs). Other frequently observed deviations from guidelines were: not diluting liquid formulations with at least an equal amount of water, crushing different tablets together, not shaking suspensions/emulsions before use,

and not selecting the most appropriate dosage form. Only about half (210/392, 54%) of the liquid dosage forms were diluted with at least an equal amount of water, whereas forty-five per cent (177/392) of them were not diluted at all. A total of 155 drugs was crushed. We observed considerable variability in crushing methods: in 64% conventional crushing devices were used (commercial pill crusher (63/155) or pestle and mortar (36/155)), while in 36% non-conventional devices were used (pestle and metal cup (42/155), or two metal cups (14/155)). We noticed that crushing devices were often shared and not cleaned between drug preparations for different residents. Hence, cross-contamination was possible in 45 of 268 (17%) medication administrations. In all residents, at least one deviation from medication preparation guidelines was observed.

Drugs were prepared ≤15 min (499/862), 16-30 min (132/862), 31-60 min (58/862), and > 60 min (170/862) before administration to the resident (max. 21h). In three cases (3/862), the time span between preparation and administration could not be determined as the prepared drug was not administered (resident went home or was too nauseated).

Medication administration

Table 2 summarizes all recommendations found in literature relating to medication administration procedures, as well as the frequency of their relevance and their implementation in our observations. When comparing our observations of medication administration with guidelines, we found that not flushing the EFT with at least 15mL water before and after drug administration, not using a syringe of ≥ 30 mL in size for drug administration, not elevating the resident's backrest ≥ 30°, and not rinsing the medicine cup were the most common deviations. For most observations flushing between drug administrations was not applicable since all drugs administered at one administration moment were mixed together as a cocktail. The guideline stating that the EFT needs to be flushed with at least 15mL water before, between and after medication administration, was not followed in most cases; respectively in 98.9% (265/268), 98.8% (82/83), and 33.6% (90/268) of administrations. However, it is relevant to note that in some of these cases, the EFT was flushed with less than 15mL

water before, between or after medication administration; respectively in 3.7% (10/268), 14.5% (12/83), and 10.4% (28/268) of the observations. We also noticed that in one RCF, EFTs were consistently flushed with cola. In all residents, at least one deviation from medication administration guidelines was observed.

DISCUSSION

Main findings

This cross-sectional observational study found that current guidelines concerning medication preparation and administration through EFT are often not followed in Belgian RCFs for individuals with ID.

Regarding medication preparation, **mixing together two or more drugs** was the most frequent deviation from guidelines (observed in about 2/3 of prepared medication). Whether mixing together different medications actually results in physicochemical incompatibilities should be studied experimentally case-by-case as this depends on various factors (i.e. the physicochemical properties of the active ingredients as well as the excipients). Incompatibility is thus difficult to predict (Bankhead et al. 2009), and therefore guidelines recommend to avoid mixing medications. The second most frequent deviation from guidelines was **not diluting liquid medication** (observed in about half of liquid medication), which is recommended to reduce viscosity, and, consequently, the resistance to flow through an EFT (Bankhead et al. 2009;Boullata 2009). For example for liquid dosage forms of carbamazepine and phenytoin, it has been shown that dilution prior to administration is associated with improved delivery of the drug dose to the distal end of the tube (Clark-Schmidt et al. 1990;Seifert et al. 1993). Another common deviation from guidelines was **not shaking suspensions/emulsions** before use (observed in about half of prepared suspensions/emulsions). This leads to a high variability in the doses administered, and consequently to underdosing and therapeutic failure on one occasion, and overdosing and potential toxicity on another (GrieBmann et al. 2007). This was demonstrated by an experimental study of the consequences of not shaking an amoxicillin suspension, which revealed manifest dosing errors (e.g. doses <10% of the labeled content) (GrieBmann et al. 2007). In our sample, the unshaken suspensions contained the antibiotics azithromycin, ciprofloxacin, trimethoprim-sulfamethoxazole and the antiepileptic drug carbamazepine. It seems likely that not shaking these formulations will

have clinical consequences for the patient. Additionally, although not occurring frequently, we observed **crushing of modified-release dosage forms** (i.e. sustained release formulations for administration through gastrostomy as well as jejunostomy, and enteric coated formulations for administration through gastrostomy). In our sample, crushed sustained release formulations contained valproic acid and carbamazepine. Crushed enteric coated formulations contained proton pump inhibitors (PPI) (es)omeprazole and pantoprazole. PPIs are known to be very acid labile molecules, e.g. the degradation half-life of omeprazole is <2 minutes at pH2 (Pilbrant 2013). Treatment failure due to crushing omeprazole has been reported (Cornish 2005).

Regarding medication administration, **not flushing** the EFT with at least 15mL water (before, between and after medication administration) was a frequent deviation from guidelines. Flushing of the EFT is recommended in order to prevent tube blockage, to avoid possible physicochemical interactions, and to prolong the life of the EFT (Bankhead et al. 2009). One RCF in our sample consistently flushed with cola instead of water (the preferred flushing solution (Bankhead et al. 2009;Dandeles and Lodolce 2011;White & Bradnam 2007)). Cola is an acidic fluid and can cause or exacerbate EFT occlusions by causing feed to coagulate or protein to denature (White & Bradnam 2007).

Notwithstanding guidelines are often not followed, also **good practice** was observed. During drug preparation, in the majority of the observations solid medication was diluted with at least 10mL water, the most suitable drug formulation was chosen, and hard gelatin capsules were opened and contents were mixed with water. Regarding medication administration, medication was never added directly to an enteral feeding formula, and tubes were mostly flushed with the preferred flushing solution water.

Another important finding is the high **variability** in working methods regarding medication preparation and administration via EFT, even between staff members of the same unit. This is consonant with our previous study on the entire medication management process, where a large

variation in procedures was identified between the participating RCFs (n=34), and even between units within the same RCF (Joos et al. 2013).

Comparison with literature and possible strategies to improve guideline adherence

To the best of our knowledge, only the study of *Idzinga et al.* focused on medication administration through EFT in an **RCF for individuals with ID**. They described that preparation errors occurred in 37% of (baseline) observations, and also identified not flushing the EFT as the main administration error, although this deviation occurred less frequently than in our observations (in respectively 2%, 11%, and 1% of observations, EFTs were flushed before, between and after medication administration) (Idzinga et al. 2009). *Idzinga et al*. also evaluated an intervention program that addressed these issues, and included communicating to the pharmacist which clients have EFT, advice on medication administration via EFT by the pharmacist, a 'medication through tube' box, and training sessions. This program was found to be effective, although the proportion of administration errors after the intervention was still considered high.

The results of our study are also in line with previous research in the **hospital setting** (Ech-chaouy et al. 2007;Heydrich et al. 2009;Seifert et al. 2002;Triki et al. 2012;van den Bemt et al. 2006), where mixing together medications, crushing of sustained release formulations, and not flushing the EFT were reported. Reported percentages of mixing together medications range from 38% to 98% of the observations (Ech-chaouy et al. 2007;Triki et al. 2012;van den Bemt et al. 2006), whereas crushing of sustained release formulations for administration through the EFT ranges from 3% to 5% of the observations (Ech-chaouy et al. 2007;Triki et al. 2012). Concerning the issue of flushing the EFT, mainly flushing before (not flushed in 11%-100% of observations (Ech-chaouy et al. 2007;Triki et al. 2012;van den Bemt et al. 2006) and between (not flushed in 100% of observations (Ech-chaouy et al. 2007;Triki et al. 2012)) drug administrations was not performed in the hospital setting (Ech-chaouy et al. 2007;Heydrich et al. 2009;Triki et al. 2012;van den Bemt et al. 2006). Intervention programs in this setting have shown to be effective in improving medication administration through EFT. The

intervention in the study of *van den Bemt et al.* (van den Bemt et al. 2006) consisted of daily ward visits by pharmacy technicians, introducing working instructions, and "enteral feeding tube" and "do not crush" indications. It resulted in a decrease in the number of tube obstructions and to a significant decrease in the number of administration errors per nurse. *Dashti-Khavidaki et al.* (Dashti-Khavidaki et al. 2012) found that an integrated educational program (i.a. booklet on administration technique/dosage forms, training session, and detailed working instruction) significantly improved knowledge and practice of nurses. Medication errors in the intervention group decreased from 43 % pre-intervention to 27 % post-intervention.

Strengths and limitations

To our knowledge, this is the first study describing in detail medication administration via EFT in multiple RCFs. However, our study also had some limitations. Main limitation is that we did not assess whether the observed guideline deviations actually caused patient harm, such as patient morbidity and/or mortality. However, in view of the relatively low incidence of these effects, a much larger sample size would be needed, which was beyond the scope of our study. Another limitation is the concern about the unexpected and unexplained reactivity to the observations of the staff members who are aware of their participation in a study, also known as the Hawthorne effect (Adair 1984). However, concern that observers would make the observed staff member more careful (preventing errors and thus underestimating deviations) or more nervous (leading to more mistakes) seems unfounded when they are doing an activity familiar to them (Allan & Barker 1990;Dean and Barber 2001). Finally, because of the time consuming nature of the observation method, observations were limited to two workdays (from 6 am to 9 pm), and drug administrations at nighttime or during the weekend were not observed. As staffing is lower during weekends and nights, frequency of guideline deviations may therefore even be underestimated.

Implications for practice and future research

Our observations demonstrate the need for practical, unequivocal recommendations and education programs on the administration of drugs via EFT in this setting. For example, the inappropriate crushing in our study may have been avoided if the delivering pharmacist had known which residents receive their medication through EFT, combined with the development and implementation of clear and practical local guidelines in each RCF, and training sessions for staff members. This type of training could reduce inappropriate crushing, as already demonstrated in an intervention study in nursing homes (Verrue et al. 2010). However, before implementing an intervention program, further research is needed to better understand why current guidelines are not followed by staff members of RCFs for individuals with ID. According to *Idzinga et al*., the small effect of the intervention on the EFT related preparation errors could partly be explained by the lack of information provided by the pharmacy (only part of the medication on the administration record was accompanied by a pharmacy advice on the correct mode of administration), and partly by the nurse attendants not following up on the pharmacy advices (Idzinga et al. 2009). In order to know exactly what the reasons are for not following guidelines, qualitative research in this area is needed. Based on this knowledge, an appropriate intervention with unequivocal, practicable guidelines can be set up and implemented in order to improve medication administration through EFT in individuals with ID.

References

ADAIR, J. G. (1984) The Hawthorne Effect - A Reconsideration of the Methodological Artifact. *Journal of Applied Psychology*, 69, (2) 334-345.

ALLAN, E. L. & BARKER, K. N. (1990) Fundamentals of Medication Error Research. *American Journal of Hospital Pharmacy*, 47, (3) 555-571.

AMERICAN SOCIETY OF CONSULTANT PHARMACISTS (2013) Medication Administration via Enteral Tubes.

BANKHEAD, R., BOULLATA, J., BRANTLEY, S., CORKINS, M., GUENTER, P., KRENITSKY, J., LYMAN, B., METHENY, N. A., MUELLER, C., ROBBINS, S. & WESSEL, J. (2009) A.S.P.E.N. Enteral nutrition practice recommendations. *JPEN J.Parenter.Enteral Nutr.*, 33, (2) 122-167.

BARKER, K. N., FLYNN, E. A. & PEPPER, G. A. (2002) Observation method of detecting medication errors. *American Journal of Health-System Pharmacy*, 59, (23) 2314-2316.

BERTSCHE, T., BERTSCHE, A., KRIEG, E. M., KUNZ, N., BERGMANN, K., HANKE, G., HOPPE-TICHY, T., EBINGER, F. & HAEFELI, W. (2010) Prospective pilot intervention study to prevent medication errors in drugs administered to children by mouth or gastric tube: a programme for nurses, physicians and parents. *Qual.Saf Health Care*.

BOULLATA, J. I. (2009) Drug Administration Through an Enteral Feeding Tube. *American Journal of Nursing*, 109, (10) 34-42.

BOULLATA, J. I. & HUDSON, L. M. (2012) Drug-Nutrient Interactions: A Broad View with Implications for Practice. *Journal of the Academy of Nutrition and Dietetics*, 112, (4) 506-517.

BRITISH ASSOCIATION FOR PARENTERAL AND ENTERAL NUTRITION (2013) Administering Drugs Via Enteral Feeding Tubes - A Practical Guide.

CLARK-SCHMIDT, A. L., GARNETT, W. R., LOWE, D. R. & KARNES, H. T. (1990) Loss of carbamazepine suspension through nasogastric feeding tubes. *Am.J.Hosp.Pharm.*, 47, (9) 2034-2037.

CORNISH, P. (2005) "Avoid the crush": hazards of medication administration in patients with dysphagia or a feeding tube. *Canadian Medical Association Journal*, 172, (7) 871-872.

DANDELES, L. M. & LODOLCE, A. E. (2011) Efficacy of Agents to Prevent and Treat Enteral Feeding Tube Clogs. *Annals of Pharmacotherapy*, 45, (5) 676-680.

DASHTI-KHAVIDAKI, S., BADRI, S., EFTEKHARZADEH, S. Z., KESHTKAR, A. & KHALILI, H. (2012) The role of clinical pharmacist to improve medication administration through enteral feeding tubes by nurses. *Int.J.Clin.Pharm.*, 34, (5) 757-764.

DEAN, B. & BARBER, N. (2001) Validity and reliability of observational methods for studying medication administration errors. *American Journal of Health-System Pharmacy*, 58, (1) 54-59.

ECH-CHAOUY, A., GIESENFELD, A., ZIEGLER, O. & QUILLIOT, D. (2007) Drugs and enteral nutrition: audit on the galenic, the crushing and the method of administration. ***Nutrition Clinique et Metabolisme*****, 21, (3) 115-119.**

GAL, E., HARDAL-NASSER, R. & ENGEL-YEGER, B. (2011) The relationship between the severity of eating problems and intellectual developmental deficit level. ***Research in Developmental Disabilities*****, 32, (5) 1464-1469.**

GRIEBMANN, K., BREITKREUTZ, J., SCHUBERT-ZSILAVECZ, M. & ABDEL-TAWAB, M. (2007) Dosing accuracy of measuring devices provided with antibiotic oral suspensions. ***Paediatric and Perinatal Drug Therapy*****, 8, (2) 61-70.**

HEYDRICH, J., HEINECK, I. & BUENO, D. (2009) Observation of preparation and administration of drugs by nursing assistants in patients with enteral feeding tube. ***Brazilian Journal of Pharmaceutical Sciences*****, 45, (1) 117-120.**

IDZINGA, J. C., DE JONG, A. L. & VAN DEN BEMT, P. M. L. A. (2009) The effect of an intervention aimed at reducing errors when administering medication through enteral feeding tubes in an institution for individuals with intellectual disability. ***Journal of Intellectual Disability Research*****, 53, 932-938.**

JOOS, E., MEHUYS, E., VAN BOCXLAER, J., REMON, J. P., VAN WINCKEL, M. & BOUSSERY, K. (2013) Medication management in residential care facilities for individuals with intellectual disability: an observational study. IN Journal of Policy and Practice in Intellectual Disabilities (Ed.). ***Accepted for publication.***

JUNGHANS, C., FEDER, G., HEMINGWAY, H., TIMMIS, A. & JONES, M. (2005) Recruiting patients to medical research: double blind randomised trial of "opt-in" versus "opt-out" strategies. ***British Medical Journal*****, 331, (7522) 940-942.**

KELLY, J., WRIGHT, D. & WOOD, J. (2011) Medicine administration errors in patients with dysphagia in secondary care: a multi-centre observational study. ***Journal of Advanced Nursing*****, 67, (12) 2615-2627.**

LONERGAN, M. T., BRODERICK, J., COUGHLAN, T., COLLINS, R. & O'NEILL, D. (2010) A majority of tube-fed patients are on medications that require special precautions. ***Age and Ageing*****, 39, (4) 495-496.**

LOURENCO, R. (2001) Enteral feeding: drug/nutrient interaction. ***Clin.Nutr.*****, 20, (2) 187-193.**

PILBRANT, A. (2013) ***Formulation of proton pump inhibitors*****, Capsugel.**

SCHIER, J. G., HOWLAND, M. A., HOFFMAN, R. S. & NELSON, L. S. (2003) Fatality from administration of Labetalol and crushed extended-release nifedipine. ***Annals of Pharmacotherapy*****, 37, (10) 1420-1423.**

SEIFERT, C. F., JOHNSTON, B. A. & ROJAS-FERNANDEZ, C. (2002) Drug administration through enteral feeding catheters. ***Am.J.Health Syst.Pharm.*****, 59, (4) 378-379.**

SEIFERT, C. F., MCGOODWIN, P. L. & ALLEN, L. V. (1993) Phenytoin Recovery from Percutaneous Endoscopic Gastrostomy Pezzer Catheters After Long-Term In-Vitro Administration. ***Journal of Parenteral and Enteral Nutrition*****, 17, (4) 370-374.**

TRIKI, E., FENDRI, S., DAMMAK, H., BOUAZIZ, M. & SFAR, S. (2012) Drug's administration via feeding tubes: Evaluation of practices in an intensive care unit of a Tunisian hospital. ***Annales Francaises D Anesthesie et de Reanimation*****, 31, (7-8) 596-599.**

VAN DEN BEMT, P. M. L. A., CUSELL, M. B. I., OVERBEEKE, P. W., TROMMELEN, M., VAN DOOREN, D., OPHORST, W. R. & EGBERTS, A. C. G. (2006) Quality improvement of oral medication administration in patients with enteral feeding tubes. ***Quality & Safety in Health Care*****, 15, (1) 44-47.**

VAN DEN BEMT, P. M. L. A., ROBERTZ, R., DE JONG, A. L., VAN ROON, E. N. & LEUFKENS, H. G. M. (2007) Drug administration errors in an institution for individuals with intellectual disability: an observational study. ***Journal of Intellectual Disability Research*****, 51, 528-536.**

VELLINGA, A., CORMICAN, M., HANAHOE, B., BENNETT, K. & MURPHY, A. W. (2011) Opt-out as an acceptable method of obtaining consent in medical research: a short report. ***Bmc Medical Research Methodology*****, 11.**

VERRUE, C. L., MEHUYS, E., SOMERS, A., VAN MAELE, G., REMON, J. P. & PETROVIC, M. (2010) Medication Administration in Nursing Homes: Pharmacists Contribution to Error Prevention. ***Journal of the American Medical Directors Association*****, 11, (4) 275-283.**

WHITE, R. & BRADNAM, V. (2007) ***Handbook of Drug Administration via Enteral Feeding Tubes*** **Pharmaceutical Press.**

WILLIAMS, N. T. (2008) Medication administration through enteral feeding tubes. ***American Journal of Health-System Pharmacy*****, 65, (24) 2347-2357.**

WOHLT, P. D., ZHENG, L., GUNDERSON, S., BALZAR, S. A., JOHNSON, B. D. & FISH, J. T. (2009) Recommendations for the use of medications with continuous enteral nutrition. ***American Journal of Health-System Pharmacy*****, 66, (16) 1458-1467.**

Tables & figures

Table 1 Medication preparation: recommendations found in literature, and the frequency of their relevance and implementation in our sample of 862 observed drug preparations

Guideline	Guideline relevant	Observations NOT compliant with guideline		Top 3 drugs involv compliance
	n	n	%*	
Avoid mixing together medications [a,b]	862	599	69,5%	N.a.**
Dilute liquid medication with at least an equal amount of water [d]	392	182	46,4%	Valproic acid levetiracetam omeprazole
Do not crush tablets together [c]	155	130	83,9%	N.a.**
Shake suspensions/emulsions thoroughly before use [a,b]	127	65	51,2%	Alginic acid domperidone omeprazole
Select most suitable formulation ǂ [a,b]	862	58	6,7%	Levetiracetam carbamazepi levodopa/benser lorazepam
Dilute solid medication with at least 10mL of water [d]	470	29	6,2%	Baclofen (topiramate phenobarbit
Open hard gelatin capsules (if allowed) and mix contents with water [a,b]	134	28	20,9%	Phenobarbita baclofen (glycopyrronium b and nitrofuran
Do not crush sustained release dosage forms [a,b]	7	7	100,0%	Valproic aci carbamazepi
Do not crush enteric coated dosage forms in case of gastrostomy [a,b]	8	6	75,0%	Esomeprazo omeprazole pantoprazo
Use protective equipment when crushing drugs like hormones or antibiotics [b]	6	6	100,0%	Levothyroxine s

* Percentage calculated on $n_{relevant}$

** Not applicable

ǂ If available, use liquids or dissolvable/dispersible tablets

[a] (Bankhead, Boullata, Brantley, Corkins, Guenter, Krenitsky, Lyman, Metheny, Mueller, Robbins, & Wessel 2009))

[b] (White & Bradnam 2007)

[c] (Boullata 2009)

[d] (British Association for Parenteral and Enteral Nutrition 2013)

Table 2 Medication administration: recommendations found in literature, and the frequency of their relevance and implementation in our sample of 268 observed drug administrations

Guideline	Guideline relevant	Observations NOT compliant with guideline	
	n	n	%*
Before medication administration, flush with at least 15mL water [a,b]	268	265	98.9%
Administer using a syringe ≥30mL in size [a]	268	165	61.6%
Elevate the backrest to a minimum of 30° [a,b]	268	130	48.5%
If used, ensure that the medicine cup is rinsed with water [b]	243	130	53.5%
After medication administration, flush with at least 15mL water [a,b]	268	90	33.6%
Between drugs, flush with at least 15mL water [a,b]	83	82	98.8%
Preferred flush solution is water [a,b]	246	44	17.9%
Temporarily hold administration of the enteral nutrition formula during medication administration [a,b]	106	37	34.9%
Hold the feeding by 30min or more when separation is indicated [a]	4	4	100.0%
Do not add medication directly to an enteral feeding formula [a,b]	268	0	0.0%

* Percentage calculated on $n_{relevant}$

[a] (Bankhead, Boullata, Brantley, Corkins, Guenter, Krenitsky, Lyman, Metheny, Mueller, Robbins, & Wessel 2009)

[b] (White & Bradnam 2007)

Table 3 Resident characteristics

Resident characteristics	*n=48*
Age (years), median (range)	15.0 (3-62)
Male sex	22
Weight (kg), mean (SD)	34.7 (13.5)
Grade of ID	
Severe (IQ 20-39)	2
Profound (IQ<20)	46
Tube type	
Gastrostomy	47
Jejunostomy	1
Tube size	
10 French	4
14 French	22
15 French	4
16 French	5
18 French	5
Size unknown	8
Type of feeding regimen	
Continuous	0
Cyclic	6
Intermittent	34
Bolus	4
No enteral feeding	4
Number of drugs via EFT per resident, median (range)	6.0 (1-14)
Number of administration moments per day	
1	1
2	3
3	25
4	12
5	2
6	4
7	1

Data are presented as n, unless indicated otherwise.

Table 4 Galenic form of the prepared medications (n=862)

		n	*(%)*
solid	Tablets	295	(34.2)
	Non-dispersible		
	crushable	*211*	*(24.5)*
	non-crushable *	*15*	*(1.7)*
	Dispersible	*69*	*(8.0)*
	Capsules	134	(15.5)
	Openable	*134*	*(15.5)*
	Non-openable	*0*	*(0.0)*
	Powder/granules	41	(4.8)
liquid	Solutions	265	(30.7)
	Suspensions	124	(14.4)
	Emulsions	3	(0.3)

* i.e. sustained release formulations in all cases, and enteric coated formulations for administration through gastrostomy

Table 5 Top 10 most frequently prepared drugs (n=862)

ATC Code	Drug name	n	(%)
N03AG01	Valproic acid	121	(14.0)
M03BX01	Baclofen	70	(8.1)
N03AX14	Levetiracetam	58	(6.7)
N03AX09	Lamotrigine	48	(5.6)
A02BC01	Omeprazole	47	(5.5)
N03AE01	Clonazepam	28	(3.2)
A02BX13	Alginic acid	27	(3.1)
A03FA03	Domperidone	26	(3.0)
N03AA02	Phenobarbital	25	(2.9)
N05BA09	Clobazam	23	(2.7)