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Adaptation of solid oral medicines for administration through enteral tubs and stomies: integrative review

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RESUMO

The objective of the present study is to identify, through integrative review, whether form adaptations farmacêuticas orais sólidas quando administrados por sondas enterais e estomias podem comprometer a segurança e eficácia terapêutica e qual o perfil de uso dessas adaptações na prática clínica. A literature search was conducted between August and September 2024 in the LILACS, Medline, SCIELO, and Scopus databases. A total of 148 records were identified, with 17 studies included in the final integrative review. Biopharmaceutical clinical trials and cross-sectional pharmacoepidemiological studies were included. We evaluated biopharmaceutical aspects: solubility, stability, adsorption, and obstruction of enteral tubes and ostomies, adaptation methods, and the prevalence of this practice in different healthcare settings and populations. Adaptations of solid oral medications are common practices in various settings and populations. Crushing, opening capsules and dividing tablets must be properly evaluated by healthcare professionals in order to avoid loss of the physical and chemical stability of the medication, its clinical efficacy, which may lead to an increase in adverse effects or toxicity. Because adaptations of solid dosage forms are a globally applied practice, instruments such as the creation of flowcharts and clear and detailed institutional protocols that guide which medications can be crushed, dispersed, or use an alternative solvent to water must be developed, and physicians, nurses, pharmacists, and caregivers must be trained.

Palavras-chave: Pharmacoepidemiology, enteral nutrition, pharmaceutical preparations.

INTRODUCTION

Medication administration through enteral feeding tubes is a necessary practice for patients who are unable to swallow solid oral dosage forms due to a swallowing condition or gastrointestinal tract dysfunction[1,2].

Naturally, as the prevalence of enteral nutrition occurs, the frequency of modification of solid oral dosage forms also increases globally, whether by partitioning, grinding, or transforming them into dispersions using solvents, usually water, when liquid oral formulations for many drugs are not available[3,4].

Although commonly recognized among professionals as a widespread practice, reports on adaptations of solid oral dosage forms with the aim of achieving the dose or facilitating its administration through enteral tubes/stomas are limited. This practice may affect dosage accuracy, bioavailability, the integrity of the dosage form and its stability, and may jeopardize the safety and efficacy of treatments[5].

In this context, the preparation of this integrative review is justified, in order to synthesize the scientific evidence from available pharmacoepidemiological studies on the phenomenon of adaptation of solid pharmaceutical forms for administration through enteral tubes and ostomies, given the significant variability in the knowledge and use of these practices among health professionals.

Thus, this study aimed to identify whether adaptations of solid oral pharmaceutical forms when administered through enteral tubes and ostomies can compromise therapeutic safety and efficacy and what the use profile of these adaptations is in clinical practice.

MATERIALS AND METHODS

The first stage of the review consisted of choosing and delimiting the topic, formulated by the PICO strategy (P = patients with enteral tubes or ostomies; I = administration of solid oral medications; C = adaptation of solid oral medications by grinding, partitioning or dispersion; O = compromise of safety and therapeutic efficacy), from which the following research question was formulated: Can adaptations of solid oral medications when administered through enteral tubes and ostomies compromise safety and therapeutic efficacy? And what is the pharmacoepidemiological profile of the use of these adaptations in clinical practice?

The next step involved searching for and retrieving articles in the LILACS, Medline, SCIELO, and Scopus databases. A search strategy was applied using the Health Sciences Descriptors (DeCS) in english: drug, pharmaceutical preparations, enteral nutrition, nasogastric tube, gastric tube, enteral tube, enteral feed, orogastric tube, nasogastric feeding, gastric feeding, oroenteric tube, intubation, gastrointestinal, and terms in Portuguese: medication, pharmaceutical preparations, enteral nutrition, nasogastric tube, gastric tube, enteral tube, enteral feeding, orogastric tube, nasogastric feeding, gastric feeding, oroenteric tube, feeding tube, gastrointestinal intubation. For each search strategy, the operators AND, OR, or NOT were used.

The inclusion criterion adopted was a temporal cut of articles published in the last 10 years (2014 to 2023), applying the restriction criteria for language: English, Portuguese or Spanish. The data used in this review were collected during the days August 1 to September 1, 2024.

The review considered studies that included children, adults, and elderly individuals in any care setting with any of the following enteral tubes in situ: orogastric, nasogastric, nasoduodenal, nasojejunal, gastrostomy, or jejunostomy.

To recover as much data as possible that is relevant to clinical practice, the types of studies were restricted. Consequently, this review includes a heterogeneous set of quantitative studies. We chose to exclude editorials, protocols, reviews, experience reports, and theoretical reflections that addressed drug-enteral nutrition interactions or enteral nutrition alone.

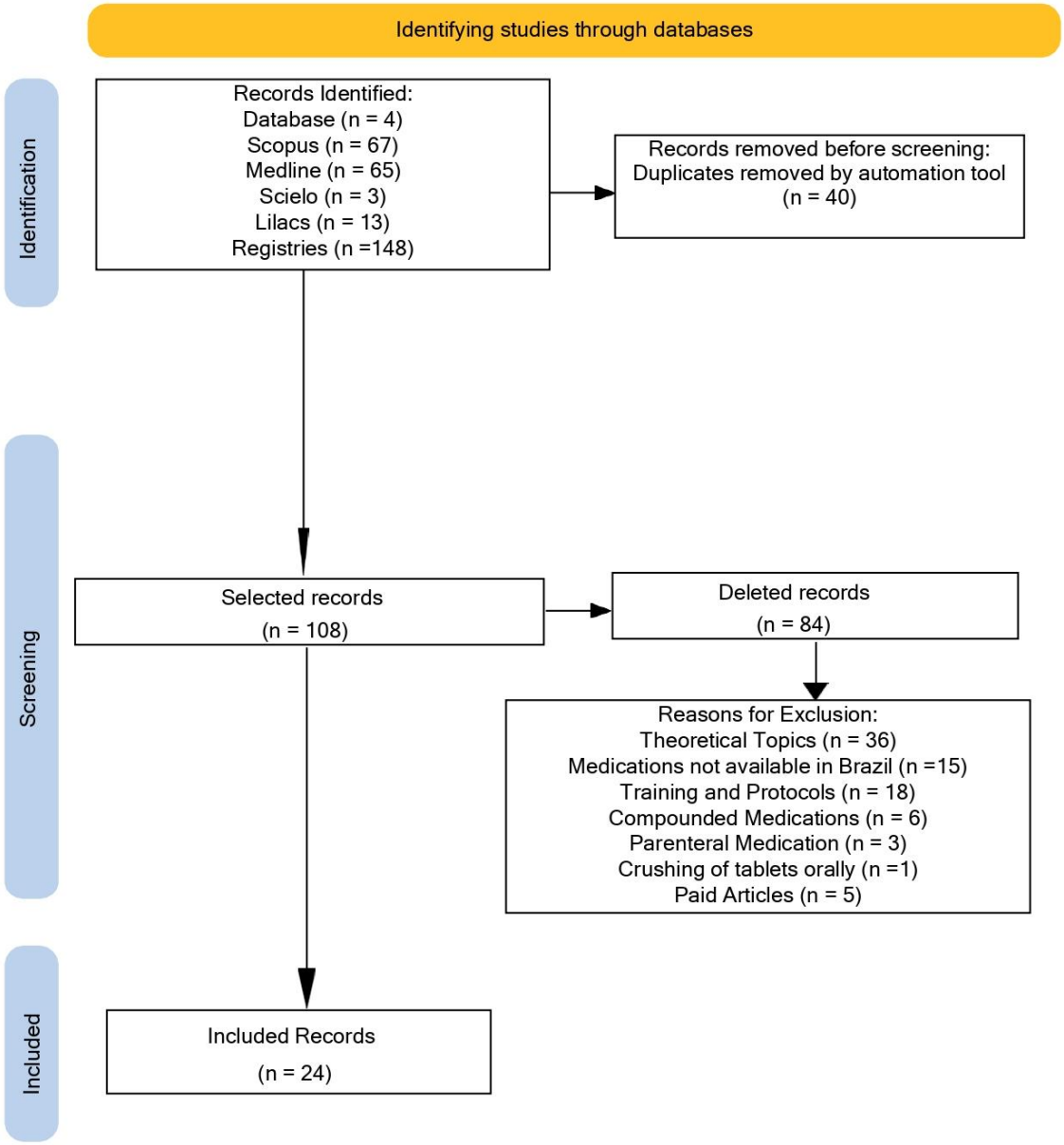
The search results from the electronic databases were imported into Rayyan (rayyan.ai), where duplicates were excluded. Studies were initially assessed for inclusion by two independent reviewers (JA and DV) by examining the title and abstract.

The full texts of the remaining articles were then assessed for eligibility. Full-text articles were independently assessed for inclusion by two reviewers (JA and DV). Disagreements between reviewers throughout the screening process were resolved through discussion, through which the reviewers reached consensus.

RESULTS

A total of 148 records were identified in the initial database search. After removing 40 duplicates, 108 records remained. After title and abstract screening, 84 records were excluded. A full-text review was conducted for 24 articles against the inclusion and exclusion criteria, resulting in 17 articles being included. The study selection process is described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart, version 2020. (Figure 1).

Figure 1- Flowchart of identification, exclusion and final eligibility of selected articles.



Source: Prepared by the authors, 2025.

Data from the included studies were entered into a Microsoft Excel® 2021 spreadsheet to gather data from eligible studies related to author/year of study, country of publication, population, objective, study methodology, and relevant results. The characteristics of the studies included in the review are summarized in Table 1.

Table 1. Presentation of results and key elements for each article described.

Author/year	Country	Study methodology	Population	Objective	Results
Phogole, CM, et al. 2024 [10].	South Africa	In vitro clinical experimental	There was no population studied	To identify physicochemical factors that contribute to lower plasma concentrations of antituberculosis drugs when crushed and administered via NGT.	The addition of ascorbic acid may overcome the low solubility and stability associated with crushed TB drugs dissolved in water and administered via NGT.
Sommerfeldt, J., et al.2024 [1].	Germany	Cross-sectional observational Retrospective	151 patients aged between 70.7 and 77.1 years.	Estimate how often solid medications are administered via NGT and analyze the potential risks associated with administration based on physicochemical properties.	The most critical medications to be administered through feeding tubes are considered to be furosemide, levodopa, and levothyroxine, as they show relevant instabilities under administration conditions and substantial dietary effects.
Bifari, N., et al.2024 [2].	Saudi Arabia	Cross-sectional observational Prospective	46 geriatric patients aged ≥ 65 years using medications via enteral tube in a home setting.	Assess the suitability of medications for administration via enteral tube, whether they were crushable or not.	The main cause of medication errors was the administration of medications unsuitable for administration through enteral feeding tubes, mainly because most medications were controlled-release or enteric-coated formulations.
Kasahun, A.E., Sendekie, A.K.Are.2023 [5].	Ethiopia	Observacional transversal-prospectivo	275 pediatric patients under 18 years of age.	To investigate the frequency, nature, and appropriateness of pill manipulations in neonatal and pediatric patients in two public hospitals in Ethiopia.	In neonates, the tablets were handled in scatters, while in adolescents, the tablets were handled primarily in smaller divisions. The study revealed that off-label use of tablets for pediatric age groups is very common in Ethiopia.
Polo, A.V., et al.2022 [16].	Spain	Observacional transversal-prospectivo	34 patients. Median age 68 years (range 44-79).	To describe and analyze the degree of adequacy of prescription of medications administered by percutaneous gastrostomy in patients with ALS and enteral nutrition.	Through the percutaneous gastrostomy route, 267 oral medications were prescribed, 81.65% were solid forms, and the pharmaceutical form was modified in 43%, due to the risk of catheter occlusion, toxicity or loss of efficacy, affecting 97% of patients.
Teder, K., et al.2022 [3].	Estonia	Cross-sectional observational Retrospective	113 adult and elderly ICU patients. Mean sample age 67 years (range 21-91)	Describe which drug formulations and how they were administered via enteral tubes to ICU patients and analyze the pharmaceutical forms and drug formulations used and information on their preparation for administration (crushed, dispersed, diluted).	A total of 306 medication administrations via feeding tubes were documented and analyzed, 67% of which were solid oral dosage forms. Exactly 91.2% of these were conventional tablets. Eighty-eight percent of the medications were classified as suitable for administration via feeding tubes. The majority (93%) of the solid dosage forms were crushed, including all modified-release dosage forms (extended-release tablets, extended-release capsules,

					and gastro-resistant tablets). Overall, eight medication formulations should not have been administered via enteral tubes because they are non-dispersible and should not be crushed (two extended-release tablets, one extended-release capsule, and one gastro-resistant tablet).
Lorente, V.P-F., et al.2021 [11].	South Africa	Observacional transversal-prospectivo	19 newborns. Postnatal age with mean of 8 days (7–13 days)	To evaluate the pharmacokinetics of crushed immediate-release levetiracetam tablets administered to neonates to terminate seizures.	The pharmacokinetics of crushed levetiracetam tablets administered to neonates are similar to those of the unchanged oral formulation of levetiracetam. Similar pharmacokinetics were observed in participants who received levetiracetam via nasogastric or orogastric tube or orally.
Spilios, M., Altshuler, R.S.2021 [14].	United States	Cross-sectional observational Retrospective	122 adult and elderly ICU patients. Mean age 62.2-62.4 years	To evaluate the safety and feasibility of crushed sevelamer tablets for administration via enteral feeding tube.	Sevelamer tablets may be crushed and administered through enteral feeding tubes, provided that clear instructions on tablet preparation are included.
Hoover, A., et al.2021 [15].	United States	In vitro clinical experimental	There was no population studied.	To develop in vitro methods to assess the risk of clogging during the administration of two orally disintegrating lansoprazole tablets through enteral feeding tubes.	Gastrostomy tubes had the highest risk of clogging compared to NGT and JGT tubes. Furthermore, larger particles and a higher amount of insoluble excipients observed in lansoprazole resulted in more irreversible clogging of the enteral tube than in comparison to pantoprazole. In vitro methods can be used to assess in vitro equivalence and to assess the risk of administering a drug through an enteral feeding tube.
Undre, N., Baccarani, U.,Britz, R. Popescu I. 2019 [6].	United Kingdom	Randomized controlled clinical trial	10 adult patients.	To investigate the pharmacokinetic profile of prolonged-release tacrolimus when administered via a nasogastric tube, after opening the capsule, administered immediately after transplantation.	Nasogastric administration of extended-release tacrolimus suspension in liver transplant patients did not substantially affect the pharmacokinetic profile of tacrolimus compared with intact capsules. Nasogastric administration is therefore a viable option for ensuring appropriate early exposure to tacrolimus in liver transplant recipient.
Daniel, E., et al.2019 (7).	United Kingdom	In vitro clinical experimental	There was no population studied.	To investigate the recovery of hydrocortisone after passage through NGT in vitro for three formulations: liquid suspension, crushed tablets	Hydrocortisone content was variable, and recovery was low after preparation in the syringe and before passage through the NGT. Washing

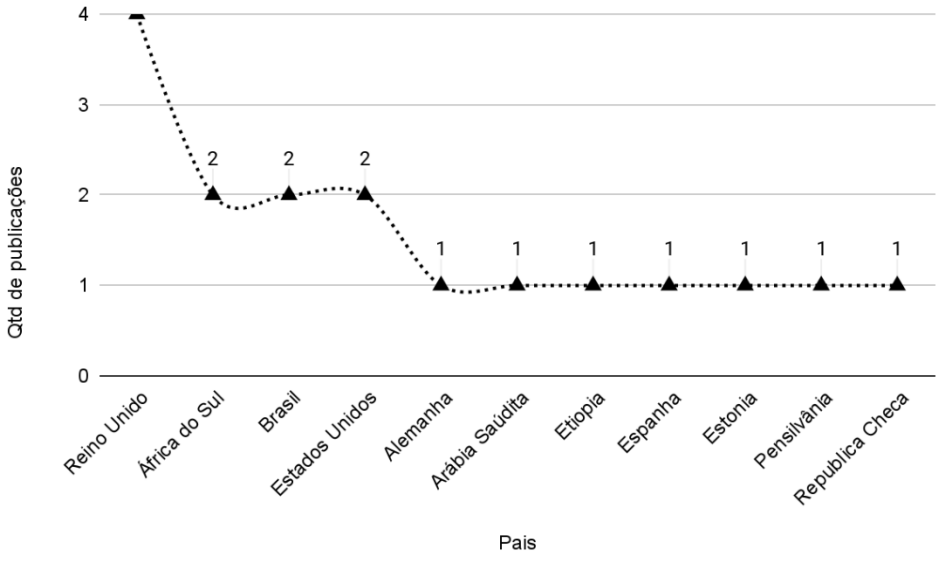
				mixed with water, and hydrocortisone granules designed for oral administration in children.	the administration syringe increased recovery. Administration of hydrocortisone granules occluded 6- and 8-Fr NGTs; however, administration using a sampling needle to prevent granules from being administered yielded a recovery of 74%–98%.
Beserra, M.P.P., et al.2017 [12].	Brazil	In vitro clinical experimental	There was no population studied.	Improve knowledge about medication administration through enteral feeding tubes in order to minimize efficacy and safety problems.	Dispersion was "satisfactory" for 82 (75.9%) of the medications; they were classified as capable of being dispersed in water in the oral syringe for subsequent administration via EFTs without the need for crushing. Using the dispenser instead of the syringe for medication administration was safer because the dispensing device did not fit into the intravenous medication administration equipment.
Undre, N., Dickinson, J. 2016 [8].	United Kingdom	In vitro clinical experimental	20 male participants, aged between 18 and 55 years old.	To evaluate the relative bioavailability of extended-release tacrolimus suspension versus intact capsules in healthy participants.	The relative bioavailability of the orally administered extended-release tacrolimus suspension was similar to that of the intact capsules. Bioavailability was lower with the suspension administered via nasogastric tube compared to the intact capsules.
Silva, M. F. B. DA ., et al. 2016 [13].	Brazil	Cross-sectional observational	There was no population studied.	To describe the profile of standardized oral medications in a hospital unit and verify their suitability for use through enteral catheters, according to recommendations in the literature.	Of the 236 oral medications dispensed, 86% (203) were in solid form; of these, 32 were "non-crushable", with liquid form available at the institution. 60% of them had specific recommendations regarding their administration via enteral tube.
Teng, R., Carlson, G., Hsia, J.2015 [9].	United Kingdom	Randomized clinical trial	36 healthy volunteers between 18 and 50 years of age	To compare the bioavailability and safety profile of crushed ticagrelor tablets suspended in water and administered orally or via nasogastric tube with those of whole tablets administered orally.	Plasma concentrations of ticagrelor were higher with crushed tablets administered orally or via nasogastric tube compared with whole tablets. Tmax of ticagrelor was shorter after administration of crushed tablets than whole tablets. All treatments were generally well tolerated.
Boullata, A.M., Boullata, J.I.2015 [17].	Pennsylvania	In vitro clinical experimental	There was no population studied.	To study the dissolution and physicochemical effects of delayed-release pancrelipase preparation in a sodium bicarbonate solution prior to	The only Creon dose that completely dissolved within 30 minutes was the 24.000 lipase unit dose. None of the Pancrease doses and only the

				administration via enteral feeding tube.	lowest dose (23.000 lipase units) of Ultresa completely dissolved within 30 minutes. However, Zenpep doses of 20.000 and 40.000 lipase units completely dissolved within 30 minutes of preparation. Higher doses of each pancrelipase product did not completely dissolve.
Ruzsíková, A,2015 [18].	Czech Republic	In vitro clinical experimental	There was no population studied.	Determine the losses of various dosage forms administered by different methods by SNG.	The crushing-and-dilution method has proven to be the most effective for all tablet types. Discharging the drug through the NGT causes greater losses during administration than crushing and transfer. All methods for intact pellets have been deemed unsuitable for clinical use due to NGT clogging.

(SNG=nasogastric tube); (TB=Tuberculosis); (ELA=Amyotrophic Lateral Sclerosis). Source: Prepared by the authors, 2025.

The included studies were conducted in the following countries: four studies from the United Kingdom[6,7,8, 9] two studies in South Africa [10,11]; Brazil [12,13] and United States [14, 15] and a study in Germany [1], Saudi Arabia [2], Ethiopia [3]; Spain [16]; Estonia [3]; Pennsylvania [17] and Czech Republic[18].

Figure 2 - Graphical representation of the scientific production of articles included in the review by country



Source: Prepared by the authors, 2025

Of the 17 studies, seven were cross-sectional observational studies [1,2,5,16,3,14,13], eight were in vitro experimental clinical studies [10,15,11, 7,12,8,17,18] and two were randomized controlled experimental clinical studies [6,9].

The number of patients participating in eleven studies ranged from twenty [8] two hundred and seventy-five [5] in the largest study. Nine of the studies included patients in hospital settings[1,5, 16,3, 11,14, 6, 8, 9], and one study included patients at home [2].

Nine studies provided the age of participants as follows: adolescents and adults <65 years[14,8,9], elderly >65 years old[1,2,16,3], neonates with an average age of 8 days [11]; children <18 years old [5]. One study did not provide the age of participants but referred to patients as adults[6].

Three articles addressed the solubility and stability profile of solid medications when administered through enteral tubes/stomas [10,12]; four articles describe bioavailability[11,6,8,9] and three articles dealt with adsorption to the tube wall and the risks of obstruction of enteral tubes [15,7,18].

The reasons given for the adaptation of solid pharmaceutical forms were present in seven articles, in which the adaptations occurred due to the use of enteral tubes/stomas [2, 5,16,3, 14,13]. In this review, four studies predominantly addressed the type of enteral device used for medication administration. Three studies reported the use of medications via NGT. [2,3,14] and one by Percutaneous Gastrostomy [16].

The most reported method of adapting the solid pharmaceutical form was trituration[2,3,14], partition[5] and opening the capsule. [2,3,13] Five retrospective studies calculated the rate of solid dosage form modifications as a percentage of the number of observed drug administrations from patient chart reviews[2,5,16,3,13].

Pharmacoepidemiologically, the prevalence of prescribing solid dosage forms for administration via tubes was documented in the different studies included here. The prescribing profile varied across ICU settings [14,3], home [1,2], pediatric ward [5] and in a hospital environment without defining the hospitalization unit[13,16].

DISCUSSION

The solubility of solid medications administered through enteral tubes/stomas was evaluated by different studies using laboratory techniques [21,22] and use of replicable solvents in clinical settings, such as 20mg/mL Ascorbic Acid solution to increase the solubility of anti-tuberculosis drugs[10] and Sodium bicarbonate 8.4% in pancreatic enzymes 40.000 UI [17].

It is important to consider that the solubility of a drug is the rate-limiting stage of

absorption and that it varies from drug to drug [27]. Additionally, formulation factors such as particle size, formulation excipients, or coating type may influence drug absorption. [17,19,20,21,22]

For enteric-coated medications, generally in the form of capsules with granules, it appears to be feasible to prepare them using solubilization techniques in a compatible solvent, such as suspending them in thick fruit juice such as apple juice, to provide stability when passing through gastric fluids and being absorbed enterally[15,23,24,25,26].

The water solubility of 108 solid pharmaceutical forms (tablets, capsules and dragees) was evaluated in an observational study, which identified that only the combined formulation of rifampicin, isoniazid, pyrazinamide and ethambutol tablets did not disperse in a volume of 10 mL of water compared to the 82 items analyzed and that 10 medications formulated in tablets, capsules and prolonged-release tablets after the crushing technique did not disperse, considered unsuitable for administration through enteral tubes/stomas, since they could obstruct the tubes or generate therapeutic ineffectiveness [12].

At the same time, aspects related to adsorption to the probe wall that lead to drug losses were evaluated by different studies[7,18], as well as the potential for obstruction.[15] There is a varied adsorption profile when different hydrocortisone formulations were tested and that crushed tablets and granules dispersed in water after administration by SNG in vitro, showed a loss between 46% and 30% and 78% and 71% of the administered dose, respectively [7].

Comparatively in the study of Ruzsiková et al.,[18] six different pharmaceutical forms were tested: plain tablet (Solatol); enteric-coated tablet (pantoprazole), plain film-coated tablet (clopidogrel), powder-filled capsule (Lactobacillus), capsules containing prolonged-release pellets (Theophylline), capsules with gastro-resistant pellets (omeprazole), showing that the different dosage forms differ in losses, but that all forms of preparation for administration of medications through probes are associated with losses < 10% [18].

The presence of water-insoluble excipients and particle size of solid medications are factors that may contribute to obstruction of enteral tubes, such as those observed in the study with orally disintegrating tablets of Lansoprazole 15 mg and 30 mg, in which lansoprazole 30 mg showed less susceptibility to clogging of nasogastric and jejunal tubes compared to gastrostomy tubes due to differences in formulation[15].

Studies included in this review evaluated the pharmacokinetic bioavailability profile of enterally administered drugs. Crushed levetiracetam tablets administered via NGT/SOG revealed similar pharmacokinetics to orally administered tablets. However, the failure to establish a complete pharmacokinetic profile and the absence of a control group do not provide support for evaluating the efficacy of crushed tablets in neonatal seizures. This necessitates

prospective controlled studies to adequately assess their efficacy[11].

A study conducted with 20 healthy participants to evaluate the characteristics of a single dose of prolonged-release tacrolimus (10 mg) and tolerability, identified that the relative bioavailability of the prolonged-release tacrolimus suspension administered orally was similar to that of the intact capsules, and that the bioavailability was lower with the suspension administered via nasogastric tube compared to the intact capsules[8].

In contrast to previously reported findings in healthy volunteers, nasogastric administration of extended-release tacrolimus suspension in liver transplant patients did not substantially affect the pharmacokinetic profile of tacrolimus vs. intact capsules, indicating that extended-release tacrolimus capsules can be opened and administered as a suspension via nasogastric tube[6].

Another randomized clinical study with 36 healthy patients compared the bioavailability and safety profile of crushed ticagrelor tablets suspended in water and administered orally or via nasogastric tube with those of whole tablets administered orally.9 Ticagrelor is an orally administered, direct-acting P2Y12 receptor antagonist used clinically for the prevention of atherothrombotic events in patients with acute coronary syndromes [28].

The results indicate that when compared to administration of ticagrelor as a whole tablet, administration as a crushed tablet (orally or via nasogastric tube) resulted in significantly higher plasma concentrations of ticagrelor in a shorter time for the crushed tablet and that crushing had no significant effect on overall exposure to ticagrelor[9].

The site of medication administration is extremely important, especially when the tube is post-pyloric, as it is more physiological. Medication absorption may be reduced due to the abnormal absorption site, as the pH difference between the stomach and intestines affects the solubility of pH-dependent medications[30].

Access to alternative dosage forms through tablet manipulation is a routine procedure worldwide that occurs in hospital or home settings 31, with a tendency to prescribe solid medications in the pharmaceutical form of simple tablets for administration through enteral tubes as an alternative to the absence of liquid formulations[3,14,5,2,13].

It should be noted that not all solid dosage forms are suitable for crushing, including those with a sustained-release formulation or enteric coating. Crushing medications can also lead to a risk of exposure to teratogenic substances or other effects when exposed to aerosolized particles[32,33].

In the retrospective review study of medical records of adult ICU patients that primarily evaluated the incidence of feeding tube obstruction or the need for replacement after

crushing sevelamer tablets for administration through an enteral feeding tube, it was identified that cases of tube obstruction occurred in only one of the fourteen tubes and that in the series of patients who continued to receive the medication after obstruction there was no recurrence, suggesting that the obstruction phenomenon was probably multifactorial, due to the increase in tube feeding and use of esomeprazole[14].

In the pediatric context, tablet manipulation (splitting or dispersing a tablet) to obtain the optimal pediatric dose occurs because adequate doses for pediatrics and neonates, especially in enteral nutrition situations, are often not available[34, 35].

In a prospective, direct observational approach, we investigated the frequency, nature, and appropriateness of tablet compounding in neonatal and pediatric patients at two public hospitals in Ethiopia. A total of 303 tablet compoundings occurred in prescriptions for 275 pediatric patients. Twenty-nine (69%) of the dispensed tablets were divided into smaller fractions due to the lack of a dosage form suitable for school-age children [5].

In 48 (15.8%) of the tablet manipulations in dispersions, practically insoluble drugs were involved (phenytoin, carbamazepine, furosemide, zinc phosphate, Artemether + Lumefantrine and albendazole), whose manipulation could probably affect their bioavailability. Among the dispersed manipulations, in 12.5% (12/94) large undissolved fractions were observed during administration through nasogastric tubes[5].

Pill splitting is commonly practiced in healthcare settings or home care settings, as part of a medical prescription. However, splitting can lead to uneven pill splitting, excessive or insufficient doses, non-adherence, and forgetfulness[36,37].

In the study, which included 113 adult ICU patients, a total of 306 medication administrations via feeding tubes were documented and retrospectively analyzed, 67% of which were solid oral dosage forms. Exactly 91.2% of these were conventional tablets, 88% of the medications were classified as suitable for tube administration, but only 48% had manufacturer information[3].

In geriatric patients receiving home health care, a cross-sectional study reported that of a total of 233 medications prescribed, 33.3% of enteral tube administrations were inappropriate due to the use of controlled-release or enteric-coated formulations (omeprazole, clopidogrel, aspirin, and atorvastatin)[2].

These findings align with previous research, in which acid-labile drugs such as proton pump inhibitors like omeprazole and pantoprazole need to be enteric coated due to their delayed-release sensitivity to gastric acid, making grinding ineffective[38].

Medication data collected from the hospital pharmacy service's dispensing system

were descriptively analyzed for appropriateness for use via enteral feeding tubes. Of the two hundred and thirty-six oral medications dispensed, 86% were in solid form, 32 were "non-crushable" (with liquid form available at the institution), and 60% of them had specific recommendations for administration via enteral feeding tube[13].

Correlationally, in a study that reviewed 207 oral medications prescribed to 34 patients with amyotrophic lateral sclerosis (ALS) with percutaneous gastrostomy, it was identified that 43% (93 of the cases) of the medications required modification of the pharmaceutical form: solid to liquid (29%), orodispersible (9.7%), granules or sachets (6.5%), immediate-release tablets (3.2%), due to the risk of catheter occlusion, toxicity or loss of efficacy, affecting 97% of patients[16].

These data demonstrate the importance of accurate information on medication administration through tubes, as insufficient availability of liquid dosage forms is often the reason for high solid intake, and grinding or dispersing solid oral dosage forms is often considered a safe option, even though there is still a lack of information from manufacturers regarding formulation changes, such as grinding, and specific instructions for administration through enteral/ostomy tubes[3].

The wide variation in prevalence in this review may be due to the heterogeneity of patient scenarios in the included studies and the various methods used in these studies to identify the forms used for adaptation of solid medications to be administered through enteral tubes/stomas.

Other factors that potentially influence the variation in prevalence are that some studies recruited different patient profiles, adults, children, elderly and in different settings.

This review had some limitations. The findings of this review cannot be generalized because most of the included studies were conducted in clinical research settings, which do not represent the practical scenarios where adaptations of solid medications for administration through enteral tubes/ostomies occur, thus limiting some recommendations and interpretations.

Few studies have evaluated clinical results after crushing and dispersing solid medications for administration through tubes, lacking additional studies to generate evidence on the phenomenon studied.

FINAL CONSIDERATIONS

This integrative review found that practices of adapting solid pharmaceutical forms for administration through enteral tubes/stomas are common and occur in a variety of

environments, such as hospitals and homes, and in pediatric and geriatric age groups.

Replacing solid oral medication adaptations with appropriate drug formulations, usually liquid ones, becomes essential to preserve efficacy, bioavailability and prevent adverse outcomes such as tube obstruction and insolubility of poorly water-soluble drugs.

Due to limited evidence and comprehensive guidance on appropriate crushing, capsule opening, and partitioning techniques for specific medications, clinical judgment by healthcare professionals is required to develop an individualized strategy for medication administration through enteral tubes and ostomies.

Because adaptations of solid pharmaceutical forms are a globally applied practice, instruments such as the creation of flowcharts and clear and detailed institutional protocols that guide which medications can be crushed, dispersed, or use an alternative solvent to water must be developed, and doctors, nurses, pharmacists, and caregivers must be trained.

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Declaração de contribuição dos autores

Para este trabalho, as seguintes funções de contribuição foram atribuídas de acordo com a Taxonomia CRediT:

Autor 1: Joaquim Alves Diniz. Funções: Conceitualização, Análise Formal, Investigação, Metodologia, Administração do Projeto, Validação, Visualização, Escrita Original, Escrita revisão-edição;

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Autor 3: Gilberto Santos Cerqueira. Funções: Conceitualização, Análise Formal, Metodologia, Validação, Visualização, Escrita Original, Escrita revisão-edição;

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Declaro não estar submetido a qualquer tipo de conflito de interesse junto aos participantes ou a qualquer outro colaborador, direto ou indireto, para o desenvolvimento do artigo intitulado "**Adaptation of solid oral medicines for administration through enteral tubs and stomies: integrative review**", cujos pesquisadores envolvidos são: **Joaquim Alves Diniz ,**Universidade Federal do Ceará, Fortaleza, Ceará, Brasil. ORCID: *https://orcid.org/0000-0001-9678-488X*.**, Lara de Carvalho Farias,** Escola de Saúde Pública do Estado do Ceará, Fortaleza, Ceará, Brasil. ORCID: https://orcid.org/0009-0008-9474-0267, **Gilberto Santos Cerqueira,**Universidade Federal do Ceará, Fortaleza, Ceará, Brasil. ORCID:https://orcid.org/0000-0001-6717-3772..

Declaro ainda que minha atuação como pesquisador é independente, autônomo e comprometida com o interesse precípuo de defesa de direitos e a segurança do(s)

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