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Solid Medication Dosage Form Modification at the Bedside and in the Pharmacy of Queensland Hospitals

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ABSTRACT

It is common practice to alter the dose form of solid medications to make them easier to administer to individuals who have difficulty swallowing.

The goal of this study is to catalog the types of medication changes done in Queensland hospitals, both at the bedside and at the pharmacy.

Method: 97 hospitals in Queensland (both urban and rural) were issued a self-report survey. The majority (n = 31, or 79%) of the hospitals that responded said that changes were made to drugs at the patient's bedside. At the bedside, 73 different drugs were adjusted. The majority of the capsules and tablets were of the standard-release kind. In addition, 11 hospitals reported crushing drugs having a narrow therapeutic index, and 8 reported crushing modified-release dose forms. Most of the time, numerous pills were crushed with a pestle and mortar (84% of hospitals) and then mixed with jam (72% of hospitals) or water (66% of hospitals) at the bedside to make them suitable for adults. As many smaller hospitals do not employ a pharmacist, only 7 reported pharmacy changes. Due to the unavailability of commercial formulations, the pharmacy adapted 17 drugs specifically for children.

In conclusion, Queensland hospitals adjust the dosage forms of commercial pharmaceuticals, especially those with the potential for toxic or subtherapeutic amounts to have harmful consequences. Nurses may benefit from pharmacists' involvement in their education by learning more about the risks associated with changing the dose forms of medications. Prescribers need to be made more aware of the availability of non-standard dose forms, which may be purchased from drug companies or created on the spot by pharmacists.

INTRODUCTION

Because of their low production cost and precise dosing, tablets and capsules are the preferred solid dosage forms. It is not always simple to be confident of consistently measuring exact amounts using liquid dosage forms, and they tend to be more costly per unit dose. But for a large number of patients (especially pediatric and geriatric patients), solid dosage forms are inappropriate, for reasons including inability to swallow or distaste for solid dosage forms, nasogastric or gastrostomy feeding tubes, and the need for non-standard doses.1-4

When conventional oral liquid formulations are not readily available, hospitals often resort to making their own. Since pure crystalline powders are not always readily available in hospital pharmacies, a commercial solid dosage form is commonly changed, i.e. tablets are broken or capsules are opened, to make an extemporaneous concoction.5,6 Therefore, while producing the liquid formulation, pharmacists must take into account not only the active medicine but also the inactive excipients included in the solid dosage form. The warfarin sodium powder used to make a solution is not interchangeable with the warfarin tablet powder used to make a suspension.Due to incompatibility caused by the tablet excipients, isoniazid powder rather than crushed tablets must be used to make the isoniazid combination.

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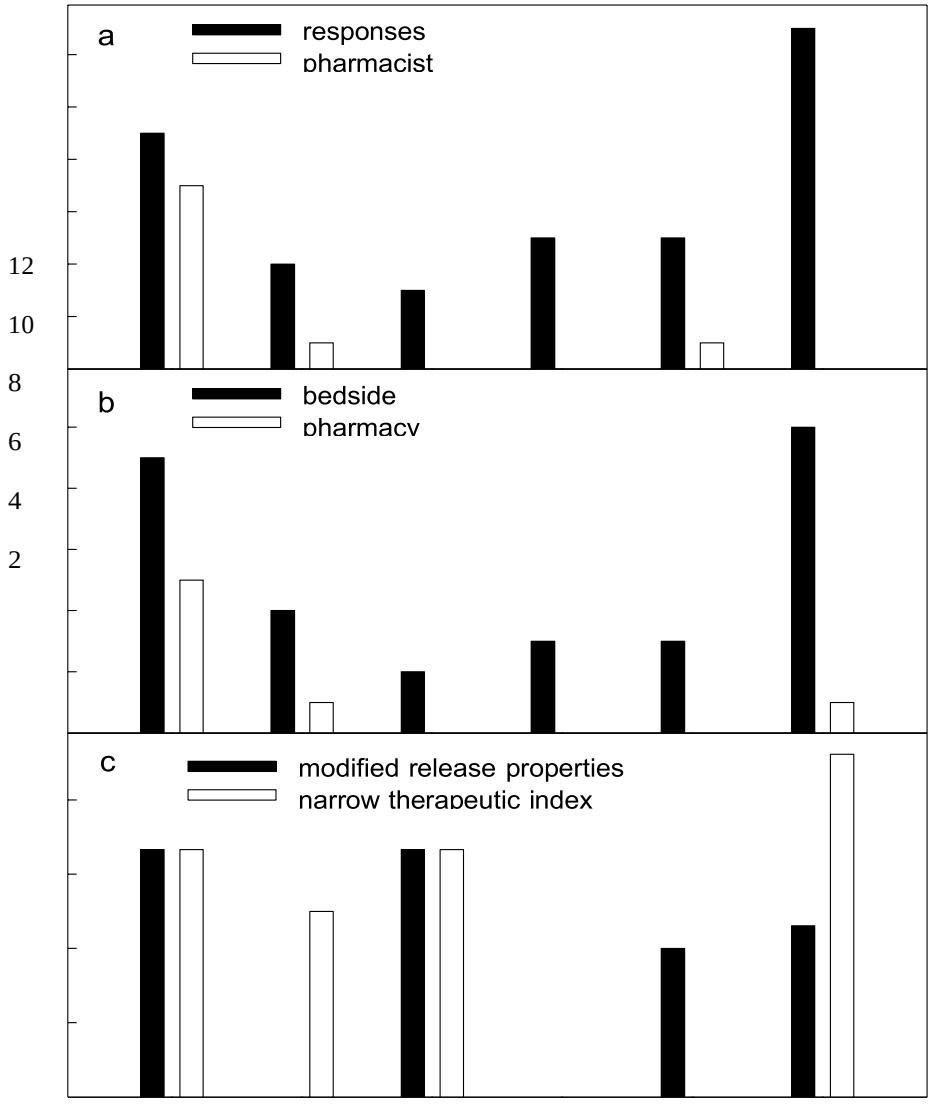
The burden of delivering a solid dose form to a patient who is unable to consume it falls squarely on the shoulders of nurses. It is well known that elderly people with mental illness often undergo dose form changes in institutional settings like nursing homes and hospital wards.9-13 The purpose of this research was to determine which drugs are most often altered by hospital staff in Queensland, both at the bedside and at the pharmacy.

METHOD

In July 2005, a self-report survey was sent to all 97 hospitals in Queensland, Australia, according to the Queensland Department of Health's definition of a hospital as having at least five inpatient beds. at order to determine which prescriptions are most often altered at the bedside and at the pharmacy, the poll included free-form questions presented in a tabular style. The survey inquired as to the patient's age, the formulation or mixers utilized, the cause for the medication adjustment, and the predicted frequency of the medication modification. The respondents were prompted to share their thoughts and opinions.

Hospital pharmacists participated in a pilot research to test the survey questions. We called each hospital and had someone do the poll on our behalf (a pharmacist, head of nursing, etc.). The questionnaires were bundled together and mailed in one package to the recipient. Uncompleted questionnaires Two phone calls were made to follow up on the survey.

= remote and 6 = very remote).



RESULTS

The 39 (40%) hospitals that responded to the survey were spread across metropolitan and rural Queensland, with representation from all six PhARIAs (Figure 1a) and generally representative in terms of hospital size and remoteness. As might be expected, the responding hospitals located in metropolitan centres (PhARIA 1) were larger, with greater annual admission and non-admission activity than hospitals located in rural areas (Figure 2). Only nine of the responding hospitals had a pharmacy staffed by a pharmacist at the time of the survey(Figure 1a).

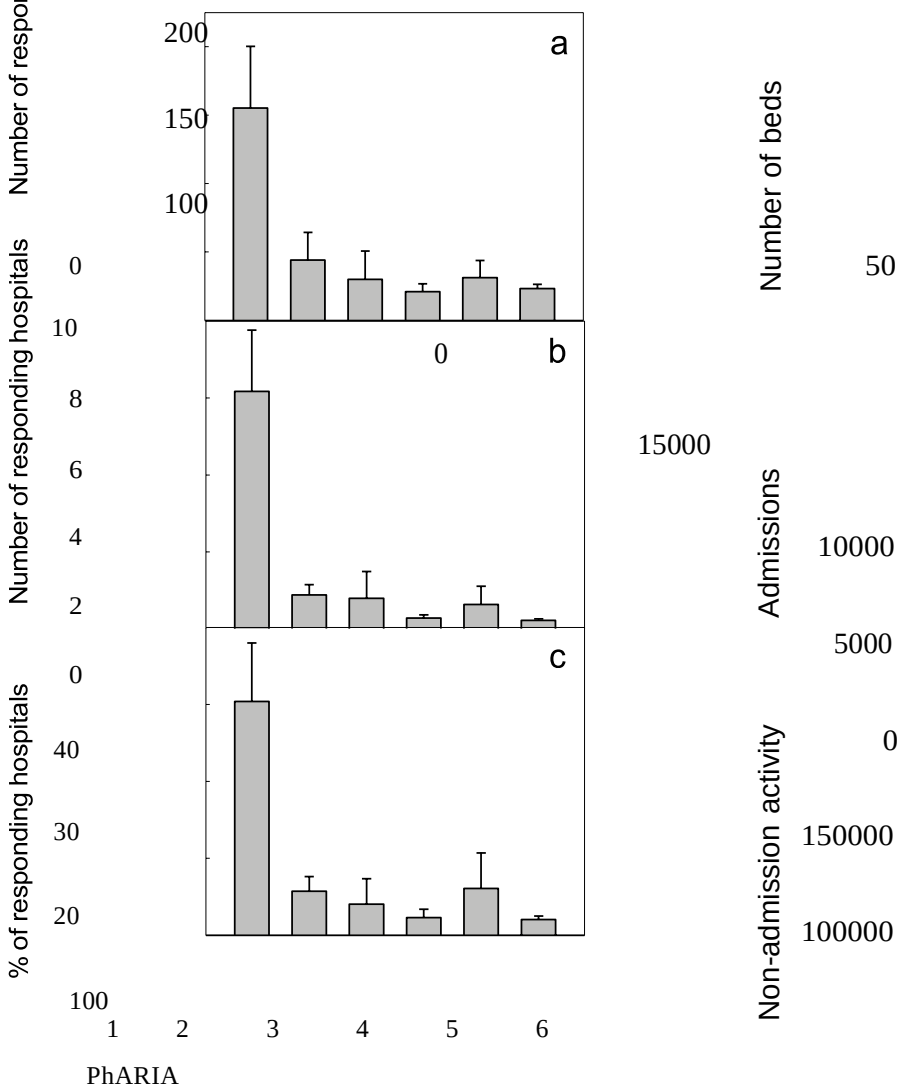


Figure 1. Pharmacy Access/Remoteness Index of Australia (PhARIA) of the Queensland hospitals that responded to the survey categorised by the a) number of hospitals responding to the survey and those that have a pharmacist;
b) number of hospitals that modify medication dose forms at the bedside or in the pharmacy; and c) percentage of hospitals that modify medications with sustained-release properties or a narrow therapeutic index.

PhARIA

Figure 2. Categorisation of the responding hospitals in terms of the Pharmacy Access/Remoteness Index of Australia (PhARIA) for the a) mean ± SE number of beds; **b)** mean ± SE number of admissions; and c) mean ± SE non-admission activity during the financial year 2005/06.

Table 1. Medications commonly modified at the bedside or in the pharmacy of Queensland hospitals

Active pharmaceutical ingredient	ATC classification	No. of hospitals	Patients	Starting material	Mixer
Modified at the Bedside					
Amlodipine	C8	4	Adult/Child	CT	Jam, food, water
Aspirin	B1	7	Adult	CT	Jam, custard, food, water
Atenolol	C7	4	Adult	CT	Jam, custard, yoghurt, water
Digoxin	C1	5	Adult/Child	CT	Jam, thickened fluid, custard, food, juice, water
Dipyridamole + aspirin	B1	4	Adult	OC	Jam, thickened fluid, food, juice, water
Docusate + senna	A6	5	Adult	CT	Jam, honey, custard, food, water
Frusemide	C3	6	Adult	CT/ST	Jam, food, water
Multivitamins	A11	5	Adult	CT	Jam, honey, thickened fluid, food, juice, water
Omeprazole	A2	7	Adult/Child	OC/CT	Jam, honey, custard, food, water
Paracetamol	N2	18	Adult/Child	CT/ST	Jam, honey, thickened fluid, custard, food, juice, water
Perindopril	C9	8	Adult/Child	CT/ST	Jam, honey, thickened fluid, custard, food, juice, water
Risperidone	N5	4	Adult	CT	Jam, custard, yoghurt
Sertraline	N6	4	Adult	CT	Jam, honey, food
Modified in the Pharmacy					
Amiodarone	C1	2	Child	CT	Extemporaneous preparation
Metoprolol	C7	2	Child	CT	Extemporaneous preparation
Omeprazole	A2	2	Child	DT	Extemporaneous preparation
Propranolol	C7	2	Child	CT	Extemporaneous preparation
Sildenafil	C2	2	Child	CT	Extemporaneous preparation
Sotalol	C7	2	Child	CT	Extemporaneous preparation
Spironolactone	C3	3	Child	CT	Extemporaneous preparation
Tacrolimus	L4	2	Child/Adult	OC	Extemporaneous preparation

ATC = Anatomical Therapeutic Chemical. CT = crushed tablet. DT = dispersed tablet. OC = opened capsule. ST = split tablet.

Modifications at the Bedside

Most hospitals (n = 31, or 79%) said that changes were made to drugs at the patient's bedside (Figure 1b). Six of the institutions mentioned several prescription changes, however they did not provide instances. Only a minority of hospitals (n = 8; 21%) in PhARIA bands 3 to 6 said they never changed the dose forms of any medications they prescribed.

The 25 hospitals found 73 unique drugs that were altered while under patient care. Table 1 shows that the majority of the drugs were used to treat disorders of the brain system, the cardiovascular system, and the digestive system and metabolism. Seventy percent of hospitals reported that paracetamol pills were altered, mostly by crushing or sometimes by splitting into bits and adding to other mixers. The most often opened capsule was for omeprazole (Probitor), and in four of the six hospitals, the enteric-coated pellets were sprinkled into a mixer, while in the other two, the pellets were crushed before being combined with water for nasogastric or gastronomy tube feeding. Tablets of omeprazole (Losec) and pantoprazole (Somac) were crushed and mixed together at one hospital.

Most of the altered pills lacked the controlled release or prolonged action of the original formulation. For instance, the hospital brands of metoprolol lacked controlled-release features. Five of the six hospitals also could not provide any instances of the drugs they had changed.

did mention that no changes were made to the controlled-release or sustained-release dose formulations. However, several controlled-release and sustained-release dose forms were found to have been crushed at the bedside (Figure 1c). Two hospitals crushed the contents of their dipyridamole+aspirin capsules (Asasantin SR), and four hospitals opened their venlafaxine (Efexor) capsules. Morphine (MS Contin), nifedipine (Adalat Oros), and verapamil (Veracaps) were each reported to have been opened once.

Eighty-eight percent of the 73 drugs were adjusted on the spot for adults, while seven were adjusted for both adults and children and nine were adjusted specifically for kids. Pediatric hospitals made all the other necessary adjustments besides giving children paracetamol. Inability to swallow the solid dose form was cited as the primary cause for modification at the bedside for 60 (82%) of the drugs. The necessity for a liquid dosage form for tube feeding accounted for the change of 38 (52%) drugs, whereas the lack of commercial availability of the necessary dose accounted for the modification of eight (11%) pharmaceuticals.

The majority of hospitals (n = 27) reported using a mortar and pestle to break down pills. A small number of hospitals (n = 5) and three hospitals (n = 3) crushed pills using spoons. Three other medical facilities shattered paracetamol pills, while another facility crushed them using a spoon.

two institutions, although the most majority (n = 13) relied on a mortar and pestle. Inevitably, capsules were broken open, and their contents dumped into the blender. The majority of hospitals (n = 21) reported crushing and mixing two or more drugs together before giving them to the patient in a single mixer. Jam (n = 18), water (n = 16), and sprinkling or mixing with patient meals (n = 12) were the most popular mixers utilized by hospitals (Table 1). Honey (n = 5), thickened fluid (n = 3), juice (n = 3), custard (n = 2), and yoghurt (n = 1) were less often employed as mixers.

Modifications in the Pharmacy

Only 7 out of the 39 responding hospitals mentioned changing the solid dose forms at the pharmacy. One reason for this is that only seven of the nine PhARIA 1 hospitals had a pharmacist on staff (Figure 1a), whereas only two of the hospitals in PhARIA 2–6 were big enough to have one.

In the pharmacy, five of the seven PhARIA 1 hospitals made adjustments. Each of these hospitals had over 150 beds, had a full-time pharmacist, and used either the Australian Pharmaceutical Formulary and Handbook or their own in-house hospital formulary. Two other hospitals from PhARIA 2 and 6 without a pharmacist adjusted dose forms in the pharmacy. Due to a lack of the proper dosage, both of these facilities often prepared a paediatric version of the drug (either omeprazole or propranolol). The nurses there used the same protocols as those used in bigger facilities.

Table 1 shows that of the 17 drugs that were altered at the pharmacy, 12 were different from the prescriptions that were altered at the bedside, and 8 were altered by 2 or more of the 7 hospitals. The majority of the drugs were heart-related. Crushing tablets was used to alter 16 of the 17 drugs; opening capsules was used to alter phenoxybenzamine (Dibenyline) and tacrolimus; and

The Minirin nasal spray is a hospital-modified form of the standard desmopressin. Omeprazole was the first extended-release drug to have its formulation altered; tablets were crushed before compounding.

Each drug was adjusted so that children could take it, and only two medical facilities made adjustments to a drug (tacrolimus) so that adults could use it as well. There was no suitable dosage for any of the 17 drugs, and for three of them, the necessity for a liquid preparation for tube feeding was an additional factor in the decision to make adjustments. Medication changes were made for both in- and out-patients.

DISCUSSION

Hospitals from all around Queensland, including those in extremely inaccessible places, responded to this survey. Nursing staff in 79% of Queensland hospitals state that they smash pills and open capsules to make it easier for patients to consume commercially available drugs. We relied on the knowledge of hospital procedures and the honesty of the staff members taking the survey since it was a self-report survey rather than an audit of nursing and pharmacy practice in each hospital. As a consequence, the findings are reflective of conditions inside the hospitals that participated in the study. It's probable that the true scale of modification and the variety of drugs being adjusted in Queensland are underestimated here.

Because of the potential for increased toxicity from the rapid absorption that occurs when the coating is broken, controlled-release, sustained-release, and modified-release medications should not be adjusted. Several healthcare facilities cited the absence of these dosage forms as an example of an area where they did not make any changes. Some nurses apparently did not get the memo, since errors were made with these drugs at eight different hospitals.

Table 2. Potential risks associated with medications modified by Queensland hospitals

Potential risks	
Increased toxicity oradverse effects Decreased efficacy	
Hazards to health workers	
Breach of legal and professional requirements	
Dosage form modifications	
Crushing an extended/modified/sustained-release formulation.	
Crushing a coating designed to protect the upper gastrointestinaltract from the active pharmaceutical ingredient.	
Crushing a coating designed to disguise a poor tasting active pharmaceutical ingredient.	
Crushing an enteric coating designed to protect an acid-labile active pharmaceutical ingredient.	
Crushing a coating designed to protect a light or air sensitive active pharmaceutical ingredient.	
Crushing a coating designed to release the active pharmaceutical ingredient at a defined site in the gastrointestinal tract.	
Incomplete dose delivery for an active pharmaceutical ingredient with a narrow therapeutic index.	
Crushing and mixing with food when 'take on an empty stomach' is advised.	
Crushing a dose form containing a cytotoxic or teratogenic active pharmaceutical ingredient.	
Modifying the medication is deemed to be unlicensed.	
Medications	
Dipyridamole+aspirin (Asasantin SR), iron+folic acid (FGF), morphine (MS Contin), nifedipine (Adalat Oros), venlafaxine (Efexor), verapamil (Veracaps)	
Iron+folic acid (FGF), metronidazole,valproate	
Ibuprofen, topiramate Omeprazole, pantoprazole	
Nifedipine (Adalat Oros) Omeprazole, pantoprazole	
Carbamazepine, digoxin, thyroxine,valproate, warfarin	
Frusemide, pravastatin, thyroxine Azathioprine, tamoxifen	
Most of the medications	

None of the three PhARIA 1 hospitals that reported this behavior lacked a pharmacist, and these incidents had nothing to do with the size of the hospital or its location.

Tablet coatings serve various purposes, and altering them may result in unintended side effects or diminished effectiveness (Table 2). The stomach lining may need protection from an irritating medicine, or a foul taste drug may benefit from a coating to increase compliance and decrease the likelihood of unpleasant side effects. Crushing bitter-tasting prednisolone pills leads to low adherence among pediatric patients; hence, a prednisolone oral solution is preferable.16 Inactivation or decreased absorption of the medicine might occur if the coating on the tablet was removed. Acid-labile medication molecules, such as those found in proton pump inhibitors, must be shielded from acidic environments until they reach the site of action.17 In most cases, the enteric-coated granules remained undamaged during handling; nevertheless, when feeding tube delivery was necessary, the nurses had greater trouble.

The study's drugs, for the most part, have dosages that are

form has no unique characteristics and was otherwise similar to other dissolving tablets. Incomplete and uneven dose delivery as a consequence of losses during the crushing and administration process reduces effectiveness, yet this is typically neglected (Table 2). For many treatments, a little decrease in dosage is not likely to have a significant effect, but for those with a narrow therapeutic index, even a small adjustment may make a big difference. For instance, it has been hypothesized that losses of oral thyroxine occur when tablets are crushed and given via a feeding tube, leading to hypothyroidism. This decreased dose delivery is not due to the adsorption of thyroxine onto the feeding tubes.18

No correlation was found between hospital PhARIA score and the possibility that a low-therapeutic-index medicine would be crushed in this investigation (Figure 1). No pharmacists are employed by any of the eleven institutions that said they altered drugs with a restricted therapeutic index. Most of the medications in this study have product information that does not specifically state not to crush them, but that also does not state that it can be done, so any alteration of the original dosage form is off-licence and the manufacturer assumes no liability for any harm that may result.19,20

At the bedside, people would often use different mixers, the most common of which were jam and water. Most of the time, you probably won't need to worry about how eating may affect your drug's absorption, but certain prescriptions include warnings like "take on an empty stomach" and are thus more likely to be implicated in a drug-food interaction (Table 2). Crushing and mixing with food or semisolid mixers is a common hospital procedure, but it may cause problems if it is stopped or altered after the patient is discharged. As a result, problems with continuity, safety, and quality of treatment might arise.

Some of the drugs that were formerly crushed at the bedside now come in an easier-to-swallow dose form, such as a suspension or dispersible tablet. Despite the availability of a liquid formulation, some hospitals still crushed tablets of amoxycillin, carbamazepine, frusemide, haloperidol, metronidazole, and valproate at the bedside. If there is no liquid form of the drug, another method of administration (such as prochlorperazine suppositories instead of tablets) or an other treatment option that comes in a smaller tablet or another dose form may be more suitable.

Patients should not be denied access to effective medications due to a lack of available commercial formulations. Alternatives to daily tablet-crushing at the bedside and the associated risks of dosage mistake and cross-contamination may be achieved via the pharmacy-formulated extemporaneous preparations. The contents of oseltamivir capsules, for example, may be bitter and better administered as flavoured syrup since they are simpler to take and more appealing than broken pills.21 In addition, health care personnel who crush tablets of drugs like cytotoxics might be put at risk, thus any

necessary adjustments should be made in the pharmacy rather than the ward.22,23 Thirteen of the crushed drugs in this investigation may have been made on the spot using stable formulations that have recently been assessed.3 Pharmacy technicians and doctors may both benefit from the six-step approach outlined in the Australian Pharmaceutical Formulary and Handbook for modifying oral formulations.There are 24 hospitals in Queensland that employ pharmacists.

site are often engaged in impromptu compounding; in 70% of cases, conventional dosage forms are used as the starting ingredient.5 In this research, the inability to prepare extemporaneous formulations was hampered by the fact that several of the responding hospitals lacked an on-site pharmacist, a circumstance that is prevalent in rural and regional areas of Australia. Community pharmacy might be called upon in these instances to concoct suitable medications. It is clear that nurses on the wards are crushing pills for adults with swallowing issues, whereas pharmacists at the hospitals that participated in this study were requested to produce formulations for dosage adjustment for their pediatric patients. Prescribers sometimes don't realize that pharmacists may help them save time and effort by making extemporaneous formulations.25 In conclusion, nurses will continue to face the terrible circumstance of giving a drug that a patient cannot swallow as long as physicians continue to prescribe solid dose forms. Nurses may benefit from pharmacists' involvement in their education by learning more about the risks associated with changing the dose forms of medications. Alternative dose forms may be commercially available or made extemporaneously by the pharmacist; clinicians should be educated to increase knowledge of these options for prescription.

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