



Oral Medications Inadvertently Given via the Intravenous Route

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ABSTRACT

The inadvertent intravenous (IV) administration of oral medications, while rarely reported, has contributed to serious patient harm, as seen in event reports submitted to the Pennsylvania Patient Safety Authority and in the clinical literature. Analysts identified 20 reports of inadvertent IV administration of oral medications submitted to the Authority between June 2004 and December 2012. All of the events reached the patient, and 20% (n = 4) resulted in patient harm, including one death. A common contributing factor cited in many of these reports was that the oral drug was administered using a parenteral syringe. While the clinical literature on these errors predominantly addresses the administration phase of the medication-use process, events and decisions that precede administration may play a role. Avoiding these types of errors requires more than one error reduction strategy. Strategies to mitigate such errors may include assessing the current medical devices within the facility to understand key system factors playing a role in this type of medication error; dispensing oral medications in the most ready-to-use forms; communicating patients' inability to swallow capsules or tablets to the pharmacy department; and improving healthcare professionals' awareness of such medication errors. (Pa Patient Saf Advis 2013 Sep;10[3]:85-91.)

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INTRODUCTION

Inadvertent intravenous (IV) administration of oral medications is a subset of medication administration errors. These errors occur most often when an oral liquid is prepared or dispensed in a parenteral syringe. According to the Institute for Safe Medication Practices (ISMP), a break in mental concentration can subsequently lead to the oral medication being unintentionally administered through the IV route.¹ Wrong-route errors at the time of administration have become an important issue in hospitals.² This also is of major interest to patients due to the central role medications have in treating illnesses, as well as the important consequences to the patient if this is done incorrectly.² Medication administration is a critical step because an error that is not caught will always reach and possibly harm the patient, and there may be limited options for corrective actions.³

While any route of administration can be involved in medication errors, patients receiving IV medications are at particular risk.⁴ More importantly, medication administration errors tend to occur frequently and are more likely to result in serious harm and death in comparison with other types of medication errors.⁵ Also, certain types of errors, including wrong-route errors, are more likely to result in patient harm compared with other error types, even though they may occur less often relative to other errors.⁶ For example, infusion of nonsterile, particulate fluid can be fatal, as it carries the risk of sepsis, diffuse intravascular coagulation, or emboli to major organs, which can lead to organ damage and pulmonary embolism. There are published studies that address certain medications, including oral medications, mistakenly given via the IV route.⁷⁻¹⁵ This analysis focuses on events involving oral medications inadvertently given intravenously.

METHODS

A query was conducted of the Pennsylvania Patient Safety Reporting System (PA-PSRS) database for reports of inadvertent IV administration of oral medications submitted between June 2004 and December 2012. Analysts queried the database for the term "oral" among the report fields for "medication prescribed route," "medication administered route," and "event detail" within medication error events that were classified by facilities as wrong-route errors. Analysts also queried for specific oral medications (e.g., niMODipine, morphine) identified during ongoing event analysis as having been inadvertently administered intravenously. Analysts manually reviewed the event reports to determine whether there was an instance of an oral medication inadvertently given intravenously. Of the initial 1,995 event reports, 20 had some description of an oral medication that was mistakenly administered intravenously.

ANALYSIS

The Table displays the medications involved in the 20 events submitted by facilities. All 20 events reached patients, with 20% (n = 4) resulting in some degree of harm, including death. The medications involved in the events with patient harm were megestrol acetate, morphine, NIFEdipine, and niMODipine.

Reports submitted to the Authority included terms such as "IV push" to describe the inadvertent IV administration of oral liquid medications. This implies that a parenteral syringe or other device with a needleless (e.g., Luer, Clave) connector was used to administer the medication. The use of parenteral syringes to prepare and administer oral liquid medications is a common contributing factor to these types of



Table. Oral Medications Inadvertently Administered Intravenously, as Reported to the Pennsylvania Patient Safety Authority between June 2004 and December 2012 (N = 20)

MEDICATION	NO. OF EVENTS	% OF TOTAL REPORTS
Acetylcysteine	5	25
niMODipine	3	15
HYDROmorphone	2	10
Acetylcholine chloride	1	5
Furosemide	1	5
Levothyroxine	1	5
LORazepam	1	5
Medium-chain triglyceride oil	1	5
Megestrol acetate	1	5
Morphine	1	5
NIFEdipine	1	5
oxyCODONE	1	5
Pantoprazole	1	5

events.¹ Using parenteral syringes that can be attached to a needleless IV system to administer oral (and enteral) liquids presents a serious danger of misadministration. After filling a parenteral syringe with an oral or enteral medication, it takes only a momentary mental lapse to connect it to an IV line and inject it.¹⁶ Reasons why parenteral syringes are used may include unavailability of patient-specific doses in labeled oral syringes prepared and delivered by pharmacy, oral syringes not being available in patient care areas for nursing staff to use, and staff not being aware or not understanding the error prevention reasons for using oral syringes to administer oral liquid medications.

In 2010, the US Food and Drug Administration (FDA) alerted healthcare professionals about the dangers of the IV administration of the contents of niMODipine capsules.¹¹ FDA identified 31 cases of medication errors, including 4 deaths, associated with the use of niMODipine between 1989 and 2009.¹¹ When reviewing event reports submitted to the Authority, analysts identified that inadvertent IV administration of oral

niMODipine continues to occur despite a history of product labeling changes, including a boxed warning to alert practitioners not to administer niMODipine intravenously or by other parenteral routes and literature providing risk reduction strategies to avoid these errors.^{10,11,13} A case reported to the Authority involving the death of a patient from the inadvertent IV administration of niMODipine is as follows:

The patient had been receiving medication since admission. A few days after the patient was admitted, a nurse prepared the patient's medication via a syringe to be given via OGT [an orogastric tube]. At the bedside, the medication was instead administered through the central line. The patient went into asystole and expired despite resuscitative measures.

Further instances of errors involving other medications include the following:

A new nurse on the floor was unfamiliar with the route of administration for liquid oxyCODONE. As a result, she gave it in the patient's IV [line] instead of PO [by mouth].

The patient was confused about the route of administration and informed the nursing staff and physicians. The department of pharmacy was contacted, and the patient had not had any adverse reactions. Patient was discharged home with precautions.

Upon retrieving the patient's medication from the automated dispensing cabinet, the nurse decided to instead override the medication to be administered and not follow the procedure for wastage. All types of morphine sulfate appeared where the 2 mg/mL oral solution appeared at the top of the list. The nurse was not sure how to get the medication out of the bottle and asked another nurse for guidance. This other nurse said to just "get a syringe and draw up one milliliter" as she left the patient's room. As the original nurse was administering the medication, she noticed that the medication was blue. Upon returning back to the patient's room, the other nurse asked the first nurse if she had to mix the medication. The first nurse responded that she did not have to mix it since she gave it intravenously. The other nurse was under the impression that the first nurse was giving the medication orally when they realized that the oral medication was inadvertently administered intravenously.

A patient was to receive Protonix® [pantoprazole] IV and 12 mL of Mucomyst® [acetylcysteine] through their PEG [percutaneous endoscopic gastrostomy] tube. The nurse drew up the Protonix in a 10 mL syringe and 10 mL of the Mucomyst in a 10 mL syringe. The nurse mixed up the syringes and gave the Mucomyst through the patient's PICC [peripherally inserted central catheter] line. The physician was on the floor and was notified immediately. The charge nurse notified the pharmacy of the incident.

In addition to not providing details on contributing factors to events, many event reports also did not include descriptions of patient outcomes. Although it may be assumed that some patients recovered fully prior to discharge, we do not know the overall outcomes of the patients.

OTHER CASES FROM THE LITERATURE

Medication errors involving oral medications inadvertently given intravenously have been published in the literature.⁷⁻¹⁵ Healthcare settings involved with such errors include hospitals (e.g., critical care units, pediatric hematology-oncology units), surgery centers, and pediatric care centers. The use of a parenteral syringe to prepare and administer doses of oral medications is a common factor in these events.

One case mentioned in the literature involved a 14-month-old female with acute lymphoblastic leukemia who was admitted with febrile neutropenia.⁸ She was receiving antibiotics through a central venous catheter, but a nasogastric tube was also placed for enteral feeding. A nursing student, under supervision of a nurse, prepared the patient's oral medication with sterile water for injection while using a parenteral syringe to administer the oral medication. The nursing student, who was left alone at the bedside of the patient, was instructed to inject the oral medication into the nasogastric tube. Unfortunately, the medication was administered into the central venous line. Another student witnessed this event and informed the physician. To prevent infection, IV antibiotics were given, and the patient was monitored for a short period with no resulting complications.

In another case, midazolam syrup and acetaminophen liquid were prepared in a parenteral syringe and subsequently administered intravenously to an 11-year-old child being prepared for surgery.¹² A nurse and fourth-year nursing student had prepared the doses, but the nurse was

called away, leaving the nursing student alone. While the nurse was gone, the nursing student inadvertently administered the drugs intravenously, believing the child was not to consume anything by mouth before surgery. The child remained unconscious for 50 minutes and required several days of antibiotics. The child recovered fully.

Not all cases result in full recovery of the patient. During a holiday weekend, a 19-month-old child was to receive treatment for a chronic gastrointestinal disorder.¹⁴ The child died after a suspension of cholestyramine was accidentally administered via a central-line IV catheter instead of through an enteral feeding tube. A case in Spain claimed the life of a premature infant.¹² The baby was delivered via cesarean section one day before his 20-year-old mother died from the swine flu. A week later, the infant died after an intermittent feeding prepared in a parenteral syringe was administered intravenously instead of via a nasogastric tube.

These errors also exact a financial toll on practitioners and facilities. According to two analyses of paid liability claims from 1997 to 2007¹⁷ and 2006 to 2010,¹⁸ CNA Insurance Companies and the Nurses Service Organization found that claims alleging wrong medication route, similar to those described above, had average paid indemnities of \$214,250 (1997 to 2007) and \$87,500 (2006 to 2010) per claim. One claim involved a nurse who floated to the neurology floor, where she was instructed to give a 19-year-old man recovering from a frontal craniotomy a dose of Dilantin® (phenytoin) oral elixir through the patient's feeding tube.¹⁷ The nurse mistakenly gave the drug through the patient's triple-lumen catheter. The patient coded within seconds, resulting in a severe nonrecoverable anoxic brain injury.

RISK REDUCTION STRATEGIES

When reviewing these errors, it is common to lay responsibility onto one

individual. Directing the individual to “be more careful” or “pay more attention next time” are low-leverage error prevention strategies. Rather, facilities may consider higher-leverage strategies to minimize the occurrence of these errors.

ISMP has been a key proponent of standardizing drug concentrations, maintaining safe and secure storage of medications, and ensuring appropriate distribution of medications and devices to patient care areas. One of its recommended strategies to help mitigate inadvertent IV administration of oral medications is to use drug products that are commercially available in ready-to-use forms.¹² While not all medications are commercially available in ready-to-use liquid forms, there have been strides made to address this issue with certain products. In the second quarter of 2013, Arbor Pharmaceuticals announced FDA approval of a new oral niMODipine solution to help reduce the medication errors seen with inadvertent IV administration of the contents of oral niMODipine capsules.¹⁵

While the healthcare system is making advancements in decreasing opportunities for administration of drugs via the incorrect route, healthcare professionals can still be diligent to reduce such errors. Institutions can strongly consider providing and using oral syringes, versus parenteral syringes, for administration of oral medications. By readily providing these devices in patient care areas, educating staff regarding their purpose, and monitoring utilization of oral syringes, facilities can help prevent some of the aforementioned errors. Following are additional strategies that facilities may consider to prevent the inadvertent IV administration of oral medications:

- Assess, through failure mode and effects analysis (FMEA), the processes and medical equipment used within the facility to understand key factors playing a role in this type of medication error. This will allow



users to determine the risks and issues leading to oral medications inadvertently being administered intravenously. Potential contributors to such errors can be revealed through the FMEA process. Suggested questions to ask during the FMEA process can be found in

“Questions to Consider during Failure Mode and Effects Analysis of Potential Wrong-Route Errors Involving Oral Medications.”

- Purchase medication administration equipment and systems that have parenteral tubing with ports that

are incompatible with oral syringes and enteral devices.^{12,19} One strategy to accomplish this is to purchase a different system of medical devices (e.g., medication administration pumps and associated supplies) for each route so that they cannot be physically connected with devices

QUESTIONS TO CONSIDER DURING FAILURE MODE AND EFFECTS ANALYSIS OF POTENTIAL WRONG-ROUTE ERRORS INVOLVING ORAL MEDICATIONS

Failure mode and effects analysis (FMEA) is a tool that can be used to evaluate processes, medications, and medical equipment used within the facility to identify potential factors and breakdowns that can lead to medication errors. Facilities can use FMEA to determine the risks and issues leading to oral medications inadvertently being administered intravenously. Grouped according to the applicable key elements from the Institute for Safe Medication Practices’ Key Elements of the Medication Use System™,¹ the following are some questions to consider when performing an FMEA.

Drug Standardization, Storage, and Distribution

- Does pharmacy use oral syringes to prepare and dispense doses of oral liquid medications?
- Does pharmacy prepare and dispense oral liquid medications in labeled, ready-to-use, patient-specific doses?
- Is the oral formulation of the medication packaged by the manufacturer in a vial that looks like a vial typically used for an injectable product (e.g., acetylcysteine)?

Medication Device Acquisition, Use, and Monitoring

- Does the facility purchase specially designed oral syringes that cannot be connected to parenteral tubing for preparation and administration of oral liquid medications that are not available in commercially prepared unit-dose cups?
- Are oral syringes available in the pharmacy for preparation and dispensing of oral liquid medications?
- Are oral syringes available and readily accessible in all patient care areas for use by nurses and other practitioners?
- Are the oral syringes visually different from parenteral and other syringes used within the facility?
- Are the oral syringes prominently labeled by the manufacturer with a warning statement similar to “Oral Use Only”?
- Does parenteral tubing used within the facility have ports that are incompatible with oral syringes and enteral devices?
- Do the ports on enteral feeding tubes used within the facility only connect to oral syringes and catheter tip connectors

(i.e., they do not have female Luer connectors)? (Exception: A Luer connector may be used for the inflation balloon that anchors some long-term-use feeding devices.)

- Who procures specially designed oral syringes for use within the facility?

Staff Competency and Education

- Is the availability and storage location of oral syringes shared with all practitioners?
- Are practitioners taught how and when oral syringes are to be used?
- Are practitioners taught the safety reasons and importance of using oral syringes to prevent medication errors?
- Is this education provided upon hire and reinforced on an ongoing basis?
- Do practitioners receive ongoing information about medication errors occurring within the organization, error-prone conditions, errors occurring in other healthcare facilities, and strategies to prevent such errors?

Quality Processes and Risk Management

- Is the use of oral syringes in pharmacy to prepare patient-specific doses of oral medications continually monitored and assessed?
- Is the use of oral syringes to administer oral liquid medications in patient care areas continually monitored and assessed?
- What procedures are in place to identify and manage the risk of errors when an alternative product is introduced to clinical areas? (Note: This applies to newly approved products as well as those brought into the facility in response to drug shortages.)

Note

1. Cohen MR. Causes of medication errors. Chapter 4. In: Cohen MR, ed. *Medication errors*. 2nd ed. Washington (DC): American Pharmacists Association; 2007:56-65.

for another route.¹⁹ Educate healthcare professionals regarding the importance of not manipulating or adapting noncompatible tubing or devices in an attempt to force a connection (e.g., tubing-to-tubing, tubing-to-device). Modifying tubing and devices may jeopardize design safety features.²⁰

- Ensure that oral syringes are available in the areas where they are needed. It is crucial to procure the appropriate drug delivery devices to help minimize the temptation to use devices intended for other routes of administration. Furthermore, by obtaining oral and parenteral syringes that look different, facilities can add an extra precautionary measure to help signal to the practitioner that the correct or incorrect device is being used for a particular route of administration.¹² Use only oral syringes marked with a statement such as “Oral Use Only.”
- Dispense, when possible, oral liquid medications from the pharmacy in the most ready-to-use forms. For oral solutions that are not available from manufacturers as unit-dose liquids, have pharmacy dispense these medications in oral syringes. Requiring medication to be dispensed from the pharmacy in labeled, patient-specific doses helps to reduce the manipulations that may occur on the patient care units.¹²
- Notify the pharmacy if patients are unable to swallow capsules or tablets. Also document this information prominently in patient charts and medication records. By having nurses or physicians communicate this information to the pharmacy, medications can be prepared in liquid form, if possible, and dispensed in oral syringes that are incompatible with attachment to IV ports.^{12,13}
- Require staff to prepare and administer oral and enteral liquids with

oral syringes. Evaluate the current workflow procedures and practices to confirm the appropriateness of preparation of oral medications. All small-volume oral and enteral solutions should be prepared and administered in oral syringes.¹²

- Reduce the tolerance of risk by sharing the dangers associated with inadvertent IV injection of oral medications. By sharing stories of external and internal errors associated with inadvertent IV injection of oral medications, facilities can help impress upon staff the severity of this issue and try to increase the awareness of this type of medication error.¹²
- Affix auxiliary labels to oral syringes indicating the medication in the oral syringe is meant to be given via the oral route. Certain companies have auxiliary labels large enough to be visible. An additional forcing function would be to apply the auxiliary label on the tip or the plunger so that the label must be removed prior to administration of the medication.^{1,12}
- For medications with oral and injectable formulations that are both available in glass vials (e.g., acetylcysteine), consider dispensing the medication in different packaging or with visible auxiliary labels, depending on the route of administration. For oral administration, pharmacy could remove the drug from the manufacturer’s container and place the proper dose in an oral syringe (or oral solution bottle if the volume is greater than the largest available oral syringe) with a label designating the drug, strength, and route of administration. Similar labels should be placed on doses dispensed for IV or other routes of administration. Include a caution statement on medication administration records so it is clear which product to use.²¹

– Label all access lines to indicate which are venous lines and which are feeding tubes. By indicating what the port or line is used for, facilities can bring attention to preventing mental lapses during the medication administration process.¹²

- Establish training programs and competency measures for healthcare professionals regarding the use of certain devices. Healthcare practitioners need to maintain a high level of understanding of errors and have ongoing monitoring efforts to ensure continued safe practices. Similarly, professional schools and new-graduate mentorship programs can help improve the safe use of syringes by including instruction on the use of oral syringes and the prevention of accidental injection of oral medications.^{1,12}

CONCLUSION

Although the inadvertent IV administration of oral medications is a rarely reported event, the potential for serious patient harm—including death, as seen in events reported to the Authority and in the literature—is great. Eliminating all medication errors involving inadvertent IV administration of oral medications is challenging; however, there are strategies that can help reduce the occurrence of these errors. Healthcare practitioners can start by proactively assessing the risks associated with these errors to better understand the contributing factors (i.e., through FMEA). By further assessing the oral syringe devices and parenteral medical equipment available in the institution, evaluating current workflows and procedures for preparation of oral medications, and increasing the awareness of professionals involved in this practice of healthcare, practitioners can mitigate the risk of errors associated with the inadvertent IV administration of oral medications.



NOTES

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LEARNING OBJECTIVES

- Recognize the causes and factors contributing to the inadvertent intravenous (IV) administration of oral medications.
- Identify oral medications at risk of contributing to patient harm when inadvertently administered intravenously.
- Determine the risks and issues leading to oral medications inadvertently being administered intravenously to be considered when conducting a failure mode and effects analysis.
- Select appropriate risk reduction strategies to prevent the inadvertent IV administration of oral medications.

SELF-ASSESSMENT QUESTIONS

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own questions.

- Which of the following is a common contributing factor in events involving the inadvertent IV administration of oral medications?
 - Provision of oral syringes
 - Use of a parenteral syringe to administer the medication
 - Dispensing of patient-specific doses from pharmacy
 - Absence of an auxiliary label indicating medication is to be given via the oral route
- In events reported to the Pennsylvania Patient Safety Authority, all of the following oral medications contributed to patient harm when inadvertently administered intravenously *except*:
 - niMODipine
 - NIFEdipine
 - Acetylcysteine
 - Megestrol acetate

SELF-ASSESSMENT QUESTIONS (CONTINUED)

3. Strategies to increase the use of oral syringes include all of the following *except*:
 - a. Provide oral syringes in patient care areas.
 - b. Educate staff about the purpose and proper use of oral syringes.
 - c. Monitor the utilization of oral syringes to prepare and administer oral medications.
 - d. Label all access lines to indicate which are venous lines and which are feeding tubes.

Question 4 refers to the following case:

The patient had been receiving medication since admission. A few days after the patient was admitted, a nurse prepared the patient's niMODipine with a parenteral syringe to be administered via an orogastric tube. At the bedside, the medication was instead administered through the central line. Despite resuscitative measures, the patient died.

4. Which of the following strategies is *most* effective in preventing the inadvertent intravenous administration of oral niMODipine?
 - a. Have pharmacy withdraw the liquid contents of the oral capsule and dispense the drug in a patient-specific and labeled parenteral syringe.
 - b. Have pharmacy dispense the commercially available niMODipine oral solution in a patient-specific and labeled oral syringe.
 - c. Have nurses withdraw the liquid contents of the capsule at the bedside for immediate administration to prevent contamination.
 - d. Have materials management supply patient care areas with oral syringes.
5. Questions to consider when conducting a failure mode and effects analysis to proactively determine the risks and issues leading to oral medications inadvertently being administered intravenously include all of the following *except*:
 - a. Does pharmacy prepare and dispense oral liquid medications in labeled, ready-to-use, patient-specific doses?
 - b. Are oral syringes available and readily accessible in all patient care areas for use by nurses and other practitioners?
 - c. Do the parenteral syringes used in the facility have needleless connectors (e.g., Luer)?
 - d. Do the ports on enteral feeding tubes used within the facility only connect to oral syringes and catheter tip connectors?
6. All of the following are risk reduction strategies to employ when purchasing medical equipment or medications *except*:
 - a. Purchase oral and parenteral syringes that look different.
 - b. Purchase drug products in bulk containers to allow dosing flexibility.
 - c. Purchase a different system of medical devices for each route so that they cannot be physically connected with devices for another route.
 - d. Purchase medication administration equipment and systems that have parenteral tubing with ports that are incompatible with oral syringes and enteral devices.

PENNSYLVANIA PATIENT SAFETY ADVISORY

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