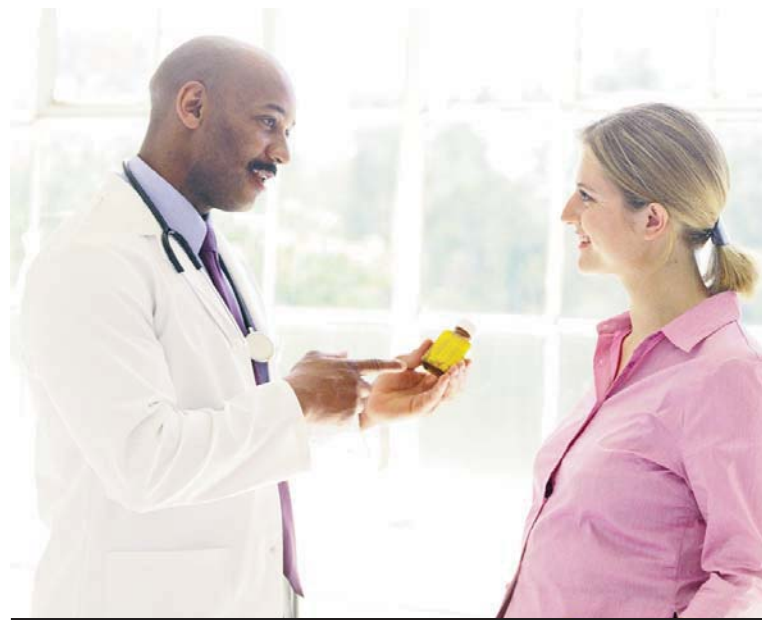


Preventing Errors Associated with Loading Doses of Medications

A 72-year-old woman came into the emergency department with acetaminophen overdose, revealing an acetaminophen level of 180 mcg/mL four hours after taking the last dose. Her physician ordered acetylcysteine intravenously to prevent liver toxicity and worked with pharmacy to double-check his weight-based dosing calculations as the medication regimen is complex, involving one loading dose and two maintenance doses to be infused during a period of 21 hours.¹ The patient was transferred to an inpatient care unit after receiving the loading dose of acetylcysteine. The nurse, who had never administered acetylcysteine before, failed to mention in the handoff report that the loading dose had already been given but did note that the two maintenance doses still needed to be given. In addition, the nurse did not document the administration of the loading dose on the medication administration record. The nurse on the inpatient care unit who received the patient saw that the patient had not

(continued on page 4)



Preventing Errors Associated with Loading Doses of Medications

(continued from page 1)

received the first maintenance dose but was under the assumption that the loading dose had not been given either. She called pharmacy asking for the loading dose and pharmacy sent up another loading dose, which was administered for the second time.

Certain medications require a loading dose, or a larger one-time dose, to reach therapeutic levels within the body rapidly.^{2,3} Thereafter, the loading dose is followed by maintenance doses at lower levels.^{2,3} This medication dosing regimen is complex and strays from the usual medication administration process, making it more prone to error.^{2,3} From June 2004 through May 2012, Pennsylvania hospitals reported 580 medication errors associated with prescribing, dispensing, and administering loading doses, resulting in harm to 15 patients.² And from January 2005 to April 2010, hospitals in England and Wales reported 1,165 incidents related to loading dose medications, resulting in four cases of severe harm and two deaths.³

“The patient safety problems with both loading and maintenance doses are multiple,” says Ronald Wyatt, MD, medical director, The Joint Commission. “You can potentially give incorrect loading or maintenance doses, omit or delay doses, or have communication and documentation breakdowns.” See the box at right for further information on the types of medication errors reported for loading and maintenance dose medications.

The most frequently reported medications associated with loading and maintenance dose errors include the following²:

- Vancomycin (antibiotic) was involved in 14.8% of the errors reported by Pennsylvania hospitals.
- Clopidogrel (antiplatelet commonly given by loading dose after percutaneous transluminal coronary angioplasty)
- Phenytoin (anticonvulsant) was most frequently involved in harmful events and fatalities.
- HYDROmorphine and morphine (opioid analgesic, which may be prescribed with loading doses more frequently when given by patient-controlled analgesia infusion pumps)

Other medications commonly given with loading and maintenance doses include digoxin, fosphenytoin, azithromycin, gentamicin, tigecycline, warfarin, amiodarone, and acetylcysteine.^{2,3} However, more than 70 to 80 different medications have been involved in these types of medication errors.^{2,3}

“Organizations need to have mitigating actions in place to decrease the chance of medication errors related to loading and maintenance doses,” Wyatt says. “These processes need

Types of Loading and Maintenance Dose Medication Errors^{2,3}

- Loading dose omitted or delayed
- Wrong loading dose given
- Loading dose given multiple times
- Maintenance dose missed
- Maintenance dose given at wrong time
- Wrong maintenance dose given
- Incorrect number of maintenance doses given

to be hardwired into organization processes using built-in redundancies, alerts, and reminders so that it is easy to administer the medications correctly and difficult to administer them in error.” To reduce the risk of errors associated with loading and maintenance dose medications, hospitals can consider the following strategies.

STRATEGY *Reduce prescription errors associated with loading and maintenance dose medications.* Loading and maintenance doses often involve complex dosing calculations based on the patient’s weight, renal function, or disease state.^{2,3} “Anytime you have to calculate doses for medications there is potential for error,” says Frank Federico, RPh, executive director, Strategic Partners, Institute for Healthcare Improvement in Cambridge, Massachusetts. Double-checking prescribed doses with a pharmacist or consulting a pharmacist to dose these medications is one solution to preventing prescription errors, says Wyatt.

In addition, order sets can be used to decrease variation involved in prescribing loading and maintenance dose medications and to encourage prescribers to follow evidence-based guidelines. “Protocols can be helpful if they are well designed in guiding the prescriber, pharmacist, or nurse in providing medication therapy,” says Federico. “However, I would be careful because order sets that have loading doses on them could lead prescribers to automatically give a loading dose even when it’s not necessary. You need a clear way to determine whether the loading dose is necessary—just because it exists does not mean that it has to be used.” Overall, Federico recommends that physicians’ orders for loading and maintenance doses clearly state that a loading dose is a one-time order and that all other subsequent doses should be at a lower level, depending on the patient’s situation.

STRATEGY *Restrict and limit availability of medications requiring loading and maintenance doses.* “Pharmacy and Therapeutics (P&T) committees at hospitals

can choose to limit the medications that can be prescribed with loading doses,” Federico says. For example, some hospitals in England and Wales choose to eliminate loading doses for warfarin for patients being treated for atrial fibrillation.^{3,4}

Organizations should consider limiting the physical availability of medications that may require loading doses on the patient care units, particularly for those medications that are most prone to error.² “Certain patient care areas may need to have access to these medications,” says Michael J. Gaunt, PharmD, senior patient safety analyst, Pennsylvania Patient Safety Authority in Harrisburg, Pennsylvania, “but some patient care units may not need these medications and then pharmacy can be more consistently involved with reviewing, preparing, and dispensing these medications. If pharmacy is not involved in the medication use process, you’re losing a safety step because a pharmacist is not providing a double check.”

STRATEGY Enhance medication reconciliation processes for loading and maintenance dose medications. “The medication reconciliation process can help strengthen handoff communication regarding medications at transfer,” says Gaunt. Thus, the practitioners should review the patient’s medications at transfer to identify potential errors with loading or maintenance dose medications, such as wrong or omitted maintenance doses.

STRATEGY Improve handoff communication regarding loading and maintenance dose medications. “Whenever you transition a patient’s care from a different care unit or to a different clinician, there are vulnerabilities in that communication process that can cause omitted, delayed, or repeated doses of medications,” says Gaunt. “Handoff communication provides critical information that will guide how and when loading or maintenance doses will be administered.” Thus, clinicians must specifically state (and document accordingly) the following during handoffs²:

- Orders that have been implemented pretransport (for example, loading dose)
- Orders that still need to be implemented posttransport (for example, maintenance doses)

At shift change, nurses should review the patient’s current medications to ensure that any errors involving loading and maintenance dose medications are detected quickly, such as medications that have been omitted by accident.²

STRATEGY Revise the way loading and maintenance dose medications are delivered and labeled. To reduce the risk of the maintenance and loading doses

being stored near each other on the patient care units, pharmacy should deliver the doses separately.² “Ideally, pharmacy should not deliver both the loading and maintenance doses to the patient care units at the same time,” says Gaunt. “Instead, the loading dose should only be available to the nurse at the time the loading dose needs to be given, and then the maintenance dose should be delivered near its administration time.” According to Wyatt, if organizations hardwire having pharmacy dispense loading and maintenance doses separately, it provides a forcing function to prevent the nurse from accidentally selecting the maintenance dose and administering it in place of the loading dose.

Furthermore, the loading and maintenance doses should be labeled to make it easy to differentiate between them.² “Injectable medications prepared by pharmacy can tend to look similar,” says Gaunt. “So, differentiating the labels on maintenance and loading dose infusion bags is helpful.”

STRATEGY Report near misses and errors associated with loading and maintenance dose medications. “Hospitals need to have a process in place to learn from errors related to loading and maintenance dose medications and work to prevent future errors,” says Federico. Wyatt adds that hospitals need to look at these errors from a systems perspective, considering communication breakdowns, human factors issues, and documentation problems.

“Hospitals should work to error-proof these types of events and not just hope that nurses and pharmacists will remember to double-check the doses or notice that a dose is incorrect,” says Federico. “It requires an organized human factors approach with reminders or alerts to ensure correct dosing, and signals on the medication labels to ensure correct selection of the loading or maintenance dose of the medication. It has to be a systematic approach to solving the problem and not just one that involves more training and education on loading and maintenance dose medications.” **TS**

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