



Preventing errors with neuromuscular blocking agents

Paralyzed by mistakes

Neuromuscular blocking agents have been inadvertently administered to patients who were not receiving proper ventilatory assistance. Because skeletal muscles, including respiratory muscles such as the diaphragm and intercostals, are paralyzed, some patients have died or sustained serious injuries. In fact, the USP-ISMP Medication Errors Reporting Program has received more than 50 reports concerning misuse of these agents over the past several years. Unfortunately, the true incidence of injuries from accidental administration of neuromuscular blocking agents is likely much higher than reflected by error reports.

While some errors have occurred in the operating room (OR), most have taken place outside this setting, in emergency departments (EDs), interventional radiology departments, intensive care units (ICUs), and other medical, surgical, and psychiatric units. Many errors can be attributed to one or more common root causes. Consider the following examples.

Look-alike packaging and labeling

▶ Nurses mistakenly reconstituted measles and BCG vaccines with pancuronium and administered the vaccines to healthy infants. One infant died after experiencing seizures and respiratory arrest. The pancuronium vial looked very similar to a vial of the correct diluent, sodium chloride injection.

▶ An ED nurse administered pancuronium instead of influenza vaccine to several patients. The vials were the same size, and the labels were quite similar. They had been stored next to each other in the refrigerator. The patients experienced dyspnea and respiratory depression but, fortunately, sustained no permanent injuries.

▶ Vials of pancuronium were misplaced in a bin holding vials of heparin flush solution. An ICU nurse failed to notice the mistake and flushed a patient's central line with the neuromuscular blocking agent. The patient arrested after the injection but fortunately recovered after 10 hours on a ventilator.

Look-alike drug names

▶ A physician prescribed vancomycin 1.5 g IV every 12 hours for a patient, but the pharmacist misread the faxed copy of the handwritten order and entered vecuronium into the pharmacy computer. A technician prepared the 1.5 g dose in 250 mL of diluent using 15 vecuronium vials (100 mg/10 mL). The checking pharmacist did not recognize the error, so the bag was dispensed. Fortunately, the technician had affixed an alert sticker stating, "Neuromuscular blocker, patient must be intubated" to the bag, which the nurse noticed, thereby averting a serious medication error.

Drug administration after extubation

▶ A ventilated ICU patient was receiving vecuronium and a potassium chloride infusion. After the patient was extubated, vecuronium was discontinued. The infusion bag containing vecuronium remained in the room and was mistaken as a potassium chloride infusion. Soon after the medication was started, the patient arrested, requiring intubation and ventilation for 6 hours. continued on next page

nicecatch



Easy catch, good rule.

An order was written for **DECADRON** (dexamethasone) 1 g IV for 3 days. The pharmacist thought the dose seemed high, and also noted that 10 vials (10 mg/mL, 10 mL vials) would be needed for each dose. He called to clarify the order and learned that the physician had intended to prescribe **SOLU-MEDROL** (methylprednisolone) 1 g IV for 3 days. Although the patient received the correct drug and dose, this case highlights a critical safety rule that should be echoed throughout the organization: Presumably, drugs are manufactured in containers that closely approximate their usual dosages; thus, the need for a large numbers of containers is often a sign of an error. In this case, the error was easy to detect—the number of vials required was a clear red flag. However, **please verify all medication orders that require more than three dosage forms to deliver a dose.**

safetywire



Lithium in mg or mEq.

Following a minor surgical procedure for empyema, a patient's medications were reordered, including lithium 100 mg daily. The only form available for this low dose was lithium citrate suspension, which was labeled in mEq (8 mEq/5 mL), not mg. The hospital pharmacist failed to notice that the syrup had been entered into the pharmacy computer system in mEq. He accidentally prepared 100 mEq, not 100 mg, of lithium citrate suspension, which equaled 3,750 mg (62.5 mL). Despite several check points, the error was not detected before dispensing the drug or before administering the dose. A different pharmacist discovered the error the following day after noticing the unusually high dose (in

continued on next page

Neuromuscular blocking agents continued

Unlabeled syringes

▶ Commercially prepared saline flush syringes were not available in the ED, so nurses prepared a supply of syringes each day from multiple-dose vials. Vecuronium had been prepared for a trauma patient but was not used. The unlabeled syringe was inadvertently placed with the saline flush syringes. The vecuronium syringe was later used to flush the IV line of an alert 3-year-old child, who became flaccid, and respiratory efforts ceased. She was quickly intubated and ventilated, and permanent harm was averted.

Unsafe storage

▶ Atracurium was administered subcutaneously instead of hepatitis B vaccine to seven infants, who developed respiratory distress within 30 minutes. Five infants recovered, one sustained permanent injury, and another died. Neuromuscular blocking agents had never been available as floor stock in the nursery. For convenience, an anesthesiologist from a nearby OR had placed the vial of atracurium in the unit refrigerator near vaccine vials of similar appearance.

▶ In a pediatric ICU, a respiratory therapist obtained what he thought was a sterile water vial to prepare a nebulizer treatment. As he was piercing the stopper, he fortunately noticed that he had accidentally grabbed a vial of atracurium that had been inadvertently returned to a respiratory box in the refrigerator. The atracurium and sterile water vials both had similar purple color accents.

▶ Unknown to pharmacy, an anesthesiologist had ordered trial supplies of **MIVACRON** (mivacurium) from a drug representative. When the product was delivered to the pharmacy, it was stocked next to look-alike bags of metronidazole. Both solutions were encased in foil wrappers. Believing metronidazole was the only product in foil wrappers in the pharmacy, a technician labeled several Mivacron bags as metronidazole. The pharmacist failed to notice the mistake and four patients received Mivacron; all experienced respiratory arrest. One patient died, and another was seriously injured.

Inadequate knowledge of drug action

▶ A trauma patient was admitted to the ED for stabilization before transfer to a local trauma center. The physician gave a verbal order for vecuronium and midazolam, and intubated the patient after the medications had been administered. He then mistakenly entered electronic orders for these medications onto an oncology patient's record. While this patient's nurse was taking a break, another ED nurse administered medications to the oncology patient without recognizing that vecuronium would paralyze the respiratory muscles. After she left the room, the patient arrested and resuscitation efforts were not successful.

▶ A physician prescribed **NARCAN** (naloxone) for a lethargic patient to reverse the effects of morphine. An ICU nurse did not recognize the drug on the automated dispensing cabinet (ADC) screen because it was listed by its generic name. She intended to ask a coworker for Narcan's generic name, but she became confused and instead asked her coworker for the generic name of **NORCURON** (vecuronium). Her coworker told her that Norcuron was vecuronium, which the nurse then administered. The patient arrested, was resuscitated and placed on a ventilator, and later fully recovered.

Failure to assure ventilator support

▶ An ED physician ordered a neuromuscular blocking agent to sedate a combative patient. However, a nurse administered the drug too soon, before the patient could be intubated. The patient arrested and suffered permanent anoxic injury.

To prevent serious harm from errors with neuromuscular blocking agents, please see page 3 for a list of recommended safeguards.

safetywire continued

mEq) and the large volume of syrup needed for each dose. The patient was transferred from the psychiatric unit to a critical care unit for monitoring but suffered no ill effects from the elevated lithium level. When administering medications, nurses should always check for an error if the volume of liquid needed for each dose seems unusually high.

⚡ Does the nose know?

Medications intended to produce local nasal mucosa effects are typically administered in **BOTH** nostrils for a single dose. However, those that are given for systemic effects are generally administered into **ONE** nostril only for each dose. **FORTICAL** and **MICALCIN** (calcitonin salmon) are prime examples; these medications are dosed as a single spray (200 international units) into one nostril daily, using alternate nostrils each day. Other examples in metered-dose or unit-dose nasal spray containers include **DDAVP** (desmopressin), **IMITREX** (sumatriptan), and **ZOMIG** (zolmitriptan). Some electronic prescribing systems have been pre-programmed to print "spray in each nostril" when nasal sprays are selected. One outpatient facility recently reported that about 50 patients had been prescribed medications intended to be given into one nostril, but the prescription label directions from the electronic prescribing system instructed the patients to administer the spray into both nostrils. Even if instructed to use the spray in one nostril, nurses who are accustomed to administering nasal medications in both nostrils may inadvertently give the patient a double dose. Orders and medication administration records (MARs) should explicitly emphasize administration into one nostril. To avoid lapses in documentation about which nostril was used each day, one hospital employs standard directions to use the right nostril on even days and the left nostril on odd days.

Preventing errors with neuromuscular blocking agents

Recommended Safeguards

Neuromuscular blocking agents are high-alert drugs because misuse can lead to catastrophic injuries or death. To reduce the risk of harm from accidental administration of these agents, consider the following recommendations:

Limit access

- When possible, neuromuscular blocking agents should be dispensed from the pharmacy when prescribed. Allow floor stock of these agents only in the OR, ED, and critical care units where patients can be ventilated and monitored.

Segregate storage

- When these agents must be available as floor stock, assemble the vials in a sealed box with warnings affixed as noted below. This provides quick access to a neuromuscular blocking agent in a crisis while also serving to remind nurses to pause, read the warning, and act accordingly.

Affix warning labels

- Affix fluorescent red labels that note: "Warning: Paralyzing Agent—Causes Respiratory Arrest" on each vial, syringe, bag, and storage box of neuromuscular blocking agents. Be sure they do not obscure important information on the vial label.



Standardize prescribing

- Do not accept neuromuscular blocking agent orders for "use as needed for agitation."
- Establish standard order sets to prevent misinterpretation of handwritten orders. Include the need for ventilation support during and after administration, and a protocol that stipulates automatic discontinuation of these agents after extubation and removal from a ventilator.
- Never accept orders to "resume the same medications" upon patient transfer.

Design computer reminders

- If neuromuscular blocking agents are available in ADCs, create a cautionary message to appear on the screen when the drug is selected. For instance, a pop-up box that asks, "Is the patient being ventilated?" may be helpful.

Verify the drug and patient

- Before administering neuromuscular blocking agents, require an independent double check of the drug, comparing it against the actual order.
- Implement point-of-care bar coding to verify drugs, doses, routes of administration, and patients before administration of medications.
- If the patient is not in a critical care unit, ED, OR, or invasive procedure area, question the order and verify ventilatory assistance before administering the drug.

Supervise during administration

- Require bedside attendance of a licensed practitioner who has experience with intubation and airway management during initial administration of a neuromuscular blocking agent.

Remove discontinued products

- Place vials, bags, and syringes of neuromuscular blocking agents in a sequestered bin for immediate pharmacy pick-up after the patient has been extubated or the drug has been discontinued.

► Special Announcements

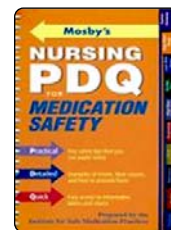
► The New Year brings a new edition!

The second edition of the ISMP book, **Medication Errors** (first published in 1999), edited by **Michael R. Cohen**, is now available. In this expanded 600+ page edition, Dr. Cohen brings together 30 experts from pharmacy, medicine, nursing, and risk management to provide the most current thinking about strategies to prevent medication errors.



Highlights include: in-depth analyses of drug administration errors; detailed discussions of errors with pediatric patients, chemotherapy, and immunizations; a comprehensive chapter on high-alert medications; and new chapters on root cause analysis, error-prone abbreviations, drug delivery devices, technology, disclosing errors, and managing risks through a culture of safety. To place an order, visit: <http://onlinestore.ismp.org/>.

► **Quick reference guide.** Mosby's pocket-sized **Nursing PDQ for Medication Safety**, prepared by ISMP, offers quick facts and error reduction strategies for high-alert medications, look-alike drugs, high-risk procedures, and error-prone abbreviations. The



guide also offers information and tips on assessing risk, error reduction, error reporting, and more. To place an order, visit: <http://onlinestore.ismp.org/>.

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Production of this peer-reviewed newsletter would not be possible without the assistance of a reliable and talented clinical advisory board. As 2006 nears an end, we want to thank each of the following members of the advisory board for their dedication to making this newsletter a valuable medication safety resource for clinicians.

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