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ISMP Institute for Safe Medication Practices
An ECRI Company

Nurse AdviseERR®
Educating the Healthcare Community About Safe Medication Practices

what's in a Name?

The "-cycline" drug stem name

Medications that end with the suffix "-cycline" belong to the tetracycline/tetracycline derivative drug class. Tetracyclines are antibiotics commonly used to treat various bacterial infections. Currently, there are eight single-agent tetracyclines and one combination product approved for use in the United States (**Table 1**).

Table 1. List of tetracycline and tetracycline derivatives available in the United States.

Generic Name(s)	Brand Name(s)	Formulation(s)
demeclocycline	generic	oral
doxycycline	**DORYX**, **DORYX MPC**, **ORACEA**	oral
	DOXY	parenteral
eravacycline	**XERAVA**	parenteral
minocycline	**EMROSI**	oral
	MINOCIN	parenteral
	AMZEEQ, **ZILXI**	topical
minocycline hydrochloride periodontal microspheres	**ARESTIN**	subgingival
omadacycline	**NUZYRA**	oral, parenteral
sarecycline	**SEYSARA**	oral
tetracycline	generic	oral
bismuth subcitrate, metronidazole, and tetracycline	**PYLERA**	oral

The single-agent products are commonly used to treat acne; gastrointestinal, respiratory, and urinary tract infections; Rickettsial infections (i.e., Rocky Mountain Spotted Fever); and sexually transmitted infections (e.g., syphilis, gonorrhea, chlamydia). Most products are available as oral or parenteral formulations. Minocycline is also available as a topical foam that is used to treat acne vulgaris. In addition, there is also a minocycline hydrochloride microsphere formulation specifically administered subgingival for the treatment of periodontitis. Although demeclocycline is approved for use in the United States, it is rarely used and alternative tetracyclines are usually preferred. The combination product, which includes tetracycline, metronidazole, and bismuth subcitrate, is available as an oral formulation and is designed specifically to treat *Helicobacter pylori (H. pylori)*, a common cause of peptic ulcer disease and gastritis.

Both oral and parenteral tetracycline derivatives are typically administered twice daily. However, for certain indications such as cholera, *H. pylori*, or syphilis, oral formulations may need to be administered up to four times daily. To enhance absorption, oral tetracyclines should be given on an empty stomach. Due to the significant risk of esophageal injury, they should be taken with plenty of water to reduce the risk of esophageal irritation. Co-administration with antacids may reduce the absorption of tetracyclines due to chelation. Therefore, tetracyclines should be administered 1 to 2 hours prior to or 4 hours after taking an antacid.

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SAFETY wire

KIDs List has been updated. Pediatric patients are at greater risk for adverse drug events due to unique factors such as the use of medications off-label, individualized dosing, and age-related differences in drug responses. To improve medication safety, the Pediatric Pharmacy Association (PPA) developed the KIDs List—a compilation of drugs that are potentially inappropriate or require caution in children, updated in 2025 to include new drugs, excipients, and age-specific recommendations. The KIDs List is intended to guide practitioners, especially those outside specialized pediatric settings, in safer prescribing and monitoring practices. Implementing the KIDs List involves reviewing organizational practices, optimizing order sets and clinical decision support systems, educating healthcare providers, collaborating with outpatient partners, and monitoring for adverse events. These steps help ensure that medications are used appropriately in pediatric patients, reducing the risk of harm and improving overall pediatric medication safety. The updated KIDS List was recently published August 2025 issue of the Journal of Pediatric Pharmacology and Therapeutics and is available here: Pediatric Pharmacy Association 2025 KIDs List of key potentially inappropriate drugs in pediatrics.

Worth repeating...

Methemoglobinemia risk after administration of Hurricaine spray

A practitioner administered **HURRICAINE** (benzocaine) spray 20% to a patient's throat prior to nasogastric tube placement to ease discomfort during the procedure. The patient became hypoxic and developed methemoglobinemia requiring methylene blue to reverse the effects. Methemoglobinemia is a serious and potentially fatal adverse effect associated with topical benzocaine products. The risk increases with the

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Common side effects include nausea, vomiting, and abdominal pain, which typically resolve upon termination of the medication. In addition, tetracyclines increase the risk of photosensitivity and patients should be encouraged to avoid sun exposure and wear sunscreen during the course of treatment. Use caution when initiating tetracyclines in pediatric patients (see ***SAFETY* wire** regarding KIDs List). There is an increased risk of dental discoloration, skin hyperpigmentation, and bone growth suppression in patients who are still developing.

Tetracyclines cross the placenta, and may cause fetal harm, so pregnant patients should consult with their prescriber to discuss alternative treatment options. Tetracyclines are present in breastmilk, and although they are not contraindicated during breastfeeding, they are generally avoided due to concerns that they could stain the breastfeeding infant's teeth.

Finally, it is important to note that tetracycline medications should not be used after the expiration date and should be discarded. Using expired tetracycline can be toxic and result in a rare kidney disease, Fanconi syndrome, which prevents the body from absorbing electrolytes.

Two health technology hazards that put patient safety at risk

Reflecting on events that occurred in 2024, we have identified two medication safety concerns, which were included in ECRI's Top 10 Health Technology Hazards for 2025. Selection was not solely based on the severity of outcomes or volume of reported events, although these factors were considered. Rather, we focused on safety concerns and errors that continue to occur but can be avoided or minimized with system and/or practice changes. In an article, Déjà Vu in Healthcare Tech Hazards: Why Are We Stuck on Repeat?, ECRI president and chief executive officer Marcus Schabacker, MD, PhD, calls for embracing these issues using a total systems approach so that healthcare stakeholders and policymakers can move the needle on these persistent patient safety threats. If you have not already taken action to mitigate these risks, we hope increased awareness informs the priorities you set for your medication safety improvement plan!

Mishandled Temporary Holds on Medication Orders

The need to suspend (or hold) the administration of a drug based on clinical circumstances is a common—but sometimes problematic—requirement during the course of patient care. Medications may be held before or shortly after a patient undergoes a procedure, or when a patient's condition changes (such that the continued administration of a drug is inappropriate), or as dictated by clinical protocols. Failure to hold a medication when indicated, or neglecting to either restart or discontinue a held medication as circumstances require, can lead to patient harm.

Errors associated with hold orders often can be attributed to uncertainty about what a hold order means, how the order should be communicated, or what process should be followed. One key concern is that the electronic health record (EHR) configuration may prevent easy access to details about a hold order. For example, the EHR may require practitioners to scroll, browse, or search for information about whether and when to hold (or resume) a medication.

Recommendations: Organizations should create and vet hold order workflows that support safe practices. Understand the various ways that medications can be placed on hold in your EHR system and then restarted. Identify which medications should be held, and when, based on a specific parameter (e.g., heart rate, blood pressure), and build required fields in the EHR that the prescriber must enter prior to placing the order. Evaluate the clinical decision support alerts configured in the system, and ensure the appropriate practitioners are receiving applicable system warnings related to the held/resumed medication and that they are addressing those alerts at the appropriate time. Ensure held orders are visible to all practitioners on all lists and the medication administration record, and that those orders clearly indicate how long the medication is on hold (e.g., number of doses, number of days) if known.

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number and duration of sprays administered outside of the prescribing information (a half second spray, which may be repeated once). However, from a human factors perspective, no one can estimate fractions of seconds reliably or visualize how thick or widespread the actual deposition of the spray really is. It is too easy for practitioners to unknowingly exceed the dose.

ISMP first warned about topical anesthetic-induced methemoglobinemia in 1997 in our acute care newsletter. Since then, we have written about it many times, including in this newsletter, and it is still ***Worth* repeating**.

Alert practitioners and patients to the proper dosing of benzocaine-containing topical anesthetics and the possibility of methemoglobinemia when these products are used. These drugs should not be used in high doses, in children less than 2 years old, or in patients who may be predisposed to methemoglobinemia. Predisposing factors include age (e.g., older patients with cardiac problems); the status of the area that is being sprayed (e.g., inflamed areas absorb more drug); concomitant use of other drugs which have been implicated in causing methemoglobinemia (e.g., phenazopyridine, sulfamethoxazole, dapsone, nitroglycerin); and genetics (e.g., autosomal recessive variants in the CYB5R3 gene, autosomal dominant variants in the globin genes).[1]

To reduce harm, consider the following:

- Ask about the patient's past medical history noting if risk factors are present.
- Educate practitioners about products used in the organization (e.g., Hurricaine spray; **HURRICAINE ONE** [a unit dose non-aerosol spray]; **TOPEX** [a metered-dose formulation]). Although these other products control the amount being applied, they will not prevent an overdose if multiple sprays are used.
- Build clinical decision support (CDS) in the electronic health record (EHR) when prescribing Hurricaine spray (e.g., spray for a half second, alert to avoid in patients less than 2 years old).
- Have pharmacy apply warning labels to avoid sprays of longer duration.

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Organizations must have a formal process outlining the designated prescriber (e.g., hospitalist, surgeon) responsible for completing medication reconciliation during transitions of care. Avoid vague orders such as, "resume all pre-op medications" or "continue all prior medications." All new postoperative medication orders should be reconciled with previously prescribed medications; prescribers should not rely solely on summaries for patient medication orders. A review of medications held and discontinued is also essential, and this information needs to be communicated during handoffs.

Additionally, EHR vendors should implement effective hold order functionality that allows practitioners to view held medication orders and associated parameters at all points of care, from the pharmacy to the bedside. Organizations should provide feedback to vendors to push for improved processes.

Incomplete Investigations of Infusion Pump Incidents

Organizations will want to conduct a thorough investigation in the aftermath of any technology-related adverse event. Investigations involving infusion pumps can be particularly challenging due to the variety of potential contributing factors. Organizations that lack the expertise or resources to conduct a thorough investigation of such incidents will be poorly positioned to prevent future, potentially fatal infusion-related medication errors or other incidents. Furthermore, it is not uncommon for staff to take steps after an event that inadvertently hinders a future investigation.

From January 2023 to August 2024, a total of 204,163 infusion pump events were submitted to FDA's MAUDE (Manufacturer and User Facility Device Experience) database. Those event outcomes were categorized as 204 deaths, 1,901 injuries, and 202,025 malfunctions. Pump-related incidents are also commonly reported to ISMP and ECRI. In our August 2023 article, Smart Infusion Pump Investigations after an Unexplained Over-Infusion, we shared a series of unexplained over-infusion events. Any unexplained infusion pump incident can be a logistical nightmare for practitioners and can erode end-users' trust in infusion pump technology. When programming errors are ruled out and an error cannot be replicated during laboratory testing, practitioners are left uncertain about what led to the incident and what actions to take to prevent a recurrence. Numerous factors—alone or in combination—must be examined, including issues related to the pump hardware and software, the intravenous (IV) administration set and other accessories, and the actions of the user.

Recommendations: Immediately report an infusion event so that error alerts on the infusion pump screen and the actions taken can be reviewed. Be sure that the pump, the involved module, all other modules attached at the time of the incident, and any consumables (e.g., IV bag and infusion set), are preserved and sequestered. To the extent possible, preserve how the pump was set up when the incident occurred. Ensure that the pump is removed from clinical use and appropriately labeled or tagged so it is clear that the pump should not be used. Extract and review the usage logs for all pump modules taking note of the timeline of events including any issues (e.g., removal of the administration set from the pump, error alerts and the corresponding actions taken).

If there was a significant discrepancy between the expected rate and how fast or slow an IV infusion was administered, review the medication order and confirm the infusion was programmed correctly (e.g., correct medication, concentration, dose-rate, and volume to be infused). If there are concerns that an infusion could have been prepared with a different volume than what was prescribed, pharmacy should investigate the possibility of a dispensing error. Reconcile event logs and physical evidence with the event description, if possible.

The pump and all its components should be examined for missing parts, damage, wear, corrosion, and broken seals. If approved by risk management, biomedical engineering can help test the pump.

Seek assistance from the pump vendor or a third-party consultant to support the investigation. ECRI provides this service along with ISMP support as needed. To learn more about the safe use of infusion systems refer to the ISMP Guidelines for Optimizing Safe Implementation and Use of Smart Infusion Pumps. To learn more about incident investigation, consider taking ECRI's Healthcare Incident Management and Investigation (HIMI) Training course.

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- Document the number and duration of sprays applied to keep track of the amount of drug administered.
- Consider methemoglobinemia if cyanosis develops after application even if pulse oximetry readings are normal.
- Create a protocol to treat methemoglobinemia that includes stopping the agent precipitating methemoglobinemia, and when to initiate intravenous (IV) hydration and oxygen supplementation.[1]
- Build an order set in the EHR with treatment options (e.g., methylene blue, ascorbic acid, blood transfusion, hemodialysis).
- Ensure reversal agents are stored in automated dispensing cabinets (ADCs) where benzocaine spray is used (e.g., emergency department, operating room).
- Use CDS when prescribing methylene blue including guidance when methylene blue may be contraindicated or precautions are warranted (e.g., avoid in patients with glucose-6-phosphate dehydrogenase [G6PD] deficiency; screen for the possibility of precipitating serotonin syndrome in individuals receiving selective serotonin reuptake inhibitors; use caution when pregnant, renal failure, and undergoing anesthesia).[1]

Reference

1) Iolascon A, Bianchi P, Andolfo I, et al. Recommendations for diagnosis and treatment of methemoglobinemia. *Am J Hematol.* 2021;96(12):1666-78.

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Report medication and vaccine errors to ISMP: Please visit: www.ismp.org/report-medication-error or call 1-800-FAIL-SAF(E). ISMP guarantees the confidentiality of information received and respects the reporters' wishes regarding the level of detail included in publications.

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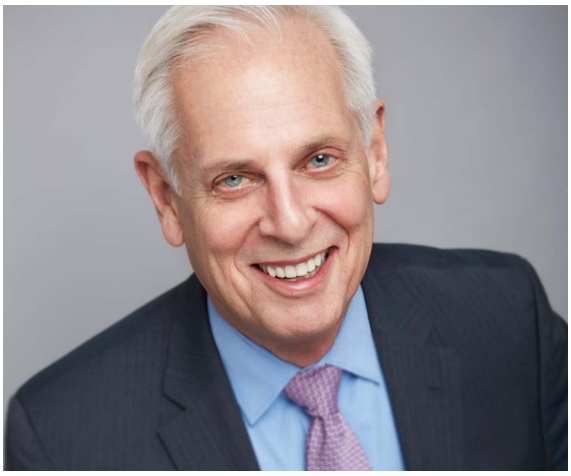
SHARING A SAFETY MISSION

ISMP 28TH ANNUAL CHEERS AWARDS

Tuesday, December 9, 2025

House of Blues – Las Vegas, NV 6:00 pm



The Michael R. Cohen Lifetime Achievement Award Winner:
Martin J. Hatlie, JD
Founding Member, Director for Policy & Advocacy, Patients For Patient Safety US

The 28th Annual ISMP Cheers Awards will celebrate individuals and organizations on a mission to make strides in medication safety. Support ISMP's ONLY annual fundraising event or attend the awards dinner to honor them and advance our shared goal of preventing errors and protecting patients!

For support opportunities and/or to register for the dinner, visit: https://home.ecri.org/pages/cheers-event

ISMP will be at the 2025 ASHP Midyear Clinical Meeting
Educational Sessions with ISMP Speakers:

Sunday, December 7, 2025

How Smart Are Smart Infusion Pumps in Preventing Medication Errors?
9:00 am – 10:15 am PT

ISMP Medication Safety Update 2025
3:30 pm – 5:00 pm PT

Tuesday, December 9, 2025

A Winning Strategy: Confronting the Top 10 Patient Safety Challenges of 2025 with ISMP
10:00 am – 11:00 am PT

Symposium: Safety Considerations for IV Push Amid Drug Shortages
11:30 am – 1:00 pm PT
Mandalay Bay Convention Center - South Paci ic D - Lower Level
Preregister here: https://home.ecri.org/blogs/ismp-upcoming-events/safe-iv-push-practices-amid-drug-shortages

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