



Supply chain disruption due to manufacturer closure

Akorn Pharmaceuticals ceases operations

Situation

On February 23, 2023, Akorn Pharmaceuticals filed for bankruptcy and ceased all manufacturing operations in the US.

Background

Akorn Pharmaceuticals has shut down all US operations secondary to bankruptcy. Prior to Akorn closing, their portfolio included over 100 medications. The generic manufacturer most noted for their ophthalmic products was also the sole manufacturer for numerous acute care injectables.

Please review the [ASHP Drug Shortages](#) for the most current shortage information.

The information provided in this document was compiled on behalf of the End Drug Shortages Alliance by the Vizient® Center for Pharmacy Practice Excellence in combination with ASHP, USP and CHA.

Assessment and recommendation

Vizient compiled a market analysis of all previously manufactured Akorn products. The following tables are organized in the following manner:

- [Table 1](#): Akorn products with greatest risk of supply disruption including products with $\geq 80\%$ market share and/or USP impact score $\geq 20\%$
- [Table 2](#): Oral and injectable products with 20-80% Akorn market share
- [Table 3](#): Ophthalmic, otic and topical products with 20-80% Akorn market share
- [Table 4](#): All products per Akorn online catalog on February 22, 2023 regardless of supply chain risk status

Included in these analyses is the United States Pharmacopoeia (USP) Supply Chain Vulnerability Score, which provides information at the product level for products that are susceptible to future drug shortages, regardless of Akorn distribution disruption. See [USP Vulnerability Score](#) for more details on score methodology.

Abbreviated mitigation strategies are provided in [Appendix 1](#). The abbreviated structure is intended to be a high-level, not all-inclusive guidance to quickly address and mitigate potential drug shortages and should be used in conjunction with clinical expertise and other resources. A summary of ophthalmic products manufactured by Akon is available in [Appendix 2](#).

Manufacturers and wholesalers

The End Drug Shortages Alliance recommends that manufacturers of impacted products evaluate their ability to maintain or increase product availability for the marketplace. Wholesalers should communicate with manufacturers and establish protective allocations for medications to ensure product is available for patient care.

Group Purchasing Organizations

The End Drug Shortages Alliance encourages Group Purchasing Organizations (GPOs) to pursue novel sourcing strategies and emergency contracting for life-saving medications. Ultimately, the goal should be to provide additional redundancy for essential medications to minimize potential patient care disruption.

Clinical and provider recommendations

The End Drug Shortages Alliance encourages providers and clinicians to exercise a [stewardship mindset](#) when ordering, prescribing and administering medications affected by supply constraints to preserve availability for vulnerable patient populations. Institutions should review their historical purchase patterns, formulary standings, and ability to use alternative agents in determining conservation and mitigation strategies for their patients.

USP Vulnerability Score

To better characterize the supply chain factors that drive resilience USP leveraged the capabilities of its [Medicine Supply Map](#) to develop the USP Drug Supply Chain Resiliency Model. This model leverages insight from the USP quality standards to enhance visibility into the supply chain, including the location of active pharmaceutical ingredient and fill-finish manufacturing, quality records of manufacturing facilities, economic and market factors as well as drug characteristics such as dosage form and complexity of manufacturing. The USP Supply Chain Vulnerability Score represents the likelihood that a medication will be on the ASHP or FDA drug shortage lists 12 months from now, whereas the USP Impact Score incorporates both market share and Vulnerability Score to assess the magnitude of supply chain risk.

Frequently Asked Questions

Are the Akorn products going to be recalled?

Akorn Pharmaceutical's trustee has issued recalls for various within-expiry medications. The discontinuation of the Quality programs results in the company's inability to assure products meet the identity, strength, quality, and purity characteristics required. As such, they are considered adulterated products and a recall of various products was initiated by Akorn's trustee. The specifics and full list of products affected can be accessed via the [FDA announcement](#). Not all products manufactured by Akorn are included in this recall. However, the products affected have been distributed nationwide to wholesalers, retailers, manufacturers, medical facilities, and repackagers.

Recommendations include the following:

- 1) Review the list of recalled products, sequester the products and destroy the products as recommended by Akorn.
- 2) For questions regarding this recall, Akorn can be contacted at 800-932-5676, Monday to Friday (8 AM - 5PM CT). A medical professional will return calls within one business day.
- 3) Please direct any additional questions to pharmacyquestions@vizientinc.com.

How much of the market share did Akorn have of concentrated albuterol?

Akorn had 3.44% of the market share of concentrated albuterol. The remaining supplier of concentrated albuterol is Nephron, which has an estimated 96% market share. Nephron produces a 0.5%, 2.5 mg/0.5 mL, 0.5-mL vial via their manufacturing side and a 0.5%, 5 mg/mL, 20-mL bottle via their 503B compounding side. An additional 503B compounder, Staq Pharma has albuterol 0.5% available in a syringe. Ritedose 503B will have albuterol 0.5% available in a 15-mL nebulizer in the coming weeks. Of note, 503B compounds are not captured in the reported market shares.

Is a list of manufacturers for which Akorn is the contracted manufacturing organization available?

Akorn was the contracted manufacturing organization for other suppliers. A list of suppliers and the products manufactured are unavailable due Akorn's closure. However, this information is publicly available and can be viewed in the package insert. Additionally, for products of concern, please contact the supplier for additional information.

The information contained within this document will be updated as additional details become available. Products where Akorn served as the contract manufacturer are not included in the scope of this document.

Table 1. Products with greatest risk of supply disruption and vulnerability^a

Drug	Vizient Essential Medication	Supplier Market Share ^b	Current ASHP Shortage ^c	Mitigation Strategy	USP Supply Chain Vulnerability Score
Adenosine inj ^d	Yes	Akorn (38%) , Auromedics, Avet, Fresenius, Northstar Rx, Pfizer, Sagent, Viatriis	Yes	Y	68.4%
Alfentanil hydrochloride inj	No	Akorn (100%)	No	N^e	NR
Calcitriol inj	Yes	Akorn (100%)	No	Y	82.4%
Cyclopentolate ophth	No	Akorn (35%) , Alcon Consumer, Bausch Health, Sandoz	No	N^f	89.2%
Dimercaprol inj	Yes	Akorn (100%)	No	Y	28.6%
Fluorescein inj	No	Akorn (82%) , Alcon	Yes	Y	NR
Hydroxyamphetamine and tropicamide ophth	No	Akorn (100%)	No	N^f	NR
Levofloxacin ophth	No	Akorn (100%)	No	N^f	6.6%
Lidocaine HCl 2% topical (mouth/throat) solution	No	Akorn (46%) , Hikma, Intl Med System, Lannett, Morton Grove, Northstar Rx, Pharmaceut Assoc	Yes	N	58.2%
Methadone inj	No	Akorn (51%) , Viatriis	No	N	68.6%
Phenylephrine ophth	No	Akorn (90%) , Bausch, Lifestar Pharm	Yes	N^f	2.3%
Physostigmine inj	Yes	Akorn (100%)	No	Y	88.4%
Sufentanil inj	No	Akorn (79%) , Pfizer	Yes	N^e	81.8%
Orphenadrine inj	No	Akorn (75%) , Hikma	Yes	N	57.1%
Tetracaine inj	No	Akorn (99%) , Cameron Pharma	No	Y^g	7.3%
Tropicamide ophth	No	Akorn (33%) , Bausch, Sandoz, Somerset Therap	Yes	N^f	89.9%

Abbreviations: Inj: Injection; NA: Not available in USP report; NR: Not reported in USP report; Ophth: Ophthalmic

^a Market share for Akorn products ≥80% in 2022 per IQVIA and/or USP Impact Score ≥20%

^b IQVIA; calendar year 2022 data; suppliers where market share rounded to 0% excluded

^c ASHP Current Drug Shortages as of 5/4/2023; <https://www.ashp.org/drug-shortages/current-shortages/drug-shortages-list?page=CurrentShortages>

^d Available as Novaplus and Novaplus Enhanced Supply from Mylan for Vizient pharmacy program participants

^e Evaluate use of other opioids in this class as an alternative (eg, fentanyl, remifentanyl).

^f See [Appendix 2](#) for detailed information about these ophthalmic products

^g Total purchases of tetracaine injection were ~15,000 units in 2022. For clinical alternatives, refer to the [local anesthetics \(bupivacaine, lidocaine, and ropivacaine\)](#) for injection mitigation strategy.

Table 2. Market analysis of injectable and oral products manufactured by Akorn^a

Drug	Vizient Essential Medication	Supplier Market Share ^b	Current ASHP Shortage ^c	Mitigation Strategy	USP Supply Chain Vulnerability Score
Cholecalciferol (D3) oral	No	Akorn (57%) , National Vitamin C, Reckitt Benckiser	No		NR
Codeine and guaifenesin oral	No	Akorn (28%) , Method Pharma, Pharmaceut Assoc, Quagen Pharma, Westminster Pharm,	No		NR
Codeine and promethazine oral	No	Akorn (27%) , Morton Grove Pharm, Pharmaceut Assoc, Tris Pharm	No		17.8%
Dronabinol oral	No	Akorn (21%) , Ascend Labs, Rhodes Pharm	No		9.3%
Mycophenolate mofetil inj ^d	Yes	Akorn (47%) , Genentech, Meitheal Pharma, Par Pharm, Viatriis	No	Y	16.3%
Pentobarbital inj ^d	No	Akorn (24%) , Hikma, Sagent			7.1%

Drug	Vizient Essential Medication	Supplier Market Share ^b	Current ASHP Shortage ^c	Mitigation Strategy	USP Supply Chain Vulnerability Score
Prednisolone oral	Yes	Akorn (30%) , Atlantic Biologica, Biocomp Pharma, Pharmaceut Assoc, Prasco Labs, Seton Pharm	No		39.9%
Pyrazinamide oral	No	Akorn, Inc (72%) , Macleods Pharma Novitium Pharma,	No		1.4%

Abbreviations: Inj: Injection; NR: Not reported in USP report

^a Market share for products where Akorn had 20 – 79% market share in 2022 per IQVIA

^b IQVIA; calendar year 2022 data; suppliers where market share rounded to 0% excluded

^c ASHP Current Drug Shortages as of 5/4/2023; <https://www.ashp.org/drug-shortages/current-shortages/drug-shortages-list?page=CurrentShortages>

^d Previously available as Novaplus from Akorn for Vizient pharmacy program participants

Table 3. Market analysis of ophthalmic, otic and topical products manufactured by Akorn^a

Drug	Vizient Essential Medication	Supplier Market Share ^b	Current ASHP Shortage ^c	USP Supply Chain Vulnerability Score
Ophthalmic^d				
Atropine ophth	Yes	Akorn (32%) , Alcon Consumer, Amneal Pharma, Apotex Corp, Bausch Health	No	46.2%
Fluorescein ophthalmic strips	Yes	Akorn (30%) , Hub Pharma	No	NR
Gatifloxacin ophth	No	Akorn (33%) , Prasco Labs, Sandoz	No	8.8%
Ketotifen ophth	No	Akorn (25%) , Bausch & Lomb, Bayshore Pharm, GSK Consumer Health, Major Pharm	No	NR
Ofloxacin ophth	Yes	Akorn (36%) , Apotex, Bausch, Rising Pharm	Yes	30.4%
Otic				
Acetic acid otic	No	Akorn (36%) , Morton Grow, Rising Pharm, Trupharma	No	35.3%
Acetic acid and hydrocortisone otic	No	Akorn (80%) , Thames Pharma	No	5.5%
Topical				
Lidocaine and prilocaine topical cream	No	Akorn (64%) , Alembic Pharm, Sandoz	No	15.5%

Abbreviations: NA: Not available in USP report; NR: Not reported in USP report; Ophth: Ophthalmic

^a Market share for products where Akorn had more than 20% market share in 2022 per IQVIA

^b IQVIA; calendar year 2022 data; suppliers where market share rounded to 0% excluded

^c ASHP Current Drug Shortages as of 5/4/2023; <https://www.ashp.org/drug-shortages/current-shortages/drug-shortages-list?page=CurrentShortages>

^d See [Appendix 2](#) for detailed information about these ophthalmic products

Table 4. Akorn catalog of products^a

Generic name	Route	Dosage Form / Presentation	Strength
Acetaminophen and codeine phosphate	Oral	Solution	120 mg/12 mg per 5 mL
Acetic acid	Otic	Solution	2%
Acetylcysteine	Injection	Vial	200 mg/mL
Acyclovir	Oral	Suspension	200 mg/mL
Adenosine	Injection	Vial	3 mg/mL
Albuterol sulfate	Oral	Solution	2 mg/5 mL
Albuterol sulfate	Inhalation	Solution	0.5%
Alfentanil hydrochloride	Injection	Ampule	500 mcg/mL
Amantadine hydrochloride	Oral	Syrup	50 mg/5 mL
Aminocaproic acid	Oral	Solution	0.25 g/mL
Aminocaproic acid	Oral	Tablet	500 mg, 1000 mg
Apraclonidine	Ophthalmic	Solution	0.5%
Atropine sulfate	Ophthalmic	Solution	1%
Azelastine hydrochloride	Ophthalmic	Solution	0.05%
Betamethasone dipropionate	Topical	Lotion	0.05%
Bimatoprost	Ophthalmic	Solution	0.05%
Brimonidine tartrate	Ophthalmic	Solution	0.2%
Bromfenac	Ophthalmic	Solution	0.2%
Buprenorphine and naloxone	Oral	Sublingual tablet	2 mg/0.5 mg, 8 mg/2 mg
Buprenorphine hydrochloride	Oral	Sublingual tablet	2 mg, 8 mg
Calcipotriene	Topical	Solution	0.005%
Calcitriol	Injection	Ampule	1 mcg/mL
Cetorelix acetate	Injection	Kit	0.26-0.27 mg
Chlorothiazide sodium	Injection	Lyophilized powder	0.5 g
Ciclopirox	Topical	Solution	8%
Cimetidine hydrochloride	Oral	Solution	300 mg/5 mL
Clobetasol propionate	Topical	Cream	0.05%
Clobetasol propionate	Topical	Gel	0.05%
Clobetasol propionate	Topical	Ointment	0.05%
Clobetasol propionate	Topical	Shampoo	0.05%
Clobetasol propionate	Topical	Solution	0.05%
Cyclopentolate hydrochloride	Ophthalmic	Solution	1%, 2%
Desonide	Topical	Ointment	0.05%
Desoximetasone	Topical	Ointment	0.25%
Detomidine hydrochloride	Injection	Vial	10 mg/mL
Dexmedetomidine hydrochloride	Injection	Vial	0.5 mg/mL
Dicyclomine hydrochloride	Injection	Ampule	10 mg/mL

Diltiazem hydrochloride	Injection	Vial	5 mg/mL
Dimercaprol	Injection	Ampule	100 mg/mL
Docusate sodium	Oral	Solution	50 mg/5 mL, 100 mg/10 mL
Dorzolamide hydrochloride and timolol maleate	Ophthalmic	Solution	22.3 mg/mL and 6.8 mg/mL
Dorzolamide hydrochloride	Ophthalmic	Solution	2%
Dronabinol	Oral	Capsule	2.5 mg, 5 mg, 10 mg
Ephedrine sulfate	Injection	Ampule, Vial	50 mg/mL
Eptifibatide	Injection	Vial	0.75 mg/mL, 2 mg/mL
Ethosuxamide	Oral	Capsule	250 mg
Fentanyl citrate	Injection	Ampule	50 mcg/mL
Ferrous sulfate	Oral	Liquid	220 mg/5 mL
Ferrous sulfate	Oral	Drops	15 mg/1 mL
Fluorescein	Ophthalmic	Vial	10%, 25%
Fluorescein sodium	Ophthalmic	Strips	0.6 mg, 1 mg
Fluticasone propionate	Nasal	Spray	50 mcg
Gabapentin	Oral	Solution	250 mg/5 mL, 300 mg/6 mL
Gatifloxacin	Ophthalmic	Solution	0.50%
Granisetron hydrochloride	Injection	Vial	1 mg/mL
Guaiatussin AC	Oral	Liquid	100 mg/10 mg
HydrALAZINE hydrochloride	Injection	Vial	20 mg/mL
Hydrocodone bitartrate and acetaminophen	Oral	Solution	10 mg/300 mg per 15 mL
Hydrocodone bitartrate and homatropine methylbromide	Oral	Solution	5 mg/1.5 mg per 5 mL
Hydrocodisone and acetic acid	Otic	Solution	1% and 2%
Hydromorphone hydrochloride	Injection	Ampule, Vial	10 mg/mL
Indocyanine green	Injection	Vial (kit with SWFI)	25 mg
Isotretinoin	Oral	Capsule	10 mg, 20 mg, 30 mg, 40 mg
Ketamine	Injection	Vial	100 mg/mL
Ketotifen fumarate	Ophthalmic	Solution	0.025%
Labetalol hydrochloride	Injection	Vial	5 mg/mL
Lactulose	Oral	Solution	10 g/15 mL
Levalbuterol hydrochloride	Inhalation	Vial	0.31 mg/3 mL, 0.63 mg/3 mL, 1.25 mg/0.5 mL, 1.25 mg/3 mL
Levetiracetam	Oral	Solution	100 mg/mL
Levocarnitine	Oral	Solution	1 g/10 mL
Levocarnitine	Oral	Tablet	330 mg
Levofloxacin	Injection	Vial	25 mg/mL
Levofloxacin	Oral	Solution	25 mg/mL

Lidocaine hydrochloride	Oral topical	Viscous solution	2%
Lidocaine and prilocaine	Topical	Cream	2.5% / 2.5%
Lorazepam	Injection	Vial	2 mg/mL
Lorazepam	Oral	Solution	2 mg/mL
Loteprednol etabonate	Ophthalmic	Gel	0.5%
Loteprednol etabonate	Ophthalmic	Suspension	0.5%
Megestrol acetate	Oral	Suspension	400 mg/ 10 mL
Methadone hydrochloride	Injection	Vial	10 mg/mL
Midazolam	Injection	Vial	5 mg/mL
Morphine sulfate	Oral	Solution	100 mg/5 mL
Mycophenolate mofetil	Injection	Lyophilized powder	500 mg
Naloxone	Injection	Vial	0.4 mg/mL
Neomycin sulfate	Oral	Tablet	500 mg
Ofloxacin	Ophthalmic	Solution	0.3%
Ofloxacin	Otic	Solution	0.3%
Olopatadine hydrochloride	Nasal	Spray	0.6%
Orphenadrine citrate	Injection	Vial	30 mg/mL
Oxcarbazepine	Oral	Suspension	300 mg/5 mL
Oxycodone hydrochloride	Oral	Solution	5 mg/5 mL, 100 mg/5 mL
Pentobarbital sodium	Injection	Vial	50 mg/mL
Phenylephrine hydrochloride	Ophthalmic	Solution	2.5%, 10%
Physostigmine salicylate	Injection	Ampule	1 mg/mL
Pilocarpine hydrochloride	Ophthalmic	Solution	1%, 2%, 4%
Polymyxin B sulfate and trimethoprim	Ophthalmic	Solution	0.1% and 10,000 units per 10 mL
Prednisolone	Oral	Solution	15 mg/5 mL
Prednisolone sodium phosphate	Oral	Solution	6.7 mg/5 mL
Progesterone	Oral	Capsule	100 mg, 200 mg
Promethazine hydrochloride	Oral	Solution	6.25 mg/5 mL
Promethazine hydrochloride and codeine phosphate	Oral	Syrup	10 mg and 6.25 mg
Promethazine hydrochloride and phenylephrine hydrochloride	Oral	Syrup	6.25 mg/5 mg per 5 mL
Promethazine hydrochloride, phenylephrine hydrochloride, and codeine phosphate	Oral	Syrup	10 mg, 6.25 mg, 5 mg
Pyrazinamide	Oral	Tablet	500 mg
Ropivacaine	Injection	Vial	5 mg/mL
Ropivacaine	Epidural	Bottle	2 mg/mL
Sodium chloride	Ophthalmic	Eye drops	5%
Sterile purified water	Ophthalmic	Eyewash	98.3%

Sufentanil citrate	Injection	Ampule	50 mcg/mL
Sulfamethoxazole and trimethoprim	Oral	Suspension	200 mg/40 mg per 5 mL
Tetracaine hydrochloride	Epidural	Ampule	10 mg/mL
Timolol maleate	Ophthalmic	Solution	0.5%
Tobramycin	Inhalation	Ampule	300 mg/5 mL
Tobramycin	Injection	Vial	40 mg/mL
Triamcinolone acetonide	Aerosol	Spray can	0.147 mg/g
Trihexyphenidyl hydrochloride	Oral	Solution	2 mg/5 mL
Tropicamide	Ophthalmic	Solution	0.5%, 1%
Valproic acid	Oral	Solution	250 mg/5 mL
Vitamin D	Oral	Drop	400 IU
Yohimbe	Injection	Vial	2 mg/mL

^a Accessed from the Akorn online catalog on February 22, 2023

Appendix 1. Abbreviated mitigation strategies for affected products

Adenosine injection

Assessment

Adenosine is an antiarrhythmic indicated for conversion to sinus rhythm of paroxysmal supraventricular tachycardia, including that associated with Wolff-Parkinson-White, and is widely used in advanced cardiovascular life support (ACLS) and pediatric advanced life support (PALS). Additionally, it is utilized as a diagnostic aid in pharmacologic cardiac stress testing. There are also data to support its use in hemodynamically stable patients as therapeutic treatment or as a diagnostic aid to differentiate between monomorphic wide complex tachycardia or supraventricular tachycardia. Use as a diagnostic aid in fractional flow reserve testing is supported by data also. Akorn is one of several manufacturers of adenosine.

Recommendation

Clinical

- 1) Prioritize adenosine for ACLS and PALS use.
- 2) For pharmacologic cardiac stress testing, evaluate regadenoson as an alternative. Per [ASNC guidelines](#), dipyridamole and dobutamine are also options.

Operational

- 1) Evaluate utilization trends in automatic dispensing cabinets or kits and shift inventory as able to prevent expiration and maximize availability.

Calcitriol injection

Assessment

Injectable calcitriol is a vitamin D analog indicated in the management of hypocalcemia in patients undergoing chronic renal dialysis. It significantly reduces elevated parathyroid hormone (PTH) levels which has been shown to result in an improvement in renal osteodystrophy. Akorn was the sole supplier of injectable calcitriol.

Recommendation

Clinical

- 1) Per [KDIGO guidelines](#), in patients with $\text{eGFR} < 15 \text{ mL/min/1.73 m}^2$ on dialysis who require PTH-lowering therapy, calcimimetics, calcitriol, or vitamin D analogs, or a combination may be utilized.
- 2) Utilize oral calcitriol formulations in the absence of injectable calcitriol.
- 3) Evaluate use of alternative agents such as other vitamin D analogs (eg, paricalcitol, doxercalciferol) or calcimimetics. A conversion ratio of intravenous paricalcitol to intravenous calcitriol of approximately 3:1 or 4:1 has been studied.

Operational

- 1) Assess inventory of injectable calcitriol and sequester available stock to monitor supply.
- 2) Implement changes in the electronic health record to direct providers to utilize oral calcitriol formulations, other vitamin D analogs, calcimimetics, or a combination, as clinically appropriate.
- 3) Reserve expired product until further notice.

Dimercaprol injection

Assessment

Dimercaprol is an antidote indicated for the treatment of heavy metal poisoning, including arsenic or gold, lead, and mercury. There are also data to support its use in lewisite exposure and polonium internal contamination. Dimercaprol is a chelating agent which contains a sulfhydryl group that binds with various heavy metal ions to form nontoxic, soluble chelates. Akorn is the sole manufacturer of dimercaprol and there are no other intramuscular chelating agents for heavy metal poisoning on the market.

Recommendation

Clinical

- 1) Oral succimer is an analogue of dimercaprol and should be considered as an alternative to dimercaprol, as clinically appropriate.
- 2) Prior to administration of dimercaprol or succimer, consult with the regional poison control center or institutional toxicologists to ensure administration is necessary on a case-by-case basis.
- 3) Consult with regional poison control center and institutional toxicologists to determine an appropriate course of action.

Operational

- 1) Assess inventory of dimercaprol and sequester available stock to monitor supply.
- 2) Reserve expired product until further notice.

Fluorescein injection

Assessment

Injectable fluorescein is an ophthalmic diagnostic agent used for angiography or angioscopy of the retina and iris vasculature. Fluorescein is considered the gold standard for diagnostic use in evaluating certain disorders such as retinal vasculitis. Akorn's injectable fluorescein represented a majority of the market share (>80%). However, injectable fluorescein is also available from Alcon Labs. Indocyanine green, another injectable diagnostic agent, is also labeled for use in ophthalmic angiography.

Recommendation

Clinical

- 1) Reserve supply for cases in which use of injectable fluorescein is essential for diagnostic purposes.
- 2) Determine if an alternative dye, such as indocyanine green, is an appropriate option and use in place of fluorescein when possible.
- 3) Consult with ophthalmology specialists to determine appropriate course of action.

Operational

- 1) Assess inventory of fluorescein and sequester available stock to monitor available supply.
- 2) Reserve expired product and consult with regulatory.

Mycophenolate mofetil injection

Assessment

Mycophenolate mofetil is FDA-labeled for the prophylaxis of organ rejection, in adult and pediatric recipients ≥ 3 months of age of allogeneic kidney, heart, or liver transplants, in combination with other immunosuppressants. Mycophenolate mofetil is also used for a number of off-label indications, such as graft-vs-host disease in allogeneic hematopoietic stem cell transplantation patients. The affected product from Akorn is an injectable formulation and accounts for approximately 50% of the injectable market share. However, injectable mycophenolate mofetil remains available from several other suppliers.

Recommendation

Clinical

- 1) Reserve intravenous mycophenolate mofetil for patients who cannot take oral mycophenolate.
- 2) Consult with institutional oncology and solid organ transplantation specialists to determine appropriate course of action.

Operational

- 1) Consider implementing decision support in the electronic health record for injectable mycophenolate mofetil to prompt ordering providers to determine if oral mycophenolate mofetil would be an appropriate alternative.

Physostigmine injection

Assessment

Physostigmine is a reversible carbamate anticholinesterase inhibitor indicated to reverse the effect on the central nervous system caused by clinical or toxic dosages of drugs capable of producing anticholinergic syndrome. Physostigmine is a tertiary amine capable of crossing the blood-brain barrier, which allows for reversal of anticholinergic effects both peripherally and centrally. Other carbamate anticholinesterase inhibitors, such as neostigmine and pyridostigmine, do not cross the blood-brain barrier and are therefore not expected to be effective in reversing central effects of anticholinergic toxicity. In past shortages of physostigmine, oral rivastigmine, a tertiary amine, has been used as a treatment alternative for patients with anticholinergic delirium; however limited evidence does not allow for recommending this product for routine use for this indication. Akorn was the sole supplier of physostigmine.

Recommendation

Clinical

- 1) Reserve remaining physostigmine for patients in whom pure anticholinergic poisoning is suspected and who require reversal of significant toxic anticholinergic effects on the central nervous system (eg, moderate to severe agitation or delirium).
- 2) Determine if alternatives, such as oral rivastigmine, may be clinically appropriate and use in place of physostigmine where possible.
- 3) Consult with institutional toxicologist or poison control center to determine appropriate course of action.

Operational

- 1) Assess inventory of physostigmine and sequester available stock to monitor available supply.
- 2) Reserve expired product until further notice.

Appendix 2: Akorn ophthalmic products^a

Ophthalmic product	Sole source	Pharmacological category	Indications	Potential Alternatives
Mydriatic agents				
Atropine	No	Mydriatic, Anticholinergic agent	<ul style="list-style-type: none">To produce mydriasis and cycloplegiaAmblyopia, healthy eye penalization	Listed products are all the marketed mydriatic agents. Except for hydroxyamphetamine and tropicamide (Paremyd), all other mydriatic agents are multisource and may be available from other suppliers. For healthy eye penalization, non-pharmacological options may be considered.
Cyclopentolate hydrochloride	No	Mydriatic, Anticholinergic agent	<ul style="list-style-type: none">To produce mydriasis and cycloplegia[Off-label]: Management of mild acute anterior uveitis	
Tropicamide (Bausch Health, Sandoz are also on shortage)	No	Mydriatic, Anticholinergic agent	<ul style="list-style-type: none">To produce mydriasis and cycloplegia in diagnostic procedures	
Hydroxyamphetamine and tropicamide (Paremyd)	Yes	Mydriatic, Fixed combination of Adrenergic agonist and anticholinergic agents	To produce mydriasis	
Phenylephrine hydrochloride	No	Ophthalmic agent, mydriatic; Alpha-adrenergic agonist	To produce mydriasis	
Antibiotic agents				
Ofloxacin	No	Fluroquinolone antibiotic	<ul style="list-style-type: none">Bacterial conjunctivitis caused by <i>S. aureus</i>, <i>S. epidermidis</i>, <i>S. pneumoniae</i>, <i>E. cloacae</i>, <i>H. influenzae</i>, <i>P. mirabilis</i>, and <i>P. aeruginosa</i>Corneal ulcers caused by <i>S. aureus</i>, <i>S. epidermidis</i>, <i>S. pneumoniae</i>, <i>P. aeruginosa</i>, <i>S. marcescens</i> and <i>C. acnes</i>.	Alternative agents will depend on suspected causative organism/condition Fluroquinolones <ul style="list-style-type: none">BesifloxacinCiprofloxacinLevofloxacinMoxifloxacin Non-fluroquinolones <ul style="list-style-type: none">Azithromycin
Gatifloxacin	No	Fluroquinolone antibiotic	<ul style="list-style-type: none">Bacterial conjunctivitis caused by <i>S. aureus</i>, <i>S. epidermidis</i>, <i>S. mitis</i> group, <i>S. oralis</i>, <i>S. pneumoniae</i>, and <i>H. influenzae</i>[Off label]: Bacterial keratitis	<ul style="list-style-type: none">BacitracinErythromycinGentamicinTobramycinVarious combination products with polymyxin
Ketotifen fumarate	No	Histamine H1 Antagonist	Temporary relief of eye itching due to allergic conjunctivitis	

Polyvinyl alcohol	No	Ophthalmic agent, misc	Ocular dryness and irritation	
Anti-glaucoma agents (Primary Open-Angle Glaucoma Preferred Practice Pattern)				
Apraclonidine	No	Alpha-2 adrenergic agonist	<ul style="list-style-type: none"> Elevated IOP, open-angle glaucoma Prevention and treatment of postsurgical intraocular pressure elevation (before or after laser surgery) 	Brimonidine
Dorzolamide	No	Carbonic anhydrase inhibitor	Elevated IOP, ocular hypertension or open-angle glaucoma	Brinzolamide
Dorzolamide/timolol PF		Carbonic anhydrase inhibitor and beta-adrenergic blocker	Elevated IOP, ocular hypertension or open-angle glaucoma in patients insufficiently responsive to beta-blockers	Individual components; no other fixed combination of a carbonic anhydrase inhibitor and beta-adrenergic blocker
Tafluprost PF	No	Prostaglandin	Elevated IOP, ocular hypertension or open-angle glaucoma	Bimatoprost, Latanoprost, Latanoprostene bunod, Travoprost
Timolol Maleate (PF and non-PF)	No	Beta-adrenergic blocking agents	<ul style="list-style-type: none"> Elevated IOP, ocular hypertension or open-angle glaucoma [Off-label] Part of a 4-drug medical management regimen in acute angle-closure glaucoma when the patient cannot be seen by an ophthalmologist for ≥ 1 h 	Nonselective <ul style="list-style-type: none"> Carteolol Levobunolol Selective <ul style="list-style-type: none"> Betaxolol

^aFacts and Comparisons eAnswers. Wolters Kluwer Health, Inc. Riverwoods, IL. <http://online.factsandcomparisons.com>

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