

Institutional Animal Care and Use Committee

Santa Barbara CA 93106-2050

Tel: (805) 893-5855

Fax: (805) 893-2005

Email: [iacuc@lifesci.ucsb.edu](mailto:iacuc@lifesci.ucsb.edu)

<https://www.research.ucsb.edu/animal-subjects/about>

IACUC GUIDELINE: ADMINISTRATION OF THERAPEUTIC OR EXPERIMENTAL  
SUBSTANCES TO ANIMALS, INCLUDING NON-  
PHARMACEUTICAL-GRADE OR CONTROLLED SUBSTANCES

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This IACUC guideline was created to provide guidance to investigators and to set clear expectations on the administration of therapeutic and experimental substances to animals, including the conditional use of non-pharmaceutical-grade substances. This document also clarifies the record keeping, storage, and labeling procedures for all laboratories administering therapeutic, experimental, or controlled substances (CS) to animals.

All therapeutic and experimental substances administered to animals must be listed in the animal protocol (i.e., tables 11 and 12 of the protocol application form) for IACUC review. Similarly, the addition of a new (i.e., not in the original protocol) experimental substance to an approved protocol requires IACUC review, as does any significant change<sup>1</sup> to a protocol. However, in order to provide for a timely review while ensuring animal welfare, this proposed significant change may be handled administratively in consultation with the Attending Veterinarian (AV), if all of the following conditions apply:

1. The administration of the new experimental substance doesn't result in greater pain or distress to the animal.
2. The addition of a new experimental substance fits within the study objectives of the protocol, and doesn't involve the addition of a new experimental procedure.
3. The experimental substance being added to the protocol is administered to animals according to a dose and route of administration that conforms to an established veterinary drug formulary and practice, and/or FDA Guidance on inter-species dose translation<sup>2</sup> or appropriate reference in the scientific literature.
4. The formulation, storage and labeling of the experimental substance, if it's not a pharmaceutical-grade substance as defined below, will conform to the procedures for

using non-pharmaceutical-grade substances that are also described below. All viral vector formulations must be of suitable purity for injection into animals.

### **Relevant Federal Regulations and Guidance:**

The Office of Laboratory Animal Welfare (OLAW)<sup>3-5</sup> has clarified the following requirements regarding the use of non-pharmaceutical-grade substances and expired drugs or medical materials:

1. Pharmaceutical-grade substances, when available, must be used in order to avoid toxicity or side effects that may threaten the health and welfare of vertebrate animals and/or interfere with the interpretation of research results.
2. A pharmaceutical-grade substance is any active or inactive drug, biologic, reagent, etc., manufactured under Good Manufacturing Practices (GMP) which is approved, conditionally approved, or indexed by the Food and Drug Administration (FDA) or for which a chemical purity standard has been written or established by a recognized compendia (e.g., United States Pharmacopeia-National Formulary (USP-NF), British Pharmacopeia (BP)).
3. The IACUC is responsible for evaluating the potential adverse consequences of non-pharmaceutical-grade substances when used for research.
4. The use of expired pharmaceuticals, biologics, and supplies is not consistent with acceptable veterinary practice or adequate veterinary care. Euthanasia, anesthesia and analgesia agents should not be used beyond their expiration date, even if a procedure is terminal. Other expired materials should not be used unless the manufacturer verifies efficacy beyond the expiration date, or the investigator is able to document to the satisfaction of the IACUC that such use would not negatively impact animal welfare or compromise the validity of the study. The veterinarian and IACUC must maintain control over the use of expired medical materials in order to meet their responsibilities to avoid or minimize discomfort, pain or distress to animals.

### **IACUC Expectations:**

Therapeutic drugs (e.g., anesthetics, analgesics, antibiotics, and euthanasia solutions) and diluents must be pharmaceutical-grade, even for acute/terminal procedures, unless an exception is approved by the IACUC. Experimental substances should be pharmaceutical-grade unless they are administered by an oral route. Approval for the use of non-pharmaceutical-grade substances, regardless of route of administration, will be made on a case-by-case basis by weighing the potential adverse consequences to the animal against scientific criteria for the use of these substances. "Cost savings alone are not an adequate justification for the use of non-pharmaceutical-grade substances in animals. However, unavailability or shortages of

pharmaceutical-grade substances may lead to cost increases and the IACUC may determine that this justifies the use of the non-pharmaceutical-grade substitution.”<sup>4</sup>

The IACUC has established an Operational Guideline (see below) for preparing, storing and labeling therapeutic drugs and experimental substances commonly used in our animal care and use program, which is briefly summarized as follows.

- For therapeutic drugs, use only FDA-approved veterinary or human pharmaceutical preparations and diluents and follow the manufacturer’s instructions for preparation (reconstitution), storage, and use.
- For experimental substances, use FDA-approved veterinary or human pharmaceutical preparations when available. When not available, use chemicals of the highest grade and purity.
- Use only sterile solutions, when experimental substances will be administered by a parenteral route (e.g., IV, IP, IM, IC or SC injection, or irrigation of a surgical opening or wound). Use of a syringe-top filter ( $\leq 0.22 \mu\text{m}$ ) is recommended for non-pharmaceutical-grade drug solutions that cannot be terminally sterilized (i.e., sterilized by dry heat, steam, or irradiation within 6 hours after completing the preparation of the drug solution in order to minimize the generation of bacterial endotoxins).
- Use only biocompatible (pH between 4.5 and 8.0, and osmolality between 150 and 600 mOsm/kg) solutions when experimental substances will be administered by a parenteral route (e.g., IV, IP, IM, IC or SC injection, or irrigation of a surgical opening or wound).
- Use aseptic processing procedures to prevent microbial contamination when preparing non-pharmaceutical-grade substances or when reconstituting or compounding<sup>6</sup> pharmaceutical-grade drugs. Manipulate all sterile products aseptically, including donning appropriate PPE and/or working in a biological safety cabinet or laminar flow hood (clean bench).
- A Beyond Use Date (BUD) should be established for each NPG experimental substance and compounded therapeutic drug (i.e., compounded FDA-approved drug) to ensure that the drug maintains its required characteristics (i.e., stability and sterility) until its BUD. When establishing a BUD, consider factors that may affect stability, including but not limited to: The chemical and physical properties of the drug and/or its formulation. The compatibility of the container–closure system with the finished preparation (e.g., leachables, interactions, and storage conditions). The environment in which the NPG is prepared and the storage conditions after its preparation. Whether or not sterility testing is performed. These standards are set forth in the USP Compounding Compendium (<797> Pharmaceutical Compounding – Sterile Preparations).<sup>6</sup>
- All experimental substances or compounded therapeutic drugs should be labeled with the drug/substance name, concentration, and a BUD/beyond-use date (i.e., the date on which the product must be discarded).

The acquisition, storage, and research use of controlled substances (e.g., ketamine, buprenorphine, euthanasia solution) must conform to DEA regulations and the Best Practices Guide from the UC Office of the President ([BUS 50](#)), and the [UCSB Controlled Substance Policy](#) administered by EH&S. At a minimum, all controlled substances should be securely stored; each drug vial or container should be uniquely identified and clearly labeled with the name, concentration, and expiration date of the drug; and the research use of controlled substances should always be properly documented to enable audit tracking by UCSB officials (i.e. IACUC or EH&S) or federal agents (i.e. DEA or USDA).

## Resources for Locating Pharmaceutical-Grade Substances for In-Vivo Use

- [DailyMed](#)
- FDA [Orange Book](#), which list approved human drug products.
- [Animal Drugs @ FDA](#)

## Reference:

1. Guidance on Significant Changes to Animal Activities. National Institutes of Health. [NOT-OD-14-063](#).
2. [Guidance for Industry: Estimating the Maximum Safe Starting Dose in Initial Clinical Trials for Therapeutics in Adult Healthy Volunteers](#). U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research (CDER), Pharmacology and Toxicology. July 2005.
3. OLAW Webinar: "[Regulatory Considerations for Using Pharmaceutical Products in Research Involving Laboratory Animals – June 4, 2015](#)"
4. OLAW FAQ: "[May investigators use non-pharmaceutical-grade substances in animals?](#)"
5. OLAW FAQ: "[May investigators use expired pharmaceuticals, biologics, and supplies in animal?](#)"
6. USP Compounding Compendium. <797> Pharmaceutical Compounding – Sterile Preparations

## Operational Guideline

**Title:** Drug Compounding and Non-Pharmaceutical-Grade Substance Preparation

### **Purpose:**

Compounding refers to any manipulation of a pharmaceutical-grade<sup>1</sup> drug beyond that stipulated on the drug label. Federal extra-label drug use regulations specifically permit compounding from FDA-approved drugs when a veterinarian believes there is a need to alter the approved drug to adequately medicate a non-food animal with a diagnosed medical condition.<sup>2</sup> Since almost none of the drugs that are administered to laboratory animals in our Animal Care and Use Program (ACUP) are formulated for those species, extra-label drug use is almost always required. This Operational Guideline describes acceptable methods for compounding and storing our most commonly used drugs, and establishes a quality assurance process for verifying drug stability and sterility, when needed. This Operational Guideline does not set standards for all the drugs used in our ACUP; however, the Operational Guideline can, in principle, be applied to most pharmaceutical-grade drugs. Contact the Campus Veterinarian if/when you need to develop a compounding procedure for a new drug.

### **Procedures:**

*Note: The procedures described below require that you use appropriate precautions to prevent microbial contamination, including using only sterile materials (e.g., needles and syringes) and solutions (e.g., diluents), and manipulating all sterile products aseptically.*

#### **I. FDA-approved therapeutic drugs that require reconstitution prior to IV administration.**

##### **1. Brevital® (methohexital sodium)**

- a. Start with an FDA-approved drug formulation, and prepare a 1% solution (10 mg/ml methohexital) according to the drug monograph (a.k.a., product insert).
  - i. Add 50 ml of Sterile Water for Injection to the vial containing the powdered (500 mg) of Brevital®. Do not use a diluent with a preservative (i.e., don't use a bacteriostatic diluent). Do not use a non-sterile diluent (i.e., nanopure water).
  - ii. Shake gently to reconstitute
- b. Any withdrawal of the drug solution from the original bottle must be performed aseptically – the septum must be wiped with alcohol, and the drug must be removed with a sterile needle and syringe. Any unused drug must be discarded and no drug or other solution must ever be added to the drug vial after initial preparation.
- c. According to the drug manufacturer, this drug solution should be stored in the original bottle, at room temperature, and discarded by 24 hrs. after preparation. Alternatively,

and according to published<sup>3</sup> quality assurance testing results, the drug solution may be stored refrigerated for up to 42 days (6 weeks). Any storage or use beyond that point requires testing to verify sterility and drug stability.

- d. The IACUC will need to verify drug stability and sterility for the following storage and use condition. Please contact the ARC to arrange for this QA testing.
  - i. Storage at cold temperatures (refrigerated) with occasional aseptic removal for drug aliquots for up to 6 months.
- e. Any removal of the drug from the original vial must be performed aseptically – the septum must be wiped with alcohol, and the drug must be removed with a sterile needle and syringe. Any unused drug should be discarded and no drug or other solution should ever be added to the drug vial after initial preparation.
- f. Label the drug bottle with the following information.
  - i. Name of the drug (the original label on the bottle already should contain this information).
  - ii. Beyond-use date (e.g., 42 days from the date of preparation).

## **2. Cefazolin catheter lock solution for rats with chronic indwelling venous catheters**

- a. Start with an FDA-approved drug formulation, and reconstitute according to the drug monograph.
  - i. Add 2.5 ml of Sterile Water for Injection to the vial containing the powdered (1 g) cefazolin. Do not use a diluent with a preservative (i.e., don't use a bacteriostatic diluent). Do not use a non-sterile diluent (i.e., nanopure water).
  - ii. Shake gently to reconstitute.
  - iii. The reconstituted solution will contain approximately 334 mg cefazolin/ml.
- b. For intravenous administration, this drug must be diluted with Sterile Water for Injection as follows:
  - i. Use an alcohol prep swab to disinfect the septum of the cefazolin bottle, and then withdraw 2.5 ml of the cefazolin solution (334 mg/ml) with a sterile needle and syringe.
  - ii. Transfer the cefazolin solution into a 10 ml Sterile Empty Vial (Hospira Inc, Lake Forest, IL; List #5816-11; HenrySchein SKU 009177).
  - iii. Transfer 5.275 ml of Sterile Water for Injection into the 10 ml Sterile Vial containing the cefazolin. Use a new sterile needle and syringe, and disinfect the septum on the Sterile Water for Injection bottle.

- iv. Transfer 0.575 ml of Heparin solution (1000 U/ml) into the 10 ml Sterile Vial containing the cefazolin. Use a new sterile needle and syringe, and disinfect the septum on the heparin vial.
  - v. The mixture now contains 100 mg/ml cefazolin, and ~70 U/ml heparin.
  - c. This drug mixture should be stored protected from light (e.g., wrapped in foil), at cold temperatures (refrigerated), and any unused drug must be discarded by 72 hrs. after preparation. Any storage beyond that point requires testing to verify sterility and drug stability.
  - d. The IACUC will verify drug stability and sterility for the following storage and use conditions. Please contact the ARC to arrange for this QA testing.
    - i. Storage at cold temperatures (refrigerated) with occasional aseptic removal for drug aliquots for up to 10 days.
  - e. Any removal of the drug from the original vial must be performed aseptically – the septum must be wiped with alcohol, and the drug must be removed with a sterile needle and syringe. Any unused drug should be discarded and no drug or other solution should ever be added to the drug vial after initial preparation.
  - f. Label the drug vial with the following information.
    - i. Name of the drugs (cefazolin and heparin) and their concentrations (100 mg/ml and 70 IU/ml).
    - ii. Beyond-use date (i.e., 3 or 10 days from the date of preparation).
- II. FDA-approved drugs that require dilution prior to administration to a small (size) laboratory animal species (i.e., rats and/or mice).**
- 1. Ketamine:Xylazine mixture for laboratory rats and laboratory mice**
- a. Start with an FDA-approved ketamine and xylazine drug formulation each of 100 mg/ml concentration.
  - b. Use an alcohol prep swab to disinfect the septum of the xylazine bottle, and then withdraw:
    - i. Rat formulation: 1 ml of the xylazine solution (100 mg/ml) with a sterile needle and syringe.
    - ii. Mouse formulation: 0.1 ml of the xylazine solution (100 mg/ml) with a sterile needle and syringe.

- c. Transfer the xylazine solution into a 10 ml Sterile Empty Vial.
- d. Use an alcohol prep swab to disinfect the septum of the ketamine bottle, and then withdraw:
  - i. Rat formulation: 7.5 ml of the ketamine solution (100 mg/ml) with a new sterile needle and syringe.
  - ii. Mouse formulation: 1 ml of the ketamine solution (100 mg/ml) with a new sterile needle and syringe.
- e. Transfer the ketamine solution into the 10 ml Sterile Empty Vial containing the xylazine solution.
- f. For the mouse formulation, transfer 8.9 ml of 0.9% Sodium Chloride Injection into the 10 ml Sterile Vial containing the ketamine:xylazine mixture. Use a new sterile needle and syringe, and disinfect the septum on the Sterile Chloride Injection bottle.
- g. The final drug concentrations in the respective rat and mouse formulations should be:
  - i. Rat formulation: The mixture now contains 11.76 mg/ml xylazine, and 88.23 mg/ml ketamine (i.e., a 1:7.5 mixture of xylazine:ketamine).
  - ii. Mouse formulation: The mixture now contains 1 mg/ml xylazine, and 10 mg/ml ketamine (i.e., a 1:10 mixture of xylazine:ketamine)
- h. According to published<sup>4</sup> quality assurance testing results, this compounded drug solution may be stored at room temperature for up to 180 days. Remember to make sure that undiluted ketamine or xylazine solutions used in this compounding mixture will not expire within the 180-day storage period, otherwise adjust the use by date accordingly. This drug mixture should be stored protected from light (e.g., wrapped in foil).
- i. Label the drug vial with the following information.
  - i. Name of the drug mixture and drug ratio.
  - ii. Beyond-use date (i.e., 180 days from the date of preparation).

## **2. Etomidate:Xylazine mixture for laboratory mice<sup>5</sup>**

- a. Start with FDA-approved etomidate (2 mg/ml) and xylazine (20 mg/ml) drug formulations.
- b. Use an alcohol prep swab to disinfect the septum of the xylazine bottle, and then withdraw 0.2 ml of the xylazine solution (20 mg/ml) with a sterile needle and syringe.
- c. Transfer the xylazine solution into a 10 ml Sterile Empty Vial.



- d. Use an alcohol prep swab to disinfect the septum of the etomidate bottle, and then withdraw 4 ml of the etomidate solution (2 mg/ml) with a new sterile needle and syringe.
- e. Transfer the etomidate solution into the 10 ml Sterile Empty Vial containing the xylazine solution.
- f. The final drug concentrations in this anesthetic cocktail should be 0.95 mg/ml xylazine, and 1.9 mg/ml etomidate. The mouse dose for this anesthetic cocktail is 10.5 ml/kg IP (i.e., 0.26 ml for a 25 g mouse), which translates to a mg/kg dose of 10 mg/kg xylazine and 20 mg/kg etomidate.
- g. This new drug formulation procedure represents a low-risk of contamination<sup>6</sup>, and in the absence of passing a sterility test, this drug should only be stored for up to 14 days at a cold temperature.
- h. Label the drug vial with the following information.
  - i. Name of the drug mixture and drug concentrations.
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

### 3. Acepromazine (PromAce®)

- a. Start with an FDA-approved acepromazine maleate injectable formulation of 10 mg/ml. This formulation can be used for treating laboratory rats without any compounding (no dilution needed). For laboratory mice, dilute this formulation 1:10 as follows.
- b. Use an alcohol prep swab to disinfect the septum of the acepromazine vial/bottle, and then withdraw 1 ml of the solution with a sterile needle and syringe.
- c. Transfer the acepromazine solution into a 10 ml Sterile Empty Vial.
- d. Add 9 ml of diluent without a preservative (Sterile Saline or Water for Injection) to the Sterile Empty Vial containing acepromazine.
  - i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
- e. This new drug formulation procedure represents a low-risk of contamination, and in the absence of passing a sterility test, this drug should only be stored for no more than 14 days at cold temperatures.
- f. Label the drug vial with the following information.
  - i. Name of the drug (i.e., acepromazine) and concentration (1 mg/ml).

- ii. Beyond-use date (i.e., 14 days from the date of preparation for the diluted formulation).

#### 4. Buprenorphine-HCl

- a. Start with an FDA-approved buprenorphine drug formulation of 0.3 mg/ml. This formulation can be used for treating laboratory rats without any compounding (no dilution needed). For laboratory mice, dilute this formulation 1:10 as follows.
- b. Use an alcohol prep swab to disinfect the septum of the buprenorphine vial/bottle, and then withdraw 1 ml of the buprenorphine solution (0.3 mg/ml) with a sterile needle and syringe.
- c. Transfer the buprenorphine solution into a 10 ml Sterile Empty Vial.
- d. Add 9 ml of diluent without a preservative (Sterile Saline or Water for Injection) to the Sterile Empty Vial containing buprenorphine.
  - i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
- e. Based on published testing results for an identical preparation method, this compounded drug may be stored for up to 180 days at room temperature.<sup>7</sup> Remember to make sure that the undiluted buprenorphine solution used in this compounding mixture will not expire within the 180-day storage period, otherwise adjust the use by date accordingly.
- f. Label the drug vial with the following information.
  - i. Name of the drug (i.e., buprenorphine) and concentration (0.3 mg/ml, or 0.03 mg/ml).
  - ii. Beyond-use date (i.e., 180 days from the date of preparation for the diluted formulation).

#### 5. Banamine® (Flunixin meglumine)

- a. Start with an FDA-approved Banamine® drug formulation of 50 mg/ml.
- b. Use an alcohol prep swab to disinfect the septum of the Banamine® bottle, and then withdraw 1 ml of the Banamine® solution (50 mg/ml) with a sterile needle and syringe. For a mouse formulation, withdraw only 0.1 ml.
- c. Transfer the Banamine® solution into a 10 ml Sterile Empty Vial (Hospira Inc., Lake Forest, IL; List #5816-11).
- d. Add 9 ml (i.e., 1:10 dilution) of diluent without a preservative (Sterile Water or Saline for Injection) to the Sterile Empty Vial containing Banamine®. For a mouse formulation, add 9.9 ml (i.e., 1:100) of diluent.

- i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
- e. This new drug formulation procedure represents a low-risk of contamination, and in the absence of passing a sterility test, this drug should only be stored for no more than 14 days at cold temperatures.
- f. Label the drug vial with the following information.
  - i. Name of the drug (i.e., Banamine®) and concentration (5 or 0.5 mg/ml).
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

## 6. Meloxicam

- a. Start with an FDA-approved veterinary drug formulation of 5 mg/ml meloxicam (Loxicam®). Once broached (first puncture of bottle septum), this product may be stored at temperatures between 20-25°C (68-77°F) for up to 6 months. The stock formulation (5 mg/ml) has been shown to cause injection site reactions in mice.<sup>14</sup> Therefore, for treating laboratory rats and laboratory mice, dilute this formulation 1:5 (rats) and 1:10 (mice) as follows.
- b. Use an alcohol prep swab to disinfect the septum of the meloxicam bottle, and then withdraw 1 ml of the meloxicam solution (5 mg/ml) with a sterile needle and syringe.
- c. Transfer the meloxicam solution into a 10 ml Sterile Empty Vial (Hospira Inc., Lake Forest, IL; List #5816-11).
- d. Add 4 ml (1:5 dilution) or 9 ml (1:10 dilution) of diluent without a preservative (Sterile Water for Injection) to the Sterile Empty Vial containing meloxicam.
  - i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
- e. This new drug formulation represents a low risk of contamination, and based on published results,<sup>15</sup> this compounded drug formulation may be stored for up to 30 days at room temperature.
- f. Label the drug vial with the following information.
  - i. Name of the drug (i.e., meloxicam) and concentration (1 or 0.5 mg/ml).
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

## 7. Carprofen (Rimadyl®)

- a. Start with an FDA-approved drug formulation of 50 mg/ml carprofen. Store this 20 ml bottle at 2°–8°C (36°–46°F). Once broached (first puncture of bottle septum), product may be stored at temperatures up to 25°C (77°F) for 28 days.

- b. Use an alcohol prep swab to disinfect the septum of the carprofen bottle, and then withdraw 1 ml of the solution with a sterile needle and syringe.
- c. Transfer the carprofen solution into a 10 ml Sterile Empty Vial (Hospira Inc., Lake Forest, IL; List #5816-11).
- d. Add 9 ml of diluent without a preservative (Sterile Water or Saline for Injection) to the Sterile Empty Vial containing the carprofen.
  - i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
- e. This new drug formulation procedure represents a low-risk of contamination, and in the absence of passing a sterility test, this drug should only be stored for up to 14 days at cold temperatures.
- f. Label the drug vial with the following information.
  - i. Name of the drug (i.e., carprofen) and concentration (5 mg/ml).
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

**8. Gentamicin catheter lock solution for rats with chronic indwelling venous catheters**

- a. Use the FDA-approved formulation of 40 mg/ml gentamicin for IV administration. ***Do not use a formulation that is not intended for IV administration (e.g., uterine flush formulation for large animals).*** This formulation should be diluted (1:20) as follows.
- b. For intravenous administration, this drug should be diluted with 0.9% Sodium Chloride Injection as follows:
  - i. Use an alcohol prep swab to disinfect the septum of the gentamicin vial, and then withdraw 0.5 ml of the gentamicin solution (40 mg/ml) with a sterile needle and syringe.
  - ii. Transfer the gentamicin solution into a 10 ml Sterile Empty Vial (Hospira Inc., Lake Forest, IL; List #5816-11).
  - iii. Transfer 9.5 ml of 0.9% Sodium Chloride Injection into the 10 ml Sterile Vial containing the gentamicin. Use a new sterile needle and syringe, and disinfect the septum on the Sterile Chloride Injection bottle.
  - iv. The mixture now contains 2 mg/ml gentamicin.
- c. This drug formulation procedure represents a low-risk of contamination, and in the absence of passing a sterility test, this drug should only be stored for up to 14 days at cold temperatures.

- d. Label the drug vial with the following information.
  - i. Name of the drug (i.e., gentamicin) and concentration (2 mg/ml).
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

## 9. Enrofloxacin

- a. Use the FDA-approved veterinary formulation. This drug has a very alkaline pH and may need to be diluted as follows to minimize the risk of an injection site reaction.
- b. Use an alcohol prep swab to disinfect the septum of the enrofloxacin bottle, and then withdraw 0.2 ml (1:50 dilution) or 1 ml (1:10 dilution) of the enrofloxacin solution with a sterile needle and syringe.
- c. Transfer the enrofloxacin solution into a 10 ml Sterile Empty Vial (Hospira Inc., Lake Forest, IL; List #5816-11).
- d. Add 9 ml (1:10 dilution) or 9.8 ml (1:50 dilution) of diluent without a preservative (0.9% Sodium Chloride Injection) to the Sterile Empty Vial containing enrofloxacin.
  - i. Use a sterile needle and syringe to withdraw this diluent solution from a new sterile vial/bottle.
  - ii. Select the dilution factor (1:10 or 1:50) based on the stock concentration of the enrofloxacin formulation (22.7 or 100 mg/ml) and the species to be treated. For mice and Nile rats, use a 2 or 2.27 mg/ml final diluted concentration, and for rats a 10 mg/ml final diluted concentration.
- e. According to the manufacturer, the Enroflox<sup>®</sup> 100 bottle containing the 100 mg/ml formulation must be “used within 30 days of the first puncture and puncture a maximum of 36 times.” Based on sterility testing results for a bottle opened for 90 days after first puncture, this formulation remained sterile for at least 90 days after first use/puncture. The procedures for withdrawing aliquots from the bottle described above (b) were followed by the ARC, and the bottle was stored at room temperature between withdrawals.
- f. Label the drug vial containing the compounded solution with the following information.
  - i. Name of the drug and diluted concentration.
  - ii. Beyond-use date.

## 10. Euthasol™ (euthanasia solution)

- a. Start with the FDA-approved Euthasol™ formulation. This formulation can be used for treating laboratory rats and larger animals (e.g., rabbits) without any compounding (no dilution needed). For laboratory mice, dilute this formulation 1:10 as follows.

- b. Use an alcohol prep swab to disinfect the septum of the Euthasol™ bottle, and then withdraw 1 ml of the Euthasol™ solution with a sterile needle and syringe.
- c. Transfer the Euthasol™ solution into a 10 ml Sterile Empty Vial (Hospira Inc, Lake Forest, IL; List #5816-11).
- d. Add 9 ml of Sterile Water for Injection or 0.9% Sodium Chloride Injection to the Sterile Empty Vial containing Euthasol™.
  - i. Use a sterile needle and syringe to withdraw this diluent solution (i.e., Sterile Water for Injection or Sodium Chloride Injection) from a new sterile vial/bottle.
- e. This procedure represents a low-risk level compounded sterile preparation, and in the absence of passing a sterility test, this drug should only be stored for up to 14 days at refrigerated temperature.
- f. Label the Sterile Empty Vial with the following information.
  - i. Name of the drug (i.e., Euthasol) and concentration (e.g., 1:10 dilution).
  - ii. Beyond-use date (i.e., 14 days from the date of preparation).

### III. Non-Pharmaceutical grade<sup>1</sup> experimental substance preparation for parenteral (e.g., IV, IP, IM, or SC) administration.

#### 1. Tamoxifen

- a. Tamoxifen-inducible Cre/loxP systems for gene regulation in mice are widely used. The tamoxifen, an estrogen receptor modulator and antagonist, can be administered orally, and is available in an FDA-approved formulation as well as being commercially available in tamoxifen-medicated rodent feed. The oral route of administration is strongly recommended, especially for pregnant mice and for pre-weanling mice.<sup>8</sup> However, many labs administer the tamoxifen intraperitoneally from non-pharmaceutical grade (NPG) bulk chemical dissolved in oil. Even when properly prepared there is still a risk of serious adverse events (peritonitis) from repeated administration of the vehicle<sup>9</sup>, break-down products of the tamoxifen, or bacterial contamination of the compounded drug. There are several published methods for preparing and administering NPG tamoxifen, and two of them are listed in the references<sup>10,11</sup>. The following is the IACUC guidance on this NPG drug preparation, and storage.
- b. Start with the highest grade and purity of Tamoxifen powder possible.
- c. Dissolve the powder in chemical-grade corn oil by shaking overnight at 37°C. Avoid preparing too small a volume, use only sterile tubes that are amber or protected from

light, and select a stock drug concentration (e.g., 10 - 20 mg/ml) that will permit you to administer  $\leq 0.1$  ml of the final solution IP to the animal at a dose of 75 mg/kg. Limiting the volume of oil that is administered is important in reducing the inflammatory response in the peritoneal cavity.

- i. Perform all drug handling steps in a HEPA-filtered laminar-flow hood or biosafety cabinet using sterile supplies (pipets, tubes, syringes) and aseptic technique.
  - ii. Sterile filter (0.2  $\mu$ m) the tamoxifen solution when transferring the dissolved solution to a sterile light-protected storage tube or tubes. Remember to use a sterile luer-lock syringe.
  - iii. Label the light-protected tube(s) containing the dissolved tamoxifen with the drug concentration, preparation date and store the tubes at 4°C. Discard any unused solution within 14 days of preparation. Remember that tamoxifen is a hazardous chemical, so arrange for appropriate disposal with EH&S.
  - iv. Remember to check the expiration date of the tamoxifen powder and the corn oil and replace them before they expire. It is further recommended that the corn oil be replaced at least once a year.
- d. Warm up the tube containing the tamoxifen solution before administering a dose to an animal. Do not overheat the tamoxifen solution and ensure that the solution is clear (no precipitate or cloudiness). Do not administer the drug solution to the animal if there is any precipitate or any cloudiness.

## 2. General guidance for NPG drugs (including CS) administered parenterally.

- a. Start with the highest grade and purity bulk chemical. Remember, to follow the drug vendor's/manufacturer's recommended drug purity retest recommendation (e.g., every three years) on the Product Specification or Certificate of Analysis to ensure chemical purity, especially for any bulk chemical stock greater than a few years old.
- b. If the drug solution is going to be administered parenterally (IV, IP, SC, or IM) then use Sterile Water for Injection or Sodium Chloride Injection to dissolve the bulk chemical powder. Do not use a non-sterile diluent (i.e., nanopure water, PBS). **If the drug cannot be reconstituted in either sterile water or saline and instead requires a different diluent/vehicle, then make sure that this diluent/vehicle is listed and approved on your protocol.** Contact the Campus Veterinarian for additional assistance.
- c. Transfer the drug solution to a 10 ml Sterile Empty Vial with a multi-use septum (Hospira Inc., Lake Forest, IL; List #5816-11).
- d. Use a sterile syringe to draw up the drug solution.
- e. Place a syringe-top filter ( $\leq 0.22$   $\mu$ m) between the syringe and a sterile needle.

- f. Puncture the septum of the Sterile Empty Vial to and inject the drug solution and into a Sterile Empty Vial.
- g. Verification of appropriate storage and beyond-use date (BUD) requires testing of sterility and drug stability. Please contact the ARC to arrange for this QA testing. In the absence of any drug stability and sterility testing, and while data/evidence is collected to support a specific BUD, use a 7-day BUD that is supported based on communication with colleagues at NIDA and scientific literature on drug stability of 15 days at refrigerated temperature for a commonly used NPG.<sup>12</sup>
- h. Label the Sterile Empty Vial with the following information.
  - i. Name of the drug and concentration (e.g., X mg/ml).
  - ii. Beyond-use date.

### 3. General guidance for NPG drugs (including CS) administered orally.

- a. Start with the highest grade and purity bulk chemical and prepare a drug solution of the desired concentration as follows.
- b. The bulk drugs should be reconstituted in filtered potable water.
- c. Verification of appropriate storage and beyond-use date (BUD) requires testing to verify sterility and drug stability. Please contact the ARC to arrange for this QA testing. In the absence of any drug stability and sterility testing, and while data/evidence is collected to support a specific BUD, use a 14-day BUD for water containing oral formulations described in the USP <795> standard for compounding nonsterile preparations.<sup>13</sup>
- d. Label the drug solution container with the following information.
  - i. Name of the drug and concentration (e.g., X mg/ml).
  - ii. Beyond-use date.

### Reference:

1. The definition of pharmaceutical-grade established by the NIH [Office of Laboratory Animal Welfare](#) is: "A pharmaceutical-grade substance is any active or inactive drug, biologic, reagent, etc., manufactured under Good Manufacturing Practices (GMP) which is approved, conditionally approved, or indexed by the Food and Drug Administration (FDA) or for which a chemical purity standard has been written or established by a recognized compendia (e.g., United States Pharmacopeia-National Formulary (USP-NF), British Pharmacopeia (BP))."



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<https://www.avma.org/KB/Resources/FAQs/Pages/Compounding-FAQs.aspx>
3. Stability of reconstituted methohexital sodium. J Oral Maxillofac Surg. 1994 Apr; 52(4) 393-396.
4. Beyond-use Dating of Extemporaneously Compounded Ketamine, Acepromazine, and Xylazine: Safety, Stability, and Efficacy Over Time. J Am Assoc Lab Anim Sci. 2009 Nov;48(6):718-26.
5. A Comparison of Ketamine or Etomidate Combined with Xylazine for Intraperitoneal Anesthesia in Four Mouse Strains. J Am Assoc Lab Anim Sci. 2020 Nov;59(5):519-30.
6. USP Compounding Compendium. <797> Pharmaceutical Compounding – Sterile Preparations.
7. Effects of Time and Storage Conditions on the Chemical and Microbiologic Stability of Diluted Buprenorphine for Injection. J Am Assoc Lab Anim Sci. 2017 Jul 01; 56(4) 457-461.
8. Refinement of inducible gene deletion in embryos of pregnant mice. Doi:10.1002/bdr2.1628
9. Intraperitoneal oil application causes local inflammation with depletion of resident peritoneal macrophages. Doi:10.1158/1541-7786.MCR-20-0650
10. Optimization of tamoxifen-induced Cre activity and its effect on immune cell populations. Doi:10.1038/s41598-020-72179-0
11. Tamoxifen administration to mice. Doi:10.1101/pdb.prot077966
12. <https://europepmc.org/article/med/26714368>
13. USP Compounding Compendium. <795> Pharmaceutical Compounding – Nonsterile Preparations.
14. Concentration-dependent Toxicity after Subcutaneous Administration of Meloxicam to C57BL/6N Mice (Mus musculus). DOI: 10.30802/AALAS-JAALAS-19-000037
15. Sterility and Stability of Diluted Meloxicam in Compounded Multi-dose Vial after 365 Days. [J Am Assoc Lab Anim Sci.](#) 2019 Sep; 58(5): 594–596.