ANIMAL CARE AND USE PROGRAM
STANDARD OPERATING PROCEDURE NUMBER 06

Guidelines for Rodent Aseptic Survival Surgery

PURPOSE

The American College of Laboratory Animal Medicine (ACLAM) recommends that all institutions that use animals in research, testing and training develop and implement written standards for performing surgical procedures on rodents. All animal use protocols (AUPs) which include rodent survival surgery must follow these guidelines for approval by the IACUC. Exceptions will be granted only when scientifically justified in writing in the AUP and approved by the IACUC.

STAFF RESPONSIBILITY

It is the responsibility of the veterinary staff, investigator, laboratory animal technicians, and the facility manager to ensure that all personnel performing the procedures outlined in this document are properly trained in the correct technique and that anesthesia, post-operative pain medication and care are provided to the animals. Where possible, surgeries should be performed during normal business hours and always evaluated the next day for post-operative complications.

INTRODUCTION

All survival surgical procedures should incorporate aseptic technique. Aseptic is defines as "free from pathogenic microorganisms. Perioperative care should be described in the protocol. Pain and distress should be minimized through appropriate use of anesthetics, analgesics, tranquilizers, nursing care and/or other treatment. The standards should be reviewed periodically and the effectiveness assessed using performance-based standards.

Recommendations for the performance of rodent surgery are based on the 1996 edition of the NIH Guide for the Care and Use of Laboratory Animals and 9 CFR, the Animal Welfare Act (AWA). Part 2 of the AWA states that major surgical procedures on rodents "must be performed using aseptic procedures". Adequate procedures include the use of sterile instruments, sterile surgical gloves, and aseptic preparation of the surgical site in order to prevent postoperative infections.

A separate facility for rodent surgery is not necessary. A rodent surgical area can be a room or portion of a room that is easily sanitized and not used for any other purpose during the time of the surgery.

Rodents include hamsters, gerbils and guinea pigs, as well as rats and mice. Guinea pigs and hamsters are USDA covered species, meaning that they are not exempt from USDA regulations and the provisions of the AWA. Rodent surgery can be classified as minor or major in nature.

Anesthesia and anesthetic agents of rodents will not be discussed here. One should not overlook the utility of local anesthetics. Please contact the attending Veterinarian for more information concerning the use of various anesthetics, analgesics, and tranquilizers.

Paralytic agents may not be used without anesthesia. To prevent corneal desiccation, place ophthalmic ointment in both eyes of rodents undergoing anesthetic procedures. The administration of antibiotics and analgesics prior to commencing a procedure can make them more effective.

CATEGORIES OF SURGICAL PROCEDURES

Surgical procedures can be divided into two main groups: survival and non-survival. Further subdivisions of survival procedures are made with regard to whether the procedure(s) involves penetrating a body cavity or causing physical impairment. Procedures penetrating a body cavity and/or causing physical impairment are termed major survival surgical procedures, those which do not, are termed minor survival surgical procedures. **Multiple major survival surgical procedures are not permitted on animals without scientific justification**.

Minor Surgery

"*Minor survival surgery is defined as any procedure which does not expose a body cavity and causes little or no physical impairment*" (*Guide for the Care and Use of Laboratory Animals*. National Research Council. 1996.) and includes injections, venipuncture, and subcutaneous implants. When conducted with proper care, these techniques present few difficulties. "*Minor procedures are often performed under less stringent conditions than major procedures but still require aseptic technique and instruments and appropriate anesthesia.*" (*Guide for the Care and Use of Laboratory Animals*. National Research Council. 1996.)

Major Surgery

Major surgery includes invasion of the cranial, abdominal, or thoracic cavities. Any procedure that might leave the rodent with a permanent handicap, whether physical or physiological, would also be considered major surgery.

It is recommended that animals be closely monitored for a minimum of seven days following major surgical procedures.

Chronic Implants

Chronic implants, such as chronic intravenous catheters and head caps, are intermediate in nature, but are techniques presenting the most severe postsurgical infections. Surgical technique needs to be meticulous, as for major surgery. Post surgically, use sterile technique when accessing the catheter (s). The most critical requirement is to inject only sterile solutions into the catheter. Solutions should be freshly prepared or stored under refrigeration if prepared in advance. The top of the vial or mouth of the container containing solutions for injection must be kept clean and wiped with alcohol or flamed before drawing up the solution. Inoculation of even a few organisms into an intravenous catheter may result in death of the animal due to sepsis.

PREPARATION OF SURGICAL SITE AND INSTRUMENTS

General Guidelines

The location of the area used for major rodent surgery is not critical but a separate room used primarily for surgical procedures is highly recommended. In any case the surgical area should be located in a portion of the animal care facility or laboratory that is not heavily traveled. (Please note: An investigator's laboratory may be used as a rodent survival surgery area provided such use is approved and certified by the IACUC and is noted as such in the institution's Assurance with PHS.)

The surgical "table" must be constructed of a material that can be washed with soap and water and then disinfected using appropriate agents such as quaternary ammonium compound or similar disinfectants or that can be heat sterilized. The immediate surgical area should be disinfected prior to and between surgeries to decrease dust borne contamination and should not be used for other purposes during the time of surgery.

Surgical instruments must be sterile. Heat sterilization is ideal. Agents such as chlorine dioxide or gluteraldehydes can be used for cold sterilization. Chlorine dioxide is not documented as being toxic to animal tissue but will corrode stainless steel instruments. Gluteraldehyde must be thoroughly rinsed off of instruments with sterile saline or water before use of delicate items, such as drills and burrs. **When using "tips only" technique, the sterility of the instrument tips must be maintained throughout the procedure**.

Disinfectants should be replaced when contaminated with blood or other body fluids. Catheters and implants can be sterilized using ionizing radiation or ethylene oxide.

NOTE: If a sterile instrument, sterile glove, or sterile surgical site comes in contact with a non-sterile item, it is NO LONGER STERILE. All contaminated items require re-sterilization or replacement before aseptic procedures may continue.

Preoperative Considerations

Performing pre-surgical evaluations help minimize the risk of post-operative complications experienced by the animal. The following guidelines should be followed:

- Ensure your prospective patients are not overtly ill; use a healthy rodent.
- A 48-hour acclimation period for the animal is recommended prior to surgery.
- Withholding food is not necessary in rodents unless specifically mandated by the protocol or surgical procedure. However, a 4-hour fast before surgery may promote the absorption of intraperitoneally administered anesthetics.
- Atropine or glycopyrrolate may be considered to decrease tracheobronchial secretions.
- To provide adequate blood/tissue levels at the time of surgery, pre-emptive antibiotics may also be administered as pre-medication before anesthesia. The use of antibiotics must never replace aseptic technique.
- Water should NOT be withheld unless required by the protocol. Withholding food for more than six hours should be discussed with the veterinarian.

Preparation of the Animal and Area for Surgery

Preparation of the animal should include clipping or shaving the surgical site with a generous border (at least 1 cm) to keep hair from contaminating the incision (hair removal should be performed in a location remote from the surgical area). The hair over the surgical site should be clipped using a #40 clipper blade taking care not to cut the skin. This should be performed in an area separate from where the surgery is to be conducted.

The surgical site should be scrubbed with a germicidal scrub, being careful to scrub from the center of the site toward the periphery. The site can then be rinsed with a 70% alcohol, sterile water, or sterile saline. Three alternating preps of germicidal scrub and rinse are considered adequate. Note that alcohol will also contribute to hypothermia if liberally used. Finally, the area should be draped with sterile drapes, which not only helps prevent stray hair from entering the surgical field, but also provides a sterile area on which to lay sterile instruments during surgery.

Surgeon Preparation

The surgeon must thoroughly scrub his or her hands with a bactericidal scrub. The use of sterile surgical gloves is necessary. A surgical mask should be worn for major surgeries. Wearing a clean lab coat is mandatory. A sterile gown is preferable for major surgeries.

Surgical instruments, gloves and other paraphernalia may be used on more than one animal. Any item used on multiple animals must be carefully cleaned and disinfected between animals. Alternating two or more sets of instruments is one way to allow time for instruments to sit in a disinfectant or sterilant solution for more than just a few minutes.

PREEMPTIVE ANALGESIA

Evidence suggests that effective blockade of painful stimuli prior to surgery may significantly reduce the duration and intensity of postoperative pain in an analgesic technique referred to as “preemptive” or “preventive” analgesia. Successful preemptive analgesia blocks the initial upregulation of central pain processing pathways by reducing subsequent mechanical allodynia, a major contributor to postoperative discomfort.

The most effective preemptive analgesic technique is local, regional or spinal sensory blockade infiltration with local anesthetics. Incisional blockade is easily implemented in rodent surgical practice.

The incision site is widely infiltrated before final surgical preparation with lidocaine 1% or bupivicaine 0.25%. Local anesthesia will occur within 1 minute of lidocaine infiltration and 5 minutes of bupivicaine administration and persists for 1-8 hours. To prevent seizures (the most common adverse affect associated with these agents), the total dose of either anesthetic should be limited to approximately 1 ml/kg (equivalent to 10 mg/kg lidocaine or 2.5 mg/kg bupivicaine).

Effective systemic preemptive analgesic agents include narcotics, nonsteroidal anti-inflammatory drugs (NSAIDS) and n-methyl-D-aspartic acid (NMDA) antagaonists (e.g. ketamine). Of these, the NSAIDS are the most consistently effective.

USE OF ANESTHETICS

Evidence indicates that rodents experience pain similar to that experienced by humans. Therefore, all procedures must be planned for applying the maximum pain/distress relief possible consistent with the goals of the research. The protocol must provide a detailed description of the anesthetic and pain management regimen.

Because the absorption and biotransformation of drugs differs among species, it is impossible to develop a single anesthetic protocol for all laboratory animals. The two main types of anesthesia used in veterinary medicine are injectable and inhalational.

The use of inhalation anesthetics requires the use of scavenging equipment or a ventilated fume hood to avoid exposure to personnel. If available, isoflurane vaporizers may be used but only after investigators have received appropriate training from the attending Veterinarian.

Extra precaution must be taken with ether, which is potentially explosive and flammable. The use of ether requires justification and explanation of safe use on animal protocols, as well as a consultation with Health and Safety.

There are many different injectable anesthetics from which to choose. One must be careful to choose an anesthetic that will control pain and distress without interfering with the objectives of the study.

MONITORING AND ASSESSMENT OF THE ANESTHESIZED ANIMAL

Animal evaluation during surgery is critical. Monitoring of anesthetic depth is usually of first importance. Unfortunately, techniques for monitoring anesthetic depth vary somewhat with the agent used. A quiet animal that does not move when a painful stimulus is applied is the most certain indicator of adequate anesthesia; however, the zone between quiet and too quiet is very narrow in rodents. The following may be used to assist in assessing the efficacy of anesthesia:

- Periodic observation of respiration, color of mucous membranes and assessment of reflected eye color in albino animals.
- The animal's ears and feet, and mucous membranes of the eyes and nose should be pink indicating adequate oxygenation.
- Loss of pedal reflex (in all rodents except Guinea pigs).
- Loss of pinna reflex (in Guinea pigs).

The animal must be under a surgical plane of anesthesia before a surgical procedure begins.

If the animal's eyes are open, artificial tears ointment should be applied for protection and lubrication.

SURGICAL GUIDELINES

Investigators must ascertain that all drugs administered for anesthetizing and post-surgical pain management are not expired. Additionally, scalpel blades and suturing materials also cannot be expired.

Maintaining body temperature is extremely important, as anesthetics induce hypothermia either directly or indirectly. It is easier to keep animals warm than warm them up. Warm water blankets or bottles provide supplementary warmth without being too hot. Bubble wrap helps small rodents maintain body temperature.

During surgeries, warm sterile fluids (saline or lactated Ringers solution) should be provided. These can be administered subcutaneously, intravenously or intraperitoneally. Any tissues exposed for long periods during surgery should be kept moist with these same warmed solutions. Some anesthetic agents, such as xylazine, will predispose an animal to volume depletion.

During a procedure, animals that are under anesthesia should NEVER be left unattended.

Additional Requirements

- Instruments and gloves may be used for a series of similar surgeries provided they are maintained clean and disinfected between animals. Please refer to Table 4.
- Absorbable suture material or electrocautery should be used to control bleeding.
- When the ventral abdominal cavity is opened, the abdominal lining, [peritoneum], and muscle layer must be closed with an appropriate number [for the length of the wound] of absorbable sutures. The skin should be closed separately.
- When the peritoneal cavity is opened from a dorsal approach [incision on the back], it is recommended that absorbable sutures be used to close the peritoneum prior to skin closure.
- Nine mm autoclips should be used for closure of the skin. Refer to Table 5 for wound closure selections.

POSTSURGICAL CARE AND MONITORING

Observation during postsurgical recovery is important. Bedding material can stick to the anesthetized animal's eyes, nose and mouth, or be aspirated during recovery. Rodent should be placed in a cage that has had the bedding removed or replaced with toweling in sterna recumbency.

The animal, in or out of its cage, must be kept warm. Warm water pads, bubble wrap, blankets, or the blue "diaper" pads work well. A sock filled with beans or chickpeas can be heated in a microwave and placed next to the recovering animal to provide warmth during recovery. The use of electric heat pads or heat lamps may overheat the animal; their use is discouraged. If electric heat pads or heat lamps must be used, provision must be made to make frequent observations and turning of a somnolent animal so that the animal will not be overheated, with preventing burns being of the utmost importance.

Provisions must also be made to allow an animal that is awake to escape the heat source when it becomes too warm. Warmed fluids can be administered subcutaneously, intravenously, or intraperitoneally if there is any suspicion the animal may be dehydrated. Over hydration is not generally a problem in animals with normal kidney function.

A recovering animal should be watched continuously (every 5 to 10 minutes). Once animals have regained all postural reflexes and are ambulatory, they can be placed in a clean cage with bedding and

returned to an animal housing area. The animal should be able to move around without plugging its nostrils with bedding.

Animals CANNOT be returned to an animal housing room until completely recovered from anesthesia. Some rodents left overnight on pads or paper bedding will eat that bedding. Rodents should be individually housed until they are ambulatory to prevent cannibalism.

TABLE 1 – Rodent Physiological Data

Rodent	Temperature	Respiratory Rate	Heart Rate
mice	96.6-99.7F (35.8-37.4C)	90-220 per minute	328-780 per minute
rats	96.6-99.5F (35.9-37.5C)	66-144 per minute	250-600 per minute
guinea pigs	98.6-103.1F (37-39.5C)	42-104 per minute	230-320 per minute
hamsters	98.6-100.4F (37-38C)	35-120 per minute	250-600 per minute
gerbils	96.3-102.7F (35.7-39.3C)	70-120 per minute	260-600 per minute

ADMINISTRATION OF ANALGESICS

Note that all doses listed are approximations and must be titrated to the animal's strain, age, sex and individual responses. Significant departures from these doses should be discussed with the attending Veterinarian. Doses will also vary depending on what other drugs are administered concurrently.

All doses are listed as milligrams per kilogram (mg/kg) unless otherwise noted. Dilution of injected drugs allows more precise dosing, but may shorten the shelf-life of the compound (UMass Boston standard: diluted drugs must be labeled and subsequently discarded after one month).

TABLE 2 – Analgesics, Mouse Formulary (courtesy of UCSF):

Drug Name	Dose (mg/kg)/Route	Frequency	Notes
Opioid Analgesia			
Buprenorphine	0.05 - 0.1 SC or IP	Used pre-operatively for preemptive analgesia and post-operatively every 4-12hrs	When used as sole analgesic, typical regimen is: once at time of procedure, second dose will be administered 4-6 hours later. Additional doses every 8-12hrs as needed. Consider multi-modal analgesia with NSAID and local analgesic.
Non-steroidal anti-inflammatory analgesia (NSAID). Note that prolonged use may cause renal, gastrointestinal, or other problems			
Carprofen	5-10 SC	Used pre-operatively for preemptive analgesia	Depending on the procedure, may be used

		and post-operatively every 12-24 hour	as sole analgesic, or as multi-modal analgesia with buprenorphine.
Meloxicam	~ 5-10 PO, IM or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketoprofen	2 – 5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketorolac	5 – 7.5 oral or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Flunixin meglumine	~ 2 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Local anesthetic/analgesics (lidocaine and bupivicaine may be combined in one syringe for rapid onset and long duration analgesia)			
Lidocaine hydrochloride	Dilute to 0.5%, do not exceed 7 mg/kg total dose, SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset than bupivicaine but short (<1 hour) duration of action
Bupivicaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose, SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Slower onset than lidocaine but longer (~ 4-8 hour) duration of action

TABLE 3 – Analgesics, Rat Formulary (courtesy of UCSF):

Drug Name	Dose (mg/kg)/Route	Frequency	Notes
Opioid Analgesia			
Buprenorphine	0.01 - 0.05 SC or IP	Used pre-operatively for preemptive analgesia and post-operatively every 4-12hrs	When used as sole analgesic, typical regimen is: once at time of procedure, second dose will be administered 4-6 hours later. Additional doses every 8-12hrs as needed. Consider multi-modal analgesia with

			NSAID and local analgesic.
Non-steroidal anti-inflammatory analgesia (NSAID). Note that prolonged use may cause renal, gastrointestinal, or other problems			
Carprofen	4-5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Meloxicam	~ 2.0 PO, IM or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketoprofen	2 – 5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketorolac	5 – 7.5 oral or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Flunixin meglumine	~ 2 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Local anesthetic/analgesics (lidocaine and bupivicaine may be combined in one syringe for rapid onset and long duration analgesia)			
Lidocaine hydrochloride	Dilute to 0.5%, do not exceed 7 mg/kg total dose, SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset than bupivicaine but short (<1 hour) duration of action
Bupivicaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose, SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Slower onset than lidocaine but longer (~ 4-8 hour) duration of action

Sutures and/or staples need to be removed 7-10 days following surgery, if the rodent has not already done so **for data on suture types and uses**. Any foreign substance left in the incision for a long period of time serves as a nidus of irritation and infection. A veterinarian should examine incisions that do not appear to be healing. Postsurgical observations include a minimum daily observation of the condition of the animal and the surgical site. A sample "Animal Surgery and Postoperative Care Record" is provided as Appendix 1.

Identify cages with postoperative animals to:

- Explain the condition of the animals to animal care staff (e.g. sedated animals thought to be ill)
- Assure animal care staff, veterinary staff, inspectors, and others that proper care is being given to the animals,
- Inform animal care and veterinary staff how recently the investigator has seen the animal to avoid contacting the investigator to inform them of the animal's condition.

The rat has always been considered "hardy" and not subject to postsurgical infections, but published research has documented that postsurgical infections in rats are subtle. The rat appears to eat and act normally, but will not respond appropriately to research stimuli.

There is ample literature available supporting the recommendations presented in this document. Please contact IACUC and/or the Campus Veterinarian for assistance.

TABLE 4 – Skin Disinfectants

Alternating disinfectants is more effective than using a single agent. For example, an iodophor scrub can be alternated three times with 70% alcohol or sterile water, followed by a final wipe with a disinfectant solution. Alcohol, by itself, is not an adequate skin disinfectant. The evaporation of alcohol can induce hypothermia in small animals.

Agent	Examples*	Comments
Iodophors	Betadine®, Prepodyne®, Wescodyne®	Reduced activity in presence of organic matter. Wide range of microbicidal action. Works best In pH 6-7
Chlorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses. Excellent for use on skin.

**The use of common brand names as examples does not indicate a product endorsement*

TABLE 5 – Recommended Hard Surface Disinfectants

Agent	Examples*	Comments
Quaternary Ammonium	Roccal®, Quatricide®	Rapidly inactivated by organic matter. Compounds may support growth of gram negative bacteria.
Chlorine	Sodium hypochlorite [Clorox® 10% solution] Chlorine dioxide [Clidox®, Alcide®, MB-10®]	Corrosive. Presence of organic matter reduces activity. Chlorine dioxide must be fresh; kills vegetative organisms within three minutes of contact.

Glutaraldehydes	Cidex®, Cetylcide®, Cide Wipes®	Rapidly disinfects surfaces.
Phenolics	Lysol®, TBQ®	Less affected by organic material than other disinfectants.
Chlorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses. Excellent for use on skin.

**The use of common brand names as examples does not indicate a product endorsement*

TABLE 6 – Recommended Instrument Sterilants

Always follow manufacturer's instructions for dilution, exposure times, and expiration periods.

Agent	Examples*	Comments
Steam Sterilization [moist heat]	Autoclave	Effectiveness dependent upon temperature, pressure and time [i.e, 121°C for 15 minutes vs. 131°C for 3 minutes]
Dry Heat	Hot Bead Sterilizer Dry Chamber	Fast. Instruments must be cooled before contacting tissue. Only tips of instruments are sterilized with hot beads.
Gas Sterilization	Ethylene Oxide	Requires 30% or greater relative humidity for effectiveness against spores. Gas is irritating to tissue and requires specialized equipment for use. All materials require safe airing time.
Chlorine	Chlorine Dioxide	Corrosive to instruments. Instruments must be rinsed with sterile saline or sterile water prior to use.
Glutaraldehydes	Cidex®, Cetylcide®, Cide Wipes®	Several hours required for sterilization. Corrosive and irritating. Instruments must be rinsed with sterile saline or water prior to use.
Hydrogen Peroxide-Acetic Acid	Actril®, Spor-Klenz®	Several hours required for sterilization. Corrosive and irritating. Instruments must be rinsed with sterile saline or water prior to use.

**The use of common brand names as examples does not indicate a product endorsement*

TABLE 7 – Recommended Instrument Disinfectant

Always follow manufacturer's instructions for dilution, exposure times, and expiration periods.

Agent	Examples*	Comments
Chlorine	Sodium hypochlorite [Clorox® 10% solution] Chlorine dioxide [Clidox®, Alcide®, MB-10®]	Corrosive. Presence of organic matter reduces activity. Chlorine dioxide must be fresh. Kills vegetative organisms within three minutes. Corrosive to instruments. Instruments must be rinsed with sterile saline or sterile water prior to use.
Chlorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses. Instruments must be rinsed with sterile saline or sterile water prior to use.

**The use of common brand names as examples does not indicate a product endorsement*

TABLE 8 – Wound Closure Selection

Material*	Characteristics and Frequent Uses
Polyglactin 910 [Vicryl®] Polyglycolic Acid [Dexon®]	Absorbable. 60-90 days. Ligate or suture tissues where an absorbable suture is desirebale.
Polydiaxanon [PDS®] Polyglyconate [Maxon®]	Absorbable. Six months. Ligate or suture tissues especially where an absorbable suture and extended wound support is desireable.
Polypropylene [Prolene®]	Nonabsorbable. Inert.
Nylon [Ethilon®]	Nonabsorbable. Inert. General closure.
Silk	Nonabsorbable. Excellent handling. Preferred for cardiovascular procedures. Caution: Tissue reactive and may wick microorganisms into the wound.
Chromic Gut	Absorbable. Versatile material.
Stainless Steel Wound Clips or Staples	Nonabsorbable. Requires instrument for removal.
Cyanoacrylate [Vetbond®, Nexaband®]	Skin glue. For non-tension bearing wounds. The glue requires adequate moisture and pressure to properly bond wound. Please note that if too much glue is applied, an exothermic [burn] reaction can occur.

**The use of common brand names as examples does not indicate a product endorsement*

References: NIH ARAC Guidelines for Survival Rodent Surgery [3/2005] and

SURGICAL AND POST-SURGICAL RECORD-KEEPING

The **Non-USDA Animal Surgery and Postoperative Care Record** (Appendix 1) must be maintained and available upon request for inspection. Record keeping requirements for USDA covered rodents such as guinea pigs, hamsters, gerbils, cotton rats, etc. differ to those for non-covered species. Contact the IACUC Administrator or other IACUC representative for surgical and post-operative record-keeping requirements for USDA-covered species.

POST-SURGICAL COMPLICATIONS

Post-surgical complications may cause unnecessary discomfort and is an area of particular concern for the IACUC. Consideration of possible complications before the procedure and regular monitoring of the patient after the procedure help to minimize unnecessary problems. Common post-op problems that may be experienced consist of the following:

Pain Management

Surgical procedures often cause painful tissue damage. Familiarity with normal animal behavior and routine observation of the post-op patient is necessary to detect signs of pain. Animals often mask their pain and changes in posture, behavior and appetite are often significant.

Ethical, scientific and regulatory considerations require effective postoperative analgesia for all animals that undergo experimental surgery. Each postoperative animal should be individually and specifically evaluated for pain to assure proper analgesic dosage and duration of the treatment. In his research, Lee-Parritz acknowledges that the difficulty of pain diagnosis in laboratory rodents complicates the development of recommendations for optimum analgesia. For example, although anorexia, lethargy, hunching, piloerection or weight loss may be an indication of the existence of postoperative pain, these signs are not specific, are difficult to assess and are generally evident only after the fact. And likewise, it should be noted further, that the absence of these symptoms does not necessarily mean that the animals are free from pain.

Pain sensitivity has also been known to vary with strain and sex. Female rodents are more sensitive to painful stimuli than males, and males have a stronger response to narcotic analgesics than females.

The following guidelines may be used as a clinical assessment of post-procedural pain:

- Reduced grooming
- Reduced level of spontaneous activity
- Piloerection (ruffled fur)
- Hunched posture
- Squint-eyes
- Pale eyes (if albino)
- Increased aggressiveness when handled
- Distance themselves from cage mates
- Porphyrin secretion in rats (red staining around eyes/nares)

- Increased back arching, horizontal stretching, abdominal writhing, falling/staggering, poor gait and twitching in rats
- Reduced food/water intake (opioids may include reduced food and water intake/loss of weight if multiple doses are given)

Incisional Dehiscence

- Animals may remove sutures, particularly if they are irritating.
- Continuous suture patterns are not acceptable. Minor problems in the suture line may lead to complete incisional dehiscence when continuous suture patterns are used.
- Local infection often causes irritation. Sterile technique, regular cleaning of incisions, bandages and avoidance of natural-fiber sutures (silk and cotton that "wick" in bacteria) help to control localized infections.
- Excessively tight sutures cause irritation. Animal skin should be sutured such that the skin edges are lightly apposed. Normal incisional post-op swelling will cause irritation if the sutures are placed tighter than this. Investigators familiar with suturing human skin tend to suture animal skin too tightly.
- Sutures left in place too long encourage suture tract infections and suggest negligence to the research animal. It is the responsibility of the Principal Investigator to remove sutures when the incision has healed. Normally, sutures should be removed by 10-14 days post-op.

Incision Infection

- Avoidance of infection is crucial to good post-op care. Infections delay healing, cause unnecessary discomfort and sometimes lead to the loss of the animal from the project. Sterile technique during surgery is necessary to prevent infections.
- Cleanliness of incisions post-op, particularly in the first 1-5 days, is important in preventing infections. Animals will not protect their incisions from contamination and, therefore, the incision should be kept clean.

Prophylactic antibiotic use can be useful, but must never replace aseptic technique. Antibiotics must be used in a therapeutic dosage regimen and be at therapeutic levels before the skin is incised. Generally, antibiotics are started the day before surgery and are continued for 3-4 days post-op. Recommendations on drugs and dosages to use are available by contacting the attending Veterinarian.

Non-USDA Animal Surgery and Postoperative Care Record

Non-USDA Animal Surgery and Postoperative Care Records are to remain with the subject animal until the animal is fully recovered from the surgical procedure, or the animal dies.

Protocol number	PI
Surgeon	Date
Describe the surgical procedure	
Describe special preoperative procedures (e.g., fasting, water deprivation, medications)	
Describe preparation of the animal for surgery	

Animal ID	Species	Sex	Weight
Physical examination results			

ANESTHESIA INDUCTION	Anesthetist		
Drug	Dose	Route	Time

GAS ANESTHETIC ADMINISTRATION

Time	:00	:15	:30	:45	:00	:15	:30	:45	:00	:15	:30	:45	:00	:15	:30
Isoflurane %															
Halothane %															

MONITORING INTRAOPERATIVE ANESTHESIA AND RECOVERY FROM ANESTHESIA

Time – Indicate surgery start time	:00	:15	:30	:45	:00	:15	:30	:45	:00	:15	:30	:45
Paw withdrawal reflex (A/P)												
Corneal reflex (A/P)												
Spontaneous movement (A/P)												
Righting reflex (A/P)												
Body temperature												
Capillary refill time												
Heart rate												
Respiratory rate												
Indicate surgery end time												

INTRAOPERATIVE PROCEDURES AND MONITORING

Describe adequacy of anesthesia			
Name any drugs administered intraoperatively			
Describe any intraoperative complications			
Analgesic drug:	Dose:	Route:	Time:
Condition of animal and time when returned to its home cage – must be at least able to maintain sternal recumbancy and appear to be recovering normally.			

**USE PAGE TWO FOR POSTOPERATIVE EVALUATION AND CARE RECORD

Animal # ______________________ Species _____________Protocol # ______________________Date of Surgery: _______________
Person responsible for Postoperative care ___________________________ Phone/pager:__________________ E-mail: ______________________________

POSTOPERATIVE EVALUATION AND CARE INSTRUCTIONS FROM PROTOCOL OR PI

General condition	
Surgical site	
Treatments and schedules	
Other	

POST-OPERATIVE EVALUATION AND CARE

Date/Initials:							
Medications: (Include name, dose, route, and time(s) of administration.)							
Analgesics:							
Antibiotics:							
Other fluids/drugs:							
Clinical Observations: (e.g., activity, grooming, respiration, vocalization, eating/drinking, urination/ defecation, movement impairment/paralysis)							
Body Weight: (if weight loss occurs, include % change from pre-operative body weight)							
Incision Monitoring: (e.g., redness or swelling around/under incision, exudate from surgical site)							
Suture/Wound Clip Removal:							

Other Notes: