
1. PURPOSE

This Standard Operating Procedure (SOP) describes the recommended volumes, injection sites and needle sizes for common routes of substance administration.

2. RESPONSIBILITY

Principal investigator (PI) and their research staff, veterinary care staff.

3. MATERIALS

- 3.1. Needles
- 3.2. Syringes
- 3.3. Administration volumes chart
- 3.4. Substance to be administered

4. CONSIDERATIONS

- 4.1. The substance:
 - 4.1.1. Verify that the pH of solutions injected subcutaneously or intramuscularly have a pH of 7.3 to 7.45 and that solutions are isotonic (same tonicity as blood; 280–310 mosm/L). Non-isotonic solutions must be injected slowly if the intraperitoneal or intravenous routes are used.
 - 4.1.2. Warm the solutions to body temperature (or at least room temperature) immediately prior to administration, if possible.
 - 4.1.3. Verify the solubility of the substance. Precipitation may cause the formation of large particles which, if injected intramuscularly, can be painful. For intravenous injections, solutions, not suspensions, must be administered.
 - 4.1.4. Inject separate substances at different sites to avoid cross reaction of chemicals.
 - 4.1.5. Avoid injecting highly viscous liquids as they can cause discomfort and require a larger needle size for injection.
 - 4.1.6. Substances to be injected must be sterile as contamination can lead to infection or irritation of the injection site. Sterilize solutions by autoclaving or microfiltration and use aseptic technique for injection.
- 4.2. Injections:
 - 4.2.1. Do not inject into inflamed or damaged tissue.
 - 4.2.2. Limit the number of puncture attempts to 3. After 3 unsuccessful attempts, request the assistance of another trained person.
 - 4.2.3. Check proper placement of the needle prior to injection. Withdraw the syringe plunger; if blood enters the needle hub, the needle has entered a blood vessel. Unless it is an IV injection, withdraw the needle slightly and redirect it.
 - 4.2.4. No resistance should be encountered during injection. Do not apply overt pressure on the syringe plunger. The injected substance should flow freely to prevent any unnecessary pain and tissue damage.
 - 4.2.5. Give injections at a constant flow rate.
 - 4.2.6. If bleeding occurs after injection, apply pressure with gauze until bleeding stops.
- 4.3. Needles:
 - 4.3.1. Always use sharp needles.
 - 4.3.2. Use the smallest gauge of needle possible that allows accurate injection of the substance.

4.3.3. Recommended needle sizes (G):

SPECIES	INTRADERMAL	SUBCUTANEOUS	INTRAMUSCULAR	INTRAPERITONEAL	INTRAVENOUS
Mouse	27	26	27	25-27	26-30
Rat	27	25	25	23-25	25-27
Rabbit	25	23-25	25	21-23	23-25
Hamster	25	25	25	25-27	25-27
Guinea pig	25	23-25	25	23-25	25-27
Non-human primate (Rhesus or Cynomolgus)	25	21-25	23-25	n/a	21-25
Non-human primate (Marmoset)	25	23-25	23-25	n/a	21-25
Dog	25	21-23	21-23	21-23	21-25
Cat	25	21-23	23	21-23	21-25
Sheep	25	19-23	21	19-21	19-21

4.4. Volumes:

4.4.1. Use the smallest possible volume for injection.

4.4.2. Recommended volumes for substance administration:

SPECIES	ORAL (ml/kg)	SUBCUTANEOUS (ml/kg)	INTRAMUSCULAR (volume/site)	INTRAPERITONEAL (ml/kg)	INTRAVENOUS BOLUS (ml/kg)	INTRADERMAL (ml/site)
Mouse	0 - 10	0 - 10	0 - 0.05 ml	0 - 20	0 - 5	0.05 – 0.1
Rat	0 - 10	0 - 5	0 - 0.1 ml	0 - 10	0 - 5	0.05 – 0.1
Rabbit	0 - 10	0 - 1	0 - 0.25 ml	0 - 5	0 - 2	0.05 – 0.1
Hamster	0 - 10	0 - 10	0 - 0.05 ml	0 - 20	0 - 5	0.05 – 0.1
Guinea pig	0 - 10	0 - 5	0 - 0.1 ml	0 - 10	0 - 5	0.05 – 0.1
Non-human primate (Rhesus or Cynomolgus)	0 - 5	0 - 2	0 - 0.25 ml	n/a	0 - 2	0.05 – 0.1
Non-human primate (Marmoset)	0 - 10	0 - 2	0 - 0.25 ml	n/a	0 - 2.5	0.05 – 0.1
Dog	0 - 5	0 - 1	0 - 0.25 ml	0 - 1	0 - 2.5	0.05 – 0.1
Cat	0 - 5	0 - 1	0 - 0.25 ml	0 - 1	0 - 2.5	0.05 – 0.1

4.4.3. If the volume administered must exceed the recommended volumes listed in section 4.4.2, justification must be provided and will require approval by the FACC.

4.4.4. Possible maximal administration volumes:

SPECIES	ORAL (ml/kg)	SUBCUTANEOUS (ml/kg)	INTRAMUSCULAR (ml/kg/site)	INTRAPERITONEAL (ml/kg)	INTRAVENOUS SLOW INJECTION (ml/kg)
Mouse	50	40	0.1	80	25
Rat	40	10	0.2	20	20
Rabbit	15	2	0.5	20	10
Hamster	50	40	0.1	80	25
Guinea pig	40	10	0.2	20	20
Non-human primate (Rhesus or Cynomolgus)	15	5	0.5	n/a	n/a
Non-human primate (Marmoset)	15	5	0.5	n/a	10
Dog	15	2	0.5	20	5
Cat	15	2	0.5	20	5
Sheep	15	2	0.5	20	5

5. PROCEDURES

5.1. Oral route (gavage):

5.1.1. If administering the recommended volume, withdrawal of food prior to oral gavage is not required. If using a higher volume, withdrawal of food for up to 4 hours is preferable.

5.2. Intranasal injections:

5.2.1. Brief anesthesia may be administered (e.g., isoflurane anesthesia).

5.2.2. Administer a maximum of 50µL to rodents and rabbits, 500µL to dogs.

5.3. Intradermal injections:

5.3.1. Intradermal injection should be limited to 6 sites.

5.4. Intramuscular injections:

5.4.1. Intramuscular administration should be limited to 2 sites per day.

5.4.2. Injection sites should be rotated.

5.5. Intraperitoneal injections:

5.5.1. This technique is not recommended for pregnant animals or birds.

5.5.2. Limit intraperitoneal injections to once per day.

5.5.3. Osmotic minipumps can be surgically implanted intraperitoneally when repeated dosing is required.

5.6. Subcutaneous injections:

5.6.1. Subcutaneous administration should be limited to 2 to 3 sites per day.

5.6.2. Osmotic minipumps can be surgically implanted subcutaneously when repeated dosing is required.

5.6.3. Recommended injection sites:

SPECIES	SITE
Mouse	Scruff
Rat	Scruff
Rabbit	Scruff, flank
Hamster	Scruff
Guinea pig	Scruff, back
Non-human primate: Rhesus or Cynomolgus	Back
Non-human primate: Marmoset	Back
Dog	Scruff, back
Cat	Scruff, back
Birds	Medial thigh

5.7. Intravenous injections:

5.7.1. Rotate injection sites, if possible.

5.7.2. Limit the number of punctures to 5 per site, per day.

5.7.3. For continuous infusion, indwelling catheters may be surgically implanted.

5.7.4. Recommended injection sites:

SPECIES	SITE
Mouse	Lateral tail vein
Rat	Lateral tail vein, sublingual vein, penile vein
Rabbit	Marginal ear vein
Hamster	Femoral or jugular vein
Guinea pig	Ear vein, saphenous vein, dorsal penile vein
Non-human primate : Rhesus or Cynomolgus	Cephalic vein, saphenous vein
Non-human primate: Marmoset	Lateral tail vein, saphenous vein
Dog	Cephalic vein, saphenous vein
Cat	Cephalic vein, saphenous vein

6. REFERENCES

- Diehl, K.-H. et al., "A Good Practice Guide to the Administration of Substances and Removal of Blood, Including Routes and Volumes", *J. Appl. Toxicol.*, **21**, 15–23 (2001)
- Guide to the Care and Use of Experimental Animals, Vol. 1 (2nd ed), Canadian Council on Animal Care, Canada, 1993: http://ccac.ca/en/CCAC_Programs/Guidelines_Policies/GUIDES/ENGLISH/V1_93/APPEN/APPVIII.HTM

SOP REVISION HISTORY

DATE	PREVIOUS VERSION	NEW VERSION
2017.01.17	4.4 Intramuscular injections, volume/site given in ml/kg	4.4 Intramuscular injections, volume/site given in ml/kg
2017.08.31	4.1.3. Verify the solubility of the substance. Precipitation may cause the formation of large particles which, if injected intramuscularly, can be painful.	4.1.3. Verify the solubility of the substance. Precipitation may cause the formation of large particles which, if injected intramuscularly, can be painful. For intravenous injections, solutions, not suspensions, must be administered.