References on the Administration of Metals Using ALZET® Osmotic Pumps

Arsenate


Agents: Arsenate, sodium; Radio-isotopes Vehicle: Arsenic-74 tracer; Water; Radio-isotopes; Route: Not Stated; Species: Hamster (pregnant); Pump: 2001; Duration: 8 days;

ALZET Comments: Functionality of mp verified by radioassay; teratology


Agents: Arsenate, sodium Vehicle: Not Stated; Route: SC; Species: Hamster; Pump: 2001; Duration: 24, 48, 72, 168 hours;

ALZET Comments: Teratology; dose-response; functionality of mp verified by radio assay


Agents: Arsenate, sodium Vehicle: Water; Route: SC; Species: Hamster (pregnant); Pump: 2001; Duration: 6-9 days;

ALZET Comments: Teratogenicity; pumps primed in saline 4 hr prior to implant; dose-response data, 4 doses tested;

Cadmium


Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Bird (hen); Pump: 2002; Duration: 23 days;

ALZET Comments: Controls received mp w/ physiological saline; pumps replaced after 13 days; animal info (willow, ptarmigan, adult, juvenile)


Agents: Cadmium chloride Vehicle: Saline; Route: SC; Species: Rat (pregnant); Pump: 2ML4; Duration: 28 days;

ALZET Comments: Dose-reponse (p. 7, table 2); comparison of SC injections vs. SC mp; teratology

P5804: M. Kondoh, et al. Property of metallothionein as a Zn pool differs depending on the induced condition of metallothionein. TOXICOLOGY LETTERS 2003;142(1-2):11-18

Agents: Cadmium acetate Vehicle: Saline; Route: SC; Species: Mice; Pump: Not Stated; Duration: 14 days;

ALZET Comments: Controls received mp w/ vehicle; no stress (see pg. 12) "None of the animals displayed any evidence of infection or other adverse effects from the procedure."; toxicology

P6661: M. Piasek, et al. Assessment of steroid disruption using cultures of whole ovary and/or placenta in rat and in human placental tissue. International Archives of Occupational and Environmental Health 2002;75(S36-S44

Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Rat (pregnant); Pump: 2ML2; Duration: 19 days;

ALZET Comments: Functionality of mp verified by placental cadmium levels; dose-response (fig. 5); teratology


Agents: Cadmium metallothionein Vehicle: Saline; Route: Not Stated; Species: Rat; Pump: 2001D; Duration: 24 hours;

ALZET Comments: Control received mp w/vehicle; comparison of bolus injections vs. mp; toxicology; dependence


Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Rat; Pump: 2001; Duration: 14 days;

ALZET Comments: controls received mp w/ dl H2O, toxicology

Agents: Cadmium Vehicle: Saline, sterile; Route: SC; Species: Mice (pregnant); Pump: Not Stated; Duration: 14 days;

ALZET Comments: Controls received no treatment or mp w/saline; functionality of mp verified by testing blood levels of cadmium; no stress (see pg. 196); teratology; investigators state that disinfectant is not necessary for sc implantation; there is no infection or other complication


Agents: Cadmium metallothionein Vehicle: Radio-isotopes; Potassium phosphate buffer; Mercaptoethanol, 2-; Route: IV (jugular); Species: Rat; Pump: Not Stated; Duration: 24 hours;

ALZET Comments: dose response; comparison of sc injections vs. mp; toxicology; Cd-MT was well tolerated if given via infusion, but nephrotoxic if given as a bolus injection


Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Rat; Pump: 2002; Duration: 2 weeks;

ALZET Comments: comparison of cadmium in diet vs. mp infusion


Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Rabbit; Pump: 2ML4; Duration: 28 days;

ALZET Comments: controls received sham operation; dose-response; stress/adverse reaction (fibrous tissue covering mp)


Agents: Cadmium chloride Vehicle: Water; Route: SC; Species: Rat; Pump: 2001; Duration: Not Stated;

ALZET Comments: Controls received mp w/ deionized water; Cd administered in diet and mp infusion; Se eliminated or supplemented in diet


Agents: Cadmium chloride Vehicle: Not Stated; Route: SC; Species: Rat; Pump: 2001; Duration: Not Stated;

ALZET Comments: Duration of mp use probably 1 week; purpose for mp use not clear, Cd delivered primarily in diet for 7 weeks


Agents: Cadmium chloride; Cadmium metallothionein; Radio-isotopes Vehicle: 109CdCl2 tracer; 109CdMt tracer; Radio-isotopes; Route: SC; Species: Rat; Pump: Not Stated; Duration: 2, 3 days;

ALZET Comments: Comparison of injections in rabbits vs. mp infusion in rats

Copper


Agents: Tricine; EDTA, copper; EDTA, zinc; EDPA; EDTA, calcium Vehicle: Saline; resyl violet; Route: CSF/CNS; Species: Rat; Pump: 2001D; Duration: 12 hours;

ALZET Comments: Controls received mp w/ vehicle; functionality of mp verified by residual volume; brain tissue distribution; animal info (male, Sprague-Dawley, >35 days old); cresyl violet used to verify injection site
*Agents*: Copper chloride; Cupric nitroltriacetate; Nitrilotriacetic acid  
*Vehicle*: Not Stated;  
*Route*: SC;  
*Species*: Rat;  
*Pump*: 2001;  
*Duration*: 3,5 days;  
*ALZET Comments*: controls received mp with saline or no treatment; toxicology; Cu-NTA is a copper chelate; copper pump implant sites were marked by tissue necrosis and massive neutrophil infiltration; “...a level of copper that proved to be lethal or highly toxic when delivered in a single bolus dose could be continuously administered with mild histological alterations and without any noticeable modification in the behavior of the rats.”

*Agents*: Copper sulfate  
*Vehicle*: Saline;  
*Route*: SC;  
*Species*: Rabbit;  
*Pump*: 2ML4;  
*Duration*: Not Stated;  
*ALZET Comments*: no comment posted

*Agents*: Copper sulfate  
*Vehicle*: Saline;  
*Route*: SC;  
*Species*: Rabbit;  
*Pump*: 2ML4;  
*Duration*: Not Stated;  
*ALZET Comments*: Uveitis model

*Agents*: Copper sulfate  
*Vehicle*: Saline;  
*Route*: SC;  
*Species*: Rat;  
*Pump*: Not Stated;  
*Duration*: 7 days;  
*ALZET Comments*: controls received mp w/ saline

*Agents*: Copper sulfate  
*Vehicle*: Not Stated;  
*Route*: SC;  
*Species*: Rabbit;  
*Pump*: 2ML4;  
*Duration*: 28 days;  
*ALZET Comments*: dose-response data; controls received anesthesia but no surgery or mp

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**Iron-saturated**

**P2580**: H. Kondo, et al. Role of iron in oxidative stress in skeletal muscle atrophied by immobilization. Pflugers Arch 1992;421(295-297)
*Agents*: Desferrioxamine; Desferrioxamine, iron-saturated  
*Vehicle*: Water, double-distilled;  
*Route*: SC;  
*Species*: Rat;  
*Pump*: 2ML1;  
*Duration*: 8 days;  
*ALZET Comments*: controls received mp w/ water

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**Magnesium**

*Agents*: Magnesium sulfate  
*Vehicle*: Not Stated;  
*Route*: SC;  
*Species*: Rat;  
*Pump*: 2ML1;  
*Duration*: Not Stated;  
*ALZET Comments*: Dose (60 mg/kg/day); animal info (10-12 week old female Sprague Dawley rats weighing 210–250 g); Therapeutic indication (preeclampsia);

*Agents*: Magnesium sulfate  
*Vehicle*: Not Stated;  
*Route*: SC;  
*Species*: Rat (pregnant);  
*Pump*: Not Stated;  
*Duration*: Not Stated;  
*ALZET Comments*: Animal info (Sprague Dawley, 14-16 wks old); multiple pumps (3) used; 2ML sized pumps used

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**Agents:** Magnesium chloride  **Vehicle:** PEG;  **Route:** IV (jugular);  **Species:** Rat;  **Pump:** 2001D; 1003D; 2001;  **Duration:** 24 hours; 48 hours; 7 days;

**ALZET Comments:** Controls received mp w/ vehicle; animal info (female, Sprague Dawley, young adult, 180-220g); functionality of mp verified by residual volume; spinal cord injury; post op. care (Bacitracin ointment, saline injection SC, heating pad, twice daily bladder expression); behavioral testing (open field test, grid walk); Primed overnight in saline 37C


**Agents:** Magnesium chloride  **Vehicle:** Bicine buffer;  **Route:** Not Stated;  **Species:** Mice;  **Pump:** 1003D;  **Duration:** 3 days;

**ALZET Comments:** Controls received mp w/ vehicle; animal info (fear-susceptible or fear-resistant, 8-10 weeks old); behavioral testing (fear testing); MRI; manganese used to enhance MRI signal


**Agents:** Magnesium sulfate  **Vehicle:** Not Stated;  **Route:** SC;  **Species:** Rat (pregnant);  **Pump:** Not Stated;  **Duration:** 6 days;

**ALZET Comments:** Control animals received mp w/ saline; animal info (pregnant SHRs, gestational day 5, 180-200 g, pregnant, WKYs, 220-240 g)


**Agents:** Magnesium sulfate  **Vehicle:** Not Stated;  **Route:** SC;  **Species:** Rat (pregnant);  **Pump:** Not Stated;  **Duration:** 10 days;

**ALZET Comments:** Controls were not treated; animal info (pregnant SHRs, gestational day 5, 180-200 g, pregnant, WKYs, 220-240 g)


**Agents:** Magnesium chloride;  **Vehicle:** SC;  **Route:** Route through common hepatic branch of the vagus inhibits voluntary lard intake and modifies plasma metabolite levels in rats

**magnesium sulfate**  **Species:** Rat (neonate);  **Pump:** 2002; 2004;  **Duration:** 14 days;

**ALZET Comments:** Controls received mp w/ saline, equimolar; dose-response (table 1); comparison of SC injections vs. mp; stress/adverse reaction : (see pg 1162) high magnesium sulfate concentrations led to necrosis and skin sloughing at implant site; animal info (Sprague-Dawley, P7); skin was closed with staples (wound clips used)


**Agents:** L-NAME; magnesium sulfate  **Vehicle:** Saline;  **Route:** SC;  **Species:** Rat (pregnant);  **Pump:** 2ML1;  **Duration:** 4 days;

**ALZET Comments:** Controls received mp w/ vehicle; cardiovascular; animal info (female, Sprague-Dawley, 150-175g.); “Infusion of L-NAME in pregnant rats represent an excellent animal model suitable for the study of cardiovascular dysfunction in preeclampsia.” (pg. 1401)


**Agents:** Magnesium sulfate  **Vehicle:** Not Stated;  **Route:** SC;  **Species:** Rat (neonate);  **Pump:** 1003D;  **Duration:** 3 days;

**ALZET Comments:** Controls received mp w/ saline; functionality of mp verified by measuring magnesium ion concentrations; teratology; seven-day old rat pups weighed on average 13.9 ± 2.5 grams; neuroprotection; ischemia (cerebral)

Agents: NMDA; Magnesium sulfate
Vehicle: PBS; Route: CSF/CNS (intrathecal); Species: Rat; Pump: 2002; Duration: 4-8 weeks;

ALZET Comments: controls received mp with PBS; long-term study, pumps replaced every 2 weeks; NMDA given with MgSO4


Agents: NMDA; Glycine; Magnesium sulfate; APV
Vehicle: PBS; Route: CSF/CNS (intrathecal); Species: Rat; Pump: Not Stated;
Duration: 1, 2, or 4 weeks;

ALZET Comments: controls received no agent or mp w/ .IMPBS alone or w/ .15M glycine in .IMPS; 0.2 and 0.5M NMDA for 1-2 weeks poorly tolerated; .15M for 2 & 4 weeks better; NMDA and other agents infused in pairs


Agents: Glutamyl diethyl ester; Magnesium sulfate; Piperidine dicarboxyl acid, cis-2,3-; Phosphonoheptanoic acid, 2-amino-7-
Vehicle: Saline; Route: CSF/CNS; Species: Rat; Pump: 2001; Duration: 48 hours;

ALZET Comments: controls received mp w/saline; mp connected to cannula

Manganese


Agents: Manganese chloride
Vehicle: Saline, tris-buffered; Route: SC; Species: Rat; Pump: 2001; Duration: 7 days;

ALZET Comments: Dose: (120 mg/kg);Controls received mp w/ vehicle; animal info: Juvenile male Wistar rats (RccHan:WIST) post op. care: Carprofen (5 mg/kg), Manganese chloride aka (MnCl2)


Agents: Manganese chloride
Vehicle: Saline, IP; Species: Mice; Pump: 1007D; Duration: 7 days;

ALZET Comments: Dose: (400 mg/kg); animal info: Male mice aged 8-12 weeks and weighing 22-26 g; behavioral testing (Y-maze test); Manganese chloride aka MnCl2; ischemia (Traumatic Brain Injury);

Q10230: R. Li, et al. Mapping accumulative whole-brain activities during environmental enrichment with manganese-enhanced magnetic resonance imaging. Neuroimage 2020;210(116588

Agents: Manganese chloride
Vehicle: Saline; Route: IP; Species: Mice; Pump: 1007D; Duration: 7 days;

ALZET Comments: Controls received mp w/ vehicle; animal info: mice (about 8 weeks old 30.5-40.5 g); post op. care: followed by closure of the wound with surgical suture and disinfection with 75% ethanol; Manganese Chloride aka (MnCl2) immunology;

Q8634: R. Li, et al. Mapping accumulative whole-brain activities during environmental enrichment with manganese-enhanced magnetic resonance imaging. Neuroimage 2020;210(116588

Agents: Manganese chloride
Vehicle: Saline; Route: Abdomen; Species: Mice; Pump: 1007D; Duration: 7 days;

ALZET Comments: Dose: 100 mg MnCl2/kg; animal info: 8 week old mice weighing 30.5–40.5 g; Manganese Chloride aka MnCl2; dependence;


Agents: Manganese Chloride
Vehicle: Saline; Route: SC; Species: Rat; Pump: 2001; Duration: 4 days;

ALZET Comments: Dose: (120 mg/kg); animal info (male Sprague Dawley rats); Manganese Chloride aka MnCl2; dependence;
**Agents:** Manganese Chloride  **Vehicle:** Saline;  **Route:** SC;  **Species:** Mice;  **Pump:** 1004;  **Duration:** 15 days;
**ALZET Comments:** Dose (25, 50 mg/kg/day); Controls received mp w/ vehicle; animal info (10-12 weeks, male, B6129SF1/Tac); post op. care (2 mg/kg meloxicam for 3 days); behavioral testing (Morris Water Maze); comparison of IP injection vs mp; MRI; stress/adverse reaction: (“mice implanted with pumps swim more slowly on the first 2 days of training than the control animals. By day 3 this difference had normalized, and there was no effect of pumps, MnCl₂ treatment, or specific treatment group on swim speed.” p.417. “Some mice that received MnCl₂ via osmotic pump developed skin ulceration where the solution was being released from the pump. In 4/17 cases, the ulceration was so severe that the mice had to be euthanized.” p.417); “when mice are given 50 mg/kg/day MnCl₂ via osmotic pump, the useable imaging window is only from day 3 to day 5. The useable imaging window for mice receiving 25 mg/kg/day is approximately 3–14 days.” p.419;

Q7932: D. A. Vousden, et al. Continuous manganese delivery via osmotic pumps for manganese-enhanced mouse MRI does not impair spatial learning but leads to skin ulceration. Neuroimage 2018;173(411-420
**Agents:** manganese chloride  **Vehicle:** Saline;  **Route:** SC;  **Species:** Mice;  **Pump:** 1004;  **Duration:** 15 days;
**ALZET Comments:** Dose (25, 50 mg/kg/day); Controls received mp w/ vehicle; animal info (10-12 weeks, male, B6129SF1/Tac); post op. care (2 mg/kg meloxicam for 3 days); behavioral testing (Morris Water Maze); comparison of IP injection vs mp; MRI; stress/adverse reaction: (“mice implanted with pumps swim more slowly on the first 2 days of training than the control animals. By day 3 this difference had normalized, and there was no effect of pumps, MnCl₂ treatment, or specific treatment group on swim speed.” p.417. “Some mice that received MnCl₂ via osmotic pump developed skin ulceration where the solution was being released from the pump. In 4/17 cases, the ulceration was so severe that the mice had to be euthanized.” p.417); “when mice are given 50 mg/kg/day MnCl₂ via osmotic pump, the useable imaging window is only from day 3 to day 5. The useable imaging window for mice receiving 25 mg/kg/day is approximately 3–14 days.” p.419;

Q6745: D. S. Poole, et al. Continuous infusion of manganese improves contrast and reduces side effects in manganese-enhanced magnetic resonance imaging studies. Neuroimage 2017;147(1-9
**Agents:** Manganese Chloride  **Vehicle:** PBS;  **Route:** SC;  **Species:** Mice;  **Pump:** 1002;  **Duration:** 8 days;
**ALZET Comments:** Dose (30 mg/kg and 60 mg/kg); Controls received mp w/ vehicle; animal info (10 week old C57BL/6J mice); comparison of IP injections vs mp; MRI; “Our study demonstrates that the osmotic pump is able to deliver Mn to the brain (and in a suitable amount) with contrast comparable to that achieved via IP injections. Although a higher dose does appear necessary to achieve a similar contrast, this higher dose administered via osmotic pump can be used without giving side effects. Additionally, the constant delivery of manganese ensures a stable blood level and presumably a more timing-independent manganese uptake during activation. Lastly, osmotic pump delivery ensures less animal handling during the experiment, which may be a large advantage for many studies involving behavior, fear or stress, where animal handling may have a large influence on the experimental outcome.” pg.8 ;

**Agents:** Manganese Chloride  **Vehicle:** Saline, Tris-buffered;  **Route:** SC;  **Species:** Mice;  **Pump:** 2002;  **Duration:** 16 days;
**ALZET Comments:** Dose (160 mg/kg/week); animal info (male, C57BL/6NCrl, 5 weeks old); post op. care (SC injection of carprofen (5 mg/kg) for analgesia);

**Agents:** Manganese chloride  **Vehicle:** Saline;  **Route:** SC;  **Species:** Rat;  **Pump:** 2001;  **Duration:** 14 days;
**ALZET Comments:** Controls received mp w/ vehicle; behavioral testing (voluntary wheel running); MRI-compatible polyetheretherketone tubing; Therapeutic indication (osteoarthritis, fmri); Dose (80 mg/kg);
ALZET®
Bibliography

Agents: Manganese Chloride Vehicle: NaOH, TRIS-HCL buffer; Route: SC; Species: Rat (pregnant); Pump: 2001; Duration: 7 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (120-day-old MPS and non-stress control female Long-Evans rats); functionality of mp verified by plasma levels; no stress, “no toxic effects were anticipated or observed” (see pg. 81); behavioral testing (open-field exploration testing); MRI imaging every second day, total of 5 time points; Multigenerational prenatal stress model; stress response measured by plasma corticosterone levels and open-field exploration in each generation; MRI-compatible pumps used (PEEK); Dose (7.14 mg/kg);

Agents: Manganese Chloride Vehicle: Saline, Tris-buffered; Route: SC; Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: animal info (male alcohol-preferring AA rats and male Wistar rats; 6 weeks old, 264–413 g); functionality of mp verified by MRI after pump removal; post op. care (carprofen injection); Dose (120 mg/kg/wk);

Agents: Manganese chloride Vehicle: Not Stated; Route: SC; Species: Rat; Pump: Not Stated; Duration: 7 days;
ALZET Comments: animal info (male alcohol-preferring AA and male Wistar rats; 6 weeks old, 264–413 g); functionality of mp verified by MRI after pump removal; post op. care (carprofen injection); Dose (120 mg/kg/wk);

Agents: Manganese Chloride Vehicle: Saline, Tris-buffered; Route: SC; Species: Rat; Pump: 2001; Duration: 1 week;
ALZET Comments: animal info (Wistar rats 571 +/-41 g); “To avoid negative side effects on basic physiology and behaviour of the animals due to the injection of the manganese chloride solution in doses sufficient for MEMRI measurement, osmotic pumps served for the gentle, but rather time-consuming continuous application of non-toxic amounts of manganese, which accumulated in the activated brain areas during the whole time course of the 7-day food test phase” (pg. 8); MRI use

Agents: Manganese chloride Vehicle: Tris-buffered saline; Route: SC; Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: animal info (Wistar, 6 weeks old); post op. care (SC injection carprofen 5 mg/kg); behavioral testing (locomotor activity, novel object recognition); MRI; pumps primed overnight in 37C saline;

Q3603: D. S. Poole, et al. Three-dimensional inversion recovery manganese-enhanced MRI of mouse brain using super-resolution reconstruction to visualize nuclei involved in higher brain function. NMR IN BIOMEDICINE 2014;27(749-759
Agents: Manganese chloride Vehicle: Not Stated; Route: SC; Species: Mice; Pump: 1007D; Duration: 8 days;
ALZET Comments: MRI;

Agents: Manganese chloride Vehicle: Not Stated; Route: SC; Species: Rat; Pump: 2001; Duration: 7 days;
ALZET Comments: animal info (Wistar rats, 257 +/- 21 g); good methods (pumps were incubated in isotonic saline for 12 h previous to implantation); For the use in MRI, the stainless steel flow moderator was replaced by a PEEK micro medical tubing; “Osmotic pump-assisted MEMRI proved to be a promising technique for functional mapping of whole brain activity…” (pg 1); “MnCl2 is administered by osmotic pumps, which slowly and continuously release the solution over a time period of up to seven days avoiding adverse effects on motor activity, but providing sufficient manganese accumulation for MRI analysis” (pg. 2); Dose (1 M solution);

Agents: Manganese chloride Vehicle: Saline; Route: SC; Species: Mice; Pump: 2004; Duration: 12, 21 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (Swiss, 2 mo old); MRI; comparison of SC injections vs SC mp; “The novel method presented in this study in mice, which is based on subcutaneously implanted mini-osmotic pumps filled with MnCl2, appears to be a better system for delivering the agent into the interstitial tissue compared with repeated agent injections.” pg 429


Agents: Manganese chloride Vehicle: Not Stated; Route: SC; Species: Mice; Pump: 1003D; 1007D; 1002; Duration: 3, 7, 14 days;

ALZET Comments: Animal info (Oxtr KO, wt, 22-30 g, age-matched adult); MRI

Q5566: S. Boretius, et al. Manganese-enhanced magnetic resonance imaging. Methods Mol Biol 2011;771(531-68

Agents: Manganese Vehicle: Not Stated; Route: Not Stated; Species: Rat; Pump: Not Stated; Duration: 48 hours;

ALZET Comments: “One approach may be the use of micro-osmotic pumps\ that constantly infuse manganese into a targeted brain area for a period of about 48 h” (p. 542); “A slow manganese release by micropumps... may be alternative approaches to reduce the acute manganese toxicity.” (p. 558)


Agents: Manganese chloride Vehicle: Saline; Route: IP; Species: Rat; Pump: 2001; Duration: Not Stated;

ALZET Comments: Controls received mp w/ vehicle; animal info (male, Sprague Dawley, 250-300 g); comparison of SC and IP injections vs IP mp; post op. care (Fynadine Essex, Baytril); behavioral testing (running wheel); “The results of this experiment clearly demonstrate the advantage of systemic administration of MnCl2 via osmotic pumps, which provide a long-lasting, continuous and slow release of Mn 2+ into intraperitoneal space... Such release rate likely is readily managed by homeostatic mechanisms, does not produce toxic effects, while allows reaching relatively high cumulative dose.” pg 2550; “In contrast (to chronic infusion with ALZET pumps), a single s.c. or i.p. application of MnCl2 in a dose range of 16 - 80 mg/kg resulted in abrupt and long-lasting toxic effects.” pg 2552; “we find the osmotic pump-administration protocol described in the present study clearly advantageous for longitudinal behavioral studies.” pg 2553


Agents: Manganese chloride Vehicle: Water; Route: IP; Species: Rat; Pump: Not Stated; Duration: 7 days;

ALZET Comments: controls received saline


Agents: Manganese chloride Vehicle: Water; Route: SC; Species: Rat; Pump: Not Stated; Duration: 7 days;

ALZET Comments: controls received saline


Agents: Manganese chloride; Radio-isotopes Vehicle: Radio-isotopes; Route: SC; Species: Monkey; Pump: Not Stated; Duration: 6 weeks;

ALZET Comments: Pump model not stated; half-life: multiple pumps per animal (2); comparison of MnCl inhalation vs. mp infusion; stress/adverse reaction (necrosis, edema at mp site); pump replaced