



Recent References (2018-Present) on the Intravenous Administration of Agents Using ALZET® Osmotic Pumps

Q10994: D. Selvakumar, *et al.* Delivery of Cardioactive Therapeutics in a Porcine Myocardial Infarction Model. *Journal of Visual Experiment* 2023;192):

Agents: Platelet-derived growth factor-AB, human **Vehicle:** Saline; **Route:** IV (jugular); **Species:** Pig; **Strain:** Large white x landrace; **Pump:** 2ML1; 2ML2; 2ML4; **Duration:** 7 days;

ALZET Comments: Dose: Controls received mp w/ vehicle; animal info: Pre-pubescent large white x landrace gilts, 18-20 kg, post op. care: 0.2 mg/kg of meloxicam SC; comparison of injections (thoracotomy, transepical, percutaneous transendocardial) vs mp; functionality of mp verified by recomb protein serum concentration (ELISA); cardiovascular (myocardial infarction); good methods p. 8, 13 fig. 2; no stress; "Jugular vein minipump insertion provides a safe and reliable method of PDGF delivery over a 7 day time period." p. 13

Q11140: X. J. Liu, *et al.* Minocycline and Pyrrolidine Dithiocarbamate Attenuate Hypertension via Suppressing Activation of Microglia in the Hypothalamic Paraventricular Nucleus. *Tohoku Journal of Experimental Medicine* 2023;259(2):163-172

Agents: Angiotensin II **Vehicle:** Saline; **Route:** IV (femoral; vena cava); **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** Not Stated; **Duration:** 4 weeks;

ALZET Comments: Dose (0.6 µg/hr); 0.3% NaCl used; Controls received mp w/ vehicle; animal info (Male; Weighed 275-300 g); peptides; polyethylene catheter; cardiovascular (hypertension)

Q11043: D. Jiang, *et al.* Natriuretic peptides potentiate cardiac hypertrophic response to noradrenaline in rats. *Peptides* 2023;166(171035

Agents: Noradrenaline; Atrial natriuretic peptide; C-type natriuretic peptides **Vehicle:** Ascorbic acid; glutathione; saline; **Route:** SC; IV (jugular); **Species:** Rat; **Strain:** Wistar; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose: 30 µg/h; ANP, CNP: 1.0 µg/h; 0.005% ascorbic acid and 5 mM glutathione; 0.9% saline used; animal info: Nine-week-old male; peptides; PE catheter used; cardiovascular; "In the present study, persistent administration of ANP and CNP augmented cardiac hypertrophic response to NA infused continuously for 14 days in rats, suggesting a possible pro-hypertrophic action of natriuretic peptides on the heart."

Q11286: Y. Huang, *et al.* A pref-1-controlled non-inflammatory mechanism of insulin resistance. *iScience* 2023;26(6):106923

Agents: Pref-1 protein, recombinant **Vehicle:** Not Stated; **Route:** IV (jugular); **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1004; **Duration:** 4 weeks;

ALZET Comments: Dose (24 µg/kg/day); controls received mp w/ vehicle; animal info (Male; 20-28 weeks old);

Q11064: A. T. Amgott-Kwan, *et al.* Endomorphin analog ZH853 shows low reward, tolerance, and affective-motivational signs of withdrawal, while inhibiting opioid withdrawal and seeking. *Neuropharmacology* 2023;227(109439

Agents: ZH853; morphine **Vehicle:** Saline; **Route:** IV; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2ML1; **Duration:** 7 days;

ALZET Comments: Dose: (ZH853 6 mg/day; Morphine 10 mg/day); 20% PEG in saline used; animal info: Male and female; 250-275 g and 200-225 g; dependence

R0436: D. Olivari, *et al.* Searching for Preclinical Models of Acute Decompensated Heart Failure: a Concise Narrative Overview and a Novel Swine Model. *Cardiovascular Drugs and Therapy* 2022;36(4):727-738

Agents: Serelaxin **Vehicle:** Saline; **Route:** IV; **Species:** Pig; **Strain:** Sus scrofa domesticus; **Pump:** Not Stated; **Duration:** 48 hrs

ALZET Comments: Dose: (30 µg/kg/day); Controls received mp w/ vehicle; animal info: 17 male pig weighing 34 ± 4 kg; post op. care: Analgesia was performed with butorphanol; Cardiovascular

Q10514: L. B. James-Allan, *et al.* A Novel Technique Using Chronic Infusion Of Small Extracellular Vesicles From Gestational Diabetes Mellitus Causes Glucose Intolerance In Pregnant Mice. *Clinical Science (Lond)* 2022;136(21):1535-1549

Agents: Vesicle, human small extracellular **Vehicle:** PBS; **Route:** IV (jugular); **Species:** Mice; **Strain:** C57BL6; **Pump:** 1003D; **Duration:** 4 days;

ALZET Comments: Controls received mp w/ vehicle; animal info (Pregnant female mice); jugular catheter used; gestational diabetes mellitus



Q10753: T. He, *et al.* Compensatory Roles of Protein Related to DAN and Cerberus (PRDC) Decrease in Pulmonary Arterial Hypertension. *International Journal of Biological Sciences* 2022;18(6):2372-2391

Agents: PRDC **Vehicle:** Saline; **Route:** IV (jugular); **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2ML4; **Duration:** 4 weeks; **ALZET Comments:** Dose (15µg); 0.9% saline solution used; animal info (Male ; 6 weeks old; 200-240 g); cardiovascular; Therapeutic indication (Pulmonary arterial hypertension);

R0461: D. Patel, *et al.* Biotechnology-based therapeutics for management of cerebral stroke. *Eur J Pharmacol* 2021;913(174638

Agents: Antibody, anti-nogo-A 7B12 **Vehicle:** Not Stated; **Route:** IV; **Species:** Rat; **Strain:** Not Stated; **Pump:** SHR; **Duration:** Not Stated;

ALZET Comments: Dose: (5 mg); ischemia; comparison of different animal models/administration routes for cerebral strokes

Q9836: Z. Zhao, *et al.* Attenuation of atrial remodeling by aliskiren via affecting oxidative stress, inflammation and PI3K/Akt signaling pathway. *Cardiovascular Drugs and Therapy* 2021;35(3):587-598

Agents: Wortmannin **Vehicle:** Not Stated; **Route:** IV; **Species:** Dog; **Strain:** Mongrel; **Pump:** Not Stated; **Duration:** 2 weeks; **ALZET Comments:** Dose (70 ug/kg/day); animal info (dogs of either sex, weighing from 11 to 17 kg); 131.71 mmHg - 117.29 mmHg; Wortmannin aka WM, PI3K antagonist; cardiovascular;

Q11230: K. Tran, *et al.* Structure-Activity Relationship and Bioactivity of Short Analogues of ELABELA as Agonists of the Apelin Receptor. *Journal of Medicinal Chemistry* 2021;64(1):602-615

Agents: Compound 6; ELABELA **Vehicle:** Saline; **Route:** IV (jugular vein); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001D; **Duration:** 24 hours;

ALZET Comments: Dose (9.9 nmol/kg/h); Controls received mp w/ vehicle; animal info: 250–350 g; behavioral testing: urinary output, water intake; PE-50 catheter used; Blood pressure measured via monitoring catheter connected to Micro-Med transducer; cardiovascular

Q9553: S. K. Woo, *et al.* SUR1-TRPM4 channels, not KATP, mediate brain swelling following cerebral ischemia. *Neuroscience Letters* 2020;718(134729

Agents: Oligodeoxynucleotide **Vehicle:** Saline, sterile normal; **Route:** IV (external jugular); **Species:** Rat; **Strain:** pMCAo; **Pump:** 2001D; **Duration:** 24 hours;

ALZET Comments: Dose (1.2 mg / 24 h); animal info (Male Wistar rats, aged 11–12 weeks (300–350 gm)); Oligodeoxynucleotide aka ODN; ischemia (cerebral);

Q9541: X. Wang, *et al.* Susceptibility of Rat Steatotic Liver to Ischemia-Reperfusion Is Treatable With Liver-Selective Matrix Metalloproteinase Inhibition. *Hepatology* 2020;72(5):1771-1785

Agents: Propionic acid, 2-[(4-biphenylsulfonyl)amino]-3-phenyl- **Vehicle:** Not Stated; **Route:** IV (inferior mesenteric); **Species:** Rat; **Strain:** Lewis; **Pump:** 2ML1; **Duration:** 2 days;

ALZET Comments: Dose (100 µg/kg/h); animal info (Male rats); 2-[(4-biphenylsulfonyl)amino]-3-phenyl-propionic acid aka MMP-2,9 inhibitor; ischemia (reperfusion injury);

Q9530: F. Wang, *et al.* Soluble (pro)renin receptor treats metabolic syndrome in mice with diet-induced obesity via interaction with PPARgamma. *JCI Insight* 2020;5(7):

Agents: Renin receptor, human recombinant soluble; PF429242 **Vehicle:** Not Stated; **Route:** IV (external jugular); **Species:** Mice; **Strain:** DIO C57/BL6; **Pump:** 1002; **Duration:** 2 weeks;

ALZET Comments: Dose (30 ug/kg/d); Controls received mp w/ vehicle; animal info (Male 36-week-old mice); Multiple pumps per animal (2 pumps); human recombinant soluble renin receptor aka sPRR, PF429242 aka PF; dependence;

Q9455: M. Shaqura, *et al.* Neuronal aldosterone elicits a distinct genomic response in pain signaling molecules contributing to inflammatory pain. *Journal of Neuroinflammation* 2020;17(1):183

Agents: FAD286 **Vehicle:** Saline; **Route:** IV (lumbar); **Species:** Rat; **Strain:** Wistar; **Pump:** Not Stated; **Duration:** Not Stated;

ALZET Comments: Dose (0.3ug/1 µl); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (male rats (180– 250g)); dependence;



- Q8861:** L. B. James-Allan, *et al.* Regulation of glucose homeostasis by small extracellular vesicles in normal pregnancy and in gestational diabetes. *FASEB Journal* 2020;34(4):5724-5739
Agents: Small extracellular vesicles, human **Vehicle:** PBS; **Route:** IV (right jugular vein); **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1003D; **Duration:** 4 days;
ALZET Comments: Controls received mp w/ vehicle; animal info (Nonpregnant female mice); human small extracellular vesicles aka human sEVs; diabetes;
- Q8857:** C. T. Huang, *et al.* Glycemic control with insulin attenuates sepsis-associated encephalopathy by inhibiting glial activation via the suppression of the nuclear factor kappa B and mitogen-activated protein kinase signaling pathways in septic rats. *Brain Research* 2020;1738(146822
Agents: Dextrose; Fluorocitrate; Minocycline; SB203580; PD98059 **Vehicle:** DMSO; **Route:** CSF/CNS (left ventricle); IV (jugular); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001; **Duration:** 7 days;
ALZET Comments: 1% DMSO used; Controls received mp w/ vehicle; animal info (male, rats (weight, 200–250 g)); behavioral testing (Von Frey filament test, Plantar test); functionality of mp verified by residual volume; SB203580 aka p38 MAPK inhibitor, PD98059 aka extracellular signal-regulated kinase inhibitor; Brain coordinates (0.8 mm posterior and 1.3 mm lateral to the bregma, and 4.0 mm ventral to the skull surface); dependence;
- Q8537:** M. Hecker, *et al.* Immunomodulation by an Omega-6 Fatty Acid Reduced Mixed Lipid Emulsion in Murine Acute Respiratory Distress Syndrome. *Journal of Clinical Medicine* 2020;9(7):
Agents: Triglycerides, long-chain; Triglycerides, medium chain **Vehicle:** Saline; **Route:** IV (external jugular); **Species:** Mice; **Strain:** Not Stated; **Pump:** Not stated; **Duration:** 3 days;
ALZET Comments: Dose (1.5 mg/kg/day); Controls received mp w/ vehicle; animal info (13-15 week old mice, 22-24 g); long-chain Triglycerides aka LCT; medium chain Triglycerides aka SMOF; dependence;
- Q8472:** T. Fujimura, *et al.* The pain-relieving effects of lactoferrin on oxaliplatin-induced neuropathic pain. *Journal of Veterinary Medical Science* 2020;
Agents: Lactoferrin, human recombinant **Vehicle:** PBS; **Route:** IV (external jugular); **Species:** Mice; **Strain:** ICR; **Pump:** Not Stated; **Duration:** 2 weeks;
ALZET Comments: Dose (10 mg/kg/day); Controls received mp w/ vehicle; animal info (five-week-old male mice); human recombinant lactoferrin aka rhLf; dependence;
- Q8453:** K. A. Duggan, *et al.* Vasoactive intestinal peptide infusion reverses existing renal interstitial fibrosis via a blood pressure independent mechanism in the rat. *European Journal of Pharmacology* 2020;873(172979
Agents: Vasoactive intestinal peptide **Vehicle:** Hartmann's Solution; **Route:** IV (iliac); **Species:** Rat; **Strain:** SHR; **Pump:** Not stated; **Duration:** 14 weeks;
ALZET Comments: Dose (5 pmol/kg/min); Controls received mp w/ vehicle; animal info (Fourteen week old spontaneous hypertensive rat); long-term study; Blood pressure measured via tail cuff plethysmography; 193 mmHg - 200 mmHg; Vasoactive intestinal peptide aka VIP; peptides; dependence;
- Q7516:** W. Yin, *et al.* Protein kinase C and protein kinase A are involved in the protection of recombinant human glucagon-like peptide-1 on glomeruli and tubules in diabetic rats. *Journal of Diabetes Investigation* 2019;10(3):613-625
Agents: Peptide-1, recombinant human glucagon-like **Vehicle:** Saline; **Route:** IV; **Species:** Rat; **Strain:** Wistar; **Pump:** 2004; **Duration:** 12 weeks;
ALZET Comments: "Dose (1.5 pmol/kg/min); 0.9% saline; Controls received mp w/ vehicle; animal info (Eight-week-old male/female); pumps replaced at 4 weeks; half-life (p.614 half-life in blood is approximately 2 h.); peptides; diabetes; "
- Q6890:** X. Wang, *et al.* Liver-Selective MMP-9 Inhibition in the Rat Eliminates Ischemia-Reperfusion Injury and Accelerates Liver Regeneration. *Hepatology* 2019;69(1):314-328
Agents: 2-[(4-biphenylsulfonyl)amino]-3-phenyl-propionic acid **Vehicle:** Not Stated; **Route:** IV (inferior mesenteric vein); IP; **Species:** Rat (transgenic); **Strain:** Low-Tg(CAG-EGFP)ys; **Pump:** 2ML1; 2001; **Duration:** 7 days;
ALZET Comments: Dose (100 µg/h); animal info (Male rats); enzyme inhibitor (Matrix metalloproteinases 2/9);



Q7500: F. Wang, *et al.* Site-1 protease-derived soluble (pro)renin receptor targets vasopressin receptor 2 to enhance urine concentrating capability. *JCI Insight* 2019;4(7):

Agents: Histidine-tagged sPRR **Vehicle:** Not stated; **Route:** IV (jugular); **Species:** Mice; **Strain:** C57/BL6; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (30 µg/kg/day); Controls received mp w/ vehicle; animal info (experiments. Male 10- to 12-week-old);

Q7573: R. Lin, *et al.* Systemic Factors Trigger Vasculature Cells to Drive Notch Signaling and Neurogenesis in Neural Stem Cells in the Adult Brain. *Stem Cells* 2019;37(3):395-406

Agents: Biotin, recombinant vascular endothelial growth factor 165 **Vehicle:** Saline; **Route:** IV (Femoral); **Species:** Mice; **Strain:** CD-1; **Pump:** Not Stated; **Duration:** 3 days;

ALZET Comments: Dose (1 mg/kg); Controls received mp w/ vehicle; animal info (9-week old mice);

Q7535: E. D. Levin, *et al.* Prolonging the Reduction of Nicotine Self-Administration in Rats by Coadministering Chronic Nicotine With Amitifadine, a Triple Monoamine Reuptake Inhibitor With CYP2B6 Inhibitory Actions. *Nicotine Tob Res* 2019;

Agents: Nicotine Ditartrate **Vehicle:** Saline; **Route:** SC, IV (jugular); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2ML4; **Duration:** 4 weeks;

ALZET Comments: Dose (2.5 mg/kg/day); animal info (Young adult female rats); post op. care (ketoprofen, bupivacaine); behavioral testing (dual-lever experiment);

Q6881: W. Deng, *et al.* Insulin ameliorates pulmonary edema through the upregulation of epithelial sodium channel via the PI3K/SGK1 pathway in mice with lipopolysaccharide-induced lung injury. *Mol Med Rep* 2019;

Agents: Insulin, human **Vehicle:** PBS; **Route:** IV (jugular); **Species:** Mice; **Strain:** C3H/HeN; **Pump:** Not Stated; **Duration:** 24 h

ALZET Comments: Dose (Human Insulin (.01 U/kg/day); Controls received mp w/ vehicle; animal info (mice, aged 7-9 weeks);

ALZET internal jugular vein catheter used; cardiovascular;

Q7367: R. A. Augustine, *et al.* Impaired hypothalamic leptin sensitivity in pseudopregnant rats treated with chronic prolactin to mimic pregnancy. *J Neuroendocrinol* 2019;e12702

Agents: Ovine prolactin **Vehicle:** CSF, artificial; **Route:** IV; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2001; **Duration:** 7 d

ALZET Comments: Dose (2.5 µg/µL/hr); Controls received mp w/ vehicle; animal info (10 week old, female,); bilateral cannula used; dependence;

R0377: X. S. Zeng, *et al.* Neurotoxin-Induced Animal Models of Parkinson Disease: Pathogenic Mechanism and Assessment. *ASN Neuro* 2018;10(1759091418777438

Agents: Rotenone, MPTP **Vehicle:** Not Stated; **Route:** IV, IP; **Species:** Rat; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** 14 days, 33 days;

ALZET Comments: Dose (Rotenone (3 mg/kg/day); MPTP (46 mg/kg/day)); neurodegenerative (Parkinson's);

Q7161: X. Yu, *et al.* Zinc Metallochaperones Reactivate Mutant p53 Using an ON/OFF Switch Mechanism: A New Paradigm in Cancer Therapeutics. *Clin Cancer Res* 2018;24(18):4505-4517

Agents: Zinc metallochaperone 1 **Vehicle:** DMSO; **Route:** IV (jugular); **Species:** Mice (nude); **Strain:** Not Stated; **Pump:** 2001; **Duration:** 7, 17 days;

ALZET Comments: Dose (1 mg/kg/d); Controls received mp w/ vehicle; animal info (8-12 week old mice); pumps replaced after 1 week; comparison of IV bolus injection vs continuous pump infusion; half-life: <30 min (p. 4505); cancer (therapeutics);

Q7838: X. Wang, *et al.* Angiotensin-(1-7) prevents atrial tachycardia induced-heat shock protein 27 expression. *J Electrocardiol* 2018;51(1):117-120

Agents: Angiotensin(1-7) **Vehicle:** Not Stated; **Route:** IV (jugular); **Species:** Dog; **Strain:** Mongrel; **Pump:** Not Stated; **Duration:** 2 weeks;

ALZET Comments: Dose (6 µg/kg/h); Controls did not receive mp; animal info (11-15 kg); cardiovascular; Therapeutic indication (intravenously administered Ang-(1-7) may be responsible for inhibiting atrial remodeling induced by rapid atrial pacing, which in turn decreases HSP27 gene and protein expression.);



Q6901: T. Vajen, *et al.* Blocking CCL5-CXCL4 heteromerization preserves heart function after myocardial infarction by attenuating leukocyte recruitment and NETosis. *Sci Rep* 2018;8(1):10647

Agents: MKEY; MKEY, scrambled **Vehicle:** Formic acid; **Route:** IV (jugular); **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (1.3 mg/kg/day); animal info (mice); cardiovascular;

Q7915: A. K. E. Hornsby, *et al.* Circulating unacylated-ghrelin impairs hippocampal neurogenesis and memory in mice and is altered in human Parkinson's disease dementia. *Cell Reports Medicine* 2018;1(7):100120

Agents: Ghrelin, unacylated **Vehicle:** Saline, sterile, heparinized; BSA, buffered; **Route:** IV (jugular); **Species:** Mice; **Strain:** C57BL/6; GOAT-null; **Pump:** 1007D; **Duration:** 7 days;

ALZET Comments: Dose (48µg/day); sterile isotonic saline containing BSA (1mg/ml) and heparin (5U/ml) used; Controls received mp w/ vehicle; animal info (6 months,); UAG is considered an inactive precursor to acyl-ghrelin; neurodegenerative (Parkinson's); replacement therapy (ghrelin);

Q7818: L. Gonzalez, *et al.* Angiotensin-(1-9) reduces cardiovascular and renal inflammation in experimental renin-independent hypertension. *Biochemical Pharmacology* 2018;156(357-370)

Agents: Angiotensin (1-9) **Vehicle:** Not stated; **Route:** IV (jugular); **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** 2002; **Duration:** 14 days;

ALZET Comments: Dose ((Ang(1-9) 600 ng/kg/min), (PD123319 28 ng/kg/min), (A779 100 ng/kg/min)); Controls received sham surgery and mp w/ vehicle; animal info (male, , 150+/-10g); PD123319 is an AT2R blocker. A779 is a Mas receptor blocker; replacement therapy (Uninephrectomized); cardiovascular; vehicle used but identity not stated.; Therapeutic indication (Ang-(1-9) protects against hypertensive cardiovascular and kidney damage induced by volume overload by decreasing inflammation in the heart, aortic wall, and kidney; these effects are not mediated by the Mas or AT2 receptor.);

Q7762: C. R. Chitambar, *et al.* Gallium Maltolate Disrupts Tumor Iron Metabolism and Retards the Growth of Glioblastoma by Inhibiting Mitochondrial Function and Ribonucleotide Reductase. *Mol Cancer Ther* 2018;17(6):1240-1250

Agents: gallium, (tris-hydroxy-2-methyl-4H-pyran-4-onato) **Vehicle:** Not Stated; **Route:** IV (Jugular); **Species:** Rat; **Strain:** athymic; **Pump:** Not Stated; **Duration:** 10 days;

ALZET Comments: Dose (50 mg/kg/day); animal info (Male rats 250g); (tris-hydroxy-2-methyl-4H-pyran-4-onato)gallium aka GaM; cancer (glioblastoma);

Q10107: L. Bhat, *et al.* Evaluation of the effects of RP5063, a novel, multimodal, serotonin receptor modulator, as single-agent therapy and co-administrated with sildenafil, bosentan, and treprostinil in a monocrotaline-induced pulmonary arterial hypertension rat model. *European Journal of Pharmacology* 2018;827(159-166)

Agents: Treprostinil **Vehicle:** Saline, sterile; **Route:** IV; SC; **Species:** Rat; **Strain:** Wistar-Kyoto; **Pump:** 2ML4; **Duration:** 28 days;

ALZET Comments: Dose: Treprostinil (100 ng/kg/min); Controls received mp w/ vehicle; animal info: 90 male rats (weights 200–250 g; 10–12 weeks; post op. care (used heating pad to maintain body temperature); Blood pressure measured via: Systemic arterial blood pressure; cardiovascular; (Pulmonary arterial hypertension); stress/adverse reaction: (see pg.161); Future studies should include a sham comparator group to accommodate for the difference in route and timing of drug administration.