Recent References (2021-Present) on the Administration of Isoproterenol Using ALZET® Osmotic Pumps

Q11035: W. Zhang, *et al.* Active Ingredient Paeonol of Jijiu Huiyang Decoction Alleviates Isoproterenol-Induced Chronic Heart Failure via the GSK3A/PPARalpha Pathway. Oxidative Medicine and Cellular Longevity 2023;2023(3271057
Agents: Isoproterenol **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6 **Pump:** 2002; **Duration:** 14 days;
ALZET Comments: Dose: 30 mg/kg/d; Controls received mp w/ vehicle; animal info: male mice 8-10 weeks; cardiovascular; chronic heart failure

Q11027: W. Wu, *et al.* Mitochondrial damage in a Takotsubo syndrome-like mouse model mediated by activation of beta-adrenoceptor-Hippo signaling pathway. American Journal of Physiology Heart and Circulatory Physiology 2023;324(4):H528-H541
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** Not Stated; **Pump:** 2001; **Duration:** 23 hours;
ALZET Comments: Dose (1.25 mg/kg/h); Controls received mp w/ vehicle; animal info: 9 mo. old menopausal; post op. care (antibiotic ointment); cardiovascular; Takotsubo syndrome (cardiomyopathy)

Q11016: P. Verdino, *et al.* Development of a long-acting relaxin analogue, LY3540378, for treatment of chronic heart failure. British Pharmacological Society 2023;180(15):1965-1980
Agents: Isoproterenol hydrochloride **Vehicle:** PBS; sodium ascorbate; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 1002; **Duration:** 14 days;
ALZET Comments: Dose Isoproterenol (15 mg/kg/day); Controls received mp w/ vehicle; animal info: Male, 11-week-old; post op. care: Postoperative analgesia was achieved with a single dose of meloxicam 4 mg/kg; ; half-life (p.13); cardiovascular (chronic heart failure)

Q11007: G. Subramaniam, *et al.* Integrated Proteomics Unveils Nuclear PDE3A2 as a Regulator of Cardiac Myocyte Hypertrophy. Circulation Research 2023;132(7):828-848
Agents: Isoproterenol **Vehicle:** Saline; ascorbic acid; **Route:** Not Stated; **Species:** Rat; **Strain:** Not Stated; **Pump:** 2ML2; **Duration:** 14 days;
ALZET Comments: Dose: (0.13 mg/kg per hour) (0.9% NaCl+0.02% ascorbic acid) used; Controls received mp w/ vehicle; animal info: Male rats (circa 6–8 months)cardiovascular (cardiac myocyte hypertrophy)

Q10998: W. Simonides, *et al.* Divergent Thyroid Hormone Levels in Plasma and Left Ventricle of the Heart in Compensated and Decompensated Cardiac Hypertrophy Induced by Chronic Adrenergic Stimulation in Mice. Metabolites 2023;13(308):
Agents: Isoproterenol; phenylephrine **Vehicle:** Water, sterile, distilled; ascorbic acid; **Route:** SC; **Species:** Mice; **Strain:** C57BL6/J-Dio3fl/flMerCreMer+/- (cD3KO-CS); **Pump:** 1007D; 1002; **Duration:** 7 days; 14 days;
ALZET Comments: Dose: 30 mg/kg/d; 0.1% ascorbic acid used; Controls received mp w/ vehicle; animal info: 12 weeks; cardiovascular; (ventricular hypertrophy, heart failure)

Q11183: J. Qian, *et al.* Toll-like receptor-2 in cardiomyocytes and macrophages mediates isoproterenol-induced cardiac inflammation and remodeling. FASEB Journal 2023;37(2):e22740
Agents: Isoproterenol **Vehicle:** Ascorbic acid; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; TLR2KO; **Pump:** 1002; **Duration:** 2 weeks;
ALZET Comments:

Q10737: R. Zhai, *et al.* Myocardial GRK2 Reduces Fatty Acid Metabolism and beta-Adrenergic Receptor-Mediated Mitochondrial Responses. International Journal of Molecular Sciences 2022;23(5):
Agents: Isoproterenol **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** Wild-type C57BL/6; **Pump:** Not Stated; **Duration:** 6, 7 days;
ALZET Comments: Dose (30 mg/kg/day); Controls received mp w/ vehicle; animal info (Male; 10-13 weeks old; ; Crossed with transgenic GRK2-overexpressing mice); cardiovascular; Therapeutic indication (Heart failure);

Q10849: Y. Yoshida, *et al.* Brown Adipose Tissue Dysfunction Promotes Heart Failure Via a Trimethylamine N-Oxide-Dependent Mechanism. Scientific Reports 2022;12(1):14883
Agents: Isoproterenol; Trimethylamine N-oxide **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/9; **Pump:** Not Stated; **Duration:** Not Stated;
ALZET Comments: Dose: (ISO 30 mg/kg/day; TMAO 25 mg/kg/day); animal info (Male; 11 weeks old); cardiovascular; Therapeutic indication (Heart failure);

Q11215: E. L. Robinson, *et al.* MSK-Mediated Phosphorylation of Histone H3 Ser28 Couples MAPK Signaling with Early Gene Induction and Cardiac Hypertrophy. Cells 2022;11(4):
Agents: Isoproterenol **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** Msk1/2; WT; **Pump:** Not Stated; **Duration:** 1 week;
ALZET Comments: Dose (10 mg/kg/day); animal info (Male; 8-10 weeks old); cardiovascular;

Q10617: D. Murashige, *et al.* Extra-Cardiac BCAA Catabolism Lowers Blood Pressure and Protects From Heart Failure. Cell Metabolism 2022;34(11):1749-1764 e7
Agents: Isoproterenol **Vehicle:** Saline, sterile; **Route:** SC; **Species:** Mice; **Strain:** BCKDK cKO; **Pump:** 1002; **Duration:** 14 days;
ALZET Comments: Dose (30 mg/kg/day.); Controls received mp w/ vehicle; animal info (mice); cardiovascular; Therapeutic indication (Heart failure);

Q11207: B. Moukette, *et al.* MiR-150 blunts cardiac dysfunction in mice with cardiomyocyte loss of beta(1)-adrenergic receptor/beta-arrestin signaling and controls a unique transcriptome. Cell Death Discovery 2022;8(1):504
Agents: Isoproterenol **Vehicle:** Ascorbic acid; saline; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6J; **Pump:** 2001; **Duration:** 7 days;
ALZET Comments: Dose (3 mg/kg/day); 0.002% ascorbic acid used; Controls received mp w/ vehicle; animal info: 8–16- week-old mice

Q10816: J. Li, *et al.* Targeting miR-30d Reverses Pathological Cardiac Hypertrophy. EBioMedicine 2022;81(104108
Agents: Angiotensin II; Isoproterenol **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** Not Stated; **Pump:** 2004; 2002; **Duration:** 4 weeks; 2 weeks;
ALZET Comments: Dose (1.3 mg/kg/day Ang II, 30 mg/kg/day ISO); Controls received mp w/ vehicle; animal info(Male; 8-10 weeks old); peptides; cardiovascular; Therapeutic indication (Cardiac hypertrophy);

Q10935: X. Han, *et al.* Syringic acid mitigates isoproterenol-induced cardiac hypertrophy and fibrosis by downregulating Ereg. Journal of Cellular and Molecular Medicine 2022;26(14):4076-4086
Agents: Isoproterenol **Vehicle:** Ascorbic acid; saline; DMSO; **Route:** Not Stated; **Species:** Mice; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** 5 days;
ALZET Comments: Dose (25 mg/kg bodyweight/day); 0.1% ascorbic acid and 0.9% saline used; Controls received mp w/ vehicle; animal info (Male; 8 weeks old; Weighed about 33 g); cardiovascular; (Cardiac hypertrophy; Fibrosis);

Q10383: L. Gao, *et al.* Schisandrin A protects against isoproterenol induced chronic heart failure via miR155. Molecular Medical Reports 2022;25(1):
Agents: Isoproterenol hydrochloride **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** Not Stated; **Pump:** 2ML2; **Duration:** 2 weeks;
ALZET Comments: Dose (30 mg/kg/day); 0.9% normal saline used; Controls received mp w/ vehicle; animal info (Male; 50 total; 10 weeks old; 22-25 g); cardiovascular; Therapeutic indication (Chronic heart failure);

Q10676: M. Abdullah Shamim, *et al.* Topical Carvedilol Delivery Prevents UV-Induced Skin Cancer with Negligible Systemic Absorption. International Journal of Pharmaceutics 2022;611(121302
Agents: Isoproterenol **Vehicle:** Not Stated; **Route:** SC; **Species:** Mice; **Strain:** SKH-1; **Pump:** 1004; **Duration:** 28 days;
ALZET Comments: Dose (20 ug/kg/day); animal info (; Female; Hairless; 7-8 weeks old); Blood pressure measured via tail-cuff method; cancer (Skin);

Q10892: T. Zhao, *et al.* Selective HDAC8 Inhibition Attenuates Isoproterenol-Induced Cardiac Hypertrophy and Fibrosis via p38 MAPK Pathway. Frontiers in Pharmacology 2021;12(677757
Agents: Isoproterenol **Vehicle:** DMSO; Saline; Ascorbic acid; **Route:** IP; **Species:** Mice; **Strain:** CD-1; **Pump:** Not Stated; **Duration:** 5 days;
ALZET Comments: Dose: (25 mg/kg/day); 0.9% Saline; 0.1% Ascorbic acid vehicle used; Controls received mp w/ vehicle; animal info: Malemice (7 weeks old and with an average weight of 33 g); cardiovascular; Cardiac Hypertrophy and Fibrosis

Q10734: L. Yanez-Bisbe, *et al.* Aging Impairs Reverse Remodeling and Recovery of Ventricular Function after Isoproterenol-Induced Cardiomyopathy. International Journal of Molecular Sciences 2021;23(1):
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1004; **Duration:** 28 days;
ALZET Comments: Dose (30 mg/kg/day); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (young 10-weeks old; elderly 22-month old Female); cardiovascular (cardiomyopathy)

Q9522: E. Walsh-Wilkinson, *et al.* Segmental analysis by speckle-tracking echocardiography of the left ventricle response to isoproterenol in male and female mice. PeerJ 2021;9(e11085
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57Bl6/J; **Pump:** 1004; **Duration:** 21 days;
ALZET Comments: Dose (30 mg/kg/day); Controls received mp w/ vehicle; animal info (mice, 8 weeks old); Isoproterenol aka Iso; dependence;

Q10695: H. Tao, *et al.* Loss of Ten-Eleven Translocation 2 Induces Cardiac Hypertrophy and Fibrosis Through Modulating ERK Signaling Pathway. Human Molecular Genetics 2021;30(10):865-879
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** 14 days;
ALZET Comments: Dose: (5 mg/kg/day)Controls received mp w/ vehicle; animal info: Hypertrophy model, adult male mice; Isoproterenol aka (ISO); cardiovascular; (cardiac hypertrophy and fibrosis)

Q10694: M. A. Tanner, *et al.* Immune Cell Beta(2)-Adrenergic Receptors Contribute to the Development of Heart Failure. American Journal of Physiology 2021;321(4):H633-H649
Agents: Isoproterenol **Vehicle:** PBS; Ascorbic acid; **Route:** Not Stated; **Species:** Mice; **Strain:** Wild-type C57BL/6J; **Pump:** Not Stated; **Duration:** 1 week;
ALZET Comments: Dose: (30mg/kg/day); 0.001% Ascorbic acid vehicle used; Controls received mp w/ vehicle; animal info: mice (8–12wk) and b2ARKO mice backcrossed; cardiovascular;

Q10349: M. Tajes, *et al.* Neurohormonal activation induces intracellular iron deficiency and mitochondrial dysfunction in cardiac cells. Cell & Bioscience 2021;11(1):89
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1004; **Duration:** 28 days;
ALZET Comments: Dose: (30 mg/kg/day); Controls received mp w/ vehicle; animal info: Sixteen 10-week-old male mice; post op. care: Buprenorphine (0.3 mg/kg, i.p.); Isoproterenol aka (ISO); cardiovascular;

Q10688: A. M. Syed, *et al.* A review on Herbal Nrf2 Activators with Preclinical Evidence in Cardiovascular Diseases. Phytotherapy Research 2021;35(9):5068-5102
Agents: Isoproterenol **Vehicle:** Not Stated; **Route:** SC; **Species:** Rat; **Strain:** Not Stated; **Pump:** Not Stated; **Duration:** 14 days;
ALZET Comments: Dose: (5 mg/kg/day)animal info: Male rats; Isoproterenol aka (ISO)cardiovascular;

Q10348: X. Sun, *et al.* Paroxetine Attenuates Cardiac Hypertrophy Via Blocking GRK2 and ADRB1 Interaction in Hypertension. Journal of American Heart Association 2021;10(1):e016364
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** SHRs; **Pump:** 2002; **Duration:** 2 weeks;
ALZET Comments: Dose: Isoproterenol (5 mg/kg per day); Controls received mp w/ vehicle; animal info: Spontaneously hypertensive rats 6 weeks of age, Blood pressure measured via: Tail cuff; 18.88 mmHg - 74.06 mmHg; cardiovascular; Hypertension

Q10659: T. Rehmani, *et al.* Specific Deletion of the FHA Domain Containing SLMAP3 Isoform in Postnatal Myocardium Has No Impact on Structure or Function. Cardiogenetics 2021;11(4):164-184
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 2001D; **Duration:** 7 days;
ALZET Comments: Dose (30 ug/g/d per animal); 0.9% saline used; Controls received mp w/ vehicle; animal info (8-weeks old,); gene therapy;

Q10046: D. Mukherjee, *et al.* PARIS–DJ-1 Interaction Regulates Mitochondrial Functions in Cardiomyocytes, Which Is Critically Important in Cardiac Hypertrophy. Molecular and Cellular Biology 2021;
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague-Dawley; **Pump:** Not Stated; **Duration:** 14 days;
ALZET Comments: Dose (5 mg/kg/day); 0.9% Saline used; Controls received mp w/ vehicle; animal info Rat (24-week-old male); Isoproterenol aka ISO; cardiovascular;

Q11131: J. Y. Li, *et al.* Upregulation of miR-128 Mediates Heart Injury by Activating Wnt/beta-catenin Signaling Pathway in Heart Failure Mice. Organogenesis 2021;17(3-4):27-39
Agents: Isoproterenol hydrochloride **Vehicle:** Saline; **Species:** Mice; **Strain:** C57BL/6; **Pump:** 1002; 1004; **Duration:** 14 days;
ALZET Comments: Dose (30 mg/kg/d); Controls received mp w/ vehicle; animal info (8-10 weeks old; male 20-25 g); cardiovascular; Therapeutic indication (Heart failure);

Q10224: J. S. Kwon, *et al.* In Vivo Stimulation of alpha- and beta-Adrenoceptors in Mice Differentially Alters Small RNA Content of Circulating Extracellular Vesicles. Cells 2021;10(5):
Agents: Isoproterenol; Phenylephrine **Vehicle:** Ascorbic acid; PBS; **Route:** Not Stated; **Species:** Mice; **Strain:** C57/BL6; **Pump:** 1007D; **Duration:** 1 week;
ALZET Comments: Dose: Isoproterenol (10 mg/kg/day); Phenylephrine (30 mg/kg/day); 0.002% Ascorbic acid vehicle used; Controls received mp w/ vehicle; animal info: 9 weeks-old male mice; cardiovascular;

Q10391: A. Ishikita, *et al.* GFAT2 mediates cardiac hypertrophy through HBP-O-GlcNAcylation-Akt pathway. iScience 2021;24(12):103517
Agents: Isoproterenol; 6-diazo-5-oxo-L-norleucine crystalline; Phenylephrine; Angiotensin II **Vehicle:** Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** Not Stated; **Pump:** 1007D; **Duration:** 1 week;
ALZET Comments: Dose (ISO 15 mg/kg body weight/day; DON 0.05 ug/kg/day; AngII 1.44 mg/kg body weight/day; PE 100 mg/kg body weight/day); dose-response (see p. 18); animal info (Male; 8-10 weeks old); Blood pressure measured via tail cuff system; peptides; cardiovascular; Therapeutic indication (Cardiac hypertrophy);

Q10486: X. Gao, *et al.* Nociceptive nerves regulate haematopoietic stem cell mobilization. Nature 2021;589(7843):591-596
Agents: Peptide, calcitonin gene related; Substance P; Isoproterenol **Vehicle:** PBS; **Route:** SC; **Species:** Mice; **Strain:** C57BL/6 CD45.1,CD45.2; **Pump:** 1007D; **Duration:** 1 week;
ALZET Comments: "Dose: CGRP (14 ug/day, 2.4 µg/day); Substance P (5 ug/day); Isoproterenol (40 µg per day); Controls received mp w/ vehicle; animal info: mice
8–10-week-old congenic mice of both gender; Calcitonin gene-related peptide also (CGRP); Isoproterenol aka (ISO)

Q10159: M. Flamant, *et al.* Early activation of the cardiac CX3CL1/CX3CR1 axis delays beta-adrenergic-induced heart failure. Scientific Reports 2021;11(1):17982
Agents: Isoproterenol **Vehicle:** Not Stated; **Route:** Not Stated; **Species:** Mice; **Strain:** C57BL/6J; **Duration:** 14; 28 days;
ALZET Comments: Dose: (30 mg/kg/day); animal info: adult male mice (9–20 week-old) mice; 11–13 week-old male C57BL/6J mice; Isoproterenol aka (ISO); cardiovascular;

Q9196: D. Coquerel, *et al.* Galphai-biased apelin analog protects against isoproterenol-induced myocardial dysfunction in rats. American Journal of Physiology Heart & Circulatory Physiology 2021;320(4):H1646-H1656
Agents: Apelin-13; Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Rat; **Strain:** Sprague Dawley; **Pump:** 2001D; 2001; **Duration:** 7 days;
ALZET Comments: Dose (10 nmol/kg/h Apelin-13; 5 mg/kg/day Isoproterenol); Controls received mp w/ vehicle; animal info (male rats, 3 months old, 400 g); 96.8 mmHg - 105.1 mmHg;Apelin-13 aka APLN-13, Isoproterenol aka ISO; cardiovascular;

Q9171: J. E. Camacho Londono*, et al.* Transcriptional signatures regulated by TRPC1/C4-mediated Background Ca(2+) entry after pressure-overload induced cardiac remodeling. Progress in Biophysics and Molecular Biology 2021;159(86-104
Agents: Isoproterenol; Angiotensin II **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** Not Stated; **Pump:** 1007D; 1002; **Duration:** 7 days; 14 days;
ALZET Comments: Dose (30 mg/kg/day Isoproterenol; 3 mg/kg/day Angiotensin II); 0.9% NaCl used; Controls received mp w/ vehicle; animal info (male mice, 2.5 to 4 months old); Blood pressure measured via 1.4F Mikro-Tip Catheter pressure transducer; Isoproterenol aka Iso, Angiotensin II aka AngII; cardiovascular;

Q10100: L. Bai*, et al.* Protocatechuic acid attenuates isoproterenol-induced cardiac hypertrophy via downregulation of ROCK1-Sp1-PKCgamma axis. Scientific Reports 2021;11(1):17343
Agents: Isoproterenol **Vehicle:** Ascorbic acid; Saline; **Route:** Not Stated; **Species:** Mice; **Strain:** CD-1; **Pump:** Not Stated; **Duration:** 5 days;
ALZET Comments: Dose: Isoproterenol (25 mg/kg/day); Protocatechuic acid (100 mg/kg/day); 0.1% ascorbic acid; 0.9% Saline; "Controls received mp w/ vehicle; Mice were
randomly divided into three following groups (n = 8/group): vehicle-treated sham group, isoproterenol-infused
group, and isoproterenol-infused group with protocatechuic acid (100 mg/kg/day). " animal info Male (age, 7 weeks; average weight 33 g); cardiovascular; (Cardiac Hypertrophy)

Q8684: A. Ahmed*, et al.* Maternal obesity persistently alters cardiac progenitor gene expression and programs adult-onset heart disease susceptibility. Mol Metab 2021;43(101116
Agents: Isoproterenol **Vehicle:** Saline; **Route:** SC; **Species:** Mice; **Strain:** Not Stated; **Pump:** Not stated; **Duration:** 14 days;
ALZET Comments: Dose (60 mg/kg/day); Controls received mp w/ vehicle; animal info (8 weeks old); cardiovascular;