

## 2. HEALTH EFFECTS

**Table 2-2. Levels of Significant Exposure to Beryllium–Oral**

Figure key <sup>a</sup>	Species (strain) No./group	Exposure parameters	Doses (mg/kg/day)	Parameters monitored	Endpoint	NOAEL (mg/kg/day)	Less serious LOAEL (mg/kg/day)	Serious LOAEL (mg/kg/day)	Effects
<b>ACUTE EXPOSURE</b>									
1	Rat (Wistar) 8 M	5 days (W)	0, 9.8	BI, HE	Hepatic		9.8 M		87% LDH increase, 76% protein carbonyl content increase, 38% increase MDA, 52% GSH decline; 35% CAT decrease, 40% SOD decrease with concomitant decrease in messenger RNA levels
					Neuro		9.8 M		Brain: 23% CAT decrease, 30% SOD decrease with concomitant decrease in messenger RNA levels; 96–133% increase in protein carbonyl content, MDA, and LDH
<b>Beryllium chloride El-Beshbishy et al. 2012</b>									
2	Rat (RccHAN: WIST) 6 F	Once (GO)	0, 2,000	BW, CS, LE	Bd wt	2000			
<b>Beryllium Strupp 2011a</b>									
3	Mouse (CBA) 5 M	1 d (GW)	0, 7.5, 25, 50, 70, 115, 140, 250		Death			140	LD <sub>50</sub>
<b>Beryllium sulfate tetrahydrate Ashby et al. 1990</b>									

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<b>INTERMEDIATE EXPOSURE</b>									
4	Rat (Wistar) 4 NS	13–42 days (F)	0, 345	BW, FI, HP	Bd wt Musc/skel	345		345	Rickets
<b>Beryllium carbonate Jacobson 1933</b>									
5	Rat (NS) 8 NR	21–22 days (F)	0, 70	BI, DX	Musc/skel Other noncancer		70	70	Severe rickets 58% decreased blood phosphate levels
<b>Beryllium carbonate Kay and Skill 1934</b>									
6	Rat (Wistar) 10 M	4 weeks (F)	0, 480	BI, BW	Bd wt Other noncancer		480 480		18% decrease in body weight gain 25% decreased serum phosphate
<b>Beryllium carbonate Matsumoto et al. 1991</b>									
7	Rat (Sprague-Dawley) 5 F	91d (W)	0, 0.7	BW, FI, WI	Bd wt	0.7			
<b>Beryllium sulfate tetrahydrate Freundt and Ibrahim 1990</b>									
8	Rat (NS) NS	24–28 days (F)	0, 35, 70, 140, 280, 840	HP	Musc/skel			35	Rickets
<b>Beryllium carbonate Guyatt et al. 1933</b>									

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9	Dog (Beagle) 5 M, 5 F	26–33 weeks (F)	M: 0, 12; F: 0, 17	HE, LE, GN, RX	Death			12	2/10 deaths
					Resp	12 M			
					Cardio	12 M			
					Gastro			12 M 17F	Ulceration in intestines
					Hemato		12 M 17 F		Hypoplasia in bone marrow Hypoplasia in bone marrow
					Musc/skel	12 M			
					Hepatic	12 M			
					Renal	12 M			
					Dermal	12 M			
					Ocular	12 M			
					Endocr	12 M			
					Repro			12 M	Testicular atrophy, testicular degeneration

**Beryllium sulfate tetrahydrate  
Morgareidge et al. 1976**

**CHRONIC EXPOSURE**

10	Rat (Wistar) 50 M, 50 F	2 years (F)	0, 0.30, 2.8, 31.0	BW, OW, FI, HP	Bd wt	31			
					Resp	31			
					Cardio	31			
					Gastro	31			
					Hemato	31			
					Musc/skel	31			
					Hepatic	31			
					Renal	31			
					Ocular	31			
					Endocr	31			

**Beryllium sulfate tetrahydrate  
Morgareidge et al. 1975**

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Figure key <sup>a</sup>	Species (strain) No./group	Exposure parameters	Doses (mg/kg/day)	Parameters monitored	Endpoint	NOAEL (mg/kg/day)	Less serious LOAEL (mg/kg/day)	Serious LOAEL (mg/kg/day)	Effects
11	Rat (Long-Evans) 52 M, 52 F	3.2 years (W)	M: 0, 0.6; F: 0, 0.7	BW, HP, BC, UR	Bd wt Resp Cardio Hepatic Renal Other noncancer	0.7 0.7 0.7 0.7 0.7 0.7			
<b>Beryllium sulfate Schroeder and Mitchener 1975a</b>									
12	Mouse (Swiss) 54 M, 54 F	898 days (W)	0, 1	BW, HP	Bd wt Resp Cardio Hemato Hepatic Renal	1 1 1 1 1 1			
<b>Beryllium sulfate Schroeder and Mitchener 1975b</b>									
13	Dog (Beagle) 5 M, 5 F	143–172 weeks (F)	M: 0, 0.02, 0.1, 1; F: 0, 0.03, 0.2, 1	BI, BC, BW, CS, HP, GN, OW, RX, DX	Bd wt Resp Cardio Gastro Hemato Musc/skel Hepatic Renal Dermal Ocular Endocr	1 1 1 1 1 1 1 1 1 1 1			

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Species	Figure (strain) key <sup>a</sup>	Exposure No./group parameters	Doses (mg/kg/day)	Parameters monitored	Endpoint	NOAEL (mg/kg/day)	Less serious	Serious	Effects
							LOAEL (mg/kg/day)	LOAEL (mg/kg/day)	
					Repro	1			
					Develop	1			

**Beryllium sulfate tetrahydrate**  
**Morgareidge et al. 1976**

<sup>a</sup>The number corresponds to entries in Figure 2-3; differences in levels of health effects and cancer effects between male and females are not indicated in Figure 2-3. Where such differences exist, only the levels of effect for the most sensitive sex are presented.

BC = blood chemistry; Bd wt or BW = body weight; BI = biochemical changes; CAT = catalase enzyme; Cardio = cardiovascular; CS = clinical signs; Develop = developmental; DX = developmental toxicity; Endocr = endocrine; (F) = feed; F = female(s); FI = food intake; Gastro = gastrointestinal; GN = gross necropsy; (GO) = gavage in oil vehicle; GSH = glutathione; (GW) = gavage with aqueous vehicle; HE = hematology; Hemato = hematological; HP = histopathological; LE = lethality; LOAEL = lowest-observed-adverse-effect level; LD<sub>50</sub> = lethal dose, 50% kill; LDH = lactate dehydrogenase; M = male(s); MDA = malondialdehyde; Musc/skel = muscular/skeletal; Neuro = neurological; NOAEL = no-observed-adverse-effect level; NS = not specified; OW = organ weight; Repro = reproductive; Resp = respiratory; RNA = ribonucleic acid; RX = reproductive function; SOD = superoxide dismutase; UR = urinalysis; (W) = drinking water; WI = water intake