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| Pulmonary Toxicity of SWCNT | | | | | | | |
| Year | Author | **Title** | animal |  | Dose | Key Effects | Comments |
| 2004 | Lam | *Pulmonary Toxicity of SWCNTs in Mice 7 and 90 Days After Intratracheal Instillation* | mouse | Intratracheal Instillation | 0, 0.1, 0.5 mg | **ALL nanotube products** induced dose-dependent epithelioid granulomas and, in some cases, interstitial inflammation |  |
| 2011 | Park | *A single intratracheal instillation of single-walled carbon nanotubes induced early lung fibrosis and subchronic tissue damage in mice* | mouse | Intratracheal Instillation | 100 µg/kg | early lung **fibrosis** and subchronic tissue damage; p53 |  |
| 2011 | Chang | *Epithelial-mesenchymal transition contributes to SWCNT-induced pulmonary fibrosis* | mouse | Intratracheal  Instillation | 80 µg | pulmonary epithelial and mesenchymal injury, followed by granulomatous and **fibrotic** changes. |  |
| 2016 | Park | *Single-walled carbon nanotubes disturbed the immune and metabolic regulation function 13-weeks after a single intratracheal instillation* | mouse | Intratracheal instillation | 50, 100, and **200** μg/kg | Disturbed immune and metabolic regulation functions |  |
| 2011 | Zhang | *Functionalized single-walled carbon nanotubes cause reversible acute lung injury and induce fibrosis in mice* | mouse | Instillation | .06,.2, **0.6, 2, and 10 mg/kg** | some f-SWCNTs could induce acute lung injury (ALI) in mice via proinflammatory cytokine storm signaling through the NF-κB pathway in vivo.. corticosteroid treatments could ameliorate the ALI induced by the f-SWCNTs in mice. … the ALI was almost completely reversed within 14 days, while mild to moderate **fibrosis**, granuloma, and DNA damage remained in the mice at day 14. |  |
| 2011 | Teeguarden | *Comparative Proteomics and Pulmonary Toxicity of Instilled Single-Walled Carbon Nanotubes, Crocidolite Asbestos, and Ultrafine Carbon Black in Mice* | mouse | Pharyngeal aspiration | 40 µg | Histologically, the incidence and severity of inflammatory and **fibrotic** responses were greatest in mice treated with SWCNTs. |  |
| 2005 | Shvedova | *Unusual inflammatory and fibrogenic pulmonary responses to single-walled carbon nanotubes in mice* | mouse | Pharyngeal aspiration | 0, 10, 20, 40 µg | A rapid progressive fibrosis found in mice exhibited two distinct morphologies: 1) SWCNT-induced granulomas mainly associated with hypertrophied epithelial cells surrounding SWCNT aggregates and 2) diffuse interstitial **fibrosis** and alveolar wall thickening likely associated with dispersed SWCNT.  \*dose dependent, see study charts |  |
| 2007 | Mercer | *Alteration of deposition pattern and pulmonary response as a result of improved dispersion of aspirated SWCNTs in a mouse model* | mouse | Pharyngeal aspiration | 10 µg | dispersed SWCNT are rapidly incorporated into the alveolar interstitium and they produce an increase in collagen deposition. |  |
| 2012 | Murray | *Factoring-in agglomeration of carbon nanotubes and nanofibers for better prediction of their toxicity versus asbestos* | mouse | Pharyngeal aspiration | 40 µg | local inflammatory and **fibrogenic** responses were accompanied by modified systemic immunity, as documented by decreased proliferation of splenic T cells ex vivo on day 28 post exposure. |  |
| 2013 | Shvedova | *Long-term effects of carbon containing engineered nanomaterials and asbestos in the lung: one year postexposure comparisons* | mouse | pharyngeal  aspiration | 40 µg | SWCNT were the most **fibrogenic** of these three particles. SWCNT induced cytogenetic alterations seen as micronuclei formation and nuclear protrusions in vivo. Inhalation exposure to SWCNT showed significantly greater inflammatory, fibrotic, and genotoxic effects than bolus pharyngeal aspiration; oncogene mutations |  |
| 2008 | Shvedova | *Inhalation vs. aspiration of single-walled carbon nanotubes in C57BL/6 mice: inflammation, fibrosis, oxidative stress, and mutagenesis* | mouse | Inhalation/  Pharyngeal aspiration | **5mg/m3**/  **5-20 µg** | SWCNT inhalation was more effective than aspiration in causing inflammatory response, oxidative stress, collagen deposition, and **fibrosis** as well as mutations of K-ras gene locus |  |
| 2007 | Li | *Cardiovascular Effects of Pulmonary Exposure to Single-Wall Carbon Nanotubes* | mouse | Intrapharyngeal instillation | 20 µg |  |  |
| 2011 | Kobayashi | *Pulmonary and systemic responses of highly pure and well-dispersed SWCNTs after intratracheal instillation in rats* | rat | Intratracheal instillation | .04, .2, 1, 2mg/kg | inflammatory responses related with the vital reaction to the foreign substance that was instilled intratracheally, and there were **no fibrosis**, atypical lesion, or tumor-related findings even at the highest dose (2mg/kg) |  |
| 2015 | Fujita | *Size effects of single-walled carbon nanotubes on in vivo and in vitro pulmonary toxicity* | rat | Intratracheal Instillation+ | 0.18 mg/kg,  1.8 mg/kg | Numerous genes were significantly upregulated or downregulated |  |
| 2017 | Ema | *Length effects of single-walled carbon nanotubes on pulmonary toxicity after intratracheal instillation in rats* | rat | Intratracheal instillation | 1 mg/kg | BALF, lung injury, inflammation |  |
| 2017 | Honda | *A 104-week pulmonary toxicity assessment of long and short single-wall carbon nanotubes after a single intratracheal instillation in rats* | rat | Intratracheal instillation | .2,1 mg/kg | Inflammatory changes, test substance deposition, test substance engulfment by macrophages, and alveolar wall **fibrosis** |  |
| 2012 | Morimoto | *Pulmonary toxicity of well-dispersed single-wall carbon nanotubes after inhalation* | rat | Inhalation | .03,.13 mg/m3 | **no increases** of total cell or neutrophil counts in the bronchoalveolar lavage fluid (BALF), or the concentration of cytokine-induced neutrophil chemoattractant in the lungs or BALF in both the high and low concentration-exposed groups. Pulmonary infiltration of neutrophils was not observed in either exposed group throughout the observation period. Well-dispersed SWCNT did not induce neutrophil inflammation in the lung |  |
| 2016 | Ema | *Review of toxicity studies of single-walled carbon nanotubes in animals* | In vivo | review |  |  |  |
| 2015 | Khaliullin | *In vitro toxic effects of different types of carbon nanotubes* | in vitro |  |  | SWCNTs caused a significant decrease in viability and induction of oxidative stress. |  |
| 2011 | Pacurari | *Raw single-walled carbon nanotube-induced cytotoxic effects in human bronchial epithelial cells: comparison to asbestos* | In vitro |  |  |  |  |
| 2011 | Wang | *Carbon Nanotubes Induce Malignant Transformation and Tumorigenesis of Human Lung Epithelial Cells* | in vitro |  |  |  |  |
| 2021 | Wang | *Postchronic Single-Walled Carbon Nanotube Exposure Causes Irreversible Malignant Transformation of Human Bronchial Epithelial Cells through DNA Methylation Changes* | in vitro |  |  |  |  |
| 2015 | Sturm | *Nanotubes in the human respiratory tract – Deposition modeling* | modeled |  |  | accumulated in sensitive lung regions with higher doses than MWCNT. |  |