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Pulmonary disease due to nanoparticles exposure

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Introduction

The fourth industrial revolution has already begun as a result of robotics, nanotechnology, biotechnology, information technology and artificial intelligence convergence. We do not still completely know the possible pulmonary effects that nanoparticles (NP) exposure could cause in humans. The aim of this study is to synthesize the available scientific evidence, from 2012 to 2017, about pulmonary toxic effects in humans exposed to NP.

Materials and Method

- A systematic review about the literature of the articles published between 2012-2017 in the PUBMED, Medline, LILACS, Web of Science, Cochrane Library and gray literature databases was made.
- MeSH terms were: nanoparticles AND ("lung disease" OR "pulmonary disease" OR "pulmonary effects" OR "lung toxicity" OR "pulmonary toxicity") NOT therapy.
- We included scientific articles with results in humans and full text (figure 1).

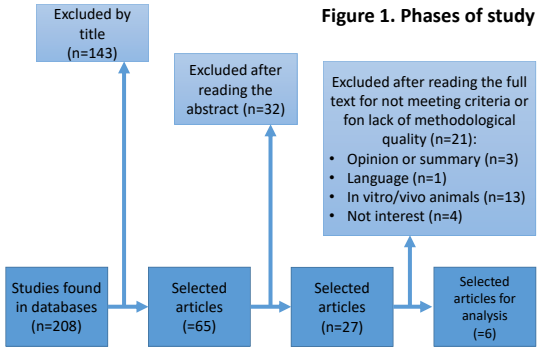

Figure 1. Phases of study

Results and Discussion

This is the first study that synthesizes the existing of scientific evidence regarding pulmonary pathology related to NP exposure in humans (2012-2017).

- Association between lung disease and NP exposure in humans has been observed.
- Several articles (table 1) agree that exposure to nanoparticles causes respiratory alterations: inflammation, restrictive functional pattern and radiological images (fibrosis, granulomas, consolidation, etc.), which can lead to respiratory failure and even death.

Table 1. Characteristics of selected scientific studies: pulmonary effects due to NP exposure in humans (2012-2017)

AUTHORS YEAR	TYPE OF NP	NP FORM	EXPOSURE MECHANISM		PULMONARY EFFECTS		
			INTENSITY	DURATION	ANATOMO-PATHOLOGICAL	RADIOLOGY	PULMONARY FUNCTION
Ferreira et al. 2012	Poliacrilate ester NP SiO2, TiO2, ZnO, nanosilver		8 workers of printing plant (adhesive, paint and decoration). 8-12hrs / day exposure	5 months	Nonspecific lung inflammation, fibrosis and pleural granulomas. BALF: ↓ macrophages, ↑ leukocytes lymphocytes, neutrophils and eosinophils. NP 30nmØ in pleural fluid.		Dyspnea, pleural and pericardial effusion. Severe restrictive pattern (CVF 24.8-35.4%, FEV1 24.8-36.5%). 1 moderate (FVC 61.3%; FEV1 63.4%). Respiratory failure and death of 2 workers.
Cheng et al. 2012	Carbon nanotube (CNT) Nano-TiO2 & nano-SiO2	NT	A 58-year-old worker exposed to polyester powder paint.	3 months	Lung biopsy: opacity and birefringence, macrophages, NP Silica, aluminum silicates, titanium dioxide, talc and rails. Granulation tissue filling the alveolar ducts and alveols. Chronic inflammation in the surrounding parenchyma. Eosinophilic pneumonia. CNT in 3 patients. Electron microscopy: titanium dioxide and silica.	RX: irregular air frames, infiltrated. HRCT: areas of airspace consolidation and opacity.	Bronchiolitis obliterans organized as pneumonia
Zhang et al. 2014	Carbon black (CB)	Tridimensional nanostructure (30-50nm)	Average concentration of CB in exposed air: 14.90 mg / m3 (almost 4.26 times higher than the VLA). There are local exhaust ventilation systems. Unlikely use of masks.		↑ interleukin 1β, IL-IL-8, inflammatory protein of macrophages-1β (MIP-1β) and tumor necrosis factor α (TNF-α) in the exposure group (P <0.05). .	No radiological changes are observed	Exposed: significant reduction in FEV1%, FEV1 / CVF, PEF%, MMF%. The level of CVF% was not significantly different between exposure group and control group. No significant differences between FEV1% and MMF% in smokers.
Wu WT et al. 2014	CNT, Nano-TiO2, Nano-SiO2, nano Ag	NT	Nanotechnology plant workers. Nano-TiO2.				The group exposed to Nano-TiO2 group had significantly higher levels of fractional exhaled nitric oxide (FENO). Even more in workers with asthma or allergic rinitis.
Andujar et al. 2014	NP metálicas: Fe2O3, Fe3O4, MnFe2O4 y CrOOH	NP chain type	Welders exhibition: complex of gases (carbon monoxide, ozone) and dangerous metal fumes. Up to 11% of the total mass, and 80% of the total number of particles emitted in the welding fumes are NP.	27 years average exposure	Macrophages in alveolar lumen and in fibrous regions. Significant overload of iron (Fe), manganese (Mn), chrome (Cr) and titanium (Ti) in some lung tissue sections. ↑ macrophages in alveolar light and in areas of fibrosis, neutrophils, lymphocytes.	X-ray micro-fluorescence: increase of sulfur and iron ratio in welders.	Several adverse respiratory outcomes have been described in welders, among whom inflammation and pulmonary remodeling are largely described
Liao et al. 2014	UFP Nanosilver Fe2O3, CNT, Nano-TiO2, Nano-SiO2	NT	Workers handling nanomaterials Average exposure of 2.43 times / week and 2.69 hours / time.	6 months follow up			↓ Maximum expiratory flow medium and forced expiratory flow to 25% between the start and follow-up at 6 months in exposed > than in the control group. Damage markers (CC16 and lung function) associated with handling nanomaterials.

Conclusions

Nanotechnology is currently in expansion. There are very few publications that study the relationship between occupational exposure to NP and the occurrence of pulmonary health damage in humans. It is essential to know more about the toxicological effects of NPs to address the growing concern about potentially harmful exposures for both the general population and the working population. The multidisciplinary approach among physicians of Occupational Medicine, Radiology, Pulmonologists and Prevention Technicians as well as education campaigns could minimize the possible occupational diseases derived from risks whose damage is not still known today.