



Statens  
arbeidsmiljøinstitutt

*Creates, utilizes and  
distributes knowledge  
on work and health*

# Possible health risks from bioaerosol exposure in the oil industry

**Kari Kulvik Heldal**  
**National Institute of Occupational Health**

**Stami**

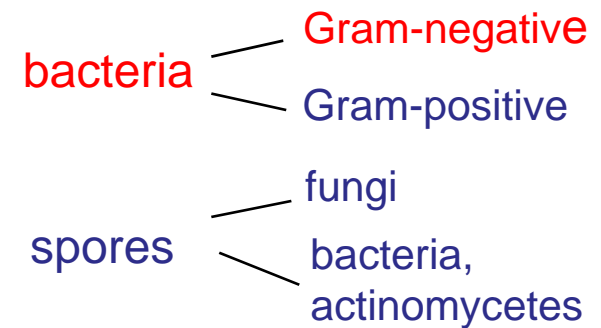




- Bioaerosol definition and health effects
- Bioaerosols and respiratory diseases in oil-related industry – a literature search
- The same risk of microbial exposure from contaminated oil-water systems in the oil industry?



- pathogenic or non-pathogenic
- live or dead microorganisms



- microbial components

endotoxins  
mycotoxins  
allergens

- fragments of animals and plants



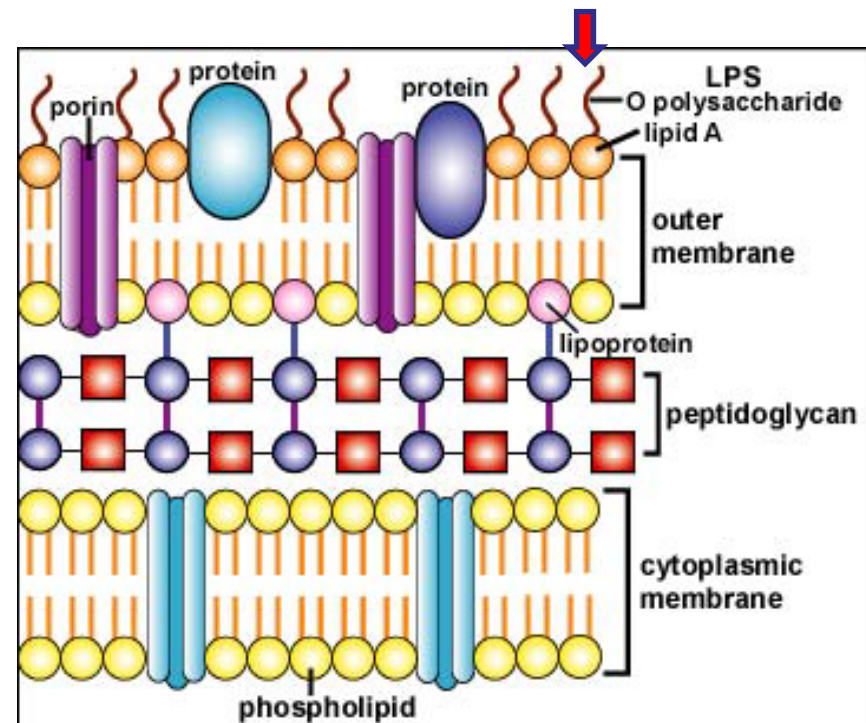
## Respiratory symptoms

- non-allergic respiratory symptoms
  - irritation in the airways
  - non-allergic asthma
  - ODTS – toxic pneumonitis
    - fever, influenza like symptoms
  - chronic bronchitis, airway obstruction (COPD)
- allergic airway symptoms
  - allergic asthma
  - hypersensitivity pneumonitis
- infectious diseases



## Important causal factor of respiratory diseases

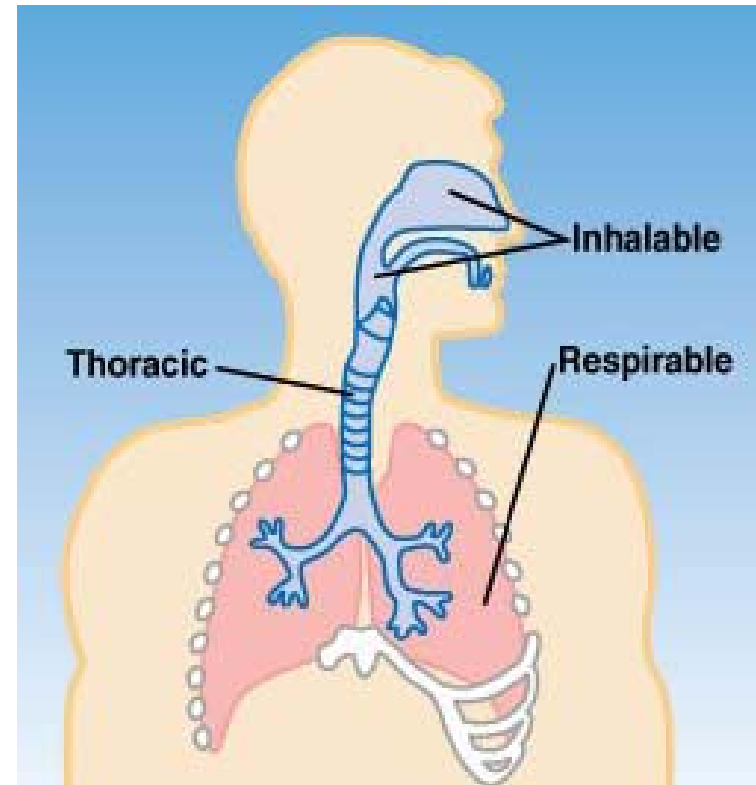
- Endotoxin is a lipopolysaccharide (LPS), lipid A the toxic part of the molecule
- Cell wall component in Gram-negative bacteria with strong inflammatory properties
- Biological active in cell fragments, live or dead bacteria
- Stable up to 300 °C
- Coats small oil-droplets in aerosols
- Present in aerosols from contaminated metal working fluid (MWF) in the metal machining industries





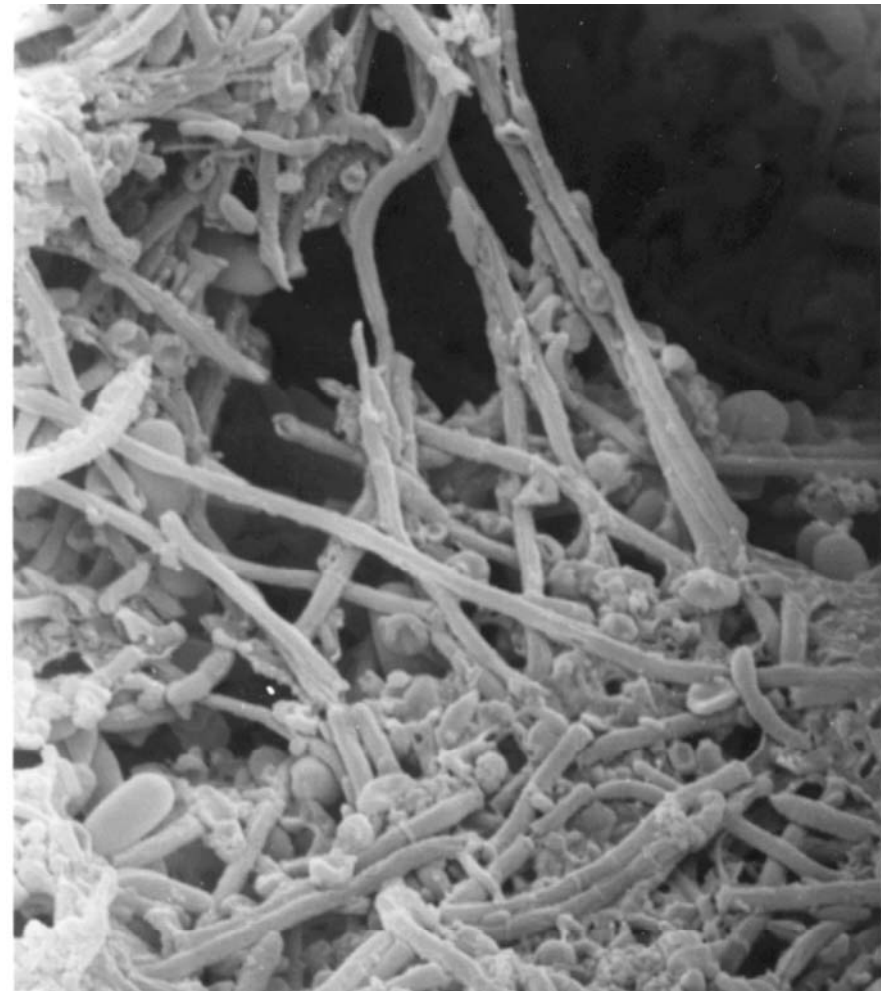
## Exposure to bioaerosols

- **Airways**      **Inhalation**
- **Oral**         **Direct contact,  
dirty hands,  
swallowing of  
particles**
- **Skin**         **Cuts, wounds**





- Metal working fluid – MWF
  - Straight
  - Soluble
  - Synthetic and semi-synthetic
- Drilling fluid – DF special for the oil industry
  - Water-based fluids
    - Freshwater
    - Seawater
  - Non-aqueous fluid
    - High aromatic content (5-35 crude oil)
    - Medium-aromatic content (0.5-5% crude oil)
    - Low/negligible aromatic content fluid (<0.5%)



Microorganisms in biofilm



- Oil mists
- Vapors
- Chemical additives
- Metallic fines
- Bioaerosols





Agents	Level		Reference
	8h TWA	12h TWA	
Oil mist (mg/m <sup>3</sup> )	<b>1</b>	<b>0.6</b>	Administrative norm on the Norwegian Continental Shelf
	<b>5</b>		USA (ACGIH) UK (NIOSH)
Oil vapor (mg/m <sup>3</sup> )	<b>50</b>	<b>0.30</b>	Administrative norm on the Norwegian Continental Shelf



	Level	Type	Reference
<b>Endotoxin</b> (EU/m <sup>3</sup> )	<b>200</b>	Occupational exposure limit	Netherland Health Council, 2002
<b>Endotoxin</b> (EU/m <sup>3</sup> )	<b>100</b>	NOEL: lung function	Castellan et al., 1987
	<b>1000</b>	systemic complaints	Rylander 1994
	<b>2000</b>	ODTS symptoms	Douwes et al., 1997



Among workers exposed to oil mist from MWF

- Respiratory symptoms

- Acute and more permanent changes in lung function
  - Zeha, Eisen et al., 2001
- Work-related asthma, cough, chronic bronchitis
  - Jarvholm et al., 1982, Kennedy et al., 1989, Ameille et al., 1995, Greaves et al., 1997, Rosenman, 2009
- ODTS (toxic pneumonia), fever reactions
  - Rosenman, 2009
- Hypersensitive pneumonitis (*Mycobacterium Immunogenum*)
  - Meredith et al., 1994, Freemann et al., 1998, Zacharisen et al., 1998, Hodgons et al., 2001, Weiss et al., 2002



## Experimental animal studies reviewed by Gordon (2004)

- Pulmonary effects observed after acute exposure to used MWF, but not to the same unused MWF
- The lung inflammation associated with the endotoxin concentration in the fluid
  - Thorne & DeKoster, 1996, Gordon et al., 1992, 1999
- Other components can contribute to the toxicity of used MWF
  - Schaper et al., 1991, 1995, 1999
- The majority of evidence strongly suggests that the microbial contaminants may play the greatest role in adverse respiratory effects in used MWF aerosols



Among workers exposed to oil mist in the oil industry

- Respiratory symptoms
  - Irritation in the airways, cough
    - Eide, 1990
  - Lung fibrosis
    - Skyberg et al., 1986, 1992



Analyte	Number	Mean	Median	Range
Mineral oil total particles (mg/m <sup>3</sup> )	45	1.11	0.55	0.06-4.38
Mineral oil mist (mg/m <sup>3</sup> )	40	<b>1.23</b>	0.78	0.03- <b>3.74</b>
Water-mix total particles (mg/m <sup>3</sup> )	296	0.67	0.32	<0.04-23.06
Water-mix MWF mist (mg/m <sup>3</sup> )	298	0.35	0.12	<0.01- <b>13.2</b>
<b>Airborne endotoxins (EU/m<sup>3</sup>)</b>	141	<b>683</b>	98	<b>0.02-28794</b>

Simpson et al., 2003

**Exposure from mineral oil and water mixed MWF assessed during different work operation in 24 representative sites of the engineering industry in UK**



- Microbial contamination appear to be an important contributors to airway symptoms among workers handling oil-water emulsions in the metal working industry.
- Few studies have addressed the exposure to endotoxins or other bioaerosol components as potential cause of reported respiratory symptoms in the oil industry
- Future epidemiological research will be important to elucidate the role of bioaerosol exposure and possible relation to biofilm
- Exposure studies are needed to indentify exposure factors in oil aerosols and levels which can be used in effective workplace controls