

Diseases associated with Metalworking fluid (MWF) exposure

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Topics Covered

- Potential causative agents of disease associated with MWF exposure
- Diseases associated with MWF exposure
- History of respiratory disease associated with MWF
- Dermatitis
- Extrinsic Allergic Alveolitis (EAA)/Hypersensitivity Pneumonitis
- Occupational Asthma
- Cancer & MWF Exposure
- Factors increasing the risk of respiratory disease
- Case study
- Conclusions

Diseases Associated with MWF

Extrinsic allergic
alveolitis (EAA)
(Hypersensitivity
Pneumonitis)

Dermatitis

Occupational
Asthma

Cancer

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Potential Causative Agents

- It should be noted that there is no clear causative agent associated with MWF induced Extrinsic Allergic Alveolitis (EAA); also known as Hypersensitivity Pneumonitis (HP).
- Disease is thought to occur via exposure to MWF which has been poorly maintained and as a consequence biologically contaminated
- There are many potential causative agents of disease, a few of which are listed below:
 1. Bacteria and fungi
 2. Endotoxins
 3. Mycobacteria

Biological Contaminants

- Pseudomonas is the most common genus of bacteria found in MWF.
- All species of the pseudomonas genus are gram negative and are able to produce endotoxins with adverse health effects.
- Mycobacteria, which include *M.chelonae*, *M.immunogenum* and *M. avium* are common in MWF's.
- Mycobacteria are opportunistic pathogens and can cause EAA in people who are exposed to MWF aerosol.
- Fungi, both mould and yeast are commonly occurring in MWF.
- Fungi are associated with EEA, Occupational Asthma (OA) and other allergies.

Biological Contaminants

- High water content, minerals, hydrocarbons and other organic substances i.e. nitrate and phosphates helps microorganisms to grow in MWF (Cyproski et al 2007).
- Bacteria and fungi are commonly detected in used MWF. The type and quantity of microorganisms may vary considerably (Gilbert et al 2010; Loddors & Kampfer 2012).
- Some microorganisms may be pathogenic to humans (Perkins & Angenent 2010).
- Some groups are thought to express antigens causative in the pathogenesis of EEA & OA

Mycobacterial Contamination

- Non-tuberculous mycobacteria (NTM) are generally found in a variety of water sources that include fresh and potable sources (Nishiuchi et al 2017)
- MWF associated mycobacteria have been implicated in the development of EAA. (Khan, Selvaraju & Yadav 2005)
- Mycobacteria are hydrophobic and regularly form biofilms on the surfaces of machining tools.
- Fox et al 1999 conducted a case-control investigation of 34 reported cases of clinically diagnosed EAA amongst machine workers in the UK

Endotoxins

- Endotoxins have been implicated in the development of respiratory symptoms via exposure to MWF mist.
- They are components of gram negative bacterial cell walls, that are released once a cell dies, or during their growth and division (Gorbet & Sefton 2005).
- Some of the reported respiratory symptoms in machinists such as cough, bronchitis and fever are consistent with the effects associated with endotoxins (Liebers et al 2008).
- The increased mobility of endotoxins, in addition to their small size, increases their surface area, thus making them readily inhalable (Thorne et al 2006).

Endotoxins

- Epidemiological studies have attempted to determine the role of endotoxins in EAA and OA.
- Lim et al 2005 demonstrated significant effects in mice after inhalation of MWF aerosols spiked with endotoxins at 10mgm^{-3} for 6 hours a day, 3 days a week for 3 weeks.
- Results suggested that lung inflammation may be immediately induced by exposure to endotoxins in MWF.

Diseases Associated with MWF Exposure

- Occupational Asthma (OA)
- Extrinsic Allergic Alveolitis (EAA) (Hypersensitivity Pneumonitis)
- Dermatitis
- Chronic bronchitis
- Impaired lung function
- Respiratory tract infection

Dermatitis

- Inflammation of the skin is a common condition seen in machinists (Barber et al 2016).
- Irritant reaction to the constant wetting of the operator's skin from splashes and spray of MWF from the machine.
- Factors such as alkaline pH and bacterial contamination have been established as the cause of dermatitis (Barber et al 2016)
- Reducing the risk of dermal exposure involves wearing nitrile gloves and improving hygiene in the workplace (COSHH MW2)
- Between 1996 – 2007, 666 cases of contact dermatitis reported to EPIDERM
- Between 1997- 2007, occupational physicians reported 92 actual cases of work-related contact dermatitis attributed to MWF.
- Frequently reported industries were manufacture of metal components, motor vehicles and trailers.
- Dermatitis is reportable through RIDDOR; however, this is not the case for HP.

History of Disease Associated with MWF

- In 1983, Hendy et al described one of the first reported cases of Occupational Asthma secondary to MWF in the UK.
- In 1995, Bernstein et al first described the potential of MWF to cause EAA. They reported a case series of 6 workers from an automobile manufacturing site.
- In 1998, Robertson et al wrote a case series of 25 patients occupationally exposed to MWFs and who had been referred to an occupational respiratory clinic with work-related asthmatic symptoms.

Extrinsic Allergic Alveolitis (EAA)

- Also referred to as hypersensitivity pneumonitis (HP).
- First described in the early 20th century in farmers exposed to mouldy hay or straw (Farmer's Lung).
- EAA can be described as an allergic reaction that occurs in the gas exchange region of the lungs (alveoli).
- Can be acute or chronic.
- Results in shortness of breath, cough and flu-like symptoms.
- For acute-EAA, symptoms can develop within 6 – 8 hours of exposure to high concentrations of the antigen.

Extrinsic Allergic Alveolitis (EAA)

- OHP cases in MWF machinists have steadily increased in the UK and other countries in the last few decades (Barber et al 2016).
- However, exposure to MWF is now considered the most commonly suspected cause of EAA (SWORD).
- EAA has been a prescribed disease since 1964 for Farmer's lung.
- Barber et al noted that workers exposed to MWF are at risk of developing EAA, OA and bronchitis.

Hypersensitivity Pneumonitis (HP)



Contents lists available at [ScienceDirect](#)

Respiratory Medicine

journal homepage: www.elsevier.com/locate/rmed

Characteristics of hypersensitivity pneumonitis diagnosed by interstitial and occupational lung disease multi-disciplinary team consensus

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Walters et al June 2019

- Retrospective cross-sectional study, patient data was collected for all 206 cases of HP diagnosed within UK-based regional NHS interstitial and occupational lung disease service between 2002-2017.
- There were 206 cases in total comprising 125 (61%) definite HP & 81 (39%) probable HP.
- MWF identified as causative agent for 36 cases (17%).
- Workers presented with more acute/subacute features and less fibrosis in CT.
- MWF workers often develop HP that is initially mistaken for sarcoidosis. It is therefore important to identify the aetiologic agent in these cases.
- Refuse work has been identified as an emerging cause of HP.

Occupational Asthma (OA)

- Characterised by variable airflow obstruction, airway hyper-responsiveness and inflammation attributable to exposure to workplace hazards.
- Symptoms include episodes of coughing, wheezing, chest tightness and shortness of breath.
- Symptoms typically worsen at work and reduce away from work.
- There have been reports of OA described in machine operators after exposure to a number of MWF components (Robertson et al 1998; Malo 2005; Suuronen et al 2007).
- However, diagnosis of OA has been based on reports of asthma-like symptoms and only a few have included clinical investigations (Hannu et al 2013).

Occupational Asthma (OA)

- In 2019, there were an estimated 198 new cases of OA reported by doctors participating in the SWORD scheme within the THOR network.
- Statistical analysis suggest an increase in the rate of new cases per year over recent years up to 2019.
- The overall occupational asthma incidence was 0.56 cases per 100,000 workers per years during the period, 2017 – 2019 in the UK
- For machine operatives' 2.1 per 100,000 (higher than the average for all occupations)
- It is estimated that OA accounts for somewhere in the region of 9-16% of all new adult cases of asthma, making it the most frequently reported work-related airway disease in Britain.
- Occupational rhinitis and OA commonly occur together especially with high molecular weight sensitisers.

MWF & Cancer Risk

- Potential carcinogens in MWF include, PAHs, formaldehyde, nitrosamines, hydrocarbons, chlorinated paraffins & aliphatic amines.
- NIOSH conducted a comprehensive review of epidemiological studies that examined association between MWF and cancer.
- Substantial evidence was found for an increased risk of cancer at several sites (larynx, rectum, pancreas, skin, scrotum and bladder).
- Changes in MWF composition over several decades may not be sufficient to eliminate the cancer risks associated with MWF exposure.
- Therefore, a reduction in airborne MWF exposures are key to controlling the risk.

MWF & Cancer Risk

- IIAC identified bladder cancer and work involving exposure to mineral oils as a potential topic for review.
- In 2012, IARC classified untreated or mildly treated mineral oils as Group 1 (Established) human carcinogen.
- The Council's Research Working Group conducted a literature review focussing on research reports on bladder cancer and mineral oils.
- Account was also taken of two key reviews; Calvert et al and Tolbert.
- Overall, a number of published studies have shown excess risks of bladder cancer in workers exposed to cutting and lubricating oils and in machinists.
- Calvert et al concluded that there is substantial evidence for an increased of cancer at several sites including the bladder.
- Calvert et al reported a relative risk of 3.1 for machine tool operators with increased duration of exposure.
- Tolbert states a number of bladder cancer case-control studies have noted an association with work as a machinist.
- Hours et al found an elevated odds ratio (OR) of 2.6 for bladder cancer cases exposed to cutting fluids.
- Friesen et al concluded that increased bladder cancer risk was associated with straight metalworking fluids but not soluble or synthetic.
- Overall, these studies and others indicate a clear evidence that there is an increased risk of bladder cancer arising from occupational exposure to mineral oils; however, the relative risks are not consistently greater than doubled.

Factors increasing the risk of respiratory disease

- **Physical dispersion** – as spray droplets and mist due to the rotation of the tools and work pieces, particularly as the rotational speed is increased.
- **Splatter & atomisation** – induced by the pressurised delivery of the MWF above the rotating cutting head of the machine (Schwarz et al 2015)
- **Increased temperature** – of the lubricant at high machining rotational cutting speeds resulting in the evaporation of the water phase of the MWF.
- Wang et al 2005 demonstrated that increased microbial contamination of MWF doubled the concentration of mist.

Case study

- 45 year old man presented with 1 year history of cough, shortness of breath and fatigue.
- Non-smoker, no pets, no reported episodes of water damage or mould at his home.
- Worked at a school as a machine shop teacher.
- Symptoms showed mild improvement over the summer holidays
- Thoracoscopic biopsies were consistent with HP
- MWF used was over a year old.
- Air samples did not detect MWF in the school machine shop air.
- Culture of the MWF showed profuse growth of Pseudomonas

Conclusion

- The MWF market size in the UK is increasing with 390M litres in 2021 with a predicted CAGR of 2.08% equating 432M litres in 2026.
- This suggests an increase in the number of workers potentially exposed to MWF. MWFs can cause Extrinsic Allergic Alveolitis (EAA), Occupational Asthma (OA), Dermatitis and other conditions.
- The general awareness of the potential causative agents for respiratory disease relating to MWF exposure needs to be improved.
- An emphasis on management of MWF should be prioritised as a form of disease prevention.
- Training with regard to potential causative agents related types of disease needs to be established amongst duty holders.
- Diagnosis of HP and occupational asthma appears to be challenging and thus, causation cannot be established in some cases.
- Reporting schemes in the UK (SWORD) between 1996 – 2015 have illustrated that MWF is the most reported causative agent relating to hypersensitivity pneumonitis.
- Many ingredients in current MWF remain from earlier formulations, it is therefore reasonable to assume that some MWF carcinogenicity persists today.
- There is a vital role of primary prevention – preventing exposures before they cause disease.

Thank You

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