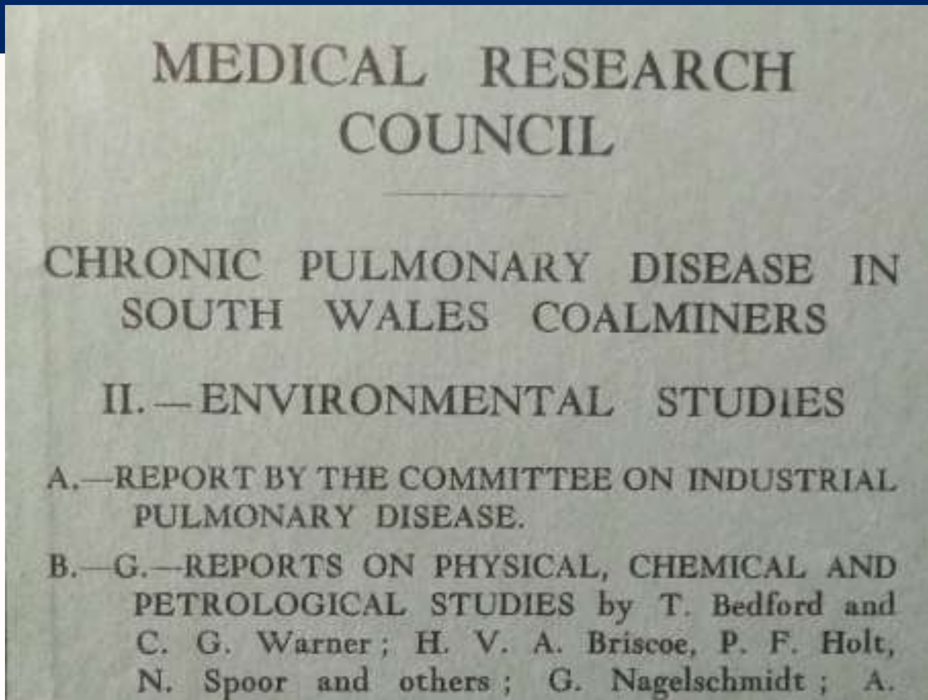
WORKING FOR A HEALTHY FUTURE

Occupational exposure limits for dusts

John Cherrie

Martie van Tongeren

Lang Tran

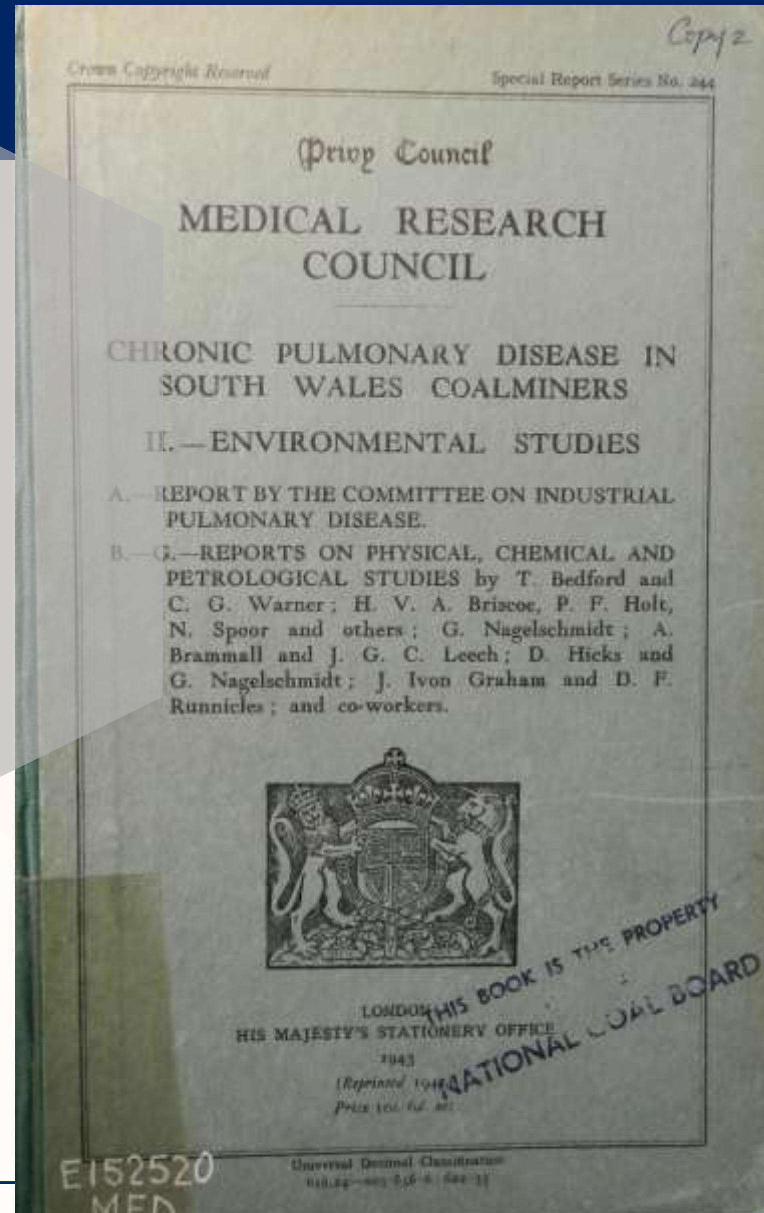

MEDICAL RESEARCH COUNCIL

CHRONIC PULMONARY DISEASE IN SOUTH WALES COALMINERS

II.—ENVIRONMENTAL STUDIES

A.—REPORT BY THE COMMITTEE ON INDUSTRIAL PULMONARY DISEASE.

B.—G.—REPORTS ON PHYSICAL, CHEMICAL AND PETROLOGICAL STUDIES by T. Bedford and C. G. Warner; H. V. A. Briscoe, P. F. Holt, N. Spoor and others; G. Nagelschmidt; A.


Copy 2

Special Report Series No. 244

Privy Council

MEDICAL RESEARCH COUNCIL

CHRONIC PULMONARY DISEASE IN SOUTH WALES COALMINERS

II.—ENVIRONMENTAL STUDIES

A.—REPORT BY THE COMMITTEE ON INDUSTRIAL PULMONARY DISEASE.

B.—G.—REPORTS ON PHYSICAL, CHEMICAL AND PETROLOGICAL STUDIES by T. Bedford and C. G. Warner; H. V. A. Briscoe, P. F. Holt, N. Spoor and others; G. Nagelschmidt; A. Brammall and J. G. C. Leech; D. Hicks and G. Nagelschmidt; J. Ivon Graham and D. F. Runnicles; and co-workers.

LONDON
HIS MAJESTY'S STATIONERY OFFICE
1943
(Reprinted 194[illegible])
Price 10s. 6d. net

Universal Decimal Classification

Summary…

- There has been a gradual realisation that exposure to most dusts can harm respiratory function
- The unifying factor may be the surface area and surface properties of the dust
- Even relatively low exposure to low-toxicity dust may cause adverse effects and current exposure limits are probably not protective
- Exposures are lower than in the past and so current exposure limits are not promoting change
- Many people are probably still exposed to dusts

COPD

- Chronic Obstructive Pulmonary Disease is characterised by progressive airflow obstruction and destruction of lung parenchyma
- It is caused by chronic exposure of genetically susceptible individuals to environmental factors
- It is associated with an enhanced chronic inflammatory response
- Smoking is an important cause, but about a quarter of COPD patients are non-smokers

Lung function assessments

- Symptoms of COPD include:
  - Dyspnea
  - Chronic cough
  - Chronic sputum production
- Episodes of acute worsening of these symptoms (exacerbations) often occur
- Spirometry used to make a clinical diagnosis
  - the presence of a post-bronchodilator FEV1/FVC < 0.70.
  - “Mild” if FEV1 ≥ 80% predicted
  - “Moderate” if 50% ≤ FEV1 < 80% predicted

HSE says…

- Work related COPD is a priority because of the human costs in terms of suffering, its effects on the quality of life and the financial costs due to working days lost and medical treatment.
  - Around 15% of COPD may be caused or made worse by dusts, fumes and irritating gases at work
  - 4,000 COPD deaths every year may be related to work exposures
  - 40% of COPD patients are below retirement age
  - A quarter of those with COPD below retirement age are unable to work at all

“Inert” or nuisance particulates

- Threshold Limit Values (TLVs) 1969
  - Published by Department of Employment as Technical Data Note 2/69
- TLV = 15 mg/m^3 or 50 mppcf of total dust <1% crystalline silica
- “*… a number of dusts or particulates that occur in the working environment ordinarily produce no specific effects upon prolonged inhalation.*”

Nuisance particulate

- By 1974 limit reduced
- TLV 10 mg/m^3 or 30 mppcf, <1% crystalline silica
- "*… when inhaled in excessive amounts, so called 'nuisance' dusts have a long history of little adverse effect on the lungs and do not produce significant organic disease or toxic effect when exposure is kept under reasonable control.*"
- By 1980 TLV was…
- 30 mppcf or 10 mg/m^3 of total dust <1% quartz or 5 mg/m^3 of respirable dust

IOM

Dust, not otherwise specified

- 1984 HSE publish Guidance Note EH40, Occupational Exposure Limits
- Recommended Limit of 10 mg/m^3 of total dust or 5 mg/m^3 of respirable dust.

COSHH Regulations

- From 1988 the definition of a “substance hazardous to health” included dust of any kind…present at a concentration in air greater than
  - 10 mg/m^3, as a time-weighted average over an 8-hours, of total inhalable dust,
  - 5 mg/m^3, as a time-weighted average over an 8-hours, of respirable dust
- From 1997 revised sampling criteria for respirable dust and the “limit” was reduced from 5 mg/m^3 to 4 mg/m^3

Low toxicity dusts

- Do NOT include: quartz, asbestos or toxic metals
- Could include: amorphous silica, silicon, silicon carbide, pulverised fuel ash, limestone, gypsum, graphite, aluminium oxide, titanium dioxide, coal dust, other mineral dusts with low crystalline silica content, etc

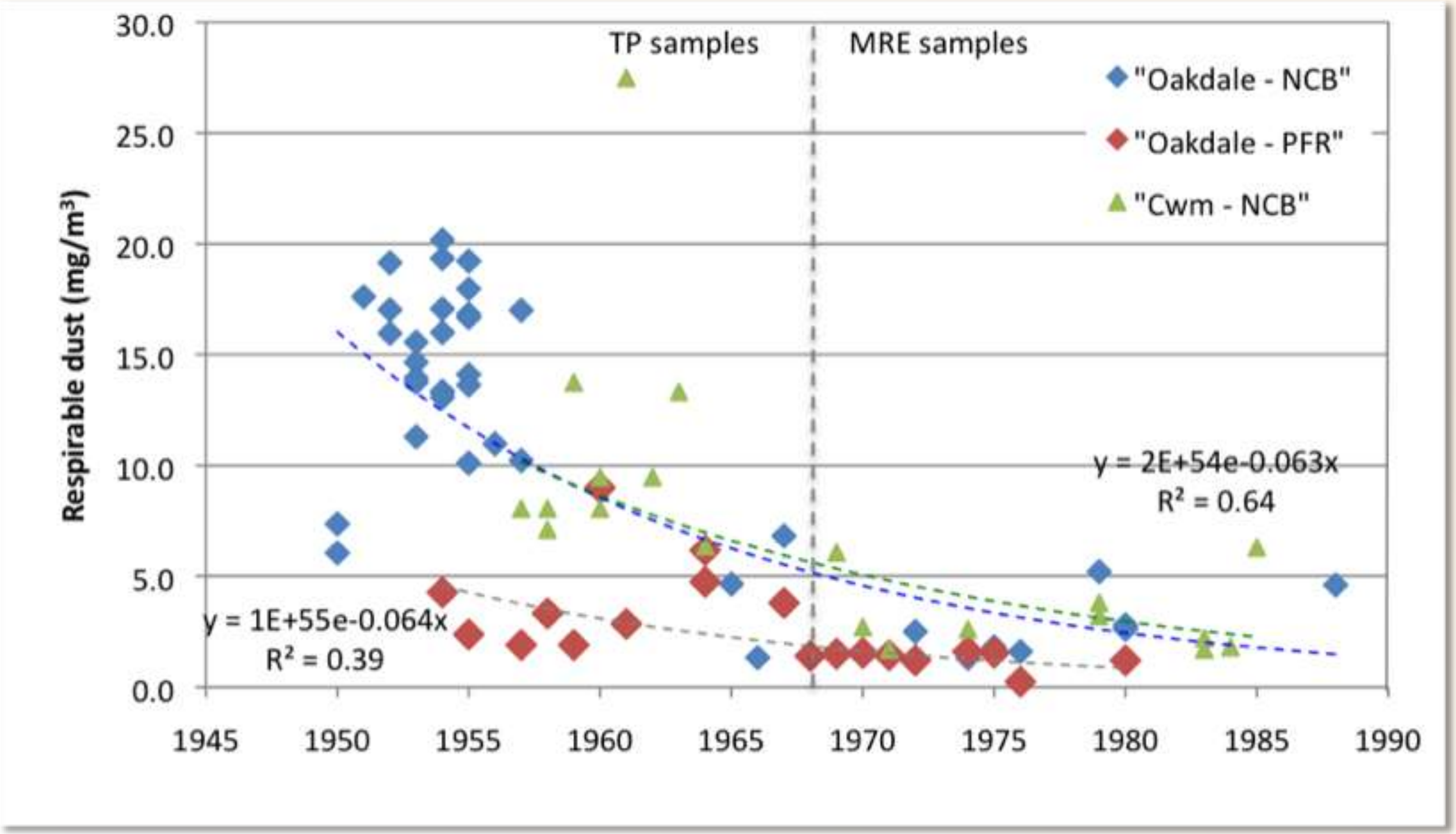
Past exposure to dust

- In British coal mines in the 1940s dust levels could be very high

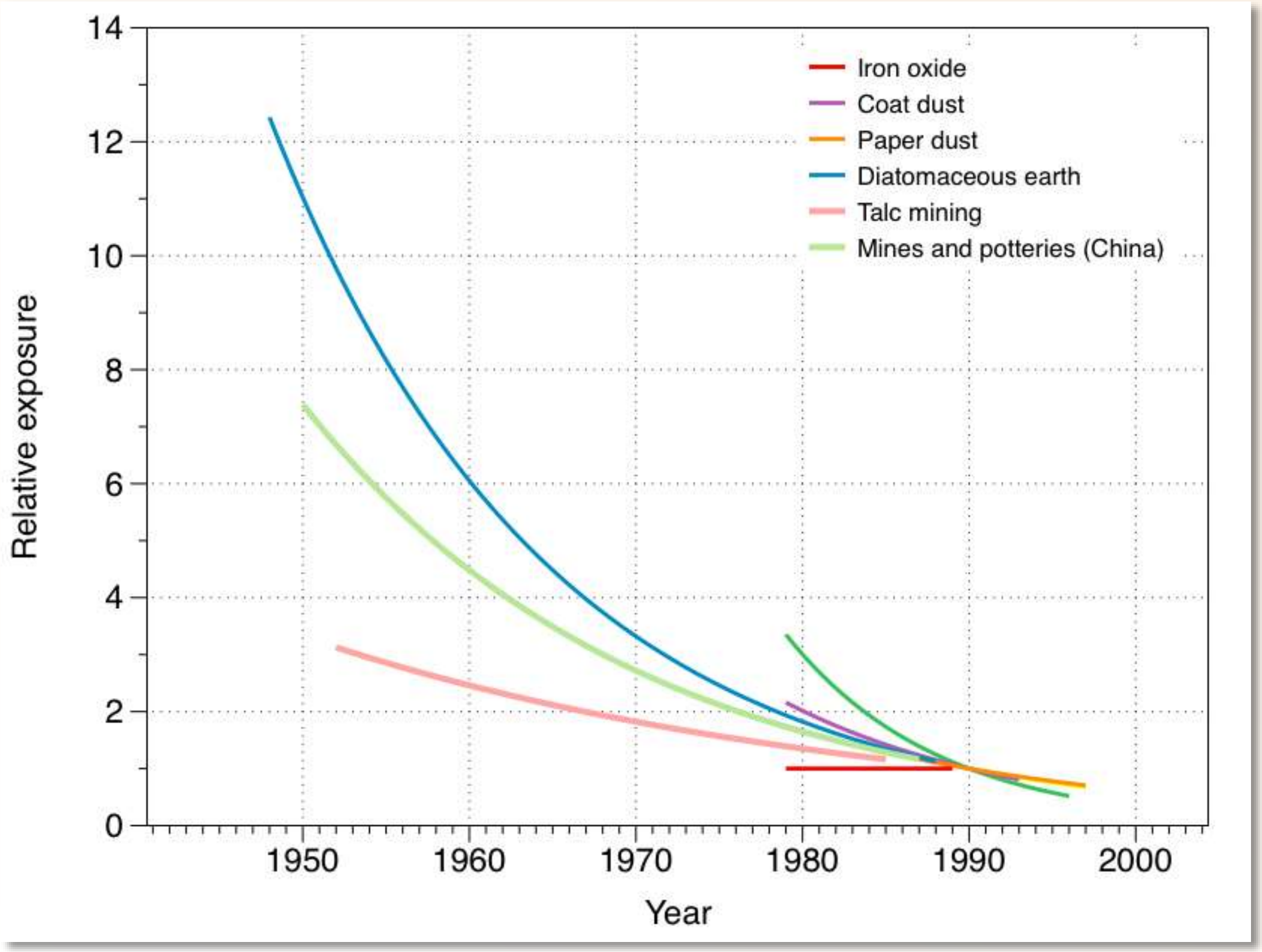
	Total (mg/m^3)	Respirable (mg/m^3)
Longwall stalls	394	14
Narrow places	215	20

Bedford and Warner (1943) Chronic pulmonary disease in South Wales coalminers – II Environmental studies. London: HMSO.

Exposures decreased over time



Exposure decreases over time…

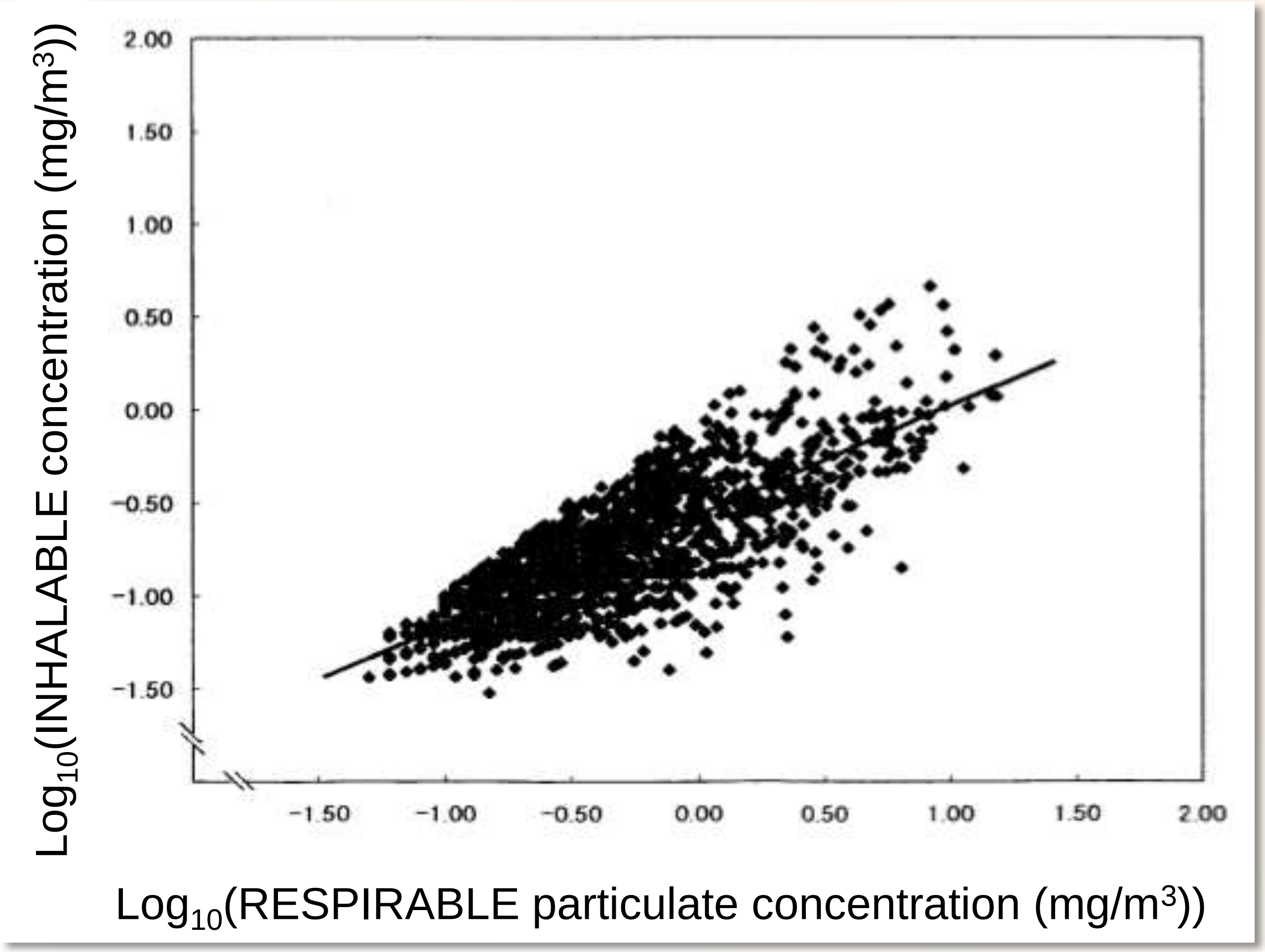


Creely KS *et al.* (2007) Trends in inhalation exposure--a review of the data in the published scientific literature. Ann Occup Hyg.; 51(8): 665-678.

Respirable vs Inhalable

- Which size fraction causes the adverse health effects?
- How are these size fractions related?
  - Implicitly one might expect inhalable dust to be about twice respirable dust levels (based on the limits)
- In typical situations inhalable dust is probably between about 2 and 5 times respirable dust concentrations

Respirable vs Inhalable



Okamoto S, *et al. Variation in the ratio of respirable particulates over inhalable particulates by type of dust workplace. Int Arch Occ Environ Health 1998; 71: 111–116.*

PVC dust

- Study of 818 workers in a PVC manufacturing plant
- Highest respirable dust levels about 2.5 mg/m^3
- FEV1 was statistically significantly lower among men with higher PVC dust exposure
- This is equivalent to a loss of 52 ml of FEV1 for the mean cumulative respirable dust exposure, equivalent to 0.7 mg/m^3 for 20 years

Soutar et al*. (1979) An epidemiological study of respiratory disease in workers exposed to polyvinylchloride dust. IOM TM 79/02.*

Amorphous silica vs silica

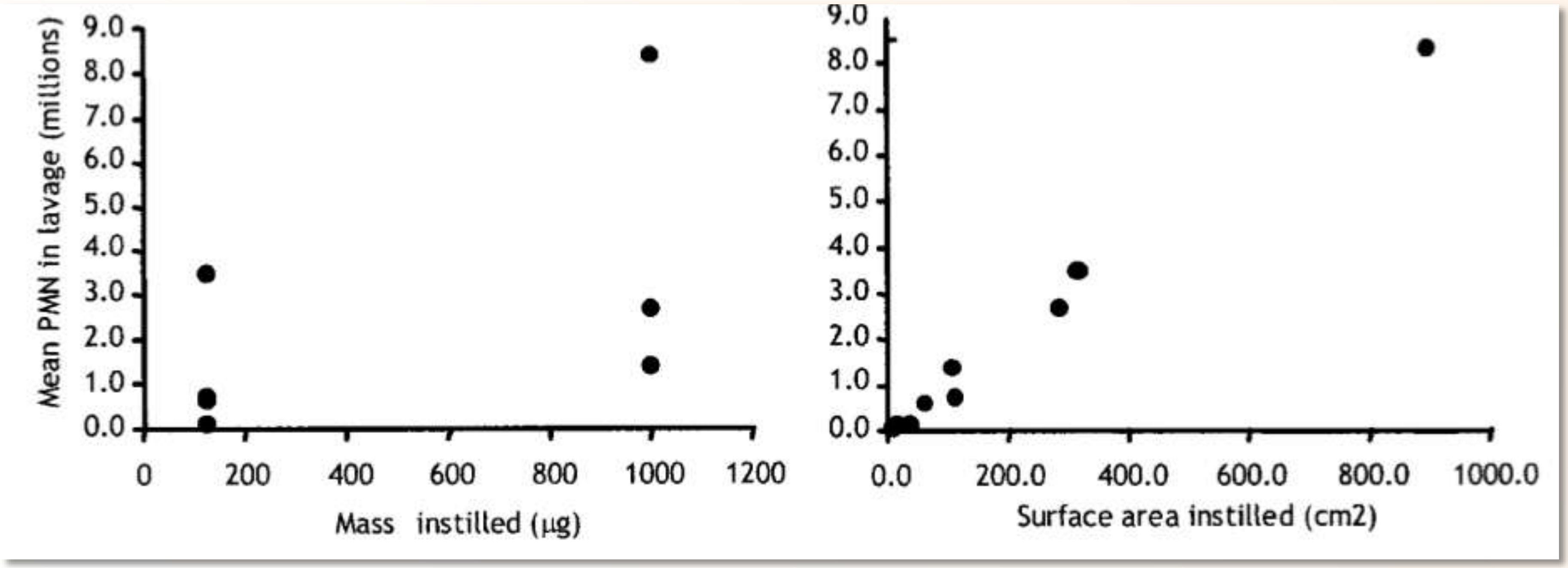
- In animal studies, quartz and amorphous silica produce inflammation during exposure
  - Surface area of amorphous silica (200 m^2/g) >> quartz (1 m^2/g)
- Post exposure amorphous silica is cleared or dissolves and inflammation decreases
- Post exposure quartz is not cleared and inflammation persists
- Quartz surface reactivity decreases when coated, e.g. with aluminum lactate

IOM

Johnston CJ, *et al. Pulmonary chemokine and mutagenic responses in rats after subchronic inhalation of amorphous and crystalline silica. Tox Sci. 2000;**56:405–413.***

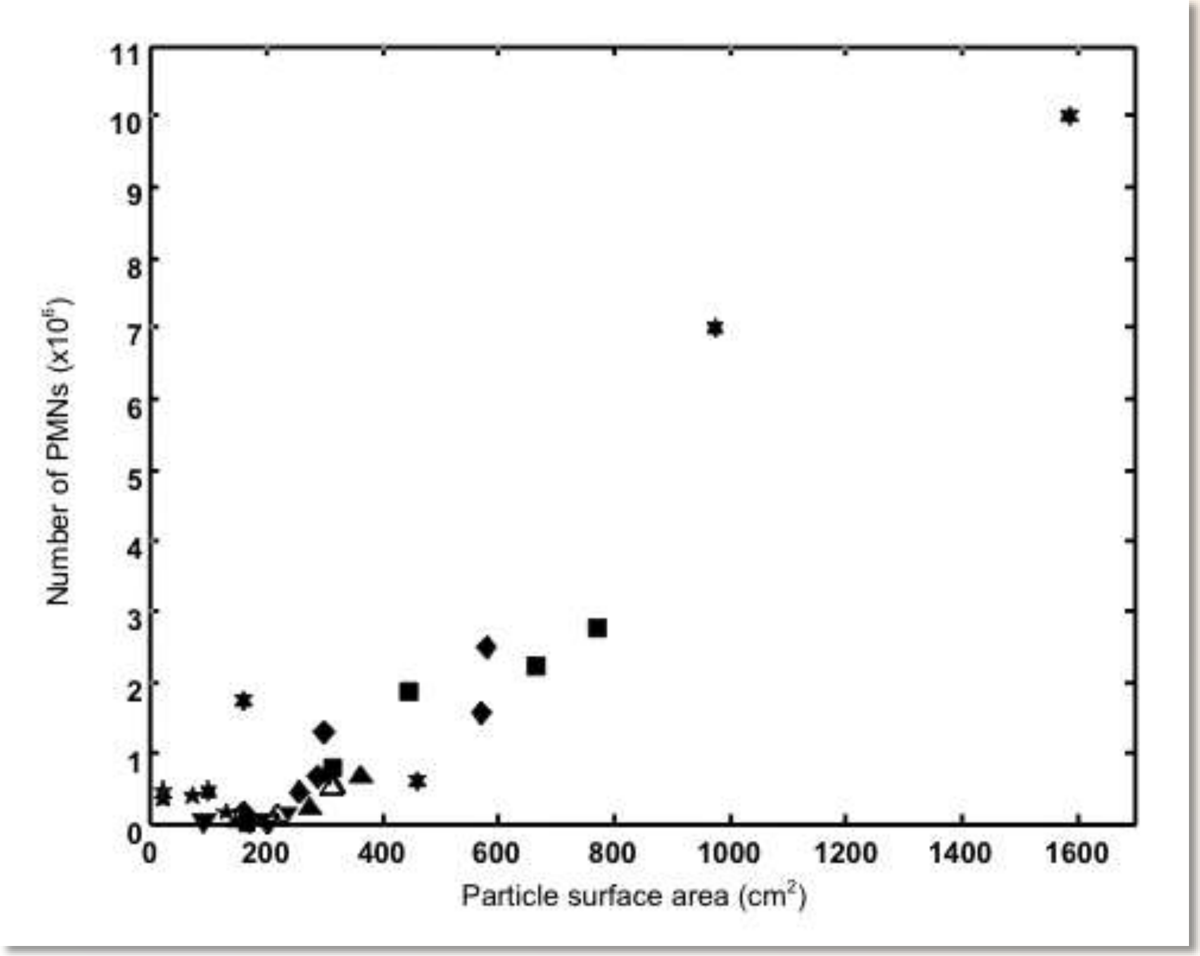
Surface area is an important factor

- Inflammatory response (neutrophils) in bronchoalveolar lavage: TiO2, CB and latex



Donaldson K, Brown D, Clouter A, *et al. The pulmonary toxicology of ultrafine particles. J Aerosol Med 2002;* ***15:213–220.***

…unifies biological response to dusts



TiO_2 (rectangle and diamond), $BaSO_4$ at two exposure concentrations (triangles) and data from Oberdörster for TiO_2 (fine and ultrafine, stars)

Faux et al (2003) *In vitro determinants of particulate toxicity: The dose-metric for poorly soluble dusts*. HSE report RR 154.

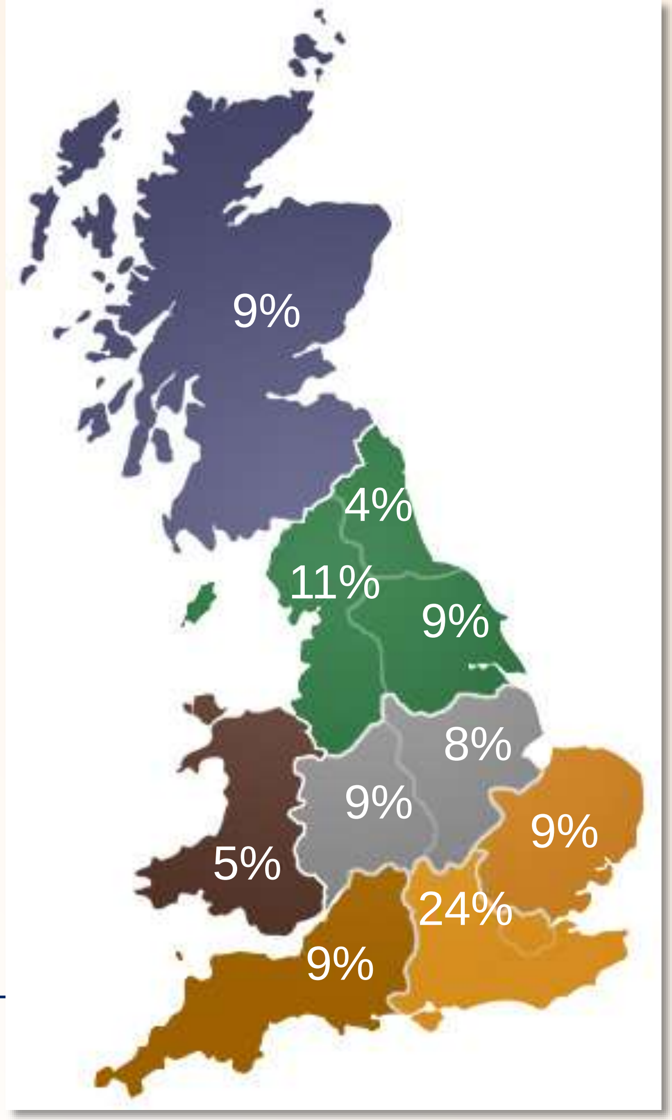
A No Observed Adverse Effect Level

- We used a mathematical model based on animal toxicity data to estimate the NOAEL for low toxicity dust – TiO_2
- Based on avoiding ‘overload’, i.e. the impairment of clearance and recruitment of inflammatory cells into the lung
  - Inflammation judged as beginning when neutrophils (PMN) constituted 2% of the total cells in the lung
- Analysis estimated human NOAEL as 1.3 mg/m^3

Tran et al. *(2003) Risk assessment of inhaled particles using a physiologically based mechanistic model. HSE report RR 141.*

How many people are exposed to dusts?

- Estimated as 9,200,000
  - Manufacturing - 29%
  - Construction - 19%
  - Hospitality - 11%
  - Professional etc. - 9%
  - Wholesale/retail - 8%
  - Agriculture - 6%
  - Utility - 5%



IOMs position…

- IOM adopts the following approach in advising its clients:
  - The current British limit values for respirable and inhalable dust (4 and 10 mg/m^3, respectively) are unsafe and it would be prudent to reduce exposures as far below these limits as is reasonably practicable.
  - We suggest that, until safe limits are put in place, employers should aim to keep exposure to respirable dust below 1 mg/m^3 and inhalable dust below 5 mg/m^3