11. Innenraumtag des Arbeitskreises Innenraumluft,
17.11.2020

Strategien zur Unterbrechung der Übertragungswege.

SARS-CoV-2-Viren als Bestandteil des

Ultrafeinstaubes sowie dessen Reduktionsmöglichkeit

ConsultAIR

Christof Braunegg

Wer bin ich?

- Seit 1994 in der Lüftungstechnik
- Hannover, Stuttgart, Singapore
- GF bei Troges 2006 bis 2016
- 2016 ConsultAIR GmbH
- GS bei Troges bis 2017

…. seit 1997

….. seit 2003

PARTICLE AND
FIBRE TOXICOLOGY

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-11654-3 OPEN

Ambient black carbon particles reach the fetal side of human placenta

Hannelore Bové[1,2,3,6], Eva Bongaerts[1,6], Eli Slenders[2], Esmée M. Bijnens[1], Nelly D. Saenen[1], Wilfried Gyselaers[4], Peter Van Eyken[4], Michelle Plusquin[1], Maarten B.J. Roeffaers[3], Marcel Ameloot[2] & Tim S. Nawrot[1,5]

ESC European Society of Cardiology

European Heart Journal (2019) **40**, 1590–1596
doi:10.1093/eurheartj/ehz135

FASTTRACK CLINICAL RESEARCH
Prevention and epidemiology

Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions

Jos Lelieveld[1,2]*, Klaus Klingmüller[1], Andrea Pozzer[1], Ulrich Pöschl[1], Mohammed Fnais[3], Andreas Daiber[4,5], and Thomas Münzel[4,5]*

[1]Max Planck Institute for Chemistry, Hahn-Meitner-Weg 1, 55128 Mainz, Germany; [2]The Cyprus Institute, 20 Kavafi Street, 2123 Nicosia, Cyprus; [3]King Saud University, College of Science, Riyadh 11451, Saudi Arabia; [4]Center for Cardiology, Cardiology I, Angiology and Intensive Care Medicine, University Medical Center of the Johannes Gutenberg University, Langenbeckstrasse 1, 55131 Mainz, Germany; and [5]German Center for Cardiovascular Research (DZHK), Partner Site Rhine-Main, Langenbeckstr. 1, 55131 Mainz, Germany

Received 18 November 2018; revised 5 December 2018; editorial decision 22 February 2019; accepted 22 February 2019; online publish-ahead-of-print 12 March 2019

Loxham and Nieuwenhuijsen *Particle and Fibre Toxicology* (2019) 16:12
https://doi.org/10.1186/s12989-019-0296-2

Particle and Fibre Toxicology

REVIEW Open Access

Health effects of particulate matter air pollution in underground railway systems – a critical review of the evidence

Matthew Loxham[1,2,3,4*] and Mark J. Nieuwenhuijsen[5,6,7]

SCIENTIFIC REPORTS

Article | OPEN | Published: 26 November 2015

Magnetite-Amyloid-β deteriorates activity and functional organization in an *in vitro* model for Alzheimer's disease

Sara Teller, Islam Bogachan Tahirbegi, Mònica Mir, Josep Samitier & Jordi Soriano

Ausgewählte wissenschaftliche Publikationen

full wording of reference

Jew, K., Herr, D., Wong, C. et al. Selective memory and behavioral alterations after ambient ultrafine particulate matter exposure in aged 3xTgAD Alzheimer's disease mice. Part Fibre Toxicol 16, 45 (2019). https://doi.org/10.1186/s12989-019-0323-3

Küster, E., Dittmar, C. Experimentelle Untersuchungen über therapeutische Beeinflussung von Impf- und Spontantumoren durch Behandlung der Versuchstiere mit unipolar negativ hochionisierter Luft. Z Krebs-forsch 50, 457–464 (1940). https://doi.org/10.1007/BF01620208

Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study (Updated April 24, 2020)

Qian H, Zheng X. Ventilation control
for airborne transmission of human exhaled bio-aerosols in
buildings. J Thorac Dis 2018;10(Suppl 19):S2295-S2304. doi:
10.21037/jtd.2018.01.24

Cui, Y., Zhang, Z., Froines, J. et al. Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study. Environ Health 2, 15 (2003). https://doi.org/10.1186/1476-069X-2-15

Exposure to air pollution and COVID-19 mortality in the United States. Xiao Wu, Rachel C. Nethery, Benjamin M. Sabath, Danielle Braun, Francesca Dominici. medRxiv 2020.04.05.20054502; doi: https://doi.org/10.1101/2020.04.05.20054502

Abt, E., Suh, H.H., Catalano, P., Koutrakis, P., 2000b. Relative contribution of outdoorand indoor particle sources to indoor concentrations. Environ. Sci. Technol. 34, 3579–3587.

Almeida-Silva, M., Almeida, S., Pegas, P., Nunes, T., Alves, C., Wolterbeek, H., 2015. Exposure and dose assessment to particle components among an elderly population. Atmos. Environ. 102, 156–166

Asbach, C., Kaminski, H., Von Barany, D., Kuhlbusch, T.A., Monz, C., Dziurowitz, N., Pelzer, J., Vossen, K., Berlin, K., Dietrich, S., 2012. Comparability of portable nanoparticle exposure monitors⇓. Ann. Occup. Hyg. 56, 606–621.

ASHRAE, 2013. Standard 62.1-2013, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Bekö, G., Weschler, C.J., Wierzbicka, A., Karottki, D.G., Toftum, J., Loft, S., Clausen, G., 2013. Ultrafine particles: exposure and source apportionment in 56 Danish homes. Environ. Sci. Technol. 47, 10240–10248

Belis, C., Karagulian, F., Larsen, B., Hopke, P., 2013. Critical review and meta-analysis of ambient particulate matter source apportionment using receptor models in Europe. Atmos. Environ. 69, 94–108.

Brasche, S., Bischof, W., 2005. Daily time spent indoors in German homes–baseline data for the assessment of indoor exposure of German occupants. Int. J. Hyg. Environ. Health 208, 247–253.

Buonanno, G., Marini, S., Morawska, L., Fuoco, F., 2012. Individual dose and exposure of Italian children to ultrafine particles. Sci. Total Environ. 438, 271–277.

Buonanno, G., Jayaratne, R.E., Morawska, L., Stabile, L., 2014. Metrological performances of a diffusion charger particle counter for personal monitoring. Aerosol Air Qual. Res. 14, 156–167.

Canha, N., Almeida, S., Freitas, M., Täubel, M., Hänninen, O., 2013. Winter ventilation rates at primary schools: comparison between Portugal and Finland. J. Toxic. Environ. Health A 76, 400–408.

Almeida, S.M., Derbez, M., 2016. Assessment of ventilation and indoor air pollutants in nursery and elementary schools in France. Indoor Air 26, 350–365.

Daisey, J.M., Angell, W.J., Apte, M.G., 2003. Indoor air quality, ventilation and health symptoms in schools: an analysis of existing information. Indoor Air 13, 53–64.

Dennekamp, M., Howarth, S., Dick, C., Cherrie, J., Donaldson, K., Seaton, A., 2001. Ultrafine particles and nitrogen oxides generated by gas and electric cooking. Occup. Environ. Med. 58, 511–516.

El Orch, Z., Stephens, B., Waring, M.S., 2014. Predictions and determinants of size-resolved particle infiltration factors in single-family homes in the US. Build. Environ. 74, 106–118.

Farhat, S., Paulo, R., Shimoda, T., Conceição, G., Lin, C., Braga, A., Warth, M., Saldiva, P., 2005. Effect of air pollution on pediatric respiratory emergency room visits and hospital admissions. Braz. J. Med. Biol. Res. 38, 227–235.

Fonseca, J., Slezakova, K., Morais, S., Pereira, M., 2014. Assessment of ultrafine particles in Portuguese preschools: levels and exposure doses. Indoor Air 24, 618–628.

Forouzanfar, M.H., Alexander, L., Anderson, H.R., Bachman, V.F., Biryukov, S., Brauer,M., Burnett, R., Casey, D., Coates, M.M., Cohen, A., 2015. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 386, 2287–2323.

He, C., Morawska, L., Hitchins, J., Gilbert, D., 2004. Contribution from indoor sources to particle number and mass concentrations in residential houses. Atmos. Environ. 38, 3405–3415.

He, C., Morawska, L., Taplin, L., 2007. Particle emission characteristics of office printers. Environ. Sci. Technol. 41, 6039–6045.

Hodas, N., Loh, M., Shin, H.M., Li, D., Bennett, D., McKone, T.E., Jolliet, O., Weschler, C.J., Jantunen, M., Lioy, P., 2015. Indoor inhalation intake fractions of fine particulate matter: review of influencing factors. Indoor Air.

Holmberg, S., Li, Y.G., 1998. Modelling of the indoor environment - particle dispersion and deposition. Indoor Air Int. J. Indoor Air Qual. Clim. 8, 113–122.

Hopke, P.K., Ramadan, Z., Paatero, P., Norris, G.A., Landis, M.S., Williams, R.W., Lewis, C.W., 2003. Receptor modeling of ambient and personal exposure samples: 1998 Baltimore Particulate Matter Epidemiology-Exposure Study. Atmos. Environ. 37,

Horemans, B., Van Grieken, R., 2010. Speciation and diurnal variation of thoracic, fine thoracic and sub-micrometer airborne particulate matter at naturally ventilated office environments. Atmos. Environ. 44, 1497–1505.

Hussein, T., Kulmala, M., 2008. Indoor aerosol modeling: basic principles and practical applications. Water Air Soil Pollut. Focus 8, 23–34.

Hussein, T., Glytsos, T., Ondráček, J., Dohányosová, P., Ždímal, V., Hämeri, K., Lazaridis, M., Smolík, J., Kulmala, M., 2006. Particle size characterization and emission rates during indoor activities in a house. Atmos. Environ. 40, 4285–4307.

Hussein, T., Wierzbicka, A., Löndahl, J., Lazaridis, M., Hänninen, O., 2015. Indoor aerosol modeling for assessment of exposure and respiratory tract deposited dose. Atmos. Environ. 106, 402–411.

Isaxon, C., Gudmundsson, A., Nordin, E., Lönnblad, L., Dahl, A., Wieslander, G., Bohgard, M., Wierzbicka, A., 2015. Contribution of indoor-generated particles to residential exposure. Atmos. Environ. 106, 458–466.

Johnson, A.M., Waring, M.S., DeCarlo, P.F., 2016. Real-time transformation of outdoor aerosol components upon transport indoors measured with aerosol mass spectrometry. Indoor Air.

Kearney, J., Wallace, L., MacNeill, M., Xu, X., VanRyswyk, K., You, H., Kulka, R., Wheeler, A., 2011. Residential indoor and outdoor ultrafine particles in Windsor, Ontario. Atmos. Environ. 45, 7583–7593.

Kim, H.-H., Lee, G.-W., Yang, J.-Y., Jeon, J.-M., Lee, W.-S., Lim, J.-Y., Lee, H.-S., Gwak, Y.- K., Shin, D.-C., Lim, Y.-W., 2014. Indoor exposure and health risk of polycyclic aromatic hydrocarbons (PAHs) via public facilities PM2.5, Korea (II). Asian J. Atmos. Environ. 8, 35–47.

Laiman, R., He, C., Mazaheri, M., Clifford, S., Salimi, F., Crilley, L.R., Mokhtar, M.A.M., Morawska, L., 2014. Characteristics of ultrafine particle sources and deposition rates in primary school classrooms. Atmos. Environ. 94, 28–35.

Leech, J.A., Nelson, W.C., Burnett, R.T., Aaron, S., Raizenne, M.E., 2002. It's about time: a comparison of Canadian and American time–activity patterns. J. Expo. Anal. Environ. Epidemiol. 12.

Litiu, A., 2012. Ventilation system types in some EU countries. REHVA J–January 2012, 18–23.

Loth, E., 2000. Numerical approaches for motion of dispersed particles, droplets and bubbles. Prog. Energy Combust. Sci. 26, 161–223.

Ausgewählte wissenschaftliche Publikationen

Mazaheri, M., Clifford, S., Jayaratne, R., Megat Mokhtar, M.A., Fuoco, F., Buonanno, G., Morawska, L., 2014. School children's personal exposure to ultrafine particles in the urban environment. Environ. Sci. Technol. 48, 113–120.

Mazaheri, M., Reche, C., Rivas, I., Crilley, L.R., Álvarez-Pedrerol, M., Viana, M., Tobias, A., Alastuey, A., Sunyer, J., Querol, X., 2016. Variability in exposure to ambient ultrafine particles in urban schools: comparative assessment between Australia and Spain. Environ. Int. 88, 142–149.

Morawska, L., He, C., Hitchins, J., Gilbert, D., Parappukkaran, S., Mengersen, K., 2003a. Characteristics of particle number and mass concentrations in residential houses in Brisbane, Australia. Atmos. Environ.

Morawska, L., Ristovski, Z., Jayaratne, E.R., Keogh, D., Ling, X., 2008. Ambient nano and ultrafine particles from motor vehicle emissions: characteristics, ambient processing and implications on human exposure. Atmos. Environ. 42, 8113–8138.

Morawska, L., He, C., Johnson, G., Guo, H., Uhde, E., Ayoko, G., 2009. Ultrafine particles in indoor air of a school: possible role of secondary organic aerosols. Environ. Sci. Technol. 43, 9103–9109.

Morawska, L., Afshari, A., Bae, G., Buonanno, G., Chao, C.Y.H., Hänninen, O., Hofmann, W., Isaxon, C., Jayaratne, E.R., Pasanen, P., 2013. Indoor aerosols: from personal exposure to risk assessment. Indoor Air 23, 462–487.

Murray, D.M., Burmaster, D.E., 1995. Residential air exchange rates in the United States: empirical and estimated parametric distributions by season and climatic region. Risk Anal. 15, 459–465.

Nazaroff, W.W., 2004. Indoor particle dynamics. Indoor Air 14, 175–183.

Nazaroff, W.W., Weschler, C.J., 2004. Cleaning products and air fresheners: exposure to primary and secondary air pollutants. Atmos. Environ. 38, 2841–2865.

Nielsen, O., 1984. Quality of air and the amount of fresh air in classrooms. In: Berglund, B., Lindvall, T., Sundell, J. (Eds.), Indoor Air: Buildings, Ventilation and Thermal Climate. 5. Swedish Council for Building Research, pp. 221–226.

Offermann, F., 2009. Ventilation and Indoor Air Quality in New Homes, California Air Resources Board and California Energy Commission, PIER Energy-related 500-2009. pp. 85.

Ogulei, D., Hopke, P.K., Wallace, L.A., 2006. Analysis of indoor particle size distributions in an occupied townhouse using positive matrix factorization. Indoor Air 16,

Persily, A., Musser, A., Emmerich, S., 2010. Modeled infiltration rate distributions for US housing. Indoor Air 20, 473–485.

Putaud, J.-P., Van Dingenen, R., Alastuey, A., Bauer, H., Birmili, W., Cyrys, J., Flentje, H., Fuzzi, S., Gehrig, R., Hansson, H.-C., 2010. A European aerosol phenomenology–3: physical and chemical characteristics of particulate matter from 60 rural, urban, and kerbside sites across Europe. Atmos. Environ. 44, 1308–1320.

Rackes, A., Waring, M.S., 2013. Modeling impacts of dynamic ventilation strategies on indoor air quality of offices in six US cities. Build. Environ. 60, 243–253.

Rackes, A., Waring, M.S., 2014. Using multiobjective optimizations to discover dynamic building ventilation strategies that can improve indoor air quality and reduce energy use. Energy Build. 75, 272–280.

Rackes, A., Waring, M., 2015. Do time-averaged, whole-building, effective volatile organic compound (VOC) emissions depend on the air exchange rate? A statistical analysis of trends for 46 VOCs in US offices. Indoor Air.

Riley, W.J., McKone, T.E., Lai, A.C., Nazaroff, W.W., 2002. Indoor particulate matter of outdoor origin: importance of size-dependent removal mechanisms. Environ. Sci. Technol. 36, 200–207.

Salthammer, T., Uhde, E., Schripp, T., Schieweck, A., Morawska, L., Mazaheri, M., Clifford, S., He, C., Buonanno, G., Querol, X., 2016. Children's well-being at schools: impact of climatic conditions and air pollution. Environ. Int. 94, 196–210.

Schripp, T., Markewitz, D., Uhde, E., Salthammer, T., 2013. Does e-cigarette consumption cause passive vaping? Indoor Air 23, 25–31.

Thatcher, T.L., Layton, D.W., 1995. Deposition, resuspension, and penetration of particles within a residence. Atmos. Environ. 29, 1487–1497.

Turk, B.H., Grimsrud, D.T., Brown, J.T., Geisling-Sobotka, K., Harrison, J., Prill, R.J., 1987. Commercial building ventilation rates and particle concentrations. The 4th International Conference on Indoor Air Quality and Climate. West Berlin, WestGermany. In: Proceedings of Indoor Air '87.

Turk, B., Grimsrud, D., Brown, J., Geisling-Sobotka, K., Harrison, J., Prill, R., 1989. Commercial building ventilation rates and particle concentrations. ASHRAE Trans. 95, 422–433.

Wallace, L., 1996. Indoor particles: a review. J. Air Waste Manage. Assoc. 46, 98–126.

Wallace, L., 2006. Indoor sources of ultrafine and accumulation mode particles: size distributions, size-resolved concentrations and source strengths. Aerosol Sci. Technol. 40, 348–360.

Wallace, L., Emmerich, S., Howard-Reed, C., 2004. Effect of central fans and in-duct filters on deposition rates of ultrafine and fine particles in an occupied townhouse. Atmos. Environ. 38, 405–413.

Wan, M.-P., Wu, C.-L., S., G.-N., Chan, T.-C., Chao, C.Y., 2011. Ultrafine particles, and PM2.5 generated from cooking in homes. Atmos. Environ. 45, 6141–6148.

Waring, M., 2014. Secondary organic aerosol in residences: predicting its fraction of fine particle mass and determinants of formation strength. Indoor Air 24, 376–389.

Waring, M.S., Siegel, J.A., 2007. An evaluation of the indoor air quality in bars before and after a smoking ban in Austin, Texas. J. Expo. Sci. Environ. Epidemiol. 17, 260–268.

Weschler, C., Shields, H., 2000. The influence of ventilation on reactions among indoor pollutants: modeling and experimental observations. Indoor Air 10, 92–100.

Weschler, C.J., Shields, H.C., 2003. Experiments probing the influence of air exchange rates on secondary organic aerosols derived from indoor chemistry. Atmos. Environ. 37, 5621–5631.

WHO, 2005. Guidelines for Air Quality. World Health Organization.

WHO, 2015. School Environment: Policies and Current Status. Regional Office for Europe, Copenhagen

Wierzbicka, A., Bohgard, M., Pagels, J., Dahl, A., Löndahl, J., Hussein, T., Swietlicki, E., Gudmundsson, A., 2015. Quantification of differences between occupancy and total monitoring periods for better assessment of exposure to particles in indoor environments. Atmos. Environ. 106, 419–428.

Yamamoto, N., Shendell, D., Winer, A., Zhang, J., 2010. Residential air exchange rates in three major US metropolitan areas: results from the relationship among indoor, outdoor, and personal air study 1999–2001. Indoor Air 20, 85–90.

Youssefi, S., Waring, M.S., 2014. Transient secondary organic aerosol formation from limonene ozonolysis in indoor environments: impacts of air exchange rates and initial concentration ratios. Environ. Sci. Technol. 48, 7899–7908.

Zhu, Y., Yang, L., Meng, C., Yuan, Q., Yan, C., Dong, C., Sui, X., Yao, L., Yang, F., Lu, Y., 2015. Indoor/outdoor relationships and diurnal/nocturnal variations in water-soluble ion and PAH concentrations in the atmospheric PM2.5 of a business office area in Jinan, a heavily polluted city in China. Atmos. Res. 153, 276–285.

Topi Rönkköa,1, Heino Kuuluvainena, Panu Karjalainena, Jorma Keskinena, Risto Hillamob, Jarkko V. Niemic, Liisa Pirjolad, Hilkka J. Timonenb, Sanna Saarikoskib, Erkka Saukkoa, Anssi Järvinena, Henna Silvennoinena, Antti Rostedta, Miska Olina, Jaakko Yli-Ojanperäa, Pekka Nousiainene, Anu Kousac, and Miikka Dal Masoa, 2017. Traffic is a major source of atmospheric nanocluster aerosol.

P. Khare, J. Machesky, R. Soto, M. He, A. A. Presto, D. R. Gentner, Asphalt-related emissions are a major missing nontraditional source of secondary organic aerosol precursors. Sci. Adv. 6, eabb9785 (2020).

Sivakumar Murugadoss1, Frederic Brassinne2, Noham Sebaihi3, Jasmine Petry3, Stevan M. Cokic4, Kirsten L. Van Landuyt4, Lode Godderis5,6, Jan Mast2, Dominique Lison7, Peter H. Hoet1* and Sybille van den Brule7, 2020. Agglomeration of titanium dioxide nanoparticles increases toxicological responses in vitro and in vivo.

1. GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016;388:P1659–724.

2. Donaldson K, Seaton A. A short history of the toxicology of inhaled particles. Part Fibre Tox. 2012;9:13.

3. Kuempel ED, Jaurand MC, Møller P, Morimoto Y, Kobayashi N, Pinkerton KE, Sargent LM, Vermeulen RCH, Fubini B, Kane AB. Evaluating the mechanistic evidence and key data gaps in assessing the potential carcinogenicity of carbon nanotubes and nanofibers in humans. Crit Rev Toxicol. 2017;47(1):1–58.

4. Bouwmeester H, Lynch I, Marvin HJ, Dawson KA, Berges M, Braguer D, Byrne HJ, Casey A, Chambers G, Clift MJ, Elia G, Fernandes TF, Fjellsbø LB, Hatto P, Juillerat L, Klein C, Kreyling WG, Nickel C, Riediker M, Stone V. Minimal analytical characterization of engineered nanomaterials needed for hazard assessment in biological matrices. Nanotoxicology. 2011;5(1):1–11.

5. Hunt G, Lynch I, Cassee F, Handy RD, Fernandes TF, Berges M, Kuhlbusch TA, Dusinska M, Riediker M. Towards a Consensus View on Understanding Nanomaterials Hazards and Managing Exposure: Knowledge Gaps and Recommendations. Materials. 2013;6(3):1090–117. https://doi.org/10.3390/ma6031090.

6. Donaldson K, Murphy FA, Duffin R, Poland CA. Asbestos, carbon nanotubes and the pleural mesothelium: a review of the hypothesis regarding the role of long fibre retention in the parietal pleura, inflammation and mesothelioma. Part Fibre Toxicol. 2010;7:5.

7. Schlesinger R, Kunzli N, Hidy GM, Gotschi T, Jerrett M. The health relevance of ambient particulate matter characteristics: coherence of toxicological and epidemiological inferences. Inhal Toxicol. 2006;18:95–125.

8. Cassee F, Héroux ME, Gerlofs-Nijland ME, Kelly FJ. Particulate matter beyond mass: recent health evidence on the role of fractions, chemical constituents and sources of emission. Inhal Toxicol. 2013;25:802–12.

9. Møller P, Danielsen PH, Jantzen K, Roursgaard M, Loft S. Oxidatively damaged DNA in animals exposed to particles. Crit Rev Toxicol. 2013;43:96–118.

10. Heusinkveld H, Wahle T, Campbell A, Westerink RH, Tran L, Johnston H, Stone V, Cassee FR, Schins RP. Neurodegenerative and neurological disorders by small inhaled particles. Neurotoxicology. 2016;56:94.

11. Lucchini R, Dorman DC, Elder A, Veronesi B. Neurological impacts from inhalation of pollutants and the nose-brain connection. Neurotoxicology. 2012;33:838–41.

12. Hougaard KS, Campagnolo L, Chavatte-Palmer P, Tarrade A, Rousseau- Ralliard D, Valentino S, Park MVDZ, de Jong WH, Wolterink G, Piersma AH, Ross BL, Hutchison GR, Hansen JS, Vogel U, Jackson P, Slama R, Pietroiusti A, Cassee FR. A perspective on the developmental toxicity of inhaled nanoparticles. Reproductive Toxicology. 2015;56:118–40.

13. Moreno T, Querol X, Alastuey A, Gibbons W. Identification of chemical tracers in the characterisation and source apportionment of inhalable inorganic airborne

14. Stone V, Miller MR, Clift MJ, Elder A, Mills NL, Møller P, Schins RP, Vogel U, Kreyling WG, Jensen KA, Kuhlbusch TA, Schwarze PE, Hoet P, Pietroiusti A, De Vizcaya-Ruiz

15. Couvreur P, Tulkens P, Roland M, Trouet A, Speiser P. Nanocapsules: a new type of lysosomotropic carrier. FEBS Letters. 1977;84:323–6. 16. Duncan R, Kopeckova-Rejmanova P, Strohalm J, Hume I, Cable HC, Pohl J, Lloyd JB, Kopecek J. Anticancer agents coupled to N-(2-hydroxypropyl)

15. Couvreur P, Tulkens P, Roland M, Trouet A, Speiser P. Nanocapsules: a new type of lysosomotropic carrier. FEBS Letters. 1977;84:323–6.

16. Duncan R, Kopeckova-Rejmanova P, Strohalm J, Hume I, Cable HC, Pohl J, Lloyd JB, Kopecek J. Anticancer agents coupled to N-(2-hydroxypropyl) methacrylamide copolymers. I. Evaluation of daunomycin and puromycin conjugates in vitro. Br J Cancer. 1987;55(2):165–74.

17. Bakhtiary Z, Saei AA, Hajipour MJ, Raoufi M, Vermesh O, Mahmoudi M. Targeted superparamagnetic iron oxide nanoparticles for early detection of cancer: Possibilities and challenges. Nanomedicine. 2016;12(2):287–307.

18. Erathodiyil N, Ying JY. Functionalization of inorganic nanoparticles for bioimaging applications. Acc Chem Res. 2011;44(10):925–35.

19. Jokerst JV, Gambhir SS. Molecular imaging with theranostic nanoparticles. Acc Chem Res. 2011;44(10):1050–60.

20. Raliya R, Singh Chadha T, Haddad K, Biswas P. Perspective on Nanoparticle Technology for Biomedical Use. Curr Pharm Des. 2016; 22(17):2481–90.

21. Date AA, Hanes J, Ensign LM. Nanoparticles for oral delivery: Design, evaluation and state-of-the-art. J Control Release. 2016;240:504–26.

22. Dilnawaz F. Polymeric biomaterial and lipid based nanoparticles for oral drug delivery. Current Medicinal Chem. 2017;24(22):2423–38.

23. Shadab M, Haque S, Sheshala R, Meng LW, Meka VS, Ali J. Recent advances in non-invasive delivery of macromolecules using nanoparticulate carriers system. Curr Pharm Des. 2017;23(3):440–53.

24. Teo PY, Cheng W, Hedrick JL, Yang YY. Co-delivery of drugs and plasmid DNA for cancer therapy. Adv Drug Del Rev. 2016;98:41–63.

25. Wen MM, El-Salamouni NS, El-Refaie WM, Hazzah HA, Ali MM, Tosi G, Farid RM, Blanco-Prieto MJ, Billa N, Hanafy AS. Nanotechnology-based drug delivery systems for Alzheimer's disease management: Technical, industrial, and clinical challenges. J Control Rel. 2017;245:95–107.

26. Maeda H, Matsumura Y. Tumoritropic and lymphotropic principles of macromolecular drugs. Crit Revi Ther Drug Carrier Syst. 1989;6(3):193–210.

27. von Roemeling C, Jiang W, Chan CK, Weissman IL, Kim BYS. Breaking Down the Barriers to Precision Cancer Nanomedicine. Trends Biotechnol. 2017; 35(2):159–71.

28. Cabral H, Kataoka K. Progress of drug-loaded polymeric micelles into clinical studies. J Control Release. 2014;190:465–76.

29. Sauvage F, Barratt G, Herfindal L, Vergnaud-Gauduchon J. The Use of Nanocarriers in Acute Myeloid Leukaemia Therapy: Challenges and Current Status. Curr Pharm Biotechnol. 2016;17(1):30–41.

30. Shevtsov M, Multhoff G. Recent Developments of Magnetic Nanoparticles for Theranostics of Brain Tumor. Curr Drug Metab. 2016;17(8):737–44.

31. Nehoff H, Parayath NN, Domanovitch L, Taurin S, Greish K. Nanomedicine for drug targeting: strategies beyond the enhanced permeability and retention effect. Int J Nanomedicine. 2014;9:2539–55.

32. Nichols JW, Bae YH. EPR: Evidence and fallacy. J Control Release. 2014;190:451–64.

33. Danhier F. To exploit the tumor microenvironment: Since the EPR effect fails in the clinic, what is the future of nanomedicine? J Control Release. 2016; 244(Pt A):108–21.

34. Huynh NT, Roger E, Lautram N, Benoit JP, Passirani C. The rise and rise of stealth nanocarriers for cancer therapy: passive versus active targeting. Nanomedicine (Lond). 2010;5(9):1415–33.

35. Parodi A, Quattrocchi N, van de Ven AL, Chiappini C, Evangelopoulos M, Martinez JO, Brown BS, Khaled SZ, Yazdi IK, Enzo MV, Isenhart L, Ferrari M, Tasciotti E. Synthetic nanoparticles functionalized with biomimetic leukocyte membranes possess cell-like functions. Nat Nanotech. 2013;8(1):61–8.

36. Hu CM, Fang RH, Wang KC, Luk BT, Thamphiwatana S, Dehaini D, Nguyen P, Angsantikul P, Wen CH, Kroll AV, Carpenter C, Ramesh M, Qu V, Patel SH, Zhu J, Shi W, Hofman FM, Chen TC, Gao W, Zhang K, Chien S, Zhang L. Nanoparticle biointerfacing by platelet membrane cloaking. Nature. 2015;526(7571):118–21.

37. Sosale NG, Spinler KR, Alvey C, Discher DE. Macrophage engulfment of a cell or nanoparticle is regulated by unavoidable opsonization, a species-specific 'Marker of Self' CD47, and target physical properties. Curr Opinion Immunol. 2015;35:107–12.

38. Toy R, Peiris PM, Ghaghada KB, Karathanasis E. Shaping cancer nanomedicine: the effect of particle shape on the in vivo journey of nanoparticles. Nanomedicine (Lond). 2014;9(1):121–34.

39. Tang S, Peng C, Xu J, Du B, Wang Q, Vinluan RD 3rd, Yu M, Kim MJ, Zheng J. Tailoring Renal Clearance and Tumor Targeting of Ultrasmall Metal Nanoparticles with Particle Density. Angew Chemie. Int Ed Engl. 2016;55(52):16039–43.

40. Choi HS, Liu W, Misra P, Tanaka E, Zimmer JP, Itty Ipe B, Bawendi MG, Frangioni JV. Renal clearance of quantum dots. Nat Biotechnol. 2007;25(10): 1165–70.

41. Ruggiero A, Villa CH, Bander E, Rey DA, Bergkvist M, Batt CA, Manova- Todorova K, Deen WM, Scheinberg DA, McDevitt MR. Paradoxical glomerular filtration of carbon nanotubes. Proc Nat Acad Sci USA. 2010; 107(27):12369–74.

42. Lacerda L, Herrero MA, Venner K, Bianco A, Prato M, Kostarelos K. Carbonnanotube shape and individualization critical for renal excretion. Small. 2008;4(8):1130–2.

43. Perez-Herrero E, Fernandez-Medarde A. Advanced targeted therapies in cancer: Drug nanocarriers, the future of chemotherapy. Eur J Pharm Biopharm. 2015;93:52–79.

44. Maeda H. SMANCS and polymer-conjugated macromolecular drugs: advantages in cancer chemotherapy. Adv Drug Deliv Rev. 2001;46(1-3): 169–85.

45. Abraham SA, Waterhouse DN, Mayer LD, Cullis PR, Madden TD, Bally MB. The liposomal formulation of doxorubicin. Methods Enzymol. 2005;391:71–97.

46. Chung JE, Tan S, Gao SJ, Yongvongsoontorn N, Kim SH, Lee JH, Choi HS, Yano H, Zhuo L, Kurisawa M, Ying JY. Self-assembled micellar nanocomplexes comprising green tea catechin derivatives and protein drugs for cancer therapy. Nat Nanotechnol. 2014;9(11):907–12.

Ausgewählte wissenschaftliche Publikationen

57. Geiser M, Kreyling W. Deposition and biokinetics of inhaled nanoparticles. Part Fibre Tox. 2010;7:2.
58. Kreyling W, Semmler M, Erbe F, Mayer P, Takenaka S, Schulz H, Oberdörster G, Ziesenis A. Translocation of ultrafine insoluble iridium particles from lung epithelium to extrapulmonary organs is size dependent but very low. J. Toxicol. Environ. Health A. 2002;65:1513–30.
59. Kreyling WG, et al. Age-Dependent Rat Lung Deposition Patterns of Inhaled 20 Nanometer Gold Nanoparticles and their Quantitative Biokinetics in Adult Rats. ACS Nano. 2018;12(8):7771–90.
60. Stone KC, Mercer RR, Gehr P, Stockstill B, Crapo JD. Allometric relationships of cell numbers and size in the mammalian lung. Am J Respir Cell Mol Biol. 1992;6(2):235–43.
61. Lehnert BE. Pulmonary and thoracic macrophage subpopulations and clearance of particles from the lung. Environ Health Perspect. 1992;97:17–46.
62. Adamson IY, Bowden DH. Adaptive responses of the pulmonary macrophagic system to carbon. II. Morphologic studies. Laboratory Investigation. 1978;38(4):430–8.
63. Adamson IY, Bowden DH. Dose response of the pulmonary macrophagic system to various particulates and its relationship to transepithelial passage of free particles. Experimental Lung Research. 1981;2(3):165–75.
64. Bowden DH, Adamson IY. Pathways of cellular efflux and particulate clearance after carbon instillation to the lung. J Pathol. 1984;143(2):117–25.
65. Thorley AJ, Ruenraroengsak P, Potter TE, Tetley TD. Critical determinants of uptake and translocation of nanoparticles by the human pulmonary alveolar epithelium. ACS Nano. 2014;8(11):11778–89.
66. Geiser M, Quaile O, Wenk A, Wigge C, Eigeldinger-Berthou S, Hirn S, Schaffler M, Schleh C, Moller W, Mall MA, Kreyling WG. Cellular uptake and localization of inhaled gold nanoparticles in lungs of mice with chronic obstructive pulmonary disease. Part Fibre Toxicol. 2013;10(1):19.
67. Geiser M, Rothen-Rutishauser B, Kapp N, Schurch S, Kreyling W, Schulz H, Semmler M, Im Hof V, Heyder J, Gehr P. Ultrafine particles cross cellular membranes by nonphagocytic mechanisms in lungs and in cultured cells. Environ Health Perspect. 2005;113(11):1555–60.
68. Nunn, J.F., Chapter 2 - Functional anatomy of the respiratory tract, in Nunn's Applied Respiratory Physiology (4th Edition). 1993, Butterworth-Heinemann. p. 13-35.
69. Weibel ER. On the tricks alveolar epithelial cells play to make a good lung. Am J Respir Crit Care Med. 2015;191(5):504–13.
70. Brain JD. Mechanisms, measurement, and significance of lung macrophage function. Environ Health Perspect. 1992;97:5–10.
71. Kreyling WG. Interspecies comparison of lung clearance of "insoluble" particles. J Aerosol Med. 1990;3:S93–S110.
72. Kreyling W, Scheuch G. Clearance of particles deposited in the lungs. In: Heyder J, Gehr P, editors. Particle Lung Interactions. New York: Marcel Dekker; 2000.
73. Macklin CC. Pulmonary sumps, dust accumulations, alveolar fluid and lymph vessels. Acta Anatomica. 1955;23:1–33.
74. Ferin J, Oberdorster G, Penney DP. Pulmonary retention of ultrafine and fine particles in rats. Am J Respir Cell Mol Biol. 1992;6:535–42.
75. Ferin J, Oberdörster G, Soderholm SC, Gelein R. The Rate of Dose Delivery Affects Pulmonary Interstitialization of Particles in Rat. Ann Occup Hyg. 1994;38(Suppl 1):289–93.
76. Adamson IY, Bakowska J, Bowden DH. Mesothelial cell proliferation: a nonspecific response to lung injury associated with fibrosis. Am J Respir Cell Mol Biol. 1994;10:253–8.
77. Oberdörster G, Oberdörster E, Oberdörster J. Nanotoxicology: An Emerging Discipline Evolving from Studies of Ultrafine Particles. Environ Health Perspect. 2005;113(7):823–39.
78. Plesch BE. Histology and immunohistochemistry of bronchus associated lymphoid tissue (BALT) in the rat. Adv Exp Med Biol. 1982;149:491–7.
79. Kreyling, W., Translocation and Accumulation in the Body, in Nanoparticles in the Lung, A.e. Tsuda, Editor. 2014, CRC Press.
80. Ruckerl R, Schneider A, Breitner S, Cyrys J, Peters A. Health effects of particulate air pollution: A review of epidemiological evidence. Inhalation Toxicol. 2011;23:555–92.
81. Kreyling WG, Holzwarth U, Haberl N, Kozempel J, Wenk A, Hirn S, Schleh C, Schäffler M, Lipka J, Semmler-Behnke M, Gibson N. Quantitative biokinetics of titanium dioxide nanoparticles after intravenous injection in rats: Part 1. Nanotoxicology. 2017;11(4):434–42.
82. Kreyling W, Holzwarth U, Schleh C, Kozempel J, Wenk A, Haberl N, Hirn S, Schäffler M, Lipka J, Semmler-Behnke M, Gibson N. Quantitative biokinetics of titanium dioxide nanoparticles after oral application in rats: Part 2. Nanotoxicology. 2017;11(4):443–53.
83. Kreyling W, Holzwarth U, Haberl N, Kozempel J, Wenk A, Hirn S, Schleh C, Schäffler M, Lipka J, Semmler-Behnke M, Gibson N. Quantitative biokinetics of titanium dioxide nanoparticles after intratracheal instillation in rats: Part 3. Nanotoxicology. 2017;11(4):454–64.
84. Oberdörster G, Castranova V, Asgharian B, Sayre P. Inhalation exposure to carbon nanotubes (CNT) and carbon nanofibers (CNF): Methodology and dosimetry. J Toxicol Environ Health Part B. 2015;18:121–212.
85. OECD 413, Subchronic Inhalation Toxicity: 90-day Study. Organisation for Economic Cooperation and Development; 2018. https://doi.org/10.1787/9789264070806-en. Accessed 18 Apr 2019.
86. Nel AE, Nasser E, Godwin H, Avery D, Bahadori T, Bergeson L, Beryt E, Bonner JC, Boverhof D, Carter J, Castranova V, DeShazo JR, Hussain SM, Kane AB, Klaessig F, Kuempel E, Lafranconi M, Landsiedel R, Maooly T, Miller MB, Morris J, Moss K, Oberdörster G, Pinkerton K, Pleus RC, Shatkin JA, Thomas R, Tolaymat T, Wang A, Wong J. A multi-stakeholder perspective on the use of alternative test strategies for nanomaterial safety assessment. ACS Nano. 2013;7:6422–33.
87. Rushton EK, Jiang J, Leonard SS, Eberly S, Castranova V, Biswas P, Elder A, Han X, Gelein R, Finkelstein J, Oberdorster G. Concept of assessing nanoparticle hazards considering nanoparticle dosemetric and chemical/ biological response metrics. J Toxicol Environ Health A. 2010;73:445–61.
88. Duffin R, Tran L, Brown D, Stone V, Donaldson K. Proinflammogenic effects of low-toxicity and metal nanoparticles in vivo and in vitro: highlighting the role of particle surface area and surface reactivity. Inhal Toxicol. 2007;19:849–56.
89. EPA. Benchmark Dose Software Tools. U.S. EPA; 2016. http://epa.gov/ncea/bmds/dwnldu.html. Accessed 18 Apr 2019.
90. Oberdörster G, Kuhlbusch TAJ. In vivo effects: Methodologies and biokinetics of inhaled nanomaterials. NanoImpact. 2018;10:38-60.
91. WHO, Environmental Health Criteria 170: Assessing human health risks of chemicals: derivation of guidance values for health-based exposure limits. Geneva: World Health Organization, International Programme on Chemical Safety; 1994. http://www.inchem.org/documents/ehc/ehc/ehc170.htm. Accessed 18 Apr 2019.
92. Asgharian B, Miller FJ, Subramaniam RP. CIIT Activities: Dosimetry software to predict particle deposition in humans and rats; 1999.
93. Miller FJ, Asgharian B, Schroeter JD, Price O. Improvements and additions to the Multiple Path Particle Dosimetry Model. J. Aerosol Science. 2016;99:14–26.
94. Oberdörster G. Dosimetric principles for extrapolating results of rat inhalation studies to humans, using nickel as an example. Health Physics. 1989;57(Supp 1):213–20.
95. OECD 116 Guidance document 116 on the conduct and design of chronic toxicity and carcinogenicity studies supporting test guidelines 451, 452 and 453. 2ND EDITION. Series on Testing and Assessment No. 116, 2012. ENV/JM/MONO (2011)47.
96. Wang J, Bahk YK, Chen S-C, Pui DYH. Characteristics of airborne fractal-like agglomerates of carbon nanotubes. Carbon. 2015;93:441–50.
97. Miller FJ, Kaczmar SW, Danzeisen R, Moss OR. Estimating lung burdens based on individual particle density estimated from scanning electron microscopy and cascade impactor samples. Inhal Toxicol. 2013;25:813–27.
98. Park K, Cao F, Kittelson DB, McMurry PH. Relationship between particle mass and mobility for diesel exhaust particles. Environ Sci Technol. 2003;37:577–83.
99. Maricq MM, Xu N. The effective density and fractal dimension of soot particles from premixed flames and motor vehicle exhaust. Aerosol Science. 2004;35:1251–74.
100. OECD 105 Water Solubility https://www.oecd-ilibrary.org/environment/testno-105-water-solubility_9789264069589-en, 1995.
101. Graham UM, Tseng MT, Jasinski JB, Yokel RA, Unrine JM, Davis BH, Dozier AK, Hardas SS, Sultana R, Grulke EA, Butterfield DA. In Vivo Processing of Ceria Nanoparticles inside Liver: Impact on Free-Radical Scavenging Activity and Oxidative Stress. Chempluschem. 2014;79:1083–8.
102. Graham, U.M., Jacobs, G., Yokel, R.A., Davis, B.H., Dozier, A.K.,. Birch, M.E., Tseng, M.T.
, Oberdörster, G., Elder, A., DeLouise, L., From Dose to Response: In Vivo Nanoparticle Processing and Potential Toxicity, in Modelling the Toxicity of Nanoparticles. Advances in Experimental Medicine and Biology, B.M. Tran L., Rallo R., Editor. 2017, Springer: Cham.
103. Yang Y, Oztekin A, Neti S, Mohapatra S. Particle agglomeration and properties of nanofluids. J Nanopart Res. 2012;14:852.
104. Lynch, I., Dawson, K.A., Lead, J.R., Valsami-Jones, E., Macromolecular Coronas and Their Importance in Nanotoxicology and Nanoecotoxicology, in Nanoscience and the Environment, J.R. Lead, Valsami-Jones, E., Editor. 2014.
105. Cedervall T, Lynch I, Lindman S, Berggård T, Thulin E, Nilsson H, Dawson KA, Linse S. Understanding the Nanoparticle-Protein Corona Using Methods to Quantify Exchange Rates and Affinities of Proteins for Nanoparticles. Proc. Natl. Acad. Sci. U. S. A. 2007;104:2050–5.
106. Monopoli MP, Walczyk D, Campbell A, Elia G, Lynch I, Bombelli FB, Dawson KA. Physical-chemical aspects of protein corona: relevance to in vitro and in vivo biological impacts of nanoparticles. J Am Chem Soc. 2011;133:2525–34.
107. Huk A, Izak-Nau E, Reidy B, Boyles M, Duschl A, Lynch I. Is the toxic potential of nanosilver dependent on its size? Part Fibre Toxicol. 2014;11. https://particleandfibretoxicology.biomedcentral.com/articles/10.1186/s12989-014-0065-1.
108. Nasser F, Lynch I. Secreted protein eco-corona mediates uptake and impacts of polystyrene nanoparticles on Daphnia magna. J Proteomics. 2015;S1874-3919:30121–4.
109. Summers HD, Brown MR, Holton MD, Tonkin JA, Hondow N, Brown AP, Brydson R, Rees P. Quantification of Nanoparticle Dose and Vesicular Inheritance in Proliferating Cells. ACS Nano. 2013;7:6129–37.
110. Cohen JM, Teeguarden JG, Demokritou P. An integrated approach for the in vitro dosimetry of engineered nanomaterials. Part Fibre Tox. 2014;11:20.
111. Izak-Nau E, Huk A, Reidy B, Uggerud H, Vadset M, Eiden S, Voetz M, Himly M, Duschl A, Dusinska M, Lynch I. Impact of Storage Conditions and Storage Time on Silver: Nanoparticles' Physicochemical Properties and Implications for their Biological Effects. RSC Advances. 2015;5:84172–85.
112. Sabuncu AC, Grubbs J, Qian S, Abdel-Fattah TM, Stacey MW, Beskok A. Probing nanoparticle interactions in cell culture media. Colloids and Surfaces B: Biointerfaces. 2012;95:96–102.
113. Maiorano G, Sabella S, Sorce B, Brunetti V, Malvindi MA, Cingolani R, Pompa PP. Effects of Cell Culture Media on the Dynamic Formation of Protein −Nanoparticle Complexes and Influence on the Cellular Response. ACS Nano. 2010;4(12):7481–91.
114. Lesniak A, Campbell A, Monopoli MP, Lynch I, Salvati A, Dawson KA. Serum heat inactivation affects protein corona composition and nanoparticle uptake. Biomaterials. 2010;31:9511–8.
115. Lesniak A, Fenaroli F, Monopoli MP, Åberg C, Dawson KA, Salvati A. Effects of the presence or absence of a protein corona on silica nanoparticle uptake and impact on cells. ACS Nano. 2012;6:5845–57.
116. Strojan K, Leonardi A, Bregar VB, Križaj I, Svete J, Pavlin M. Dispersion of Nanoparticles in Different Media Importantly Determines the Composition of Their Protein Corona. PLOS ONE. 2017;12(1):e0169552.
117. Bihari P, Vippola M, Schultes S, Praetner M, Khandoga AG, Reichel CA, Coester C, Tuomi T, Rehberg M, Krombach F. Optimized dispersion of nanoparticles for biological in vitro and in vivo studies. Part Fibre Tox. 2008;5(1):14.
118. Keller AA, Wang H, Zhou D, Lenihan HS, Cherr G, Cardinale BJ, Miller R, Ji Z. Stability and Aggregation of Metal Oxide Nanoparticles in Natural Aqueous Matrices. Environ. Sci. Technol. 2010;44:1962–7.
119. Quik JT, Lynch I, Van Hoecke K, Miermans CJ, De Schamphelaere KA, Janssen CR, Dawson KA, Stuart MA, Van De Meent D. Effect of natural organic matter on cerium dioxide nanoparticles settling in model fresh water. Chemosphere. 2010;81:711–5.
120. McKenzie Z, Kendall M, Mackay R-M, Whitwell H, Elgy C, Ding P, Mahajan S, Morgan C, Griffiths M, Clark H, Madsen J. Surfactant protein A (SP-A) inhibits agglomeration and macrophage uptake of toxic amine modified nanoparticles. Nanotoxicology. 2015;9(8):952–62.
121. Levak M, et al. Effect of Protein Corona on Silver Nanoparticle Stabilization and Ion Release Kinetics in Artificial Seawater. Environ Sci Technol. 2017;51(3):1259–66.
122. Miclăuș T, Beer C, Chevallier J, Scavenius C, Bochenkov VE, Enghild JJ, Sutherland DS. Dynamic protein coronas revealed as a modulator of silver nanoparticle sulphidation in vitro. Nature Communications. 2016;7:11770.
123. Stepien G, Moros M, Pérez-Hernández M, Monge M, Gutiérrez L, Fratila RM, Las Heras M, Menao Guillén S, Puente Lanzarote JJ, Solans C, Pardo J, de la Fuente JM. Effect of Surface Chemistry and Associated Protein Corona on the Long-Term Biodegradation of Iron Oxide Nanoparticles In Vivo. ACS Appl Mater Interfaces. 2018;10(5):4548–60.
124. Albanese A, Walkey CD, Olsen JB, Guo H, Emili A, Chan WCW. Secreted Biomolecules Alter the Biological Identity and Cellular Interactions of Nanoparticles. ACS Nano. 2014;8(6):5515–26.
125. Lundqvist M, Stigler J, Cedervall T, Berggård T, Flanagan MB, Lynch I, Elia G, Dawson K. The Evolution of the Protein Corona around Nanoparticles: A Test Study. ACS Nano. 2011;5(9):7503–9.
126. Winkelstein JA. Opsonins: Their function, identity, and clinical significance. J Pediatr. 1973;82(5):747–53.
127. Cao Y, Li J, Liu F, Li X, Jiang Q, Cheng S, Gu Y. Consideration of interaction between nanoparticles and food components for the safety assessment of nanoparticles following oral exposure: A review. Environ Toxicol Pharmacol. 2016;46:206–10.
128. Bhattacharya K, Mukherjee SP, Gallud A, Burkert SC, Bistarelli S, Bellucci S, Bottini M, Star A, Fadeel B. Biological interactions of carbon-based nanomaterials: From coronation to degradation. Nanomed Nanotechnol Biol Med. 2016;12(2):333–51.
129. Zhao Y, Allen BL, Star A. Enzymatic Degradation of Multiwalled Carbon Nanotubes. J. Phys. Chem. A. 2011;115(34):9536–44.
130. Lalwani G, Xing W, Sitharaman B. Enzymatic Degradation of Oxidized and Reduced Graphene Nanoribbons by Lignin Peroxidase. Journal of materials chemistry. B Mater Biol Med. 2014;2(37):6354–62.
131. Kreyling WG, Hirn S, Möller W, Schleh C, Wenk A, Celik G, Lipka J, Schäffler M, Haberl N, Johnston BD, Sperling R, Schmid G, Simon U, Parak WJ, Semmler-Behnke M. Air–Blood Barrier Translocation of Tracheally Instilled Gold Nanoparticles Inversely Depends on Particle Size. ACS Nano. 2014;8(1):222–33.
132. Schleh C, Semmler-Behnke M, Lipka J, Wenk A, Hirn S, Schäffler M, Schmid G, Simon U, Kreyling WG. Size and surface charge of gold nanoparticles determine absorption across intestinal barriers and accumulation in secondary target organs after oral administration. Nanotoxicology. 2012;6(1):36–46.
133. Prapainop K, Witter DP, Wentworth P. A Chemical Approach for Cell-Specific Targeting of Nanomaterials: Small-Molecule-Initiated Misfolding of Nanoparticle Corona Proteins. J Am Chem Soc. 2012;134(9):4100–3.
134. Lynch I. Are there generic mechanisms governing interactions between nanoparticles and cells? Epitope mapping the outer layer of the proteinmaterial interface. Physica A – Stat Mech Appl. 2007;373:511–20.
135. Arami H, Khandhar A, Liggitt D, Krishnan KM. In vivo delivery, pharmacokinetics, biodistribution and toxicity of iron oxide nanoparticles. Chemical Society Reviews. 2015;44(23):8576–607.
136. Feliu N, Docter D, Heine M, del Pino P, Ashraf S, Kolosnjaj-Tabi J, Macchiarini P, Nielsen P, Alloyeau D, Gazeau F, Stauber RH, Parak WJ. In vivo degeneration and the fate of inorganic nanoparticles. Chemical Society Reviews. 2016;45(9):2440–57.
137. Kreyling WG, Abdelmonem AM, Ali Z, Alves F, Geiser M, Haberl N, Hartmann R, Hirn S, de Aberasturi DJ, Kantner K, et al. In vivo integrity of polymercoated gold nanoparticles. Nature Nano. 2015;10:619–23.
138. Blanco E, Shen H, Ferrari M. Principles of nanoparticle design for overcoming biological barriers to drug delivery. Nat Biotechnol. 2015;33:941–51.
139. Albanese A, Tang PS, Chan WCW. The Effect of Nanoparticle Size, Shape, and Surface Chemistry on Biological Systems. Annu. Rev. Biomed. Eng. 2012;14:1–16.
140. Lundqvist, M.S., J.; Elia, G.; Lynch, I.; Cedervall, T.; Dawson, K.A. , Nanoparticle size and surface properties determine the protein corona with possible implications for biological impacts. Proc. Natl. Acad. Sci. U.S.A., 2008. 105: 14265–14270.
141. Foroozandeh P, Aziz AA. Merging Worlds of Nanomaterials and Biological Environment: Factors Governing Protein Corona Formation on Nanoparticles and Its Biological Consequences. Nanoscale Research Letters. 2015;10:221.
142. Wang J, Bai R, Yang R, Liu J, Tang J, Liu Y, Li J, Chai Z, Chen C. Size- and surface chemistry-dependent pharmacokinetics and tumor accumulation of engineered gold nanoparticles after intravenous administration. Metallomics. 2015;7(3):516–24.
143. Wan S, Egri G, Oddo L, Cerroni B, Dähne L, Paradossi G, Salvati A, Lynch I, Dawson KA, Monopoli MP. Biological in situ characterization of polymeric microbubble contrast agents. Int J Biochem Cell Biol. 2016;75:232–43.
144. Dobrovolskaia MA, Shurin M, Shvedova AA. Current understanding of interactions between nanoparticles and the immune system. Toxicol Appl Pharmacol. 2016;299:78–89.
145. Boraschi D, Italiani P, Palomba R, Decuzzi P, Duschl A, Fadeel B, Moghimi SM. Nanoparticles and innate immunity: new perspectives on host defence. Seminars in Immunology. 2017;34:33–51.
146. Liu Y, Hardie J, Zhang X, Rotello VM. Effects of engineered nanoparticles on the innate immune system. Seminars Immunol. 2017;34:25–32.
147. Silva AL, Peres C, Conniot J, Matos AI, Moura L, Carreira B, Sainz V, Scomparin A, Satchi-Fainaro R, Préat V, Florindo HF. Nanoparticle impact on innate immune cell pattern-recognition receptors and inflammasomes activation. Seminars Immunol. 2017;34:3–24.
148. Abukabda AB, McBride CR, Batchelor TP, Goldsmith WT, Bowdridge EC, Garner KL, Friend S, Nurkiewicz TR. Group II innate lymphoid cells and microvascular dysfunction from pulmonary titanium dioxide nanoparticle exposure. Particle and Fibre Toxicology. 2018;15(1):43.
149. Gornati R, Longo A, Rossi F, Maisano M, Sabatino G, Mauceri A, Bernardini G, Fasulo S. Effects of titanium dioxide nanoparticle exposure in Mytilus galloprovincialis gills and digestive gland. Nanotoxicology. 2016;10(6):807–17.
150. Horie M, Shimizu K, Tabei Y. Validation of metallothionein, interleukin-8, and heme oxygenase-1 as markers for the evaluation of cytotoxicity caused by metal oxide nanoparticles. Toxicol Mech Methods. 2018;28(8):630–8.
151. Xi C, Zhou J, Du S, Peng S. Autophagy upregulation promotes macrophages to escape mesoporous silica nanoparticle (MSN)-induced NF-κB-dependent inflammation. Inflammation Research. 2016;65(4):325–41.
152. Galbiati V, Cornaghi L, Gianazza E, Potenza MA, Donetti E, Marinovich M, Corsini E. In vitro assessment of silver nanoparticles immunotoxicity. Food Chem Toxicol. 2018;112:363–74.
153. Li Y, Fujita M, Boraschi D, Endotoxin Contamination in Nanomaterials Leads to the Misinterpretation of Immunosafety Results. Front Immunol. 2017;8(472).
154. Boraschi D, Tagliabue A. The interleukin-1 receptor family. Seminars Immunol. 2013;25(6):394–407.
155. Dinarello, C., Novick, D., Kim, S., Kaplanski, G., Interleukin-18 and IL-18 Binding Protein. Front Immunol, 2013. 4(289).
156. Farrera C, Fadeel B. It takes two to tango: Understanding the interactions between engineered nanomaterials and the immune system. European Journal of Pharmaceutics and Biopharmaceutics. 2015;95:3–12.
157. Himly M, Grotz B, Sageder M, Geppert M, Duschl A. Immune Frailty and Nanomaterials: The Case of Allergies. Curr Bionanotechnol. 2016;2(1):20–8.
158. Radauer-Preiml I, Andosch A, Hawranek T, Luetz-Meindl U, Wiederstein M, Horejs-Hoeck J, Himly M, Boyles M, Duschl A. Nanoparticle-allergen interactions mediate human allergic responses: protein corona characterization and cellular responses. Part Fibre Tox. 2015;13:3.
159. Gibbs, A.R., Wagner, J.C., Diseases due to silica, in Pathology of Occupational Lung Diseases, 2nd ed. , A. Churg, Green, F.H.Y., Editor. 1998, Igaku-Shoin Medical Publishers: New York. p. 155–176.
160. Honma K, Abraham JL, Chiyotani K, De Vuyst P, Dumortier P, Gibbs AR, Green FH,
Hosoda Y, Iwai K, Williams WJ, Kohyama N, Ostiguy G, Roggli VL, Shida H, Taguchi O, Vallyathan V. Proposed criteria for mixed-dust pneumoconiosis: definition, descriptions, and guidelines for pathologic diagnosis and clinical correlation. Hum Pathol. 2004;35:1515–23.
161. Vallurupalli S, Chawla K, Kupfer Y, Tessler S. Mixed dust pneumoconiosis occurring in an unusual setting. BMJ Case Rep. 2013;2013:bcr2013200976.
162. Domej W, Földes-Papp Z, Schlagenhaufen C, Wippel R, Tilz GP, Krachler M, Demel U, Lang J, Urban-Woltron H. Detection of graphite using laser microprobe mass analysis of a transbronchial biopsy from a foundry worker with mixed dust pneumoconiosis. Wien Klin Wochenschr. 2002;114:216–21.
163. Ichihara S, Li W, Omura S, Fujitani Y, Liu Y, Wang Q, Hiraku Y, Hisanaga N, Wakai K, Ding X, Kobayashi T, Ichihara G. Exposure assessment and heart rate variability monitoring in workers handling titanium dioxide particles: a pilot study. J Nanoparticle Research. 2016;18:52.
164. Fleischer N, Merialdi M, van Donkelaar A, Vadillo-Ortega F, Martin RV, Betran AP, Souza JP. Outdoor air pollution, preterm birth, and low birth weight: analysis of the world health organization global survey on maternal and perinatal health. Environ Health Perspect. 2014;122:425–30.
165. Osmond C, Barker DJ, Winter PD, Fall CH, Simmonds SJ. Early growth and death from cardiovascular disease in women. BMJ. 1993;307:1519–24.
166. Xu G, Umezawa M, Takeda K. Early development origins of adult disease caused by malnutrition and environmental chemical substances. J Health Sci. 2009;55:11–9.
167. Allen, J., Oberdorster, G, Morris-Schaffer, K, Wong, C, Klocke, C, Sobolewski, M, Conrad, K, Mayer-Proschel, M, Cory-Slechta, DA. , Developmental neurotoxicity of inhaled ambient ultrafine particle air pollution: Parallels with neuropathological and behavioral features of autism and other neurodevelopmental disorders. Neurotoxicology., 2015. S0161-813X: p. 30048-6.

ConsultAIK

Ausgewählte wissenschaftliche Publikationen

168. Raz R, Roberts AL, Lyall K, Hart JE, Just AC, Laden F, Weisskopf MG. Autism spectrum disorder and particulate matter air pollution before, during, and after pregnancy: a nested case-control analysis within the Nurses' Health Study II Cohort. Environ Health Perspect. 2015;123:264–70.

169. Woodward N, Finch CE, Morgan TE. Traffic-related air pollution and brain development. AIMS Environ Sci. 2015;2:353–73.

170. Onoda A, Umezawa M, Takeda K, Ihara T, Sugamata M. Effects of maternal exposure to ultrafine carbon black on brain perivascular macrophages and surrounding astrocytes in offspring mice. PLoS One. 2014;9:e94336.

171. Onoda A, Takeda K, Umezawa M. Dose-dependent induction of astrocyte activation and reactive astrogliosis in mouse brain following maternal exposure to carbon black nanoparticle. Part Fibre Tox. 2017a;14(1):4.

172. Onoda A, Takeda K, Umezawa M. Pretreatment with N-acetyl cysteine suppresses chronic reactive astrogliosis following maternal nanoparticle exposure during gestational period. Nanotoxicology. 2017b;11(8):1012–25.

173. Win-Shwe T, Kyi-Tha-Thu C, Moe Y, Fujitani Y, Tsukahara S, Hirano S. Exposure of BALB/c Mice to Diesel Engine Exhaust Origin Secondary Organic Aerosol (DESOA) during the Developmental Stages Impairs the Social Behavior in Adult Life of the Males. Front Neurosci. 2016;9:524.

174. Chao M, Yang CH, Lin PT, Yang YH, Chuang YC, Chung MC, Tseng CY. Exposure to PM2.5 causes genetic changes in fetal rat cerebral cortex and hippocampus. Environ Toxicol. 2017;32:1412–142.

175. Johnston HJ, Verdon R, Gillies S, Brown DM, Fernandes TF, Henry TB, Rossi AG, Tran L, Tucker C, Tyler CR, Stone V. Adoption of in vitro systems and zebrafish embryos as alternativemodels for reducing rodent use in assessments of immunological and oxidative stress responses to nanomaterials. Crit Rev Toxicol. 2018;48(3):252–71.

176. Chakraborty C, Sharma AR, Sharma G, Lee SS. Zebrafish: A complete animal model to enumerate the nanoparticle toxicity. J Nanobiotechnology. 2016;14:65.

177. Strähle U, Scholz S, Geisler R, Greiner P, Hollert H, Rastegar S, Schumacher A, Selderslaghs I, Weiss C, Witters H, Braunbeck T. Zebrafish embryos as an alternative to animal experiments--a commentary on the definition of the onset of protected life stages in animal welfare regulations. Reprod Toxicol. 2012;33:128–32.

178. Lee KJ, Nallathamby PD, Browning LM, Osgood CJ, Xu XH. In vivo imaging of transport and biocompatibility of single silver nanoparticles in early development of zebrafish embryos. ACS Nano. 2007;1:133–43.

179. Berry JP, Gantar M, Gibbs PD, Schmale MC. The zebrafish (Danio rerio) embryo as a model system for identification and characterization of developmental toxins from marine and freshwater microalgae. Comp Biochem Physiol C Toxicol Pharmacol. 2007;145:61–72.

180. Xue JY, Li X, Sun MZ, Wang YP, Wu M, Zhang CY, Wang YN, Liu B, Zhang YS, Zhao X, Feng XZ. An assessment of the impact of SiO_2 nanoparticles of different sizes on the rest/wake behavior and the developmental profile of zebrafish larvae. Small. 2013;9:3161–8.

181. Bayat N, Lopes VR, Schölermann J, Jensen LD, Cristobal S. Vascular toxicity of ultra-small TiO_2 nanoparticles and single walled carbon nanotubes in vitro and in vivo. Biomaterials. 2015;63:1–13.

182. Asharani PV, Lianwu Y, Gong Z, Valiyaveettil S. Comparison of the toxicity of silver, gold and platinum nanoparticles in developing zebrafish embryos. Nanotoxiclogy. 2011;5:43–54.

183. Ozel RE, Alkasir RS, Ray K, Wallace KN, Andreescu S. Comparative evaluation of intestinal nitric oxide in embryonic zebrafish exposed to metal oxide nanoparticles. Small. 2013;9:4250–61.

184. Truong L, Tilton SC, Zaikova T, Richman E, Waters KM, Hutchison JE, Tanguay RL. Surface functionalities of gold nanoparticles impact embryonic gene expression responses. Nanotoxicology. 2013;7:192–201.

185. Patel S, Jana S, Chetty R, Thakore S, Singh M, Devkar R. TiO_2 nanoparticles induce omphalocele in chicken embryo by disrupting Wnt signaling pathway. Sci Rep. 2018;8:4756.

186. Kurantowicz N, Sawosz E, Halik G, Strojny B, Hotowy A, Grodzik M, Piast R, Pasanphan W, Chwalibog A. Toxicity studies of six types of carbon nanoparticles in a chicken-embryo model. Int J Nanomedicine. 2017;12:2887–98.

187. Samak DH, El-Sayed YS, Shaheen HM, El-Far AH, Onoda A, Abdel-Daim MM, Umezawa M. In-ovo exposed carbon black nanoparticles altered mRNA gene transcripts of antioxidants, proinflammatory and apoptotic pathways in the brain of chicken embryos. Chem Biol Interact. 2018; 295:133–9.

188. Strojny B, Grodzik M, Sawosz E, Winnicka A, Kurantowicz N, Jaworski S, Kutwin M, Urbańska K, Hotowy A, Wierzbicki M, Chwalibog A. Diamond Nanoparticles Modify Curcumin Activity: In Vitro Studies on Cancer and Normal Cells and In Ovo Studies on Chicken Embryo Model. PLoS One. 2016;11:e0164637.

189. Reiter LT, Potocki L, Chien S, Gribskov M, Bier E. A systematic analysis of human disease-associated gene sequences in Drosophila melanogaster. Genome Res. 2001;11:1114–25.

190. Vega-Alvarez S, Herrera A, Rinaldi C, Carrero-Martínez FA. Tissue-specific direct microtransfer of nanomaterials into Drosophila embryos as a versatile in vivo test bed for nanomaterial toxicity assessment. Int J Nanomedicine. 2014;9:2031–41.

191. Takeda K, Suzuki K, Ishihara A, Kubo-Irie M, Fujimoto R, Tabata M, Oshio S, Nihei Y, Ihara T, Sugamata M. Nanoparticles transferred from pregnant mice to their offspring can damage the genital and cranial nerve systems. J Health Sci. 2009;55:95–102.

192. Wick P, Malek A, Manser P, Meili D, Maeder-Althaus X, Diener L, Diener PA, Zisch A, Krug HF, von Mandach U. Barrier capacity of human placenta for nanosized materials. Environ Health Perspect. 2010;118:432–6.

193. Kubo-Irie M, Uchida H, Mastuzawa S, Yoshida Y, Shinkai Y, Suzuki K, Yokota S, Oshio S, Takeda K. Dose-dependent biodistribution of prenatal exposure to rutile-type titanium dioxide nanoparticles on mouse testis. J Nanopart Res. 2014;16:2284.

194. Semmler-Behnke M, Lipka J, Wenk A, Hirn S, Schäffler M, Tian F, Schmid G, Oberdörster G, Kreyling WG. Size dependent translocation and fetal accumulation of gold nanoparticles from maternal blood in the rat. Part Fibre Toxicol. 2014;11:33.

195. Yang H, Sun C, Fan Z, Tian X, Yan L, Du L, Liu Y, Chen C, Liang XJ, Anderson GJ, Keelan JA, Zhao Y, Nie G. Effects of gestational age and surface modification on materno-fetal transfer of nanoparticles in murine pregnancy. Sci Rep. 2012;2:847.

196. Grafmueller S, Manser P, Diener L, Maurizi L, Diener PA, Hofmann H, Jochum W, Krug HF, Buerki-Thurnherr T, von Mandach U, Wick P. Transfer studies of polystyrene nanoparticles in the ex vivo human placenta perfusion model: key sources of artifacts. Sci Technol Adv Mater. 2015;16:044602.

197. Myllynen P, Loughran MJ, Howard CV, Sormunen R, Walsh AA, Vähäkangas KH. Kinetics of gold nanoparticles in the human placenta. Reprod Toxicol. 2008;26:130–7.

198. Hougaard K, Jackson P, Jensen KA, Sloth JJ, Löschner K, Larsen EH, Birkedal RK, Vibenholt A, Boisen AM, Wallin H, Vogel U. Effects of prenatal exposure to surface-coated nanosized titanium dioxide (UV-Titan). A study in mice. Part Fibre Toxicol. 2010;7:16.

199. Kannan S, Misra DP, Dvonch JT, Krishnakumar A. Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework for exploring potential effect modification by nutrition. Environ Health Perspect. 2006;114:1636–42.

200. Fedulov A, Leme A, Yang Z, Dahl M, Lim R, Mariani TJ, Kobzik L. Pulmonary exposure to particles during pregnancy causes increased neonatal asthma susceptibility. Am J Respir Cell Mol Biol. 2008;38:57–67.

201. Jackson P, Vogel U, Wallin H, Hougaard KS. Prenatal exposure to carbon black (printex 90): effects on sexual development and neurofunction. Basic Clin Pharmacol Toxicol. 2011;109:434–7.

202. Lamoureux D, Kobzik L, Fedulov AV. Customized PCR-array analysis informed by gene-chip microarray and biological hypothesis reveals pathways involved in lung inflammatory response to titanium dioxide in pregnancy. J Toxicol Environ Health A. 2010;73:596–606.

203. Jackson P, Hougaard KS, Boisen AM, Jacobsen NR, Jensen KA, Møller P, Brunborg G, Gutzkow KB, Andersen O, Loft S, Vogel U, Wallin H. Pulmonary exposure to carbon black by inhalation or instillation in pregnant mice: effects on liver DNA strand breaks in dams and offspring. Nanotoxicology. 2012a;6:486–500.

204. Jackson P, Halappanavar S, Hougaard KS, Williams A, Madsen AM, Lamson JS, Andersen O, Yauk C, Wallin H, Vogel U. Maternal inhalation of surfacecoated nanosized titanium dioxide (UV-Titan) in C57BL/6 mice: effects in prenatally exposed offspring on hepatic DNA damage and gene expression. Nanotoxicology. 2013;7:85–96.

205. Yoshida S, Hiyoshi K, Ichinose T, Takano H, Oshio S, Sugawara I, Takeda K, Shibamoto T. Effect of nanoparticles on the male reproductive system of mice. Int J Androl. 2009;32:337–42.

206. Yoshida S, Hiyoshi K, Oshio S, Takano H, Takeda K, Ichinose T. Effects of fetal exposure to carbon nanoparticles on reproductive function in male offspring. Fertil Steril. 2010;93:1695–9.

207. Boisen A, Shipley T, Jackson P, Hougaard KS, Wallin H, Yauk CL, Vogel U. NanoTIO2 (UV-Titan) does not induce ESTR mutations in the germline of prenatally exposed female mice. Part Fibre Toxicol. 2012;9:19.

208. Boisen A, Shipley T, Jackson P, Wallin H, Nellemann C, Vogel U, Yauk CL, Hougaard KS. In utero exposure to nanosized carbon black (Printex90) does not induce tandem repeat mutations in female murine germ cells. Reprod Toxicol. 2013;41:45–8.

209. Hougaard K, Jackson P, Kyjovska ZO, Birkedal RK, De Temmerman PJ, Brunelli A, Verleysen E, Madsen AM, Saber AT, Pojana G, Mast J, Marcomini A, Jensen KA, Wallin H, Szarek J, Mortensen A, Vogel U. Effects of lung exposure to carbon nanotubes on female fertility and pregnancy. A study in mice. Reprod Toxicol. 2013;41:86–97.

210. Ritz C, Ruminski W, Hougaard KS, Wallin H, Vogel U, Yauk CL. Germline mutation rates in mice following in utero exposure to diesel exhaust particles by maternal inhalation. Mutat Res. 2011;712:55–8.

211. Kyjovska Z, Boisen AM, Jackson P, Wallin H, Vogel U, Hougaard KS. Daily sperm production: application in studies of prenatal exposure to nanoparticles in mice. Reprod Toxicol. 2013;36:88–97.

212. Shimizu R, Umezawa M, Okamoto S, Onoda A, Uchiyama M, Tachibana K, Watanabe S, Ogawa S, Abe R, Takeda K. Effect of maternal exposure to carbon black nanoparticle during early gestation on the splenic phenotype of neonatal mouse. J Toxicol Sci. 2014;39:571–8.

213. El-Sayed Y, Shimizu R, Onoda A, Takeda K, Umezawa M. Carbon black nanoparticle exposure during middle and late fetal development induces immune activation in male offspring mice. Toxicology. 2015;327:53–61.

214. Sugamata M, Ihara T, Takano H, Oshio S, Takeda K. Maternal diesel exhaust exposure damages newborn murine brains. J Health Sci. 2006a;52:82–4.

215. Sugamata M, Ihara T, Sugamata M, Takeda K. Maternal exposure to diesel exhaust leads to pathological similarity to autism in newborns. J Health Sci. 2006b;52:486–8.

216. Tachibana K, Takayanagi K, Akimoto A, Ueda K, Shinkai Y, Umezawa M, Takeda K. Prenatal diesel exhaust exposure disrupts the DNA methylation profile in the brain of mouse offspring. J Toxicol Sci. 2015;40:1–11.

217. Suzuki T, Oshio S, Iwata M, Saburi H, Odagiri T, Udagawa T, Sugawara I, Umezawa M, Takeda K. In utero exposure to a low concentration of diesel exhaust affects spontaneous locomotor activity and monoaminergic system in male mice. Part Fibre Toxicol. 2010;7:7.

218. Yokota S, Moriya N, Iwata M, Umezawa M, Oshio S, Takeda K. Exposure to diesel exhaust during fetal period affects behavior and neurotransmitters in male offspring mice. J Toxicol Sci. 2013;38:13–23.

219. Okada Y, Tachibana K, Yanagita S, Takeda K. Prenatal exposure to zinc oxide particles alters monoaminergic neurotransmitter levels in the brain of mouse offspring. J Toxicol Sci. 2013;38:363–70.

220. Takahashi Y, Mizuo K, Shinkai Y, Oshio S, Takeda K. Prenatal exposure to titanium dioxide nanoparticles increases dopamine levels in the prefrontal cortex and neostriatum of mice. J Toxicol Sci. 2010;35:749–56.

221. Shimizu M, Tainaka H, Oba T, Mizuo K, Umezawa M, Takeda K. Maternal exposure to nanoparticulate titanium dioxide during the prenatal period alters gene expression related to brain development in the mouse. Part Fibre Toxicol. 2009;6:20.

222. Umezawa M, Tainaka H, Kawashima N, Shimizu M, Takeda K. Effect of fetal exposure to titanium dioxide nanoparticle on brain development - brain region information. J Toxicol Sci. 2012;37:1247–52.

223. Kumamoto T, Tsukue N, Takano H, Takeda K, Oshio S. Fetal exposure to diesel exhaust affects X-chromosome inactivation factor expression in mice. J Toxicol Sci. 2013;38:245–54.

224. Thirtamara Rajamani K, Doherty-Lyons S, Bolden C, Willis D, Hoffman C, Zelikoff J, Chen LC, Gu H. Prenatal and early-life exposure to high-level diesel exhaust particles leads to increased locomotor activity and repetitive behaviors in mice. Autism Res. 2013;6:248–57.

225. Allen JL, Oberdorster G, Morris-Schaffer K, Wong C, Klocke C, Sobolewski M, Conrad K, Mayer-Proschel M, Cory-Slechta DA. Developmental neurotoxicity of inhaled ambient ultrafine particle air pollution: Parallels with neuropathological and behavioral features of autism and other neurodevelopmental disorders. Neurotoxicology. 2017;59:140–54.

226. Allen JL, Liu X, Weston D, Prince L, Oberdörster G, Finkelstein JN, Johnston CJ, Cory-Slechta DA. Developmental Exposure to Concentrated Ambient Ultrafine Particulate Matter Air Pollution in Mice Results in Persistent and Sex-Dependent Behavioral Neurotoxicity and Glial Activation. Toxicol Sci. 2014;140:160–78.

227. Engler-Chiurazzi E, Stapleton PA, Stalnaker JJ, Ren X, Hu H, Nurkiewicz TR, McBride CR, Yi J, Engels K, Simpkins JW. Impacts of prenatal nanomaterial exposure on male adult Sprague-Dawley rat behavior and cognition. J Toxicol Environ Health A. 2016;79:447–52.

228. Jackson P, Hougaard KS, Vogel U, Wu D, Casavant L, Williams A, Wade M, Yauk CL, Wallin H, Halappanavar S. Exposure of pregnant mice to carbon black by intratracheal instillation: Toxicogenomic effects in dams and offspring. Mutat Res. 2012;745:73–83.

229. Mato M, Ookawara S, Sakamoto A, Aikawa E, Ogawa T, Mitsuhashi U, Masuzawa T, Suzuki H, Honda M, Yazaki Y, Watanabe E, Luoma J, Yla-Herttuala S, Fraser I, Gordon S, Kodama T. Involvement of specific macrophage-lineage cells surrounding arterioles in barrier and scavenger function in brain cortex. Proc Natl Acad Sci U S A. 1996;93: 3269–74.

230. Williams K, Alvarez X, Lackner AA. Central nervous system perivascular cells are immunoregulatory cells that connect the CNS with the peripheral immune system. Glia. 2001;36:156–64.

231. Umezawa M, Onoda A, Korshunova I, Jensen ACØ, Koponen IK, Jensen KA, Khodosevich K, Vogel U, Hougaard KS. Maternal inhalation of carbon black nanoparticles induces neurodevelopmental changes in mouse offspring. Part Fibre Tox. 2018;15(1):36.

232. Powers C, Bale AS, Kraft AD, Makris SL, Trecki J, Cowden J, Hotchkiss A, Gillespie PA. Developmental neurotoxicity of engineered nanomaterials: identifying research needs to support human health risk assessment. Toxicol Sci. 2013;134:225–42.

233. Weinstein P, Horwell CJ, Cook A. Volcanic emissions and health. In: Selinus O, Alloway B, Centeno JA, Finkelman RB, Fuge R, Lindh U, Smedley P, editors. Essentials of medical geology. Netherlands: Springer Dordrecht; 2013. p. 217–38.

234. Henderson SB, Brauer M, MacNab YC, Kennedy SM. Three measures of forest fire smoke exposure and their associations with respiratory and cardiovascular health outcomes in a population-based cohort. Environ Health Perspect. 2011;119:1266–71.

235. Derbyshire E. Natural minerogenic dust and human health. Ambio. 2007;36:73–7.

236. Griffin DW, Kellogg CA, Shinn EA. Dust in the wind: long range transport of dust in the atmosphere and its implications for global public and ecosystem health. Global Change Human Health. 2001;2:20–33.

237. Davidson CI, Phalen RF, Solomon PA. Airborne particulate matter and human health: a review. Aerosol Sci Technol. 2005;39:737–49.

238. Kahn ME. The death toll from natural disasters: the role of income, geography, and institutions. Review Econ Stat. 2005;87:271–84.

239. Silva RA, West JJ, Zhang Y, Anenberg SC, Lamarque JF, Shindell DT, Collins WJ, Dalsoren S, Faluvegi G, Folberth G, Horowitz LW. Global premature mortality due to anthropogenic outdoor air pollution and the contribution of past climate change. Environ Res Letters. 2013;8:034005.

240. Lenton TM, Caldeira KG, Franck SA, Horneck G, Jolly A, Rabbow E, Schellnhuber HJ, Szathmáry E, Westall F, Zavarzin GA, Zimmermann-Timm H. Group Report: Long-term Geosphere–Biosphere Coevolution and Astrobiology. In: Schellnhuber HJ, Crutzen PJ, Clark WC, Claussen M, Held H, editors. Earth System Analysis for Sustainability. Massachusetts: MIT Press; 2004. p. 11–140.

241. Hewitt G. The genetic legacy of the Quaternary ice ages. Nature. 2000;405:907–13.

242. Xu J, Campbell JM, Zhang N, Hickey WJ, Sahai N. Did mineral surface chemistry and toxicity contribute to evolution of microbial extracellular polymeric substances? Astrobiology. 2012;12:785–98.

243. Graves JL Jr, Tajkarimi M, Cunningham Q, Campbell A, Nonga H, Harrison SH, Barrick JE. Rapid evolution of silver nanoparticle resistance in Escherichia coli. Front Genetics. 2015;6.

244. Jacobs FM, Greenberg D, Nguyen N, Haeussler M, Ewing AD, Katzman S, Paten B, Salama SR, Haussler D. An evolutionary arms race between KRAB zinc-finger genes ZNF91/93 and SVA/L1 retrotransposons. Nature. 2014;516:242–5.

245. Sharratt BS, Tatarko J, Abatzoglou JT, Fox FA, Huggins D. Implications of climate change on wind erosion of agricultural lands in the Columbia Plateau. Weather Climate Extremes. 2015;10:20–31.

246. Vierkötter A, Schikowski T, Ranft U, Sugiri D, Matsui M, Krämer U, Krutmann J. Airborne particle exposure and extrinsic skin aging. J Investigative Dermatol. 2010;130:2719–26.

247. Kim KE, Cho D, Park HJ. Air pollution and skin diseases: Adverse effects of airborne particulate matter on various skin diseases. Life Sciences. 2016;152:126–34.

248. Fao W. CODEX Alimentarius - International Food Standards; 2018.

249. Anonymous, The Food Safety Act. Chapter 16. London: HMSO; 1990. http://www.legislation.gov.uk/ukpga/1990/16/pdfs/ukpga_19900016_en.pdf. Accessed 18 Apr 2018.

250. Gitrowski C, Al-Jubory AR, Handy RD. Uptake of different crystal structures of TiO_2 nanoparticles by Caco-2 intestinal cells. Toxicology Letters. 2014;226:264–76.

251. Millette JR, Clark PJ, Stober J, Rosenthal M. Asbestos in water supplies of the United States. Environ Health Perspect. 1983;53:45–8.

252. Sigurdson EE, Levy BS, Mandel J, McHugh R, Michienzi LJ, Jagger H, Pearson J. Cancer morbidity investigations: lessons from the Duluth study of possible effects of asbestos in drinking water. Environ Res. 1981;25:50–61.

253. Bouwmeester H, Hollman PC, Peters RJ. Potential health impact of environmentally released micro-and nanoplastics in the human food production chain: experiences from nanotoxicology. Environ Sci Technol. 2015;49:8932–47.

254. Chaudhry Q, Scotter M, Blackburn J, Ross B, Boxall A, Castle L, Aitken R, Watkins R. Applications and implications of nanotechnologies for the food sector. Food Addit Contam. 2008;25:241–58.

255. Tiede K, Hanssen SF, Westerhoff P, Fern GJ, Hankin SM, Aitken RJ, Chaudhry Q, Boxall AB. How important is drinking water exposure for the risks of engineered nanoparticles to consumers? Nanotoxicology. 2016;10:102–10.

256. Von der Kammer F, Ferguson PL, Holden PA, Masion A, Rogers KR, Klaine SJ, Koelmans AA, Horne N, Unrine JM. Analysis of engineered nanomaterials in complex matrices (environment and biota): general considerations and conceptual case studies. Environm Toxicol Chem. 2012;31:32–49.

257. Gottschalk F, Sonderer T, Scholz RW, Nowack B. Modeled environmental concentrations of engineered nanomaterials (TiO_2, ZnO, Ag, CNT, fullerenes) for different regions. Environ Sci Technol. 2009;43:9216–22.

258. Gottschalk F, Sun T, Nowack B. Environmental concentrations of engineered nanomaterials: review of modeling and analytical studies. Environ Pollution. 2013;181:287–300.

259. Handy RD, Ahtiainen J, Navas JM, Goss G, Bleeker EAJ, von der Kammer F. Proposal for a tiered dietary bioaccumulation testing strategy for engineered nanomaterials using fish. Environ Sci Nano. 2018;5:2030–46.

260. Aronson JC, Blatt CM, Aronson TB. Restoring ecosystem health to improve human health and well-being: physicians and restoration ecologists unite in a common cause. Ecol Soc. 2016;21:39.

261. Bayles BR, Brauman KA, Adkins JN, Allan BF, Ellis AM, Goldberg TL, Golden CD, Grigsby-Toussaint DS, Myers SS, Osofsky SA, Ricketts TH. Ecosystem services connect environmental change to human health outcomes. EcoHealth. 2016;13:443–9.

262. Sandifer PA, Sutton-Grier AE, Ward BP. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. Ecosystem Services. 2015;2:1–15.

263. Paoletti E, Schaub M, Matyssek R, Wieser G, Augustaitis A, Bastrup-Birk AM, Bytnerowicz A, Günthardt-Goerg MS, Müller-Starck G, Serengil Y. Advances of air pollution science: from forest decline to multiple-stress effects on forest ecosystem service. Environ Pollution. 2010;158:1986–9.

264. Webster I. Silicosis in South Africa. In: Proceedings of the International Conference on Pneumoconiosis, 1969. Johannesburg: Publisher: Oxford University Press, Cape Town; 1970.

265. Simson FW. Pulmonary Asbestosis in South Africa. Br Med J. 1928;1(May 26; 3516):885–7.

266. Middleton EL. Report on the International Conference on Silicosis. London: His Majesty's Stationery Office; 1931.

267. Goldstein B, Webster I. Coal workers' pneumoconiosis in South Africa. Ann N Y Acad Sci. 1972;200:306–15.

268. Cummins SL. Pneumonoconiosis: With Special Reference to the Silico-Anthracosis of Coal Miners. Br Med J. 1935;2(3893):287–90.

269. Gough J. The pathology of pneumoconiosis. Postgrad Med J. 1949;25(290): 611–8 illust.

270. Seaton A. Historical perspective fifty years of particles: a personal retrospect. Part Fibre Toxicol. 2011;8:35.

271. ILO. Silicosis Records of the International Conference held at Johannesburg 13-27 August 1930. in http://www.ugr.es/~amenende/investigacion/ILOSilicosis-Conference-1930.pdf. 1930. PS Kimg & Sons Ltd, London.

272. Wagner, J.C. Some Pathological Aspects of Asbestos in the Union of South Africa. in Proceedings of the Pneumoconiosis. 1959. The University of Witwatersrand, Johannesburg, 1960: J. & A. Churchhill Ltd, (London).

273. Wagner JC, Sleggs CA, Marchand P. Diffuse pleural mesothelioma and asbestos exposure in the North Western Cape Province. Br J Ind Med. 1960; 17:260–71.

274. Wagner JC. Experimental production of mesothelial tumours of the pleura by implantation of dusts in laboratory animals. Nature. 1962;196:180–1.

275. Wagner JC. Asbestosis in experimental animals. Br J Ind Med. 1963;20:1–12.

276. Jacobsen M, Rae S, Walton WH, Rogan JM. The relation between pneumoconiosis and dust-exposure in British coal mines. Inhaled Part. 1970;2:903–19.

277. McCrae, J., The ash of silicotic lungs, in The South African Institute for Medical Research. 1913: Johannesburg.

278. Orenstein, A.J., Proceedings of the Pneumoconiosis Conference, Johannesburg 1959, 8-11. Edited by AJ Orenstein. Published by J & A Churchil Ltd, London. 1960.

279. Orenstein AJ. The history of pneumoconiosis; a brief review. S Afr Med J. 1957;31(32):797–802.

280. Goldstein, B. Animal experiments on important parameters of dust in relation to the production of fibrosis. in Proceedings of the Pneumoconiosis Conference, Johannesburg. 1959. Published by J & A Chrchill Ltd, London, 94-107. 1960.

281. King EJ, Mohanty GP, Harrison CV, Nagelschmidt G. The action of different forms of pure silica on the lungs of rats. Br J Ind Med. 1953;10(1):9–17.

282. Beadle, D.G. and A.A. Bradley. The composition of airborne dust in South African gold mines. Pneumoconiosis, Proceedings of the International Conference, Johannesburg, 1969. 1970. Oxford University Press.

283. Stanton MF, Layard M, Tegeris A, Miller E, May M, Morgan E, Smith A. Relation of particle dimension to carcinogenicity in amphibole asbestoses and other fibrous minerals. J Natl Cancer Inst. 1981;67(5): 965–75.

284. Stanton MF, Laynard M, Tegeris A, Miller E, May M, Kent E. Carcinogenicity of fibrous glass: pleural response in the rat in relation to fiber dimension. J Natl Cancer Inst. 1977;58(3):587–603.

285. Turgeon F, Devries J, Thompson AG. Asbestos and Cancer; the Report and Recommendations of a Working Group Convened under the Auspices of the Geographical Pathology Committee of the International Union against Cancer. Can Med Assoc J. 1965;92:1020–5.

286. UICC. Report and recommendations of the working group on asbestos and cancer: Convened under the auspices of the Geographical Pathology Committee of the International Union against Cancer (U.I.C.C.). Br J Ind Med. 1965;22(3):165–71.

287. Timbrell V, Gibson JC, Webster I. UICC standard reference samples of asbestos. Int J Cancer. 1968;3(3):406–8.

288. Timbrell V, Rendall REG. Preparation of the Union Internationale Contre le Cancer (UICC) Standard Reference Samples of Asbestos. Powder Tech. 1971/72;5:279–87.

289. Timbrell, V. Characteristics of the International Union Against Cancer standard reference samples of asbestos. In: Pneumoconiosis Proceedings of International Conference, Johannesburg, 1969. Ed. HA Shapiro. Oxford University Press, Cape Town, , p 28. 1970.

290. Marasas LW, Harington JS. Some oxidative and hydroxylative actions of quartz: their possible relationship to the development of silicosis. Nature. 1960;188:1173–4.

291. Marasas LW. The redox properties of quartz, some of its derivatives, and other dusts: their possible implication in the genesis of the pneumoconiosis. La Medicina del Lavoro. 1964;55(10):579–88.

292. Johnson GR, Scholes G, Weiss J. Formation of keto acids from alpha amino acids by the action of free radicals in aqueous solution. Science. 1951; 114(2964):412–3.

293. Nutt, A., Harington, J. S., The reaction of reduced glutathione with quartz powder and with associated iron and copper. .La Medicina del Lavoro, 1964. 55(3): p. 176-183.

294. Vigliani, E.C., Pernis, B., Monaco, L., A study of the action of quartz particles on macrophages in vitro. In: Inhaled Particles and Vapours (C. N. Davis, Ed.), Pergamon Press, London, , pp. 348-353. 1961.

295. Dale JC, King EJ. Adsorption of dyes, amino acids, proteins, and metal hydroxides on quartz. AMA Arch Ind Hyg Occup Med. 1953;7(6):484–9.

296. Harington JS, Smith M. Studies of Hydrocarbons in Mineral Dusts. The Elution of 3:4-Benzpyrene and Oils from Asbestos and Coal Dusts by Serum. Arch Environ Health. 1964;8:453–8.

297. Selikoff IJ, Hammond EC, Churg J. Asbestos exposure, smoking, and neoplasia. JAMA. 1968;204(2):106–12.

298. Jaurand MC, Bignon J, Sebastien P, Goni J. Leaching of chrysotile asbestos in human lungs. Correlation with in vitro studies using rabbit alveolar macrophages. Environ Res. 1977;14(2):245–54.

299. Denny JJ, Robson WD, Irwin DA. The Prevention of Silicosis by Metallic Aluminum Ii. Can Med Assoc J. 1939;40(3):213–28.

300. Sutton DA. The chemical approach to therapy in the pneumoconiosis. In: Proceedings of the Pneumoconiosis Conference, vol. 1960. Johannesburg: J & A Churchill Ltd.; 1959.

301. Marks J. The neutralization of silica toxicity in vitro. Br J Ind Med. 1957;14(2):81–4.

302. Marks J. Further studies of the neutralization of silica toxicity in vitro. Br J Ind Med. 1959;16(2):166–9.

303. Marks J, James DM, Morris TG. The treatment of experimental silicosis with compound 48/80. Br J Ind Med. 1958;15(1):1–7.

304. Nordlander NB. The use of a new histamine liberating substance, compound 48/80, in human subjects. Acta Med Scand. 1957;157(3):235–40.

305. Schlipkoter H. Brockhaus, A, The action of polyvinylpyridine on experimental silicosis. Dtsch Med Wochenschr. 1960;85:920–3.

306. Schlipkoter HW, Brockhaus A. Die Hemmung der experimentellen Silikose durch subcutane Verbreichung von poly-vinylpyridine-N-oxyd. Klin Wochenschr. 1961;39:1182–9.

307. Holt PF. Poly (vinylpyridine oxides) in pneumoconiosis research. Br J Ind Med. 1971;28(1):72–7.

308. Goldstein, B. Animal experiments on important parameters of dust in relation to the production of fibrosis. in Proceedings of the Pneumoconiosis Conference, Johannesburg. Ed AJ Orenstein. 1969. JA Churchill Ltd, London, 441-443. 1970.

309. Stöber W. Chemische Adsorption von Methylchlorsilanen an kristallinem und amorphem Siliziumdioxyd. Kolloid-Zeitschrift. 1956;149(1):39–46.

310. Donaldson K, Borm P. Particle paradigms. Inhalation Toxicol. 2000; 12(Suppl 3):1–6.

311. Donaldson K, Stone V, Tran CL, Kreyling W, Borm PJ. Nanotoxicology. Occup Environ Med. 2004;61(9):727–8.

312. Wagner JC, Berry G. Mesotheliomas in rats following inoculation with asbestos. Br J Cancer. 1969;23(3):567–81.

313. Wagner JC, Berry G, Timbrell V. Mesotheliomata in rats after inoculation with asbestos and other materials. Br J Cancer. 1973;28(2):173–85.

314. Chamberlain M, Brown RC. The cytotoxic effects of asbestos and other mineral dust in tissue culture cell lines. Br J Exp Pathol. 1978;59(2):183–9.

315. Davis JM, Addison J, Bolton RE, Donaldson K, Jones AD, Smith T. The pathogenicity of long versus short fibre samples of amosite asbestos administered to rats by inhalation and intraperitoneal injection. Br J Exp Pathol. 1986;67(3):415–30.

316. Goodglick LA, Kane AB. Cytotoxicity of long and short crocidolite asbestos fibers in vitro and in vivo. Cancer Res. 1990;50(16):5153–63.

317. Ferin J, Oberdorster G. Biological effects and toxicity assessment of titanium dioxides: anatase and rutile. Am Ind Hyg Assoc J. 1985;46(2):69–72.

318. Szyba K, Lange A. Presentation of benzo(a) pyrene to microsomal enzymes by asbestos fibers in the Salmonella/mammalian microsome mutagenicity test. Environ Health Perspect. 1983;51:337–41.

319. Mossman BT, Eastman A, Landesman JM, Bresnick E. Effects of crocidolite and chrysotile asbestos on cellular uptake and metabolism of benzo(a) pyrene in hamster tracheal epithelial cells. Environ Health Perspect. 1983;51: 331–5.

320. Eastman A, Mossman BT, Bresnick E. Influence of asbestos on the uptake of benzo(a) pyrene and DNA alkylation in hamster tracheal epithelial cells. Cancer Res. 1983;43(3):1251–5.

321. Wallace WE Jr, Vallyathan V, Keane MJ, Robinson V. In vitro biologic toxicity of native and surface-modified silica and kaolin. J Toxicol Environ Health. 1985;16(3-4):415–24.

322. Jaurand MC, Gaudichet A, Halpern S, Bignon J. In vitro biodegradation of chrysotile fibres by alveolar macrophages and mesothelial cells in culture: comparison with a pH effect. Br J Ind Med. 1984;41(3):389–95.

323. Thomassin JH, Touray JC, Baillif P, Jaurand MC, Magne L, Goni J. Surface interaction between chrysotile and solutions (dissolution and adsorption): systematic x-ray photoelectron spectroscopy studies. IARC Sci Publ. 1980;30:105–12.

324. Weitzman SA, Graceffa P. Asbestos catalyzes hydroxyl and superoxide radical generation from hydrogen peroxide. Arch Biochem Biophys. 1984; 228(1):373–6.

325. Gulumian M, van Wyk JA. Hydroxyl radical production in the presence of fibres by a Fenton-type reaction. Chem Biol Interact. 1987;62(1):89–97.

326. Fubini B, Giamello E, Volante M, Bolis V. Chemical functionalities at the silica surface determining its reactivity when inhaled. Formation and reactivity of surface radicals. Toxicol Ind Health. 1990;6(6):571–98.

327. Vallyathan V, Shi XL, Dalal NS, Irr W, Castranova V. Generation of free radicals from freshly fractured silica dust. Potential role in acute silica-induced lung injury. Am Rev Respir Dis. 1988;138(5):1213–9.

328. Pezerat H, Zalma R, Guignard J, Jaurand MC. Production of oxygen radicals by the reduction of oxygen arising from the surface activity of mineral fibres. IARC Sci Publ. 1989;90:100–11.

329. Gulumian M, Kilroe-Smith TA. Crocidolite-induced lipid peroxidation in rat lung microsomes. I. Role of different ions. Environ Res. 1987;43(1):267–73.

330. Zsoldos T, Tigyi A, Montsko T, Puppi A. Lipid peroxidation in the membrane damaging effect of silica-containing dust on rat lungs. Exp Pathol. 1983; 23(2):73–7.

331. Shi XL, Dalal NS, Vallyathan V. ESR evidence for the hydroxyl radical formation in aqueous suspension of quartz particles and its possible significance to lipid peroxidation in silicosis. J Toxicol Environ Health. 1988; 25(2):237–45.

332. Jajte J, Lao I, Wisniewska-Knypl JM. Enhanced lipid peroxidation and lysosomal enzyme activity in the lungs of rats with prolonged pulmonary deposition of crocidolite asbestos. Br J Ind Med. 1987;44(3):180–6.

333. Gulumian M, Sardianos F, Kilroe-Smith T, Ockerse G. Lipid peroxidation in microsomes induced by crocidolite fibres. Chem Biol Interact. 1983;44(1-2):111–8.

334. Gulumian, M., van Wyk, J. .A., Lipid peroxidation by mineral dusts and fibres: ESR studies of oxygen uptake during peroxidation of lipids in multilamellar liposomes. S Afr J Sc, 1991. 87: p. 591-594.

335. Lund LG, Aust AE. Iron mobilization from asbestos by chelators and ascorbic acid. Arch Biochem Biophys. 1990;278(1):61–4.

336. Gulumian M, Bhoolia DJ, Theodorou P, Röllin HB, Pollak H, van Wyk JA. Parameters which determine the activity of the transition metal iron in crocidolite asbestos: ESR, Mössbauer and iron mobilization studies. S Afr J Sci. 1993;89:405–9.

337. Klockars M, Hedenborg M, Vanhala E. Effect of two particle surfacemodifying agents, polyvinylpyridine-N-oxide and carboxymethylcellulose, on the quartz and asbestos mineral fiber-induced production of reactive oxygen metabolites by human polymorphonuclear leukocytes. Arch Environ Health. 1990;45(1):8–14.

338. Donaldson K, Cullen RT. Chemiluminescence of asbestos-activated macrophages. Br J Exp Pathol. 1984;65(1):81–90.

339. Hedenborg M, Klockars M. Quartz-dust-induced production of reactive oxygen metabolites by human granulocytes. Lung. 1989;167(1):23–32.

340. Hansen K, Mossman BT. Generation of superoxide (O_2 -.) from alveolar macrophages exposed to asbestiform and nonfibrous particles. Cancer Res. 1987;47(6):1681–6.

341. Donaldson K, Davis JM, James K. Asbestos-activated peritoneal macrophages release a factor(s) which inhibits lymphocyte mitogenesis. Environ Res. 1984;35(1):104–14.

342. Bissonnette E, Rola-Pleszczynski M. Pulmonary inflammation and fibrosis in a murine model of asbestosis and silicosis. Possible role of tumor necrosis factor. Inflammation. 1989;13(3):329–39.

343. Dubois CM, Bissonnette E, Rola-Pleszczynski M. Asbestos fibers and silica particles stimulate rat alveolar macrophages to release tumor necrosis factor. Autoregulatory role of leukotriene B4. Am Rev Respir Dis. 1989; 139(5):1257–64.

344. Piguet PF, Collart MA, Grau GE, Sappino AP, Vassalli P. Requirement of tumour necrosis factor for development of silica-induced pulmonary fibrosis. Nature. 1990;344(6263):245–7.

345. Goodglick LA, Kane AB. Role of reactive oxygen metabolites in crocidolite asbestos toxicity to mouse macrophages. Cancer Res. 1986;46(11):5558–66.

346. Mossman BT, Marsh JP, Shatos MA, Doherty J, Gilbert R, Hill S. Implication of active oxygen species as second messengers of asbestos toxicity. Drug Chem Toxicol. 1987;10(1-2):157–80.

NCBI Resources

PMC

US National Library of Medicine
National Institutes of Health

BMC Part of Springer Nature

Particle and Fibre Toxicology

DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

BASE

Bielefeld Academic Search Engine

PNAS Proceedings of the National Academy of Sciences of the United States of America

- Über 400 wissenschaftliche Publikationen,
- Monatlich neue!

Meta Studie – April 2019

Particle and Fibre Toxicology

Home About Articles Submission Guidelines

Review | Open Access | Published: 23 April 2019

Particle toxicology and health - where are we?

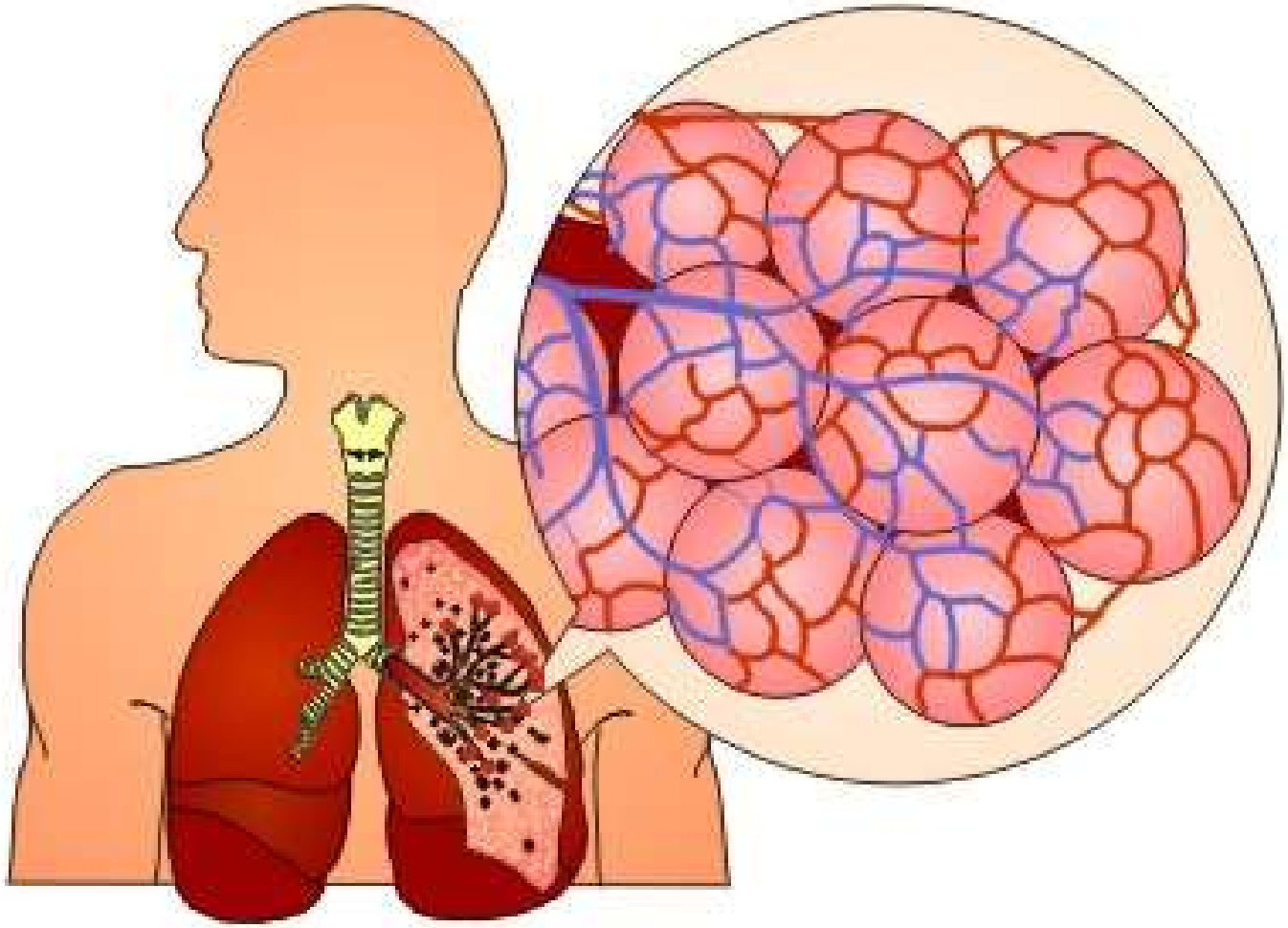
Michael Riediker, Daniele Zink, Wolfgang Kreyling, Günter Oberdörster, Alison Elder, Uschi Graham, Iseult Lynch, Albert Duschl, Gaku Ichihara, Sahoko Ichihara, Takahiro Kobayashi, Naomi Hisanaga, Masakazu Umezawa, Tsun-Jen Cheng, Richard Handy, Mary Gulumian, Sally Tinkle & Flemming Cassee

Particle and Fibre Toxicology **16**, Article number: 19 (2019) | Cite this article

5171 Accesses | **5** Citations | **1** Altmetric | Metrics

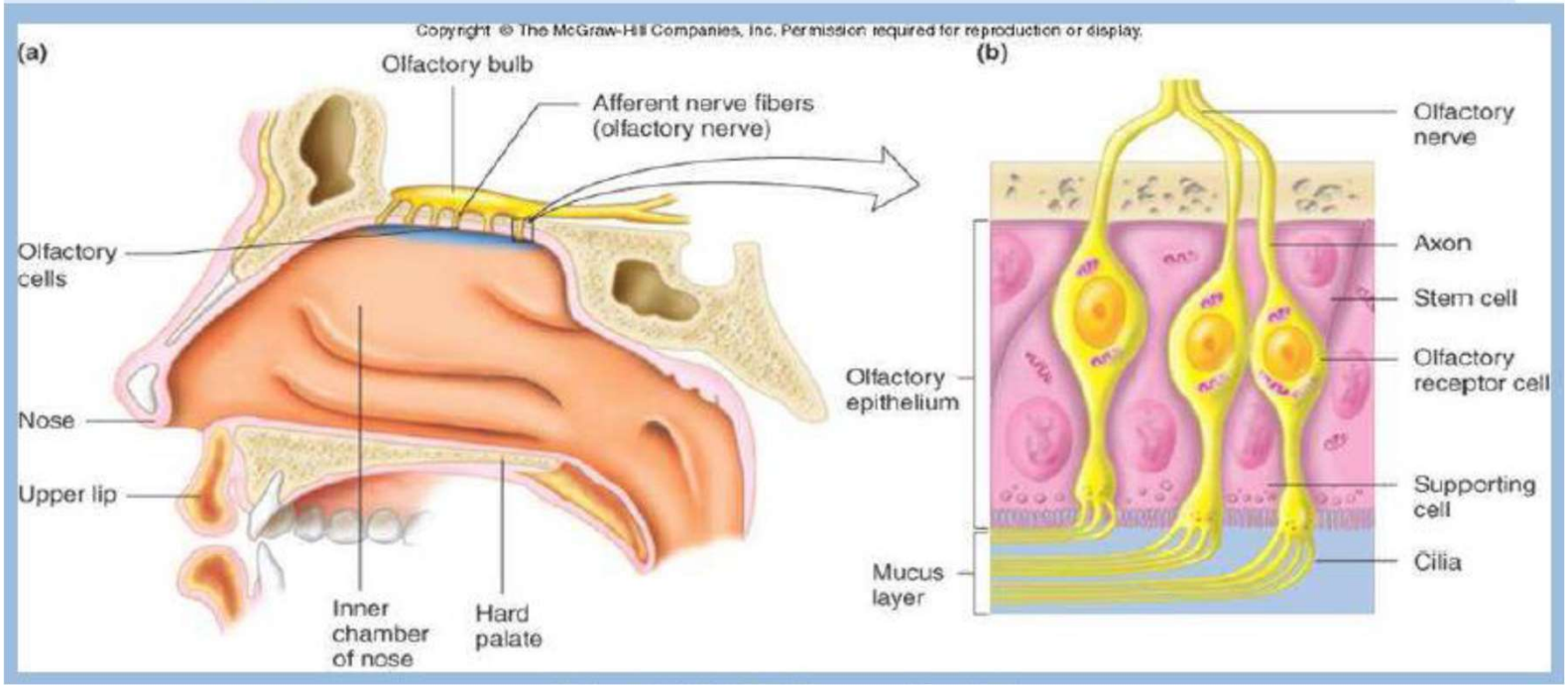
Metastudie - zitiert 422 (!) Studien zu diesem Thema

ConsultAIR



- Courtesy https://www.google.at/search?biw=1220&bih=716&tbm=isch&sa=1&ei=dLTrXIWCD6mcjLsP1pGw2AQ&q=alveolen&oq=alveolen&gs_l=img.3..0l10.291415.1198786..1200259...6.0..1.250.3165.0j18j3.....0....1..gws-wiz-img.....35i39j0i67j0i10i24.epFkNwXsCw0#imgrc=XrO7ZMtv3abyHM:

Translokationsweg via Riechnerven: So gelangen ultrafeine/Nano-Partikel direkt ins zentrale Nervensystem



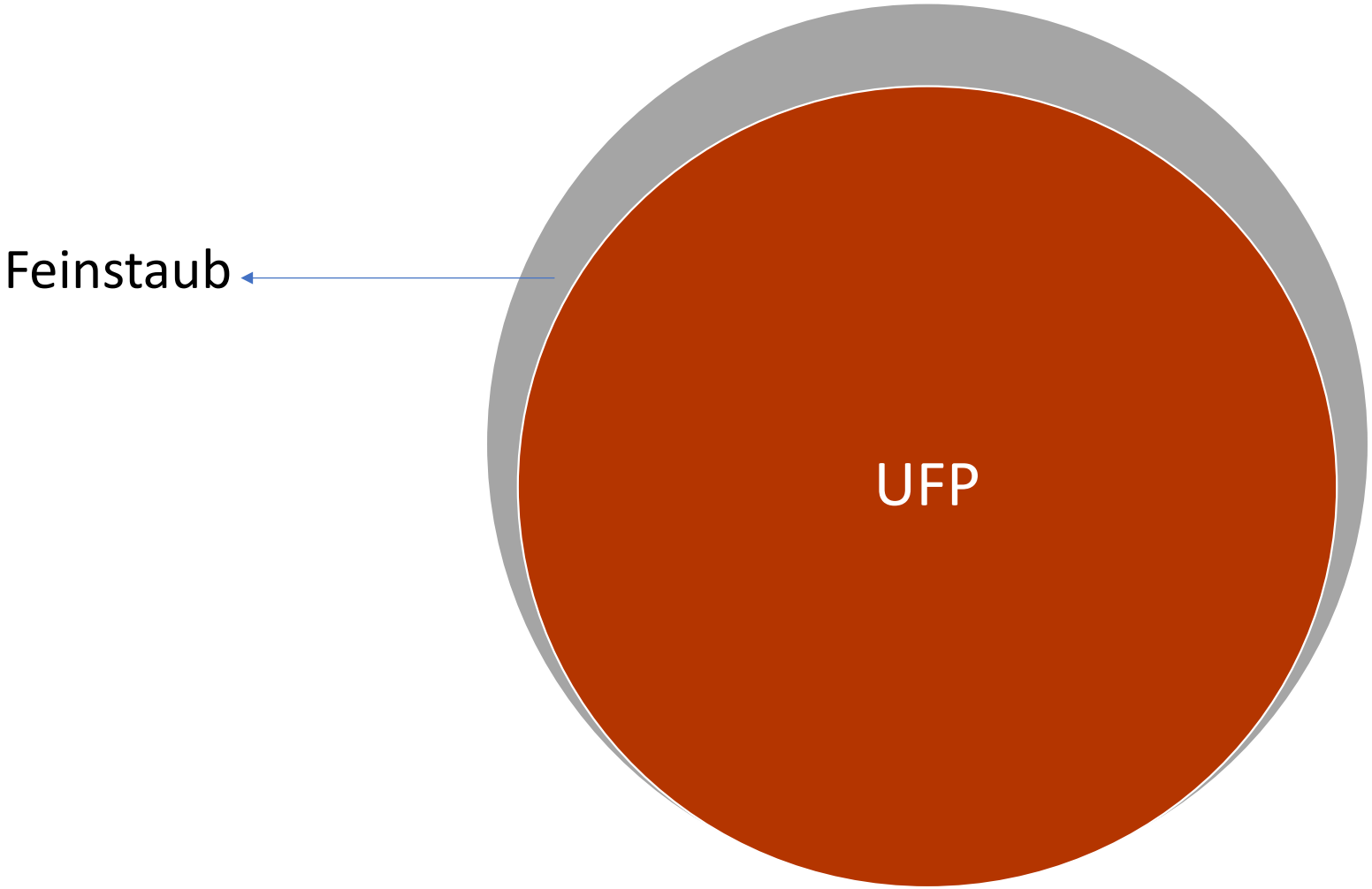
Quelle: Dr. Heinz Fuchsig,
Arbeits- und Umweltmedizin, Baubiologe (IBO)
wissenschaftlicher Leiter des Kurses Umweltmedizin der ÖÄK, Vortrag „Wirkungen von und Maßnahmen gegen Verkehrsluftschadstoffe aus medizinischer Sicht“, 2018

UFP

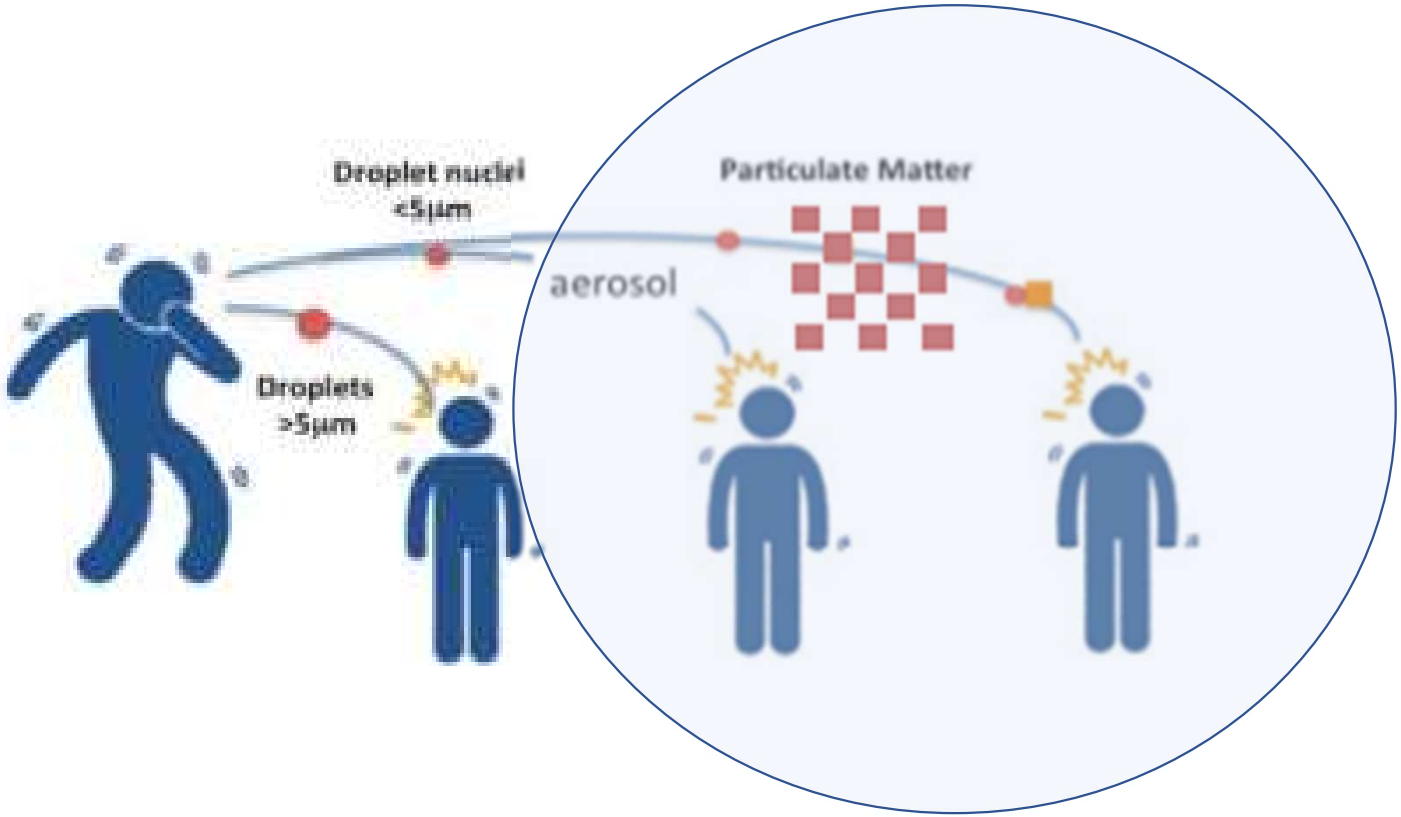
?

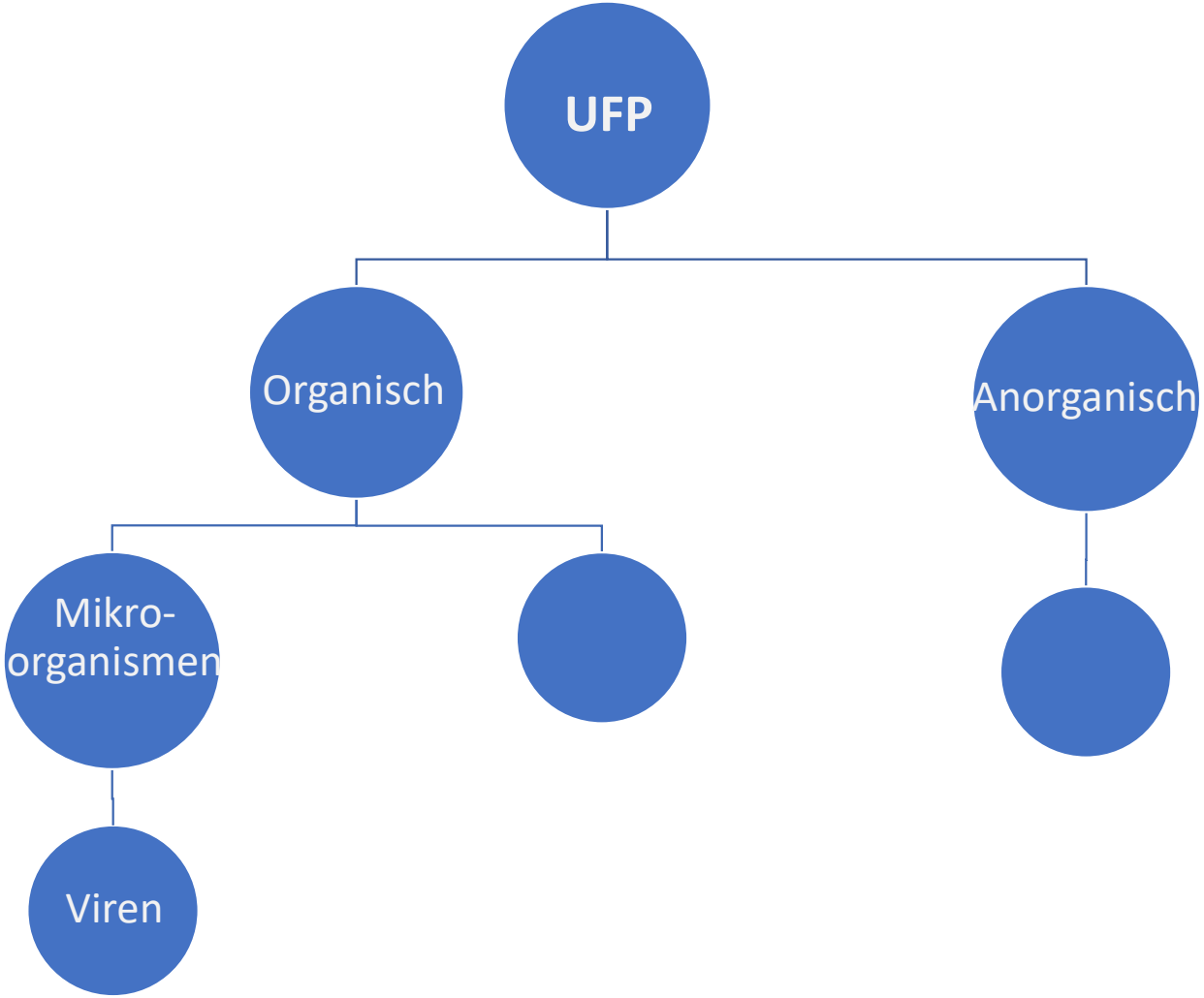
Viren – COVID 19

Sekundäre Übertragungswege

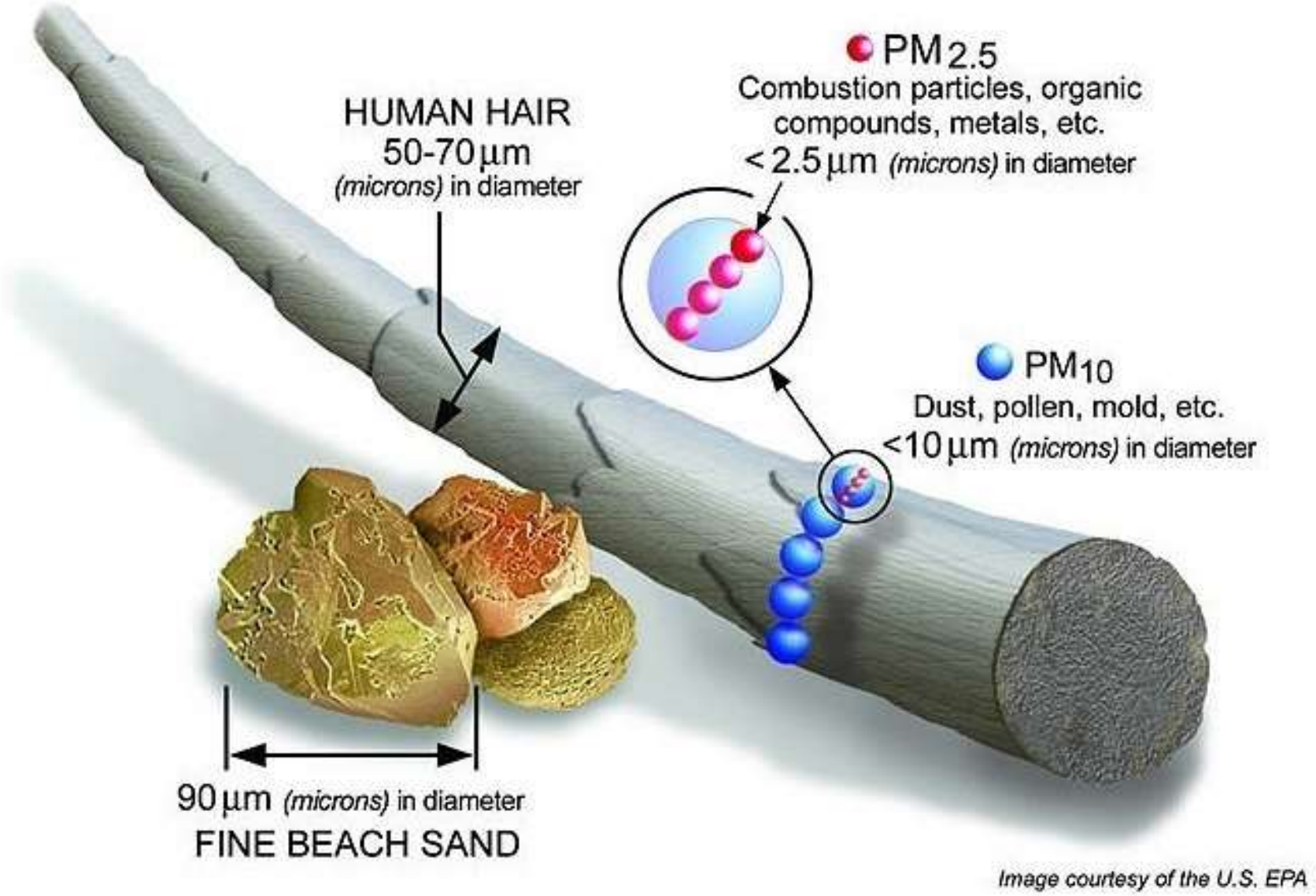

Feinstaub
UFP

Sekundäre Übertragungswege




UFP
Organisch
Anorganisch
Mikro-
organismen
Viren

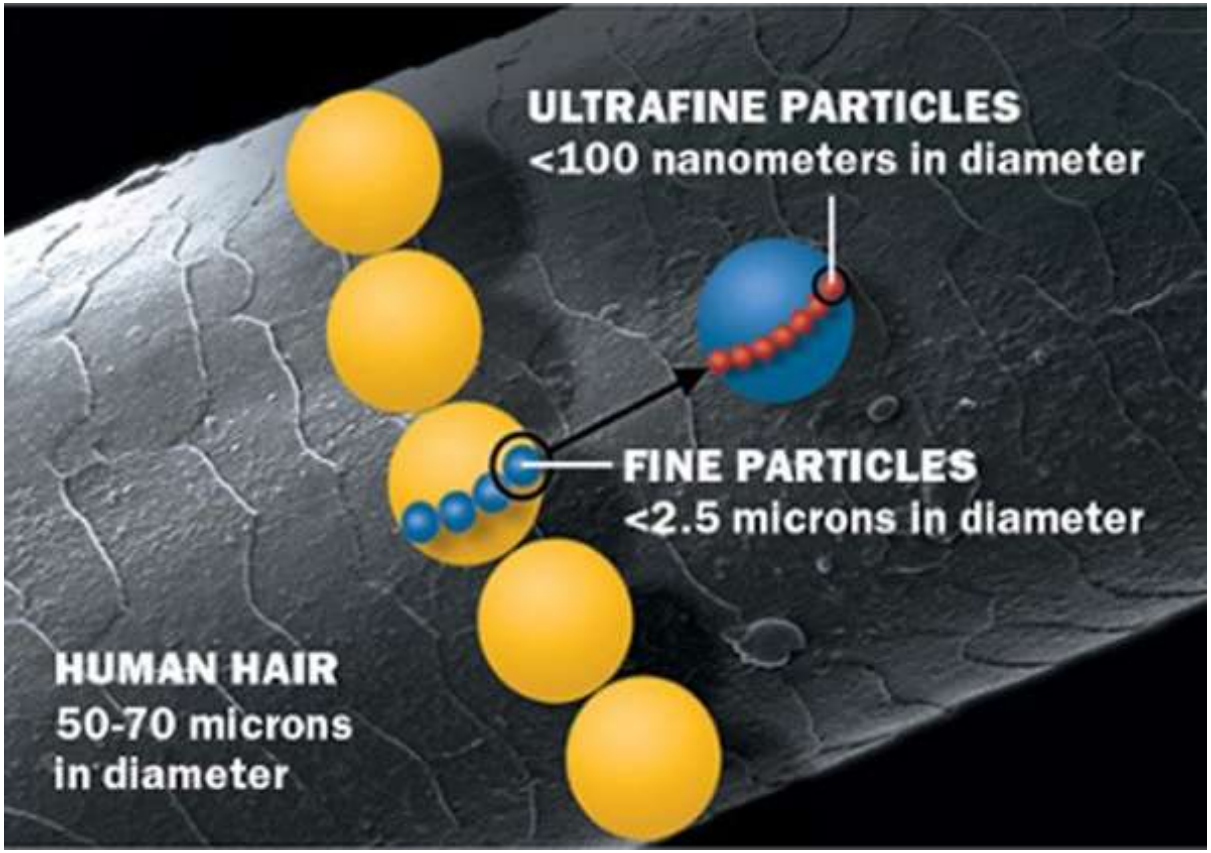
Problemlösung?


HUMAN HAIR
50-70 µm
(microns) in diameter
PM2.5
Combustion particles, organic compounds, metals, etc.
< 2.5 µm (microns) in diameter
PM10
Dust, pollen, mold, etc.
<10 µm (microns) in diameter
90 µm (microns) in diameter
FINE BEACH SAND
Image courtesy of the U.S. EPA

Menschliches Haar: 70 µm = 0,07mm

PM2,5 = Feinstaub: 2,5 µm = 0,0025 mm

1 mm = 1.000 µm



Quelle: Tufts University, Massachusetts, USA, https://now.tufts.edu/articles/big-road-blues-pollution-highways, heruntergeladen 27.10.2020

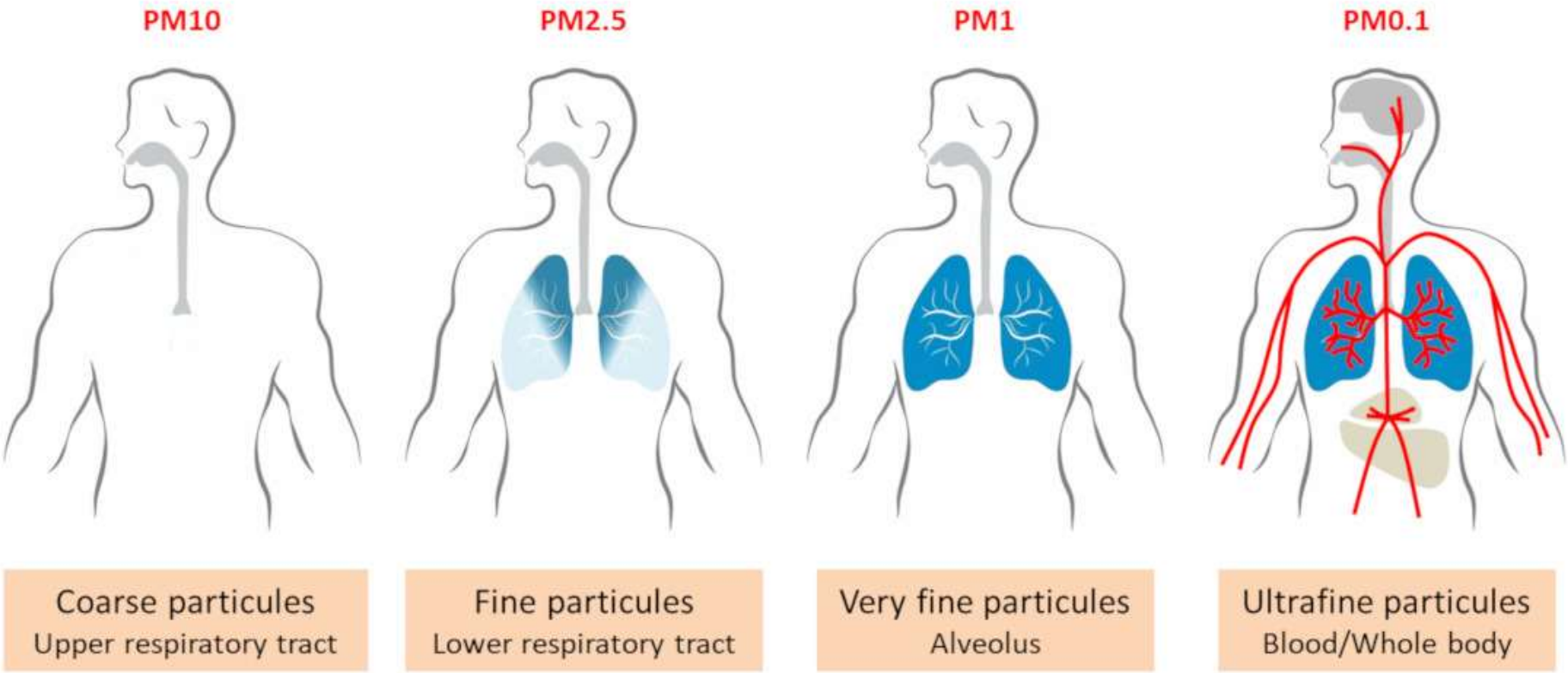
Ultrafeinstaub PM 0,1

Feinstaub PM 2,5

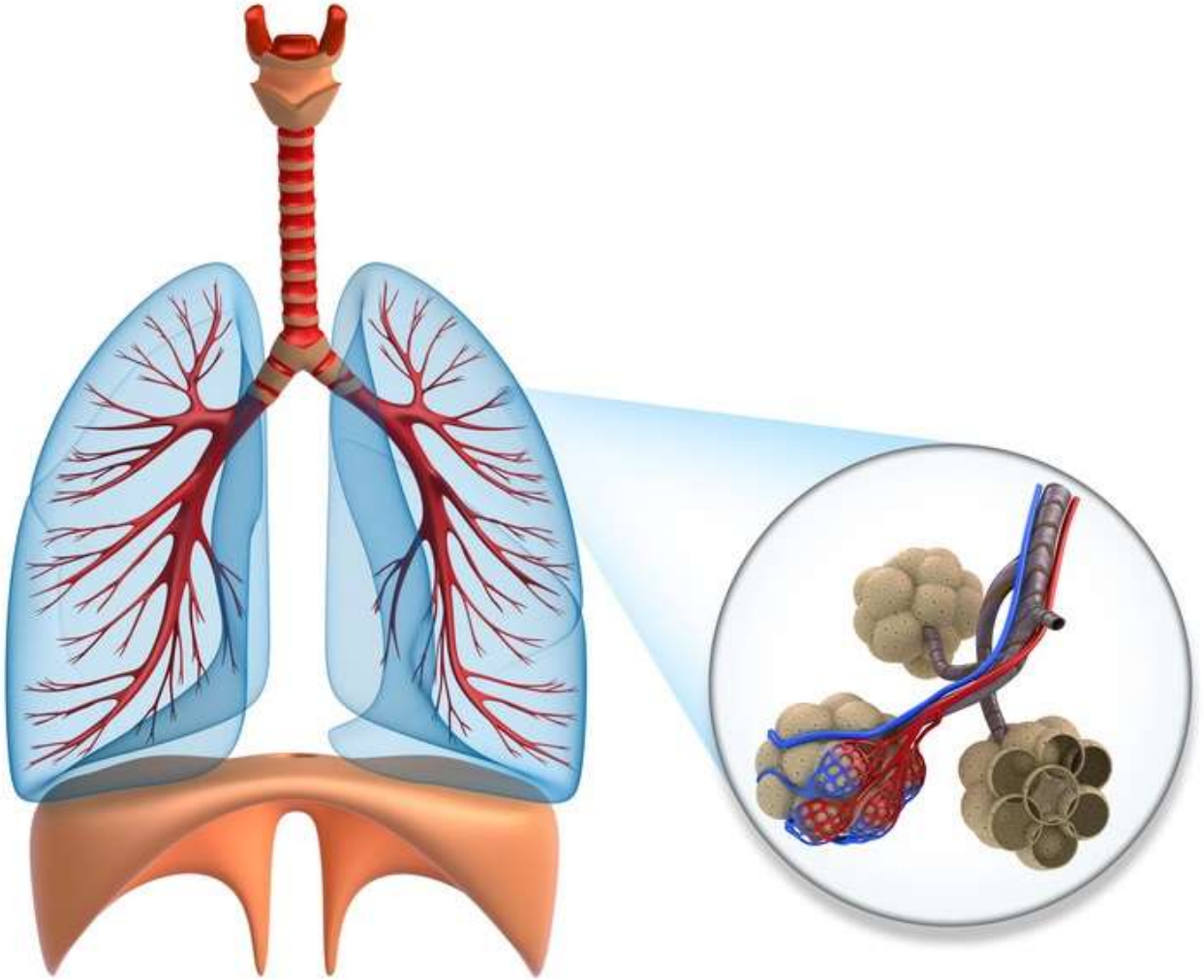
Ultrafeinstaub

- 0,1 µm …. 0,0001 mm

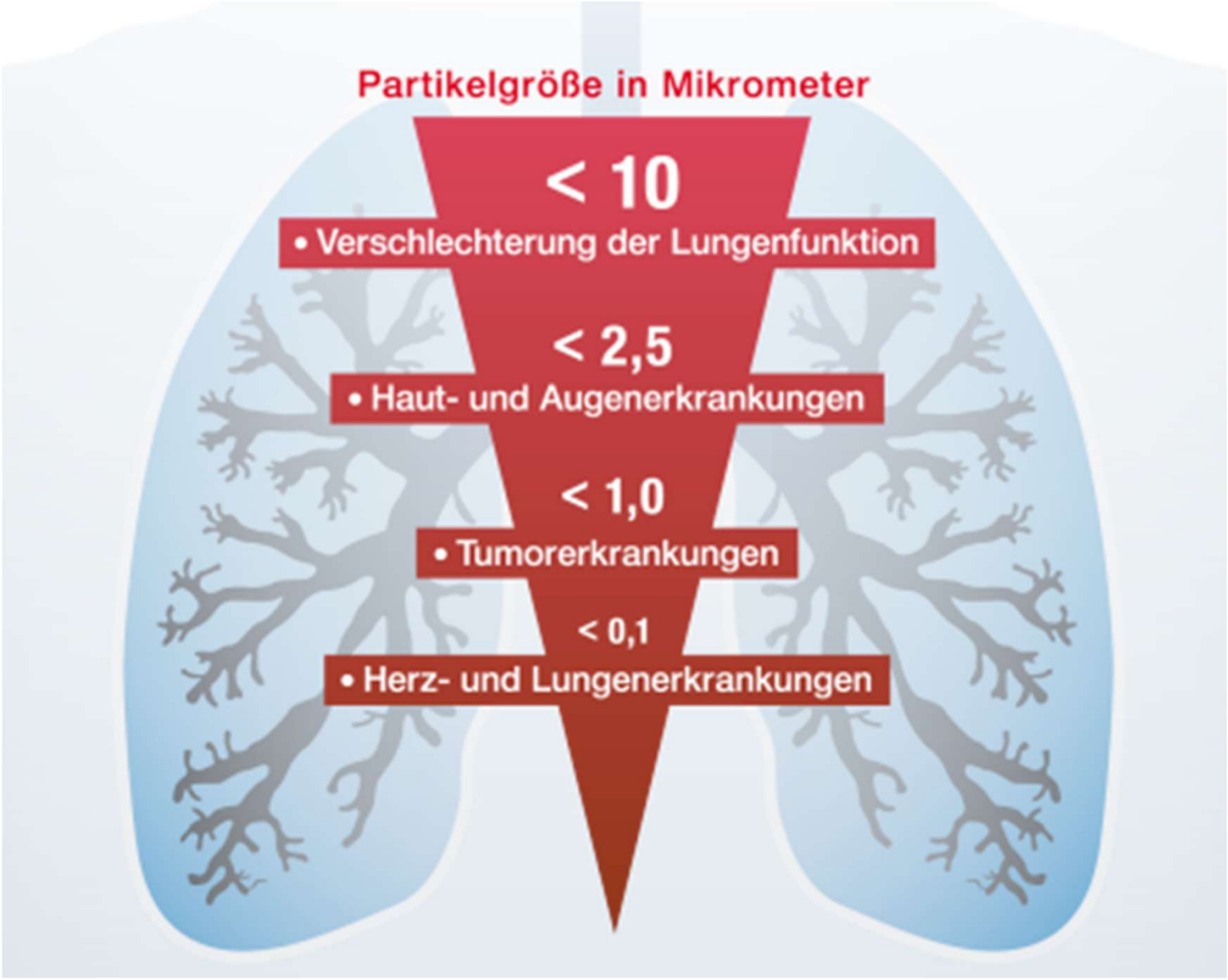
- UFP … *Ultra fine particle*



Quelle: https://www.encyclopedie-environnement.org/en/health/airborne-particulate-health-effects/



https://www.google.at/search?biw=1220&bih=716&tbm=isch&sa=1&ei=dLTrXIWCD6mcjLsP1pGw2AQ&q=alveolen&oq=alveolen&gs_l=img.3..0l10.291415.1198786..1200259...6.0..1.250.3165.0j18j3.....0....1..gws-wiz-img.....35i39j0i67j0i10i24.epFkNwXsCw0#imgrc=s-FJlxHJrYtHNM:


Partikelgröße in Mikrometer
< 10
• Verschlechterung der Lungenfunktion
< 2,5
• Haut- und Augenerkrankungen
< 1,0
• Tumorerkrankungen
< 0,1
• Herz- und Lungenerkrankungen

Partikelanzahl pro Atemzug / pro Tag

2 Liter pro Atemzug
14 Atemzüge in der Minute
30 Liter Luft in der Minute

Im innerstädtischen Bereich: > **40.000** luftgetragene Partikel

Wir atmen bis zu …:

pro Minute: 1,2 mio. Partikel

pro Tag: 1,7 Mrd. Partikel

Feinstaub

luftgetragene Partikel bzw.
einatembare Partikel

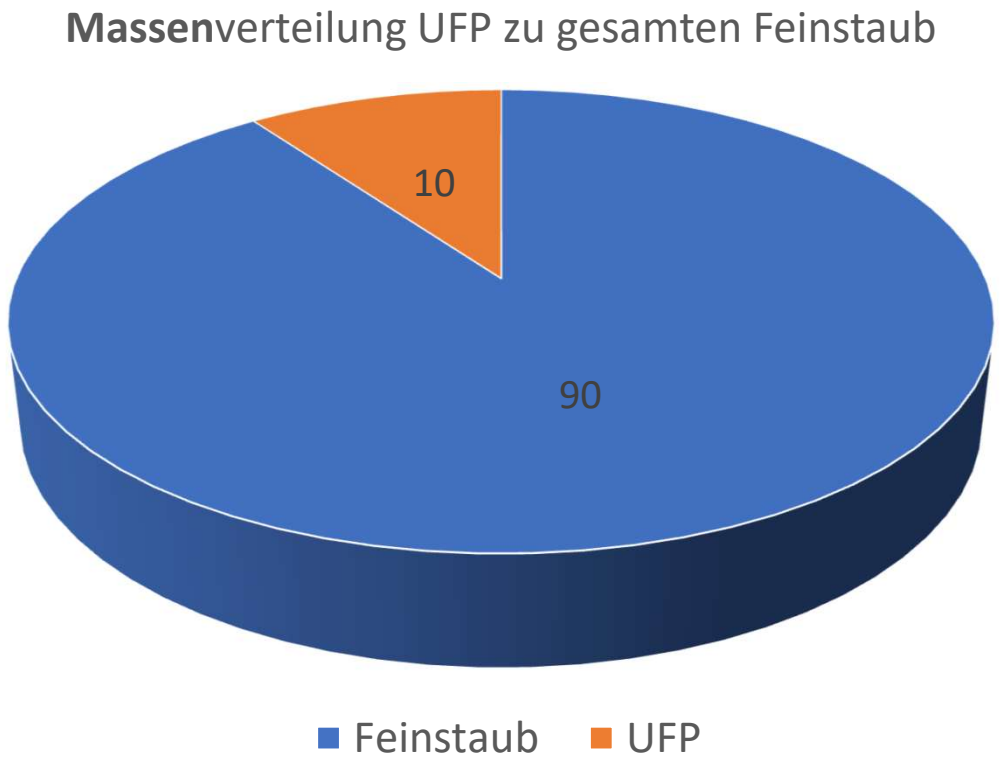
ab ca. 10 µm

PM 10 PM 5 PM 2,5 PM 1 UFP

Verschiedene Stoffe:
organisch oder anorganisch

Feinstaub: Masse vs. Anzahl

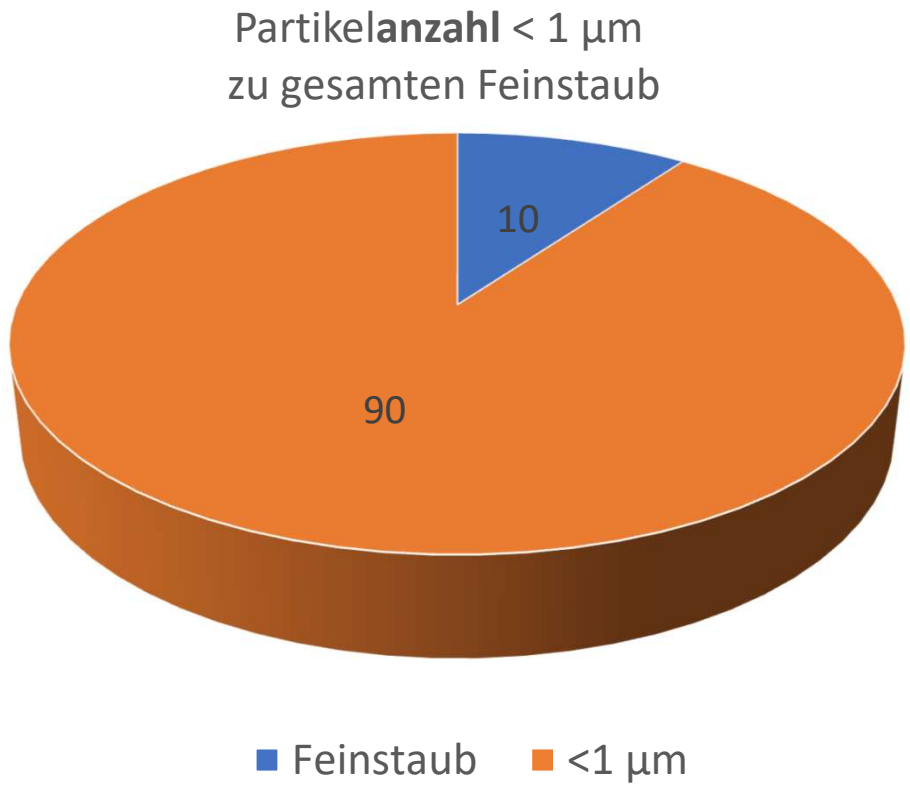
Problem: Angaben zu Feinstaubmessungen in Gewicht nicht in Anzahl!!!



ConsultAIR

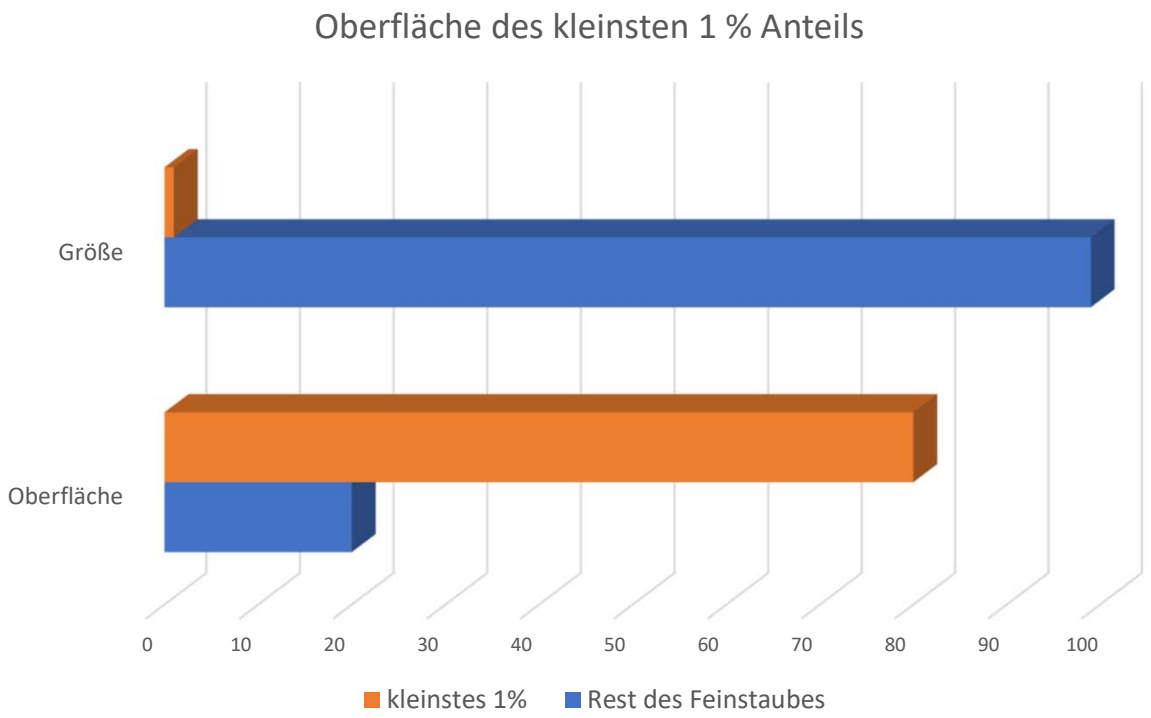
Feinstaub: Masse vs. Anzahl

Problem: Angaben zu Feinstaubmessungen in Gewicht nicht in Anzahl!!!

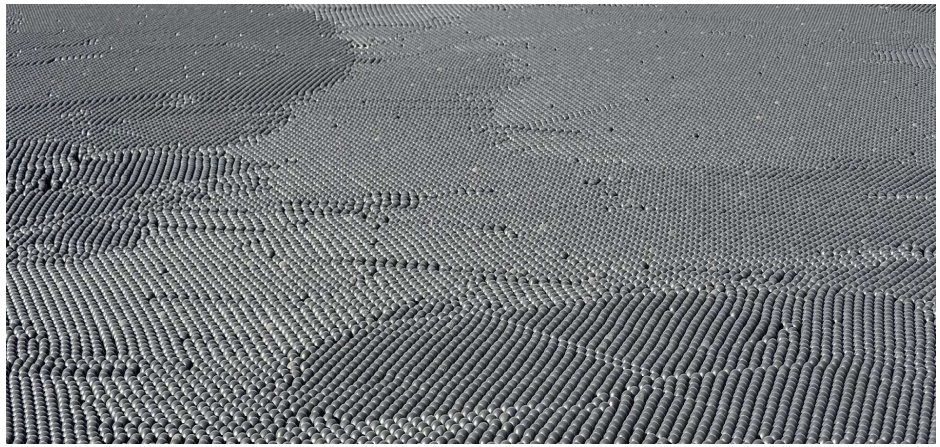


ConsultAIR

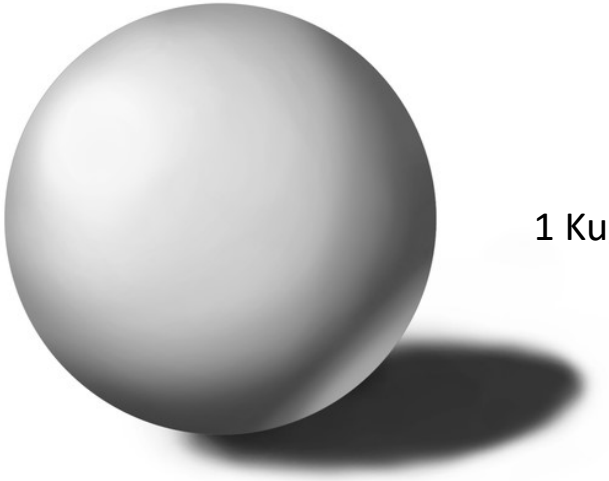
Feinstaub: kleinsten 1 % = 80 % der Oberfläche



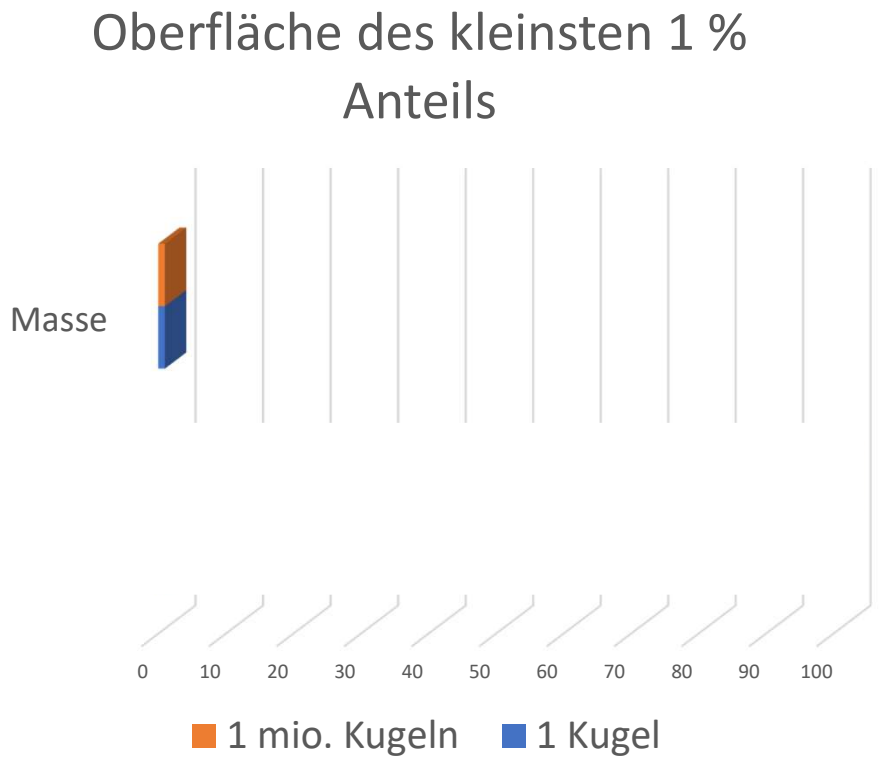
ConsultAIR



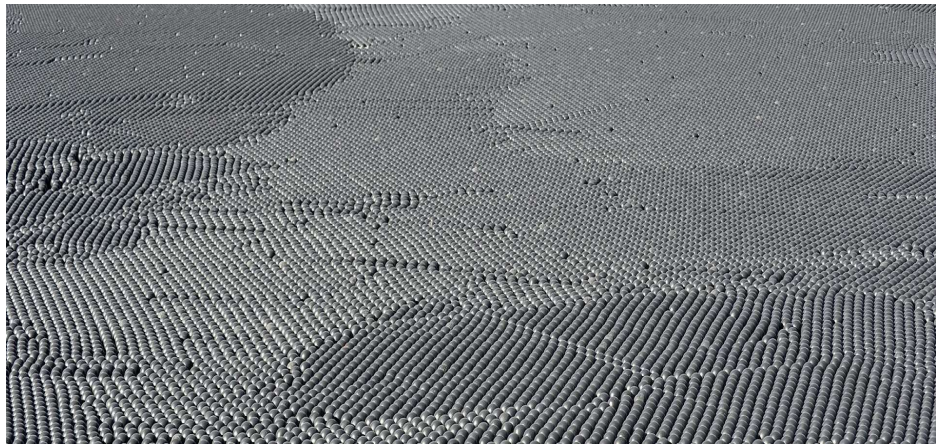
1mio. Kugeln 50 nm = 0,05 µm



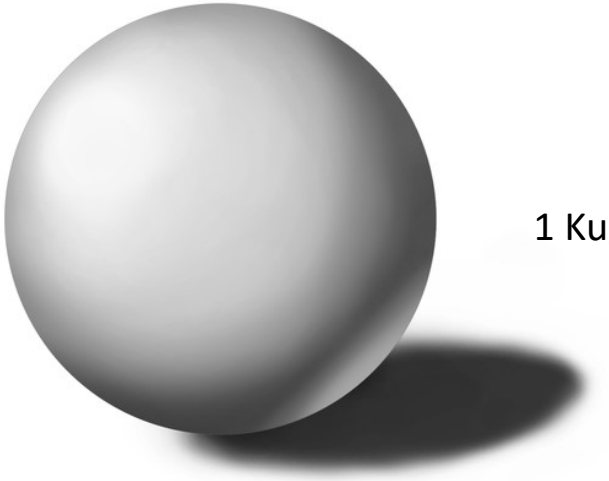
1 Kugel 5 µm



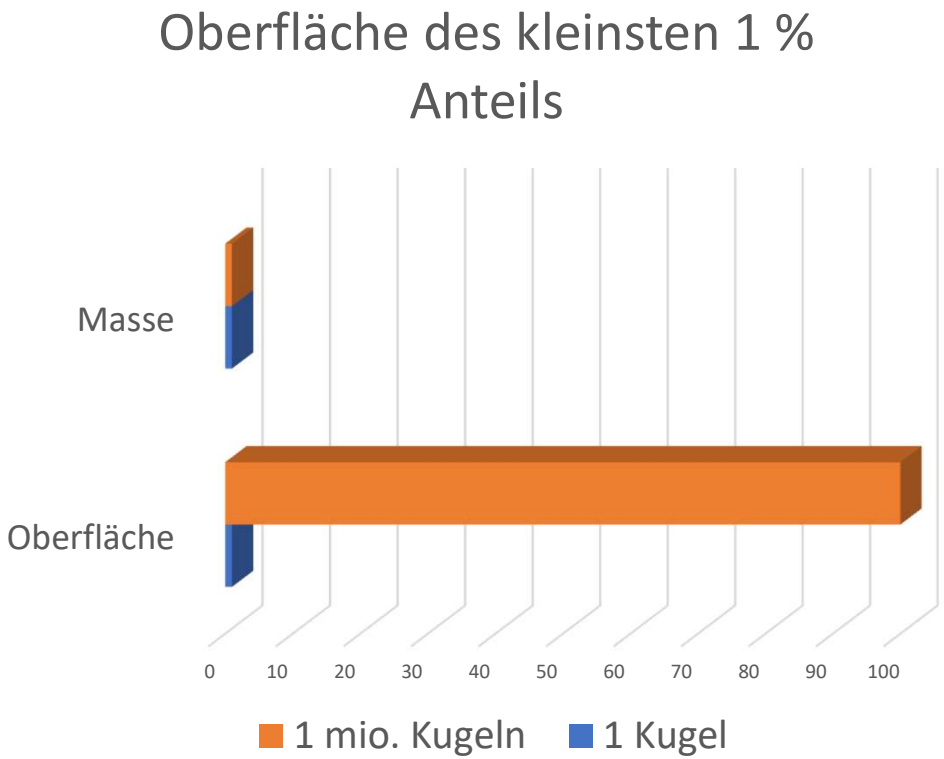
ConsultAIR



1mio. Kugeln 50 nm = 0,05 µm



1 Kugel 5 µm



ConsultAIR

Immissionsschutzgesetz Luft - IG-L

Grenzwert für PM 2,5: 20 µg/m³ (= Jahresmittelwert)

Beispiel:

20 µg/m³ PM 2,5 bei einer Dichte von 1 kg / dm³:

2,5 µm: 2,4 mio. Partikel

0,1 µm: 38 Mrd. Partikel

=> 15.600 fache !!!

Wissenschaftliche Publikation

ESC European Society of Cardiology

European Heart Journal (2019) **40**, 1590–1596
doi:10.1093/eurheartj/ehz135

FASTTRACK CLINICAL RESEARCH
Prevention and epidemiology

Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions

Jos Lelieveld[1,2]*, Klaus Klingmüller[1], Andrea Pozzer[1], Ulrich Pöschl[1], Mohammed Fnais[3], Andreas Daiber[4,5], and Thomas Münzel[4,5]*

[1]Max Planck Institute for Chemistry, Hahn-Meitner-Weg 1, 55128 Mainz, Germany; [2]The Cyprus Institute, 20 Kavafi Street, 2123 Nicosia, Cyprus; [3]King Saud University, College of Science, Riyadh 11451, Saudi Arabia; [4]Center for Cardiology, Cardiology I, Angiology and Intensive Care Medicine, University Medical Center of the Johannes Gutenberg University, Langenbeckstrasse 1, 55131 Mainz, Germany; and [5]German Center for Cardiovascular Research (DZHK), Partner Site Rhine-Main, Langenbeckstr. 1, 55131 Mainz, Germany

Received 18 November 2018; revised 5 December 2018; editorial decision 22 February 2019; accepted 22 February 2019; online publish-ahead-of-print 12 March 2019

European Heart Journal, ehz135, https://doi.org/10.1093/eurheartj/ehz135

Published: **12 March 2019**

WHO stuft die Auswirkungen von UFP gefährlicher ein als die Auswirkungen durch das Rauchen!

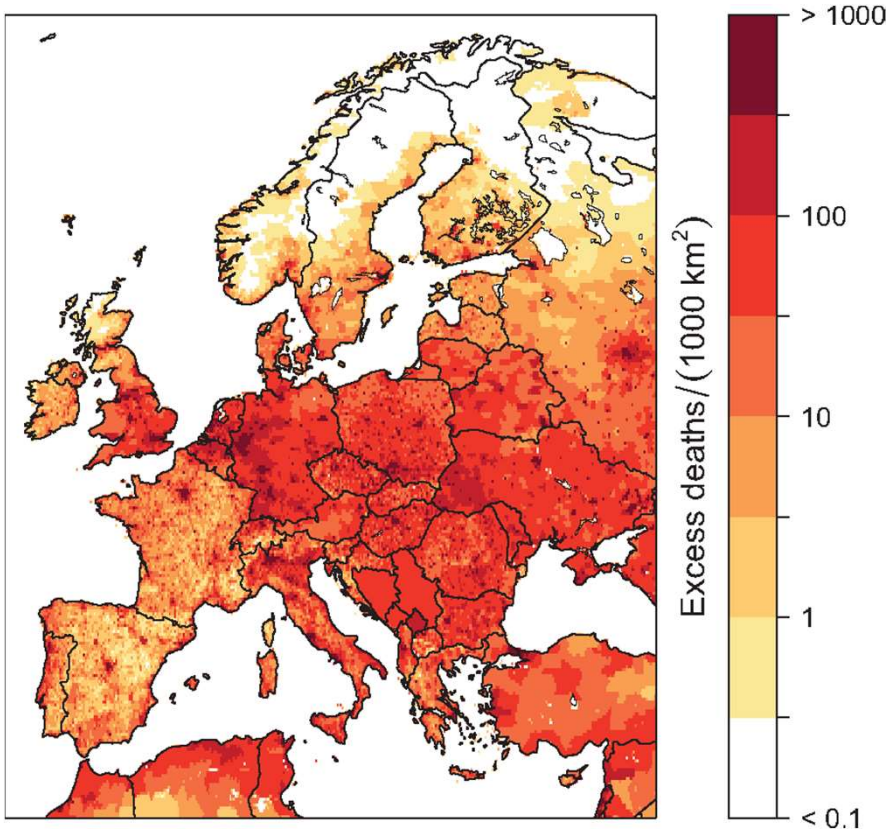
[…] air pollution reduces the mean life expectancy in Europe by about 2.2 years […]

[…] the health impacts attributable to ambient air pollution in Europe are substantially higher than previously assumed [….]

With the new Global Exposure Mortality Model we estimate 8.79 million in 2015.To put this into perspective, the WHO estimates that the excess death rate from tobacco smoking is 7.2 million per year; **hence air pollution is now rated as the larger risk factor.**

ConsultAIR

Figure 2 Regional distribution of estimated annual excess mortality rates from cardiovascular diseases (CVD = IHD + + CEV) attributed to air pollution. These rates are lower limits as other noncommunicable diseases are not included.



European Heart Journal, ehz135, https://doi.org/10.1093/eurheartj/ehz135

Wissenschaftliche Publikation

UFP & Alzheimer / Demenz

Article | OPEN | Published: 26 November 2015

Magnetite-Amyloid-β deteriorates activity and functional organization in an *in vitro* model for Alzheimer's disease

Sara Teller, Islam Bogachan Tahirbegi, Mònica Mir, Josep Samitier & Jordi Soriano

Quelle: http://www.nature.com/articles/srep17261

Feinstaub => Alzheimer

in UFP:

- **Magnetit** = Komplex aus Eisen und Sauerstoff, entsteht bei Oxidation von Eisen, bei industriellen Anwendungen in Nanogröße! => Blutkreislauf!

im Körper:

- **Peptid =** Molekül, organische Verbindung, kleines Protein

ConsultAIR

Quelle: https://www.biosyn.com/faq/what-is-a-peptide.aspx

Quelle: istockphoto-505094626-612x612

Peptide + Magnetit

Amyloid-beta 40 (Aβ40) und 42 (Aβ40)

Amyloid Fibrillen = neurotoxische Fasern = „senile Plaques“

Wissenschaftliche Publikation

Review | Open Access | Published: 02 November 2020

Translocation of (ultra)fine particles and nanoparticles across the placenta; a systematic review on the evidence of in vitro, ex vivo, and in vivo studies

Eva Bongaerts, Tim S. Nawrot, Thessa Van Pee, Marcel Ameloot & Hannelore Bové

Particle and Fibre Toxicology **17**, Article number: 56 (2020) | Cite this article

https://particleandfibretoxicology.biomedcentral.com/articles/10.1186/s12989-020-00386-8#citeas08%2011%202020

Published: 02 November 2020

ConsultAIR

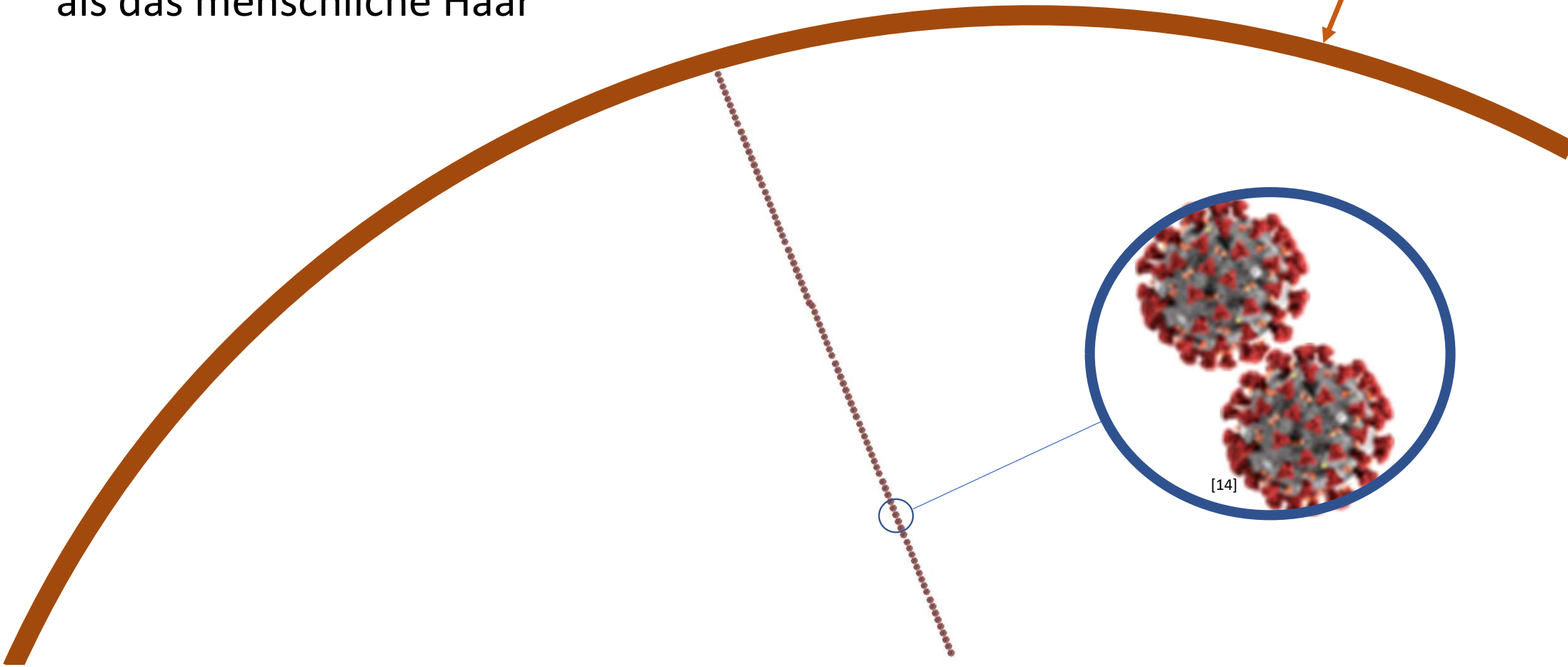
Corona Virus - size matters

Upon analysis of negative-stained SARS-CoV-2 articles by electron microscopy, researchers have determined the diameter of this virus to **range between 60 nanometers (nm) to a maximum diameter of 140 nanometers (nm).**

https://www.news-medical.net/health/The-Size-of-SARS-CoV-2-Compared-to-Other-Things.aspx
Download 08.11.2020

CORONA Virus

Ca. 500 bis 1000 -fach kleiner
als das menschliche Haar



Positive Korrelation SARS Erkrankung zu Luftverschmutzung in China [12]

Environmental Health: A Global Access Science Source

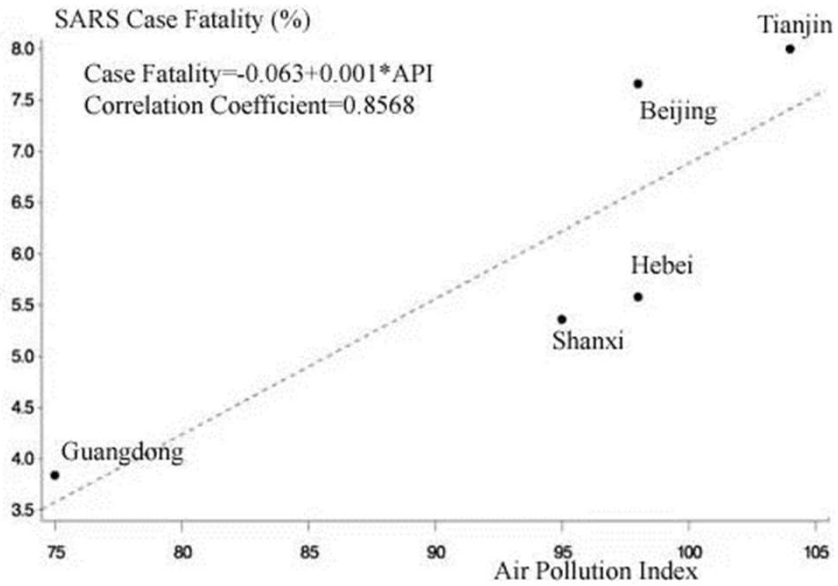
BioMed Central

Research

Open Access

Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study

Yan Cui[1], Zuo-Feng Zhang*[1], John Froines[2], Jinkou Zhao[3], Hua Wang[3], Shun-Zhang Yu[4] and Roger Detels[1]



Conclusion: Our studies demonstrated a positive association between air pollution and SARS case fatality in Chinese population by utilizing publicly accessible data on SARS statistics and air pollution indices. Although ecologic fallacy and uncontrolled confounding effect might have biased the results, the possibility of a detrimental effect of air pollution on the prognosis of SARS patients deserves further investigation.

Positive Korrelation COVID 19 Erkrankung zu Luftverschmutzung in China

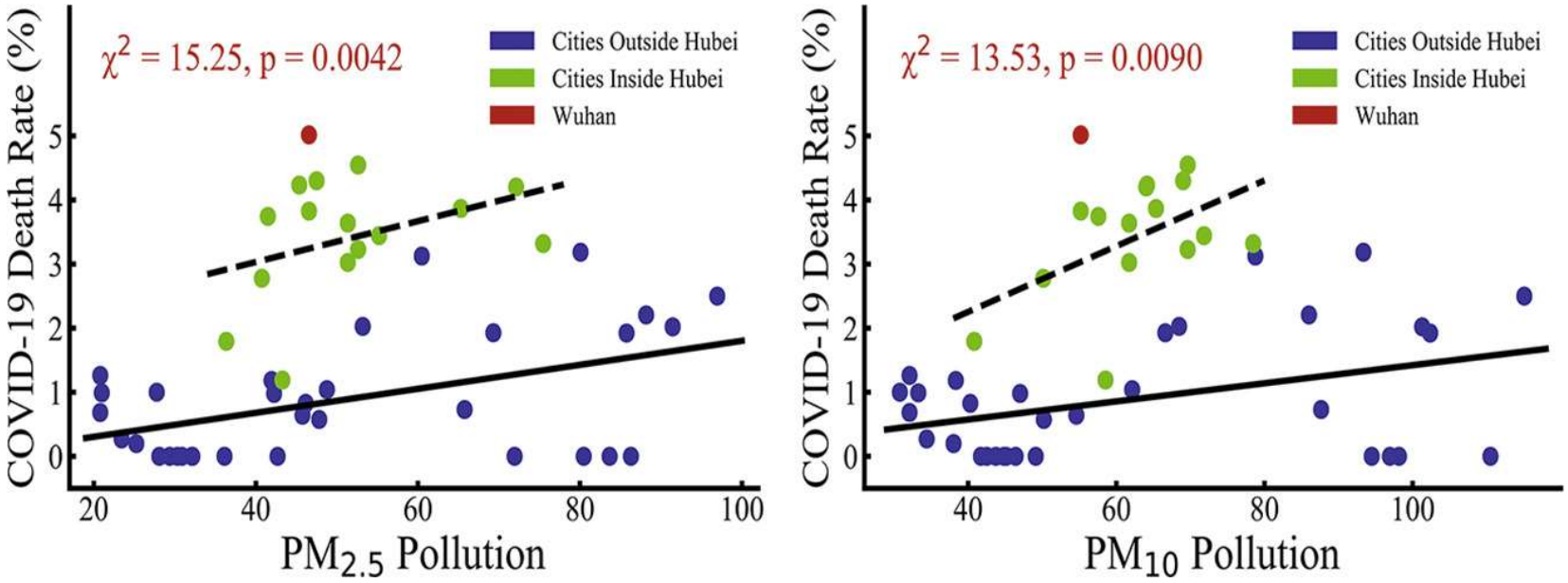
ELSEVIER

Science of The Total Environment

Volume 741, 1 November 2020, 140396

Association of particulate matter pollution and case fatality rate of COVID-19 in 49 Chinese cities

Ye Yao [a, 1], Jinhua Pan [a, 1], Weidong Wang [a, 1], Zhixi Liu [a, 1], Haidong Kan [a, c], Yang Qiu [b], Xia Meng [a] [2] ✉, Weibing Wang [a, c, 2] ✉



Quelle:
https://www.sciencedirect.com/science/article/pii/S0048969720339188#f0015
Downloaded 08.11.2020

Positive Korrelation COVID 19 Erkrankung zu Luftverschmutzung in USA [13]

HARVARD UNIVERSITY

COVID-19 PM2.5

A national study on long-term exposure to air pollution and COVID-19 mortality in the United States

Exposure to air pollution and COVID-19 mortality in the United States (Updated April 5, 2020)

Xiao Wu MS, Rachel C. Nethery PhD, M. Benjamin Sabath MA, Danielle Braun PhD, Francesca Dominici PhD
All authors are part of the Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, MA, 02115, USA

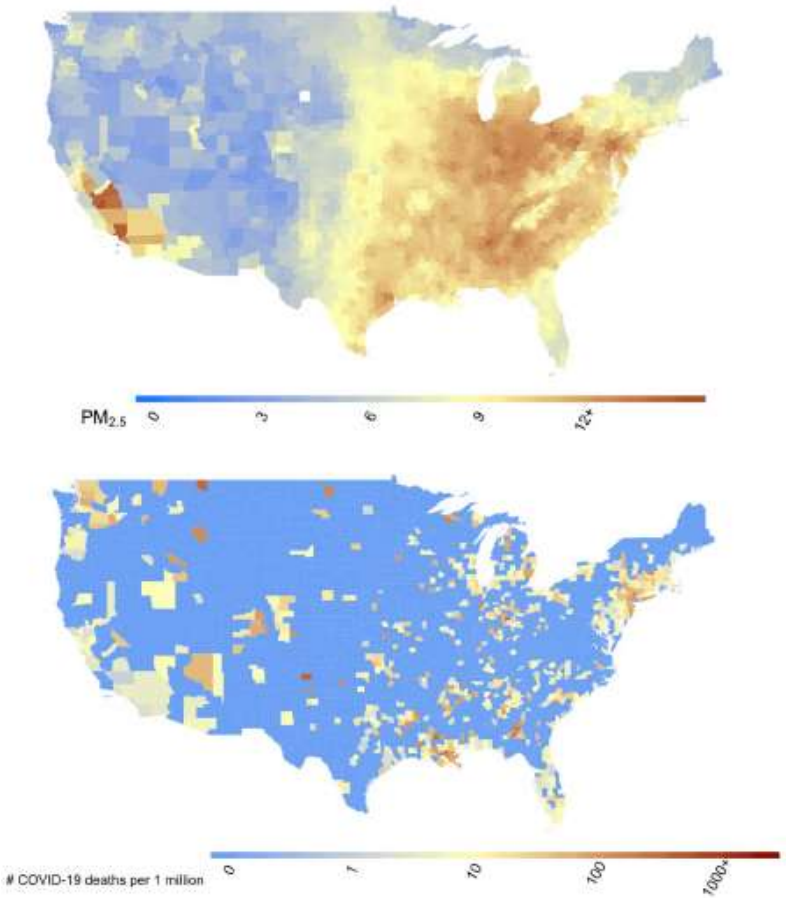


Figure 1: Maps show (a) county level 17-year long-term average of $PM_{2.5}$ concentrations (2000-2016) in the US in g/m^3 and (b) county level number of COVID-19 deaths per one million population in the US up to and including April 4, 2020.

Conclusion: "We found that an increase of only 1µg/m3 in PM2.5 [particles] is associated with a 15% increase in the Covid-19 death rate,"

Coronavirus in Aerosolen nachgewiesen

- Untersuchungen der Raumluft im Klinikzimmer von Erkrankten bestätigen: Aerosole können tatsächlich intakte Viruspartikel enthalten. Laut den US-Forschern zumindest ein Indiz dafür, dass SARS-CoV-2 auch über die winzigen, lange in der Luft verbleibenden Schwebeteilchen übertragen werden könnte.

- published Aug. 2020
- https://www.medrxiv.org/content/10.1101/2020.08.03.20167395v1
- Abgerufen am 14.10.2020

Virusfreie Krankenhausbetten lebensrettend

- Der "Journal of Clinical Oncology“ erschienene **Studie** liegen Daten von 9.171 Patienten aus 55 Ländern und fünf verschiedenen Kontinenten zugrunde. Sie zeigt, dass bei einer Behandlung der Patienten in Covid-19-freien Spitalsbereichen die Lungen-Komplikationen (2,2 Prozent statt 4,9 Prozent) als auch die postoperativen Sterblichkeit (0,7 Prozent statt 1,7 Prozent) deutlich geringer ausfielen.

- published Oct. 2020
- https://ascopubs.org/doi/abs/10.1200/JCO.20.01933
- abgerufen am 14.10.2020

Quellen des Ultra-Feinstaub - UFP:

Von der Natur: > 1 µm : Vulkane, Waldbrände, Wüstensand

500 mio. bis mehrere Mrd. Tonnen pro Jahr [20]

Vom Menschen:

Verbrennung

- Dieselmotore: je moderner desto kleiner die Partikel!!
- Verbrennungsmotore: moderne Ottomotore mit Hochdruck-Direkteinspritzung!
- Feuer (offene Flamme)
- Brenner (Gas, Öl, Pellets, etc.)

Abrieb

- Bremsvorgänge bei Bahn, Straßenverkehr
- Reifenabrieb
- Industrielle Bearbeitungen

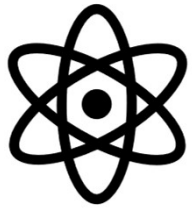
Filterung von UFP

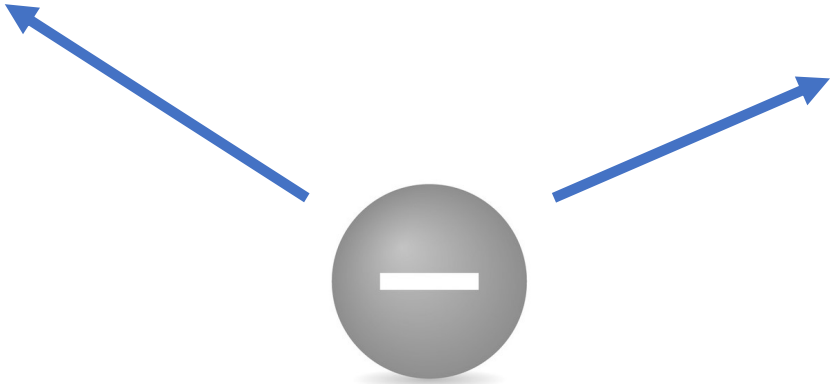
Aus physikalischen Gründen können selbst F9 Filter Feinstaub kleiner 0,2 µm **nicht** aus der Luft **ausfiltern**!

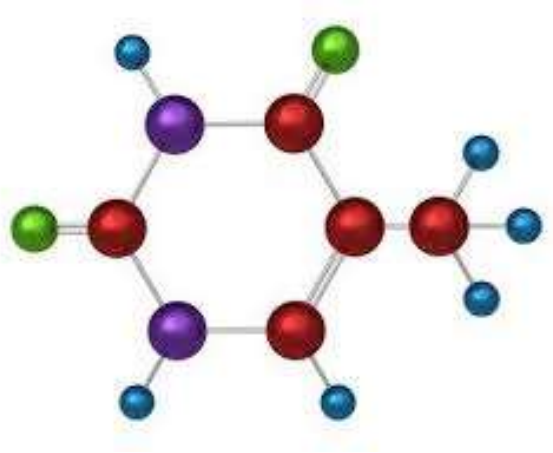
Problemlösung

Mit der Kraft der Natur
zur frischen und gesunden Atemluft.

Luftionen







- klein
- negativ geladen

Konzentration in der Luft

Durchschnittswerte für Luftionenkonzentrationen der Luft in Luftionen/cm³:	
Wasserfälle:	20.000
Wald, Gebirge, Meer:	5.000
Stadtrand, Wiesen, Felder:	700 – 1.500
Innerstädtische Parkanlagen:	400 – 600
Innerstädtische Straßen:	100 – 200
Innerstädtische Wohnungen:	40 – 50
Geschlossene, klimatisierte Räume:	0 – 25

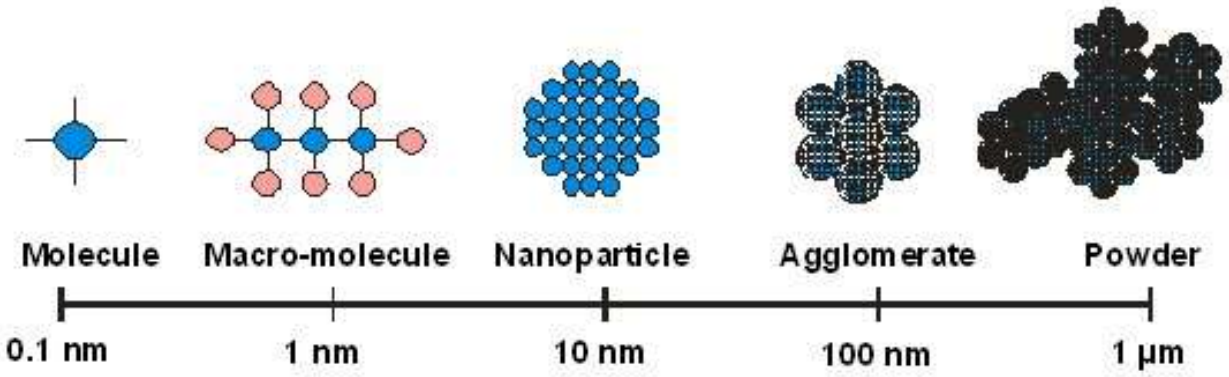
natürliche Ionen – Reduktion und Vernichtung

- Kunststoffe
- Feinstaub
- Rauch
- Lüftungsanlagen (elektrische Felder, Erdung, …)

Wie entstehen Luftionen?

- Elektrische Entladung – **Blitze**
- Natürliche **radioaktive Strahlung** (in Erdreich, auch in einigen Granitarten)
- **Kosmische Strahlung** (ionisierende Strahlung)
- Kurzwellige **UV-Strahlung**
- **Offene Feuer** (Plasma)
- **Wasserfalleffekt** (Lenardeffekt): Zerstäubung und Deformation von kleinen Wassertröpfchen führen zu Polarisation und Ladunsgverschiebung und bilden Luftionen, auch **„Ionendusche“**!
- **Piezoelektrische Effekte**: hohe Drücke führen unter bestimmten Umständen bei bestimmten Kristallen zu einer Ladungsverschiebung und hohen Polarisationsfeldern.
- **Natürliche Materialien** mit hohen Polarisationsfeldern die bei Kontakt mit Luft Luftionen bilden, zB Turmaline
- **Ionisatoren:** künstliche Erzeugung mittels elektrischer Hochspannung, Ozon!
- **Radioaktive Präparate**, künstliche Erzeugung

Agglomerierung, Akkumulation, Bündelung, Clusterbildung

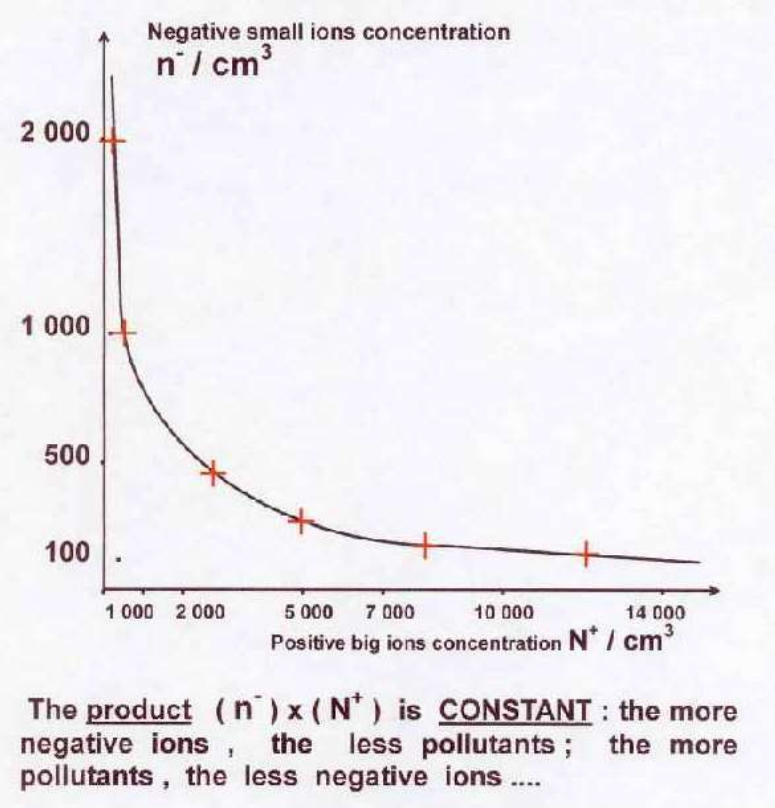


Bis zu 90% Reduktion der UFP in der Luft !!

Agglomerieren [lat.] bedeutet anhäufen, in der Verfahrenstechnik die Vergrößerung eines Partikels.
Agglomerate: Teilchenverbände

Quelle: https://www-amdis.iaea.org/w/index.php/Dust_in_fusion_devices_and_in_laboratory_plasmas:_A_summary_of_production_mechanisms_and_of_dust_properties

Gesetz von Bricard



Das Produkt von
negativ geladenen Ionen
und
positiv geladenen Partikeln
(= Feinstaub)
ist konstant! (1,4 mio)

ConsultAIR

Ionometer

[5]

Luftionen: 1-50 nm groß, messbar mit Ionometern
Meßgröße: Luftionen pro cm³ Luft

Messung durch Baubiologen bzw. baubiologische Messtechniker

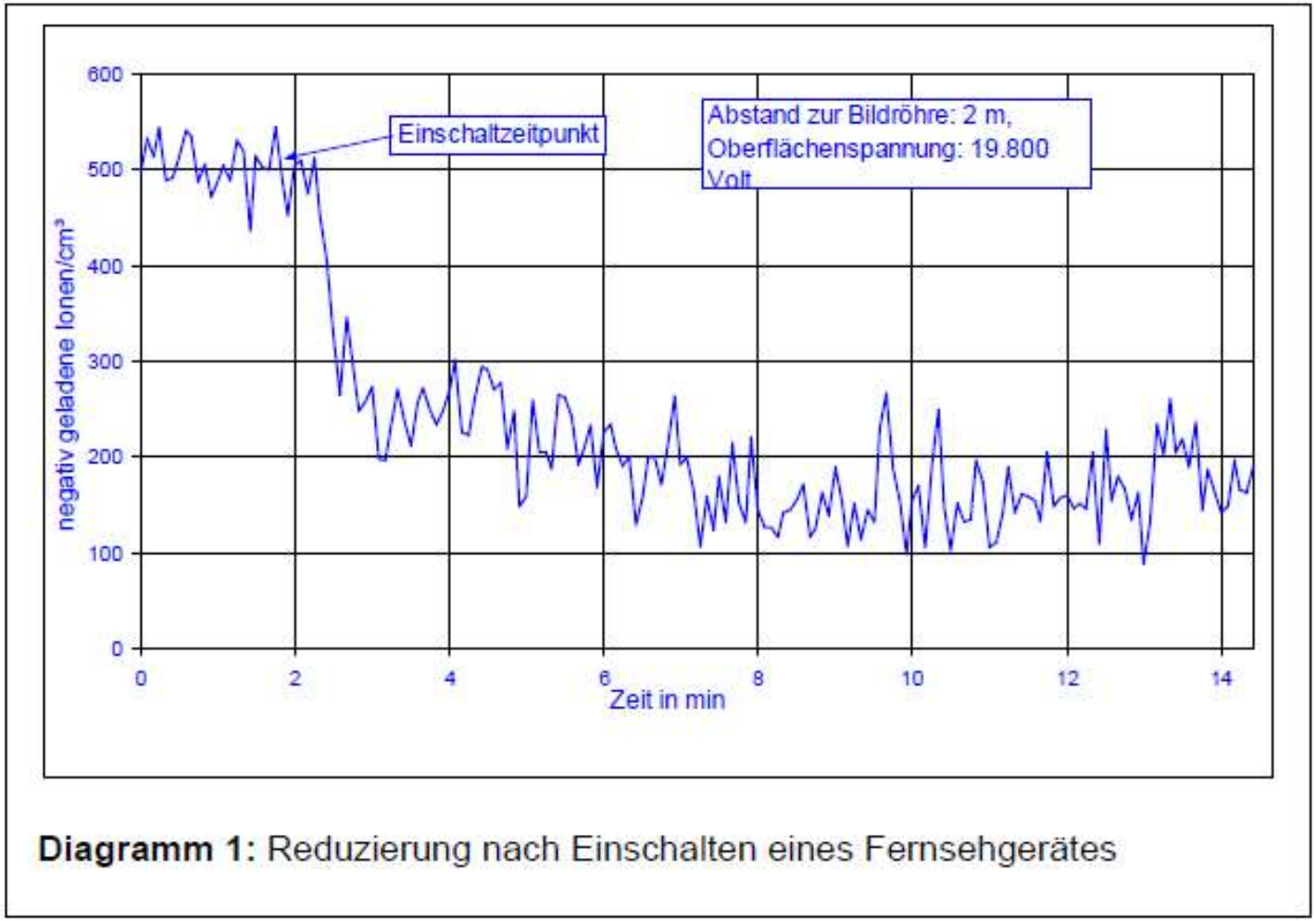


Diagramm 1: Reduzierung nach Einschalten eines Fernsehgerätes

Quelle: Holbach, Helmut, Umweltanalytik Holbach, 66687 Wadern, Deutschland

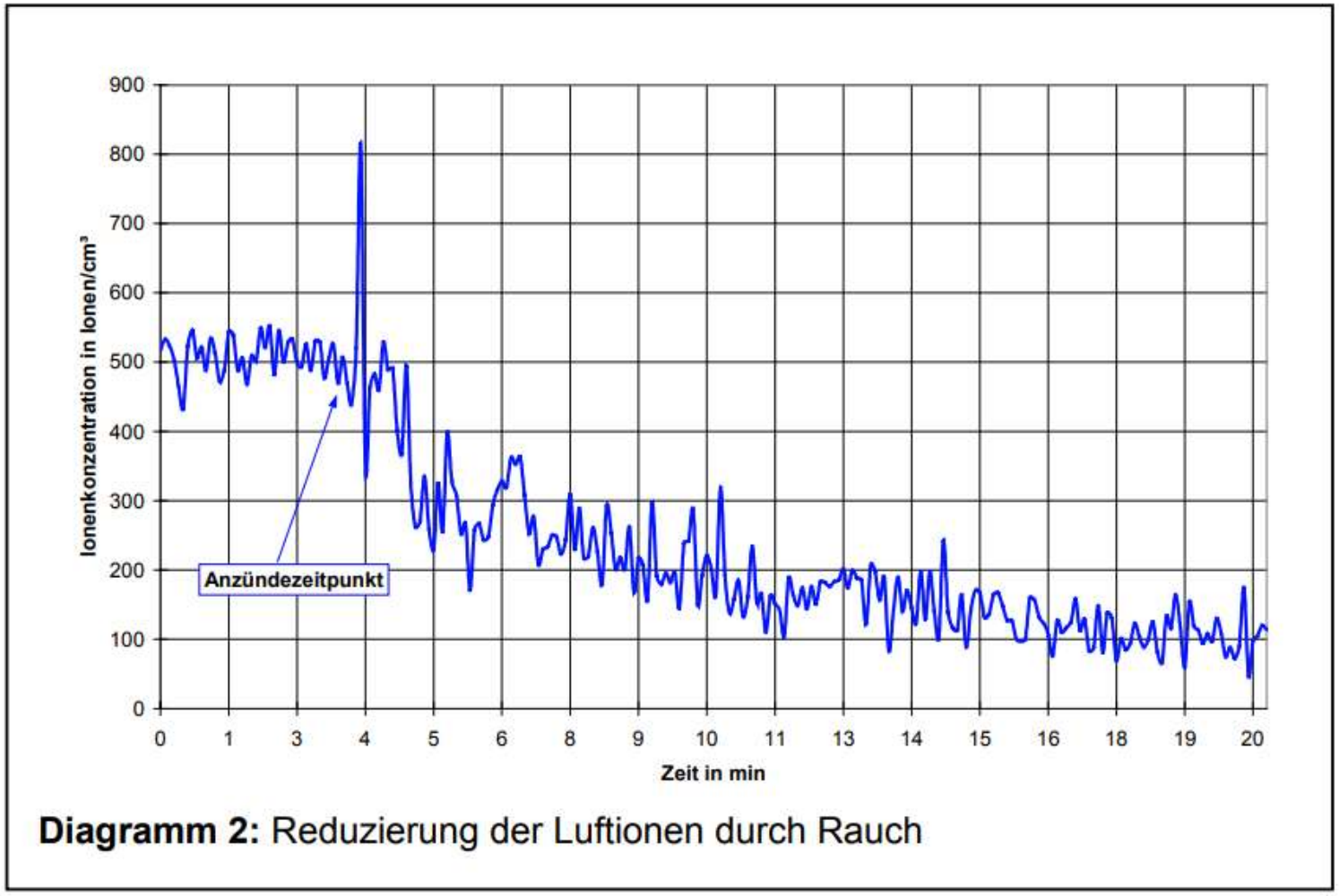


Diagramm 2: Reduzierung der Luftionen durch Rauch

Abrauchen eines Räucherstäbchens: Nach 13 Minuten hatte sich die Ionenkonzentration von 500 Ionen/cm³ auf 100 Ionen/cm³ reduziert. Die Wirkung mit Zigarettenrauch ist die gleiche.

Nach der Messung konnte nur durch intensives Lüften des Raumes die ursprüngliche Ionenkonzentration wieder hergestellt werden.

Quelle: Holbach, Helmut, Umweltanalytik Holbach, 66687 Wadern, Deutschland

Reduktion von UFP
Beispiel: Besprechungszimmer in KH

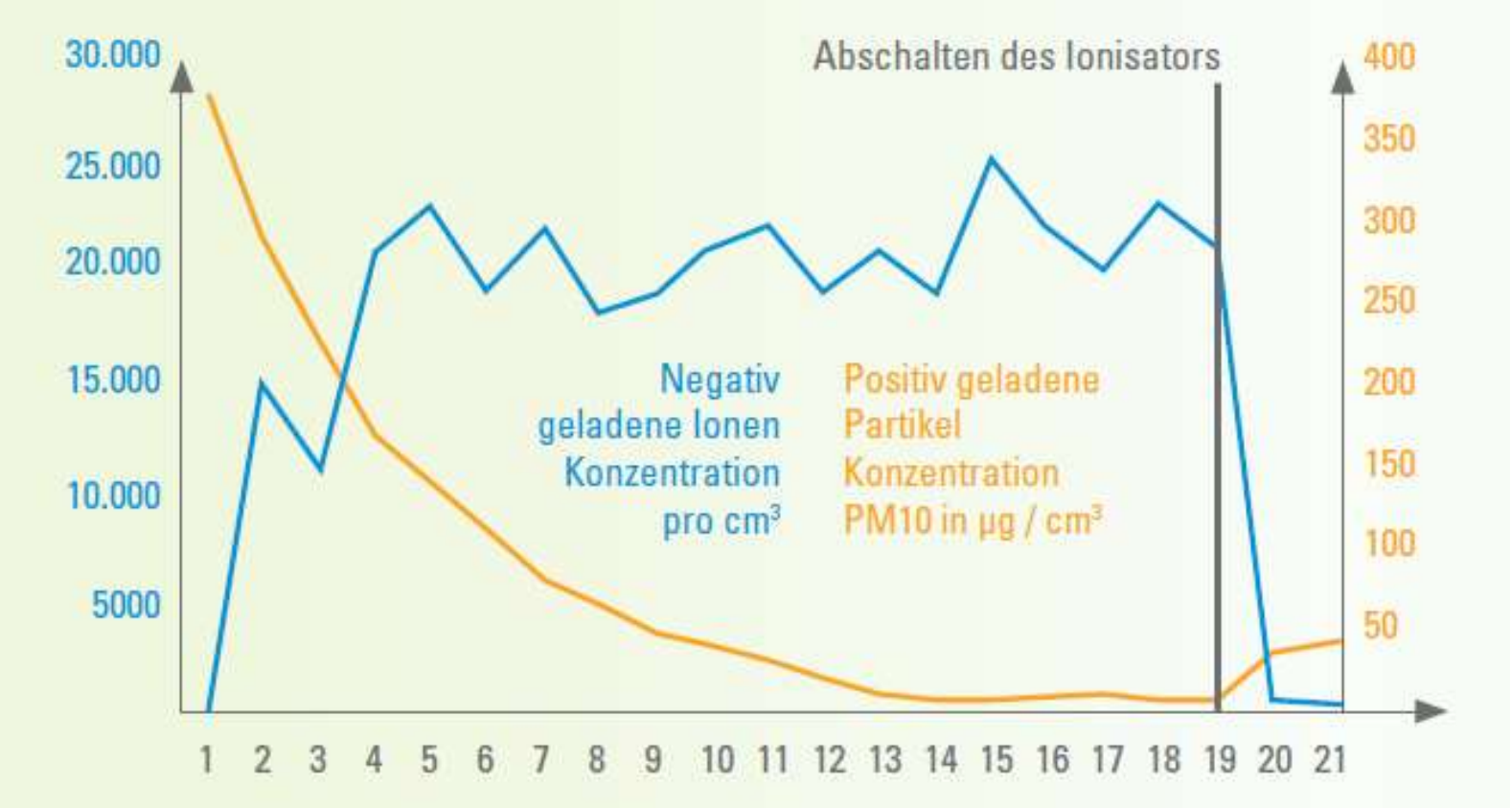
ConsultAIR

Ergebnisse

		Krankenhaus in Wien												
Ort		Besprechungszimmer						Parkplatz vor dem KH	Besprechungszimmer					
	Messung #	1	2	3	4	5	6	7						
	Datum	25.03.2019	25.03.2019	25.03.2019	25.03.2019	25.03.2019	25.03.2019	25.03.2019	22.08.2019	22.08.2019	22.08.2019	30.09.2019	30.09.2019	30.09.2019
	Bemerkungen:	Ohne Luftbehandlung			mit Luftbehandlung				mit Luftbehandlung			mit Luftbehandlung		
	Partikelgröße in µm	Vor der Inbetriebnahme, Raum leer			ca.30min nach Inbetriebnahme				während einer Besprechung			Anlage ca.60min in Betrieb, Raum leer		
Partikelanzahl pro Größengruppe	0,3	1.501	1.798	1.471	1.029	1.419	1.156	25.487	334	658	471	180	172	161
	0,5	595	791	486	455	430	255	6.547	178	126	101	199	74	79
	1	137	281	71	34	33	34	1.037	17	1	15	0	1	34
	2,5	21	39	17	8	5	9	131	5	5	0	0	2	5
	5	6	1	4	2	1	-	9	2	0	0	0	2	4
	10	7	4	2	2	3	1	7	1	0	0	2	1	2
	Summen:	2.267	2.914	2.051	1.530	1.891	1.455	33.218	537	790	587	381	252	285
	Mittel	2411			1625				638			306		
Abweichung von „ohne Behandlung“:					**-33%**				**-74%**			**-87%**		

Angaben in differentieller Mengenanzahl:
Beispiel für die Messung #1: 1.501 Partikel sind kleiner gleich 0,3 µm groß; 7 Partikel sind größer 5 µm aber kleiner oder gleich 10 µm groß.

Messergebnisse

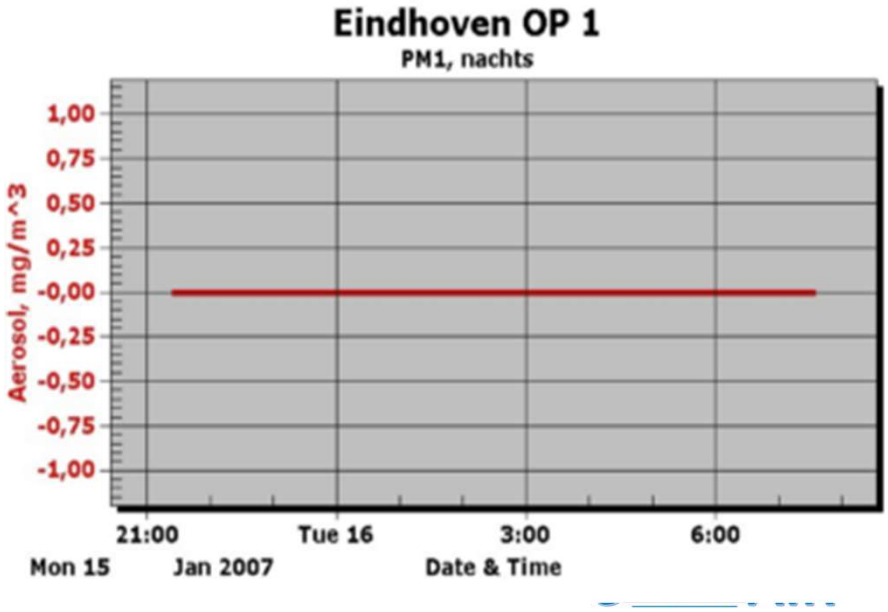


ConsultAIR

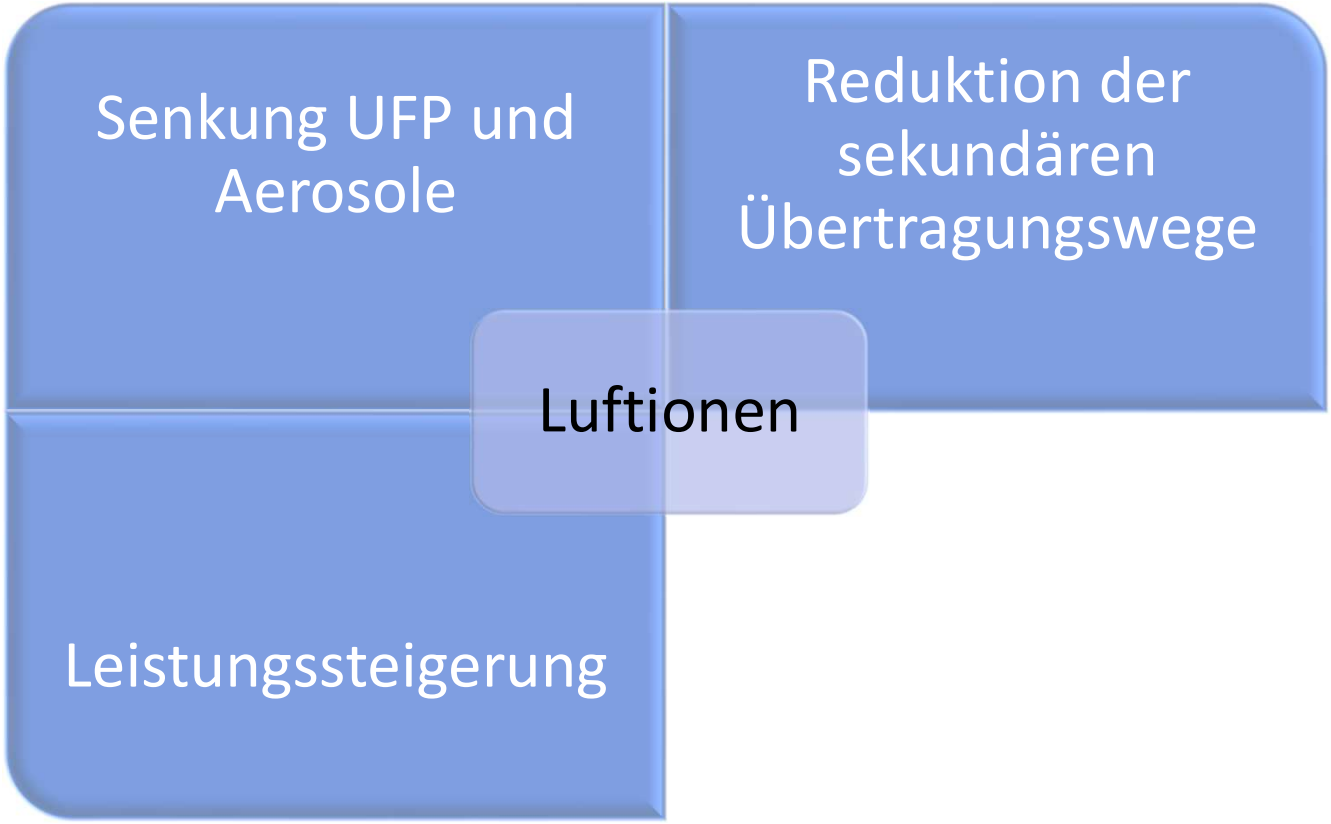
Dauerhafte Raumionisierung zur Vorbeugung einer Aerosolinfektion

- Problem: Bei einer infizierte Person in einem Raum mit einer zweiten Person: es besteht eine Ansteckungsgefahr!
- Lösung: Reduktion der Aerosole mittels Ionisierung aus der Raumluft.

Beispiel aus der Praxis: Seit 14 Jahren (2006) wird im größten Spital Hollands (Eindhoven) bei 21 OP Anlagen eine Luftiniosation durchgeführt. Die Anlagen zur Luftionisation werden jährlich vom Hygieneamt geprüft.
Ergebnis:
Keime: 0
Aerosole:0



Vorteile der Raumluft-Aktivierung



ConsultAIR

Leistungssteigernde Effekte Ionisierte Luft

Wissenschaftlich erwiesen und messbar:

Leistungs- und Konzentrationsfähigkeit des Menschen wird zwischen **10 bis über 50% gesteigert.**

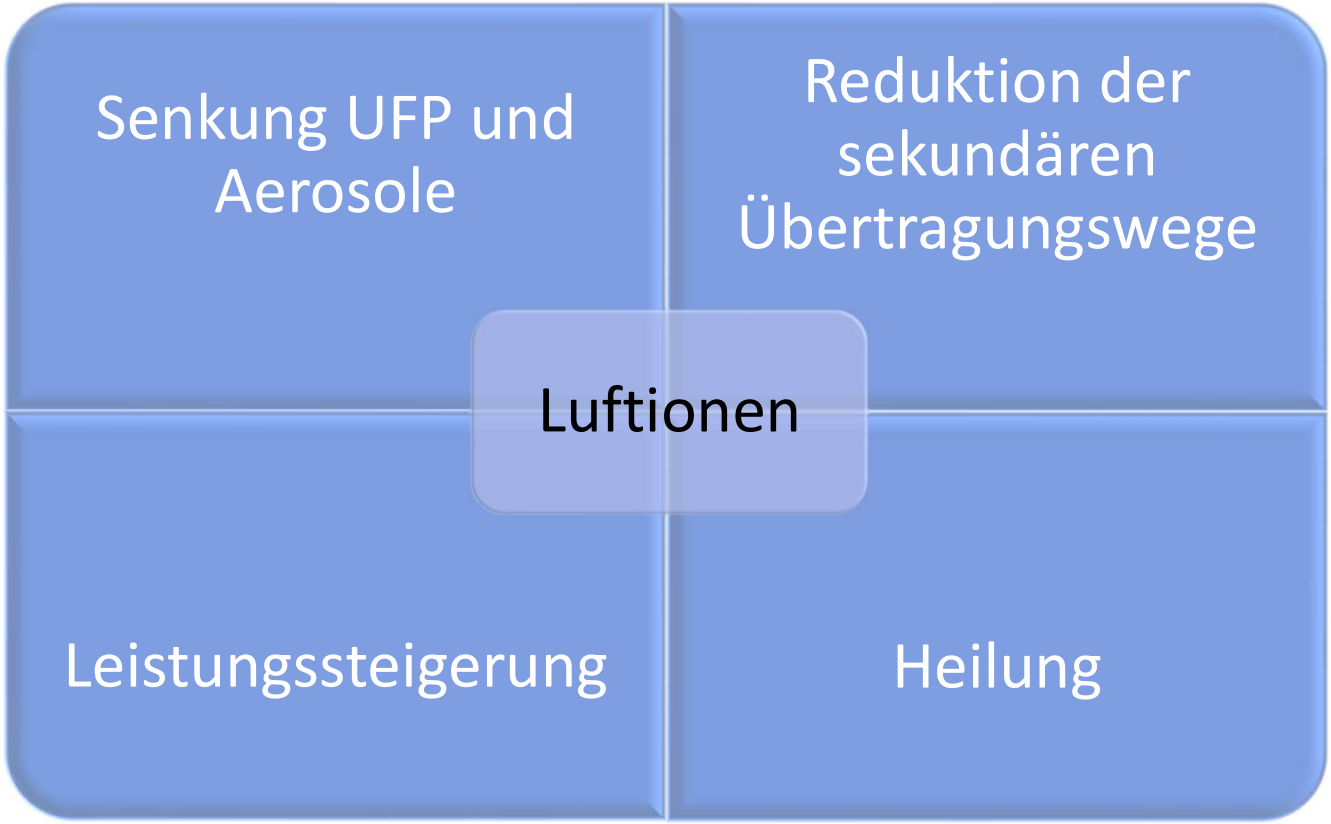
Wissenschaftliche Publikationen

Leistungssteigernde Effekte von aktivierter (=ionisierter) Luft:

- Hutter HP, Kundi M, Wallner P (2011) Einfluss von Luftionen in Innenräumen auf Wohlbefinden, Gesundheit und Leistungsfähigkeit.“
- Hutter H-P, Wallner P, Kundi M, Piegler K, Tappler P, Damberger B, Moshammer H (2014): Air ions, well-being and cognitive performance: results of a cross-over experiment in children. 4th Central & Eastern Europe Conference on Health and the Environment (CEECHE): The Environment – A Platform for Health (Cluj-Napoca, Romania, 25.-30.5.2014):43
- Eichmeier J (1964): Eigenschaften und biologische Wirkungen atmosphärischer Kleinionen. Umschau 14:420-422.
- Fischer G, Kobinger W (1991): Arbeitsmedizinische Ergebnisse bei künstlicher Luftionisation. Atemw-Lungenkrkh 17, 1. Beiheft: B78-B80.
- Flory R, Ametepe J, Bowers B. (2010): A randomized, placebo-controlled trial of bright light and high-density negative air ions for treatment of Seasonal Affective Disorder. Psychiatry Res. 177:101-8.
- Jorde W, Schata M (1979): Inhalation unipolarer Ionen. Atemw-Lungenkrkh 5:443-453.
- König H (1986): Unsichtbare Umwelt. 5. Aufl., Eigenverlag, München.
- Moser M, Auerbach D, Frohmann E, Grote V, Lackner H, Messerschmidt D, Muhry F, Zeiringer C (2004): Wasserfallelektrizität – Wirkung von Luftionen auf die Gesundheit. In: Voigt Beatrice, in Beitrag von Moser Max, Wasser – Schatz der Zukunft. Impulse für eine nachhaltige Wasserkultur. 1, 172; Oekom. Gesellschaft für Ökologie, München.
- Varga A (1981): Grundzüge der Elektrobioklimatologie. E. Fischer, Heidelberg.

ConsultAIR

Vorteile der Raumluft-Aktivierung



ConsultAIR

Wissenschaftliche Studie

Küster, Emil, Dittmar, Carl

Veröffentlicht Nov. 1940

Experimentelle Untersuchungen über therapeutische Beeinflussung von Impf- und Spontantumoren durch Behandlung der Versuchstiere mit unipolar negativ hochionisierter Luft.

Z Krebs-forsch 50, 457–464 (1940

https://doi.org/10.1007/BF01620208

„Besserung und Heilung durch ionisierte Atemluft“

- Bei Inhalation von ionisierter Luft wird das Wachstum von Tumoren gehemmt

- Ionisierte Atemluft zur Unterstützung bei
  - Krebsbehandlung,
  - Asthmaerkrankung,
  - Regeneration des zentralen Nervensystems
  - uvm.

- Ionisierter Sauerstoff – Heilmittel Nr. 1 bei allen Krankheiten (Medizin aus der Luft)

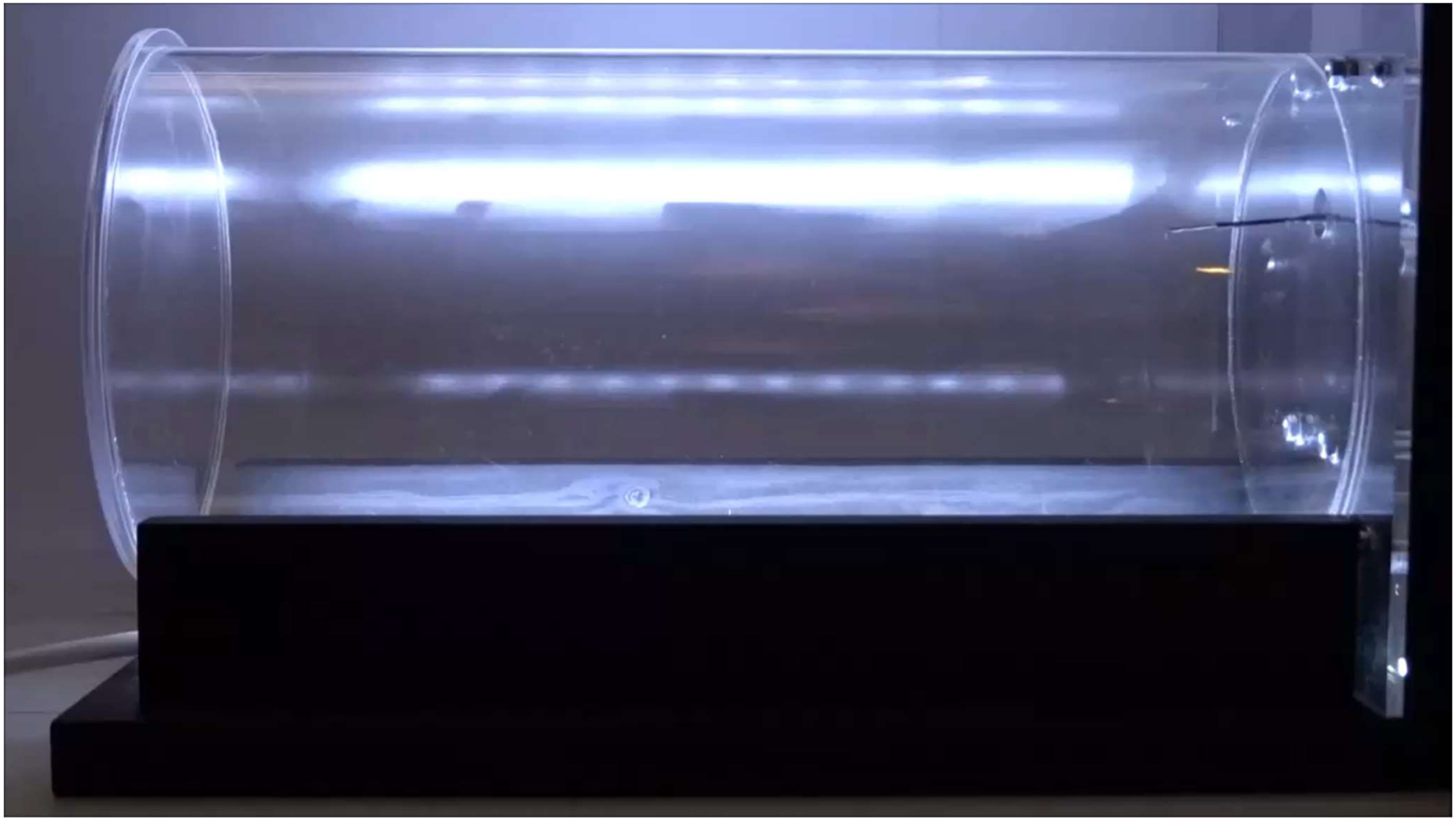
[13]

Gesunde Luft

- weniger pathogene Keime wie Bazillen, Bakterien, Viren, Pilze und Pilzsporen
- frei von Stäuben und Partikel
- Frei von VOCs - flüchtige (gasförmige) organische (kohlenstoffhaltige) Verbindungen
- frei von Gerüchen
- ausreichend Luft-Ionen

Vorteile der ausreichend negativ ionisierten Raumluft

- Reduzierung von Staub, Schadstoffen Keimen, Viren, Bakterien und Pollen
- Keimfreiheit in der Zuluftanlage
- Erhöhte Sauerstoffaufnahme im Blut
- Senkung des Blutdrucks und der Pulsfrequenz
- Erhöhte Leistungsfähigkeit
- Stärkung des Immunsystems



https://www.youtube.com/watch?v=YD-UgxIY9VM&feature=youtu.be

Literaturverzeichnis

[1] … http://medienschafe.files.wordpress.com/2011/03/ionisation.jpg
[2] … http://topsurfen.org/atom.htm
[3] … http://www.raumluft.org/schadstoffe-schimmel-co/luftionen/
[4] … Aga Wagner, „Der Luftionen Faktor“, Books on demand, 2012
[5] … http://www.priggen.com/
[6] … KOFEC: „Über Luft …“
[7] … http://www.topchem.de/Ozongeneratoren/
[8] … Wang (1975) in „Richtlinien zur Bewertung der Innenraumluft“, Fassung 2017
[9] … „Feinstaub wandert ins Gehin“ 06.09.2016, Forscherin Barbara Maher: http://science.orf.at/stories/2795137/
[10] … Spiegel online, 04.03.2018: „Wie schädlich ist Feinstaub?“ http://www.spiegel.de/gesundheit/diagnose/abgas-feinstaub-durch-benzinmotoren-wie-schaedlich-ist-er-a-1189739.html
[11] … Youtube, 18.04.2018: Effekt Ionisierung und Rauchpartikel: https://www.youtube.com/watch?v=kYdqtJ0ApRs&feature=youtu.be
[12[… Cui, Y., Zhang, Z., Froines, J. et al. Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study. Environ Health 2, 15 (2003). https://doi.org/10.1186/1476-069X-2-15
[13] … Krebs - Chance oder Finale: Ursache des Ausbruchs, von L.W. Göring, R. Garve
[14] … Quelle Foto: Von CDC/ Alissa Eckert, MS; Dan Higgins, MAM - https://phil.cdc.gov/Details.aspx?pid=23312Dieses Medium stammt aus der Public Health Image Library (PHIL), mit der Identifikationsnummer #23312 der Centers for Disease Control and Prevention.Hinweis: Nicht alle PHIL-Bilder sind gemeinfrei; überprüfe unbedingt den Urheberrechtsstatus und die Nennung der Autoren und Inhaltsanbieter.Deutsch | English | македонски | slovenščina | +/−Diese Datei wurde von diesem Werk abgeleitet: 2019-nCoV-CDC-23312.png:, Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=86444014
[15] … https://www.dailymail.co.uk/news/article-3204873/How-100-million-shade-balls-brought-protect-LA-s-reservoir-evaporating-fact-bacterial-nightmare.html, downloaded on 09.11.2020
[20] … Weinstein P, Horwell CJ, Cook A. Volcanic emissions and health. In: Selinus O, Alloway B, Centeno JA, Finkelman RB, Fuge R, Lindh U, Smedley P, editors. Essentials of medical geology. Netherlands: Springer ordrecht; 2013. p. 217–38.
Henderson SB, Brauer M, MacNab YC, Kennedy SM. Three measures of forest fire smoke exposure and their associations with respiratory and cardiovascular health outcomes in a population-based cohort. Environ Health Perspect. 2011;119:1266–71.
Derbyshire E. Natural minerogenic dust and human health. Ambio. 2007;36:73–7.
Griffin DW, Kellogg CA, Shinn EA. Dust in the wind: long range transport of dust in the atmosphere and its implications for global public and ecosystem health. Global Change Human Health. 001;2:20–33.
Davidson CI, Phalen RF, Solomon PA. Airborne particulate matter and human health: a review. Aerosol Sci Technol. 2005;39:737–49.
Kahn ME. The death toll from natural disasters: the role of income, geography, and institutions. Review Econ Stat. 2005;87:271–84.

ConsultAIR

Danke!

https://www.proluft.at/de/Ultra-Feinstaub-Reduktion.htm

Christof Braunegg

office@consultair.at