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Risk Communication
Towards a sustainable working life
Forum on new and emerging OSH risks
Brussels, 29-30 October

30. November 2017

| Peter Wiedemann

Overview

Definitions and core concepts

Risks of nano-materials

Cardinal rules for risk communication

Outlook

The benefit of risk communication

Risk communication is a key component in effective risk management.

Done properly, it empowers non-experts to make informed judgements and informed decisions.

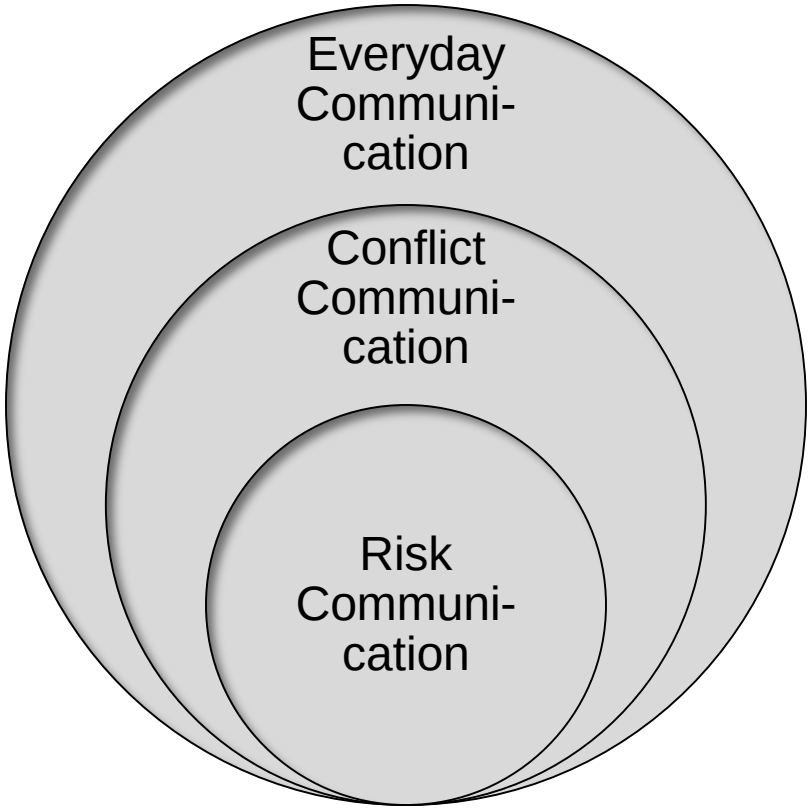
- Workers
- Consumers
- Stakeholders

Challenges

- Providing the right information in the right way in order to allow changes in the receiver's belief, attitude or behavior related to risk issues

- Selecting the most credible information and choosing an appropriate interpretation of the information in order to make judgments about risk issues

Perspective: The Russian doll model



Is there a Risk?

The main conclusion of the studies on these specific carbon nanotubes relating to a risk for mesothelioma is that such a risk cannot be excluded.

SCENIHR 2009

The six cardinal rules of risk communication

- Focus the right problem.
- Assist people to get the entire picture
- Communicate straightforward.
- Support informed judgement about trust.
- Inform about both sides of the issue.
- Be aware of side effects of your communication.

Rule 1: Focus the right problem

The core of the nano issue is the suspected health risk

- Experts have to weight the available scientific evidence with respect to adverse health effects

Rule 1: Focus the right problem

Key question: Is there a hazard?

IARC: “The distinction between hazard and risk is important, and the *Monographs* identify cancer hazards even when risks are very low at current exposure levels, because new uses or unforeseen exposures could engender risks that are significantly higher. ”

- *Preamble, Part A, Section 2*

Rule 2: Assist people to get the entire picture

In summary, our data provide the first experimental evidence that MWCNT can induce mutations in lung cells.

Mueller, J et al. (2008) Clastogenic and aneugenic effects of mult-wall carbone nanotubes in epithelial cells, Carcinogenesis

➔ ■ Necessary but insufficient information for risk assessment

- Other studies
- Critical exposure relations
- Extrapolation to humans

Rule 2: Assist people to get the entire picture

Reviews of Nanotechnology Risks

BAuA - German Federal Institute for Occupational Safety and Health. (August 2006). Nanotechnology: Health and Environmental Risks of Nanoparticles. Report

Department for Environment, Food, and Rural Affairs (Defra, UK). (December 2007). Characterising the Potential Risks posed by Engineered Nanoparticles: A Second UK Government Research Report. Article

Department for Environment, Food, and Rural Affairs (Defra, UK). (2005). Characterizing the Risks Posed by Nanoparticles:A First UK Government Risk Report. Article

Environmental Defense – DuPont Nano Partnership. (February 2007). NanoRisk Framework. Draft.

European Commission (2004, March). Nanotechnologies: A Preliminary Risk Analysis, on the Basis of a Workshop Organized in Brussels on 1-2 March 2004 by the Health and Consumer Protectorate General of the European Commission. Article

FOEN (Swiss Federal Office for the Environment) and FOPH (Swiss Federal Office of Public Health). (July 2007). Risk Assessment and management of engineered nanoparticles. Report

Health & Safety Executive. (2004). Health Effects of Particles Produced for Nanotechnologies. Suffolk, United Kingdom. Article

International Council on Nanotechnology, Rice University, Houston, Texas. (May 2008). Towards Predicting Nano-Biointeractions: An International Assessment of Nanotechnology Environment, Health and Safety Research Needs. Report

ISO, IEC, NIST and OECD. (June 2008). International workshop on documentary standards for measurement and characterization for nanotechnologies. Report.

KEMI, Swedish Chemicals Agency. (June 2008). Nanotechnology – high risks with small particles? Report

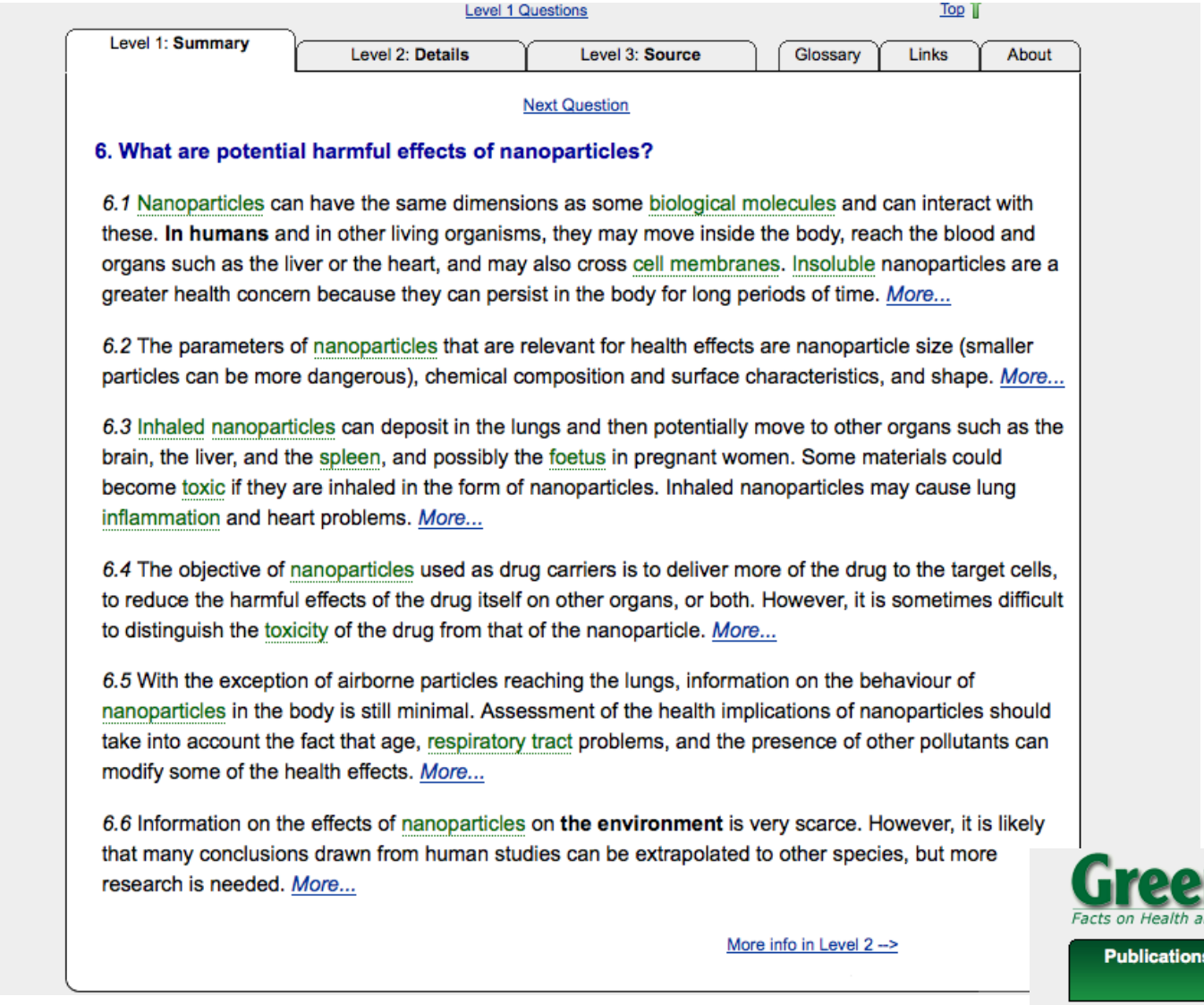
National Institutes of Occupational Safety and Health, Nanotechnology, Approaches to Safe Nanotechnology; An Information Exchange with NIOSH. Article

OPECST (French Parliamentary Office for Evaluation of scientific and technological options). (November 2006). Public hearing on "Nanotechnologies : potential risks and ethical issues". Transcripts

Royal Society & The Royal Academy of Engineering. (2004). Nanoscience and Nanotechnologies: Opportunities and Uncertainties. Article

Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). (March 2006). The appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies. Report

Rule 2: Assist people to get the entire picture



Level 1 Questions Top

Level 1: **Summary** | Level 2: **Details** | Level 3: **Source** | Glossary | Links | About

Next Question

6. What are potential harmful effects of nanoparticles?

6.1 Nanoparticles can have the same dimensions as some biological molecules and can interact with these. **In humans** and in other living organisms, they may move inside the body, reach the blood and organs such as the liver or the heart, and may also cross cell membranes. Insoluble nanoparticles are a greater health concern because they can persist in the body for long periods of time. *More...*

6.2 The parameters of nanoparticles that are relevant for health effects are nanoparticle size (smaller particles can be more dangerous), chemical composition and surface characteristics, and shape. *More...*

6.3 Inhaled nanoparticles can deposit in the lungs and then potentially move to other organs such as the brain, the liver, and the spleen, and possibly the foetus in pregnant women. Some materials could become toxic if they are inhaled in the form of nanoparticles. Inhaled nanoparticles may cause lung inflammation and heart problems. *More...*

6.4 The objective of nanoparticles used as drug carriers is to deliver more of the drug to the target cells, to reduce the harmful effects of the drug itself on other organs, or both. However, it is sometimes difficult to distinguish the toxicity of the drug from that of the nanoparticle. *More...*

6.5 With the exception of airborne particles reaching the lungs, information on the behaviour of nanoparticles in the body is still minimal. Assessment of the health implications of nanoparticles should take into account the fact that age, respiratory tract problems, and the presence of other pollutants can modify some of the health effects. *More...*

6.6 Information on the effects of nanoparticles on **the environment** is very scarce. However, it is likely that many conclusions drawn from human studies can be extrapolated to other species, but more research is needed. *More...*

More info in Level 2 -->

GreenFacts
Facts on Health and the Environment
Publications | Blog | A-Z List

Rule 3: Communicate straightforward

Some specific hazards, discussed in the context of risk for human health, have been identified. These include the possibility of some nanoparticles to induce protein fibrillation, the possible pathological effects caused by specific types of carbon nanotubes, the induction of genotoxicity, and size effects in terms of biodistribution.

SCEHNIR 2009

Rule 3: Communicate straightforward

Friends of the Earth

Australia risks repeat of asbestos tragedy

This article is reprinted from ***New Matilda 22.06.09***

"Prime Minister Kevin Rudd **has described** Bernie Banton as a "great Australian hero" for his tireless campaigning for justice for asbestos victims. But despite serious warnings from scientists and risk assessors that carbon nanotubes could pose similar risks to asbestos, the Rudd government is refusing to bring in new regulations to ensure we don't repeat the asbestos tragedy.

» **read more**

Who is right?

Rule 4: Support informed judgements about trust

Who deserves trust and why?

- Development of an approach for characterizing and ranking the fairness, social responsibility and competency of scientific advisory groups engaged in EMF risk assessment
  - Mandate & membership
  - Impartiality
  - Expertise & consultation
  - Evaluation & transparency

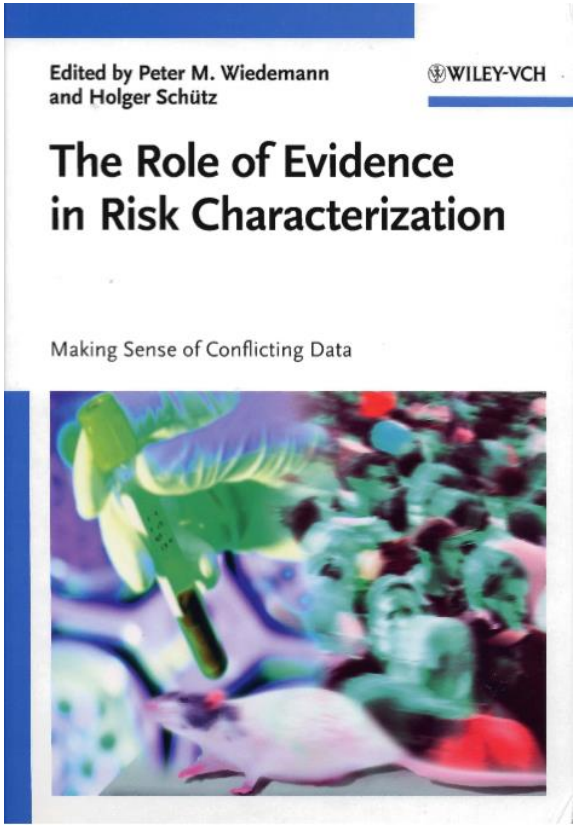
Rule 5: Address both sides of the issue

Level of evidence

Pro- and con arguments

Uncertainties and certainties

Conclusions



Rule 5: Address both sides of the issue

supporting

- **Antioxidative reactions very low, thus permanent disturbance of ox. homeostasis**
- **Catalytical activity has been shown**

Pro-Argument (5 Studies with effect):

- Intratracheal dose 2mg/Animal; <30nm
- TiO_2-NP +; fine TiO_2 -; in vitro
- oxidative stress in vitro
- TiO_2 P25; ROS in Brain-Microglia BV2
- TiO_2-NP; oxidative stress in vitro

attenuating

- **Unreal. high conc. for an effect**
- **Microglia left stable + resistant**
- **Effect is only weak**

supporting

- **No effect despite overload and uptake**
- **One methodical brilliant study**
- **No effects despite high concentrations**

Contra-Argument (2 Studies without Effect):

- no ROS-formation in vitro
- no ROS-formation by amorphous TiO_2

attenuating

- **ROS by TiO_2-NP higher than by microfine TiO_2**

Evidence Basis :

- 7 Studies

Conclusion :

Due to the conflicting results of the studies so far no evaluation can be done

Remaining Uncertainties

- Differences in crystallinity?
- Threshold for NOEL existing?
- Methodical Limits: ROS in vivo not detectable; in vitro inducible only by very high doses

ROS by TiO_2

Rule 6: Be aware of side effects of your communication

Currently, the risk assessment procedure for the evaluation of potential risks of nanomaterials is still under development. It can be expected that this will remain so until there is sufficient scientific information available to characterise the possible harmful effects on humans and the environment.

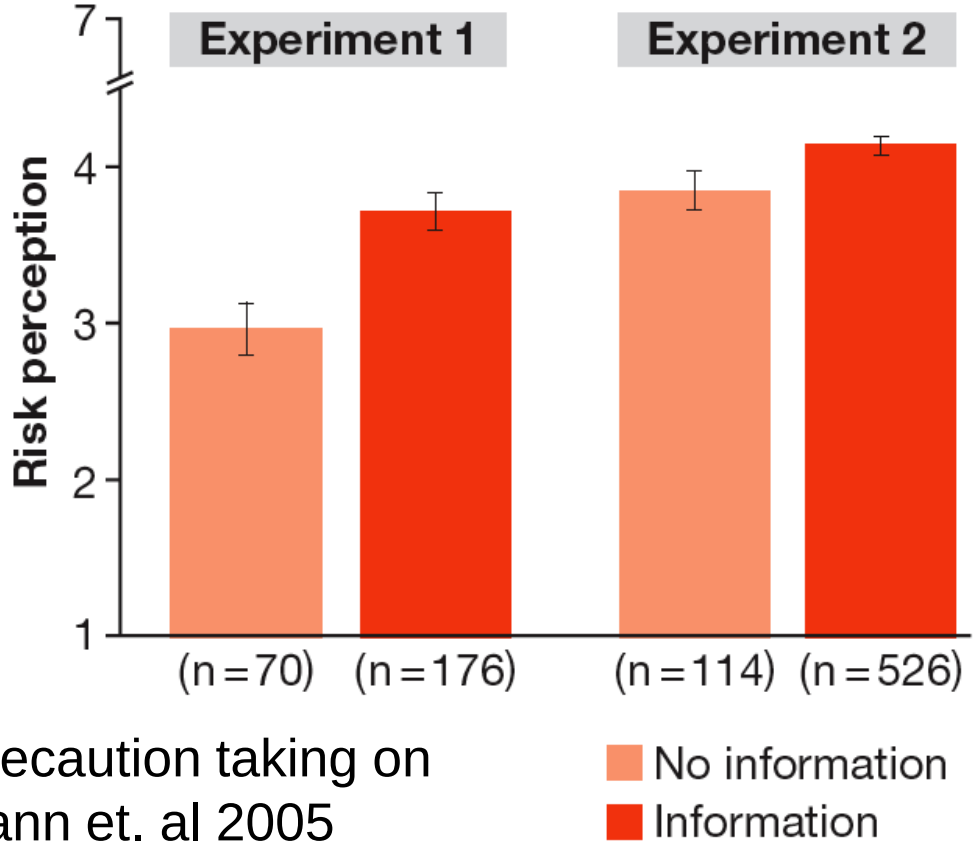
SCENIR, 2009

➔Precautionary measures

Rule 6: Be aware of side effects of your communication

Implement precautionary messages with caution

Rule 6: Be aware of side effects of your communication



Impact of informing on precaution taking on risk perception, Wiedemann et. al 2005

Outlook

Risk communication should help to improve risk policy

- Improving transparency of health risk assessment
- Supporting informed decision making
- Avoiding unnecessary public anxieties
- Building trust in regulation
- Helping to develop socially robust risk management strategies

Outlook

“ Risk communication is not just a matter of good intentions ... Risk messages must be understood by the recipients, and their impacts and effectiveness must be understood by communicators. To that end, it is not longer appropriate to rely on hunches and intuitions regarding the details of message formulation. ”

Morgan & Lave, 1990, 358

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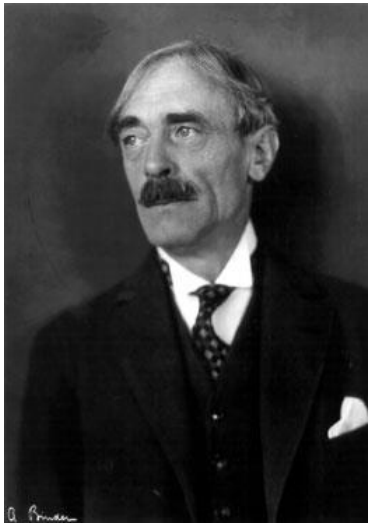
“What is simple is wrong,
what is complex is useless.”

Paul Valéry



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Thank You For Your Attention!

Contact Information

Prof. Peter M. Wiedemann

ROS by TiO_2

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Evidence Map - Tissue Barrier Air/Blood

supporting

- **Inhaled TiO_2 appears within the respiratory tract and the lung cells**
- **Particle uptake by unspecific processes/not only one process**
- **Particles 24 h after inhalation found in the blood (rats)**
- **Human in vitro models: TiO_2 is found in cells not only in vesicles**
- **Translocation is dependent on particle size**
- **Instilled Ag-particles have been found throughout the observation period of 7 days within lung cells**

Pro-Argument (5 Studies with effect):

- TiO_2 4 Studies
- Silver 1 Study

attenuating

- **After incubation/exposure no toxic effects although particles have been taken up by lung tissue**
- **Number of instilled/inhaled Ag-particles decreases very fast by lung clearance: on day 7 only 4% remain in the lung**

Evidence Basis :

- 5 Studies

Conclusion :

All 5 studies demonstrate a translocation via the air-blood-barrier

Remaining Uncertainties

- Period of disposition and stability not clear (persistence)
- Particles not clearly characterised: ADME is unclear
- Role of specific properties like size, dose, administration….?
- Different susceptibility of the different species (rats, mice, humans?)
- Portion of ENM entering the body is very small – relevance?

DNA-Damage by TiO_2

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- No effect of micro TiO_2, but with nano-TiO_2 (Gurr, Rahmann, Donaldson)
- Effects by different nano-TiO_2 samples (Dunford)
- DNA-damage dependent on free radical formation (Donaldson)
- High relevance of BEAS-2B lung cells (Gurr)

supporting

Pro-Argument: 6 Studies describe Effect

- DNA-damage by anatase nano-TiO_2 w/o photoactivation (Gurr)
- Chromosomal distribution error after nano-TiO_2 in SHE-cells (Rahman)
- Photoactivated nano-TiO_2 induces oxidative DNA-damage in fibroblasts (Dunford)
- Free radical formation on the surface of nano-TiO_2 (Donaldson)
- Cytotoxicity and genotoxicity in human WIL2-NS cells (Wang)
- UV-induced DNA strand breaks in L5178Y cells from mice and DNA-damage by photoactivated nano-TiO_2 dependent on dose and light intensity (Nakagawa)

attenuating

- w/o UV-activation DNA-damage only with huge doses (Nakagawa)
- No mutations by photoactivated nano-TiO_2 in cellular systems (Nakagawa)

Contra-Argument: 2 Studies w/o Effect

- No mutagenicity by nano-TiO_2 nor chromosome aberrations in CHO cells (Warheit)
- No oxidative damage of isolated DNA by anatase nano-TiO_2 (Warner)

attenuating

- Significant photo-oxidation by particles (Warner)

Evidence Basis

8 Studies

Conclusion:

- Indication for DNA-damage by nano-TiO_2 exist
- Mechanism seems to be dependent on oxidative stress

Remaining Uncertainties:

- Oxidative stress a consequence of intratracheal instillation (method?)
- Smaller particle more reactive than larger ones (but Warheit demonstrates no dependency on surface area)
- Results do not confirm compatibility for nano-TiO_2 in absence of photoactivation
- Effects dependent on preparation of particles (e.g. coating)
- The role of particle properties is unclear: bioavailability, solubility, surface reactivity, photoactivation, adsorption, coatings…..)

DNA-Damage by Fullerenes C_{60}

supporting

- **Ames test: mutagenicity is important for the evaluation of genotoxicity and carcinogenicity**

Pro-Argument: 1 Study describes Effect

- **Mutagenic activity in Salmonella by pure C_{60} Fullerenes (Sera et al.)**

supporting

- **Not acute toxicity during the first 72 h after treatment with C_{60}**
- **After subchronic exposure during 24 weeks no tumour promoting activity in DMBA initiated skin tumours**
- **realistic exposure level (industry) against C_{60} is low**

Contra-Argument: 1 Study w/o Effect

- **No DNA-damage within the epidermis of mice (Nelson et al.)**

Evidence Basis

2 Studies **(Nelson et al., Sera et al.)**

Conclusion:

- No evaluation possible (too few studies, differing methods, varying results)
- Studies not comparable because of different model systems and methods

Remaining Uncertainties:

- No replication studies available
- Differences of effects possibly a result of different models?
- Fullerene source different

DMBA: 7,12-dimethylbenz(a)anthracene