A structured observational method to assess dermal exposure to engineered nanoparticles.

A DREAM to tell …

TNO | Knowledge for business

Outline

- Introduction
- DREAM
- Case study
- Discussion
- Questions

Introduction - Opportunities

- Various applications
  - Coatings, materials
  - Cosmetics
  - Food
  - Medicine

Introduction – Risks

- The possibilities of skin contacts with nanoparticles (powders/suspensions) are numerous: cleaning, maintenance, handling powders, etc.

Introduction - Health

- Some studies suggest that nanomaterials could potentially enter the body through the skin during occupational exposure (NIOSH, 2009).

- At this time, it is not fully known whether skin penetration of nanoparticles would result in adverse effects in animal models (NIOSH, 2009).

→ Precautionary measures are warranted

DREAM

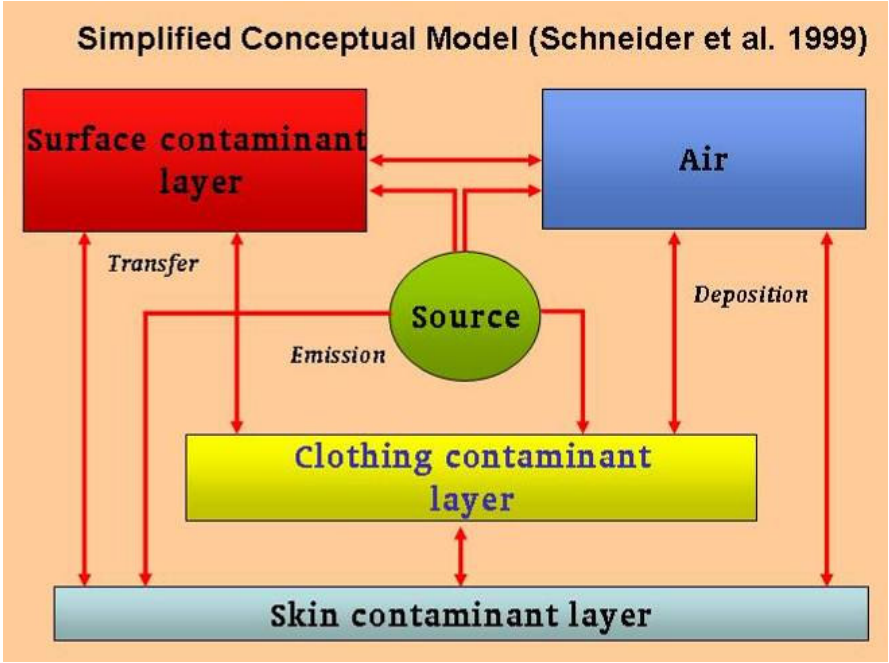
Method for semi-quantitative **D**e**R**mal **E**xposure **A**ssess**M**ent for chemical or biological agents, applicable in occupational hygiene and epidemiology in any given situation (van Wendel de Joode et al., 2003).

- DREAM can serve:
  - Initial method to assess dermal exposure
  - Framework for measurement strategies
  - Basis for control measures (e.g. selection PPE)

DREAM - Model

Described by Van Wendel de Joode et al. (2003) based on:

- Conceptual model (Schneider et al., 1999)
- Method for structured subjective assessment of airborne concentrations (Cherrie et al., 1996)



DREAM – Inventory

Table 1. Summarizing the information obtained in the inventory part

Module	Data obtained on	Processes in conceptual model of Schneider *et al.* (1999)
1. Company	General information about company and observer	
2. Department	Chemical or biological agents that occur in work environment Cleaning activities at department	Source present (no/yes), surface contaminant layer present (no/yes) Decontamination of surface contaminant layer
3. Agent	Physical characteristics of substance for which dermal exposure is assessed, such as concentration of active ingredient in substance, physical state, boiling temperature, viscosity, formulation (powder, granules), dustiness, stickiness	Source strength, emission, evaporation, decontamination
4. Job	Hygienic behaviour Number of people with this job title	Decontamination of skin
5. Task	Percentage of time that task is performed Number of people performing task	Event per unit of time
6. Exposure to a substance assessed for a certain task	Probability and intensity of dermal exposure routes (per body part) Use of clothing (per body part) (covered versus uncovered body parts, clothing material, repeated use of clothing) Contamination of work environment	Emission, deposition, transfer Clothing barrier, contamination of clothing, redistribution

(Van Wendel de Joode et al., 2003)

DREAM - Inventory

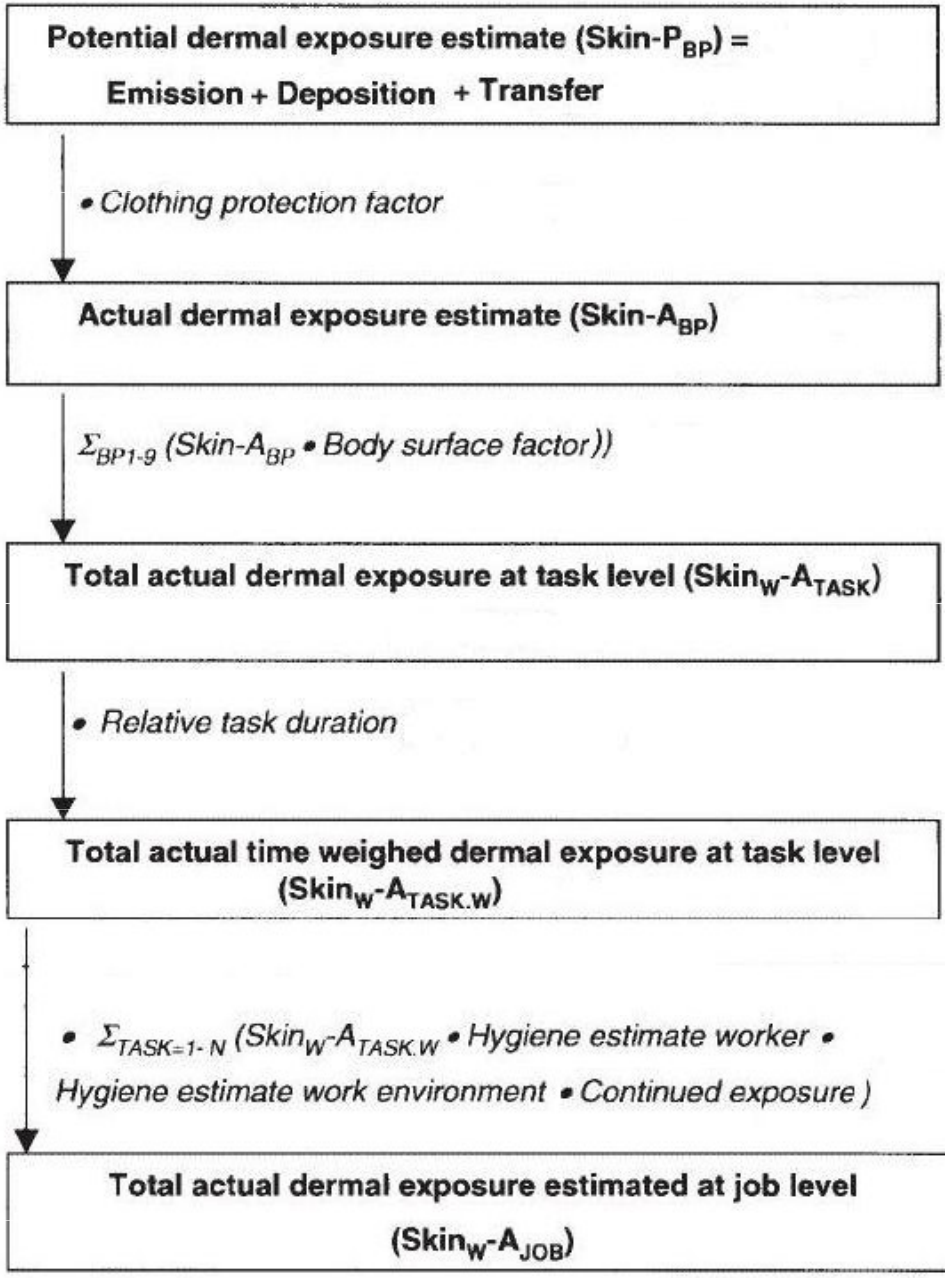
1. Name of the agent used during the task	
2. The agent is pure, mixture of a residue? In this case, the active ingredient is the amount of nano particles.	O pure (>= 90% active ingredient of interest) O mixture (1-90% active ingredient of interest) O residue (< 1% active ingredient of interest)
3. Specify physical state of agent	O Solid → 4 O Liquid → 5 O Vapour → go to exposure O Gaseous → go to exposure
4. The agent's form	O Powder O Granules O Flocks / shreds / chips / flakes O Pellets O Other specify: _____
4a. Agent is dusty	O no O yes

DREAM - Inventory

Deposition. When performing task airborne particles of the agent are formed or present in working environment and deposited on (covered) body parts?	O no, unlikely→ 7 O yes, occasionally (<10% of task duration) O yes, repeatedly (10-50% of task duration) O yes, almost constantly (>50% of task duration)	
Specify amount	O small amount (not visible / <10% body part) O medium amount (visible / 10 – 50% body part) O large amount (visible / > 50% body part)	
Please tick body parts exposed due to deposition	Body parts	Agent deposited
	Head / neck	O
	Upper arms	O
	Forearms	O
	Hands - wrists	O
	Torso (front)	O
	Torso (back)	O
	Lower abdomen and upper legs	O
	Lower legs	O
	Feet	O

DREAM – Evaluation

Evaluation part:



Case study – NANOSH

NANOSH project: EU-funded research project focusing on occupational exposure to nanoparticles and their health effects.

- Inhalation exposure: exposure measurements
- Dermal exposure: DREAM questionnaire

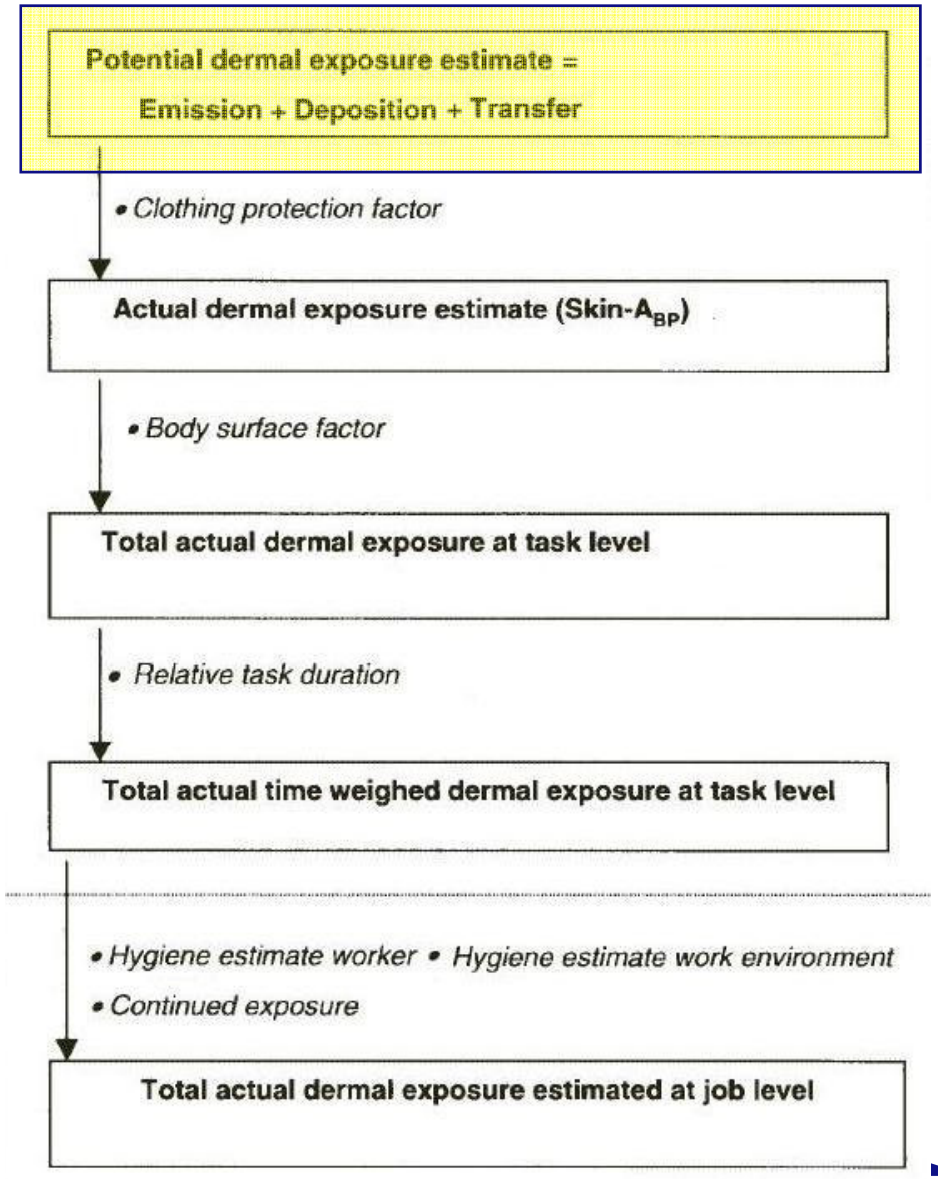
Case-study - Method

Simplified DREAM questionnaire was used, only containing:

- Agent module
- Exposure module

- 5 occupational hygienists
- 8 companies visited
- 32 tasks observed

Case study - method



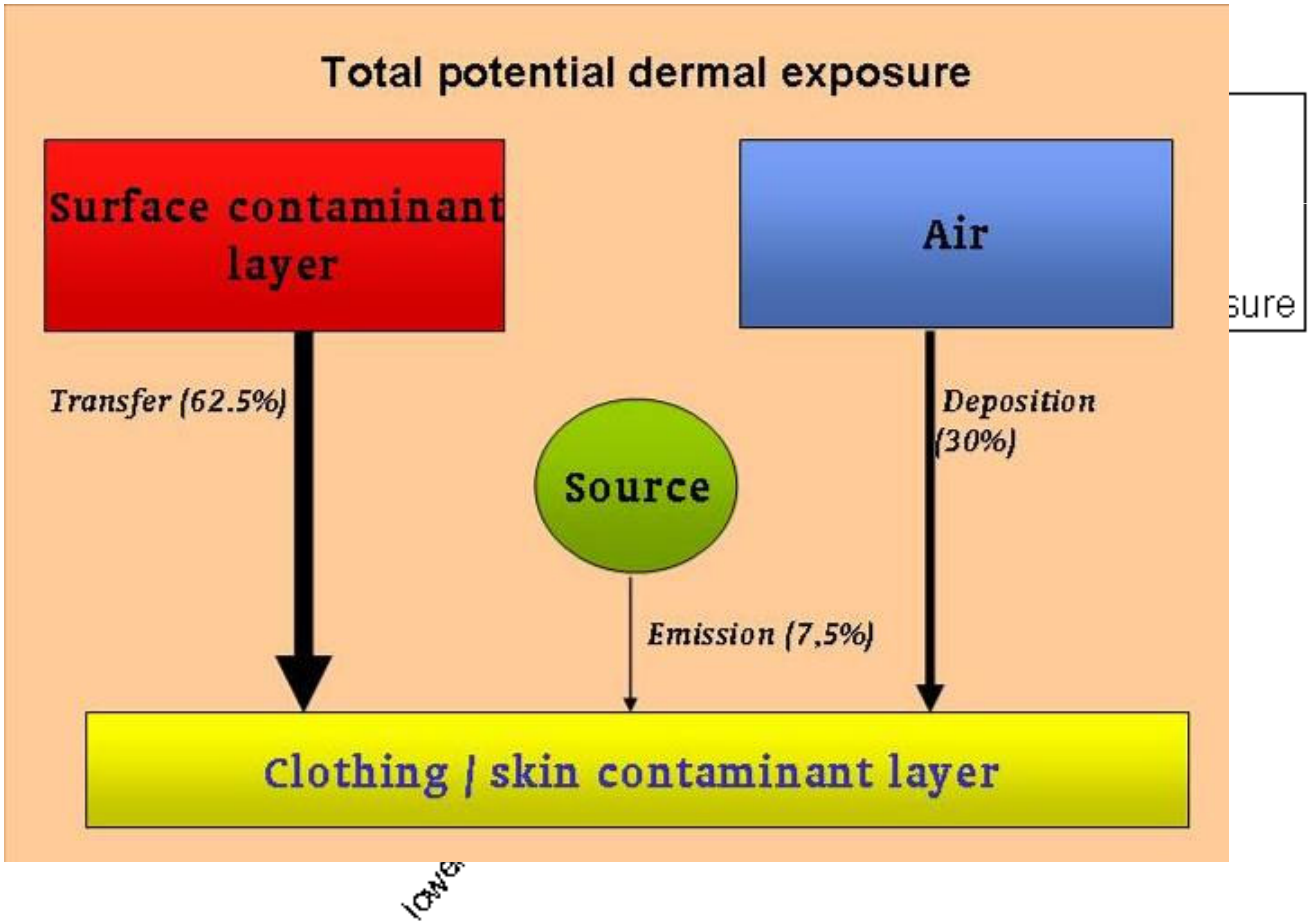
Case study - Example

- Dumping fumed silica from bags

In practice, example

- Dumping fumed silica from bags

DREAM estimate



In practice

Category	Likelihood
-	Almost impossible
±	Very low
+	Low
++	Significant
+++	High

Task	Agent	Emission	Transfer	Deposition	Total
Handling of fumed silica in suspension/dipping	Fumed silica	-	-	-	-
Preperation of iron hydroxyhydride	Iron	±	±	-	±

In practice

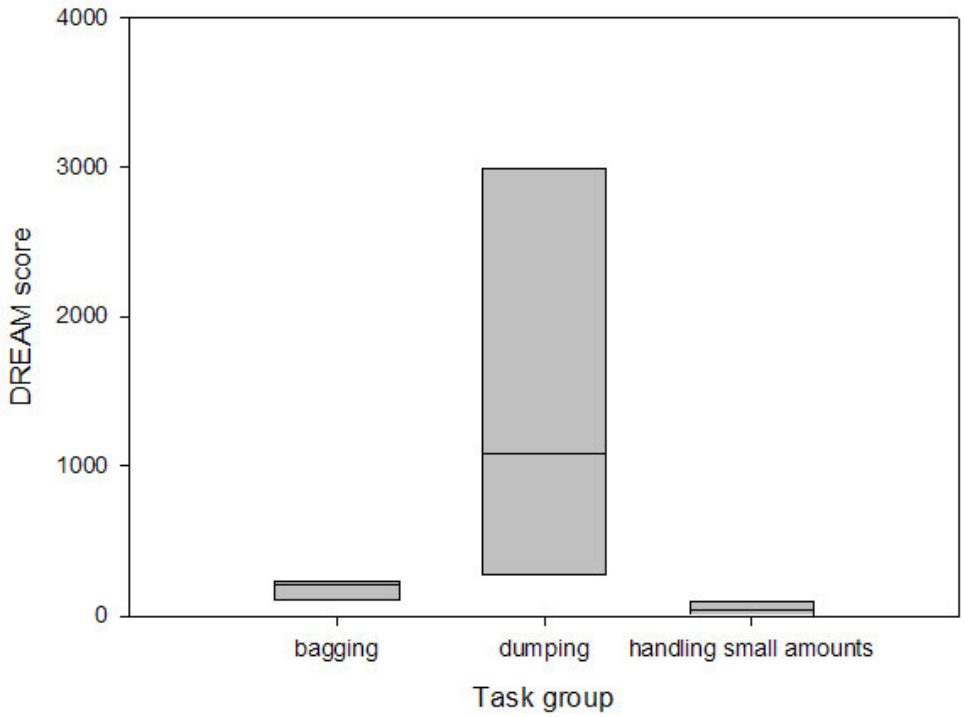
Category	Likelihood
-	Almost impossible
±	Very low
+	Low
++	Significant
+++	High

Task	Agent	Emission	Transfer	Deposition	Total
Sampling from production reactor	Carbon nanotubes	-	-	-	-
Weighing product	Silver powder	-	-	-	-
Changing of filters	Aluminiumoxide suspension	-	-	-	-
Preperation of iron hydroxyhydride	Iron hydroxyhydride	±	±	-	±
Scratch test	Fumed silica dried	-	-	±	±
Production of polymer	Carbon nanotubes	-	±	-	±
Sampling	Toner	±	±	-	±
Operator	Toner	-	+	-	+
Vacuum cleaning	Ceriumoxide, titaniumoxide	-	+	±	+
Cleaning using dry tissue	Ceriumoxide, titaniumoxide	±	+	-	+
Weighing product	Fumed silica dried	±	±	±	+
Emptying and filling plates with powder	Catalyst	±	+	±	+
Bagging of product	Carbon nanotubes	-	+	±	++
Bagging of product	Dry Perkalite	±	+	+	++
Dumping of product from bags	Aluminiumhydroxide	±	+	±	++
Calibration extruder	Carbon nanotubes	-	++	±	++
Filling and changing of bins	Nanoparticle powder	+	++	-	++
Bagging nanoparticle powder	Nanoparticle powder	+	++	-	++
Bagging of product	Dry Perkalite	++	+	+	++
Dumping of product from bags	Wet cake	±	++	+	++
Emptying kettle and vacuum cleaning	catalyst-dry	±	+++	±	+++
Coupling bags carbon nanotubes to extruder	Carbon nanotubes	-	+++	-	+++
Handling dry powder	Carbon nanotubes	++	+++	+	+++
Dumping of product from bags	TiO2	+++	+	++	+++
compressing empty bags	Various	-	+++	+++	+++
Dumping of product from bags	Fumed silica	+	+++	+++	+++
Dumping of product from big bags	Carbon Black	-	+++	-	+++
Suction of powder out of bins	Nanoparticle powder	+++	+++	-	+++
Dumping of product from bags	Ceriumoxide	-	+++	±	+++
Dumping of product from bags	Titaanoxide	±	+++	+	+++

In practice

Category	Likelihood
-	Almost impossible
±	Very low
+	Low
++	Significant
+++	High

Group	Task
Bagging	Bagging of product
	Bagging of product
	Bagging of product
	Bagging of product
	Filling and changing of bins
Dumping	Dumping of product from bags
	Dumping of product from bags
	Dumping of product from bags
	Dumping of product from bags
	Dumping of product from bags
	Dumping of product from bags
	Dumping of product from big bags
Handling small amounts	Weighing product
	Sampling from production reactor
	Emptying and filling plates with powder
	Weighing product
	Calibration extruder
	Handling little amounts of product



Implications control measures

Exposure route	Control measure
Emission	Gloves
	Clothing
Transfer	Gloves
	Clothing
	Organization of work: interval between event and contact
	Cleaning of surfaces
Deposition	Gloves
	Clothing
	Segregation
	Ventilation (including LEV)

Marquart et al. (2003)

- Control measures not included in the evaluation in the present study.

Discussion

- Feasible and useful to assess dermal exposure to engineered nanoparticles using the modified DREAM method
- In potential dermal exposure is likely to occur
- The results give:
  - insight in the main routes of exposures
  - an indication for the exposure control measures needed
- NANOSH study mainly focussed on scenarios concerning solids

Discussion

- Exploration possibilities quantitative exposure assessment by means of measurements
- Efficiency of PPE for the different exposure routes and nanoparticles need be studied

References

- Cherrie et al. (1996) A new method for structured, subjective asssessments of past concentrations. Occup. Hyg.; 3: 75-83
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- National Institute for Occupational Safety and Health (NIOSH) (2009) Approaches to safe nanotechnology - managing the health and safety concerns associated with engineered nanomaterials. Prepublication copy.
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- Van Wendel de Joode et al. (2003) DREAM: A method for semi-quantitative dermal exposure assessment. Ann Occup Hyg; 47: 71-87

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Thank you for your attention

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