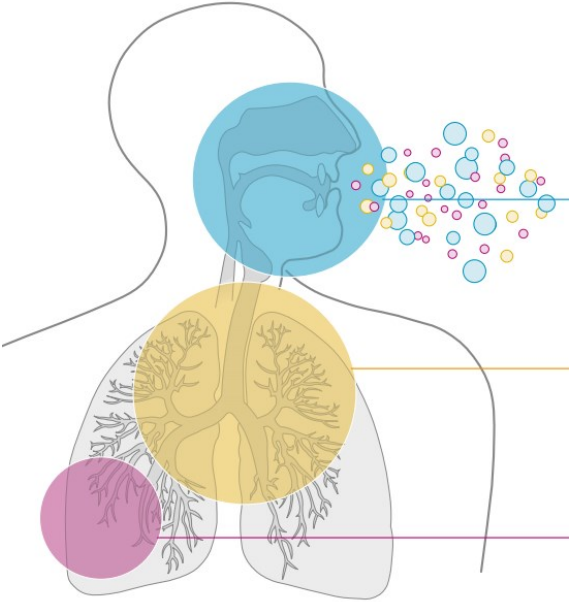


# Occupational inhalation exposure during surface disinfection – exposure assessment based on exposure models compared with measurement data



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# Surface disinfection

- Daily activity for healthcare workers



Pictures: DGUV Regel 101-605

- Inhalation exposure by volatile disinfectant active ingredients (e.g. alcohols, peroxides)
- Before starting a disinfection activity → exposure assessment

# Inhalation exposure assessment at a workplace

## Workplace air measurements

- German “Technical Rules for Hazardous Substances 400 and 402”
- European standard DIN EN 689

## Exposure models

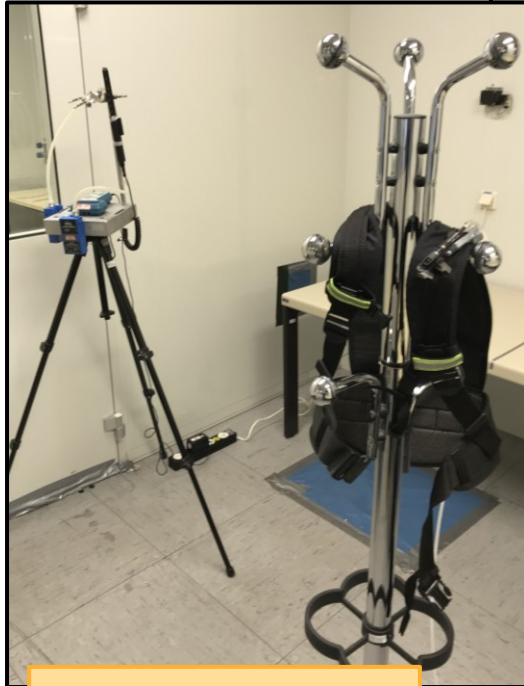
- Deterministic physico-chemical models (e.g. ConsExpo)
- Modifying-factor models (e.g. Stoffenmanager<sup>®</sup>)

## Surface disinfection in the healthcare sector:

- Air measurements are often not feasible or available
- Decision as to which exposure model is suitable remains difficult
- **Project:** Exposure modelling in combination with air measurements at one specific workplace for surface disinfection

# Surface disinfection and air measurements

Test chamber  
(39.9 m<sup>3</sup>, 0.7-0.9 / h)



W. Wegscheider

Disinfectant no.	Active ingredient	Concentration in application solution
1	Ethanol	45 g / 100 g
2	Formaldehyde	0.051 g / 100 g
	Glutaraldehyde	0.041 g / 100 g
3	Glutaraldehyde	0.048 g / 100 g
4	Hydrogen peroxide	4.7 g / 100 g
	Peroxyacetic acid	0.15 g / 100 g

- **Surface sizes:** 0.5 / 2 / 5 m<sup>2</sup> (No. 3: plus 10 / 15 m<sup>2</sup>)
- **Air Measurements** (personal and stationary air sampling for 15 min)
- Recording of further parameters (temperature, relative humidity, amount of applied disinfectant, disinfection/drying time)

# Used exposure models

## Deterministic models

- Unsteady 1-zone model L. Anhäuser
- ConsExpo (Tier 1, Tier 2) B. Piorr
- 2-component model (Tier 1, Tier 2)

## Modifying-factor models

- Stoffenmanager<sup>®</sup> M. Arnone



## Method to assess the quality of exposure models for surface disinfection:

$$\frac{\text{PRED}}{\text{EXP}} = 1$$

**perfect accuracy**

$$0.5 < \frac{\text{PRED}}{\text{EXP}} < 5$$

**good accuracy**

$$0.1 < \frac{\text{PRED}}{\text{EXP}} < 10$$

**acceptable accuracy**

PRED = predicted value / modelled value

EXP = mean of measured values of personal air sampling

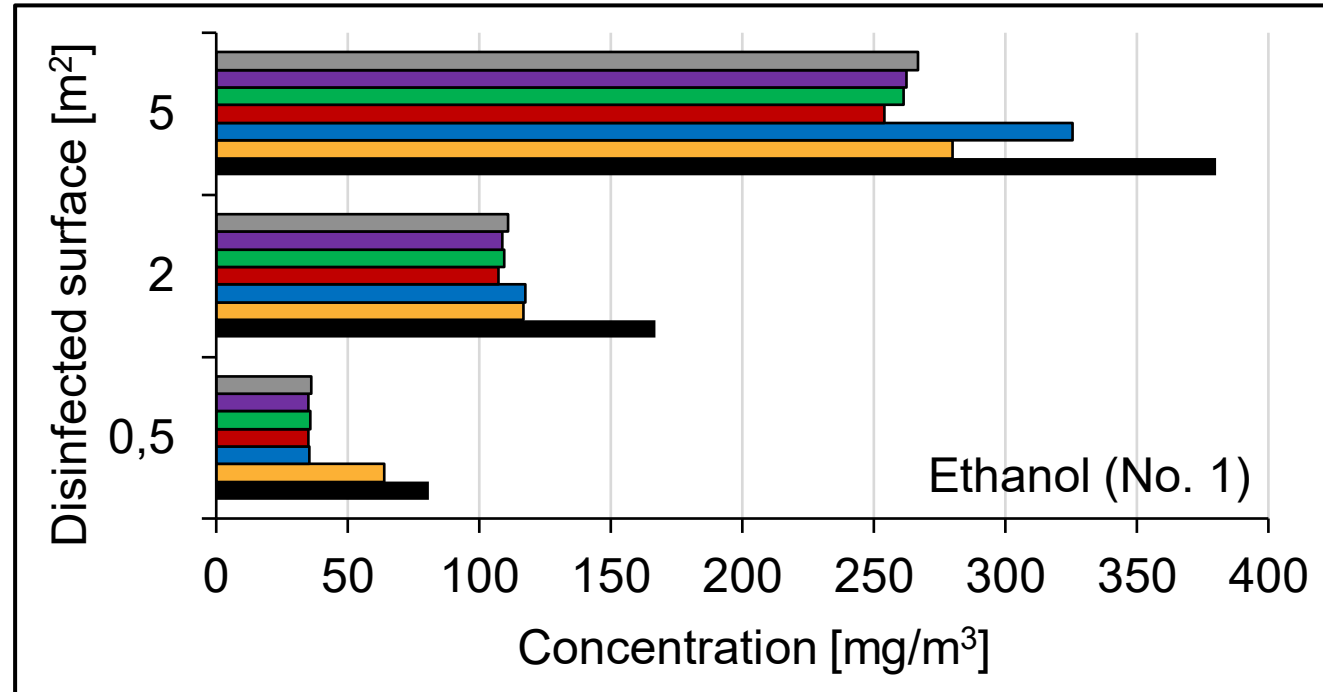
# Disinfectants with peroxides and aldehydes

## Deterministic models

Disinfectant no.	Active ingredient	Comparison (PRED/EXP <sub>personal air sampling</sub> )	
2	Formaldehyde	$1.27 < \frac{\text{PRED}}{\text{EXP}} < 1.90$	<b>good accuracy</b>
	Glutaraldehyde	$1.41 < \frac{\text{PRED}}{\text{EXP}} < 4.38$	<b>good accuracy</b>
3	Glutaraldehyde	$1.55 < \frac{\text{PRED}}{\text{EXP}} < 6.69$	<b>good/acceptable accuracy</b>
4	Hydrogen peroxide	$1.78 < \frac{\text{PRED}}{\text{EXP}} < 4.86$	<b>good accuracy</b>
	Peroxyacetic acid	$1.20 < \frac{\text{PRED}}{\text{EXP}} < 1.83$	<b>good accuracy</b>

# Disinfectant with ethanol

## Deterministic models



### Legend:

- mean (personal air sampling)
- mean (stationary air sampling)
- unsteady 1-zone model
- ConsExpo model (Tier 1)
- ConsExpo model (Tier 2)
- 2-component model (Tier 1)
- 2-component model (Tier 2)

- The deterministic models underestimated the exposure

$$0.43 < \frac{\text{PRED}}{\text{EXP}} < 0.86$$

→ **Occupational safety and health:** Underestimation of exposure by modelling should be avoided.

# Disinfectant with ethanol

## Stoffenmanager<sup>®</sup>

Percentile	Modelled values [mg/m <sup>3</sup> ]	Comparison (PRED/EXP <sub>personal air sampling</sub> )		
		0.5 m <sup>2</sup>	2 m <sup>2</sup>	5 m <sup>2</sup>
50 <sup>th</sup>	80.42	0.99	0.48	0.21
75 <sup>th</sup>	257	3.17	1.54	0.68
90 <sup>th</sup>	726	8.96	4.35	1.91
95 <sup>th</sup>	1,360	16.79	8.14	3.58

**good accuracy**

- Stoffenmanager<sup>®</sup> is suitable for the assessment of the inhalation exposure of ethanolic disinfectants.
- No application for highly diluted or very reactive substances.



# Summary


- Guidance for the applicability of exposure modelling for surface disinfection in healthcare or similar settings
- Combined planning of air measurements and modelling
- For the described setting:
  - Overestimation mostly below the factor of 5
  - Deterministic models are suitable for disinfectants with peroxides or aldehydes
  - Stoffenmanager<sup>®</sup> is suitable for disinfectants with ethanol

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# Thank you for your attention!



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