DEVELOPMENT OF A NEW RISK ASSESSMENT TOOL FOR EXPOSURE TO BIOLOGICAL AGENTS

Carlota Alejandre Colomo, Ph.D.

21st November 2023

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The COVID-19 pandemic reinforces the need to protect workers from exposure to biological agents.

However, there is a lack in risk assessment tools for OSH professionals.

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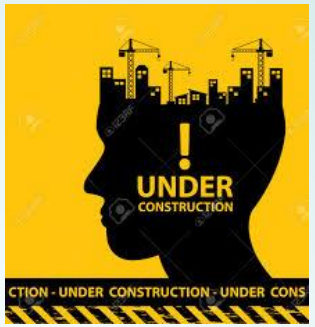

Stoffenmanager® is the knowledge-based platform aimed at reducing exposure risks to hazardous substances and biological agents in the workplace. We offer a sustainable and simple solution in 11 languages to help organizations worldwide meet (local) regulatory requirements and to be responsible employers by creating a safe workplace. We do this by means of consultancy, training courses and the scientifically validated tool, Stoffenmanager® version 8. Together with you, we work on a safe and healthy work environment!

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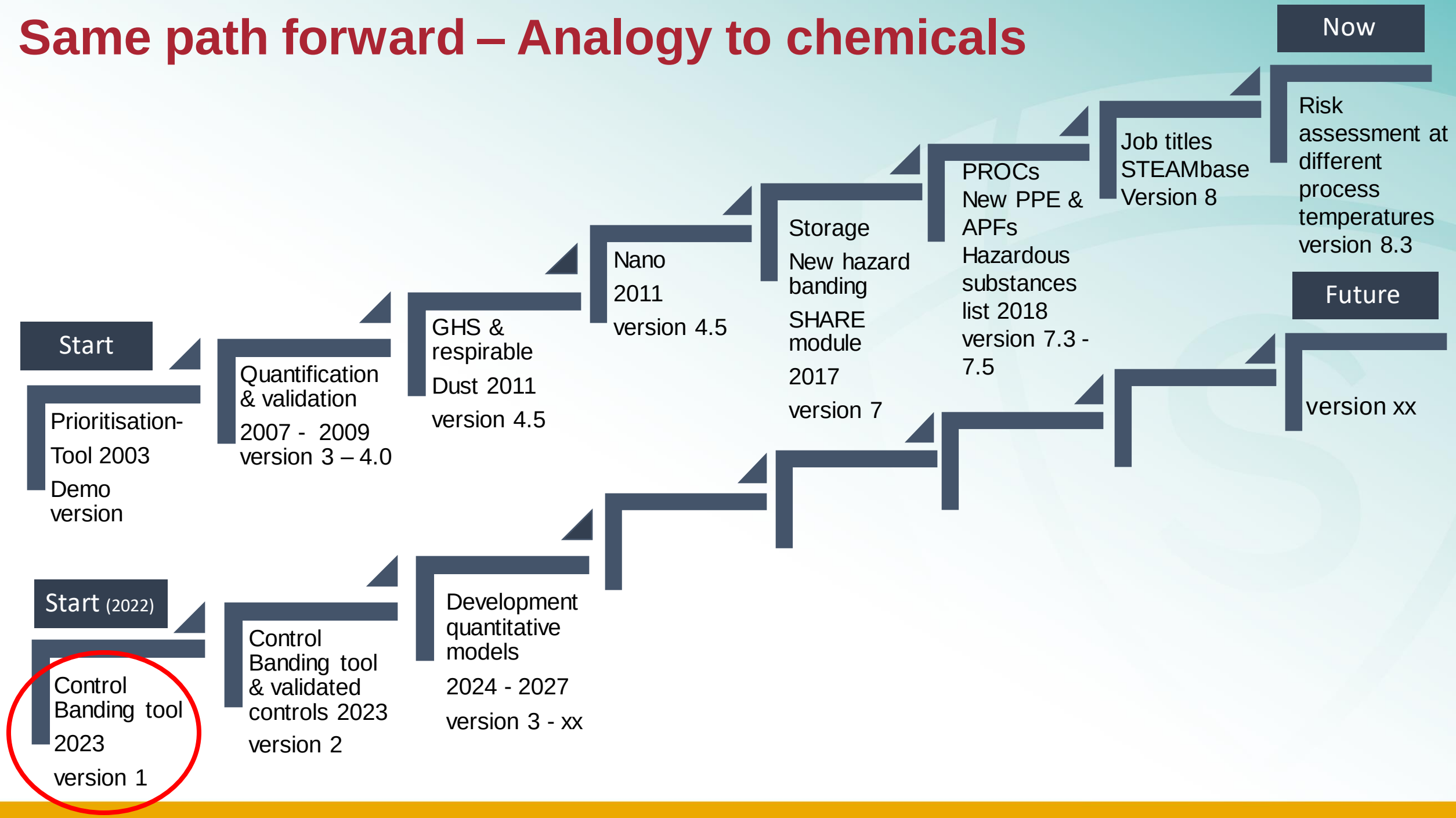
Stoffenmanager® is an online system to identify the chemical hazards, control the exposure at workplaces and communicate in an understandable, transparent manner to managers, employees and external stakeholders.

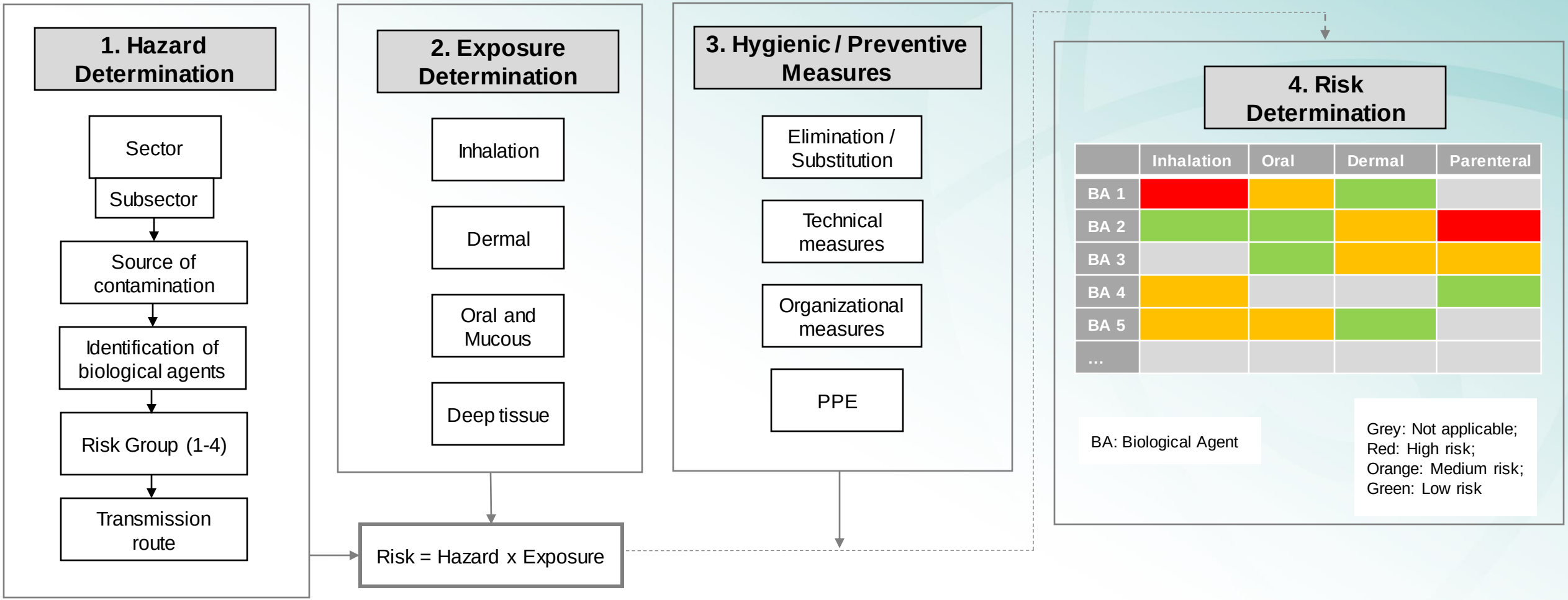
Same path forward – Analogy to chemicals



Project steps for Stoffenmanager® Biorisk

PHASES	EXPLANATION	PARTICIPANTS
Phase 1	Literature research and comparison of existing tools (Master Thesis). Functional requirements for the development of a new qualitative biological risk assessment tool. (completed)	Rudolf van der Haar (MC Mutual) Cristina Bercero (MC Mutual) Asun Galera Rodrigo (Universitat Politècnica de Catalunya) Geneviève Marchand (IRSST) Carla Viegas (IPL) Remko Houba (NKAL)
Phase 2	Control Banding Inhalation Model (completed)	Rudolf van der Haar (MC Mutual) Cristina Bercero (MC Mutual) Geneviève Marchand (IRSST) Carla Viegas (IPL) Anne Mette Madsen (NFA/NRCWE)
Phase 3	Testing of Phase 2 (ongoing)	Rudolf van der Haar (MC Mutual) Cristina Bercero (MC Mutual) Geneviève Marchand (IRSST) Carla Viegas (IPL) Anne Mette Madsen (NFA/NRCWE) Karen Galea (IOM WORLD)
Phase 4	Proposal for quantification – QMRA (to be developed)	Rudolf van der Haar (MC Mutual) Cristina Bercero (MC Mutual) Geneviève Marchand (IRSST) Carla Viegas (IPL) Anne Mette Madsen (NFA/NRCWE) Lidwien Smit (IRAS/NKAL) Karen Galea (IOM WORLD)
Phase 5	Control Banding for other routes (ongoing)	Rudolf van der Haar (MC Mutual) Cristina Bercero (MC Mutual) Geneviève Marchand (IRSST) Carla Viegas (IPL) Anne Mette Madsen (NFA/NRCWE) Karen Galea (IOM WORLD)
Phase 6	Presentation of results at national & international scientific and practically oriented OSH events, congresses (ISES, etc.) (ongoing)	

Phase 1. Literature research and comparison of existing tools



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STOFFENMANAGER® INHALATION BIOAEROSOL MODEL

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Development steps

1. Development of the conceptual model
2. Choose the model parameters
3. Assign scores to the parameters (based on literature)
4. Implement the model in the Stoffenmanager® Model Research & Validation Platform
5. Test performance of the model
6. If needed, make adjustments

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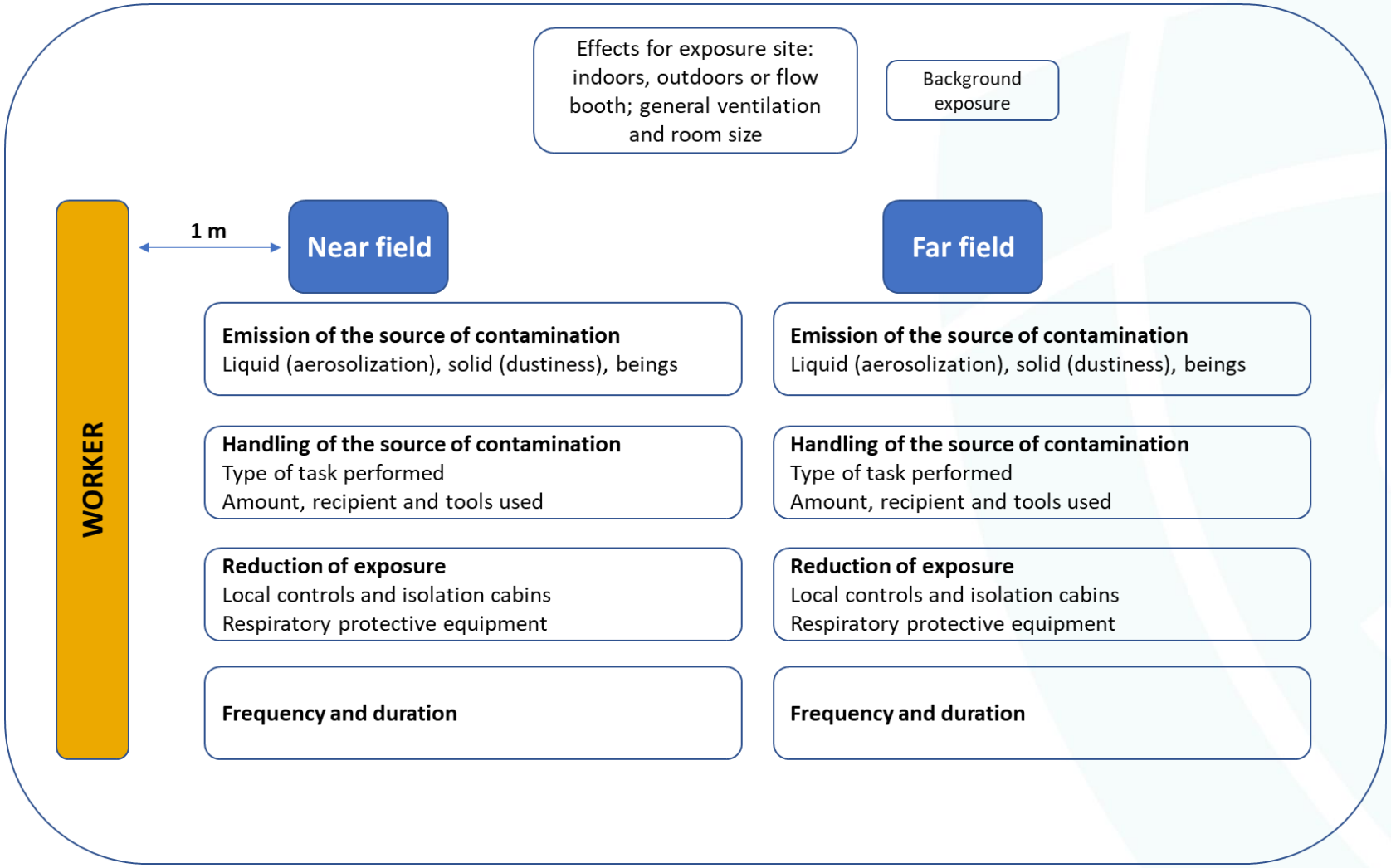
Conceptual model



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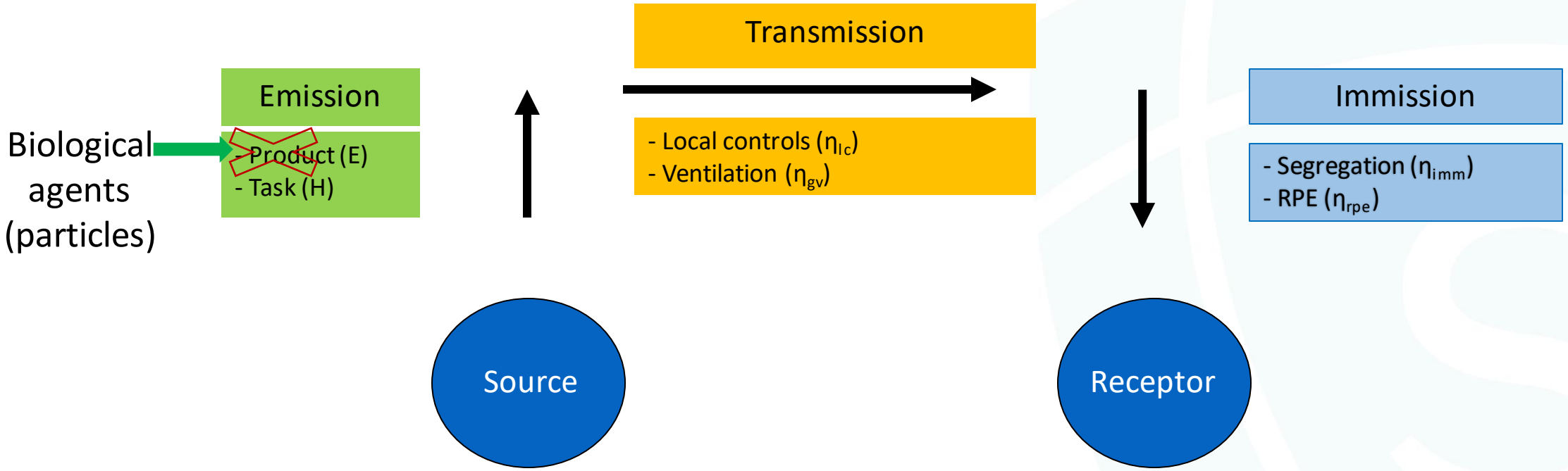
Exposure control banding - INHALATION



$$B_t = [(E \cdot a) + (E \cdot H \cdot \eta_{lc} \cdot \eta_{gv\_r}$$

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Validation of a New Method for Structured Subjective Assessment of Past Concentrations

JOHN W. CHERRIE*†§ and THOMAS SCHNEIDER‡

*University of Aberdeen, Department of Environmental and Occupational Medicine, Foresterhill, Aberdeen AB25 2ZD, UK; †Institute of Occupational Medicine, 8 Roxburgh Place, Edinburgh EH8 9SU, UK; ‡National Institute of Occupational Health, Lersø Parkallé 105, DK-2100, Copenhagen 0, Denmark

Semi-quantitative Algorithm for Inhalation

$$B_t = [(E \cdot a) + (E \cdot H \cdot \eta_{lc} \cdot \eta_{gv\_nf}) + (E \cdot H \cdot \eta_{lc} \cdot \eta_{gv\_ff})] \cdot \eta_{imm} \cdot \eta_{rpe} \cdot t_h \cdot f_h$$

B_t = exposure score;
E = intrinsic emission score → source of contamination
a= multiplier for the relative influence of background sources;
H= handling (or task) score;
n_{lc}= multiplier for the effect of local control measures
$n_{gv\text{-}nf}$= multiplier for the effect of general ventilation in relation to the room size on the exposure due to near-field sources
$n_{gv\text{-}ff}$= multiplier for the effect of general ventilation in relation to the room size on the exposure due to far-field sources
n_{imm} = multiplier for the reduction of exposure due to control measures at the worker;
n_{rpe} = multiplier for the effect of personal protective equipment (ppe) on the exposure
t_h = duration of the handling;
f_h = frequency of the handling;

Matrix

Priority levels

Score

	Risk Group 1	Risk Group 2	Risk Group 3	Risk Group 4
Score Low Exposure	III	III	II	I
Score Medium Exposure	III	II	II	I
Score High Exposure	II	II	I	I
Score Very High Exposure	II	I	I	I

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WORKPLACE SCENARIO EXAMPLES

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Phase 3. Testing of Inhalation Model

NL – Netherlands
CA – Canada
SP – Spain
UK – United Kingdom
PT – Portugal

SOURCE OF CONTAMINATION	SECTORS - JOBS	NUMBER OF WORKPLACE SCENARIOS	LOCATIONS
Human or animal contaminated by use	Waste disposal, wastewater	34	NL
Human or animal contaminated by nature	Municipality Maintenance	4	NL
Processed materials	Food industry	7	NL, CA, SP
Materials from nature (not human nor animal contaminated)	Green waste, forestry, seeds	9	NL, UK
Pure biological agents	Laboratories	40	NL
Beings	Farms, health care, embalming	19	NL, CA, SP
Archival materials	-	-	-
Wood dust	Sawmills	7 (ongoing)	PT
Total		**117 + ongoing**	

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ADDITIONAL SCENARIOS ARE WELCOME

Workplace scenario 1 – Pure BA Lab work

Scenario: Manual spraying of inoculum – pouring suspension with a Pure Biological Agent.
Sprayed on plants with 45 ml bottle, open on lab working bench, no PPE, nitrile bio gloves

$$B_t = [(E \cdot a) + (E \cdot H \cdot \eta_{lc} \cdot \eta_{gv\_nf}) + (E \cdot H \cdot \eta_{lc} \cdot \eta_{gv\_ff})] \cdot \eta_{imm} \cdot \eta_{rpe} \cdot t_h \cdot f_h$$

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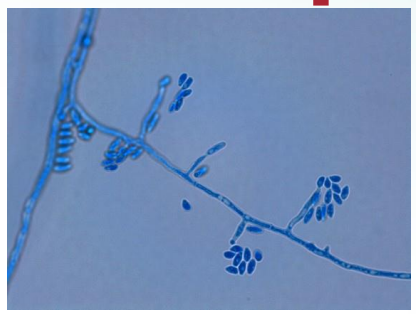
Workplace scenario 1



Fusarium oxisporum (G2)
Puccinia allii (G1)
Pyrenochaeta terrestris (G1)

Peronospora destructor (G1)
Alternaria porri (G1)
Stemphylium vesicarium (G1)

	Risk Group 1	Risk Group 2	Risk Group 3	Risk Group 4
Score Low Exposure	III	III	II	I
Score Medium Exposure	III	II	II	I
Score High Exposure	II	II	I	I
Score Very High Exposure	II	I	I	I

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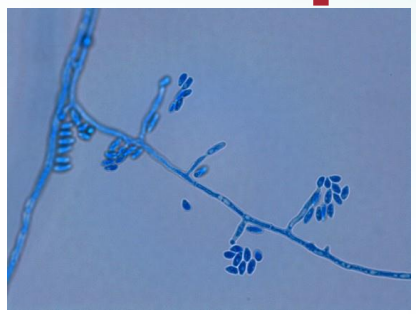
Workplace scenario 1: Pure BA - Lab work



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Alternaria porri (G1)
Stemphylium vesicarium (G1)

	Risk Group 1	Risk Group 2	Risk Group 3	Risk Group 4
Score Low Exposure	III	III*	II	I
Score Medium Exposure	III	II	II	I
Score High Exposure	II	II	I	I
Score Very High Exposure	II	I	I	I

*Allergenic – Highest risk!

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Workplace scenario 2: Beings - embalming

Scenario: Embalming, removing intestinal material with trocar

Atmosphere **2022**, *13*(8), 1281; https://doi.org/10.3390/atmos13081281

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Workplace scenario 2

Mycobacterium tuberculosis (G3)
Streptococcus pneumoniae (G2)
Pseudomonas spp. (G2)
Enterobacter spp. (G2)
Staphylococcus spp. (G2)

Serratia spp. (G2)
Leclercia spp. (G2)
Hafnia spp. (G2)
Moraxella spp. (G3)

	Risk Group 1	Risk Group 2	Risk Group 3	Risk Group 4
Score Low Exposure	III	III	II	I
Score Medium Exposure	III	II	II	I
Score High Exposure	II	II	I	I
Score Very High Exposure	II	I	I	I

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Workplace scenario 2

Mycobacterium tuberculosis (G3)
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Serratia spp. (G2)
Leclercia spp. (G2)
Hafnia spp. (G2)
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Score Very High Exposure	II	I	I	I

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Workplace scenario 3: Beings - restaurant

Scenario: family in a restaurant

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Volume 26, Number 7—July 2020

Research Letter

COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020

Jianyun Lu[1], Jieni Gu[1], Kuibiao Li[1], Conghui Xu[1], Wenzhe Su, Zhisheng Lai, Deqian Zhou, Chao Yu, Bin Xu✉, and Zhicong Yang✉
Author affiliations: Guangzhou Center for Disease Control and Prevention, Guangzhou, China (J. Lu, K. Li, C. Xu, W. Su, C. Yu, Z. Yang); Guangzhou Yuexiu District Center for Disease Control and Prevention, Guangzhou, China (J. Gu, Z. Lai, D. Zhou, B. Xu)
Main Article

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Workplace scenario 3: Beings - restaurant

Scenario: waiter in a restaurant

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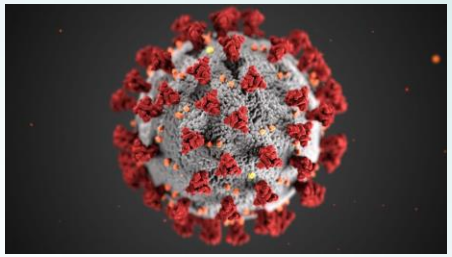
Workplace scenario 3: Beings - restaurant

***SARS-CoV-2* (G3)**



	Risk Group 1	Risk Group 2	Risk Group 3	Risk Group 4
Score Low Exposure	III	III	II	I
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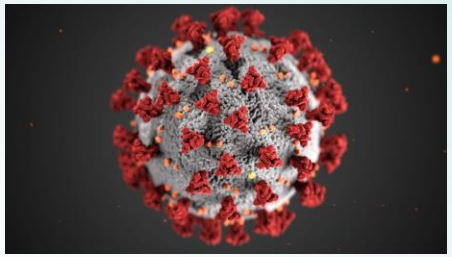
Workplace scenario 3: Beings - restaurant

***SARS-CoV-2* (G3)**



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CURRENT AND FUTURE PERSPECTIVES

Model & field test results

Scientific

- model sufficiently distinctive

- results comparable with expert judgement

- Conferences: first & thus far only generic inhalation bioaerosol model

Occupational health & safety practice

- structured exposure assessment > good understanding of risks

- refined model > calculate measures

- useful: combination of substances and biological agents > also like to further refine substance models

- other transmission routes - continue > Risk assessment Biological Agents

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How to proceed (1)?

1. Possibilities quantifying bioaerosol model
    - Refined model based on mathematical equations
    - By sector (example Wastewater Treatment Plants)?
    - Further model source strength (growth factors)?
    - How? What level of detail?
    - Measurement data
2. Which quantification units should be used?
    - Inhalable / respirable dust
    - Viable CFU e.g. total counts; specific species
    - Endotoxins
    - Mycotoxins
    - Viral particles
    - Biomarkers e.g. SAA / CRP serum levels

Model calibration & validation – analogy to chemicals with specific BA determinants

Chemicals

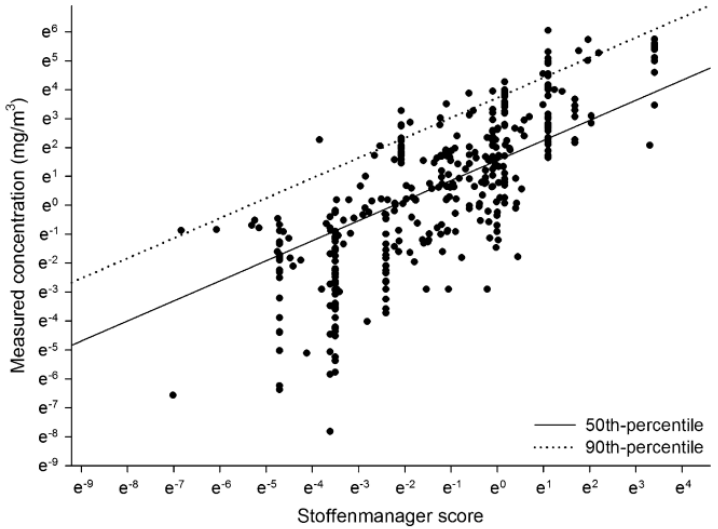
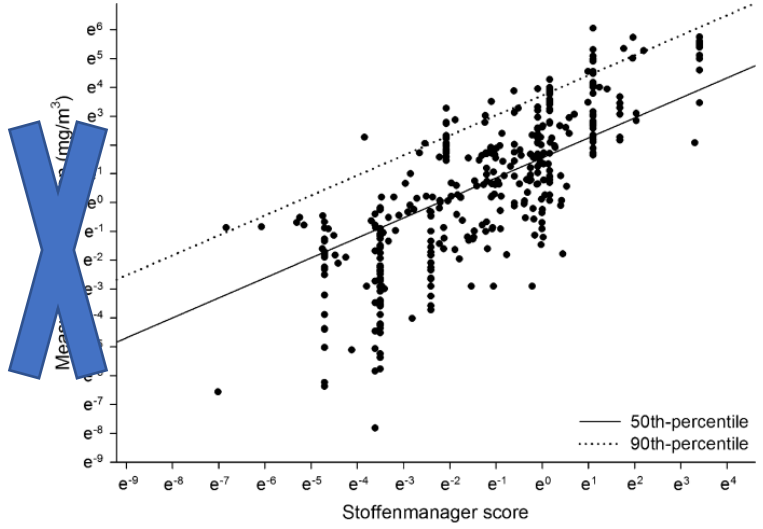


Fig. 1. Association between Stoffenmanager scores and measured inhalable exposure concentrations (mg m^{-3}) for handling of solids.

Future: Biological agents

CFU/m3
and/or?



Eg. Source domain Materials from Nature – solids

WP scenario Green waste, data on CFU/m^3 available *Aspergillus spp.* and several General (Mesophilic) moulds

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How to proceed (2)?

3. Development of the other transmission routes:

- Model-based and/or pragmatic

"Research into both inadvertent ingestion and ocular exposure has been essentially ignored by occupational exposure scientists, and in my experience is seldom considered by occupational hygienists. They may, however, be important in the transmission of infectious agents, such as SARS-CoV-2 (Davis et al. 2022) and other situations."

Annals of Work Exposures and Health, 2023, **XX**, 1–5
https://doi.org/10.1093/annweh/wxad052
Advance access publication 5 September 2023
Commentary

BOHS British Occupational Hygiene Society — The Chartered Society for Worker Health Protection — OXFORD

Occupational exposure science

John W. Cherrie[1,2,*]

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[2]Institute of Biological Chemistry, Biophysics and Bioengineering, Heriot Watt University, Edinburgh, United Kingdom
[*]Corresponding author: Institute of Occupational Medicine, Research Avenue North, Edinburgh, EH14 4AP, UK. Email: john.cherrie@iom-world.org

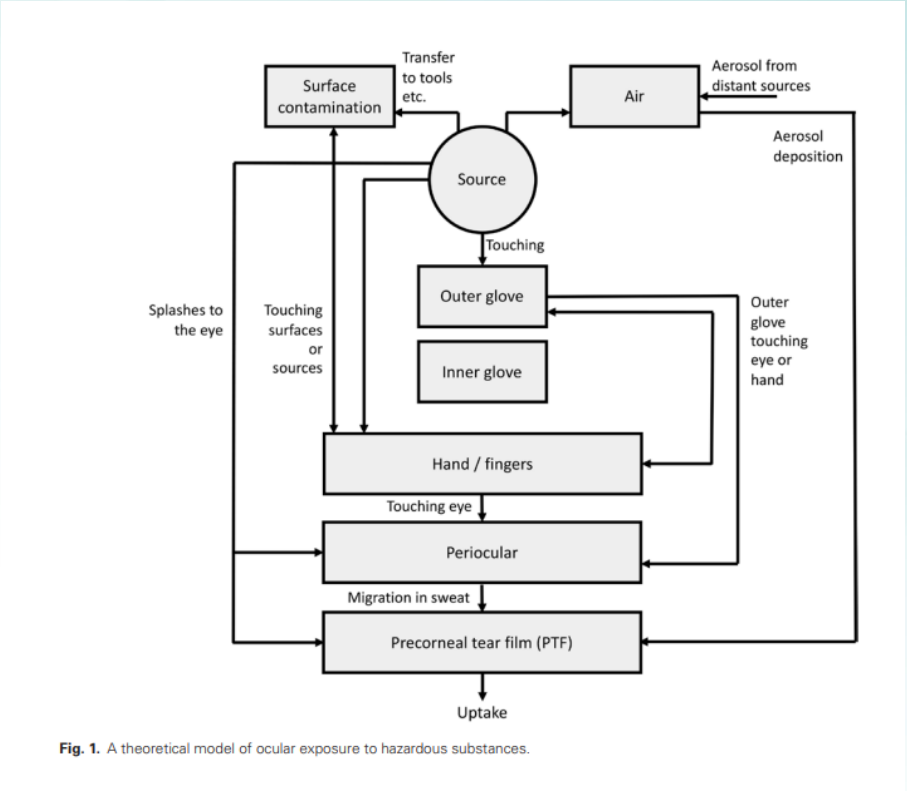

Fig. 1. A theoretical model of ocular exposure to hazardous substances.

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THANK YOU FOR LISTENING

Questions?
Suggestions?
Comments?

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