FEDERAL INSTITUTE
FOR RISK ASSESSMENT

BfR
Risiken erkennen – Gesundheit schützen

Neues Verfahren zur Flugzeugdesinsektion

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24
111
114
10
10
100
Großraum Berlin
100
BfR
Dahlem
BfR
Marienfelde
Potsdam
115
10
13
12
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Flugzeug Desinsektion

Schädlingsbekämpfungen in Flugzeugen sind aus seuchenhygienischen Erwägungen notwendig, um Ausbreitungen von Krankheiten bei Mensch, Tier und Pflanze entgegenwirken zu können, die durch Einschleppung, Verschleppung und Verbreitung von Vektoriellen Schädlingen (einschließlich von Ektoparasiten) und Pflanzenschädlingen entstehen würden.

Aircraft disinsection

- periodic residual applications of pesticides to passenger cabins
- coupled with the use of an aerosol spray
- represent an effective treatment method for aircraft leaving areas where vector-borne diseases are endemic

WHO 2005

In-flight spraying

The blocks-away method
involves aerosol spraying of the passenger cabin after the doors have been locked following embarkation but before take-off

Top-of-descent spraying
is an in-flight spraying carried out as the aircraft starts its descent to the arrival airport

WHO 2005

Countries required disinsection for Lufthansa- and Condor-aircrafts

Destination	Remarks
Australia	on arrival, with passengers and crew on board
Barbados	on arrival, with passengers and crew on board
Bolivia	flights ex Lima (Lloyd Aero Boliviano)
Cuba	on arrival, with passengers and crew on board
Egypt	after landing by local authorities
India	before take-off „blocks away“, with passengers and crew on board
Jamaica	on arrival, with passengers and crew on board
Marocco	on arrival, with passengers and crew on board
Mauritius	on arrival
Mexico	on arrival, with passengers and crew on board
Nigeria	without passengers after landing
Pakistan	before boarding
Philippines	on arrival
Seychelles	on arrival, with passengers and crew on board

Eingesetzte Biozide

- SRA Standard Reference Aerosol
  1,25 % Naturpyrethrum
  2,6 % Piperonylbutoxid (PBO)

- 2 % D-phenothrin, Resmethrin, Bioresmethrin (Aerosole)

- 2 % Permethrin (Aerosol, Residualbehandlung
  alle 8 Wochen)

In-flight spraying
Luft-Messungen in der Passagierkabine

	0 - 40 min
Pyrethrum	3 - 80 µg/m^3
Piperonyl butoxide	54 - 541 µg/m^3
D-phenothrin	127 - 280 µg/m^3

Berger-Preißet al. 2004

Reports

Many reports completed by flight attendants or airline personnel suggest the possibility of the onset of symptoms in passengers and crew members consequent to pyrethroid application

Reports

The reported symptoms varied from

- metallic taste, slight and unspecific irritation of eyes, throat and upper respiratory tract, in some cases skin
- to severe respiratory symptoms such as dyspnoea, cough and even asthma
- in some cases, flu, headache and allergic reaction

WHO 2005

Mitteilungen nach § 16e Abs. 2 ChemG zu Pyrethroiden

(* in Zusammenhang mit der Desinsektion in Flugzeugen ?)

Meldejahr	„Pyrethroidfall“	Gesamtzahl der Meldungen
1990	2	319
1991	9	355
1992	16	742
1993	39	1075
1994	42	520
1995	106	776
1996	29	1019
1997	67 1*	1169
1998	38 1*	827
1999	29	964
2000	37 1*	2771
2001	16	8599
2002	25	7855
2003	28	6539
2004	3	5541
2005	5 1*	4292

Mitteilung nach § 16e Abs. 2 ChemG

Oktober 2005

Flug aus USA nach Ffm

unmittelbar nach Landung starke Rötung und Juckreiz an Unterarmen und im Gesichtsbereich

rechte Gesichtspartie: berührungsempfindlich

Frage: Symptome typisch für Pyrethrum / Pyrethroide **?**

Flugzeugdesinsektion **?**

Reports

Unfortunately, in many of these reports details on the type of active ingredient used and methods of application are lacking

In most of the reported cases the observed symptoms are not typical of pyrethroids, and might be attributable to other etiological factors, such as solvents present in the formulation

Reports

The possibility of a „psychological“ reaction, related to the well known awareness of the general public to pesticides, should also be considered

WHO 2005

BfR - UBA
Kritik / Empfehlungen zur in-flight-Desinsektion

Keine offene Ausbringung von Schädlingsbekämpfungsmitteln in Gegenwart von Passagieren und Flugpersonal (gesundheitliche Probleme?)

Für Flüge aus Deutschland infektionsepidemiologisch nicht nachvollziehbar

Im Passagierraum nur Kurzzeitmittel

Keine Langzeit-Pyrethroide (Permethrin evtl. zur Residualbehandlung)

Alternative Methoden (z.B. Einsatz von Repellents, imprägnierte Netze im Eingangsbereich etc.)

Disinsection: other methods

Residual spraying
involves the regular application of a residual insecticide to internal surfaces of the aircraft, except in food preparation areas, at intervals based on the duration of effectiveness.
In addition, spot applications are made to surfaces that are frequently cleaned

Pre-flight spraying
involves the aircraft cabin being sprayed on the ground with aerosol containing a residual insecticide before passengers board the aircraft.
It may be combined with the blocks or top-of-descent spraying methods

WHO 2005

Aircraft disinsection

WHO recommendation:

- for top-of-descent spraying, the same amount of 2 % d-phenothrin should be used

- for pre-flight spraying is to spray 35 g of the formulation containing 2 % permethrin per 100 m^3

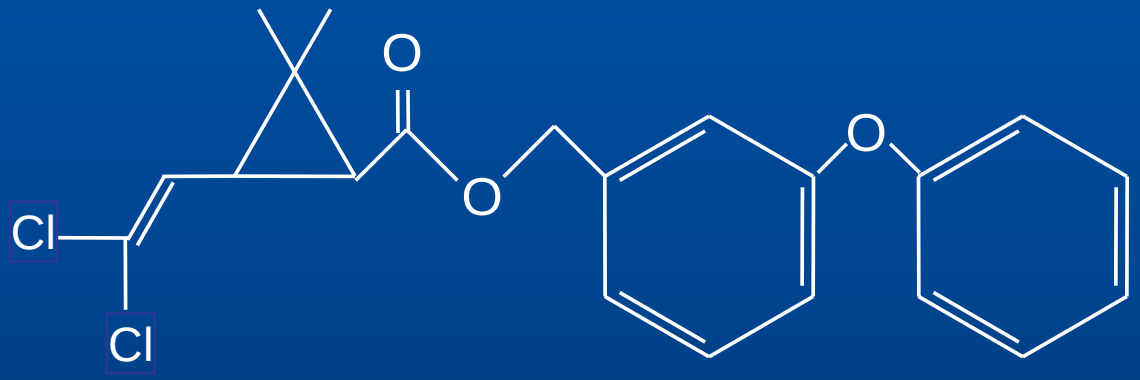
WHO 2005

Acute and dermal toxicity of pyrethroid insecticides commonly used for public health purposes

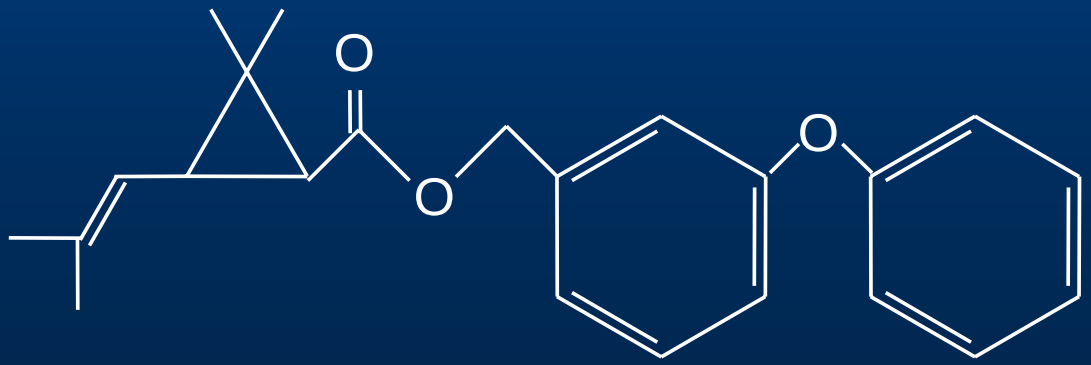
Compound	Oral toxicity LD50 rat (mg/kg/bw)	Dermal toxicity LD50 rat (mg/kg/bw)
bifenthrin	55	>2000
lambda-cyhalothrin	56	632
alpha-cypermethrin	79	>100
deltamethrin	135	>2900
cyfluthrin	254	>5000
permethrin	500	>2000
d-phenothrin	>10 000	>10 000
etofenprox	>10 000	>2140

(IPCS 2002)

Permethrin



D-phenothrin



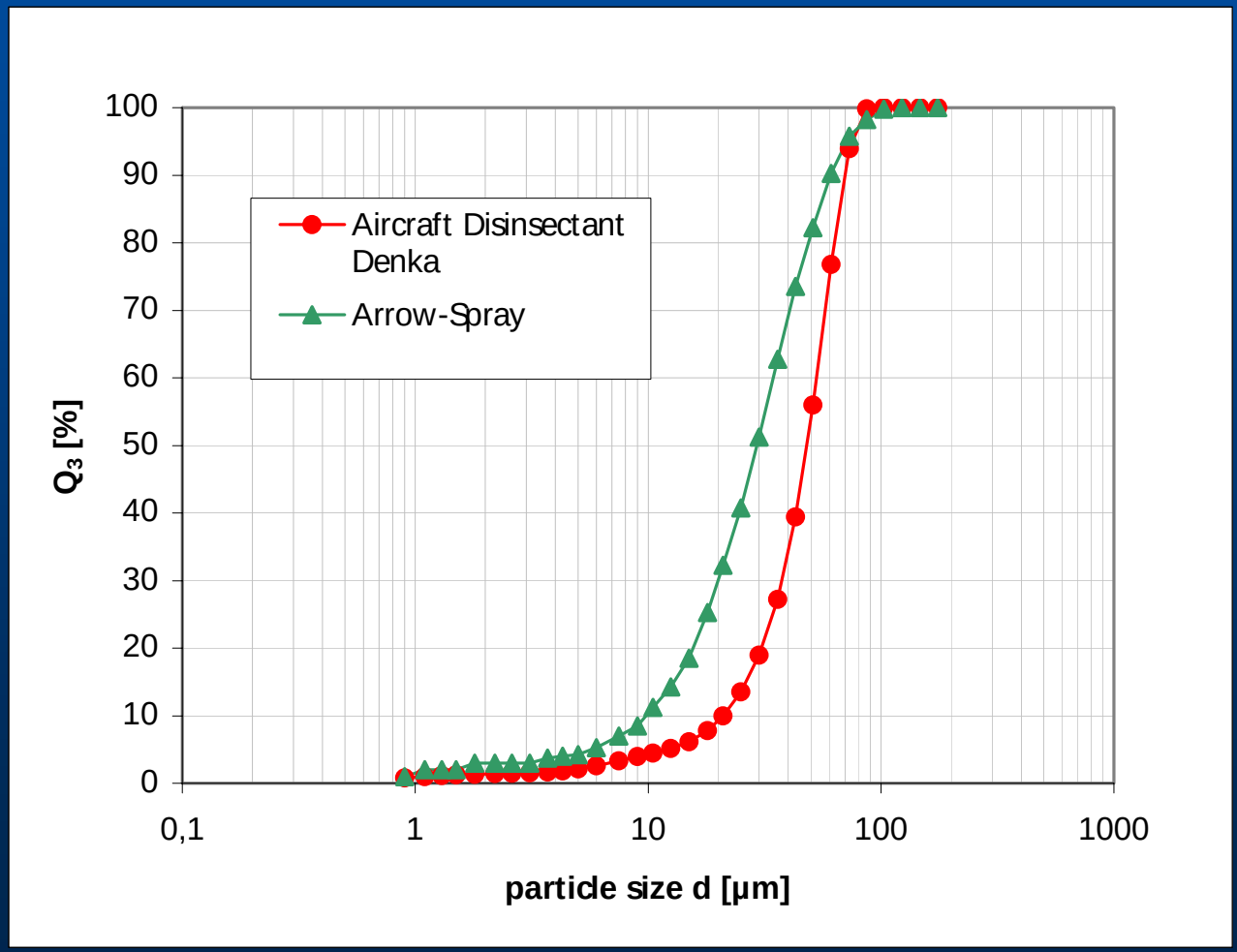
Forschungsvorhaben

BfR / UBA / Fraunhofer Institut:

„pre-embarkation-method“

d-phenothrin

Spray characterization by measurement with a laser diffraction spectrometer



Spraying experiments in parked aircrafts

Experiment Number	Type of aircraft/ disinsection technique	Amount (g) of spray applied	Characteristics
E1	A 310 - 300 pre-embarkation	173	Aircraft Disinsectant Denka 4 spray containers* at 50 ml each, without air exchange for 20 min followed by 20 min fresh air exchange rate [1/h]: 22.2
E2	A 310 - 300 pre-embarkation	144	Arrow Aircraft Disinsection Spray 4 spray containers* at 250 ml each, without air exchange for 20 min followed by 20 min fresh air exchange rate [1/h]: 22.2
E3	B747 pre-embarkation	202	Arrow Aircraft Disinsection Spray 8 spray containers* at 250 ml each, fresh air exchange rate [1/h]: 20
E4	A 310 - 308 top-of-descent (simulated in-flight)	113	Aircraft Disinsectant Denka 4 spray containers* at 50 ml each, fresh air exchange rate [1/h]: 22.2
E5	A 310 - 300 top-of-descent (simulated in-flight)	91	Arrow Aircraft Disinsection Spray 4 spray containers* at 250 ml each, fresh air exchange rate [1/h]: 22.2

Pre-embarkation Method
Application A 310

- Step 1:

  Two persons, each using one spray can started at the front of the cabin moving towards the rear by spraying with the right hand under the right seat row and moving from the rear to the front by spraying under the left seat row

- Step 2 :

  Two persons, each using two spray can started at the front of the cabin walked along the aisles of the passenger cabin to the rear, spraying at the height of their shoulders

Concentration of d-phenothrin in the aircraft

- air
- various interior surfaces
- settled dust
- data for inhalational and dermal exposures were determined
- biomonitoring

(Fraunhofer Institut, Hannover)

Entomological methods

medically important insect species

- two strains of houseflies

  (Musca domestica L., LEI, susceptible)
  (Musca domestica L., Sander, resistant)

- three different strains of mosquitoes

  (Aedes aegypti L., susceptible)
  (Anopheles stephensi, susceptible)
  (Culex pipiens molestus, susceptible)

(UBA, Berlin)

Entomological methods

Efficacy of space spraying:

cages with insects were placed at three different levels:

- under the seat (low)
- on the seat (middle)
- top of the seat (high)
- controls in extra rooms (e.g. cockpit)

Entomological methods

Residual efficacy:

- 10 x 10 pads (indoor material) at the corresponding places

seat cloth:	horizontal and vertical
carpet:	under the seats
wall surfaces:	below the windows

- one hour after spraying test insects were placed on the pads
- knock-down-time and mortality were determined

Results: Entomological methods

Mortality was monitored 20 minutes after spraying

Arrow spray 23-24°C 50-53% r.h.

	***Musca domestica* Lei and Sandner**						***Anopheles stephensi***		
Position	**No. of cages**		**No. exposed**		**% dead**		**No. of cages**	**No. exposed**	**% dead**
	Lei	San	Lei	San	Lei	San			
High	6	6	1146	1152	99,7	81	5	139	100
Middle	6	6	1184	1148	99,9	88	5	139	100
Low	6	6	1087	1142	100	82	25	688	100
Control	**2**	**2**	**416**	**459**	**0**	**0**	**8**	**211**	**0**

- d-phenothrin concentrations in the air were sufficient to kill flying insects

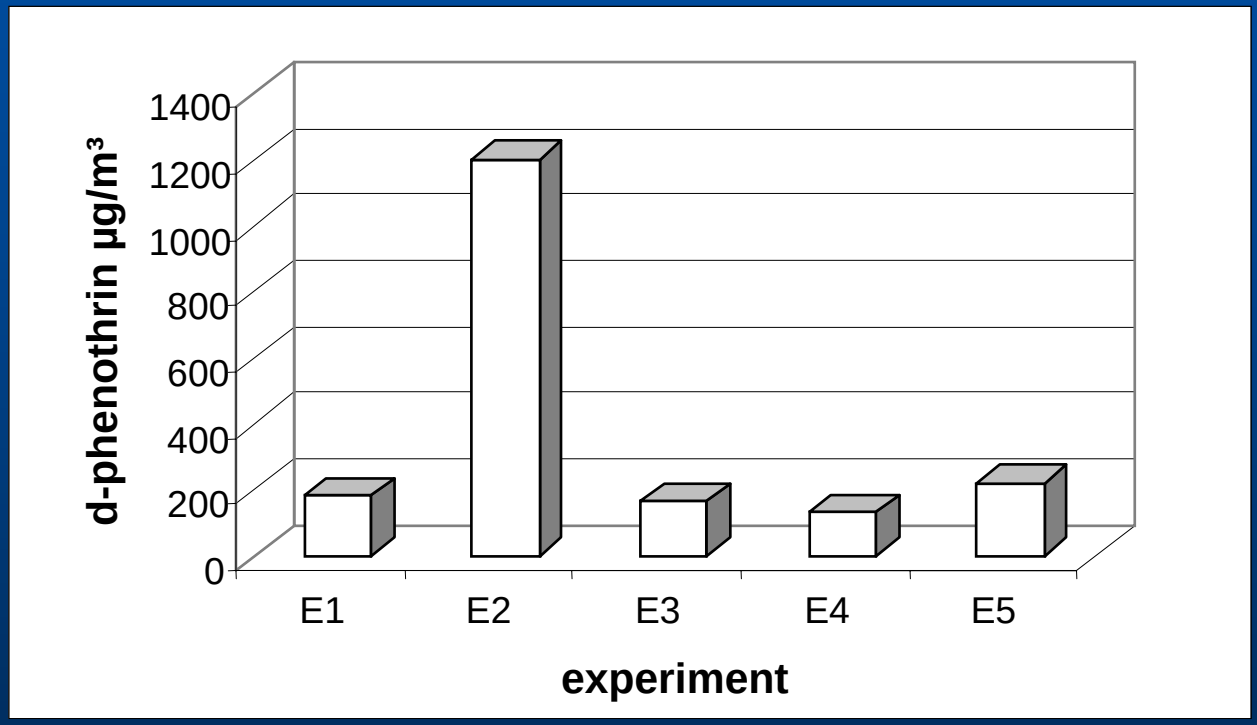
Results

Surface measurements of the cabin interior

- horizontal surface areas were considerably higher contaminated than vertical surfaces
- floor, under seats 387 - 1159 ng/ cm^2 (median)
- on seats 376 - 714 ng/ cm^2 (median)
- on headrests 96 - 376 ng/ cm^2 (median)
- settled dust 122 - 262 mg/Kg

- horizontal surfaces were 100 % effective up to 24 h after spraying

Results
Concentrations of *d*-phenothrin in the air of the passenger cabin (0 - 40 min)



A 310 E 1 air conditioning system off Denka
E 2 air conditioning system off Arrow
B 747 E 3 air conditioning system on Arrow

Results

Concentrations of d-phenothrin in the air of the passenger cabin

E 3 B 747-400 air conditioning system on
different locations in the cabin

- During spraying and up 5 min after spraying

  853 - 1753 µg/m^3

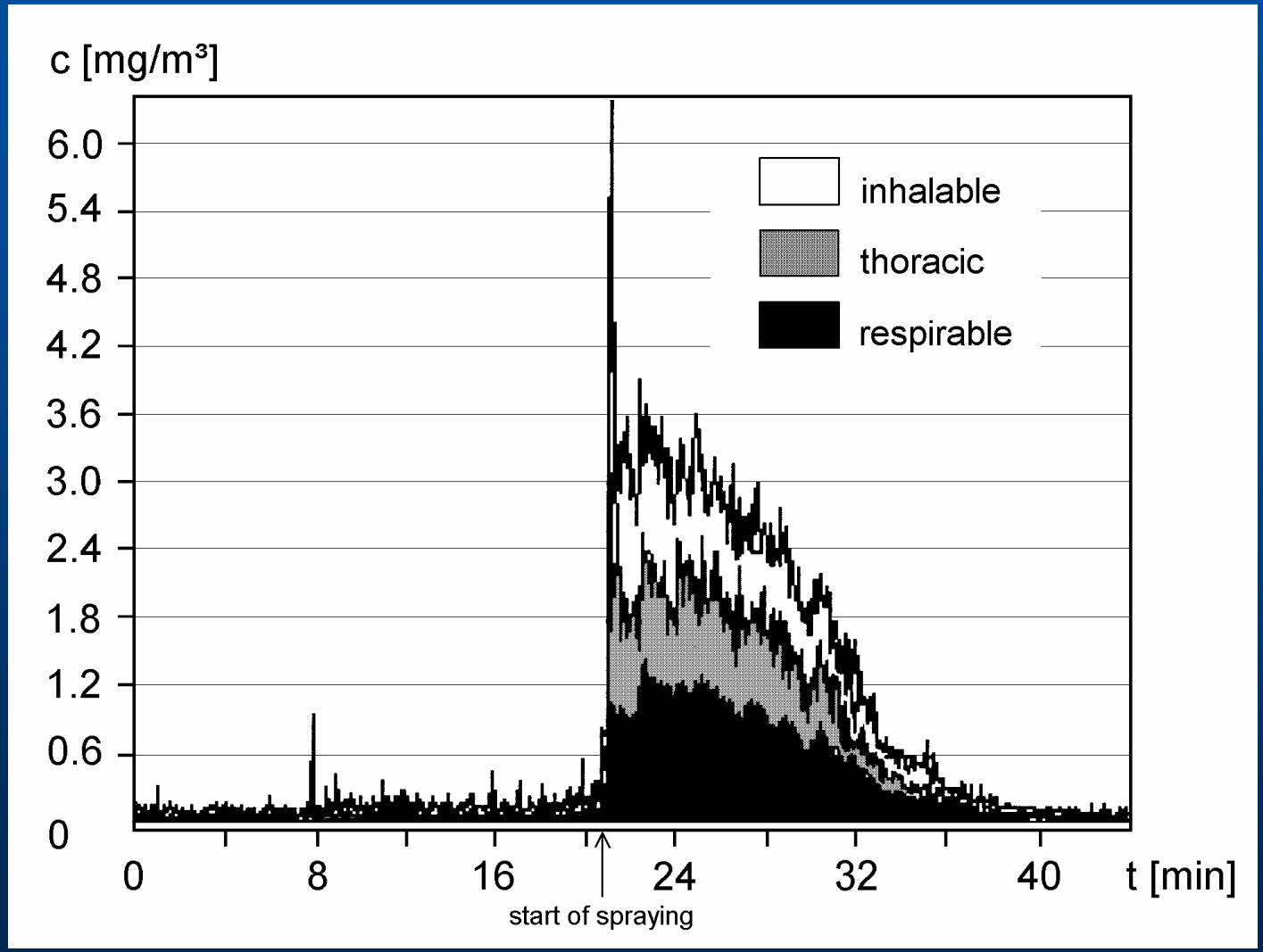
- 5 - 20 min after spraying

  36 - 205 µg/m^3

- 20 - 40 min after spraying

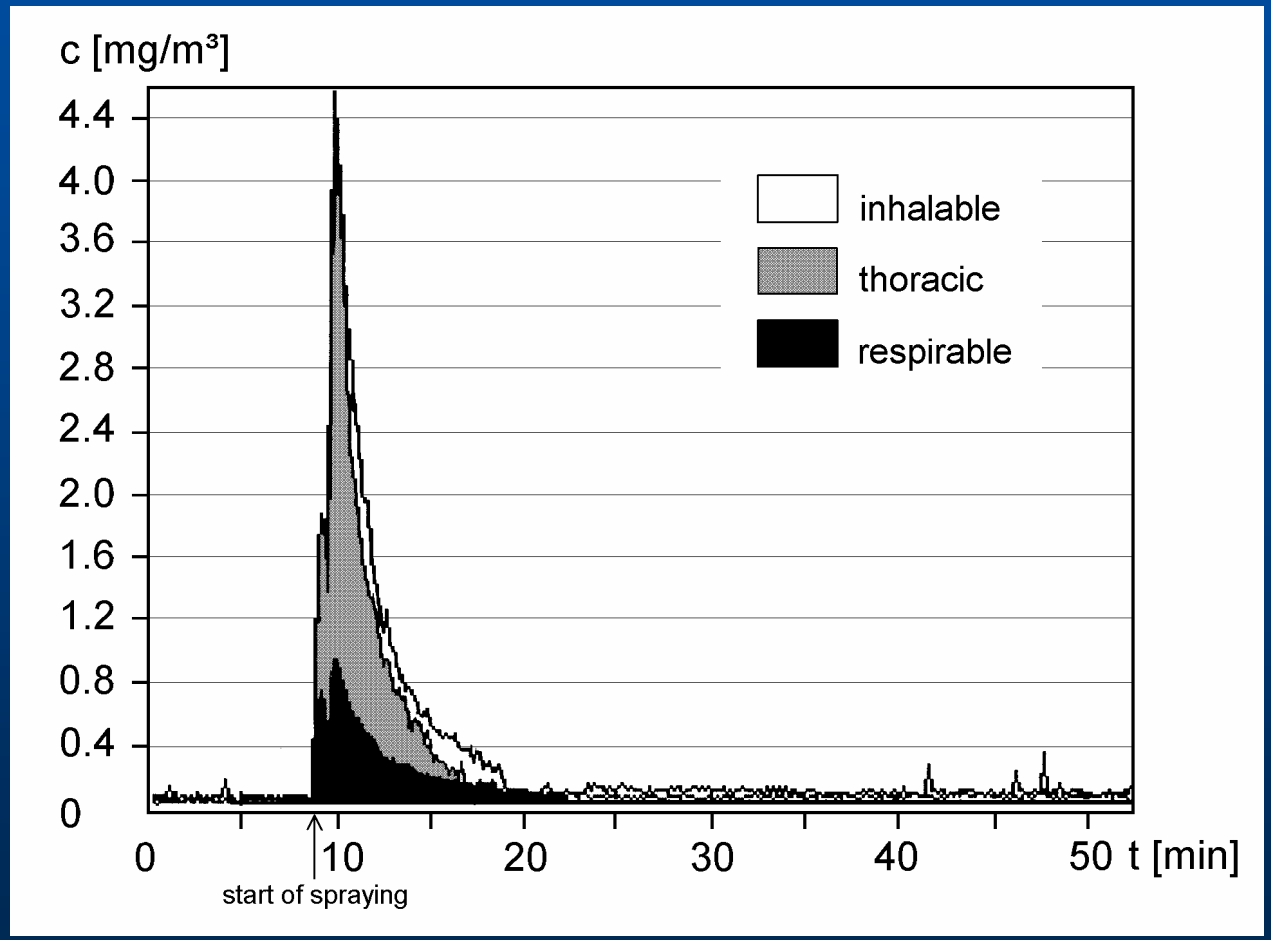
  1 µg/m^3

time-resolved concentration curve



E 2 Arrow Spray air conditioning system off

time-resolved concentration curve



E 3 air conditioning system on

Risk Assessment - Operator

a) inhalation

- personal exposure measurements during spraying and over a period of 20 min
- air concentration: 234 - 1313 µg / m^3
- respiratory min volume: 12 l / min
- absorption rate: 100 %

maximal inhalable dose: **235 µg**
(100 g aerosol)

- B 747-400: 887 m^3 0.35 g aerosol / m^3

maximal inhalable dose: **730 µg**
(310 g aerosol)

Risk Assessment - Operator

b) dermal

- entire body surface: ca. 2800 µg d-phenothrin (100 g aerosol)
- absorption rate: 1 %
- B 747- 400: maximum dermal exposure: **87 µg** (310 g aerosol)

Risk Assessment - Operator

c) total exposure B 747- 400:

(inhalation and dermal) 730 µg + 87 µg

- 817 µg ⛽ ca. 0.0135 mg / kg bw

- ADI d-phenothrin 0.07 mg / kg bw

Risk Assessment - Passengers

inhalational exposure:

- passengers should board 20 - 40 min after spraying has been terminated
- inhalational exposure is negligible (ca. 1 µg d-phenothrin / m^3 and lower)

Risk Assessment - Passengers

dermal exposure:

- residues on seats
- back, thighs, back of head, neck
  exposure area ~ 2560 cm^2 (adult male)
- worst case 1000 ng d-phenothrin / cm^2
- ~ 2,5 mg d-phenothrin potentially absorbable through the skin
- absorption rate 1 %
- 0.0004 mg / kg bw (60 kg person)
- ADI d-phenothrin 0.07 mg / kg bw

Conclusions

- A new “pre-embarkation” method for disinsection of aircrafts was developed and tested using d-phenothrin as the active agent of the aerosol
- Using spray containers generating small droplet aerosols by high pressure a uniform distribution of the active agents on surfaces of the passenger cabin was observed.
- Entomological investigations show that d-phenothrin concentrations were sufficient to kill medically important insects in the air and on surfaces
- Inhalational and dermal exposures for operators and other persons present in the passenger cabin during the disinsection procedures are low and margins of safety are sufficient

Conclusions

- Boarding should not started before a period of 20 min has elapsed after the termination of the disinsection procedure. Therefore passengers and crew are not directly exposed to the aerosol in the respiratory air
- Inhalational exposure and dermal exposure for crew members and passengers are negligible
- The new “pre-embarkation“ technique is an alternative method with safer health aspects than the established “in-flight” methods

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Aircraft disinsection: Exposure assessment and evaluation of a new pre-embarkation method

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Danke

Fragen ?

In some cases, symptoms reported after aircraft disinsection resemble „multiple chemical sensitivity“ (MCS) or „chemical intolerance“ which has been given as an explanation to subjective respitatory problems and even asthma attacks after exposure to chemicals at concentrations lower than the minimum concentrations able to cause any symptom in most of the general population.

However, there is currently no clear nosological definition of the „multiple chemical sensitivity syndrome“ and, while some authors suggested it as a disease, some others hypothesize that MCS is not a physical entity but rather a particular type of psychosomatic reaction

Airbus A 300 / 600

Cockpit	Permethrin	PBO
Raumluft ng/m ^{3}	28	141
Staub mg/m ^{2}	690,7	1761,3

Galley	Permethrin	PBO
Raumluft ng/m ^{3}	28	30
Staub mg/kg	87,2	12,3
Wischprobe mg/m ^{2}	3,89	0,075

Passagierraum	Permethrin	PBO
Raumluft ng/m ^{3}	5	6
Sitzbezug mg/kg	107,9	0,4

No-observed-adverse-effect level (NOAEL) and acceptable daily intake (ADI) of pyrethroid insecticides commonly used in public health

Active ingredient	Relevant NOAEL (mg/ai/kg bw/day)	ADI (mg/ai/kg bw/day) SF=100
alpha-cypermethrin	1,5	0-0,02
bifenthrin	1,5	0-0,02
cyfluthrin	2	0-0,02
deltamethrin	1	0-0,01
D-phenothrin	7	0-0,07
etofenprox	3,1	0-0,03
lambda-cyhalothrin		
permethrin	5	0-0,05
etofenprox	>10 000	>2140

IPCS 1989, 1993, 1994, 1996, 1997b, 2000a-b, 2001

Dermal Absorption (Human Studies)

Substance	Dose	Appl. Site	Time	Absorption rate
^{14}C - Pyrethrin	487 µg (in 200 µl commercial formulation)	ventral forearm	0,5 h	1,9 ± 1,2 % urine radioactivity
Cypermethrin	31 mg (in 1,2 ml sojaoil-based formulation)	back	8 h	1,2 % (0,85-1,8%) urine metabolites
Cypermethrin	25 mg (in hexylene glycol-	forearm	4 h	0,1 %
Permethrin	1250 mg (25 g of a 5 % cream)	whole body scabies patient	8 h	0,5 % urine metabolites
^{14}C - Permethrin Rhesus monkey	7 µg (in 100 µl Aceton)	forearm	24 h	5 % - 12 % urine radioactivity

from Wester et al. (1994), Wollen et al. (1992), Eadsforth et al. (1988), van der Rhee et al. (1989), Sidon et al. (1988)

Disinsection procedures by WHO

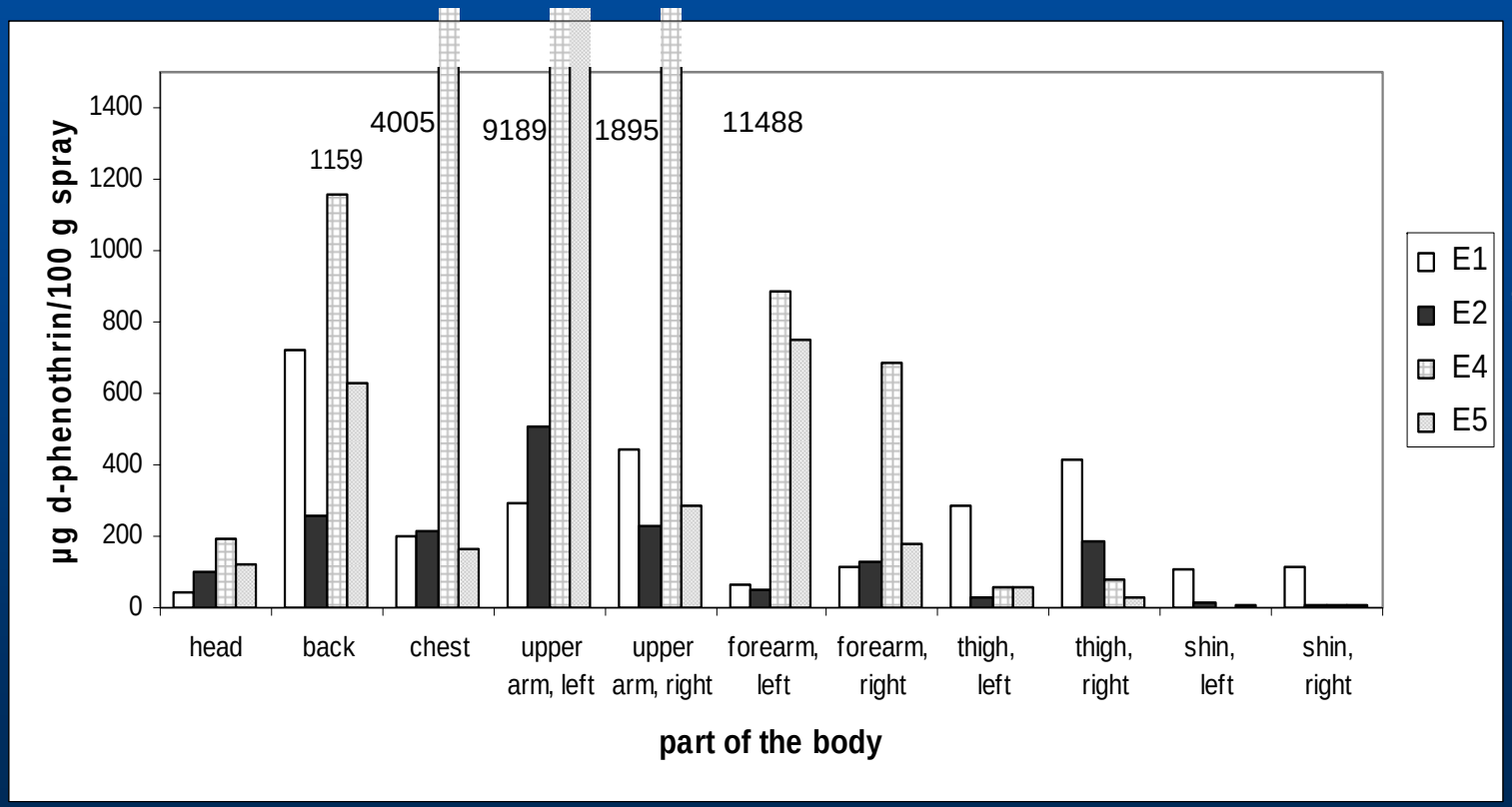
Recommended by WHO 1985 as an alternative to disinsection with passengers and crew on board

Reduced adverse effects

Control of the treatment and certification by health authorities possible if required at the destination

Performance with 2 % emulsion of permethrin in distilled water, using a pneumatically driven compression sprayer or 2 % permethrin solution with an aerosole dispenser for smaller spaces and electrically sensitive areas

Concentration of individual body parts of sprayers after spraying



„pre-embarcation“

„top-of-descent“