PANDHUB

Prevention and management of High Threat Pathogen Incidents in Transport Hubs

Recovery - Disinfection and decontamination

PANDHUB Final Symposium
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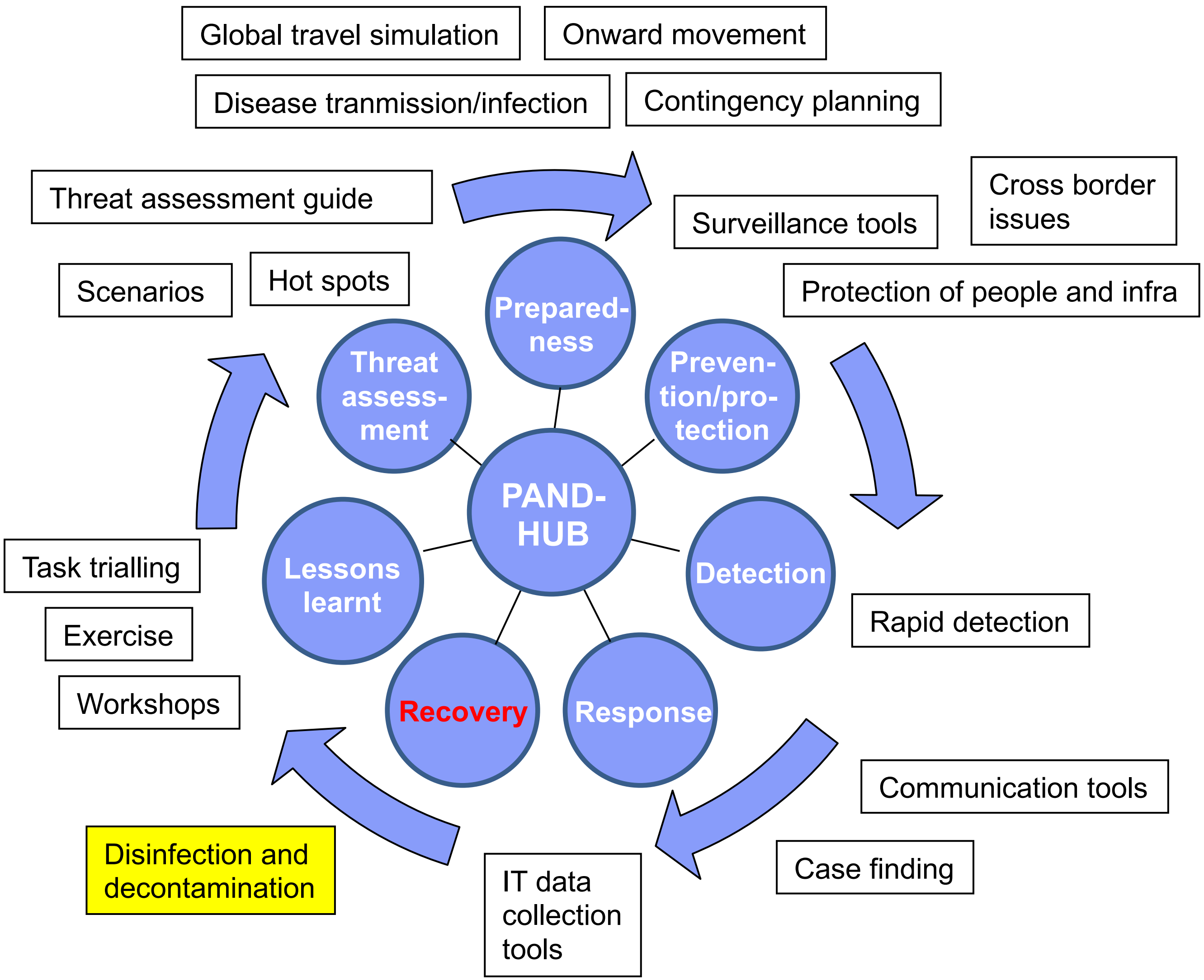
PANDHUB Preparedness tool set



Why decontamination is needed

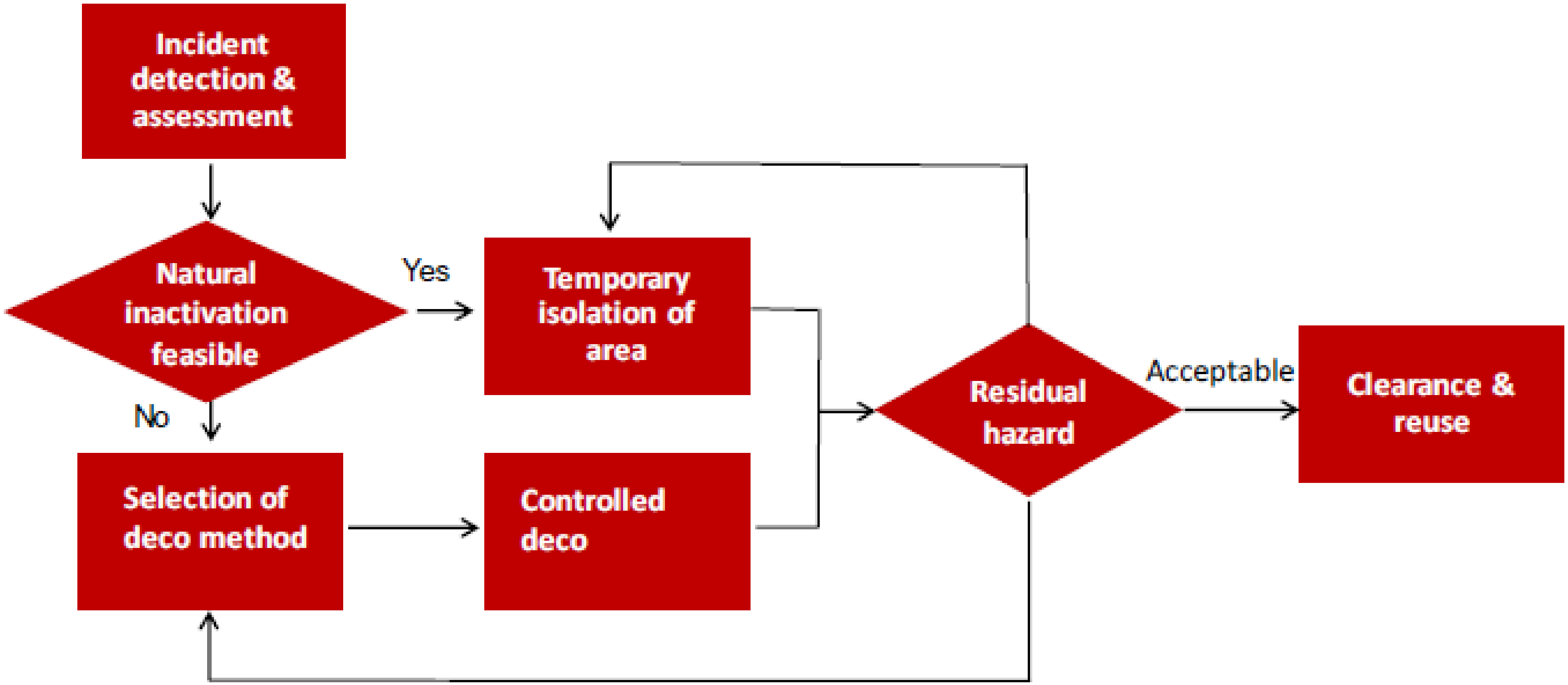
In a case of high impact microbial contamination in transport hub environments, quick, safe and efficient disinfection and/or decontamination of the affected facilities is required to minimize the risk of disease spread.

Disinfection and/or decontamination are needed in cases of

- Outbreak management
- Intentional spread of pathogens

Hygiene survey at an airport showed that respiratory viruses can be found on frequently touched surfaces during epidemics.

Decontamination decision chart



Resistance of pathogens against decontamination

Most resistant

BACTERIAL SPORES
B. anthracis, C. difficile

↓

MYCOBACTERIA
M. tuberculosis

↓

NON-ENVELOPED VIRUSES *Polio virus, Coxsackievirus*

↓

GRAM-NEGATIVE VEGETATIVE BACTERIA
Yersinia pestis, E.Coli

↓

FUNGI
Trichophyton spp

↓

LARGE NON-ENVELOPED VIRUSES
Variola

↓

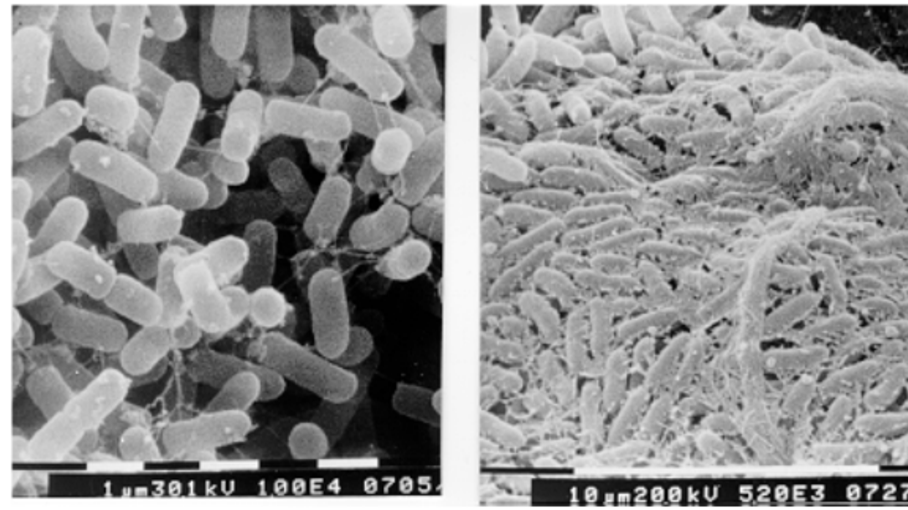
GRAM-POSITIVE BACTERIA
Staphylococcus aureus

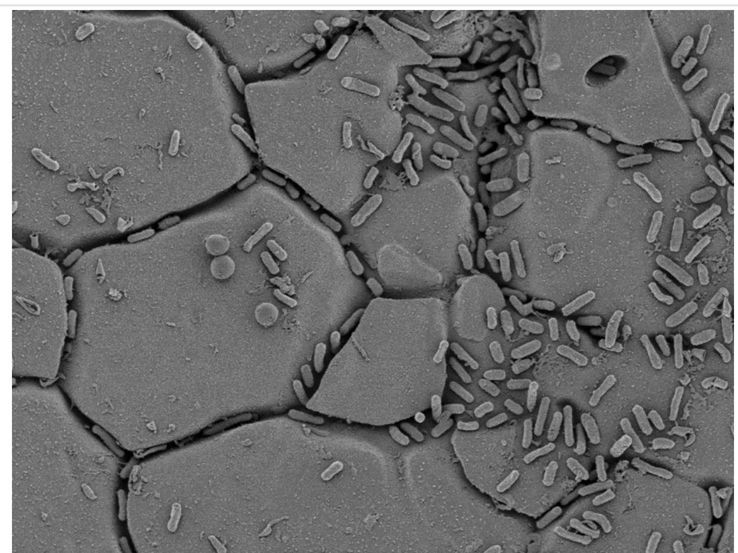
↓

ENVELOPED, LIPID VIRUSES
Influenza, Ebola

Least resistant

Descending order of resistance of microbial pathogens to inactivation





Decontamination methods

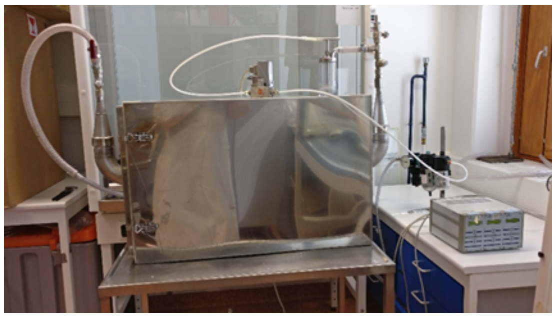
- Mechanical cleaning
  - Washing: brushing, water flow
  - HEPA vacuuming
- Chemical cleaning
  - Detergents

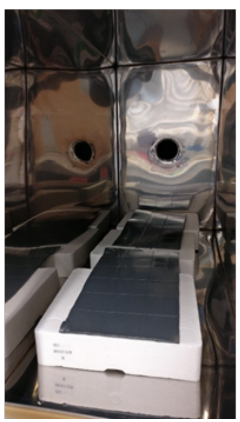
- Physical decontamination
  - Natural inactivation/Weathering
  - Heat treatment
  - UV light
  - Non-thermal plasma
- Chemical decontamination
  - Oxidative: oxidative chlorination, hydrogen peroxide
  - Alkaline hydrolysis
  - Ozone

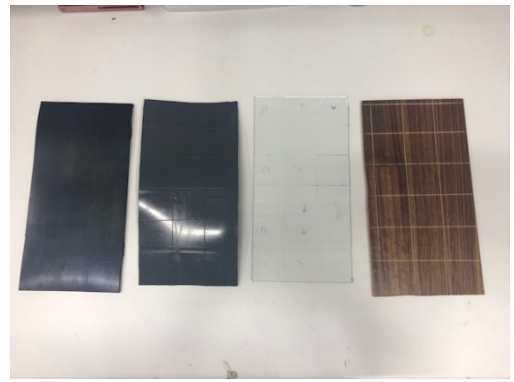
Decontamination – information for practical decisions

Active ingredient	Efficacy: gram-bacteria	Efficacy: bacteria spores	Efficacy: viruses	Suitability to be used at transport hubs
Alcohols	+	-	+/-	suitable for wiping surfaces, volatile, colourless, common product, easy to use, non-toxic, harmless on skin
Chlorine, chlorine-producing compounds	+	+	+	suitable for wiping surfaces, toxic by-products, residues, corrosive, discoloration, explosive gas, effective in low concentration, easy to use
Formalde-hyde	+	+	+	potential carcinogen and limited employee exposure, can be used as a liquid and as gaseous states
Hydrogen peroxide	+	+	+	suitable for wiping surfaces as a solution and as a vapour (removal/protection of people needed), can be corrosive, decomposes to water and oxygen, easy to use
Peracetic acid	+	+	+	suitable for wiping surfaces, corrosive, unstable, non-toxic (acetic acid and water), can be used with hydrogen peroxide
Quaternary ammonium compounds	-	-	+/-	non-irritating, non-corrosive, odourless, flavourless, non-toxic, prevents regrowth, supports microbial detachment,

Experimental setup for disinfection studies

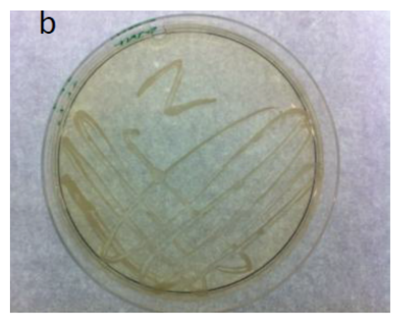




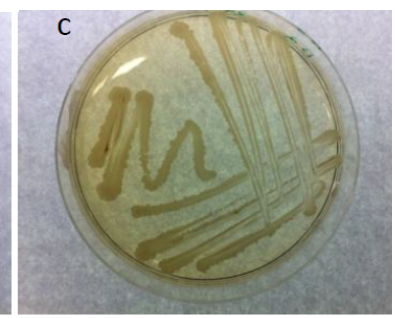


A_B	C_C	A_C
C_C	A_B	C_B
P_B	P_C	A_C
C_B	A_B	P_C
P_B	P_C	C_C
A_C	C_B	P_B

Staphylococcus



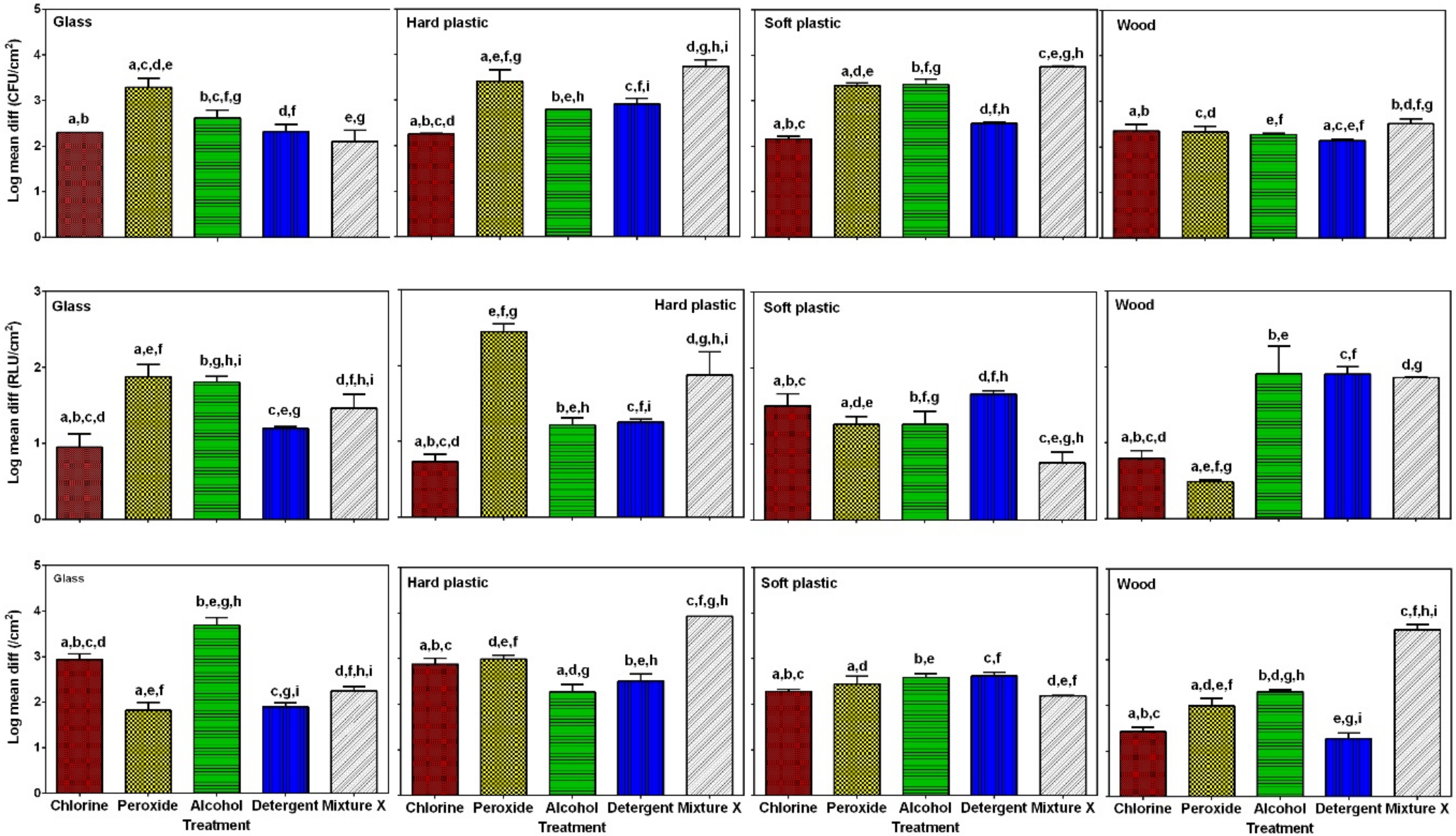
Bacillus



Total 405 samples

Disinfection efficiency

Glass | Hard plastic | Soft plastic | Wood



Factors affecting to the efficacy of decontamination procedure

- Presence of organic soil – removal of visual dirt needed!
- Surface material e.g. it’s porosity
- Concentration and volume of disinfectant solution
- Exposure time

Case studies showed that live microbes were detected from all surfaces after disinfection
=> it is important to check if microbes have survived the decontamination procedure

Decontamination tests with gaseous H_2O_2

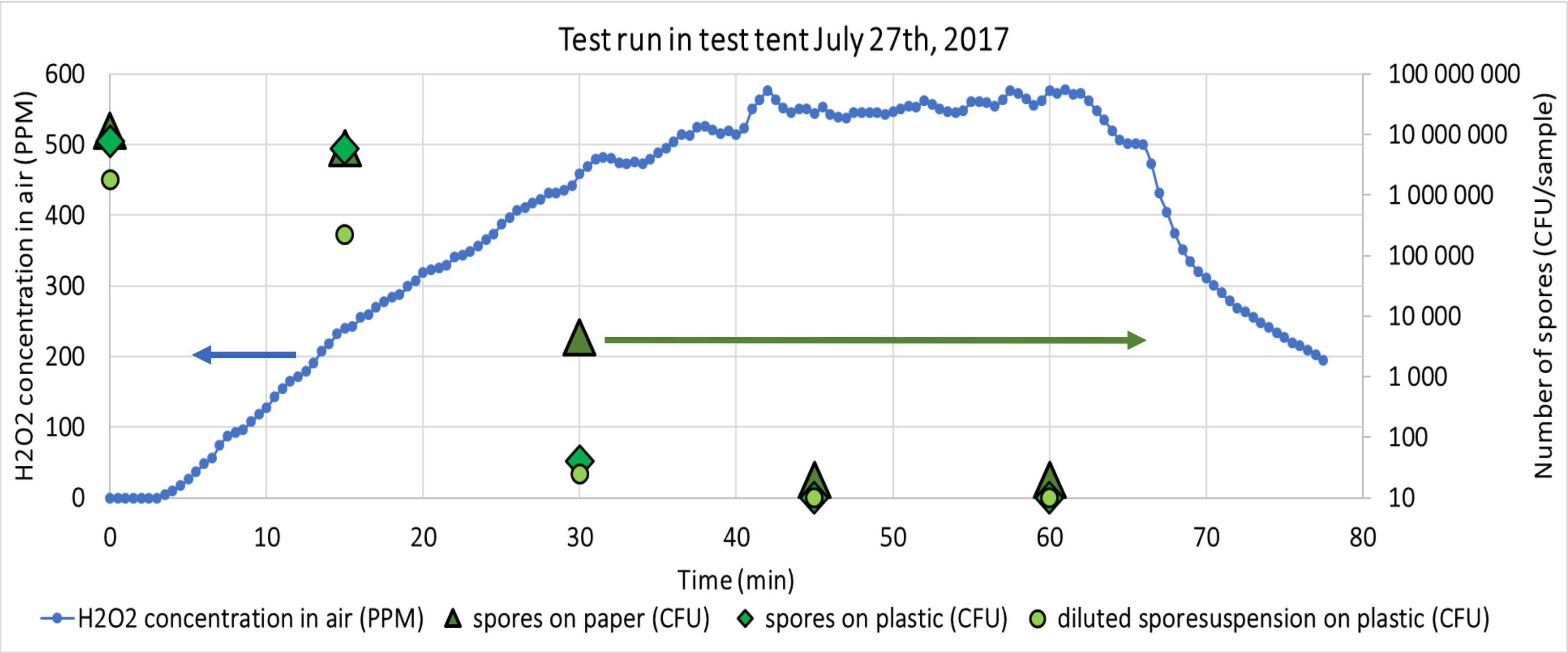
For decontamination of large spaces or sensitive equipment effective but gentle methods are needed

H_2O_2 vapour is an attractive alternative:

- does not leave harmful residuals
- relatively safe
- Good material compatibility
- Vapour penetrates also to hard to reach areas
- Results independ of human behaviour

Field deployable set-up for testing H_2O_2 decontamination procedure

Tests results with gaseous H_2O_2



Inactivation of *Bacillus atrophaeus* –spores
Over 6-log reduction was achieved with 45 min treatment at 500 ppm H_2O_2

Considerations

Risk of cross contamination: skilled cleaning personnel (+ personal protection)

- Professional cleaning company vs. hub’s own cleaning personnel

Resistance of microbe

- Bacterial spores are most difficult to kill

Efficacy of disinfectant

- Efficient disinfectants are often harmful also to people, may be incompatible with materials or have some other disadvantages

Conclusions

- Large space decontamination (fumigation)
  - Needed in cases of highly dangerous and/or easily spreading pathogens
  - Vapour H_2O_2 is efficient, but needs to be tested in transport hubs properly (only for closed and well sealed spaces)

- Small scale decontamination (manual disinfection, e.g. hypochlorite)
  - Suitable in cases of limited and clearly defined contaminated areas
  - E.g. disinfection can reduce respiratory viruses attached on frequently touched surfaces

Poster presentation:

Public Health England

EFFICACY OF CLEAMIX VCS-100B DECONTAMINATION SYSTEM – INACTIVATION OF MICROBES USING H_2O_2 VAPOUR

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Introduction

Hydrogen peroxide (H_2O_2) is a widely used chemical and it is well known efficient disinfectant especially in vapour form. The aims of this study were to check the generation rate of H_2O_2 vapour in various applications and capability to eliminate *Bacillus atrophaeus* (VTT E-052737) –spores with Cleamix VCS-100B decontamination system. *B. atrophaeus* spores are widely used as *B. anthracis* surrogates and are amongs to the hardest to kill microbes.

Measuring the efficacy of H_2O_2 decontamination

Decontamination system was run by Cleamix personnel in a test tent and empty hospital rooms (Figure 1). H_2O_2 concentration was measured with a sensor (Vaisala) belonging to decontamination system. *Bacillus* spore suspension was cultured and heat treated at VTT. Spore suspension was spread on steel surface and it was dried on surface before placing the steel surfaces to test area. Steel surface was covered with 1 ml of spore suspension containing 900 000 CFU/ml. After decontamination microbes from the biological indicators were collected using cotton tipped swab and cultured.

Results

Figure 2 shows concentration of H2O2 in air during test trial performed in the test tent. On the axis on the right hand side is the amount of spores; red spot shows dead cells and green live ones. Figure 3 shows concentration of H_2O_2 in air during test trial performed in a hospital room. All spores (6 log units) were killed from steel surfaces during the 2 h decontamination procedure in the test tent.

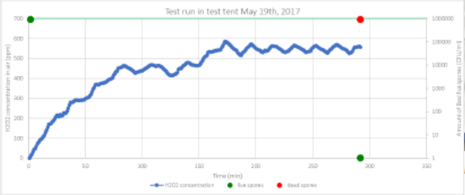

Figure 2. Test results from test trial in test tent on May 21, 2017.

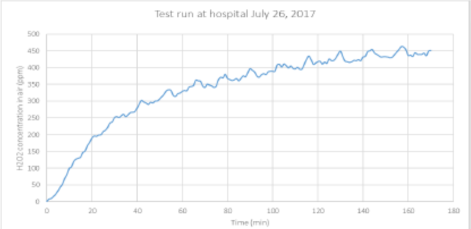

Figure 3. Test results from test trial in hospital room on July 26, 2017. Feed of H_2O_2 was 3 ml/min and the volume of the room 27 m³. Relative humidity of the room was 45% at the beginning of the test.

Figure 1. Test set ups: top row: hospital rooms, below: test tent.

Reference: VTT customer report VTT-CR-04266-17

CONCLUSIONS

Cleamix VCS-100B decontamination system was able to generate vapourised H_2O_2 effectively in test tent and hospital rooms.

High amount of *Bacillus atrophaeus* spores (log 6 CFU) were killed from steel surface during the decontamination.

PANDHUB Participants

VTT

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