A Study of the Effectiveness of the Containment Level 4 (CL-4) Chemical Shower in Decontaminating Dover Positive Pressure Suits

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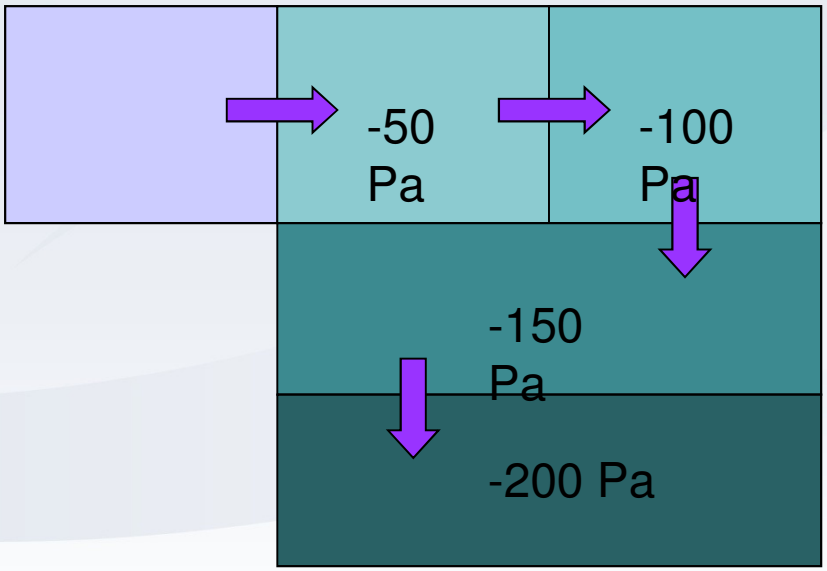
What is studied in CL-4 labs?

- CL-4 organisms:
  - Dangerous, exotic agents
  - High risk of life-threatening disease (community and individual)
  - High risk of aerosol transmission
  - No available vaccine or therapy
  - ie. Ebola Virus, Crimean-Congo Haemorrhagic Fever Virus, Kyanasur Forest Disease Virus, H5N1 High Pathogenic Influenza Virus, 1918 Influenza Virus, etc.

CL-4 Biosafety Features

- Primary Barriers
  - Proper lab technique, biosafety cabinets, **personal protective equipment**

- Secondary Barriers
  - Facility design
    - ie. Directional airflow



Personal Protective Equipment

Dover Positive Pressure Suit:

- Primary barrier: personal protective equipment
- Fully contained, air-supplied
- Positively pressurized
- Requires decontamination shower upon exit from CL-4

Chemical Shower Requirements

- Vague description of requirements:
  - *"A chemical shower of appropriate duration is required for personnel in suits who are leaving the containment laboratory; the disinfectant used must be effective against the agents of concern, be diluted as specified and prepared fresh as required"*

-Laboratory Biosafety Guidelines 3rd Edition (2004), Canada

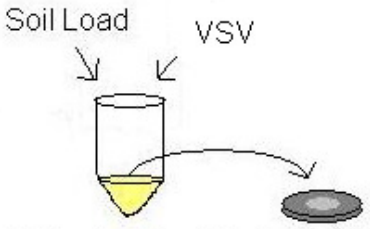
Standard Chemical Shower Procedure at NML

- MicroChem-Plus™
  - Quaternary Ammonium Compound (Quat)
  - Effective against some vegetative bacteria and enveloped viruses
  - Cationic surfactant activity – solubilizes anionic lipid membranes
  - Low biodegradability, corrosive
- 2 minute 5% MicroChem-Plus followed by 3 minute water rinse
  - “rub wash” technique employed
  - effluent waste water heat inactivated before release

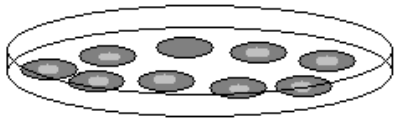
Objectives

1. Test the decontamination effectiveness of the current chemical shower methodology
2. Test the decontamination effectiveness of a pure water rinse cycle
3. Test the decontamination effectiveness of a mild surfactant wash in conjunction with a water rinse cycle

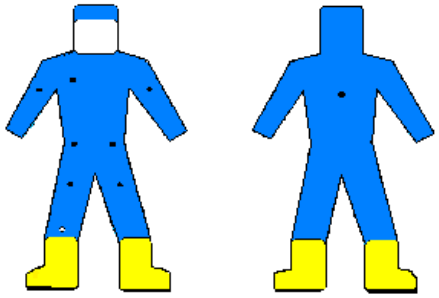
Experimental Outline



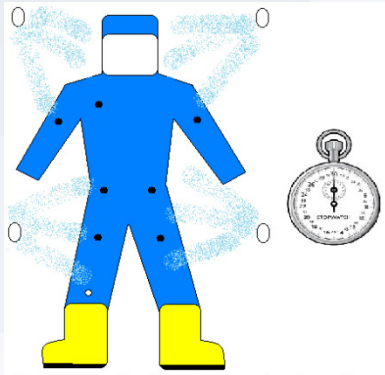
VSV and soil load dried on stainless steel carriers



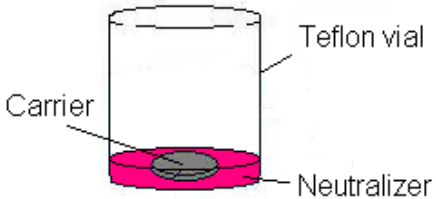
Carriers transported to CL-4 chemical shower



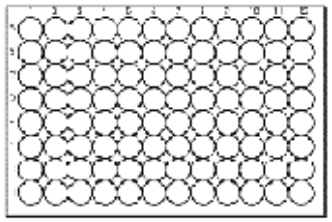
Carriers affixed onto Dover positive pressure suit



Exposure of suit to shower treatments at 1, 3 and 5 minute timepoints



Carriers added to neutralizer after exposure to shower cycle



TCID50 performed on eluate dilutions

Exposure Times

Shower Cycle	Time Point		
	1 minute	**3 minutes**	**5 minutes**
Standard Chemical Shower	1 minute 5% MicroChem-Plus™	2 minutes 5% MicroChem-Plus™ 1 minute water rinse	2 minutes 5% MicroChem-Plus™ 3 minute water rinse
Water Rinse	1 minute water rinse	3 minute water rinse	5 minute water rinse
Mild surfactant Shower	1 minute 5% Dove™ detergent	2 minutes 5% Dove™ detergent 1 minute water rinse	2 minutes 5% Dove™ detergent 3 minute water rinse

Table 1. Composition and duration of the standard chemical shower cycle, water rinse cycle and surfactant shower cycle during shower efficacy testing

Carrier Placement on Dover positive pressure suit

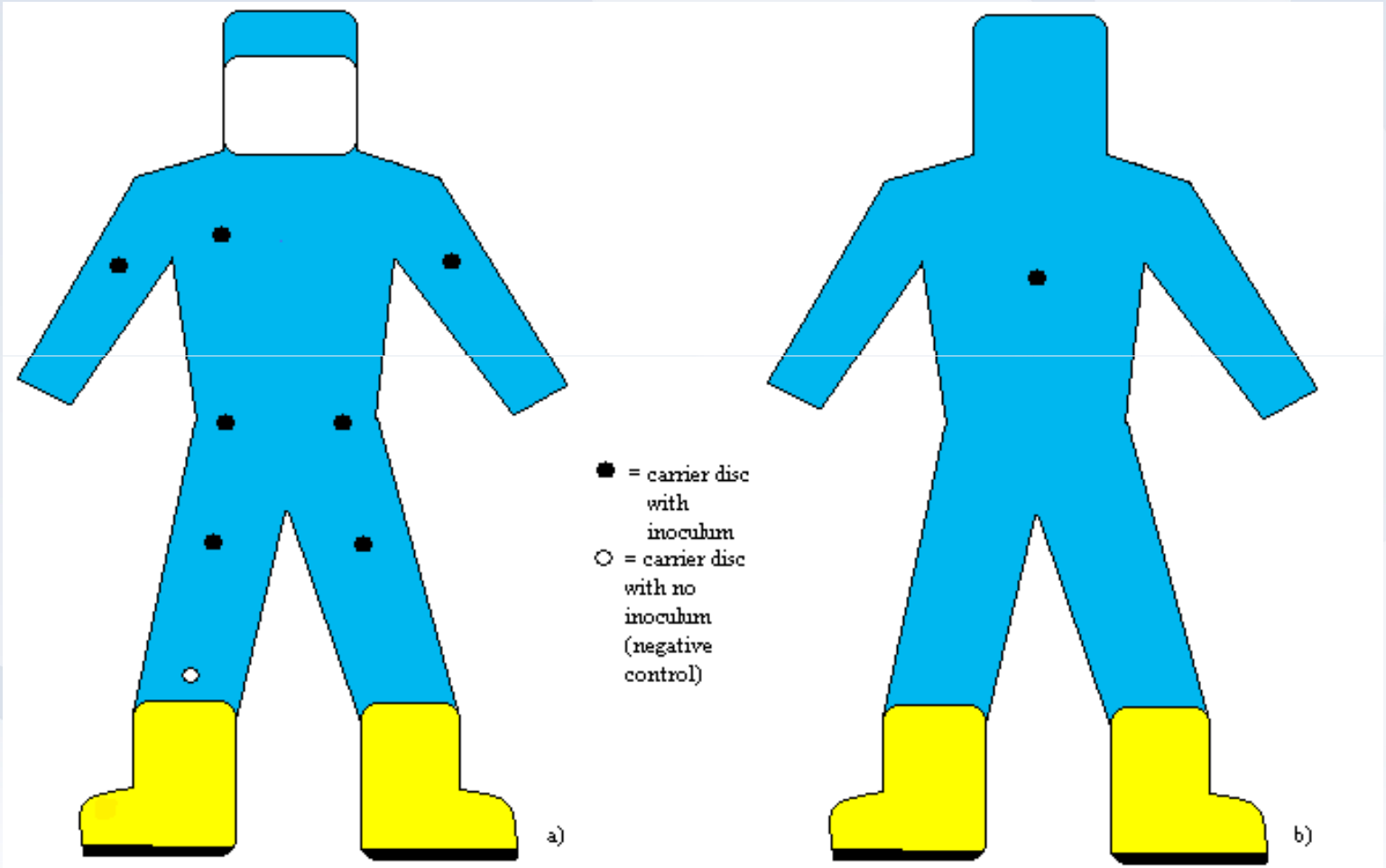
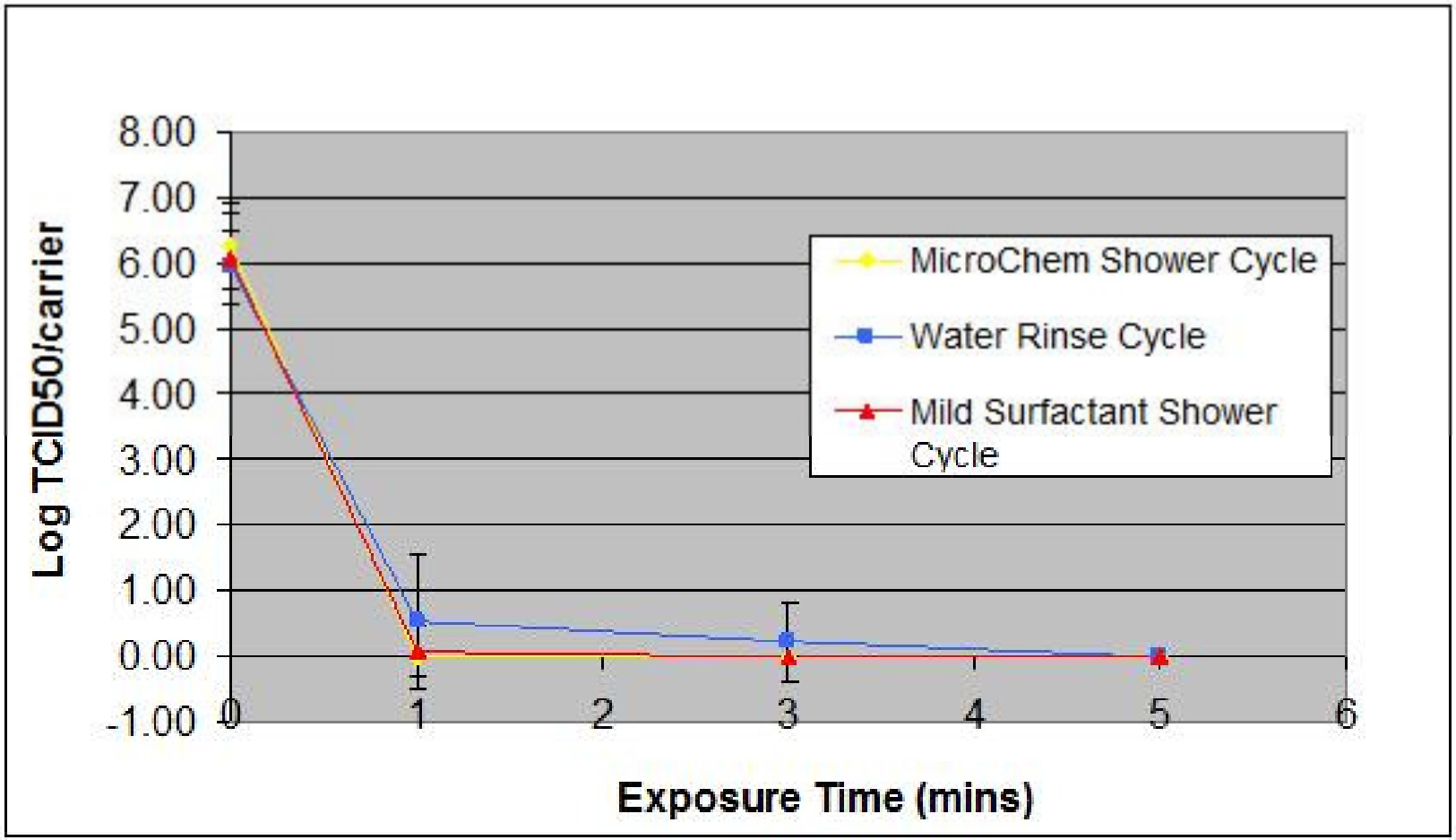


Figure 1. Diagrammatic representation of carrier placement on Dover positive pressure suit during chemical shower efficacy testing; a) front view of carrier placement; b) back view of carrier placement

Results



Average TCID50/carrier decrease of VSV following 1, 3, and 5 minute exposure times to the standard chemical shower cycle, water rinse cycle and mild surfactant cycle. Positive control carriers left unexposed to the shower cycles served to calculate the average initial starting concentration (at t=0).

Results

Shower Cycle	Average Log TCID50/carrier			
	Exposure Time			
	0 min.	1 min.	3 mins.	5 mins.
Standard Chemical Shower Procedure	6.26±0.65	0.00±0.00	0.00±0.00	0.00±0.00
Water Rinse Cycle	5.95±0.55	0.52±1.03	0.22±0.59	0.00±0.00
Mild Surfactant Cycle	6.09±0.69	0.08±0.37	0.00±0.00	0.00±0.00

Table 2. Effect of varying shower cycles on concentration of infectious VSV on Vero E6 cells

Conclusions

- Current shower methodology is effective in fully decontaminating Dover suits
- Mild surfactant cycle completely effective at 3 and 5 minute exposure times
- Water cycle completely effective at 5 minute exposure time

Recommendations

- Potential to decrease dependency on costly and environmentally hazardous chemicals
- Possibility to decrease total duration of shower cycle

Acknowledgments

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