Version 2

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WASP-D Field Protocol V.2

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1 *Works for me* This protocol is published without a DOI.

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ABSTRACT

WASP-D (**W**arm**A**nd**S**low**P**athogen-**D**econtamination) enables the safe and simple decontamination of PPE from SARS-CoV-2 without damage or reduction of PPE effectiveness. Only heat, time and ambient humidity are required to lower SARS-CoV-2 viral load by six orders of magnitude. Heat also has the advantage of penetrating areas that cannot be reached by vapors or UV light, thus simplifying the decontamination process and reducing operating costs. WASP-D is well suited for low-resource environments and to relieve temporary PPE shortages.

To avoid damage to PPE materials, temperatures are limited to a "warm" range between 110F-122F (43C-50C), for a decontamination interval of 12hrs (at 46C/115F). Above 50C, or in the presence of UV-C, steam or chemical sanitizers, PPE elasticity or tear strength may be compromised, limiting reuse and possibly affecting its ability to exclude pathogens. See "Guidelines and Warnings" for more details.

At these "warm" temperatures, some but not all pathogens will be diminished. Thus an "index' system where decontaminated PPE are returned to their original wearer is prudent. Never the less, in situations where SARS-CoV-2 is the primary infectious agent, WASP-D can relieve PPE shortages and improve patient and health system outcomes.

THIS PROTOCOL ACCOMPANIES THE FOLLOWING PUBLICATION

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GUIDELINES

As every WASP-D system will be vary in configuration, we cannot guarantee this protocol is effective in all situations. Please implement carefully and use at your own risk. Please share your field experience with the authors (contact **Prof Greg Blonder gblonder@bu.edu or message via protocols.io**) so we can update and improve this advice.

The WASP-D decontamination facility can take multiple forms, depending on local skills and resources. For example, a clean exterior shed. A greenhouse. A spare storage room. A shipping container. A car in the hot sun with closed windows and ventilation fan ON. Multiple WASP-D facilities allows for overlapping decontamination cycles.

Heat sources include sunlight (e.g. a greenhouse or black-painted shipping container), and electric heaters (ceramic heaters or oil radiators are preferred for fire safety and to prevent PPE exposure to infra-red radiation emanating from red-hot electric heating wires). Place heater inside facility near air inlet duct to pre-heat ventilation air.

Ideally, PPE should be stored on wire shelves (commercial, or locally built with chicken wire), with each shelf dedicated to PPE from one health worker. While gowns may be folded to save space, try to avoid contact between the presumably cleaner PPE interiors with the more highly exposed exterior surfaces. *Unlike UV-C and vaporized peroxide, heat will penetrate stacked masks and gowns, and in some cases, these denser arrangements of non-indexed PPE are expedient forms of decontamination.*

A remote thermometer to read the interior temperature is required-- multiple thermometers, distributed within the facility, are preferred. **One thermometer probe should be placed inside the thickest (and/or moistest) PPE to confirm the decontamination temperature has been reached**. Temperatures should be maintained in the range of 110F to 125F (42C to 53C), perferably 115F (46C). Lower temperatures may not kill pathogens, and higher temperatures may damage some (but not all) PPE.

A ventilation fan to prevent mold and fungal growth is important. Preferably, this fan should blow air throughout the facility and exit via an exhaust vent or pipe which is oriented away from human contact or direct inhalation. One to two air exchanges an hour should be sufficient. Make sure heaters and wall insulation are adjusted to maintain target temperatures. In the absence of fans, natural convection from air registers near the floor of the facility to ceiling exhaust vents may be sufficient. However, in this case the entire facility must be located away from accidental human contact. For ventilation to be effective, do not over-stuff the facility with PPE.

MATERIALS TEXT

Hardware examples in links

Fans Primary fans to dry PPE via external ventilation of WASP-D facility. Secondary fans to convect air within the WASP-D enclosure to assure thermal uniformity.
Tables and racks to hold PPE, while allowing for unimpeded airflow while drying and warming.
Heat source - sunlight or space-heaters that block direct infa-red radiation from exposed heating elements.
Digital thermometer with corded sensors long enough to reach outside the WASP-D facility. Wireless also acceptable. A data logging thermometer is preferred. Penetrating thermal probes with needle tips (e.g. thermocouples) are preferred to reach to the center of a PPE pile/mattress/equipment.

DISCLAIMER:

> This is a PRELIMINARY protocol intended for field use in uncontrolled environments. Thus it may not work as intended in all circumstances. We are interested in your field experience, and will adjust the protocol accordingly.

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2 is the primary infectious agent, WASP-D can relieve PPE shortages and improve patient and health system outcomes.

BEFORE STARTING

The 12 hours cycle is predicated on thin, dry PPE. Wet PPE will evaporatively cool until it dries out. In a low humidity room this cooling can be substantial - perhaps 10C or more. And could take (in the case of a wrung-out sponge) five hours or more to dry, perhaps days for moist bedding. Similarly, if WASP-D is used to decontaminate thick, heavy insulating material, such as books or mattresses, extra time will be required. A single book might take three hours to reach 43C in a 46C room, while a stack of books (due to the insulation value of cellulosic paper) might take a day or more. These heating time delays must be added to the 12 hour WASP-D cycle. That is, if it takes 6 hours for a moist sponge to reach 43C, the entire WASP-D cycle is 18hrs=12hrs +6hrs.

1 Before used-PPE is submitted for decontamination, the user should indelibly mark their PPE with their name and current date. Since WASP-D cannot guarantee all possible pathogens are fully deactivated, an "index" method where PPE is returned to the original user is prudent, though not required. Used-PPE often takes the shape of the user's head or face, which is an additional benefit of indexing.

2 Used PPE should be inspected by gloved, masked and gowned staff on a clean table. Damaged PPE must be separated from re-usable PPE.

3 Damaged PPE should be securely bagged for disposed. Damage includes broken straps, torn gowns, clouded face shields, excess of bodily fluids, toxic chemicals, etc.

4 PPE exteriors are more likely highly contaminated than the interior. Thus, care should be taken to prevent individual PPE from touching each other. This step is not required if PPE is not indexed.

5 After PPE are stored in the WASP-D facility, the heat source is activated and the ventilation fan triggered. Internal temperatures should be monitored during the 12 hour decontamination cycle to confirm it maintains 114F-120F (45C-49C), nominally 115F/46C.

6 Additional decontamination time may be required beyond 12 hours. Moist or sweaty PPE will evaporatively cool, and until it reaches ambient humidity , may plateau 10C or more below ambient temperature. Thick materials gathered in a heap will see-inslulate, delaying heat transfer to the center of the pile.

***WE HIGHLY RECOMMEND* WHEN APPLYING WASP-D ON THICK DAMP MATERIALS, SUCH AS MATTRESSES, TO INSERT A DIGITAL THERMOMETER PROBE INTO THE MIDDLE OF THE OBJECT AND CONFIRM IT HAS REACHED 114F (45C) BEFORE STARTING THE 12 HOUR DECONTAMINATION COUNTDOWN.**

If for some reason the temperature drops (e.g. loss of heater power or sunlight) for a time interval, the WASP-D decontamination cycle should be increased by the same amount, plus time to return to target temperature. In-situ temperature measurement within the PPE are the best guide to confirm the PPE has reached target temperature of 115F (46C) or above. At which point the 12 hour cycle begins/continues.

7 A log of temperatures vs time during the pre-heat and 12 hour decontamination cycle should be maintained. Temperature swings ABOVE 50C (122F) should be avoided to limit thermal degradation of the PPE

8 After the WASP-D cycle completes, the facility may be opened. Decontaminated PPE may be collected by their indexed users directly from dedicated facility staff or stored in labeled and clean paper bags for later use.

9 As a precaution, a representative sample of PPE should be swabbed and tested to confirm pathogens levels are below target.

10 The facility should be thoroughly cleaned with soap/and or bleach and water, and allowed to dry between cycles. This reduces cross-contamination from pathogens which are less heat-sensitive.