DHS SCIENCE AND TECHNOLOGY

S&T's Research, Development, Testing and Evaluation (RDT&E) Efforts re COVID-19

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April 13, 2020

Bottom Line Up Front

DHS S&T is engaged in extensive operationally-focused RDT&E efforts to support DHS with the best possible information to assist decision-making.

	What?	Why?	Findings	Impact	Next Steps
SURFACE STABILITY	Testing stability of SARS-CoV-2 virus on solid surfaces as function of temp, humidity, and solar intensity	To try and find conditions that promote virus decay as well as better characterize the virus	Virus is most stable in cool/dry conditions. Virus decays faster in higher humidity and temperature, much faster in sunlight	Increasing temperature & humidity in contaminated areas as well as moving any feasible operations outdoors in sunlight reduces risk	Validation testing across more surface types; development of **predictive decay model** as a function of temp/ humidity/solar
DECON	Testing commercially-available products for efficacy against SARS-CoV-2	To verify that these products work not only on the virus, but also on the virus in complex samples (like saliva)	Bleach and 70% isopropyl alcohol both work well when using manufacturer's recommended contact time	Commercially available products tested to date appear effective even against complex samples (saliva).	Test shorter contact times; test more commercially-available products (8 in total)
AEROSOL STABILITY	Testing stability of SARS-CoV-2 virus in the air as function of temp, humidity, and solar intensity	To inform aerosol/ respiratory hazard and PPE decisions	Virus is very stable in no-solar conditions	Increasing air exchanges (increasing HVAC exchanges, opening windows) may reduce indoor aerosol risk; Importance of respiratory protection for staff who may be near to COVID-19 (+) individuals indoors	Development of predictive decay model as a function of temp/ humidity /solar
PPE REUSE	Testing if vaporous hydrogen peroxide (VHP) is effective against virus and doesn't degrade mask; developing low-cost decon alternatives	Close critical gaps on VHP operations and develop low-tech solutions for non-VHP locations	TBD; testing starting this week	Inform large-scale (VHP) and low-resource decisions on PPE decon & reuse	Obtain laboratory results and disseminate information
TECH SCOUTING	Constant crosswalk of commercial solutions and known Component needs	Quickly match Component needs to capabilities	Ongoing; tailor analyses available; standing up decon-specific office	Reduce burden on individual Components; leverage S&T expertise & capabilities to rapidly triage solutions	Continue to support crosswalk of commercial solutions to Component needs

Overview

- Emerging Results from NBACC's COVID-19 Characterization Efforts
  - Surface Stability
  - Disinfectant Testing
  - Aerosol Stability
- Other DHS S&T COVID-19 efforts
- Master Question List (MQL)
- DHS S&T Tech Scouting

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NBACC's Planned SARS-CoV-2 Characterization Research

Study Type	Parameters						
Virus in **three** suspensions: 1) cell culture, 2) saliva (modified), 3) respiratory fluid (modified)	Wet and Dry (Virus)	Small and Large Particle	Droplet	Temperature	Humidity	Sunlight	Notes
Surface Stability	✓	✓	✓	✓	✓	✓	Stainless Steel, Plastic, Nitrile
Decontamination	✓	N/A	✓	N/A	N/A	N/A	Stainless steel; 8 EPA Recommended Disinfectants
Aerosol Stability	N/A	✓	N/A	✓	✓	✓	

Completed | In Progress | Not Started Yet

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NBACC's Emerging Results: Surface Stability *Indoor Conditions*

- **What is being tested:** how long does the virus survive in a droplet of saliva (e.g., from a cough/sneeze) and a dried droplet of saliva deposited on stainless steel in varying temperature, humidity, and sunlight
- **Results**
  - Virus lives longer at low humidity and inactivates faster at higher humidity
  - Virus lives longer at low temperatures and inactivates faster as temperature increases
  - Sunlight destroys the virus *quickly*
- **Operational Relevance**
  - Risk of transmission from surfaces outdoors is lower during daylight
  - Higher temperature & humidity of indoor environments will reduce the viral contamination on surfaces faster
  - Surfaces in low humidity environments (e.g., airplane cabins) may require additional care to minimize risk of transmission

Why stainless steel?

- NBACC had already-established methods for recovery off of this surface (generate data quickly)
- Generally, in our experience, nonporous surfaces are more conducive to biological stability than porous surfaces (like cloth or cardboard)
  - Thus, data generated on this surface will be a conservative, or worst-case, estimate of decay
- Methods for recovery off of porous surfaces are not well developed and hard to make repeatable/reproducible
- NBACC plans to validate findings on other surface types and on nonporous surfaces in future tests

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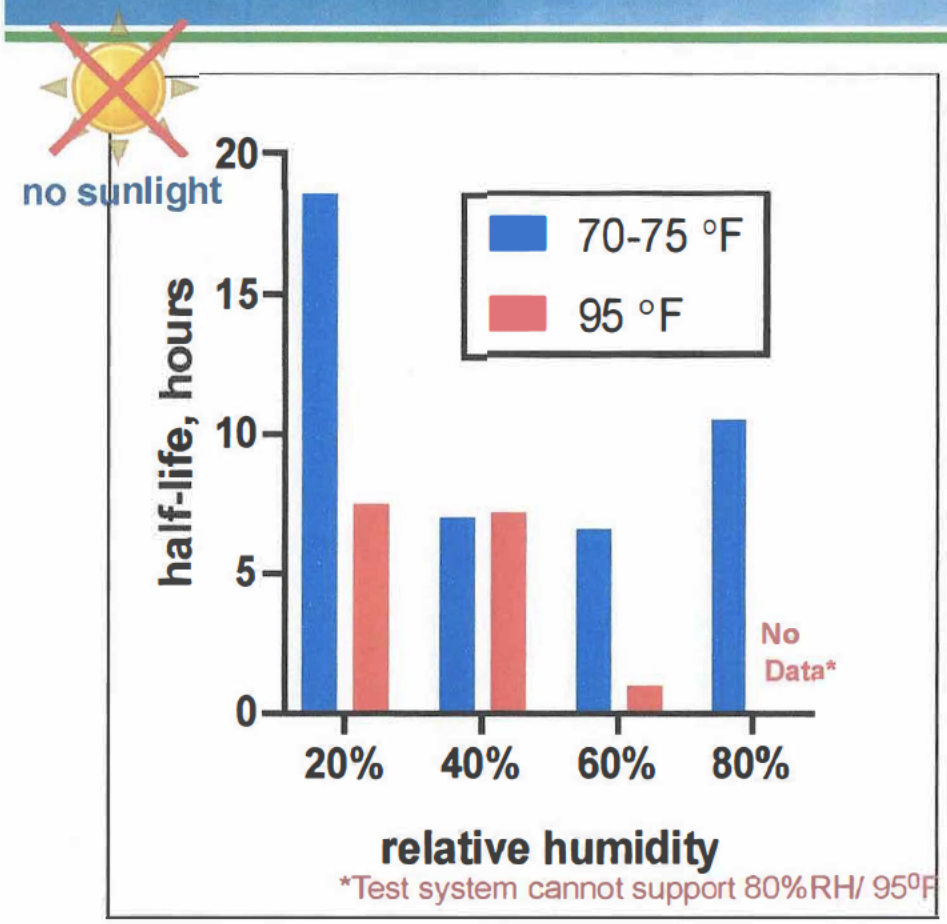
NBACC's Emerging Results: SARS-CoV-2 Stability on *Indoor Surfaces*



Summary:

- Virus is most stable at low humidity (20%) and decays faster at RH >40%
- Virus is less stable at higher temperatures

Operational Relevance:

If a location has a COVID-19 (+) individual and is going to be vacated for cleaning, turn up indoor heat & humidity if possible.

Ongoing work:

Developing an equation to predict virus decay at any temperature & humidity combination (next week)

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NBACC's Emerging Results: SARS-CoV-2 Stability on Indoor Surfaces

Results:

- Simulated sunlight greatly increases inactivation rate of virus dried on surfaces (relative to darkness)

Solar Intensity	Half-Live (Min)
Full Intensity	~2 min
Half Intensity	3 min
Quarter Intensity	4 min
No Light (Dark	No decay > 60 min

Frame of Reference:

Full intensity = *NYC/DC during clear day on summer solstice*

Quarter Intensity = *NYC/ DC clear day end of February*

- Sunlight reduced infectious virus to undetectable levels after just 3 minutes of exposure to the solar equivalent of midday sun on a sunny day in the middle latitudes of the US.

Summary:

- Simulated solar light rapidly inactivated the virus (outdoor)

Operational Relevance:

Outdoor surfaces exposed to sunlight are lower risk for virus transmission

Ongoing and planned work:

Repeat with a higher concentration of virus to better understand decay rate

What else needs to be known:

1. How much virus does it take to infect?
2. How much virus is on the surface?
3. How much virus comes off when touched?

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NBACC's Emerging Results: SARS-CoV-2 Decontamination from surfaces

Estimated Reduction in Virus			
Matrix	Droplet	**70% Isopropyl Alcohol (IPA)** 30 sec contact	**Diluted Bleach (0.26% Hypochlorite)** 5 min contact
Culture medium	Wet	> 99.9%	> 99.9%
	Dried	> 98.1%	> 99.9%
Simulated saliva	Wet	> 99.3%	> 99.3%
	Dried	> 96.4%	> 96.2%

Summary:
0.26% hypochlorite (bleach) OR 70% isopropyl alcohol killed SARS-CoV-2 in both wet and dried saliva on stainless steel

Operational Relevance:

Commercially available & EPA recommended disinfectants (Bleach & IPA) used as recommended are effective at disinfecting both old (dried) and freshly (wet) contaminated saliva on a non-porous surface.

Ongoing and planned work:

- Test shorter contact times for cleaners;
- Test other off-the-shelf products (Lysol spray, peracetic acid, Clorox hydrogen peroxide cleaner, etc.)

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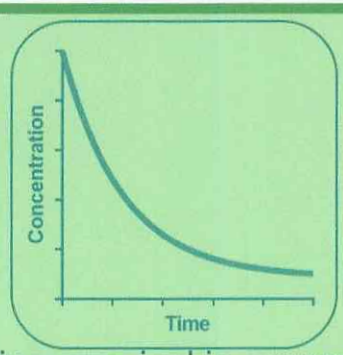
NBACC's Aerosol Hazard Assessment Approach/Capabilities

Aerosolization of Virus
- Concentration of virus in air
- Size of virus-containing particle



Virus survival in aerosols
- Virus in relevant matrix
- Indoor (temp/humidity)
- Outdoor (temp/humidity/ sunlight)

Host Susceptibility to Infection
- Infectious dose
- Immunization
- Therapeutics

NBACC is the *only* US biocontainment laboratory with the capability to evaluate survival of biological hazards in aerosols under a range of operationally relevant conditions:

- Custom aerosol chambers with ability to control temp, humidity, and sunlight simultaneously
  - Determine how long biological agent survives in the air under indoor and outdoor conditions
- Expertise in aerobiology, aerosol science, and aerosol engineering
  - Over a decade of experience and established methods for in-depth and "operationally focused" analysis of aerosols containing biological agents
  - Experimental design is used to produce a model which accounts for interaction between test factors-enabling virus decay predictions between tested conditions.

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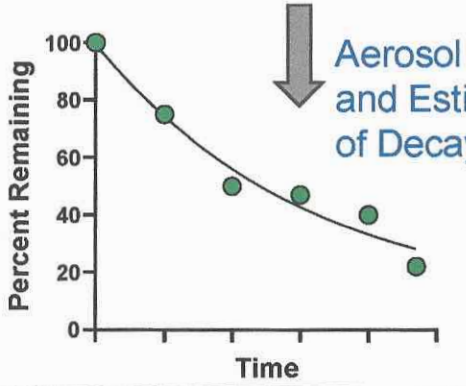
NBACC's Emerging Results: SARS-CoV-2 Aerosol Stability

Methodology:

Aerosol Generation

Aerosol Aging in Environmentally Controlled Chamber



Aerosol Sampling and Estimation of Decay Rate

Preliminary Data Summary:

- Virus suspended in saliva treated **with full intensity simulated sunlight** rapidly killed virus in aerosols
  - Half life: **~2-3 minutes** at room temp, 20%RH
  - 90% decrease in virus in **~9-10** minutes
- **Without simulated sunlight**, no significant loss of virus was detected in 60 minutes (room temp, 20%RH)
- Sunlight increases inactivation of infectious virus in aerosols (coughs, sneezes)

Operational Relevance:

- Outdoor daytime environments are lower risk for transmission
- Importance of respiratory protection for staff who may be in close proximity to infected individuals indoors
- Increasing air exchange rates indoors may reduce risk

Ongoing work:

Testing with additional solar and relative humidity levels

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Additional ongoing DHS S&T COVID-19 Projects

Project: PPE Decon & Reuse

1. Verify vaporous hydrogen peroxide (VHP) techniques are effective against SARS-CoV-2 with a range of mask types
   - Evaluate both biological decay and physical degradation & fit
2. Test additional small-scale, low-tech techniques that could be implemented in lower-resource settings
   - Looking at devices such as rice cookers, clothes steamers, electric pressure cookers

Operational Relevance:

- Address key unknowns in VHP decontamination and reuse protocols
- Provide options that could be implemented in smaller regional settings

Project: Waste stream survivability

- Understand the survival of the virus in human waste streams to inform decontamination and remediation decisions

Operational Relevance:

In addition the healthcare relevance, may impact DHS operations along the border, especially in low-resource or improvised settings (e.g., using port-a-johns)

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Master Question List

- S&T developed & maintains a SARS-CoV-2 Master Question List (MQL):
  - Summarizes current knowledge and provides authoritative sources/citations
  - Tracks ongoing research efforts on the virus worldwide
  - **IMPACT:** Provides situational awareness of these important efforts
    - Similar model used during the response to 2015 Ebola outbreak
- Key elements of MQL:
  - What is known?
  - What additional information is needed?
  - Who may be working to address such fundamental questions?

https://www.dhs.gov/publication/st-master-question-list-covid-19

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Tech Response and Scouting Updates

Recent Support to DHS Components and Key HSE Partners

→ Tech Scouting reports on diagnostic test kits and disinfectants for **USSS** & **FLETC**.
→ Disinfectants report and Ambulance Decon Systems Survey provided to **MGMT**
→ Provided U.S. Navy with Ambulance Decon Survey, disinfectants scouting report, COVID-19 Response Opportunities document, & NASA robotics program info

Reviewing Input From Industry for Consideration

39 New products/proposals reviewed (March 30 – April 6). Received by S&T PMs, S&T SMEs, and the Innovation Inbox. Reviewed by S&T SMEs.

83 Total reviewed (March 18-April 6)

"Hot topics": Face shields and masks, ventilators, rapid screening to detect COVID-19, and sanitizer/disinfectants.

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5RD International Research Overview

	Australia	Canada	UK	New Zealand
Primary Foci	Diagnostics, Vaccines	Diagnostics, Experimental Therapeutics, Vaccines, Animal Susceptibility	Diagnostics, Vaccines	In development
Alignment with DHS priorities	**Virus Characterization-** Decay of dried virus on range of surfaces using metal coupons *(no capability for aerosolized)* ▪ *Slightly different virus* ▪ *Slightly different conditions*	**Surface Stability-** Dried virus on various surfaces (N95, nitrile, Tyvek) **Decontamination-** 1) Decon with different agents (VPH, temperature, Peroxide cloths, Masks, etc. – *results pending*) 2) Mask tests (*results pending*) [&]	**Surface stability-** Virus survival on surfaces & recovery from aluminum (simulated military material[&]) **Decontamination-** Using military grade products[&]	In development

[&]: Denotes valuable capability or aspect not currently implemented in current DHS S&T studies

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24/7/365 Availability | Biological Threat Characterization | Bioforensic Analysis | Biosafety Level 2,3, and 4 Laboratories

About NBACC:

- Supports America's defense against biological threats. Primary capabilities include:
  - National Bioforensic Analysis Center (NBFAC)
  - National Biological Threat Characterization Center (NBTCC)
- A national resource for 24/7 biodefense including sensitive experiments.
- Only domestic maximum biocontainment lab built specifically for national security purposes.

Recent notable NBACC mission impacts via its two Centers:

- **NBFAC Conducted Nearly 600K Analyses Last Year for FBI and Other Gov't Partners:** The NBACC's NBFAC conducted nearly 600,000 analyses in 2019 in support of the FBI and other U.S. Government partners—more than in any previous 12-month period in NBFAC's history. Federal prosecutions using NBFAC analyses have been 100% successful.
- **NBACC R&D Innovations Enhance Our Ability to Research Ebola**: Research scientists from the facility's NBTCC designed new methods to measure the amount of infectious Ebola virus present in an air sample using a technique that is ten times more sensitive than previous methods used to effectively evaluate the risk of transmitting the virus.

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How is the NBACC Different?

NBACC located in Fort Detrick, Maryland, specializes in bioforensics and characterization of biological threats for national security.

Homeland Security Mission

- Focused to meet the specific needs of the DHS and Homeland Security Enterprise biodefense mission space

Highly-Relevant Expertise

- Aerobiology specialization
- Scientists with security clearances
- Ability to conduct sensitive studies

Optimized Infrastructure

- Maximum biocontainment (BSL-4)
- Support 24/7 operations for biodefense 365 days a year

- NBACC is equipped with unique aerobiology containers used to assess biological agents like COVID-19 and their survivability across multiple environments

Key Characteristics of NBACC and Peer Biodefense Labs	NBACC	NIAID IRF-RML (MT)	NIAID IRF-Frederick (MD)	USAMRIID	CDC	U.Tex
❑ *Diagnostics	✓	✓	✓	✓	✓	✓
❑ *Evaluation of therapeutics/vaccines in cells and animal models	✓ Surge capacity	✓	✓	✓	✓	✓
❑ Aerobiology: Inhalational exposure studies in animal models	✓	✓	✓	✓	-	✓
❑ Conduct classified life science research with high risk agents	✓	-	-	-	-	-
❑ Conduct operationally focused bioforensic case work	✓	-	-	-	-	-
❑ Aerobiology: Assess environmental factors that affect agent decay in the air	✓	✓ Limited to ambient conditions	-	-	-	-
❑ Aerobiology: Assess environmental factors for agent decay on surfaces	✓	✓ Limited to ambient conditions	-	-	-	-
❑ Advanced medical imaging of animal models of disease	-	-	✓	-	-	-