



Homeland
Security

Science and Technology

VOLUME II

BATTLING THE INVISIBLE ENEMY

The Department of Homeland Security Science
and Technology Directorate's COVID-19 Response

ONE YEAR LATER

www.dhs.gov/science-and-technology/science-and-technology-directorate-s-covid-19-response



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CONTENTS

	Message from Bill Bryan	3
	Public Health Security	4
	Studies to Stop the Spread	6
	Travel and Transit Security	9
	Industry Partnerships	12
	Intergovernmental Engagement	14
	Scientific Journal Publications	17
	Looking Ahead	19

MESSAGE FROM BILL BRYAN



For millions of citizens around the world locked down in quarantine, staying at home and waiting to learn more about COVID-19, it may have felt like life was put on pause for most of 2020. But for emergency managers, policy makers, research scientists, countless frontline workers, and the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), everything kicked into high gear.

This pandemic has tested all of us in numerous ways, but our nation – and those around the world – has emerged more determined than ever to vanquish this common foe. We have discovered what it really means to come together across not only the federal government, but also across borders both foreign and domestic. We have gained new insights into the complex dynamics of a pandemic and the many moving parts needed to evolve our infrastructure to accommodate the “new normal.” We have seen firsthand the critical importance of information-sharing and collaboration. We have developed a greater appreciation for the bravery of essential workers, the tenacity of scientists, and the precious gift of not having to be “socially distant.” While we are all eager to leave this tumultuous time far in our collective rearview mirror, we must remember everything we have learned so we can be ready for whatever the future holds.

Response and recovery are a life-and-death balancing act, and it takes great fortitude to make hard decisions and work around the clock to save lives. Incredible things can be accomplished through funding, partnership, determination, and creative thinking, though, and we will need more of it to continue this fight.

This document highlights just some of the important work S&T has contributed to during this turbulent time. It describes scientific studies and their corresponding conclusions, recounts multifaceted support given without hesitation to fellow DHS components and other key partners, and it looks forward to what’s next for this response. I am incredibly proud of the way so many people have stepped up and risen to the challenge to stop this pandemic.

BILL BRYAN

Under Secretary for Science and Technology (Acting)



PUBLIC HEALTH SECURITY

S&T has used all the resources at its disposal to characterize the SARS-CoV-2 virus responsible for the COVID-19 pandemic. The work supported by the [Probabilistic Analysis for National Threats Hazards and Risks \(PANTHR\)](#) program provided valuable insight that has directly translated into actionable guidance, resources, and tools to improve the safety of the public.

MASTER QUESTION LIST

The [Master Question List \(MQL\) for COVID-19](#) organizes our collective knowledge about the virus. This consolidation of recent, trustworthy research findings helps identify what information is needed, provides details on who might be working to address the most pressing questions, and aggregates what is known about the virus to identify how best to leverage S&T's technical resources. S&T started publishing the MQL in March 2020 and has since updated it almost every week with the latest results and data relevant to weathering the pandemic. The list of what we do not know about the virus is still long, but thanks to the dedication of numerous researchers, such as those at S&T's National Biodefense Analysis and Countermeasures Center (NBACC), [many important questions have been answered](#), including the following:



How does it spread from one host to another? How easily is it spread?

COVID-19 is highly contagious, and you can catch it simply by inhaling the virus. Most symptomatic cases are mild, but severe disease can be found in any age group (though it increases with age and certain underlying medical conditions).



How long after infection do symptoms appear? Are people infectious during this time?

On average, symptoms develop five days after exposure to the virus, and people are most infectious before they start showing symptoms. Pre-symptomatic transmission causes most (51-75.9%) infections. Also, asymptomatic people can transmit the disease as soon as two days after they become infected.



Can individuals become re-infected after recovery?

Studies show that re-infection is possible, but not common.

INTERACTIVE SARS-COV-2 SURVIVABILITY CALCULATORS

Researchers at S&T's NBACC began their environmental studies in March 2020 to fill knowledge gaps identified in the MQL. They focused on testing how resistant the virus is to sunlight, heat, and humidity in droplets on surfaces and in airborne particles. Studies showed that increased temperature and relative humidity cause a minimal increase in SARS-CoV-2 decay, but the addition of simulated sunlight causes rapid decay of the virus. These data have been used to develop predictive models to estimate virus decay both [on surfaces](#) and [in the air](#) under a limited range of environmental conditions. Interactive calculators for these estimates are available online.



CANINE DETECTION SUPPORT

S&T's [Canine Detection Program](#) is exploring whether working canines can be properly trained on targeted odor from SARS-CoV-2 infection and deployed to screen and detect infected people in large crowds and open venues. The team is conducting laboratory exposure of lung cell samples to SARS-CoV-2 and identifying the unique chemical profiles and associated biomarkers to help detect infected people in a real-world environment. Study results will be used to generate a library of infection signatures. This work has the potential to inform the development of canine training aids along with other detection approaches for identifying infectious disease in asymptomatic humans.

DECONTAMINATION BEST PRACTICES GUIDANCE

A series of one-pagers were released to enhance the ability of the DHS workforce to protect themselves from COVID-19 infection. Some helpful tips included:



Dilute hypochlorite-based household bleach to approximately 2% and allow at least one minute of contact time when cleaning equipment and surfaces



Wash hands with soap and water for at least 20 seconds and avoid touching your face, eyes, or respirator



Use a hand sanitizer with at least 60% ethanol or 70% isopropanol when soap and water are not available

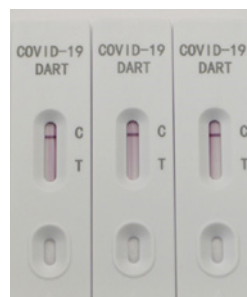
SUPPLY CHAIN RESILIENCE

Supply chains are expansive, complex, and composed of various interdependencies that can affect our critical infrastructure, public health, and economy. The COVID-19 pandemic has disrupted supply chains worldwide and revealed vulnerabilities on a massive scale. S&T's [Centers of Excellence](#) designed and executed a series of workshops to identify tools and technologies that can help address current pandemic challenges, discuss key lessons learned that will better prepare our supply chains for future disasters, and pinpoint areas for future research investments. This public-private initiative featured 35 experts from industry, academia, and government seeking to treat public health preparedness, including supply chains, as a national security issue.

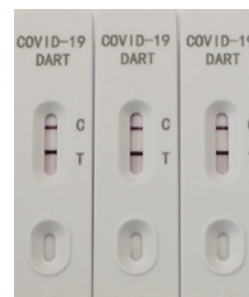
RAPID DIAGNOSTIC TEST KIT



S&T's NBACC evaluated a rapid COVID-19 test kit and provided data to the manufacturer for a request for Emergency Use Authorization to the Food and Drug Administration (FDA). The NBACC evaluation was made possible by S&T's [Office of Industry Partnerships](#) which drafted, conducted, and approved legal and compliance reviews to deliver a Cooperative Research and Development Agreement within 24 hours and ensure the FDA had trusted data for informed decision-making.



Three replicates
Sample contains:
Staphylococcus aureus
only



Three replicates
Sample contains:
Staphylococcus aureus
and SARS-CoV-2 Fr/
IDF0372



STUDIES TO STOP THE SPREAD

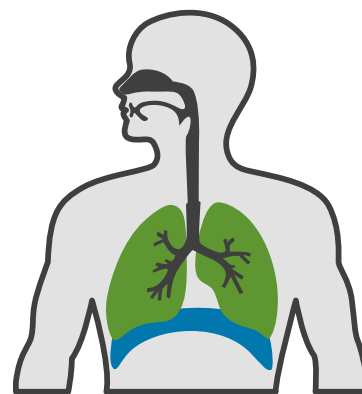
Better understanding the infectious dose, or how much virus exposure it takes to cause COVID-19 infection, is one key element to locking down the proliferation of this disease. Countless other variables are at play when it comes to how the virus travels from one host to another, and S&T scientists are finding creative ways to identify and prevent viral spread through various mechanisms.

INFECTIOUS DOSE FOR SARS-COV-2 IN AEROSOLS

Researchers at S&T's NBACC have continuously worked to address one of the most pivotal questions surrounding the COVID-19 pandemic: how much virus is needed to cause an infection? Data on the amount of virus required to cause an infection and the amount of virus that is shed from the respiratory tract of infected people have not been fully evaluated, and it is vitally necessary to inform disease transmission modeling and assess the risk associated with various transmission scenarios. At NBACC, the amount of SARS-CoV-2 required to cause an infection was estimated in a nonhuman primate (inhalation exposure) and small animal-hamster (inhalation and mucosal exposure) model of COVID-19. The amount of infectious virus and size of particles exhaled were assessed. For the hamster model, final data analysis of results is underway and nearing completion. For nonhuman primates, final exposure of small particle aerosols has been completed and data analysis is underway. Results from these efforts will provide the critical information necessary to address key knowledge gaps on how many virus particles of SARS-CoV-2 are needed to trigger an infection.

HUMAN SHEDDING OF SARS-COV-2 AFFECTING TRANSMISSION

Over the last year, we have improved our understanding about how much virus is being shed into the environment by infected people or by activities of those working with infected people. S&T and other researchers have worked to estimate the size of the virus-containing particles that are exhaled while people breathe or speak. S&T researchers and collaborators sought to assess SARS-CoV-2 re-aerosolization of virus shed onto surfaces and in the air from infected people and during respiratory personal protective equipment (PPE) donning and doffing, as well as to examine viral contamination on PPE (N95 masks, gloves, and face-shields) worn during interactions with people who tested positive for COVID-19 infection. Results will provide insights into the hazard frontline personnel face when interacting with infected people and will inform PPE use procedures as well as decontamination strategies following a potential environmental contamination from people.



WASTEWATER-BASED EPIDEMIOLOGY

S&T lent critical expertise to a multiagency wastewater-based epidemiology (WBE) initiative that will not only gather virus data from sewer systems but also standardize the science used to analyze the findings.

The U.S. Centers for Disease Control and Prevention (CDC)'s National Wastewater Surveillance System leads this coalition with the goal of turning sewers into health monitors and, in the case of COVID-19, better understanding the spread of the virus in communities to contain and defeat it.

S&T is working with the National Institute of Standards and Technology (NIST) and the University of Louisville School of Medicine to develop guidelines to standardize WBE testing methods nationwide. Because there are many ways to test wastewater, data gathered from across the country could be difficult to compare; using the new standards, the data can be shared more readily and compared across cities, states, and regions to inform more effective healthcare decisions. For example, having reliable WBE data on where outbreaks are occurring and how severe they are can inform critical decisions about prioritizing PPE, immunizations, and customizing countermeasures.

In May 2020, S&T started working with the University of Louisville on the standards project, focusing on sampling and testing methods tied to defined epidemiological frameworks. These standards will not only help with this pandemic but also with future public health threats and ongoing population health risks.

The Louisville researchers use 24-hour timed autosamplers installed in manholes and send them to multiple labs for analysis to see how much SARS-CoV-2 RNA is in the samples. The researchers then compare the data with the findings of randomly sampled COVID-19 tests from residents done every eight weeks across the city. A single sample could provide insight into the infection prevalence of a whole community, making this testing quite cost effective.

“New kinds of commercial laboratory and data analytics companies can develop a panel of pathogens, toxins, and health status biomarkers that we regularly check to assess a population, and we could potentially identify a problem much earlier and then make a much bigger difference in its trajectory.”

Dr. Ted Smith

University of Louisville professor of environmental medicine



STUDIES OF NEW VARIANTS

Researchers at S&T's NBACC are leveraging previously completed work to assess the infectivity of an earlier variant of SARS-CoV-2 and provide additional data to address knowledge gaps related to the inhalational infectious dose of SARS-CoV-2 – specifically, the variability in infectious dose and disease presentation between different variants. Anticipated results should inform modeling and assessments of the hazard associated with aerosol transmission of SARS-CoV-2.



ASSESSMENT OF HVAC SYSTEMS' EFFECT ON SPREAD

S&T's Probabilistic Analysis for National Threats Hazards and Risks (PANTHR) program received a request from senior advisors to DHS leaders regarding the effect heating, ventilation, and air conditioning (HVAC) units were having on the spread of COVID-19 in the hottest regions of the United States. There was a desire for clarity on the conflicting evidence of the impact of HVAC systems on the dispersion of SARS-CoV-2 in indoor spaces. This modeling effort aimed to identify the potential risk of infection associated with HVAC systems and to estimate the impact of modifying or tuning HVAC systems to reduce the risk of SARS-CoV-2 transmission in indoor spaces. Except in the modeled scenarios featuring the lowest fraction of outside air, poor efficiency filters or air circulation frequency, HVAC was found to be either a neutral or beneficial factor in reducing the estimated transmission of SARS-CoV-2. Results from this study were assembled into a manuscript that has cleared for public release; it is currently awaiting peer review before publication.

ASSESSMENT OF INFECTIOUS DOSE MODELING

S&T's PANTHR program explored the possibility of using modeling to discover the infectious dose for SARS-CoV-2 by back-calculating and using methods of estimation. Researchers are also eager to understand the amount of virus aerosolized by people during routine behaviors, the range of the aerosolization, and the various effectiveness of mitigation measures, such as masks and barrier screens. This study provided an initial estimate of the infectious dose of SARS-CoV-2 based upon the presently available information about the virus and augmented by understanding of the infectious dose of viruses similar to SARS-CoV-2. Results from this study were assembled into a manuscript that has cleared for public release; it is currently awaiting peer review before publication.

STUDIES OF SARS-COV-2 IN VEHICLES



Studies of viruses similar to SARS-CoV-2 have shown inactivation after a few hours of exposure to 104°F heat. The interior temperature of a parked vehicle will vary depending on factors such as the time of year and exposure to sunlight, but vehicle interiors can exceed 104°F even when parked in the shade during a 70°F day. This “ambient disinfection” method offers a simple and elegant solution for transportation decontamination.



TRAVEL AND TRANSIT SECURITY

Public transportation poses a myriad of challenges: large crowds, tight spaces, and enormous economic implications – not to mention the special role of public confidence and trust. Even when the world “shut down” in 2020, some travel was (and still is) simply unavoidable. Assessing and mitigating risk to the greatest extent possible is a noble goal, and it is one S&T is continually striving for on our roads, railways, on the seas, and in the skies.

MODELING OF VIRAL SPREAD ON AIRCRAFT

S&T's [Chemical Security Analysis Center \(CSAC\)](#) conducted assessments of viral spread on aircraft to examine potential mitigations to airborne transmission of viruses on airplanes. Ongoing S&T research was used to characterize the viral emission and particle size distribution from common activities such as breathing, talking, and coughing. The number of inhaled particles in various zones of an airplane were calculated using previously developed and validated computer models for narrow and wide body airframes.

The bulk of the analysis was focused on a narrow body plane, which compose 99% of U.S. domestic flights. The aircraft was subdivided into various zones, including the flight deck and cargo hold. Estimates of surface contamination were calculated based on the initial bounding assumptions of particle size and distribution from breathing, talking, and coughing. The reduction in particles based on filtration, mask wearing, and fraction of fresh air in an aircraft were calculated, and the viral output from talking and breathing were varied to reflect the large uncertainty in these values. In addition, the impact of a short walk of an infected passenger from their seat to the lavatory was considered.

Results showed that high-efficiency particulate air (HEPA) filtration is effective at reducing airborne particles in aircraft cabins (45-100% reduction), especially outside of the particle release zone. HEPA filters also reduced surface contamination, although to a lesser degree. Masks were also shown to be very effective, reducing contamination from the source passenger and providing protective benefits to others within the cabin. There was an 80-94% reduction in inhaled particles if all passengers wore cloth masks. This percentage increased to +99% when all passengers wore N95 or KN95 masks. There is a wide range of reported mask efficiencies; therefore, the magnitude of the impact could vary. In addition, gaps in masks decreased overall effectiveness. Preliminary results indicate that varying the fresh air to recirculated air was not a universally effective mitigation strategy. A comparison with experimental field trial data is underway to better understand this phenomenon.

S&T will continue to study viral spread on aircraft. Next steps include analyzing the effects of multiple, simultaneous sources within a single aircraft, as well as updating the results based on ongoing experimental work characterizing the SARS-CoV-2 virus.

SUPPORT TO NEW YORK CITY MASS TRANSIT AUTHORITY

S&T has partnered with the Metropolitan Transportation Authority (MTA) in New York City to study how simulated coronavirus aerosols travel through buses and train cars to inform disinfection and other virus mitigation methods.

S&T is collaborating with the city's transportation, health, and public safety agencies, as well as federal counterparts, to simulate real-world threat environments and hazards as part of a whole-of-government approach to preparedness and resiliency. The effort is part of S&T's Urban Security Initiative (USI) to ensure the security of U.S. public transit systems from hazards – be they natural, accidental, or intentional in nature.

As part of a [viral phenomenology study](#), S&T released a benign airborne coronavirus simulant into out-of-service MTA buses as well as subway and commuter railroad train cars to see how a virus travels when somebody breathes, coughs, or sneezes. The non-toxic, inert particle tracers were released in a controlled fashion to evaluate practical methods to reduce and mitigate airborne concentrations of aerosols. Buses and cars were cleaned at the conclusion of the study. Outcomes from the USI can be used to inform New York City and other U.S. cities' emergency response planning, including high-quality detection technology for subways, other urban environments, and modeling tools.

“The value of this important work with the S&T USI cannot be overstated. Almost immediately they approached us to help in practical ways with the pandemic, fast-tracking projects that can have an immediate impact and influence procedure and policy to keep people safe.”

Michael Gemelli
Environmental Detection &
Emergency Response Initiatives
Manager for New York City MTA



BIOMETRICS AND FACE MASKS

Due to the COVID-19 pandemic, DHS priorities for the 2020 Biometric Technology Rally focused on evaluating the ability of systems to reliably collect or match images of people wearing face masks. The intent is to improve the ability to recognize people without requiring travelers to remove personal protective equipment, reducing risk for both the public and frontline personnel.

Both biometric image capture systems (“acquisition systems”) and biometric matching algorithms (“matching systems”) were tested. Acquisition systems designed to take under eight seconds per transaction were evaluated on efficiency, effectiveness (capture and matching capability), and user satisfaction. Matching systems were evaluated based on their ability to reliably match images from each acquisition system. Face recognition performance was assessed on a sample of 582 diverse people under two independent conditions: when individuals were asked to remove their personal face masks before using each system and when individuals were asked to keep their personal face masks on. The 2020 Rally included six acquisition systems and 13 matching systems. Data collection and analysis occurred at the Maryland Test Facility, a DHS-affiliated biometrics testing laboratory, in September and October 2020.



DISINFECTANT STUDY OF SARS-COV-2 ON SECURITY SCREENING BINS

The pandemic necessitated that the Transportation Security Administration (TSA) update its current concept of operations (CONOPS) to prevent the spread of SARS-CoV-2 without compromising operational effectiveness. S&T researchers evaluated the effectiveness of six disinfectants for their ability to inactivate SARS-CoV-2 in artificial saliva droplets that had been deposited onto surfaces (stainless steel disks or coupons generated from passenger screening bins). The specific products tested were selected because TSA had previously identified them as being compatible with Explosive Trace Detectors (ETDs) used at airport screening check points, thus enabling operators to maintain mission essential functions. No pre-cleaning or wiping following contamination of the surfaces was performed during these tests, and this methodology was able to model a high tempo operational scenario where disinfectant is simply applied onto a potentially contaminated surface without further cleaning. Data on disinfectant efficacy generated by this study can be used to inform TSA CONOPS regarding the selection and use of ETD-compatible disinfectants at TSA checkpoint locations and provide additional confidence in the ability of these disinfectants to reduce SARS-CoV-2 contamination on surfaces.





INDUSTRY PARTNERSHIPS

S&T regularly seeks out promising small businesses, innovative prototypes, and commercialization strategies to bring new capabilities to the nation. Various mechanisms are in place to mobilize the startup community and to help technical needs find viable solutions, but the worldwide crisis of COVID-19 made these efforts all the more vital. And when the call was put out for scientific solutions, industry answered.

BUSINESS RESILIENCE CALCULATOR

The Critical Infrastructure Resilience Institute (CIRI), an S&T Center of Excellence led by the University of Illinois, Urbana-Champaign, held a five-part webinar series focusing on important issues for the COVID-19 era such as cybersecurity and critical infrastructure resilience. Focused on business continuity, the inaugural webinar presented the CIRI-developed Business Resilience Calculator (BRC), a software tool that measures and evaluates the resilience of a business after a disruption such as a natural disaster, infrastructure collapse, or terrorist attack. The BRC enables businesses to precisely measure resilience by assessing the potential economic impact of damage to critical infrastructure. It was created with individual businesses in mind, as well as public and non-profit sector agencies providing support and assistance in building disaster resilience in the business community.

TRACKING SYSTEM FOR COVID-RELATED INQUIRIES

S&T's Office of Industry Partnerships (OIP) received more than 250 domestic and international inquiries concerning COVID-19 technologies and capabilities from across S&T, DHS components, and other federal agencies. Along with the Technology Scouting Program, OIP developed a complex prioritized tracking system for inquiries and prepared a defined tool that stores valuable information from industry on COVID-19 technologies and capabilities. Throughout 2020, this tracker was triaged daily and dispositions were inserted hourly. The input included a wide range of topics (e.g., standoff temperature detection, disinfectant and sanitizer solutions, COVID-19 diagnostic test kits, wastewater testing, face masks and shields, ventilators and respirators, rapid screening, and pandemic surveillance) that were filtered to the correct S&T leaders for review. OIP determined the vast scope of requirements and thoroughly reviewed each inquiry to determine next steps, ensuring every email received an official response. OIP continues to maintain this database of proposals and responses.



TECH SCOUTING

Tech Scouting is a process of identifying, tracking, and evaluating existing or developing technologies, products, services, and emerging trends. S&T leverages these existing capabilities to increase partnership opportunities and resources, enabling faster development of current or future homeland security solutions. The [Tech Scouting Office](#) identified more than 500 solutions relevant to the COVID-19 response for S&T program offices, DHS components, and senior leaders. Recent areas of interest include contact tracing, monitoring and screening, thermal imaging, travel assessment, and wastewater testing. These reports played an invaluable role in ensuring DHS had the broadest awareness of technologies available to safeguard American lives and informed real-time purchase and research and development decisions for DHS components and first responders.

150 + APPLICATIONS FOR SVIP COVID-19 TOPIC CALL

250 + INQUIRIES FIELD BY OFFICE OF INDUSTRY PARTNERSHIPS

500 + POSSIBLE SOLUTIONS IDENTIFIED BY TECH SCOUTING

SILICON VALLEY INNOVATION PROGRAM

S&T's [Silicon Valley Innovation Program \(SVIP\)](#) saw record participation at its Virtual Industry Day in 2020 and the COVID-19 topic call addressing various areas such as self-screening solutions and disinfectants received more than 150 applications from around the world.

S&T awarded \$198,600 to AppCensus, a start-up based in El Cerrito, California, to [develop testing and validation services for digital contact tracing applications](#). The phase 1 award was made under the SVIP [Emerging Needs: COVID-19 Response & Future Mitigation solicitation](#), which addressed multiple near-term use cases in response to the pandemic and prepared DHS for future mitigation efforts. AppCensus is the first of six start-ups to receive a phase 1 award.

As the COVID-19 pandemic hit the United States, private industry and the tech sector developed smartphone-based solutions to automate the manual contact tracing process; DHS wants to ensure privacy and civil liberties are protected when using them. In this SVIP solicitation, DHS sought potential solutions to enable a robust application testing ecosystem to ensure digital contact tracing apps are used as intended, while also protecting sensitive and personal information. AppCensus has a platform for analyzing the runtime behaviors of mobile apps and assessing their security and privacy risks at scale. The phase 1 project will adapt this platform to develop an on-demand, automated mobile-app testing system to enhance the security and privacy testing of publicly available android and iOS digital contact tracing apps.





INTERGOVERNMENTAL ENGAGEMENT

Day in and day out, S&T facilitates mission success for not only DHS components, but also other federal agencies; state, local, and tribal governments; and even other nations. We partner up on emergency exercises, operational assessments, design and development, and much more. Doing the science and having our stakeholders' back is just what we do. So, when national security colleagues seek out our expertise, we are happy when we can help.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) SUPPORT

The FEMA Office of Counterterrorism and Security Preparedness requested assistance from the S&T PANTHR program for an important preparedness issue related to COVID-19 response. FEMA needed information regarding estimates for the number of people likely to become infected with SARS-CoV-2 and the timing of the peak number of infections in FEMA Region VI. The goal was to understand the potential demand for hospital care and the potential impact that an intentional chemical or biological attack affecting the capacity of the healthcare system could have on consequence estimates.

BIOMEDICAL ADVANCED RESEARCH AND DEVELOPMENT AUTHORITY SUPPORT

The U.S. Department of Health and Human Services (HHS) Biomedical Advanced Research and Development Authority (BARDA) provided a portal as a single point of entry for the submission of market research packages and meeting requests from interested stakeholders. HHS sought information about available medical countermeasures in development. The department was particularly interested in products and technologies that have progressed into or beyond clinical trials, have established large-scale manufacturing capability, or use an approved platform. Information regarding diagnostics, therapeutics, vaccines, and other products or technologies relevant to addressing the COVID-19 outbreak were sought. S&T attended BARDA CoronaWatch meetings and provided input to vendors interested in developing solutions to address the pandemic.

INTERNATIONAL COLLABORATION



S&T has held bilateral leadership meetings with partners from the Five Nation Research and Development Council (5RD), which includes Australia, Canada, New Zealand, and the United Kingdom, as well as counterparts in Sweden and Israel to share knowledge and identify complementary research activities. Of particular note is the exchange of SARS-CoV-2 isolates between S&T's National Biodefense Analysis and Countermeasures Center (NBACC) and the UK Defence Science and Technology Laboratory (DSTL).



TEMPERATURE SCREENING GUIDANCE FOR RETURN TO WORKPLACE

As the federal government implements a phased approach to bringing teleworking and displaced employees back to the workplace, long-term enhanced entry screening was identified as a critical step to ensuring safety. Agencies must consider what facility screening services (to perform temperature checks, for example) to purchase out of the many products that have flooded the market.

S&T assembled a small team to provide guidance and inform DHS components on return-to-the-workplace solutions among the myriad of market-available technologies to mitigate operational risk. Urgency was critical. S&T served as the point of contact to the Office of the Chief Security Officers for information on screening technologies, publishing tech scouting reports for market offerings of both febrile (e.g., “fever camera”) and non-febrile (e.g., breathalyzer) FDA-approved, cleared, or authorized solutions. One result of this support was the adoption of a kiosk solution first fielded by the DHS St. Elizabeth Campus, now in use at S&T offices in downtown Washington, D.C.



SYSTEM OF SYSTEMS OPERATIONAL ANALYTICS DASHBOARDS

S&T’s System of Systems Operational Analytics team developed a conceptual model of COVID-19 virus spread in the United States and border countries, enabling information sharing among DHS headquarters and DHS components and providing quick-turn visualizations of COVID-19 data points. Dashboards reduced time that analysts spent manually updating spreadsheets and reports. Enhanced analytics improved situational awareness, collaboration, and briefing capabilities across offices and stakeholders. Efficiencies realized from cross-functional collaboration and improved data visualization allowed DHS to respond to COVID-19 issues rapidly, with minimal impacts to analysts’ steady workload. Additionally, geospatial visualization of the complex and time-variant COVID-19 case counts along the border allowed for rapid identification of anomalous cases with regards to county population and facilitated focused discussion of whether they might be related to cross-border traffic.

U.S. COAST GUARD ACADEMY VENTILATOR AND FACE MASK PROTOTYPE PATENTS

S&T's intellectual property attorneys worked with inventors from the U.S. Coast Guard Academy (USCGA) to draft and submit patent applications for two important technologies that have the potential to save many lives.

USCGA engineering staff, all of whom have extensive industry experience, realized a shortage of ventilators was likely imminent due to increased demand from the COVID-19 pandemic. They decided to try their hands at creating an original design that would be both simple and affordable. After multiple iterations, they came up with a final prototype that supplies a precise quantity of air for breathing at a precise pressure, based on the relative heights of water that surround and fill a set of cylinders. The device uses all commercial-off-the-shelf parts.

As the ventilator project was underway, a parallel effort unfolded to address shortages of personal protective equipment for first responders on the front lines. USCGA faculty decided to help a local physician who was 3D-printing face masks test his designs for effectiveness. They built a vacuum-powered testing apparatus to determine how many airborne particles flowed through the mask. One of the hundreds of 3D-printed mask designs that they tested was shown to filter out 90% of particles. (A commercial N95 mask filters out 95%.)

Patents for both the 3D-printed face mask and the water bellows ventilator were filed under expedited examination to speed up the process, which can normally take years. As the patent process is underway, the S&T Technology Transfer and Commercialization Branch is also evaluating the commercial opportunities for these technologies and exploring how DHS can effectively move these products to market for the widest possible public benefit.

“ We're always innovating, always creating things, and that's why we have this history with S&T. ”

Dr. Ronald Adrezin
USCGA mechanical engineering professor



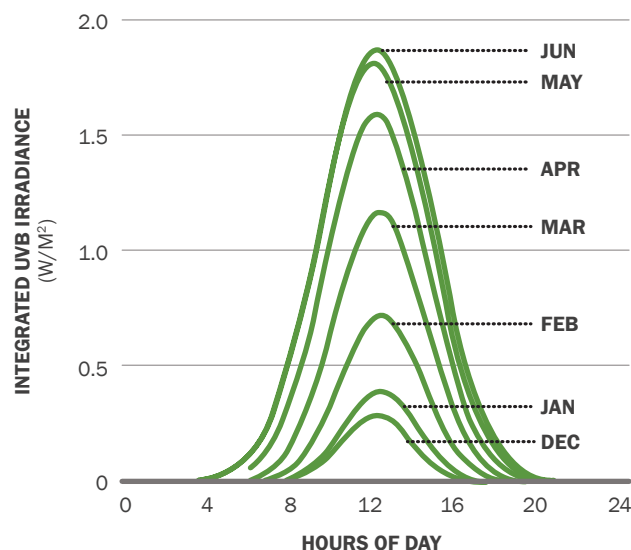
SCIENTIFIC JOURNAL PUBLICATIONS

The importance of information-sharing cannot be overstated. Knowledge of parallel efforts boosts efficiency and, in the case of COVID-19 response, potentially saves lives. Peer-reviewed and published research findings like the following ones from S&T helped guide biotechnologists seeking a viable vaccine, informed epidemiologists about current models and simulations tracking transmission, and gave peace of mind to millions of concerned citizens unsure of what practical measures they should take to protect themselves.

Simulated Sunlight Rapidly Inactivates Sars-Cov-2 On Surfaces

The Journal of Infectious Diseases | Volume 222, Issue 2, 15 July 2020, Pages 214–222

“...simulated sunlight rapidly inactivated SARS-CoV-2 suspended in either simulated saliva or culture media and dried on stainless steel coupons. Ninety percent of infectious virus was inactivated every 6.8 minutes in simulated saliva and every 14.3 minutes in culture media when exposed to simulated sunlight representative of the summer solstice at 40°N latitude at sea level on a clear day. Significant inactivation also occurred, albeit at a slower rate, under lower simulated sunlight levels. The present study provides the first evidence that sunlight may rapidly inactivate SARS-CoV-2 on surfaces, suggesting that persistence, and subsequently exposure risk, may vary significantly between indoor and outdoor environments...”



Airborne SARS-CoV-2 is Rapidly Inactivated by Simulated Sunlight

The Journal of Infectious Diseases | Volume 222, Issue 4, 15 August 2020, Pages 564–571

“...Simulated sunlight and matrix significantly affected decay rate of the virus. Relative humidity alone did not affect the decay rate; however, minor interactions between relative humidity and other factors were observed. Mean decay rates (\pm SD) in simulated saliva, under simulated sunlight levels representative of late winter/early fall and summer were $0.121 \pm 0.017 \text{ min}^{-1}$ (90% loss, 19 minutes) and $0.306 \pm 0.097 \text{ min}^{-1}$ (90% loss, 8 minutes), respectively. Mean decay rate without simulated sunlight across all relative humidity levels was $0.008 \pm 0.011 \text{ min}^{-1}$ (90% loss, 286 minutes). These results suggest that the potential for aerosol transmission of SARS-CoV-2 may be dependent on environmental conditions, particularly sunlight...”

Increasing Temperature and Relative Humidity Accelerates Inactivation of SARS-CoV-2 on Surfaces

American Society for Microbiology Journal *mSphere* | Volume 5, Issue 4, 1 July 2020, e00441-20

“...SARS-CoV-2 decayed more rapidly when either humidity or temperature was increased but that droplet volume (1 to 50 μ l) and surface type (stainless steel, plastic, or nitrile glove) did not significantly impact decay rate. At room temperature (24°C), virus half-life ranged from 6.3 to 18.6 h depending on the relative humidity but was reduced to 1.0 to 8.9 h when the temperature was increased to 35°C. These findings suggest that a potential for fomite transmission may persist for hours to days in indoor environments and have implications for assessment of the risk posed by surface contamination in indoor environments.”

The Influence of Temperature, Humidity, and Simulated Sunlight on the Infectivity of SARS-CoV-2 in Aerosols

Aerosol Science and Technology | Volume 55, Issue 2, 2 November 2020, Pages 142-153

“...temperature, simulated sunlight, and humidity are all significant factors influencing the persistence of infectious SARS-CoV-2 in aerosols, but that simulated sunlight and temperature have a greater influence on decay than humidity across the range of conditions tested. The time needed for a 90% decrease in infectious virus ranged from 4.8 min at 40°C, 20% relative humidity, and high intensity simulated sunlight representative of noon on a clear day on the summer solstice at 40°N latitude, to greater than two hours under conditions representative of those expected indoors or at night...”

Decontamination of SARS-CoV-2 Contaminated N95 Filtering Facepiece Respirators (FFRs) with Moist Heat Generated by a Multicooker

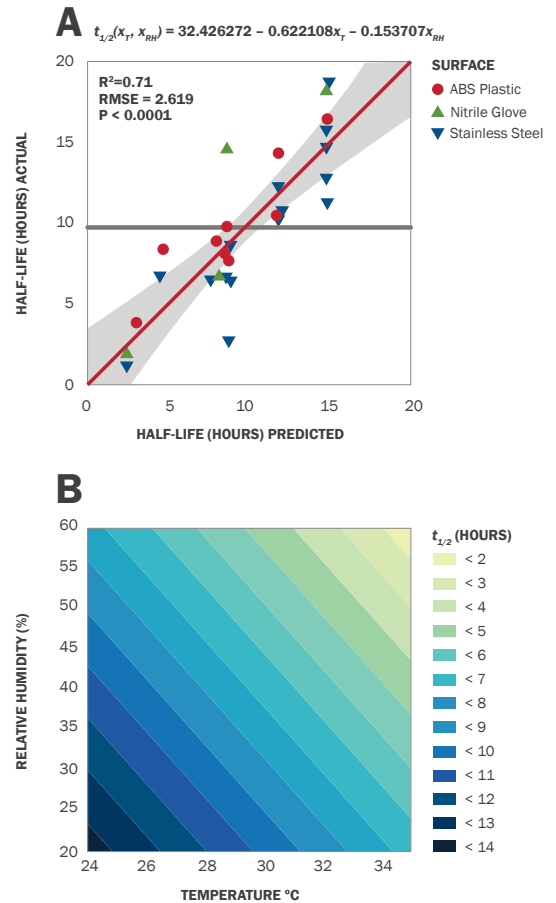
Society for Applied Microbiology's *Letters in Applied Microbiology* | Volume 72, Issue 4, 21 December 2020, Pages 366-374)

“...Four of five multicooker models examined met the acceptance criteria for the test and one model was selected for inactivation testing. Tests were performed on four different FFR models with SARS-CoV-2 suspended in culture media, simulated saliva, or simulated lung fluid. Moist heat treatment reduced recoverable titers of SARS-CoV-2 virus to levels below the limit of detection in all tests. Furthermore, these four FFR models showed no loss in collection efficiency, inhalation resistance, or visual damage after up to 10 decontamination cycles...”

SARS-CoV-2 is Rapidly Inactivated at High Temperature

Environmental Chemistry Letters | 3 February 2021, DOI: 10.1007/s10311-021-01187-x

“...we investigated the environmental stability of SARS-CoV-2 in a clinically relevant matrix dried onto stainless steel at a high temperature. The results show that at 54.5°C, the virus half-life was 10.8 \pm 3.0 min and the time for a 90% decrease in infectivity was 35.4 \pm 9.0 min. These findings suggest that in instances where the environment can reach temperatures of at least 54.5°C, such as in vehicle interior cabins when parked in warmer ambient air, that the potential for exposure to infectious virus on surfaces could be decreased substantially in under an hour.”





LOOKING AHEAD

Going through the horrific trials and tribulations of a natural disaster, terrorist attack, or even a global pandemic has a dimly shining but very real silver lining. It makes us better prepared for the (inevitable) next time. It builds resilience. COVID-19 is still threatening the health and wellbeing of our loved ones and our very way of life, but it has taught S&T important lessons on what it takes to make it through a large scale, prolonged public health emergency. We can use that knowledge to be ready for whatever the future holds.

■ AFRICAN SWINE FEVER MASTER QUESTION LIST

Just like the COVID-19 Master Question List (MQL), which consolidates the most relevant research findings related to SARS-CoV-2, an MQL has been launched for African Swine Fever (ASF) to organize our collective knowledge and help facilitate a coordinated response effort.

A mass outbreak of ASF in our nation's domestic swine population—and any outbreak of ASF has the potential to become widespread due to its high transmissibility—could land a powerful blow to the U.S. economy. Our nation is the largest pork exporter in the world. More than 115 million U.S. hogs go to market each year with a value of \$24 billion. An ASF outbreak wouldn't just mean lost revenue from sales, though. It threatens livestock as well as livelihoods. Controlling the spread of ASF in the United States would cost additional billions of dollars to control the spread and could hobble our agricultural infrastructure.

Although ASF originated in Africa, the virus has wiped out 40% of China's swine population since the current outbreak began in 2018. The United States has been spared so far, but with the disease expanding to more than 50 countries, it may be a matter of time before it reaches our shores and infiltrates our livestock. That's why S&T is being proactive and meeting this emerging threat now.

S&T's [Plum Island Animal Disease Center \(PIADC\)](#) and the U.S. Department of Agriculture (USDA) formed an ASF Task Force for better interagency coordination of research and diagnostics. Together, PIADC and USDA are working closely with other federal agencies, industry, academia, and domestic and international partners to study the ASF virus. Researchers seek to understand prevention, transmission, impacts, and potential countermeasures. The ASF MQL is an important aspect of the task force's goal to ensure effective collaboration as it will help track what we know and focus in on the knowledge gaps that remain. [The ASF MQL is available on our website now.](#) It will be regularly updated as new information becomes available.



NATIONAL ATOMIC TESTING MUSEUM EXHIBIT

The National Atomic Testing Museum (NATM) is a Smithsonian-affiliated national science, history, and educational institution in Las Vegas, Nevada that tells the story of America’s nuclear weapons testing program. Exhibits cover decades of scientific and technological advancements. The museum showcases the importance of innovation to our national security, which makes S&T’s COVID-19 response efforts a natural fit. The NATM “[Battling the Invisible Enemy](#)” exhibit is an interactive display, which opened in January 2021, and features S&T’s contributions to the nation’s pandemic response, as well as ongoing COVID-19 research conducted by the National Biodefense Analysis and Countermeasures Center (NBACC).

NBACC senior research scientist Dr. Paul Dabisch took part in the NATM Distinguished Lecture Series with a special virtual presentation on October 29, 2020. The free event explained how S&T’s laboratory research is informing the broader U.S. response community and helping keep front line and essential workers safe. Dr. Dabisch’s talk is available in the museum exhibit and can also be viewed online: [Distinguished Lecture with Dr. Paul Dabisch, National Biodefense Analysis and Countermeasures Center - YouTube](#)

ONLINE RESOURCES FOR FIRST RESPONDERS AND OTHER PARTNERS

To assist first responders in conducting activities as safely and efficiently as possible, S&T is continuing to curate a list of [authoritative resources](#) to help inform and guide response plans. There are also brand-new knowledge products available online, including:

[**Disinfection and Reuse of Personal Protective Equipment Factsheet**](#)

[**Reference Guide for Operating in Environments where SARS-CoV-2 may be Present**](#)

[**Non-Medical Interventions: A Desk Reference to Help Planners Recover from COVID-19 and Prepare for Future Outbreaks and Pandemics**](#)



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www.dhs.gov/science-and-technology/st-support-covid-19-response