SARS-CoV-2 Indoor Environmental Stability Predictive Model

Homeland Security
Science and Technology

PREDICTING NATURAL DECAY OF THE SARS-COV-2

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) has leveraged laboratory findings to develop a predictive model to estimate natural decay of SARS-CoV-2 (virus that causes COVID-19) under a range of temperatures and relative humidity (RH). The model can be integrated into an Excel spreadsheet or web-based application to estimate the environmental persistence of the SARS-CoV-2 virus under certain combinations of temperatures and RH and is available at https://www.dhs.gov/science-and-technology/sars-calculator.

This model will be enhanced as DHS/S&T produces additional data for virus stability in different environments (e.g., droplets in the air vs. on a surface, expanded temperature and humidity ranges, different surfaces).

UNDERSTANDING TRANSMISSION TO CONTROL THE SPREAD

Preventing person-to-person spread of SARS-CoV-2 is one way to reduce the impact of COVID-19 in the absence of an effective treatment. Transmission occurs primarily through respiratory droplets produced by talking, coughing, and sneezing, though contact with contaminated surfaces and objects may also contribute.

S&T has studied the stability of SARS-CoV-2 in simulated saliva using droplets of varying size deposited on non-porous surfaces under a range of environmental conditions. Studies show SARS-CoV-2 can survive in saliva on surfaces for extended periods of time, depending on temperature, RH, and matrix (e.g., bodily fluids).

These data have been used to develop a predictive model to estimate virus decay under a limited range of environmental conditions: room temperature (70-95°F) and RH (20-60%). This model does not include the effects of conditions such as exposure to solar light.

Future iterations will expand temperature range and surface comparisons as well as evaluate the virus in respiratory fluid.

Additional considerations to better understand viral transmission include:

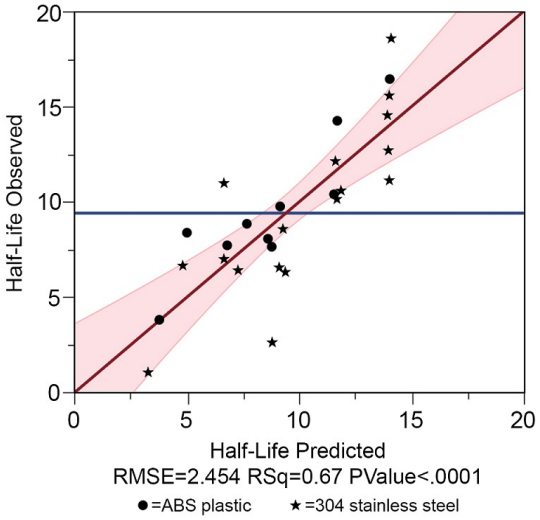
- Infectious dose (how much makes a person sick)
- Virus shedding (how much a sick person puts into the environment)
- Contact hazard (how much virus comes off from touching surfaces)

CURRENT DATA

S&T is evaluating the indoor stability of SARS-CoV-2 in saliva droplets under a range of environmental conditions on three surfaces:

- Stainless Steel
- ABS Plastic (phones, computer keyboards, computer mouse, etc.)
- Nitrile Rubber (e.g., disposable gloves)

The virus is most stable in saliva on stainless steel under cool, dry, indoor conditions (70-75°F, 20% RH, and no direct sunlight). Results indicate that there is no significant difference between stability on ABS plastic, stainless steel or nitrile.



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Based on the data collected to date, the National Biodefense Analysis and Countermeasures Center (NBACC) has developed a formula that can predict the decay of the virus in saliva on stainless steel and ABS plastic under certain environmental conditions.

USING THE PREDICTIVE FORMULA

RH and temperature can be used to provide an estimated half-life for SARS-CoV-2 with this model with some degree of certainty. The predictive power is limited to temperature between 70-95°F and RH between 20-60%. The formula below was developed in Celsius but has been modified in the spreadsheet calculator to use Fahrenheit.

Examples of Applying Surface Stability Model to Estimate SARS-CoV-2 Stability on Indoor Surfaces

Equation:

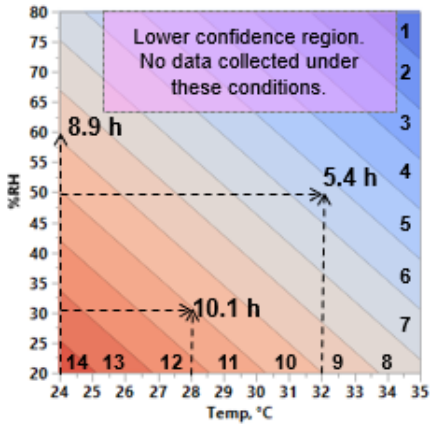
$$t_{1/2}(T,RH) = 29.98 - 0.58T - 0.12RH$$

Examples:

$t_{1/2}(28,30) = 29.98 - 0.58(28) - 0.12(30)$
$t_{1/2}(28,30) = 10.1$ hrs

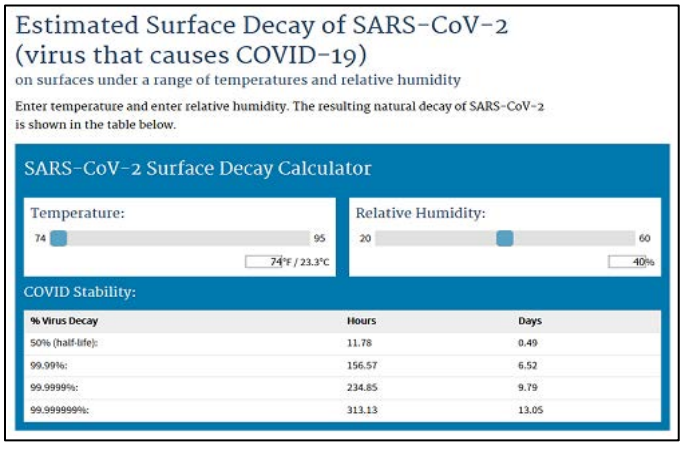
$t_{1/2}(24,60) = 29.98 - 0.58(24) - 0.12(60)$
$t_{1/2}(24,60) = 8.9$ hrs

$t_{1/2}(32,50) = 29.98 - 0.58(32) - 0.12(50)$
$t_{1/2}(32,50) = 5.4$ hrs



Contours are labeled with half-life estimates in hours.

S&T has integrated the model into an interactive webpage. The user inserts RH and temperature in °F.



NEXT STEPS

S&T is partnering with the DHS Countering Weapons of Mass Destruction (CWMD) Office to develop a tool that is easily accessible and could be used by Occupational Safety and Health (OSH) professionals to support risk assessment, cleaning, and disinfecting—in accordance with guidance provided by the Centers for Disease Control and Prevention and the Environmental Protection Agency, such as "Guidance for Cleaning and Disinfecting: Public Spaces, Workplaces, Businesses, Schools, and Homes" available online at: https://www.cdc.gov/coronavirus/2019-ncov/community/cleaning-disinfecting-decision-tool.html