Classification of SARS-CoV2

Order Nidovirales

Family Coronaviridae

Subfamily Coronavirusae Torovirinae

Genus

- Beta (Human CoV-229E, Human CoV-NL63)
- Delta (Coronavirus [SARS-CoV, SARS-CoV2, and many other SARS-Covs])
- Gamma (Torovirus, Betanivovirus, Okeovirus, Arterivirus, Alphacoronivovirus)

Enveloped positive-sense, single-stranded non-segmented RNA viruses with distinctive “nested set” transcription strategy
RaTG13, specimen from feces of *R. affinis* collected from a cave in 2013 in Yunnan China
RaTG13, specimen from feces of *R. affinis* collected from a cave in 2013 in Yunnan China
Spike Protein (SARS-CoV2)

Image from: https://amarolab.ucsd.edu/
COVID 19 Status 16 March 2020

- The rest of the world has now outpaced China in the number of confirmed cases of COVID19
  - China: 81,007
  - Rest of the world 83,760

This will continue until the rest of the world takes all the measures needed to flatten the curve
Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1

To the Editor:

A novel human coronavirus that is now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (formerly called HCoV-49) emerged in Wuhan, China, in late 2019 and is now causing a pandemic.² We analyzed the aerosol and surface stability of SARS-CoV-2 and compared it with SARS-CoV-1, the most closely related human coronavirus.²

We evaluated the stability of SARS-CoV-2 and SARS-CoV-1 in aerosols and on various surfaces and estimated their decay rates using a Bayesian regression model (see the Methods section in the Supplementary Appendix, available with the full text of this letter at NEJM.org). SARS-CoV-2 nCoV-WA1-2020 (MN985325.1) and SARS-CoV-1 Tor2 (AY274119.3) were the strains used. Aerosols (<5 µm) containing SARS-CoV-2 (10⁵-⁶ 50% tissue-culture infectious dose [TCID₅₀] per milliliter) or SARS-CoV-1 (10⁶-⁷ 5/0 TCID₅₀ per milliliter) were generated with the use of a three-jet Collison nebulizer and fed into a Goldberg drum to create an aerosolized environment. The inoculum resulted in cycle-threshold values between 20 and 22, similar to those observed in samples obtained from the upper and lower respiratory tract in humans.

Our data consisted of 10 experimental conditions involving two viruses (SARS-CoV-2 and SARS-CoV-1) in five environmental conditions (aerosols, plastic, stainless steel, copper, and cardboard). All experimental measurements are reported as means across three replicates.

SARS-CoV-2 remained viable in aerosols throughout the duration of our experiment (3 hours), with a reduction in infectious titer from 103.5 to 102.7 TCID₅₀ per liter of air. This reduction was similar to that observed with SARS-CoV-1, from 104.3 to 103.5 TCID₅₀ per milliliter (Figure 1A).

SARS-CoV-2 was more stable on plastic and stainless steel than on copper and cardboard, and viable virus was detected up to 72 hours after application to these surfaces (Figure 1A), although the virus titer was greatly reduced (from 103.7 to 100.5 TCID₅₀ per milliliter of medium after 72 hours on plastic and from 103.7 to 100.6 TCID₅₀ per milliliter after 48 hours on stainless steel). The stability kinetics of SARS-CoV-1 were similar (from 103.4 to 100.7 TCID₅₀ per milliliter after 72 hours on plastic and from 103.6 to 100.6 TCID₅₀ per milliliter after 48 hours on stainless steel). On copper, no viable SARS-CoV-2 was measured after 4 hours and no viable SARS-CoV-1 was measured after 8 hours. On cardboard, no viable SARS-CoV-2 was measured after 24 hours and no viable SARS-CoV-1 was measured after 8 hours (Figure 1A).
Stability of SARS-CoV2

Aerosols and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1

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This article is a preprint and has not been peer-reviewed [what does this mean?]. It reports new medical research that has yet to be evaluated and should not be used to guide clinical practice.

Abstract

A novel human coronavirus, now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, referred to as HCoV-19 here) that emerged in Wuhan, China in late 2019 is now causing a pandemic. Here, we analyze the aerosol and surface stability of HCoV-19 and compare it with SARS-CoV-1, the most closely related human coronavirus. We evaluated the stability of HCoV-19 and SARS-CoV-1 in aerosols and on different surfaces and estimated their decay rates using a Bayesian regression model.

HCoV-19 remained viable in aerosols throughout the duration of our experiment (3 hours) with a reduction in infectious titer from $10^{3.5}$ to $10^{2.7}$

These experiments are of “pure” virus (without stabilizers)

Sensitive to heat at 140 °F (60°C) for 30 minutes; Sensitive to 60 minutes of UV radiation
Inactivated by Household bleach (5 minutes), 70% ethanol (10 minutes), 100% ethanol (5 minutes), paraformaldehyde (2 minutes), Glutaraldehyde (2 minutes)
• Infectious Dose
• Lethal Dose

- \( ID_{10}, ID_{20}, ID_{50}, ID_{80}, ID_{100} \)
- \( LD_{10}, LD_{20}, LD_{50}, LD_{80}, LD_{100} \)

Current data for SARS-CoV1 indicates an \( ID_{50} \) of 100-150 viral plaque forming units. Current data about the ID for SARS-CoV2 is unknown, however it is clearly more infectious than SARS-CoV1 and thus the \( ID_{50} \) is likely to be at least 100 – 150 plaque forming units, or more likely LESS.
SARS-CoV2:

• Serial interval (time between successive cases) is 4 - 4.6 days
  – This is far shorter than the 7 day serial interval for SARS-CoV1

• Incubation period generally 2 -12.5 days (most 5.5 to 6.5 days)
  – (Exceptional cases at 1 day, or as long as 19 – 27 days)

This introduces two key contributors to the rapid spread:
1. Asymptomatic transmitters
2. Rapid case generations (which challenges standard contact tracing systems)

\[ R_0 = \]

**Duration of Infectious Period**
- Number of people or surfaces you come in contact with

**Opportunity (Contact Rate)**
- How close you get & how long you are near infected host, if infected host projects viral droplets on you, if you touch your face after touching a contaminated surface (or hand)

**Transmission Probability**
- Probability of infection spreading from one person to another

**Susceptibility Probability**
- How likely you are to be infected if exposed to the virus

**GOAL is to:**
- \( < 1 \) (outbreak will extinguish)

**Limit size of mass gatherings**
- Limit TIME near infectious persons
- Hand Hygiene
- Proper use PPE
- Room Hygiene (Decontamination)
- Negative Pressure rooms
- Animal-control methods

**Limit ability of SARS-CoV2 to cause new infections**
- Via Testing, Contact tracing & Isolation, Quarantine, Social Distancing, e.g. Elbow-bump, Burial Methods

**Immune enhancement methods:**
- Healthy Living (exercise, proper sleep, proper nutrition)
- Decrease stress, stop smoking, etc
- Treat co-morbidities
- Pre-exposure vaccine (not available)
Clinical Presentation and Clinical Course for COVID-19
USA COVID-19 Data

<table>
<thead>
<tr>
<th>COVID-19 symptoms</th>
<th>Children (&lt;18-years)</th>
<th>Adults (≥18-years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>56%</td>
<td>71%</td>
</tr>
<tr>
<td>Cough</td>
<td>54%</td>
<td>80%</td>
</tr>
<tr>
<td>Headache</td>
<td>28%</td>
<td>58%</td>
</tr>
<tr>
<td>Sore Throat</td>
<td>24%</td>
<td>35%</td>
</tr>
<tr>
<td>Muscle pain</td>
<td>23%</td>
<td>61%</td>
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<tr>
<td>Shortness of breath</td>
<td>13%</td>
<td>43%</td>
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<tr>
<td>Diarrhea</td>
<td>13%</td>
<td>31%</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>11%</td>
<td>16%</td>
</tr>
<tr>
<td>Runny nose</td>
<td>7.2%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>5.8%</td>
<td>12%</td>
</tr>
<tr>
<td>Fever, Cough, or shortness of breath</td>
<td>73%</td>
<td>93%</td>
</tr>
</tbody>
</table>

DOI: [http://dx.doi.org/10.15585/mmwr.mm6914e4external icon](http://dx.doi.org/10.15585/mmwr.mm6914e4external icon).
COVID19: Infection Prevention and Control Principles that can be applied to correctional Facilities

• Set up screening and triage
• Assure adequate PPE for staff and inmates
  – Surgical masks (not N95 facemasks) for inmates
  – Gloves and N95 facemasks for staff
• Assure cleaning of all heavily touched surfaces and structures every 4 – 8 hours
• Set up COVID19 designated wards
  – You can have persons who are all COVID19+ in the same ward, if they are asymptomatic or mildly symptomatic
  – Assure that anyone entering these wards is using proper PPE
  – In these wards, cleaning of heavily touched surfaces every 2 – 3 hours (except during sleeping hours)
Identify High-risk inmates

- ≥ 60-years of age
- Underlying medical conditions, particularly if not well controlled, including:
  - Serious heart conditions
  - High Blood pressure
  - Chronic lung disease or moderate to severe asthma
  - Diabetes
  - Cancer
  - Obesity
  - Chronic Kidney disease needing dialysis
  - Liver disease
  - Immunocompromised
Perform IgG/IgM as well as rtPCR on all staff and inmates

- Isolate each asymptomatic rtPCR COVID\(^+\) inmate away from COVID\(^-\) inmates (you can put two or more COVID\(^+\) inmates in the same ward)
  - If COVID\(^+\) by rtPCR, and IgM\(^+\) assure they have proper medical care
  - If COVID\(^+\), asymptomatic, and IgG\(^+\) isolate and watch
- Inmates that are rtPCR COVID \(-\) but have IgG to COVID19 most likely already recuperated, but watch and keep separate from rtPCR - inmates
- Staff
  - Send COVID\(^+\) staff to medical care for disposition
  - Allow the COVID\(^-\) staff to work in the COVID- areas
    - If COVID\(^-\) by rtPCR but with +IgG – can work in the COVID+ wards
    - If COVID\(^-\) by rtPCR and has positive IgM, send to medical care for disposition.
• Establish separate community facilities for COVID-19 negative (rtPCR and IgG, IgM negative)

• You CAN group COVID+ inmates with mild to moderate disease in the same facility, if they have no underlying co-morbidities and are ≤ 60-years of age.
### Diagnosis
- Short term testing goals
- Improve rtPCR sensitivity and specificity
- Fine-tune our testing of blood, urine, and other body fluids to identify
- Prognostic indicators (markers that reveal if the patient is improving or likely to need stronger intervention)
- Biomarkers
- Improve Specimen collection
- Develop and Improve Serologic tests
- Accuracy and honesty of governmental reporting of test results worldwide
- Long term goals
  - Point-of-care diagnostics
  - At home testing
  - Proper surveillance testing worldwide
- **Diagnosis**

### Treatment
- Identify new and old drugs that
  - Are safe in humans
  - Decrease duration of infectivity
  - Decrease or eliminate symptoms and signs of COVID19
  - Stop or hinder viral replication and growth
- Speed pharmaceutical manufacture and distribution of needed medications to all
- Speed production and availability of needed equipment and spaces to all
- Assure Health Care providers are safe, protected, and well trained
- **Treatment**

### Prevention
- Review old and new drugs – including antibody based drugs for their
  - Safety in humans
  - Capability to offer prophylactic protection
  - Capacity to offer post-exposure protection
  - Best dose for each patient and best duration of treatment
- Develop pre-exposure and or post-exposure vaccines that
  - Are safe in humans
  - Provide significant protection (>80% from SARS-CoV2)
  - Assess the dose, number, and frequency of booster
  - Assure that preventive drugs and vaccines are quickly manufactured and deliverable to all – including low-resources settings
- **Prevention**

### Transmission Reduction
- Identify how SARS-CoV2 evolved and was able to enter the human population
- Identify which other animals are capable of transmitting SARS-CoV2 infection and
- Determine how to reduce the risk to animals
- Determine how to reduce risk from animals to humans and to other animals
- Understand the post-infectious state of COVID19 individuals
  - If protective immunity lasts and for how long it lasts
  - If there is or is not an increased risk from reinfection from a closely related virus (because of antibody mediated enhancement)
- Promote and evaluate known public health measures that help reduce spread (social distancing, hygiene, testing and intense contact tracing, healthy living, and reasonable PPE)
- **Transmission Reduction**
Questions?
Questions?
Questions?