DHS SCIENCE AND TECHNOLOGY

Master Question List for COVID-19 (caused by SARS-CoV-2)

Weekly Report

26 May 2020

For comments or questions related to the contents of this document, please contact the DHS S&T Hazard Awareness & Characterization Technology Center at HACTechnologyCenter@hq.dhs.gov.

Homeland Security

Science and Technology

FOREWORD

The Department of Homeland Security (DHS) is paying close attention to the evolving Coronavirus Infectious Disease (COVID-19) situation in order to protect our nation. DHS is working very closely with the Centers for Disease Control and Prevention (CDC), other federal agencies, and public health officials to implement public health control measures related to travelers and materials crossing our borders from the affected regions.

Based on the response to a similar product generated in 2014 in response to the Ebolavirus outbreak in West Africa, the DHS Science and Technology Directorate (DHS S&T) developed the following "master question list" that quickly summarizes what is known, what additional information is needed, and who may be working to address such fundamental questions as, "What is the infectious dose?" and "How long does the virus persist in the environment?" The Master Question List (MQL) is intended to quickly present the current state of available information to government decision makers in the operational response to COVID-19 and allow structured and scientifically guided discussions across the federal government without burdening them with the need to review scientific reports, and to prevent duplication of efforts by highlighting and coordinating research.

The information contained in the following table has been assembled and evaluated by experts from publicly available sources to include reports and articles found in scientific and technical journals, selected sources on the internet, and various media reports. It is intended to serve as a "quick reference" tool and should not be regarded as comprehensive source of information, nor as necessarily representing the official policies, either expressed or implied, of the DHS or the U.S. Government. DHS does not endorse any products or commercial services mentioned in this document. All sources of the information provided are cited so that individual users of this document may independently evaluate the source of that information and its suitability for any particular use. This document is a "living document" that will be updated as needed when new information becomes available.

Table of Contents

SARS-CoV-2 (COVID-19)	Infectious Dose – How much agent will make a healthy individual ill?
What do we know?	**The human infectious dose of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is unknown by all exposure routes. SARS-CoV-2 is the cause of coronavirus disease 19 (COVID-19).** *Work using SARS-CoV-2* • A total dose of approximately 700,000 plaque-forming units (PFU) of the novel coronavirus SARS-CoV-2 infected cynomolgus macaques via combination intranasal and intratracheal exposure (10^6 $TCID_{50}$ total dose).[319] Macaques did not exhibit clinical symptoms, but virus was shed from the nose and throat.[319] • Rhesus and cynomolgus macaques showed mild to moderate clinical infections at doses of $4.75x10^6$ PFU (SARS-CoV-2 delivered through several routes), while common marmosets developed mild infections when exposed to $1.0x10^6$ PFU intranasally.[237] • Rhesus macaques are effectively infected with SARS-CoV-2 via the ocular conjunctival and intratracheal route at a dose of approximately 700,000 PFU (10^6 $TCID_{50}$).[109] • Rhesus macaques infected with 2,600,000 $TCID_{50}$ of SARS-CoV-2 by the intranasal, intratracheal, oral and ocular routes combined recapitulate moderate disease observed in the majority of human cases.[272] • African green monkeys developed symptoms consistent with severe human disease when exposed to 500,000 PFU of SARS-CoV-2 via the intranasal and intratracheal routes.[387] • Ferrets infected with 316,000 $TCID_{50}$[189] or 600,000 $TCID_{50}$[312] of SARS-CoV-2 by the intranasal route show similar symptoms to human disease.[189, 312] Uninfected ferrets in direct contact with infected ferrets test positive and show disease as early as 2 days post-contact.[189] In one study, direct contact was required to transfer infection between ferrets,[189] however, transmission without direct contact was found in another study.[312] • Golden Syrian hamsters infected with 100,000 PFU via the intranasal route closely resemble human respiratory infection. Uninfected hamsters in close contact with infected hamsters show symptoms within 4 days of exposure.[71] • Domestic cats exposed to 100,000 PFU of SARS-CoV-2 via the intranasal route developed severe pathological symptoms including lesions in the nose, throat, and lungs.[335] • Mice genetically modified to express the human ACE2 receptor (transgenic hACE2 mice) were inoculated intranasally with 100,000 $TCID_{50}$ (~70,000 PFU), and all mice developed pathological symptoms consistent with COVID-19.[28] • Transgenic (hACE2) mice became infected after timed aerosol exposure (36 $TCID_{50}$/minute) to between 900 and 1080 $TCID_{50}$ (~630-756 PFU). All mice (4/4) exposed for 25-30 minutes became infected, while no mice (0/8) became infected after exposure for 0-20 minutes (up to 720 $TCID_{50}$, ~504 PFU). [29] Key methodological details (e.g., particle size, quantification of actual aerosol dose) are missing from the study's report. • Golden Syrian hamsters exposed to 80,000 $TCID_{50}$ (~56,000 PFU) via the intranasal route developed clinical symptoms reminiscent of mild human infections (all hamsters infected).[337] • It has been suggested that higher viral loads at hospitalization correspond to more severe clinical outcomes,[232, 350] though pre- and asymptomatic individuals also show viral loads comparable to symptomatic individuals.[21, 426] *Related Coronaviruses* • The infectious dose for severe acute respiratory syndrome coronavirus 1 (SARS-CoV-1) in mice is estimated to be between 67-540 PFU (average 240 PFU, intranasal route).[106, 108] • Genetically modified mice expressing DPP4 exposed intranasally to doses of Middle East respiratory syndrome coronavirus (MERS-CoV) between 100 and 500,000 PFU show signs of infection. Infection with higher doses result in severe syndromes.[12, 91, 217, 417]
What do we need to know?	**Identifying the infectious dose for humans by the various routes through which we become infected is critical to the effective development of computational models to predict risk, develop diagnostics and countermeasures, and effective decontamination strategies. Animal studies are a plausible surrogate.** • Human infectious dose by aerosol, surface contact (fomite), fecal-oral routes, and other potential routes of exposure • Most appropriate animal model(s) to estimate the human infectious dose for SARS-CoV-2

SARS-CoV-2 (COVID-19)	Transmissibility – How does it spread from one host to another? How easily is it spread?
What do we know?	**SARS-CoV-2 is passed easily between humans, likely through close contact with relatively large droplets and possibly through smaller aerosolized particles.** • Pandemic COVID-19 has caused 5,522,931 infections and 346,873 deaths[177] in at least 188 countries and territories (as of 5/26/2020).[61, 330, 381] In the US there are 1,663,221 confirmed COVID-19 cases across all 50 US states, with 98,228 deaths (as of 5/26/2020).[177] • Initial high-quality estimates of human transmissibility (R_0) range from 2.2 to 3.1.[248, 291, 315, 391, 416] • SARS-CoV-2 is believed to spread through close contact and droplet transmission,[65] with fomite transmission likely[180] and close-contact aerosol transmission plausible[45, 148] but unconfirmed.[379] • SARS-CoV-2 replicates in the upper respiratory tract, and infectious virus is detectable in throat and lung tissue for at least 8 days.[384] SARS-CoV-2 also infects human gut cell lines,[204] and ocular cells extracted from humans.[164] SARS-CoV-2 genetic material has been found in semen from both clinically symptomatic and recovered cases,[216] however, the infectiousness and the possibility of sexual transmission is unknown. Infectious SARS-CoV-2 has been cultured from patient feces.[396] • Contamination of patient rooms with aerosolized SARS-CoV-2 in the human respirable range (0.25-2.5 µm) indicates the potential for airborne transmission.[231] Viral RNA was detected up to 4 meters from ICU patient beds.[150] To date infectious virus has not been isolated from aerosol samples.[327] • SARS-CoV-2 may be spread by conversation and exhalation in the absence of cough, however more work is needed.[9, 215, 327, 340] A preliminary study in China detailing a restaurant-associated outbreak supports aerosol transmission, though confirmation is needed.[222] • Experimentally infected ferrets were able to transmit SARS-CoV-2 to other ferrets by both direct contact (another ferret in same enclosure) as well as through the air (ferrets in an adjacent enclosure, separated by 10 cm).[312] Similar results have been documented in transgenic mice.[29] • Evidence suggests that SARS-CoV-2 is not transmitted to infants during birth.[77, 81, 84, 329, 403, 407] **Individuals can transmit SARS-CoV-2 to others before they have symptoms.** • Pre-symptomatic[339, 419] or asymptomatic[26, 162, 242] patients can transmit SARS-CoV-2. At least 12% of all cases are estimated to be due to asymptomatic transmission.[114] It has been estimated that 23%,[229] 44%,[153] or as much as 56%[57] of infections may be caused by pre-symptomatic transmission. Infected patients transmit infections most often before symptoms began and within 5 days of symptom onset,[83] and pre-symptomatic individuals contribute to environmental contamination.[178] • Individuals may be infectious for 1-3 days prior to symptom onset,[369] and culturable virus has been found in individuals up to 6 days prior to symptom onset.[21] • Severe cases are more likely to transmit disease, and most new infections are within households of infected patients.[240] In China, it is estimated that infected individuals transmit COVID-19 to between 11.2%[38] and 16.3%[220] of household contacts, though even more may lack symptoms.[242] In New York, 38% of household contacts of infected patients became infected, with the proportion increasing with age (20% for contacts <5 years old, 55% for >65 years old).[320] **Undetected cases play a major role in transmission, and most cases are not reported.** • Models suggest up to 86% of early COVID-19 cases in China were undetected, and these infections were the source for 79% of reported cases.[219] • Models estimate that the true number of cases may be approximately 11 times greater than the reported number of cases in the UK,[404] and 5 to 10 times greater than the reported number of cases in the US.[181, 324] Preliminary estimates of the case reporting rate vary widely among countries, from roughly 1 reported case for every 3 actual cases (in Germany), to 1 in 149 (in China).[194] **Individuals who have recovered clinically, but test positive, appear unable to transmit COVID-19.** • Epidemiological investigations by the Korean CDC suggest that individuals who have clinically recovered from COVID-19, but later show PCR positive tests, are not infectious.[187]
What do we need to know?	**Identifying the contribution of asymptomatic or pre-symptomatic transmission is important for implementing control measures. Additionally, the relative contributions of different infection sources – fomites, droplets, aerosols, and potentially feces – are unknown.** • Capability of SARS-CoV-2 to be transmitted by contact with fomites (phones, doorknobs, surfaces, clothing, etc.) – see also Experimental Stability • Is sexual transmission possible? • Are small-diameter (<5 µm) aerosol exposures capable of infecting humans? • How far do infectious aerosols (small-diameter, <5 µm) travel?

SARS-CoV-2 (COVID-19)	Host Range – How many species does it infect? Can it transfer from species to species?
What do we know?	**SARS-CoV-2 is closely related to other coronaviruses circulating in bats in Southeast Asia. Previous coronaviruses have passed through an intermediate mammal host before infecting humans, but the identity of the SARS-CoV-2 intermediate host is unknown.** • Early genomic analysis indicates similarity to SARS-CoV-1,[423] with a suggested bat origin.[93, 423] • Positive samples from the South China Seafood Market strongly suggests a wildlife source,[67] though it is possible that the virus was circulating in humans before the disease was associated with the seafood market.[31, 94, 398, 408] • Analysis of SARS-CoV-2 genomes suggests that a non-bat intermediate species is responsible for the beginning of the outbreak.[318] The identity of the intermediate host remains unknown.[221, 225-226] • Viruses similar to SARS-CoV-2 were present in pangolin samples collected several years ago.[203] **SARS-CoV-2 uses the same receptor for cell entry as the SARS-CoV-1 coronavirus that circulated in 2002/2003.** • Experiments show that SARS-CoV-2 Spike (S) receptor-binding domain binds the human cell receptor (ACE2) stronger than SARS-CoV-1,[389] potentially explaining its high transmissibility. The same work suggests that differences between SARS-CoV-2 and SARS-CoV-1 Spike proteins may limit the therapeutic ability of SARS antibody treatments.[389] • Modeling of SARS-CoV-2 Spike and ACE2 proteins suggests that SARS-CoV-2 can bind and infect human, bat, civet, monkey and swine cells.[361] Host range predictions based on structural modeling, however, are difficult,[132] and additional animal studies are needed to better define the host range. • In vitro experiments suggest a broad host range for SARS-CoV-2, with more than 44 potential animal hosts, based on viral binding to species-specific ACE2 orthologs.[230] The host range is predicted to be limited primarily to mammals. • Genetic and protein analysis of primates suggests that African and Asian primates are likely more susceptible to SARS-CoV-2, while South and Central American primates are likely less susceptible.[261] Identifying the SARS-CoV-2 host range is important for identifying animal reservoirs. • Changes in proteolytic cleavage of the Spike protein can also affect cell entry and animal host range, in addition to receptor binding.[262] **To date, ferrets, mink, hamsters, cats, and primates have been shown to be susceptible to SARS-CoV-2 infection. It is unknown whether these animals can transmit infection to humans.** • Animal model studies suggest that Golden Syrian hamsters, primates, and ferrets may be susceptible to infection.[71, 189] In the Netherlands, farmed mink developed breathing and gastrointestinal issues, which was diagnosed as SARS-CoV-2 infection.[2] It is thought that an infected mink has transmitted SARS-CoV-2 to a human.[196] Golden Syrian hamsters are able to infect other hamsters via direct contact and close quarters aerosol transmission.[337] • Domestic cats are susceptible to infection with SARS-CoV-2 (100,000-520,000 PFU via the intranasal route[335] or a combination of routes[151]), and can transmit the virus to other cats via droplet or short-distance aerosol.[335] Dogs exposed to SARS-CoV-2 produced anti-SARS-CoV-2 antibodies but exhibited no clinical symptoms.[335, 338] • Wild cats (tigers)[368] can be infected with SARS-CoV-2, although their ability to spread to humans is unknown.[249, 413] Two cases have been confirmed of pet domestic cats infected with SARS-CoV-2.[60] • Ducks, chickens, and pigs remained uninfected after experimental SARS-CoV-2 exposure (30,000 CFU for ducks and chickens, 100,000 PFU for pigs, all via intranasal route).[335] There is currently no evidence that SARS-CoV-2 infects livestock,[169] though modeling suggests sheep, cows, pigs, and goats may be susceptible to infection by SARS-CoV-2.[202] • Pigs and chickens were not susceptible to SARS-CoV-2 infection when exposed to an intranasal dose of 10^5 $TCID_{50}$ (~70,000 PFU), confirmed by lack of positive swab and tissue samples.[133] Fruit bats and ferrets were susceptible to this same exposure.[133]
What do we need to know?	**Several animal models have been developed to recreate human-like illness, though to date they have been infected with high dose exposures. Lower dose studies may better replicate human disease acquisition.** • What is the intermediate host(s)? • Can infected animals transmit to humans (e.g., pet cats to humans)? • Can SARS-CoV-2 circulate in animal reservoir populations, potentially leading to future spillover events?

SARS-CoV-2 (COVID-19)	**Incubation Period – How long after infection do symptoms appear? Are people infectious during this time?**
What do we know?	**The majority of individuals develop symptoms within 14 days of exposure. For most people, it takes at least 2 days to develop symptoms, and on average symptoms develop 5 days after exposure. Incubating individuals can transmit disease for several days before symptom onset. Some individuals never develop symptoms but can still transmit disease.** • The best current estimate of the COVID-19 incubation period is 5.1 days, with 99% of individuals exhibiting symptoms within 14 days of exposure.[210] Fewer than 2.5% of infected individuals show symptoms sooner than 2 days after exposure.[210] • Individuals can test positive for COVID-19 even if they lack clinical symptoms.[26, 70, 149, 346, 419] • Individuals can be infectious while asymptomatic,[65, 321, 346, 419] and asymptomatic and pre-symptomatic individuals have similar amounts of virus in the nose and throat compared to symptomatic patients.[21, 188, 426] • Peak infectiousness may be during the incubation period, one day before symptoms develop.[153] Infectious virus has been cultured in patients up to 6 days before the development of symptoms.[21] • Infectious period is unknown, but possibly up to 10-14 days.[8, 219, 330] • Asymptomatic individuals are estimated to be infectious for a median of 9.5 days.[160] • On average, there are approximately 4[114] to 7.5[218] days between symptom onset in successive cases of a single transmission chain (i.e., the serial interval). Based on data from 339 transmission chains in China, the mean serial interval is 5.29 days.[113] • Children are estimated to shed virus for 15 days on average, with asymptomatic individuals shedding virus for less time (11 days) than symptomatic individuals (17 days).[239] • Most hospitalized individuals are admitted within 8-14 days of symptom onset.[421]
What do we need to know?	**The incubation period is well-characterized. Patients may be infectious, however, for days before symptoms develop.** • What is the average infectious period during which individuals can transmit the disease?

SARS-CoV-2 (COVID-19)	Clinical Presentation – What are the signs and symptoms of an infected person?
What do we know?	**Many COVID-19 cases are asymptomatic. Most symptomatic cases are mild, but severe disease can be found in any age group.[6] Older individuals and those with underlying medical conditions are at higher risk of serious illness and death.** • Approximately 18-31% of patients are asymptomatic throughout the course of their infection.[269, 277, 352] These estimates are based on studies that minimize the likelihood of including pre-symptomatic patients, which can obscure asymptomatic rates.[21] • The majority of symptomatic COVID-19 cases are mild (81%, n=44,000 cases).[346] Initial COVID-19 symptoms include fever (87.9% overall, but only 44-52% present with fever initially),[19, 149] cough (67.7%),[149] fatigue, shortness of breath, headache, and reduced lymphocyte count.[66, 74, 161] Chills, muscle pain, headache, sore throat, and loss of taste or smell[401] are also possible COVID-19 symptoms.[66] The prevalence of GI symptoms varies.[135] Neurological symptoms such as agitation and confusion may present with COVID-19,[154] and may be more common in severe cases.[100] Ocular issues[393] and skin lesions may also be symptoms of COVID-19.[41] • Complications include acute respiratory distress syndrome (ARDS, 17-29% of hospitalized patients, leading to death in 4-15% of cases),[80, 161, 363] pneumonia,[287] cardiac injury (20%),[336] secondary infection, kidney damage,[341] arrhythmia, sepsis, and shock.[149, 161, 363, 421] Most deaths are caused by respiratory failure or respiratory failure combined with myocardial (heart) damage.[322] A number of immunological indicators may help differentiate between severe and non-severe cases.[23, 117, 152, 163, 297, 343] • Approximately 15% of hospitalized patients are classified as severe,[149, 346] and approximately 5% of patients are admitted to the ICU.[149, 346] Patient deterioration can be rapid.[145] The survival rate of patients requiring mechanical ventilation varies widely (e.g., 35%,[168] 70%,[22] 75.5%[313]). Mortality rates in hospitalized patients can be high (~39%), although 37% of patients remained hospitalized, which may affect the final mortality rate.[101] • Clotting issues may be associated with severely ill COVID-19 patients[191] and those with ARDS.[100] COVID-19 patients should be monitored for possible thrombosis.[213] **The case fatality rate varies substantially by patient age and underlying comorbidities.** • Cardiovascular disease, hypertension, diabetes, and respiratory conditions all increase the CFR.[259, 346, 421] Hypertension and obesity are common in the US[135] and contribute to mortality.[20, 289] • Individuals >60 are at higher risk of death, and the CFR for individuals >85 is between 10 and 27%.[346, 421] In a small study, men exhibited more severe symptoms and died at higher rates than women.[179] The effect of comorbidities on the likelihood of severe symptoms is higher for men.[263] • Deaths due to COVID-19 are underreported. In New York City, up to 5,293 (22%) of period-specific excess deaths are unexplained and could be related to the pandemic.[281] More work is needed. **Additional studies on vulnerable subpopulations are required.** • African Americans are disproportionately represented in hospitalized populations,[135] despite having similar rates of several underlying conditions as other groups.[144] African American communities also contribute disproportionately to the number of deaths in the US.[267] • Pregnant women appear to develop severe symptoms at the same rate as the general population,[79, 184, 410] and current reports suggest no increase in risk of pre-term birth.[402] Severe symptoms in pregnant women may be associated with underlying conditions such as obesity.[233] Most studies of COVID-19 in pregnancy represent women in later stages of pregnancy. **Children are susceptible to COVID-19,[112] though generally show milder[75, 238] or no symptoms.** • Between 21-28% of children may be asymptomatic.[238, 292, 300] A detailed study of 100 children with COVID-19 found that 21% were asymptomatic, 58% developed mild illness, 19% had moderate illness, 1% had severe illness, and 1% developed critical illness.[292] • Severe symptoms in children are possible[228] and more likely in those with complex medical histories.[331] Infant deaths have been recorded.[47, 238] • Early reports indicate the possibility of rare hyperinflammatory syndromes or shock in children (termed Pediatric Multi-System Inflammatory Syndrome)[143] linked to COVID-19 infection.[316] The WHO[380] and US CDC[176] have issued case definitions for this condition.
What do we need to know?	**The true case fatality rate is unknown, as the exact number of cases is uncertain. Testing priorities and case definitions vary by location. The proportion of asymptomatic infections is not known.** • How long does it take for infected individuals to recover outside of a healthcare setting? • What proportion of infected individuals are asymptomatic? Does this vary by age, location, or comorbidities?

SARS-CoV-2 (COVID-19)	**Protective Immunity – How long does the immune response provide protection from reinfection?**
What do we know?	**Infected patients show productive immune responses, however more data is needed.** • In a limited study (n=9), hospitalized patients shed high levels of infectious virus for 7 days via the nasal-pharyngeal route, 50% of patients produced antibodies within 7 days, and all patients produced antibodies by 14 days. Antibody production did not correlate with lower viral load.[384] • In a larger study (n=175), most patients developed neutralizing antibodies within 10-15 days after disease onset. Elderly patients had significantly higher neutralizing antibody titers than younger patients.[390] In a separate study, elderly patients also showed higher viral loads than younger patients.[350] • In a study of 285 COVID-19 patients, 100% developed antiviral immunoglobulin-G within 19 days of symptom onset.[234] The neutralizing ability of these antibodies was not tested.[234] In a smaller in vitro study (n=23 patients), levels of antibodies (immunoglobulins M and G) were positively correlated with SARS-CoV-2 neutralizing ability.[350] • In a small series of 26 mild COVID-19 cases, researchers found prolonged persistence of SARS-CoV-2 antibodies and SARS-CoV-2 RNA for up to 50 days. Additionally, one patient cleared SARS-CoV-2 without developing a significant antibody response.[362] • Based on one patient, a productive immune response is generated and sustained for at least 7 days.[347] Previous studies on coronavirus immunity suggest that neutralizing antibodies may wane after several years.[52, 392] More data are needed. • A small subset of COVID-19 patients in China (8%) did not develop a serological response to infection, though the potential for reinfection in these patients is unknown.[390] Similarly, between 16.7% (for IgG) and 51.7% (for IgM) of patients in a separate study did not exhibit any immune response, in terms of production of those two types of antibodies.[344] • In a study of 221 COVID-19 patients, levels of two types of antibodies (IgM and IgG) were not associated with the severity of symptoms.[159] However, in a smaller study, patients with severe disease showed stronger antibody responses than those with non-severe symptoms.[350] • The early recovery phase of COVID-19 patients is characterized by inflammatory immune response,[371] suggesting the potential for adverse reactions after clinical improvement. • Two studies identified key components of the adaptive immune system ($CD4^+$ T cells) in the majority of recovered COVID-19 patients, and these cells reacted to SARS-CoV-2 Spike protein.[43, 146] Interestingly, these studies also identified Spike protein responses in $CD4^+$ T cells of ~30-40% of unexposed patients (via blood samples from 2015-2018, before the COVID-19 pandemic),[146] suggesting some cross-reactivity between other circulating human coronaviruses and SARS-CoV-2.[43, 146] The degree of protection provided by these immune responses is currently unknown. **Currently, there is no evidence that recovered patients can be reinfected with SARS-CoV-2.** • Two studies suggest limited reinfection potential in macaques. In the first, two experimentally infected macaques were not capable of being reinfected 28 days after their primary infection resolved.[27] In the second, rhesus macaques exposed to different doses of SARS-CoV-2 via the intranasal and intratracheal routes (10^4 – 10^6 PFU) developed pathological infection and were protected upon secondary challenge 35 days after initial exposure (little to no clinical symptoms, large reduction in viral titer compared to initial infection).[73] Longer-term research and work in humans still needs to be conducted.[73] • According to the WHO, there is no evidence of re-infection with SARS-CoV-2 after recovery.[209] • Patients can test positive via PCR for up to 37 days after symptoms appear,[421] and after recovery and hospital discharge.[205] The ability of these individuals to infect others is unknown. **Similarly, there is no evidence that recovered patients are protected against reinfection with SARS-CoV-2.[376]** • Additional research is required before any conclusions can be drawn about the duration of protective immunity after SARS-CoV-2 infection.[14]
What do we need to know?	**Understanding the duration of protective immunity is limited by small sample sizes. Animal models are plausible surrogates. Additional research to quantify the risk of reinfection after weeks, months, and years is needed.** • How long does the immune response last? Is there evidence of waning immunity? • Can humans become reinfected? • How does the patient immune response vary by age or disease severity? • How do different components of the immune response contribute to long-term protection?

SARS-CoV-2 (COVID-19)	Clinical Diagnosis – Are there tools to diagnose infected individuals? When during infection are they effective?
What do we know?	**Diagnosis relies on identifying the genetic signature of the virus in patient nose, throat, or sputum samples. These tests are relatively accurate. Confirmed cases are still underreported.** • The US CDC has expanded testing criteria to include symptomatic patients at clinician discretion.[30] • PCR protocols and primers have been widely shared internationally.[58, 96, 218, 334, 375, 382] PCR-based diagnostic assays are unable to differentiate between active and inactive virus. • A combination of pharyngeal (throat) RT-PCR and chest tomography is the most effective diagnostic criteria (correctly diagnoses 91.9% of infections).[310] A single throat swab detects 78.2% of infections, and duplicate tests identify 86.2% of infections.[310] PCR tests using saliva were better able to detect SARS-CoV-2 RNA than those using nasopharyngeal swabs, and may be useful for self, at-home sampling.[395] • Nasal and pharyngeal swabs may be less effective as diagnostic specimens than sputum and bronchoalveolar lavage fluid,[365] although evidence is mixed.[384] Combination RT-PCR and serology (antibody) testing may increase the ability to diagnose patients with mild symptoms, or identify patients at higher risk of severe disease.[418] Assays targeting antibodies against the nucleocapsid protein (N) instead of the Spike protein (S) of SARS-CoV-2 may improve detection.[48] • The timing of diagnostic PCR tests impacts results. The false-negative rate for RT PCR tests is lowest between 7 and 9 days after exposure, and PCR tests are more likely to give false-negative results before symptoms begin (within 4 days of exposure) and more than 14 days after exposure.[198] These results suggest PCR screening may be ineffective in recently exposed individuals.[198] • The FDA issued an Emergency Use Authorization for an antigen-based diagnostic assay, limited to use in certified laboratories (clinical laboratory improvement amendments, CLIA).[119] • The FDA released an Emergency Use Authorization enabling laboratories to develop and use tests in-house for patient diagnosis.[123] Tests from the US CDC are available to states.[58, 65] Multiple rapid or real-time test kits have been produced by universities and industry, including the Wuhan Institute of Virology,[102] BGI,[36] Cepheid,[360] Abbot,[121] and Mesa Biotech.[39] Home tests are being developed; however, none are FDA approved, nor are they useable as a diagnostic.[273-274, 290] • The US CDC is developing serological tests to determine what proportion of the population has been exposed to SARS-CoV-2.[183] A rapid antibody test by Cellex is now authorized by the FDA.[156, 372] • Artificial intelligence algorithms were able to improve the ability of radiologists to distinguish COVID-19 pneumonia from non-COVID-19 pneumonia on chest CT scans.[25] **Validated serological (antibody) assays are being developed to help determine who has been exposed to SARS-CoV-2. Serological evidence of exposure does not indicate immunity.** • Researchers found high specificity in a number of enzyme-linked immunosorbent assays (ELISA), though sample sizes for SARS-CoV-2 patients were small.[280] Additional research has shown high variability in the ability of tests (ELISA and lateral flow assays) by different manufacturers to accurately detect positive and negative cases (sensitivity and specificity, respectively).[208, 373] Lateral flow assays may be less reliable than ELISA.[10] • In one German town, serological testing has been used to identify the percent of the population already exposed to SARS-CoV-2 (14%), which can assist in public health response planning.[307] • Preliminary serological studies in Santa Clara and Los Angeles, California, estimated that 2.5-4.1% of the population has already been exposed to SARS-CoV-2 since the first confirmed cases in January,[34, 250] which is between 28 and 85 times greater than official reports. There are issues, however, with non-random study populations,[34] as well as false positive rates of the diagnostic tests themselves.[250] The false positive rate of the diagnostic assay used may account for a substantial portion of the reported infections,[34] particularly if the true proportion of positive patients is low. • In New York, initial serological testing indicates that 13.9% of the population has been exposed to COVID-19, approximately 10 times greater than the number of reported cases.[3] This is in line with other underreporting estimates in the US.[181, 324]
What do we need to know?	**In general, PCR tests appear to be sensitive and specific, though confirmation of symptoms via chest CT is recommended. The sensitivity and specificity of serological testing methods is variable, and additional work needs to be done to determine factors that affect test accuracy.** • How accurate are clinical diagnoses compared to genetic tests? • How effective are different swab specimens as diagnostic samples? • How many serological tests need to be done to obtain an accurate picture of underlying exposure?

SARS-CoV-2 (COVID-19)	Medical Treatments – Are there effective treatments?
What do we know?	**Treatment for COVID-19 is primarily supportive care including ventilation if necessary.[149, 251] Numerous clinical trials are ongoing, but results are preliminary.[33, 90] Several drugs show efficacy.** • Two WHO-backed clinical trials (Solidarity and Discovery)[199] include remdesivir, hydroxychloroquine and chloroquine, ritonavir/lopinavir, and ritonavir/lopinavir and interferon-beta.[199] • The WHO has temporarily halted the hydroxychloroquine arm of its Solidarity trial due to concerns about adverse patient reactions.[141] **Remdesivir shows promise for reducing symptom duration in humans.[32]** • Remdesivir can reduce the duration of symptoms in infected individuals, from 15 days to 11 days on average (compared to controls).[32] There is a possibility remdesivir may reduce mortality rates, though the result was not statistically significant.[32] In this trial, individuals with mild symptoms were excluded, and remdesivir was most effective in patients requiring supplemental oxygen (but not mechanical ventilation).[32] Remdesivir received an Emergency Use Authorization from FDA.[275] • In a separate clinical trial of severe COVID-19 patients, the effects of remdesivir were inconclusive due to a limitation in the study sample size.[366] For available patients, remdesivir did not reduce the time to recovery overall, but did show a tendency to reduce symptom duration for patients given the drug early.[366] This trial ended early, reducing its statistical power.[366] **Hydroxychloroquine is associated with elevated risk of cardiac arrhythmias and provides limited to no clinical benefit at this point in time. Large, randomized clinical trial results are necessary.** • A very large (n=14,888) observational, retrospective study found elevated rates of mortality and cardiac arrythmias in moderately to severely ill COVID-19 patients taking hydroxychloroquine compared to matched control groups.[260] This adds to existing studies that have found no benefit of hydroxychloroquine (with or without azithromycin)[78, 138, 244-245, 345] as well as cardiac side effects[35, 88, 140, 174, 246, 264] and elevated risk of mortality.[244] Individuals taking hydroxychloroquine for autoimmune disorders were not protected from COVID-19,[139] though sample sizes were limited. • Initial results purporting benefits of hydroxychloroquine and azithromycin[137] have been called into question by other researchers[166] and the journal's publishing society.[172] One small clinical trial (n=62) suggests that hydroxychloroquine can reduce recovery time compared to control group.[82] Key details are missing from this preprint.[82] A small retrospective study (n=48) found benefits to hydroxychloroquine, though details on patient study population selection were limited.[405] **Other pharmaceutical interventions are being investigated.** • A randomized Phase II trial found that a triple combination of interferon beta-1b, lopinavir-ritonavir, and ribavirin administered early in infection reduced symptom severity, viral shedding, and hospital stay time compared to patients taking lopinavir-ritonavir alone.[167] • Limited, preliminary evidence from clinical trials supports the efficacy of favipiravir[76] (which has been approved to treat COVID-19 in China)[1] and intravenous immunoglobulin.[54] • Early research found no efficacy from combination ritonavir and lopinavir,[53] as well as an increase in gastrointestinal symptoms.[223] • Early results from a randomized clinical trial found that high doses (600 mg, twice per day) of chloroquine diphosphate were associated with toxicity and lethality in patients with severe COVID-19.[40] The trial did not have a large enough sample size to assess chloroquine treatment efficacy.[40] • A small (n=21), observational study found benefits of tocilizumab in severe COVID-19 patients.[399] Potential benefits of immunosuppressants[7] should be weighed against potential risks.[303] • The anticoagulant heparin is being used to mitigate risks of pulmonary embolism.[117] Systemic anticoagulant use was associated with reduced mortality rates in severely ill patients.[288] • Passive antibody therapy (convalescent serum)[55] is being given to patients (FDA Investigational New Drug approval).[122] In a small trial (n=5 patients),[332] convalescent sera administration was followed by clinical improvement.[332] Large efforts are underway to broaden and enhance serum therapies.[333] Preliminary results from a small study (n=39 patients) found that those receiving convalescent plasma were more likely to see improvements in their need for supplemental oxygen.[227] Additionally, there was a reduction in mortality in those receiving plasma.[227]
What do we need to know?	**Additional clinical trial results are being released, and data from these trials are needed.** • Are convalescent plasma treatments effective in humans or animals? • Do monoclonal antibodies exhibit any efficacy in human trials?

SARS-CoV-2 (COVID-19)	Vaccines – Are there effective vaccines?
What do we know?	**Work is ongoing to develop a SARS-CoV-2 vaccine in human and animal trials. Early results are being released, but evidence should be considered preliminary until larger trials are completed.** • Multiple entities are working to produce a SARS-CoV-2 vaccine,[15] including HHS/NIH/NIAID,[155, 214] CEPI, Moderna Therapeutics, Pfizer,[118] Gilead Sciences,[4-5, 276] Sanofi,[42] and Johnson and Johnson.[182] • Vaccine candidates undergoing clinical trial are listed below. *Phase II Trials (initial testing for efficacy, continued testing for safety):* • China's CanSino is the first to complete Phase I safety trials of their adenovirus type5 vector based Sars-CoV-2 vaccine, Ad5-nCoV, and has advanced to Phase II human trials.[224] • University of Oxford's ChAdOx1 candidate has begun Phase II/III human trials.[285] *Phase I Trials (initial testing for safety)*: • Sinovac Biotech has reported that their inactivated virus vaccine shows protective effects in rhesus macaques, particularly at high doses.[134] The vaccine is currently in Phase I clinical trials.[92] • Phase I trial results for the CanSino vaccine (Ad5-nCoV) showed few severe adverse reactions in humans within 28 days of follow-up (side effects included fever [sometimes severe], fatigue, headache, and muscle pain).[424] Immune responses were found in most patients, peaking at 14 days for T-cells and 28 days for antibodies.[424] Two doses were selected for human Phase II trials. Vaccine efficacy in humans is currently unknown.[424] • Moderna has a Phase I trial underway based on its mRNA platform, mRNA-1273. Preliminary data from the trial suggests that the vaccine is well-tolerated by human subjects, and induces an antibody response against SARS-CoV-2.[270] Results from trials designed to test efficacy are needed. • Inovio had their IND approved by the FDA and have started their Phase I clinical trials on their DNA vaccine candidate INO-4800.[325] • Shenzhen Geno-Immune Medical Institute is testing its aAPC[257] and lentiviral[255] vaccines in Phase I clinical trials. • BioNTech and Pfizer's BNT162 program is in Phase I/II clinical trial for four of its mRNA vaccine candidates.[296] • University of Oxford's ChAdOx1 vaccine is in Phase I clinical trials. This vaccine is based on a chimpanzee adenovirus expressing SARS-CoV-2 proteins.[295] The ChAdOx1 platform has shown protective efficacy in rhesus macaques in preclinical trials. Safety and efficacy still need to be determined in human trials.[357] • The Beijing Institute of Biological Products/Wuhan Institute of Biological Products have initiated a Phase I trial of their inactivated vaccine candidate.[383] • Symvivo Corporation has received approval to begin a Phase I trial with their oral bacTRL-Spike vaccine candidate in Canada.[253] • Novavax is testing a recombinant spike protein nanoparticle vaccine in Phase I trials.[254] • Immunitor LLC is starting Phase I trials of a heat-inactivated vaccine derived from pooled patient plasma.[258] • Aivita Biomedical will begin a Phase Ib/II randomized double blind clinical trial of 180 people, specifically healthcare workers and first responders. Their vaccine DC-ATA consists of autologous dendritic cells loaded with antigens from SARS-CoV-2.[256] *Co-opting existing vaccines* • Some efforts have begun to enroll healthcare workers in clinical trials to study the efficacy of the BCG (Bacillus Calmette-Guérin) vaccine for reducing symptom severity in COVID-19 patients.[252] *Additional vaccine research* • Research has identified several DNA vaccine candidates that show protective efficacy in rhesus macaques, in terms of reduction in viral load compared to non-vaccinated controls, though animals exhibited mild clinical symptoms.[406] Human trials with these candidates are needed.
What do we need to know?	**Published results from Phase I trials are needed.** • Safety of candidate vaccines in humans and animals • Efficacy of candidate vaccines in humans and animals • Length of any vaccine-derived immunity • Evidence for vaccine-derived enhancement (immunopotentiation)

SARS-CoV-2 (COVID-19)	Non-pharmaceutical Interventions – Are public health control measures effective at reducing spread?
What do we know?	**Broad-scale control measures such as stay-at-home orders are effective at reducing movement and contact rates, and modeling shows evidence that they reduce transmission.** • Social distancing and other policies are estimated to have reduced COVID-19 spread by 44% in Hong Kong[99] and reduced spread throughout China[193, 197, 201, 235, 247] and Italy.[136] Restrictive lockdowns in China are estimated to have reduced disease transmission within only a few days,[425] in part, through reductions in an individual's average number of contacts.[411] • Modeling demonstrates that multifaceted restrictions and quarantines in China reduced the R_0 of SARS-CoV-2 from greater than 3 to less than 1 between January 23 and February 5.[286] Additionally, movement restrictions and other control measures helped limit the amount of time where community transmission was possible (i.e., $R_0 > 1$).[412] • A US county-level model found that shelter in place orders (SIPOs) and restaurant and bar closures were associated with large reductions in exponential growth rate of cases.[97] SIPOs had larger independent effects, but restaurant and bar closures contributed more to overall case reductions because they were in place longer. [97] School closures and cancellation of large gatherings had smaller effects.[97] Similarly, researchers found that a larger number of public health interventions in place was strongly associated with lower COVID-19 growth rates in the next week.[185] • Mobility[129, 207] and physical contact rates[175] decline after public health control measures are implemented. • Models indicate that a combination of school closures, work restrictions, and other measures are required to effectively limit transmission.[126] School closures alone appear insufficient.[173, 201] • Non-pharmaceutical interventions in China did not reduce transmission equally across all groups; transmission rates in younger individuals, particularly infants, as well as hospital workers continued to increase even while overall transmission rates declined.[286] • Contact tracing to identify infected individuals reduces the amount of time infectious individuals can transmit disease in a population and increases the time between successive cases.[38] **The effect of relaxing control measures is unknown, and research is needed to help plan for easing of restrictions.** • Modeling indicates that COVID-19 is likely to become endemic in the US population, with regular, periodic outbreaks, and that additional social or physical distancing measures may be required for several years to keep cases below critical care capacity in absence of a vaccine or effective therapeutic.[190] Results depend critically on the duration of immunity after exposure.[190] • Two modeling studies suggest that contact tracing combined with high levels of testing may be capable of limiting the potential for large second waves of COVID-19 transmission once initial social distancing policies are relaxed.[13, 127] • Modeling suggests that premature lifting of social distancing measures will substantially increase the number of local COVID-19 cases in Wuhan, China.[298] Similarly, forecasts in the US estimate a resumption of exponential case growth if social distancing measures are relaxed.[103] • In the UK, modelers are assessing the efficacy of rolling interventions, whereby social distancing measures are put into place every few weeks to keep healthcare demand below a critical point.[404] • A modeling study using Chinese data suggests that carefully balancing control measures to maintain R_0 below 1 would be more efficient than allowing R_0 to increase above 1 at any point.[211] • Robust contact tracing and case finding may be needed to control COVID-19 in the US, but would require additional staff and resources to conduct effectively.[367] • The WHO has released guidelines on public health strategy,[374] and Johns Hopkins released a report outlining how to re-open certain categories of activities (e.g., schools, restaurants, events) while reducing COVID-19 risk.[317] • SARS-CoV-2 levels in wastewater may track with prevalence in the population,[394] and could be used to monitor viral elimination in an area.
What do we need to know?	**As different US states have implemented differing control measures at various times, a comprehensive analysis of social distancing efficacy has not yet been conducted.** • What are plausible options for relaxing social distancing and other intervention measures without resulting in a resurgence of COVID-19 cases? • How is COVID-19 incidence changing in states that have begun easing movement and activity restrictions?

SARS-CoV-2 (COVID-19)	Environmental Stability – How long does the agent live in the environment?
What do we know?	**SARS-CoV-2 can persist on surfaces for at least 3 days and on the surface of a surgical mask for up to 7 days depending on conditions. If aerosolized intentionally, SARS-CoV-2 is stable for at least several hours. The seasonality of COVID-19 transmission is unknown. SARS-CoV-2 on surfaces is inactivated rapidly with sunlight.** *SARS-CoV-2 Data* • In simulated saliva on stainless steel surface, SARS-CoV-2 exhibits negligible decay over 60 minutes in darkness, but loses 90% of infectivity every 6.8-12.8 minutes, depending on the intensity of simulated UVB irradiation levels.[306] • SARS-CoV-2 can persist on plastic and metal surfaces between 3 days (21-23°C, 40% RH)[355] and 7 days (22°C, 65% RH). Infectious virus can be recovered from a surgical mask after 7 days (22°C, 65% RH).[87] • SARS-CoV-2 has an aerosol half-life of 2.7 hours (particles <5 µm, tested at 21-23°C and 65% RH).[355] • SARS-CoV-2 is susceptible to heat treatment (70°C) but can persist for at least two weeks at refrigerated temperatures (4°C).[87, 305] • SARS-CoV-2 genetic material (RNA) was detected in symptomatic and asymptomatic cruise ship passenger rooms up to 17 days after cabins were vacated. The infectiousness of this material is not known.[271] • In a preliminary study, SARS-CoV-2 stability was enhanced when present with bovine serum albumin, which is commonly used to represent sources of protein found in human sputum.[293] • No strong evidence exists showing a reduction in transmission with seasonal increase in temperature and humidity.[241] Modeling suggests that even accounting for potential reductions in transmission due to weather and behavioral changes, public health interventions will still need to be in effect to limit COVID-19 transmission.[265] *Surrogate Coronavirus data*: • Studies suggest that other coronaviruses can survive on non-porous surfaces up to 9-10 days (MHV, SARS-CoV),[56, 72] and porous surfaces for up to 3-5 days (SARS-CoV)[116] in air conditioned environments (20-25°C, 40-50% RH). • Coronavirus survival tends to be higher at lower temperatures and lower relative humidity (RH),[56, 72, 302, 356] though infectious virus can persist on surfaces for several days in typical office or hospital conditions.[356] • SARS can persist with trace infectivity for up to 28 days at refrigerated temperatures (4°C) on surfaces.[56] • One hour after aerosolization approximately 63% of airborne MERS virus remained viable in a simulated office environment (25°C, 75% RH).[299] • Porous hospital materials, including paper and cotton cloth, maintain infectious SARS-CoV for a shorter time than non-porous material.[200]
What do we need to know?	**Additional testing on SARS-CoV-2, as opposed to surrogate viruses, is needed to support initial estimates of stability.** • Stability of SARS-CoV-2 in aerosol, droplets, and other matrices (mucus/sputum, feces) • Particle size distribution (e.g., droplet, large droplet, and true aerosol distribution) • Duration of SARS-CoV-2 infectivity via fomites and surfaces (contact hazard) • Stability of SARS-CoV-2 on PPE (e.g., Tyvek, nitrile, etc.) • Evidence for seasonality in transmission, or other environmental impacts (UV, temperature, humidity)

SARS-CoV-2 (COVID-19)	Decontamination – What are effective methods to kill the agent in the environment?
What do we know?	**Soap and water, as well as common alcohol and chlorine-based cleaners, hand sanitizers, and disinfectants are effective at inactivating SARS-CoV-2 on hands and surfaces.** *SARS-CoV-2* • Alcohol-based hand rubs are effective at inactivating SARS-CoV-2.[195] • Chlorine bleach (1%, 2%), 70% ethanol and 0.05% chlorhexidine are effective against live virus in lab tests.[86] • Twice-daily cleaning with sodium dichloroisocyanurate decontaminated surfaces in COVID-19 patient hospital rooms.[282] • EPA has released a list of SARS-CoV-2 disinfectants, but solutions were not tested on live virus.[11] *Other Coronaviruses* • Chlorine-based[378] and ethanol-based[95] solutions are recommended. • Heat treatment (56°C) is sufficient to kill coronaviruses,[302, 420] though effectiveness depends partly on protein in the sample.[302] • 70% ethanol, 50% isopropanol, sodium hypochlorite (0.02% bleach), and UV radiation can inactivate several coronaviruses (MHV and CCV).[326] • Ethanol-based biocides effectively disinfect coronaviruses dried on surfaces, including ethanol containing gels similar to hand sanitizer.[165, 385] • Surface spray disinfectants such as Mikrobac, Dismozon, and Korsolex are effective at reducing infectivity of the closely related SARS-CoV-1 after 30 minutes of contact.[301] • Coronaviruses may be resistant to heat inactivation for up to 7 days when stabilized in stool.[348-349] • Coronaviruses are more stable in matrixes such as respiratory sputum.[115] **Methods for decontaminating N95 masks have been approved by the FDA under an Emergency Use Authorization (EUA).** • Researchers have identified four methods capable of decontaminating N95 respirators while maintaining physical integrity (fit factor): UV radiation, heating to 70°C, and vaporized hydrogen peroxide (VHP).[128] Ethanol (70%) was associated with loss of physical integrity.[128] • Hydrogen peroxide vapor (VHP) can repeatedly decontaminate N95 respirators.[314] Devices capable of decontaminating 80,000 masks per day have been granted Emergency Use Authorization from the FDA.[119] • The FDA has issued an Emergency Use Authorization for a system capable of decontaminating 10 N95 masks at a time using devices already present in many US hospitals.[44]
What do we need to know?	**Additional decontamination studies, particularly with regard to PPE and other items in short supply, are needed.** • What is the minimal contact time for disinfectants? • Does contamination with human fluids/waste alter disinfectant efficacy profiles? • How effective is air filtration at reducing transmission in healthcare, airplanes, and public spaces? • Are landfills and wastewater treatment plants effective at inactivating SARS-CoV-2? • Is heat or UV decontamination effective to clean N95 masks, respirators and other types of PPE for multi-use?

SARS-CoV-2 (COVID-19)	PPE – What PPE is effective, and who should be using it?
What do we know?	**The effectiveness of PPE for SARS-CoV-2 is currently unknown, and data from other related coronaviruses are used for guidance. Healthcare workers are at high risk of acquiring COVID-19, even with recommended PPE.** • Healthcare worker illnesses[346] demonstrates human-to-human transmission despite isolation, PPE, and infection control.[328] Risk of transmission to healthcare workers is high, with up to 20% of healthcare workers in Lombardy, Italy becoming infected.[309] Over 50% of US healthcare workers infected with COVID-19 report work in a healthcare setting as their single source of exposure.[49] • "Healthcare personnel entering the room [of SARS-CoV-2 patients] should use standard precautions, contact precautions, airborne precautions, and use eye protection (e.g., goggles or a face shield)."[63] WHO indicates healthcare workers should wear clean long-sleeve gowns as well as gloves.[377] Clothing and PPE that covers all skin may reduce exposure to pathogens.[125, 370] • Respirators (NIOSH-certified N95, EUFFP2 or equivalent) are recommended for those dealing with possible aerosols.[378] Additional protection, such as a Powered Air Purifying Respirator (PAPR) with a full hood, should be considered for high-risk procedures (i.e., intubation, ventilation).[46] • Particular attention should be paid to the potential for transmission via exhaled air during supportive respiratory procedures.[148] • There is evidence both for[231] and against[282] the detection of SARS-CoV-2 RNA via air sampling in patient rooms and other hospital areas. • Research at Johns Hopkins Center for Health Security has provided initial estimates of PPE needs in the US: 7.8 billion gloves, 668 million gowns, 360 million surgical masks, and 136 million N95 or similar respirators.[351] • KN95 respirators are, under certain conditions, approved for use under FDA Emergency Use Authorization.[120] On May 7, the FDA rescinded a number of KN95 models that no longer meet the EUA criteria and are no longer authorized.[124] **Masks may be effective at slowing transmission.** • A non-peer-reviewed report of an experimental trial with hamsters suggests that masks may reduce SARS-CoV-2 transmission via aerosol when the mask material is used as a filter between separate cages housing infected and uninfected hamsters.[157] • Surgical face masks, respirators and homemade face masks may prevent transmission of coronaviruses from infectious individuals (with or without symptoms) to other individuals.[105, 212, 354] Surgical masks were associated with a significant reduction in the amount of seasonal coronavirus (not SARS-CoV-2) expressed as aerosol particles (<5 µm) compared to not wearing a mask.[212] Other preliminary work has failed to document protective efficacy of surgical or cotton masks,[24] and more SARS-CoV-2 specific research is needed. • On 4/3/2020, the US CDC recommended wearing cloth face masks in public where social distancing measures are difficult to maintain.[64] • The efficacy of homemade PPE, made with T-shirts, bandanas, or similar materials, is less than standard PPE, but may offer some protection if no other options are available.[89, 104, 311] The filtering efficiency of homemade mask materials is variable. Some non-standard materials (e.g., cotton, cotton hybrids) may be able to filter out >90% of simulant particles >0.3µm,[192] while other materials (e.g., T-shirt, vacuum cleaner bag, towels) appear to have lower filtration efficacy (~35-62%).[364] • In a meta-analysis of mask studies, N95 respirators were found to be beneficial for reducing the occurrence of respiratory illness in health care professionals including influenza, though surgical masks were similarly effective for influenza.[279] N95 respirators were associated with large reductions (up to 80%) in SARS-CoV-1 infections.[279]
What do we need to know?	**Most PPE recommendations have not been made on SARS-CoV-2 data, and comparative efficacy of different PPE for different tasks (e.g., intubation) is unknown. Identification of efficacious PPE for healthcare workers is critical due to their high rates of infection.** • What is the importance of aerosol transmission (particles <5µm)? What is the effective distance of spread via droplet or aerosol? • How effective are barriers such as N95 respirators or surgical masks for SARS-CoV-2? • What is the appropriate PPE for first responders? Airport screeners? • What are proper procedures for reducing spread and transmission rates in medical facilities? • How effective are homemade masks at reducing SARS-CoV-2 transmission?

SARS-CoV-2 (COVID-19)	Forensics – Natural vs intentional use? Tests to be used for attribution.
What do we know?	**All current evidence supports the natural emergence of SARS-CoV-2 via a bat and possible intermediate mammal species.** • Genomic analysis places SARS-CoV-2 into the beta-coronavirus clade, with close relationship to bat coronaviruses. The SARS-CoV-2 virus is distinct from SARS-CoV-1 and MERS viruses.[111] • Genomic analysis suggests that SARS-CoV-2 is a natural variant and is unlikely to be human-derived or otherwise created by "recombination" with other circulating strains of coronavirus.[17, 423] • Genomic data support at least two plausible origins of SARS-CoV-2: "(i) natural selection in a non-human animal host prior to zoonotic transfer, and (ii) natural selection in humans following zoonotic transfer."[17] Both scenarios are consistent with the observed genetic changes found in all known SARS-CoV-2 isolates. • Some SARS-CoV-2 genomic evidence indicates a close relationship with pangolin coronaviruses,[386] and data suggest that pangolins may be a natural host for beta-coronaviruses.[225-226] Genomic evidence suggests a plausible recombination event between a circulating coronavirus in pangolins and bats could be the source of SARS-CoV-2.[397] Emerging studies are showing that bats are not the only reservoir of SARS-like coronaviruses.[414] Additional research is needed. • A novel bat coronavirus (RmYN02) has been identified in China with an insertion in the viral furin cleavage site. While distinct from the insertion in SARS-CoV-2, this evidence shows that such insertions can occur naturally.[422] • Additionally, "[…] SARS-CoV-2 is not derived from any previously used virus backbone," reducing the likelihood of laboratory origination,[17] and "[…] genomic evidence does not support the idea that SARS-CoV-2 is a laboratory construct, [though] it is currently impossible to prove or disprove the other theories of its origin."[17] • Work with other coronaviruses has indicated that heparan sulfate dependence can be an indicator of prior cell passage, due to a mutation in the previous furin enzyme recognition motif.[107]
What do we need to know?	**Identifying the intermediate species between bats and humans would aid in reducing potential spillover from a natural source. Wide sampling of bats, other wild animals, and humans is needed to address the origin of SARS-CoV-2.** • What tests for attribution exist for coronavirus emergence? • What is the identity of the intermediate species? • Are there closely related circulating coronaviruses in bats or other animals with the novel PRRA cleavage site found in SARS-CoV-2?

SARS-CoV-2 (COVID-19)	Genomics – How does the disease agent compare to previous strains?
What do we know?	**Current evidence suggests that SARS-CoV-2 accumulates substitutions and mutations at a similar rate as other coronaviruses. Mutations and deletions in specific portions of the SARS-CoV-2 genome have not been linked to any changes in transmission or disease severity, though modeling work is attempting to identify possible changes.** • There have been no documented cases of SARS-CoV-2 prior to December 2019. Preliminary genomic analyses, however, suggest that the first human cases of SARS-CoV-2 emerged between 10/19/2019 – 12/17/2019.[18, 31, 304] • Analysis of more than 7,000 SARS-CoV-2 genome samples provides an estimated mutation rate of $6x10^{-4}$ nucleotides per genome per year.[358] The same analysis estimates the emergence of SARS-CoV-2 in humans between October and December 2019.[358] This aligns with the first known human cases in China in early December 2019, in Europe in late December 2019,[110] and circulation in the US (Washington State) in February 2020.[388] • Despite evidence of variation in the genome[69] and areas under positive selection,[50] there are no known associations between particular mutations and changes in transmission or virulence.[51] Thus, there is currently no evidence of distinct SARS-CoV-2 phenotypes at this time.[243, 358] Research attempting to define clades or subgroups of SARS-CoV-2 based solely on genomic features has suffered from limited data[409] and sampling bias.[131] • Analysis shows that no recurrent SARS-CoV-2 mutations are associated with increases in viral transmission, providing no evidence of distinct lineage with different rates of growth.[359] • In 94 COVID-19 patients where both symptoms and genetic sequences of SARS-CoV-2 were known, there was no association between viral genotype and clinical severity.[415] • Pangolin coronaviruses are closely related to both SARS-CoV-2 and closely related bat coronaviruses. Phylogenetic analysis suggests that SARS-CoV-2 is of bat origin, but is closely related to pangolin coronavirus.[225-226] • The SARS-CoV-2 Spike protein, which mediates entry into host cells and is the major determinant of host range, is very similar to the SARS-CoV-1 Spike protein.[236] The rest of the genome is more closely related to two separate bat[236] and pangolin[226] coronaviruses. • An analysis of SARS-CoV-2 sequences from Singapore has identified a large nucleotide (382 bp) deletion in ORF-8.[342] In Arizona, researchers identified an 81-base pair deletion (removing 27 amino acids) in the ORF-7a protein, indicating that mutations can be detected by routine sentinel surveillance. The function of these deletions are unknown at this time.[158] • A recent report of virus mutations within patients needs more research.[186] Additional analysis of data suggests the results may be due to experimental methods.[142, 400] • Structural modeling suggests that observed changes in the genetic sequence of the SARS-CoV-2 Spike protein may enhance binding of the virus to human ACE2 receptors.[283] More specifically, changes to two residues (Q493 and N501) are linked with improving the stability of the virus-receptor binding complex.[283] Additionally, structural modeling identified several existing mutations that may enhance the stability of the receptor binding domain, potentially increasing binding efficacy.[284] Infectivity assays are needed to validate the genotypic changes and possible phenotypic results identified in these studies. • A key difference between SARS-CoV-2 and other beta-coronaviruses is the presence of a polybasic furin cleavage site in the Spike protein (insertion of a PRRA amino acid sequence between S1 and S2).[98] • The US CDC is launching a national genomics consortium to assess SARS-CoV-2 genomic changes over time.[59]
What do we need to know?	**Research linking genetic changes to differences in phenotype (e.g., transmissibility, virulence, progression in patients) is needed.** • Are there similar genomic differences in the progression of coronavirus strains from bat to intermediate species to human? • Are there different strains or clades of circulating virus? If so, do they differ in virulence? • What are the mutations in SARS-CoV-2 that allowed human infection and transmission?

SARS-CoV-2 (COVID-19)	Forecasting – What forecasting models and methods exist?
What do we know?	**There are many groups focused on forecasting cases, hospitalizations, or fatalities due to COVID-19. Each model has its own methods and goals, summarized in this section. An evaluation of model performance is beyond the scope of this document. Assumptions and limitations of each model are detailed at the linked reference.** *US CDC forecasting* • The US CDC is hosting an ongoing forecasting initiative, and provides ensemble forecasts based on the arithmetic mean of participating groups.[62] • Columbia University Model: Spatially-explicit SEIR model incorporating contact rate reductions due to social distancing. Estimates total cases and risk of healthcare overrun.[323] • Imperial College London: Week-ahead forecasts of cases, deaths, and transmissibility (R_0) at the country-level. Transmissibility estimates used to forecast incidence based on Poisson renewal process.[37] • Institute of Health Metrics and Evaluation (IHME): Mechanistic SEIR model combined with curve-fitting techniques to forecast cases, hospital resource use, and deaths at the state and country level.[170] • Los Alamos National Laboratory: Forecasts of state-level cases and deaths based on statistical growth model fit to reported data. Implicitly accounts for effects of social distancing and other control measures.[206] • Massachusetts Institute of Technology: Mechanistic SEIR model that forecasts cases, hospitalizations, and deaths. Also includes estimates of intervention measures, allows users to project based on different intervention scenarios (e.g., social distancing lasting for 3 vs. 4 weeks).[268] • Northeastern University: Spatially explicit, agent-based epidemic model used to forecast fatalities, hospital resource use, and the cumulative attack rate (proportion of the population infected) for unmitigated and mitigated scenarios.[278] • Notre Dame University: Agent-based model forecasting cases and deaths for Midwest states. Includes effectiveness of control measures like social distancing.[294] • University of California, Los Angeles: Mechanistic SIR model with statistical optimization to find best-fitting parameter values. Estimates confirmed and active cases, fatalities, and transmission rates at the national and state levels.[353] • University of Chicago: Age-structured SEIR model that accounts for asymptomatic individuals and the effectiveness of social distancing policies. Forecasts only for Illinois.[85] • University of Geneva: Country-level forecasts of cases, deaths, and transmissibility (R_0). Uses statistical models fit to reported data, not mechanistic models.[130] • University of Massachusetts, Amherst: Aggregation of state and national forecasts to create ensemble model.[308] • University of Texas, Austin: Machine learning model aimed at identifying links between social distancing measures and changes in death rates. Forecasts fatalities at the state, metropolitan area, and national level. Cannot be used to make projections beyond initial infection wave.[266] • Youyang Gu: Mechanistic SEIR model coupled with machine learning algorithms to minimize error between predicted and observed values. Forecasts deaths and infections at the state and national level, including 60 non-US countries. Includes effects of public health control efforts.[147] *Other forecasting efforts*: • University of Georgia: Statistical models used to estimate the current number of symptomatic and incubating individuals, beyond what is reported (e.g., "nowcasts"). Available at the state and national level for the US.[68] • Hospital IQ has a dashboard that forecasts hospital and ICU admissions for each county in the US. Relies in part on IHME forecasts.[171]
What do we need to know?	**Forecasts differ in how they handle public health interventions such as shelter-in-place orders. Tracking how methods change in the near future will be important for understanding limitations going forward.**

Table 1. Definitions of commonly-used acronyms

Acronym/Term	Definition	Description
ACE2	Angiotensin-converting enzyme 2	Acts as a receptor for SARS-CoV and SARS-CoV-2, allowing entry into human cells
Airborne transmission	Aerosolization of infectious particles	Aerosolized particles can spread for long distances (e.g., between hospital rooms via HVAC systems). Particles generally <5 µm.
ARDS	Acute respiratory distress syndrome	Leakage of fluid into the lungs which inhibits respiration and leads to death
Attack rate	Proportion of "at-risk" individuals who develop infection	Defined in terms of "at-risk" population such as schools or households, defines the proportion of individuals in those populations who become infected after contact with an infectious individual
CCV	Canine coronavirus	Canine coronavirus
CFR	Case Fatality Rate	Number of deaths divided by confirmed patients
CoV	Coronavirus	Virus typified by crown-like structures when viewed under electron microscope
COVID-19	Coronavirus disease 19	Official name for the disease caused by the SARS-CoV-2 virus
Droplet transmission	Sneezing, coughing	Transmission via droplets requires relatively close contact (e.g., within 6 feet)
ELISA	Enzyme-linked immunosorbent assay	Method for serological testing of antibodies
Fomite	Inanimate vector of disease	Surfaces such as hospital beds, doorknobs, healthcare worker gowns, faucets, etc.
HCW	Healthcare worker	Doctors, nurses, technicians dealing with patients or samples
Incubation period	Time between infection and symptom onset	Time between infection and onset of symptoms typically establishes guidelines for isolating patients before transmission is possible
Infectious period	Length of time an individual can transmit infection to others	Reducing the infectious period is a key method of reducing overall transmission; hospitalization, isolation, and quarantine are all effective methods
Intranasal	Agent deposited into external nares of subject	Simulates inhalation exposure by depositing liquid solution of pathogen/virus into the nose of a test animal, where it is then taken up by the respiratory system
MERS	Middle-East Respiratory Syndrome	Coronavirus with over 2,000 cases in regional outbreak since 2012
MHV	Mouse hepatitis virus	Coronavirus surrogate
Nosocomial	Healthcare- or hospital-associated infections	Characteristic of SARS and MERS outbreaks, lead to refinement of infection control procedures
PCR	Polymerase chain reaction	PCR (or real-time [RT] or quantitative [Q] PCR) is a method of increasing the amount of genetic material in a sample, which is then used for diagnostic testing to confirm the presence of SARS-CoV-2
PFU	Plaque forming unit	Measurement of the number of infectious virus particles as determined by plaque forming assay. A measurement of sample infectivity
PPE	Personal protective equipment	Gowns, masks, gloves, and any other measures used to prevent spread between individuals
R_0	Basic reproduction number	A measure of transmissibility. Specifically, the average number of new infections caused by a typical infectious individual in a wholly susceptible population

Acronym/Term	Definition	Description
SARS	Severe Acute Respiratory Syndrome	Coronavirus with over 8,000 cases in global 2002-2003 outbreak
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2	Official name for the virus previously known as 2019-nCoV
SEIR	Susceptible (S), exposed (E), infected (I), and resistant (R)	A type of modeling that incorporates the flow of people between the following states: susceptible (S), exposed (E), infected (I), and resistant (R), and is being used for SARS-CoV-2 forecasting
Serial interval	Length of time between symptom onset of successive cases in a transmission chain	The serial interval can be used to estimate R_0, and is useful for estimating the rate of outbreak spread
SIR	Susceptible (S), infected (I), and resistant (R)	A type of modeling that incorporates the flow of people between the following states: susceptible (S), infected (I), and resistant (R), and is being used for SARS-CoV-2 forecasting
Superspreading	One individual responsible for an abnormally large number of secondary infections	Superspreading can be caused by high variance in the distribution of secondary cases caused by a single individual; most individuals infect very few people, while some infect a large number, even with the same average number of secondary infections
$TCID_{50}$	50% Tissue Culture Infectious Dose	The number of infectious units which will infect 50% of tissue culture monolayers. A measurement of sample infectivity
Transgenic	Genetically modified	In this case, animal models modified to be more susceptible to MERS and/or SARS by adding proteins or receptors necessary for infection

Literature Cited:

1. (U) China approves first anti-viral drug against coronavirus Covid-19. *Pharmaceutical Technology* 2020. https://www.pharmaceutical-technology.com/news/china-approves-favilavir-covid-19/
2. (U) Coronavirus diagnosed at mink farms in North Brabant. *NOS* 2020. https://nos.nl/artikel/2331784-coronavirus-vastgesteld-bij-nertsenfokkerijen-in-noord-brabant.html
3. (U) Coronavirus Survey Reveals 13.9% In New York Have COVID-19 Antibodies, Cuomo Says. *CBS* 2020. https://newyork.cbslocal.com/2020/04/23/coronavirus-survey-reveals-13-9-percent-in-new-york-have-covid-19-antibodies-cuomo-says/
4. (U) A Multicenter, Adaptive, Randomized Blinded Controlled Trial of the Safety and Efficacy of Investigational Therapeutics for the Treatment of COVID-19 in Hospitalized Adults 2020. https://clinicaltrials.gov/ct2/show/NCT04280705
5. (U) Phase I, Open-Label, Dose-Ranging Study of the Safety and Immunogenicity of 2019-nCoV Vaccine (mRNA-1273) in Healthy Adults 2020. https://clinicaltrials.gov/ct2/show/record/NCT04283461?term=mrna-1273&draw=2&rank=1
6. (U) Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020. . *MMWR* **2020**. https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e2.htm?s_cid=mm6912e2_w#suggestedcitation
7. (U) Tocilizumab improves significantly clinical outcomes of patients with moderate or severe COVID-19 pneumonia. Assistance Publique - Hôpitaux de Paris/Universities/INSERM-REACTing COVID-19 academic research collaboration: 2020. https://www.aphp.fr/contenu/tocilizumab-improves-significantly-clinical-outcomes-patients-moderate-or-severe-covid-19
8. (U) [Wuhan Pneumonia] The Hospital Authority stated that 2 critically ill patients needed external life support treatment. https://www.singtao.ca/4037242/2020-01-14/news-%E3%80%90%E6%AD%A6%E6%BC%A2%E8%82%BA%E7%82%8E%E3%80%91%E9%86%AB%E7%AE%A1%E5%B1%80%E6%8C%872%E5%90%8D%E9%87%8D%E7%97%87%E7%97%85%E6%82%A3%E9%9C%80%E9%AB%94%E5%A4%96%E7%94%9F%E5%91%BD%E6%94%AF%E6%8C%81%E6%B2%BB%E7%99%82/?variant=zh-hk.
9. (U) AAAS, You may be able to spread coronavirus just by breathing, new report finds. *Science* 2 April, 2020. https://www.sciencemag.org/news/2020/04/you-may-be-able-spread-coronavirus-just-breathing-new-report-finds
10. (U) Adams, E. R.; Anand, R.; Andersson, M. I.; Auckland, K.; Baillie, J. K.; Barnes, E.; Bell, J.; Berry, T.; Bibi, S.; Carroll, M.; Chinnakannan, S.; Clutterbuck, E.; Cornall, R. J.; Crook, D. W.; De Silva, T.; Dejnirattisai, W.; Dingle, K. E.; Dold, C.; Eyre, D. W.; Farmer, H.; Hoosdally, S. J.; Hunter, A.; Jeffrey, K.; Klenerman, P.; Knight, J.; Knowles, C.; Kwok, A. J.; Leuschner, U.; Liu, C.; Lopez-Camacho, C.; Matthews, P. C.; McGivern, H.; Mentzer, A. J.; Milton, J.; Mongkolsapaya, J.; Moore, S. C.; Oliveira, M. S.; Pereira, F.; Peto, T.; Ploeg, R. J.; Pollard, A.; Prince, T.; Roberts, D. J.; Rudkin, J. K.; Screaton, G. R.; Semple, M. G.; Skelly, D. T.; Smith, E. N.; Staves, J.; Stuart, D.; Supasa, P.; Surik, T.; Tsang, P.; Turtle, L.; Walker, A. S.; Wang, B.; Washington, C.; Watkins, N.; Whitehouse, J.; Beer, S.; Levin, R.; Espinosa, A.; Georgiou, D.; Martinez Garrido, J. C.; Thraves, H.; Perez Lopez, E.; del Rocio Fernandez Mendoza, M.; Sobrino Diaz, A. J.; Sanchez, V., Evaluation of antibody testing for SARS-Cov-2 using ELISA and lateral flow immunoassays. *medRxiv* **2020**, 2020.04.15.20066407. https://www.medrxiv.org/content/medrxiv/early/2020/04/20/2020.04.15.20066407.full.pdf
11. (U) Agency, U. S. E. P., EPA's Registered Antimicrobial Products for Use Against Novel Coronavirus SARS-CoV-2, the Cause of COVID-19. https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2.
12. (U) Agrawal, A. S.; Garron, T.; Tao, X.; Peng, B. H.; Wakamiya, M.; Chan, T. S.; Couch, R. B.; Tseng, C. T., Generation of a transgenic mouse model of Middle East respiratory syndrome coronavirus infection

and disease. *J Virol* **2015,** *89* (7), 3659-70.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4403411/pdf/zjv3659.pdf
13. (U) Aleta, A.; Martin-Corral, D.; Pastore y Piontti, A.; Ajelli, M.; Litivinova, M.; Chinazzi, M.; Dean, N.; Halloran, M. E.; Longini, I.; Merler, S.; Pentland, A.; Vespignani, A.; Moro, E.; Moreno, Y., Modeling the impact of social distancing, testing, contact tracing and household quarantine on second-wave scenarios of the COVID-19 epidemic. *Preprint* **2020**. https://www.mobs-lab.org/uploads/6/7/8/7/6787877/tracing_main_may4.pdf
14. (U) Altmann, D. M.; Douek, D. C.; Boyton, R. J., What policy makers need to know about COVID-19 protective immunity. *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)30985-5
15. (U) Amanat, F.; Krammer, F., SARS-CoV-2 vaccines: status report. *Journal of Immunology* **2020,** *Early View*. https://marlin-prod.literatumonline.com/pb-assets/journals/research/immunity/SARS-CoV-2%20vaccines%20status%20report.pdf
16. (U) AMS, *Position Statement from the National Centre for Infectious Diseases and the Chapter of Infectious Disease Physicians, Academy of Medicine, Singapore – 23 May 2020*; Academy of Medicine Singapore: 2020.
https://www.ncid.sg/Documents/Period%20of%20Infectivity%20Position%20Statementv2.pdf
17. (U) Andersen, K. G.; Rambaut, A.; Lipkin, W. I.; Holmes, E. C.; Garry, R. F., The proximal origin of SARS-CoV-2. *Nature Medicine* **2020**. https://doi.org/10.1038/s41591-020-0820-9
18. (U) Anderson, K., Estimates of the clock and TMRCA for 2019-nCoV based on 27 genomes. http://virological.org/t/clock-and-tmrca-based-on-27-genomes/347 (accessed 01/26/2020).
19. (U) Arentz, M.; Yim, E.; Klaff, L.; Lokhandwala, S.; Riedo, F. X.; Chong, M.; Lee, M., Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State. *JAMA* **2020**.
https://doi.org/10.1001/jama.2020.4326
20. (U) Argenziano, M. G.; Bruce, S. L.; Slater, C. L.; Tiao, J. R.; Baldwin, M. R.; Barr, R. G.; Chang, B. P.; Chau, K. H.; Choi, J. J.; Gavin, N.; Goyal, P.; Mills, A. M.; Patel, A. A.; Romney, M.-L. S.; Safford, M. M.; Schluger, N. W.; Sengupta, S.; Sobieszczyk, M. E.; Zucker, J. E.; Asadourian, P. A.; Bell, F. M.; Boyd, R.; Cohen, M. F.; Colquhoun, M. I.; Colville, L. A.; de Jonge, J. H.; Dershowitz, L. B.; Dey, S. A.; Eiseman, K. A.; Girvin, Z. P.; Goni, D. T.; Harb, A. A.; Herzik, N.; Householder, S.; Karaaslan, L. E.; Lee, H.; Lieberman, E.; Ling, A.; Lu, R.; Shou, A. Y.; Sisti, A. C.; Snow, Z. E.; Sperring, C. P.; Xiong, Y.; Zhou, H. W.; Natarajan, K.; Hripcsak, G.; Chen, R., Characterization and Clinical Course of 1000 Patients with COVID-19 in New York: retrospective case series. *medRxiv* **2020**, 2020.04.20.20072116.
https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.20.20072116.full.pdf
21. (U) Arons, M. M.; Hatfield, K. M.; Reddy, S. C.; Kimball, A.; James, A.; Jacobs, J. R.; Taylor, J.; Spicer, K.; Bardossy, A. C.; Oakley, L. P.; Tanwar, S.; Dyal, J. W.; Harney, J.; Chisty, Z.; Bell, J. M.; Methner, M.; Paul, P.; Carlson, C. M.; McLaughlin, H. P.; Thornburg, N.; Tong, S.; Tamin, A.; Tao, Y.; Uehara, A.; Harcourt, J.; Clark, S.; Brostrom-Smith, C.; Page, L. C.; Kay, M.; Lewis, J.; Montgomery, P.; Stone, N. D.; Clark, T. A.; Honein, M. A.; Duchin, J. S.; Jernigan, J. A., Presymptomatic SARS-CoV-2 Infections and Transmission in a Skilled Nursing Facility. *New England Journal of Medicine* **2020**.
https://www.nejm.org/doi/full/10.1056/NEJMoa2008457
22. (U) Auld, S.; Caridi-Scheible, M.; Blum, J. M.; Robichaux, C. J.; Kraft, C. S.; Jacob, J. T.; Jabaley, C. S.; Carpenter, D.; Kaplow, R.; Hernandez, A. C.; Adelman, M. W.; Martin, G. S.; Coopersmith, C. M.; Murphy, D. J., ICU and ventilator mortality among critically ill adults with COVID-19. *medRxiv* **2020**, 2020.04.23.20076737.
https://www.medrxiv.org/content/medrxiv/early/2020/04/26/2020.04.23.20076737.full.pdf
23. (U) Aziz, M.; Fatima, R.; Assaly, R., Elevated Interleukin-6 and Severe COVID-19: A Meta-Analysis. *J Med Virol* **2020**.
24. (U) Bae, S.; Kim, M.-C.; Kim, J. Y.; Cha, H.-H.; Lim, J. S.; Jung, J.; Kim, M.-J.; Oh, D. K.; Lee, M.-K.; Choi, S.-H.; Sung, M.; Hong, S.-B.; Chung, J.-W.; Kim, S.-H., Effectiveness of Surgical and Cotton Masks in

Blocking SARS–CoV-2: A Controlled Comparison in 4 Patients. *Annals of Internal Medicine* **2020**. https://doi.org/10.7326/M20-1342
25. (U) Bai, H. X.; Wang, R.; Xiong, Z.; Hsieh, B.; Chang, K.; Halsey, K.; Tran, T. M. L.; Choi, J. W.; Wang, D. C.; Shi, L. B.; Mei, J.; Jiang, X. L.; Pan, I.; Zeng, Q. H.; Hu, P. F.; Li, Y. H.; Fu, F. X.; Huang, R. Y.; Sebro, R.; Yu, Q. Z.; Atalay, M. K.; Liao, W. H., AI Augmentation of Radiologist Performance in Distinguishing COVID-19 from Pneumonia of Other Etiology on Chest CT. *Radiology* **2020**, 201491.
26. (U) Bai, Y.; Yao, L.; Wei, T.; Tian, F.; Jin, D.-Y.; Chen, L.; Wang, M., Presumed Asymptomatic Carrier Transmission of COVID-19. *JAMA*.
27. (U) Bao, L.; Deng, W.; Gao, H.; Xiao, C.; Liu, J.; Xue, J.; Lv, Q.; Liu, J.; Yu, P.; Xu, Y.; Qi, F.; Qu, Y.; Li, F.; Xiang, Z.; Yu, H.; Gong, S.; Liu, M.; Wang, G.; Wang, S.; Song, Z.; Zhao, W.; Han, Y.; Zhao, L.; Liu, X.; Wei, Q.; Qin, C., Reinfection could not occur in SARS-CoV-2 infected rhesus macaques. *bioRxiv* **2020**, 2020.03.13.990226.
https://www.biorxiv.org/content/biorxiv/early/2020/03/14/2020.03.13.990226.full.pdf
28. (U) Bao, L.; Deng, W.; Huang, B.; Gao, H.; Liu, J.; Ren, L.; Wei, Q.; Yu, P.; Xu, Y.; Qi, F.; Qu, Y.; Li, F.; Lv, Q.; Wang, W.; Xue, J.; Gong, S.; Liu, M.; Wang, G.; Wang, S.; Song, Z.; Zhao, L.; Liu, P.; Zhao, L.; Ye, F.; Wang, H.; Zhou, W.; Zhu, N.; Zhen, W.; Yu, H.; Zhang, X.; Guo, L.; Chen, L.; Wang, C.; Wang, Y.; Wang, X.; Xiao, Y.; Sun, Q.; Liu, H.; Zhu, F.; Ma, C.; Yan, L.; Yang, M.; Han, J.; Xu, W.; Tan, W.; Peng, X.; Jin, Q.; Wu, G.; Qin, C., The pathogenicity of SARS-CoV-2 in hACE2 transgenic mice. *Nature* **2020**.
29. (U) Bao, L.; Gao, H.; Deng, W.; Lv, Q.; Yu, H.; Liu, M.; Yu, P.; Liu, J.; Qu, Y.; Gong, S.; Lin, K.; Qi, F.; Xu, Y.; Li, F.; Xiao, C.; Xue, J.; Song, Z.; Xiang, Z.; Wang, G.; Wang, S.; Liu, X.; Zhao, W.; Han, Y.; Wei, Q.; Qin, C., Transmission of SARS-CoV-2 via close contact and respiratory droplets among hACE2 mice. *The Journal of Infectious Diseases* **2020**. https://doi.org/10.1093/infdis/jiaa281
30. (U) BBC, Coronavirus: California declares emergency after death. *BBC* 2020.
https://www.bbc.com/news/world-us-canada-51740706
31. (U) Bedford, T.; Neher, R., Genomic epidemiology of novel coronavirus (nCoV) using data from GISAID. https://nextstrain.org/ncov.
32. (U) Beigel, J. H.; Tomashek, K. M.; Dodd, L. E.; Mehta, A. K.; Zingman, B. S.; Kalil, A. C.; Hohmann, E.; Chu, H. Y.; Luetkemeyer, A.; Kline, S.; Lopez de Castilla, D.; Finberg, R. W.; Dierberg, K.; Tapson, V.; Hsieh, L.; Patterson, T. F.; Paredes, R.; Sweeney, D. A.; Short, W. R.; Touloumi, G.; Lye, D. C.; Ohmagari, N.; Oh, M.-d.; Ruiz-Palacios, G. M.; Benfield, T.; Fätkenheuer, G.; Kortepeter, M. G.; Atmar, R. L.; Creech, C. B.; Lundgren, J.; Babiker, A. G.; Pett, S.; Neaton, J. D.; Burgess, T. H.; Bonnett, T.; Green, M.; Makowski, M.; Osinusi, A.; Nayak, S.; Lane, H. C., Remdesivir for the Treatment of Covid-19 — Preliminary Report. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMoa2007764
33. (U) Belhadi, D.; Peiffer-Smadja, N.; Yazdanpanah, Y.; Mentré, F.; Laouénan, C., A brief review of antiviral drugs evaluated in registered clinical trials for COVID-19. *medRxiv* **2020**, 2020.03.18.20038190.
https://www.medrxiv.org/content/medrxiv/early/2020/03/20/2020.03.18.20038190.full.pdf
34. (U) Bendavid, E.; Mulaney, B.; Sood, N.; Shah, S.; Ling, E.; Bromley-Dulfano, R.; Lai, C.; Weissberg, Z.; Saavedra, R.; Tedrow, J.; Tversky, D.; Bogan, A.; Kupiec, T.; Eichner, D.; Gupta, R.; Ioannidis, J.; Bhattacharya, J., COVID-19 Antibody Seroprevalence in Santa Clara County, California. *medRxiv* **2020**, 2020.04.14.20062463.
https://www.medrxiv.org/content/medrxiv/early/2020/04/17/2020.04.14.20062463.full.pdf
35. (U) Bessière, F.; Roccia, H.; Delinière, A.; Charrière, R.; Chevalier, P.; Argaud, L.; Cour, M., Assessment of QT Intervals in a Case Series of Patients With Coronavirus Disease 2019 (COVID-19) Infection Treated With Hydroxychloroquine Alone or in Combination With Azithromycin in an Intensive Care Unit. *JAMA Cardiology* **2020**. https://doi.org/10.1001/jamacardio.2020.1787
36. (U) BGI, BGI Responds to Novel Coronavirus with Real-Time Detection Kits, Deploys Emergency Team to Wuhan. 2020. https://www.bgi.com/global/company/news/bgi-responds-to-novel-coronavirus-with-real-time-detection-kits-deploys-emergency-team-to-wuhan/

37. (U) Bhatia, S.; al., e., Short-term forecasts of COVID-19 deaths in multiple countries. https://mrc-ide.github.io/covid19-short-term-forecasts/index.html#introduction.
38. (U) Bi, Q.; Wu, Y.; Mei, S.; Ye, C.; Zou, X.; Zhang, Z.; Liu, X.; Wei, L.; Truelove, S. A.; Zhang, T.; Gao, W.; Cheng, C.; Tang, X.; Wu, X.; Wu, Y.; Sun, B.; Huang, S.; Sun, Y.; Zhang, J.; Ma, T.; Lessler, J.; Feng, T., Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. *Lancet Infect Dis* **2020**. https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30287-5/fulltext
39. (U) Biotech, M., Mesa Biotech Receives Emergency Use Authorization from FDA for a 30 Minute Point of Care Molecular COVID-19 Test. Mesa Biotech: 2020. https://www.mesabiotech.com/news/euacoronavirus
40. (U) Borba, M. G. S.; Val, F. F. A.; Sampaio, V. S.; Alexandre, M. A. A.; Melo, G. C.; Brito, M.; Mourão, M. P. G.; Brito-Sousa, J. D.; Baía-da-Silva, D.; Guerra, M. V. F.; Hajjar, L. A.; Pinto, R. C.; Balieiro, A. A. S.; Pacheco, A. G. F.; Santos, J. D. O., Jr; Naveca, F. G.; Xavier, M. S.; Siqueira, A. M.; Schwarzbold, A.; Croda, J.; Nogueira, M. L.; Romero, G. A. S.; Bassat, Q.; Fontes, C. J.; Albuquerque, B. C.; Daniel-Ribeiro, C.-T.; Monteiro, W. M.; Lacerda, M. V. G.; Team, f. t. C.-. Effect of High vs Low Doses of Chloroquine Diphosphate as Adjunctive Therapy for Patients Hospitalized With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection: A Randomized Clinical Trial. *JAMA Network Open* **2020,** *3* (4), e208857-e208857. https://doi.org/10.1001/jamanetworkopen.2020.8857
41. (U) Bouaziz, J.; Duong, T.; Jachiet, M.; Velter, C.; Lestang, P.; Cassius, C.; Arsouze, A.; Domergue Than Trong, E.; Bagot, M.; Begon, E.; Sulimovic, L.; Rybojad, M., Vascular skin symptoms in COVID-19: a french observational study. *Journal of the European Academy of Dermatology and Venereology n/a* (n/a). https://onlinelibrary.wiley.com/doi/abs/10.1111/jdv.16544
42. (U) Branswell, H., Sanofi announces it will work with HHS to develop a coronavirus vaccine. Statnews, Ed. 2020. https://www.statnews.com/2020/02/18/sanofi-announces-it-will-work-with-hhs-to-develop-coronavirus-vaccine/
43. (U) Braun, J.; Loyal, L.; Frentsch, M.; Wendisch, D.; Georg, P.; Kurth, F.; Hippenstiel, S.; Dingeldey, M.; Kruse, B.; Fauchere, F.; Baysal, E.; Mangold, M.; Henze, L.; Lauster, R.; Mall, M.; Beyer, K.; Roehmel, J.; Schmitz, J.; Miltenyi, S.; Mueller, M. A.; Witzenrath, M.; Suttorp, N.; Kern, F.; Reimer, U.; Wenschuh, H.; Drosten, C.; Corman, V. M.; Giesecke-Thiel, C.; Sander, L.-E.; Thiel, A., Presence of SARS-CoV-2 reactive T cells in COVID-19 patients and healthy donors. *medRxiv* **2020**, 2020.04.17.20061440. https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.17.20061440.full.pdf
44. (U) Brennan, Z., FDA issues 2nd EUA for decontamination system for N95 masks. *Regulatory Focus* 2020. https://www.raps.org/news-and-articles/news-articles/2020/4/fda-issues-2nd-eua-for-decontamination-system-for
45. (U) Brosseau, L. M., COMMENTARY: COVID-19 transmission messages should hinge on science. http://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science.
46. (U) Brosseau, L. M.; Jones, R., Commentary: Protecting health workers from airborne MERS-CoV - learning from SARS. http://www.cidrap.umn.edu/news-perspective/2014/05/commentary-protecting-health-workers-airborne-mers-cov-learning-sars.
47. (U) Bryner, J., First US infant death linked to COVID-19 reported in Illinois. *LiveScience* 2020. https://www.livescience.com/us-infant-dies-coronavirus.html
48. (U) Burbelo, P. D.; Riedo, F. X.; Morishima, C.; Rawlings, S.; Smith, D.; Das, S.; Strich, J. R.; Chertow, D. S.; Davey, R. T.; Cohen, J. I., Detection of Nucleocapsid Antibody to SARS-CoV-2 is More Sensitive than Antibody to Spike Protein in COVID-19 Patients. *J Infect Dis* **2020**.
49. (U) Burrer, S. L.; de Perio, M. A.; Hughes, M. M.; Kuhar, D. T.; Luckhaupt, S. E.; McDaniel, C. J.; Porter, R. M.; Silk, B.; Stuckey, M. J.; Walters, M., Characteristics of health care personnel with COVID-19—United States, February 12–April 9, 2020. **2020**.

50. (U) Cagliani, R.; Forni, D.; Clerici, M.; Sironi, M., Computational inference of selection underlying the evolution of the novel coronavirus, SARS-CoV-2. *J Virol* **2020**.
51. (U) Cagliani, R.; Forni, D.; Clerici, M.; Sironi, M., Computational inference of selection underlying the evolution of the novel coronavirus, SARS-CoV-2. *Journal of Virology* **2020**, JVI.00411-20. https://jvi.asm.org/content/jvi/early/2020/03/27/JVI.00411-20.full.pdf
52. (U) Callow, K.; Parry, H.; Sergeant, M.; Tyrrell, D., The time course of the immune response to experimental coronavirus infection of man. *Epidemiology & Infection* **1990,** *105* (2), 435-446.
53. (U) Cao, B.; Wang, Y.; Wen, D.; Liu, W.; Wang, J.; Fan, G.; Ruan, L.; Song, B.; Cai, Y.; Wei, M.; Li, X.; Xia, J.; Chen, N.; Xiang, J.; Yu, T.; Bai, T.; Xie, X.; Zhang, L.; Li, C.; Yuan, Y.; Chen, H.; Li, H.; Huang, H.; Tu, S.; Gong, F.; Liu, Y.; Wei, Y.; Dong, C.; Zhou, F.; Gu, X.; Xu, J.; Liu, Z.; Zhang, Y.; Li, H.; Shang, L.; Wang, K.; Li, K.; Zhou, X.; Dong, X.; Qu, Z.; Lu, S.; Hu, X.; Ruan, S.; Luo, S.; Wu, J.; Peng, L.; Cheng, F.; Pan, L.; Zou, J.; Jia, C.; Wang, J.; Liu, X.; Wang, S.; Wu, X.; Ge, Q.; He, J.; Zhan, H.; Qiu, F.; Guo, L.; Huang, C.; Jaki, T.; Hayden, F. G.; Horby, P. W.; Zhang, D.; Wang, C., A Trial of Lopinavir–Ritonavir in Adults Hospitalized with Severe Covid-19. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMoa2001282
54. (U) Cao, W.; Liu, X.; Bai, T.; Fan, H.; Hong, K.; Song, H.; Han, Y.; Lin, L.; Ruan, L.; Li, T., High-dose intravenous immunoglobulin as a therapeutic option for deteriorating patients with Coronavirus Disease 2019. *Open Forum Infectious Diseases* **2020**. https://doi.org/10.1093/ofid/ofaa102
55. (U) Casadevall, A.; Pirofski, L.-a., The convalescent sera option for containing COVID-19. *The Journal of Clinical Investigation* **2020,** *130* (4). https://doi.org/10.1172/JCI138003
56. (U) Casanova, L. M.; Jeon, S.; Rutala, W. A.; Weber, D. J.; Sobsey, M. D., Effects of air temperature and relative humidity on coronavirus survival on surfaces. *Applied and environmental microbiology* **2010,** *76* (9), 2712-2717. https://www.ncbi.nlm.nih.gov/pubmed/20228108
57. (U) Casey, M.; Griffin, J.; McAloon, C. G.; Byrne, A. W.; Madden, J. M.; McEvoy, D.; Collins, A. B.; Hunt, K.; Barber, A.; Butler, F.; Lane, E. A.; O Brien, K.; Wall, P.; Walsh, K. A.; More, S. J., Estimating pre-symptomatic transmission of COVID-19: a secondary analysis using published data. *medRxiv* **2020**, 2020.05.08.20094870. https://www.medrxiv.org/content/medrxiv/early/2020/05/11/2020.05.08.20094870.full.pdf
58. (U) CDC, 2019 Novel Coronavirus RT-PCR Identification Protocols. https://www.cdc.gov/coronavirus/2019-ncov/lab/rt-pcr-detection-instructions.html.
59. (U) CDC, CDC launches national viral genomics consortium to better map SARS-CoV-2 transmission. Centers for Disease Control and Prevention: 2020. https://www.cdc.gov/media/releases/2020/p0501-SARS-CoV-2-transmission-map.html
60. (U) CDC, Confirmation of COVID-19 in Two Pet Cats in New York. Centers for Disease Control and Prevention: 2020. https://www.cdc.gov/media/releases/2020/s0422-covid-19-cats-NYC.html
61. (U) CDC, Confirmed 2019-nCoV Cases Globally. https://www.cdc.gov/coronavirus/2019-ncov/locations-confirmed-cases.html.
62. (U) CDC, COVID-19 Forecasts. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/forecasting-us.html.
63. (U) CDC, Interim healthcare infection prevention and control recommendations for patients under investigation for 2019 novel coronavirus. https://www.cdc.gov/coronavirus/2019-ncov/infection-control.html.
64. (U) CDC, Recommendation Regarding the Use of Cloth Face Coverings, Especially in Areas of Significant Community-Based Transmission. **2020**. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover.html
65. (U) CDC, Situation summary. https://www.cdc.gov/coronavirus/2019-nCoV/summary.html.
66. (U) CDC, Symptoms of Coronavirus. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html.

67. (U) CDC, C., China's CDC detects a large number of new coronaviruses in the South China seafood market in Wuhan http://www.chinacdc.cn/yw_9324/202001/t20200127_211469.html (accessed 01/27/2020).
68. (U) CEID, Nowcasts for the US, states, and territories. http://2019-coronavirus-tracker.com/nowcast.html.
69. (U) Ceraolo, C.; Giorgi, F. M., Genomic variance of the 2019-nCoV coronavirus. *J Med Virol* **2020,** *92* (5), 522-528.
70. (U) Chan, J. F.-W.; Yuan, S.; Kok, K.-H.; To, K. K.-W.; Chu, H.; Yang, J.; Xing, F.; Liu, J.; Yip, C. C.-Y.; Poon, R. W.-S.; Tsoi, H.-W.; Lo, S. K.-F.; Chan, K.-H.; Poon, V. K.-M.; Chan, W.-M.; Ip, J. D.; Cai, J.-P.; Cheng, V. C.-C.; Chen, H.; Hui, C. K.-M.; Yuen, K.-Y., A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *The Lancet* **2020**. https://www.sciencedirect.com/science/article/pii/S0140673620301549
71. (U) Chan, J. F.; Zhang, A. J.; Yuan, S.; Poon, V. K.; Chan, C. C.; Lee, A. C.; Chan, W. M.; Fan, Z.; Tsoi, H. W.; Wen, L.; Liang, R.; Cao, J.; Chen, Y.; Tang, K.; Luo, C.; Cai, J. P.; Kok, K. H.; Chu, H.; Chan, K. H.; Sridhar, S.; Chen, Z.; Chen, H.; To, K. K.; Yuen, K. Y., Simulation of the clinical and pathological manifestations of Coronavirus Disease 2019 (COVID-19) in golden Syrian hamster model: implications for disease pathogenesis and transmissibility. *Clin Infect Dis* **2020**.
https://www.ncbi.nlm.nih.gov/pubmed/32215622
72. (U) Chan, K. H.; Peiris, J. S.; Lam, S. Y.; Poon, L. L.; Yuen, K. Y.; Seto, W. H., The Effects of Temperature and Relative Humidity on the Viability of the SARS Coronavirus. *Adv Virol* **2011,** *2011*, 734690.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3265313/pdf/AV2011-734690.pdf
73. (U) Chandrashekar, A.; Liu, J.; Martinot, A. J.; McMahan, K.; Mercado, N. B.; Peter, L.; Tostanoski, L. H.; Yu, J.; Maliga, Z.; Nekorchuk, M.; Busman-Sahay, K.; Terry, M.; Wrijil, L. M.; Ducat, S.; Martinez, D. R.; Atyeo, C.; Fischinger, S.; Burke, J. S.; Slein, M. D.; Pessaint, L.; Van Ry, A.; Greenhouse, J.; Taylor, T.; Blade, K.; Cook, A.; Finneyfrock, B.; Brown, R.; Teow, E.; Velasco, J.; Zahn, R.; Wegmann, F.; Abbink, P.; Bondzie, E. A.; Dagotto, G.; Gebre, M. S.; He, X.; Jacob-Dolan, C.; Kordana, N.; Li, Z.; Lifton, M. A.; Mahrokhian, S. H.; Maxfield, L. F.; Nityanandam, R.; Nkolola, J. P.; Schmidt, A. G.; Miller, A. D.; Baric, R. S.; Alter, G.; Sorger, P. K.; Estes, J. D.; Andersen, H.; Lewis, M. G.; Barouch, D. H., SARS-CoV-2 infection protects against rechallenge in rhesus macaques. *Science* **2020**, eabc4776.
https://science.sciencemag.org/content/sci/early/2020/05/19/science.abc4776.full.pdf
74. (U) Changzheng, L. J. L., Experts in the medical treatment team: Wuhan's unexplained viral pneumonia patients can be controlled more. https://www.cn-healthcare.com/article/20200110/content-528579.html.
75. (U) Chen, C.; Cao, M.; Peng, L.; Guo, X.; Yang, F.; Wu, W.; Chen, L.; Yang, Y.; Liu, Y.; Wang, F., Coronavirus Disease-19 Among Children Outside Wuhan, China. *SSRN* **2020**.
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3546071
76. (U) Chen, C.; Huang, J.; Cheng, Z.; Wu, J.; Chen, S.; Zhang, Y.; Chen, B.; Lu, M.; Luo, Y.; Zhang, J.; Yin, P.; Wang, X., Favipiravir versus Arbidol for COVID-19: A Randomized Clinical Trial. *medRxiv* **2020**, 2020.03.17.20037432.
https://www.medrxiv.org/content/medrxiv/early/2020/03/20/2020.03.17.20037432.full.pdf
77. (U) Chen, H.; Guo, J.; Wang, C.; Luo, F.; Yu, X.; Zhang, W.; Li, J.; Zhao, D.; Xu, D.; Gong, Q., Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *The Lancet* **2020,** *395* (10226), 809-815.
78. (U) CHEN Jun, L. D., LIU Li, LIU Ping, XU Qingnian, XIA Lu, LING Yun, HUANG Dan, SONG Shuli, ZHANG Dandan, QIAN Zhiping, LI Tao, SHEN Yinzhong, LU Hongzhou, A pilot study of hydroxychloroquine in treatment of patients with moderate COVID-19. *J Zhejiang Univ (Med Sci)* **2020,** *49* (2), 215-219.
http://www.zjujournals.com/med/EN/10.3785/j.issn.1008-9292.2020.03.03

79. (U) Chen, L.; Li, Q.; Zheng, D.; Jiang, H.; Wei, Y.; Zou, L.; Feng, L.; Xiong, G.; Sun, G.; Wang, H.; Zhao, Y.; Qiao, J., Clinical Characteristics of Pregnant Women with Covid-19 in Wuhan, China. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2009226
80. (U) Chen, N.; Zhou, M.; Dong, X.; Qu, J.; Gong, F.; Han, Y.; Qiu, Y.; Wang, J.; Liu, Y.; Wei, Y.; Xia, J.; Yu, T.; Zhang, X.; Zhang, L., Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* **2020**. https://www.ncbi.nlm.nih.gov/pubmed/32007143
81. (U) Chen, Y.; Peng, H.; Wang, L.; Zhao, Y.; Zeng, L.; Gao, H.; Liu, Y., Infants Born to Mothers With a New Coronavirus (COVID-19). *Frontiers in Pediatrics* **2020,** *8* (104). https://www.frontiersin.org/article/10.3389/fped.2020.00104
82. (U) Chen, Z.; Hu, J.; Zhang, Z.; Jiang, S.; Han, S.; Yan, D.; Zhuang, R.; Hu, B.; Zhang, Z., Efficacy of hydroxychloroquine in patients with COVID-19: results of a randomized clinical trial. *medRxiv* **2020**, 2020.03.22.20040758. https://www.medrxiv.org/content/medrxiv/early/2020/04/10/2020.03.22.20040758.full.pdf
83. (U) Cheng, H.-Y.; Jian, S.-W.; Liu, D.-P.; Ng, T.-C.; Huang, W.-T.; Lin, H.-H.; Team, f. t. T. C.-O. I., Contact Tracing Assessment of COVID-19 Transmission Dynamics in Taiwan and Risk at Different Exposure Periods Before and After Symptom Onset. *JAMA Internal Medicine* **2020**. https://doi.org/10.1001/jamainternmed.2020.2020
84. (U) Cheruiyot, I.; Henry, B. M.; Lippi, G., Is there evidence of intra-uterine vertical transmission potential of COVID-19 infection in samples tested by quantitative RT-PCR? *Eur J Obstet Gynecol Reprod Biol* **2020**.
85. (U) Chicago, Forecasting for Illinois SARS-CoV-2 model. https://github.com/cobeylab/covid_IL/tree/master/Forecasting.
86. (U) Chin, A.; Chu, J.; Perera, M.; Hui, K.; Yen, H.-L.; Chan, M.; Peiris, M.; Poon, L., Stability of SARS-CoV-2 in different environmental conditions. *medRxiv* **2020**, 2020.03.15.20036673. https://www.medrxiv.org/content/medrxiv/early/2020/03/27/2020.03.15.20036673.full.pdf
87. (U) Chin, A. W. H.; Chu, J. T. S.; Perera, M. R. A.; Hui, K. P. Y.; Yen, H.-L.; Chan, M. C. W.; Peiris, M.; Poon, L. L. M., Stability of SARS-CoV-2 in different environmental conditions. *The Lancet Microbe*. https://doi.org/10.1016/S2666-5247(20)30003-3
88. (U) Chong, V. H.; Chong, P. L.; Metussin, D.; Asli, R.; Momin, R. N.; Mani, B. I.; Abdullah, M. S., Conduction abnormalities in hydroxychloroquine add on therapy to lopinavir/ritonavir in COVID-19. *J Med Virol* **2020**.
89. (U) Chughtai, A. A.; Seale, H.; MacIntyre, C. R., Use of cloth masks in the practice of infection control—evidence and policy gaps. *Int J Infect Control* **2013,** *9* (3), doi: 10.3396/IJIC.v9i3.020.13.
90. (U) Coalition, C.-C. R., Global coalition to accelerate COVID-19 clinical research in resource-limited settings. *The Lancet* **2020**. http://www.sciencedirect.com/science/article/pii/S0140673620307984
91. (U) Cockrell, A. S.; Yount, B. L.; Scobey, T.; Jensen, K.; Douglas, M.; Beall, A.; Tang, X.-C.; Marasco, W. A.; Heise, M. T.; Baric, R. S., A mouse model for MERS coronavirus-induced acute respiratory distress syndrome. *Nature microbiology* **2016,** *2* (2), 1-11.
92. (U) Cohen, J., COVID-19 vaccine protects monkeys from new coronavirus, Chinese biotech reports. *Science* 2020. https://www.sciencemag.org/news/2020/04/covid-19-vaccine-protects-monkeys-new-coronavirus-chinese-biotech-reports
93. (U) Cohen, J., Mining coronavirus genomes for clues to the outbreak's origins. *Science* 2020. https://www.sciencemag.org/news/2020/01/mining-coronavirus-genomes-clues-outbreak-s-origins
94. (U) Cohen, J., Wuhan seafood market may not be source of novel virus spreading globally. https://www.sciencemag.org/news/2020/01/wuhan-seafood-market-may-not-be-source-novel-virus-spreading-globally (accessed 01/27/2020).

95. (U) Control), E. E. C. f. D. P. a., *Interim guidance for environmental cleaning in non-healthcare facilities exposed to SARS-CoV-2*; European Centre for Disease Prevention and Control: European Centre for Disease Prevention and Control, 2020. https://www.ecdc.europa.eu/en/publications-data/interim-guidance-environmental-cleaning-non-healthcare-facilities-exposed-2019#no-link
96. (U) Corman, V. M.; Landt, O.; Kaiser, M.; Molenkamp, R.; Meijer, A.; Chu, D. K.; Bleicker, T.; Brunink, S.; Schneider, J.; Schmidt, M. L.; Mulders, D. G.; Haagmans, B. L.; van der Veer, B.; van den Brink, S.; Wijsman, L.; Goderski, G.; Romette, J. L.; Ellis, J.; Zambon, M.; Peiris, M.; Goossens, H.; Reusken, C.; Koopmans, M. P.; Drosten, C., Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill* **2020,** *25* (3). https://www.ncbi.nlm.nih.gov/pubmed/31992387
97. (U) Courtemanche, C.; Garuccio, J.; Le, A.; Pinkston, J.; Yelowitz, A., Strong Social Distancing Measures In The United States Reduced The COVID-19 Growth Rate. *Health Affairs* **2020**, 10.1377/hlthaff.2020.00608. https://doi.org/10.1377/hlthaff.2020.00608
98. (U) Coutard, B.; Valle, C.; de Lamballerie, X.; Canard, B.; Seidah, N.; Decroly, E., The spike glycoprotein of the new coronavirus 2019-nCoV contains a furin-like cleavage site absent in CoV of the same clade. *Antiviral research* **2020,** *176*, 104742.
99. (U) Cowling, B. J.; Ali, S. T.; Ng, T. W. Y.; Tsang, T. K.; Li, J. C. M.; Fong, M. W.; Liao, Q.; Kwan, M. Y.; Lee, S. L.; Chiu, S. S.; Wu, J. T.; Wu, P.; Leung, G. M., Impact assessment of non-pharmaceutical interventions against COVID-19 and influenza in Hong Kong: an observational study. *medRxiv* **2020**, 2020.03.12.20034660.
https://www.medrxiv.org/content/medrxiv/early/2020/03/16/2020.03.12.20034660.full.pdf
100. (U) Creel-Bulos, C.; Hockstein, M.; Amin, N.; Melhem, S.; Truong, A.; Sharifpour, M., Acute Cor Pulmonale in Critically Ill Patients with Covid-19. *New England Journal of Medicine* **2020**, e70.
https://www.nejm.org/doi/full/10.1056/NEJMc2010459
101. (U) Cummings, M. J.; Baldwin, M. R.; Abrams, D.; Jacobson, S. D.; Meyer, B. J.; Balough, E. M.; Aaron, J. G.; Claassen, J.; Rabbani, L. E.; Hastie, J.; Hochman, B. R.; Salazar-Schicchi, J.; Yip, N. H.; Brodie, D.; O'Donnell, M. R., Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)31189-2
102. (U) Daily, H., Wuhan Institute of Virology, Chinese Academy of Sciences and others have found that 3 drugs have a good inhibitory effect on new coronavirus. Chen, L., Ed. 2020.
http://news.cnhubei.com/content/2020-01/28/content_12656365.html
103. (U) Dandekar, R.; Barbastathis, G., Neural Network aided quarantine control model estimation of global Covid-19 spread. *arXiv preprint arXiv:2004.02752* **2020**.
104. (U) Dato, V. M.; Hostler, D.; Hahn, M. E., Simple respiratory mask. *Emerg Infect Dis* **2006,** *12* (6), 1033-4. https://www.ncbi.nlm.nih.gov/pubmed/16752475
105. (U) Davies, A.; Thompson, K. A.; Giri, K.; Kafatos, G.; Walker, J.; Bennett, A., Testing the efficacy of homemade masks: would they protect in an influenza pandemic? *Disaster Med Public Health Prep* **2013,** *7* (4), 413-8. https://www.ncbi.nlm.nih.gov/pubmed/24229526
106. (U) De Albuquerque, N.; Baig, E.; Ma, X.; Zhang, J.; He, W.; Rowe, A.; Habal, M.; Liu, M.; Shalev, I.; Downey, G. P.; Gorczynski, R.; Butany, J.; Leibowitz, J.; Weiss, S. R.; McGilvray, I. D.; Phillips, M. J.; Fish, E. N.; Levy, G. A., Murine hepatitis virus strain 1 produces a clinically relevant model of severe acute respiratory syndrome in A/J mice. *J Virol* **2006,** *80* (21), 10382-94.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1641767/pdf/0747-06.pdf
107. (U) de Haan, C. A. M.; Haijema, B. J.; Schellen, P.; Schreur, P. W.; te Lintelo, E.; Vennema, H.; Rottier, P. J. M., Cleavage of Group 1 Coronavirus Spike Proteins: How Furin Cleavage Is Traded Off against Heparan Sulfate Binding upon Cell Culture Adaptation. *Journal of Virology* **2008,** *82* (12), 6078-6083. https://jvi.asm.org/content/jvi/82/12/6078.full.pdf

108. (U) Dediego, M. L.; Pewe, L.; Alvarez, E.; Rejas, M. T.; Perlman, S.; Enjuanes, L., Pathogenicity of severe acute respiratory coronavirus deletion mutants in hACE-2 transgenic mice. *Virology* **2008,** *376* (2), 379-389. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2810402/
109. (U) Deng, W.; Bao, L.; Gao, H.; Xiang, Z.; Qu, Y.; Song, Z.; Gong, S.; Liu, J.; Liu, J.; Yu, P.; Qi, F.; Xu, Y.; Li, F.; Xiao, C.; Lv, Q.; Xue, J.; Wei, Q.; Liu, M.; Wang, G.; Wang, S.; Yu, H.; Liu, X.; Zhao, W.; Han, Y.; Qin, C., Ocular conjunctival inoculation of SARS-CoV-2 can cause mild COVID-19 in Rhesus macaques. *bioRxiv* **2020**.
110. (U) Deslandes, A.; Berti, V.; Tandjaoui-Lambotte, Y.; Alloui, C.; Carbonnelle, E.; Zahar, J. R.; Brichler, S.; Cohen, Y., SARS-CoV-2 was already spreading in France in late December 2019. *International Journal of Antimicrobial Agents* **2020**, 106006.
http://www.sciencedirect.com/science/article/pii/S0924857920301643
111. (U) Dong, N.; Yang, X.; Ye, L.; Chen, K.; Chan, E. W.-C.; Yang, M.; Chen, S., Genomic and protein structure modelling analysis depicts the origin and infectivity of 2019-nCoV, a new coronavirus which caused a pneumonia outbreak in Wuhan, China. *bioRxiv* **2020**, 2020.01.20.913368.
https://www.biorxiv.org/content/biorxiv/early/2020/01/22/2020.01.20.913368.full.pdf
112. (U) Dong, Y.; Mo, X.; Hu, Y.; Qi, X.; Jiang, F.; Jiang, Z.; Tong, S., Epidemiological Characteristics of 2143 Pediatric Patients With 2019 Coronavirus Disease in China. *Pediatrics* **2020**, e20200702.
https://pediatrics.aappublications.org/content/pediatrics/early/2020/03/16/peds.2020-0702.full.pdf
113. (U) Du, Z.; Xu, x.; Wu, Y.; Wang, L.; Cowling, B. J.; Meyers, L. A., COVID-19 serial interval estimates based on confirmed cases in public reports from 86 Chinese cities. *medRxiv* **2020**, 2020.04.23.20075796.
https://www.medrxiv.org/content/medrxiv/early/2020/04/27/2020.04.23.20075796.full.pdf
114. (U) Du, Z.; Xu, X.; Wu, Y.; Wang, L.; Cowling, B. J.; Meyers, L. A., The serial interval of COVID-19 from publicly reported confirmed cases. *medRxiv* **2020**, 2020.02.19.20025452.
https://www.medrxiv.org/content/medrxiv/early/2020/03/13/2020.02.19.20025452.full.pdf
115. (U) Duan, S.; Zhao, X.; Wen, R.; Huang, J.-j.; Pi, G.; Zhang, S.; Han, J.; Bi, S.; Ruan, L.; Dong, X.-p., Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. *Biomedical and environmental sciences: BES* **2003,** *16* (3), 246-255.
116. (U) Duan, S. M.; Zhao, X. S.; Wen, R. F.; Huang, J. J.; Pi, G. H.; Zhang, S. X.; Han, J.; Bi, S. L.; Ruan, L.; Dong, X. P., Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. *Biomed Environ Sci* **2003,** *16* (3), 246-55.
117. (U) Endeman, H.; van der Zee, P.; van Genderen, M. E.; van den Akker, J. P. C.; Gommers, D., Progressive respiratory failure in COVID-19: a hypothesis. *The Lancet Infectious Diseases* **2020**.
https://doi.org/10.1016/S1473-3099(20)30366-2
118. (U) EuroTimes, Pfizer/BioNTech target April vaccine trial launch. *EuroTimes* 2020.
https://www.eurotimes.org/pfizer-biontech-target-april-vaccine-trial-launch/
119. (U) FDA, *Emergency Use Authorization*; Food and Drug Administration: 2020.
https://www.fda.gov/media/137886/download
120. (U) FDA, FAQs on Shortages of Surgical Masks and Gowns. https://www.fda.gov/medical-devices/personal-protective-equipment-infection-control/faqs-shortages-surgical-masks-and-gowns#kn95.
121. (U) FDA, *ID NOW COVID-19*; Food and Drug Administration: 2020.
https://www.fda.gov/media/136525/download
122. (U) FDA, *Investigational COVID-19 Convalescent Plasma - Emergency INDs*; Food and Drug Administration: 2020. https://www.fda.gov/vaccines-blood-biologics/investigational-new-drug-ind-or-device-exemption-ide-process-cber/investigational-covid-19-convalescent-plasma-emergency-inds
123. (U) FDA, Policy for Diagnostics Testing in Laboratories Certified to Perform High Complexity Testing under CLIA prior to Emergency Use Authorization for Coronavirus Disease-2019 during the Public Health

Emergency; Immediately in Effect Guidance for Industry and Food and Drug Administration Staff. 2020. https://www.regulations.gov/docket?D=FDA-2020-D-0987
124. (U) FDA, Respirator Models Removed from Appendix A. https://www.fda.gov/media/137928/download (accessed 05/15/2020).
125. (U) Feldman, O.; Meir, M.; Shavit, D.; Idelman, R.; Shavit, I., Exposure to a Surrogate Measure of Contamination From Simulated Patients by Emergency Department Personnel Wearing Personal Protective Equipment. *JAMA* **2020**. https://doi.org/10.1001/jama.2020.6633
126. (U) Ferguson, N.; Laydon, D.; Nedjati-Gilani, G.; Imai, N.; Ainslie, K.; Baguelin, M.; Bhatia, S.; Boonyasiri, A.; Cucunuba, Z.; Cuomo-Dannenburg, G.; Dighe, A.; Dorigatti, I.; Fu, H.; Gaythorpe, K.; Green, W.; Hamlet, A.; Hinsley, W.; Okell, L.; van Elsland, S.; Thompson, H.; Verity, R.; Volz, E.; Wang, H.; Wang, Y.; Walker, P.; Walters, C.; Winskill, P.; Whittaker, C.; Donnelly, C.; Riley, S.; Ghani, A., *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand*; 2020. https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf
127. (U) Firth, J. A.; Hellewell, J.; Klepac, P.; Kissler, S. M.; Group, C. C.-W.; Kucharski, A. J.; Spurgin, L. G., Combining fine-scale social contact data with epidemic modelling reveals interactions between contact tracing, quarantine, testing and physical distancing for controlling COVID-19. *Preprint* **2020**. https://cmmid.github.io/topics/covid19/reports/2020_05_25_firth_et_al_manuscript.pdf
128. (U) Fischer, R.; Morris, D. H.; van Doremalen, N.; Sarchette, S.; Matson, J.; Bushmaker, T.; Yinda, C. K.; Seifert, S.; Gamble, A.; Williamson, B.; Judson, S.; de Wit, E.; Lloyd-Smith, J.; Munster, V., Assessment of N95 respirator decontamination and re-use for SARS-CoV-2. *medRxiv* **2020**, 2020.04.11.20062018. https://www.medrxiv.org/content/medrxiv/early/2020/04/24/2020.04.11.20062018.full.pdf
129. (U) Fitzpatrick, J.; DeSalvo, K., Helping public health officials combat COVID-19. Google: 2020. https://www.blog.google/technology/health/covid-19-community-mobility-reports?hl=en
130. (U) Flahault, A.; Manetti, E.; Simonson, T.; Lee, G.; Choirat, C., COVID-19 Forecasting. https://renkulab.shinyapps.io/COVID-19-Epidemic-Forecasting/_w_e0463e1e/#shiny-tab-about.
131. (U) Forster, P.; Forster, L.; Renfrew, C.; Forster, M., Phylogenetic network analysis of SARS-CoV-2 genomes. *Proceedings of the National Academy of Sciences* **2020,** *117* (17), 9241-9243. https://www.pnas.org/content/pnas/117/17/9241.full.pdf
132. (U) Frank, H. K.; Enard, D.; Boyd, S. D., Exceptional diversity and selection pressure on SARS-CoV and SARS-CoV-2 host receptor in bats compared to other mammals. *bioRxiv* **2020**, 2020.04.20.051656. https://www.biorxiv.org/content/biorxiv/early/2020/04/20/2020.04.20.051656.full.pdf
133. (U) Friedrich-Loeffler-Institute, Novel Coronavirus SARS-CoV-2: Fruit bats and ferrets are susceptible, pigs and chickens are not. https://www.fli.de/en/press/press-releases/press-singleview/novel-coronavirus-sars-cov-2-fruit-bats-and-ferrets-are-susceptible-pigs-and-chickens-are-not/.
134. (U) Gao, Q.; Bao, L.; Mao, H.; Wang, L.; Xu, K.; Yang, M.; Li, Y.; Zhu, L.; Wang, N.; Lv, Z.; Gao, H.; Ge, X.; Kan, B.; Hu, Y.; Liu, J.; Cai, F.; Jiang, D.; Yin, Y.; Qin, C.; Li, J.; Gong, X.; Lou, X.; Shi, W.; Wu, D.; Zhang, H.; Zhu, L.; Deng, W.; Li, Y.; Lu, J.; Li, C.; Wang, X.; Yin, W.; Zhang, Y.; Qin, C., Rapid development of an inactivated vaccine for SARS-CoV-2. *bioRxiv* **2020**, 2020.04.17.046375. https://www.biorxiv.org/content/biorxiv/early/2020/04/19/2020.04.17.046375.full.pdf
135. (U) Garg, S., Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019—COVID-NET, 14 States, March 1–30, 2020. *MMWR. Morbidity and Mortality Weekly Report* **2020,** *69*.
136. (U) Gatto, M.; Bertuzzo, E.; Mari, L.; Miccoli, S.; Carraro, L.; Casagrandi, R.; Rinaldo, A., Spread and dynamics of the COVID-19 epidemic in Italy: Effects of emergency containment measures. *Proceedings of the National Academy of Sciences* **2020**, 202004978. https://www.pnas.org/content/pnas/early/2020/04/22/2004978117.full.pdf

137. (U) Gautret, P.; Lagier, J.-C.; Parola, P.; Meddeb, L.; Mailhe, M.; Doudier, B.; Courjon, J.; Giordanengo, V.; Vieira, V. E.; Dupont, H. T., Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. *International Journal of Antimicrobial Agents* **2020**, 105949.
138. (U) Geleris, J.; Sun, Y.; Platt, J.; Zucker, J.; Baldwin, M.; Hripcsak, G.; Labella, A.; Manson, D.; Kubin, C.; Barr, R. G.; Sobieszczyk, M. E.; Schluger, N. W., Observational Study of Hydroxychloroquine in Hospitalized Patients with Covid-19. *New England Journal of Medicine* **2020**.
https://www.nejm.org/doi/full/10.1056/NEJMoa2012410
139. (U) Gendelman, O.; Amital, H.; Bragazzi, N. L.; Watad, A.; Chodick, G., Continuous hydroxychloroquine or colchicine therapy does not prevent infection with SARS-CoV-2: Insights from a large healthcare database analysis. *Autoimmunity Reviews* **2020**, 102566.
http://www.sciencedirect.com/science/article/pii/S1568997220301282
140. (U) Gérard, A.; Romani, S.; Fresse, A.; Viard, D.; Parassol, N.; Granvuillemin, A.; Chouchana, L.; Rocher, F.; Drici, M.-D., "Off-label" use of hydroxychloroquine, azithromycin, lopinavir-ritonavir and chloroquine in COVID-19: A survey of cardiac adverse drug reactions by the French Network of Pharmacovigilance Centers. *Therapies* **2020**.
http://www.sciencedirect.com/science/article/pii/S0040595720300913
141. (U) Ghebreyesus, T. A., WHO Director-General's opening remarks at the media briefing on COVID-19 - 25 May 2020. World Health Organization: 2020. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---25-may-2020
142. (U) GitHub Inc., Reproducible analyses for rejecting rare genomic inversions in SARS-CoV-2. https://github.com/alexcritschristoph/sars_cov_2_inversion (accessed 04 April).
143. (U) Godoy, M., Mystery Inflammatory Syndrome In Kids And Teens Likely Linked To COVID-19. *NPR* 2020. https://www.npr.org/sections/health-shots/2020/05/07/851725443/mystery-inflammatory-syndrome-in-kids-and-teens-likely-linked-to-covid-19
144. (U) Gold, J. A., Characteristics and Clinical Outcomes of Adult Patients Hospitalized with COVID-19—Georgia, March 2020. *MMWR. Morbidity and Mortality Weekly Report* **2020,** *69*.
145. (U) Goyal, P.; Choi, J. J.; Pinheiro, L. C.; Schenck, E. J.; Chen, R.; Jabri, A.; Satlin, M. J.; Campion, T. R.; Nahid, M.; Ringel, J. B.; Hoffman, K. L.; Alshak, M. N.; Li, H. A.; Wehmeyer, G. T.; Rajan, M.; Reshetnyak, E.; Hupert, N.; Horn, E. M.; Martinez, F. J.; Gulick, R. M.; Safford, M. M., Clinical Characteristics of Covid-19 in New York City. *New England Journal of Medicine* **2020**.
https://www.nejm.org/doi/full/10.1056/NEJMc2010419
146. (U) Grifoni, A.; Weiskopf, D.; Ramirez, S. I.; Mateus, J.; Dan, J. M.; Moderbacher, C. R.; Rawlings, S. A.; Sutherland, A.; Premkumar, L.; Jadi, R. S., Targets of T cell responses to SARS-CoV-2 coronavirus in humans with COVID-19 disease and unexposed individuals. *Cell* **1920**.
147. (U) Gu, Y., COVID-19 Projections Using Machine Learning. https://covid19-projections.com/#view-projections.
148. (U) Guan, L.; Zhou, L.; Zhang, J.; Peng, W.; Chen, R., More awareness is needed for severe acute respiratory syndrome coronavirus 2019 transmission through exhaled air during non-invasive respiratory support: experience from China. *European Respiratory Journal* **2020,** *55* (3), 2000352.
https://erj.ersjournals.com/content/erj/55/3/2000352.full.pdf
149. (U) Guan, W.-j.; Ni, Z.-y.; Hu, Y.; Liang, W.-h.; Ou, C.-q.; He, J.-x.; Liu, L.; Shan, H.; Lei, C.-l.; Hui, D. S. C.; Du, B.; Li, L.-j.; Zeng, G.; Yuen, K.-Y.; Chen, R.-c.; Tang, C.-l.; Wang, T.; Chen, P.-y.; Xiang, J.; Li, S.-y.; Wang, J.-l.; Liang, Z.-j.; Peng, Y.-x.; Wei, L.; Liu, Y.; Hu, Y.-h.; Peng, P.; Wang, J.-m.; Liu, J.-y.; Chen, Z.; Li, G.; Zheng, Z.-j.; Qiu, S.-q.; Luo, J.; Ye, C.-j.; Zhu, S.-y.; Zhong, N.-s., Clinical Characteristics of Coronavirus Disease 2019 in China. *New England Journal of Medicine* **2020,** *382*, 1708-1720.
https://www.nejm.org/doi/full/10.1056/NEJMoa2002032?query=recirc_artType_railA_article

150. (U) Guo, Z.; Wang, Z.; Zhang, S.; Li, X.; Li, L.; Li, C.; Cui, Y.; Fu, R.; Dong, Y.; Chi, X., Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020. *Emerging infectious diseases* **2020,** *26* (7).
151. (U) Halfmann, P. J.; Hatta, M.; Chiba, S.; Maemura, T.; Fan, S.; Takeda, M.; Kinoshita, N.; Hattori, S. I.; Sakai-Tagawa, Y.; Iwatsuki-Horimoto, K.; Imai, M.; Kawaoka, Y., Transmission of SARS-CoV-2 in Domestic Cats. *N Engl J Med* **2020**.
152. (U) He, R.; Lu, Z.; Zhang, L.; Fan, T.; Xiong, R.; Shen, X.; Feng, H.; Meng, H.; Lin, W.; Jiang, W.; Geng, Q., The clinical course and its correlated immune status in COVID-19 pneumonia. *Journal of Clinical Virology* **2020,** *127*, 104361. http://www.sciencedirect.com/science/article/pii/S1386653220301037
153. (U) He, X.; Lau, E. H. Y.; Wu, P.; Deng, X.; Wang, J.; Hao, X.; Lau, Y. C.; Wong, J. Y.; Guan, Y.; Tan, X.; Mo, X.; Chen, Y.; Liao, B.; Chen, W.; Hu, F.; Zhang, Q.; Zhong, M.; Wu, Y.; Zhao, L.; Zhang, F.; Cowling, B. J.; Li, F.; Leung, G. M., Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nature Medicine* **2020**. https://doi.org/10.1038/s41591-020-0869-5
154. (U) Helms, J.; Kremer, S.; Merdji, H.; Clere-Jehl, R.; Schenck, M.; Kummerlen, C.; Collange, O.; Boulay, C.; Fafi-Kremer, S.; Ohana, M.; Anheim, M.; Meziani, F., Neurologic Features in Severe SARS-CoV-2 Infection. *New England Journal of Medicine* **2020**.
https://www.nejm.org/doi/full/10.1056/NEJMc2008597
155. (U) HHS, 2019-nCoV Update. 2020. https://www.hhs.gov/live/live-2/index.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fmedia%2Freleases%2F2020%2Fa0128-hhs-coronavirus-update.html#11465
156. (U) Hinton, D., qSARS-CoV-2 IgG/IgM Rapid Test- Letter of Authorization. FDA, Ed. FDA: 2020.
https://www.fda.gov/media/136622/download
157. (U) HKU, HKU hamster research shows masks effective in preventing Covid-19 transmission. University of Hong Kong: 2020. https://fightcovid19.hku.hk/hku-hamster-research-shows-masks-effective-in-preventing-covid-19-transmission/
158. (U) Holland, L. A.; Kaelin, E. A.; Maqsood, R.; Estifanos, B.; Wu, L. I.; Varsani, A.; Halden, R. U.; Hogue, B. G.; Scotch, M.; Lim, E. S., An 81 base-pair deletion in SARS-CoV-2 ORF7a identified from sentinel surveillance in Arizona (Jan-Mar 2020). *medRxiv* **2020**, 2020.04.17.20069641.
https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.17.20069641.full.pdf
159. (U) Hu, Q.; Cui, X.; Liu, X.; Peng, B.; Jiang, J.; Wang, X.; Li, Y.; Hu, W.; Ao, Z.; Duan, J.; Wang, X.; Zhu, L.; Guo, S.; Wu, G., The production of antibodies for SARS-CoV-2 and its clinical implication. *medRxiv* **2020**, 2020.04.20.20065953.
https://www.medrxiv.org/content/medrxiv/early/2020/04/24/2020.04.20.20065953.full.pdf
160. (U) Hu, Z.; Song, C.; Xu, C.; Jin, G.; Chen, Y.; Xu, X.; Ma, H.; Chen, W.; Lin, Y.; Zheng, Y.; Wang, J.; Hu, Z.; Yi, Y.; Shen, H., Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. *Science China Life Sciences* **2020**. https://doi.org/10.1007/s11427-020-1661-4
161. (U) Huang, C.; Wang, Y.; Li, X.; Ren, L.; Zhao, J.; Hu, Y.; Zhang, L.; Fan, G.; Xu, J.; Gu, X.; Cheng, Z.; Yu, T.; Xia, J.; Wei, Y.; Wu, W.; Xie, X.; Yin, W.; Li, H.; Liu, M.; Xiao, Y.; Gao, H.; Guo, L.; Xie, J.; Wang, G.; Jiang, R.; Gao, Z.; Jin, Q.; Wang, J.; Cao, B., Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* **2020**. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30183-5/fulltext
162. (U) Huang, R.; Xia, J.; Chen, Y.; Shan, C.; Wu, C., A family cluster of SARS-CoV-2 infection involving 11 patients in Nanjing, China. *The Lancet Infectious Diseases* **2020,** *20* (5), 534-535.
https://doi.org/10.1016/S1473-3099(20)30147-X
163. (U) Huang, Y.; Lyu, X.; Li, D.; Wang, Y.; Wang, L.; Zou, W.; Wei, Y.; Wu, X., A cohort study of 223 patients explores the clinical risk factors for the severity diagnosis of COVID-19. *medRxiv* **2020**,

2020.04.18.20070656.
https://www.medrxiv.org/content/medrxiv/early/2020/04/24/2020.04.18.20070656.full.pdf
164. (U) Hui, K. P. Y.; Cheung, M.-C.; Perera, R. A. P. M.; Ng, K.-C.; Bui, C. H. T.; Ho, J. C. W.; Ng, M. M. T.; Kuok, D. I. T.; Shih, K. C.; Tsao, S.-W.; Poon, L. L. M.; Peiris, M.; Nicholls, J. M.; Chan, M. C. W., Tropism, replication competence, and innate immune responses of the coronavirus SARS-CoV-2 in human respiratory tract and conjunctiva: an analysis in ex-vivo and in-vitro cultures. *The Lancet Respiratory Medicine* **2020**. https://doi.org/10.1016/S2213-2600(20)30193-4
165. (U) Hulkower, R. L.; Casanova, L. M.; Rutala, W. A.; Weber, D. J.; Sobsey, M. D., Inactivation of surrogate coronaviruses on hard surfaces by health care germicides. *American journal of infection control* **2011,** *39* (5), 401-407. https://www.sciencedirect.com/science/article/pii/S0196655310009004
166. (U) Hulme, O. J.; Wagenmakers, E.-J.; Damkier, P.; Madelung, C. F.; Siebner, H. R.; Helweg-Larsen, J.; Gronau, Q.; Benfield, T. L.; Madsen, K. H., A Bayesian reanalysis of the effects of hydroxychloroquine and azithromycin on viral carriage in patients with COVID-19. *medRxiv* **2020**, 2020.03.31.20048777. https://www.medrxiv.org/content/medrxiv/early/2020/04/28/2020.03.31.20048777.full.pdf
167. (U) Hung, I. F.-N.; Lung, K.-C.; Tso, E. Y.-K.; Liu, R.; Chung, T. W.-H.; Chu, M.-Y.; Ng, Y.-Y.; Lo, J.; Chan, J.; Tam, A. R.; Shum, H.-P.; Chan, V.; Wu, A. K.-L.; Sin, K.-M.; Leung, W.-S.; Law, W.-L.; Lung, D. C.; Sin, S.; Yeung, P.; Yip, C. C.-Y.; Zhang, R. R.; Fung, A. Y.-F.; Yan, E. Y.-W.; Leung, K.-H.; Ip, J. D.; Chu, A. W.-H.; Chan, W.-M.; Ng, A. C.-K.; Lee, R.; Fung, K.; Yeung, A.; Wu, T.-C.; Chan, J. W.-M.; Yan, W.-W.; Chan, W.-M.; Chan, J. F.-W.; Lie, A. K.-W.; Tsang, O. T.-Y.; Cheng, V. C.-C.; Que, T.-L.; Lau, C.-S.; Chan, K.-H.; To, K. K.-W.; Yuen, K.-Y., Triple combination of interferon beta-1b, lopinavir–ritonavir, and ribavirin in the treatment of patients admitted to hospital with COVID-19: an open-label, randomised, phase 2 trial. *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)31042-4
168. (U) ICNARC, *ICNARC report on COVID-19 in critical care, 24 April 2020*; Intensive Care National Audit and Research Centre: 2020. https://www.icnarc.org/DataServices/Attachments/Download/c5a62b13-6486-ea11-9125-00505601089b
169. (U) IDEXX, Leading Veterinary Diagnostic Company Sees No COVID-19 Cases in Pets. IDEXX: 2020. https://www.idexx.com/en/about-idexx/news/no-covid-19-cases-pets/
170. (U) IHME, COVID-19 Projections. https://covid19.healthdata.org/united-states-of-america.
171. (U) IQ, H., COVID-19 Forecast for United States. https://app.hospiq.com/covid19?region=.
172. (U) ISAC, Statement on IJAA paper. International Society of Antimicrobial Chemotherapy: 2020. https://www.isac.world/news-and-publications/official-isac-statement
173. (U) Iwata, K.; Doi, A.; Miyakoshi, C., Was School Closure Effective in Mitigating Coronavirus Disease 2019 (COVID-19)? Time Series Analysis Using Bayesian Inference. **2020**.
174. (U) Jankelson, L.; Karam, G.; Becker, M. L.; Chinitz, L. A.; Tsai, M. C., QT prolongation, torsades de pointes and sudden death with short courses of chloroquine or hydroxychloroquine as used in COVID-19: a systematic review. *Heart Rhythm* **2020**.
175. (U) Jarvis, C. I.; Van Zandvoort, K.; Gimma, A.; Prem, K.; Klepac, P.; Rubin, G. J.; Edmunds, W. J., Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK. *BMC Med* **2020,** *18* (1), 124.
176. (U) Jenco, M., CDC details COVID-19-related inflammatory syndrome in children. *AAP News* 2020. https://www.aappublications.org/news/2020/05/14/covid19inflammatory051420
177. (U) JHU, Coronavirus COVID-19 Global Cases by Johns Hopkins CSSE. https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6.
178. (U) Jiang, F.-C.; Jiang, X.-L.; Wang, Z.-G.; Meng, Z.-H.; Shao, S.-F.; Anderson, B. D.; Ma, M.-J., Detection of Severe Acute Respiratory Syndrome Coronavirus 2 RNA on Surfaces in Quarantine Rooms. *Emerging Infectious Diseases* **2020,** *26*. https://wwwnc.cdc.gov/eid/article/26/9/20-1435_article

179. (U) Jin, J.-M.; Bai, P.; He, W.; Wu, F.; Liu, X.-F.; Han, D.-M.; Liu, S.; Yang, J.-K., Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. *Frontiers in Public Health* **2020,** *8* (152). https://www.frontiersin.org/article/10.3389/fpubh.2020.00152
180. (U) Jing, C.; Wenjie, S.; Jianping, H.; Michelle, G.; Jing, W.; Guiqing, H., Indirect Virus Transmission in Cluster of COVID-19 Cases, Wenzhou, China, 2020. *Emerging Infectious Disease journal* **2020,** *26* (6). https://wwwnc.cdc.gov/eid/article/26/6/20-0412_article
181. (U) Johndrow, J. E.; Lum, K.; Ball, P., Estimating SARS-CoV-2-positive Americans using deaths-only data. *arXiv preprint arXiv:2004.02605* **2020**.
182. (U) Johnson, J. a., Johnson & Johnson Announces a Lead Vaccine Candidate for COVID-19; Landmark New Partnership with U.S. Department of Health & Human Services; and Commitment to Supply One Billion Vaccines Worldwide for Emergency Pandemic Use. Johnson and Johnson: 2020. https://www.jnj.com/johnson-johnson-announces-a-lead-vaccine-candidate-for-covid-19-landmark-new-partnership-with-u-s-department-of-health-human-services-and-commitment-to-supply-one-billion-vaccines-worldwide-for-emergency-pandemic-use
183. (U) Joseph, A., CDC developing serologic tests that could reveal full scope of U.S. coronavirus outbreak. *STAT* 2020. https://www.statnews.com/2020/03/11/cdc-developing-serologic-tests-that-could-reveal-full-scope-of-u-s-coronavirus-outbreak/
184. (U) Juan, J.; Gil, M. M.; Rong, Z.; Zhang, Y.; Yang, H.; Poon, L. C. Y., Effects of Coronavirus Disease 2019 (COVID-19) on Maternal, Perinatal and Neonatal Outcomes: a Systematic Review of 266 Pregnancies. *medRxiv* **2020**, 2020.05.02.20088484. https://www.medrxiv.org/content/medrxiv/early/2020/05/06/2020.05.02.20088484.full.pdf
185. (U) Jüni, P.; Rothenbühler, M.; Bobos, P.; Thorpe, K. E.; da Costa, B. R.; Fisman, D. N.; Slutsky, A. S.; Gesink, D., Impact of climate and public health interventions on the COVID-19 pandemic: A prospective cohort study. *Canadian Medical Association Journal* **2020**, cmaj.200920. https://www.cmaj.ca/content/cmaj/early/2020/05/08/cmaj.200920.full.pdf
186. (U) Karamitros, T.; Papadopoulou, G.; Bousali, M.; Mexias, A.; Tsiodras, S.; Mentis, A., SARS-CoV-2 exhibits intra-host genomic plasticity and low-frequency polymorphic quasispecies. *bioRxiv* **2020**, 2020.03.27.009480. http://biorxiv.org/content/early/2020/03/28/2020.03.27.009480.abstract
187. (U) KCDC, Findings from investigation and analysis of re-positive cases. Korean Centers for Disease Control and Prevention: 2020. https://www.cdc.go.kr/board/board.es?mid=a30402000000&bid=0030
188. (U) Kim, S. E.; Jeong, H. S.; Yu, Y.; Shin, S. U.; Kim, S.; Oh, T. H.; Kim, U. J.; Kang, S. J.; Jang, H. C.; Jung, S. I.; Park, K. H., Viral kinetics of SARS-CoV-2 in asymptomatic carriers and presymptomatic patients. *Int J Infect Dis* **2020**.
189. (U) Kim, Y.-I.; Kim, S.-G.; Kim, S.-M.; Kim, E.-H.; Park, S.-J.; Yu, K.-M.; Chang, J.-H.; Kim, E. J.; Lee, S.; Casel, M. A. B.; Um, J.; Song, M.-S.; Jeong, H. W.; Lai, V. D.; Kim, Y.; Chin, B. S.; Park, J.-S.; Chung, K.-H.; Foo, S.-S.; Poo, H.; Mo, I.-P.; Lee, O.-J.; Webby, R. J.; Jung, J. U.; Choi, Y. K., Infection and Rapid Transmission of SARS-CoV-2 in Ferrets. *Cell Host & Microbe* **2020**. http://www.sciencedirect.com/science/article/pii/S1931312820301876
190. (U) Kissler, S. M.; Tedijanto, C.; Goldstein, E.; Grad, Y. H.; Lipsitch, M., Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. *Science* **2020**, eabb5793. https://science.sciencemag.org/content/sci/early/2020/04/14/science.abb5793.full.pdf
191. (U) Klok, F.; Kruip, M.; van der Meer, N.; Arbous, M.; Gommers, D.; Kant, K.; Kaptein, F.; van Paassen, J.; Stals, M.; Huisman, M., Incidence of thrombotic complications in critically ill ICU patients with COVID-19. *Thrombosis Research* **2020**.
192. (U) Konda, A.; Prakash, A.; Moss, G. A.; Schmoldt, M.; Grant, G. D.; Guha, S., Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks. *ACS Nano* **2020**. https://www.ncbi.nlm.nih.gov/pubmed/32329337

193. (U) Kraemer, M. U. G.; Yang, C.-H.; Gutierrez, B.; Wu, C.-H.; Klein, B.; Pigott, D. M.; du Plessis, L.; Faria, N. R.; Li, R.; Hanage, W. P.; Brownstein, J. S.; Layan, M.; Vespignani, A.; Tian, H.; Dye, C.; Pybus, O. G.; Scarpino, S. V., The effect of human mobility and control measures on the COVID-19 epidemic in China. *Science* **2020**, eabb4218.
https://science.sciencemag.org/content/sci/early/2020/03/25/science.abb4218.full.pdf
194. (U) Krantz, S. G.; Rao, A. S. S., Level of under-reporting including under-diagnosis before the first peak of COVID-19 in various countries: Preliminary Retrospective Results Based on Wavelets and Deterministic Modeling. *Infection Control & Hospital Epidemiology* **2020**, 1-8.
195. (U) Kratzel, A.; Todt, D.; V'kovski, P.; Steiner, S.; Gultom, M. L.; Thao, T. T. N.; Ebert, N.; Holwerda, M.; Steinmann, J.; Niemeyer, D.; Dijkman, R.; Kampf, G.; Drosten, C.; Steinmann, E.; Thiel, V.; Pfaender, S., Efficient inactivation of SARS-CoV-2 by WHO-recommended hand rub formulations and alcohols. *bioRxiv* **2020**, 2020.03.10.986711.
https://www.biorxiv.org/content/biorxiv/early/2020/03/17/2020.03.10.986711.full.pdf
196. (U) Krever, M.; Picheta, R., A mink may have infected a human with Covid-19, Dutch authorities believe. *CNN* 2020. https://edition.cnn.com/2020/05/20/europe/coronavirus-mink-netherlands-testing-intl/index.html
197. (U) Kucharski, A. J.; Russell, T. W.; Diamond, C.; Liu, Y.; Edmunds, J.; Funk, S.; Eggo, R. M.; Sun, F.; Jit, M.; Munday, J. D., Early dynamics of transmission and control of COVID-19: a mathematical modelling study. *The lancet infectious diseases* **2020**.
198. (U) Kucirka, L. M.; Lauer, S. A.; Laeyendecker, O.; Boon, D., Variation in False-Negative Rate of Reverse Transcriptase Polymerase Chain Reaction–Based SARS-CoV-2 Tests by Time Since Exposure. *Annals of Internal Medicine* **2020,** *0* (0), null. https://www.acpjournals.org/doi/abs/10.7326/M20-1495
199. (U) Kupferschmidt, K.; Cohen, J., WHO launches global megatrial of the four most promising coronavirus treatments. *Science* 2020. https://www.sciencemag.org/news/2020/03/who-launches-global-megatrial-four-most-promising-coronavirus-treatments
200. (U) Lai, M. Y.; Cheng, P. K.; Lim, W. W., Survival of severe acute respiratory syndrome coronavirus. *Clinical Infectious Diseases* **2005,** *41* (7), e67-e71.
https://academic.oup.com/cid/article/41/7/e67/310340
201. (U) Lai, S.; Ruktanonchai, N. W.; Zhou, L.; Prosper, O.; Luo, W.; Floyd, J. R.; Wesolowski, A.; Santillana, M.; Zhang, C.; Du, X.; Yu, H.; Tatem, A. J., Effect of non-pharmaceutical interventions to contain COVID-19 in China. *Nature* **2020**. https://doi.org/10.1038/s41586-020-2293-x
202. (U) Lam, S.; Bordin, N.; Waman, V.; Scholes, H.; Ashford, P.; Sen, N.; van Dorp, L.; Rauer, C.; Dawson, N.; Pang, C.; Abbasian, M.; Sillitoe, I.; Edwards, S.; Fraternali, F.; Lees, J.; Santini, J.; Orengo, C., SARS-CoV-2 spike protein predicted to form stable complexes with host receptor protein orthologues from mammals, but not fish, birds or reptiles. *bioRxiv* **2020**, 2020.05.01.072371.
https://www.biorxiv.org/content/biorxiv/early/2020/05/01/2020.05.01.072371.full.pdf
203. (U) Lam, T. T.-Y.; Shum, M. H.-H.; Zhu, H.-C.; Tong, Y.-G.; Ni, X.-B.; Liao, Y.-S.; Wei, W.; Cheung, W. Y.-M.; Li, W.-J.; Li, L.-F.; Leung, G. M.; Holmes, E. C.; Hu, Y.-L.; Guan, Y., Identifying SARS-CoV-2 related coronaviruses in Malayan pangolins. *Nature* **2020**. https://doi.org/10.1038/s41586-020-2169-0
204. (U) Lamers, M. M.; Beumer, J.; van der Vaart, J.; Knoops, K.; Puschhof, J.; Breugem, T. I.; Ravelli, R. B. G.; Paul van Schayck, J.; Mykytyn, A. Z.; Duimel, H. Q.; van Donselaar, E.; Riesebosch, S.; Kuijpers, H. J. H.; Schippers, D.; van de Wetering, W. J.; de Graaf, M.; Koopmans, M.; Cuppen, E.; Peters, P. J.; Haagmans, B. L.; Clevers, H., SARS-CoV-2 productively infects human gut enterocytes. *Science* **2020**, eabc1669. https://science.sciencemag.org/content/sci/early/2020/04/30/science.abc1669.full.pdf
205. (U) Lan, L.; Xu, D.; Ye, G.; Xia, C.; Wang, S.; Li, Y.; Xu, H., Positive RT-PCR Test Results in Patients Recovered From COVID-19. *Jama* **2020**. https://jamanetwork.com/journals/jama/fullarticle/2762452
206. (U) LANL, COVID-19 Confirmed and Forecasted Case Data. https://covid-19.bsvgateway.org/.

207. (U) Lasry, A.; Kidder, D.; Hast, M.; Poovey, J.; Sunshine, G.; Zviedrite, N.; Ahmed, F.; Ethier, K. A., Timing of community mitigation and changes in reported COVID-19 and community mobility—four US metropolitan areas, February 26–April 1, 2020. *morbidity and Mortality Weekly Report* **2020,** *69*, 451-457. https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e2.htm
208. (U) Lassaunière, R.; Frische, A.; Harboe, Z. B.; Nielsen, A. C.; Fomsgaard, A.; Krogfelt, K. A.; Jørgensen, C. S., Evaluation of nine commercial SARS-CoV-2 immunoassays. *medRxiv* **2020**, 2020.04.09.20056325.
https://www.medrxiv.org/content/medrxiv/early/2020/04/10/2020.04.09.20056325.full.pdf
209. (U) Lau, S., Coronavirus: WHO official says there's no evidence of 'reinfected' patients in China https://www.scmp.com/news/china/society/article/3074045/coronavirus-who-official-says-theres-no-evidence-reinfected.
210. (U) Lauer, S. A.; Grantz, K. H.; Bi, Q.; Jones, F. K.; Zheng, Q.; Meredith, H. R.; Azman, A. S.; Reich, N. G.; Lessler, J., The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. *Annals of Internal Medicine* **2020**.
https://doi.org/10.7326/M20-0504
211. (U) Leung, K.; Wu, J. T.; Liu, D.; Leung, G. M., First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)30746-7
212. (U) Leung, N. H. L.; Chu, D. K. W.; Shiu, E. Y. C.; Chan, K.-H.; McDevitt, J. J.; Hau, B. J. P.; Yen, H.-L.; Li, Y.; Ip, D. K. M.; Peiris, J. S. M.; Seto, W.-H.; Leung, G. M.; Milton, D. K.; Cowling, B. J., Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nature Medicine* **2020**.
https://doi.org/10.1038/s41591-020-0843-2
213. (U) Levi, M.; Thachil, J.; Iba, T.; Levy, J. H., Coagulation abnormalities and thrombosis in patients with COVID-19. *The Lancet Haematology* **2020**. https://doi.org/10.1016/S2352-3026(20)30145-9
214. (U) Levine, J., Scientists race to develop vaccine to deadly China coronavirus.
https://nypost.com/2020/01/25/scientists-race-to-develop-vaccine-to-deadly-china-coronavirus/.
215. (U) Lewis, D., Is the coronavirus airborne? Experts can't agree. *Nature* **2020**. 10.1038/d41586-020-00974-w
216. (U) Li, D.; Jin, M.; Bao, P.; Zhao, W.; Zhang, S., Clinical Characteristics and Results of Semen Tests Among Men With Coronavirus Disease 2019. *JAMA Network Open* **2020,** *3* (5), e208292-e208292.
https://doi.org/10.1001/jamanetworkopen.2020.8292
217. (U) Li, K.; Wohlford-Lenane, C.; Perlman, S.; Zhao, J.; Jewell, A. K.; Reznikov, L. R.; Gibson-Corley, K. N.; Meyerholz, D. K.; McCray, P. B., Jr., Middle East Respiratory Syndrome Coronavirus Causes Multiple Organ Damage and Lethal Disease in Mice Transgenic for Human Dipeptidyl Peptidase 4. *J Infect Dis* **2016,** *213* (5), 712-22. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4747621/pdf/jiv499.pdf
218. (U) Li, Q.; Guan, X.; Wu, P.; Wang, X.; Zhou, L.; Tong, Y.; Ren, R.; Leung, K. S. M.; Lau, E. H. Y.; Wong, J. Y.; Xing, X.; Xiang, N.; Wu, Y.; Li, C.; Chen, Q.; Li, D.; Liu, T.; Zhao, J.; Liu, M.; Tu, W.; Chen, C.; Jin, L.; Yang, R.; Wang, Q.; Zhou, S.; Wang, R.; Liu, H.; Luo, Y.; Liu, Y.; Shao, G.; Li, H.; Tao, Z.; Yang, Y.; Deng, Z.; Liu, B.; Ma, Z.; Zhang, Y.; Shi, G.; Lam, T. T. Y.; Wu, J. T.; Gao, G. F.; Cowling, B. J.; Yang, B.; Leung, G. M.; Feng, Z., Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMoa2001316

https://www.nejm.org/doi/10.1056/NEJMoa2001316
219. (U) Li, R.; Pei, S.; Chen, B.; Song, Y.; Zhang, T.; Yang, W.; Shaman, J., Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV2). *Science* **2020**, eabb3221.
https://science.sciencemag.org/content/sci/early/2020/03/13/science.abb3221.full.pdf

220. (U) Li, W.; Zhang, B.; Lu, J.; Liu, S.; Chang, Z.; Cao, P.; Liu, X.; Zhang, P.; Ling, Y.; Tao, K.; Chen, J., The characteristics of household transmission of COVID-19. *Clinical Infectious Diseases* **2020**. https://doi.org/10.1093/cid/ciaa450
221. (U) Li, X.; Zai, J.; Zhao, Q.; Nie, Q.; Li, Y.; Foley, B. T.; Chaillon, A., Evolutionary history, potential intermediate animal host, and cross-species analyses of SARS-CoV-2. *Journal of Medical Virology* **2020,** *n/a* (n/a). https://onlinelibrary.wiley.com/doi/abs/10.1002/jmv.25731
222. (U) Li, Y.; Qian, H.; Hang, J.; Chen, X.; Hong, L.; Liang, P.; Li, J.; Xiao, S.; Wei, J.; Liu, L.; Kang, M., Evidence for probable aerosol transmission of SARS-CoV-2 in a poorly ventilated restaurant. *medRxiv* **2020**, 2020.04.16.20067728. https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.16.20067728.full.pdf
223. (U) Li, Y.; Xie, Z.; Lin, W.; Cai, W.; Wen, C.; Guan, Y.; Mo, X.; Wang, J.; Wang, Y.; Peng, P.; Chen, X.; Hong, W.; Xiao, G.; Liu, J.; Zhang, L.; Hu, F.; Li, F.; Zhang, F.; Deng, X.; Li, L., Efficacy and safety of lopinavir/ritonavir or arbidol in adult patients with mild/moderate COVID-19: an exploratory randomized controlled trial. *Med*. https://doi.org/10.1016/j.medj.2020.04.001
224. (U) Liu, A., China's CanSino Bio advances COVID-19 vaccine into phase 2 on preliminary safety data. *Fierce Pharma* 2020. https://www.fiercepharma.com/vaccines/china-s-cansino-bio-advances-covid-19-vaccine-into-phase-2-preliminary-safety-data
225. (U) Liu, P.; Chen, W.; Chen, J.-P., Viral Metagenomics Revealed Sendai Virus and Coronavirus Infection of Malayan Pangolins (Manis javanica). *Viruses* **2019,** *11* (11), 979. https://www.mdpi.com/1999-4915/11/11/979
226. (U) Liu, P.; Jiang, J.-Z.; Wan, X.-F.; Hua, Y.; Wang, X.; Hou, F.; Chen, J.; Zou, J.; Chen, J., Are pangolins the intermediate host of the 2019 novel coronavirus (2019-nCoV) ? *bioRxiv* **2020**, 2020.02.18.954628. http://biorxiv.org/content/early/2020/02/20/2020.02.18.954628.abstract
227. (U) Liu, S. T. H.; Lin, H.-M.; Baine, I.; Wajnberg, A.; Gumprecht, J. P.; Rahman, F.; Rodriguez, D.; Tandon, P.; Bassily-Marcus, A.; Bander, J.; Sanky, C.; Dupper, A.; Zheng, A.; Altman, D. R.; Chen, B. K.; Krammer, F.; Mendu, D. R.; Firpo-Betancourt, A.; Levin, M. A.; Bagiella, E.; Casadevall, A.; Cordon-Cardo, C.; Jhang, J. S.; Arinsburg, S. A.; Reich, D. L.; Aberg, J. A.; Bouvier, N. M., Convalescent plasma treatment of severe COVID-19: A matched control study. *medRxiv* **2020**, 2020.05.20.20102236. https://www.medrxiv.org/content/medrxiv/early/2020/05/22/2020.05.20.20102236.full.pdf
228. (U) Liu, W.; Zhang, Q.; Chen, J.; Xiang, R.; Song, H.; Shu, S.; Chen, L.; Liang, L.; Zhou, J.; You, L.; Wu, P.; Zhang, B.; Lu, Y.; Xia, L.; Huang, L.; Yang, Y.; Liu, F.; Semple, M. G.; Cowling, B. J.; Lan, K.; Sun, Z.; Yu, H.; Liu, Y., Detection of Covid-19 in Children in Early January 2020 in Wuhan, China. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2003717
229. (U) Liu, Y.; Funk, S.; Flasche, S., *The Contribution of Pre-symptomatic Transmission to the COVID-19 Outbreak*; London School of Hygiene and Tropical Medicine: 2020. https://cmmid.github.io/topics/covid19/control-measures/pre-symptomatic-transmission.html
230. (U) Liu, Y.; Hu, G.; Wang, Y.; Zhao, X.; Ji, F.; Ren, W.; Gong, M.; Ju, X.; Li, C.; Hong, J.; Zhu, Y.; Cai, X.; Wu, J.; Lan, X.; Xie, Y.; Wang, X.; Yuan, Z.; Zhang, R.; Ding, Q., Functional and Genetic Analysis of Viral Receptor ACE2 Orthologs Reveals a Broad Potential Host Range of SARS-CoV-2. *bioRxiv* **2020**, 2020.04.22.046565. https://www.biorxiv.org/content/biorxiv/early/2020/05/03/2020.04.22.046565.full.pdf
231. (U) Liu, Y.; Ning, Z.; Chen, Y.; Guo, M.; Liu, Y.; Gali, N. K.; Sun, L.; Duan, Y.; Cai, J.; Westerdahl, D.; Liu, X.; Xu, K.; Ho, K.-f.; Kan, H.; Fu, Q.; Lan, K., Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. *Nature* **2020**. https://doi.org/10.1038/s41586-020-2271-3
232. (U) Liu, Y.; Yan, L.-M.; Wan, L.; Xiang, T.-X.; Le, A.; Liu, J.-M.; Peiris, M.; Poon, L. L. M.; Zhang, W., Viral dynamics in mild and severe cases of COVID-19. *The Lancet Infectious Diseases*. https://doi.org/10.1016/S1473-3099(20)30232-2

233. (U) Lokken, E. M.; Walker, C. L.; Delaney, S.; Kachikis, A.; Kretzer, N. M.; Erickson, A.; Resnick, R.; Vanderhoeven, J.; Hwang, J. K.; Barnhart, N.; Rah, J.; McCartney, S. A.; Ma, K. K.; Huebner, E. M.; Thomas, C.; Sheng, J. S.; Paek, B. W.; Retzlaff, K.; Kline, C. R.; Munson, J.; Blain, M.; Lacourse, S. M.; Deutsch, G.; Adams Waldorf, K., Clinical Characteristics of 46 Pregnant Women with a SARS-CoV-2 Infection in Washington State. *Am J Obstet Gynecol* **2020**.
234. (U) Long, Q.-X.; Liu, B.-Z.; Deng, H.-J.; Wu, G.-C.; Deng, K.; Chen, Y.-K.; Liao, P.; Qiu, J.-F.; Lin, Y.; Cai, X.-F.; Wang, D.-Q.; Hu, Y.; Ren, J.-H.; Tang, N.; Xu, Y.-Y.; Yu, L.-H.; Mo, Z.; Gong, F.; Zhang, X.-L.; Tian, W.-G.; Hu, L.; Zhang, X.-X.; Xiang, J.-L.; Du, H.-X.; Liu, H.-W.; Lang, C.-H.; Luo, X.-H.; Wu, S.-B.; Cui, X.-P.; Zhou, Z.; Zhu, M.-M.; Wang, J.; Xue, C.-J.; Li, X.-F.; Wang, L.; Li, Z.-J.; Wang, K.; Niu, C.-C.; Yang, Q.-J.; Tang, X.-J.; Zhang, Y.; Liu, X.-M.; Li, J.-J.; Zhang, D.-C.; Zhang, F.; Liu, P.; Yuan, J.; Li, Q.; Hu, J.-L.; Chen, J.; Huang, A.-L., Antibody responses to SARS-CoV-2 in patients with COVID-19. *Nature Medicine* **2020**. https://doi.org/10.1038/s41591-020-0897-1
235. (U) Lu, J.; Plessis, L. d.; Liu, Z.; Hill, V.; Kang, M.; Lin, H.; Sun, J.; Francois, S.; Kraemer, M. U. G.; Faria, N. R.; McCrone, J. T.; Peng, J.; Xiong, Q.; Yuan, R.; Zeng, L.; Zhou, P.; Liang, C.; Yi, L.; Liu, J.; Xiao, J.; Hu, J.; Liu, T.; Ma, W.; Li, W.; Su, J.; Zheng, H.; Peng, B.; Fang, S.; Su, W.; Li, K.; Sun, R.; Bai, R.; Tang, X.; Liang, M.; Quick, J.; Song, T.; Rambaut, A.; Loman, N.; Raghwani, J.; Pybus, O.; Ke, C., Genomic epidemiology of SARS-CoV-2 in Guangdong Province, China. *medRxiv* **2020**, 2020.04.01.20047076. https://www.medrxiv.org/content/medrxiv/early/2020/04/04/2020.04.01.20047076.full.pdf
236. (U) Lu, R.; Zhao, X.; Li, J.; Niu, P.; Yang, B.; Wu, H.; Wang, W.; Song, H.; Huang, B.; Zhu, N.; Bi, Y.; Ma, X.; Zhan, F.; Wang, L.; Hu, T.; Zhou, H.; Hu, Z.; Zhou, W.; Zhao, L.; Chen, J.; Meng, Y.; Wang, J.; Lin, Y.; Yuan, J.; Xie, Z.; Ma, J.; Liu, W. J.; Wang, D.; Xu, W.; Holmes, E. C.; Gao, G. F.; Wu, G.; Chen, W.; Shi, W.; Tan, W., Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)30251-8
237. (U) Lu, S.; Zhao, Y.; Yu, W.; Yang, Y.; Gao, J.; Wang, J.; Kuang, D.; Yang, M.; Yang, J.; Ma, C.; Xu, J.; Qian, X.; Li, H.; Zhao, S.; Li, J.; Wang, H.; Long, H.; Zhou, J.; Luo, F.; Ding, K.; Wu, D.; Zhang, Y.; Dong, Y.; Liu, Y.; Zheng, Y.; Lin, X.; Jiao, L.; Zheng, H.; Dai, Q.; Sun, Q.; Hu, Y.; Ke, C.; Liu, H.; Peng, X., Comparison of SARS-CoV-2 infections among 3 species of non-human primates. *bioRxiv* **2020**, 2020.04.08.031807. https://www.biorxiv.org/content/biorxiv/early/2020/04/12/2020.04.08.031807.full.pdf
238. (U) Lu, X.; Zhang, L.; Du, H.; Zhang, J.; Li, Y. Y.; Qu, J.; Zhang, W.; Wang, Y.; Bao, S.; Li, Y.; Wu, C.; Liu, H.; Liu, D.; Shao, J.; Peng, X.; Yang, Y.; Liu, Z.; Xiang, Y.; Zhang, F.; Silva, R. M.; Pinkerton, K. E.; Shen, K.; Xiao, H.; Xu, S.; Wong, G. W. K., SARS-CoV-2 Infection in Children. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2005073
239. (U) Lu, Y.; Li, Y.; Deng, W.; Liu, M.; He, Y.; Huang, L.; Lv, M.; Li, J.; Du, H., Symptomatic Infection is Associated with Prolonged Duration of Viral Shedding in Mild Coronavirus Disease 2019: A Retrospective Study of 110 Children in Wuhan. *Pediatr Infect Dis J* **2020**.
240. (U) Luo, L.; Liu, D.; Liao, X.-l.; Wu, X.-b.; Jing, Q.-l.; Zheng, J.-z.; Liu, F.-h.; Yang, S.-g.; Bi, B.; Li, Z.-h.; Liu, J.-p.; Song, W.-q.; Zhu, W.; Wang, Z.-h.; Zhang, X.-r.; Chen, P.-l.; Liu, H.-m.; Cheng, X.; Cai, M.-c.; Huang, Q.-m.; Yang, P.; Yang, X.-f.; Huang, Z.-g.; Tang, J.-l.; Ma, Y.; Mao, C., Modes of contact and risk of transmission in COVID-19 among close contacts. *medRxiv* **2020**, 2020.03.24.20042606. https://www.medrxiv.org/content/medrxiv/early/2020/03/26/2020.03.24.20042606.full.pdf
241. (U) Luo, W.; Majumder, M. S.; Liu, D.; Poirier, C.; Mandl, K. D.; Lipsitch, M.; Santillana, M., The role of absolute humidity on transmission rates of the COVID-19 outbreak. *medRxiv* **2020**, 2020.02.12.20022467. https://www.medrxiv.org/content/medrxiv/early/2020/02/17/2020.02.12.20022467.full.pdf
242. (U) Luo, Y.; Trevathan, E.; Qian, Z.; Li, Y.; Li, J.; Xiao, W.; Tu, N.; Zeng, Z.; Mo, P.; Xiong, Y.; Ye, G., Asymptomatic SARS-CoV-2 Infection in Household Contacts of a Healthcare Provider, Wuhan, China. *Emerging Infectious Disease journal* **2020,** *26* (8). https://wwwnc.cdc.gov/eid/article/26/8/20-1016_article

243. (U) MacLean, O. A.; Orton, R. J.; Singer, J. B.; Robertson, D. L., No evidence for distinct types in the evolution of SARS-CoV-2. *Virus Evolution* **2020**. https://doi.org/10.1093/ve/veaa034
244. (U) Magagnoli, J.; Narendran, S.; Pereira, F.; Cummings, T.; Hardin, J. W.; Sutton, S. S.; Ambati, J., Outcomes of hydroxychloroquine usage in United States veterans hospitalized with Covid-19. *medRxiv* **2020**, 2020.04.16.20065920.
https://www.medrxiv.org/content/medrxiv/early/2020/04/23/2020.04.16.20065920.full.pdf
245. (U) Mahévas, M.; Tran, V.-T.; Roumier, M.; Chabrol, A.; Paule, R.; Guillaud, C.; Fois, E.; Lepeule, R.; Szwebel, T.-A.; Lescure, F.-X.; Schlemmer, F.; Matignon, M.; Khellaf, M.; Crickx, E.; Terrier, B.; Morbieu, C.; Legendre, P.; Dang, J.; Schoindre, Y.; Pawlotsky, J.-M.; Michel, M.; Perrodeau, E.; Carlier, N.; Roche, N.; de Lastours, V.; Ourghanlian, C.; Kerneis, S.; Ménager, P.; Mouthon, L.; Audureau, E.; Ravaud, P.; Godeau, B.; Gallien, S.; Costedoat-Chalumeau, N., Clinical efficacy of hydroxychloroquine in patients with covid-19 pneumonia who require oxygen: observational comparative study using routine care data. *BMJ* **2020,** *369*, m1844. http://www.bmj.com/content/369/bmj.m1844.abstract
246. (U) Mahevas, M.; Tran, V.-T.; Roumier, M.; Chabrol, A.; Paule, R.; Guillaud, C.; Gallien, S.; Lepeule, R.; Szwebel, T.-A.; Lescure, X.; Schlemmer, F.; Matignon, M.; Khellaf, M.; Crickx, E.; Terrier, B.; Morbieu, C.; Legendre, P.; Dang, J.; Schoindre, Y.; Pawlotski, J.-M.; Michel, M.; Perrodeau, E.; Carlier, N.; Roche, N.; De Lastours, V.; Mouthon, L.; Audureau, E.; Ravaud, P.; Godeau, B.; Costedoat, N., No evidence of clinical efficacy of hydroxychloroquine in patients hospitalized for COVID-19 infection with oxygen requirement: results of a study using routinely collected data to emulate a target trial. *medRxiv* **2020**, 2020.04.10.20060699.
https://www.medrxiv.org/content/medrxiv/early/2020/04/14/2020.04.10.20060699.full.pdf
247. (U) Maier, B. F.; Brockmann, D., Effective containment explains subexponential growth in recent confirmed COVID-19 cases in China. *Science* **2020,** *368* (6492), 742-746.
https://science.sciencemag.org/content/sci/368/6492/742.full.pdf
248. (U) Majumder, M.; Mandl, K., Early transmissibility assessment of a novel coronavirus in Wuhan, China. *SSRN* **2020**. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3524675
249. (U) Mallapaty, S., Coronavirus can infect cats — dogs, not so much. *Nature* **2020**.
https://www.nature.com/articles/d41586-020-00984-8
250. (U) Mason, M., Hundreds of thousands in L.A. County may have been infected with coronavirus, study finds. *LA Times* 2020. https://www.latimes.com/california/story/2020-04-20/coronavirus-serology-testing-la-county
251. (U) Matthay, M. A.; Aldrich, J. M.; Gotts, J. E., Treatment for severe acute respiratory distress syndrome from COVID-19. *The Lancet Respiratory Medicine* **2020**. https://doi.org/10.1016/S2213-2600(20)30127-2
252. (U) Medicine, U. S. N. L. o., BCG Vaccination to Protect Healthcare Workers Against COVID-19 (BRACE). https://clinicaltrials.gov/ct2/show/NCT04327206?term=COVID-19&cond=BCG&draw=2&rank=4.
253. (U) Medicine, U. S. N. L. o., Evaluating the Safety, Tolerability and Immunogenicity of bacTRL-Spike Vaccine for Prevention of COVID-19. https://clinicaltrials.gov/ct2/show/NCT04334980.
254. (U) Medicine, U. S. N. L. o., Evaluation of the Safety and Immunogenicity of a SARS-CoV-2 rS (COVID-19) Nanoparticle Vaccine With/Without Matrix-M Adjuvant.
https://clinicaltrials.gov/ct2/show/NCT04368988?term=Novavax&draw=2&rank=23.
255. (U) Medicine, U. S. N. L. o., Immunity and Safety of Covid-19 Synthetic Minigene Vaccine. ClinicalTrials.gov: 2020. https://clinicaltrials.gov/ct2/show/NCT04276896
256. (U) Medicine, U. S. N. L. o., Phase Ib-II Trial of Dendritic Cell Vaccine to Prevent COVID-19 in Frontline Healthcare Workers and First Responders.
https://clinicaltrials.gov/ct2/show/NCT04386252?term=Aivita+Biomedical&draw=2&rank=1.

257. (U) Medicine, U. S. N. L. o., Safety and Immunity of Covid-19 aAPC Vaccine. ClinicalTrials.gov: 2020. https://clinicaltrials.gov/ct2/show/NCT04299724
258. (U) Medicine, U. S. N. L. o., Tableted COVID-19 Therapeutic Vaccine (COVID-19). https://clinicaltrials.gov/ct2/show/NCT04380532?term=immunitor&draw=2&rank=11.
259. (U) Mehra, M. R.; Desai, S. S.; Kuy, S.; Henry, T. D.; Patel, A. N., Cardiovascular Disease, Drug Therapy, and Mortality in Covid-19. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMoa2007621
260. (U) Mehra, M. R.; Desai, S. S.; Ruschitzka, F.; Patel, A. N., Hydroxychloroquine or chloroquine with or without a macrolide for treatment of COVID-19: a multinational registry analysis. *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)31180-6
261. (U) Melin, A. D.; Janiak, M. C.; Marrone, F.; Arora, P. S.; Higham, J. P., Comparative ACE2 variation and primate COVID-19 risk. *bioRxiv* **2020**, 2020.04.09.034967. https://www.biorxiv.org/content/biorxiv/early/2020/04/19/2020.04.09.034967.full.pdf
262. (U) Menachery, V. D.; Dinnon, K. H.; Yount, B. L.; McAnarney, E. T.; Gralinski, L. E.; Hale, A.; Graham, R. L.; Scobey, T.; Anthony, S. J.; Wang, L.; Graham, B.; Randell, S. H.; Lipkin, W. I.; Baric, R. S., Trypsin Treatment Unlocks Barrier for Zoonotic Bat Coronavirus Infection. *Journal of Virology* **2020,** *94* (5), e01774-19. https://jvi.asm.org/content/jvi/94/5/e01774-19.full.pdf
263. (U) Meng, Y.; Wu, P.; Lu, W.; Liu, K.; Ma, K.; Huang, L.; Cai, J.; Zhang, H.; Qin, Y.; Sun, H.; Ding, W.; Gui, L.; Wu, P., Sex-specific clinical characteristics and prognosis of coronavirus disease-19 infection in Wuhan, China: A retrospective study of 168 severe patients. *PLoS Pathog* **2020,** *16* (4), e1008520.
264. (U) Mercuro, N. J.; Yen, C. F.; Shim, D. J.; Maher, T. R.; McCoy, C. M.; Zimetbaum, P. J.; Gold, H. S., Risk of QT Interval Prolongation Associated With Use of Hydroxychloroquine With or Without Concomitant Azithromycin Among Hospitalized Patients Testing Positive for Coronavirus Disease 2019 (COVID-19). *JAMA Cardiology* **2020**. https://doi.org/10.1001/jamacardio.2020.1834
265. (U) Merow, C.; Urban, M. C., Seasonality and uncertainty in COVID-19 growth rates. *medRxiv* **2020**, 2020.04.19.20071951. https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.19.20071951.full.pdf
266. (U) Meyers, L. A., COVID-19 Mortality Projections for US States and Metropolitan Areas. https://covid-19.tacc.utexas.edu/projections/.
267. (U) Millett, G. A.; Jones, A. T.; Benkeser, D.; Baral, S.; Mercer, L.; Beyrer, C.; Honermann, B.; Lankiewicz, E.; Mena, L.; Crowley, J. S.; Sherwood, J.; Sullivan, P., Assessing Differential Impacts of COVID-19 on Black Communities. *Annals of Epidemiology* **2020**. http://www.sciencedirect.com/science/article/pii/S1047279720301769
268. (U) MIT, DELPHI Epidemiological Case Predictions. https://www.covidanalytics.io/projections.
269. (U) Mizumoto, K.; Kagaya, K.; Zarebski, A.; Chowell, G., Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. *Eurosurveillance* **2020,** *25* (10), 2000180. https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.10.2000180
270. (U) Moderna, Moderna Announces Positive Interim Phase 1 Data for its mRNA Vaccine (mRNA-1273) Against Novel Coronavirus. Moderna: 2020. https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-positive-interim-phase-1-data-its-mrna-vaccine/
271. (U) Moriarty, L. F.; Plucinski, M. M.; Marston, B. J. e. a., Public Health Responses fo COVID-19 Outbreaks on Cruise Ships - Worldwide, February - March 2020. *MMWR* **2020,** (ePub: 23 March 2020). https://www.cdc.gov/mmwr/volumes/69/wr/mm6912e3.htm
272. (U) Munster, V. J.; Feldmann, F.; Williamson, B. N.; van Doremalen, N.; Pérez-Pérez, L.; Schulz, J.; Meade-White, K.; Okumura, A.; Callison, J.; Brumbaugh, B.; Avanzato, V. A.; Rosenke, R.; Hanley, P. W.; Saturday, G.; Scott, D.; Fischer, E. R.; de Wit, E., Respiratory disease and virus shedding in rhesus

macaques inoculated with SARS-CoV-2. *bioRxiv* **2020**, 2020.03.21.001628. https://www.biorxiv.org/content/biorxiv/early/2020/03/21/2020.03.21.001628.full.pdf
273. (U) Muoio, D., Scanwell Health, myLAB Box unveil more at-home COVID-19 testing services. *MobiHealthNews* 20 March, 2020. https://www.mobihealthnews.com/news/scanwell-health-mylab-box-unveil-more-home-covid-19-testing-services
274. (U) Nadi, A., An at-home fingerprick blood test may help detect your exposure to coronavirus. *NBC NEWS* 04 April, 2020. https://www.nbcnews.com/health/health-news/home-fingerprick-blood-test-may-help-detect-your-exposure-coronavirus-n1176086
275. (U) NIH, *Fact Sheet for Patients And Parent/Caregivers - Emergency Use Authorization (EUA) Of Remdesivir For Coronavirus Disease 2019 (COVID-19)*; National Institutes of Health: 2020. https://www.fda.gov/media/137565/download
276. (U) NIH, NIH clinical trial of remdesivir to treat COVID-19 begins https://www.nih.gov/news-events/news-releases/nih-clinical-trial-remdesivir-treat-covid-19-begins.
277. (U) Nishiura, H.; Kobayashi, T.; Miyama, T.; Suzuki, A.; Jung, S.-m.; Hayashi, K.; Kinoshita, R.; Yang, Y.; Yuan, B.; Akhmetzhanov, A. R.; Linton, N. M., Estimation of the asymptomatic ratio of novel coronavirus infections (COVID-19). *International Journal of Infectious Diseases* **2020,** *94*, 154-155. http://www.sciencedirect.com/science/article/pii/S1201971220301399
278. (U) Northeastern, Modeling of COVID-19 epidemic in the United States. https://covid19.gleamproject.org/#icubedproj.
279. (U) Offeddu, V.; Yung, C. F.; Low, M. S. F.; Tam, C. C., Effectiveness of Masks and Respirators Against Respiratory Infections in Healthcare Workers: A Systematic Review and Meta-Analysis. *Clin Infect Dis* **2017,** *65* (11), 1934-1942. https://www.ncbi.nlm.nih.gov/pubmed/29140516
280. (U) Okba, N.; Müller, M.; Li, W.; Wang, C.; GeurtsvanKessel, C.; Corman, V.; Lamers, M.; Sikkema, R.; de Bruin, E.; Chandler, F., Severe Acute Respiratory Syndrome Coronavirus 2-Specific Antibody Responses in Coronavirus Disease 2019 Patients. *Emerging infectious diseases* **2020,** *26* (7).
281. (U) Olson, D. R.; Huynh, M.; Fine, A.; Baumgartner, J.; Castro, A.; Chan, H. T.; Daskalakis, D.; Devinney, K.; Guerra, K.; Harper, S.; Kennedy, J.; Konty, K.; Li, W.; McGibbon, E.; Shaff, J.; Thompson, C.; Vora, N. M.; Van Wye, G., Preliminary Estimate of Excess Mortality During the COVID-19 Outbreak — New York City, March 11–May 2, 2020. *Morbidity and Mortality Weekly Report* **2020,** (ePub: 11 May 2020). https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e5.htm?s_cid=mm6919e5_w
282. (U) Ong, S. W. X.; Tan, Y. K.; Chia, P. Y.; Lee, T. H.; Ng, O. T.; Wong, M. S. Y.; Marimuthu, K., Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *Jama* **2020**. https://jamanetwork.com/journals/jama/articlepdf/2762692/jama_ong_2020_ld_200016.pdf
283. (U) Ortega, J. T.; Serrano, M. L.; Pujol, F. H.; Rangel, H. R., Role of changes in SARS-CoV-2 spike protein in the interaction with the human ACE2 receptor: An in silico analysis. *EXCLI journal* **2020,** *19*, 410-417. https://pubmed.ncbi.nlm.nih.gov/32210742

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7081066/
284. (U) Ou, J.; Zhou, Z.; Dai, R.; Zhang, J.; Lan, W.; Zhao, S.; Wu, J.; Seto, D.; Cui, L.; Zhang, G.; Zhang, Q., Emergence of RBD mutations in circulating SARS-CoV-2 strains enhancing the structural stability and human ACE2 receptor affinity of the spike protein. *bioRxiv* **2020**, 2020.03.15.991844. https://www.biorxiv.org/content/biorxiv/early/2020/04/20/2020.03.15.991844.full.pdf
285. (U) Oxford, Oxford COVID-19 vaccine to begin phase II/III human trials. University of Oxford: 2020. http://www.ox.ac.uk/news/2020-05-22-oxford-covid-19-vaccine-begin-phase-iiiii-human-trials
286. (U) Pan, A.; Liu, L.; Wang, C.; Guo, H.; Hao, X.; Wang, Q.; Huang, J.; He, N.; Yu, H.; Lin, X., Association of Public Health Interventions With the Epidemiology of the COVID-19 Outbreak in Wuhan, China. *JAMA* **2020**.

287. (U) Pan, F.; Ye, T.; Sun, P.; Gui, S.; Liang, B.; Li, L.; Zheng, D.; Wang, J.; Hesketh, R. L.; Yang, L.; Zheng, C., Time Course of Lung Changes On Chest CT During Recovery From 2019 Novel Coronavirus (COVID-19) Pneumonia. *Radiology 0* (0), 200370. https://pubs.rsna.org/doi/abs/10.1148/radiol.2020200370
288. (U) Paranjpe, I.; Fuster, V.; Lala, A.; Russak, A.; Glicksberg, B. S.; Levin, M. A.; Charney, A. W.; Narula, J.; Fayad, Z. A.; Bagiella, E.; Zhao, S.; Nadkarni, G. N., Association of Treatment Dose Anticoagulation with In-Hospital Survival Among Hospitalized Patients with COVID-19. *Journal of the American College of Cardiology* **2020**, 27327. http://www.onlinejacc.org/content/accj/early/2020/05/05/j.jacc.2020.05.001.full.pdf
289. (U) Paranjpe, I.; Russak, A.; De Freitas, J. K.; Lala, A.; Miotto, R.; Vaid, A.; Johnson, K. W.; Danieletto, M.; Golden, E.; Meyer, D.; Singh, M.; Somani, S.; Manna, S.; Nangia, U.; Kapoor, A.; O'Hagan, R.; O'Reilly, P. F.; Huckins, L. M.; Glowe, P.; Kia, A.; Timsina, P.; Freeman, R. M.; Levin, M. A.; Jhang, J.; Firpo, A.; Kovatch, P.; Finkelstein, J.; Aberg, J. A.; Bagiella, E.; Horowitz, C. R.; Murphy, B.; Fayad, Z. A.; Narula, J.; Nestler, E. J.; Fuster, V.; Cordon-Cardo, C.; Charney, D. S.; Reich, D. L.; Just, A. C.; Bottinger, E. P.; Charney, A. W.; Glicksberg, B. S.; Nadkarni, G., Clinical Characteristics of Hospitalized Covid-19 Patients in New York City. *medRxiv* **2020**, 2020.04.19.20062117. https://www.medrxiv.org/content/medrxiv/early/2020/04/26/2020.04.19.20062117.full.pdf
290. (U) Park, A., An At-Home Coronavirus Test May Be on the Way in the U.S. *TIME* 25 March, 2020. https://time.com/5809753/at-home-coronavirus-test/
291. (U) Park, S. W.; Champredon, D.; Earn, D. J. D.; Li, M.; Weitz, J. S.; Grenfell, B. T.; Dushoff, J., Reconciling early-outbreak preliminary estimates of the basic reproductive number and its uncertainty: a new framework and applications to the novel coronavirus (2019-nCoV) outbreak. **2020**, 1-13.
292. (U) Parri, N.; Lenge, M.; Buonsenso, D., Children with Covid-19 in Pediatric Emergency Departments in Italy. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2007617
293. (U) Pastorino, B.; Touret, F.; Gilles, M.; de Lamballerie, X.; Charrel, R., Prolonged viability of SARS-CoV-2 in fomites. **2020**.
294. (U) Perkins, A.; Espana, G., NotreDame-FRED COVID-19 forecasts. https://github.com/confunguido/covid19_ND_forecasting/blob/master/README.md.
295. (U) Peuchmaurd, S., Oxford University Just Injected The First Participants in a COVID-19 Vaccine Trial. *Science Alert* 2020. https://www.sciencealert.com/oxford-university-has-just-launched-a-human-trial-of-a-potential-covid-19-vaccine
296. (U) Pfizer, BIONTECH AND PFIZER ANNOUNCE REGULATORY APPROVAL FROM GERMAN AUTHORITY PAUL-EHRLICH-INSTITUT TO COMMENCE FIRST CLINICAL TRIAL OF COVID-19 VACCINE CANDIDATES. 2020. https://www.pfizer.com/news/press-release/press-release-detail/biontech_and_pfizer_announce_regulatory_approval_from_german_authority_paul_ehrlich_institut_to_commence_first_clinical_trial_of_covid_19_vaccine_candidates
297. (U) Pigoga, J. L.; Friedman, A.; Broccoli, M.; Hirner, S.; Naidoo, A. V.; Singh, S.; Werner, K.; Wallis, L. A., Clinical and historical features associated with severe COVID-19 infection: a systematic review. *medRxiv* **2020**, 2020.04.23.20076653. https://www.medrxiv.org/content/medrxiv/early/2020/04/27/2020.04.23.20076653.full.pdf
298. (U) Prem, K.; Liu, Y.; Russell, T. W.; Kucharski, A. J.; Eggo, R. M.; Davies, N.; Flasche, S.; Clifford, S.; Pearson, C. A. B.; Munday, J. D.; Abbott, S.; Gibbs, H.; Rosello, A.; Quilty, B. J.; Jombart, T.; Sun, F.; Diamond, C.; Gimma, A.; van Zandvoort, K.; Funk, S.; Jarvis, C. I.; Edmunds, W. J.; Bosse, N. I.; Hellewell, J.; Jit, M.; Klepac, P., The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. *The Lancet Public Health* **2020**. https://doi.org/10.1016/S2468-2667(20)30073-6
299. (U) Pyankov, O. V.; Bodnev, S. A.; Pyankova, O. G.; Agranovski, I. E., Survival of aerosolized coronavirus in the ambient air. *Journal of Aerosol Science* **2018,** *115*, 158-163. http://www.sciencedirect.com/science/article/pii/S0021850217302239

300. (U) Qiu, H.; Wu, J.; Hong, L.; Luo, Y.; Song, Q.; Chen, D., Clinical and epidemiological features of 36 children with coronavirus disease 2019 (COVID-19) in Zhejiang, China: an observational cohort study. *The Lancet Infectious Diseases*. https://doi.org/10.1016/S1473-3099(20)30198-5
301. (U) Rabenau, H.; Kampf, G.; Cinatl, J.; Doerr, H., Efficacy of various disinfectants against SARS coronavirus. *Journal of Hospital Infection* **2005,** *61* (2), 107-111. https://www.sciencedirect.com/science/article/pii/S0195670105000447
302. (U) Rabenau, H. F.; Cinatl, J.; Morgenstern, B.; Bauer, G.; Preiser, W.; Doerr, H. W., Stability and inactivation of SARS coronavirus. *Med Microbiol Immunol* **2005,** *194* (1-2), 1-6. https://link.springer.com/content/pdf/10.1007/s00430-004-0219-0.pdf
303. (U) Radbel, J.; Narayanan, N.; Bhatt, P. J., Use of tocilizumab for COVID-19 infection-induced cytokine release syndrome: A cautionary case report. *Chest* **2020**.
304. (U) Rambaut, A., Phylodynamic analysis of nCoV-2019 genomes - 27-Jan-2020. http://virological.org/t/phylodynamic-analysis-of-ncov-2019-genomes-27-jan-2020/353.
305. (U) Rapid Expert Consultation, *Rapid Expert Consultation Update on SARS-CoV-2 Surface Stability and Incubation for the COVID-19 Pandemic (March 27, 2020)*. The National Academies Press: Washington, DC, 2020. https://www.nap.edu/read/25763/chapter/1
306. (U) Ratnesar-Shumate, S.; Williams, G.; Green, B.; Krause, M.; Holland, B.; Wood, S.; Bohannon, J.; Boydston, J.; Freeburger, D.; Hooper, I.; Beck, K.; Yeager, J.; Altamura, L. A.; Biryukov, J.; Yolitz, J.; Schuit, M.; Wahl, V.; Hevey, M.; Dabisch, P., Simulated Sunlight Rapidly Inactivates SARS-CoV-2 on Surfaces. *The Journal of Infectious Diseases* **2020**. https://doi.org/10.1093/infdis/jiaa274
307. (U) Regalado, A., Blood tests show 14% of people are now immune to covid-19 in one town in Germany. *Technology Review* 2020. https://www.technologyreview.com/2020/04/09/999015/blood-tests-show-15-of-people-are-now-immune-to-covid-19-in-one-town-in-germany/
308. (U) Reich, N., Ensemble. https://reichlab.io/.
309. (U) Remuzzi, A.; Remuzzi, G., COVID-19 and Italy: what next? *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)30627-9
310. (U) Ren, X.; Liu, Y.; Chen, H.; Liu, W.; Guo, Z.; Chen, C.; Zhou, J.; Xiao, Q.; Jiang, G.-M.; Shan, H., Application and Optimization of RT-PCR in Diagnosis of SARS-CoV-2 Infection. *medRxiv* **2020**.
311. (U) Rengasamy, S.; Eimer, B.; Shaffer, R. E., Simple respiratory protection--evaluation of the filtration performance of cloth masks and common fabric materials against 20-1000 nm size particles. *Ann Occup Hyg* **2010,** *54* (7), 789-98. https://www.ncbi.nlm.nih.gov/pubmed/20584862
312. (U) Richard, M.; Kok, A.; de Meulder, D.; Bestebroer, T. M.; Lamers, M. M.; Okba, N. M. A.; Fentener van Vlissingen, M.; Rockx, B.; Haagmans, B. L.; Koopmans, M. P. G.; Fouchier, R. A. M.; Herfst, S., SARS-CoV-2 is transmitted via contact and via the air between ferrets. *bioRxiv* **2020**, 2020.04.16.044503. https://www.biorxiv.org/content/biorxiv/early/2020/04/17/2020.04.16.044503.full.pdf
313. (U) Richardson, S.; Hirsch, J. S.; Narasimhan, M.; Crawford, J. M.; McGinn, T.; Davidson, K. W.; Consortium, a. t. N. C.-R., Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA* **2020**. https://doi.org/10.1001/jama.2020.6775
314. (U) Richter, W.; Hofacre, K.; Willenberg, Z., *Final Report for the Bioquell Hydrogen Peroxide Vapor (HPV) Decontamination for Reuse of N95 Respirators*; Battelle Memorial Institute: 2016. http://wayback.archive-it.org/7993/20170113034232/http://www.fda.gov/downloads/EmergencyPreparedness/Counterterrorism/MedicalCountermeasures/MCMRegulatoryScience/UCM516998.pdf
315. (U) Riou, J.; Althaus, C. L., Pattern of early human-to-human transmission of Wuhan 2019 novel coronavirus (2019-nCoV), December 2019 to January 2020. *Eurosurveillance* **2020,** *25* (4), 2000058. https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.4.2000058

316. (U) Riphagen, S.; Gomez, X.; Gonzalez-Martinez, C.; Wilkinson, N.; Theocharis, P., Hyperinflammatory shock in children during COVID-19 pandemic. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)31094-1
317. (U) Rivers, C.; Martin, E.; Watson, C.; Schoch-Spana, M.; Mullen, L.; Sell, T. K.; Gottlieb, S.; Warmbrod, K. L.; Hosangadi, D.; Kobokovich, A.; Potter, C.; Cicero, A.; Inglesby, T. V., *Public Health Principles for a Phased Reopening During COVID-19: Guidance for Governers*; Johns Hopkins Center for Health Security: 2020. https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/reopening-guidance-governors.pdf
318. (U) Robertson, D., nCoV's relationship to bat coronaviruses & recombination signals (no snakes) **2020**. http://virological.org/t/ncovs-relationship-to-bat-coronaviruses-recombination-signals-no-snakes/331
319. (U) Rockx, B.; Kuiken, T.; Herfst, S.; Bestebroer, T.; Lamers, M. M.; Oude Munnink, B. B.; de Meulder, D.; van Amerongen, G.; van den Brand, J.; Okba, N. M. A.; Schipper, D.; van Run, P.; Leijten, L.; Sikkema, R.; Verschoor, E.; Verstrepen, B.; Bogers, W.; Langermans, J.; Drosten, C.; Fentener van Vlissingen, M.; Fouchier, R.; de Swart, R.; Koopmans, M.; Haagmans, B. L., Comparative pathogenesis of COVID-19, MERS, and SARS in a nonhuman primate model. *Science* **2020**, eabb7314. https://science.sciencemag.org/content/sci/early/2020/04/16/science.abb7314.full.pdf
320. (U) Rosenberg, E. S.; Dufort, E. M.; Blog, D. S.; Hall, E. W.; Hoefer, D.; Backenson, B. P.; Muse, A. T.; Kirkwood, J. N.; George, K. S.; Holtgrave, D. R.; Hutton, B. J.; Zucker, H. A.; Team, N. Y. S. C. R., COVID-19 Testing, Epidemic Features, Hospital Outcomes, and Household Prevalence, New York State—March 2020. *Clinical Infectious Diseases* **2020**. https://doi.org/10.1093/cid/ciaa549
321. (U) Rothe, C.; Schunk, M.; Sothmann, P.; Bretzel, G.; Froeschl, G.; Wallrauch, C.; Zimmer, T.; Thiel, V.; Janke, C.; Guggemos, W.; Seilmaier, M.; Drosten, C.; Vollmar, P.; Zwirglmaier, K.; Zange, S.; Wölfel, R.; Hoelscher, M., Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2001468

https://www.nejm.org/doi/10.1056/NEJMc2001468
322. (U) Ruan, Q.; Yang, K.; Wang, W.; Jiang, L.; Song, J., Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. *Intensive Care Medicine* **2020**. https://doi.org/10.1007/s00134-020-05991-x
323. (U) Rundle, A., Severe COVID-19 Risk Mapping. https://columbia.maps.arcgis.com/apps/webappviewer/index.html?id=ade6ba85450c4325a12a5b9c09ba796c.
324. (U) Russell, T. W.; Hellewell, J.; Abbott, S.; Golding, N.; Gibbs, H.; Jarvis, C. I.; van Zandvoort, K.; group, C. n. w.; Flasche, S.; Eggo, R. M.; Edmunds, W. J.; Kucharski, A. J., Using a delay-adjusted case fatality ratio to estimate under-reporting. CMMID: 2020. https://cmmid.github.io/topics/covid19/severity/global_cfr_estimates.html
325. (U) Sagonowsky, E., Swelling ranks of COVID-19 vaccines in human testing, Inovio doses its first patients. *Fierce Pharma* 2020. https://www.fiercepharma.com/vaccines/number-covid-19-vaccines-human-testing-grows-inovio-study-more-expected
326. (U) Saknimit, M.; Inatsuki, I.; Sugiyama, Y.; Yagami, K., Virucidal efficacy of physico-chemical treatments against coronaviruses and parvoviruses of laboratory animals. *Jikken Dobutsu* **1988,** *37* (3), 341-5. https://www.jstage.jst.go.jp/article/expanim1978/37/3/37_3_341/_pdf
327. (U) Santarpia, J. L.; Rivera, D. N.; Herrera, V.; Morwitzer, M. J.; Creager, H.; Santarpia, G. W.; Crown, K. K.; Brett-Major, D.; Schnaubelt, E.; Broadhurst, M. J.; Lawler, J. V.; Reid, S. P.; Lowe, J. J., Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. *medRxiv* **2020**, 2020.03.23.20039446. https://www.medrxiv.org/content/medrxiv/early/2020/03/26/2020.03.23.20039446.1.full.pdf

328. (U) Schnirring, L., New coronavirus infects health workers, spreads to Korea. http://www.cidrap.umn.edu/news-perspective/2020/01/new-coronavirus-infects-health-workers-spreads-korea.
329. (U) Schwartz, D. A., An analysis of 38 pregnant women with COVID-19, their newborn infants, and maternal-fetal transmission of SARS-CoV-2: maternal coronavirus infections and pregnancy outcomes. *Archives of Pathology & Laboratory Medicine* **2020**.
330. (U) Security, J. C. f. H., 2019-nCoV resources and updates on the emerging novel coronavirus. **2020**. http://www.centerforhealthsecurity.org/resources/2019-nCoV/
331. (U) Shekerdemian, L. S.; Mahmood, N. R.; Wolfe, K. K.; Riggs, B. J.; Ross, C. E.; McKiernan, C. A.; Heidemann, S. M.; Kleinman, L. C.; Sen, A. I.; Hall, M. W.; Priestley, M. A.; McGuire, J. K.; Boukas, K.; Sharron, M. P.; Burns, J. P.; Collaborative, f. t. I. C.-P., Characteristics and Outcomes of Children With Coronavirus Disease 2019 (COVID-19) Infection Admitted to US and Canadian Pediatric Intensive Care Units. *JAMA Pediatrics* **2020**. https://doi.org/10.1001/jamapediatrics.2020.1948
332. (U) Shen, C.; Wang, Z.; Zhao, F.; Yang, Y.; Li, J.; Yuan, J.; Wang, F.; Li, D.; Yang, M.; Xing, L.; Wei, J.; Xiao, H.; Yang, Y.; Qu, J.; Qing, L.; Chen, L.; Xu, Z.; Peng, L.; Li, Y.; Zheng, H.; Chen, F.; Huang, K.; Jiang, Y.; Liu, D.; Zhang, Z.; Liu, Y.; Liu, L., Treatment of 5 Critically Ill Patients With COVID-19 With Convalescent Plasma. *JAMA* **2020**. https://doi.org/10.1001/jama.2020.4783
333. (U) Sheridan, C., Convalescent serum lines up as first-choice treatment for coronavirus. *Nature Biotechnology* 2020. https://www.nature.com/articles/d41587-020-00011-1
334. (U) Sheridan, C., Coronavirus and the race to distribute reliable diagnostics. https://www.nature.com/articles/d41587-020-00002-2.
335. (U) Shi, J.; Wen, Z.; Zhong, G.; Yang, H.; Wang, C.; Huang, B.; Liu, R.; He, X.; Shuai, L.; Sun, Z.; Zhao, Y.; Liu, P.; Liang, L.; Cui, P.; Wang, J.; Zhang, X.; Guan, Y.; Tan, W.; Wu, G.; Chen, H.; Bu, Z., Susceptibility of ferrets, cats, dogs, and other domesticated animals to SARS–coronavirus 2. *Science* **2020**, eabb7015. https://science.sciencemag.org/content/sci/early/2020/04/07/science.abb7015.full.pdf
336. (U) Shi, S.; Qin, M.; Shen, B.; Cai, Y.; Liu, T.; Yang, F.; Gong, W.; Liu, X.; Liang, J.; Zhao, Q.; Huang, H.; Yang, B.; Huang, C., Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China. *JAMA Cardiology* **2020**. https://doi.org/10.1001/jamacardio.2020.0950
337. (U) Sia, S. F.; Yan, L. M.; Chin, A. W. H.; Fung, K.; Choy, K. T.; Wong, A. Y. L.; Kaewpreedee, P.; Perera, R.; Poon, L. L. M.; Nicholls, J. M.; Peiris, M.; Yen, H. L., Pathogenesis and transmission of SARS-CoV-2 in golden hamsters. *Nature* **2020**.
338. (U) Sit, T. H. C.; Brackman, C. J.; Ip, S. M.; Tam, K. W. S.; Law, P. Y. T.; To, E. M. W.; Yu, V. Y. T.; Sims, L. D.; Tsang, D. N. C.; Chu, D. K. W.; Perera, R.; Poon, L. L. M.; Peiris, M., Infection of dogs with SARS-CoV-2. *Nature* **2020**.
339. (U) Song, J.-Y.; Yun, J.-G.; Noh, J.-Y.; Cheong, H.-J.; Kim, W.-J., Covid-19 in South Korea — Challenges of Subclinical Manifestations. *New England Journal of Medicine* **2020**. https://www.nejm.org/doi/full/10.1056/NEJMc2001801
340. (U) Stadnytskyi, V.; Bax, C. E.; Bax, A.; Anfinrud, P., The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission. *Proceedings of the National Academy of Sciences* **2020**, 202006874. https://www.pnas.org/content/pnas/early/2020/05/12/2006874117.full.pdf
341. (U) Su, H.; Yang, M.; Wan, C.; Yi, L.-X.; Tang, F.; Zhu, H.-Y.; Yi, F.; Yang, H.-C.; Fogo, A. B.; Nie, X.; Zhang, C., Renal histopathological analysis of 26 postmortem findings of patients with COVID-19 in China. *Kidney International*. https://doi.org/10.1016/j.kint.2020.04.003
342. (U) Su, Y. C.; Anderson, D. E.; Young, B. E.; Zhu, F.; Linster, M.; Kalimuddin, S.; Low, J. G.; Yan, Z.; Jayakumar, J.; Sun, L.; Yan, G. Z.; Mendenhall, I. H.; Leo, Y.-S.; Lye, D. C.; Wang, L.-F.; Smith, G. J., Discovery of a 382-nt deletion during the early evolution of SARS-CoV-2. *bioRxiv* **2020**, 2020.03.11.987222. https://www.biorxiv.org/content/biorxiv/early/2020/03/12/2020.03.11.987222.full.pdf

343. (U) Sun, S.; Cai, X.; Wang, H.; He, G.; Lin, Y.; Lu, B.; Chen, C.; Pan, Y.; Hu, X., Abnormalities of peripheral blood system in patients with COVID-19 in Wenzhou, China. *Clinica Chimica Acta* **2020,** *507*, 174-180. http://www.sciencedirect.com/science/article/pii/S0009898120301790
344. (U) Tan, W.; Lu, Y.; Zhang, J.; Wang, J.; Dan, Y.; Tan, Z.; He, X.; Qian, C.; Sun, Q.; Hu, Q.; Liu, H.; Ye, S.; Xiang, X.; Zhou, Y.; Zhang, W.; Guo, Y.; Wang, X.-H.; He, W.; Wan, X.; Sun, F.; Wei, Q.; Chen, C.; Pan, G.; Xia, J.; Mao, Q.; Chen, Y.; Deng, G., Viral Kinetics and Antibody Responses in Patients with COVID-19. *medRxiv* **2020**, 2020.03.24.20042382.
https://www.medrxiv.org/content/medrxiv/early/2020/03/26/2020.03.24.20042382.full.pdf
345. (U) Tang, W.; Cao, Z.; Han, M.; Wang, Z.; Chen, J.; Sun, W.; Wu, Y.; Xiao, W.; Liu, S.; Chen, E.; Chen, W.; Wang, X.; Yang, J.; Lin, J.; Zhao, Q.; Yan, Y.; Xie, Z.; Li, D.; Yang, Y.; Liu, L.; Qu, J.; Ning, G.; Shi, G.; Xie, Q., Hydroxychloroquine in patients with mainly mild to moderate coronavirus disease 2019: open label, randomised controlled trial. *BMJ* **2020,** *369*, m1849.
http://www.bmj.com/content/369/bmj.m1849.abstract
346. (U) The Novel Coronavirus Pneumonia Emergency Response Epidemiology, T., The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19) — China, 2020. *China CDC Weekly* **2020,** *2*, 1-10. http://weekly.chinacdc.cn//article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51
347. (U) Thevarajan, I.; Nguyen, T. H. O.; Koutsakos, M.; Druce, J.; Caly, L.; van de Sandt, C. E.; Jia, X.; Nicholson, S.; Catton, M.; Cowie, B.; Tong, S. Y. C.; Lewin, S. R.; Kedzierska, K., Breadth of concomitant immune responses prior to patient recovery: a case report of non-severe COVID-19. *Nature Medicine* **2020**. https://doi.org/10.1038/s41591-020-0819-2
348. (U) Thomas, P. R.; Karriker, L. A.; Ramirez, A.; Zhang, J.; Ellingson, J. S.; Crawford, K. K.; Bates, J. L.; Hammen, K. J.; Holtkamp, D. J., Evaluation of time and temperature sufficient to inactivate porcine epidemic diarrhea virus in swine feces on metal surfaces. *Journal of Swine Health and Production* **2015,** *23* (2), 84.
349. (U) Thomas, P. R.; Ramirez, A.; Zhang, J.; Ellingson, J. S.; Myers, J. N., Methods for inactivating PEDV in Hog Trailers. *Animal Industry Report* **2015,** *661* (1), 91.
350. (U) To, K. K.-W.; Tsang, O. T.-Y.; Leung, W.-S.; Tam, A. R.; Wu, T.-C.; Lung, D. C.; Yip, C. C.-Y.; Cai, J.-P.; Chan, J. M.-C.; Chik, T. S.-H., Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study. *The Lancet Infectious Diseases* **2020**.
351. (U) Toner, E., *Interim Estimate of the US PPE Needs for COVID-19*; Johns Hopkins Center for Health Security: 2020. https://www.centerforhealthsecurity.org/resources/COVID-19/PPE/PPE-estimate.pdf
352. (U) Treibel, T. A.; Manisty, C.; Burton, M.; McKnight, Á.; Lambourne, J.; Augusto, J. B.; Couto-Parada, X.; Cutino-Moguel, T.; Noursadeghi, M.; Moon, J. C., COVID-19: PCR screening of asymptomatic health-care workers at London hospital. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)31100-4
353. (U) UCLA, COVID-19 Cases in the United States. https://covid19.uclaml.org/model.html.
354. (U) van der Sande, M.; Teunis, P.; Sabel, R., Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population. *Plos One* **2008,** *3* (7). <Go to ISI>://WOS:000264065800020
355. (U) van Doremalen, N.; Bushmaker, T.; Morris, D. H.; Holbrook, M. G.; Gamble, A.; Williamson, B. N.; Tamin, A.; Harcourt, J. L.; Thornburg, N. J.; Gerber, S. I.; Lloyd-Smith, J. O.; de Wit, E.; Munster, V. J., Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *New England Journal of Medicine* **2020**. https://doi.org/10.1056/NEJMc2004973
356. (U) van Doremalen, N.; Bushmaker, T.; Munster, V. J., Stability of Middle East respiratory syndrome coronavirus (MERS-CoV) under different environmental conditions. *Euro Surveill* **2013,** *18* (38).
357. (U) van Doremalen, N.; Lambe, T.; Spencer, A.; Belij-Rammerstorfer, S.; Purushotham, J. N.; Port, J. R.; Avanzato, V.; Bushmaker, T.; Flaxman, A.; Ulaszewska, M.; Feldmann, F.; Allen, E. R.; Sharpe, H.;

Schulz, J.; Holbrook, M.; Okumura, A.; Meade-White, K.; Pérez-Pérez, L.; Bissett, C.; Gilbride, C.; Williamson, B. N.; Rosenke, R.; Long, D.; Ishwarbhai, A.; Kailath, R.; Rose, L.; Morris, S.; Powers, C.; Lovaglio, J.; Hanley, P. W.; Scott, D.; Saturday, G.; de Wit, E.; Gilbert, S. C.; Munster, V. J., ChAdOx1 nCoV-19 vaccination prevents SARS-CoV-2 pneumonia in rhesus macaques. *bioRxiv* **2020**, 2020.05.13.093195.
https://www.biorxiv.org/content/biorxiv/early/2020/05/13/2020.05.13.093195.full.pdf
358. (U) van Dorp, L.; Acman, M.; Richard, D.; Shaw, L. P.; Ford, C. E.; Ormond, L.; Owen, C. J.; Pang, J.; Tan, C. C. S.; Boshier, F. A. T.; Ortiz, A. T.; Balloux, F., Emergence of genomic diversity and recurrent mutations in SARS-CoV-2. *Infection, Genetics and Evolution* **2020**, 104351.
http://www.sciencedirect.com/science/article/pii/S1567134820301829
359. (U) van Dorp, L.; Richard, D.; Tan, C. C.; Shaw, L. P.; Acman, M.; Balloux, F., No evidence for increased transmissibility from recurrent mutations in SARS-CoV-2. *bioRxiv* **2020**, 2020.05.21.108506.
https://www.biorxiv.org/content/biorxiv/early/2020/05/21/2020.05.21.108506.full.pdf
360. (U) Verdict, Cepheid to develop automated molecular test for coronavirus. Verdict Medical Devices: 2020. https://www.medicaldevice-network.com/news/cepheid-automated-test-coronavirus/
361. (U) Wan, Y.; Shang, J.; Graham, R.; Baric, R. S.; Li, F., Receptor recognition by novel coronavirus from Wuhan: An analysis based on decade-long structural studies of SARS. *Journal of Virology* **2020**, JVI.00127-20. https://jvi.asm.org/content/jvi/early/2020/01/23/JVI.00127-20.full.pdf
362. (U) Wang, B.; Wang, L.; Kong, X.; Geng, J.; Xiao, D.; Ma, C.; Jiang, X. M.; Wang, P. H., Long-term Coexistence of SARS-CoV-2 with Antibody Response in COVID-19 Patients. *J Med Virol* **2020**.
363. (U) Wang, D.; Hu, B.; Hu, C.; Zhu, F.; Liu, X.; Zhang, J.; Wang, B.; Xiang, H.; Cheng, Z.; Xiong, Y.; Zhao, Y.; Li, Y.; Wang, X.; Peng, Z., Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. *JAMA* **2020**.
https://doi.org/10.1001/jama.2020.1585

https://jamanetwork.com/journals/jama/articlepdf/2761044/jama_wang_2020_oi_200019.pdf
364. (U) Wang, D.; You, Y.; Zhou, X.; Zong, Z.; Huang, H.; Zhang, H.; Yong, X.; Cheng, Y.; Yang, L.; Guo, Q.; Long, Y.; Liu, Y.; Huang, J.; Du, L., Selection of homemade mask materials for preventing transmission of COVID-19: a laboratory study. *medRxiv* **2020**.
365. (U) Wang, W.; Xu, Y.; Gao, R.; Lu, R.; Han, K.; Wu, G.; Tan, W., Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *JAMA* **2020**. https://doi.org/10.1001/jama.2020.3786
366. (U) Wang, Y.; Zhang, D.; Du, G.; Du, R.; Zhao, J.; Jin, Y.; Fu, S.; Gao, L.; Cheng, Z.; Lu, Q.; Hu, Y.; Luo, G.; Wang, K.; Lu, Y.; Li, H.; Wang, S.; Ruan, S.; Yang, C.; Mei, C.; Wang, Y.; Ding, D.; Wu, F.; Tang, X.; Ye, X.; Ye, Y.; Liu, B.; Yang, J.; Yin, W.; Wang, A.; Fan, G.; Zhou, F.; Liu, Z.; Gu, X.; Xu, J.; Shang, L.; Zhang, Y.; Cao, L.; Guo, T.; Wan, Y.; Qin, H.; Jiang, Y.; Jaki, T.; Hayden, F. G.; Horby, P. W.; Cao, B.; Wang, C., Remdesivir in adults with severe COVID-19: a randomised, double-blind, placebo-controlled, multicentre trial. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)31022-9
367. (U) Watson, C.; Cicero, A.; Blumenstock, J.; Fraser, M., *A National Plan to Enable Comprehensive COVID-19 Case Finding and Contact*; Johns Hopkins Center for Health Security: 2020.
https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/a-national-plan-to-enable-comprehensive-COVID-19-case-finding-and-contact-tracing-in-the-US.pdf
368. (U) WCS, A Tiger at Bronx Zoo Tests Positive for COVID-19; The Tiger and the Zoo's Other Cats Are Doing Well at This Time. https://newsroom.wcs.org/News-Releases/articleType/ArticleView/articleId/14010/A-Tiger-at-Bronx-Zoo-Tests-Positive-for-COVID-19-The-Tiger-and-the-Zoos-Other-Cats-Are-Doing-Well-at-This-Time.aspx (accessed April 6, 2020).
369. (U) Wei, W. E.; Li, Z.; Chiew, C. J.; Yong, S. E.; Toh, M. P.; Lee, V. J., Presymptomatic transmission of SARS-CoV-2 - Singapore, January 23 - March 16, 2020. *Morbidity and Mortality Weekly Report* **2020,** *ePub* (1 April 2020). https://www.cdc.gov/mmwr/volumes/69/wr/mm6914e1.htm

370. (U) Weissman, D. N.; de Perio, M. A.; Radonovich, L. J., Jr, COVID-19 and Risks Posed to Personnel During Endotracheal Intubation. *JAMA* **2020**. https://doi.org/10.1001/jama.2020.6627
371. (U) Wen, W.; Su, W.; Tang, H.; Le, W.; Zhang, X.; Zheng, Y.; Liu, X.; Xie, L.; Li, J.; Ye, J.; Dong, L.; Cui, X.; Miao, Y.; Wang, D.; Dong, J.; Xiao, C.; Chen, W.; Wang, H., Immune cell profiling of COVID-19 patients in the recovery stage by single-cell sequencing. *Cell Discov* **2020,** *6*, 31.
372. (U) Wetsman, N., FDA authorizes first antibody-based test for COVID-19. *The Verge* 2 April, 2020. https://www.theverge.com/2020/4/2/21204478/fda-authorization-coronavirus-antibody-test-diagnostic-covid-19
373. (U) Whitman, J. D.; Hiatt, J.; Mowrey, C. T.; al., e., Test performance evaluation of SARS-CoV-2 serological assays. *Unpublished Preprint* **2020**. https://www.dropbox.com/s/cd1628cau09288a/SARS-CoV-2_Serology_Manuscript.pdf?dl=0
374. (U) WHO, *COVID-19 Strategy Update*; World Health Organization: 2020. https://www.who.int/publications-detail/strategic-preparedness-and-response-plan-for-the-new-coronavirus
375. (U) WHO, Diagnostic detection of Wuhan coronavirus 2019 by real-time RTPCR -Protocol and preliminary evaluation as of Jan 13, 2020. https://www.who.int/docs/default-source/coronaviruse/wuhan-virus-assay-v1991527e5122341d99287a1b17c111902.pdf?sfvrsn=d381fc88_2 (accessed 01/26/2020).
376. (U) WHO, *"Immunity passports" in the context of COVID-19*; World Health Organization: 2020. https://www.who.int/news-room/commentaries/detail/immunity-passports-in-the-context-of-covid-19
377. (U) WHO, *Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected*; 2020. https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125
378. (U) WHO, Laboratory testing for 2019 novel coronavirus (2019-nCoV) in suspected human cases.
379. (U) WHO, *Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations*; World Health Organization: 2020. https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations
380. (U) WHO, Multisystem inflammatory syndrome in children and adolescents temporally related to COVID-19. World Health Organization: 2020. https://www.who.int/news-room/commentaries/detail/multisystem-inflammatory-syndrome-in-children-and-adolescents-with-covid-19
381. (U) WHO, Novel Coronavirus (2019-nCoV) Situation Report-5 25 January 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200125-sitrep-5-2019-ncov.pdf?sfvrsn=429b143d_4.
382. (U) WHO, Novel Coronavirus (2019-nCoV) technical guidance: Laboratory testing for 2019-nCoV in humans. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance.
383. (U) WHO, Update on WHO Solidarity Trial – Accelerating a safe and effective COVID-19 vaccine. World Health Organization: 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/global-research-on-novel-coronavirus-2019-ncov/solidarity-trial-accelerating-a-safe-and-effective-covid-19-vaccine
384. (U) Wölfel, R.; Corman, V. M.; Guggemos, W.; Seilmaier, M.; Zange, S.; Müller, M. A.; Niemeyer, D.; Jones, T. C.; Vollmar, P.; Rothe, C.; Hoelscher, M.; Bleicker, T.; Brünink, S.; Schneider, J.; Ehmann, R.; Zwirglmaier, K.; Drosten, C.; Wendtner, C., Virological assessment of hospitalized patients with COVID-2019. *Nature* **2020**. https://doi.org/10.1038/s41586-020-2196-x

385. (U) Wolff, M. H.; Sattar, S. A.; Adegbunrin, O.; Tetro, J., Environmental survival and microbicide inactivation of coronaviruses. In *Coronaviruses with special emphasis on first insights concerning SARS*, Springer: 2005; pp 201-212.
386. (U) Wong, M. C.; Javornik Cregeen, S. J.; Ajami, N. J.; Petrosino, J. F., Evidence of recombination in coronaviruses implicating pangolin origins of nCoV-2019. *bioRxiv* **2020**, 2020.02.07.939207. https://www.biorxiv.org/content/biorxiv/early/2020/02/13/2020.02.07.939207.full.pdf
387. (U) Woolsey, C. B.; Borisevich, V.; Prasad, A. N.; Agans, K. N.; Deer, D. J.; Dobias, N. S.; Heymann, J. C.; Foster, S. L.; Levine, C. B.; Medina, L.; Melody, K.; Geisbert, J. B.; Fenton, K. A.; Geisbert, T. W.; Cross, R. W., Establishment of an African green monkey model for COVID-19. *bioRxiv* **2020**, 2020.05.17.100289. http://biorxiv.org/content/early/2020/05/17/2020.05.17.100289.abstract
388. (U) Worobey, M.; Pekar, J.; Larsen, B. B.; Nelson, M. I.; Hill, V.; Joy, J. B.; Rambaut, A.; Suchard, M. A.; Wertheim, J. O.; Lemey, P., The emergence of SARS-CoV-2 in Europe and the US. *bioRxiv* **2020**, 2020.05.21.109322. https://www.biorxiv.org/content/biorxiv/early/2020/05/23/2020.05.21.109322.full.pdf
389. (U) Wrapp, D.; Wang, N.; Corbett, K. S.; Goldsmith, J. A.; Hsieh, C.-L.; Abiona, O.; Graham, B. S.; McLellan, J. S., Cryo-EM Structure of the 2019-nCoV Spike in the Prefusion Conformation. *bioRxiv* **2020**, 2020.02.11.944462. https://www.biorxiv.org/content/biorxiv/early/2020/02/15/2020.02.11.944462.full.pdf
390. (U) Wu, F.; Wang, A.; Liu, M.; Wang, Q.; Chen, J.; Xia, S.; Ling, Y.; Zhang, Y.; Xun, J.; Lu, L.; Jiang, S.; Lu, H.; Wen, Y.; Huang, J., Neutralizing antibody responses to SARS-CoV-2 in a COVID-19 recovered patient cohort and their implications. *medRxiv* **2020**, 2020.03.30.20047365. https://www.medrxiv.org/content/medrxiv/early/2020/04/06/2020.03.30.20047365.full.pdf
391. (U) Wu, J. T.; Leung, K.; Leung, G. M., Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *The Lancet* **2020**. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30260-9/fulltext
392. (U) Wu, L.-P.; Wang, N.-C.; Chang, Y.-H.; Tian, X.-Y.; Na, D.-Y.; Zhang, L.-Y.; Zheng, L.; Lan, T.; Wang, L.-F.; Liang, G.-D., Duration of antibody responses after severe acute respiratory syndrome. *Emerging infectious diseases* **2007,** *13* (10), 1562. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2851497/pdf/07-0576_finalD.pdf
393. (U) Wu, P.; Duan, F.; Luo, C.; Liu, Q.; Qu, X.; Liang, L.; Wu, K., Characteristics of Ocular Findings of Patients With Coronavirus Disease 2019 (COVID-19) in Hubei Province, China. *JAMA Ophthalmology* **2020**. https://doi.org/10.1001/jamaophthalmol.2020.1291
394. (U) Wurtzer, S.; Marechal, V.; Mouchel, J.-M.; Maday, Y.; Teyssou, R.; Richard, E.; Almayrac, J. L.; Moulin, L., Evaluation of lockdown impact on SARS-CoV-2 dynamics through viral genome quantification in Paris wastewaters. *medRxiv* **2020**, 2020.04.12.20062679. https://www.medrxiv.org/content/medrxiv/early/2020/05/06/2020.04.12.20062679.full.pdf
395. (U) Wyllie, A. L.; Fournier, J.; Casanovas-Massana, A.; Campbell, M.; Tokuyama, M.; Vijayakumar, P.; Geng, B.; Muenker, M. C.; Moore, A. J.; Vogels, C. B. F.; Petrone, M. E.; Ott, I. M.; Lu, P.; Lu-Culligan, A.; Klein, J.; Venkataraman, A.; Earnest, R.; Simonov, M.; Datta, R.; Handoko, R.; Naushad, N.; Sewanan, L. R.; Valdez, J.; White, E. B.; Lapidus, S.; Kalinich, C. C.; Jiang, X.; Kim, D. J.; Kudo, E.; Linehan, M.; Mao, T.; Moriyama, M.; Oh, J. E.; Park, A.; Silva, J.; Song, E.; Takahashi, T.; Taura, M.; Weizman, O.-E.; Wong, P.; Yang, Y.; Bermejo, S.; Odio, C.; Omer, S. B.; Dela Cruz, C. S.; Farhadian, S.; Martinello, R. A.; Iwasaki, A.; Grubaugh, N. D.; Ko, A. I., Saliva is more sensitive for SARS-CoV-2 detection in COVID-19 patients than nasopharyngeal swabs. *medRxiv* **2020**, 2020.04.16.20067835. https://www.medrxiv.org/content/medrxiv/early/2020/04/22/2020.04.16.20067835.full.pdf
396. (U) Xiao, F.; Sun, J.; Xu, Y.; Li, F.; Huang, X.; Li, H.; Zhao, J.; Huang, J.; Zhao, J., Infectious SARS-CoV-2 in Feces of Patient with Severe COVID-19. *Emerging Infectious Diseases* **2020,** *26*. https://wwwnc.cdc.gov/eid/article/26/8/20-0681_article

397. (U) Xiao, K.; Zhai, J.; Feng, Y.; Zhou, N.; Zhang, X.; Zou, J. J.; Li, N.; Guo, Y.; Li, X.; Shen, X.; Zhang, Z.; Shu, F.; Huang, W.; Li, Y.; Zhang, Z.; Chen, R. A.; Wu, Y. J.; Peng, S. M.; Huang, M.; Xie, W. J.; Cai, Q. H.; Hou, F. H.; Chen, W.; Xiao, L.; Shen, Y., Isolation of SARS-CoV-2-related coronavirus from Malayan pangolins. *Nature* **2020**.
398. (U) Xinhua, China detects large quantity of novel coronavirus at Wuhan seafood market http://www.xinhuanet.com/english/2020-01/27/c_138735677.htm.
399. (U) Xu, X.; Han, M.; Li, T.; Sun, W.; Wang, D.; Fu, B.; Zhou, Y.; Zheng, X.; Yang, Y.; Li, X.; Zhang, X.; Pan, A.; Wei, H., Effective treatment of severe COVID-19 patients with tocilizumab. *Proceedings of the National Academy of Sciences* **2020**, 202005615. https://www.pnas.org/content/pnas/early/2020/04/27/2005615117.full.pdf
400. (U) Xue, K. S.; Bloom, J. D., Reconciling disparate estimates of viral genetic diversity during human influenza infections. *Nature Genetics* **2019,** *51* (9), 1298-1301. https://doi.org/10.1038/s41588-019-0349-3
401. (U) Yan, C. H.; Faraji, F.; Prajapati, D. P.; Boone, C. E.; DeConde, A. S., In *Association of chemosensory dysfunction and Covid-19 in patients presenting with influenza-like symptoms*, International Forum of Allergy & Rhinology, Wiley Online Library: 2020.
402. (U) Yan, J.; Guo, J.; Fan, C.; Juan, J.; Yu, X.; Li, J.; Feng, L.; Li, C.; Chen, H.; Qiao, Y.; Lei, D.; Wang, C.; Xiong, G.; Xiao, F.; He, W.; Pang, Q.; Hu, X.; Wang, S.; Chen, D.; Zhang, Y.; Poon, L. C.; Yang, H., Coronavirus disease 2019 (COVID-19) in pregnant women: A report based on 116 cases. *Am J Obstet Gynecol* **2020**.
403. (U) Yang, H.; Wang, C.; Poon, L., Novel coronavirus infection and pregnancy. *Ultrasound in Obstetrics & Gynecology* **2020**.
404. (U) Yang, P.; Qi, J.; Zhang, S.; Bi, G.; Wang, X.; Yang, Y.; Sheng, B.; Mao, X., Feasibility of Controlling COVID-19 Outbreaks in the UK by Rolling Interventions. *medRxiv* **2020**, 2020.04.05.20054429. https://www.medrxiv.org/content/medrxiv/early/2020/04/07/2020.04.05.20054429.full.pdf
405. (U) Yu, B.; Li, C.; Chen, P.; Zhou, N.; Wang, L.; Li, J.; Jiang, H.; Wang, D. W., Low dose of hydroxychloroquine reduces fatality of critically ill patients with COVID-19. *Sci China Life Sci* **2020**, 1-7.
406. (U) Yu, J.; Tostanoski, L. H.; Peter, L.; Mercado, N. B.; McMahan, K.; Mahrokhian, S. H.; Nkolola, J. P.; Liu, J.; Li, Z.; Chandrashekar, A.; Martinez, D. R.; Loos, C.; Atyeo, C.; Fischinger, S.; Burke, J. S.; Slein, M. D.; Chen, Y.; Zuiani, A.; N. Lelis, F. J.; Travers, M.; Habibi, S.; Pessaint, L.; Van Ry, A.; Blade, K.; Brown, R.; Cook, A.; Finneyfrock, B.; Dodson, A.; Teow, E.; Velasco, J.; Zahn, R.; Wegmann, F.; Bondzie, E. A.; Dagotto, G.; Gebre, M. S.; He, X.; Jacob-Dolan, C.; Kirilova, M.; Kordana, N.; Lin, Z.; Maxfield, L. F.; Nampanya, F.; Nityanandam, R.; Ventura, J. D.; Wan, H.; Cai, Y.; Chen, B.; Schmidt, A. G.; Wesemann, D. R.; Baric, R. S.; Alter, G.; Andersen, H.; Lewis, M. G.; Barouch, D. H., DNA vaccine protection against SARS-CoV-2 in rhesus macaques. *Science* **2020**, eabc6284. https://science.sciencemag.org/content/sci/early/2020/05/19/science.abc6284.full.pdf
407. (U) Yu, N.; Li, W.; Kang, Q.; Zeng, W.; Feng, L.; Wu, J., No SARS-CoV-2 detected in amniotic fluid in mid-pregnancy. *The Lancet Infectious Diseases*. https://doi.org/10.1016/S1473-3099(20)30320-0
408. (U) Yu, W.-B.; Tang, G.-D.; Zhang, L.; Corlett, R. T., Decoding evolution and transmissions of novel pneumonia coronavirus using the whole genomic data. *ChinaXiv* **2020**. http://www.chinaxiv.org/abs/202002.00033
409. (U) Yu, W. B.; Tang, G. D.; Zhang, L.; Corlett, R. T., Decoding the evolution and transmissions of the novel pneumonia coronavirus (SARS-CoV-2 / HCoV-19) using whole genomic data. *Zool Res* **2020,** *41* (3), 247-257.
410. (U) Zaigham, M.; Andersson, O., Maternal and perinatal outcomes with COVID-19: A systematic review of 108 pregnancies. *Acta Obstet Gynecol Scand* **2020**.
411. (U) Zhang, J.; Litvinova, M.; Liang, Y.; Wang, Y.; Wang, W.; Zhao, S.; Wu, Q.; Merler, S.; Viboud, C.; Vespignani, A.; Ajelli, M.; Yu, H., Changes in contact patterns shape the dynamics of the COVID-19

outbreak in China. *Science* **2020**, eabb8001.
https://science.sciencemag.org/content/sci/early/2020/05/04/science.abb8001.full.pdf
412. (U) Zhang, J.; Litvinova, M.; Wang, W.; Wang, Y.; Deng, X.; Chen, X.; Li, M.; Zheng, W.; Yi, L.; Chen, X.; Wu, Q.; Liang, Y.; Wang, X.; Yang, J.; Sun, K.; Longini, I. M., Jr.; Halloran, M. E.; Wu, P.; Cowling, B. J.; Merler, S.; Viboud, C.; Vespignani, A.; Ajelli, M.; Yu, H., Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. *The Lancet Infectious Diseases*. https://doi.org/10.1016/S1473-3099(20)30230-9
413. (U) Zhang, Q.; Zhang, H.; Huang, K.; Yang, Y.; Hui, X.; Gao, J.; He, X.; Li, C.; Gong, W.; Zhang, Y.; Peng, C.; Gao, X.; Chen, H.; Zou, Z.; Shi, Z.; Jin, M., SARS-CoV-2 neutralizing serum antibodies in cats: a serological investigation. *bioRxiv* **2020**, 2020.04.01.021196.
http://biorxiv.org/content/early/2020/04/03/2020.04.01.021196.abstract
414. (U) Zhang, T.; Wu, Q.; Zhang, Z., Probable Pangolin Origin of SARS-CoV-2 Associated with the COVID-19 Outbreak. *Current Biology* **2020,** *30* (7), 1346-1351.e2.
http://www.sciencedirect.com/science/article/pii/S0960982220303602
415. (U) Zhang, X.; Tan, Y.; Ling, Y.; Lu, G.; Liu, F.; Yi, Z.; Jia, X.; Wu, M.; Shi, B.; Xu, S.; Chen, J.; Wang, W.; Chen, B.; Jiang, L.; Yu, S.; Lu, J.; Wang, J.; Xu, M.; Yuan, Z.; Zhang, Q.; Zhang, X.; Zhao, G.; Wang, S.; Chen, S.; Lu, H., Viral and host factors related to the clinical outcome of COVID-19. *Nature* **2020**.
https://doi.org/10.1038/s41586-020-2355-0
416. (U) Zhao; Musa; Lin; Ran; Yang; Wang; Lou; Yang; Gao; He; Wang, Estimating the Unreported Number of Novel Coronavirus (2019-nCoV) Cases in China in the First Half of January 2020: A Data-Driven Modelling Analysis of the Early Outbreak. *Journal of Clinical Medicine* **2020,** *9* (2), 388.
417. (U) Zhao, G.; Jiang, Y.; Qiu, H.; Gao, T.; Zeng, Y.; Guo, Y.; Yu, H.; Li, J.; Kou, Z.; Du, L.; Tan, W.; Jiang, S.; Sun, S.; Zhou, Y., Multi-Organ Damage in Human Dipeptidyl Peptidase 4 Transgenic Mice Infected with Middle East Respiratory Syndrome-Coronavirus. *PLoS One* **2015,** *10* (12), e0145561.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4689477/pdf/pone.0145561.pdf
418. (U) Zhao, J.; Yuan, Q.; Wang, H.; Liu, W.; Liao, X.; Su, Y.; Wang, X.; Yuan, J.; Li, T.; Li, J.; Qian, S.; Hong, C.; Wang, F.; Liu, Y.; Wang, Z.; He, Q.; He, B.; Zhang, T.; Ge, S.; Liu, L.; Zhang, J.; Xia, N.; Zhang, Z., Antibody Responses to SARS-CoV-2 in Patients of Novel Coronavirus Disease 2019. *SSRN* **2020**.
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3546052#
419. (U) Zhen-Dong, T.; An, T.; Ke-Feng, L.; Peng, L.; Hong-Ling, W.; Jing-Ping, Y.; Yong-Li, Z.; Jian-Bo, Y., Potential Presymptomatic Transmission of SARS-CoV-2, Zhejiang Province, China, 2020. *Emerging Infectious Disease journal* **2020,** *26* (5). https://wwwnc.cdc.gov/eid/article/26/5/20-0198_article
420. (U) Zhongchu, L., The sixth press conference of "Prevention and Control of New Coronavirus Infected Pneumonia". Hubei Provincial Government: 2020.
http://www.hubei.gov.cn/hbfb/xwfbh/202001/t20200128_2015591.shtml
421. (U) Zhou, F.; Yu, T.; Du, R.; Fan, G.; Liu, Y.; Liu, Z.; Xiang, J.; Wang, Y.; Song, B.; Gu, X.; Guan, L.; Wei, Y.; Li, H.; Wu, X.; Xu, J.; Tu, S.; Zhang, Y.; Chen, H.; Cao, B., Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*.
https://doi.org/10.1016/S0140-6736(20)30566-3
422. (U) Zhou, H.; Chen, X.; Hu, T.; Li, J.; Song, H.; Liu, Y.; Wang, P.; Liu, D.; Yang, J.; Holmes, E. C.; Hughes, A. C.; Bi, Y.; Shi, W., A novel bat coronavirus reveals natural insertions at the S1/S2 cleavage site of the Spike protein and a possible recombinant origin of HCoV-19. *bioRxiv* **2020**, 2020.03.02.974139.
https://www.biorxiv.org/content/biorxiv/early/2020/03/11/2020.03.02.974139.full.pdf
423. (U) Zhou, P.; Yang, X.-L.; Wang, X.-G.; Hu, B.; Zhang, L.; Zhang, W.; Si, H.-R.; Zhu, Y.; Li, B.; Huang, C.-L.; Chen, H.-D.; Chen, J.; Luo, Y.; Guo, H.; Jiang, R.-D.; Liu, M.-Q.; Chen, Y.; Shen, X.-R.; Wang, X.; Zheng, X.-S.; Zhao, K.; Chen, Q.-J.; Deng, F.; Liu, L.-L.; Yan, B.; Zhan, F.-X.; Wang, Y.-Y.; Xiao, G.; Shi, Z.-L., Discovery of a novel coronavirus associated with the recent pneumonia outbreak in humans and its

potential bat origin. *bioRxiv* **2020**, 2020.01.22.914952.
https://www.biorxiv.org/content/biorxiv/early/2020/01/23/2020.01.22.914952.1.full.pdf
424. (U) Zhu, F.-C.; Li, Y.-H.; Guan, X.-H.; Hou, L.-H.; Wang, W.-J.; Li, J.-X.; Wu, S.-P.; Wang, B.-S.; Wang, Z.; Wang, L.; Jia, S.-Y.; Jiang, H.-D.; Wang, L.; Jiang, T.; Hu, Y.; Gou, J.-B.; Xu, S.-B.; Xu, J.-J.; Wang, X.-W.; Wang, W.; Chen, W., Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: a dose-escalation, open-label, non-randomised, first-in-human trial. *The Lancet* **2020**. https://doi.org/10.1016/S0140-6736(20)31208-3
425. (U) Zhu, Y.; Chen, Y. Q., On a Statistical Transmission Model in Analysis of the Early Phase of COVID-19 Outbreak. *Statistics in Biosciences* **2020**, 1-17.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7113380/
426. (U) Zou, L.; Ruan, F.; Huang, M.; Liang, L.; Huang, H.; Hong, Z.; Yu, J.; Kang, M.; Song, Y.; Xia, J.; Guo, Q.; Song, T.; He, J.; Yen, H.-L.; Peiris, M.; Wu, J., SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. *New England Journal of Medicine* **2020**.
https://www.nejm.org/doi/full/10.1056/NEJMc2001737