LAB BIOSAFETY GUIDELINES: HANDLING AND PROCESSING SPECIMENS ASSOCIATED WITH COVID-19
WHAT IS COVID-19?

- COVID-19 is the disease caused by infection with SARS-CoV-2
- Coronaviruses (CoV) = largest known RNA viruses
- Seven CoV have been found to infect humans and cause respiratory diseases:
  - Four cause common self-limited disease
  - Other three cause severe disease:
    - SARS-CoV = Severe Acute Respiratory Syndrome (2002-2003)
    - MERS-CoV = Middle East Respiratory Syndrome (2012)
    - SARS-CoV-2 = COVID-19 (Current outbreak)
**VIRAL LOAD OF SARS-COV-2 IN CLINICAL SAMPLES**

- **Respiratory samples** (nasopharyngeal swabs, throat swabs, sputum, bronchoalveolar lavage) have high viral loads
  - Maximum, $7.11 \times 10^8$ copies/swab by day 4/5 (per one study)
- A few studies have shown detectable viral RNA in **stool**
  - Although the viral loads were less than those of respiratory samples, precautionary measures should be considered when handling fecal samples
- Limited data have shown that viral RNA could be detected in **plasma or serum** from COVID-19 patients
  - Viremia in up to 15% patients, generally those with severe illness
  - Median PCR cycle threshold value was 35.1 (95% CI: 34.7-35.1), suggesting a very low RNA concentration
- **Urine** samples tested for viral RNA have shown 0% to 6.9% (in one study) samples with detectable viral RNA in COVID-19 patients

**To date, laboratory-acquired infection has not been reported for SARS-CoV-2**

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: [https://www.coronavirus.gov](https://www.coronavirus.gov) or [https://coronavirus.ucsf.edu/](https://coronavirus.ucsf.edu/)
## SARS-COV-2 IN CLINICAL SAMPLES

<table>
<thead>
<tr>
<th>Study patients</th>
<th>BLOOD/ SERUM</th>
<th>STOOL/ ANAL SWAB</th>
<th>URINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing; N=2 followed daily after hospitalization</td>
<td>N/A</td>
<td>0/2</td>
<td>0/2</td>
</tr>
<tr>
<td>Beijing; N=17</td>
<td>N/A</td>
<td>9/17 (53%) pos (viral load lower Vs resp samples)</td>
<td>N/A</td>
</tr>
<tr>
<td>Wuhan; N=41</td>
<td>6/41 (15%) patients; low viral load (Median PCR value 35.1)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Sichuan; N=19 suspected clinically with 9 confirmed</td>
<td>0/19</td>
<td>8/9 (89%) pos</td>
<td>0/9</td>
</tr>
<tr>
<td>Guangzhou; N=57 in-patients</td>
<td>6/57 (10.5%); all 6 with severe illness</td>
<td>11/28 (39%) anal swab pos (stool not tested)</td>
<td>N/A</td>
</tr>
<tr>
<td>Shanghai; N=62 convalescent patients</td>
<td>0/14 (0%) positive during convalescence</td>
<td>54/66 (81.8%) stool positive for viral RNA</td>
<td>4/58 (6.9%) positive for viral RNA</td>
</tr>
</tbody>
</table>
Quick Guide to Biosafety Levels (BSL)

**Biosafety**: application of safety precautions that reduce a laboratorian’s risk of exposure to a potentially infectious microbe and limit contamination of the work environment and, ultimately, the community.

- There are **4 biosafety levels**; each has specific controls for containment of microbes and biological agents.

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
STANDARD MICROBIOLOGICAL PRECAUTIONS

• Common to all labs, REGARDLESS OF BSL
• Based on the principle that all blood, body fluids, secretions, nonintact skin, mucous membranes, and excretions (except sweat) may contain transmissible infectious agents
• Includes:
  • Not eating, drinking, or applying cosmetics in the lab
  • No shorts, short skirts, or open-toed shoes
  • Washing hands frequently (e.g. after working with biological materials and before leaving the lab)
  • Use of PPE (gloves, lab coats, etc.) depending on the anticipated exposure
  • Routinely decontaminating work surfaces
Risk Group I (RG1) microbes not known to consistently cause disease in healthy adults and present minimal potential hazard (e.g. nonpathogenic strain of *E. coli*).

Use BSL-1 containment which requires:

- **Laboratory practices:**
  - Standard microbiological practices are followed
  - Work can be performed on an open lab bench or table

- **Safety equipment:**
  - PPE worn as needed

- **Facility construction:**
  - Sink must be available for hand washing
  - Lab should have doors to separate the working space with the rest of the facility

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
• Risk Group 2 (RG2) microbes pose moderate hazards to laboratorians and the environment (e.g. Staphylococcus aureus)

• Use BSL-2 containment which requires BSL-1 PLUS:
  • Laboratory practices
    • Restricted access (to approved users only)
    • Keep doors closed during active procedures
  • Safety equipment:
    • Eye protection and face shields worn, as needed
    • All procedures that can cause aerosols or splashes are performed within a biological safety cabinet (BSC)
    • An autoclave or an alternative method of decontamination is used for waste treatment
  • Facility construction:
    • Lab has self-closing doors
    • Sink and eyewash readily available
• Risk Group 3 (RG3) microbes there can be either indigenous or exotic, and they can cause serious or potentially lethal disease through respiratory transmission (e.g. *Mycobacterium tuberculosis*).

• Use BSL-3 containment which requires BSL-2 PLUS:
  
  • Laboratory practices:
    • Laboratorians are under medical surveillance and might receive immunizations for microbes they work with
    • Access to the laboratory is restricted and controlled at all times
  
  • Safety equipment
    • All work with microbes must be performed within a certified BSC
    • Appropriate PPE must be worn which may require the use of respirators
  
  • Facility construction
    • Hands-free sink and eyewash are available near the exit
    • Entrance to the lab is through an antechamber and self-closing, interlocked doors
    • Exhausted air is via a dedicated system and is not recirculated to any other location
    • Laboratory maintains sustained directional inward airflow by drawing air into the laboratory from clean areas towards potentially contaminated areas

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: [https://www.coronavirus.gov](https://www.coronavirus.gov) or [https://coronavirus.ucsf.edu/](https://coronavirus.ucsf.edu/)
Risk Group 4 (RG4) microbes are dangerous and exotic, posing a high risk of aerosol-transmitted infections and are frequently fatal without treatment or vaccines (e.g. Ebola virus).

BSL-4 containment includes BSL-3 PLUS:

- Laboratory practices
  - Change clothing before entering
  - Shower upon exiting
  - Decontaminate all materials before exiting
- Safety equipment
  - Perform all work with microbe within appropriate Class III BSC
  - Users wear a full body, air-supplied, positive pressure suit
- Facility construction
  - Lab located in a separate building or in an isolated and restricted zone of the building
  - Lab has dedicated supply and exhaust air, as well as vacuum lines and decontamination systems

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
COVID-19 AND BSL STATUS

- Routine diagnostic testing of specimens can be handled using Standard Precautions
- For procedures with a high likelihood to generate aerosols or droplets, use either a certified Class II Biological Safety Cabinet (BSC) or additional precautions to provide a barrier between the specimen and personnel
- Virus isolation in cell culture and initial characterization of viral agents recovered in cultures of SARS-CoV-2 specimens must be done in a BSL-3 lab

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
Use Standard Precautions to provide a barrier between the specimen and personnel during specimen manipulation.
PROCEDURES WITH A HIGH LIKELIHOOD TO GENERATE DROPLETS OR AEROSOLS

• Many routine lab procedures can potentially generate aerosols and droplets (especially vortexing, centrifugation, aggressive pipetting)
• Use a certified Class II Biological Safety Cabinet (BSC) for uncapped samples, or for respiratory samples
• Additional precautions to provide a barrier between the specimen and personnel may include:
  • Splash guards or face shield
  • Centrifuge safety cups
  • Sealed centrifuge rotors

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
DECONTAMINATION OF SURFACES

- Wear disposable gloves when cleaning
- If surfaces are dirty, clean using a detergent or soap and water prior to disinfection
- For disinfection, effective protocols include:
  - diluted household bleach solutions (diluted to 10%)
  - Alcohol solutions with at least 70% alcohol
    - Use when equipment may be damaged by use of bleach
  - Other common EPA-registered household disinfectants

NOTE: Always follow designated contact times

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
LABORATORY WASTE MANAGEMENT

- **NO** evidence to suggest need for additional packaging or disinfection procedures
- Handle waste from testing suspected or confirmed COVID-19 patient specimens as all other biohazardous waste in the lab

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
UCSF COVID-19 BIOSPECIMEN GUIDELINES

- **NO additional handling precautions** are recommended (Standard precautions OK)
- **NO additional storage requirements** are recommended
- In the event you are exposed (inhalation, ingestion, injury, or contact with mucosal surface) to any biospecimens, contact the **UCSF Exposure Hotline at 415-353-7842** immediately and follow UCSF’s policy on seeking medical care and reporting
- In the event of a biospecimen spill or leak onto a surface, follow UCSF’s Bloodborne Pathogen’s Exposure Plan and immediately contact EH&S at 9-911

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
**BOTTOM LINE**

- For routine diagnostic tests on serum, stool, blood, or urine specimens follow standard laboratory practices, including **Standard Precautions**, when handling potential COVID-19 patient specimens.
  - Wear a lab coat in the lab, & remove before exiting. Consider it dirty.
  - Wear gloves when handling specimens. Change if torn/damaged. Consider gloves dirty.
  - Be aware of hand motions and what you touch.
  - Treat every sample as if it is infectious.
  - If risk of splash (e.g., uncapping samples, pour-offs, minimal pipetting) use splash shield/face shield.
- For procedures with the potential to generate aerosols or droplets (e.g., vortexing, centrifuging):
  - Use certified Class II BSC if uncapped samples.
  - Capped samples (non-respiratory origin) may be processed outside a BSC.
- Manipulations of respiratory samples, use certified Class II BSC.

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/
RESOURCES

- CDC: Interim Laboratory Biosafety Guidelines for Handling and Processing Specimens Associated with Coronavirus Disease 2019 (COVID-19)
- CDC: Recognizing the Biosafety Levels
- Chen W et al. Emerging Microbes & Infections 2020 Vol 9. Detectable 2019-nCoV viral RNA in blood is a strong indicator for the further clinical severity
- UCSF COVID-19 Biospecimen Guidelines (March 15, 2020)
- Public Health England Guidance - COVID-19: safe handling and processing for samples in laboratories (Updated 12 March 2020)

COVID-19 is an emerging, rapidly evolving situation. For latest information please visit CDC: https://www.coronavirus.gov or https://coronavirus.ucsf.edu/