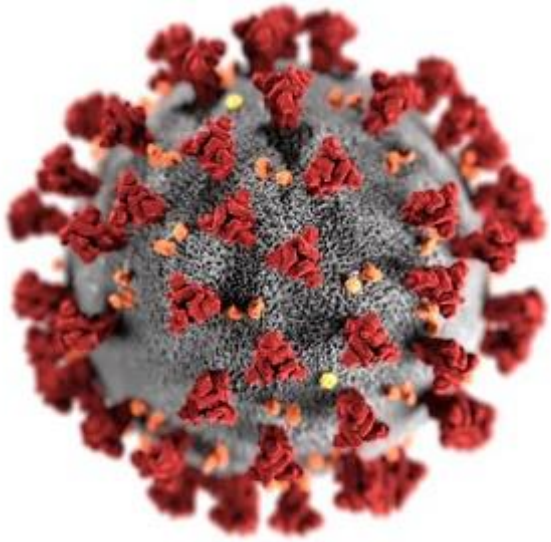
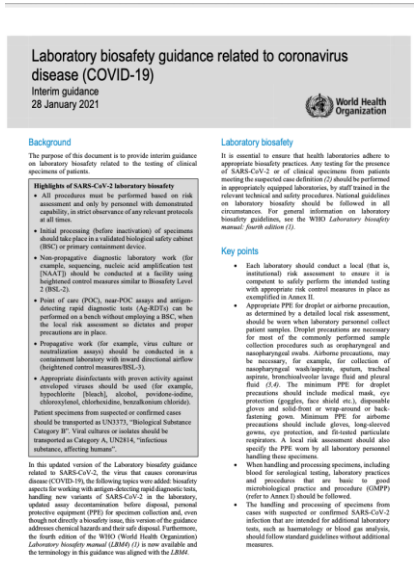
Preparing to Work with SARS-CoV-2:

in supplement to

WHO Laboratory biosafety guidance related to coronavirus disease (COVID-19)

Interim Guidance (28 January 2021)





Laboratory biosafety guidance related to coronavirus disease (COVID-19)

Interim guidance

28 January 2021

World Health Organization

Background

The purpose of this document is to provide interim guidance on laboratory biosafety related to the testing of clinical specimens of patients.

Highlights of SARS-CoV-2 laboratory biosafety

- All procedures must be performed based on risk assessment and only by personnel with demonstrated capability, in strict observance of any relevant protocols at all times.
- Initial processing (before inactivation) of specimens should take place in a validated biological safety cabinet (BSC) or primary containment device.
- Non-propagative diagnostic laboratory work (for example, sequencing, nucleic acid amplification test [NAAT]) should be conducted at a facility using heightened control measures similar to Biosafety Level 2 (BSL-2).
- Point of care (POC), near-POC assays and antigen-detecting rapid diagnostic tests (Ag-RDTs) can be performed on a bench without employing a BSC, when the local risk assessment so dictates and proper precautions are in place.
- Propagative work (for example, virus culture or neutralization assays) should be conducted in a containment laboratory with inward directional airflow (heightened control measures/BSL-3).
- Appropriate disinfectants with proven activity against enveloped viruses should be used (for example, hypochlorite [bleach], alcohol, povidone-iodine, chloroxylenol, chlorhexidine, benzalkonium chloride).

Patient specimens from suspected or confirmed cases should be transported as UN3373, "Biological Substance Category B". Viral cultures or isolates should be transported as Category A, UN2814, "infectious substance, affecting humans".

In this updated version of the Laboratory biosafety guidance related to SARS-CoV-2, the virus that causes coronavirus disease (COVID-19), the following topics were added: biosafety aspects for working with antigen-detecting rapid diagnostic tests, handling new variants of SARS-CoV-2 in the laboratory, updated assay decontamination before disposal, personal protective equipment (PPE) for specimen collection and, even though not directly a biosafety issue, this version of the guidance addresses chemical hazards and their safe disposal. Furthermore, the fourth edition of the WHO (World Health Organization) *Laboratory biosafety manual (LBM4) (1)* is now available and the terminology in this guidance was aligned with the *LBM4*.

Laboratory biosafety

It is essential to ensure that health laboratories adhere to appropriate biosafety practices. Any testing for the presence of SARS-CoV-2 or of clinical specimens from patients meeting the suspected case definition *(2)* should be performed in appropriately equipped laboratories, by staff trained in the relevant technical and safety procedures. National guidelines on laboratory biosafety should be followed in all circumstances. For general information on laboratory biosafety guidelines, see the WHO *Laboratory biosafety manual: fourth edition (1)*.

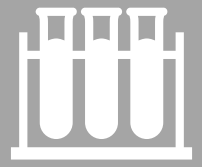
Key points

- Each laboratory should conduct a local (that is, institutional) risk assessment to ensure it is competent to safely perform the intended testing with appropriate risk control measures in place as exemplified in Annex II.
- Appropriate PPE for droplet or airborne precaution, as determined by a detailed local risk assessment, should be worn when laboratory personnel collect patient samples. Droplet precautions are necessary for most of the commonly performed sample collection procedures such as oropharyngeal and nasopharyngeal swabs. Airborne precautions, may be necessary, for example, for collection of nasopharyngeal wash/aspirate, sputum, tracheal aspirate, bronchioalveolar lavage fluid and pleural fluid *(3,4)*. The minimum PPE for droplet precautions should include medical mask, eye protection (goggles, face shield etc.), disposable gloves and solid-front or wrap-around or back-fastening gown. Minimum PPE for airborne precautions should include gloves, long-sleeved gowns, eye protection, and fit-tested particulate respirators. A local risk assessment should also specify the PPE worn by all laboratory personnel handling these specimens.
- When handling and processing specimens, including blood for serological testing, laboratory practices and procedures that are basic to good microbiological practice and procedure (GMPP) (refer to Annex I) should be followed.
- The handling and processing of specimens from cases with suspected or confirmed SARS-CoV-2 infection that are intended for additional laboratory tests, such as haematology or blood gas analysis, should follow standard guidelines without additional measures.

World Health Organization

Overview of Key Points

- Good Microbiological Practice and Procedure
- Biological Risk Assessment
- Clinical testing (non-propagative)
- Culture and isolation of SARS-CoV-2
- Transport and shipping
- Disinfection, inactivation, waste management



Good Microbiological Practice and Procedure

Good Microbiological Practice and Procedure (GMPP)

A series of best biosafe practice and procedure for working with infectious material in the laboratory

- Hand hygiene
- Prevent dispersal
  - Appropriate decontamination and deactivation/disposal
- Avoid injection
  - Safe sharp procedures
- Avoid ingestion and contact with skin and eyes
  - Use personal protective equipment (PPE)
- Avoid inhalation
  - Prevent aerosol formation

GMPP is part of the "Core Requirements" (see Annex I of the WHO Laboratory biosafety guidance related to coronavirus disease (COVID-19)[1] or the fourth edition of the Laboratory Biosafety Manual[2])

[1] https://www.who.int/publications/i/item/WHO-WPE-GIH-2021.1
[2] https://www.who.int/publications/i/item/9789240011311

Biological Risk Assessment

Biological Risk Assessment

A systematic process of gathering information and evaluating the likelihood and impact of exposure to or release of workplace hazard(s) and determining the appropriate risk control measures to reduce the risk.

STEP 1. Gather information (hazard identification)

STEP 2. Evaluate the risks

STEP 3. Develop a risk control strategy

STEP 4. Select and implement risk control measures

STEP 5. Review risks and risk control measures

Refer to Annex II of the WHO Laboratory biosafety guidance related to coronavirus disease (COVID-19)[1] or the fourth edition of the Laboratory Biosafety Manual[2]

This process is best carried out by a team of staff that are involved in various processes related to the laboratory work

[1] https://www.who.int/publications/i/item/WHO-WPE-GIH-2021.1

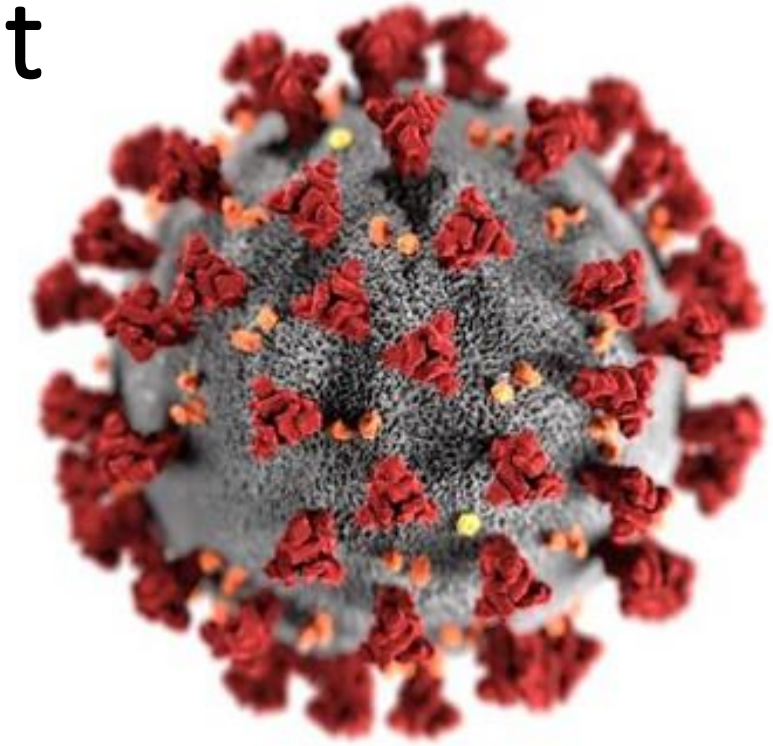
[2] https://www.who.int/publications/i/item/9789240011311

STEP 1. Gather information (hazard identification)

Consider the laboratory process to be performed and the following factors that influence risk:

- The biological agent (SARS-CoV-2)
- Laboratory procedures and equipment
- Control measures already in place
- Facility
- Personnel
- Other factors

SARS-CoV-2: the aetiological agent



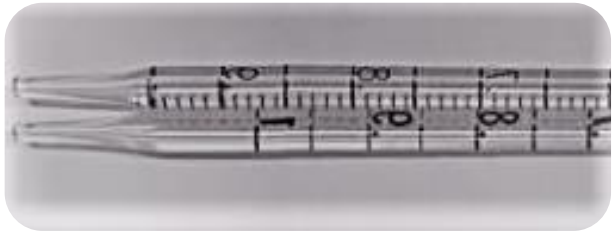
- Contact and droplet transmission (transmission via aerosols and fomites discussed but not yet proven)
- Vaccination possible but limited availability
- Highly contagious
- Infectious dose unknown
- Surface half-life uncertain
- Non-specific and varied symptoms
- Asymptomatic persons can spread disease
- Severe morbidity among immuno-incompetent and some persons with comorbidities
- Likelihood of mortality increases with age and infirmity
- No preexisting specific immunity in human population but an increasing number of convalescents and vaccinated people. Though the duration of the immunity is not yet reliably determined, and herd immunity could not be assumed at the moment.
- Some antiviral drugs under trial; treatment of symptoms

These factors will influence the consequence of accidental exposure or release!

Procedures and equipment

<u>Aerosol producing procedures:</u>

- Vortexing
- Shaking
- Centrifuging
- Pipetting



<u>Sharps</u> use (glass or needles)

<u>Culture</u> – highly concentrated or large volumes of virus

<u>Laboratory animals</u> - scratches or bites

These procedures increase the likelihood of an accidental exposure or release

Control measures in place

Biocontainment

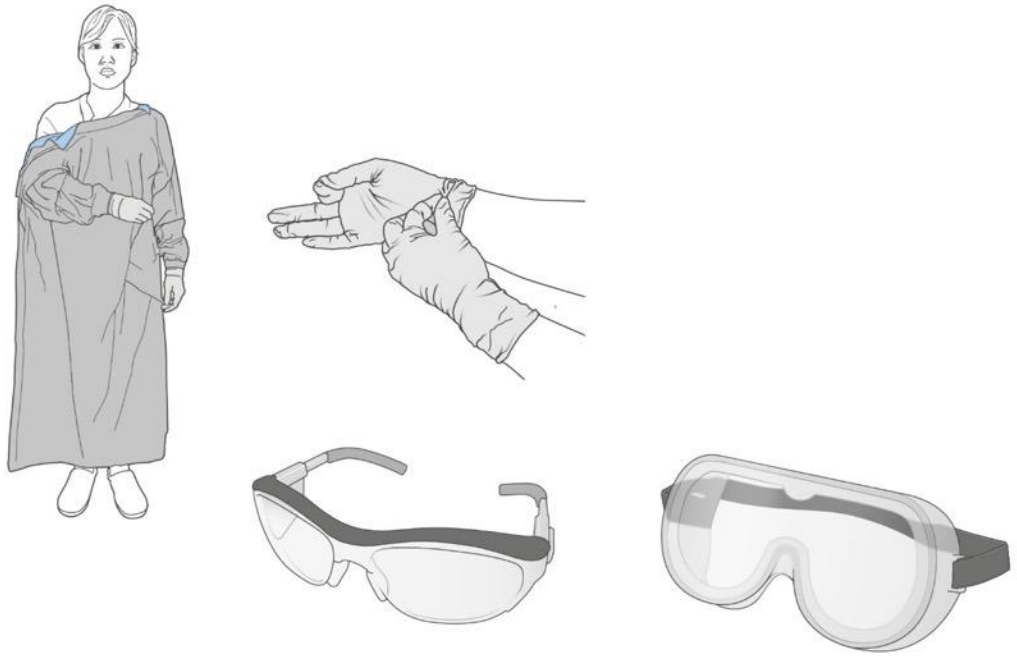
- Biosafety cabinet (BSC)
- Glovebox (possible alternative)

Personal Protective Equipment

- Disposable gloves
- Full-length laboratory coats/gowns
- Eye protection
- Face shields
- Masks/respirators

Administrative Controls

- Training
- Good Microbiological Practice and Procedure (GMPP)
- Standard operating procedures (SOPs)
- Biosafety manual



These control measures reduce the likelihood of an accidental release or exposure

Facility

Integrity

- Ample space with a hand-washing basin
- Intact (no gaps or breaches in structure)
  - Easy to clean and decontaminate
- Designed or refitted for safe, efficient and ergonomic operations

Safety and Security

- Restricted access to labs/corridors
- Doors labelled with biohazard sign
- Workflow – tidy and uncluttered

Ventilation

- Sufficient ventilation
- Directional airflow into the lab (virus isolation)

Facilities with these features reduce the likelihood of an accidental release or exposure

Personnel

Competence

Trained to perform the work

- Methods and equipment
- Biosafe practices and correct use of PPE
- Continual learning

Understanding of risks

- Mitigation and remediation

Experience

- Trained and knowledgeable in relevant lab techniques

Attitude

- Professional
- Focused

Well-trained, experienced laboratory personnel reduce the likelihood of an accidental release or exposure

STEP 2. Evaluate the risks

- What situations could lead to potential exposure or release?
  - Spills, aerosols, injury?
- How likely are these situations to happen?

What are the consequences of exposure or release?

Consequences of exposure/ release	Severe	Medium	High	Very high
	Moderate	Low	Medium	High
	Negligible	Very low	Low	Medium
		Unlikely	Possible	Likely
		Likelihood of exposure/release		

Inherent Risk working with SARS-CoV-2 in the Laboratory

Procedures	Hazards	How likely is this ?**	Consequence	Inherent Risk
Sample accessioning	• Container leaks • Container breakage (sharps) • Infectious material spill	**Unlikely to Possible**	**Moderate**	**Low to Medium**
Viral Culture* Sample collection*	• Aerosol exposure during sample processing • Eye splash during sample processing • Infectious material spill	**Possible to Likely**		**Medium to High**
RT-PCR ELISA (serology)		**Possible**		**Medium**
Near Point-of-Care (PoC)		**Unlikely to Possible**		**Low to Medium**
PoC		**Unlikely**		**Low**
Whole Genome Sequencing	None (if sample is already inactivated)	**Unlikely**	**Negligible**	**Very low**

* These are the procedures that involve the greatest risk

**The likelihood will depend on control measures that are already in place

STEP 3. Develop a risk control strategy

Considerations:

- Are resources sufficient to secure and maintain potential risk control measures?
- Will any conditions identified limit the ability to reduce risk?
- Can the work be done without additional risk control measures?

STEP 4. Select and implement risk control measures

Add control measures (PPE, BSC, others as appropriate)

Procedures	Hazards	How likely is this ?**	Consequence	Inherent Risk
Sample accessioning	• Container leaks • Container breakage (sharps) • Infectious material spill	**Unlikely to Possible**	**Moderate**	**Low to Medium**

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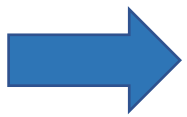
Additional Control Measures
BSC, respiratory protection, eye protection, ventilation



Consequences of exposure/ release				
	Severe	Medium	High	Very high
	Moderate	Low	Medium	High
	Negligible	Very low	Low	Medium
		Unlikely	Possible	Likely
		Likelihood of exposure/release		

Procedures	Hazards	How likely is this ?**	Consequence	Residual Risk
Sample accessioning	• Container leaks • Container breakage (sharps) • Infectious material spill	**Unlikely**	**Moderate**	**Low**

Risk should be reduced to a level that is acceptable!

Adding control measures to reduce risk

Procedures	Hazards	Inherent Risk	Additional Control Measures
Sample accessioning	• Container leaks • Container breakage (sharps) • Infectious material spill	**Low to Medium**	**BSC, respiratory protection, eye protection, ventilation**
Viral Culture* **Sample collection***	• Aerosol exposure during sample processing • Eye splash during sample processing • Infectious material spill	**Medium to High**	**Heightened control measures/BSL3, inward air flow, BSC, enhanced respiratory protection** **Face shield, respiratory protection**
RT-PCR **ELISA (serology)**		**Medium**	**BSC, respiratory protection, eye protection, ventilation**
Near POC		**Low to Medium**	**Respiratory protection, eye protection or face shield, ventilation**
POC		**Low**	**Respiratory protection, eye protection or face shield, ventilation**
Whole Genome Sequencing	None	**Very low**	**None needed**

Residual Risk: Risk remaining after adding controls (previous slide)

Procedures	Hazards	How likely is this ?**	Consequence	Residual Risk
Sample accessioning	• Container leaks • Container breakage (sharps) • Infectious material spill	**Unlikely**	**Moderate**	**Low**
Viral Culture* Sample collection*	• Aerosol exposure during sample processing • Eye splash during sample processing • Infectious material spill	**Unlikely to Possible**		**Low to Medium**
RT-PCR ELISA (serology)		**Unlikely**		**Low**
Near POC		**Unlikely**		**Low**
POC		**Unlikely**		**Very low**
Whole genome sequencing	None	**Unlikely**	**Negligible**	**Very low**

* These are the procedures that involve the greatest risk

**The likelihood will depend on control measures that can be added to reduce risk

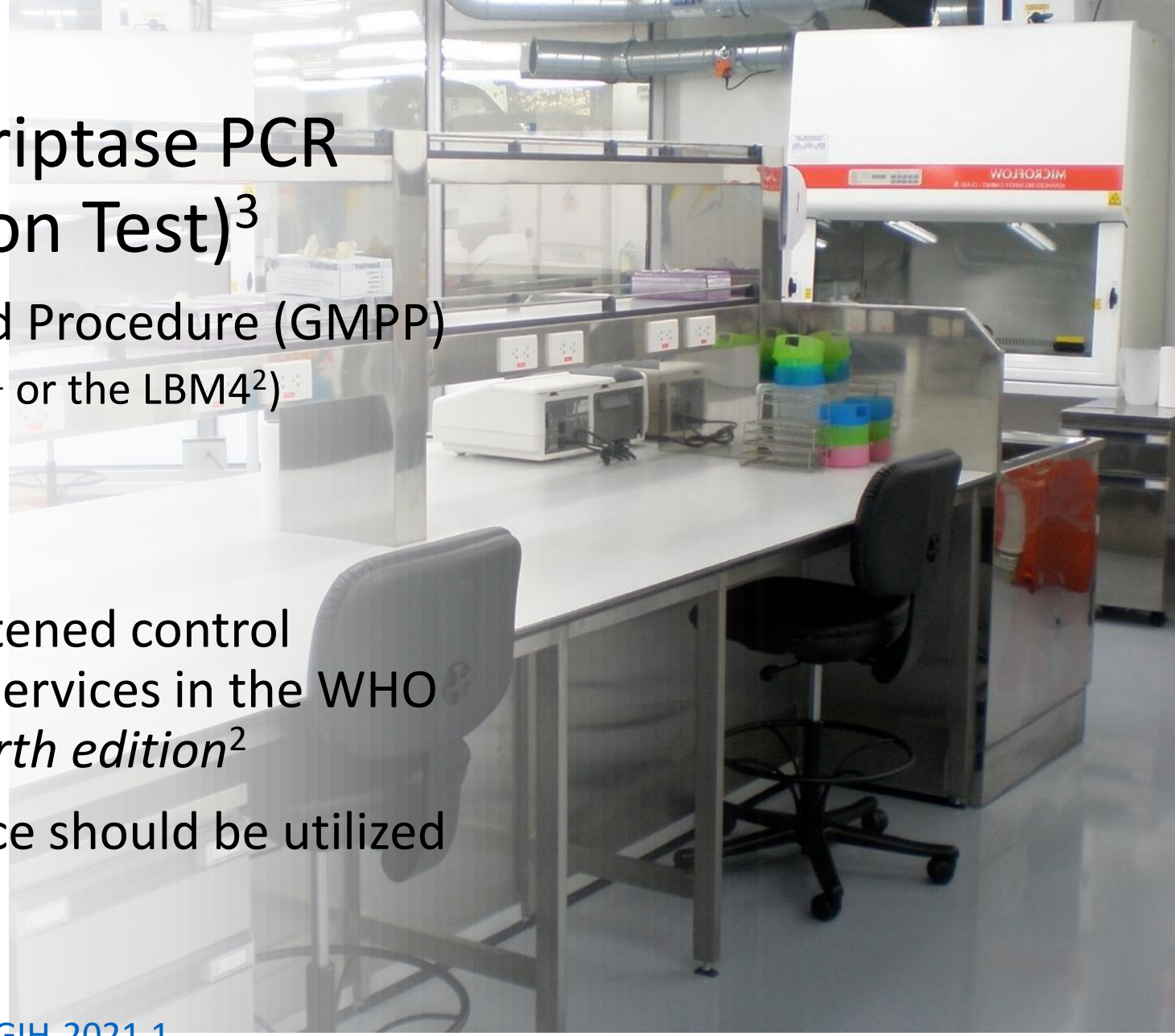
STEP 5. Review risks and risk control measures

- Risk assessment should be a continuous process
- Should be performed whenever changes take place:
  - Personnel
  - Facility
  - Equipment
  - Methods
  - Regulations

Clinical testing (non-propagative)

Real Time Reverse Transcriptase PCR (Nucleic Acid Amplification Test)[3]

- Good Microbiological Practice and Procedure (GMPP)
  - (See "Core Requirements", Annex I [1] or the LBM4[2])
- Appropriate PPE
- Staff Competence
- Biosafety Level 2 (BSL-2) or heightened control measures suitable for diagnostic services in the WHO *Laboratory biosafety manual: fourth edition*[2]
- BSC or primary containment device should be utilized



[1] https://www.who.int/publications/i/item/WHO-WPE-GIH-2021.1
[2] https://www.who.int/publications/i/item/9789240011311
[3] https://www.fda.gov/media/134922/download

Point of Care (PoC) and near-POC Assays

including antigen-detecting RDTs (Ag-RDT)

(No nucleic acid extraction)

- Good Microbiological Practice and Procedure (GMPP)
- Appropriate PPE
- Staff Competence
- May be performed on bench (outside a lab)
  - Well-ventilated area (see the following slides)
  - On absorbent towel or diaper
  - Free of clutter
- Optional
  - Biosafety cabinet/glove box
  - Use primary containment if readily available

SARS CoV-2 Antigen Tests

Detect only active COVID-19 infection

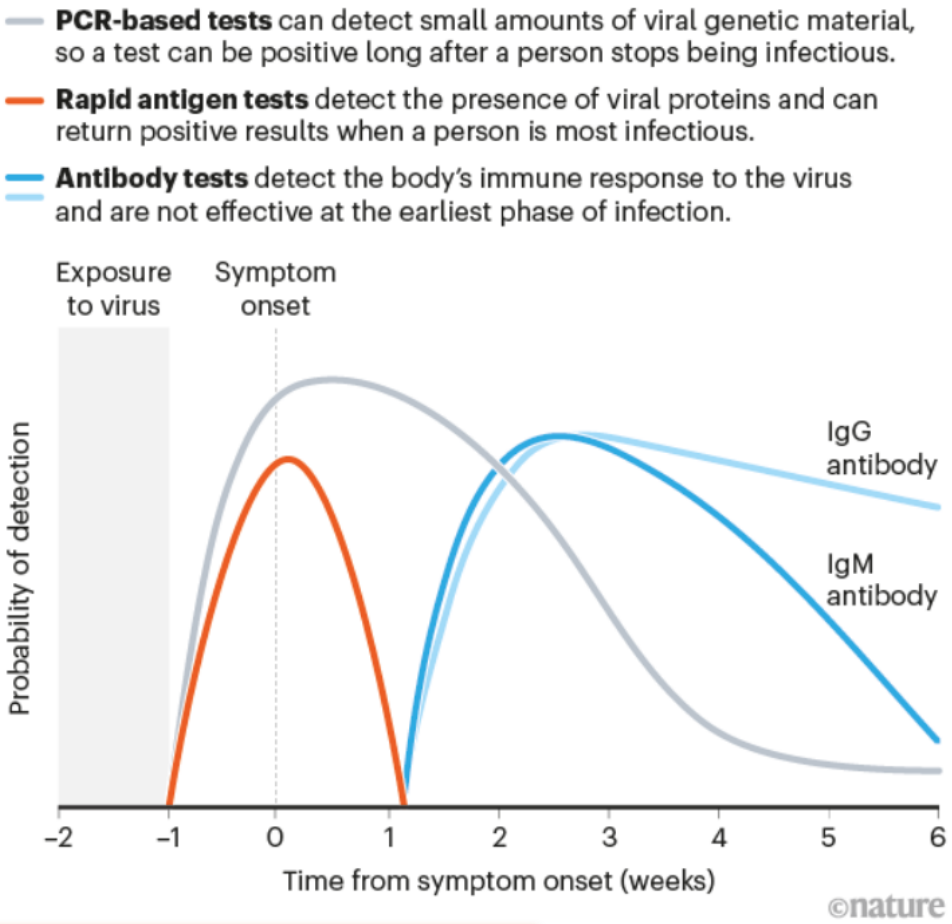
Simple, rapid, easy to perform

Pre-symptomatic and within 5-7 days after symptom onset

WHO interim Guidance
Antigen-detection in the diagnosis of SARS-CoV-2 infection using rapid immunoassays[4]

Suggested Use Cases during Outbreaks

- PCR is unavailable/long turnaround times
  - Remote settings, within institutions
- Screening of at-risk individuals (before NAAT)
- Monitor trends in disease incidence
- Early detection and isolation
  - Widespread transmission
  - Asymptomatic contacts



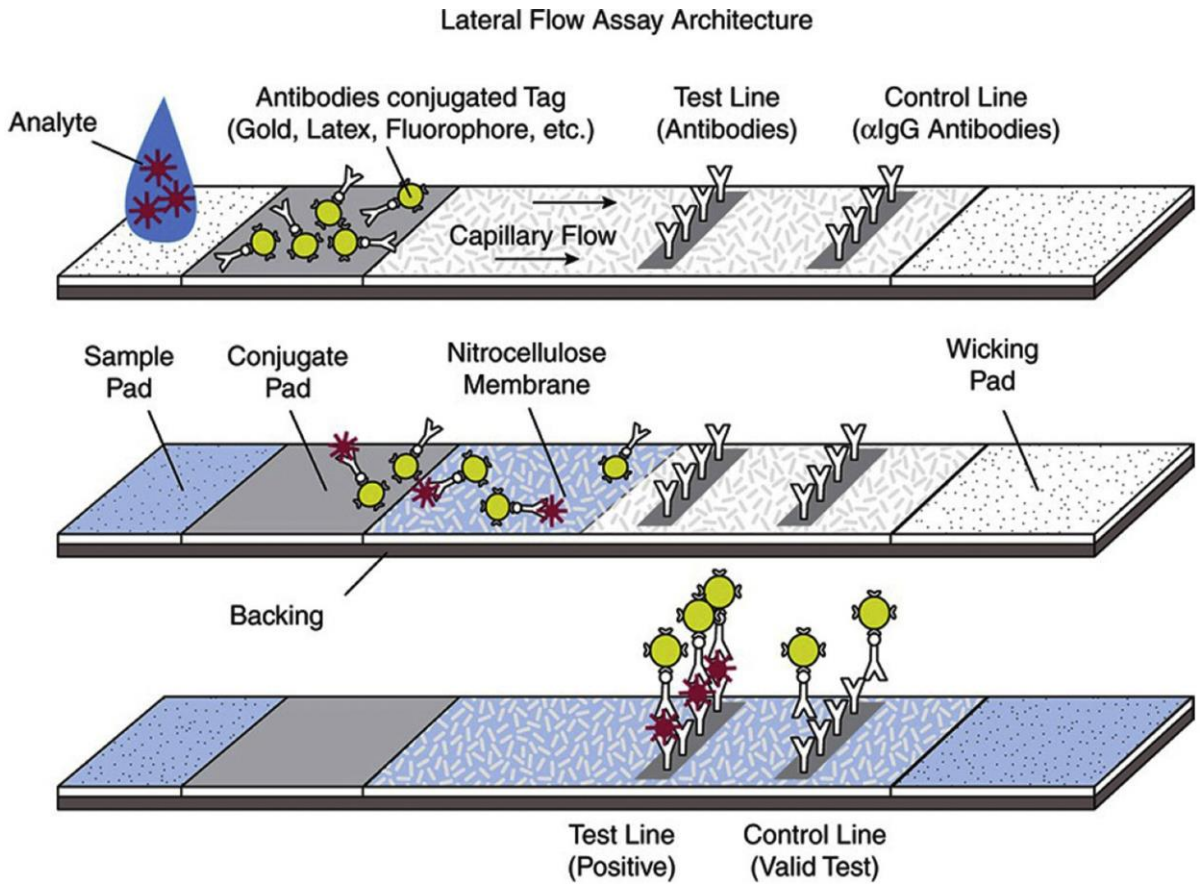
From Guglielmli G.[5]

Ag RDT should meet diagnostic criteria of ≥ 80% sensitivity and ≥ 97% specificity

[4] https://www.who.int/publications/i/item/antigen-detection-in-the-diagnosis-of-sars-cov-2infection-using-rapid-immunoassays

[5] Guglielmli G. 2020. Nature Vol 585. pp 496-98.

Antigen Test (POC)



From: https://doi.org/10.1016/j.nmni.2020.100713

Ventilation

The movement of fresh air around a closed space, or the system that does this

Types[6]

- Natural:

Purpose-built, building openings (windows, doors, whirlybirds, chimneys, etc.)

- Assisted (mixed mode):

Relies on natural driving forces to provide the desired (design) flow rate.

- Mechanical- Fans drive mechanical ventilation.

Installed in windows, walls, air ducts

The risk assessment decides the type of lab ventilation based on suitability and availability

[6] https://medicalguidelines.msf.org/viewport/TUB/latest/appendix-18-advantages-and-disadvantages-of-ventilation-techniques-20324472.html

	Natural ventilation	Assisted ventilation	Mechanical ventilation
Climate	Cannot be used in extreme hot or cold environments	In extreme climates, must be used with HVAC and heating systems.	Suitable for all weather climates
Equipment Cost	Inexpensive	Installation costs low to medium	Expensive to install and maintain
User control	High but binary (all or nothing)	Greater control by user	Greatest control by user
Air exchange/ ventilation rate	Least control. Cannot establish negative pressure	Greater control by user	Greatest control by user, but can fail to maintain air exchange
Energy cost	Low	Medium	High to very high. May need filter, HEPA
Comfort	Potential for noise intrusion	Potential for equipment noise	Potential for equipment noise
Product protection	Highest potential for contamination of the specimens	Potential for contamination of the specimens without containment	Lowest potential for contamination of the specimens without containment

Culture and isolation of SARS-CoV-2

Requirements for culture and isolation of SARS-CoV-2

- Special training
- Detailed risk assessment
- Heightened Control meaures or Biosafety Level 3 (BSL-3)
- Appropriate PPE
- Facility with inward directional airflow into the laboratory (negative pressure)
- Not suitable for most laboratories
  - → Outside the main scope of this supplementary guidance

This is a medium to high risk activity if performed without adequate biosafety controls and mitigations!

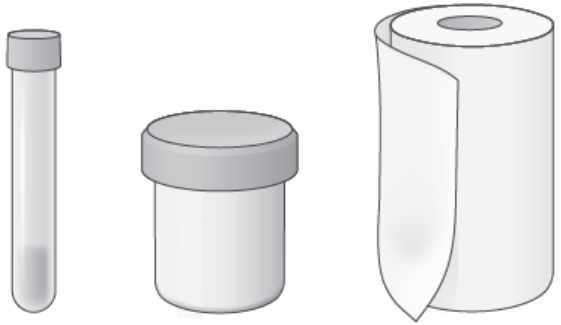
Transport and shipping

Intra-facility transfer[7,8]

- From clinic to laboratory
- Between buildings
- Between non-adjoining laboratories
- Use a cart if many samples are being moved
- Spill kit available and staff trained
- Pneumatic tube system
  - Detailed risk assessment required if necessary to use
  - Tightly sealable bag system recommended

Primary receptacle

Watertight, leak-proof or siftproof receptical wrapped in absorbent material



Pneumatic tube system

Sealable bag

Disinfect external surfaces of carrier and cart before moving between laboratories

[7] https://www.who.int/ihr/publications/WHO-WHE-CPI-2019.20/en/

[8] https://www.cdc.gov/csels/dls/locs/2020/transport_recommendations_for_covid-19_specimens.html

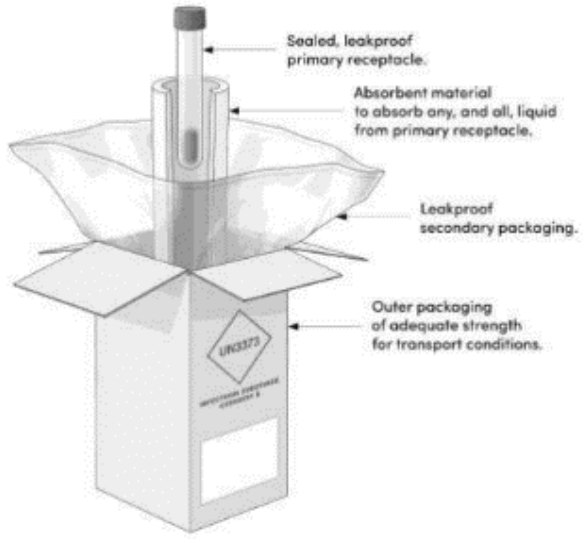
Inter-facility (between facilities) transportation

1. Human specimens that may contain SARS-CoV2
   - Ground Transport
     - Follow local and applicable international regulations for ground transport
     - Ideally triple-packaged
     - If using commercial carrier, Category B Regulations apply (UN3373)
   - Air transport
     - Category B UN3373 regulations
2. Live viral cultures

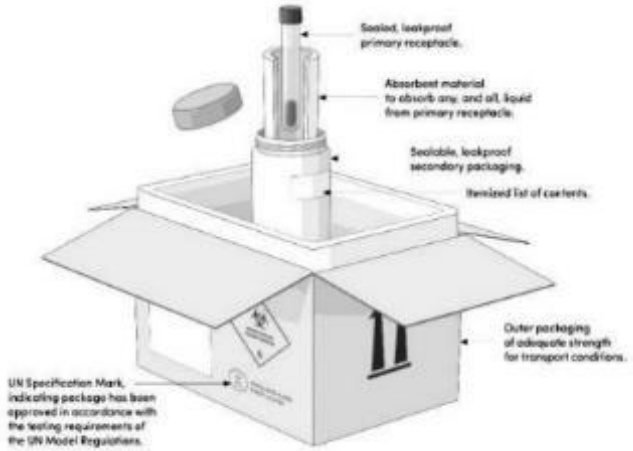
Must be shipped according to Category A UN2814 regulations

Follow WHO Guidance on regulations for the transport of infectious substances 2019–2020[9]

Triple packaging



Category B



Category A

Follow WHO Guidance on regulations for the transport of infectious substances 2019–2020

[9] https://www.who.int/ihr/publications/WHO-WHE-CPI-2019.20/en/

Disinfection, inactivation, waste management

Disinfection

- Use with caution in well-ventilated areas
- Allow appropriate contact time
- Do not use expired chemicals

1. Sodium hypochlorite (bleach)[2]

- 1000 parts per million [ppm] (0.1%) for general surface disinfection
- 10 000 ppm (1%) for disinfection of sample spills
- Prepare new dilution every 24 hours
- Contact time ≥ 10 min

2. Ethanol (EtOH) 62–71% (Contact time ≥ 10 min)
3. Hydrogen peroxide (H_2O_2) 0.5%
4. Quaternary ammonium compounds and phenolic compounds, if used according to the manufacturer's recommendations
5. Other compounds according to manufacturer's directions[2]

[2] https://www.who.int/publications/i/item/9789240011311
[10] https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19

Inactivation

Inactivate SARS CoV-2 whenever possible BEFORE manipulation to prevent accidental exposure or release

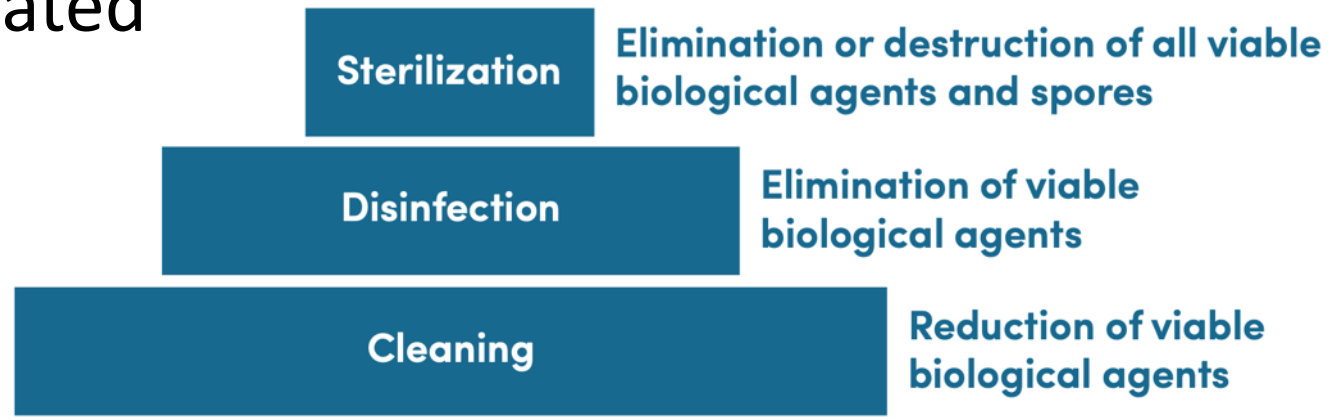
1. Chemical
   - Some viral RNA extractions buffers[9,3,10]
   - Formalin for tissue samples[10]
2. Gamma Irradiation (≥1 Mrad)[11]
3. Heat
   - 30 min at 65°C[3] (conservative)
   - *Serology – may be affected (Read manufacturer's instructions)

External lysis buffer of the common RNA extraction kits is effective in inactivating the COVID-19 virus without heat or other additional means[3]

[10] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7354533/pdf/viruses-12-00624.pdf
[3] https://www.fda.gov/media/134922/download
[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7354523/pdf/viruses-12-00622.pdf
[12] https://absa.org/wp-content/uploads/2020/04/ABSA2020-InVitroInactivation-ofSARS-CoV-2-UsingGammaRadiation.pdf

Decontamination and waste management principles

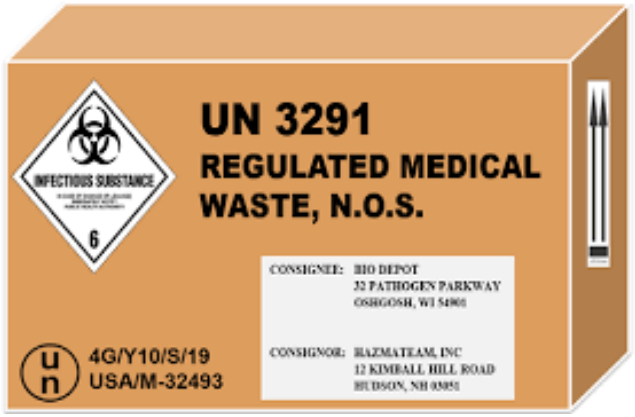
1. Control biological risks
   - Any surfaces or materials known to be or potentially contaminated
   - Benchtops, interior surfaces of BSC, equipment and devices
2. Identify and Segregate contaminated materials
   - Sharps
   - Contaminated waste
   - Chemical waste
   - General (non-hazardous) waste



3. For <u>all</u> contaminated materials or liquids
   - Decontaminate onsite to allow further safe handling *or* package and transport safely to another treatment site

Waste Management

- Autoclave or incinerate infectious waste[2]
- Waste is Category B for transportation purposes
  - Regulated Medical Waste UN 3291
- Disposal of POC spent test cartridges
  - Read manufacturers specific instructions
  - Read Material Safety Data Sheets
  - Follow national, local regulations for disposal



[2] https://www.who.int/publications/i/item/9789240011311

Remember…

Use caution when working with products containing guanidinium iso/thiocyanate (GTC/GITC)[12,13]

GTC/GITC lyses cells and denatures nucleases (RNase/DNase)

Products containing /GTCGITC

- Most DNA/RNA extraction kits
- GeneXpert cartridges
- TRIzol™ and similar products
- *Some* viral transport media (e.g. PrimeStore® MTM, Zymo DNA/RNA Shield)

Read and follow manufacturer's instructions and Safety Data Sheets (SDS/MSDS)

Do not use bleach in the presence of GTC/GITC

- **Reaction produces cyanide and chlorine gases**
- GTC/GITC inactivates organisms, so bleach not required

GTC/GITC waste is Hazardous Waste

- Toxic to marine and aquatic life
- **Do not** dispose of in wastewater stream
- Segregate GTC/GITC waste
  - Dispose of according to federal, state and local guidelines

[13] Paik SY, Wu X. 2005 Chemical Health and Safety 12(4):33-38

[14] https://www.ehs.harvard.edu/sites/default/files/lab_safety_guideline_qiagen_kits_0.pdf

Waste Management at a glance

	Human test samples	Nucleic Acid POC Cartridges; PCR extraction buffers	Antigen RDT Cartridges; Antibody test buffers
Hazard	SARS-CoV2 (potential)	GTC (Guanidinium iso/thiocyanate)	Sodium azide (NaN_3)[15] buffers
Precautions	Handle with appropriate PPE Prevent aerosolization.	Releases toxic gases in the presence of Sodium hypochlorite (bleach)	Toxic to aquatic life and acute toxic for humans.
Cleaning and disinfection	0.1-1.0% Sodium hypochlorite (bleach) or other recommended disinfectant	GCT inactivates SARS-CoV-2 RNA. Do not use bleach in the presence of GTC. Use a 70% solution of ethanol or isopropyl alcohol.	Sodium azide inactivates SARS-CoV-2, use appropriate disinfectant such as 70% ethanol or isopropyl alcohol. Do not autoclave.
Disposal	Category B Waste Autoclave or incinerate	Follow manufacturer's instructions. Segregate PCR extraction buffers as hazardous waste for professional disposal.	Read Safety Data Sheet and follow manufacturer's instructions for disposal or dispose of with hazardous waste. Do not pour sodium azide down the drain.

[15] https://pubchem.ncbi.nlm.nih.gov/compound/Sodium-azide

Summary

Before beginning laboratory work…

Understand and practice GMPP

Heightened control measures (or BSL3) for work with live cultures

Understand and practice Biological Risk Assessment (BRA)

Understand and practice safe transport and shipping of samples

Use appropriate containment and control measures as per Core Requirements for clinical testing

Understand and practice appropriate viral inactivation, disinfection and waste inactivation procedures

Reference, Acknowledgements, Thanks

WHO Laboratory biosafety guidance related to coronavirus disease (COVID-19) Interim guidance 28 January 2021

https://www.who.int/publications/i/item/WHO-WPE-GIH-2021.1

- Christina Scheel (Centers for Disease Control and Prevention, United States of America)
- Stuart Blacksell (Mahidol Oxford Tropical Medicine Research Unit, Thailand)
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Highlights of Guidance

Focus Topic	Change	Slide #s
POC – Antigen test	Suggested use cases and diagnostic window	23-24
Ventilation	Types of ventilation and advantages/disadvantages of each according to climate and facility resources	25-26
Inactivation	Most nucleic acid extraction buffers and some transport media contain detergents and chemicals that deactivate SARS-CoV-2. Sodium azide inactivates SARS-CoV-2.	34
Waste	Disposal of POC cartridges; sodium azide cannot be poured down the drain.	36
GTC: cleaning and disposal	Guanadinium iso/thiocyanate: segregate for professional disposal. Do NOT use bleach in the presence of GTC/GITC. Disinfection is not needed for GTC/GITC waste since it kills SARS-CoV-2.	35-37