

*Engraved for BANKES'S New System of GEOGRAPHY, Published by Royal Authority.*

# SARS-CoV-2 PANDEMIC AND THE SUBMARINE SERVICE



*A perspective view of the ADMIRALTY OFFICE, DOCK-YARD, STOREHOUSES &c. at Amsterdam.*



Lucio Ricciardi, University of Pavia - Italy

**SAMAP**  
2024



# WHO'S WHO

The COVID-19 pandemic has officially spanned the period between December 31<sup>st</sup>, 2019 and May 5<sup>th</sup>, 2023

(cases about  $765 \cdot 10^6$ ; casualties about 1 % WHO).



# SARS CoV-2

The first transmission to humans was in Wuhan, China. Since then, the virus has mostly spread through person-to-person contact, via aerosol droplets.

Coronaviruses are a group of viruses that can cause disease in both animals and humans. The **severe acute respiratory syndrome (SARS)** virus strain known as SARS-CoV is an example of a coronavirus.

SARS spread rapidly in 2002–2003.

The new strain of coronavirus is called **severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)**. The virus causes coronavirus disease 19 (COVID-19).





Los Angeles Times

Deep underwater, submariners are likely unaware of pandemic roiling the world above

Blissful ignorance

**THE | DIPLOMAT**  
*Read The Diplomat, Know the Asia-Pacific*

**COVID-19 Cases Reported on Both US Aircraft Carriers in Western Pacific**  
**Coronavirus cases have been found on USS *Theodore Roosevelt* and USS *Ronald Reagan* as well as a U.S. base in Japan.**





# Causes of virus spreading

(U) Evaluation of the Navy's Plans and Response to the Coronavirus Disease-2019 Onboard Navy Warships and Submarines (February 4, 2021)

The ineffective implementation of social distancing and the premature release of sailors from quarantine were primary causes of increased infection onboard the ship (e.g. Aircraft carriers)

As quarantine spaces were crowded, most believed that the quarantine itself would cause more sailors to become infected.

In a submarine, its recirculated air means the entire crew could be exposed to a virus in a short time span.

Cramped spaces would prevent correct distances (6 foot rule).



# Coronavirus Disease 2019 On Board a Submarine: A Retrospective Review

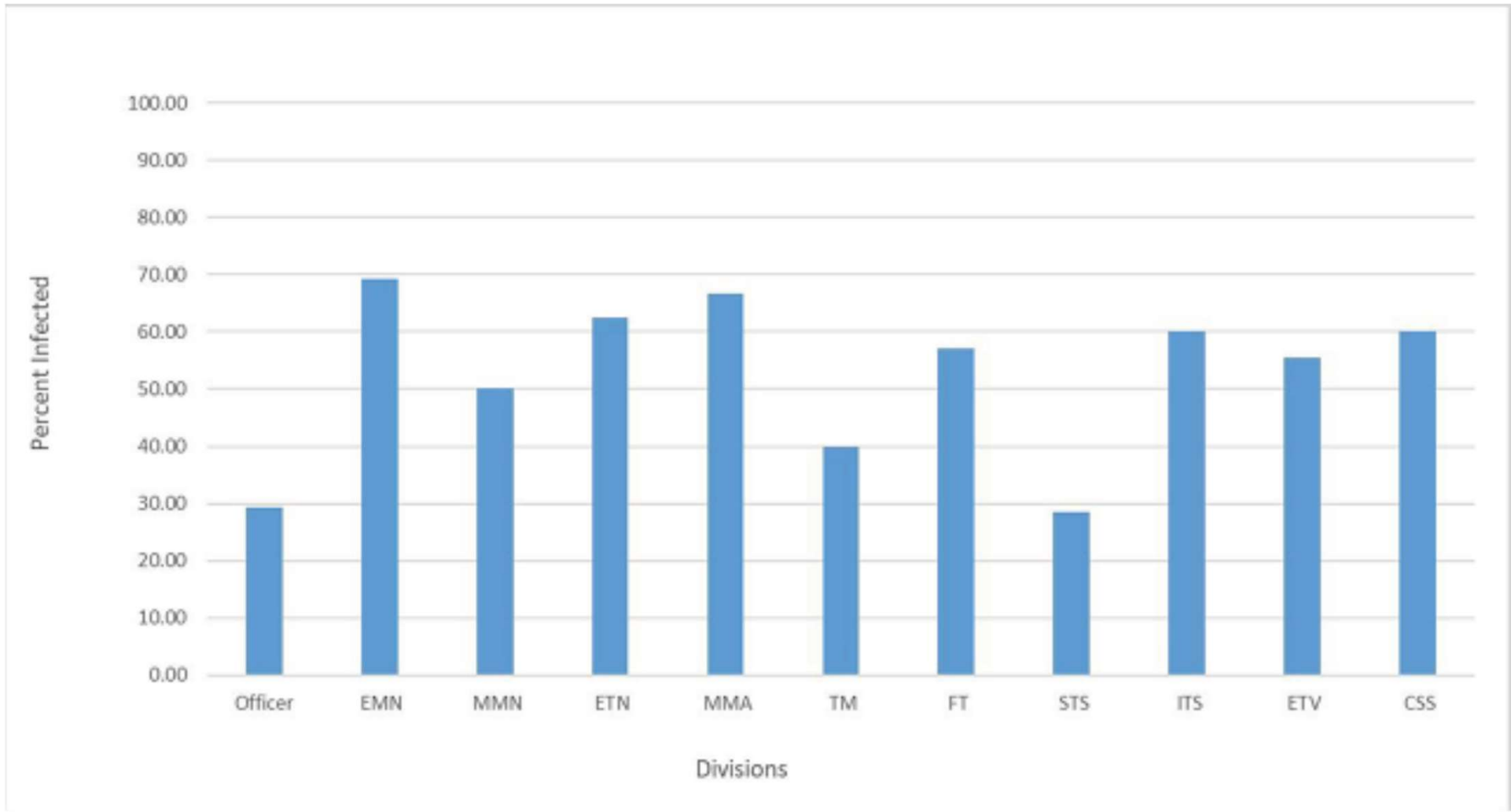
Submarine Readiness Squadron – Honolulu

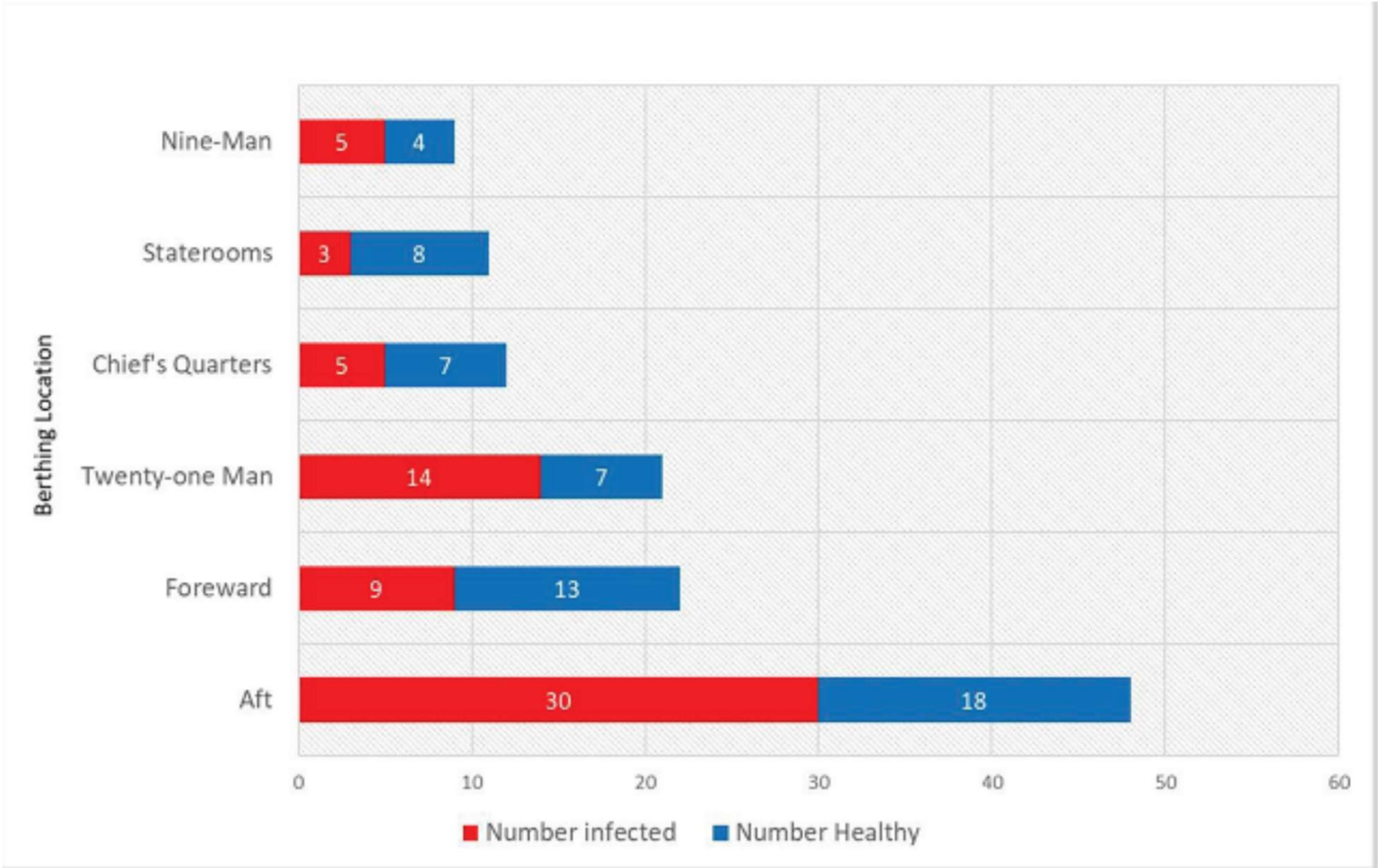
*Military Medicine* 187, November/December 2022

## *Abstract*

The submarine environment presents unique challenges in mitigating the spread of respiratory viruses because of the re-circulatory atmosphere and lack of ability to physically distance. The atmosphere of a submarine is periodically ventilated and continuously scrubbed. However, the air is recycled for months until the ship is able to ventilate. An outbreak of coronavirus disease 2019 (COVID-19) occurred on a U.S. Navy fast-attack nuclear submarine (SSN) with a crew of 128 personnel.











The U.S. submarine force, which has a little more than 24,000 members, has managed to keep the coronavirus at bay with an infection rate of less than 0.5%, according to the force's commander.

- “a culture of compliance”
- “strong team ethos”
- “compliance of local communities”





# USN Policy

Prior to deploying, a submarine crew quarantines on board the submarine, while it is tied up pier-side, for 14 days. Sailors are tested for COVID-19 at the beginning of the quarantine period, at the seven-day mark, and at the end of the 14 days. As long as the entire crew tests negative and no one is exhibiting COVID-19 symptoms at the end of the quarantine period, the submarine is released to go on deployment.





The Surgeon General of the Navy did review and update OPNAV Instruction 3500.41A, “Pandemic Influenza and Infectious Disease Policy,” and Navy Technical Reference Publication 4-02.10, “Shipboard Quarantine and Isolation,” September 2014, to include guidance and lessons learned from the COVID-19 pandemic.

For example, implementation of restriction of movement (ROM), pre-deployment sequesters, personal protective equipment supply requirements, and shipboard quarantine procedures.





# Prevention framework

Prevention measures for off-duty sailors and their families, for submarine crews while not deployed, for crews while preparing for a deployment, and for crew while at sea on a deployment.

An example of a pre-underway preparation activity is crew sequestration to establish a COVID-free 'bubble.'

The Navy defines a 'bubble' as a crew that has been at sea, or ROM-sequestered at the pier, for greater than 14 days without COVID-19 positive personnel and without COVID-19 symptoms.





# Mitigation framework

Guidance for submarines for a response if a crew member has COVID-19 symptoms while deployed or underway. The COVID-19 Mitigation Framework also includes shipboard protocols for patient isolation. For example, it states that if a patient starts showing signs of possible COVID-19 infection, that crew member has to be isolated until they are cleared by a medical department representative.





# Recovery framework

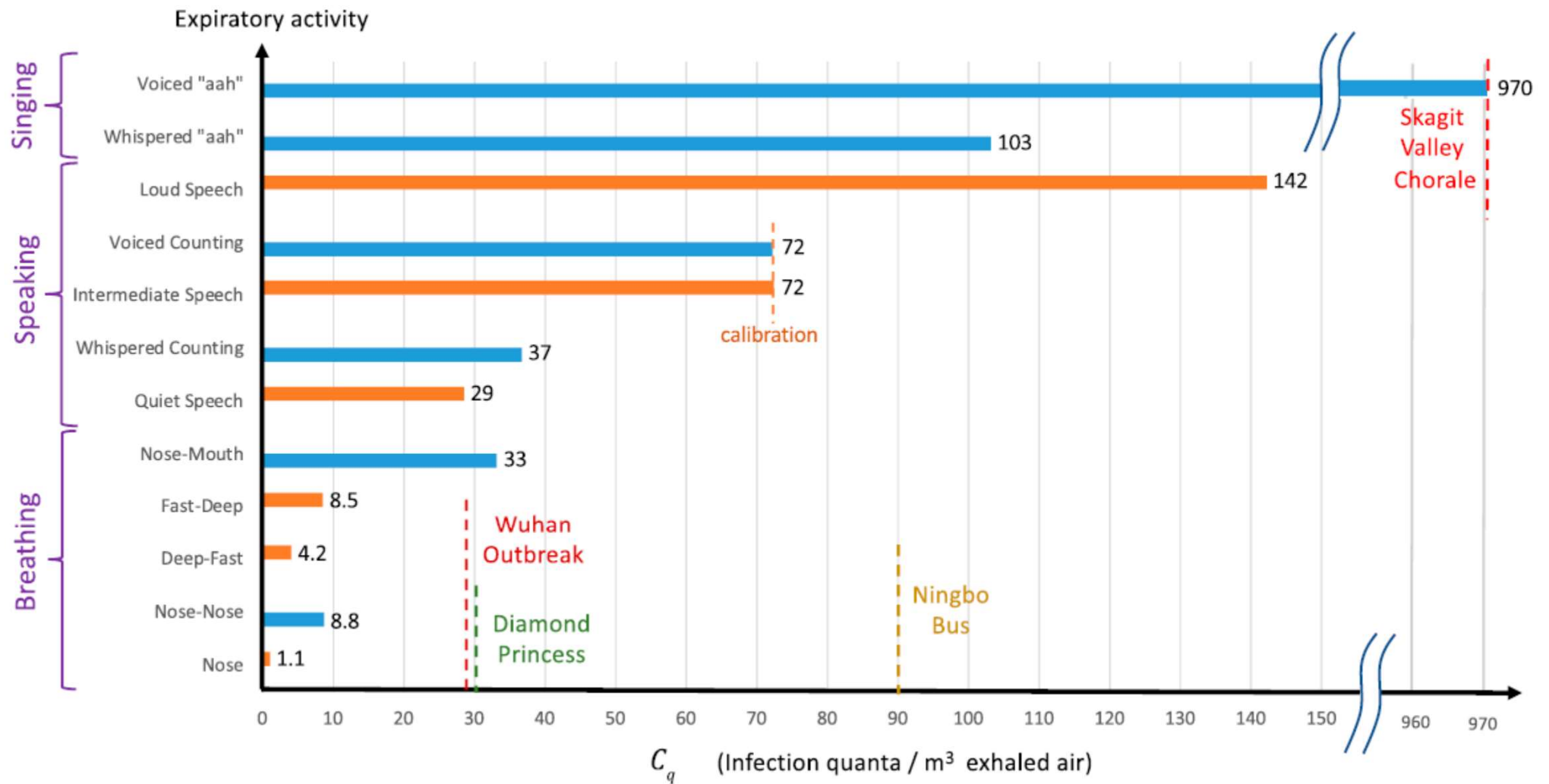
Guidance for submarines to recover from a COVID-19 outbreak. The measures to recover from a COVID-19 outbreak include attaining a 'clean' crew and a 'clean' ship, free of COVID-19. For example, measures to attain a clean ship include dividing the ship's spaces into different areas of importance and disinfecting spaces based on importance.



# SCIENTIFIC LITERATURE

1. COVID-19 pandemic containment: following the example of military submarine (BMJ Mil Health, 2020)
2. A guideline to limit indoor airborne transmission of COVID-19 (MIT, 2020)
3. Monitoring carbon dioxide to quantify the risk of indoor airborne transmission of COVID-19 (MIT, 2021)
4. Biosensors for Monitoring Airborne Pathogens (JALA, 2015)

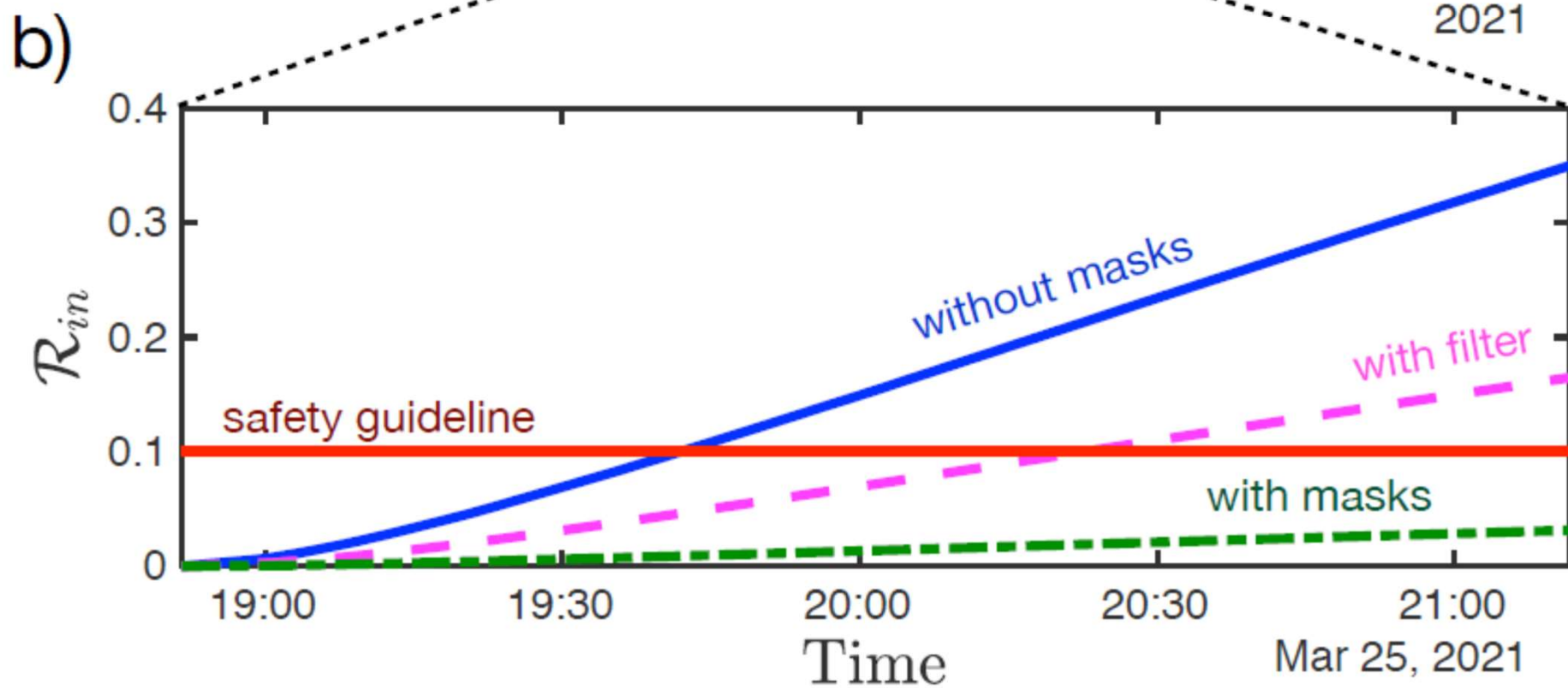
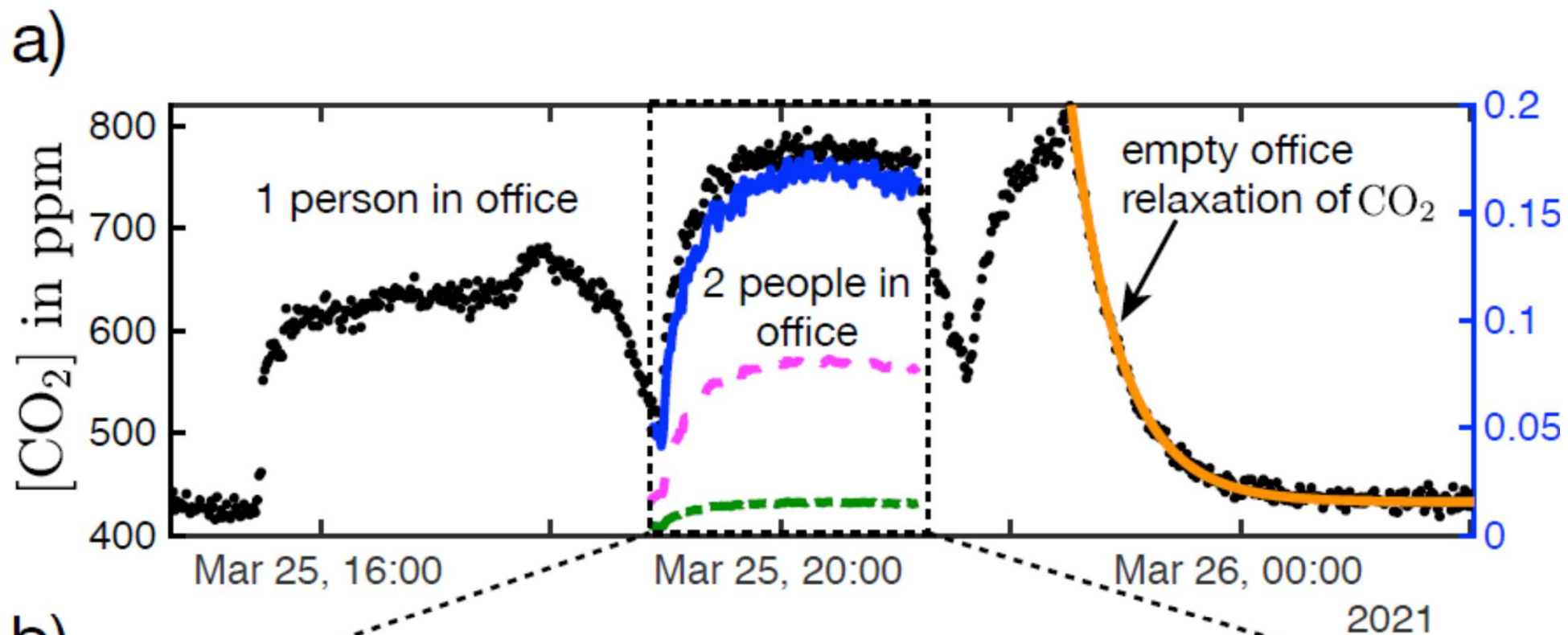




The higher the pitch, the higher the respiratory volume and the number of infection quanta in the exhaled air.

Algorithm based on number of people, time inside a given space and level of respiratory activity.





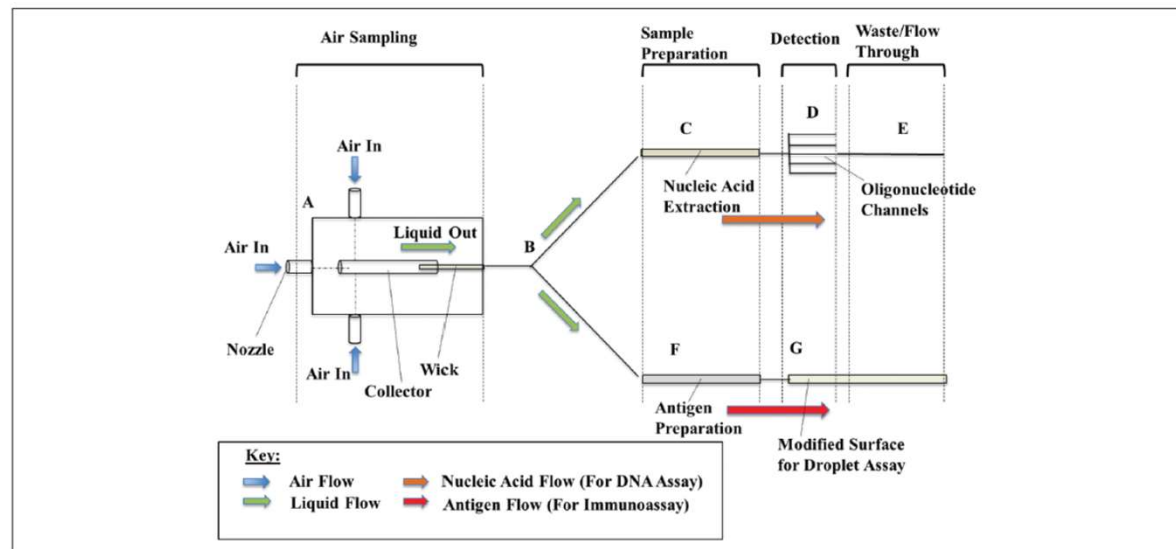
# Aerosol samplers

# Immunological biosensors

# Nucleic acid-based biosensors



# Autonomous pathogen detection system





**TANK YOU FOR YOUR ATTENTION**