Preventing Cross Infection In the Pulmonary Function Laboratory

Terrence Shenfield MS, RRT-ACCS, RPFT, NPS, AE-C

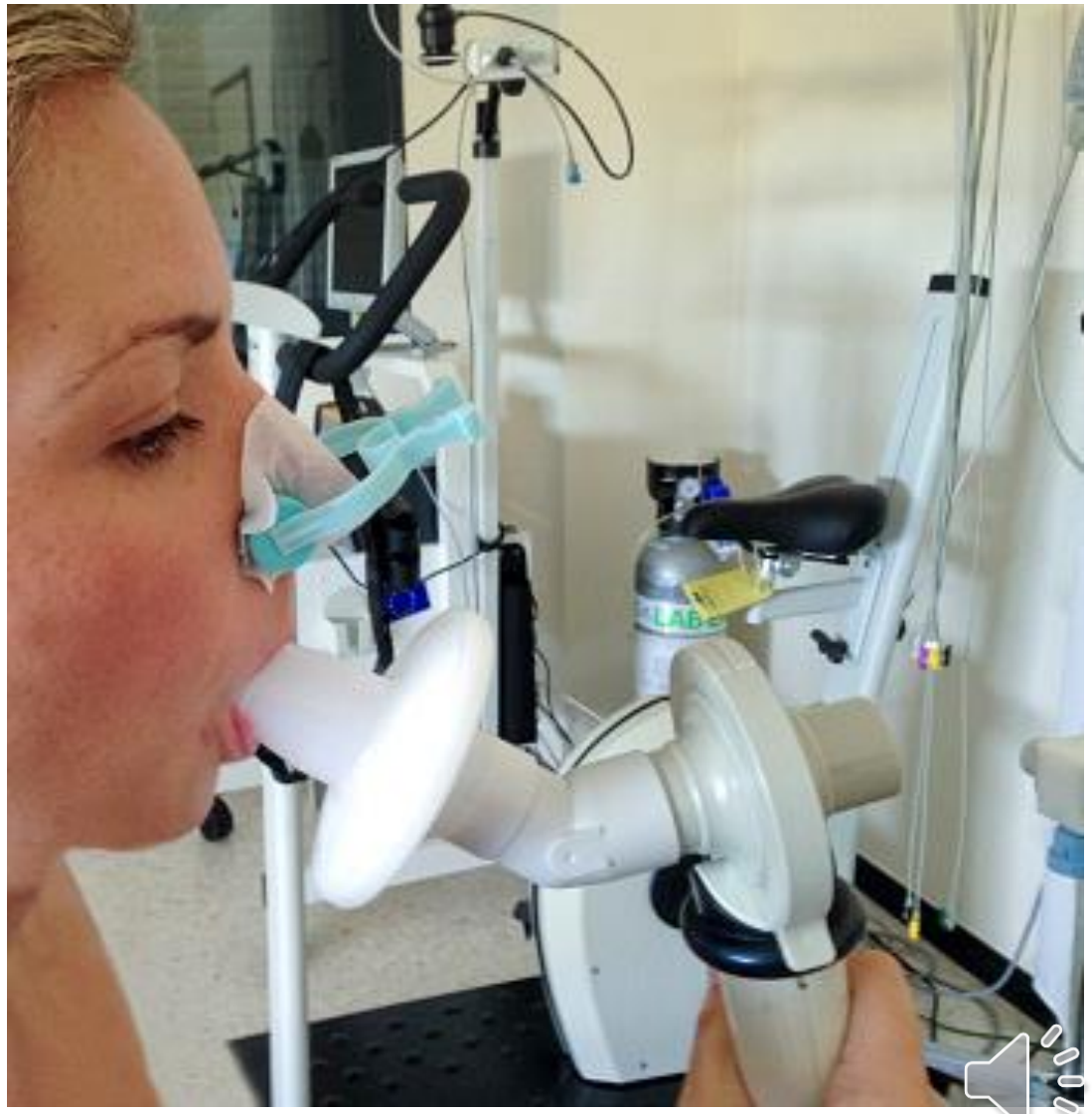
Why should we be concerned about infection control practices in the PFT laboratory

Objectives

- Identify the risk and potential organisms implicated in cross infection into pulmonary function lab
- Sources of causative organisms in the PFT laboratory
- Methods of contamination
- Sterilization and disinfection techniques
- Preventative methods for infection control in the PFT lab
- Newer method and the future of infection control practices in the PFT lab

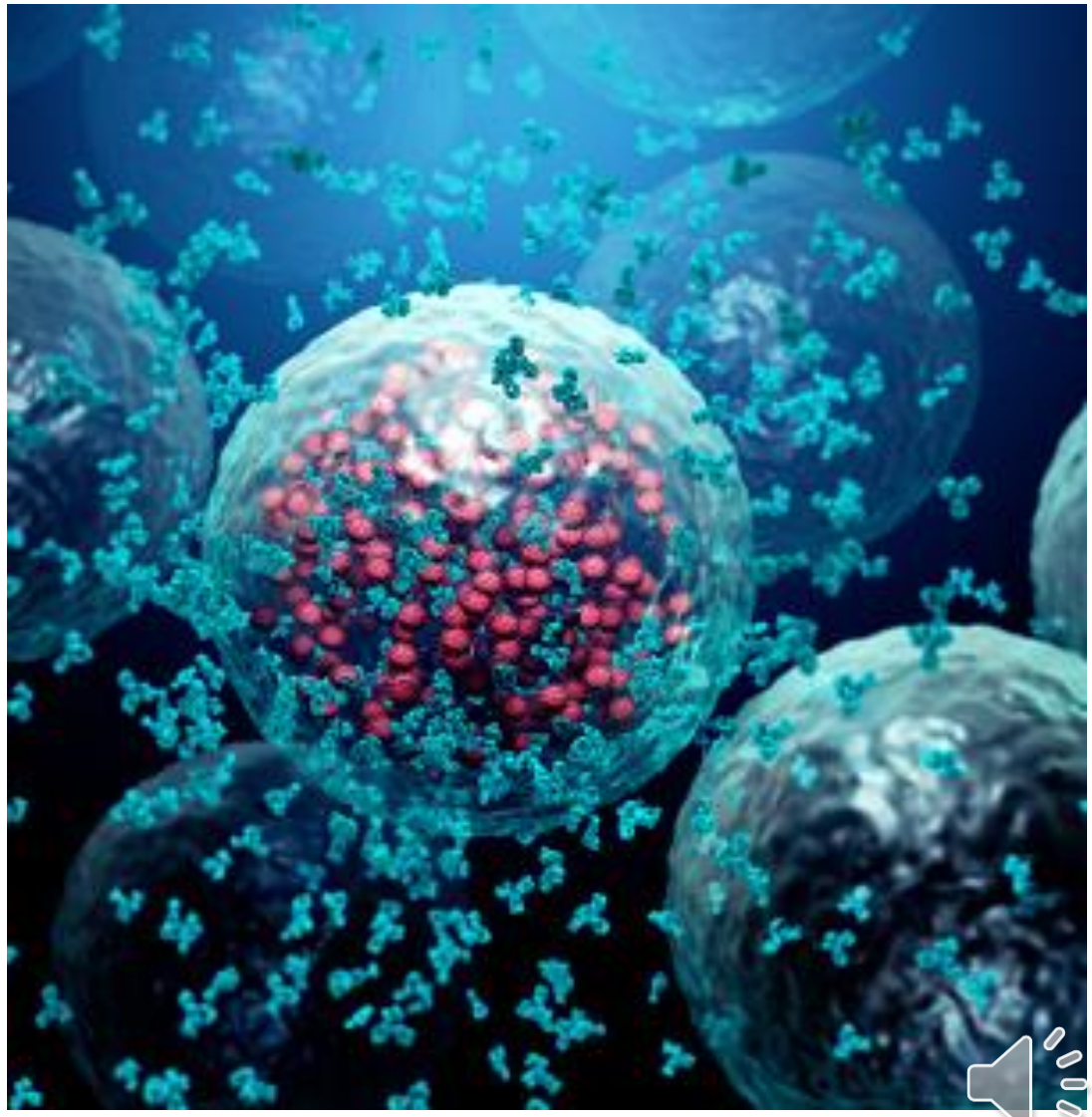
Sources of contamination

- Spirometry
- Impulse Oscillometry
- Body Plethysmography
- Diffusing Lung Co-efficient for Carbon Monoxide
- Bronchial challenge testing for measuring bronchial hyper-responsiveness
- Sputum induction
- Cardiopulmonary exercise testing
- Six-minute walk test



Guidelines for infection control practices

- Patients need to perform varied breathing maneuvers such as tidal breathing, forced expiratory maneuvers, as well as deep inspiratory and expiratory maneuvers.
- Some patients cough into the test device while performing the above maneuvers either due to an underlying infection or bronchospasm.
- The American Thoracic Society (ATS) has recommended referring to the guidelines developed by National Committee for Clinical Laboratory Standards (NCCLS) and Centre for Disease Control and Prevention (CDC) for controlling nosocomial infections in a laboratory and hospital setting.
- The NCCLS has published guidelines addressing laboratory worker protection from biohazards, and the CDC has published recommendations on how to control nosocomial-acquired pneumonia in hospital settings.
- These should be present and followed in all PFT laboratories.



Precautions

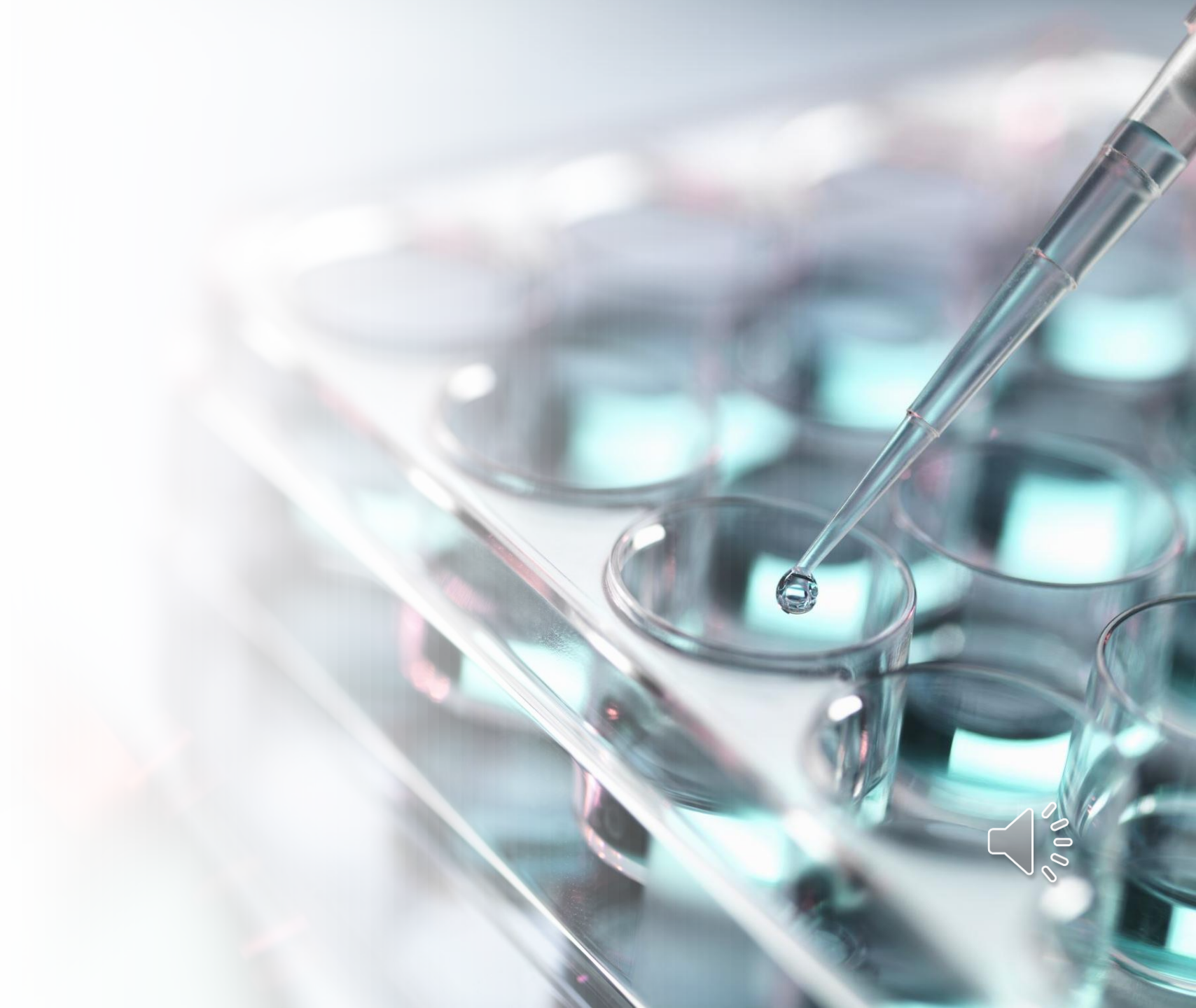
- Contact precautions
  - Spread by direct or indirect contact
- Droplet precautions
  - Spread by large particles in the air
  - Most common mode of spread
- Airborne precautions
  - Spread by small particles in the air)

Skin contact

- Direct skin contact is a major source of infection with rhinoviruses and Pseudomonas cepacia
- Repetitive lung function assessment tests are extremely prone to develop cross infections through a simple handshake
- Cystic fibrosis patients are at risk

Equipment concerns in the spread of infection

- Spirometer
- Consumables
- Nebulizers
- Peak flow meters
- Laboratory infrastructure



Spirometer

- Most used instrument in the PFT laboratory
- Mouthpieces have the greatest risk of bacterial contamination (92%), followed by the proximal tubing (50%)
- Risk of transmission of infection is minimal with an ultrasonic sensor-based spirometer
- No information available on the risk of bacterial contamination of flow sensor-based spirometers, such as the turbine-based spirometer and unheated pneumotachographs

Consumables in the PFT laboratory

- Include mouthpieces, rebreathing valves and tubing's used in the pulmonary function laboratory.
- Mouthpieces are by far the commonest cause of cross infection in a PFT laboratory.
- These get contaminated with patients' saliva, which is a rich source of normal healthy flora as well as pathogenic organisms.
- It has been a concern that viruses such as HIV, HBV, HCV, HDV, and so on, are transmitted through contaminated body fluids.
- However, saliva is an unlikely medium for HIV transmission

Nebulizers and spacers

- Nebulizers and spacers used often in the lung function laboratory for bronchial challenge testing, sputum induction and reversibility testing, nebulizers and spacers may contribute to cross infection in the PFT laboratory.
- When not cleaned and maintained well, nebulizers may be colonized with Pseudomonas species, Staphylococcus aureus, Pseudomonas aeruginosa,

Peak flow meters

- Crucial outpatient diagnostic tool
- Multiple users of the same device with disposable mouthpieces may confer a high risk of transmission of respiratory viral infections, methicillin-resistant Staphylococcus aureas (MRSA) infection and fungal infections.

Laboratory Infrastructure

- Infrastructure of a PFT laboratory plays a significant role in the transmission of infections
- High temperature and humidity provide a suitable environment for growth of pathogens.
- General clutter, quality of upholstery, air conditioning (if present), temperature and humidity conditions, and frequency of use are known to influence cross infection

Potential pathogens in a PFT laboratory with suggested precautions

Microorganism	High-risk group/condition	Precautions
Mycobacterium tuberculosis	All individuals in room. Droplets remain viable for many hours in air.	Airborne precautions
Pseudomonas cepacia now called Burkholderia cepacia	Person to person contact Contact with contaminated surfaces Immunocompromised patients	Testing should be done in separate room Contact precautions
Branhamella catarrhalis	Immune-suppressed patients	Droplet precautions

Potential pathogens in a PFT laboratory with suggested precautions

Microorganism	High-risk group/condition	Precautions
Respiratory viruses *S. pneumoniae, S. aureus*	Children and elderly person or immune-suppressed patients	Airborne precautions plus contact precautions should be taken for such microorganism
Haemophilus influenza	May be infectious to immune-suppressed patients	Airborne precautions plus contact precautions should be taken for such microorganism Contact precautions
Legionella	All individual in room	Regular cleaning of cooling towers prevent spread of Legionella spp

Potential pathogens in a PFT laboratory with suggested precautions

Microorganism	High-risk group/condition	Precautions
Neisseria sp	Immunocompromised patients	Airborne precautions plus droplet precautions should be taken
Human immunodeficiency virus	Immunocompromised patients	Droplet precautions and contact precautions should be taken for such patients
Hepatitis B, C virus	All individual in room	Infection can be controlled by immunization of health care workers Droplet precautions can prevent infection

Potential pathogens in a PFT laboratory with suggested precautions

Microorganism	High-risk group/condition	Precautions
Varicella zoster	All individual	Airborne precautions Direct contact
Measles	All individual	Airborne precautions plus contact precautions
Aspergillus	All individual in room	Airborne precautions Cutaneous infection have been traced to contaminated biomedical devices.

- PREVENTIVE METHODS FOR INFECTION CONTROL IN THE PFT LABORATORY

Personal hygiene

- Barriers between skin/clothing and reduces the risk of cross contamination
- Specifically for testing of infected patients such as TB, various viral infections, opportunistic infections, and nosocomial pneumonia
- Hand washing helps to render strongly adherent microorganisms of the transient bacterial skin flora inactive/nonviable
- Sinks should have hand elbow or wrist lever operated mixer taps or automated controls

Patients screening and segregation

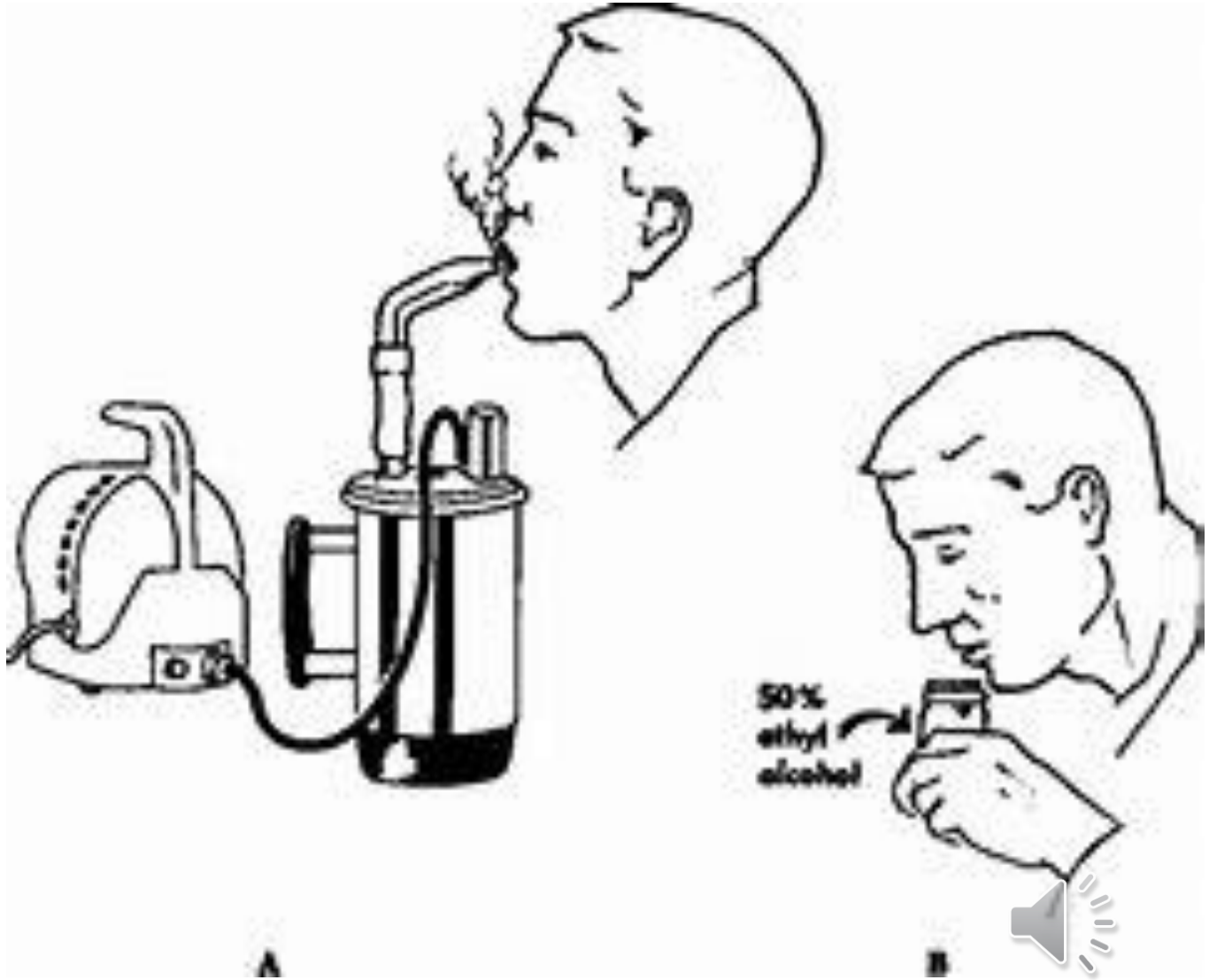
- Health care workers, who are the first point of contact in facilities, should be trained to ask questions that will facilitate identification of patients with signs and symptoms suggestive of TB, immunocompromised status and patients with a significant exposure to communicable diseases such as chicken pox and measles.

Patients screening and segregation

- Patients with known susceptible disease should be placed in a separate room, if possible.
- Separation of patients by at least 1 m distance can help control infection effectively.
- Contact in waiting room with potentially infectious patients should be minimized.
- Surgical facemasks, tissues, and waste container, alcohol-based sanitizers should be made easily available for infectious patients

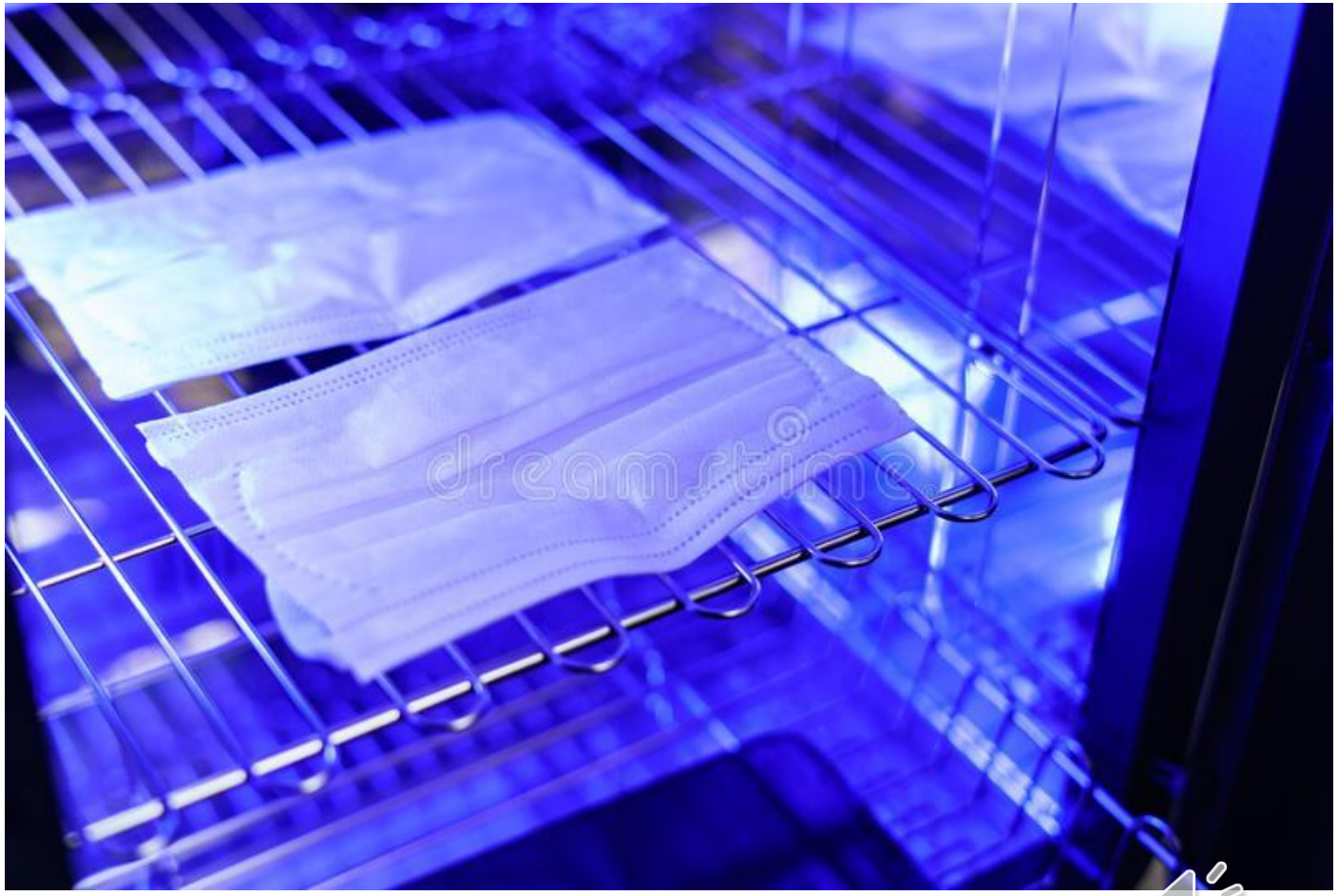
Sputum induction equipment and accessories

- Personal protective equipment should be use by health care worker during sputum induction and processing
- Exhaust ventilation or room having same ventilation characteristics as negative pressure isolation rooms is recommended for use during sputum induction



Sterilization and disinfection

- Manufacturer's recommendations on material provide valuable advice for decontamination.
- Cleaning is an important step before sterilization or disinfection.
- Dust, dirt, and other foreign materials neutralize the action of disinfectant or sterilant; hence cleaning increases the quality of disinfection
- Use of biological indicators, containing bacterial spores, located inside a glass capsules should always be used during sterilization of critical items or at least once a week, which assures the quality of sterilization



Methods of infection control in a pulmonary function test laboratory

Equipment	Type of disinfection/ sterilization	Method	Eliminates infection of	Quality control/precautions
Mouthpieces, nose clips, valves, tubing, spacers used for reversibility testing	Chemical disinfection (2% activated glutaraldehyde	Rinse in running tap water. Then dip in solution for 40-60 min and finally rinse in sterile water Keep in solution for 3 h, same remaining steps	Vegetative bacteria including TB, viruses including HIV and Hepatitis viruses. Bacterial spore	Use good ventilated room for procedure Wear personal protective equipment For Q.C. Equipment should be keep in solution for adequate time
Tubing, petri-dishes, funnels, cryo-vial, Eppendorf tubes, polypropylene centrifuge tubes (autoclavable	Steam under pressure (autoclave)	Autoclave at 121°C at 15 psi for 15 minutes	Vegetative bacteria including TB, viruses including HIV and Hepatitis viruses and bacterial spores	Wear a personal protective equipment For Q.C. Use Of biological indicator Use of chemical indicator
Mopping of floor Equipment surfaces and work surfaces	Phenols Ethanol or isopropanol	As per instructions Wipe the surfaces	Disinfection	Use personal protective equipment

Potential measures that can be taken for protection of the lung function test personnel for tidal breathing and forced measurements.

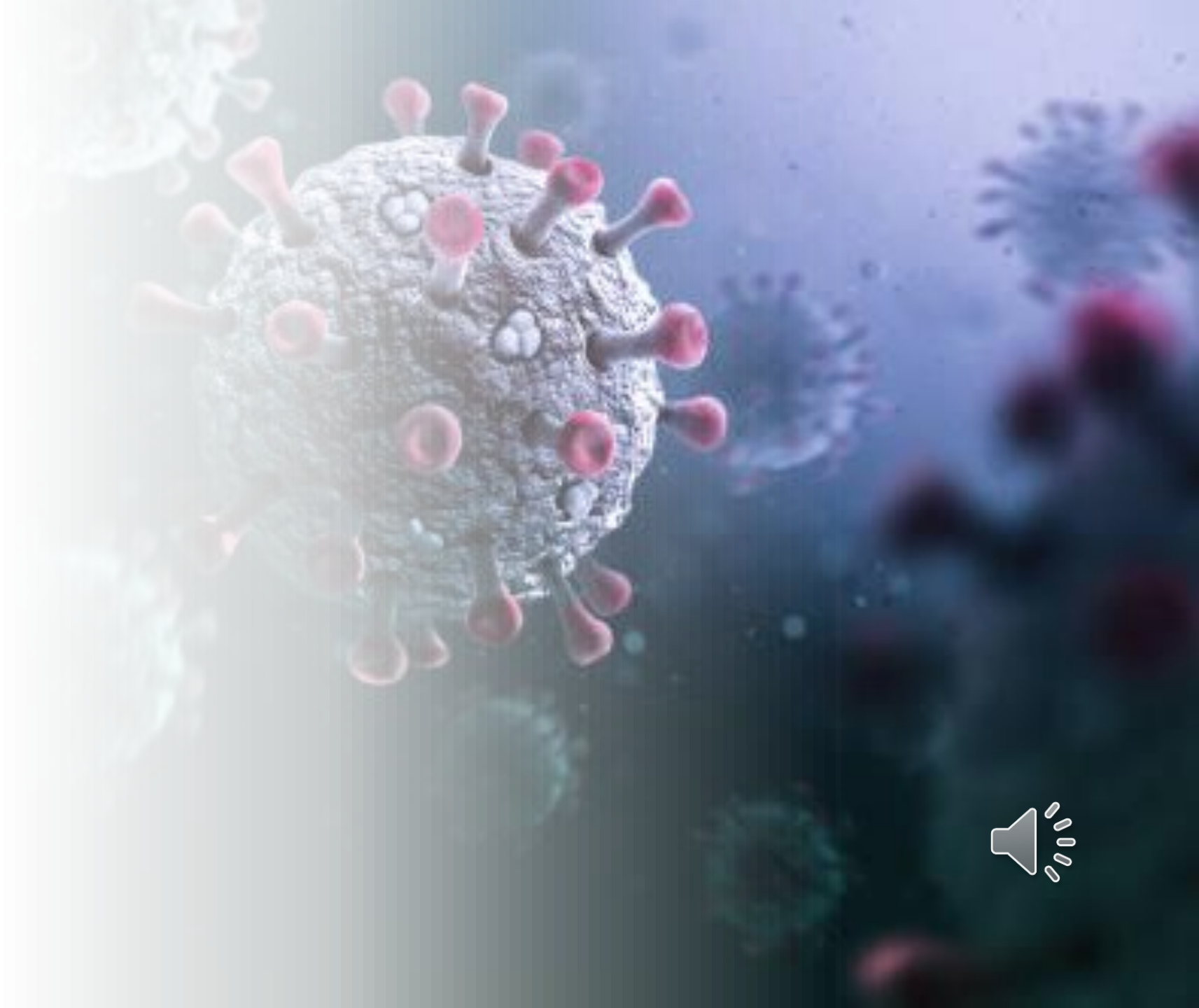
Protecting your staff

- Respiratory therapists performing forced expiration techniques such as spirometry, DLCO and FeNO are required to wear a mask; in some centers or situations, this mask must be a N95 mask.

Method	Proposed protection measures for the personnel
Techniques involving larger expiration than tidal volume and/or forced (spirometry, DLCO, FeNO, MIP/MEP etc)	Wearing N95 masks, gowns, gloves and face shield or goggles Continuous air purifying respiratory (CAPRs) use Adding a plexiglass (Perspex) divider between the patient and therapist
Tidal breathing techniques (multiple breathing nitrogen washout, interrupter technique (Rint), oscillometry etc)	Wear surgical face masks, gloves

Pulmonary function in COVID-19 survivors

- Emerging research shows a burden of chronic symptoms and reduced quality of life in coronavirus disease 2019 (COVID-19) survivors
- Approximately half of patients recovering from COVID-19 report chronic dyspnea 2–3 months after infection



Pulmonary Function Laboratories: Advice Regarding COVID-19

ATS Recommendations

- *Concern has been raised that pulmonary function testing could represent a potential avenue for COVID 19 transmission due to the congregation of patients with lung disease and because of the potential for coughing and droplet formation surrounding pulmonary function testing procedures.*
- *It is difficult to screen and assess pulmonary patients who are more likely to have respiratory symptoms unrelated to COVID 19.*
- *There remain many unknowns about the possibility of transmission in this setting and the data are in evolution; however, the risks of transmission may be significant, and likely vary based on the prevalence of the virus in the community and the age, severity of lung disease and presence of immunosuppression.*
- *We recommend that pulmonary function testing be limited to tests that are only essential for immediate treatment decisions, that the type of pulmonary function testing be limited to the most essential tests when possible, and that measures to protect both the staff and individuals being tested should be put in place.*
- *Protective measures include personal protective equipment (PPE) that limits aerosolized droplet acquisition for staff and enhanced cleaning of the testing space such as wiping down surfaces with appropriate cleaners. Use of PPE should be considered in discussions with your infection control team.*
- *Decisions regarding the conduct of pulmonary function tests need to balance the potential risks against the need for assessment of lung function to make treatment decisions. We realize that this is an evolving situation and that the risk/benefit ratio will also continue to change over time.*

Summary

- Know the sources of contamination
- Know how to screen and segregate patents before they come to laboratory
- Know the different pathogens emerging from the laboratory
- Know how to use PPE
- COVID-19 precautions

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