Respiratory Protection for TB and Other Airborne Infectious Diseases (including COVID-19)

Paul Arthur Jensen, PhD, PE, CIH

16 June 2020

www.StopTB.org/wg/ett
Outline

- Basics of Airborne IPC . . . Next webinar
- Hierarchy of Airborne IPC
- Introduction to PPE
- Surgical / Procedure Masks
- N95 / FFP2 Respirators
Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings

www.cdc.gov
Violent Sneeze
Droplets (1)

• Large droplets - larger than 100 μm
  – Settling velocities >> 0.5 m/s
  – Fall out of air quickly

• Medium-size particles - 10 to 100 μm
  – Settling velocities > 0.2 m/s
  – Settles out slowly
Droplets (2)

- Small particles – 1 to 10 μm
  - Falls very slowly, take days to years to settle out of a quiet atmosphere. In a turbulent atmosphere they may never settle out
Droplets (3)

- A 1.0 μm *Droplet Nucleus* or *Micro-Droplet* will settle at a rate of 0.0035 cm/s or 3 m in 24 hours!
Tuberculosis

- Globally, 1.5 million people died from TB in 2018 (including 251 000 people with HIV).
- Worldwide, TB is one of the top 10 causes of death and the leading cause from a single infectious agent (above HIV/AIDS).
- In 2018, an estimated 10 million people fell ill with TB worldwide. 5.7 million men, 3.2 million women and 1.1 million children.
Modes of TB Transmission (1)

- Person-to-Person through Airborne Route!
- When a person breathes TB bacteria deep into the lungs, it can begin to grow.
- From there, they can move through the blood to other parts of the body, such as the kidney, spine, and brain.
Modes of TB Transmission (2)

• TB is NOT spread by:
  – Shaking someone’s hand
  – Sharing food or drink
  – Touching bed linens or toilet seats
  – Sharing toothbrushes
  – Kissing
COVID-19

11 February, WHO announced official name - COVID-19

- CO = corona,
- VI = virus,
- D = disease, and
- 19 = 2019 (year theorized it “jumped” to humans)
Coronavirus that causes COVID-19

- SARS-CoV-2
- Novel or new coronavirus
- Coronaviruses have been around for a long, long, time
- Most recent coronaviruses:
  - SARS
  - MERS
Globally, as of 7:35pm CEST, 15 June 2020, there have been 7,823,289 confirmed cases of COVID-19, including 431,541 deaths, reported to WHO.
COVID-19

Confirmed Cases Over Time

7,823,289
confirmed cases
Source: World Health Organization

Deaths Over Time

431,541
deaths
Source: World Health Organization
Confirmed Cases Over Time

7,823,289 confirmed cases

Source: World Health Organization

Deaths Over Time

431,541 deaths

Source: World Health Organization
Person-to-Person Spread of CoV

- Mainly from person-to-person.
- Mainly between people who are in close contact with one another (3/6? feet / 1/2? meters)
- Through respiratory droplets produced when an infected person coughs, sneezes, talks, sings, shouts . . .
- Droplets can land in the mouths or noses of people who are nearby or possibly be inhaled into the lungs.
- May be spread by people who are not showing symptoms.
How easily does the CoV spread?

- Very easily and sustainably between people.
- Information from the ongoing COVID-19 pandemic suggest that this virus is spreading more efficiently than influenza, but not as efficiently as measles, which is highly contagious.
- Need “cleaning” of surfaces and air!
Hierarchy of Airborne Infection Prevention and Control (IPC)
Hierarchy of Airborne IPC

Managerial and Administrative
Personal Protective Equipment
Environmental
Hierarchy of Airborne IPC

Managerial and Administrative
Environmental
Personal Protective Equipment
Worker
Patient
Facility
Cough Etiquette / Respiratory Hygiene Demonstration (1)
Coughing, Sneezing and You

Public Health Agency of Canada
Stop the spread of germs that make you and others sick!

Cover your Cough

Cover your mouth and nose with a tissue when you cough or sneeze or cough or sneeze into your upper sleeve, not your hands.

Put your used tissue in the waste basket.

You may be asked to put on a surgical mask to protect others.

Clean your Hands after coughing or sneezing.

Wash with soap and water or clean with alcohol-based hand cleaner.
Stop the spread of germs that make you and others sick!

Cover your Cough

Cover your mouth and nose with a tissue when you cough or sneeze or cough or sneeze into your upper sleeve, not your hands.

Put your used tissue in the waste basket.

You may be asked to put on a surgical mask.

Clean your Hands after coughing or sneezing.

Wash with soap and water or clean with alcohol-based hand cleaner.

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How effective are surgical/procedure masks?
Coronavirus (Covid19) Simulation of sneeze using Cradle scFLOW.

Cycle: 2105
Time: 2.105000

PA Jensen – 16 June 2020

https://youtu.be/ICc_H75R05A
How effective are surgical/procedure masks at reducing risk of TB transmission when patients used masks?

- 10%
- 30%
- 50%
- 70%
- 90%
How effective are surgical/procedure masks at reducing risk of TB transmission when patients used masks?

- 10%
- 30%
- 50%
- 70%
- 90%

56%

(95% CI, 33-70.5%)

WHEN TO USE A MASK

For healthy people wear a mask only if you are taking care of a person with suspected 2019-nCoV infection

Wear a mask, if you are coughing or sneezing

Masks are effective only when used in combination with frequent hand-cleaning with alcohol-based hand rub or soap and water

If you wear a mask then you must know how to use it and dispose of it properly

World Health Organization

PA Jensen – 16 June 2020
WHEN TO USE A MASK

For healthy people wear a mask only if you are taking care of a person with suspected 2019-nCoV infection

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Masks are effective only when used in combination with frequent hand-cleaning with alcohol-based hand rub or soap and water

If you wear a mask then you must know how to use it and dispose of it properly
Surgical Mask Instructions?
Stop the spread of germs that make you and others sick!

Cover your Cough:

- Cover your mouth and nose with a tissue when you cough or sneeze or cough or sneeze into your upper sleeve, not your hands.
- Put your used tissue in the waste basket.
- You may be asked to put on a surgical mask to protect others.

Clean your Hands after coughing or sneezing:

- Wash with soap and water or clean with alcohol-based hand cleaner.
Stop the spread of germs that make you and others sick!

Cover your Cough

Cover your mouth and nose with a tissue when you cough or sneeze or cough or sneeze into your upper sleeve, not your hands.

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Stop the spread of germs that make you and others sick!

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Put your used tissue in the waste basket.

Clean your Hands after coughing or sneezing.

Wash with soap and water or clean with alcohol-based hand cleaner.

May be asked to put on a surgical mask to protect others.
The Biggest Virus On Earth Is Still Human Behavior.
Hierarchy of Airborne IPC

Managerial and Administrative
Environmental
Personal Protective Equipment
Worker
Patient
Facility
Hierarchy of Airborne IPC

Managerial and Administrative
Personal Protective Equipment
Environmental

Worker
Patient
Facility
Hierarchy of Airborne IPC

Managerial and Administrative
Environmental
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Worker
Patient
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COVID-19 Personal Protective Equipment (PPE) for Healthcare Personnel

Preferred PPE – Use

N95 or Higher Respirator

Face shield or goggles

N95 or higher respirator
When respirators are not available, use the best available alternative, like a facemask.

One pair of clean, non-sterile gloves

Isolation gown

Acceptable Alternative PPE – Use

Facemask

Face shield or goggles

Facemask
N95 or higher respirators are preferred but facemasks are an acceptable alternative.

One pair of clean, non-sterile gloves

Isolation gown

Source: cdc.gov/COVID19
Personal Protective Equipment

Masks vs. Respirators
Selected PPE

Masks . . . Large & Medium droplets
  Protect environment from wearer
  People (patients, HCWs, etc.)
  Surfaces
  Protect wearer from environment

Respirators . . . Micro-Droplets / Droplet Nuclei
  Protect wearer from environment
  Protect environment from wearer
  (if no valve)
Surgical or Procedure Masks
Surgical or Procedure Masks
Surgical or Procedure Masks
How to Make a Mask

Tutorial: How to Sew a Face Mask for Hospitals | Coronavirus COV19

bit.ly/UPHMask

DIY FABRIC TIE FACE MASK

How to Sew a REUSABLE MEDICAL FACE MASK

NURSE preferred fit!

How to make ANY MASK PATTERN WITHOUT ELASTIC

The 15 Minute Mask by Ready Set Sew

Make Your Own Face Mask jet your 'Pattern and watch the video too!

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Negative Pressure Respirator

A respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.
Air-Purifying Respirator (APR)

A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.
TABLE 4. Nonpowered air-purifying respirator filter classes certified in 42 CFR* 84

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<td>P (Oil proof)</td>
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* Code of Federal Regulations.
† The percentages in parenthesis indicate the minimum allowable laboratory filter efficiency value when challenged with 0.3 μm particles.
Selection of N-, R-, and P-Series Filters

- If no oil particles are present in the work environment, use a filter of any series.
- If oil particles are present, use and R- or P-series filter
- Selection of filter efficiency depends on size of particulate and how much filter leakage is acceptable
N95 Respirators

• N95 or higher disposable respirators are generally acceptable for most Coronavirus & TB situations
• Higher level of protection may be prudent during high risk procedures
  – Sputum induction
  – Bronchoscopy
  – Autopsy
CEN Standards

- Initial filter penetration (NaCl & paraffin oil)
- Total inward leakage
- Maximum breathing resistance
- Loading test
CEN Standards
(Initial Filter Penetration)

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<th>NaCl</th>
<th>Paraffin Oil</th>
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<td>&lt; 20%  = P1</td>
<td>NA           = P1</td>
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<tr>
<td>&lt; 6%   = P2</td>
<td>&lt; 2%   = P2</td>
</tr>
<tr>
<td>&lt; 3%   = P3</td>
<td>&lt; 1%   = P3</td>
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CEN Standards

Total inward leakage
< 25% = FFP1
< 11% = FFP2
< 5% = FFP3
CEN Respirators

- FFP2 or higher disposable respirators are generally acceptable for most Coronavirus & TB situations
- Higher level of protection may be prudent during high risk procedures
  - Sputum induction
  - Bronchoscopy
  - Autopsy
“Real” vs “Counterfeit” Respirators
“Real” vs “Counterfeit” Respirators
“Real” vs “Counterfeit” Respirators
“Real” vs “Counterfeit” Respirators
The National Personal Protective Technology Laboratory (NPPTL)

NIOSH-Approved N95 Particulate Filtering Facepiece Respirators

Manufacturers Listed Alphabetically - H

The N95 respirator is the most common of the seven types of particulate filtering facepiece respirators. This product filters at least 95% of airborne particles but is not resistant to oil.

This web page provides a table of NIOSH-approved N95 respirators, listed alphabetically by manufacturer. You can select a particular manufacturer by clicking on the first letter of their name on the index below.

There are some products that are approved by NIOSH as an N95 respirator and also cleared by the Food and Drug Administration (FDA) as a surgical mask. These products are referred to as Surgical N95 Respirators. View a definition of Surgical N95 Respirators. For your convenience the Surgical N95 Respirators are indicated with the Model Number/Product Line in bold text followed by (FDA). If you have a product you believe is NIOSH-approved and FDA-cleared that does not appear on this list, you will need to check with the FDA Center for Devices and Radiological Health at 1-866-363-2041 for validation of clearance.

Disclaimer: The links in this section go to websites outside of CDC/NIOSH and should not be considered as an endorsement of their content, or as a statement of NIOSH policy. The donning procedure and/or user instruction, either on the websites or the PDF version, should not be considered an official endorsement of their content, or as a statement of NIOSH policy.

Index for N95 Manufacturers:

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<th>Supplier/Manufacturer and Contact Information</th>
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<th>Approval Number</th>
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<th>Manufacturer’s Donning Procedure User Instructions</th>
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<td>84A-5460</td>
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www.cdc.gov/niosh/nppttl/topics/respirators
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User’s Instructions

FITTING INSTRUCTIONS:
1. Hold the respirator in hand with the nosepiece at your fingertips. Allow headbands to hang freely below hand.
2. Cup the respirator firmly against your face with the nosepiece on the bridge of your nose.
3. Stretch and pull the lower headband over the head and position below your ears. Stretch and pull the top headband on the back of your head above your ears.
4. Press soft metal nosepiece to conform snugly around the nose.
5. (a) To test fit for respirator without exhalation valve: Cup both hands over the respirator and exhale sharply. If air flows around your nose, tighten the nosepiece. If air leaks around the edges, reposition the headband for better fit. (b) To test fit for respirator with exhalation valve: Cup both hands over the respirators and inhale sharply. A negative pressure should be felt inside respirator. If air flows around your nose, tighten the nosepiece. If air leaks around the edges, reposition the headband for better fit.
6. Change respirator immediately if breathing becomes difficult or respirator becomes damaged or distorted, or a proper face fit can not be maintained. Careful observance of these instructions is an important step in safe respirator use.
Other Classes of Respirators

- Powered air-purifying respirator
- Atmosphere-supplying respirators
  - Supplied air respirator
  - Self-contained breathing apparatus
  - Emergency escape
Respiratory Protection Program Elements

- Training
- Medical evaluation
- Fit testing
- Respirator Selection
- Respirator Use
- Maintenance and care of respirators
- Program evaluation
Health Care N95 Particulate Respirator and Surgical Mask

Donning instructions (to be followed each time product is worn):

1. Cup the respirator in your hand, using the nosepiece or fingers, allowing the headbands to hang freely below.
2. Position the respirator under your chin with the nosepiece up.
3. Pull the cap strap over your head so it rests high on the back of head.
4. Pull the bottom strap over your head and position it around neck below ear.
5. Using two hands, hold the nosepiece in the shape of your nose, by pushing inward while moving fingers don't dislocate the nosepiece. Pushing the nosepiece using one hand may result in less effective respirator performance.
6. FACE FIT CHECK: The nosepiece should be checked before each use. To check, place the fingers completely over the nosepiece and try to blow air out of it. If you can hear air, adjust the nosepiece as described in step 5 and recheck the fit.

NOTE: If you cannot achieve proper fit, do not enter the isolation or treatment area. See your supervisor.

Removal instructions:

1. Cup the respirator in your hand, using the nosepiece or fingers, allowing the headbands to hang freely below.
2. Still holding respirator in position, pull top strap over head.
3. Remove respirator from face and discard or store according to your facility's policy.
Sources of Facepiece Leakage

- Through air-purifying filter
- Through exhalation valve
- Around facepiece/skin interface
Mom, why are humans wearing muzzles?

Honey, they are too dumb to learn "sit" and "stay".
3M 1860
Selection of Respirators
3M 1860 Use Instructions

– Before use for respiratory protection, a written respiratory protection program must be implemented.

– Respirator may be used until damaged, breathing becomes difficult, or contaminated with blood or body fluids.

– Filtering facepieces are to be inspected prior to each use.
APIC Position Paper: Extending the Use and/or Reusing Respiratory Protection in Healthcare Settings During Disasters

Co-Authored by APIC Emergency Preparedness Committee, Public Policy Committee and Regulatory Review Panel

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04 December 2009
II. Recommendations for extending the use and/or reusing respirators

Disposable N-95 respirators, when used solely to prevent occupational exposure to *Mycobacterium tuberculosis*, can be safely reused until contaminated, damaged, or no longer form a good seal. Unlike *Mycobacterium tuberculosis*, which is transmitted exclusively via airborne droplet nuclei, most other respiratory pathogens are transmitted primarily via direct and indirect (droplet) contact with respiratory secretions. Therefore the exterior of respiratory protection used in caring for patients with respiratory pathogens other than tuberculosis can become contaminated and serve as a reservoir for infectious agents. Special precautions must be taken when extending the use or reusing disposable respiratory protection to prevent healthcare personnel exposure.

Extended use of respiratory protection is defined as the wearing of a disposable respirator during serial patient encounters without the removal or re-donning of the device between encounters. Reuse of respiratory protection consists of removing and re-donning the device between encounters. Both of these actions pose a transmission risk to healthcare personnel due to potential respirator contamination. This transmission risk can be minimized if healthcare personnel adhere stringently to hand hygiene before and after handling the respiratory protection device.
Disinfection of N95/FFP2 Respirators

- Vaporized Hydrogen Peroxide (VHP)
- Ultraviolet Germicidal Irradiation (UVGI) / Germicidal Ultraviolet (GUV)
- Dry heat
- Autoclave (wet heat)
- Ethylene Oxide (EtO)
- Formalin or Formaldehyde
- Bleach (Sodium hypochlorite)
- Soap & Water
- Alcohol (Ethanol or Isopropanol)
Disinfection of N95/FFP2 Respirators

- Vaporized Hydrogen Peroxide (VHP)
- Ultraviolet Germicidal Irradiation (UVGI) / Germicidal Ultraviolet (GUV)
- Dry heat
- Autoclave (wet heat)
- Ethylene Oxide (EtO)
- Formalin or Formaldehyde
- Bleach (Sodium hypochlorite)
- Soap & Water
- Alcohol (Ethanol or Isopropanol)
What Can You Do?

- Be proactive
- Research and select well-designed respirators
- Take care of your respirator
  - Decontamination
  - Cleaning
  - Keep your respirator clean!
  - Storage
- Take care when reusing respirator – closely monitor hygiene and service life
- Dispose of respirator if you question its cleanliness or performance
What Can You Do?

- Be proactive
- Research and select well-designed respirators
- Take care of your respirator
  - Decontamination
  - Cleaning
    - Keep your respirator clean!
    - Storage
  - Not easily!
  - Not FFP respirators!
    - Cover with a mask
    - Clean & dry place!
- Take care when reusing respirator – closely monitor hygiene and service life
- Dispose of respirator if you question its cleanliness or performance
RP Summary (1)

- Need lots and lots of SOPs!
  And FOLLOW THEM!!!

- HCWs
  - Use valveless, certified respirators when in close proximity to patients
    - Protect yourself from micro-droplets
    - Protect others from you

- General Public
  - Use surgical or procedure masks
    - Protect yourself from large droplets
    - Protect others from you
Support Each Other !!!
RP Summary (2)

- Work hard!
- Play hard!
- Promote good public health!
- Be safe!
- Enjoy life!
http://www.stoptb.org/wg/ett/resources.asp

This presentation was made possible through the support of Stop TB Partnership’s End TB Transmission Initiative (ETT) Working Group provided by the United States Agency for International Development (USAID), under the terms of cooperative agreement number STBP/USAID/GSA/2018-04.
Thank you!
Ракмет сизге!
Рахмат сага!
Sag boluň!
Muito obrigado
Muchas gracias!
Rahmat!
Спасибо!
Tashakor!