Respiratory protection for TB and airborne diseases (including COVID-19) transmitted by airborne and droplet spread

Tuesday 12\textsuperscript{th} May 2020

Chairpersons: Amanda Christensen and Niesje Jansen

Union webinars are member-led, one of the many benefits of being a Union member.
Join us in championing change for lung health.

MEMBERSHIP.THEUNION.ORG/REGISTER
Presentation

Respiratory protection for TB and airborne infectious diseases (including COVID-19) transmitted by airborne and droplet spread.

Chairs: Amanda Christensen and Niesje Jansen

1. Appropriate use of masks (cloth and surgical masks), respirators and re-use
   Dr Carrie Tudor, International council of nurses

2. Personal Respiratory Protection programme for airborne IPC
   Dr Grigory Volchenkov, Vladimir, Russia

Questions and Answers will follow the presentations.
Appropriate use of masks (cloth and surgical masks), respirators and re-use

Carrie Tudor, PhD, MPH, RN

12 May 2020

http://www.stoptb.org/wg/ett/
Happy International Nurse’s Day and Year !!!

It’s time to recognize the critical contribution nurses and midwives make to global health!

2020
INTERNATIONAL YEAR OF THE NURSE AND THE MIDWIFE.

World Health Organization

C Tudor – 12 May 2020
‘It may seem a strange principle to enunciate as the very first requirement of a hospital that it should do the sick no harm’

Notes on Hospitals, 1859

Florence Nightingale (1820 – 1910)
Outline

- Basics of Airborne IPC
- Hierarchy of Airborne IPC
- Introduction to PPE
- Surgical / Procedure Masks
- N95 / FFP2 Respirators
- Reuse
Slow motion sneeze
Droplets

• **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

• **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
  – 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!
Modes of TB Transmission (1)

• Person-to-Person through Airborne Route!

• When a person breathes TB bacteria deep into the lungs and 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.
Person-to-Person Spread of CoV

- Mainly from person-to-person.
- Mainly between people who are in close contact with one another (6? feet / 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 **inhaled into the respiratory tract**.
- May be spread by people who are not showing symptoms.
Why 2 meters / 6 ft?


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Hierarchy of Airborne Infection Prevention and Control (IPC)

Source: PA Jensen
Personal Protective Equipment

Respirators vs. Masks

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Personal protective equipment

**Surgical Mask**
- Worn by patients
- Worn by HCWs for large droplets (flu, H1N1, SARS CoV2, etc.)

**Respirator**
- Worn by HCWs
Selected PPE

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

**Respirators** . . . Micro-Droplets / Droplet Nuclei
  Protect environment from wearer
  (if no valve)
  Protect wearer from environment
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

[cdc.gov/COVID19](http://cdc.gov/COVID19)
A filtering face piece respirator that filters out at least 95% of airborne particles during “worse case” testing using a “most-penetrating” sized particle is given a 95 rating.

Source: www.N95decon.org
N95 respirator (CDC NIOSH standards)

TABLE 4. Nonpowered air-purifying respirator filter classes certified in 42 CFR* 84

<table>
<thead>
<tr>
<th>Resistance to efficiency filter degradation</th>
<th>Filter efficiencies†</th>
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<tr>
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<td>95 (95%)</td>
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<tr>
<td>N (Not resistant to oil)</td>
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</tr>
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<td>R (Resistant to oil)</td>
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</tr>
<tr>
<td>P (Oil proof)</td>
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</table>

* Code of Federal Regulations.
† The percentages in parenthesis indicate the minimum allowable laboratory filter efficiency value when challenged with 0.3 μm particles.
# CEN Standards

(Initial Filter Penetration)

<table>
<thead>
<tr>
<th>NaCl</th>
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</table>

C Tudor – 12 May 2020
List of certified N95 respirators

NIOSH-Approved N95 Particulate Filtering Facepiece Respirators

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 1-800-638-2041 for validation of clearance. View a comprehensive table of Surgical N95 Respirators.

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 downloading 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:
2M A B C D E F G H I J K L M N O P Q R S T U V W X Y Z Notes

<table>
<thead>
<tr>
<th>Supplier/Manufacturer and Contact Information</th>
<th>Model Number/Product Line</th>
<th>Approval Number</th>
<th>Valve Yes/No</th>
<th>Manufacturer’s Donning Procedure User Instructions</th>
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http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/n95list1.html
Counterfeit N95 respirators
HI-TECH
SH9550
NIOSH N95
PARTICULATE RESPIRATOR
<table>
<thead>
<tr>
<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>Honeywell International [*E] 800-430-5490</td>
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</tbody>
</table>
N95 (or FFP2) respirator use

• N95/FFP2 disposable respirators are generally acceptable for most TB situations

• Higher level of protection may be necessary during high-risk procedures
  • Bronchoscopy
  • Autopsy
  • Sputum induction
  • Intubation / extubation

C Tudor – 12 May 2020
Selection of Respirators
One size does not fit all

3M 1860

3M 1860S

PA Jensen

PA Jensen

C Tudor – 12 May 2020
Half-piece elastomeric 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.
Other Classes of Respirators

- Powered air-purifying respirator (PAPR)
- Atmosphere-supplying respirators
  - Supplied air respirator
  - Self-contained breathing apparatus
  - Emergency escape
Why we ask people to wear masks

Use and Reuse of N95/ffp2 respirators
Recommendations for extended use and reuse

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.

https://www.apic.org/Resource_/TinyMceFileManager/Advocacy-PDFs/APIC_Position_Ext_the_Use_and_or_Reus_Resp_Prot_in_Hlthcare_Settings1209l.pdf
Respirator use and reuse

• Respirator may be used until damaged, breathing becomes difficult, or contaminated with blood or other body fluids
• Respirators are to be inspected prior to each use to ensure proper fit and seal
  – Store in a dry place
  – Do NOT write on the respirator
  – Do NOT bend the respirator
• Dispose of respirator if you question its performance
Storage of N95 respirators

Dalian, China (C. Tudor)

Manzini, eSwatini (C. Tudor)
Suggestions to extend use
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)
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### CORONAVIRUS INACTIVATION

- **Hydrogen peroxide**
  - 70°C dry heat for 60 min inactivated
  - SARS-CoV-2 on N95 under lab conditions
  - 99.9% reduction in SARS-CoV-2 on N95 under lab conditions
  - 99.99% reduction in SARS-CoV-2 on N95 under lab conditions

- **UVA**
  - Limited effectiveness against viruses

- **N95 user should perform a 3-log inactivation check after each don/undo cycle.

### N95 MASK INTEGRITY

- Several 3M N95 models (1860, 8210, 8210+) keep fit and filtration for multiple 30 min cycles at 70-85°C and >50% humidity.

- Many models (e.g., 3M 8200, 3M 8511) keep fit performance for multiple 30 min cycles at 75°C dry heat.

- Each N95 model responds differently to heat; many have not been tested with the heating conditions above.

- Repeated thermal cycles may damage N95 fit and filtration.

### KEY CONSIDERATIONS

- Temperature and humidity must be calibrated and monitored; heating devices can be highly variable.

- N95 must be isolated and returned to original user.

- User seal check must be performed before each use.

- Each don/undo can reduce N95 fit; some models fit unacceptably after 5 don/undo cycles.

### RISKS

- Heat inactivation is **highly sensitive** to temperature, humidity, time, surface, and co-contaminants.

- N95 fit and filtration may be damaged if the temperature is too high or after multiple cycles.

- N95 will NOT be sterilized by the heat & humidity treatments listed above.

Source: [www.N95decon.org](http://www.N95decon.org) & [https://multimedia.3m.com/mws/media/1824869O/decontamination-methods-for-3m-filtering-facepiece-respirators-technical-bulletin.pdf](https://multimedia.3m.com/mws/media/1824869O/decontamination-methods-for-3m-filtering-facepiece-respirators-technical-bulletin.pdf)
What Can You Do?

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

https://apps.who.int/iris/bitstream/handle/10665/311259/9789241550512-eng.pdf

Respiratory infection IPC

https://www.who.int/csr/bioriskreduction/infection_control/publication/en/
COVID-19 infection control guidelines

Coronavirus disease (COVID-19) Pandemic

Public Advice

Country & technical guidance

Donate

Your questions

https://www.who.int/emergencies/diseases/novel-coronavirus-2019

C Tudor – 12 May 2020
COVID-19 infection control guidelines (2)

Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings

Update April 13, 2020

Key Concepts in This Guidance

- **Reduce facility risk.** Cancel elective procedures, use telemedicine when possible, limit points of entry and manage visitors, screen everyone entering the facility for COVID-19 symptoms, implement source control for everyone entering the facility, regardless of symptoms.

- **Isolate symptomatic patients as soon as possible.** Set up separate, well-ventilated triage areas, place patients with suspected or confirmed COVID-19 in private rooms with the door closed and with private bathrooms (as possible). Reserve all air for patients with COVID-19 undergoing aerosol generating procedures and for care of patients with pathogens transmitted by the airborne route (e.g., tuberculosis, measles, varicella).

- **Protect healthcare personnel.** Emphasize hand hygiene, install barriers to limit contact with patients at triage, cohort patients with COVID-19, limit the numbers of staff providing their care, prioritize respirators for aerosol generating procedures.
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 (ETTi) Working Group provided by the United States Agency for International Development (USAID), under the terms of cooperative agreement number STBP/USAID/GSA /2020-04.

C Tudor – 12 May 2020
Thank you!
Рахмет сізге!
Спасибо!
Sag boluň!
Muito obrigado
Rahmat!
 Merci beaucoup!
谢谢!
Tashakor!
Muchas gracias!

C Tudor – 12 May 2020
Personal Respiratory Protection Programme for Airborne IPC

Grigory Volchenkov,
Vladimir, Russia

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
**Recommendation 7:** Particulate respirators, within the framework of a respiratory protection programme, are recommended to reduce *M. tuberculosis* transmission to health workers, persons attending health care facilities or other persons in settings with a high risk of transmission.
Effective Programme Components

Personal respiratory protection to prevent airborne transmission of TB and COVID-19

- Education & Training
- Risk Assessment
- Risk Related Zoning and Signage
- Model/size Selection and Procurement
- Respirator Fit Testing
- Proper use of Respirators and Surgical Masks
Who are HIGH risk Airborne Infections transmitters?

- Undetected, undiagnosed patients with (or without) respiratory symptoms
- RT-PCR-confirmed cases of COVID-19
- TB patients which do not receive EFFECTIVE treatment
  - Treatment delay, interruption, default
  - Ineffective treatment regimen
  - TB patients on palliative care
- Fluoroquinolone resistant patients during the first 2(?) weeks after EFFECTIVE treatment initiation

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Airborne Transmission Risk Assessment

Factors to consider:

• Patients and visitors with fever, cough and other respiratory symptoms
• TB patients
  • Sputum smear AFB positive, rapid molecular testing confirmed, DST (risk of DR TB)
  • Is treatment regimen adequate?
  • Is patient compliant?
  • Cough etiquette, mask use
• Work practices and aerosol generating procedures
• Environment
  • Crowding
  • Air stagnation
• Engineering controls: installation, maintenance, certification, use
• Subject’s immune status

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
“Safety first!
Do not enter without respirator!”

Put warning signage at entrance to high risk areas

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Respirator use and fit testing policy

• Authorized responsible staff
• Annual training and fit testing for all HCWs
• Respirators distribution according to risk level (models, sizes, amount and protection class)
• Proper respirator use is mandatory in designated high risk areas and during such procedures
• Supervision, education and motivation

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
• Must be performed before a respirator is first issued to a HCW and is recommended annually thereafter.
• Additional fit test is required whenever there are changes in the users face physical condition
• NOTE: a separate USER SEAL CHECK must be performed each time the respirator is worn

Qualitative Fit Test

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Respirator Qualitative Fit Testing kit

- Nebulizer
- Test hood
- Collar
- Sensitivity solution (sweet & bitter)
- Fit test solution (sweet & bitter)

Costs USD 200 – 250, lasts forever

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Preparation of Bitrex Solutions

• The Sensitivity Test Solution is prepared by adding 13.5 milligrams of Bitrex to 100 ml of 5% salt (NaCl) solution in distilled water.

• The Fit Test Solution is prepared by adding 337.5 mg of Bitrex to 200 ml of a 5% salt (NaCl) solution in warm water.

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
10 minutes per test

Respirator Fit Testing

ETTi educational materials available

http://www.stoptb.org/wg/ett/resources.asp
Staff Education

- Initial instruction and fit-testing for new staff
- Annual Infection Control training related HCWs
- Annual qualitative test for all staff
- Posters and signage

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
3M-6000 (FFP3) respirator use for the highest risk procedures

- Cough/sputum induction procedures
- Bronchoscopy
- Endotracheal in- and ex-tubation in ER & OR
- Autopsy

Lasts longer, lower long term cost than for disposal respirators

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Disposable respirators needs assessment based on risk level and work load.

For **TB facilities** our estimates are:

- **High risk area** – 1 respirator per 2 working days
- **Medium risk area** – 1 respirator per 4-5 working days
- **Low risk area** – 1 respirator per 10-20 working days

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Respirators procurement

1. Models and sizes selection based on staff fit testing
2. Certified respirators
   • European Standard: EN149:2001+A1:2009 Respiratory protective devices - Filtering half masks to protect against particles - Requirements, testing, marking
   • US NIOSH Standard: 42 C.F.R. PART 84 — Approval of Respiratory Protective Devises

Avoid counterfeit goods!

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Counterfeit/poor quality respirators

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
NIOSH-Approved Particulate Filtering Facepiece Respirators

NIOSH-Approved N95 Particulate Filtering Facepiece Respirators

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Back to NIOSH-Approved Particulate Filtering Facepiece Respirators Main Page

This site contains documents in PDF format. You will need Adobe Acrobat Reader to access the file. If you do not have the Acrobat Reader, you may download a free copy from the Adobe Web site.

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<td>1850 (FDA)</td>
<td>84A-0005</td>
<td>No</td>
<td>PDF Only 72 KB (4 pg pages)</td>
</tr>
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</table>

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
• Select a fit tested respirator
• Place over nose, mouth and chin
• Fit flexible nose piece over nose bridge
• Secure on head with elastic
• Adjust to fit
• Perform a USER SEAL CHECK –
  ➢ Inhale – respirator should collapse
  ➢ Exhale – check for leakage around face

Disposable Respirator Donning

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Re-use of disposable respirators

Definition

Definition: *Single-use respirator* means a respirator that is entirely discarded after excessive resistance, sorbent exhaustion, or physical damage renders it unsuitable for further use.

US NIOSH Standard: 42 C.F.R. PART 84—APPROVAL OF RESPIRATORY PROTECTIVE DEVICES

Mind contact SARS-CoV-2 transmission from contaminated respirator!

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
## HCW Compliance Issues

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<tr>
<th>Reason</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skepticism</td>
<td>Educate</td>
</tr>
<tr>
<td>Negligence</td>
<td>Motivate</td>
</tr>
<tr>
<td>Discomfort</td>
<td>Train, offer other models/sizes</td>
</tr>
<tr>
<td>Communication difficulty</td>
<td>Educate, offer other model</td>
</tr>
</tbody>
</table>

Compliance among staff is growing in time and initially is much higher among younger HCWs

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Disposal respirators

- Never clean, wash, disinfect, repair
- Keep in dry cloth
- Dispose if:
  - Worn
  - Damaged
  - Contaminated
  - Does not provide seal
- Replace if it gets wet

Elastomeric face piece respirators

- Can be cleaned and disinfected (not filters!)
- Replace filters if
  - Damaged
  - Contaminated
  - Excessive resistance to breathing

Respirator Care

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Respirator disposal

• Re-aerosolisation of infectious particles from respirator is extremely unlikely
• Contaminated respirators may pose risk of contact infections, including SARS-CoV-2, not TB
• Used respirator should be disposed with other potentially infected medical waste according to national regulations

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Personal respiratory protection program cycle

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Conclusions

• Personal respiratory protection program can be feasible if based on adequate administrative and environmental controls

• Compliance among staff is growing in time and much higher among younger HCWs

• This program contains important educational component for HCW, patients and visitors on Airborne Precautions (THINK RISK!)

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Thank You!

vlchnkv@yahoo.com

Grigory Volchenkov, Vladimir, Russia

Personal respiratory protection to prevent airborne transmission of TB and COVID-19
Questions?

Follow us on:
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NAPS Membership

NAPS Sub-Section of the TB Section
Membership across all regions
Members representing TB, HIV, Adult & Child Lung Health and Tobacco Control
A strength of the group and members is the diversity of knowledge, skills and expertise within their global community of practice
NAPS Activities

• Conference Planning
  – Contribute to the scientific program annual WHLC
  – Develop post graduate course/workshops/tracks/sessions for sub-section
  – Host training and Education Materials discussion session
  – Coordinate conference activities for members

• Working Groups
  – TB Education & Training (updated TOR)
  – Membership Development (new)
  – Conference Activities Planning (new)

• Webinars

• 25 year retrospective of NAPS
NAPS Leadership

CHAIR:
• Amanda Christensen, Australia
  • amandachristensen@thearc.org.au

PROGRAMME SECRETARY/Representative CCSA:
• Niesje Jansen, Netherlands
  • niesje.jansen@kncvtbc.org
THANK YOU

Register now for upcoming webinars:
https://www.theunion.org/news-centre/covid-19

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