"Use of Masks"

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This lecture

- SARS-CoV-2 and Covid-19
  - SARS-CoV-2 vs SARS-CoV-1
  - Viability and susceptibility
  - Main transmission modes
- Aerosols and aerosol transmission
- Face masks – Main types

SARS-CoV-2 and Covid-19

- Definitions
  - Covid-19 = Coronavirus Disease 2019
  - SARS-CoV-2 = the causative agent of Covid-19
  - SARS = Severe Acute Respiratory Syndrome

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- Coronavirus infections
  - Coronavirus strains as a cause of common cold (”rhinitis”…)
  - More severe infections caused by
    - SARS-CoV(-1) – Outbreak in Asia, then worldwide (2002-2004)
    - MERS-CoV – Outbreak in Middle East (2012-…)
    - SARS-CoV-2 – Outbreak and pandemic (Dec. 2019-…)

SARS-CoV-2 vs SARS-CoV-1 – Similarities

79% of genetic similarity (RNA)

- Disease and epidemiology – Main similarities
  - Common origin (bats)
  - Responsible for respiratory diseases
  - Both likely to lead to severe acute respiratory syndrome (SARS), likely to require oxygen supply and/or artificial ventilation
  - Similar viability and resistance patterns
  - Same high risk groups (older people, poor health status…)

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Click a

SARS-CoV-2 vs SARS-CoV-1 – Main differences

- SARS-CoV-1
  - More severe disease, with higher mortality rates (10% vs 0.5 to 3%)
- SARS-CoV-2
  - Higher receptor affinity in human cells ☛ More virulent
  - Some virus shedding *before* the onset of symptoms (up to 24 hours), possibly also in asymptomatic and very mild cases
    ☛ Hidden transmission, making prevention more difficult
  - Highest virus load in nose and throat immediately after the onset of symptoms (only later after the onset of symptoms in SARS-CoV-1)
    ☛ More easily transmissible
  - Wider variety of symptoms ☛ Less easily recognisable

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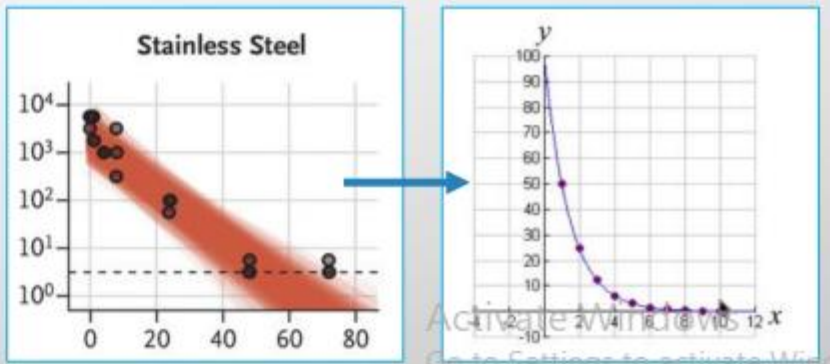
Viability of SARS-CoV-2

- Apparently more or less similar to SARS-CoV-1
- Virus stays viable for
  - More than 3 hours in aerosols – Median half-time (MHT) 1.1-1.2 hours
  - 72 hours on stainless steel and plastic – MHT 5.6-6.8 hours
  - 24 hours on cardboard
  - 4 hours on copper
- Classical exponential viral decay
  - Steep decrease followed by a smoother curve and a final plateau



* NIAID, 2020 (https://www.nejm.org/doi/10.1056/NEJMc2004973)

Susceptibility of SARS-CoV-2

- Rather classical susceptibility (still to be defined more precisely)
  - UV light
  - Heat
  - Desiccation
  - Alcohol (70% ethanol, hydroalcoholic solutions or gels…)
  - Bleach
  - Acetic acid
  - Hydrogen peroxide (H_2O_2)
  - Water and soap (hand washing!)
  - …

Transmission of SARS-CoV-2

Transmission through airborne droplets (aerosols)

- Main transmission modes
  1. Direct or close contact
  2. Exposure to contaminated surfaces
  3. Remote (at a distance) exposure to aerosols

☛ Main prevention means
  1. Physical distance
  2. Cleaning and disinfection
  3. Wearing of masks

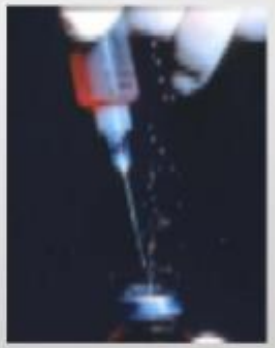
Part II – Aerosols and aerosol transmission

Aerosols

- Aerosols = liquid droplets or solid particles suspended in the air (or in a gas)

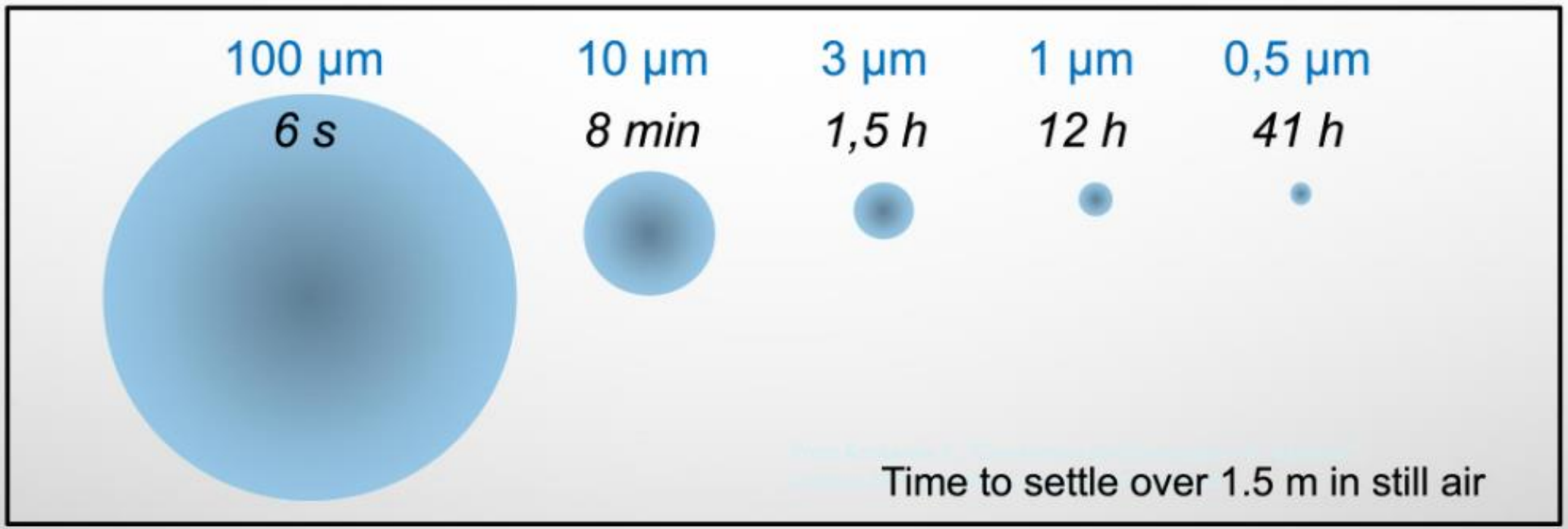



- Infectious aerosols
  - Suspended liquid droplets containing infectious agents
  - Possibly suspended biological agents (e.g. when droplets have evaporated)

Settling time of aerosols according to size

- Variety of particle sizes depending on the energy of the aerosol production



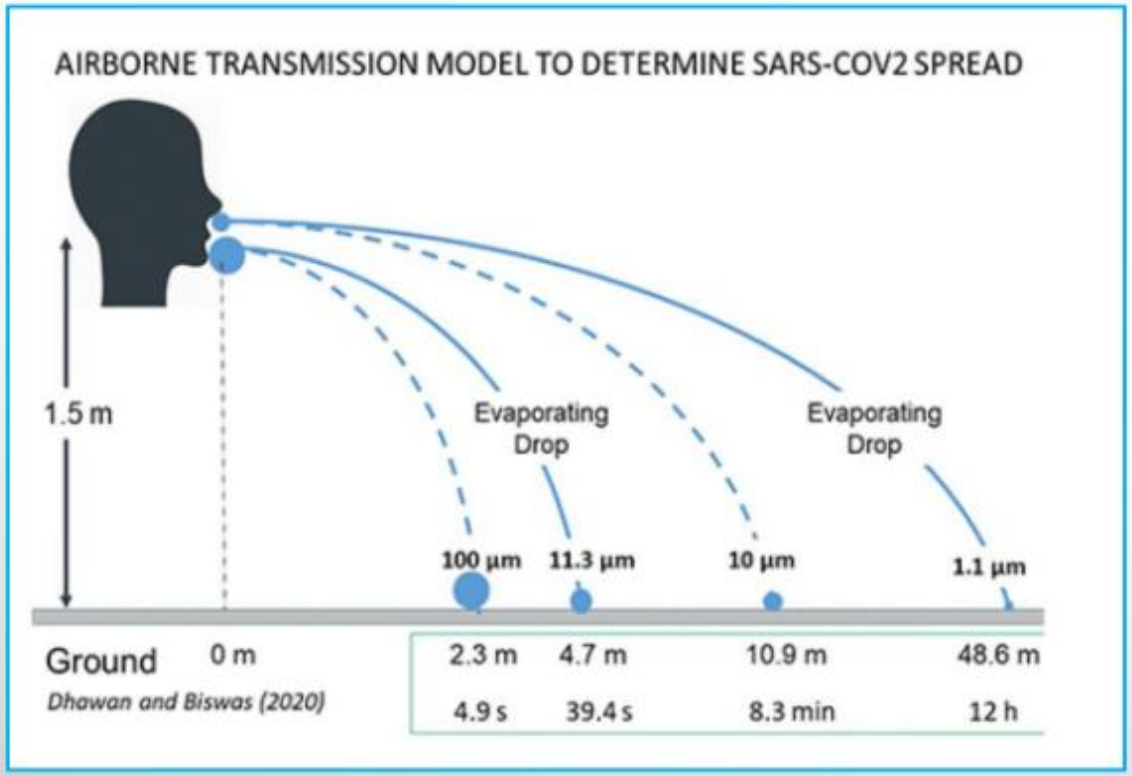
- Settling time related to particle sizes (longer for smaller particles)

Coughing and sneezing as sources of aerosols

- Small droplets tend to stay suspended in the air and can possibly travel long distances (through air flows)
- Large droplets tend to settle quickly

- Coughing and sneezing
  - Highly energetic aerosol emission
  - Very effective mode of aerosol dissemination !
- Droplets also likely to be emitted while breathing (exhaling), talking… but in more limited number, and with much less energy

Aerosol dissemination and risk of infection



- Theoretically, time and distance for aerosol settling may be long (up of 12 hours and 48 meters)!
- In practice, dilution and viral decay occur with increasing time and distance
  - ☛ Virus load much lower
  - ☛ Risk of infection much lower

* Washington University, CASE, 2020
(https://source.wustl.edu/2020/04/aerosol-researchers-at-mckelvey-school-of-engineering-tackle-novel-coronavirus/)

Importance of aerosols and air flows

- Aerosols are a major source of dissemination and transmission of SARS-CoV-2 (and other biological agents)
  - In natural conditions
  - In healthcare or laboratory conditions (aerosol-generating procedures or accidental spills)

☞ Controlling aerosols
  - Though personal protection
    - Personal Protective Equipment (PPE) – Different types of masks
  - Through containment
    - Biosafety cabinets (BSCs)
    - Negative pressure and HEPA filtration

Part III – Face masks

Main types of face masks and respirators

- Respiratory face masks (US: “respirators”):
  - N95, FFP2, FFP3, KN95…
  - R95, P95…
- Surgical masks
- Cloth masks – Do-it-yourself (DIY) or manufactured
- Other masks and respirators*

* Not covered in this course because expensive and generally not available in Pakistan

Respiratory face masks

Designed to protect the wearer from aerosol particles and droplets

- Different types: molded or not, with or without a valve…
- Numerous models (significant differences in design, composition…)

Respiratory face masks without a valve

Valved respiratory face masks

- Performances fixed and tested according to various standards

Respiratory face masks – Standards and performances

- Equivalence of standards (based on *minimum* efficiency levels)

USA (NIOSH-42CFR84)	Europe (EN149 / EN143)	China (GB2626)	Australia - N. Zealand (AS/NZE1716)	Korea (KMOEL 2017-64)
N95* (>95%)	FFP2/P2 (>94%)	KN95 (>95%)	P2 (>94%)	1st Class (>94%)
N99 (>99%)	FFP3 (>99%)	KN99 (>99%)	P3 (>99%)	-
N100 (>99.97%)	P3 (>99.95%)	-	-	-

* R95 if also resistant to oil, P95 if oil-proof

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N95 / FFP2 (or N99 / FFP3) are the protective masks generally recommended for high-risk situations in hospitals and medical laboratories

Respiratory face masks – Performances and fitting

- In actual conditions, suitable performances only achievable if masks are
  - Worn properly
  - Well-adjusted to the face (‘’fitting’’)
- Importance of
  - Choice of a suitable model
  - Some training
  - Fit-testing

Fitting is suboptimal or poor in presence of facial hair (beard)

☛ An issue for males, esp. in Muslim countries

Respiratory face masks – With or without a valve?

- Purposes
  - Facilitate exhaling (“exhaling valve”)
  - Reduce moisture inside the mask
  - ☛ Facilitate breathing and improve wearing comfort
- Drawback
  - No filtration of the wearer’s exhaled air
  - ☛ No protection of colleagues and patients if wearer infected

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☛ Covid-19 context: valved masks not to be worn in healthcare settings !

Surgical masks

Designed to arrest bodily fluids from the wearer

- Characteristics
  - Generally three-layered –
    Filtering medium sandwiched between
    two layers of non-woven fabrics
  - No tight face fit
  - Usually, no safety rating... and no claimed protection of the wearer

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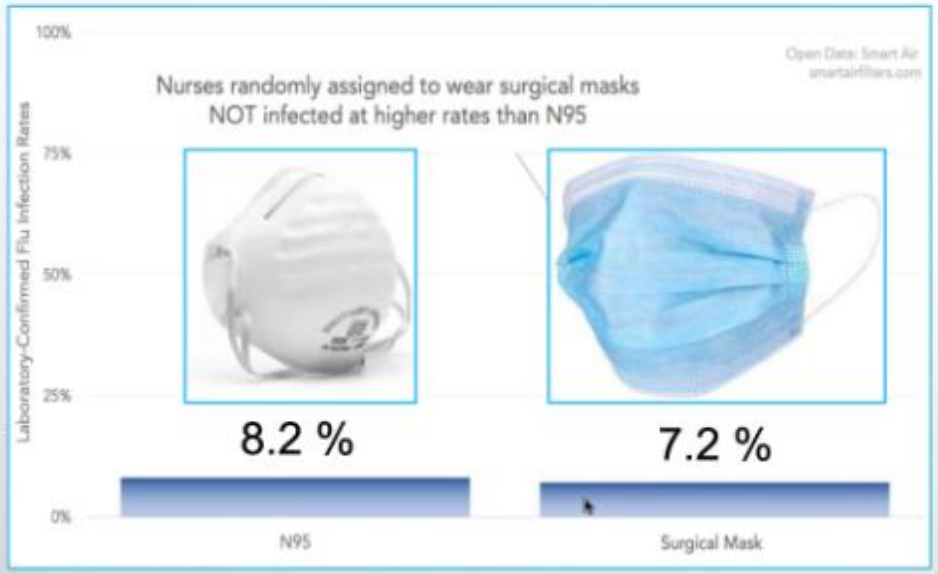
☞ Not considered personal protective equipment (PPE)

☞ Covid-19 context: mostly recommended for Covid patients !

Surgical masks – Theory vs practice !

- Results from recent field studies (incl. before the Covid-19 outbreak) show no significant difference betwen the protection from N95 and surgical masks



Example of study*

- 2862 nurses in 7 US medical centers
- 2 groups randomly assigned N95 or surgical masks
- 4-year study (2011-2015)
- Incidence of Influenza virus disease (size of virus similar to SARS-CoV-2)

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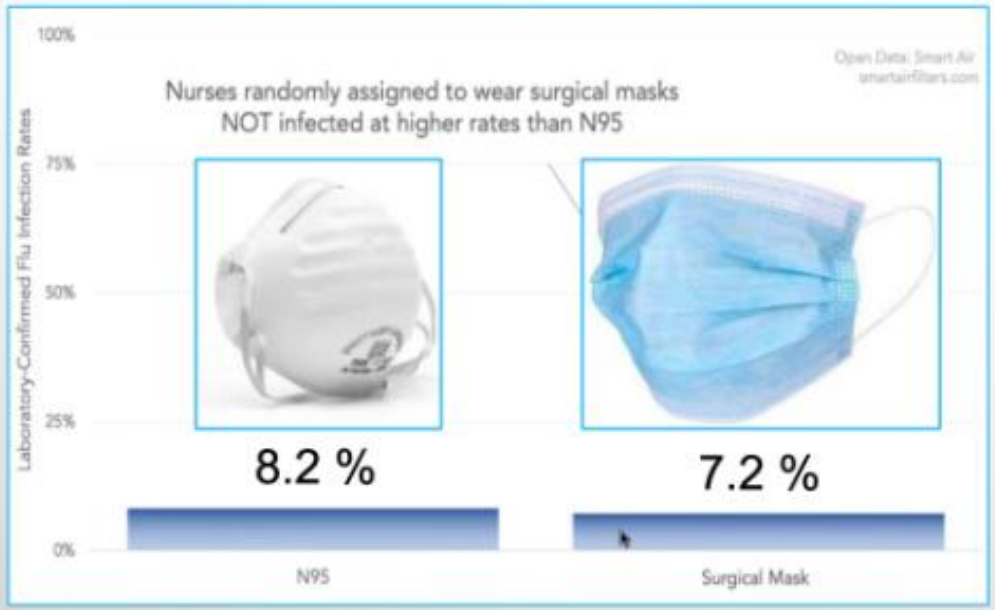

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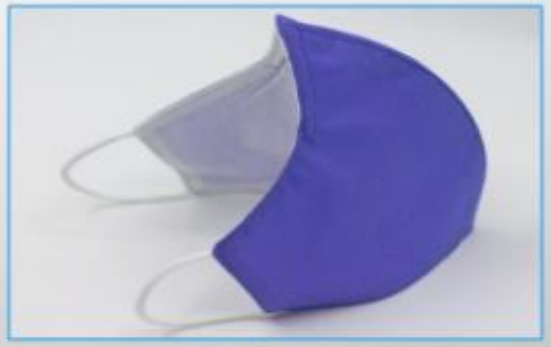
☛ Surgical masks may offer some significant personal protection !

Cloth masks

- Many different types
  - Home-made (''do-it-yourself'', or DIY) or manufactured
  - No specification or performance standard
  - No defined or demonstrated protection
  - Huge differences in design and materials
  - Probably significant differences in effective protection



Other types of masks and respirators

Half-face P3 respirator

Full-face P3 respirator

Half-face powered air purifying respirator (PAPR)

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Full-face PAPR

- Usually not worn in front of patients or for laboratory activities
- Expensive and not readily available fof labs and hospitals in Pakistan

Questions, comments, suggestions... ?