Introduction to Coronavirus

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COVID-19: A Brief History

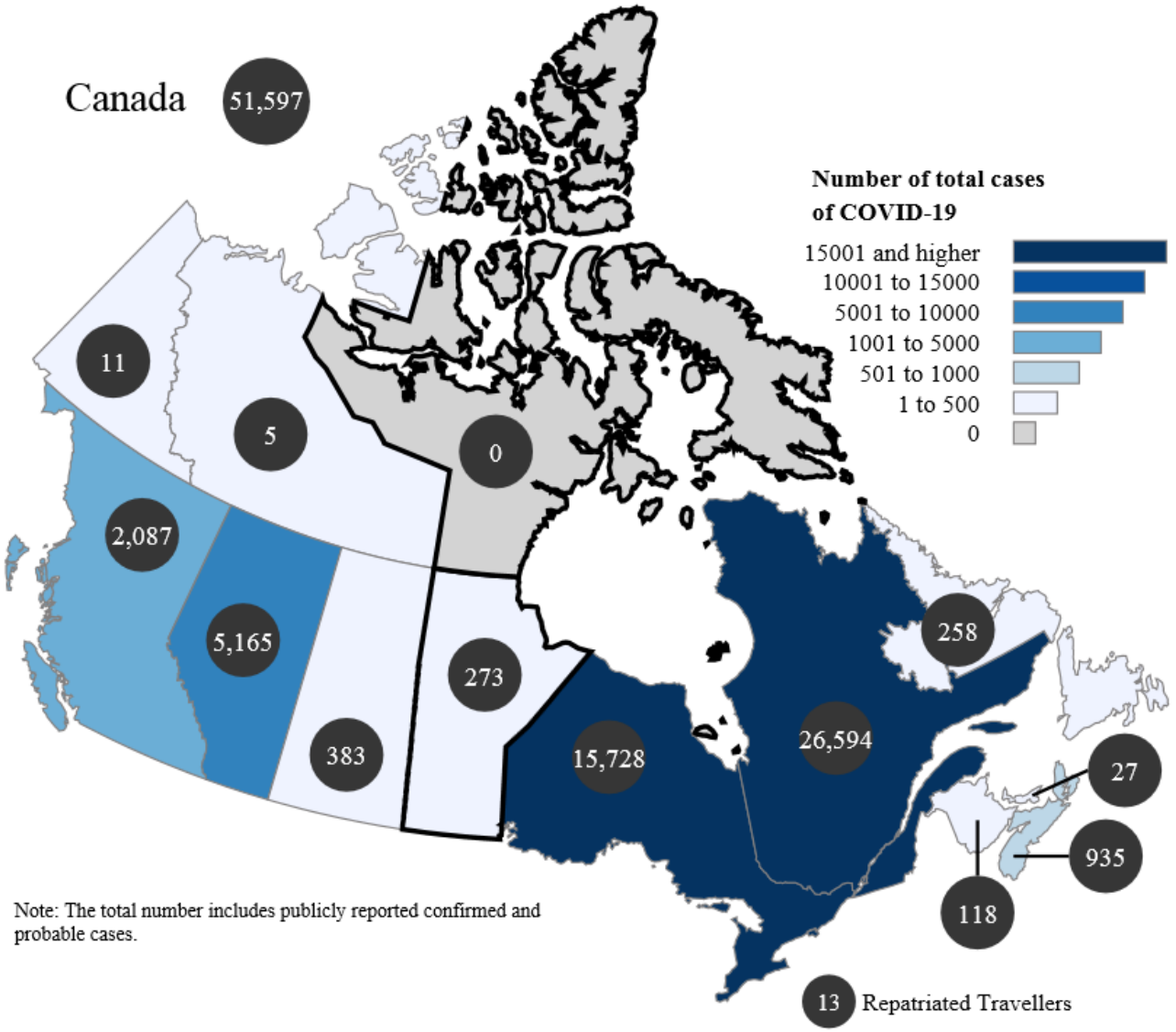
- December 2019
  - a novel coronavirus identified in Wuhan, China
- January 2020
  - genome sequenced from BAL's from 5 Chinese hospitalized pts
- Feb 11, 2020
  - virus given the name "severe acute respiratory virus coronavirus 2 (SARS-CoV-2)"
  - disease caused by the virus named "COVID-19"
- March 11, 2020
  - global pandemic declared by WHO

COVID-19: Terminology

- Viruses and the diseases they cause often have different names (eg- HIV and AIDS)
- Viruses are named based on genetic structure to facilitate development of diagnostic tests, vaccines, medicines
- Named by International Committee on Taxonomy of Viruses (ICTV)
- Diseases are named to enable discussion on disease prevention, spread, transmissibility, severity and treatment
- Named by WHO in International Classification of Diseases (ICD)

COVID-19: Scope of Disease as of April 30, 2020 (WHO)

- Global Cases
  - 3 059 642
  - Europe >1.4 million
  - Americas >1.2 million
- Global Deaths
  - 211 028
- Countries/Areas/Territories with Cases
  - 213



Total Number of Cases in Canada as of April 29, 2020 (Government of Canada)

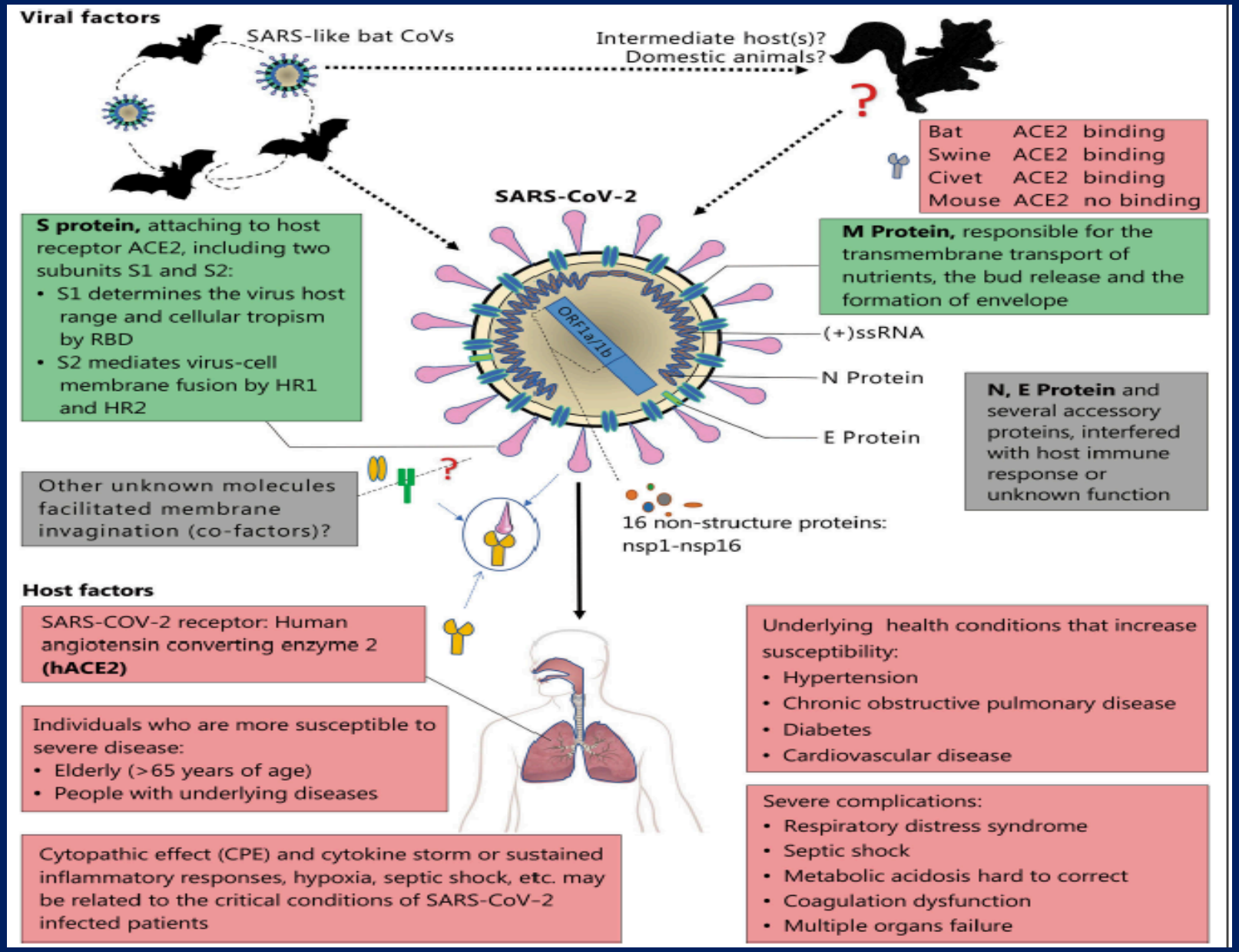
The Virus

COVID-19: The Virus

- RNA virus with protein envelope
- 7 known species that can produce human infection
- Certain zoonotic strains have the ability to produce severe lower respiratory symptoms and disease
  - MERS-CoV
  - SARS-CoV (SARS)
  - SARS-CoV-2 (COVID-19)
- 79% similar to SARS-CoV, 52% similar to MERS-CoV, 88% similar to other SARS-like CoV's from Chinese bats

COVID-19: Where Did It Come From??

- Bats in caves in China carry coronaviruses
- It is believed that the virus crossed over into a pangolin (ant-eater like animal)
- Live food markets in China have multiple animal species in close quarters, facilitating transfer to humans
- Cluster of persons with pneumonia in Wuhan, China in December 2019 epidemiologically linked to Huanan Seafood Wholesale Market
- Spread initially to adjacent countries, then widely


Viral factors
SARS-like bat CoVs
Intermediate host(s)?
Domestic animals?
?
Bat ACE2 binding
Swine ACE2 binding
Civet ACE2 binding
Mouse ACE2 no binding
SARS-CoV-2
S protein, attaching to host receptor ACE2, including two subunits S1 and S2:
• S1 determines the virus host range and cellular tropism by RBD
• S2 mediates virus-cell membrane fusion by HR1 and HR2
M Protein, responsible for the transmembrane transport of nutrients, the bud release and the formation of envelope
ORF1a/1b
(+)ssRNA
N Protein
E Protein
N, E Protein and several accessory proteins, interfered with host immune response or unknown function
Other unknown molecules facilitated membrane invagination (co-factors)?
16 non-structure proteins:
nsp1-nsp16
Host factors
SARS-COV-2 receptor: Human angiotensin converting enzyme 2 (hACE2)
Underlying health conditions that increase susceptibility:
• Hypertension
• Chronic obstructive pulmonary disease
• Diabetes
• Cardiovascular disease
Individuals who are more susceptible to severe disease:
• Elderly (>65 years of age)
• People with underlying diseases
Severe complications:
• Respiratory distress syndrome
• Septic shock
• Metabolic acidosis hard to correct
• Coagulation dysfunction
• Multiple organs failure
Cytopathic effect (CPE) and cytokine storm or sustained inflammatory responses, hypoxia, septic shock, etc. may be related to the critical conditions of SARS-CoV-2 infected patients

How Does It Spread?

Spread of the Virus

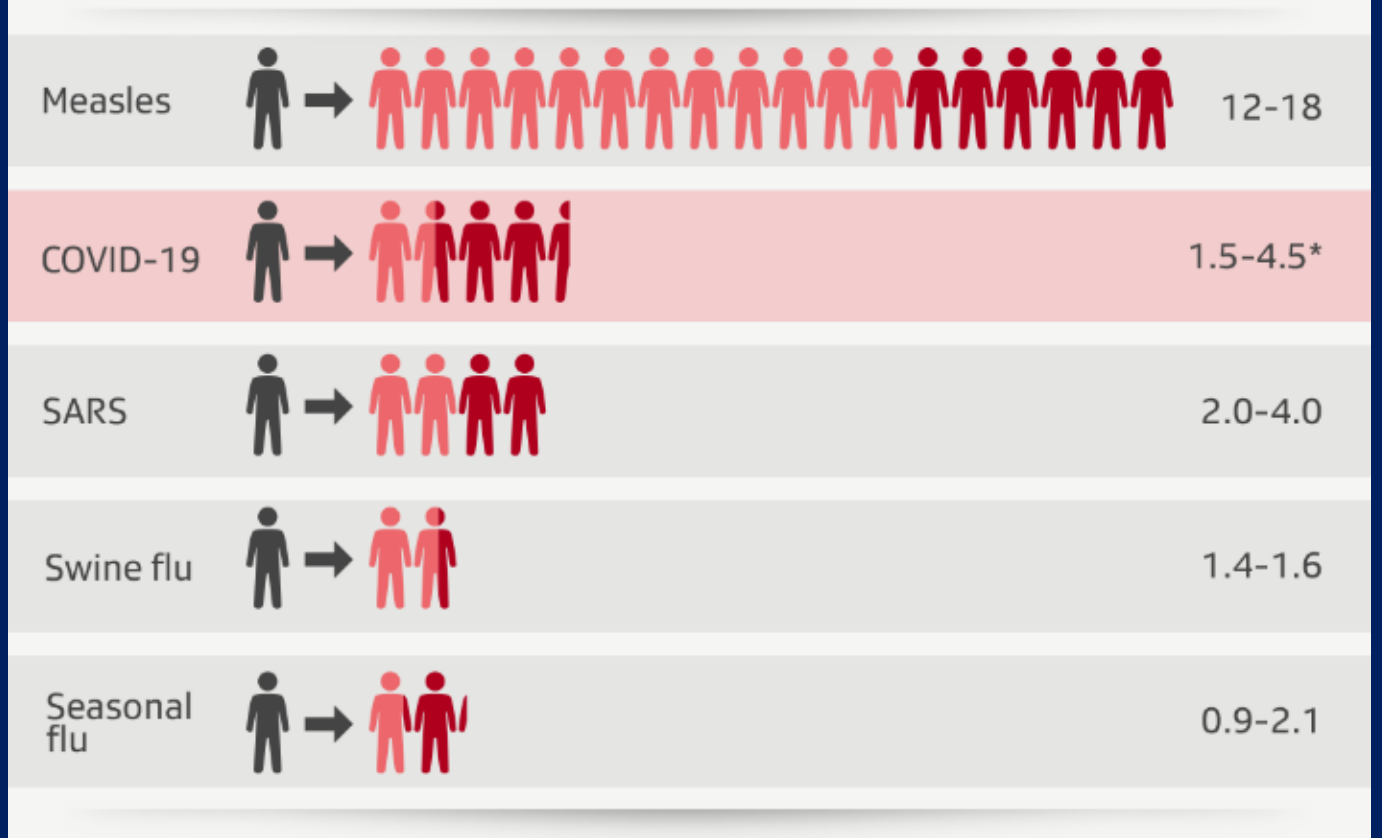
- ***Droplet, not airborne***
- No risk of airborne spread unless virus is aerosolized
- Viral particles identified in stool/GI tract- ?infectious
- Viral particles not identified in genital tract secretions

Infectivity of the Virus

- R_0=infection rate, the number of people an ill person infects
- If >1, infection spreads; if <1 it dies down
- Goal is to get R_0 as close to zero as possible
- For this virus, R_0 is estimated at 2.2 without protection/containment measures

Infection rate

The average number of people an ill person infects



*according to data from Wuhan

Source: Estimates from the WHO, the CDC, the London School of Hygiene and Tropical Medicine and various studies

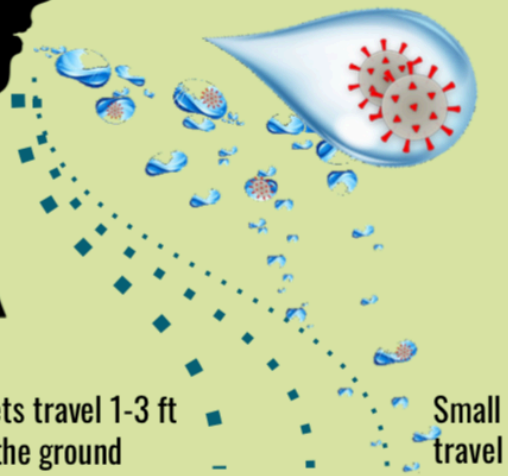
SWI

DROPLET SPREAD

SARS-CoV-2 / Coronavirus

Cough
Sneeze
Speech
Yawn
Burp

Viruses are contained in water droplets which arc through the air and land on surfaces



Large droplets travel 1-3 ft then fall to the ground

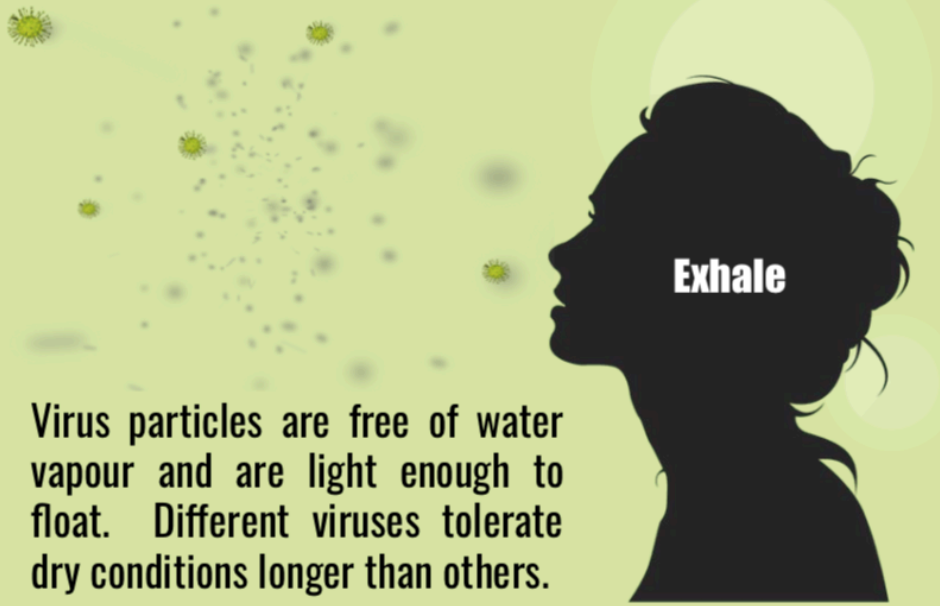
Small droplets travel 3-5 ft

Surfaces in the "spray zone" AT THE TIME OF THE SPRAY get dusted in droplets containing virus. As they dry, the virus starts to decay, at a different rate on different surfaces. YOU are a surface.

VS

AIRBORNE SPREAD

Chickenpox / Varicella



Virus particles are free of water vapour and are light enough to float. Different viruses tolerate dry conditions longer than others.

Surfaces in the room within an HOUR of the spray get dusted with viral particles. They decay somewhat faster on surfaces without the protective water droplet but can float farther.

DROPLET SPREAD

SARS-CoV-2 / Coronavirus

VS

AIRBORNE SPREAD

Chickenpox / Varicella

It is possible to inhale <u>droplets</u> only if "in the line of fire" and close proximity.

Plastic half life 7h

Cardboard half life 1h

Stainless steel half life 5h

Droplets leave a residue on surfaces that starts to dry. Some surfaces are more hospitable than others. One "half life" is the time it takes for 50% of the viruses to dry up and die.

Varicella decays at a rate of 50% per hour

Airborne particles are inhaled passively regardless of distance in an enclosed space.

Particles also settle on surfaces but the air is their main vehicle.

DROPLET SPREAD is mostly

SARS-CoV-2 / Coronavirus

vs

AIRBORNE SPREAD

Chickenpox / Varicella

It is possible to inhale droplets only if "in the line of fire" and close proximity.

Contaminated hands touch the face & introduce the virus to airways

The average person touches their face 15x /hr

Touching any contaminated surface that hosts VIABLE virus contaminates your hands. RNA fragments, which can last for days or weeks are like the "bones" left by viral "carcases." They are harmless.

Airborne particles are inhaled passively regardless of distance in an enclosed space.

DROPLET AIRWAY PROTECTION

SARS-CoV-2 / Coronavirus

VS

AIRBORNE PROTECTION

Chickenpox / Varicella

Droplets are propelled a short distance and then fall. If in quite close proximity, these droplets land on a surgical mask and start to dry.

Surgical masks offer very good droplet protection - we rely on them to keep surgery safe for staff & patients every day.

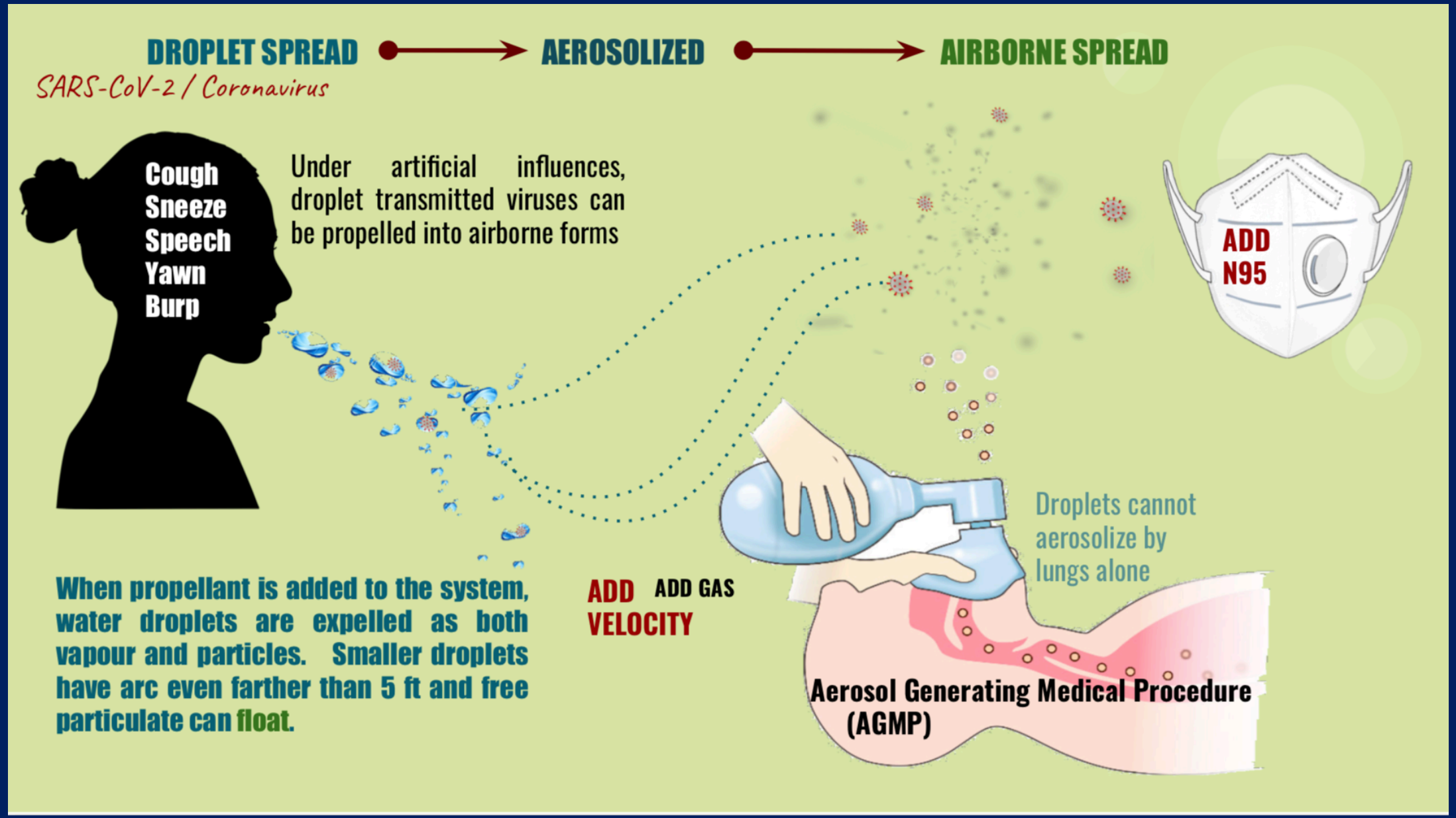
Viruses cannot penetrate the mask unless it's wet through.

Droplets can't turn corners

Particles float in ALL directions

The primary defense of the N95 mask is the close fit, which prevents particulate drift into airways.

Because of the loose fit of routine surgical masks, airborne pathogens can float through gaps. N95 respirators are needed.


DROPLET SPREAD
AEROSOLIZED
AIRBORNE SPREAD
SARS-CoV-2 / Coronavirus
Cough
Sneeze
Speech
Yawn
Burp
Under artificial influences, droplet transmitted viruses can be propelled into airborne forms
ADD
N95
When propellant is added to the system, water droplets are expelled as both vapour and particles. Smaller droplets have arc even farther than 5 ft and free particulate can float.
ADD
VELOCITY
ADD GAS
Droplets cannot aerosolize by lungs alone
Aerosol Generating Medical Procedure (AGMP)

HOW CAN I TRUST THAT MY PATIENT WON'T SPONTANEOUSLY AEROSOLIZE?

SARS-CoV-2 / Coronavirus

While there is much to learn about SARS-CoV-2 we have studied its cousin SARS-CoV-1 extensively and already examined Coronavirus' ability to be aerosolized. Not even the most forceful cough changes the nature of transmission. Surgical masks are effective droplet barriers for non-AGMP encounters.

Why is Labour and Delivery NOT an Aerosolized Event?

- 2 forms of droplets
- **Droplet nuclei**
  - small particles (<5 micrometres) that can stay in air
  - AGMP can increase likelihood of producing these
- **Droplets**
  - Larger than droplet nuclei
  - Produced when talk/scream/cough/sneeze
  - Can't travel long distances, fall quickly to ground/surfaces

Clinical Features

Incubation Period and Transmission

- Incubation period can be as long as 14 days
- Most people with clinical illness develop symptoms within 5 days (98% within 11 days)
- Can be infectious for few days before symptom onset
- Most likely to be infectious during symptoms and up to 10 days after symptom onset
- Virus can be detected long after symptoms resolve, but likely not infectious then

Testing

- **PCR**
  - Nasopharyngeal swabs on respiratory samples
  - Results available in hours
- **Serology**
  - Detection of antibodies (IgM and/or IgG)
  - IgM usually detectable in several days (not reliable)
  - IgG usually detectable by day 10-14, peak by day 28 and persist

Reliability of PCR Testing

- **Variability in Testing**
  - Anatomic area sampled
  - Quantity of virus present
  - Stability of RNA
  - Timepoint in disease course
  - Assay variability
- **False Negatives**
  - Reported rates 17%-63%

Reliability of Antibody Testing

- **The Jury is Still Out!**
  - Most tests measure binding (not neutralizing) Abs
  - Test properties still unclear
  - Tests not proven to document immunity
  - Unclear what level of Ab needed for immunity, and how long/durable Ab response will be
- **The Good News**
  - this virus does NOT mutate in the same way as influenza, so presumably prior infection will give some level of immunity