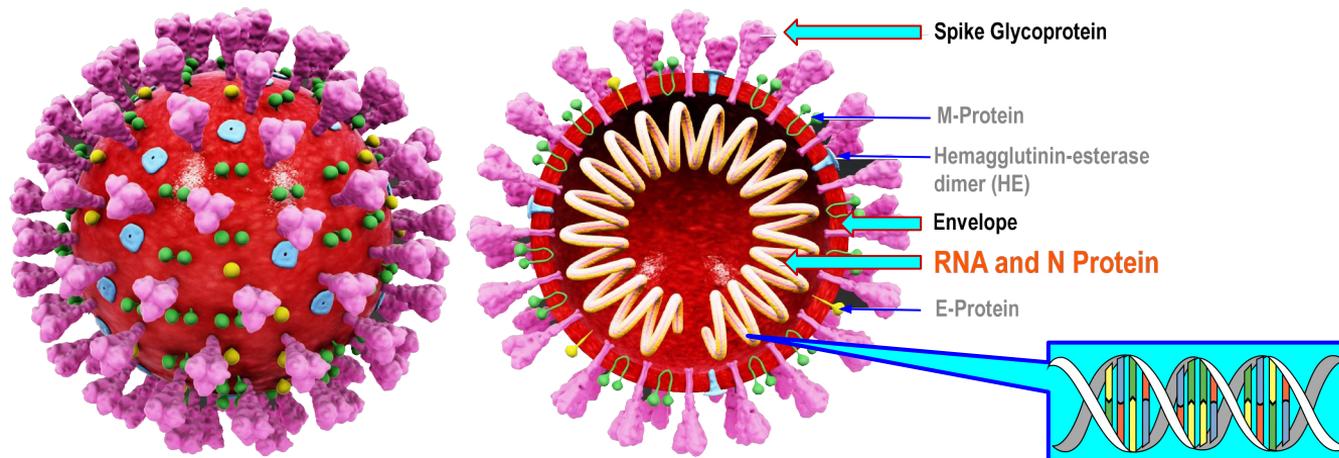


RailCARE

**Transport
Sanitation
Solutions**

Antiviral strategies in public transport

Get to know your enemy: COVID-19



elaboration by Lorenzo Bellone
original by <https://www.scientificanimations.com>

There are *three important parts of the viral cell* we need to consider in order to better understand it for our purposes:

- **THE SPIKES**- its way of attacking our cells, its “keys” to unlock access to our organs and wreak havoc in our bodies.
- **THE ENVELOPE**- its protection towards external hazards that enables it to live for a time outside our bodies and enter new hosts.
- **THE RNA**- containing the vital instructions to replicate itself inside us, without it working properly, it’s harmless.

What are the objectives of COVID-19?

All **living beings** have something in common: they strive **to survive** in order **to reproduce** and pass on their genetic code and thus **evolve** along ever mutating generations. We humans are not different.

BUT - some curious facts not everyone knows:

- **VIRUSES** are **NOT “ALIVE”**, not in the common sense of “life” as we define it.
- **VIRUSES** are **NOT made to SURVIVE**, few viral cells can exist for a prolonged period of time outside the host: air pressure, sun rays, temperature shifts... the outside world is full of dangers for a viral cell.
- **VIRUSES** **cannot EVOLVE on their own**, in order to evolve and mutate they need to interact with the host, even so, they cannot evolve faster than the host itself... unless they jump species and adapt to new hosts, that's why COVID19 is noticeably more dangerous than others, it has already proven it can do so.



1. Survival
2. Reproduction
3. Evolution



1. ~~Survival~~
2. Reproduction
3. ~~Evolution~~



The death of the host is in fact an *unintended negative consequence* for a virus, because it limits the ability of finding new hosts and thus the capability of reproducing. A **successful virus** is able to reproduce quickly, adapt itself to new hosts and allow the host to infect as many new subjects as possible guaranteeing future evolution.

What are the objectives of COVID-19?

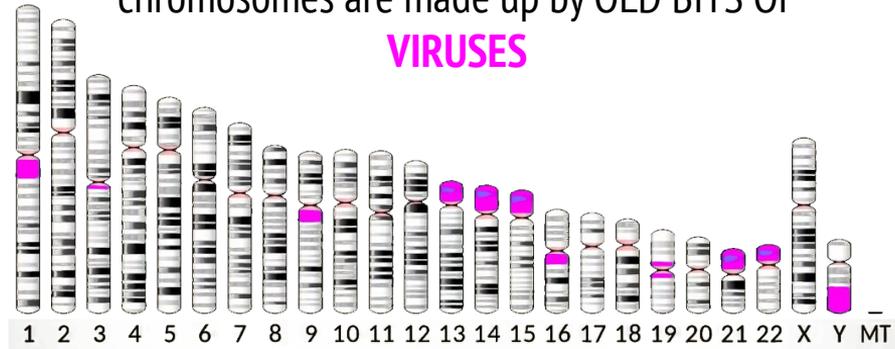
Viral Reproduction



- WE are the ecosystem the virus needs in order to live,
- WE are its chance of spreading,
- WE are enriching its genetic code and allowing it to evolve.

Viruses are us?

About 10% of our human
chromosomes are made up by OLD BITS OF
VIRUSES



Tracing a natural history of viruses is a daunting, nearly impossible task, they are far *too frail* to become fossils or leave any other useful trace...except... they leave a trace inside the creatures that hosted them.

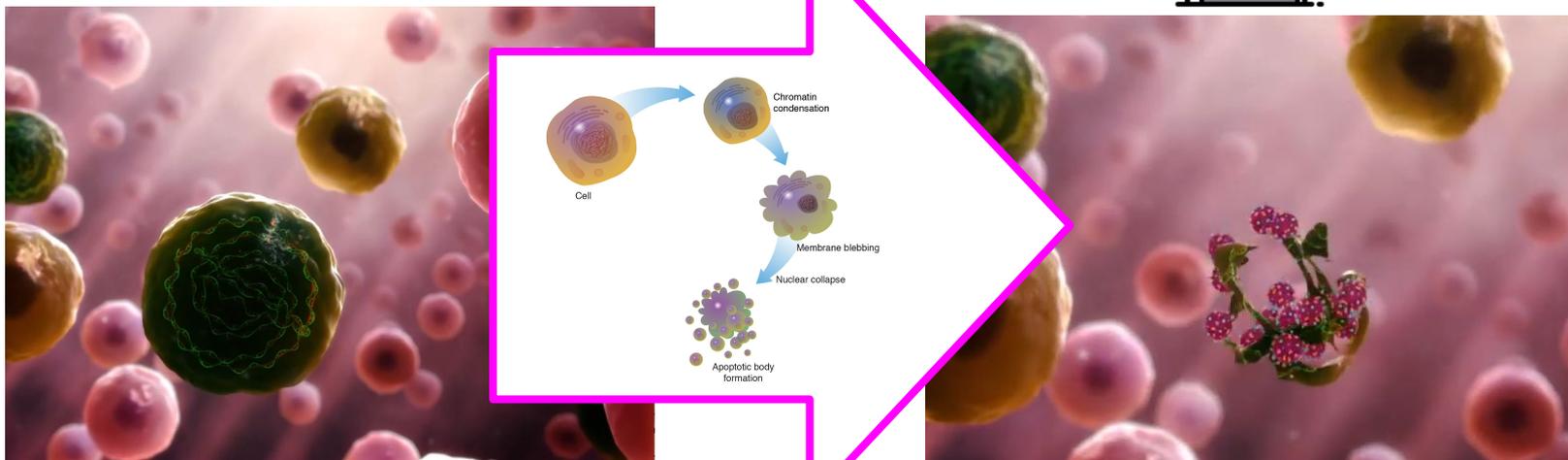
Paleovirology, coupled with genomics, has shown that DNA of viruses can enter and integrate with the host DNA and can be transmitted to its offsprings.

Viruses can affect ALL FORMS OF LIFE, even bacteria.

Why COVID-19 is so dangerous?

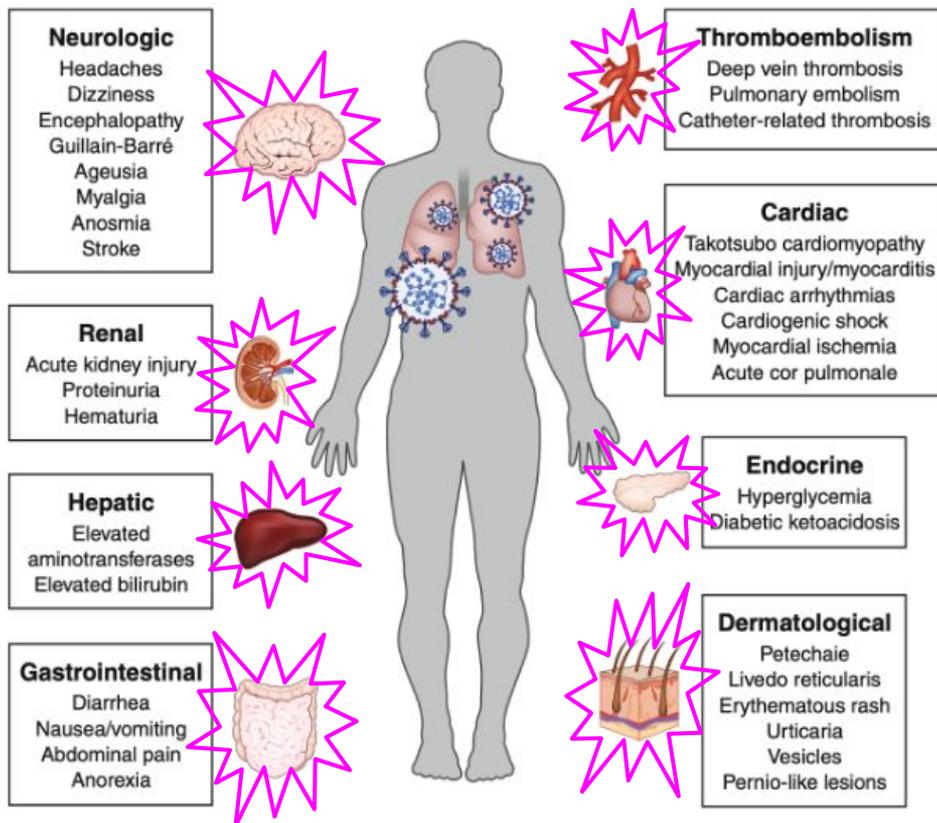
In order to reproduce, its main and only function, the virus hijacks our cells and force them to produce copies of itself, compromising the cell and leading to malfunction and its destruction. If enough cells inside the tissue of a vital organ are compromised, that organ might cease to function.

Reproduction = Death of host cell



(apoptosis)

Why COVID-19 is so dangerous?

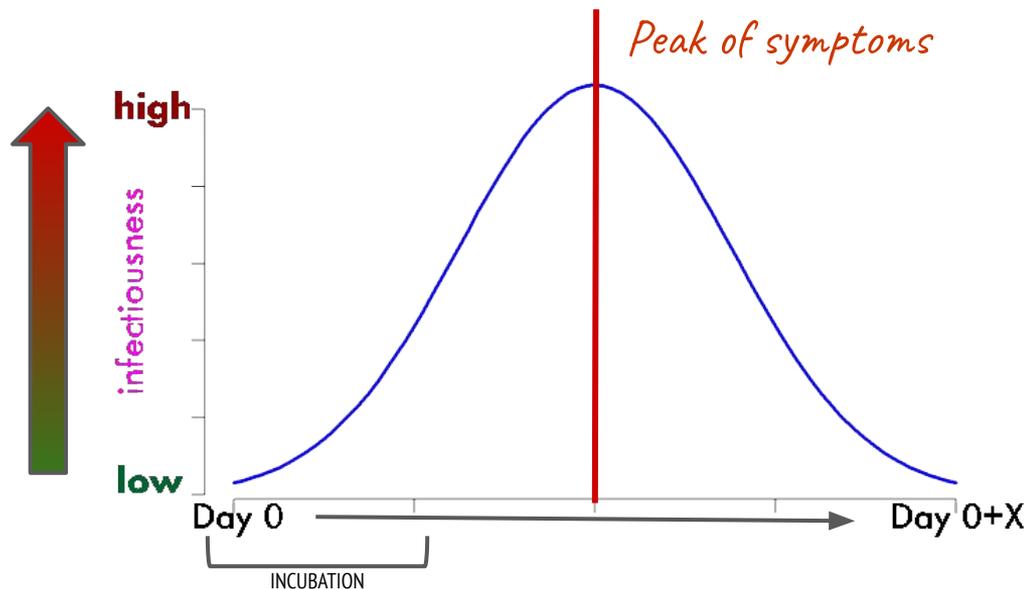


CAN TARGET MANY RECEPTORS

= **INCREDIBLY WIDESPREAD DAMAGE**

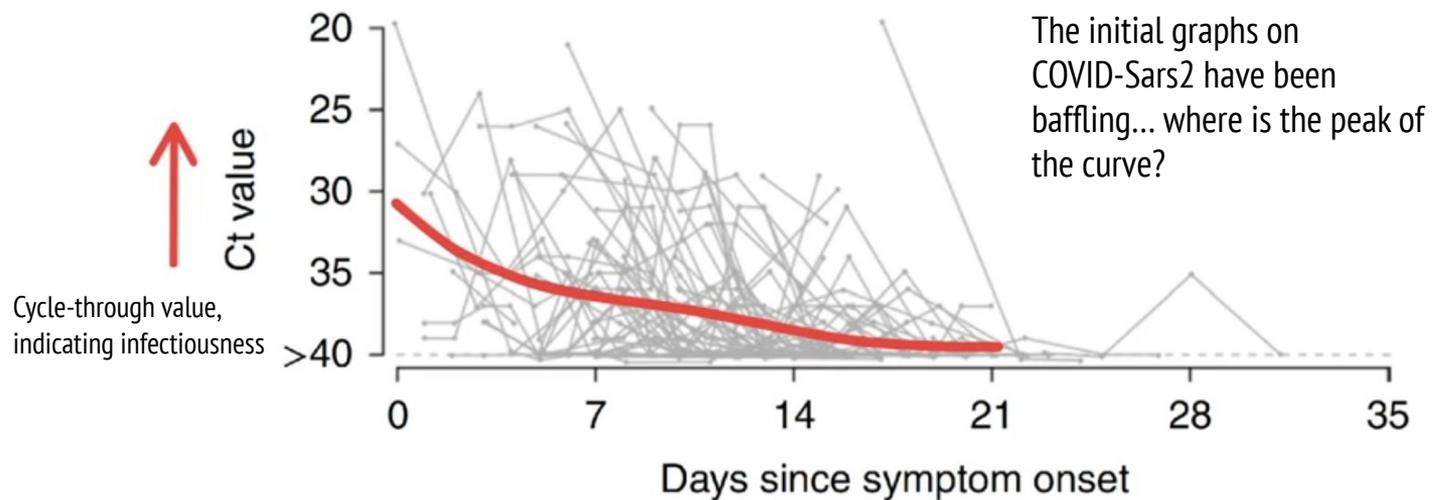
With the mRNA encoding several other proteins, the COVID-19 virus uses a *spike protein S1* that enables the attachment of the virion to the cell membrane by interacting with host ACE2 receptor, in the later study, it was shown that the ACE2 binding affinity of the 2019-nCoV spike protein ectodomain (compatibility) was **10–20-fold higher** than that of the (normal) SARS-CoV spike protein.

VIRAL SHEDDING - the key to COVID-19 SUCCESS

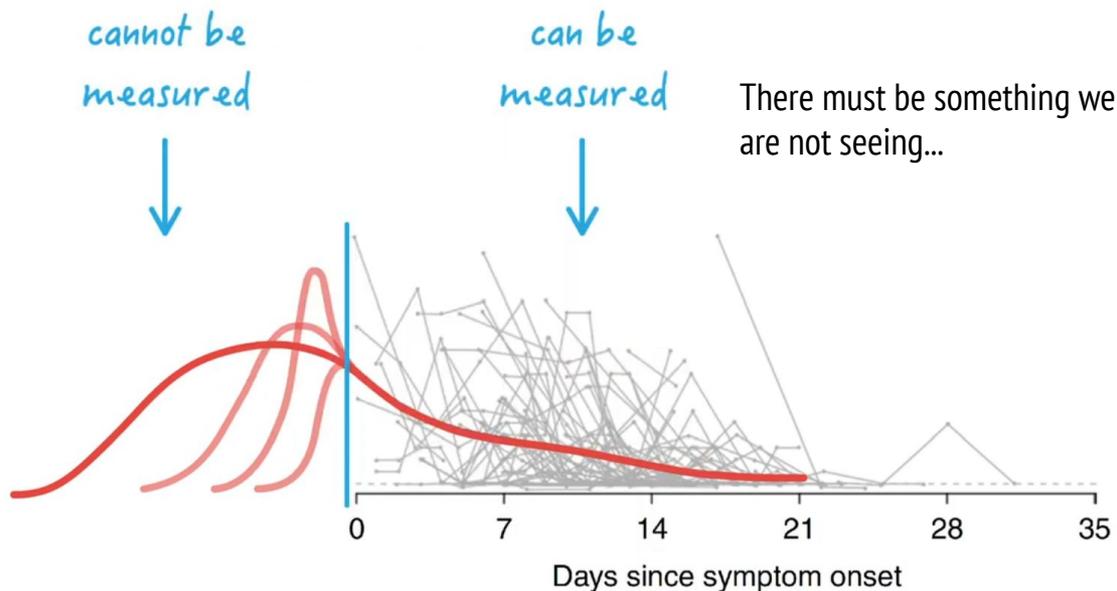


What could be expected as a “Normal” course of infection: as symptoms do manifest, the viral shedding, hence the capacity to infect other hosts, is at its peak.

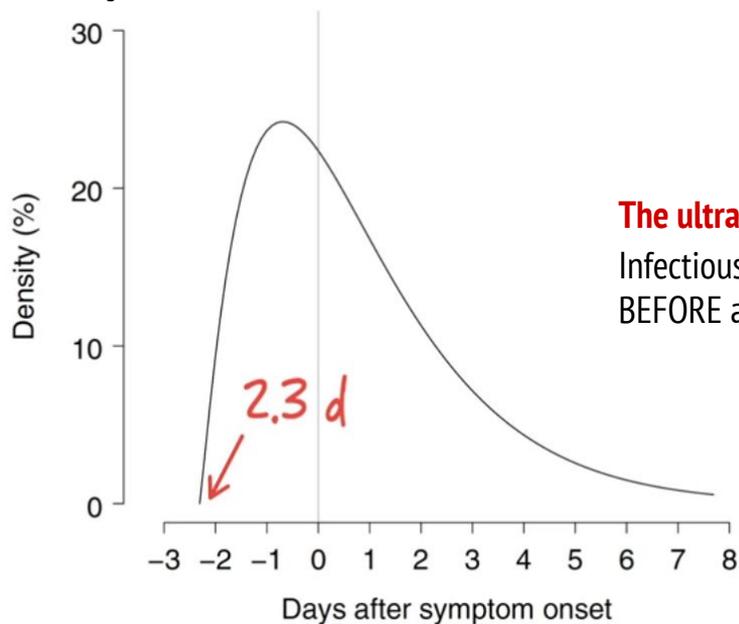
VIRAL SHEDDING - the key to COVID-19 SUCCESS



VIRAL SHEDDING - the key to COVID-19 SUCCESS



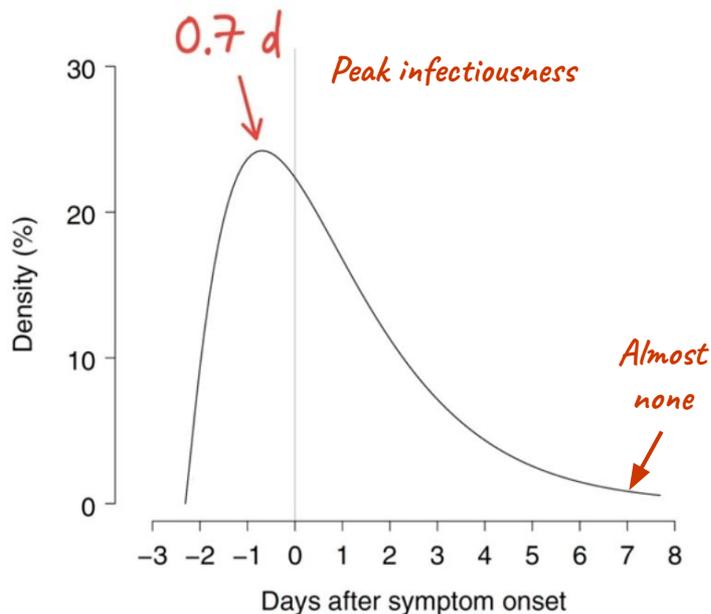
VIRAL SHEDDING - the key to COVID-19 SUCCESS



The ultra-effective COVID-19 strategy

Infectiousness starts about 2.3 days
BEFORE any symptoms.

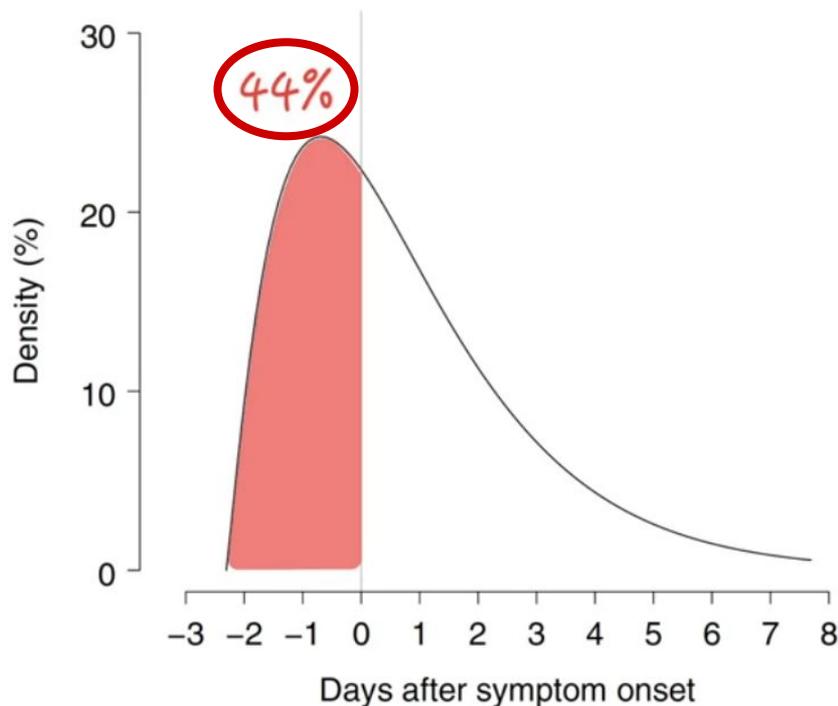
VIRAL SHEDDING - the key to COVID-19 SUCCESS



The effective strategy of COVID-19

The **peak** of reproductive efficiency (infectiousness) is reached about A DAY BEFORE ANY SYMPTOMS ONSET

VIRAL SHEDDING - the key to COVID-19 SUCCESS



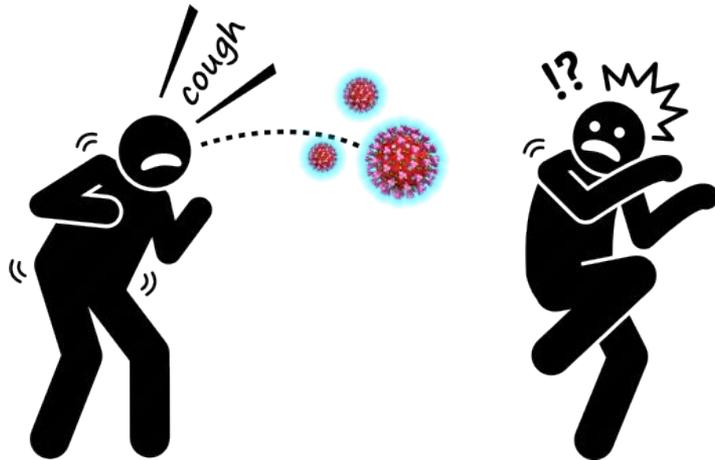
The ultra-effective COVID-19 strategy

44% of the infections happen before any symptoms can be recognized.

Thus meaning that **screening for symptoms** is useful against 56% of possible spreaders, a valuable instrument but nowhere near as useful and game changing as some depict it to be... Again we can see how a solution to our problems can only be a complex one, no magic bullet.

Our strategy: **VIRAL LOAD** is the real target

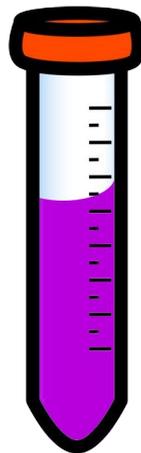
What is **infectious dose**?



It's the average number of **viral particles** needed to **establish an infection**, if less than that is passed from an infectious person to a healthy one, no infection is possible.

Our strategy: **VIRAL LOAD** is the real target

What is **viral load**?

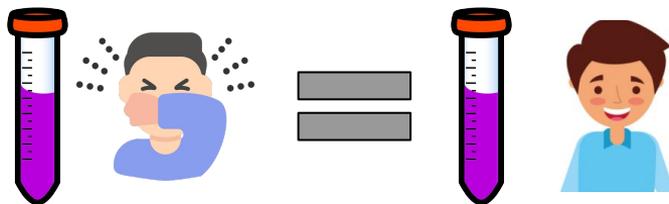


Is the amount of a specific virus in a **test sample**
taken from a patient

Our strategy: **VIRAL LOAD** is the real target

QUESTION 1:

Is HIGH VIRAL LOAD linked to HIGHER RISK of
Severe pneumonia or death?



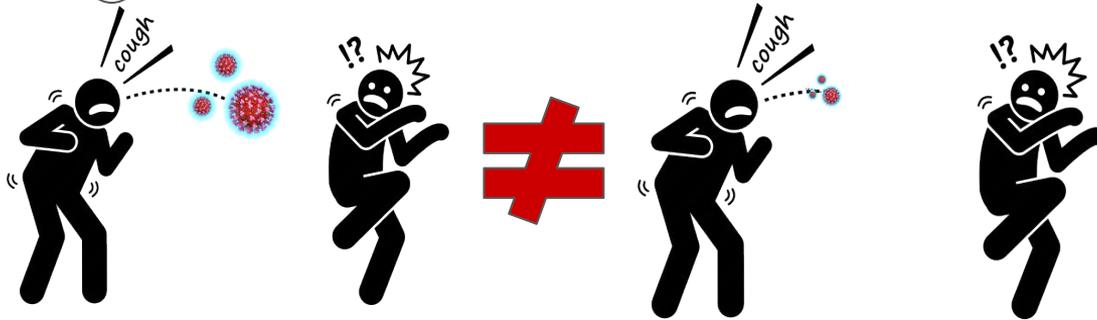
Not really, sometimes ASYMPTOMATIC patients
have the same high viral load

Of patients demonstrating *severe symptoms*, therefore they are as dangerous as.

Our strategy: **VIRAL LOAD** is the real target

QUESTION 2:

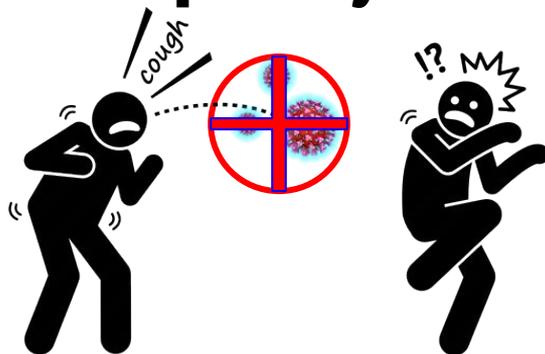
Does HIGH VIRAL LOAD increase the probability of
INFECTING others with the virus?



Yes, indeed a higher viral load means
A higher probability of passing a high enough infectious dose.

Therefore...

targeting the **capacity** of transmission



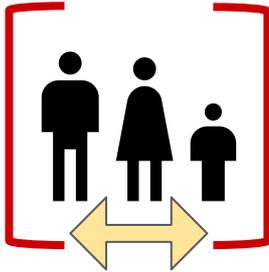
is the effective strategy because:

nearly half of infectious passengers *could* pass a screening before entering the transport system

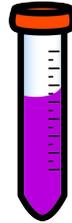
What factors in the **capacity** of transmission



DURATION OF
CONTACT



DISTANCE OF
CONTACT



VIRAL LOAD



ENVIRONMENT

All parameters are in play: a long distance train travel with few passengers has roughly the *same transmission dangers* as a short ride in crowded bus (all other factors being equal).

Therefore, the solution needs to be flexible & adaptable.



Transport
Sanitation
Solutions

So our plan is:

To build **long term systemic resilience**

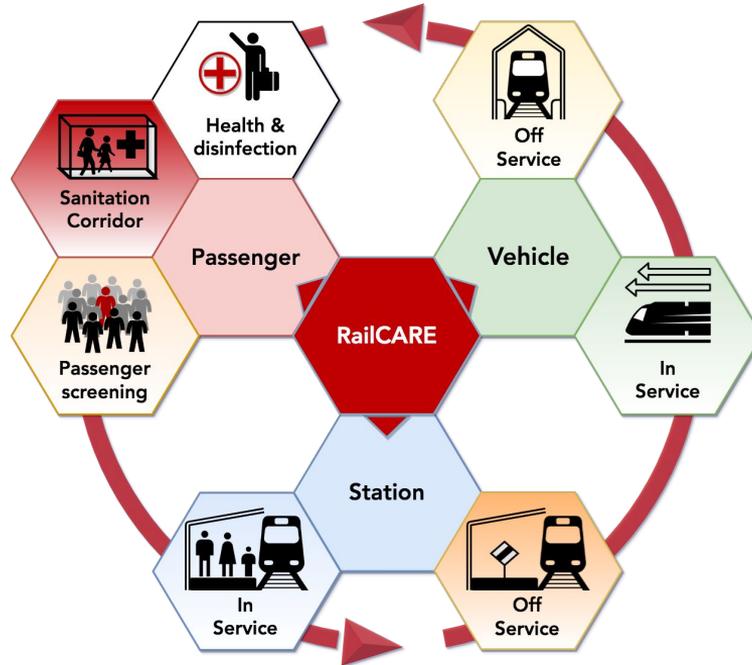
- Effective against *all kinds* of foreseeable viruses.
- Without “weak links” that may compromise the system.
- Requiring the very minimum of personnel with short training.
- Adaptable to any environment from small bus station to transport hub.
- Sustainable on the long run without adverse unintended effects.
- Providing cheap, scalable and modular component-based solutions.
- Guaranteeing seamless integration with minimum disruption to the existing operative protocols and structures.

RailCARE

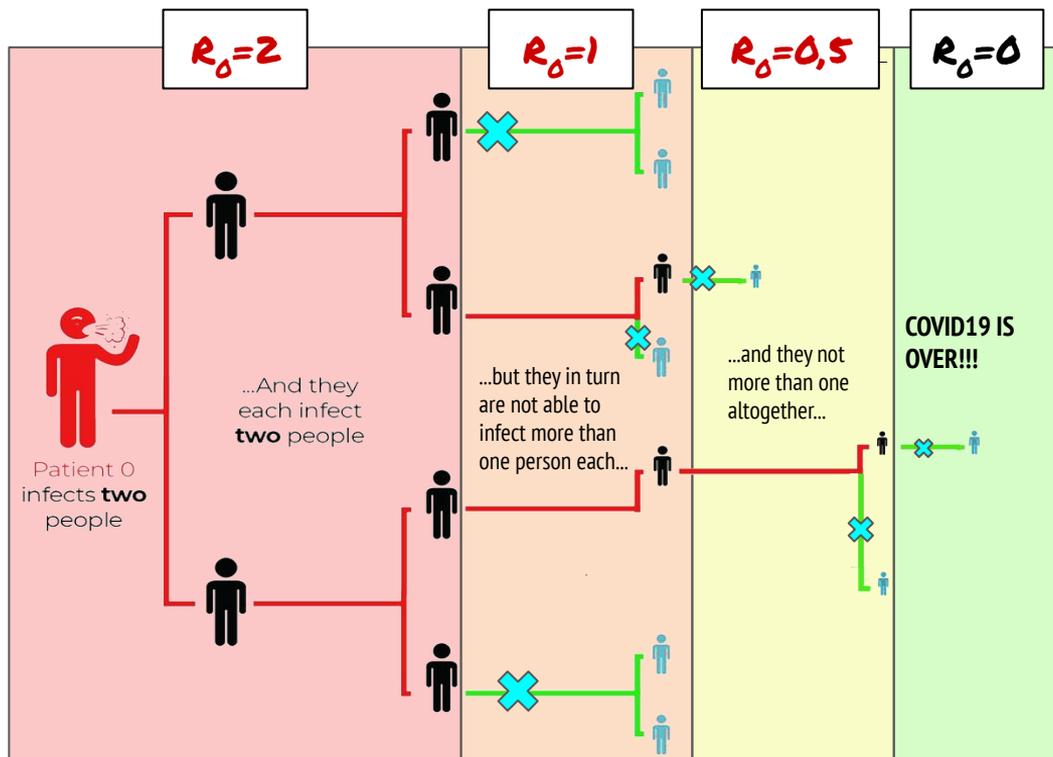
Transport
Sanitation
Solutions

So our plan is:

To create a **solid continuity** within the chain



Our final objective: To stop transmission *significantly*



From $R > 1$ to $R < 1$

making the virus “manageable” at first and then condemning it, in a *mathematically certain* way, to **disappear due to lack of hosts**.

(Remember, it cannot live on its own, it's not able to survive for long outside US).

Physical constraints in application scenario

1. Kl.-Wagen
(Apmzf 411.0)
Nr. 28/38



1. Kl.-/2. Kl.-Wagen
(ABpmz 411.1)
Nr. 27/37



2. Kl.-Endwagen
(Bpmzf 411.5)
Nr. 21/31



ICE model As a general representative of the high speed, long distance trains, this model will be considered as the typical transport. The ICE-T it's the most numerous of this type with 70 trains in service (67 with DB, 3 with ÖBB), of which 59 are of the 411 type illustrated here.

**OXIDATION
PROBLEM
VEHICLES**

1 Klasse ICE 3



2 Klasse ICE 1



Materials and configuration All furniture, equipment and their positioning must be taken into account when calculating the optimal solution since the oxidation effect could damage some materials. With the correct dosing of O_3 and automated exposure times all wear and tear of the interiors can be avoided while granting deep reach.

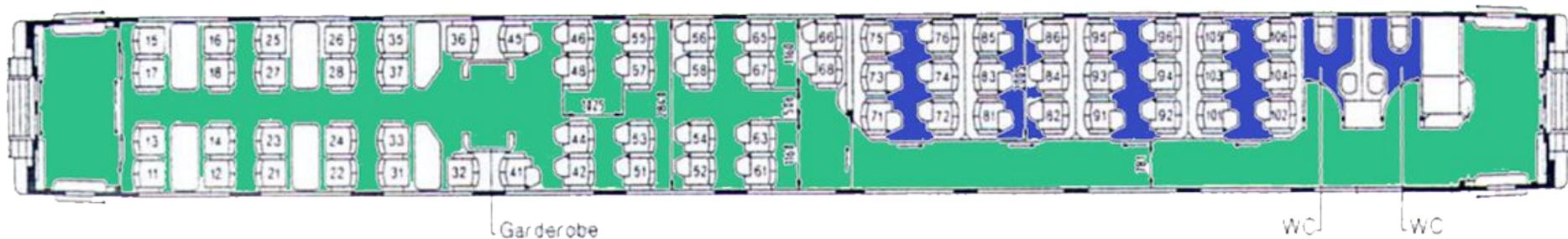
**Shadowing
problem:
INTERIORS**



**Shadowing
problem:
INTERIORS**



Shadowing problem:



The cluttering of equipment and furniture inside a passenger wagon poses many problems in applying the target value of UV radiation uniformly.

Certain spaces are further enclosed in separate cabins, requiring extra care by operators and posing a significant risk of human error.



Open common spaces

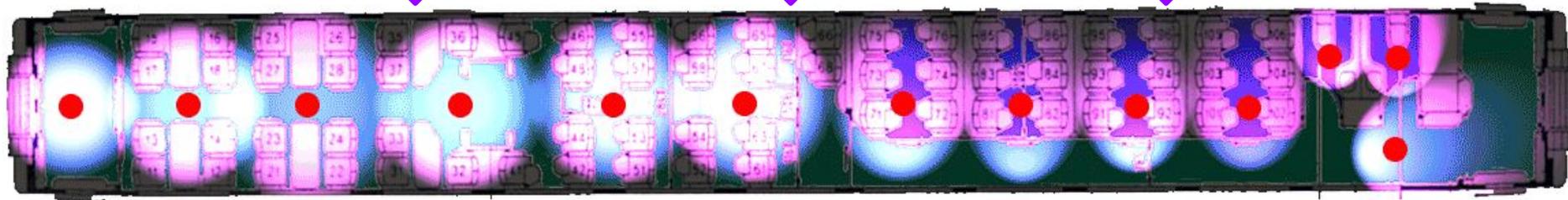
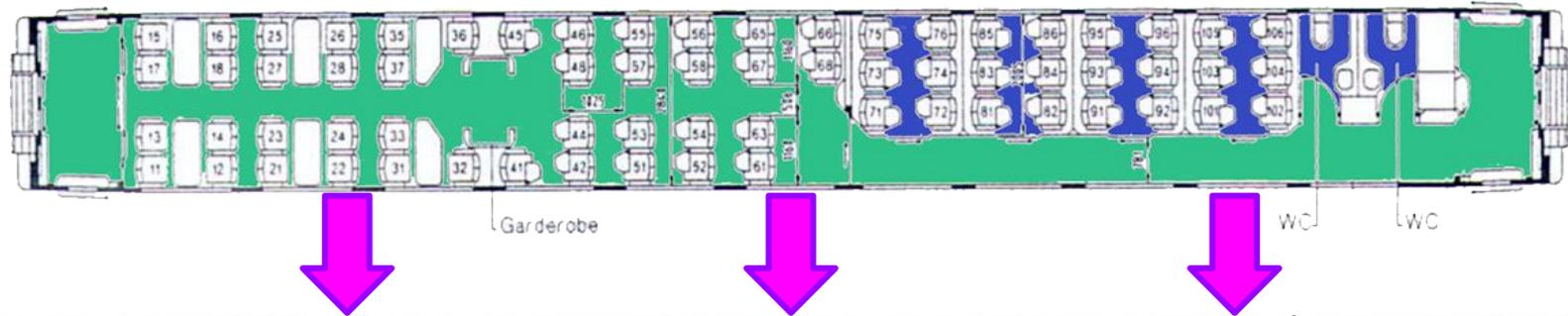


Enclosed spaces

Shadowing problem:

FIXED/POSITIONED LIGHT SOURCES

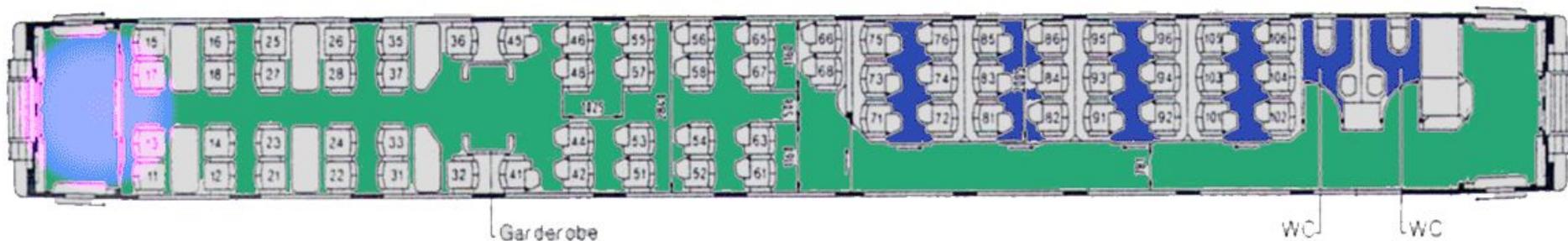
If fixed light sources are to be placed in order to conduct routine sanitation, more will be required in cluttered spaces for the system to be truly effective. Thus meaning longer time for placement and retrieval as well.



Shadowing problem:

MOBILE (AUTONOMOUS) LIGHT SOURCES

The desired level of efficacy in sanitation is best obtained by a robotized autonomous unit. Capable of top efficiency 24/7 and requiring minimum human exposure and work hours.



When humans are involved, a certain degree of latitude should be taken into account when applying solutions, both to make those efficient and to avoid a negative response as well, not always the stick works as well as the carrot...

your
PERFECT
PLANNING

human behaviour

HUMAN SIMULATION SIMUGENS- to apply the solution EXACTLY where it's needed

To achieve the maximum functionality we use a unique “human simulator” developed by D&T - SHRail software house, capable of encoding, simulating and predicting the most ephemeral and yet crucial factor in viral transmission: human behaviour in crowd dynamics. The movement of groups and individuals is then analysed to strategically place equipment and understand which areas are more at risk, saving any waste of efforts and allowing far better targeting of the solution.

