Epidemiology of

Infectious Diseases

Corona-virus 2019 (COVID-19)

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و

مرکز تحقیقات مدل سازی در سلامت /کمیته دانشگاهی اپیدمیولوژی کووید۱۹

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OUTLINE

❖ **Epidemiology**

❖ **Infectious disease epidemiology**

  ❖ **Infectious Disease/ Case definition for coronavirus disease 2019 (COVID-19)**

  ❖ **Severity of infections**

❖ **Modes of Disease Transmission**

❖ **Exposure to Infectious Agents**

❖ **Serial interval**

  ❖ **Epidemiologic Triad**

  ❖ **Factors Influencing Disease Transmission**

  ❖ **Reproductive Rate**

  ❖ **What determines R_0 ?**

  ❖ **Herd immunity, Sporadic, Endemic and Pandemic**

  ❖ **Epidemic Curve, Epidemic Control**

  ❖ **Epidemiology Status of COVID-19 in the World, WHO region and Iran**

  ❖ **Projection of COVID-19 in the World, WHO region and Iran**

Epidemiology

Epi Demio (Demos) Logy

The Study of the distribution and **determinants** of health related states and events in populations, and the application of this study to control health problems.

INFECTIOUS DISEASE PIDEMIOLOGY

Major Differences

- Ecological **Models**
- A case can also be an **exposure**
- **Subclinical** infections influence epidemiology
- **Contact** patterns play major role
- Immunity and herd **immunity**
- There is sometimes a need for **urgency**
- **Pandemic** & Epidemic, Endemic, Sporadic,
- The **Horror** and **fear** in community
- Political and social **pressure**

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What is *infectious disease epidemiology?*

- <u>Epidemiology</u>
- **Deals with one population** ➡
- **Risk ➜ case** ➡
- **Identifies causes** ➡

<u>**Infectious disease epidemiology**</u>
- ❖ **Two or more populations**
- ❖ **A case is a risk factor**
- ❖ **The cause often known**

اپیدمیولوژی علم مشاهده و مقایسه است.

بیماری های واگیر و غیرواگیر

What is *infectious disease epidemiology?*

Two or more populations

❖ **Humans**

➡ ❖ **Infectious agents**

  ❖ Helminths, bacteria, fungi, protozoa, **viruses**, prions

❖ **Vectors**

  ❖ Mosquito (protozoa-malaria), snails (helminths-schistosomiasis)
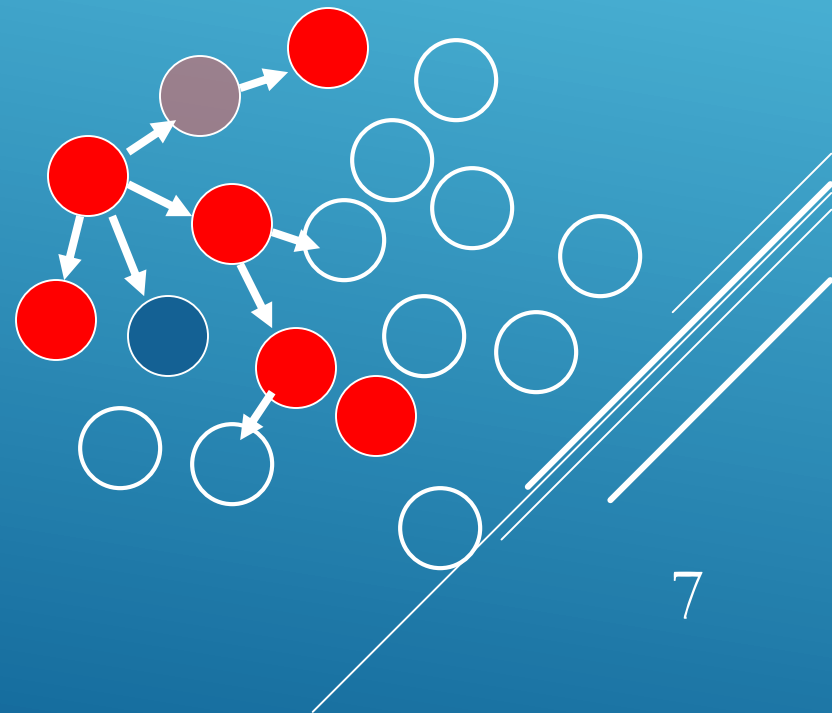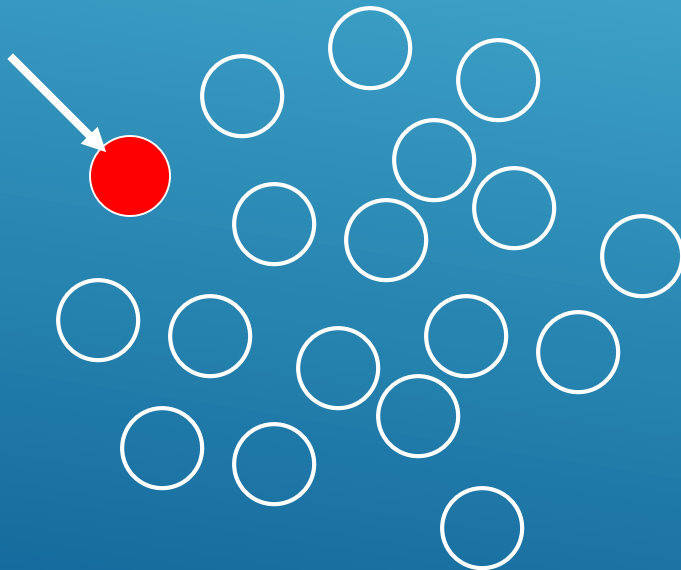
❖ **Animals**

  ❖ Dogs and sheep/goats – *Echinococcus*

  ❖ Mice and ticks – *Borrelia*

What is *infectious disease epidemiology?*

A case is a risk factor …

❖ **Infection in one person can be transmitted to others**

Coronaviruses are important human and animal pathogens. At the end of 2019, a novel coronavirus was identified as the cause of a **cluster of pneumonia cases in Wuhan**, a city in the Hubei Province of China. It rapidly spread, resulting in an epidemic throughout China, followed by an increasing number of cases in other countries throughout the world. In **February 2020**, the World Health Organization designated the disease COVID-19, which stands for coronavirus disease 2019.

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Case definition for coronavirus disease 2019 (COVID-19)

❖ Clinical criteria

Any person with at least one of the following symptoms: cough, fever, shortness of breath, sudden onset of anosmia, ageusia or dysgeusia

❖Diagnostic imaging criteria

Radiological evidence showing lesions compatible with COVID-19

❖Laboratory criteria

Detection of SARS-CoV-2 nucleic acid in a clinical specimen: PCR+

❖ Epidemiological criteria

At least one of the following two epidemiological links:

close contact with a confirmed COVID-19 case in the 14 days prior to onset of symptoms

having been a resident or a staff member, in the 14 days prior to onset of symptoms, in a residential institution for vulnerable people where ongoing COVID-19 transmission has been confirmed

❖Case classification

1.Possible case: Any person meeting the clinical criteria

2.Probable case:
Any person meeting the clinical criteria with an epidemiological link
OR
Any person meeting the diagnostic criteria

3.Confirmed case: Any person meeting the laboratory criteria

What is *infectious disease epidemiology?*

The cause often known

➡ ❖ **An infectious agent is a necessary cause**

What is infectious disease epidemiology then used for?

❖ **Identification of causes of new, emerging infections, e.g. HIV, vCJD (Variant Creutzfeldt–Jakob disease), SARS, MERS, Coronaviruses (CoV) are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). A novel coronavirus (nCoV) is a new strain that has not been previously identified in humans. COVID-19**

❖ **Surveillence of infectious disease**

❖ **Identification of source of outbreaks**

❖ **Studies of routes of transmission and natural history of infections**

❖ **Identification of new interventions**

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Infectious Disease
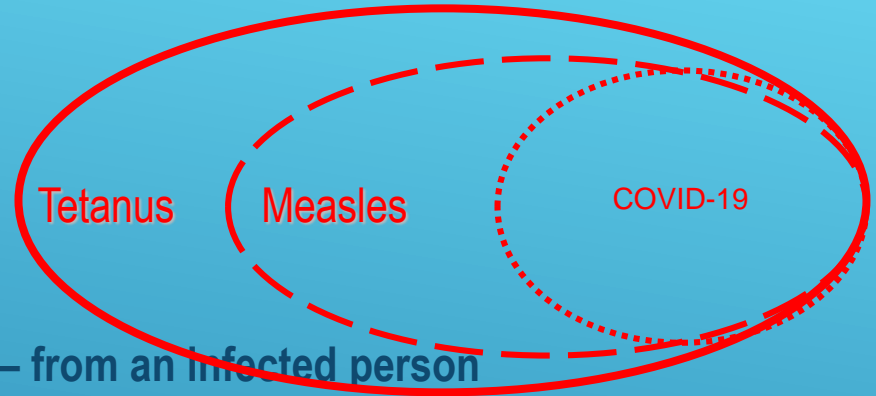
Definitions

❖ **Infectious diseases**

    ❖ **Caused by an infectious agent**

❖ **Communicable diseases**

    ❖ **Transmission – directly or indirectly – from an infected person**

❖ **Transmissible diseases**

    ❖ **Transmission – through unnatural routes – from an infected person**

Note

❖ Infections are often subclinical – infections **vs** infectious diseases!

❖ Antonyms not well-defined

    ❖ Non-communicable diseases – virus involved in pathogenesis of diabetes?

    ❖ Chronic diseases – HIV?

Tetanus   Measles   COVID-19

Severity of infections

Covid-19

Severe or critical illness :2.5% to 5%

Tuberculosis

Measles

Rabies
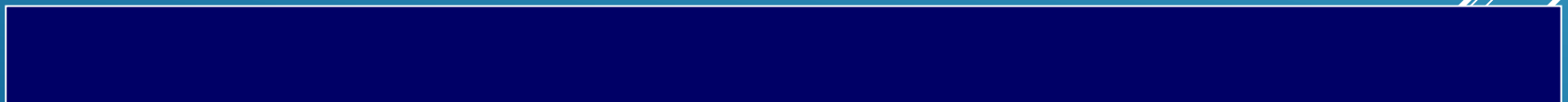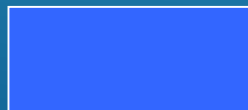
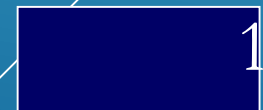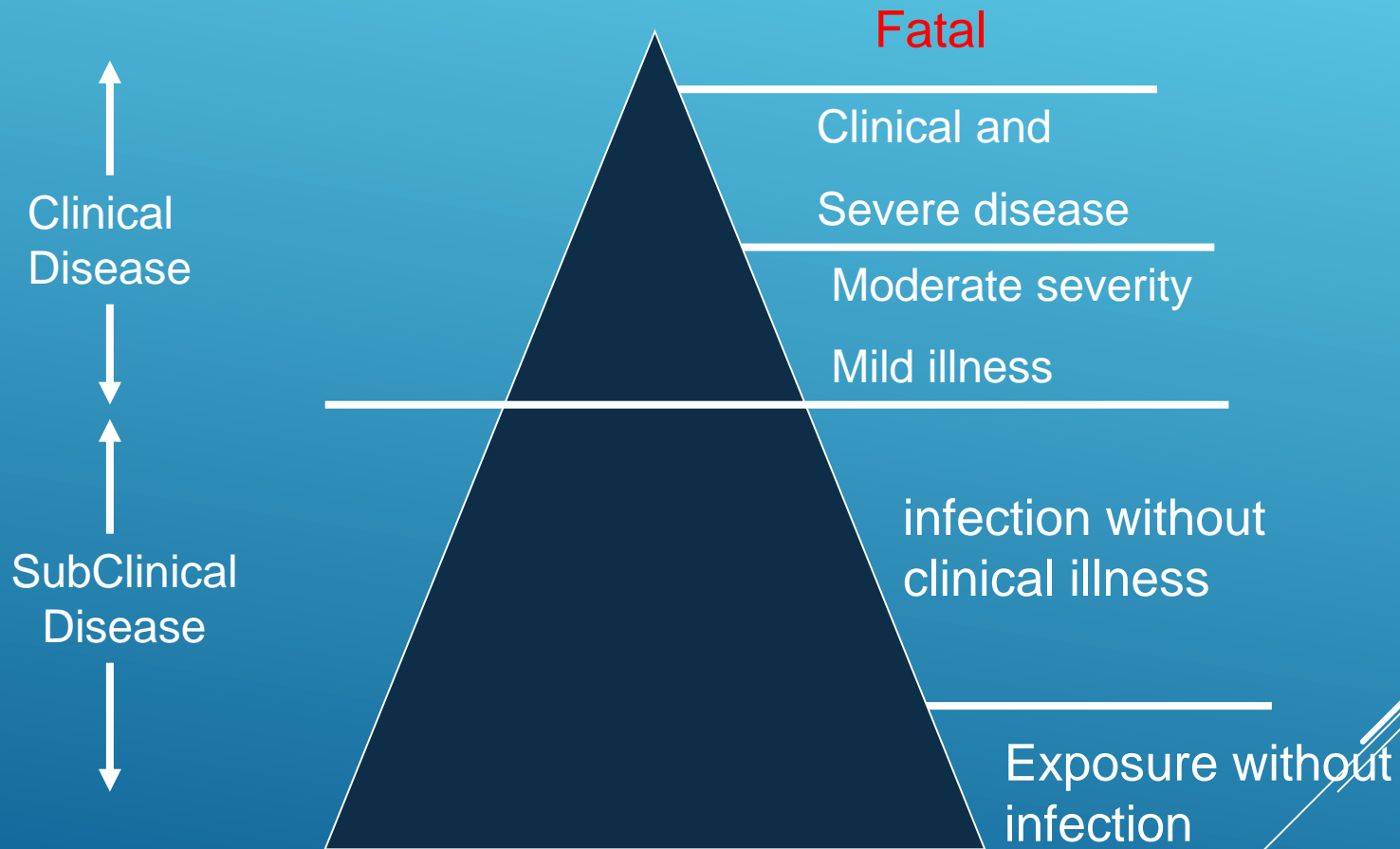| inapparent | mild | moderate | severe | fatal |

Iceberg Concept of Infection

Fatal

Clinical and

Severe disease

Moderate severity

Mild illness

infection without clinical illness

Exposure without infection

Clinical Disease

SubClinical Disease

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Modes of Disease Transmission

Direct

- ❖ Skin-skin
  - ❖ Herpes type 1
- ❖ Mucous-mucous
  - ❖ STI
- ❖ Across placenta
  - ❖ toxoplasmosis
- ❖ Through breast milk
  - ❖ HIV
- ❖ Sneeze-cough
  - ❖ Influenza
  - ❖ **COVID-19**

Respiratory droplets remain on surfaces and people may be infected with the virus by touching contaminated surfaces and then touching their eyes, nose, or mouth.

Indirect:

A. Vheicle Transmission
- ❖ Food-borne
  - ❖ Salmonella
- ❖ Water-borne
  - ❖ Hepatitis A
- ❖ Air-borne
  - ❖ Chickenpox , Ting-borne
  - ❖ Scarlatina
  - ❖ **COVID-19**

B. Vector Transmission
- ❖ Mecanical (on insect bodies)
  - ❖ Thrachoma
- ❖ Biological
  - ❖ Malaria

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Transmission — Understanding of the transmission risk is **incomplete**. Epidemiologic investigation in Wuhan at the beginning of the outbreak identified an initial association with a **seafood market** that **sold live animals**, where most patients had worked or visited and which was subsequently closed for disinfection. However, as the outbreak progressed, **person-to-person** spread became the main mode of transmission.

Person-to-person

SARS-CoV-2 can also be transmitted through the **airborne route** (through inhalation of **particles smaller than droplets that remain in the air over time and distance**), but the extent to which this mode of transmission has contributed to the pandemic is controversial.

SARS-CoV-2 has been detected in **non-respiratory specimens**, including **stool, blood, ocular secretions, and semen**, but the role of these sites in transmission is **uncertain.**
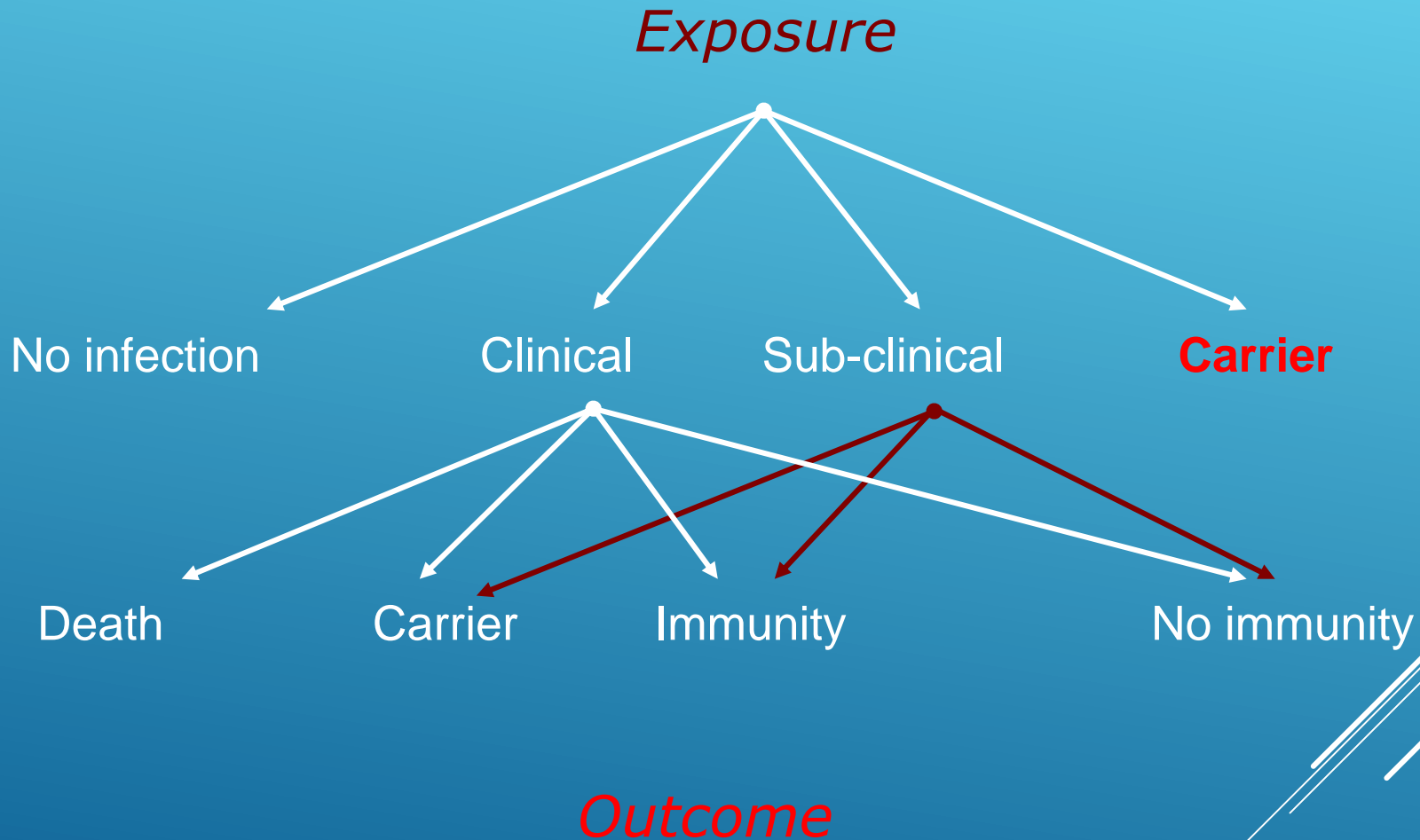
WHO-China report, transmission through the **fecal-oral route did not** appear to be a significant factor in the spread of infection .

There is also **no evidence** that SARS-CoV-2 can be transmitted through contact with **non-mucous membrane sites** (eg, abraded skin).

Transmission can occur despite the absence of symptoms.
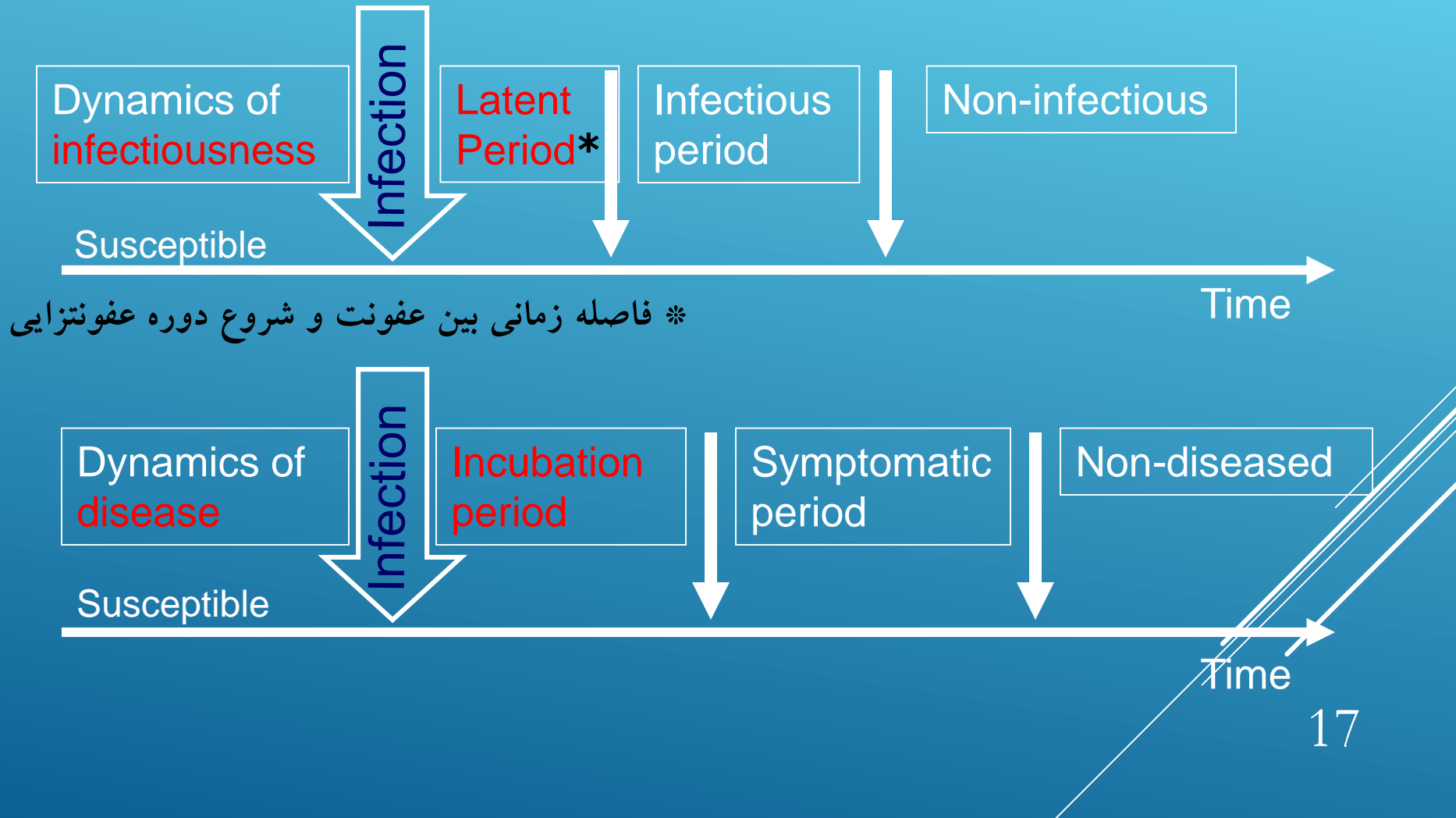
Risk of transmission depends on exposure type —type and duration of exposure: household contacts, health care settings(OR=3.4), social or work gatherings, Traveling, **Environmental contamination** (surfaces for up to six to nine days without disinfection),
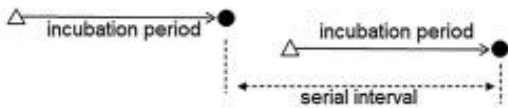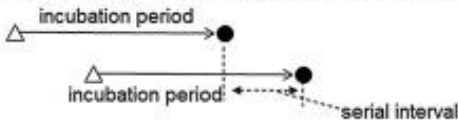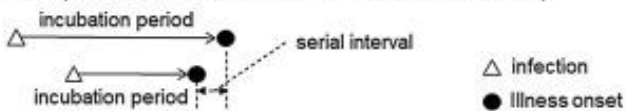
Exposure

No infection   Clinical   Sub-clinical   **Carrier**

Death   Carrier   Immunity   No immunity

Outcome

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Timeline for Infection

Dynamics of **infectiousness**

Infection

Latent Period*

Infectious period

Non-infectious

Susceptible

Time

٭ فاصله زمانی بین عفونت و شروع دوره عفونتزایی

Dynamics of **disease**

Infection

Incubation period

Symptomatic period

Non-diseased

Susceptible

Time

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Serial interval

median serial interval at 4.0 days (95% credible interval [CrI]: 3.1, 4.9).

Symptomatic transmission (incubation period ≤ serial interval)
incubation period — serial interval

Pre-symptomatic transmission (incubation period > serial interval & serial interval > 0)
incubation period — serial interval

Pre-symptomatic transmission (incubation period > serial interval & serial interval ≤ 0)
incubation period — serial interval
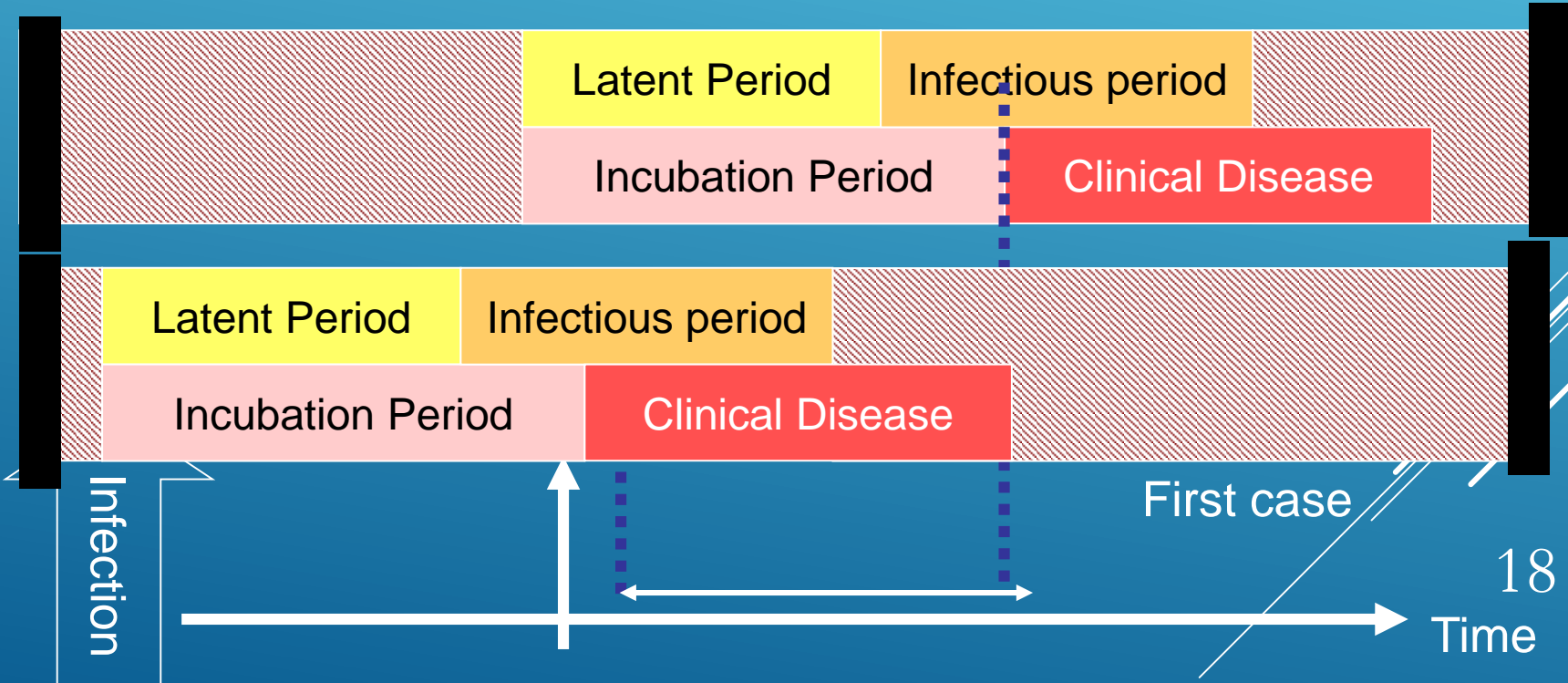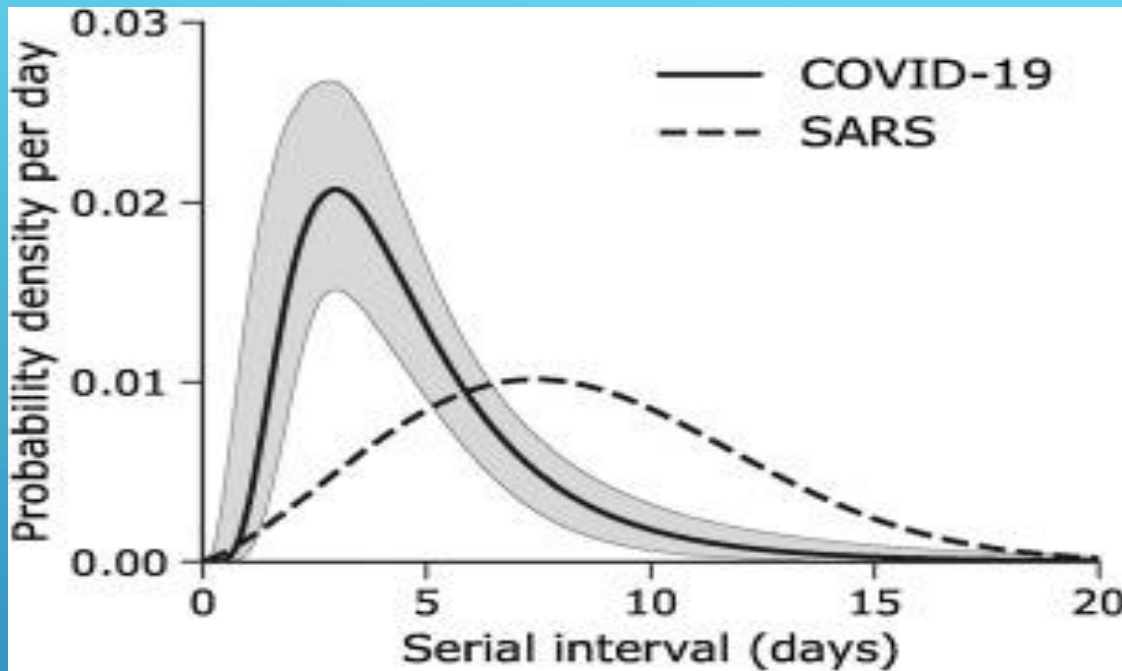
△ infection
● Illness onset

Time

Second case

Latent Period | Infectious period
Incubation Period | Clinical Disease

Latent Period | Infectious period
Incubation Period | Clinical Disease

First case

Infection

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Time

The incubation period of COVID-19, which is the time between exposure to the virus and symptom onset, is on average 5-6 days, but can be as long as 14 days. Thus, quarantine should be in place for 14 days from the last exposure to a confirmed case.

 The estimated median incubation period was 7.76 days [95% confidence interval (CI): 7.02 to 8.53], and the 90th percentile was 14.28 days (95% CI: 13.64 to 14.90). By including the possibility that a small portion of patients may contract the disease on their way out of Wuhan, the estimated probability that the incubation period is longer than 14 days was between 5 and 10%.

Person-to-Person Transmission

Cases

- ❖ **Index** – the first case identified
- ❖ **Primary** – the case that brings the infection into a population
- ❖ **Secondary** – infected by a primary case
- ❖ **Tertiary** – infected by a secondary case

Susceptible

Immune

Sub-clinical

Clinical
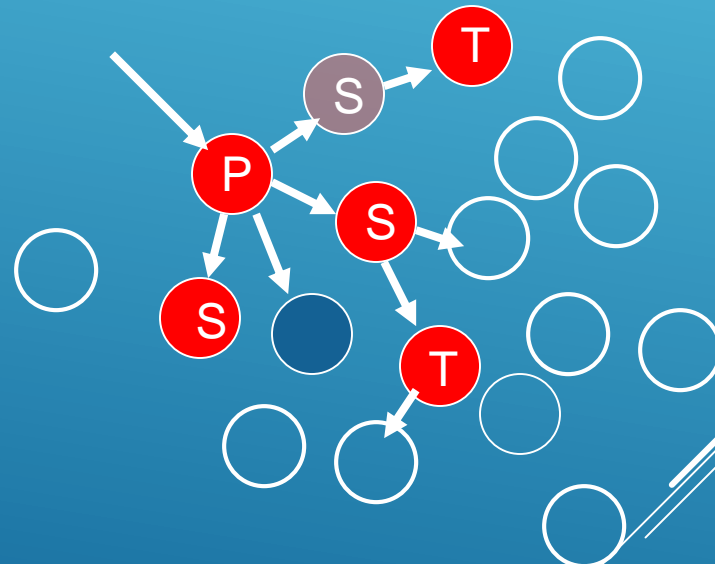
Person-to-Person Transmission

Attack rate = $\dfrac{\text{ill}}{\text{exposed}}$

Data from Dr. Simpson's studies in England (1952)

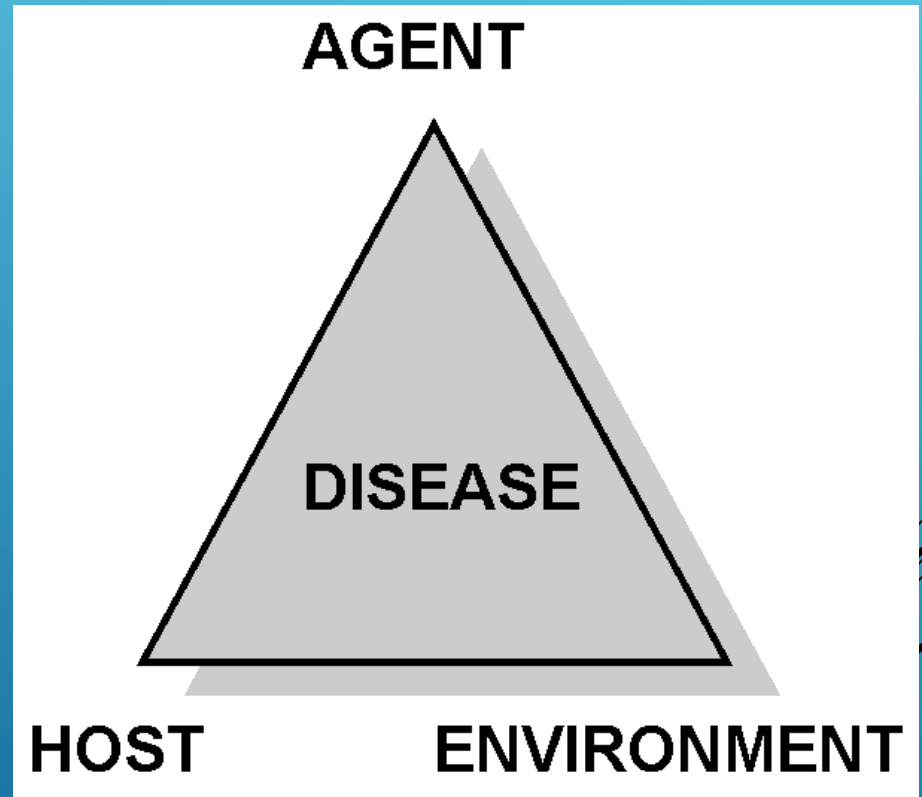|	Measles	Chickenpox	Rubella
Children exposed	251	238	218
Children ill	201	172	82
attack rate	0.80	0.72	0.38

Note:

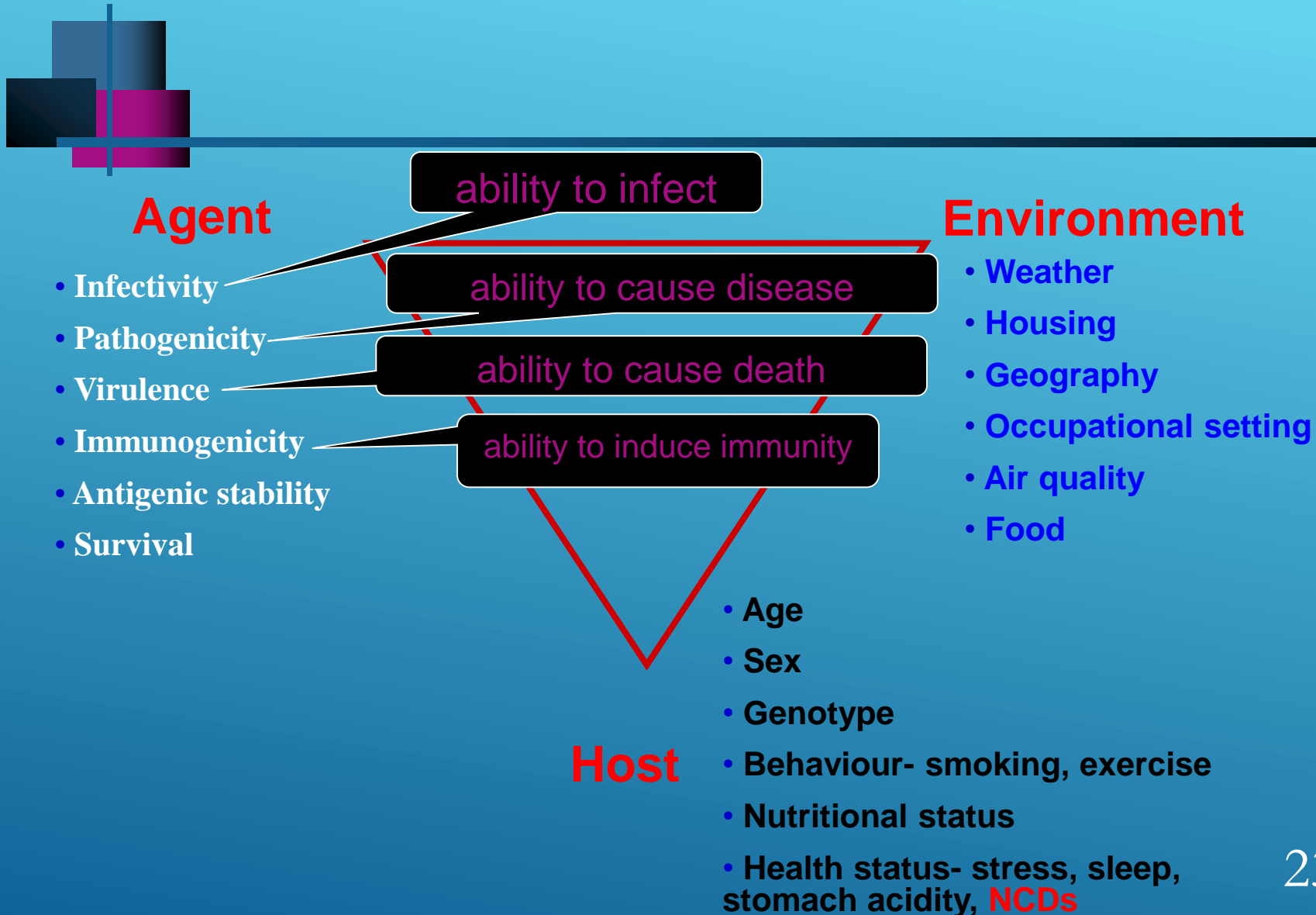- The attack rate is useful for comparing the risk of disease in groups with different exposures.

Epidemiologic Triad

Disease is the result of forces within a dynamic system consisting of:

◈   agent of infection
◈   host
◈   environment

AGENT

DISEASE

HOST   ENVIRONMENT

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Factors Influencing Disease Transmission

Agent

- **Infectivity**
- **Pathogenicity**
- **Virulence**
- **Immunogenicity**
- **Antigenic stability**
- **Survival**

ability to infect

ability to cause disease

ability to cause death

ability to induce immunity

Environment

- **Weather**
- **Housing**
- **Geography**
- **Occupational setting**
- **Air quality**
- **Food**

Host

- **Age**
- **Sex**
- **Genotype**
- **Behaviour- smoking, exercise**
- **Nutritional status**
- **Health status- stress, sleep, stomach acidity, NCDs**

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Infectious Agents

Bacteria

Viruses

Fungi

Protoctists / Protozoa

Helminths

Vectors   Carrier

A host that **carries** a pathogen without injury to itself and spreads the pathogen to susceptible organisms

(asymptomatic carriers of pathogens)

Reservoirs

A host that carries a pathogen without injury to itself and serves as a source of infection for other host organisms

(asymptomatic infective carriers)

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Reservoirs

Humans

{hepatitis, COVID-19}

Other Vertebrates

{zoonosis}

Birds & **Bats**

{histoplasmosis}

Covid-19

NOT vectors

در محاسبه میزان کشندگی بیماری در یک اپیدمی باید به چند نکته توجه داشت:

۱- ممکن است محاسبه و گزارش این میزان در ابتدای اپیدمی بالا باشد. بنابراین بایستی صبر نمود و تمام بیماران را بعنوان مخرج کسر حساب کرد. صورت کسر موارد فوت در بین مبتلایان مخرج کسر است.

۲- عفونت / بیماری (مخرج کسر؟)

۳-نسبت کشندگی در جامعه/ بیمارستان/ بخش مراقبت ویژه/

۴- در ایران، به دلیل گزارش روزانه موارد قطعی کوید ۱۹ و استفاده از آنها در مخرج کسر این شاخص، درصد کشندگی به ظاهر بالاست که در تفسیر ان باید دقت نمود. بالا بودن این شاخص کاذب است. متفاوت بودن این شاخص در روزهای متعدد بیانگر غیرواقعی بودن آن است. بنابراین در محاسبه آن باید تمام بیماران را از ابتدا تا انتها پیگیری نمود و پیامد همه را در نظر داشت.

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Reproductive Rate

A measure of the potential for transmission: *The basic reproductive number*, R_0, the mean number of individuals directly infected by *an infectious case* through the total infectious period, when introduced to a susceptible population.

متوسط تعداد افرادی است که وقتی مورد عفونی به یک جمعیت کاملا حساس وارد میشود، بطور مستقیم بوسیله مورد عفونی در خلال دوره واگیری آن، آلوده میشود.
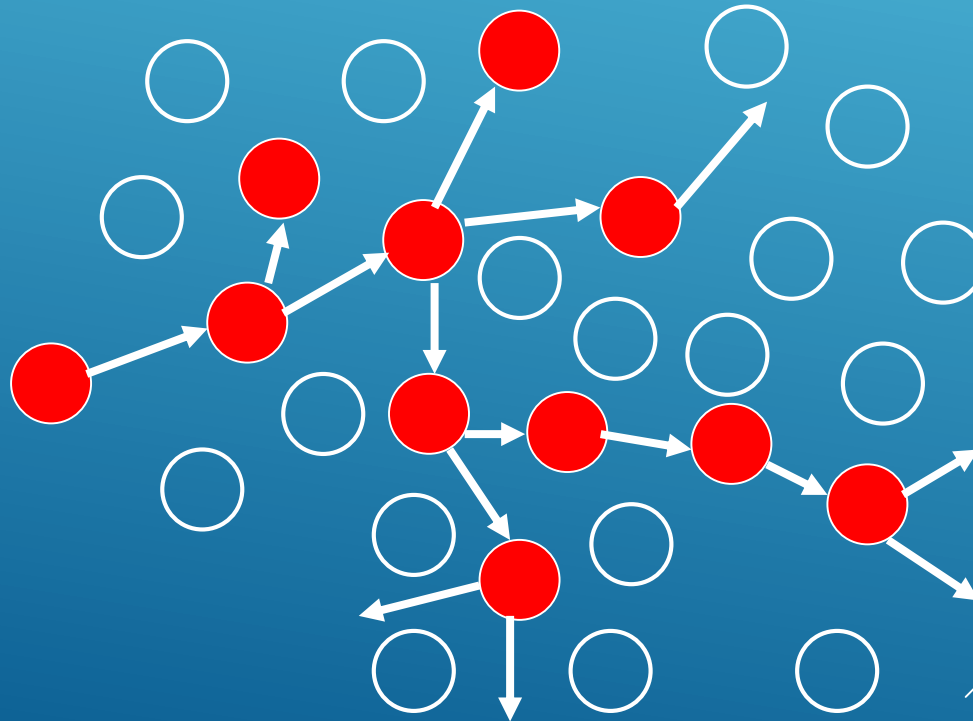
SUSCEPTIBLE POPULATION

اگر بیماری بصورتی باشد که پس از عفونت در فرد ایجاد ایمنی پایدار کند، تعداد افراد مظنون (حساس) در جمعیت در طی زمان کاهش خواهد یافت و تماس های فرد عفونی افزایش یافته و بیشتر با کسانی خواهد بود که قبلا ایمنی پیدا کرده اند. بنابراین مقدار واقعی مولد با وجود گسترش عفونت کم میشود اما روی میزان مولد پایه تاثیری نمی گذارد.

Basic Reproductive Rate, R_0

$$R_0 = \frac{1+2+0+3+0+1+2+1+1+2+2}{10} = 1.5$$
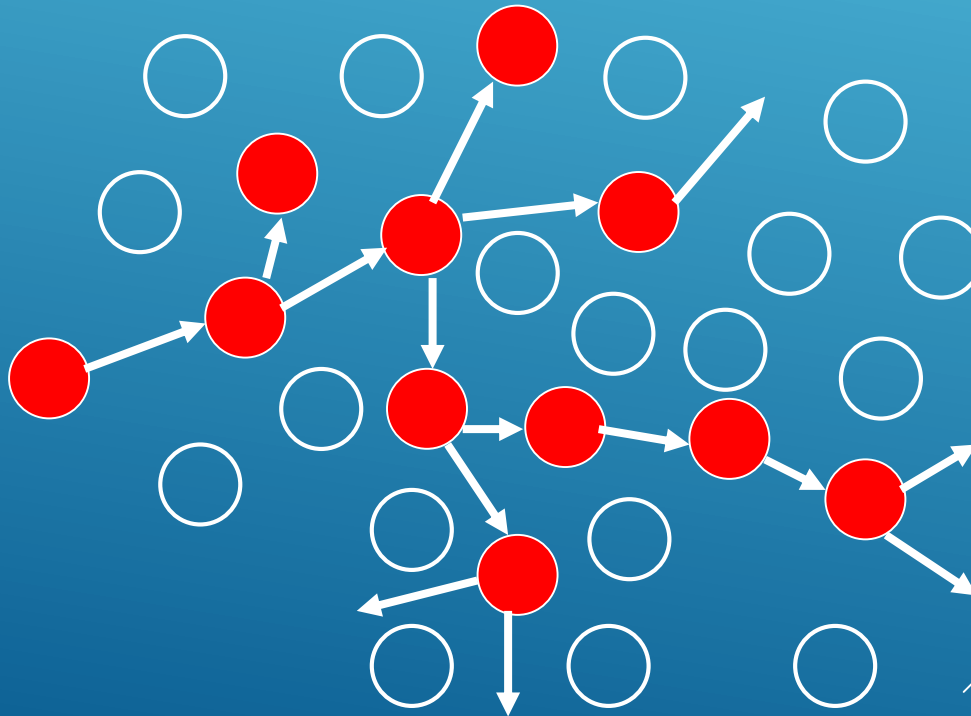
Basic Reproductive Rate, R_0

- If $R_0 < 1$ then infection cannot invade a population
  - **implications**: infection control mechanisms unnecessary (therefore not **cost-effective**)

- If $R_0 > 1$ then (on average) the pathogen will invade that population
  - **implications**: control measure necessary to prevent (delay) an epidemic

  - زمانی که همه گیری در راه است، میزان مولد حاضر بطور معمول با **R** نمایش داده میشود. باید اقداماتی شود تا مقدار **R** به کمتر از ۱ برسد.

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What determines R_0 ?

probability of transmission per contact

$$R_0 = p \cdot c \cdot d$$

duration of infectiousness

contacts per unit time

Use in COVID-19 Control :

p masking,

c health education, negotiating skills

D case ascertainment (screening,partner notification), treatment, compliance, health seeking, behaviour, accessibility of services

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Nonpharmaceutical interventions (NPIs):
isolating patients, handwashing,
staying at home, cancellation of mass
gatherings, working at home,
social distance, avoiding suspicious
individuals, quarantine of exposed persons,
travel restrictions,
school and workplace closures.

What is R_0 for COVID-19?

THE REPRODUCTIVE NUMBER R_0 OF BASED ON ESTIMATE OF A STATISTICAL TIME DELAY DYNAMICAL SYSTEM

the growth rate r of COVID-19 is almost in $[0.30, 0.32]$ which is larger than the growth rate 0.1 estimated by CCDC [9], and the reproductive number R_0 of COVID-19 is estimated by

$$3.25 \leq R_0 \leq 3.4 \text{ if we simply use } R = 1 + r * T_c \text{ with } T_c = 7.5$$
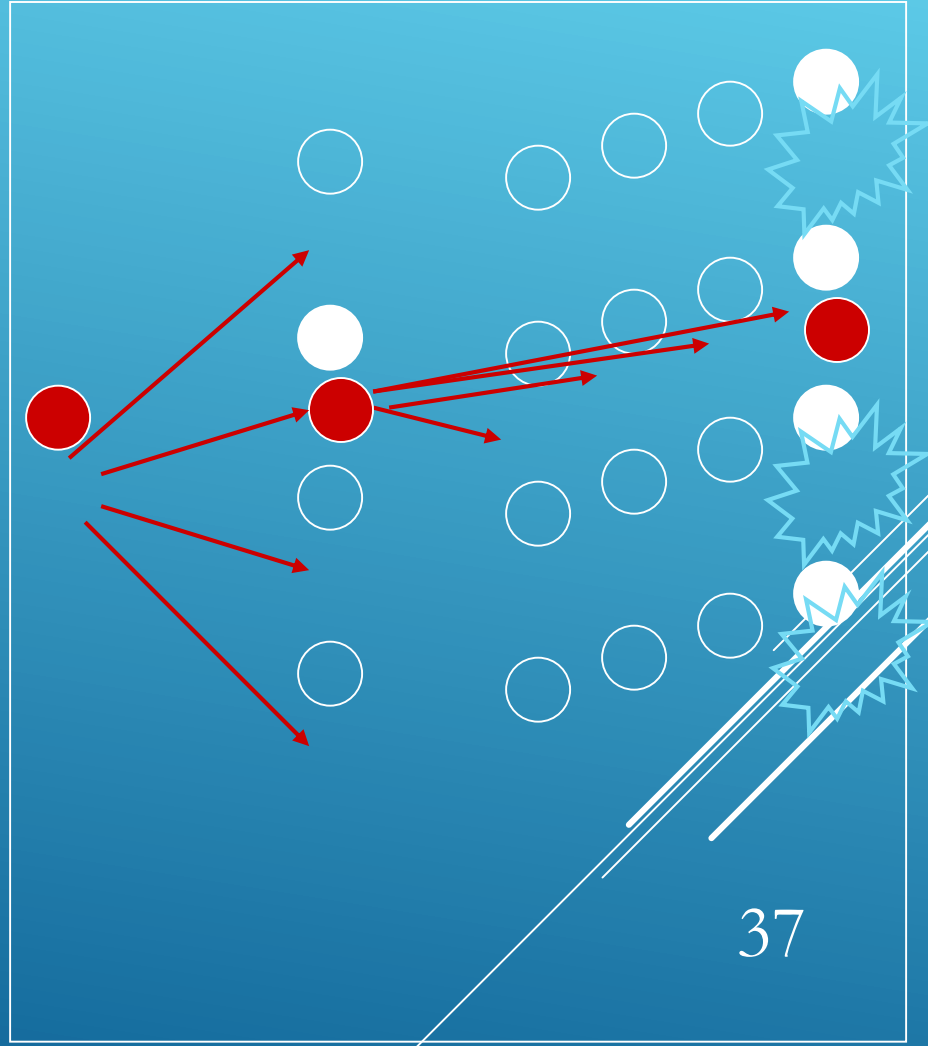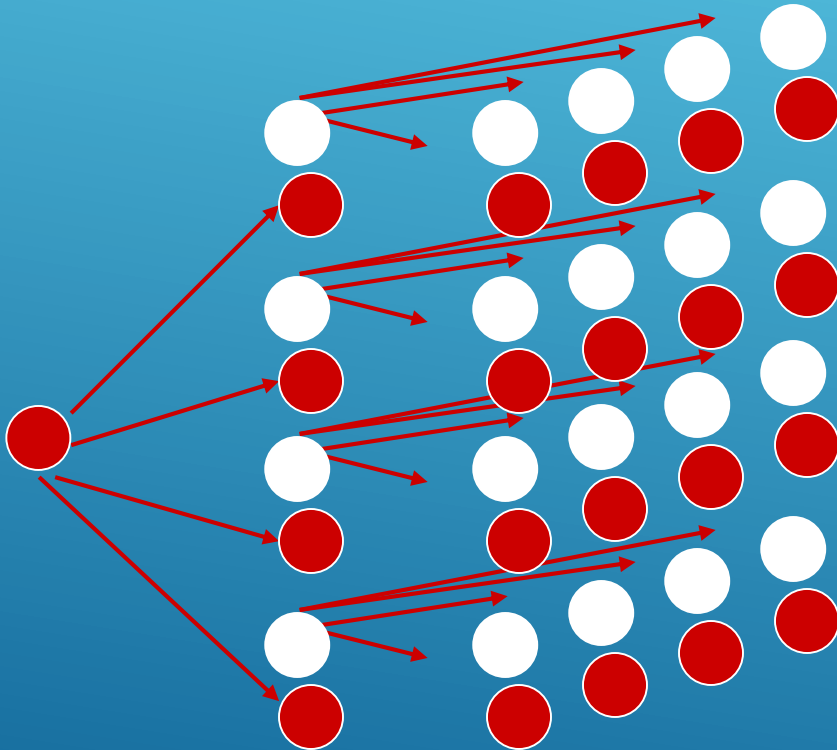
which is bigger than that of SARS.

در کووید ۱۹. بطور متوسط ۳ تا ۴ تخمین زده شد.

منبع:
https://www.medrxiv.org/content/10.1101/2020.02.17.20023747v2

Basic reproduction number, R_0
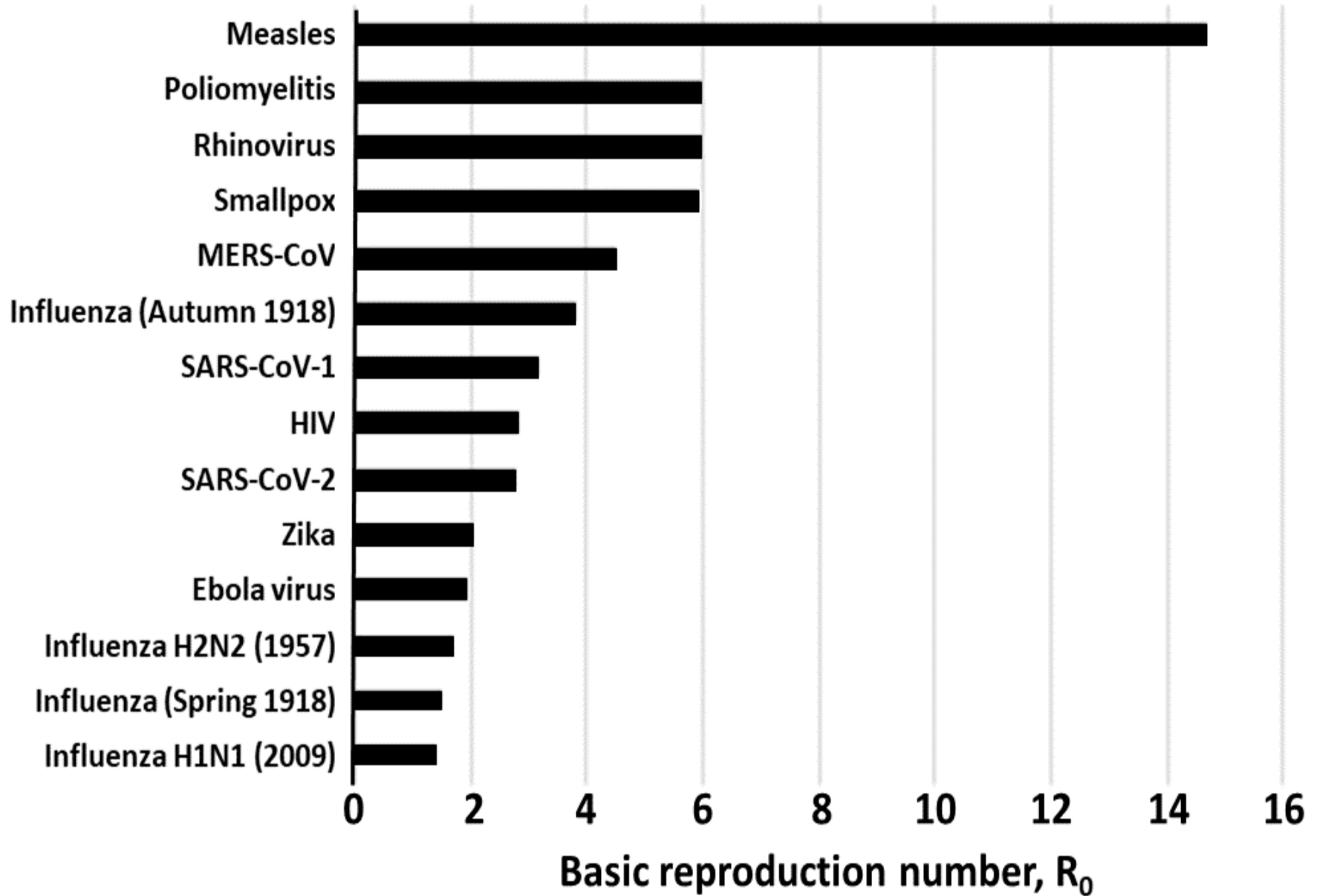
Herd immunity

The resistance of a group to an attack by a disease to which a large proportion of the members of the group are immune.

Herd immunity

$1- 1/R_0$ is also defined as fraction of the population to be vaccinated for getting herd immunity.

If R_0 is 2.5 then $1/R_0$ is 0.4, i.e., for control of the disease less than 0.4 fraction of the population be susceptible or more than 60% be non-susceptible or immune. Vaccination policy: if proportion of susceptible individuals is reduced to below $1/R_o$ the disease can be control. if R0 = 5 then **vaccine coverage** will have to be in excess of 80%.

HERD IMMUNITY ⬜ The term herd immunity was first used in 1923. ⬜ It was an integral part During the Small Pox eradication in the 1960s and 1970s
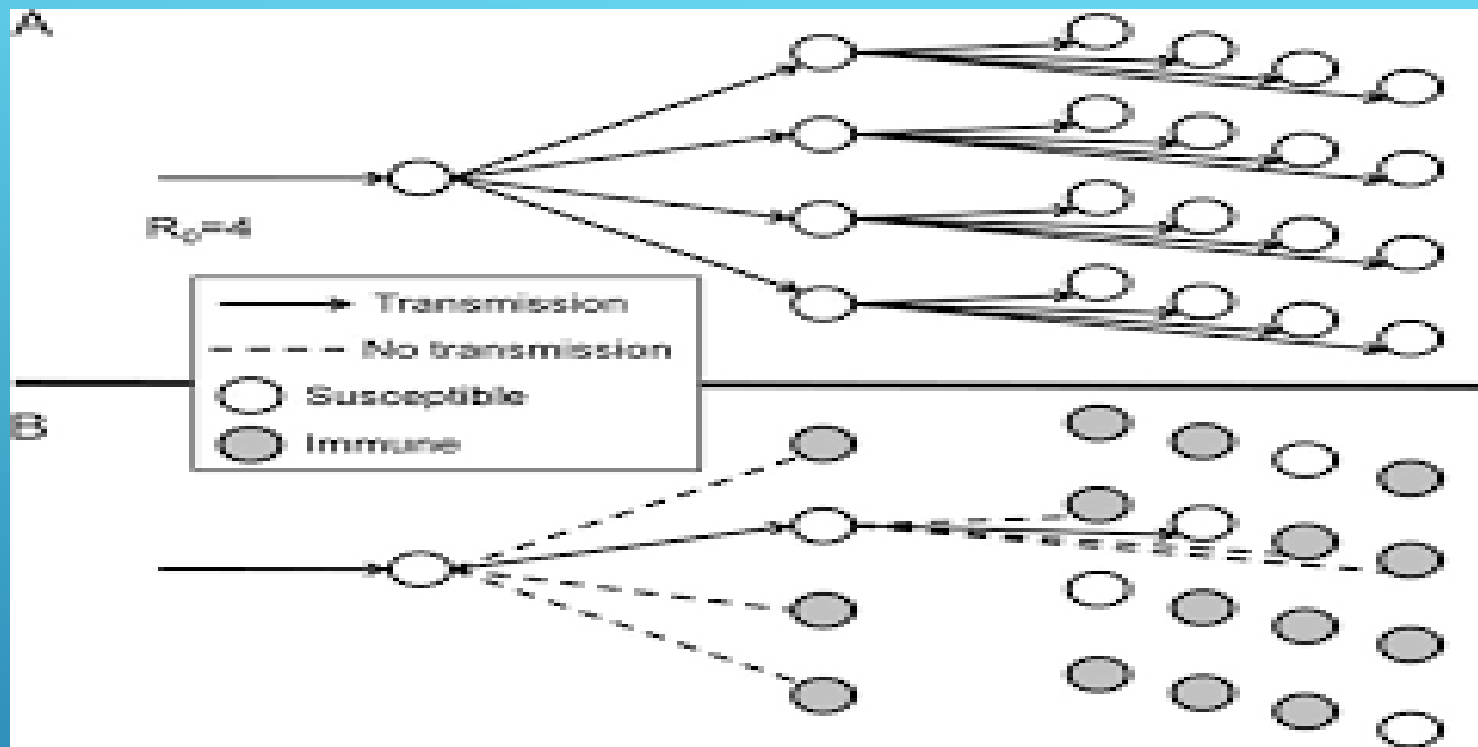
$V_C = 1 - 1/R_0 = 67\%.$

Figure 1. Diagram illustrating transmission of an infection with a basic reproduction number $R_0 = 4$ (see Table 1). A, Transmission over 3 generations after introduction into a totally susceptible population (1 case would lead to 4 cases and then to 16 cases). B, Expected transmissions if $(R_0 - 1)/R_0 = 1 - 1/R_0 = 3/4$ of the population is immune. Under this circumstance, all but 1 of the contacts for each case s immune, and so each case leads to only 1 successful transmission of the infection. This implies constant incidence over time. If a greater proportion are immune, then incidence will decline. On this basis, $(R_0 - 1)/R_0$ is known as the ``herd immunity threshold.''
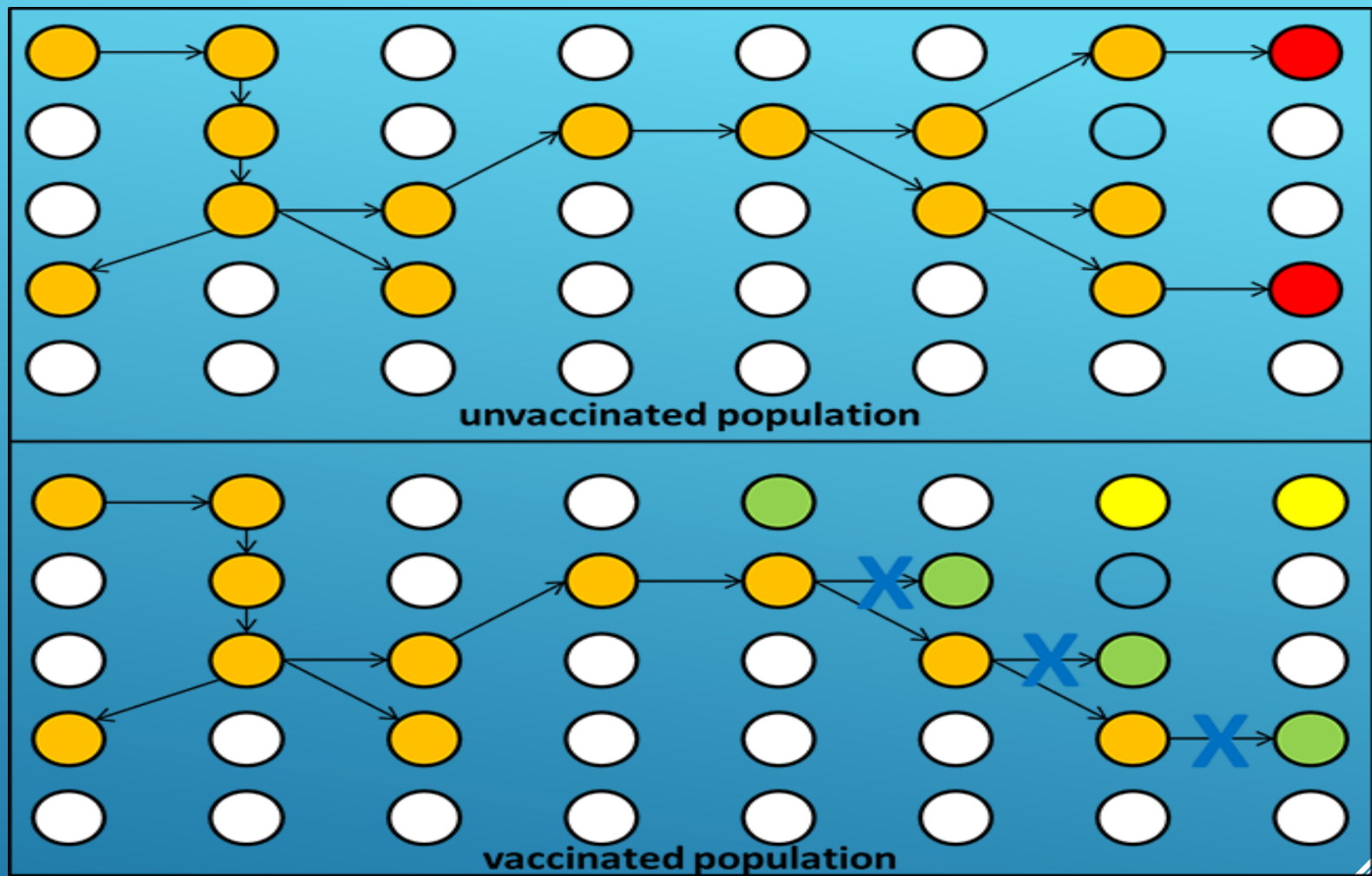
People are shown as circles. Infectious agents (germs) spread between the people in orange, although they do not get severe disease. When the infection reaches people who are highly susceptible (red) they get the disease and can be very sick or die.

In the lower panel, the people in green have been vaccinated. This now protects those in yellow as well, who had previously got the infection and possibly the disease. Although the figure only shows a few people being vaccinated, in reality many people have to be vaccinated for herd immunity to work.
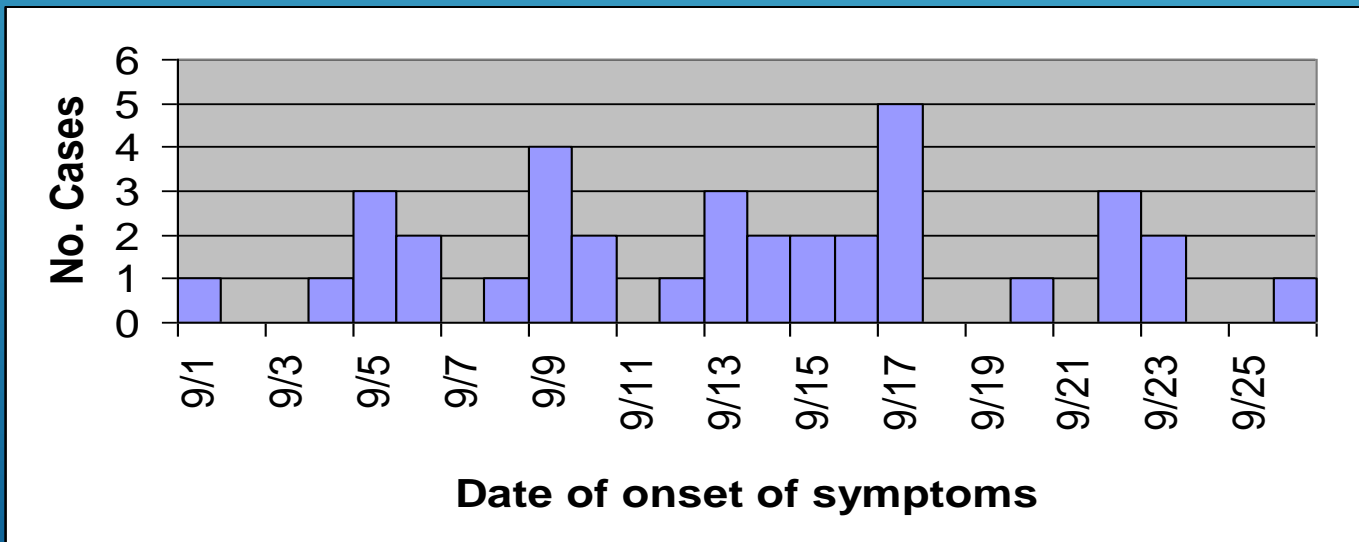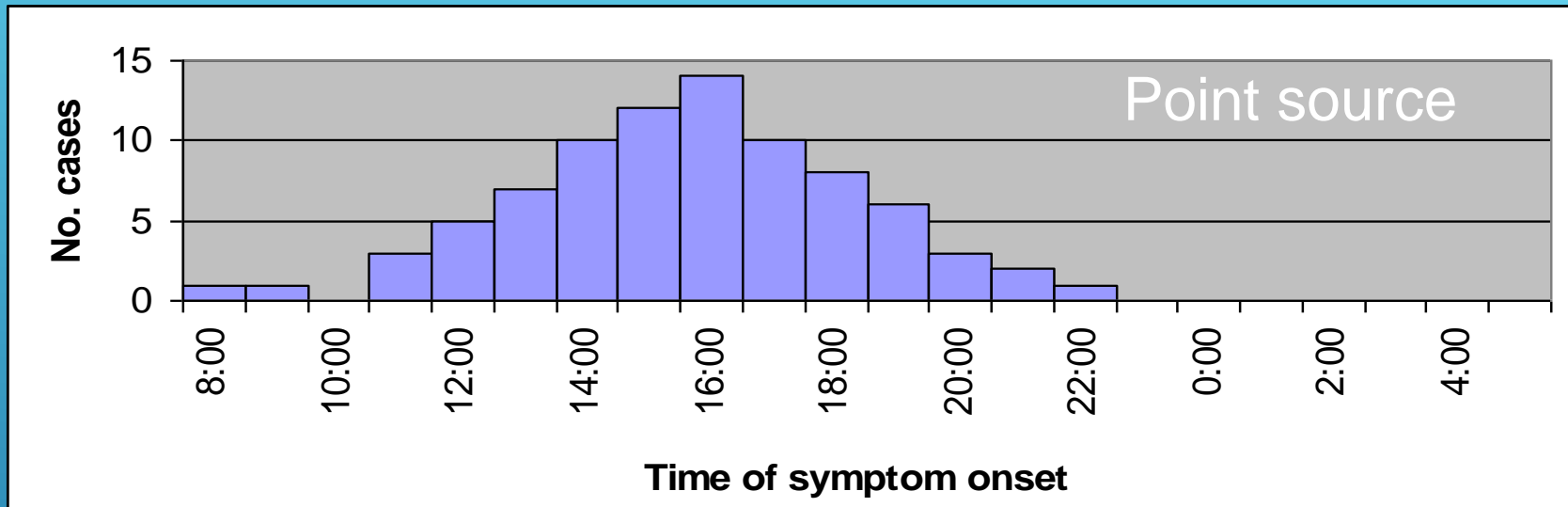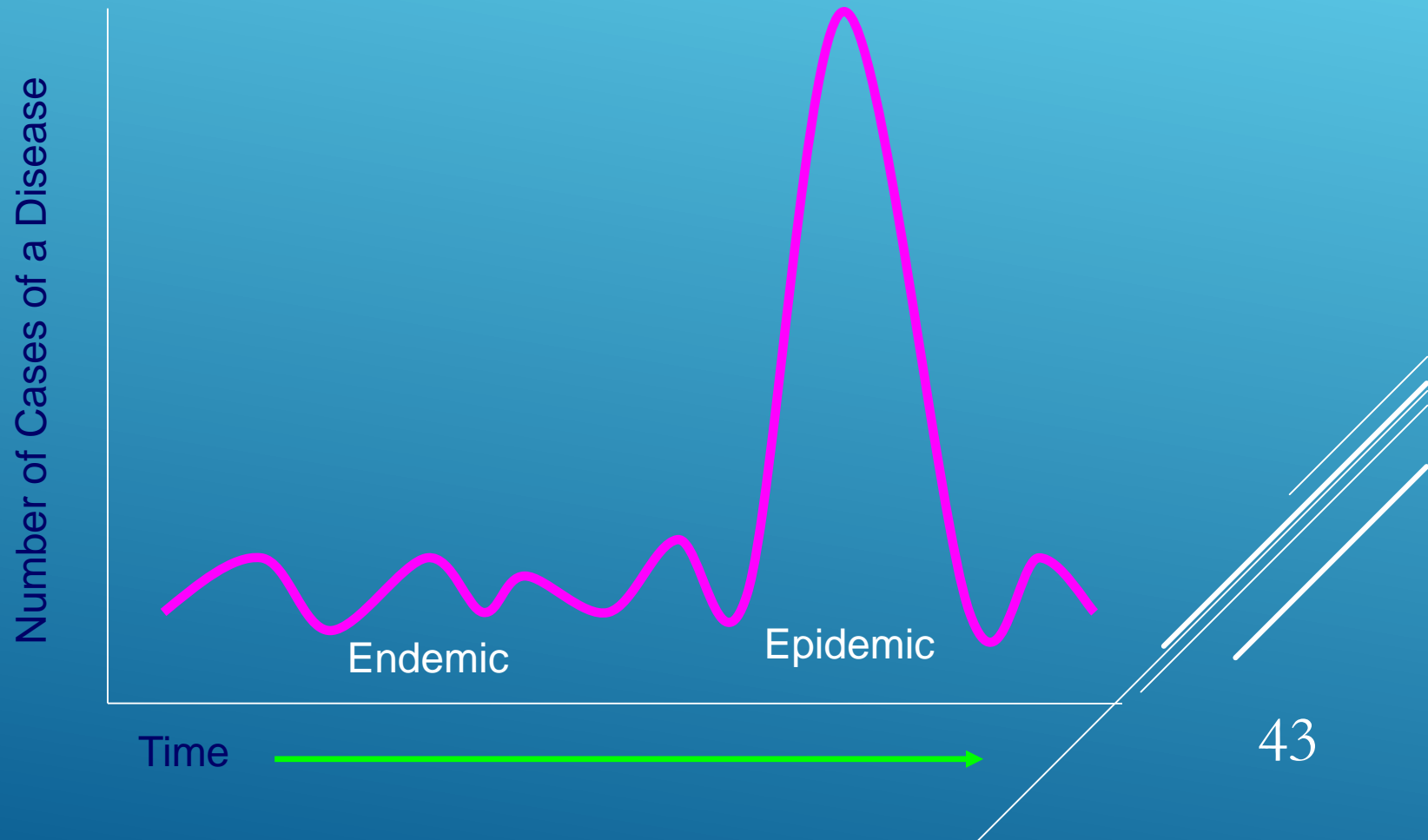
EPIDEMIC CURVE

- Represent cases over time by a histogram
- Horizontal axis: time
  - Date of exposure
  - Date of symptom onset
  - Date of diagnosis
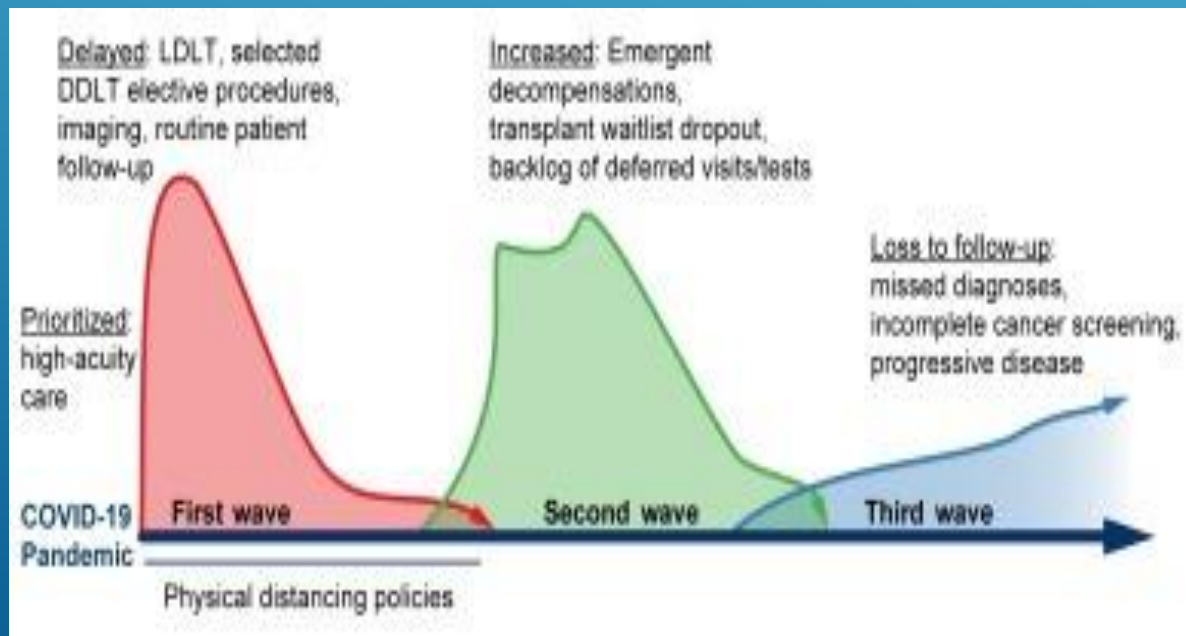- Vertical axis: number of cases
- Clues to nature of outbreak

Number

Time

Exposure
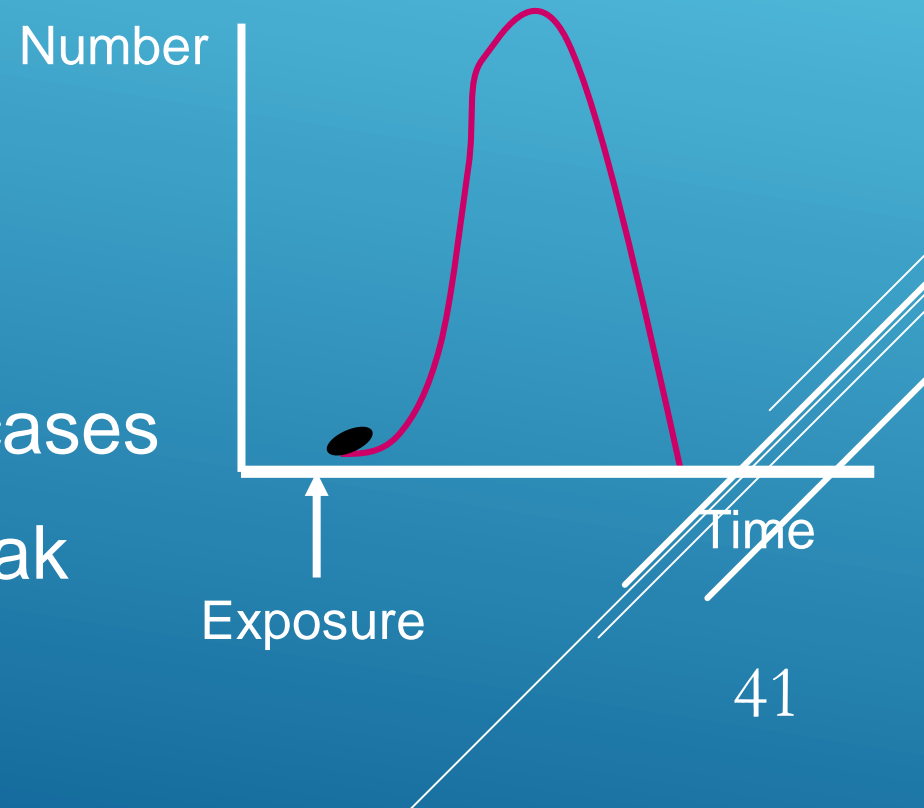
EPIDEMIC CURVE

Endemic vs Epidemic, Wave/Peak

Number of Cases of a Disease

Endemic

Epidemic

Time

Number of COVID-19 cases in HK

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Transmission status at national or sub-national level

No cases: Countries/area/territories with no cases
Sporadic cases: Countries/area/territories with 1 or more cases, imported or locally detected
Clusters of cases: Countries/area/territories experiencing cases clustered in time, geographic location and/or common exposure
Community transmission: Countries/area/territories experiencing larger outbreaks of local transmission defined through an assessment of factors including, but not limited to:
•Large numbers of cases not linked to transmission chains
•High proportion of SARS-CoV-2 positive cases from sentinel lab surveillance
•Multiple unrelated clusters in several areas of the country/territory/area

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فازهای پاندمی

۱- فاز اول: ویروس در **میزبان حیوانی** شروع میشود و هیچگاه در انسان عفونت شناخته شده ای ایجاد نمی کند.

۲- فاز دوم: بیماری **زئونوز** باعث عفونت در انسان میشود.

۳- فاز سوم: موارد پراکنده/ خوشه بیماری عفونی در انسان/ **انتقال انسان به انسان** از نظر زمان و مکان محدود است و برای طغیان در سطح جامعه کافی نیست.

٤- فاز چهارم: **انتقال حیوان به انسان / انسان به انسان/ پایداری انسان به انسان**

٥- فاز پنجم: **عفونت گسترده انسانی**

٦- فاز ششم: طغیان در سطح جامعه **کشوری دیگر و عبور از مرز قاره و منطقه دیگری از** WHO

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استراتژی دولت ها برای مقابله با اپیدمی ها

۱- پیشگیری از اپیدمی/ مراقبت (اکتیو و پاسیو)، فقدان نظام **مراقبت** کافی ← **اپیدمی**

۲- در صورت رخداد اپیدمی: کاهش سرایت پذیری و کنترل اپیدمی(مدیریت/ مهار/کنترل)

مهار: کنترل ورود و خروج/ افزایش نظارت/ مداخله سازمان یافته/ بسیج اجتماعی و...

کنترل: تغییر در دینامیک بیماری

چالش های کنترل اپیدمی در دنیا:

۱- تاخیر در اقدام موثر و به موقع

۲- شدت عمل ناکافی/ نظام مراقبت ناکافی (تشخیص/ آمادگی/ دیده وری/ گزارش و ...)

۳- غلبه تفکر درمان بر پیشگیری/ مواجهه با سیاستهای دوگانه/ مسایل اقتصادی/سیاسی

۴- عدم استفاده کافی از فناوری اطلاعات و دیجیتال اپیدمیولوژی

۵- تناقض در پیام های رسانه ها و پیام رسانی توسط افراد بدون تخصص مرتبط با اپیدمی

۶- عدم استفاده از همه ظرفیت موجود/ کم توجهی یا غفلت از مردم/ انتظار داشتن

۷- تصمیم گیری بدون شواهد کافی و یا کم توجهی به نظر مشورتی اپیدمیولوژیستها

۸- عدم کافی پوشش ردیابی/ تست/ جداسازی/ قرنطینه/ تشخیص زودرس و مراقبت

۹- برخورد احساسی و گاها نابجا و ...

۴۷- دخالت افراد غیر مرتبط و برخی تصمیم گیریها بدون اپیدمیولوژیست با تجربه

STRATEGIC OBJECTIVES: COVID-19

WHO's strategic objectives for this response are to:

1- Limit human-to-human transmission including reducing secondary infections among close contacts and health care workers, preventing transmission amplification events, and preventing further international spread from China*;

2- Identify, isolate and care for patients early, including providing optimized care for infected patients;

3- Identify and reduce transmission from the animal source;

4- Address crucial unknowns regarding clinical severity, extent of transmission and infection, treatment options, and accelerate the development of diagnostics, therapeutics and vaccines;

5- Communicate critical risk and event information to all communities and counter misinformation;

6- Minimize social and economic impact through multisectoral partnerships.

*This can be achieved through a combination of public health measures, such as rapid identification, diagnosis and management of the cases, identification and follow up of the contacts, infection prevention and control in health care settings, implementation of health measures for travelers, awareness-raising in the population and risk communication.

https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200222-sitrep-33-covid-19.pdf?sfvrsn=c9585c8f_2

https://www.cidrap.umn.edu/covid-19/epidemiology

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TRENDING TOPICS   COVID-19   Ebola   Antimicrobial Stewardship   Chronic Wasting Disease

COVID-19 Epidemiology

Situation Reports
- Novel coronavirus (COVID-2019) situation reports (WHO)
- COVID-19 situation summary (CDC)
- Cases of coronavirus disease (COVID-19) in the US (CDC)
- Daily briefing on novel coronavirus cases in China (China NHC)
- Coronavirus disease (COVID-19) (PAHO landing page with links to epidemiologic updates)
- COVID-19: epidemiology, virology, and clinical features (PHE)
- COVID-19 situation reports (Johns Hopkins Center for Health Security)

COVID-19 CONTENT
- COVID-19 Home
- CIDRAP News
- Other News Resources
- Bibliography
- Disease Backgrounder
- Epidemiology
- Lab & Diagnostics
- Higher Education
- Supply Chain Issues

Epidemiology Essentials
- The First Few X (FFX) cases and contact investigation protocol for 2019-novel coronavirus (COVID-19) infection (WHO)
- COVID-19: epidemiology (UpToDate)

Epidemiolgy Status of COVID-19 in the World and Iran

https://www.who.int/

https://covid19.who.int/?gclid=CjwKCAjw2Jb7BRBHEiwAXTR4jYiLXFDtzXai
MfN4CHNxmzwswRQYVKUm7i6eHfYSMMdOQUNxAZft4BoCyqoQAvD_BwE

https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1?

https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

Projection of COVID-19 in the World, WHO region and Iran

https://covid19.healthdata.org/global?view=total-deaths&tab=trend

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#	Country, Other	Total Cases	New Cases	Total Deaths	New Deaths	Total Recovered	Active Cases	Serious, Critical	Tot Cases/ 1M pop	Deaths/ 1M pop	Total Tests	Tests/ 1M pop	Population
	World	31,344,422	+114,509	966,514	+1,762	22,930,389	7,447,519	61,337	4,021	124.0			
1	USA	7,015,789	+11,021	204,212	+94	4,269,688	2,541,889	14,031	21,168	616	98,303,303	296,598	331,436,330
2	India	5,523,917	+38,305	88,345	+436	4,440,775	994,797	8,944	3,994	64	64,392,594	46,560	1,383,011,810
3	Brazil	4,547,150	+2,521	136,997	+102	3,851,227	558,926	8,318	21,359	643	15,011,116	70,509	212,896,182
4	Russia	1,109,595	+6,196	19,489	+71	911,973	178,133	2,300	7,603	134	43,100,000	295,309	145,948,591
5	Peru	768,895		31,369		615,255	122,271	1,425	23,249	948	3,693,813	111,687	33,072,805
6	Colombia	765,076		24,208		633,199	107,669	863	15,001	475	3,393,562	66,537	51,002,905
7	Mexico	697,663	+3,542	73,493	+235	499,302	124,868	2,481	5,399	569	1,586,191	12,274	129,232,607
8	South Africa	661,211		15,953		590,071	55,187	539	11,118	268	4,041,453	67,954	59,473,498
9	Spain	659,334		30,495		N/A	N/A	1,345	14,101	652	10,756,835	230,049	46,758,867
10	Argentina	631,365		13,053		488,231	130,081	3,261	13,941	288	1,729,040	38,179	45,287,825
11	France	452,763		31,285		91,574	329,904	827	6,933	479	10,000,000	153,125	65,306,013
12	Chile	447,468	+1,194	12,298	+12	421,111	14,059	915	23,363	642	3,055,155	159,516	19,152,666
13	Iran	425,481	+3,341	24,478	+177	361,523	39,480	3,912	5,051	291	3,773,300	44,798	84,229,800
14	UK	398,625	+4,368	41,788	+11	N/A	N/A	138	5,865	615	22,171,979	326,223	67,965,784
15	Bangladesh	350,621	+1,705	4,979	+40	258,717	86,925		2,124	30	1,834,323	11,114	165,052,979

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شاخص	ایران	ترکیه	تایلند	امریکا	ژاپن	المان	ایتالیا
بروز در یک میلیون	۵۰۵۱	۳۸۸۳	۵۰	۴۰۲۱	۶۲۲	۳۲۷۷	۴۹۵۵
مرگ در یک میلیون	۲۹۱	۸۹	۰/۸	۶۱۶	۱۲	۱۱۳	۵۹۱
تستها	۳۷۷۳۳۰۰	۹۲۶۹۰۱۵	۷۴۹۲۱۳	۹۸۳۰۳۳۰۳	۱۸۴۲۵۰۶	۱۴۵۵۷۱۳۶	۱۰۴۸۸۶۷۶
تست در یک میلیون	۴۴۷۹۸	۱۰۹۶۴۱	۱۰۷۲۸	۲۹۶۵۹۸	۱۴۵۷۸	۱۷۳۶۲۱	۱۷۳۵۳۴
جمعیت	۸۴۲۲۹۸۰۰	۸۴۵۳۹۸۵۰	۶۹۸۳۹۳۶۸	۳۳۱۴۳۶۳۳۰	۱۲۶۳۸۸۴۶۵	۸۳۸۴۴۱۱۳	۶۰۴۴۱۶۸۰

رتبه ایران در بروز موارد۶۴، بروز مرگ۲۴، شمارش تست۱۷، تست به جمعیت ۱۱۳، درصد موارد شدید۴، موارد فعال ۲۰، تعداد مرگ ۱۰، **تعداد ۱۲**

In **Iran (Islamic Republic of)**, from **Jan 3** to **4:30pm CEST, 21 September 2020**, there have been **422,140 confirmed cases** of COVID-19 with **24,301 deaths**.

REFERENCES

1- https://www.medrxiv.org/content/10.1101/2020.02.17.20023747v2
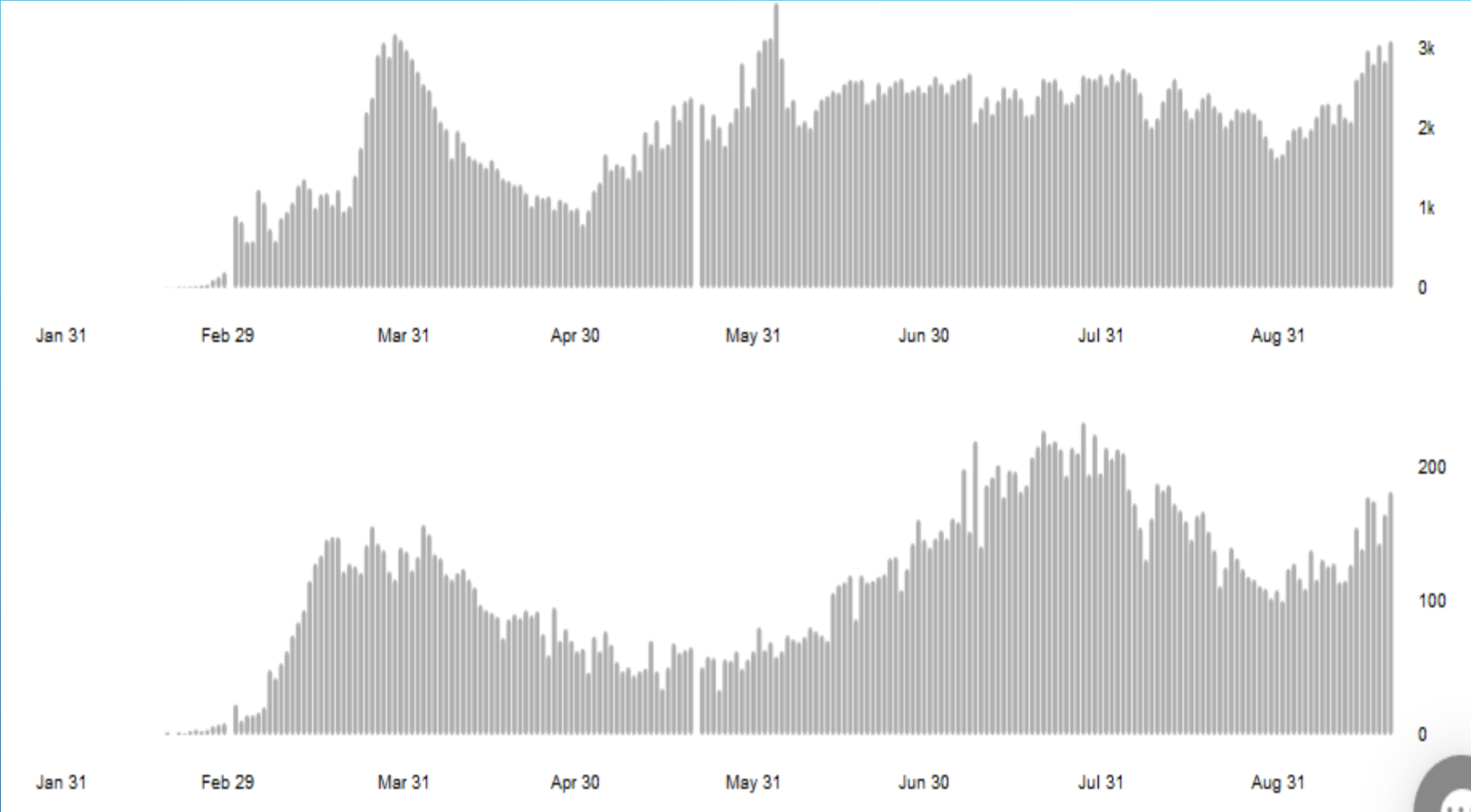
2- Johan Giesecke .Modern Infectious Disease Epidemiology 2nd Edition

3- https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19-epidemiology-virology-and-prevention

4- آقای دکتر حسین صافی زاده درباره اپیدمیولوژی بیماریهای عفونی ا

5- https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200222-sitrep-33-covid-19.pdf?sfvrsn=c9585c8f_2

6- آمار روزانه اعلامی مدیریت روابط عمومی وزارت بهداشت درمان و آموزش پزشکی

7- روزنگار کرونا ویروس گروه اپیدمیولوژی دانشگاه علوم پزشکی شهید بهشتی

8- http://www.healthdata.org/covid/data-downloads

9-
https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1?

▸10-
https://covid19.who.int/?gclid=CjwKCAjw2Jb7BRBHEiwAXTR4jYjLXFDtzXaiMfN4CHNxmzwswRQYVKUm7i6eHfYSMMdOQUNxAZft4BoCyqoQAvD_BwE