

Concepts for the prevention and control of microbial threats – 1

Center for Infectious Disease Preparedness
UC Berkeley School of Public Health
URL: <http://www.idready.org>

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Learning objectives:

Participants will be able to ...

- Describe how and why microbial agents are transmitted from an infectious source to a susceptible human host;
- Describe the natural history of infection and infectiousness;
- Describe how humans and microbes interact with each other and their environment to produce infectious disease epidemics.

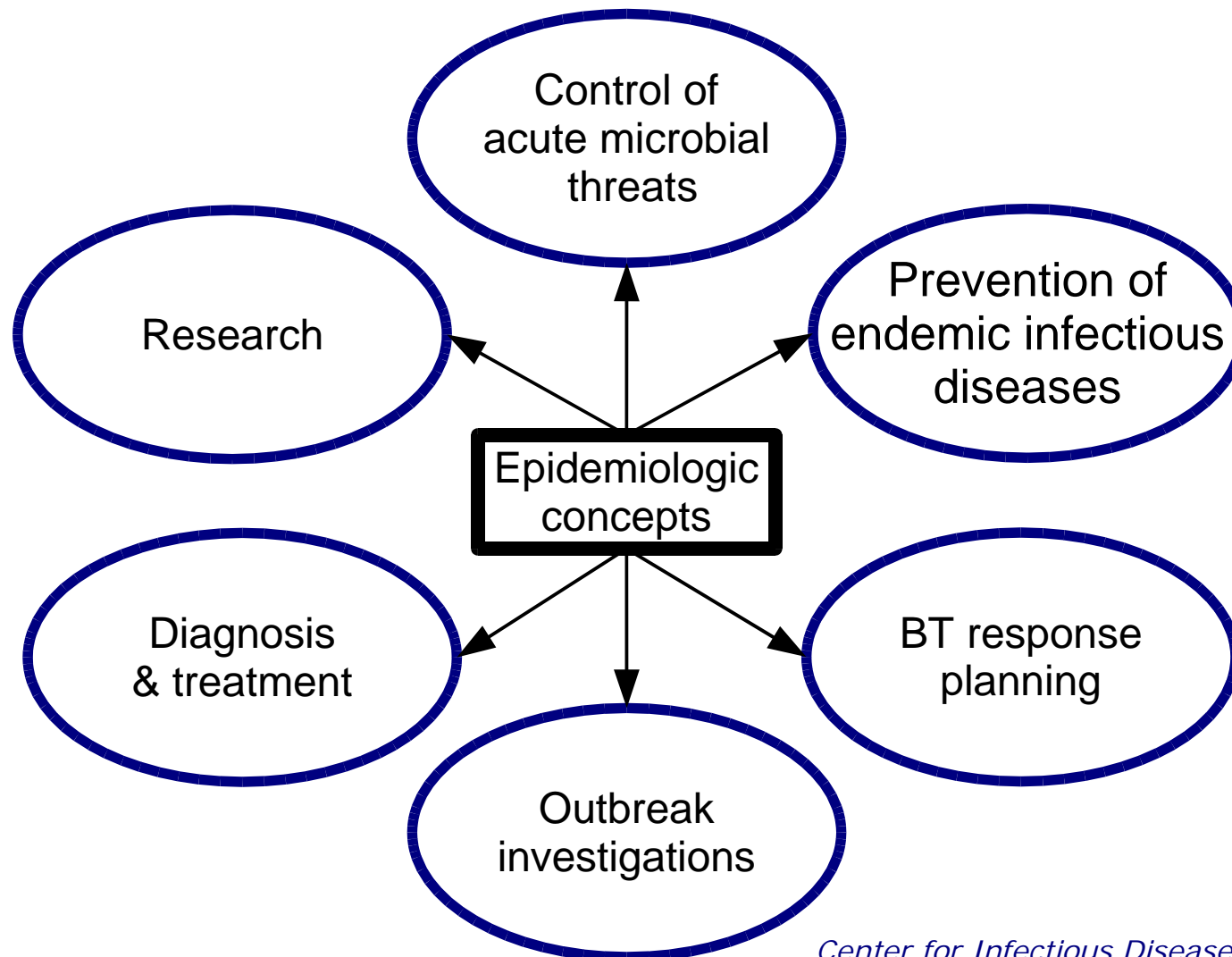


Understanding interventions to control infectious diseases

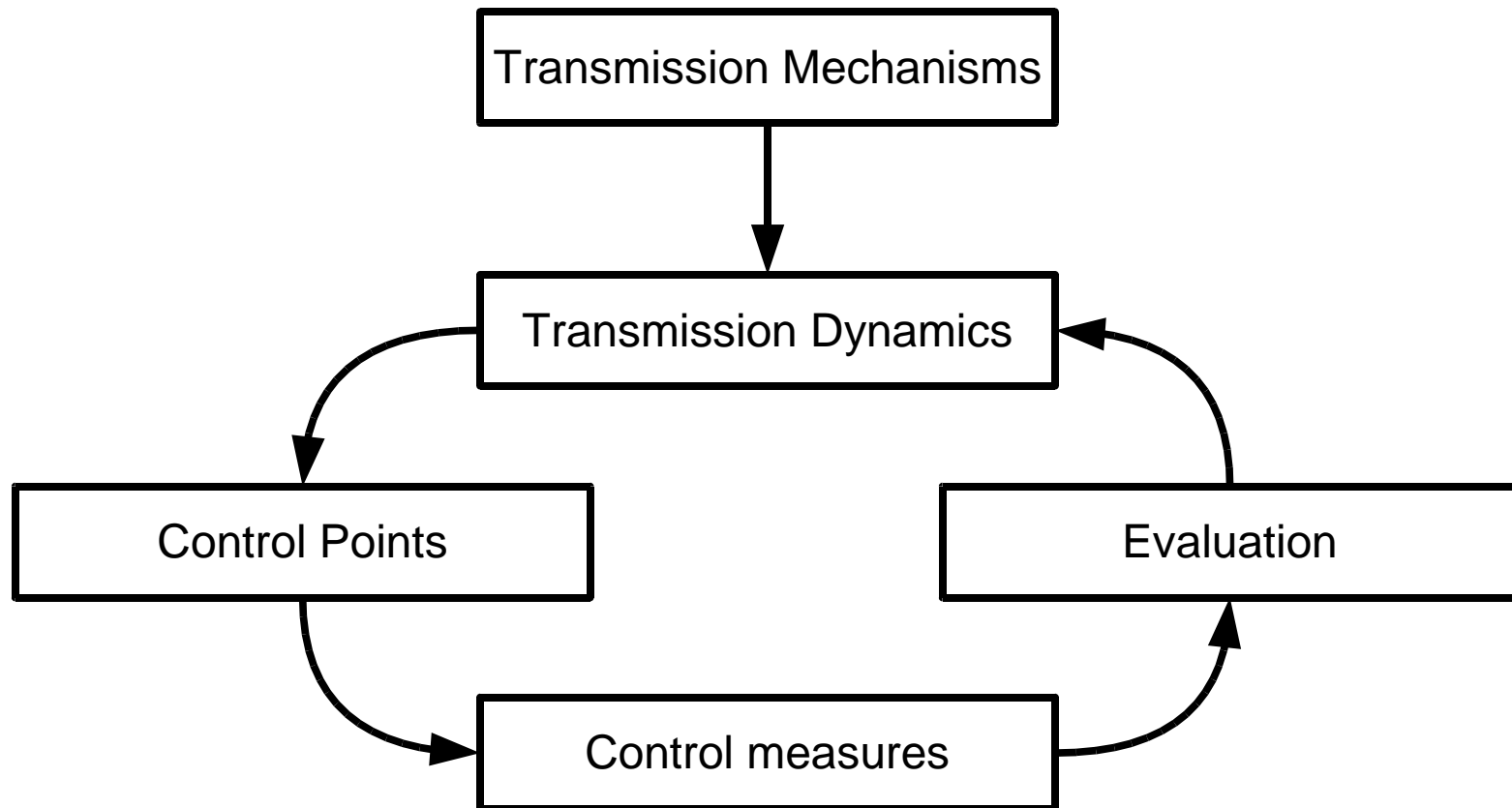
- Alter risk factors (e.g., behavior)
- Post-exposure prophylaxis
- Diagnosis, treatment
- Vaccination, immune globulin
- Infection control practices
- Case finding and isolation
- Contact tracing and quarantine
- Environmental disinfection
- Identify and control infectious sources



Use of epidemiologic concepts



Epidemiologic concepts for the control of microbial threats

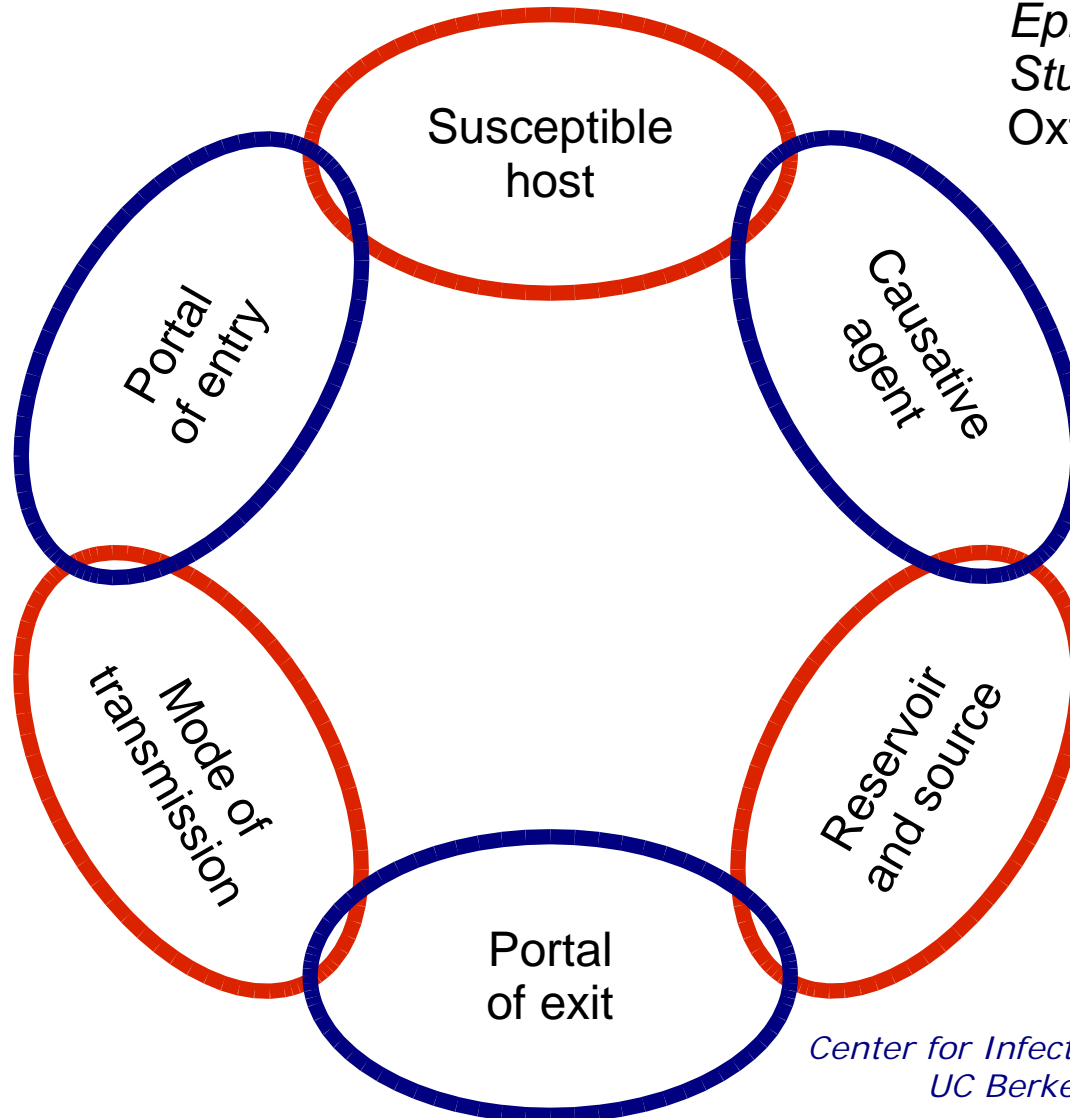


Infectious disease epidemiology concepts – Overview

- Mechanisms (Part 1)
 - Chain model of infectious diseases
 - Natural history of infection/infectiousness
 - Convergence model for human-microbe interaction
- Dynamics (Part 2)
 - Reproductive number (R)
 - Conditional infection rate (I)
 - Generation time (T)
- Control points and Control measures



Chain model of infectious diseases



Epidemiologic Methods for the Study of Infectious Diseases, Oxford University Press 2001



Chain model of ID: Causative agent

- Transmissible microbe, microbe-like, or microbial toxin
 - Bacteria
 - Viruses
 - Fungi
 - Parasites (protozoa, multicellular)
 - Prions



Chain model of ID: Agent transmission and infection

- Transmissibility = $P(\text{transmission}|\text{exposure}^a)$
- Infectivity = $P(\text{Infection}|\text{transmission}^b)$
- Pathogenicity = $P(\text{Disease}|\text{Infection})$
- Virulence = $P(\text{Complication}|\text{Disease})$

- a. Exposure to external source; could be within species (e.g., human influenza to humans) or between species (e.g., avian influenza to humans)
- b. Or colonization; could be endogenous



Chain model of infectious diseases: Reservoir

- Human
 - Symptomatic illness
 - Carriers
 - Asymptomatic (no illness during infection)
 - Incubatory (pre-illness)
 - Convalescent (post-illness recovery)
 - Chronic (persistent infection)
- Animal (zoonoses)
- Environmental

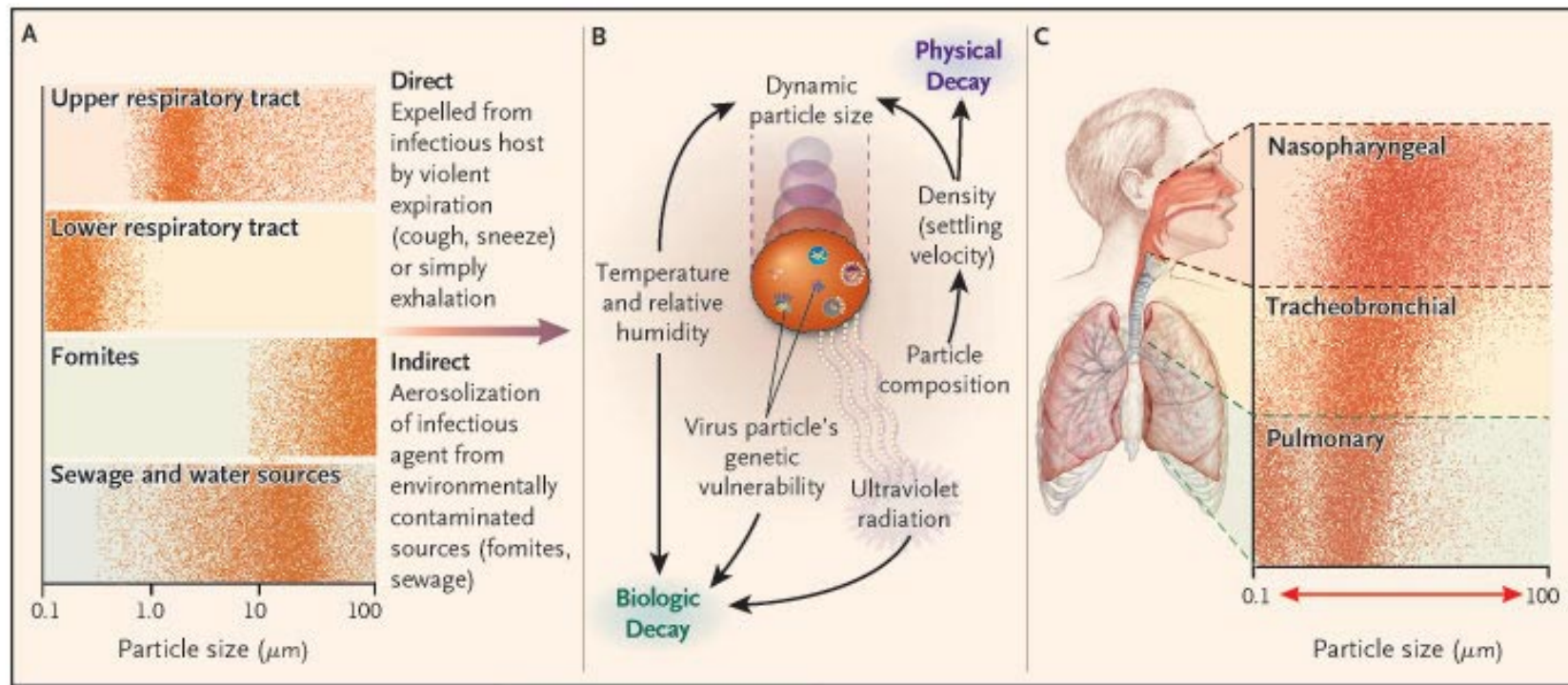


Modes of transmission for an exogenous agent

- Contact
 - Direct contact (touch, kissing, sex)
 - Indirect contact (intermediate objects, fomites)
 - Vertical transmission (before, during, and after birth)
- Respiratory droplets/secretions (cough, sneeze)
- Airborne (droplet nuclei, dust)
- Vehicle-borne (ingestion, instrumentation, injection, infusion)
- Vector-borne (mechanical, biologic)



Aerobiologic transmission of a respiratory microbial agent



Good infection control starts with common sense



American Society for Microbiology

Cover the source!

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Disease scare at San Jose airport 5 on flight from Asia examined -- none found with SARS, SF Chronicle April 2, 2003

In a false alarm heard 'round the world, the Santa Clara County health system jumped into high alert Tuesday morning when an American Airlines flight from Tokyo radioed that it might have five cases of the mysterious flulike illness known as SARS on board.

[Joan] Krizman said she had no hard feelings about being treated as a potential health threat. The couple had just completed an exhausting, monthlong journey that included stops in Vietnam, Thailand and Hong Kong -- three Southeast Asian hot spots for SARS.

"There were four fire trucks and eight police cars and four or five ambulances," she recalled. "I couldn't believe it. I thought, 'Wow! What's going on here?' Little did I know that we were to be the 'victims.' "

The couple were asked twice to go to Valley Medical Center, and twice they politely declined. "And then," Krizman said, "they soon opened up the ambulance doors and said, sorry, we're taking you to the hospital."

At the hospital, according to Krizman, "we were the only ones there not wearing masks." When word got out just who they were, she said, "People started running like crazy, like we were the bubonic plague. They put us in a room full of people with plastic boots and face shields and masks."



Nurse wearing N-95 respirator outside of intensive care unit

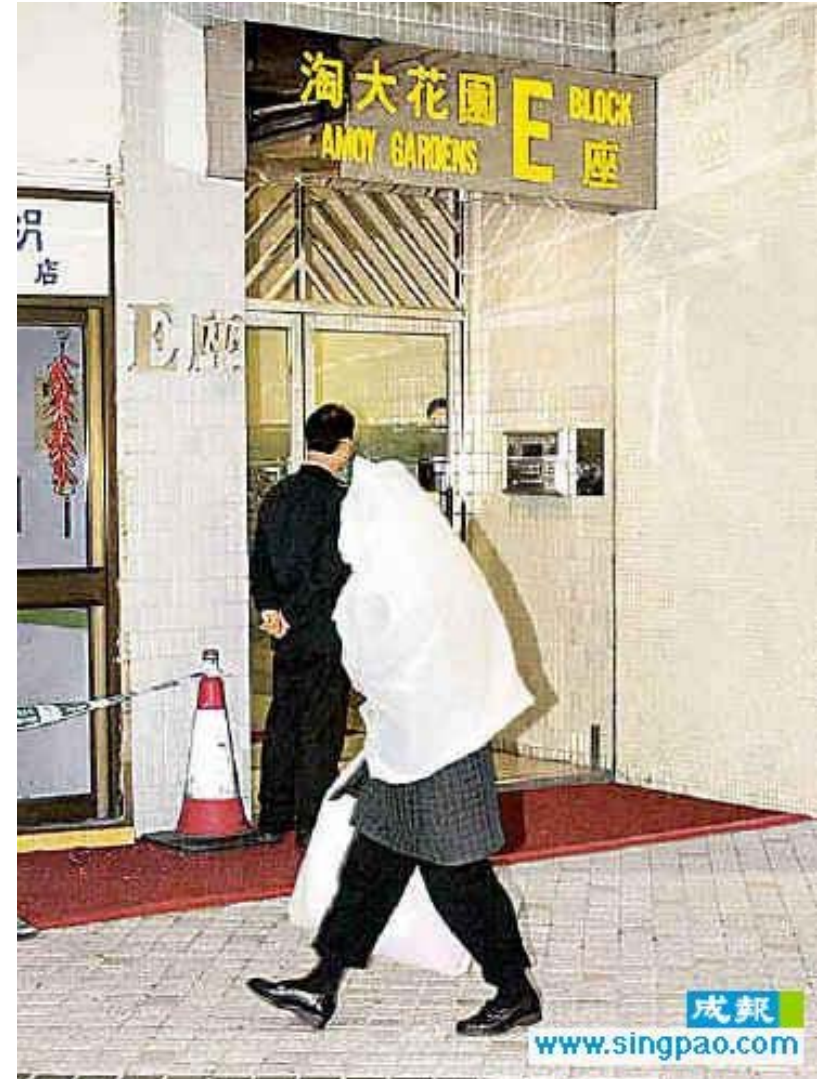


Associated Press: In a ward at Sunnybrook and Womens Hospital in Toronto, a nurse waits outside the door of a patient diagnosed with the illness [SARS].

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Public devised infection control during SARS outbreak, 2003



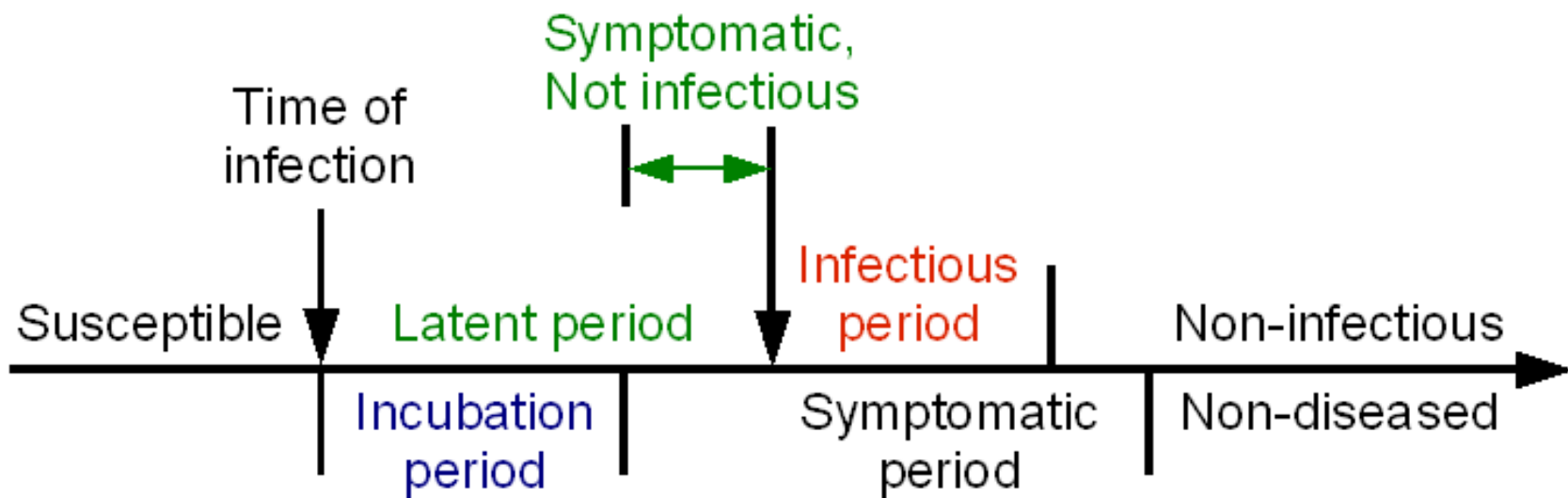
Inappropriate infection control during SARS outbreak, 2003



Reuters: An Indian woman diagnosed with SARS sits on her bed at the Doctor Naidu Infectious Diseases Hospital in the western city of Pune. Doctors reported India's first case of the disease in a marine engineer from the western coastal state of Goa on Friday, April 18, 2003



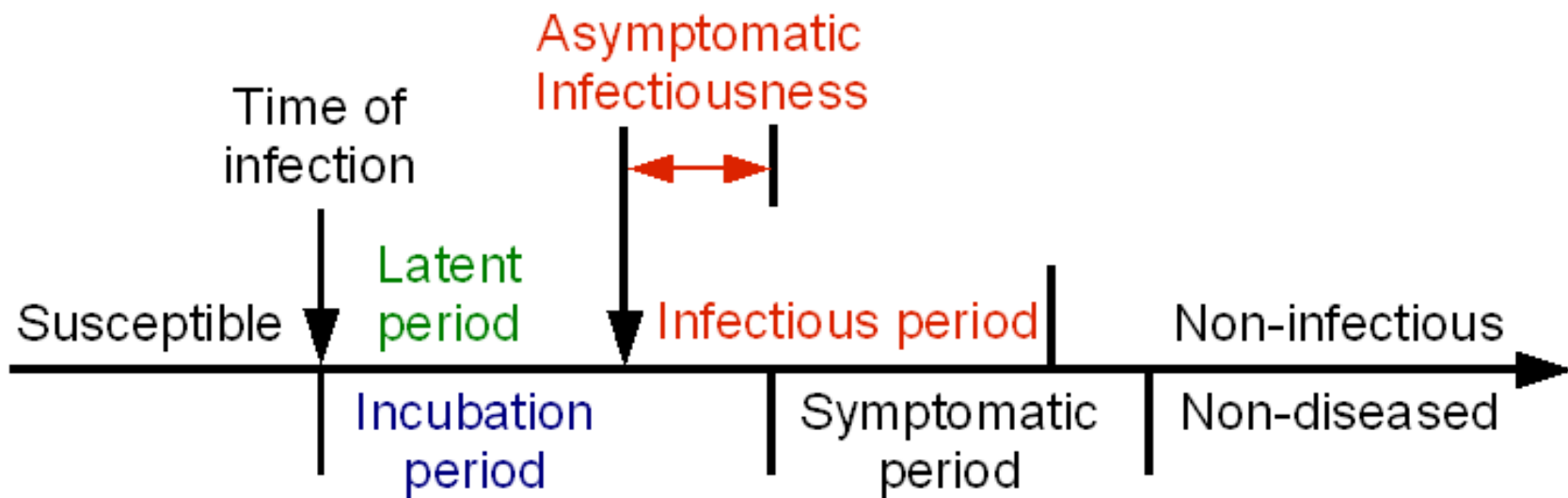
Natural history of infection: Latent period > Incubation period



When the latent period is *longer* than the incubation period, an infected person becomes infectious after symptom onset.



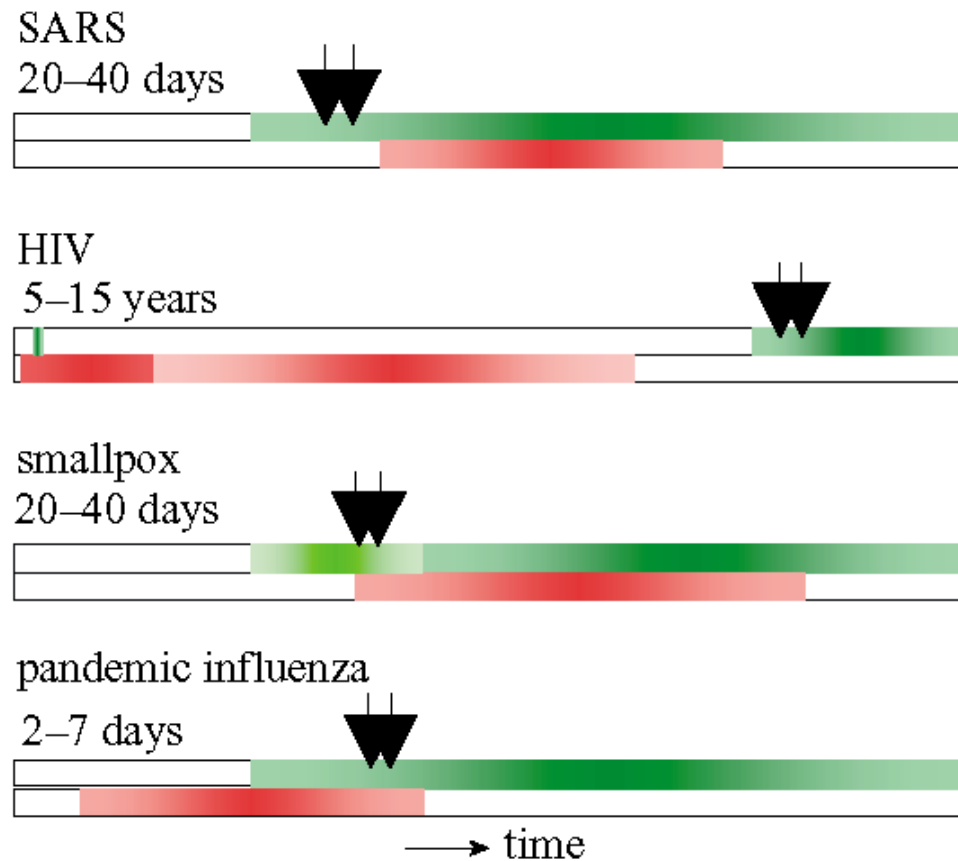
Natural history of infection: Latent period < Incubation period



When the latent period is *shorter* than the incubation period, an infected person becomes infectious before symptom onset.



Distribution of infectiousness of selected infectious diseases



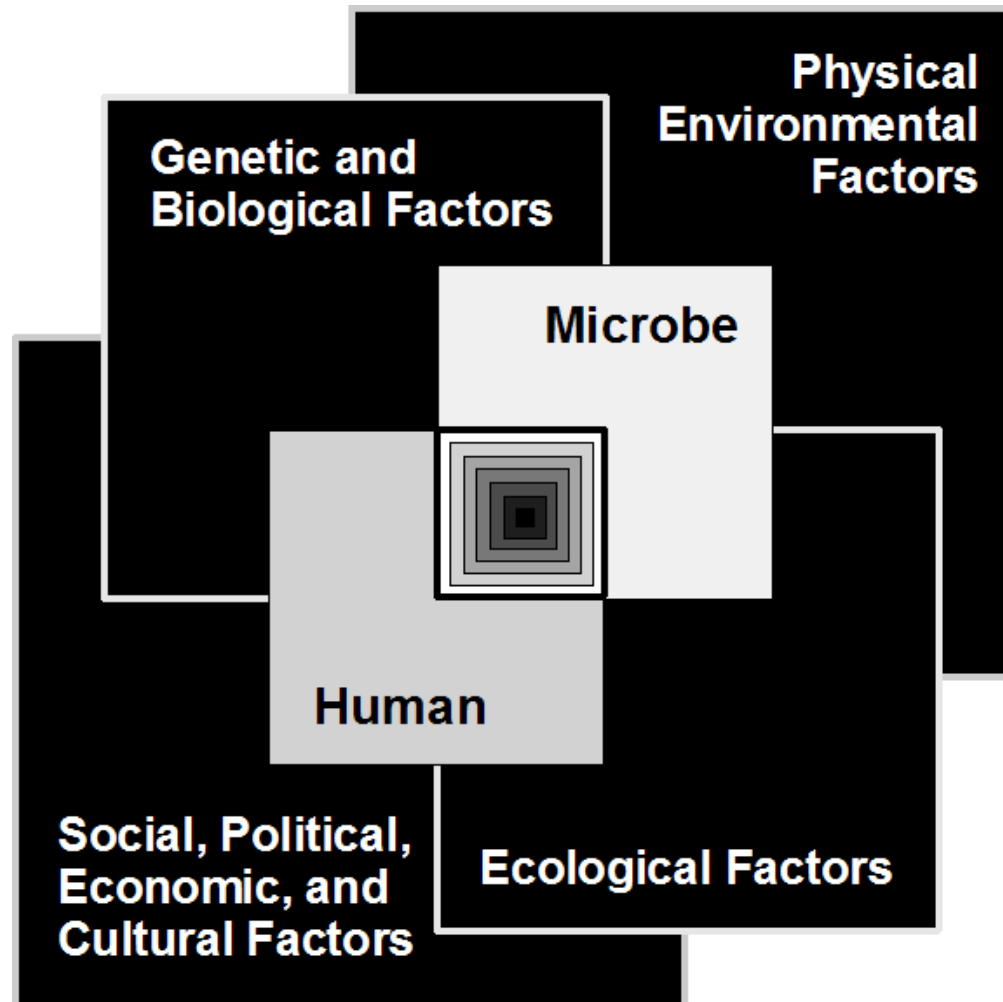
■ symptoms—duration

■ infectiousness

▼ isolation



Convergence model for human-microbe interaction

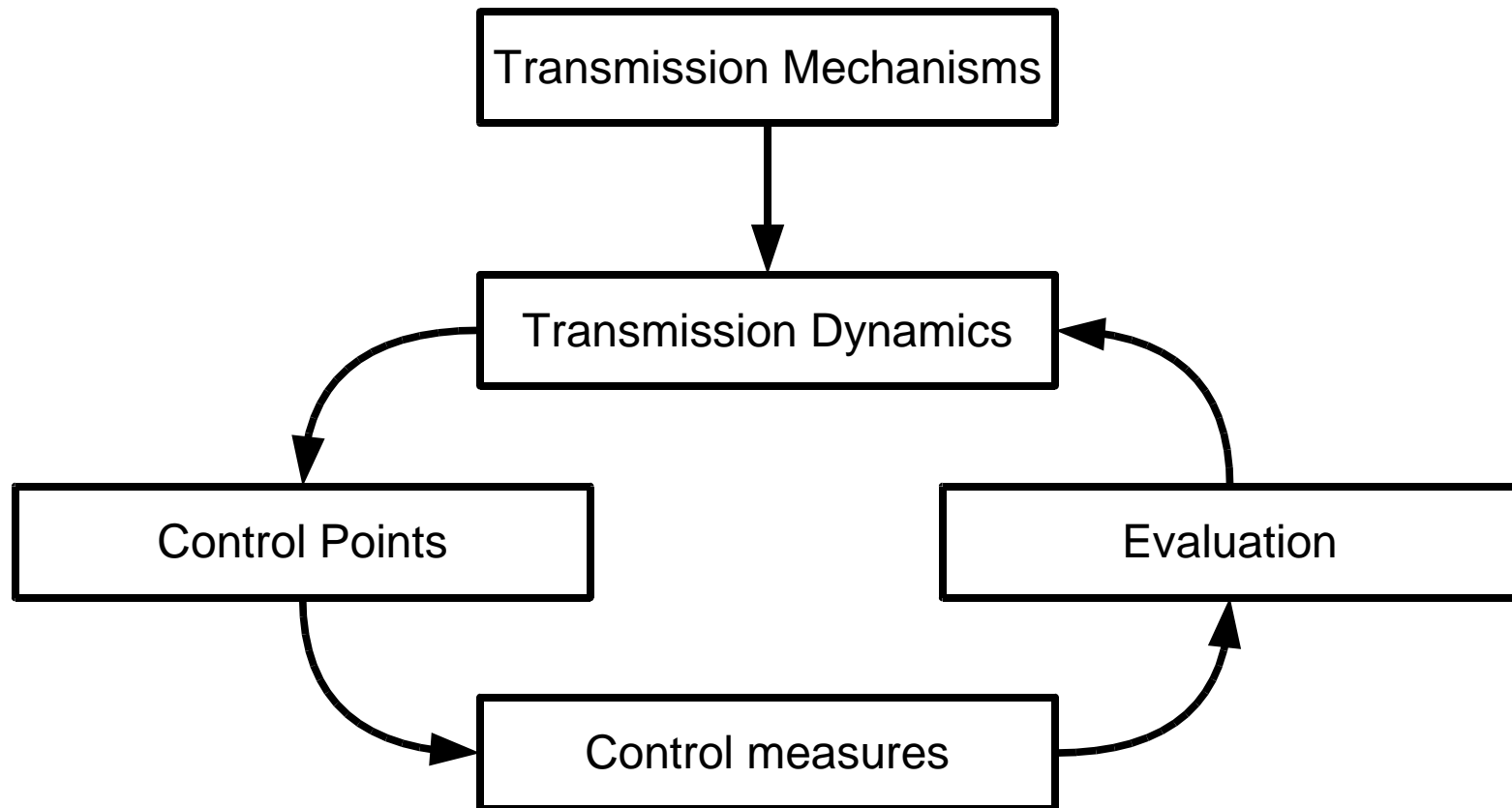


Adapted from Institute of Medicine. *Microbial threats to health: Emergence, Detection, and Response*. National Academy Press 2003

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Epidemiologic concepts for the control of microbial threats



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