Non-pharmaceutical Strategies to Limit Spread of Pandemic Influenza

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Definitions

- Isolation
  - Separation of ill persons with contagious diseases
  - For ill people
  - Usually in hospital, but can be at home or in a dedicated isolation facility
- Quarantine
  - Separation or restriction of movement select person(s)
  - For people exposed but not ill
  - Home, institutional, or other forms (“work quarantine”)
  - Voluntary vs. compulsory

Social Distancing and Infection Control

- Social Distancing (Contact Interventions)
  - School closure
  - Work closure (telecommuting)
  - Cancellation of public gatherings
- Infection Control (Transmission Interventions)
  - Facemasks
  - Cough etiquette
  - Hand hygiene

Outline

1. The challenge
2. Epidemiology: Breaking the cycle of transmission
3. What is to be done? A strategy for communities

Pandemic Influenza Threat

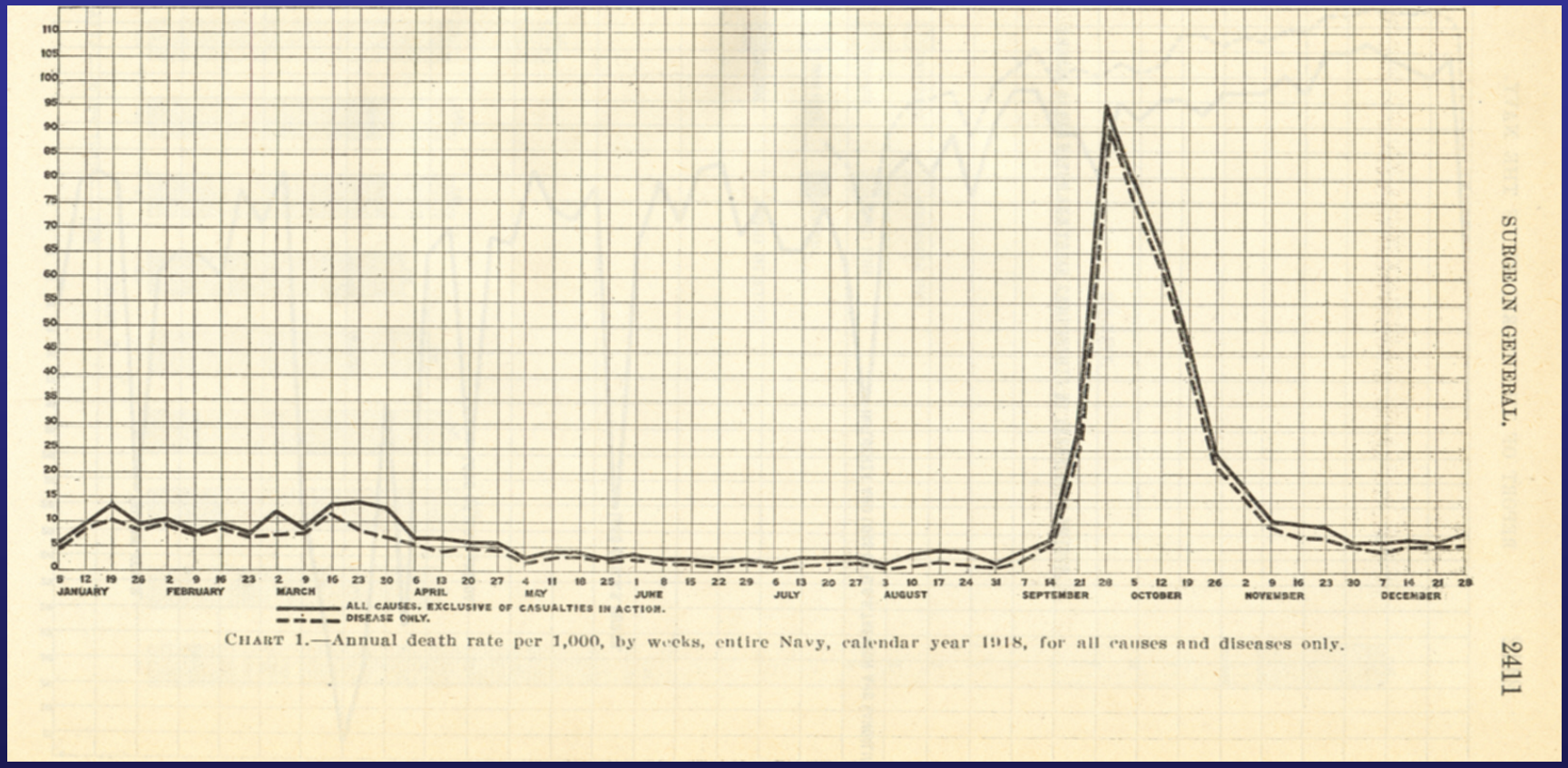
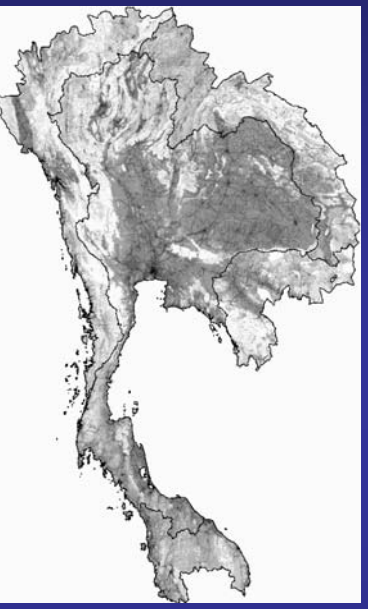


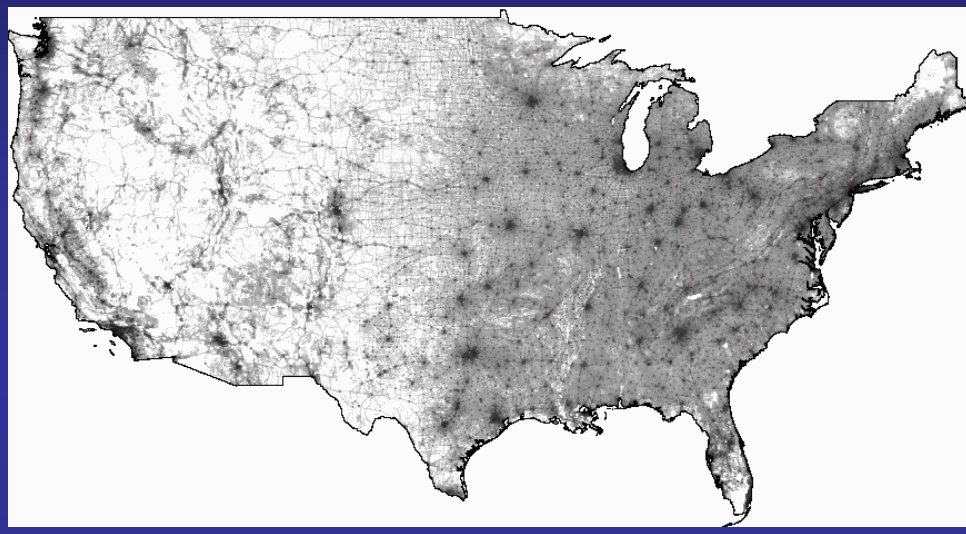
CHART 1.—Annual death rate per 1,000, by weeks, entire Navy, calendar year 1918, for all causes and diseases only.

Admiral Benson, CNO, Annual Report to Congress, 1919

Containment Unlikely



Without intervention, expect international spread in 1 month and U.S. cases in 1 to 2 months.



- Failed containment may still delay international spread by 1 month
- Severe travel restrictions may delay U.S. cases by 1-4 weeks

Parameters

Epidemiologic

- Incubation period
- Infectious period
- Mode of transmission
- Symptoms
- Age distribution
- Reproductive rate
- Intergeneration time

Social

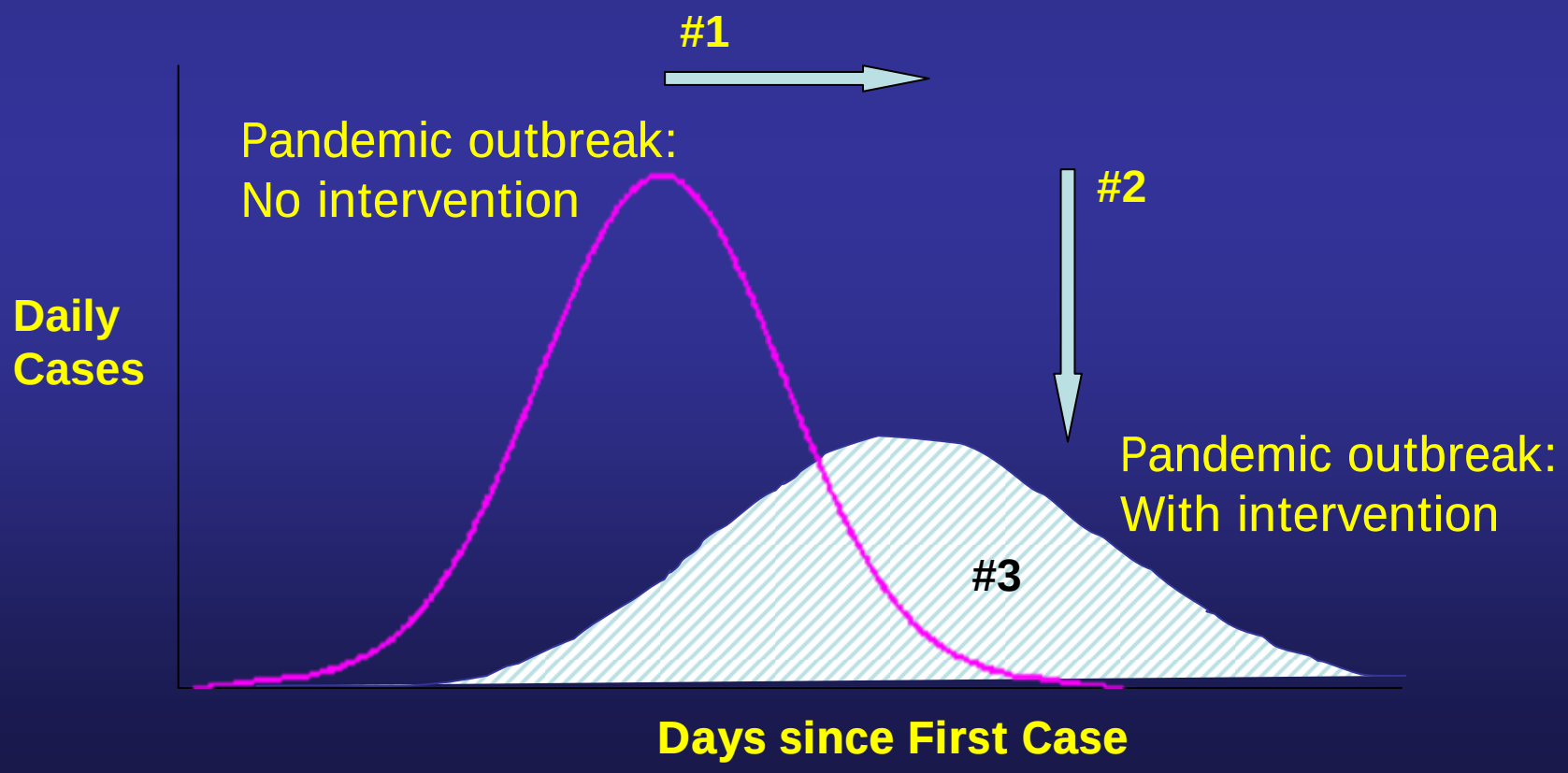
- Mixing patterns
- Mobility
- Acceptability of collective actions
- Acceptability of imposed restrictions
- Expectations
- Affordability
- Resiliency

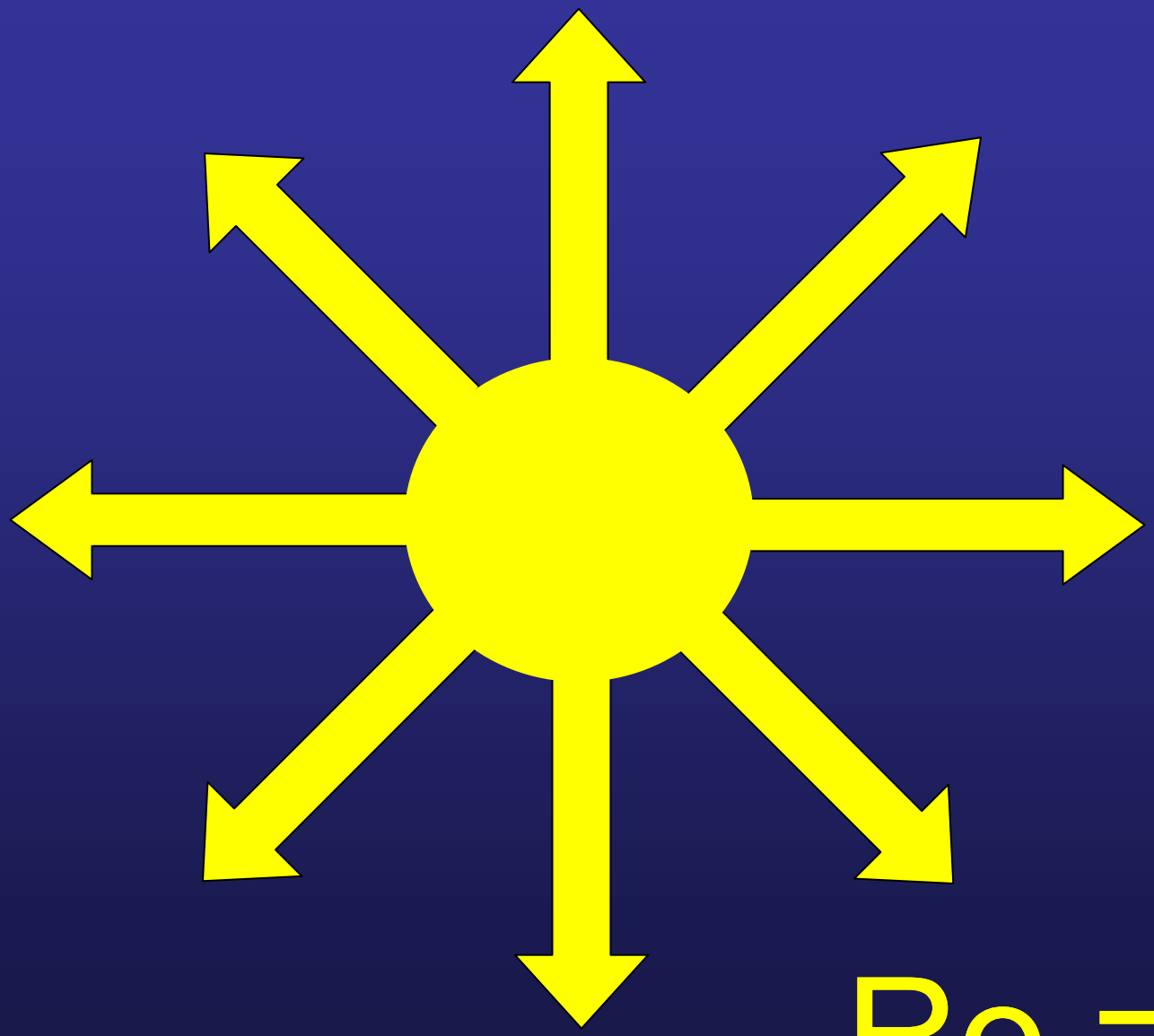
Potential Tools in Our Toolbox

- Our best countermeasure – vaccine – will probably be unavailable during the first wave of a pandemic
- Antiviral treatment may improve outcomes but will have only modest effects on transmission
- Antiviral prophylaxis may have more substantial effects on reducing transmission
- Infection control and social distancing should reduce transmission, but strategy requires clarification

Community-Based Interventions

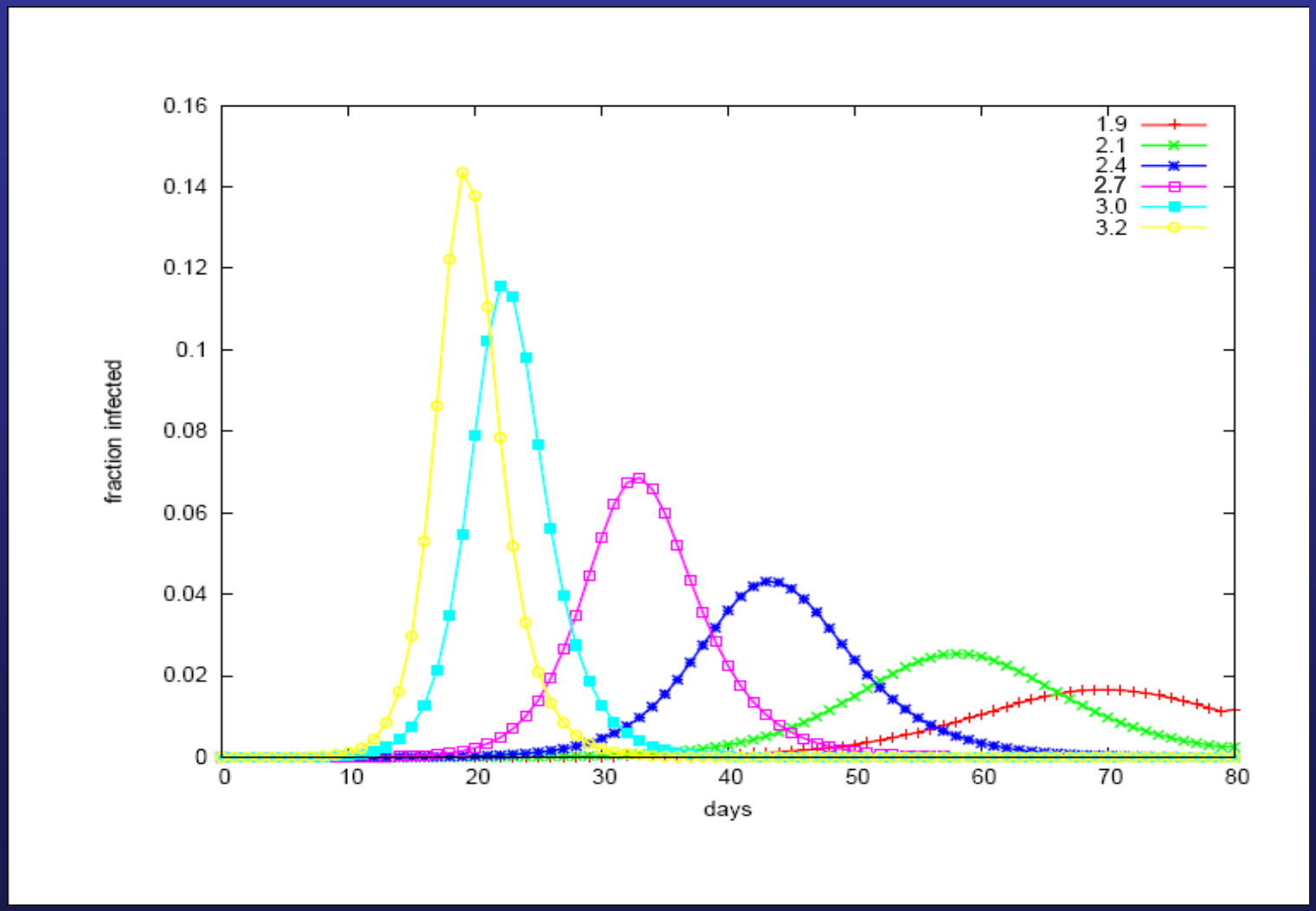
1. Delay disease transmission and outbreak peak
2. Decompress peak burden on healthcare infrastructure
3. Diminish overall cases and health impacts



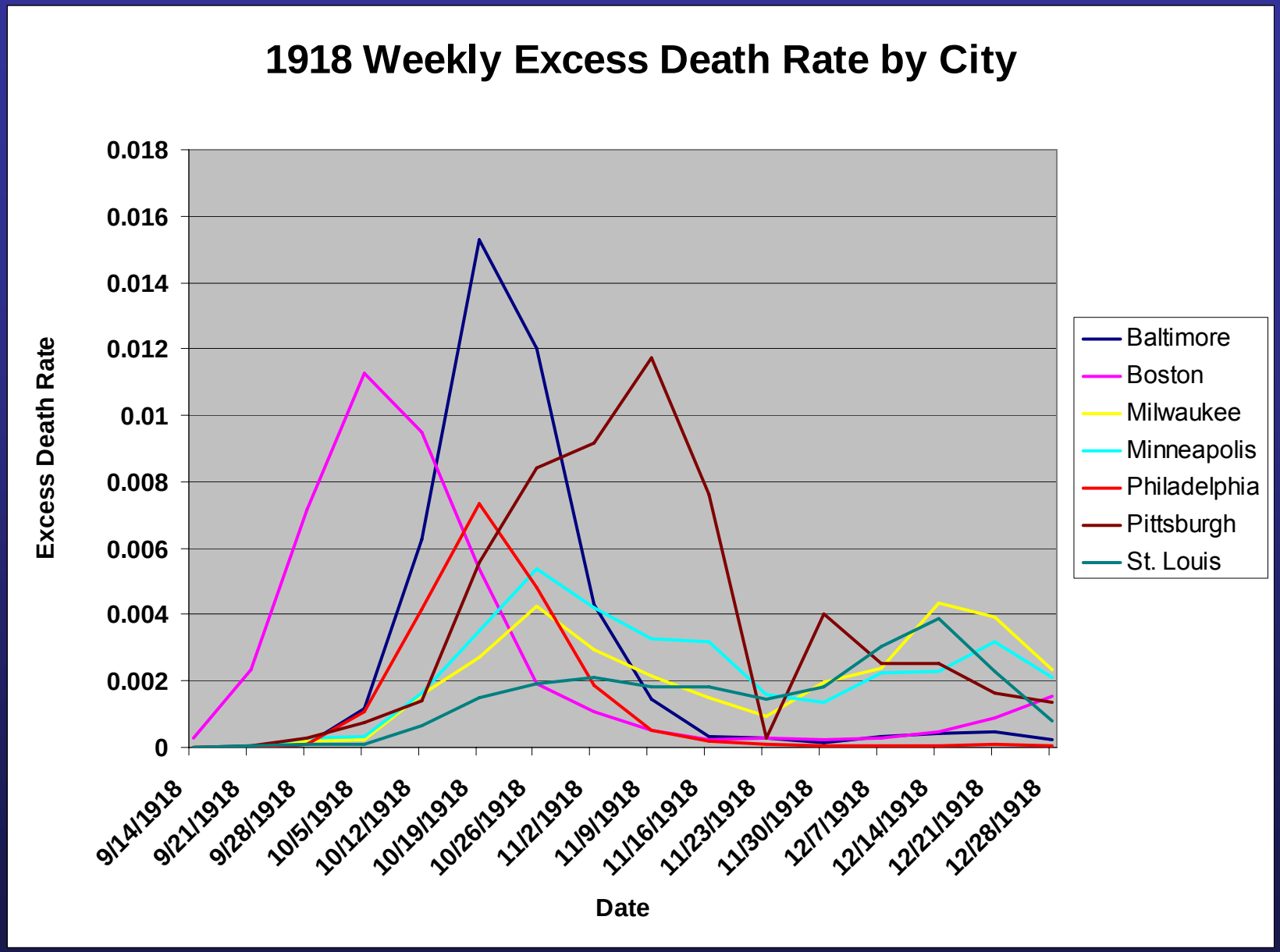


Ro = 2

Effect of Ro on Epidemic Curve



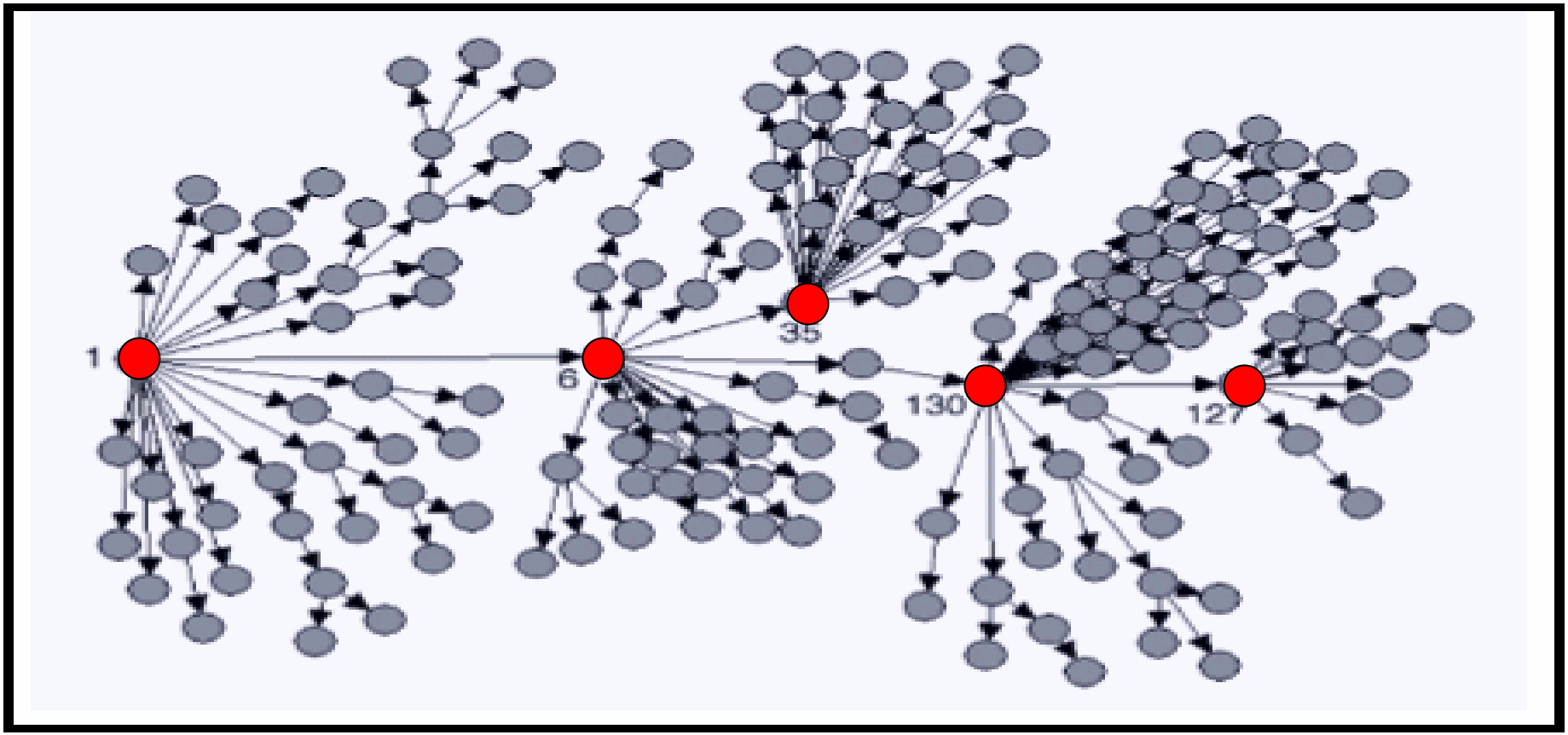
Eubank S, personal communication



Weekly mortality data provided by Marc Lipsitch (personal communication)

Breaking the Cycle of Transmission

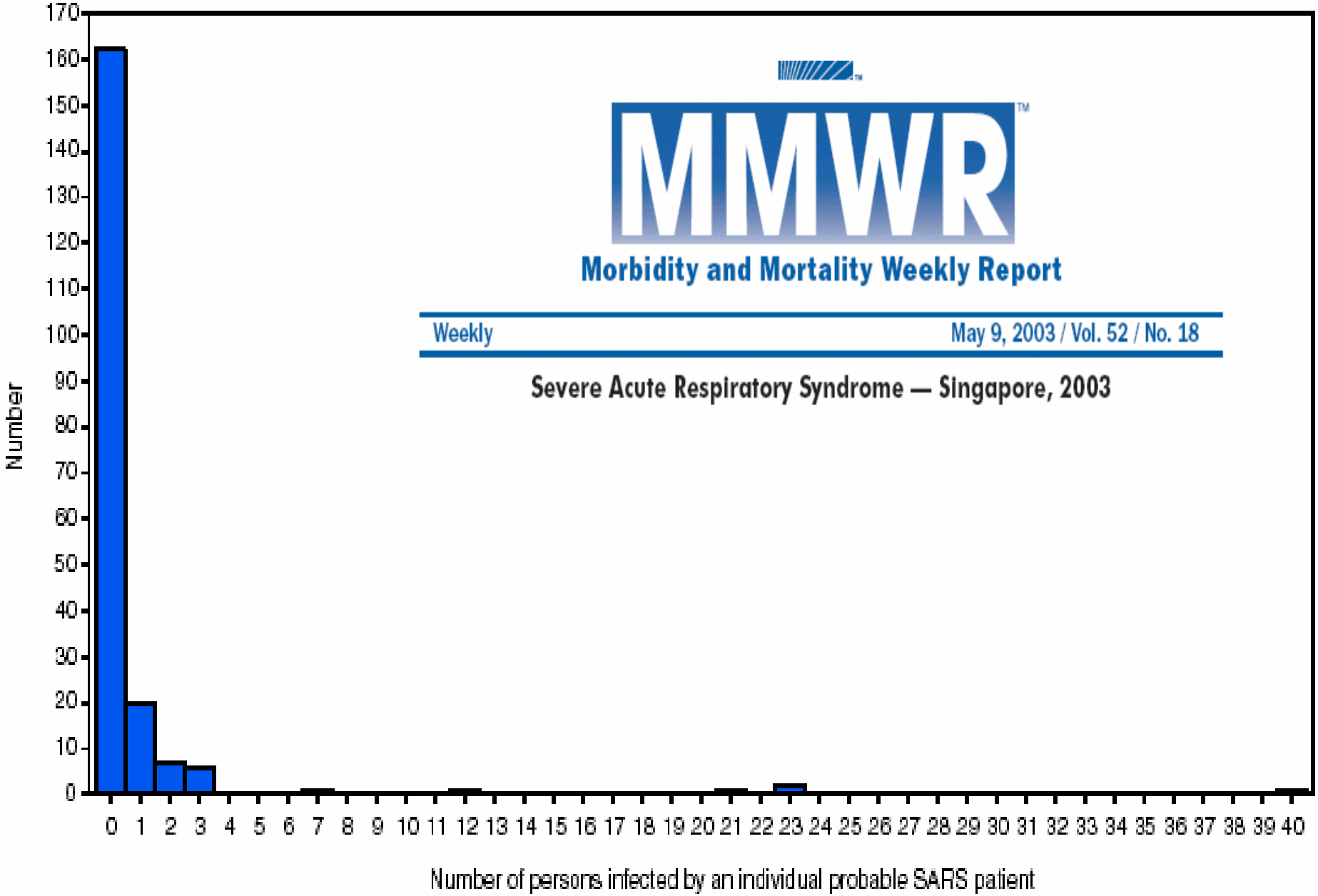
FIGURE 2. Probable cases of severe acute respiratory syndrome, by reported source of infection* — Singapore, February 25–April 30, 2003



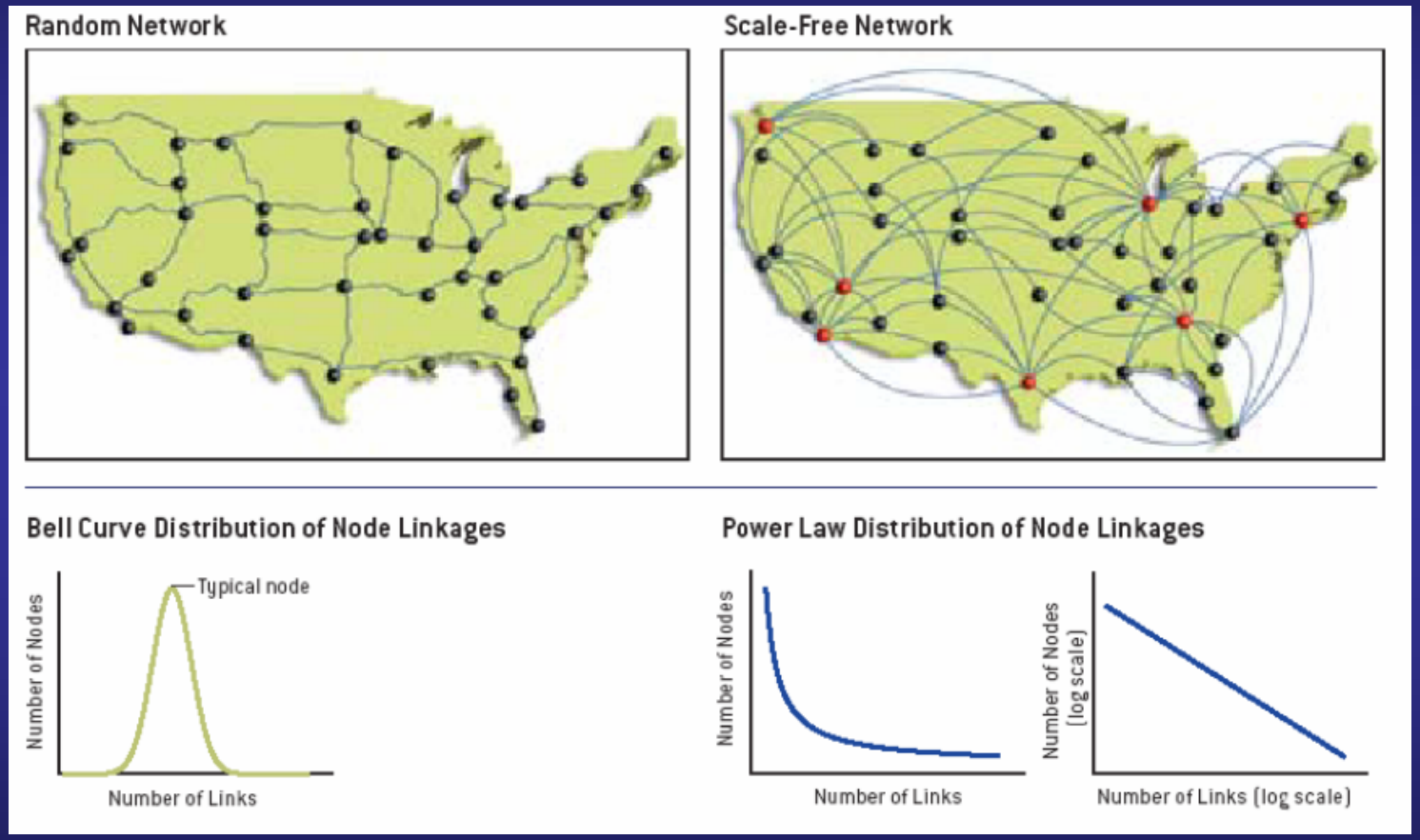
* Patient 1 represents Case 1; Patient 6, Case 2; Patient 35, Case 3; Patient 130, Case 4; and Patient 127, Case 5. Excludes 22 cases with either no or poorly defined direct contacts or who were cases translocated to Singapore and the seven contacts of one of these cases.

Reference: Bogatti SP. Netdraw 1.0 Network Visualization Software. Harvard, Massachusetts: Analytic Technologies, 2002.

FIGURE 3. Number of direct secondary cases from probable cases of severe acute respiratory syndrome — Singapore, February 25–April 30, 2003

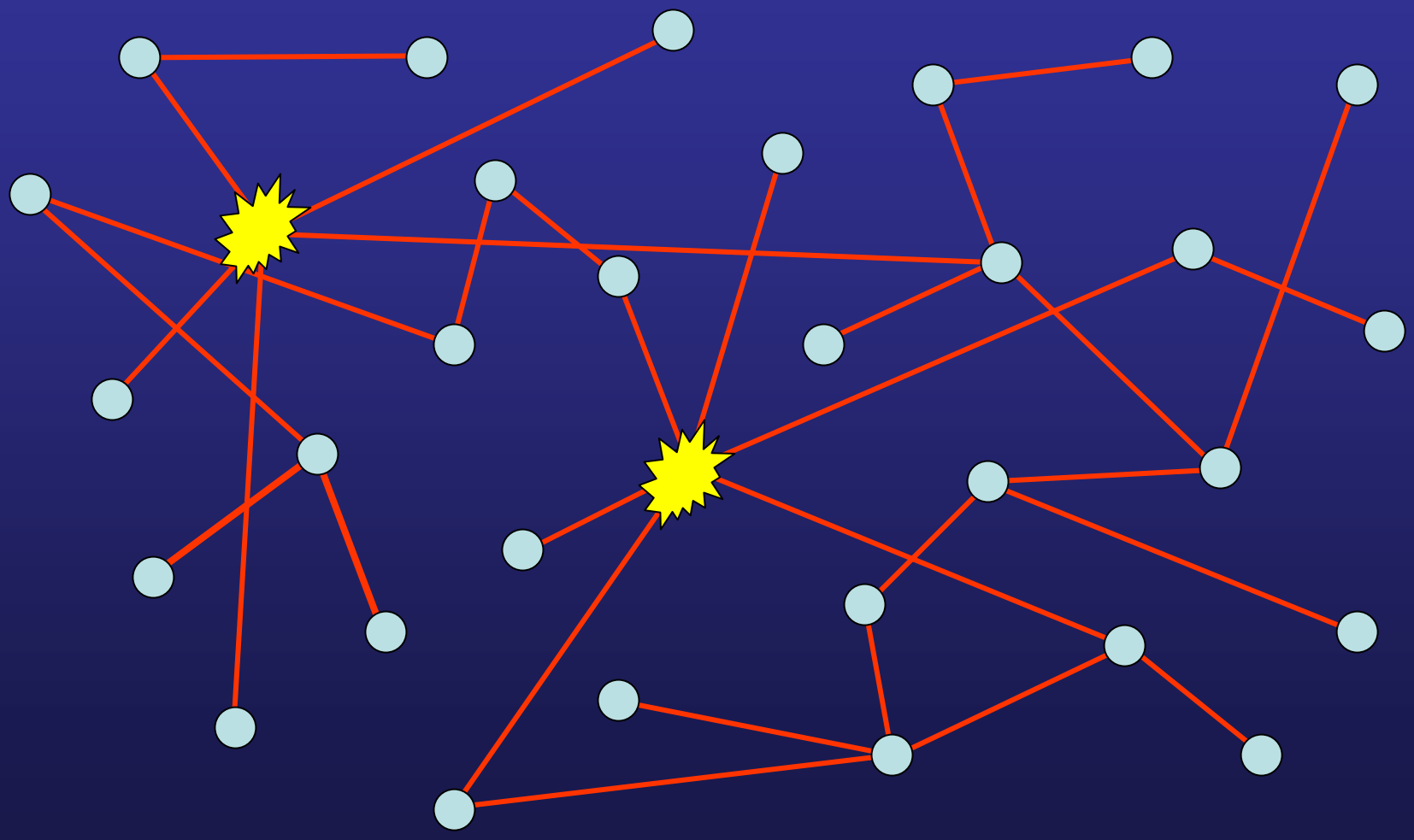


Scale-free Networks

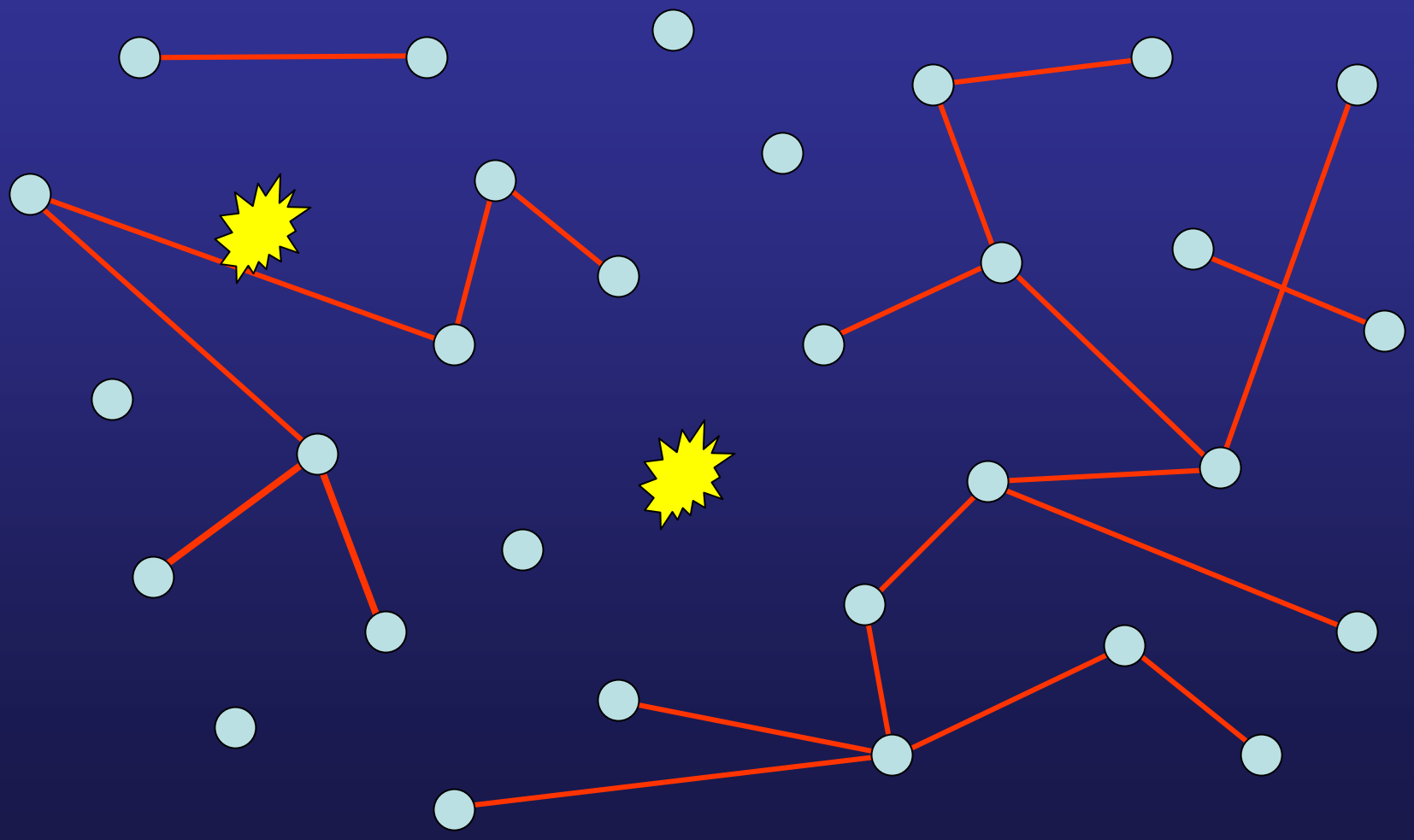


Barabasi AL, Bonabeau E. Scientific American 2003;288:60-69.

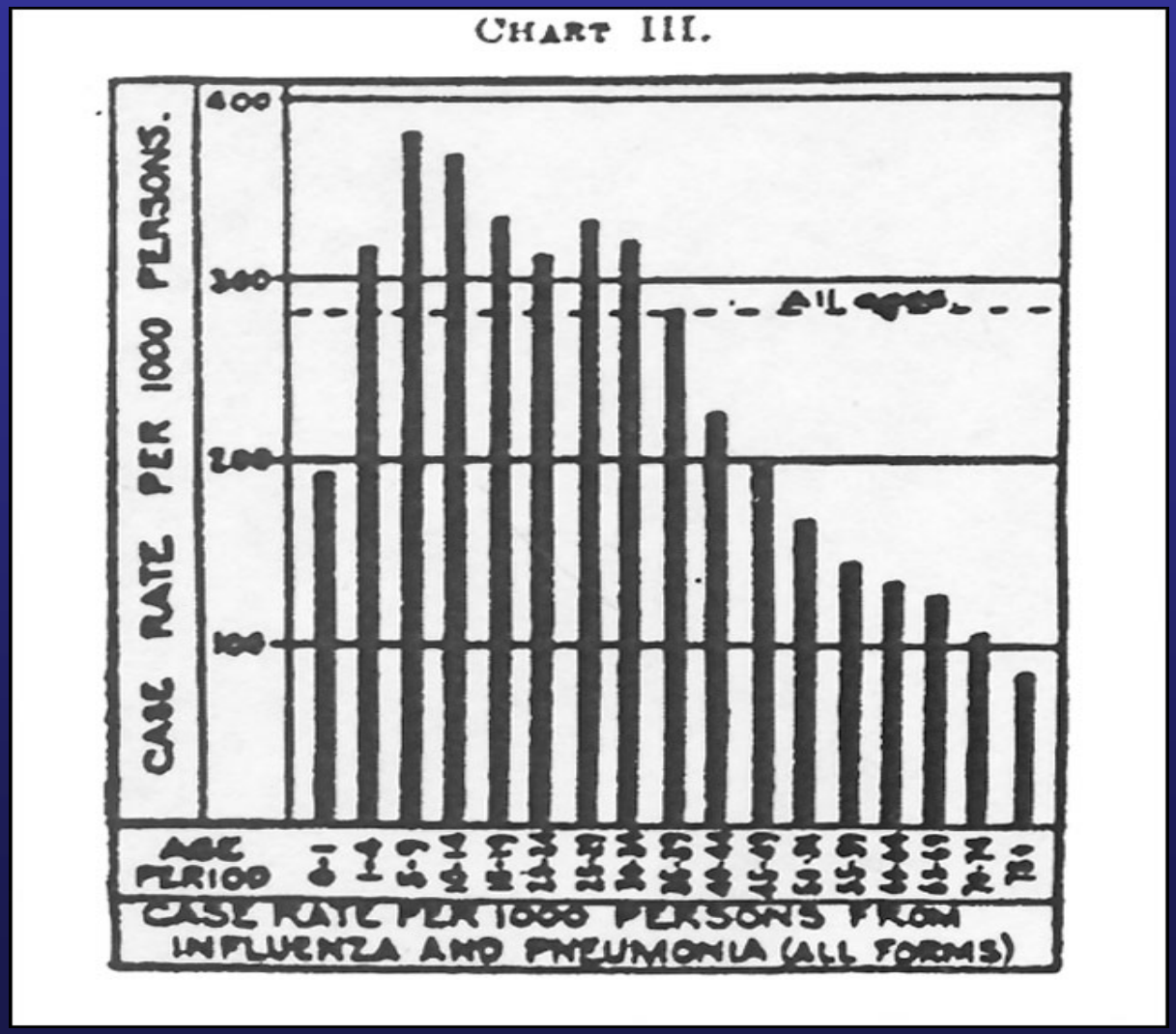
Susceptible to Targeted Attack



Susceptible to Targeted Attack



1918 Age-specific Attack Rates



McLaughlin AJ. Epidemiology and Etiology of Influenza. Boston Medical and Surgical Journal, July 1920.

Who Infects Who?

	To Children	To Teenagers	To Adults	To Seniors	Total From
From Children	**21.4**	**3.0**	**17.4**	**1.6**	**43.4**
From Teenagers	**2.4**	**10.4**	**8.5**	**0.7**	**21.9**
From Adults	**4.6**	**3.1**	**22.4**	**1.8**	**31.8**
From Seniors	**0.2**	**0.1**	**0.8**	**1.7**	**2.8**
Total To	**28.6**	**16.6**	**49.0**	**5.7**	

Likely sites of transmission

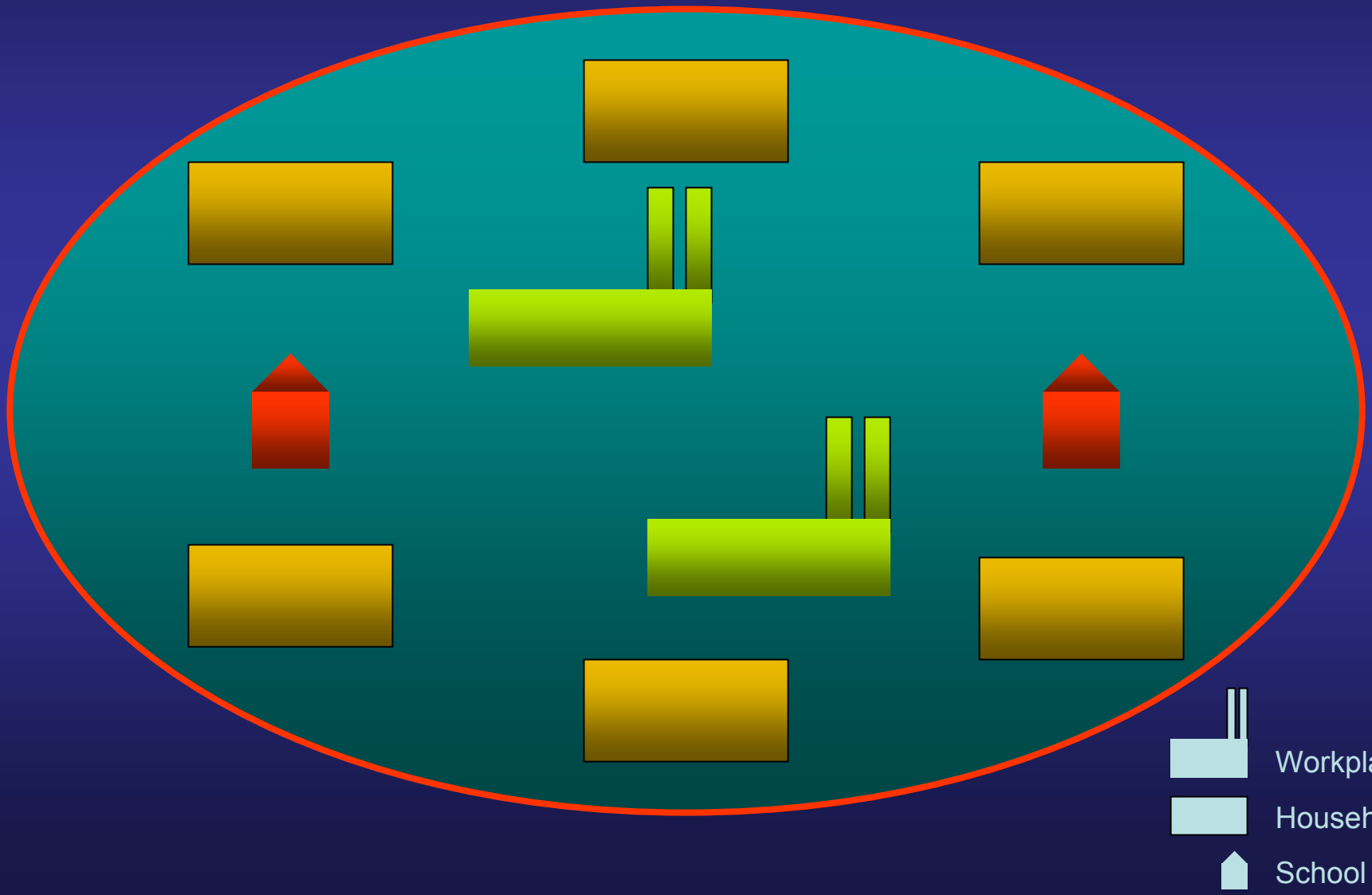
- **School**
- **Household**
- **Workplace**

Demographics

Children/Teenagers	**29%**
Adults	**59%**
Seniors	**12%**

Glass, RJ, et al. Local mitigation strategies for pandemic influenza. NISAC, SAND Number: 2005-7955J

Social Compartments



What is to be done?

Targeted Layered Containment: A Strategy for Communities

Layered Interventions

2.1

Close schools → 1.9

↓ cases

↑ HH & community transmission

1.9

Keep kids home → 1.5

↓ HH & community transmission

↑ relative importance of HH & workplace transmission

1.5

HH quarantine → 1.2

↓ cases

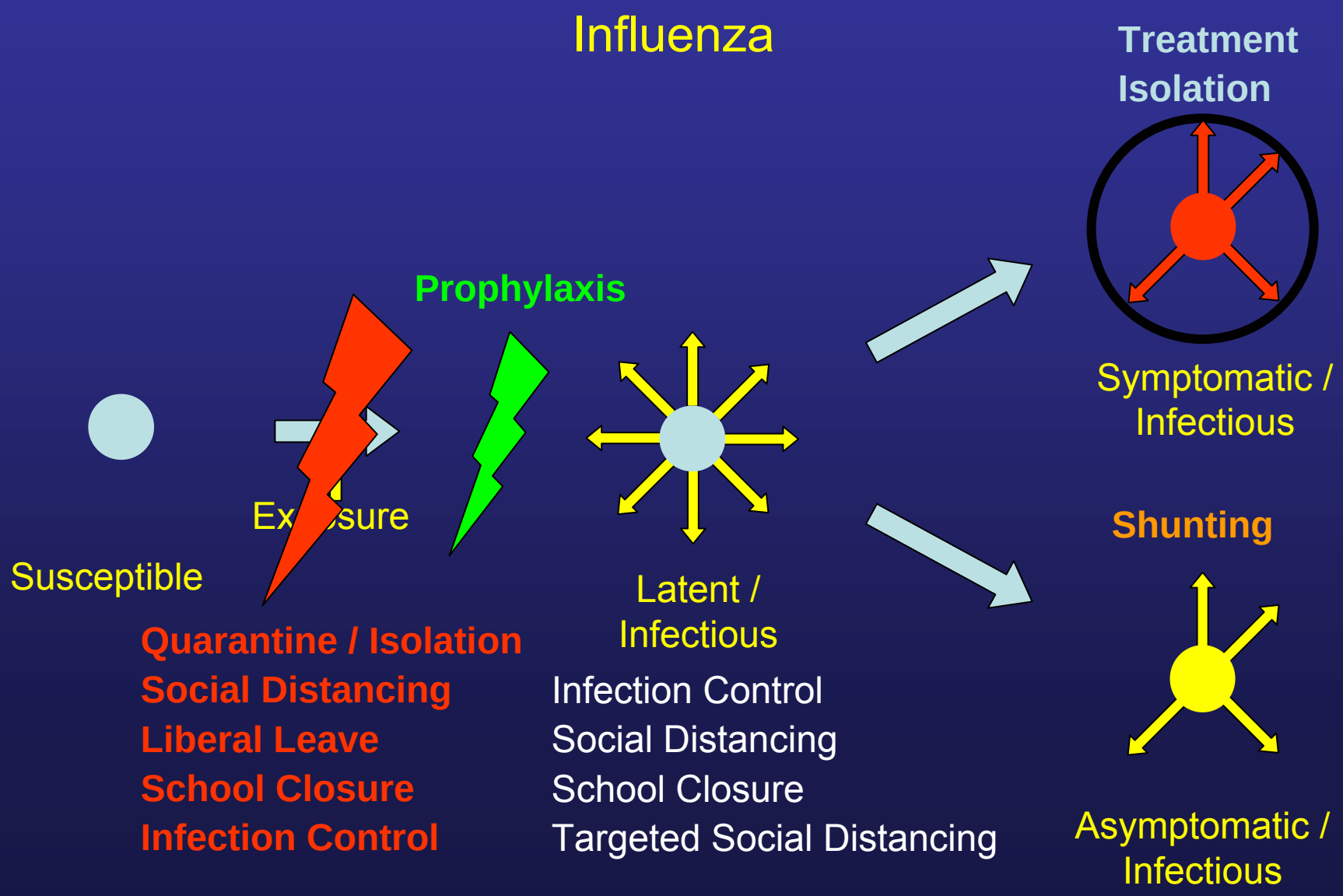
↑ relative importance of workplace & community

1.2

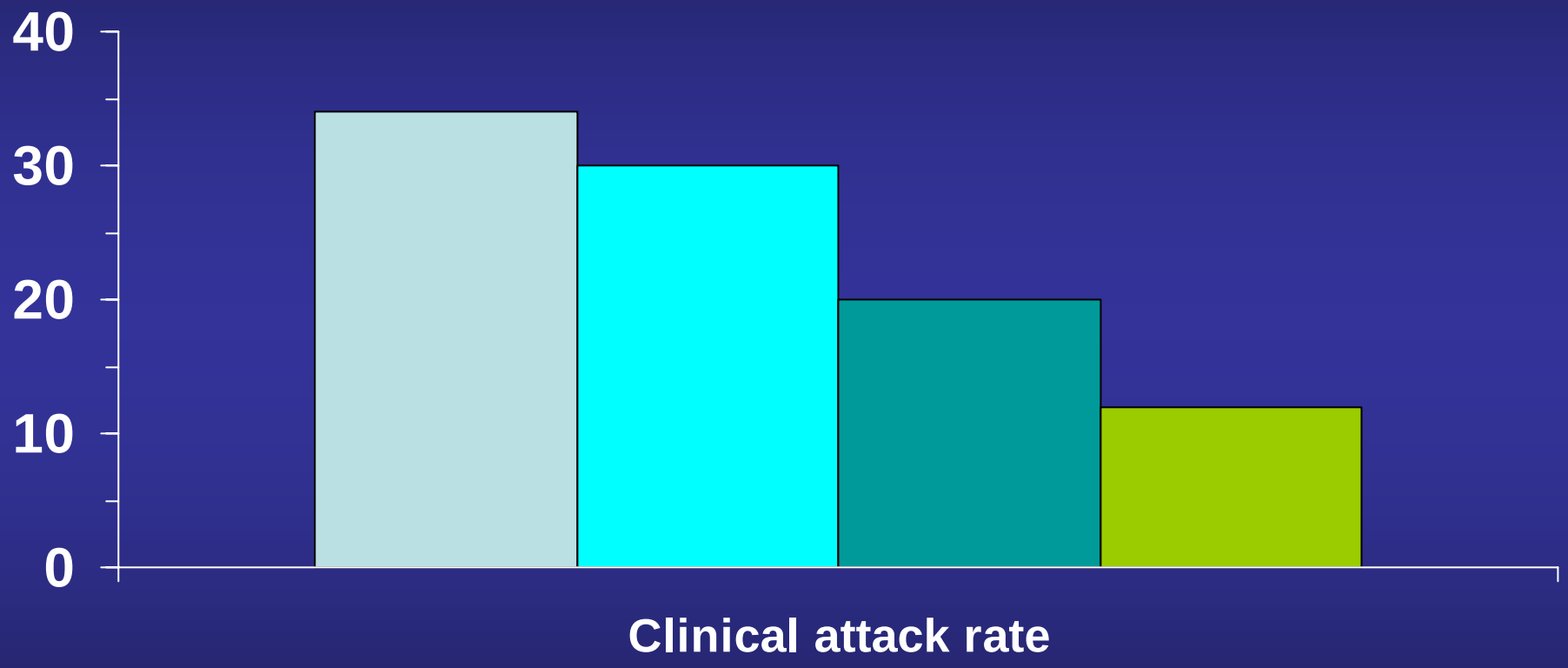
Social distancing → 0.9

↓ cases

Population-based Containment

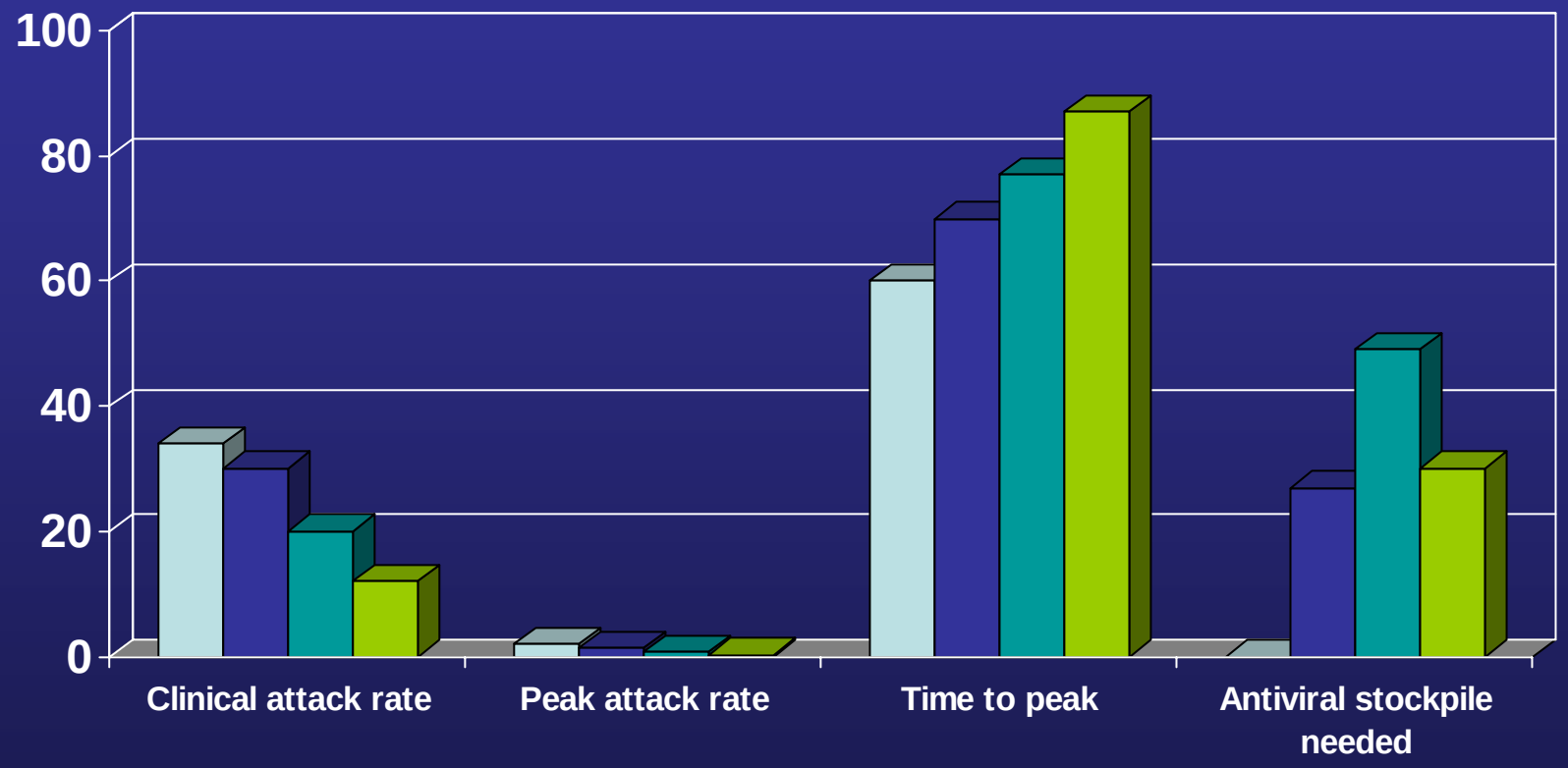


Value of Combining Strategies – Ferguson Model



- Base case (Ro=2.0)
- 90% case treatment + school closure
- 90% case treatment + school closure + 90% household prophylaxis
- 90% case treatment + school closure + 90% household prophylaxis + 70% household quarantine

Value of Combining Strategies – Ferguson Model



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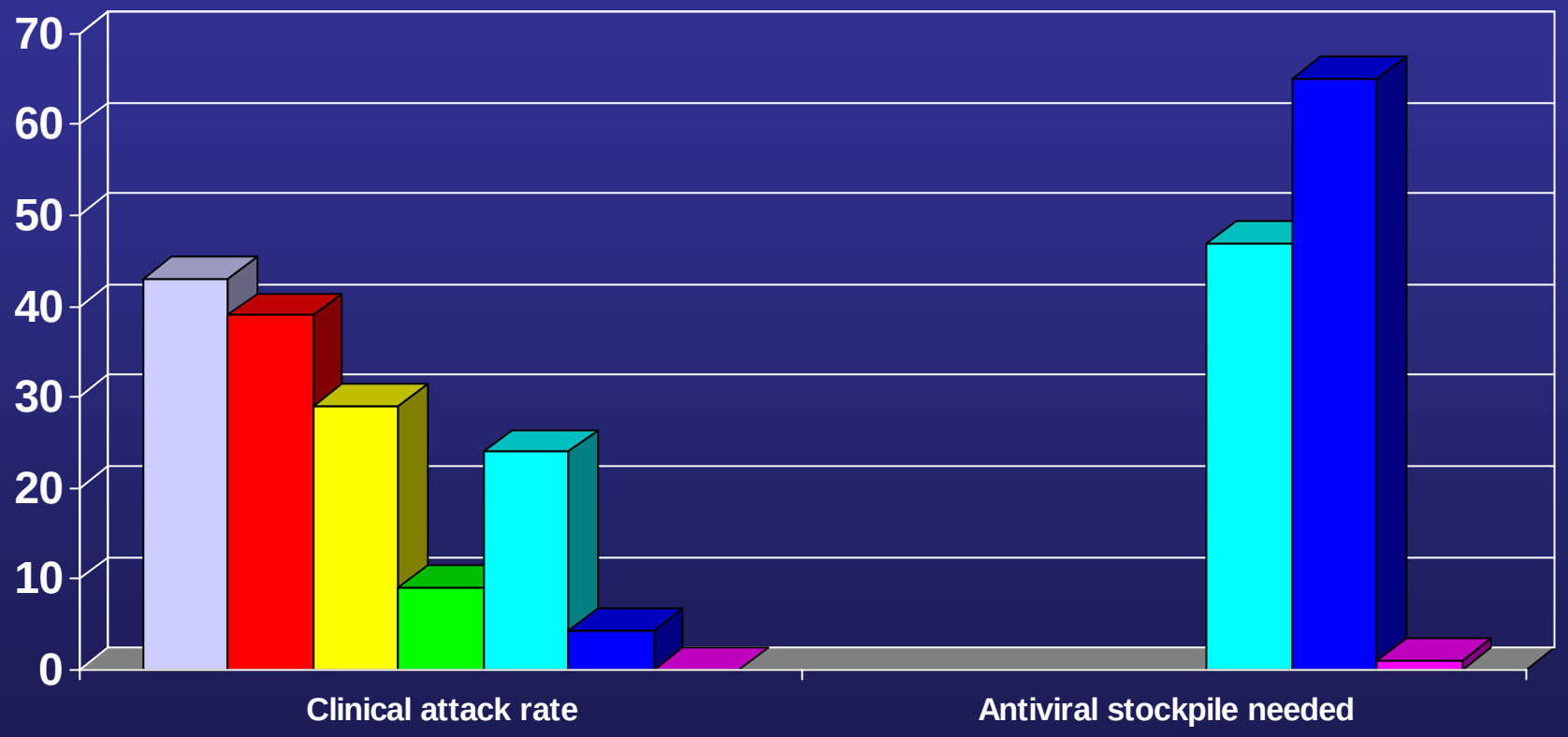
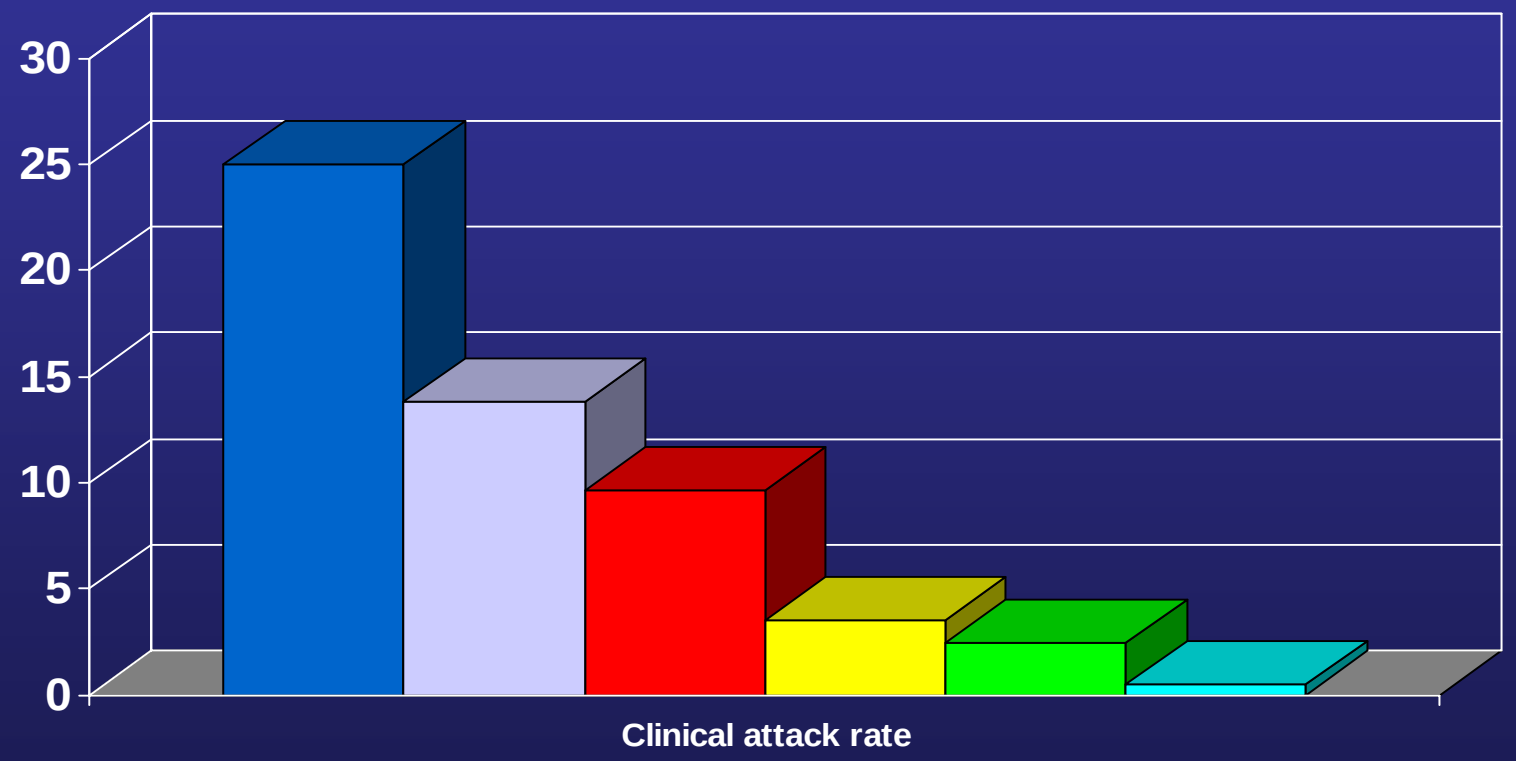
Value of combining strategies – Longini model



- Base case (Ro=1.9)
- Generic social distancing
- School closure
- School closure + generic social distancing
- 60% Case treatment + 60% household prophylaxis
- 60% Case treatment + 60% household prophylaxis + 60% social prophylaxis (60% TAP)
- 60% TAP + School closure + generic social distancing

Combining strategies – Glass model: Targeted Social Distancing



- Base case (Ro ~ 1.6)
- School closure alone
- School closure + targeted social distancing (10% compliance)
- School closure + targeted social distancing (30% compliance)
- School closure + targeted social distancing (50% compliance)
- School closure + targeted social distancing (90% compliance)

Community Planning for Pandemic Influenza

WHO Pandemic Influenza Phase

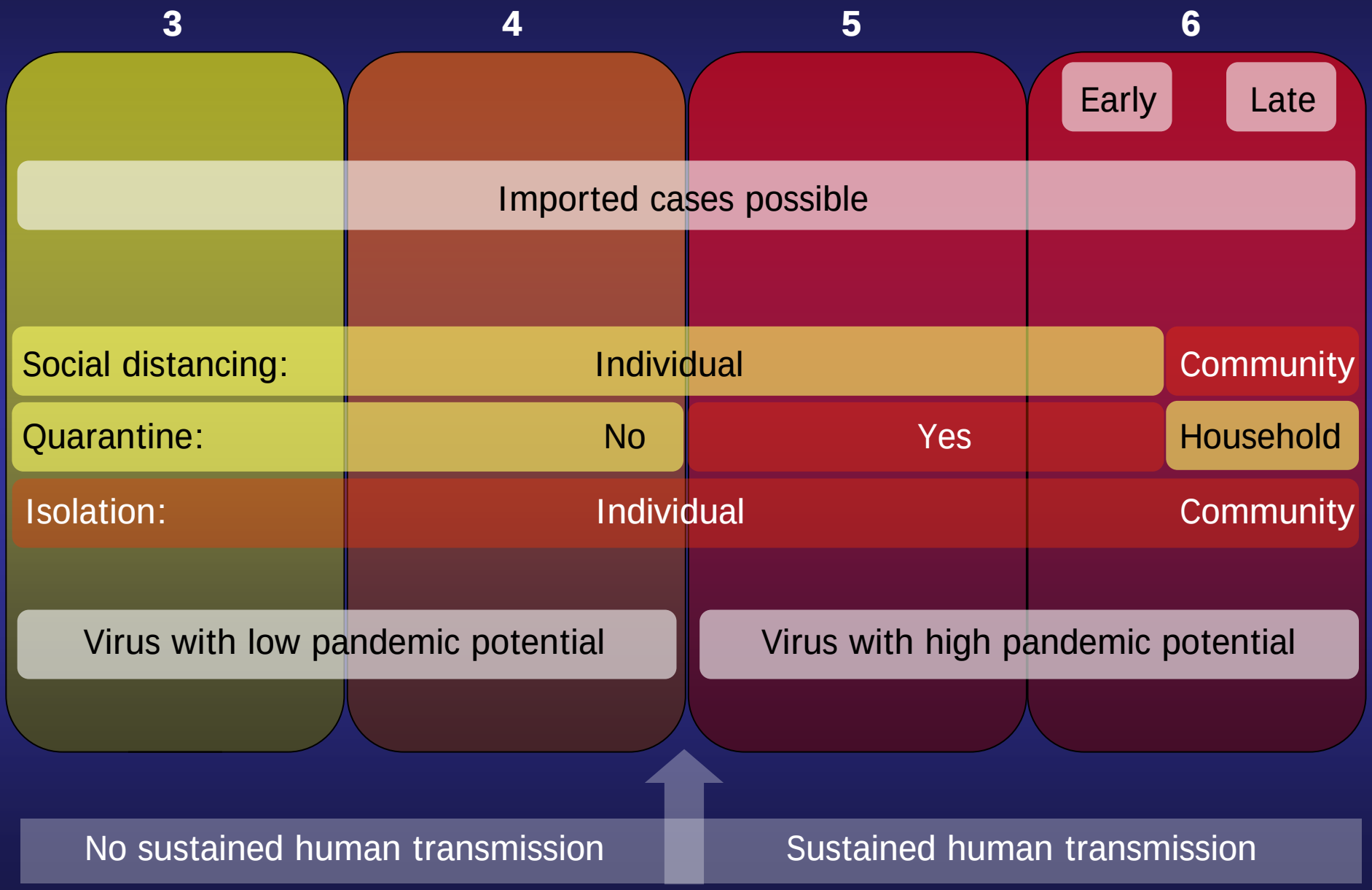
3	4	5	6
Human infections with new subtype No clusters No human-to-human transmission	Rare clusters Small number of cases per cluster Very limited human-to-human transmission Localized	Frequent clusters More cases per cluster Common human-to-human transmission Localized	Continuous transmission Regular human-to-human transmission Involves general population of large regions (worldwide)
Virus with low pandemic potential		Virus with high pandemic potential	

No sustained human transmission

Sustained human transmission

WHO Pandemic Influenza Phase

Proposed U.S. public health response in relationship to WHO Phases



Summary I: Non-pharmaceutical Interventions

- Depend on virus transmission characteristics and illness severity
- Measures at borders (international or within countries)- *limited early focus, phase 5-6a*
  - Health alert notices
  - Entry screening of international travelers
  - Exit screening from affected countries is recommended, especially if most countries not yet affected

Summary: Non-pharmaceutical Interventions TLC

- Ill patients should stay home
- Home quarantine for household contacts
- Social distancing measures
  - School closures may have profound impact
  - Workplace COOP (liberal leave vs. closure)
  - Cancellation of public events
- Individual infection control measures
  - Hand washing and cough etiquette
  - Mask use for ill persons
- Disinfection of contaminated surfaces
- Antiviral for treatment & targeted prophylaxis

Additional Considerations

- Planning for second-order effects
- Duration of implementation
- Intervention fatigue
- Socioeconomic disparities
- Sustained, predictable absenteeism
- Economic impact

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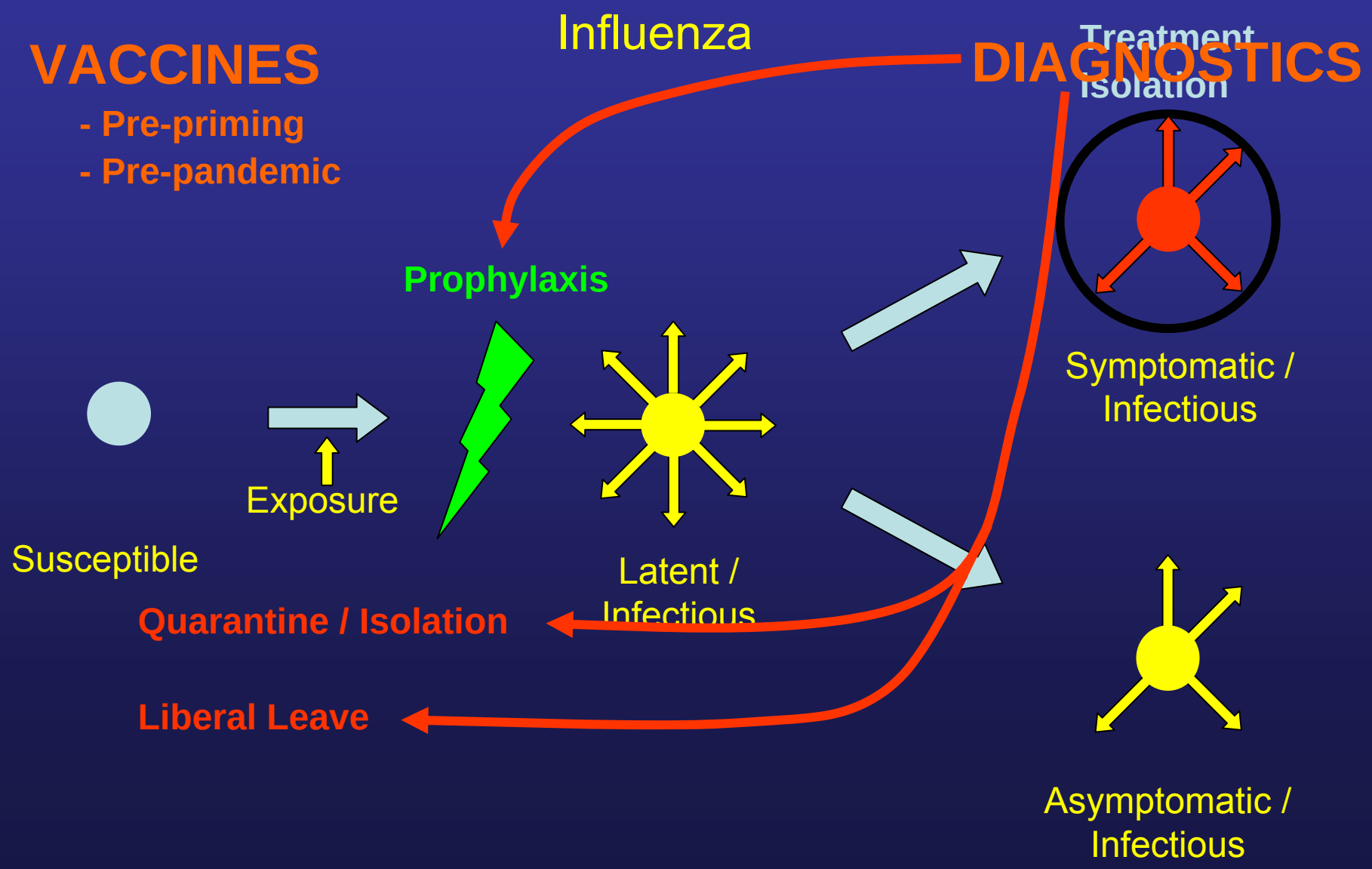
Ira Longini, PhD

Evidence to Support School Closure

- Children are thought to be the main introducers of influenza into households.
- Children appear to be more susceptible to influenza and more infectious than adults in well-designed prospective studies of risk factors of influenza transmission in households.
- Nationwide school closure in Israel during an influenza epidemic resulted in significant decreases in the diagnoses of respiratory infections (42%), visits to physicians (28%) and emergency departments (28%), and medication purchases (35%).

Population-based Containment



Critical Insight

Averaging over a highly heterogeneous contact network can hide critical features that could be exploited to design effective mitigation strategies

Baseball 2005 – Using Tools Effectively

Team Batting Average	On-base Percentage	Runs Scored	Team	Record
.262	.322	741	White Sox	99-63
.263	.320	701	Royals	56-106

TRIVIA QUESTION: Between them, how many times have clubs that Mark McGwire, Sammy Sosa, and Barry Bonds played for won the World Series?

ANSWER: 1 (Oakland Athletics, 1989)