

# Introduction to Stochastic Epidemic Models with Inference

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# Philosophy of this course (i.e., Reductionist statements)

- Analytic work on the transmission and control of infectious diseases depends on an understanding of epidemic theory
- A technical understanding of the underlying non-linear, stochastic dynamics of infectious disease transmission is the basis for this understanding
  - This almost always involves non-linear functions for the interaction of  $x$  susceptible and  $y$  infected people at time  $t$ .
- This technical understanding leads to sound inferential structures for estimation of governing parameters and functions

# Some Books of Interest for This Course

**Lecture Notes in  
Statistics**

**151**

**Håkan Andersson Tom Britton**

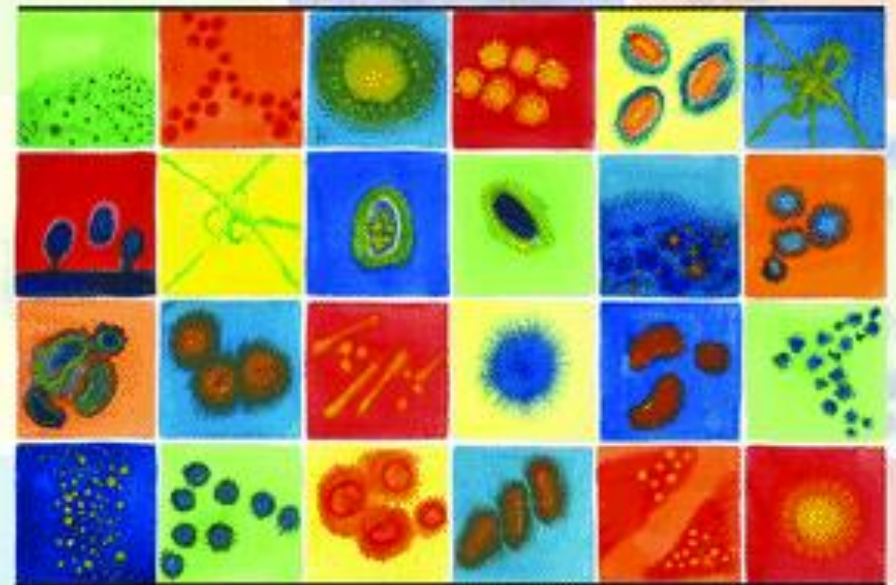
**Stochastic Epidemic  
Models and Their  
Statistical Analysis**



**Springer**

**Mathematical Tools for  
Understanding Infectious  
Disease Dynamics**

PRINCETON SERIES IN THEORETICAL AND COMPUTATIONAL BIOLOGY



**ODO DIEKMANN, HANS HEESTERBEEK, & TOM BRITTON**

M. Elizabeth Halloran • Ira M. Longini, Jr. • Claudio J. Struchiner

**Design and Analysis of Vaccine Studies**

Widespread immunization has many different kinds of effects in individuals and populations, including in the unvaccinated individuals. The challenge is in understanding and estimating all of these effects. This book presents a unified conceptual framework of the different effects of vaccination at the individual and at the population level. The book covers many different vaccine effects, including vaccine efficacy for susceptibility, for disease, for post-infection outcomes, and for infectiousness. The book includes methods for evaluating indirect, total and overall effects of vaccination programs in populations. Topics include household studies, evaluating correlates of immune protection, and applications of casual inference. Material on concepts of infectious disease epidemiology, transmission models, casual inference, and vaccines provides background for the reader. This is the first book to present vaccine evaluation in this comprehensive conceptual framework.

This book is intended for colleagues and students in statistics, biostatistics, epidemiology, and infectious diseases. Most essential concepts are described in simple language accessible to epidemiologists, followed by technical material accessible to statisticians.

Elizabeth Halloran and Ira Longini are professors of biostatistics at the University of Washington and the Fred Hutchinson Cancer Research Center in Seattle. Claudio Struchiner is professor of epidemiology and biostatistics at the Brazilian School of Public Health of the Oswaldo Cruz Foundation in Rio de Janeiro. The authors are prominent researchers in the area. Halloran and Struchiner developed the study designs for dependent happenings to delineate indirect, total, and overall effects. Halloran has made contributions at the interface of epidemiological methods, causal inference, and transmission dynamics. Longini works in the area of stochastic processes applied to epidemiological infectious disease problems, specializing in the mathematical and statistical theory of epidemics. Struchiner has contributed to understanding the role of transmission in interpreting vaccine effects.

EPIDEMIOLOGY

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» [springer.com](http://springer.com)

Design and Analysis of Vaccine Studies

**Design and Analysis  
of Vaccine Studies**
 Springer

Chapman & Hall/CRC  
Handbooks of Modern  
Statistical Methods

# Handbook of Infectious Disease Data Analysis

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*Edited by*  
**Leonhard Held**  
**Niel Hens**  
**Philip O'Neill**  
**Jacco Wallinga**

 **CRC Press**  
Taylor & Francis Group  
A CHAPMAN & HALL BOOK



# The Mathematical Theory of Infectious Diseases and its Applications

**Norman T. J. Bailey, M.A., D.Sc.**

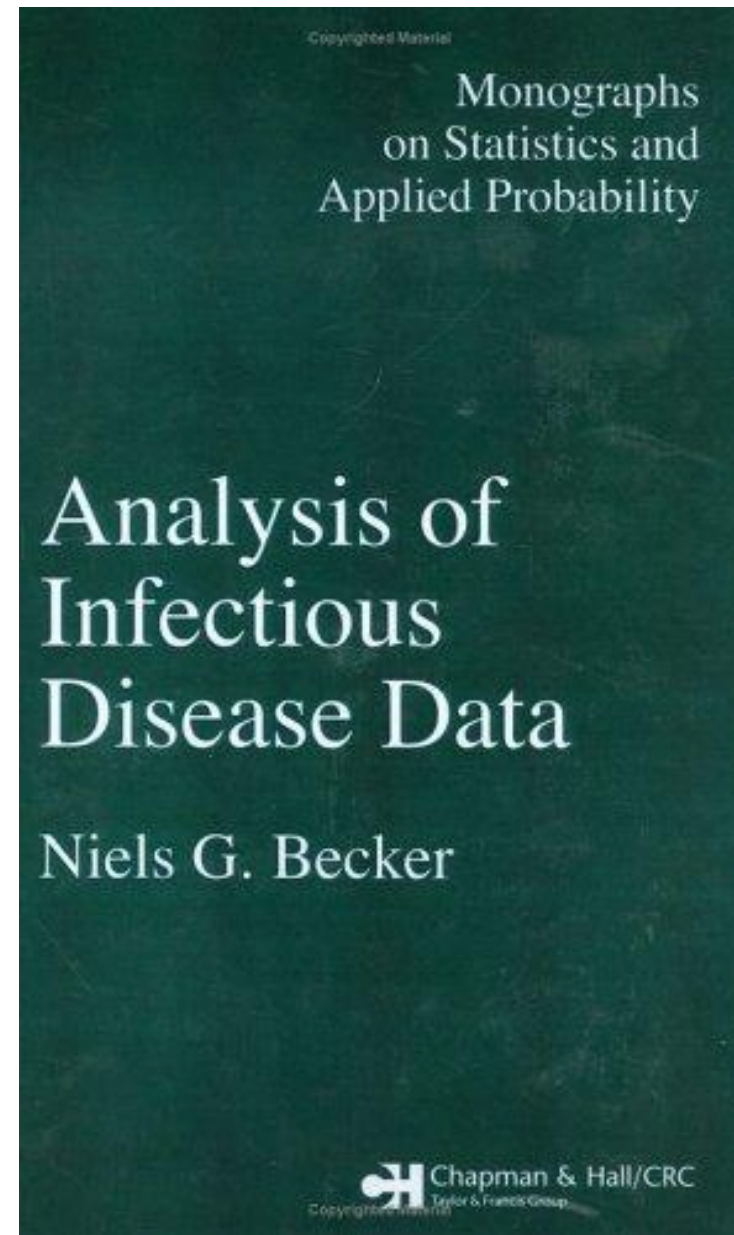
Unit of Health Statistical Methodology, World Health Organization,  
Geneva. Formerly Professor of Biomathematics, Cornell University  
Graduate School of Medical Sciences, and Member of  
the Sloan-Kettering Institute for Cancer Research

*Second edition*



**CHARLES GRIFFIN & COMPANY LTD**  
London and High Wycombe

1975, 1<sup>st</sup> addition 1957



# WHO Blueprint

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## WHO R&D Blueprint for Epidemics

[Credits](#)

### Targeting research on diseases of greatest epidemic and pandemic threat

**Prioritizing viruses of greatest epidemic and pandemic threat to accelerate R&D on safe and effective medical countermeasures.**

*The WHO list of priority pathogens of epidemic and pandemic threat is expected to be publicly release in the first half of 2024.*

In a proactive approach to bolster global readiness and response to potential future epidemics and pandemics, the Research and Development (R&D) Blueprint maintains its commitment to expediting research on emerging disease threats. The overarching goal is to reduce the time required for the development of safe and effective medical countermeasures—both curative and preventive.

To strategically channel collaborative research efforts with the worldwide scientific community, the World Health Organization (WHO) regularly issues an official list spotlighting pathogens with the highest epidemic and pandemic potential. This list specifically targets



21 November 2022 | News release

**WHO to identify pathogens that could cause future outbreaks and pandemics**

21 February 2023 | Call for experts

<https://www.who.int/teams/blueprint/who-r-and-d-blueprint-for-epidemics>



# Prioritizing the world's greatest pathogen threats

There are over **1,400** species of human pathogens in the world. These include viruses, bacteria and fungi.

To guide future research efforts, the World Health Organization (WHO) R&D Blueprint for Epidemics launched on 21 November 2022, a global initiative to scientifically review all pathogens that could cause a future global pandemic (like COVID-19) or an epidemic of international concern.

## How are the most dangerous pathogens shortlisted?

**200 plus** Global experts are independently reviewing and shortlisting pathogens of pandemic threat

**30** Viral families are being studied to ensure all viruses that can infect humans are reviewed for any pathogen X

**1** Bacteria group is being studied to scientifically screen for any bacteria pathogen X

**Pathogen X** A yet unknown pathogen not currently infecting humans but could be pathogenic due to: their zoonotic risk, mode of transmission, global warming, tropical deforestation, or other factors.

## Key scientific criteria to shortlist

How **transmissible** are they?

How **virulent** are they?

Are there sufficient **vaccines or treatments** in the event of an epidemic or pandemic?

Pathogen reviewed and not shortlisted. These are viruses or bacteria unlikely to cause an epidemic or pandemic or there is equitable access to safe and effective vaccines / treatments.

Pathogens reviewed and not shortlisted. These are viruses or bacteria that have epidemic or pandemic potential but where there is equitable access to safe and effective vaccines / treatments.

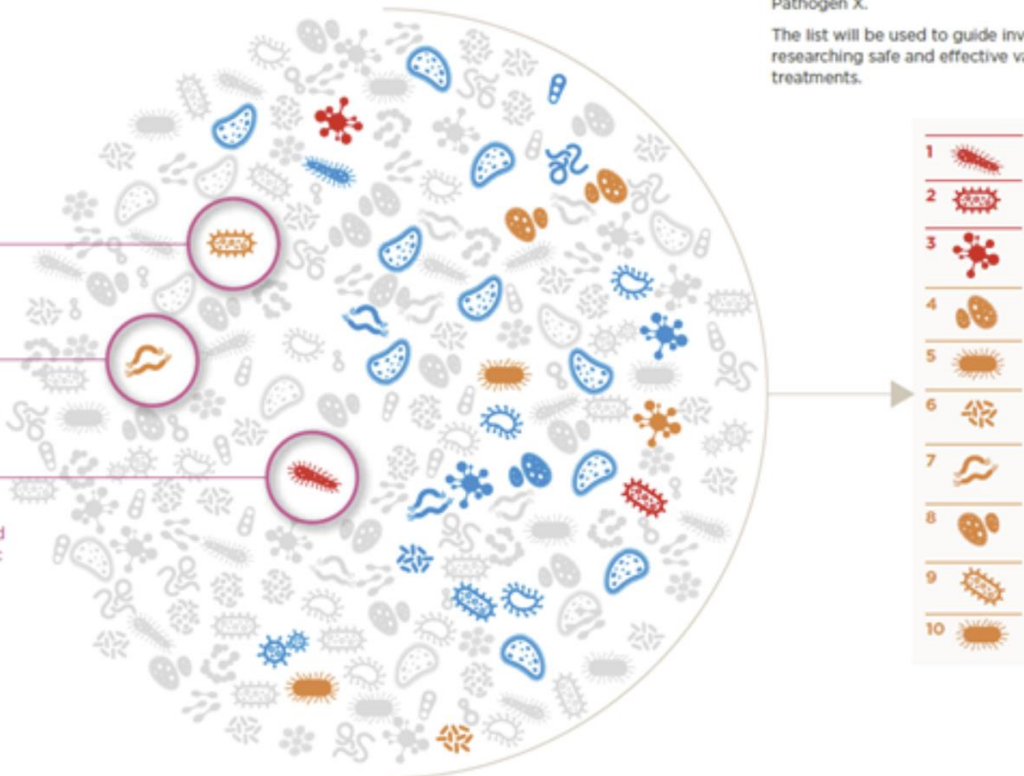
Pathogens reviewed and shortlisted. These are viruses or bacteria that have epidemic or pandemic potential and where there are no or insufficient vaccines / treatments.

Pathogens reviewed and shortlisted. These are viruses or bacteria where the epidemic or pandemic potential is currently unknown but shortlisted as potential Pathogen X.

## The final shortlist of priority pathogens

The list is expected in early 2024 and will shortlist priority viral families, the highest threat pathogens, the prototype pathogens for research and any Pathogen X.

The list will be used to guide investments into researching safe and effective vaccines and treatments.



Current trial design: filoviruses (Sudan, Marburg), mpox, COVID-19, maybe pandemic influenza soon.



# Seventy-seventh World Health Assembly

#WHA77

Credits

[← World Health Assembly](#)[77th World Health Assembly](#)[Daily updates](#)

The Seventy-seventh World Health Assembly is being held in Geneva, Switzerland, on 27 May – 1 June 2024. The theme of this year's Health Assembly is: All for Health, Health for All.

Proceedings will be webcast live from this web page. Simultaneous interpretation will be available in Arabic, Chinese, English, French, Russian and Spanish.

This content was last updated on 28 May 2024.

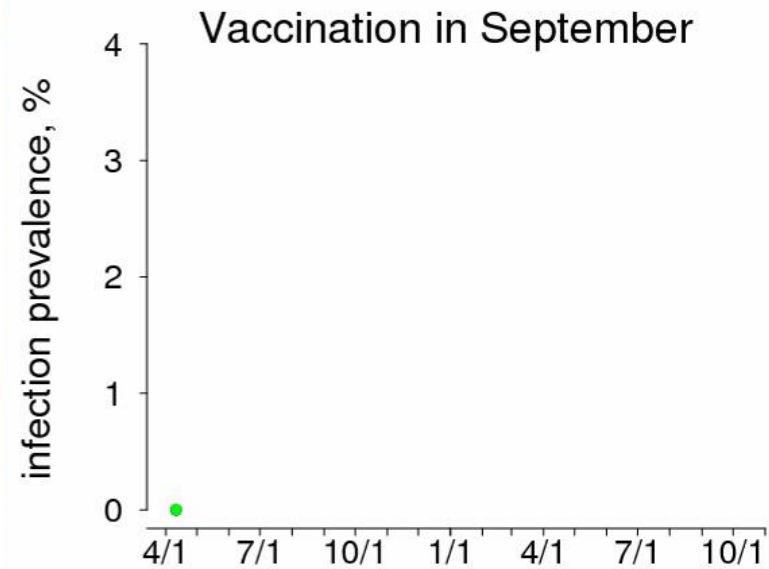
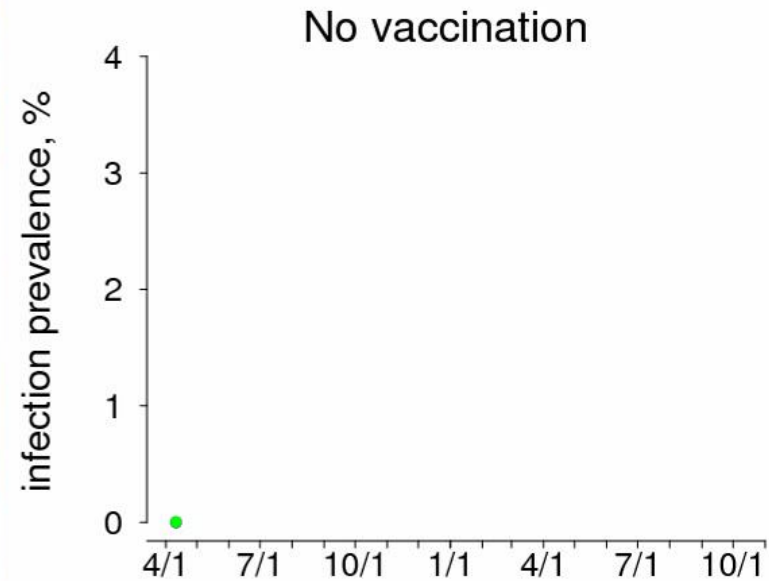
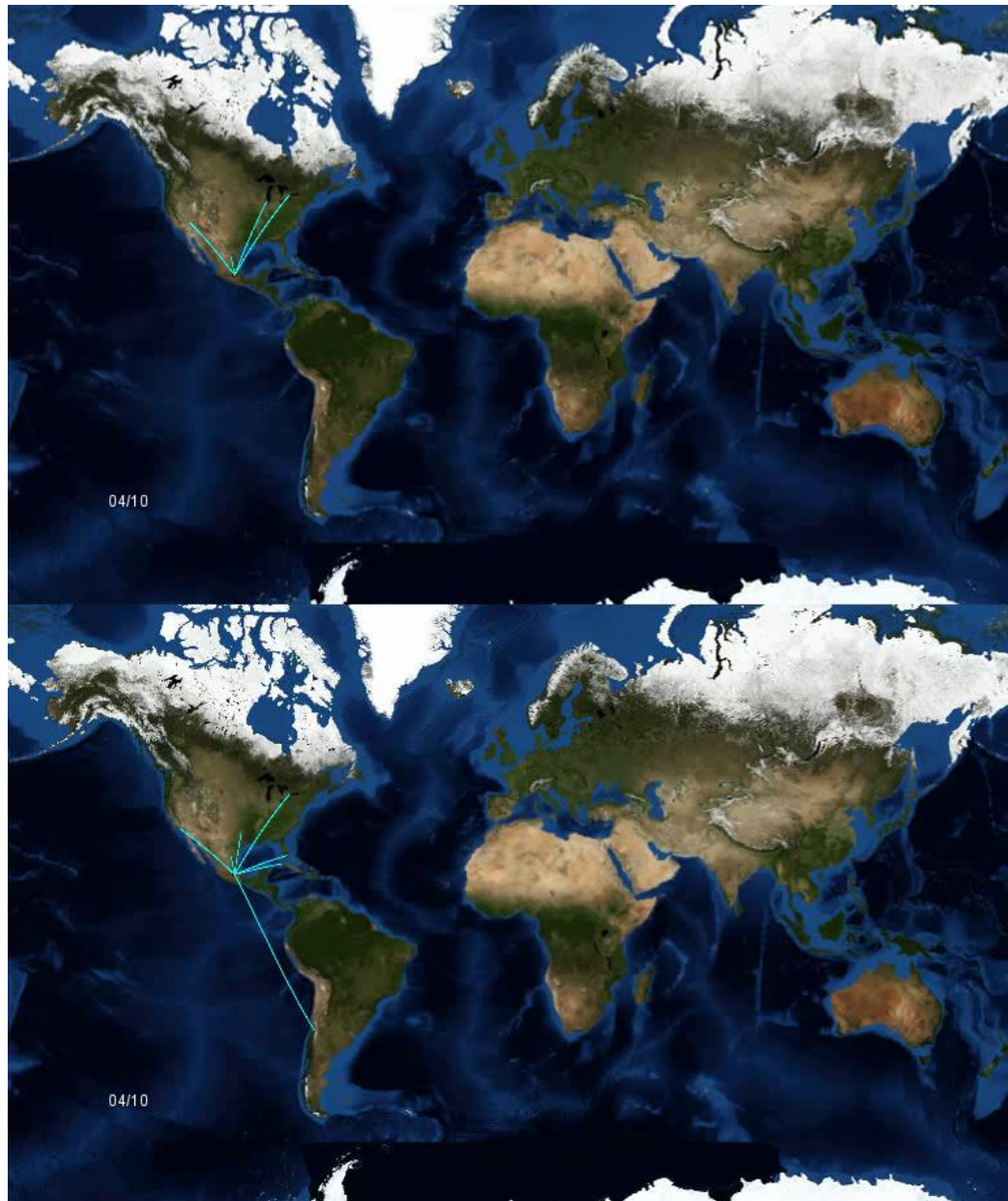
[WHO and the WHA – an explainer](#)[Media resources](#)

## Watch the World Health Assembly sessions

# An example



# Pandemic H1N1, 2009-2010: Stochastic, Compartmental, Patch Model



# Thanks

## On with the course!