SOCIETY OF ACTUARIES

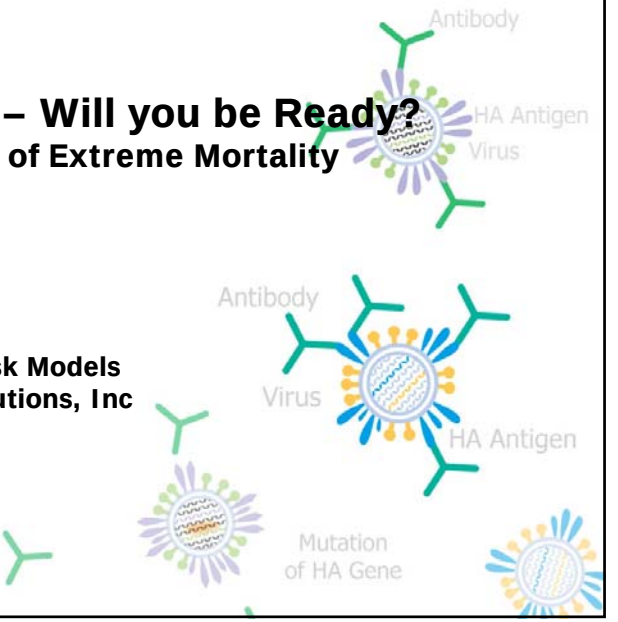
Life 2008 Spring Meeting
June 16-18, 2008

Session 8, Emerging Risk – Will You Be Ready?

Moderator
John O. Nigh, FSA, MAAA

Authors
Charles-Antoine Laplante
Maria Lomelo
John O. Nigh, FSA, MAAA

Emerging Risk – Will you be Ready?
Managing the Risk of Extreme Mortality

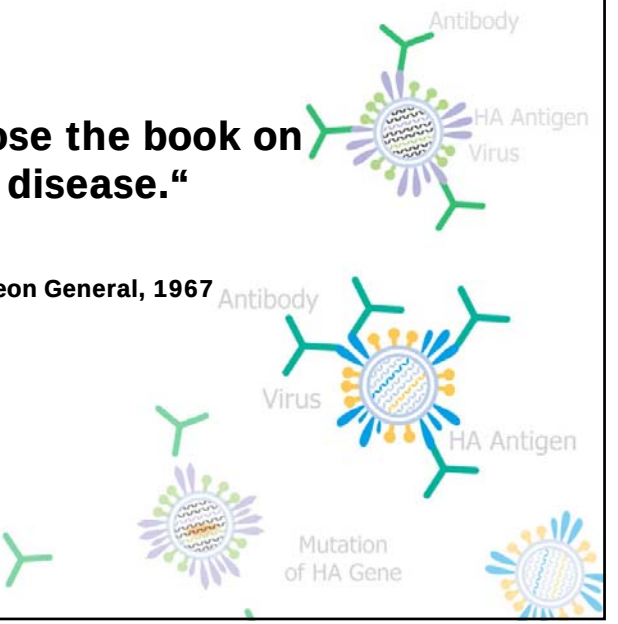


Maria Lomelo
Director, Emerging Risk Models
Risk Management Solutions, Inc

https://www.soa.org/files/pd/las/2008-qc-lomelo-8.pdf
(retrieved 16 May 2016)

It is "time to close the book on infectious disease."

-William Stewart, US Surgeon General, 1967

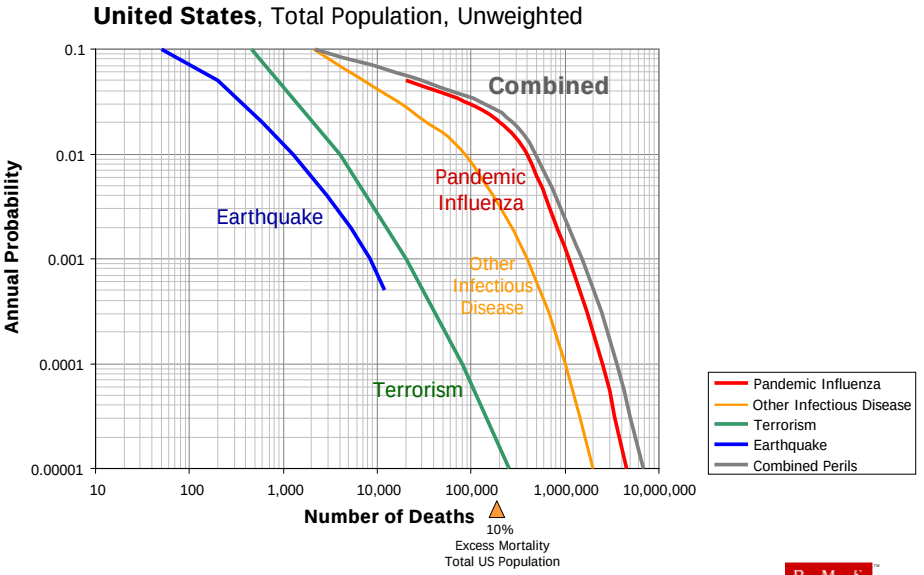


Agenda

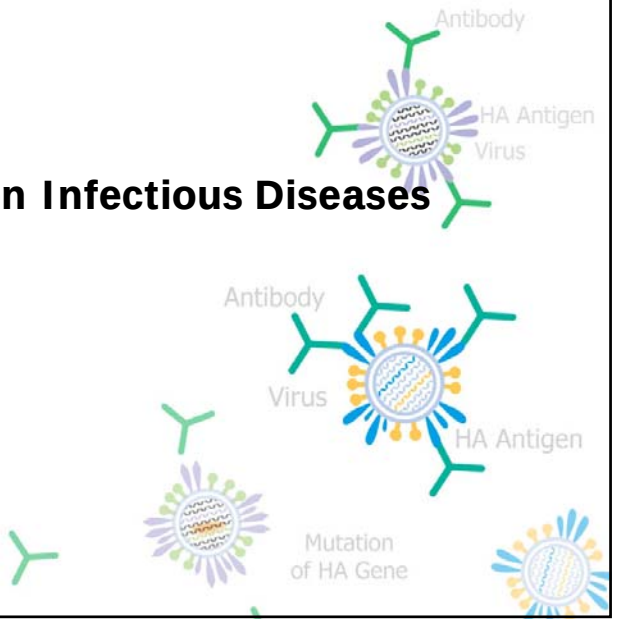
- Sources of Extreme Mortality
- Approach to Modeling Extreme Mortality
- Overview of Best Practices and Risk Management Applications of Stochastic Models

https://www.soa.org/files/pd/las/2008-qc-lomelo-8.pdf (retrieved 16 May 2016)

Event Mortality for Different Perils

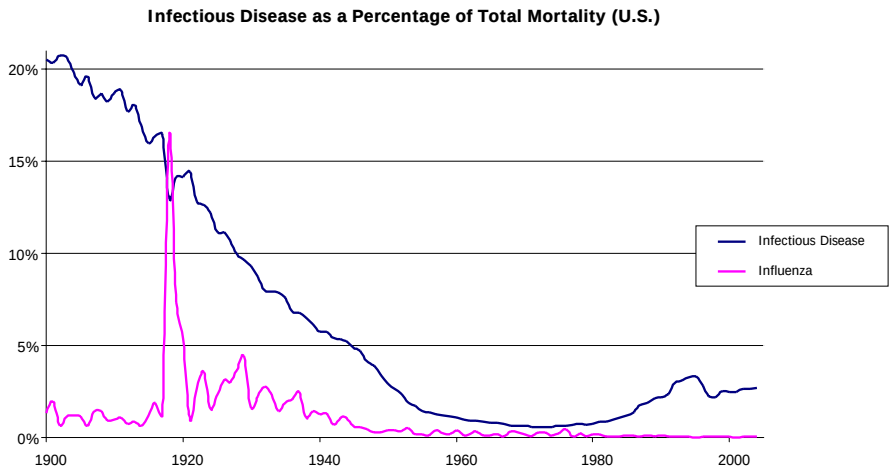


Background on Infectious Diseases



Historical Infectious Disease Risk

- Risk is changing as infectious agents and human populations adapt



Infectious Diseases Historically Responsible for Extreme Mortality

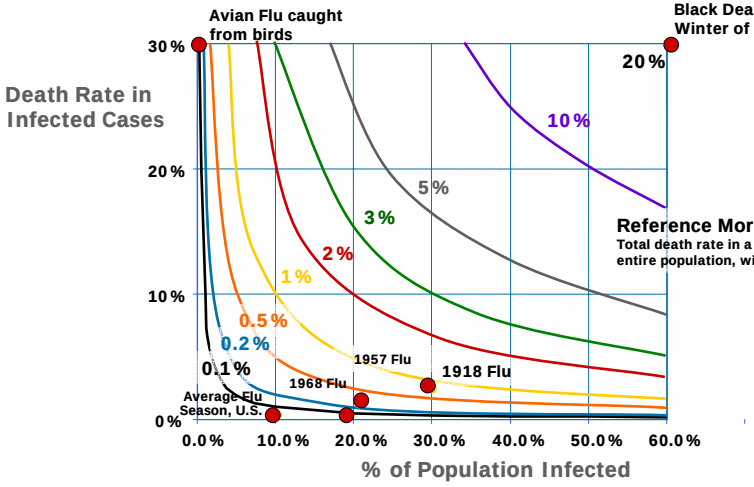
- Influenza (Pandemic candidate)
- HIV/AIDS (Low transmissibility)
- Measles (Effective vaccine, childhood illness)
- Smallpox (Effective vaccine)
- Tuberculosis (Treatment with antibiotics, low transmissibility)
- Polio (Effective vaccine)
- Syphilis (Treatment with antibiotics)
- Bubonic plague (Treatment with antibiotics)
- Malaria (Not endemic in index countries)
- Typhus (Effective vaccine)
- Yellow fever (Effective vaccine)
- Cholera (Water treatment, treatment with rehydration and antibiotics)
- Typhoid (Effective vaccine, treatment with antibiotics)
- Dysentery (Water treatment, treatment with amoebicide and antibiotics)

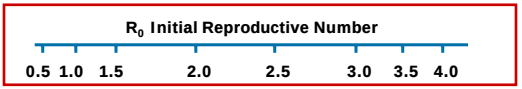
Infectious Disease Today

- At least 30 infectious diseases for which there are no cures have been identified since 1967
- One-third of deaths worldwide are caused by infectious disease

Disease	Number (millions)	Percent
Respiratory Infection	3.9	6.90%
HIV/AIDS	2.8	4.90%
Diarrheal	1.8	3.20%
Tuberculosis	1.6	2.70%
Malaria	1.3	2.20%
Measles	0.6	1.10%
Pertussis	0.29	0.50%
Tetanus	0.21	0.40%
Meningitis	0.17	0.30%
Syphilis	0.16	0.30%

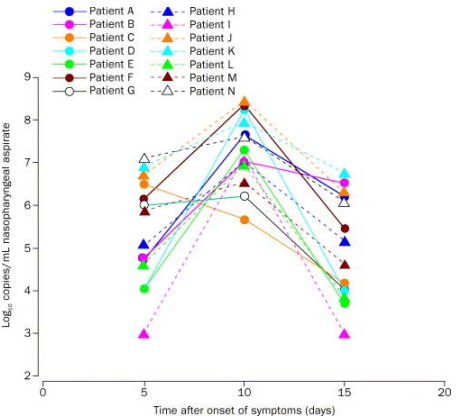
The Characteristics of an Infectious Disease





The difference between SARS and Flu

SARS	Pandemic Influenza
~8000 cases, 800 deaths (10%)	100s of millions infected, 2% or less died in 1918
R_0 ~ 3	R_0 ~ 2.5
Serial interval or generation time ~ 8.5 days	~ 4 days
People show symptoms before they are infectious	People can be infectious before they are symptomatic
Quarantine and isolation tremendously successful	Quarantine and isolation have limited benefit
No drugs or vaccine	Very limited supplies
Hospital transmission important	Community transmission major route

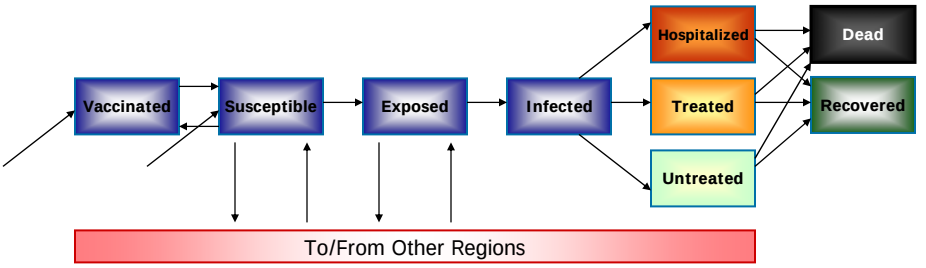


Factors Affecting the Impact of Infectious Disease

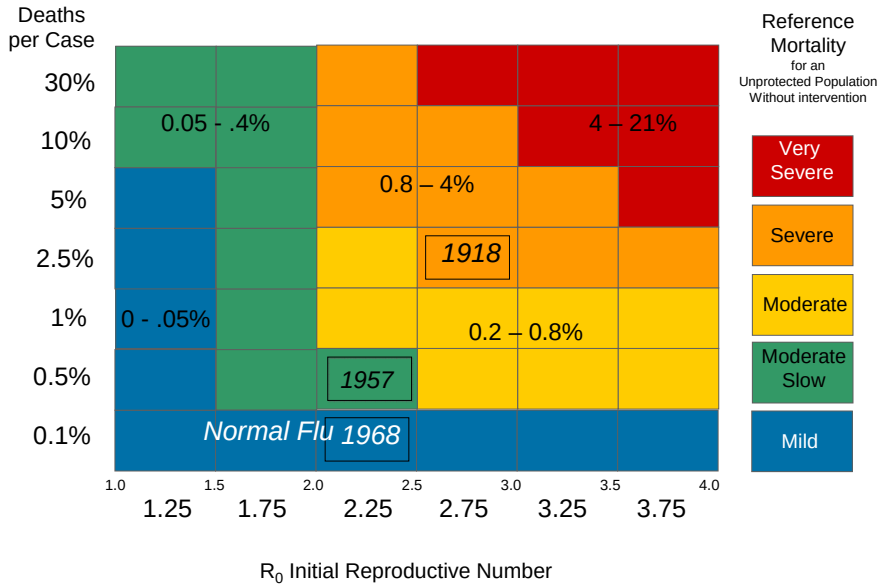
Agent	Environment	Host
Virulence	Global travel	Dose response
Transmissibility	Agriculture	Co-morbidity
Genetics	Interventions	Age
Susceptibility to treatment	Quarantine	Genetics
Mutation rate	Social Distancing	Nutrition
Type of organism	Access to care	Co-infection
Transmission route	Quality of care	Gender
Serial Interval	Global change	Antibodies
Incubation period	Weather	Past exposure
Latency period	Migration patterns	General health
Ability to survive	Animal lifecycles	Ethnicity

SIR Modeling

- Model the spread of the infection through the population using Susceptible, Infected, Recovered (SIR) epidemiogical modeling
- This is a well-established technique for epidemiologists and accurately describes the spread of diseases



Representative Pandemic Events

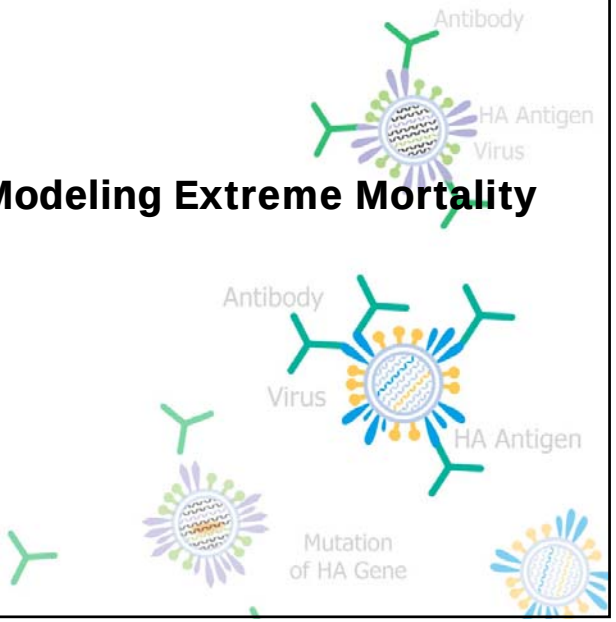


Stochastic Model Framework

Example:

1. **Probability of Pandemic** — Probability of antigenic shift occurring
2. **Infectiousness and Lethality** — 42 permutations of infectiousness and virulence
3. **Demographic Impact** — 3 Age mortality distributions
4. **Location of Outbreak** — 5 Regions where the outbreak may begin
5. **Vaccine Production** — 3 assumption sets about vaccine production
6. **National Counter-Measures** — Country-specific measures
7. **Pandemic Lifecycle** — Three year lifecycle

Approach to Modeling Extreme Mortality



Overview of Best Practices

Best practices for managing extreme mortality risk in the L&H industry involves obtaining a ***comprehensive*** view of the risk

- A comprehensive view is determined by ***probabilistically*** quantifying:
  - All applicable sources of extreme mortality (such as infectious disease, terrorism, earthquake, tsunami, industrial accident…)
  - All geographies covered
  - All lines of business provided
  - Correlation of other exposed assets such as real estate
- Stochastic modeling for key extreme mortality perils in territories with significant insurance exposure:
  - Earthquake: US, Japan, Taiwan, China
  - Terrorism: Global
  - Infectious Diseases: Global
  - Other perils include: Tsunami, industrial accident, volcano, war

Baseline Mortality

- Expect 1%-2% of policyholders to die in given year
- Excess Mortality occurs when extreme death rate (e.g. 10%) over baseline mortality occurs
- Incorporation of an autoregressive time series approach to determine portfolio-specific baseline mortality

General Mortality Performance of Insured Portfolios

Urban Concentrations of Pandemic Risk

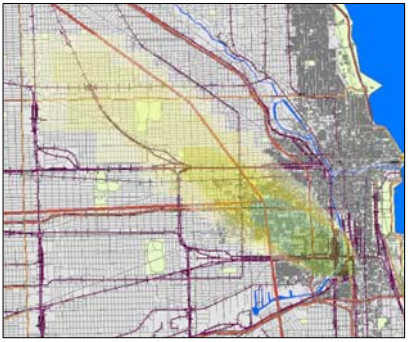
- Major cities have dense social networks with high contact rates,
- Disease spreads faster through population – higher infection levels
- Major transport hubs – index cases arrive earlier
- Public transport networks, schools and public assembly are key contributors
- But public health measures and infrastructure tend to be better

Influenza Pandemic Scenario: infected cases Day 65

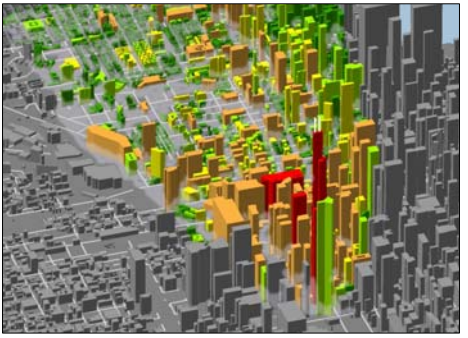
Risk by Occupation Type

- Risk driven by amount and type of human to human contact
- Higher risk occupations include:
  - Health care and emergency responders
  - Education & childcare
  - Jobs requiring contact with general public
    - Travel industry
    - Retail
    - Hospitality
- Insured locations with large numbers of employees
- Workers Comp insurance may respond to some occupations

Terrorism Risk Modeling



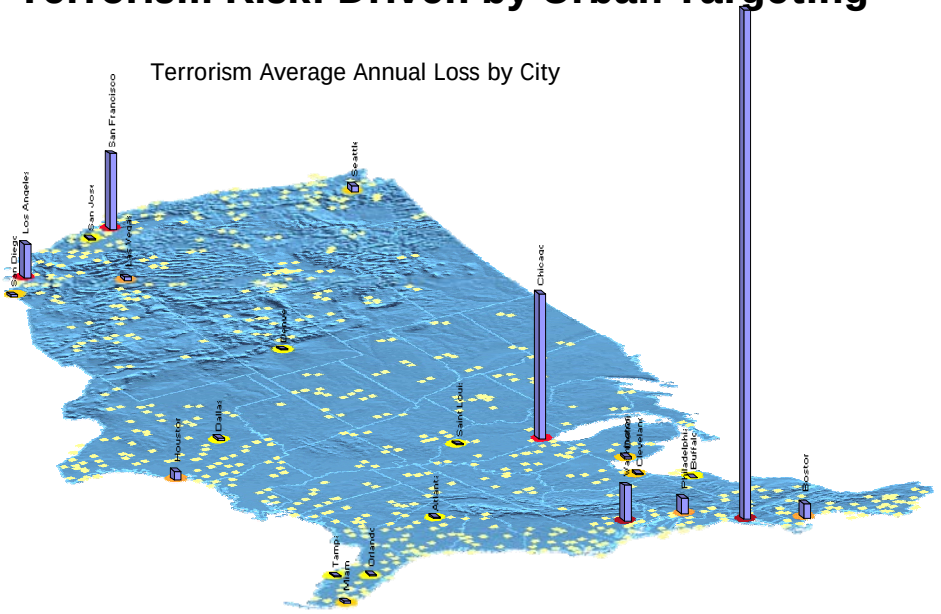
90 ton chlorine gas release from a rail tanker in Chicago



70 kg aerosolized anthrax biological agent released in Chicago

- CBRN terrorism has potential to cause large-scale mortality
- Spectacular terrorism strikes in western countries likely to be targeted at major cities
- Terrorism mortality likely to be highly concentrated in age-ranges of concern to insurers

Terrorism Risk: Driven by Urban Targeting



Risk Management Applications

- Portfolio Management
  - Risk transfer: provide a probabilistic quantification of excess mortality risk and inform risk transfer decisions
    - Reinsurance: return period losses, evaluation of reinsurance options
    - Securitization: develop triggers and structures to access the capital markets
  - Capital allocation
  - Understand correlation with non- L&H cat losses (e.g. real estate, corporate)
- Underwriting
  - Informing risk selection and pricing
  - Formulating underwriting guidelines
- Investment
  - Evaluate CAT risk of acquisition targets
  - Analyze the value and correlation of investing in CAT bonds

Summary

- Despite advances in healthcare infectious disease is still the greatest catastrophic threat facing human populations
- Modeling helps us understand and plan for what has happened and for what is possible
- Stochastic modeling approach provides ability to:
  - Quantify correlation within lines of business
  - Quantify correlation across risk transfer mechanisms
  - Recognition of the dynamic nature of mortality risk.