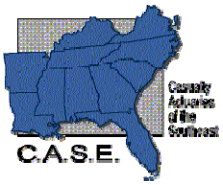
Pandemic Modelling

September 22, 2014

Presented To:



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Topics

- Background
- Potential Impact of a Pandemic on the U.S. Life Insurance Industry
- Potential Impact of a Pandemic on the U.S. Health Insurance Industry
- AIR Worldwide Stochastic Model

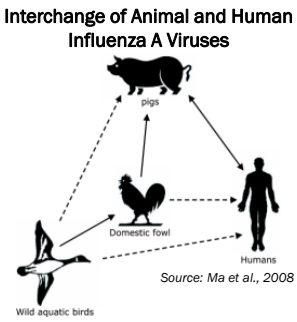
2

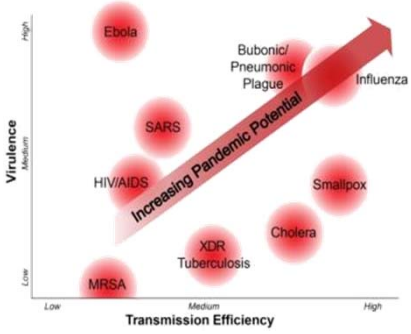
About Pandemics

- Pandemic influenza
  - New strain of virus; limited immunity
  - Ability to infect humans
  - Ability to transmit between humans (H2H)
- Pandemics are worldwide
  - Multiple waves common
    - Mutations attack different groups in each wave
    - Waves can occur at any time of the year
  - High morbidity (25-30%), low mortality (<<1%)

Influenza Has Significant Potential to Cause a High-Severity Pandemic

- New influenza strains arise from genetic mutations
  - Frequent re-assortment between human and animal strains
  - Low-fidelity replication results in many genetic variants
- Little to no human immunity to pandemic strains
- Novel influenza viruses have the potential for both high transmission efficiency and high virulence





History

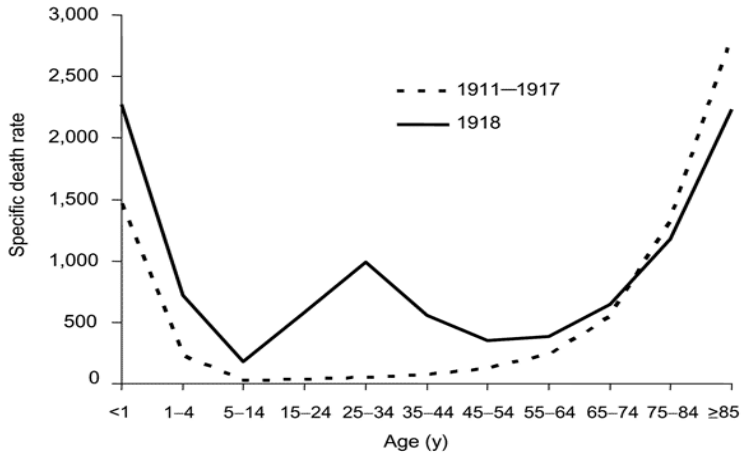
- Avg. of 3-4 influenza pandemics per century
- 20th century
  - 1968 Hong Kong flu
    - 50% of deaths above age 65
    - Many of rest were young
  - 1957 Asian flu
    - 65% of deaths above age 65
  - 1918 Spanish flu
    - 99% of deaths below age 65
    - V\ shaped mortality curve (normal is U)

1918 - 1920 Pandemic

- Worst in recorded history
  - 50 to 100 million died worldwide
    - Mostly fall 1918
  - 675,000 died in US
  - Virus mutated directly from birds
    - Other recent pandemics used reassortment (pigs)
  - Developed world impacted less
    - Sanitation
    - Better able to deal with secondary infections
    - Smaller percentage aged 20-40

Mortality Curve: U or W Shape?

Source: 1918 Influenza: the Mother of All Pandemics
Jeffery K. Taubenberger and David M. Morens†*



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Scenarios – U.S. Dept. HHS

- Moderate
  - Modeled using 1957
  - 90 million sick
  - 209,000 dead
  - GDP reduced minimally
- Severe
  - Modeled using 1918
  - 90 million sick
  - 2 million dead
  - GDP reduced 4.25%

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Why a Severe Scenario Won't Happen

- Better health care
  - Intensive care units
  - Germ theory
  - Antibiotics
  - Antivirals
- Better coordination between human and animal disease researchers
- Working toward a vaccine

Why a Severe Scenario Could Happen

- Supply chain constraints
  - Health care
  - Food/Energy/Services
- Virus mutations build resistance to drugs
- At risk population (smoking, HIV, cancer, diabetes)
- Poverty and malnutrition
- Response time
  - Vaccines take 6-9 months to develop

Special Populations

- Technological survivors
  - Hardware dependent (hemodialysis)
  - Drug dependent (insulin)
- Immuno-suppressed
- Chronic Illnesses
  - Heart disease, lung disease, COPD
- Smokers
- Elderly (65 – 84, 85+)

Hemodialysis

- Approximately 450,000 in US
  - Can live 1 – 2 weeks without dialysis
  - Typically take many medications
  - Many rely on public transportation
- Generally a shortage of nurses and tech
  - Assume 40% or more out
  - Limited number of machines running
  - Might have 2 – 4 weeks of supplies on hand
  - Need clean water and power
- How will decisions be made?

Potential Impact of a Pandemic on the U.S. Life Insurance Industry

Modelling Issues and Decisions

- Coverage types to include
- Pandemic scenarios to be considered
  - Stochastic vs deterministic
  - Source of pandemic scenario assumptions
  - Insured vs. population mortality
- Estimating industry aggregates
- Reinsurance counterparty risk
- Correlated asset depreciation risk

Coverages Included

- Life Insurance
  - Primary impetus for study
  - Analyze individual and group separately
    - But not product types (e.g., UL vs term)
- Annuities not included
  - Payout
  - GMDB
  - Some offset to life

Pandemic Scenarios: Stochastic vs. Deterministic

- Stochastic: powerful
- BUT parameters?
  - Prevalence: ask epidemiologists?
  - Severity data sparse & imprecise
    - 3 flu pandemics, SARS, current avian flu
    - Prevalence & mortality estimated
- Also, can miss extreme event
- Deterministic sources available

✓ Decision: Deterministic

Insured vs. Population Mortality

- HHS scenarios for population mortality
- Correlations favoring insured mortality:
  - Socio-economic
  - Health insurance
  - Nonsmoking
  - Disease burden
- BUT 1918 flu killed healthiest
- Used results of a Delphi study to estimate

Estimating Industry Aggregates

- In-force by quin age
  - LIMRA Study
  - US Census Bureau
- Reinsurance ceded by quin age
  - Industry Survey + Oversight group data
- Average reserve/1000 by quin age
  - Oversight group data
- Statutory surplus & total invested assets

Reinsurance Counterparty Risk

- Sensitive issue for reinsurers
- Material consideration for direct writers
- Model uses factor
- For industry aggregates, factor is ratio of:
  - Identifiable reinsurance capital
  - To scenario reinsurance death claims surge
  - Capped at 100%

Asset Depreciation Risk

- Severe pandemic would affect economy
- Asset values could decline
  - Global recession possible
  - Correlated with insurer cash need
  - Liquidity risk
- BUT possibly short duration
- Not explicitly modelled

Estimating Industry Aggregates

Exhibit 2, Page

Gross Claims Total - Moderate Scenario

General population 0.7 excess deaths per 1000, "U " mortality curve

Age Range	US Census Population (1)	Percent Owning (2)	Total IL & GL Policyholders (3)	Average Face (4)	Face Amount In Force (5)	Population XS Deaths per 1000 (6)	Mort Ratio Insured vs Gen Pop (7)	Insured Pop XS Deaths per 1000 (8)	General Population XS Deaths (9)	Total IL & GL Policyholder XS Deaths (10)	Gross Claims (11)
0 - 4	20,071,268	30%	6,021,380	21,500	129,459,670,000	1.75	57.1%	1.00	35,125	6,021	129,459,670
5 - 9	19,605,572	50%	9,802,786	21,500	210,759,899,000	0.11	57.1%	0.06	2,059	588	12,645,594
10 - 14	21,145,156	60%	12,687,094	21,500	272,772,521,000	0.11	57.1%	0.06	2,220	761	16,366,351
15 - 19	20,729,802	65%	13,474,372	36,154	487,150,370,000	0.11	57.1%	0.06	2,177	808	29,229,022
20 - 24	20,971,302	50%	10,485,652	55,000	576,710,860,000	0.11	57.1%	0.06	2,202	629	34,602,652
25 - 29	19,560,906	65%	12,714,589	100,769	1,281,239,390,000	0.21	57.1%	0.12	4,108	1,526	153,748,727
30 - 34	20,471,032	80%	16,376,826	131,250	2,149,458,440,000	0.21	57.1%	0.12	4,299	1,965	257,935,013
35 - 39	21,052,318	90%	18,947,086	208,333	3,947,309,565,000	0.21	57.1%	0.12	4,421	2,274	473,677,148
40 - 44	23,056,334	95%	21,903,517	213,158	4,668,907,545,000	0.21	57.1%	0.12	4,842	2,628	560,268,905
45 - 49	22,122,629	100%	22,122,630	150,000	3,318,394,500,000	0.42	57.1%	0.24	9,292	5,309	796,414,680
50 - 54	19,496,176	100%	19,496,176	125,000	2,437,022,000,000	0.63	57.1%	0.36	12,283	7,019	877,327,920
55 - 59	16,489,501	90%	14,840,550	112,500	1,669,561,875,000	0.84	57.1%	0.48	13,851	7,123	801,389,700
60 - 64	12,589,423	85%	10,701,009	90,588	969,385,520,000	1.12	57.1%	0.64	14,100	6,849	620,406,733
65 - 69	9,956,467	80%	7,965,174	69,375	552,583,950,000	1.40	57.1%	0.80	13,939	6,372	442,067,160
70 - 74	8,507,005	75%	6,380,254	61,667	393,449,010,000	1.75	57.1%	1.00	14,887	6,380	393,449,010
75 - 79	7,410,757	70%	5,187,530	56,429	292,724,920,000	2.24	57.1%	1.28	16,600	6,640	374,687,898
80 - 84	5,560,125	70%	3,892,088	45,714	177,924,025,000	2.73	57.1%	1.56	15,179	6,072	277,561,479
85+	4,859,631	70%	3,401,742	45,714	155,508,210,000	7.00	57.1%	4.00	34,017	13,607	622,032,840
Total	293,655,404		216,400,455		23,690,322,270,000				205,600	82,573	**6,873,270,501**
							Excess deaths per 1000		**0.70**	**0.38**	**0.29**
			Average Face Amount		109,474		*Percent less than 20*		**20.2%**	**9.9%**	**2.7%**
			Net Amount Inforce (billions)		18,127		*Percent 20 - 64*		**33.8%**	**42.8%**	**66.6%**
			% Total Policyholders		73.7%			*Percent 65+*	**46.0%**	**47.3%**	**30.7%**

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Exhibit 2, Page

Total Net Life Insurance Claims - Moderate Scenario

General population 0.7 excess deaths per 1000, "U " mortality curve

Age Range	Gross Claims (1)	Reserve Release (2)	Reinsurance Credit (3)	Net Claims Before Taxes (4)	Tax Rate (5)	Net Claims After Taxes (6)
0 - 4	129,459,670	663,680	6,249,006	122,546,984	35%	79,655,539
5 - 9	12,645,594	138,348	553,612	11,953,634	35%	7,769,862
10 - 14	16,366,351	313,800	642,068	15,410,483	35%	10,016,814
15 - 19	29,229,022	1,267,049	762,671	27,199,303	35%	17,679,547
20 - 24	34,602,652	1,643,825	1,860,894	31,097,932	35%	20,213,656
25 - 29	153,748,727	1,565,037	28,657,825	123,525,865	35%	80,291,812
30 - 34	257,935,013	2,658,814	47,472,270	207,803,928	35%	135,072,553
35 - 39	473,677,148	5,415,058	97,296,060	370,966,029	35%	241,127,919
40 - 44	560,268,905	10,691,741	117,344,948	432,232,217	35%	280,950,941
45 - 49	796,414,680	21,842,102	211,512,048	563,060,530	35%	365,989,345
50 - 54	877,327,920	25,194,403	295,572,714	556,560,803	35%	361,764,522
55 - 59	801,389,700	30,966,486	272,742,116	497,681,098	35%	323,492,714
60 - 64	620,406,733	35,254,699	230,018,452	355,133,583	35%	230,836,829
65 - 69	442,067,160	54,871,344	149,094,317	238,101,499	35%	154,765,974
70 - 74	393,449,010	92,007,888	127,087,510	174,353,612	35%	113,329,848
75 - 79	374,687,898	118,848,364	107,831,289	148,008,245	35%	96,205,360
80 - 84	277,561,479	124,389,072	41,811,660	111,360,746	35%	72,384,485
85+	622,032,840	353,366,218	64,444,683	204,221,939	35%	132,744,261
Total	6,873,270,501	881,097,928	1,800,954,143	4,191,218,431		2,724,291,980

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Pandemic Claims as % of Surplus

U.S. Direct Life Insurance Industry Estimated Net Claims *(Billions of Dollars)*			
		Moderate Scenario	Severe Scenario
	Individual	$ 1.3	$ 34.3
	Group	1.5	30.0
	Total	2.8	64.3
	2005 Claims	$ 107.6	$ 107.6
	% Claims	2.6%	59.8%
	2005 Surplus	$ 255.7	$ 255.7
	% Surplus	1.1%	25.1%
	2005 RBC	$ 62.5	$ 62.5
	% of RBC	4.5%	102.9%

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Potential Impact of a Pandemic on the U.S. Health Insurance Industry

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Summary

- Assumption development
- Impact on providers
- Impact on insurers
- Impact on self insured plans
- Other issues

Exposure

- United States
- Private Payers
  - *Insured and Self-Insured*
- Major Medical Only
  - *No LTD, STD, LTC*

Modeling Approach

- How many covered individuals get sick
  - Morbidity
- What type of care they receive
  - Severity of illness
  - Provider level & capacity
- Estimate the cost of services
- Distribute costs to payers

Morbidity

- Attack Rate: *How Many?*
- Severity: *Level of Care*
- Distribution by Age: *0 – 17, 18 – 64, 65+*
- Insured vs. General Population: *Impact of Selection?*

Levels of Care

- Three in the literature
  - *Self - Care*
  - *Outpatient*
  - *Hospitalization*
- Distribution varies by scenario
- Additional level contemplated in severe
  - *Alternative Care Facility (Overflow)*

Waves and Surge Duration

- Waves
  - Pandemics have different wave patterns
  - Attack rate is sum of all waves
- Surge Duration
  - Like waves, duration varies
  - Will interact with system capacity
  - Conservative (and simplifying) approach is to assume all in one year

Potential Impact on Providers

Provider Landscape – Hospital

- Private Providers
  - Hospital Chains
  - HMOs
  - Urban vs Rural
  - Profit vs Not-For-Profit
- Public Providers
  - Department of Defense
  - Veterans Administration
  - Indian Health Service
  - Public/Municipal (Local)
- Alternate / Overflow

Provider Assumptions – Hospital

- Capacity Constraints
  - Staffed Beds
  - Average Length of Stay
- Cost Estimate
  - Acute Respiratory Distress Syndrome (ARDS)
  - SARS
  - Drug resistant pneumonia
  - Influenza
- Length of Stay Depends on Scenario
  - *Mid LOS may be longer, cost more than severe*

Pandemic Scenarios – US Dept. HHS

Characteristic	Moderate (1957-like)	Severe(1918-like)
Illness	90 million (30%)	90 million (30%)
Outpatient	45 million (50%)	45 million (50%)
Hospitalization	865,000	9,900,000
ICU care	128,750	1,485,000
Mechanical Ventilation	64,975	742,500
Deaths	209,000	1,903,000

U.S. System Capacity

- 975,000 beds
  - Worldwide nursing shortage
  - Reduction in acute beds
- 105,000 mechanical ventilators
  - 100,000 in use during normal flu season
  - National stockpile has 5,000
- 110,000 flu hospitalizations per year

Displacement

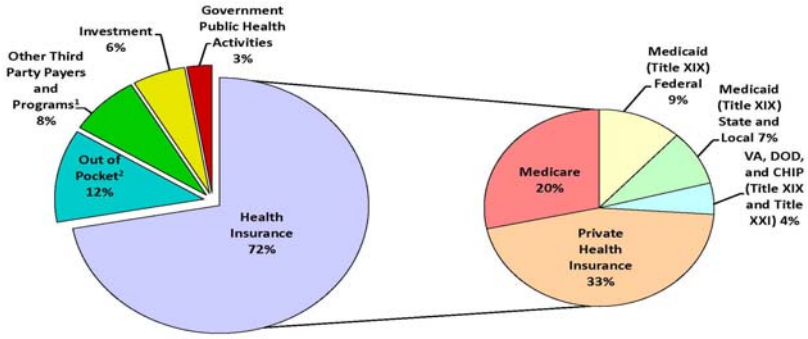
- Every $1 spent on pandemic care crowds out elective care
- Conventional wisdom in a natural disaster is claims go down with little or no "make up"
  - Health infrastructure damaged
  - People busy surviving
- Pandemic tougher to pin down
  - CW is decrease in short term

Alternative Care Facilities – ACF

- Surge Capacity in Severe Scenario
- Every Locale Will Handle Differently
  - Nursing rather than acute care
  - Step down from hospital / convalescent
- No Precedent – How to Model?
  - Assume unbilled rejected by POG
  - Assume average bill between outpatient and hospital rate

Potential Impact on Health Insurers

The Nation's Health Dollar ($2.8 Trillion), Calendar Year 2012: Where It Came From



[1] Includes worksite health care, other private revenues, Indian Health Service, workers' compensation, general assistance, maternal and child health, vocational rehabilitation, Substance Abuse and Mental Health Services Administration, school health, and other federal and state local programs.
[2] Includes co-payments, deductibles, and any amounts not covered by health insurance.
Note: Sum of pieces may not equal 100% due to rounding.

SOURCE: Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group.

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Payor Landscape

- Private Payors
  - Fully Insured
  - Advantage
  - Self Insured
  - MEWAs / PEOs
  - Uninsured
- Public Payors
  - Medicare / Medicaid
  - Federal Employee Health Benefits (FEHB)
  - Department of Defense
  - Veterans Administration
  - Indian Health Service

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Other Considerations

- Cash Flow
  - Providers
  - Insurers
- Pricing and Reserving
  - IBNR
  - Adequacy
- Renewal Options
  - Will actuaries be able to sign off?
  - Will companies be able to pull out?
- Professional and Regulatory Implications

Self- Insured Plans

- Attempt similar methodology
  - No annual statements
  - Reasonable data sources?
- Less rigorous approaches
  - “Sample” plan (10,000 lives) and gross up?
- Reinsurance more important consideration
- Self insurers need to understand extent of risk

Why Self Insured Matters

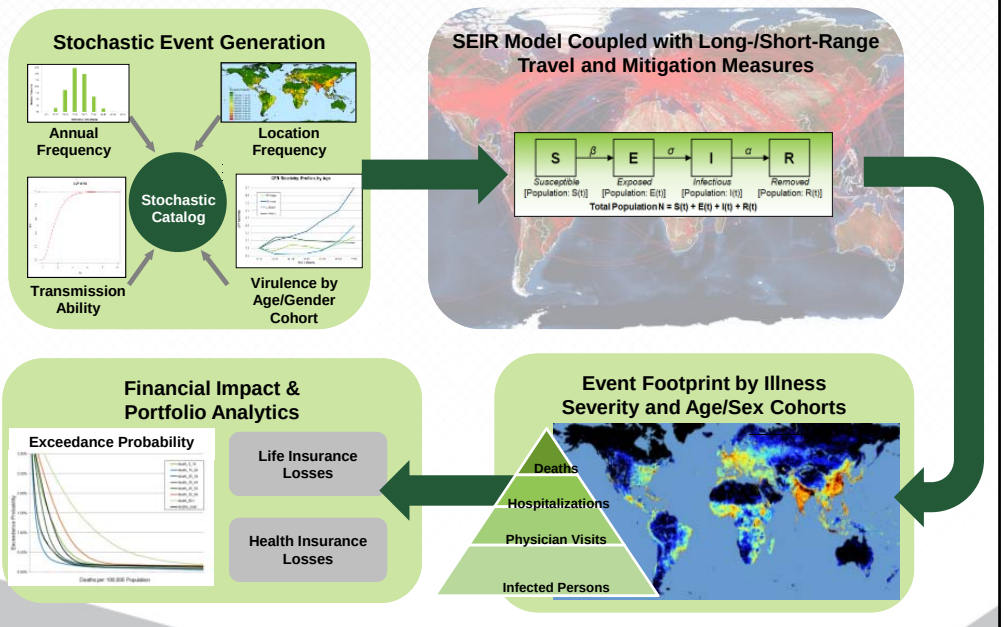
- What is the exposure?
- Reinsurance Impact
  - Acute cost likely less than specific
  - Aggregate cover more on smaller groups
- ERM Double - Whammy
  - Business Continuity
  - Cash Flow Issues
  - Supply Chain

Total System Estimated Gross Costs as of 2010

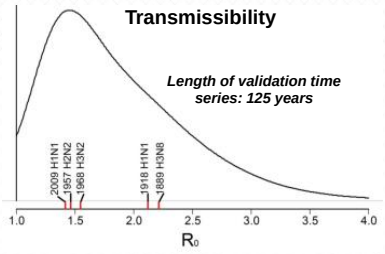
		Gross Cost as of 2003 (Millions)		
		Seasonal	Moderate	Severe
(1)	Outpatient	$ 3,146	$ 13,270	$ 10,354
(2)	Hospital	5,442	16,921	111,066
(3)	Death	1,932	12,132	105,171
(4)	Gross Cost	10,519	42,324	226,592
(5)	ACF Cost Allocation	$ -	$ -	$ 2,172
(6)	Deferred Elective Care Allocation	$ -	$ 11,649	$ 48,115
(7)	Net 2003 Payer Cost	$ 10,519	$ 30,674	$ 180,649
(8)	Inflation 2003–2010	60.6%	60.6%	60.6%
(9)	**2010 Gross Cost**	$ 16,892	$ 49,256	$ 290,082
(10)	*Diff. from Seasonal*		$ 32,365	$ 240,826
(11)	% of National Health Expenditures	0.6%	1.9%	11.2%
(12)	Deaths	42,005	213,045	1,944,149
(13)	Hospitalizations	298,226	889,388	7,912,135

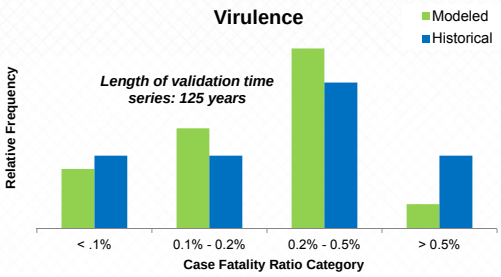
Stochastic Pandemic Modelling

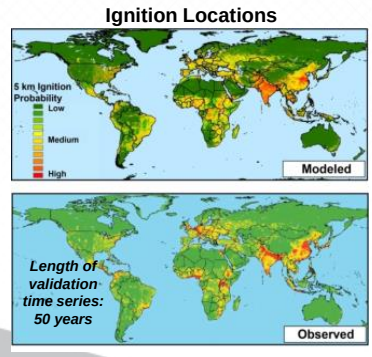
Process Flow of a Stochastic Pandemic Model

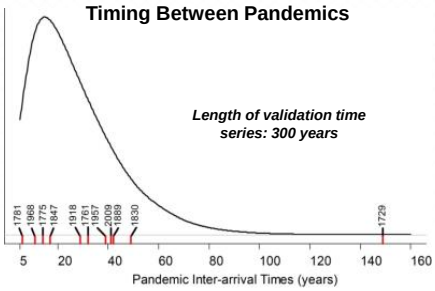


Each Component of a Stochastic Catalog Should Be Extensively Validated Using Available Data



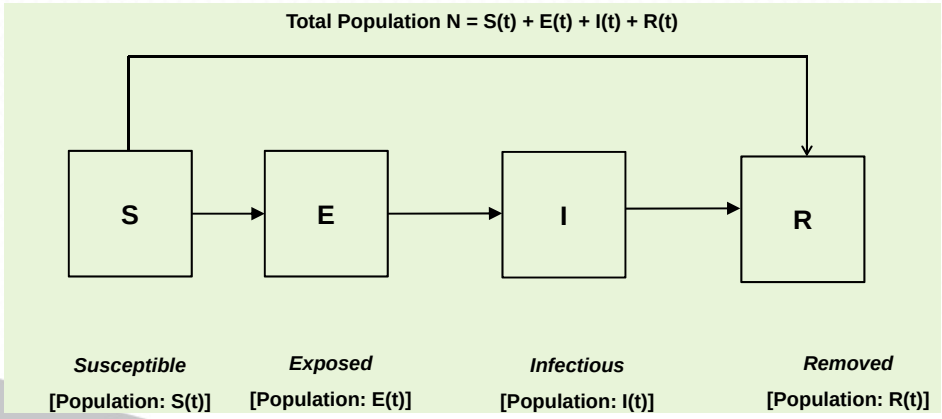






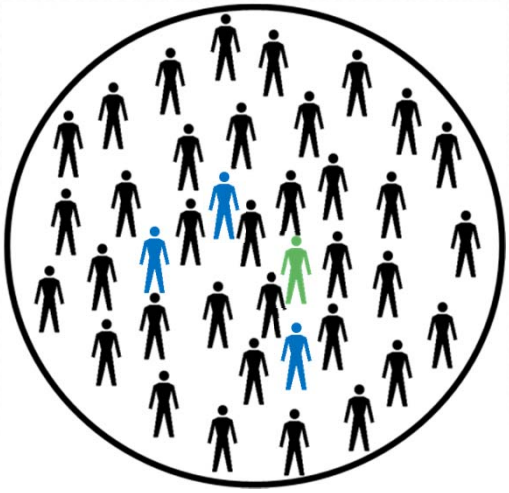
Epidemiologic Components Captured with Susceptible-Exposed-Infectious-Removed (SEIR) Model

- SEIR model operates at a daily time step with seven age bands and two gender groupings
- Potential considerations
  - Individual country stockpiles of antivirals and antibiotics
  - Time lag in the creation of the vaccine and its impact
  - Wealth per capita in a given country
  - Travel restrictions and airport closures

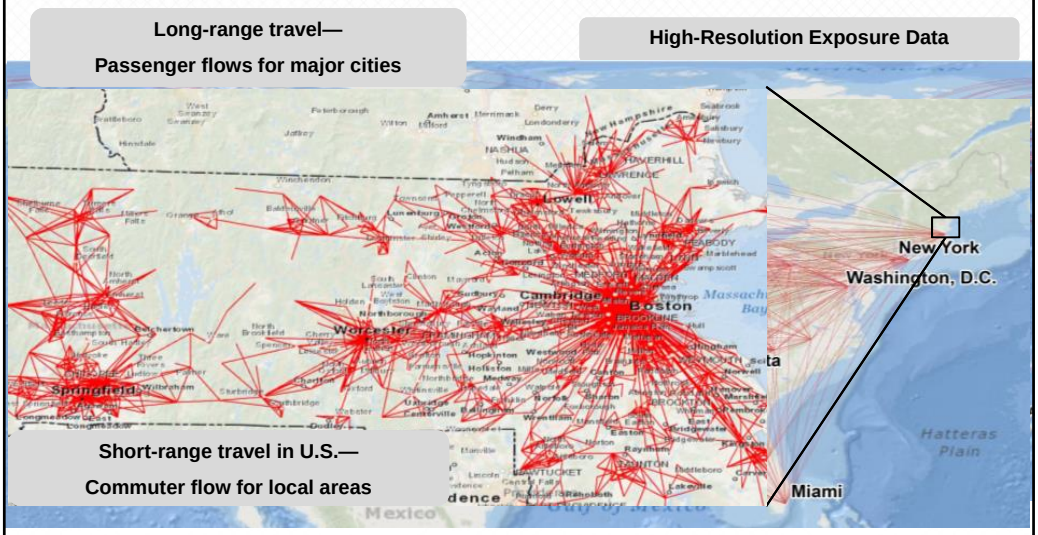


Epidemiologic Modeling Occurs at Each High-Resolution Area

- Fundamental technique of epidemiologic modeling realistically captures disease transmission dynamics

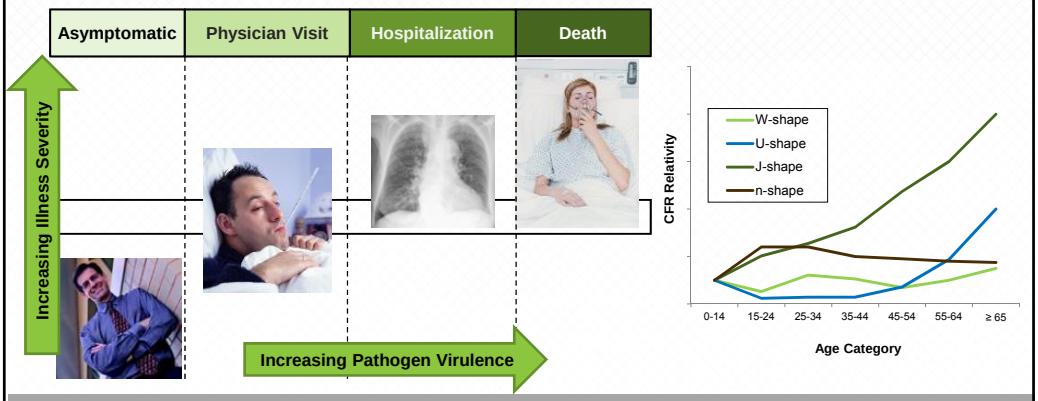


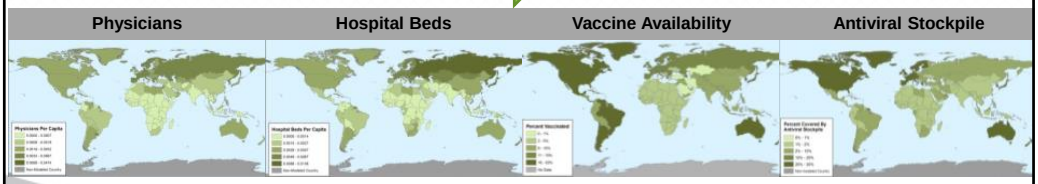
Modeling Population Movement Helps to Provide Insight In How a Disease May Spread



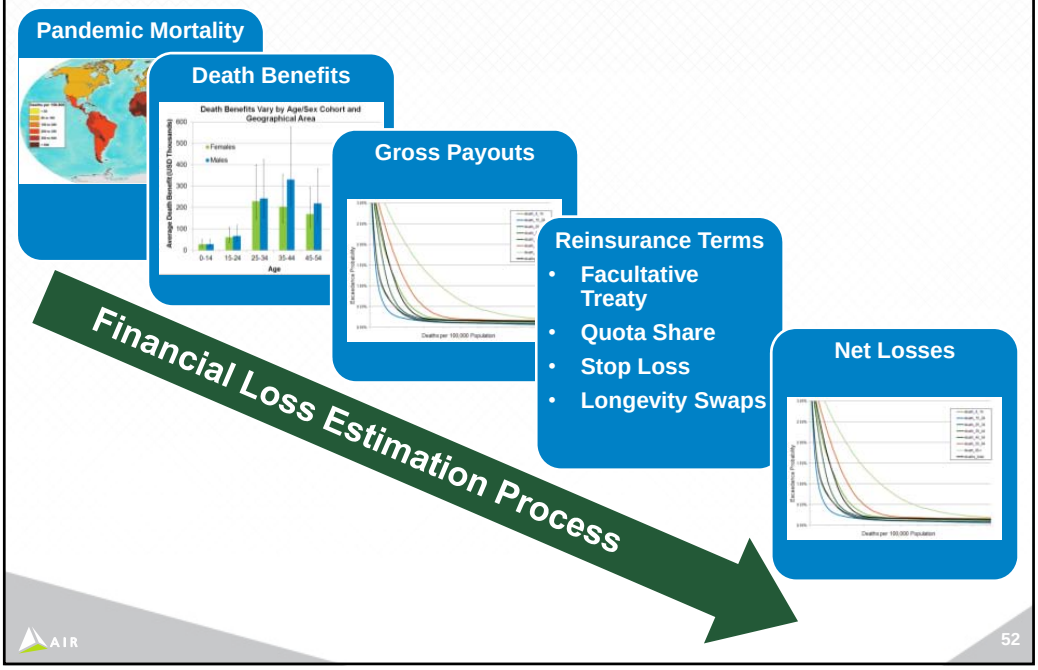
Source:
U.S. Census Tract-to-Tract Worker Flow Data

Pathogen Virulence, Age, Healthcare, and Mitigation Affect Illness Severity





Combining All Components Can be Combined to Create Policy or Portfolio Loss Distribution



Insurance and Pandemic Planning

- Can't prevent a pandemic
  - Delay onset / reduce peak
  - Increases resources available
  - Beds, doctors, nurses, supplies
- Interests are aligned
  - Good risk management
- Governments strapped for resources
- Goodwill with stakeholders
  - *Customers and policymakers!!*

Mitigation and Intervention

- Delay Onset / Reduce Peak
- Mitigation
  - Individual, business and community preparation efforts
  - Challenge in quantifying impact
- Intervention
  - Anti-virals & vaccines
  - Availability and effectiveness in question

"Investing in public health infrastructure to defend against a pandemic goes far beyond the threat of H5N1.

The resulting global health and surveillance systems protect us from emerging diseases while improving basic health services and enhancing regional stability."

Questions / Comments