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# The Demographic Impact of an Avian Flu Pandemic

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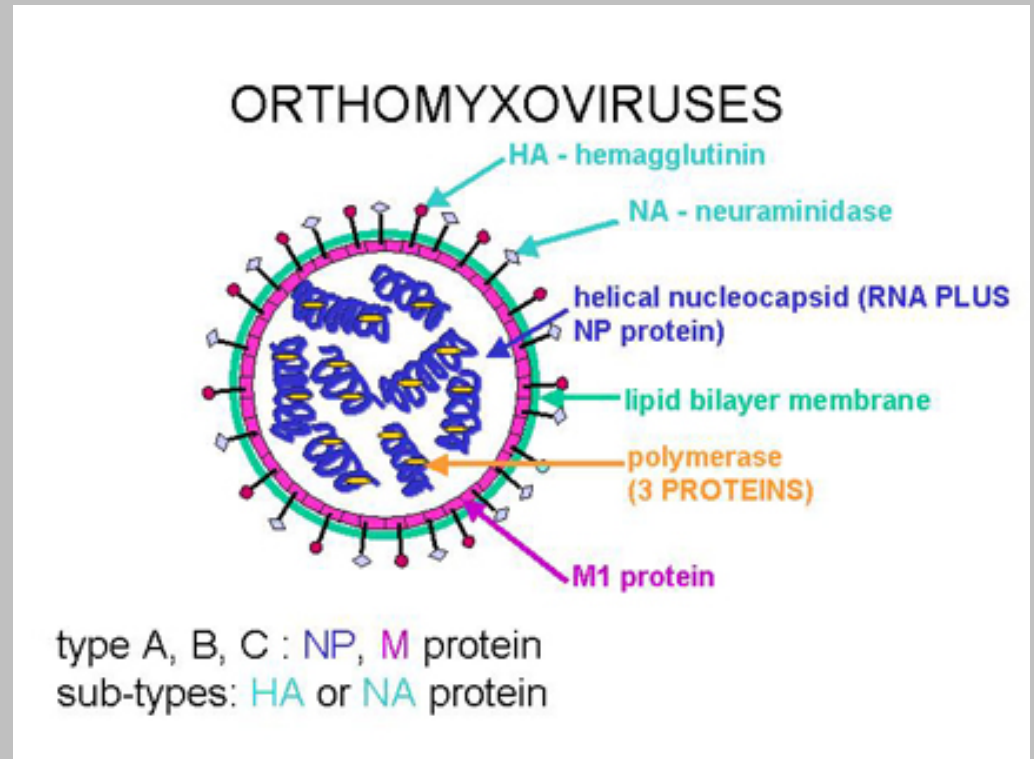
13 May 2007

# Overview

- Based on paper authored also by Dr Glenn Staples, Cassie Hamman and Jaco van der Merwe
- Influenza overview
- Avian Influenza
  - History
  - Current status
  - Clinical aspects: mortality, treatment, vaccination
- Modelling method
- Results:
  - Severe & mild scenarios
  - Impact of limited hospital beds
- Conclusion

# Influenza

- Viral infection
- Orthomyxovirus
- Infects upper resp tract
- Mutates readily
  - Seasonal epidemics
  - Pandemics
- Antibiotics useless



# Clinical (influenza)

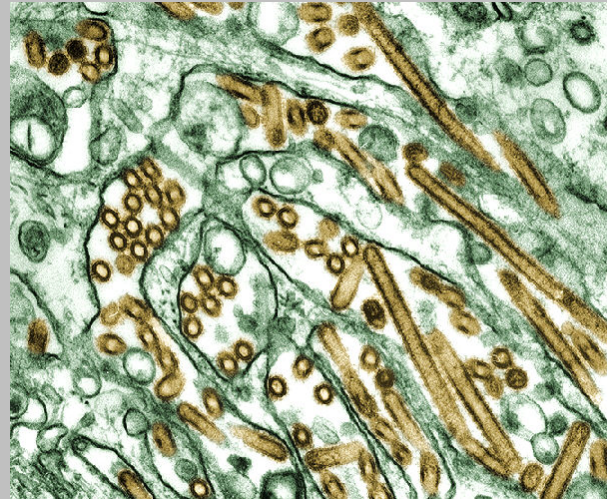
- Respiratory droplet and contact spread
- Incubation: 18-72 hrs
- Highly infectious
- Typical symptoms
  - Fever; sore throat; muscle pain; nasal congestion
- Increased mortality:
  - Elderly
  - Very young
  - Other medical conditions
  - No clear evidence of worse effects in HIV + patients

# Pandemic Influenza

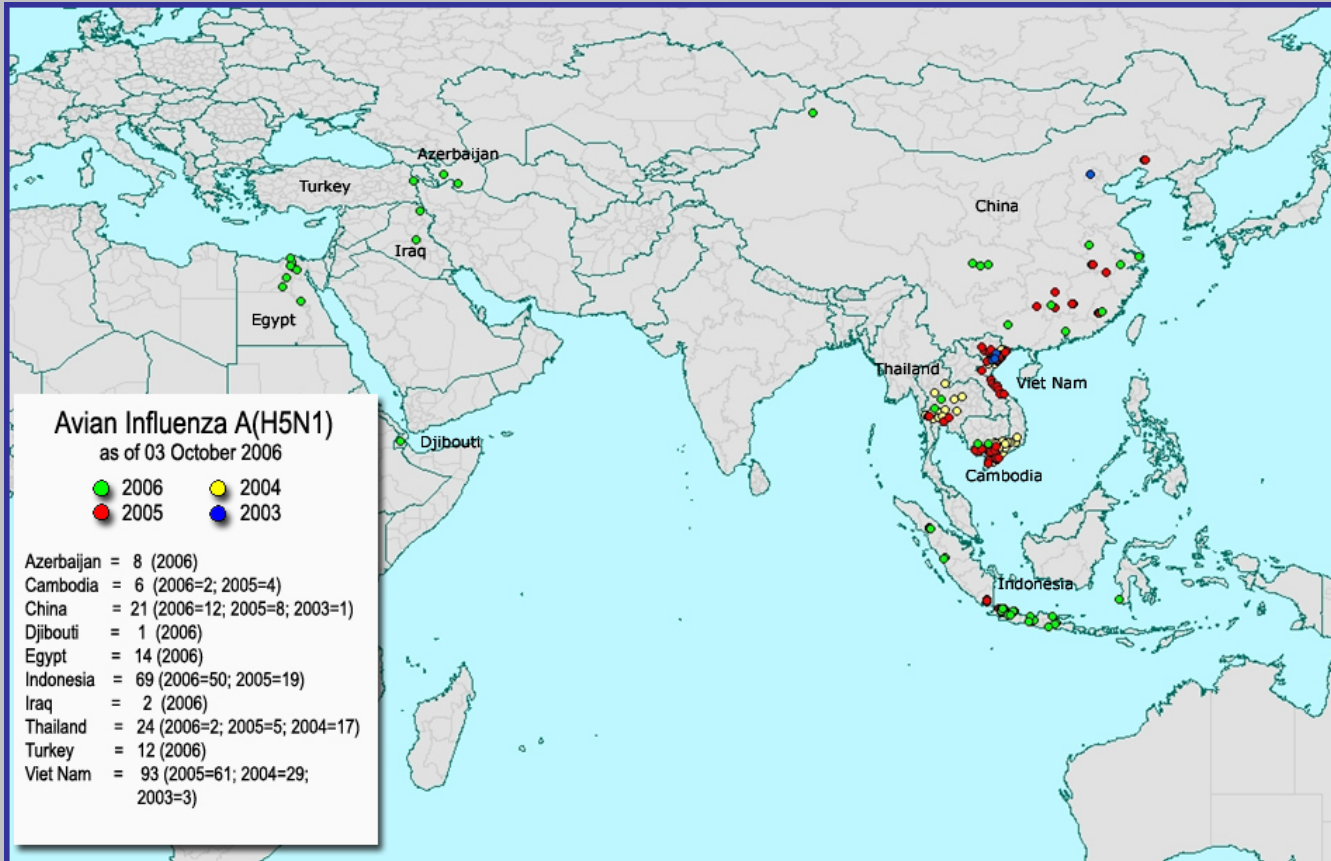
- Every 20-50 yrs
- Due to antigenic shift
  - Co-infection with human and animal virus
  - No human immunity to new virus
- Always Type A virus
- 3 Pandemics in 20<sup>th</sup> Century:
  - 1918 (Spanish) 40-50 million deaths
  - 1957 2 million deaths
  - 1968 (Hong Kong) 1 million deaths

# Avian Influenza

- Endemic in wild birds and poultry
- First human infection with H5N1 in 1998
- Escalating human infections since 2003
- Severe disease
  - >50 % mortality



# Human cases



# Human cases

Country	2003		2004		2005		2006		Total	
	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths
Azerbaijan	0	0	0	0	0	0	8	5	8	5
Cambodia	0	0	0	0	4	4	2	2	6	6
China	1	1	0	0	8	5	12	8	21	14
Djibouti	0	0	0	0	0	0	1	0	1	0
Egypt	0	0	0	0	0	0	14	6	14	6
Indonesia	0	0	0	0	19	12	50	40	69	52
Iraq	0	0	0	0	0	0	3	2	3	2
Thailand	0	0	17	12	5	2	3	3	25	17
Turkey	0	0	0	0	0	0	12	4	12	4
Viet Nam	3	3	29	20	61	19	0	0	93	42
<b>Total</b>	<b>4</b>	<b>4</b>	<b>46</b>	<b>32</b>	<b>97</b>	<b>42</b>	<b>105</b>	<b>70</b>	<b>252</b>	<b>148</b>

# Treatment

- Anti-virals (Tamiflu & Relenza)
  - Reduce severity & duration
  - Prophylaxis
- Vaccination
  - Only effective means of control
  - Requires mutated virus for production
  - 3 month development time
  - Limited global production capacity
  - Herd immunity (>30%)

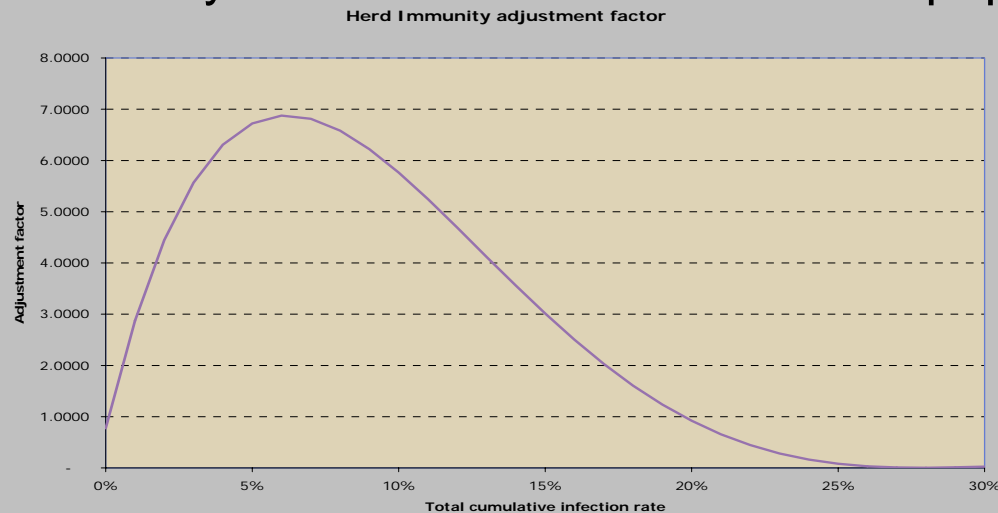


# Modelling method

- Multi-state model
  - Needed to explicitly model the impact of limited resources
- States modelled:
  - Remain in a healthy state
  - Move into a symptomatic state, i.e. have flu symptoms but decide not to seek medical advice (self-treatment).
  - Flu symptoms may be more serious and therefore the individual visits a doctor and/or obtains medicine.
  - The individual requires hospitalisation
  - The individual shows severe influenza symptoms requires treatment in an ICU facility
  - The individual dies

# Modelling method

- 3 modifications to transition matrix
  - Remove time-homogeneity: allow for herd immunity
    - Herd immunity threshold reached at 30% of population



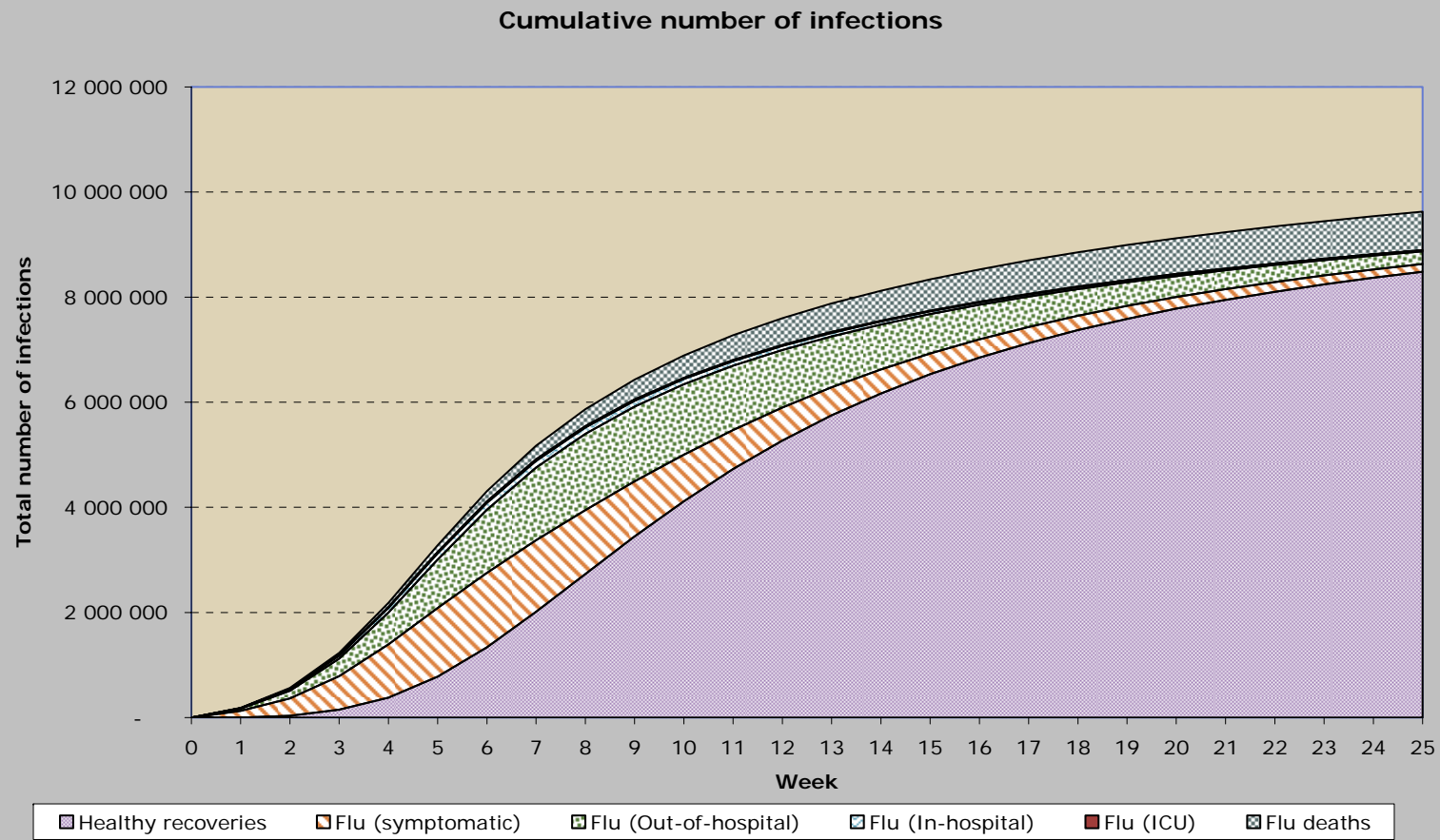
- Allow for demographic factors
- Allow for limited hospital beds

# Modelling method

- Most severe shortages will be:
  - ICU facilities
  - Nurses
- We did not allow for temporary facilities, as we doubt whether qualified staff would be available
- Allowed for HIV / AIDS, although not clear at all that mortality / infection would be higher
- Calibrated to fit experience of previous pandemics...

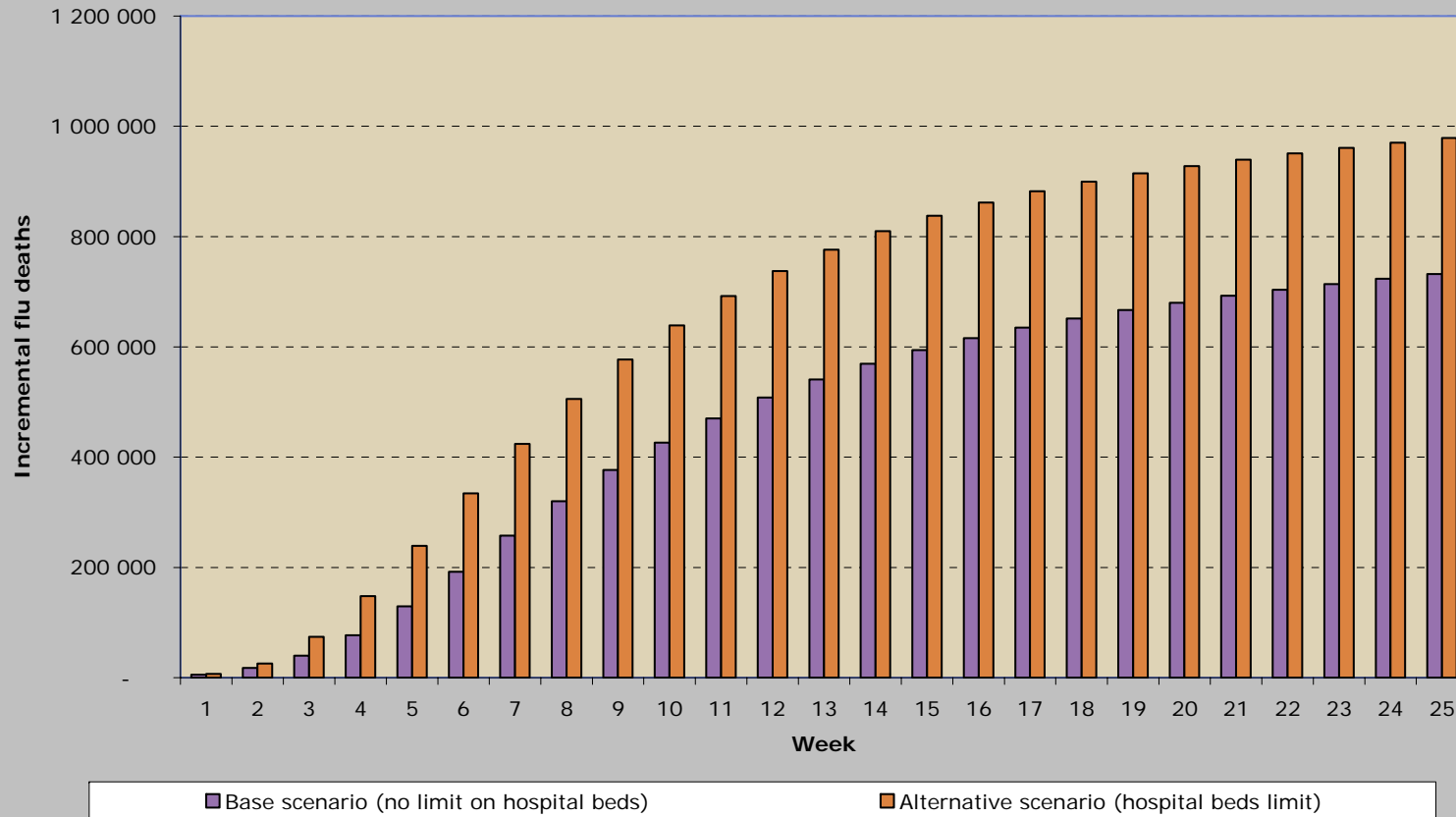
Date	World population	per 100 000 people	Mortality rate	Actual estimated death toll	Comparative death toll for current world population
1918	1.8 billion	3 500	3.50%	50-100 million	±225 million
1957	2.9 billion	50	0.05%	1-4 million	±3.5 million
1968	3.6 billion	25	0.025%	1-2 million	±1.5 million

# Results: severe pandemic: no hosp limit

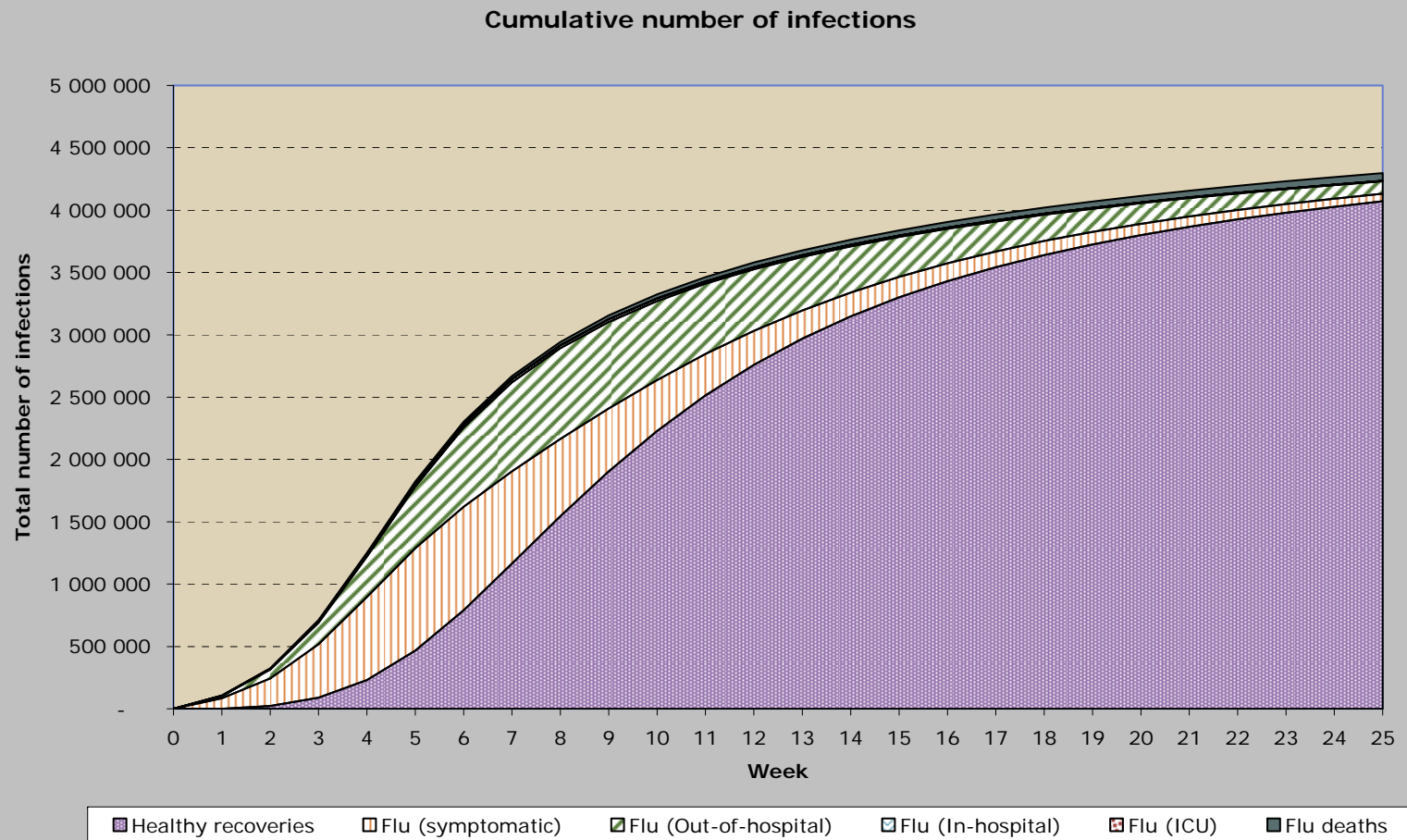


# Results: severe pandemic: with hosp limit

Comparison of number of cumulative flu deaths (base scenario vs alternative)

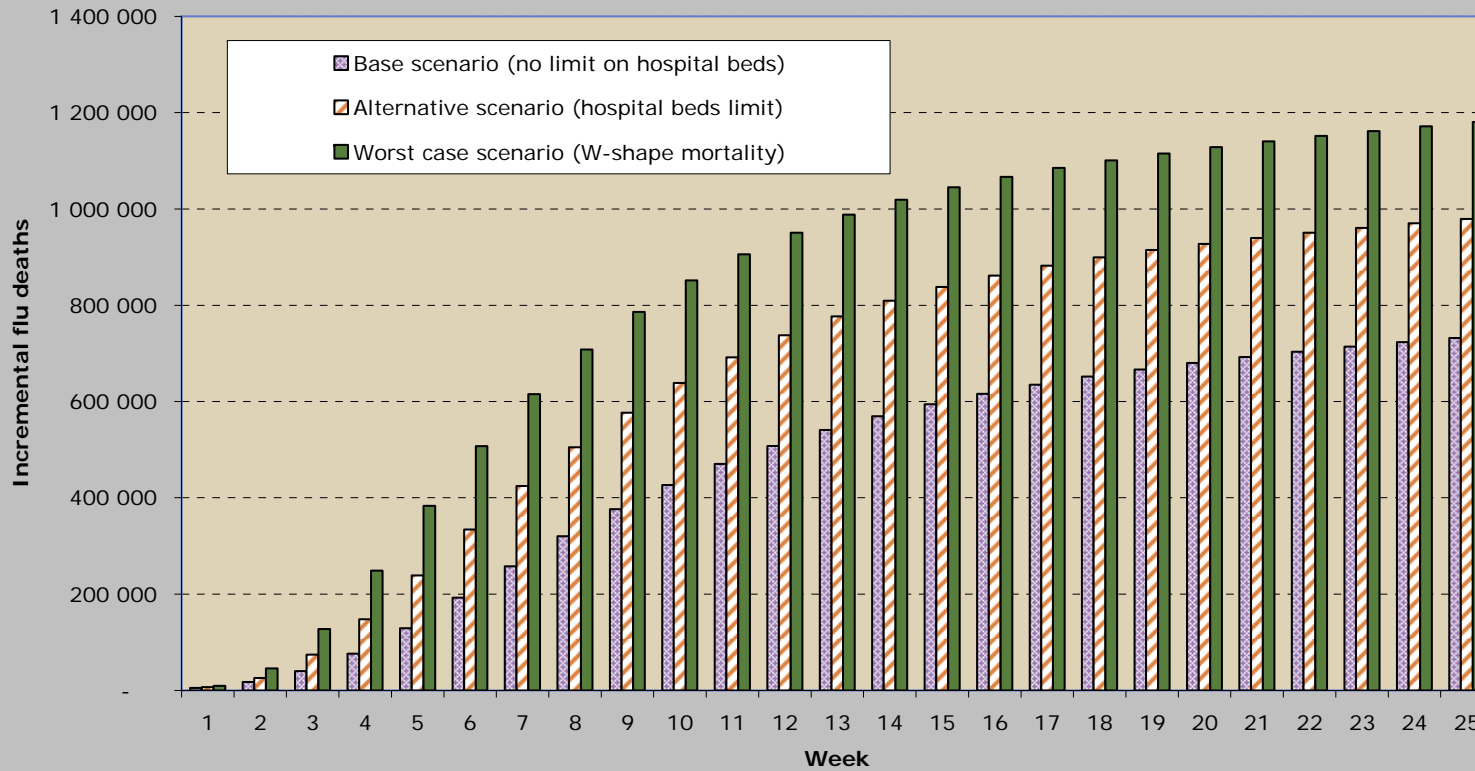


# Results: mild pandemic: with hosp limit



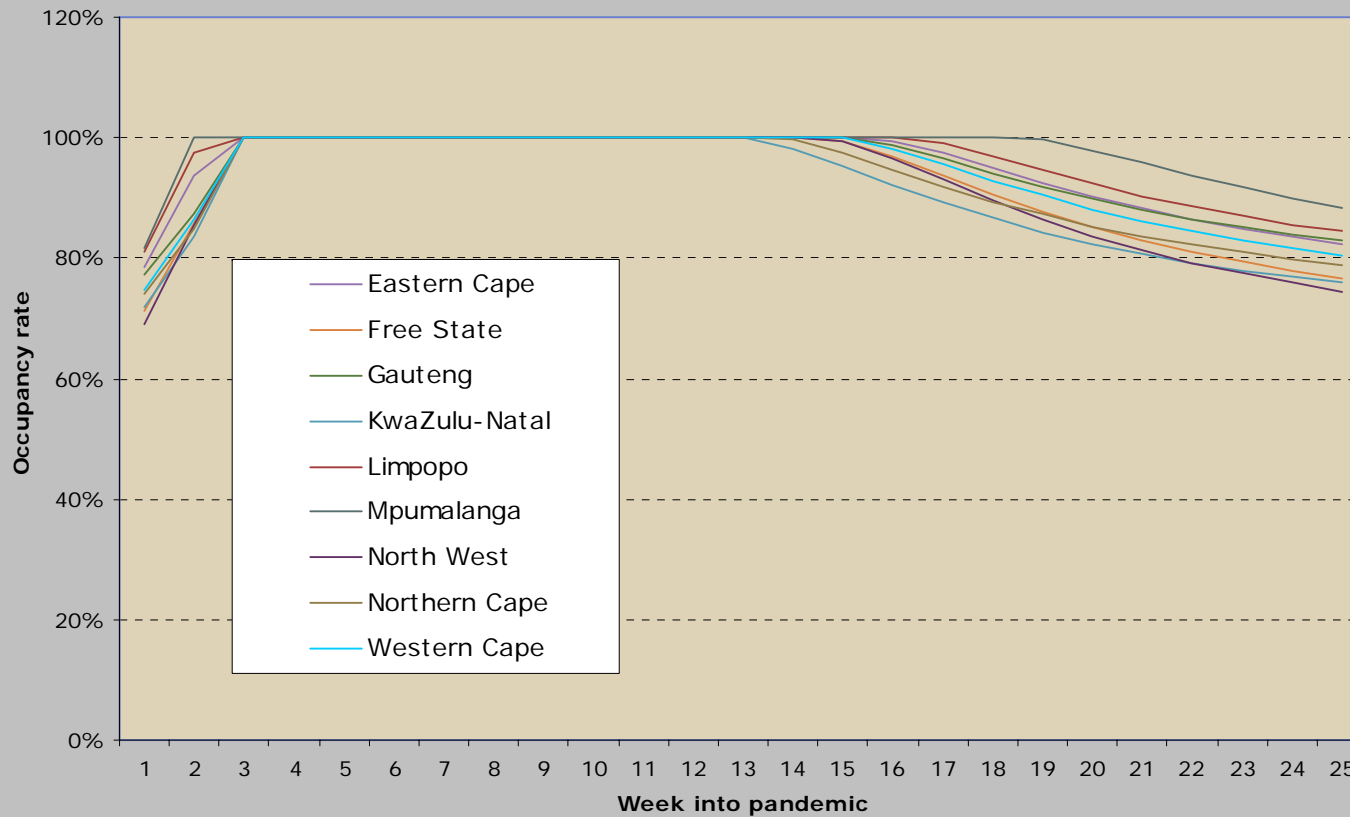
# Results: severe pandemic: w-shape mort

Comparison of number of cumulative flu deaths (base scenario vs alternative vs worst case)



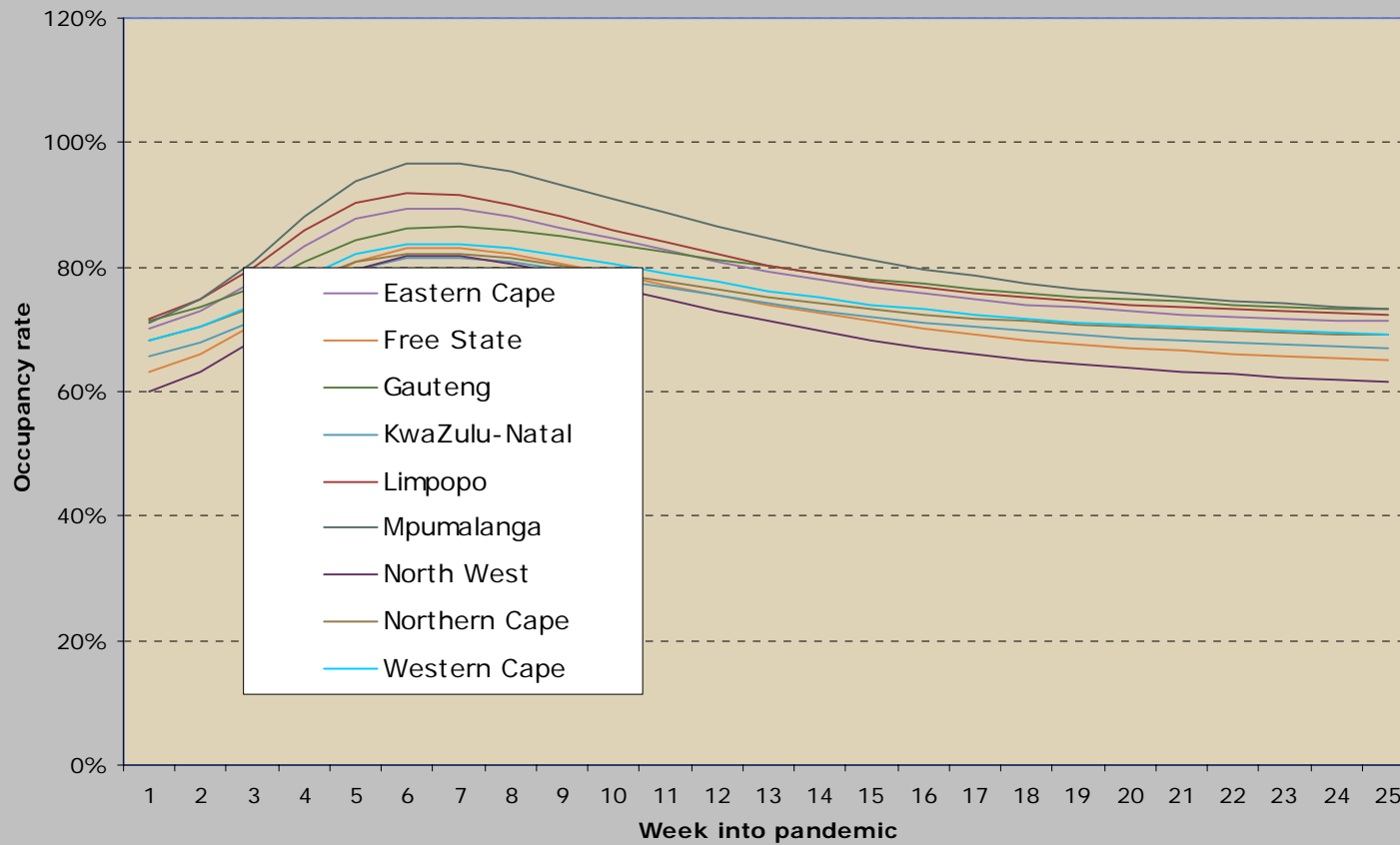
# Results: severe epidemic (W): hospital beds

Devastating scenario - Hospital bed occupancy



# Results: mild pandemic: hospital beds

Mild scenario - Hospital bed occupancy



# Results: mortality rate comparison



# Results: sensitivity analysis

Ignoring the effect of AIDS and with 25% herd immunity

Pandemic scenario	Cumulative infection rate	Overall crude mortality	Number of flu deaths
Severe pandemic (No limit on hospital beds)	20.1%	1.008%	477 801
Severe pandemic (Limit on hospital beds)	20.1%	1.537%	728 507
Mild pandemic (Limit on hospital beds)	9.0%	0.117%	55 240
Worst case scenario (W-shape mortality)	21.8%	1.783%	844 815

Allowing for the effect of AIDS and with 30% herd immunity

Pandemic scenario	Cumulative infection rate	Overall crude mortality	Number of flu deaths
Severe pandemic (No limit on hospital beds)	20.3%	1.545%	732 077
Severe pandemic (Limit on hospital beds)	20.3%	2.066%	979 048
Mild pandemic (Limit on hospital beds)	9.1%	0.128%	60 713
Worst case scenario (W-shape mortality)	22.0%	2.491%	1 180 519

# Conclusion

- Supply of health services will have significant impact on mortality: even in mild scenario, all available hospital beds occupied by week 4, but available again by week 7
- Hence timeous response could avert many deaths
- Should assume that vaccinations would not be available in South Africa until the second wave
- Depending on type of epidemic, impact varies
- Severe pandemic will have far-reaching demographic and economic consequences