How to give a talk

RSV vaccination as an example

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Preparation

* Your academic talk is the showcase of your work
* People are more likely to be exposed to your talk than to read your paper
* It also showcases your professionalism
  - your reputation will matter in the future
* Think of it as the big-budget movie version of your paper
  - educate, enlighten and entertain.

Creation

* Do not create your talk at the last minute
* NEVER make it during the conference
  - it's rude
  - pay attention to other talks as you would want others to pay attention to yours
  - you will also not know the timing or if some constructions don't work.

Spacing

* Do not clutter your slides
  - do not use fancy colours or backgrounds
  - simpler is better
* If you have too much to say on a page, make it two pages
* Keep points crisp and short
  - no bullet should be more than three lines
* Pictures, pictures, pictures
  - avoid "reading out" as much as possible.

Biological introduction

* Be sure to start with something accessible
* Spend time on the biology
  - a lot of time
* Explain the background and issues
  - what is the disease?
  - what intervention are you considering?
  - what are the complications?
* A non-math expert should still understand what problem you are trying to solve.

The Model

* Introduce the model with a flow diagram
* Explain everything visually
* Then write down the equations
* All parameters should be explained on every page
* State assumptions clearly
* The model is the major thing you are creating
  - it needs to be set up carefully.

Analysis

* Only write down the key results
* Generally, don't include the details
  - unless you need them elsewhere in the talk
* Pictures whenever possible
* Use LaTeXiT to import equations
  - beware of copy and paste signifiers.

Numerical simulations

* Your pictures tell the story
* You want a narrative
* Label everything clearly
* You can use the slide transition to convey information
* Use colour
* Summarise key results in words.

Summary

* Be concise
* Identify what we have learned that we didn't know
* List your limitations
* Don't introduce new results
* No equations here, only words.

Conclusion

* One page only
  - What did we study?
  - Why?
  - What did we learn?
  - What are the recommendations?
* The audience will see many talks and remember very little
* You only get to have a few takeaways
  - make them count.

Final page

* Include a reference to your paper
* Collaborators can be thanked verbally
* Include a link to your website with all your publications as free pdfs
  - you have the right to host your work
  - should be accessible to people in developing countries
* The more easily people can find your work, the more they're likely to read it
  - and cite it.

Worked example

* RSV vaccination talk
* Built from the paper
* But focused on being a talk
* The talk is visually rich and not exhaustive
  - if they wanted to read the paper, they would
* Key points highlighted

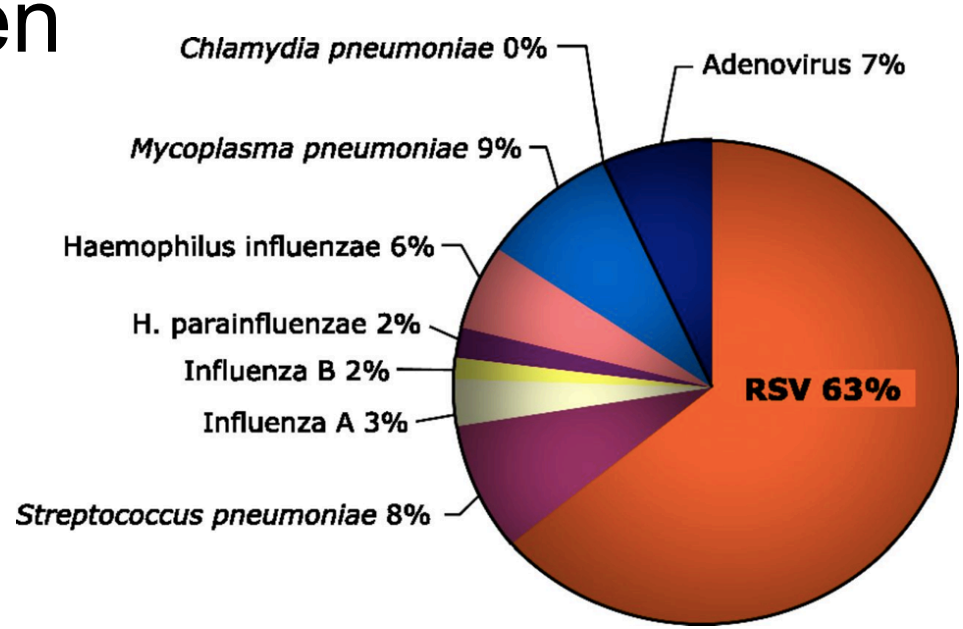
  (not every slide is included).

Respiratory Syncytial Virus (RSV)

- The main cause of acute lower respiratory infections in adult[illegible]young children
- Almost a[illegible]have been infected b[illegible]ge 2
- About 0.5–2% of infants require hospitalisation due to infe[illegible]tion
- In 2005, 3[illegible]new episodes of RS[illegible]d in children under 5 worldwide.

Animation keeps the audience awake

A period shows my last slide on each page.



Etiology of acute respiratory infections in children.

Symptoms

Express information consisely

- Mild symptoms:
  - cough
  - runny nose
  - sore throat
  - earache

Pictures add flavour...

- Major symptoms:
  - difficulty breathing
  - blue lips due to lack of oxygen
  - bronchiolitis
  - pneumonia.

...but they shouldn't distract.

Burden of RSV

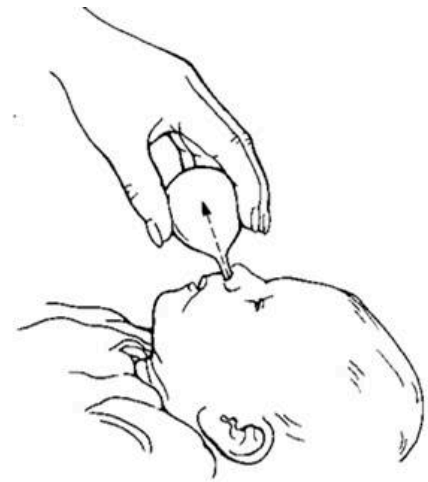
- Highest number of observed cases occurs in children aged six weeks to six months
- Morbidity occurs in <0.1% of cases
- Immunity is short-lasting
- Reinfection is common
- Hospitalization costs are substantial
- Infection occurs throughout adult life
  - often a cause of mortality in the elderly
- RSV is a significant economic and healthcare system burden.

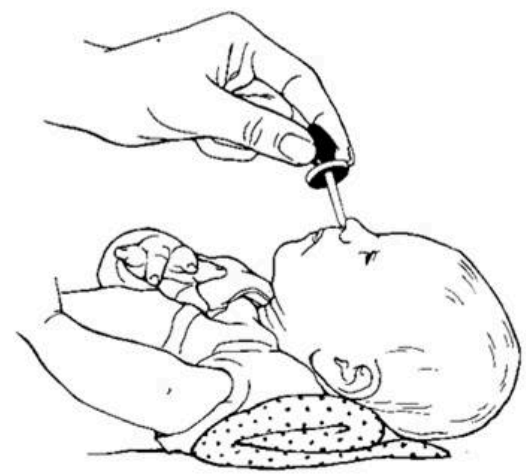
Sub-points add extra info, break up the text.

Seasonal patterns

Seasonality informs the model.

- In temperate climates, RSV epidemics exhibit consistent seasonal patterns
- Most infections occur during winter months, whether wet or dry
- Outbreaks typically last 2–5 months
- In tropical climates, RSV is detected throughout the year, with less pronounced seasonal peaks
- The onset of RSV is typically associated with the rainy season.





Prophylaxis

- Immunoprophylaxis with the monoclonal antibody Palivizumab has proven effective in reducing the severity of symptoms
- However, it cannot prevent the onset of
  - very e[illegible]ve
  - $1416.48 for a 100mg vial
  - generally only administered to high-risk children.

Treatment exists but is not a viable option.

Vaccination

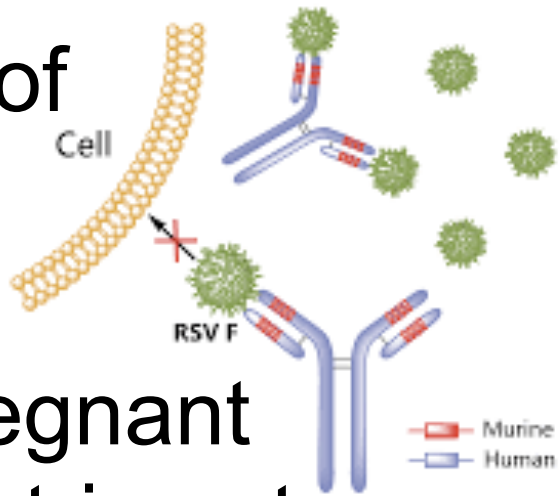
Vaccination is most promising.

- Re[illegible]rch has focused on the develop[illegible]f particle-based, subunit and vectored vaccines
- Several such vaccines are being evaluated in clinical trials
- Other vaccines are in pre-clinical development
- Live attenuated vaccines are also undergoing Phase I trials.

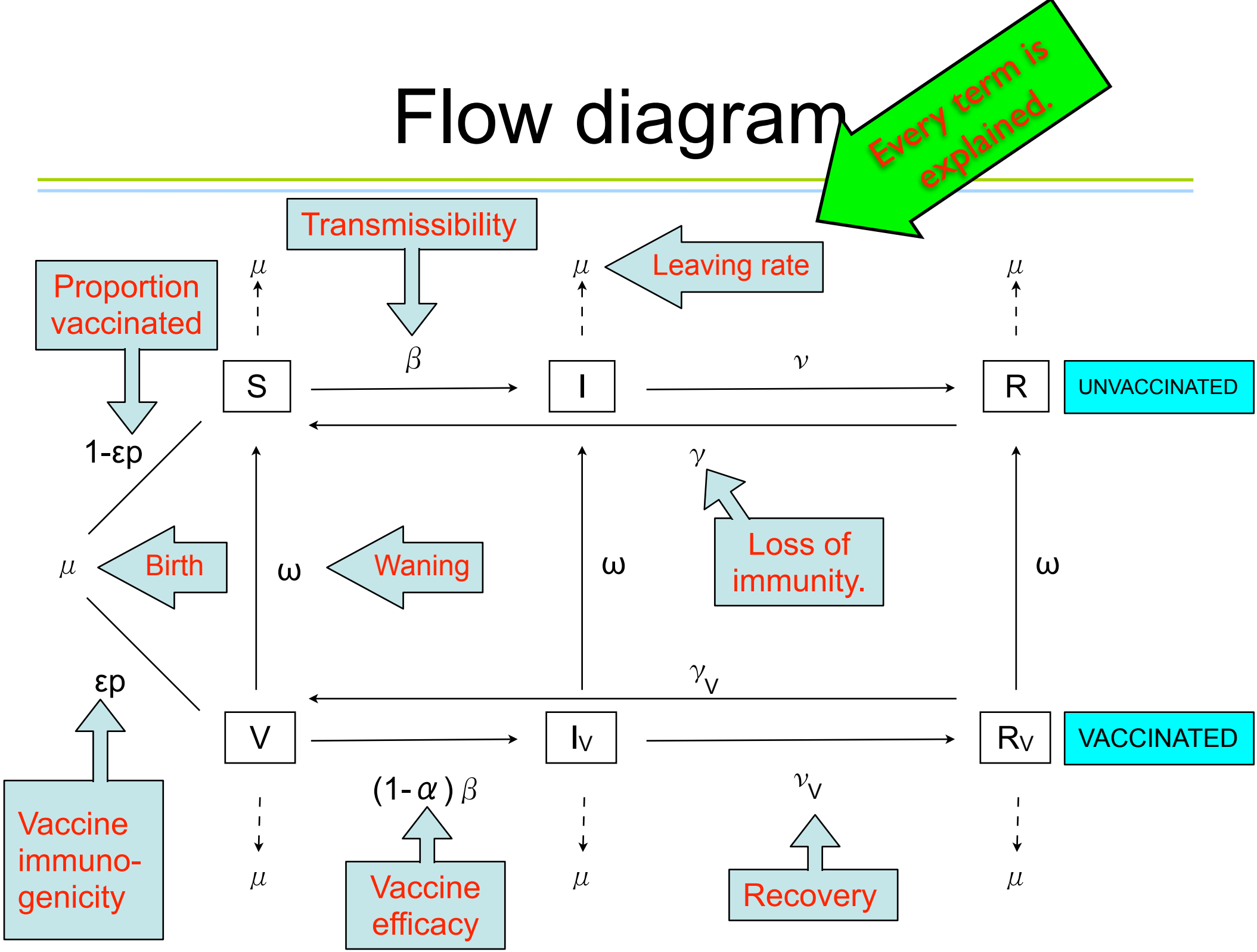
Model 1

Model assumptions.

- We ex[illegible] on existing RSV model for a single age cohort to [illegible]lude vaccination
- We first assume a fixed proportion of individuals entering the model are temporarily immune to infection
- This reflects the situation where pregnant women are vaccinated in their third trimester
- Protective maternal antibodies are transferred placentally to the unborn infant
- This confers protection for the first few months of life.



Flow diagram



The continuous model

- The [illegible] model with vaccination is

$$\begin{aligned}
S' &= \mu(1-\epsilon p) - \mu S - \beta(t)S(I+I_V) + \gamma R + \omega V \\
I' &= \beta(t)S(I+I_V) - \nu I - \mu I + \omega I_V \\
R' &= \nu I - \mu R - \gamma R + \omega R_V \\
V' &= \epsilon p \mu - \mu V - \beta_V(t)V(I+I_V) + \gamma_V R_V - \omega V \\
I_V' &= \beta_V(t)V(I+I_V) - \nu_V [illegible] - \omega I_V \\
R_V' &= \nu_V I_V - \mu R_V - \gamma_V R_V [illegible]
\end{aligned}$$

with $\beta(t) = \beta_0(1+\beta_1\cos(2\pi t+\varphi))$

and $\beta_V(t) = (1-\alpha)\beta(t)$

(α may possibly be negative).

Indicates another model to come

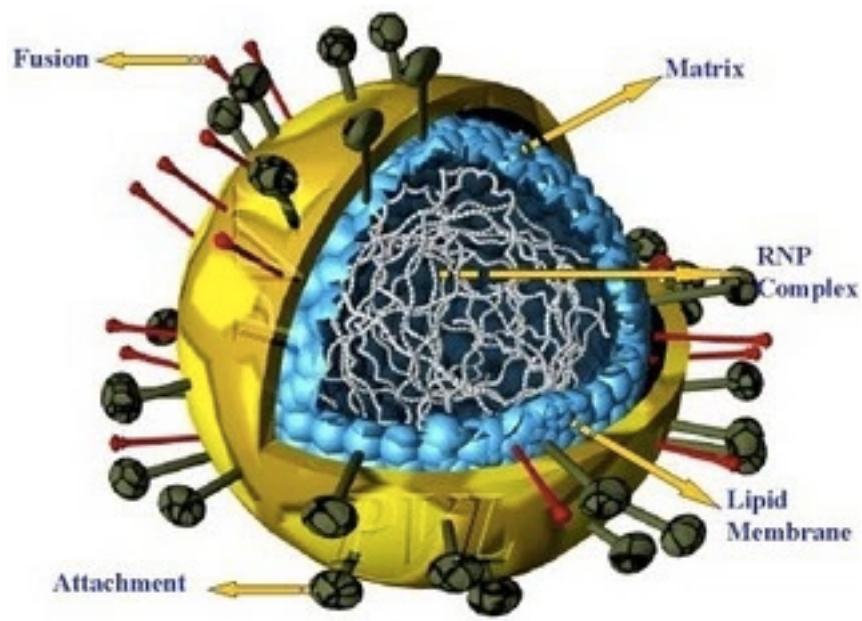
Parameters are footnoted every time.

S=susceptible I, I_V=infected R, R_V=recovered V=vaccinated μ=background death ϵ=efficacy p=coverage ω=waning β, β_V=transmissibility ν, ν_V=recovery γ, γ_V=loss of immunity

Key assumptions

Ethically, we need to state the assumptions.

- We assume
  - the leaving rate is unchanged across all classes
  - no disease-specific death
  - entry and leaving rates are scaled so the population is constant
  - transmissibility oscillates seasonally.



Constant transmission

- There is a DFE satisfying

$$\bar{R}_V) = \left(\frac{(1-\epsilon p)\mu + \omega}{\mu + \omega}, 0, 0, \frac{\epsilon p \mu}{\mu + \omega}, 0, 0 \right)$$

- We can prove that this equilibrium is stable if

$$\lambda^2 + b_1 \lambda + c_1 = 0$$

has roots with negative real part, where

$$b_1 = -\beta \bar{S} + \mu + \nu - \beta_V \bar{V} + \nu_V + \mu + \omega$$

$$c_1 = (\beta \bar{S} - \quad)(\beta_V \bar{V} - \nu_V - \mu - \omega) - \beta_V \bar{V}(\beta \bar{S} + \omega)$$

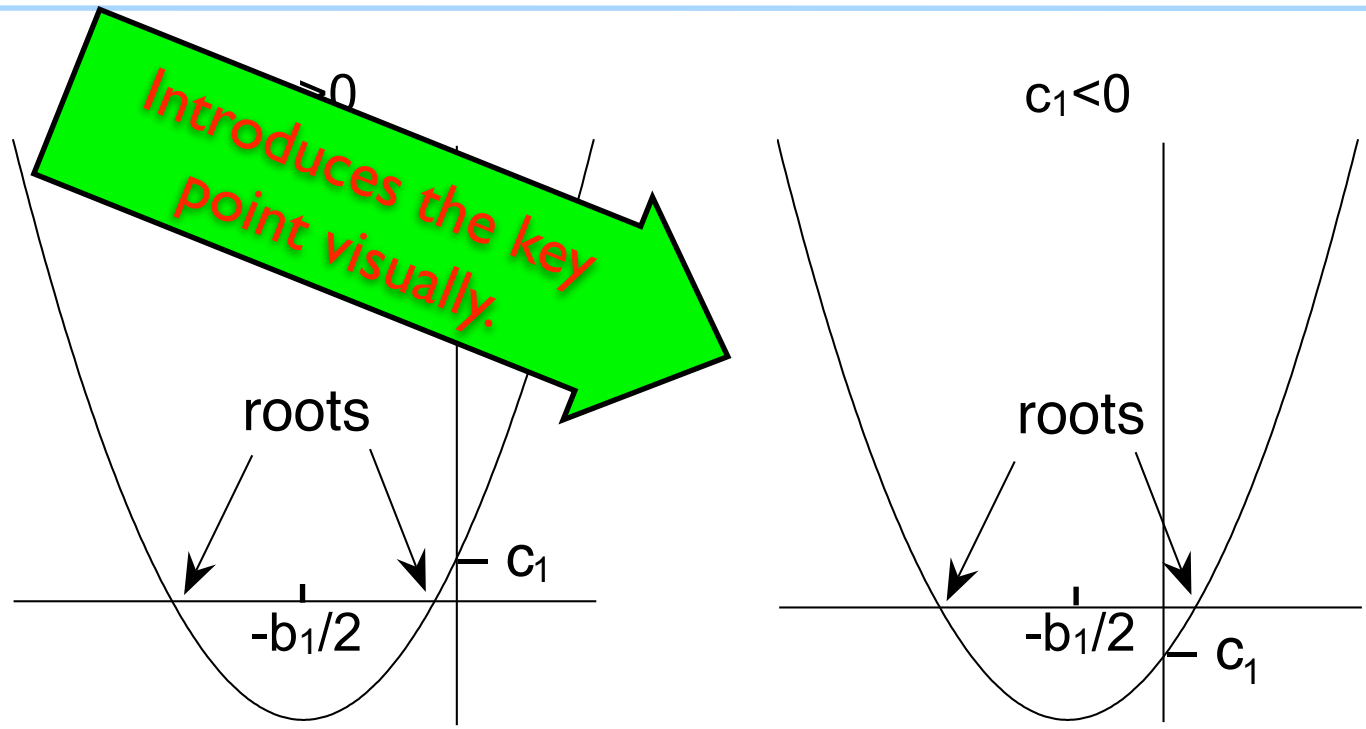
$$= \beta \bar{S}(- \quad (\mu + \nu)(\beta_V \bar{V} - \nu_V - \mu - \omega) - \beta_V \bar{V} \omega.$$

Results are stated, details omitted

Audience won't remember definitions from earlier pages.

S=susceptible I=infected R=recovered V=vaccinated susceptible I_V=vaccinated infected R_V=vaccinated recovered μ=background death ϵ=efficacy p=coverage ω=waning

Stability of eigenvalues



- If $b_1>0$, then c_1 is a proxy for the eigenvalues
- If $b_1<0$, then the DFE is unstable and c_1 is not a threshold.

b_1=vertex
c_1=intercept

Basic reproduction number

- Rearran[illegible]e constant term leads to

$$R_0 = \frac{\beta[illegible] + \beta_V \bar{V}(\mu+\nu+\omega)}{(\mu+\nu_V+\omega)}$$

- If c_1=0 and b_1>0, then we have a bifurcation with the property that the DFE is stable if R_0<1 and unstab[illegible]

  (as desired)
- However, it possible that when c_1=0, b_1<0
- In this case, R_0 is not a threshold, and the disease can persist if R_0<1.

Standard result, to contrast with...

...non-standard result.

S=susceptible V=vaccinated
μ=background death ω=waning
β,β_V=transmissibility
ν,ν_V=recovery

Positive vertex

Details included only for original material

- When c_1=0, ve

$$b_1\Big|_{c_1=0} = \frac{1}{\nu_V + \mu + \omega}\left[\beta_V \bar{V}(\nu - \nu_V) + (\nu_V + \mu + \omega)^2\right]$$

- Note that if ν=ν_V (i.e., vaccination does not affect recovery) then b_1>0
- However, we expect tha accinated individuals will rec r than unvaccinate als
- Thus ν_V>ν
- It follows that b_1 could be negative.

Not for their own sake; we will use this.

V=vaccinated b_1=vertex
c_1=intercept
μ=background death
ω=waning
β_V=transmissibility
ν,ν_V=recovery

A possible turning point?

Shows that the result doesn't always happen

- this is equivalent to vaccinated individ covering instantaneously
- In this case,

$$\lim_{\nu_V \to \infty} b_1 = \lim_{\nu_V \to \infty} \frac{\beta_V \bar{V}(\nu - \nu_V)}{\omega + \mu + \nu_V} + \omega + \mu + \nu_V$$
$$= -\beta_V \bar{V} + \infty > 0$$

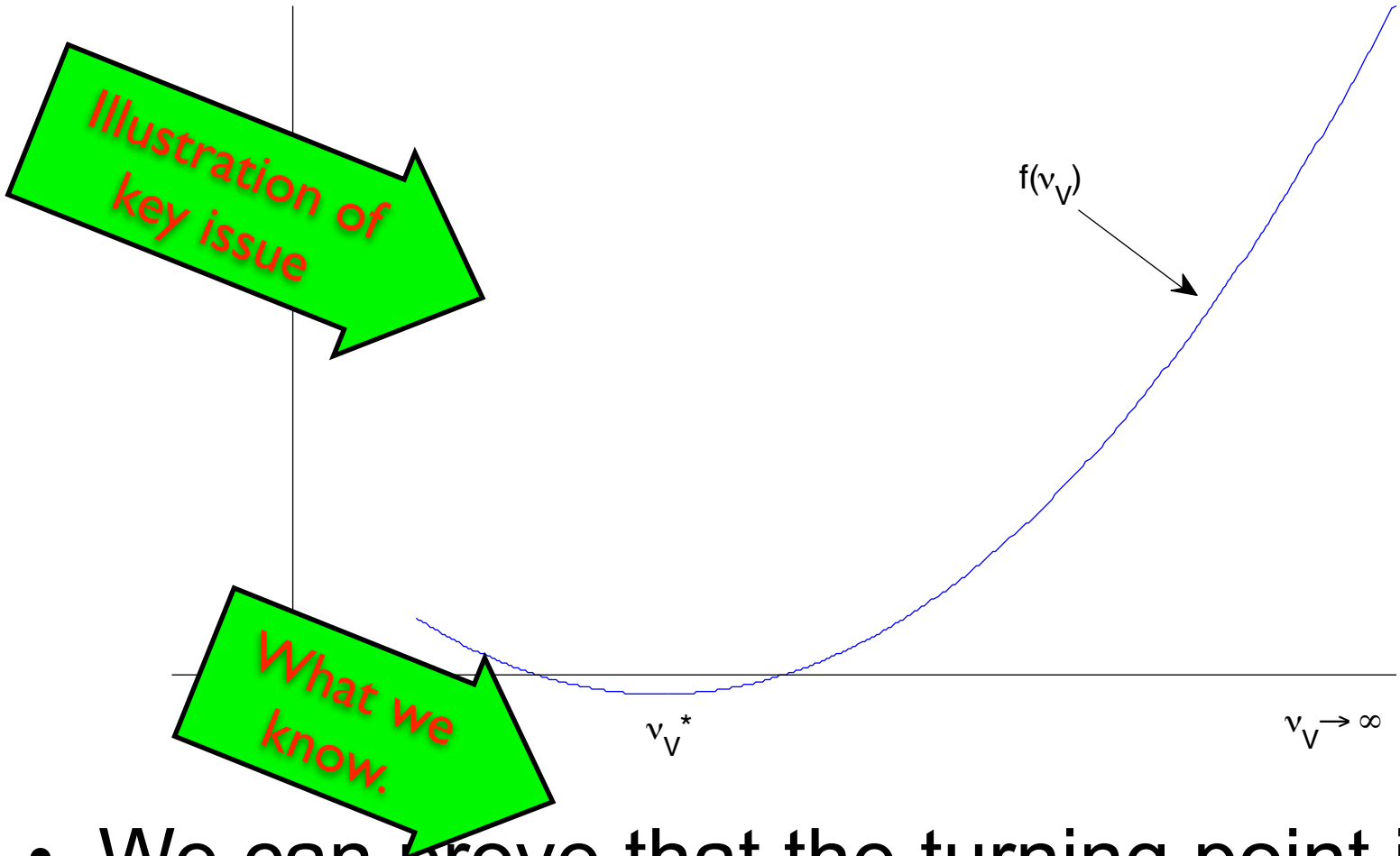
- fining $f(\nu_V) = \frac{\beta_V \bar{V}(\nu - \nu_V) + (\omega + \mu + \nu_V)^2}{\omega + \mu + \nu_V}$,

The issue boils down to this.

we)>0 and f(∞)>0
- Does f have a local minimum?
- If so, could it be negative?

V=vaccinated b_1=vertex
μ=background death
ω=waning
β_V=transmissibility
ν, ν_V=recovery

Potential form of f(ν_V)



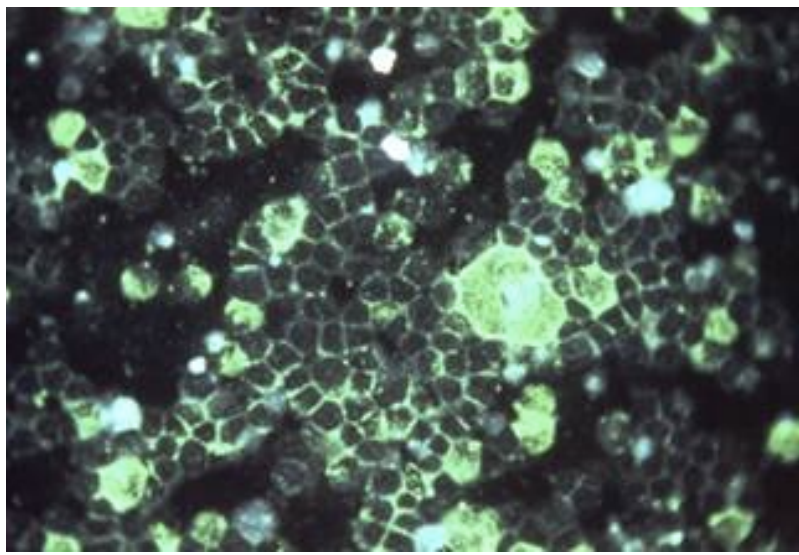
- We can prove that the turning point is a local minimum whenever it exists.

f=vertex
v,v_V=recovery

Regular vaccinations

- W[illegible] refine the continuous model
- Vacc[illegible]may not occur before birth
- It may also be administered at regular times
  - eg in schools or daycare centres
- We model a vaccine that reduces the susceptible population by a fixed proportion r
- This is described by a series of non-autonomous impulsive differential equations.

Switch to second model.



r=coverage

The impulsive model

$$
\begin{aligned}
S' &= \mu - \mu S - \beta(t)S(I + I_V) && t \neq t_k \\
I' &= \beta(t)S(I + I_V) - \nu I - \mu I + \omega I_V && t \neq t_k \\
R' &= \nu I - \mu R - \gamma R + \omega R_V && t \neq t_k \\
V' &= -\mu V - \beta_V(t)V(I + I_V) + \gamma_V R_V - \omega V && t \neq t_k \\
I_V' &= \beta_V V(I + I_V) - \nu_V I_V - \mu I_V - \omega I_V && t \neq t_k \\
R_V' &= \nu_V I_V - \mu R_V - \gamma_V R_V - \omega R_V && t \neq t_k \\
\Delta S &= -rS && t = t_k \\
\Delta V &= rS && t = t_k,
\end{aligned}
$$

Fundamentally different kind of model.

where r is the coverage

and t_k are the vaccination times.

S=susceptible I, I_V=infected
R, R_V=recovered V=vaccinated
μ=background death ω=waning
β, β_V=transmissibility
ν, ν_V=recovery γ, γ_V=loss of immunity

Susceptible individuals

Outline of proof, results only.

Assuming transmission is constant, we can [illegible] that solutions are bounded below by a [illegible]sive periodic orbit with endpoints

$$S_\infty^- = \frac{\mu\left(1-e^{-(\mu+\beta)\tau}\right)}{(\mu+\beta)\left(1-(1-r)e^{-(\mu+\beta)\tau}\right)}$$

$$S_\infty^+ = \frac{\mu(1-r)\left(1-e^{-(\mu+\beta)\tau}\right)}{(\mu+\beta)\left(1-(1-r)e^{-(\mu+\beta)\tau}\right)}$$

- These correspond to the local maximum and minimum values for the unvaccinated susceptibles after a long time
- Note in particular that $\lim_{\tau\to 0} S_\infty^- = 0.$

S=susceptible μ=background death β=transmissibility r=coverage τ=period

Infected individuals

- Assuming infected vaccinated individuals are negligible, we can prove that

$$I' \leq \frac{\beta\mu\left(1-e^{-(\mu+\beta)\tau}\right)}{(\mu+\beta)\left(1-(1-r)e^{-(\mu+\beta)\tau}\right)}I - \nu I - \mu I$$

Defining a useful new concept.

- s define a new quantity, the *impulsive rep* *number*

$$T_0 = \frac{\beta\mu\left(1-e^{-(\mu+\beta)\tau}\right)}{(\nu+\mu)(\mu+\beta)\left(1-(1-r)e^{-(\mu+\beta)\tau}\right)},$$

which has the condition that the disease will be controlled if $T_0<1$.

I=infected μ=background death
β=transmissibility v=recovery
r=coverage τ=period

Impulsive reproduction number

- From the condition T_0=1, we can define the maximal period as

$$\hat{\tau} = \frac{1}{\mu+\beta} \ln \frac{(1-r)(\nu+\mu)(\mu+\beta)-\beta\mu}{(\nu+\mu)(\mu+\beta)-\beta\mu}$$

- This is defined only if

$$r < r^* = 1 - \frac{\beta\mu}{(\nu+\mu)(\mu+\beta)}$$

- We can show that $\hat{\tau}$ is increasing as r increases, for r<r*
- disease can then be controlled if $\tau < \hat{\tau}$
- For r>r*, T_0<1 and the disease is always controlled.

Determining optimal period

Second case.

T_0=impulsive reproduction #
μ=background death
β=transmissibility v=recovery
r=coverage τ=period

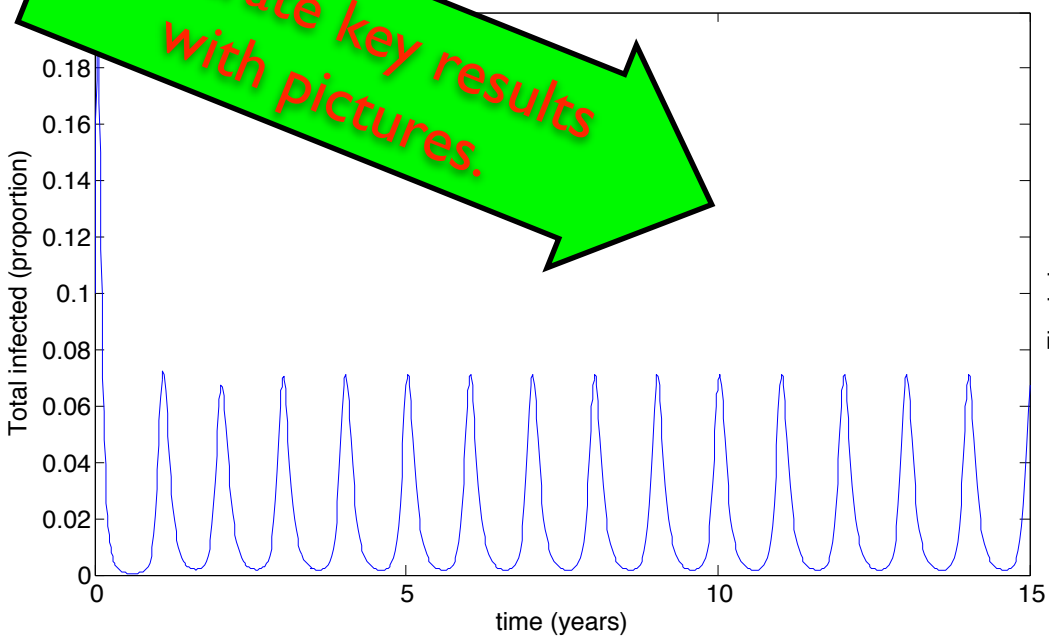
Summarise math results in practical terms.

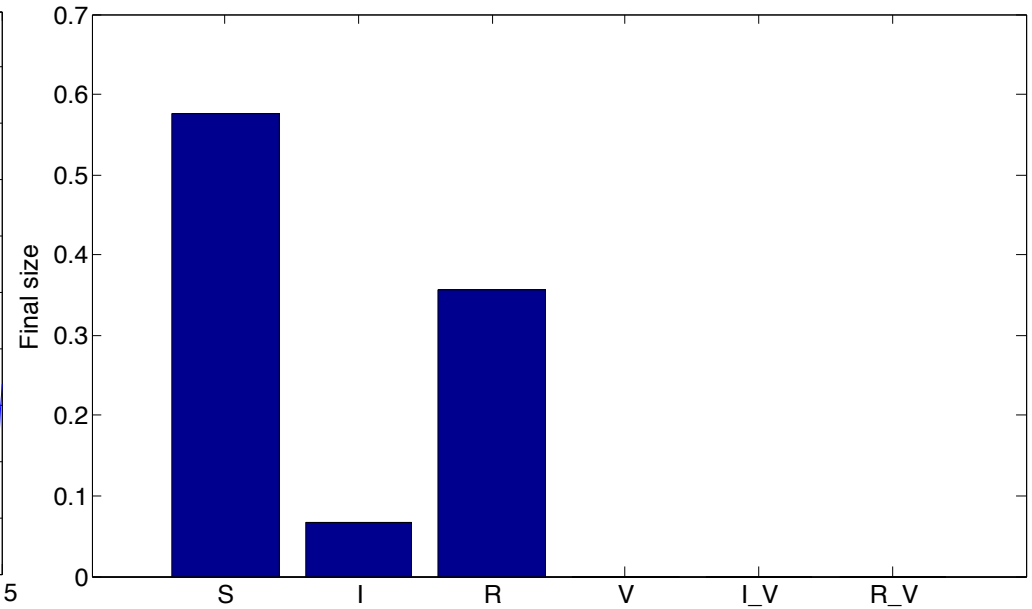
mary of theoretical results

- High coverage can thus control the disease
- If coverage is limited, then sufficiently frequent vaccinations can also achieve control
- Note that the impulsive reproduction number is conditional.

Impulsive model, no vaccine

Illustrate key results with pictures.



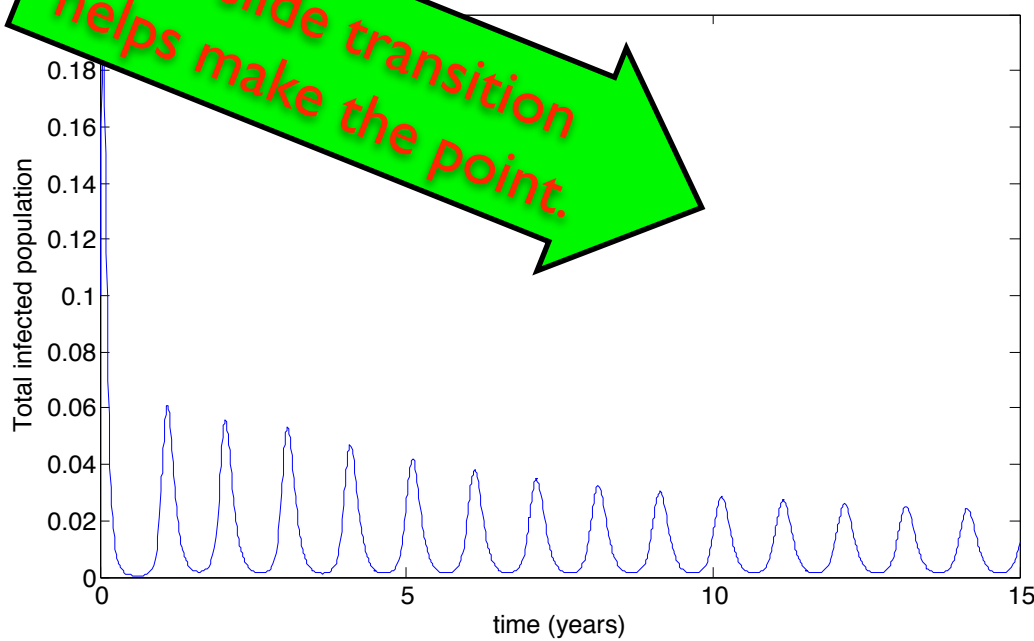


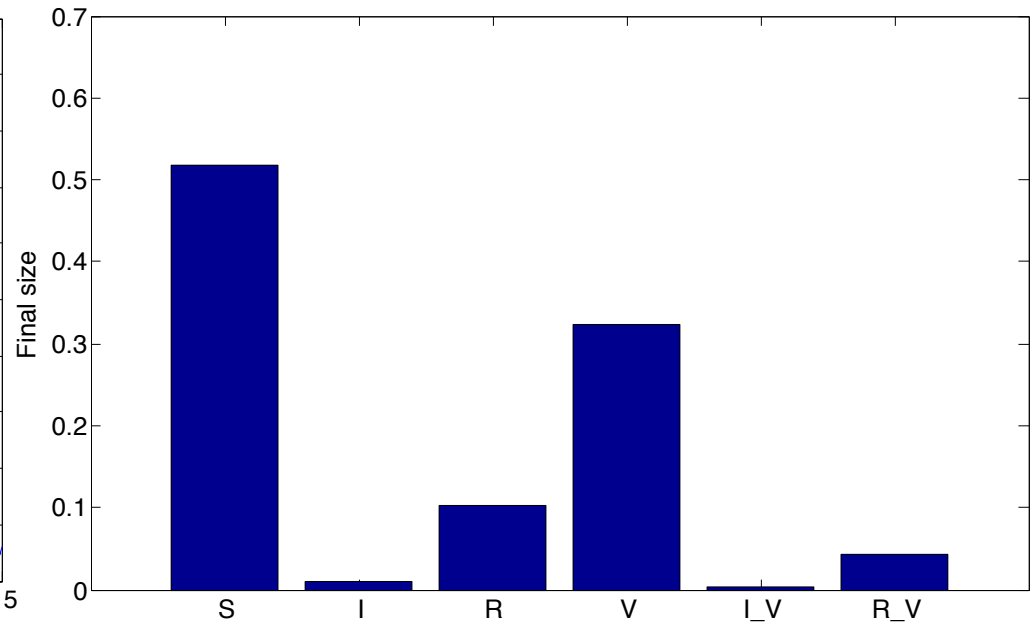
$\mu=1/70$, $\omega=0.1$, $b_0=60$, $b_1=0.16$, $\varphi=0.15$, $\beta_V=0.5\beta$, $\nu=36$, $\nu_V=1.2\nu$, $\gamma=1.8$, $\gamma_V=0.8\gamma$, $r=0$.

μ=background death ω=waning
b_0=average transmissibility
b_1=seasonal amplitude φ=phase
β_V=transmissibility ν,ν_V=recovery
γ,γ_V=loss of immunity, r=coverage

Impulsive model, 10% vaccination

The slide transition helps make the point.





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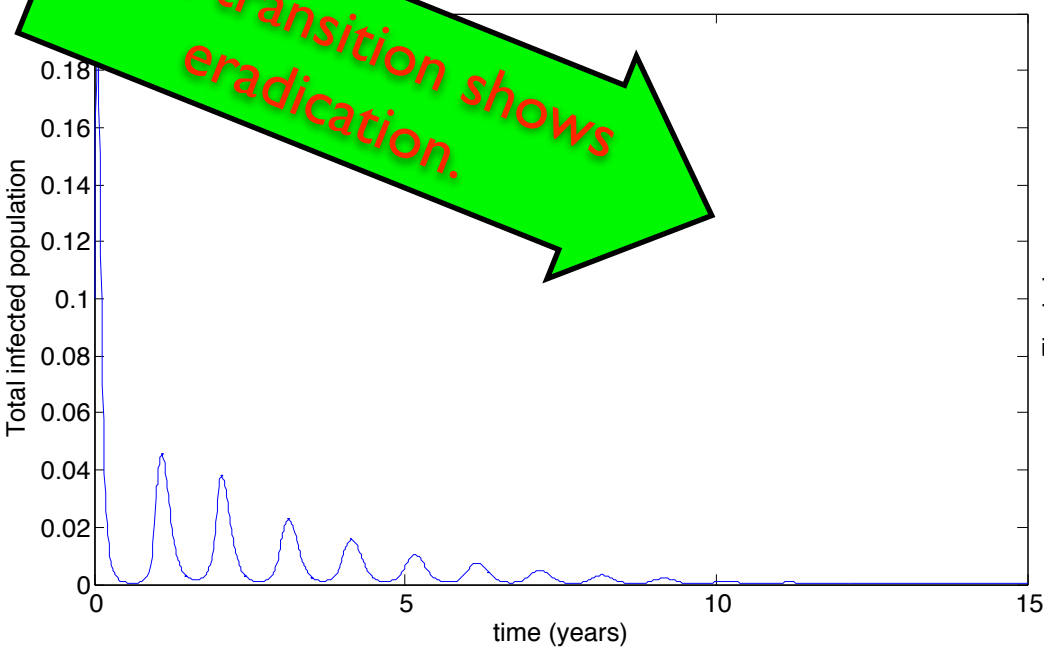
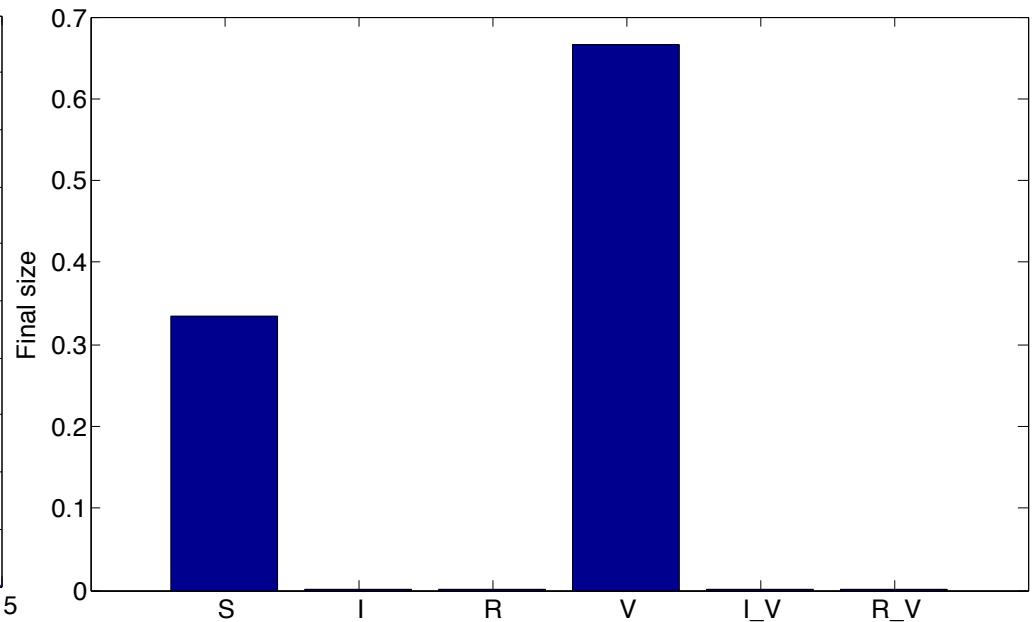
μ=background death ω=waning
b_0=average transmissibility
b_1=seasonal amplitude φ=phase
β_V=transmissibility ν,ν_V=recovery
γ,γ_V=loss of immunity, r=coverage

Impulsive model, 25% vaccination

Final transition shows eradication.

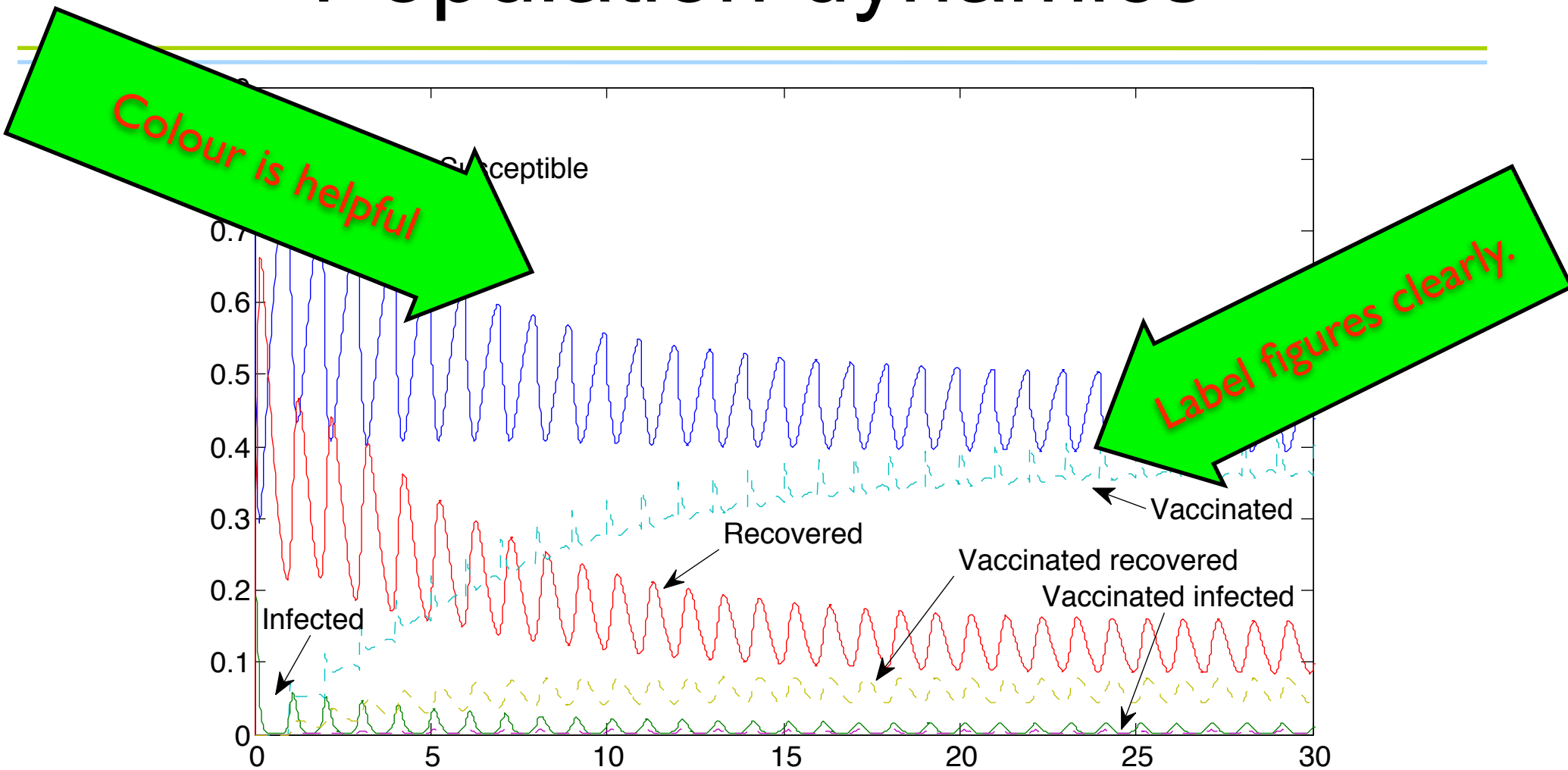




$\mu=1/70$, $\omega=0.1$, $b_0=60$, $b_1=0.16$, $\varphi=0.15$, $\beta_V=0.5\beta$, $\nu=36$, $\nu_V=1.2\nu$, $\gamma=1.8$, $\gamma_V=0.8\gamma$, $r=0.25$.

μ=background death ω=waning
b_0=average transmissibility
b_1=seasonal amplitude φ=phase
β_V=transmissibility ν,ν_V=recovery
γ,γ_V=loss of immunity, r=coverage

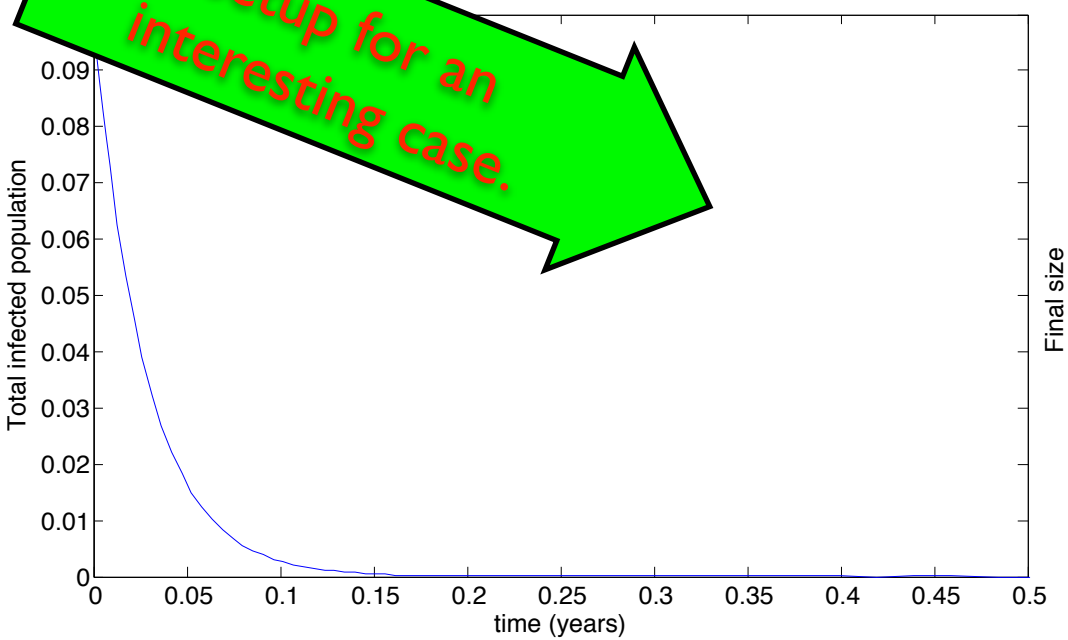
Population dynamics

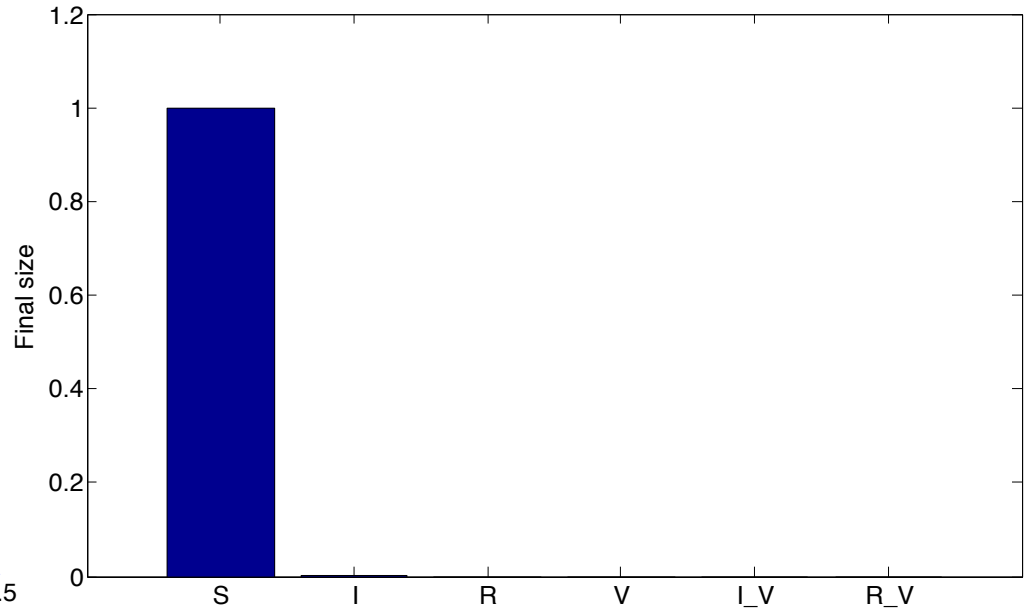


- 10% vaccination
- Note the low-level oscillations in both infected classes.

Extreme parameters, no vaccine

Setup for an interesting case.



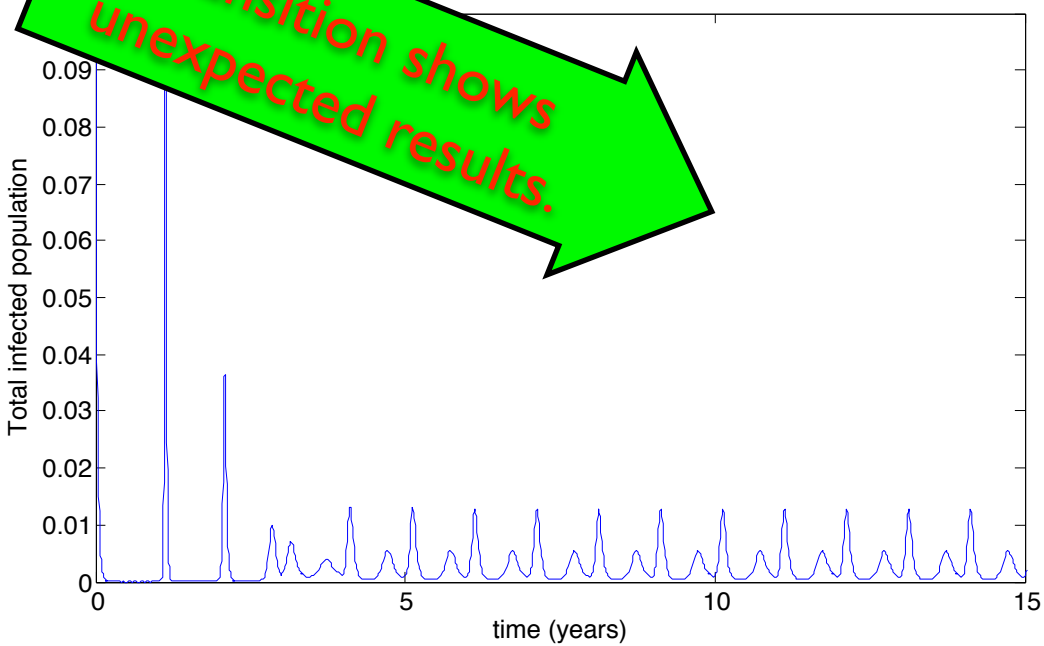


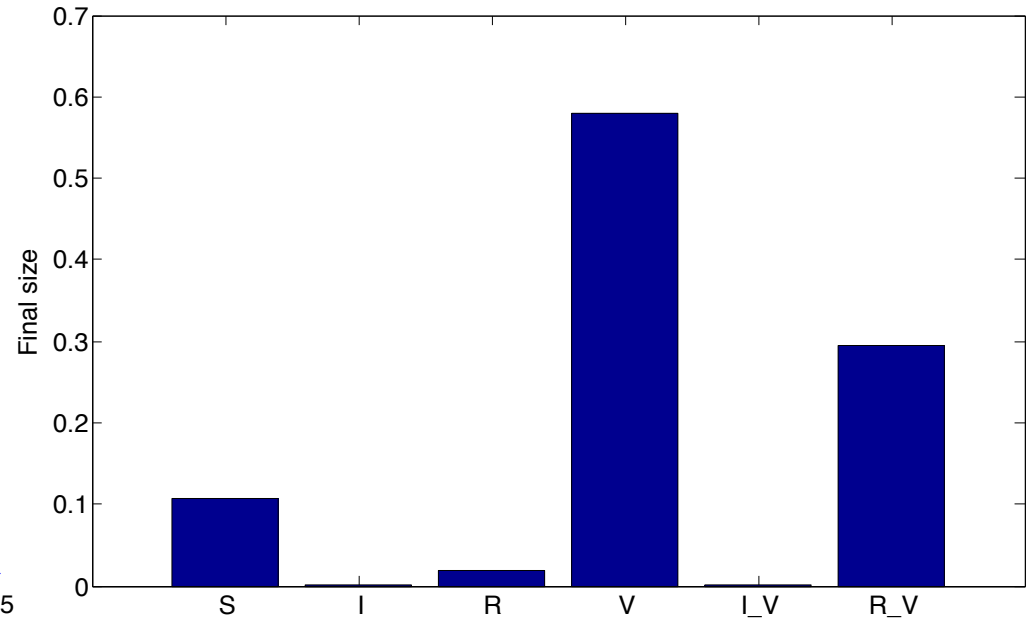
μ=1/70, ω=0.1, β=0.03, β_V=300, ν=36, ν_V=177, γ=1.8, γ_V=0.8γ, r=0.

μ=background death ω=waning
b_0=average transmissibility
b_1=seasonal amplitude φ=phase
β_V=transmissibility v,v_V=recovery
γ,γ_V=loss of immunity, r=coverage

Extreme parameters, 100% vaccination

Transition shows unexpected results.





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μ=background death ω=waning
b_0=average transmissibility
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β_V=transmissibility v,v_V=recovery
γ,γ_V=loss of immunity, r=coverage

Unexpected infection spikes

- We used extreme vaccination parameters
- Transmission due to vaccinated individuals was extremely high
- But recovery was fast
- This allowed low-level infec spikes to occu d populations

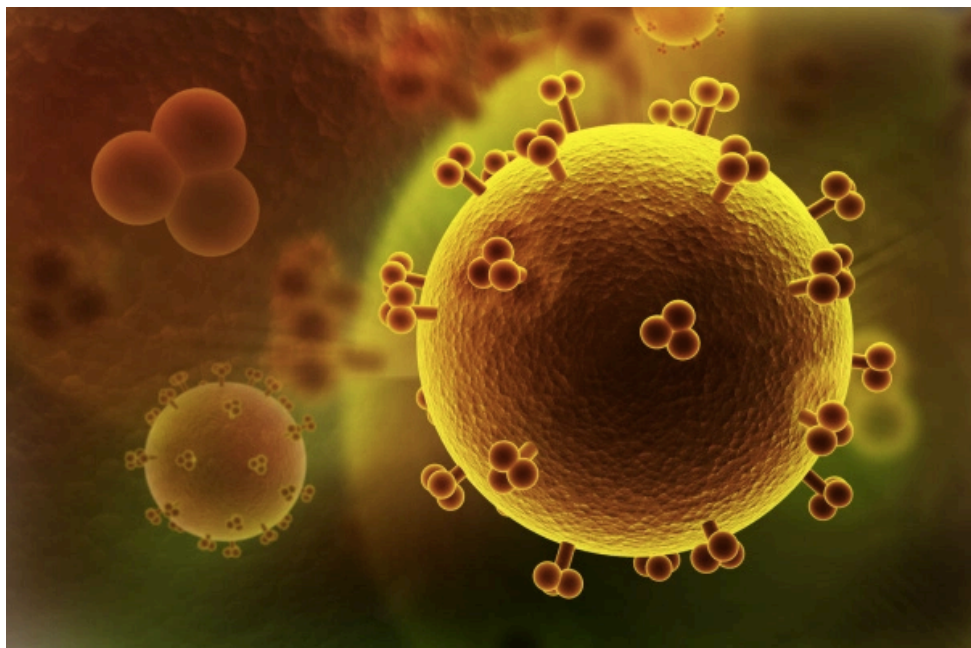
Eliminate conclusion most people will make.

- Note that this is not a backward bifurcation
- Rather, it is a destabilisation of the DFE.

Summary

Summary is concise.

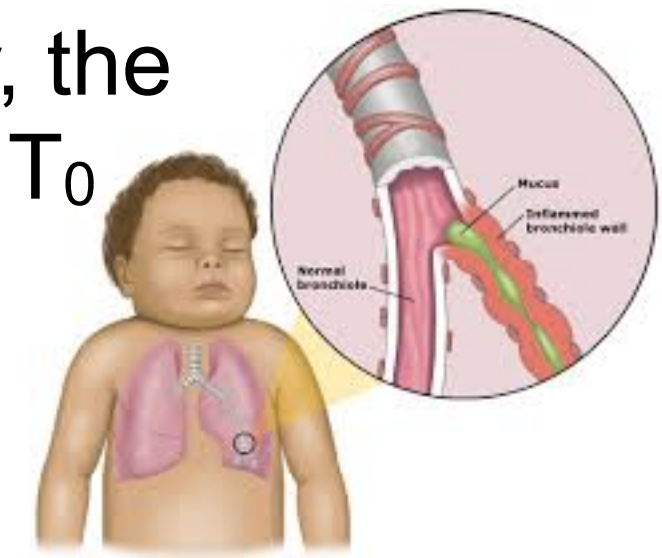
- We considered two forms of vaccination:
  - single administration before infection
    - e.g., a maternal vaccine
  - periodic vaccination
- Using impulsive differential equations, we were able to formulate conditions on the period and strength of vaccination to allow for disease control.



Impulsive reproduction number

Highlights the new quantity.

- We also defined a new quantity, the impulsive reproduction number T_0
- This is a sufficient (but not necessary) condition that ensures eradication if $T_0<1$



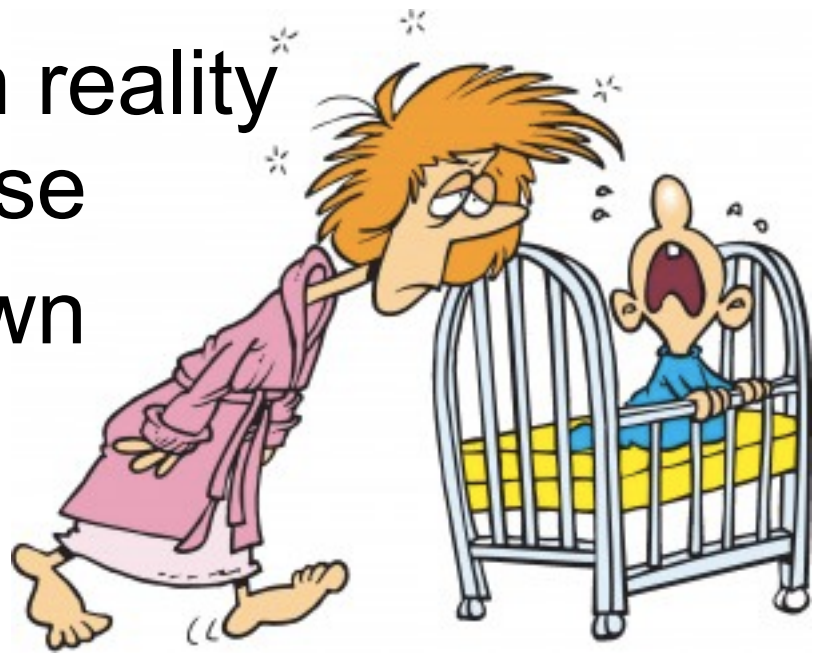
- In this case, the infected population is contracting within each impulsive cycle
- The result is eventual eradication of the infection.

T_0=impulsive reproduction number

Infection spikes

Notes the unexpected numerical result.

- tion spikes occur when vaccine-induc mission is extremely high but recovery is extremely fast
- They occur even when the transmission function is not oscillating
- They are unlikely to occur in reality with the parameters we chose
- Nevertheless, we have shown proof-of-concept that such an outcome is possible.



Limitations

Always list your limitations.

We assumed:

- The time to administer the vaccine was significantly shorter than the time between vaccinations
- A well-mixed population
- A single age cohort
- A population of fixed size
- Constant birth and death
- Maternal vaccination in the first model.

Conclusions

- A vaccine that targets RSV infection has the potential to significantly reduce the overall incidence of the disease
- Long-term, periodic vaccination can theoretically control the disease, but coverage needs to be high or administration sufficiently frequent
- Some parameters have the potential to increase unexpected infection spikes
- Care should be taken to understand long-term effects when introducing new vaccines.

Reminder of what we studied

One audience takeaway

Second audience takeaway

What does this mean for the real world?

Only one page for the conclusion.

Acknowledge collaborators verbally

Key reference

- R.J. Smith?, A.B. Hogan, G.N. Mercer *Unexpected infection spikes in a model of Respiratory Syncytial Virus vaccination* (Vaccines, 2017, 5:12).

http://mysite.science.uottawa.ca/rsmith43

Have a website where people can find you and your work.

Summary

* You should be telling a story
* It should have a beginning, middle and end
* Make it appealling to an audience who will be both reading and listening
  - needs to work on both levels
  - they should not be the same
  - try not to "read out" your slides
* Talks should have pizzazz.

Practice, practice, practice

* Practice every talk three times
  - once for saying the words
  - once for timing
  - once for a polish
* The talk is the major way you will get other people interested in your work
* It needs to be deep, dramatic and digestible
* Do not go over time
  - leave time for questions.

The take-home message

* If you're junior, bring hard copies of your papers to hand out to interested parties
  - people are more likely to read a hard copy at a conference or on the train
* This is your moment in the sun
* Don't waste it through poor preparation
* The audience will take away 1-2 points from your talk, no more
  - make sure they're the points you want them to remember.

Final page

* People will be looking at this page a lot
  - far longer than any other in your talk
* Make sure they have something to look at.

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