COVID-19 epidemic modelling

(**very simplified version**)

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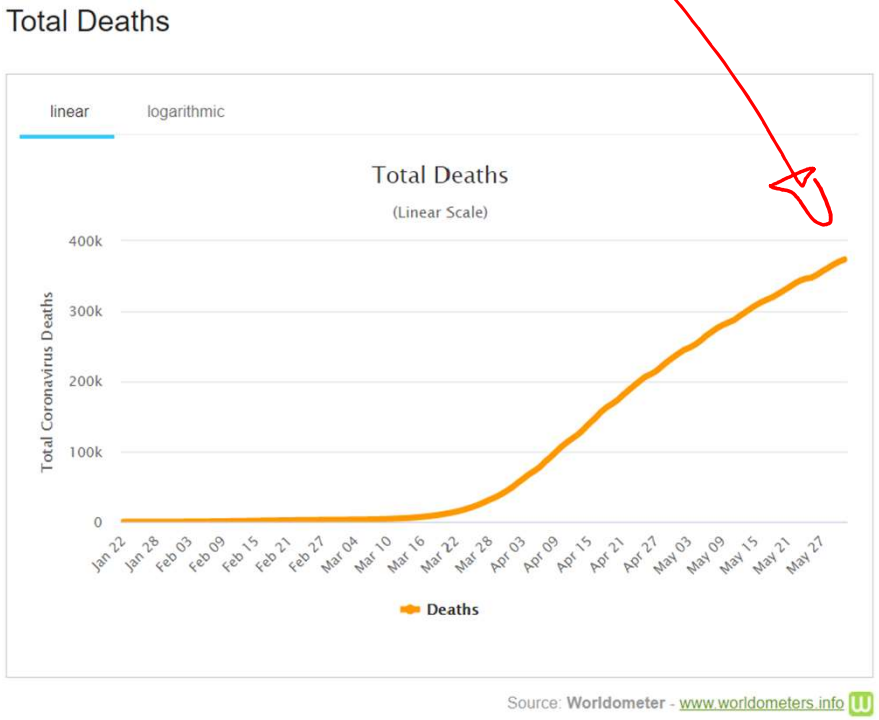
Agenda

- Introduction
- Epidemiologic Modelling
- At risk populations, epidemiology toolbox
- Case for Ontario
- Questions

Introduction

- Pandemics are scary
- Health, economic implications
- Quarantine, social distancing cannot last forever (?)
- Flattening the curve -> “communication problem”
- Epidemics are well behaved mathematically if you make the proper assumptions and have the reasonable parameters:

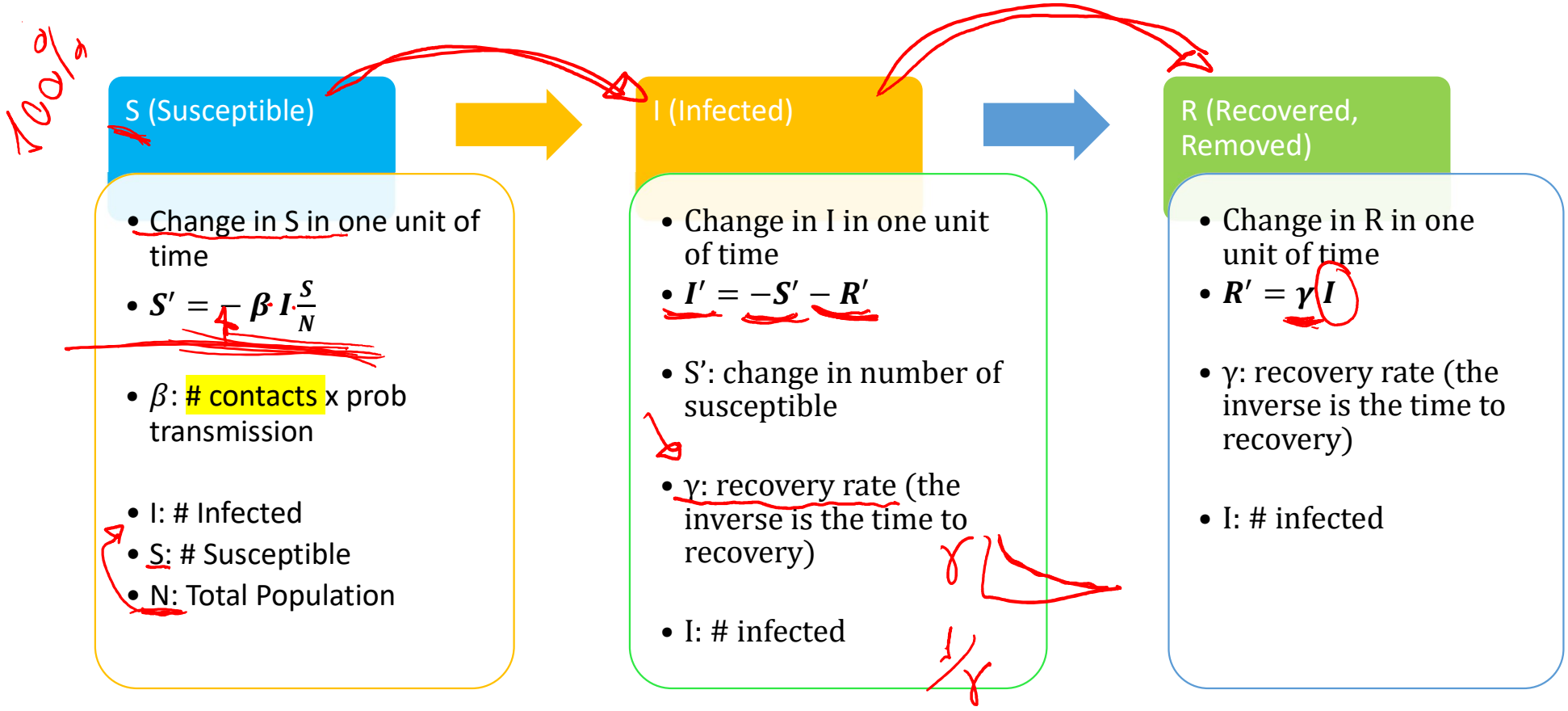


The "Susceptible-Infected-Removed" model (SIR)

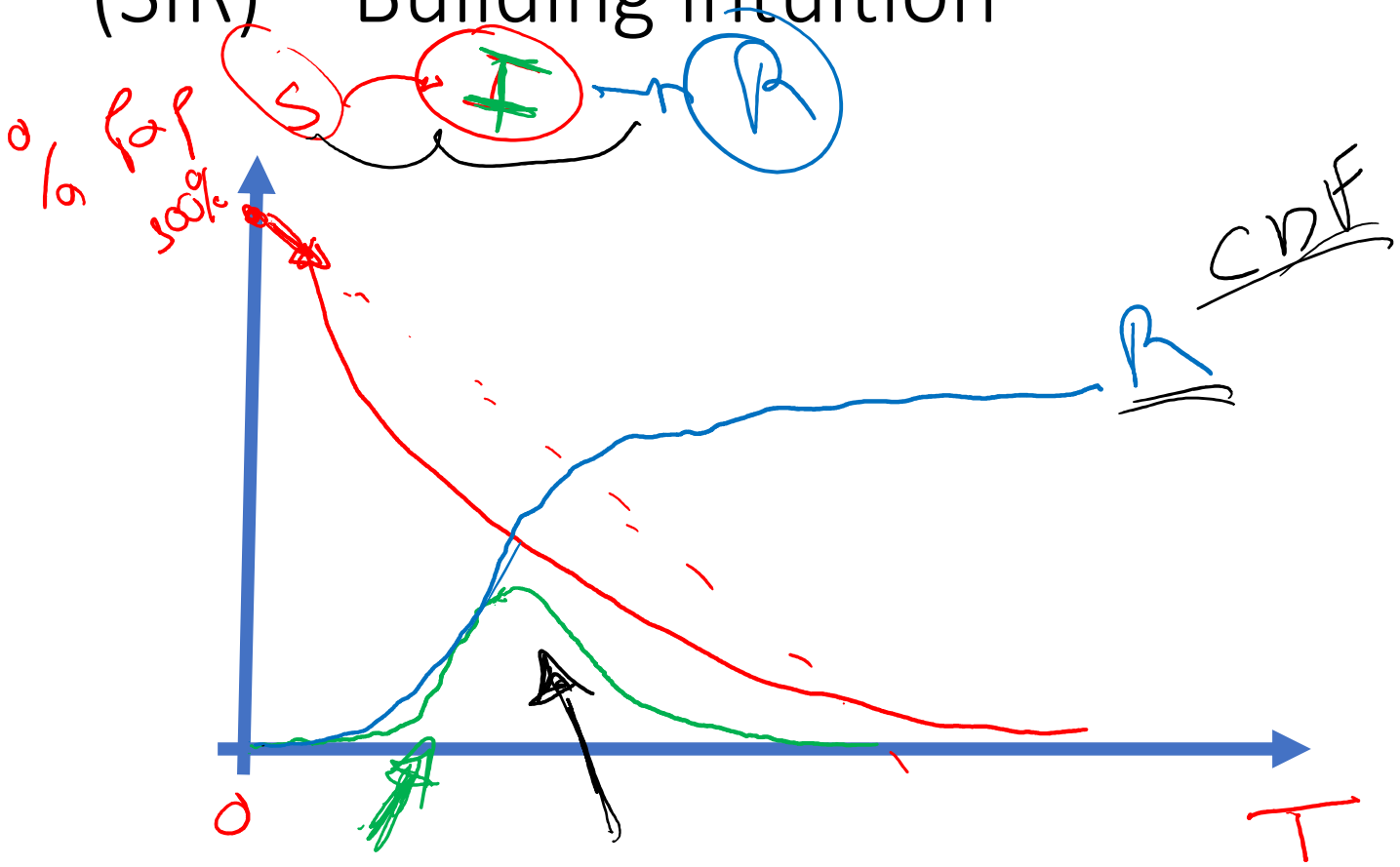
Key parameter: R_0

- R_0 is the "basic reproduction number"
- The "R-zero", "R-naught"
  - β is a measurement of the force of infection
    - # contacts * prob of transmission
  - $\frac{1}{\gamma}$ is the infections period
- $R_0 = \frac{\beta}{\gamma}$,

The "Susceptible-Infected-Removed" model (SIR)



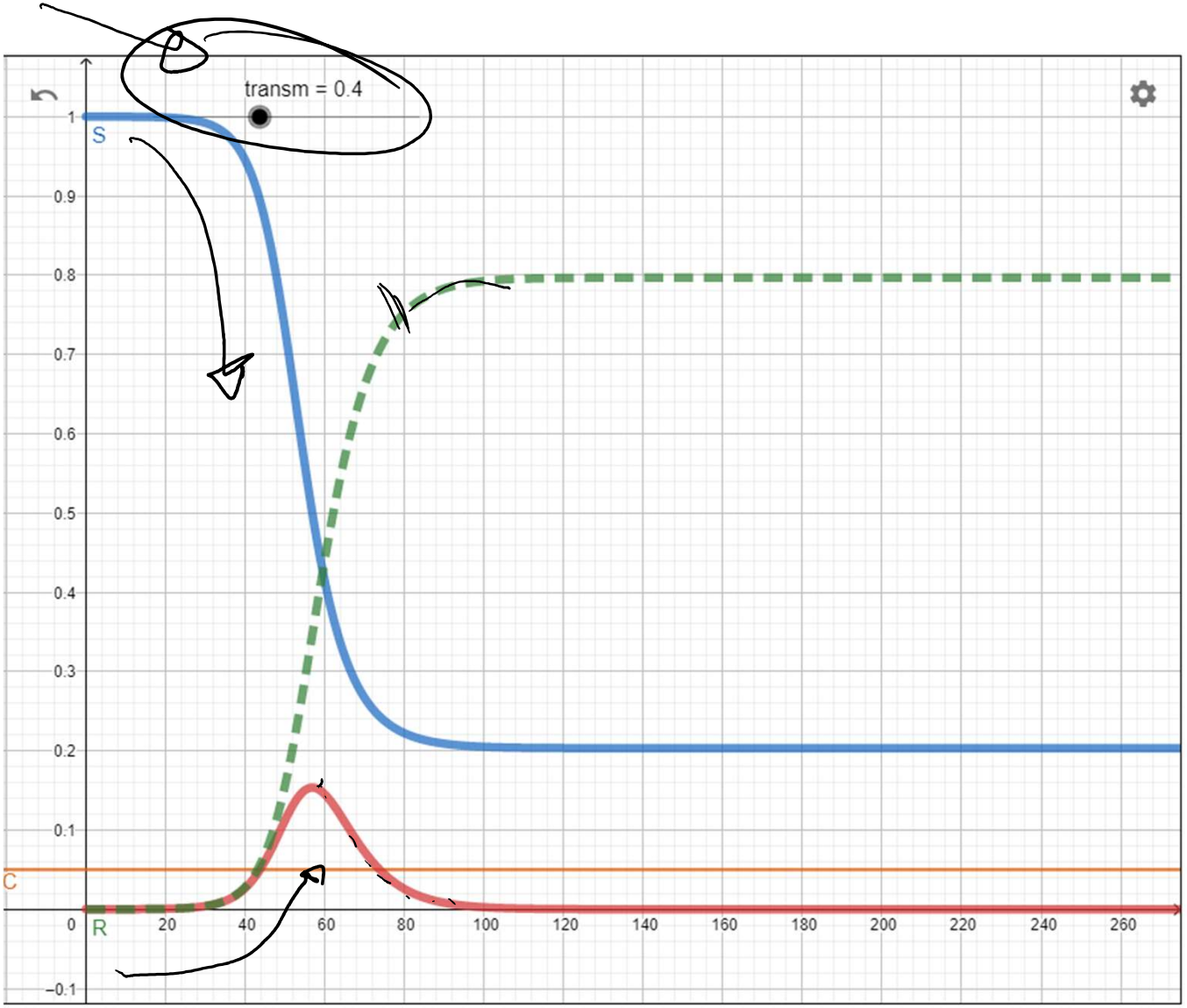
The “Susceptible-Infected-Removed” model (SIR) – Building intuition



SIR Model

R_0

$R_0 = \frac{\beta}{\gamma}$



Implications

- Flattening = spreading infection over time…there will still be the infection and will take time
- ICU beds need to be used by people with strokes, cardiac arrest, invasive surgeries, cancer etc…
- When will it be safe to go outside?

COVID-19 Mortality by Age and Pre-Existing Condition*

Age (yrs)	Case Fatality Rate (%)
80	14.8
70-79	8.0
60-69	3.6
50-59	1.3
40-49	0.4
30-39	0.2
20-29	0.2
10-19	0.2
0-9	None

Pre-existing conditions	Case Fatality Rate (%)
Cardiovascular disease	10.5
Diabetes	7.3
Chronic respiratory disease	6.3
Hypertension	6.0
Cancer	5.6
No pre-existing conditions	0.9

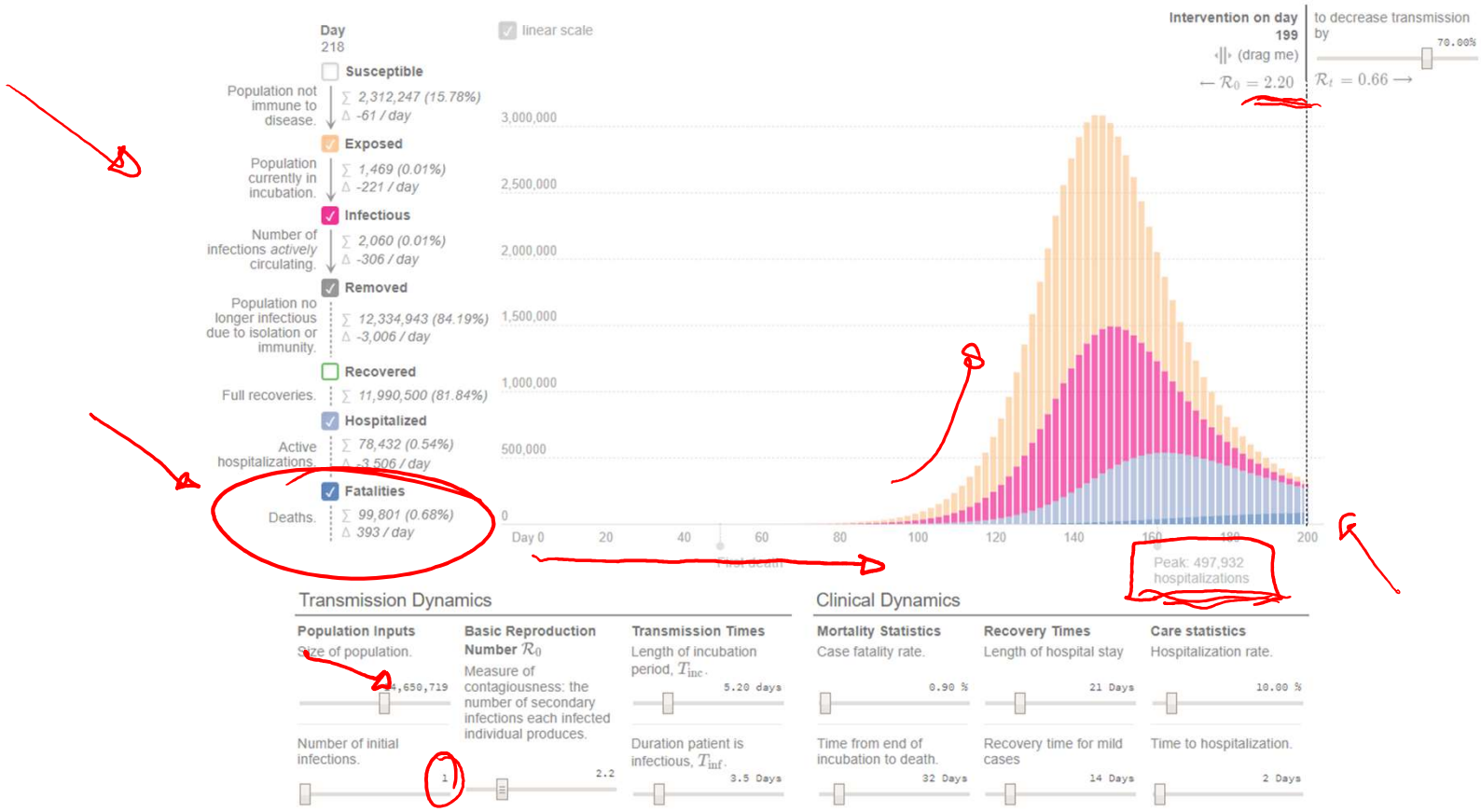
Case fatality rate for COVID-19 based on age and pre-existing conditions.

*Case Fatality Rate (%) = (number of deaths / number of COVID-19 cases) x 100 for each group

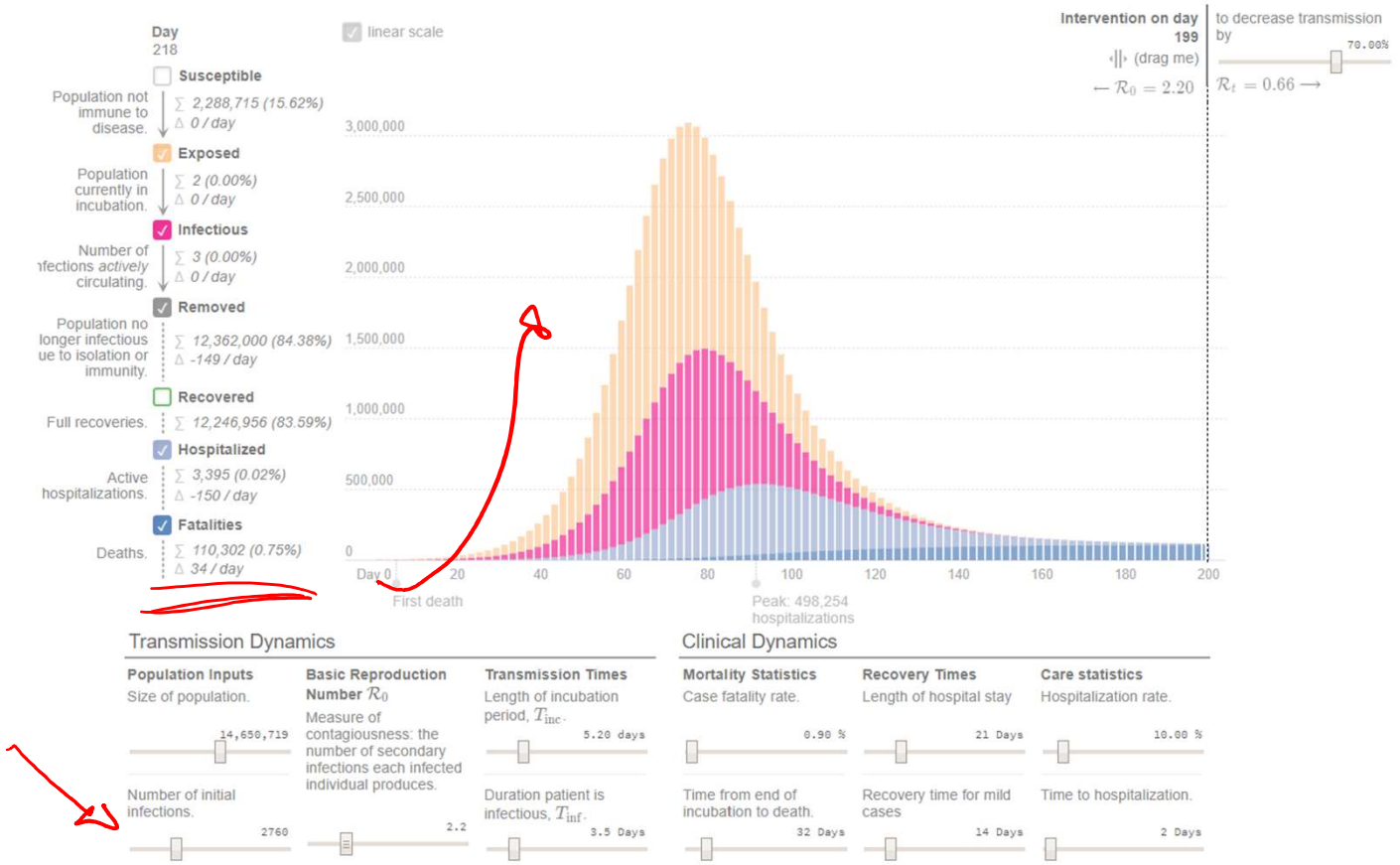
Source: Worldometers.info. Accessed 14 March 2020.

S-E-I-R

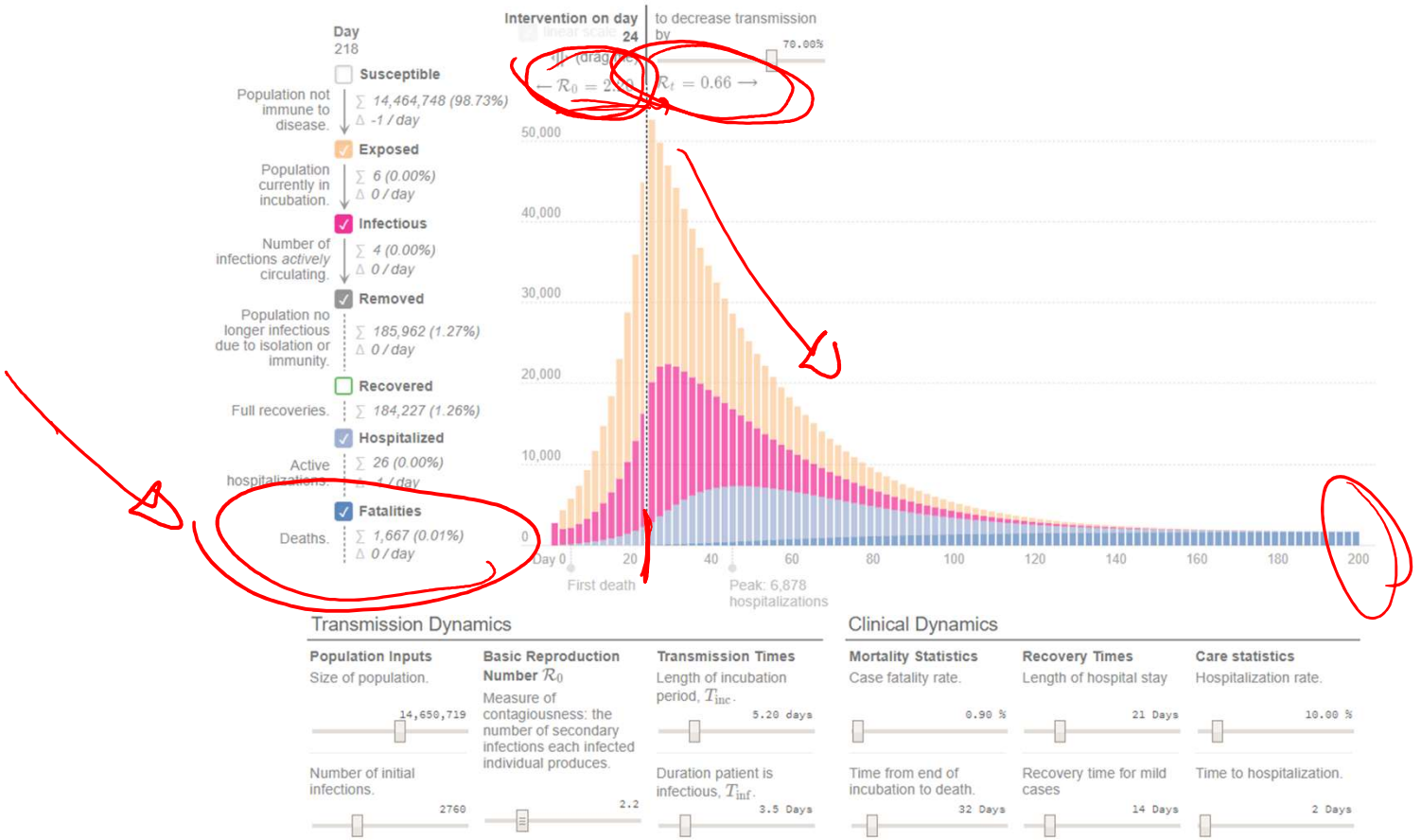
Ontario – patient "zero"



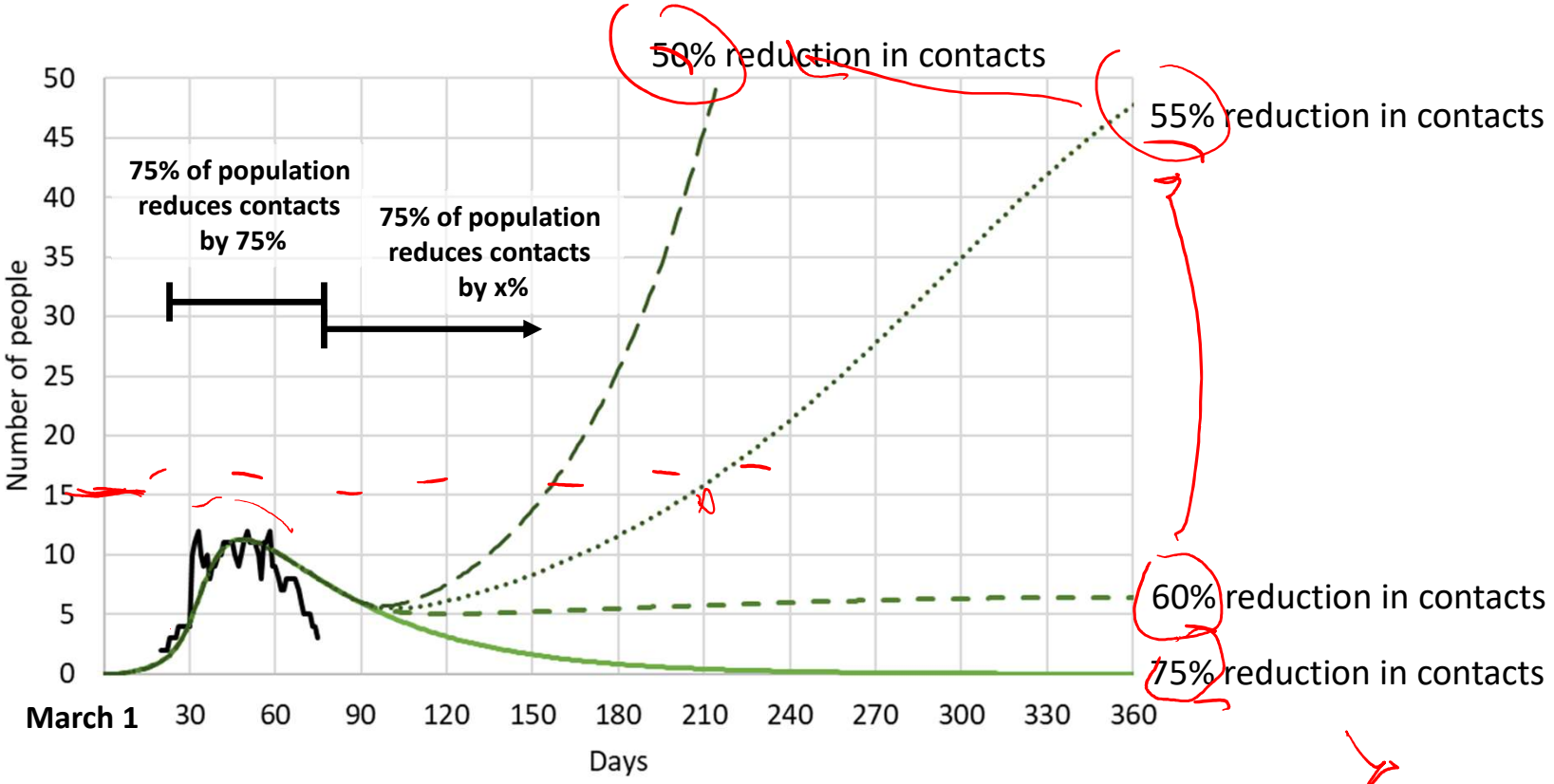
Ontario – reasonable assumptions, no quarantine



Ontario – effective intervention measures



Projected critical care demand with reductions in physical distancing effort



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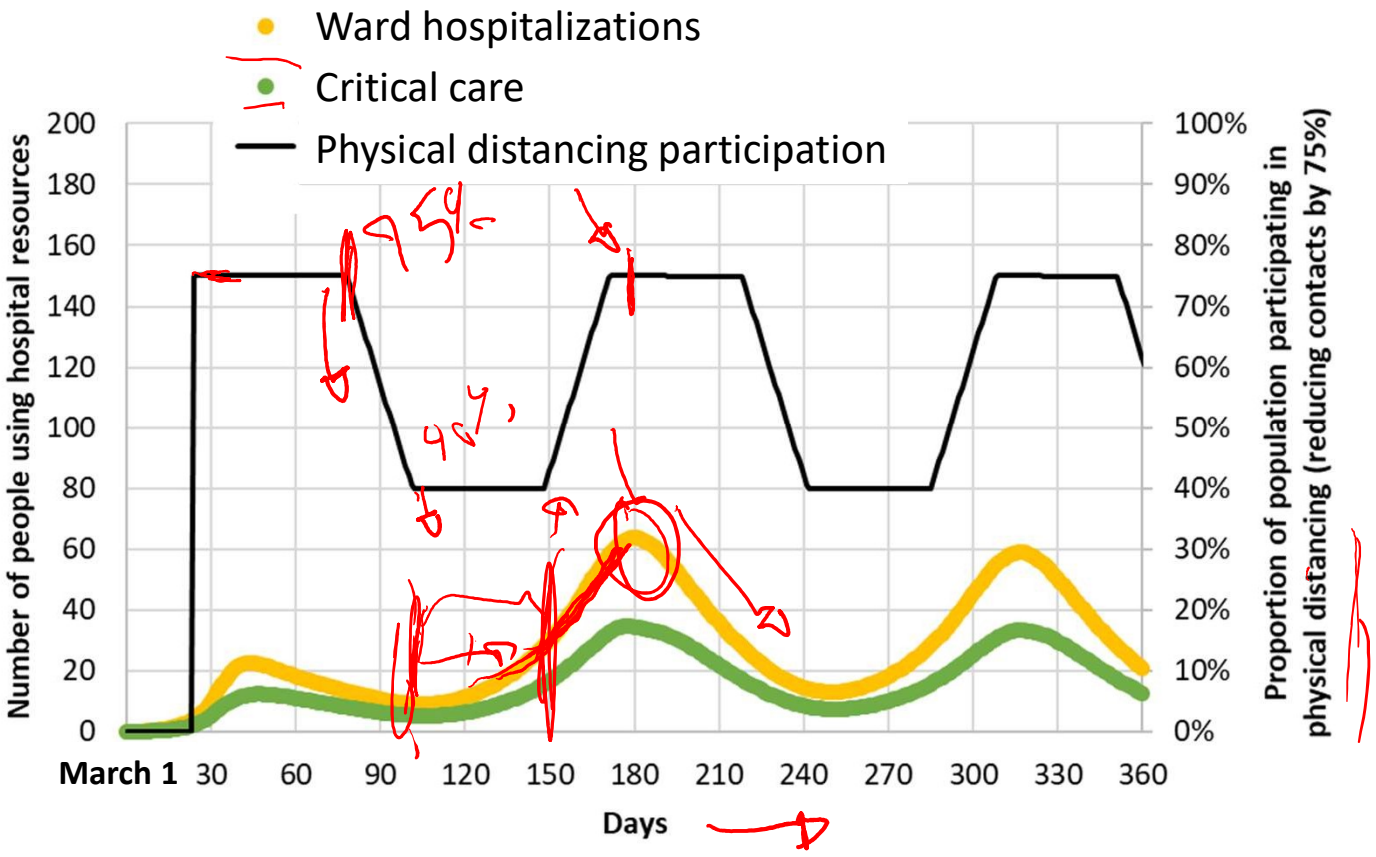
How does Modelling and forecasting help?

Community may cycle through levels of SD intensity



Scenario

Participation in community physical distancing decreases 1.5% per day (to min of 40%) when hospital capacity < 45 beds

Participation in community physical distancing increases 1.5% per day (to max of 75%) after hospital capacity > 45 beds

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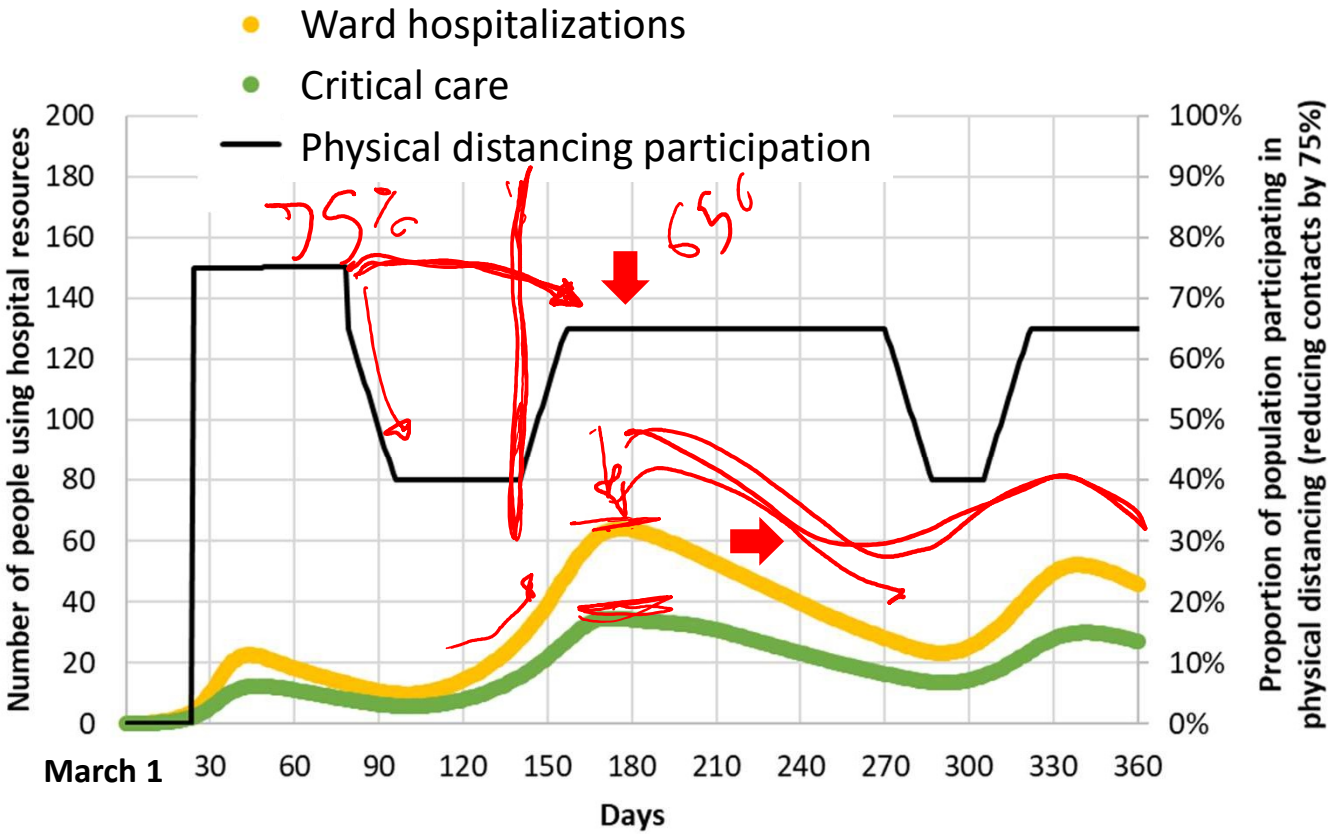
Community engagement affects need for hospital resource endurance



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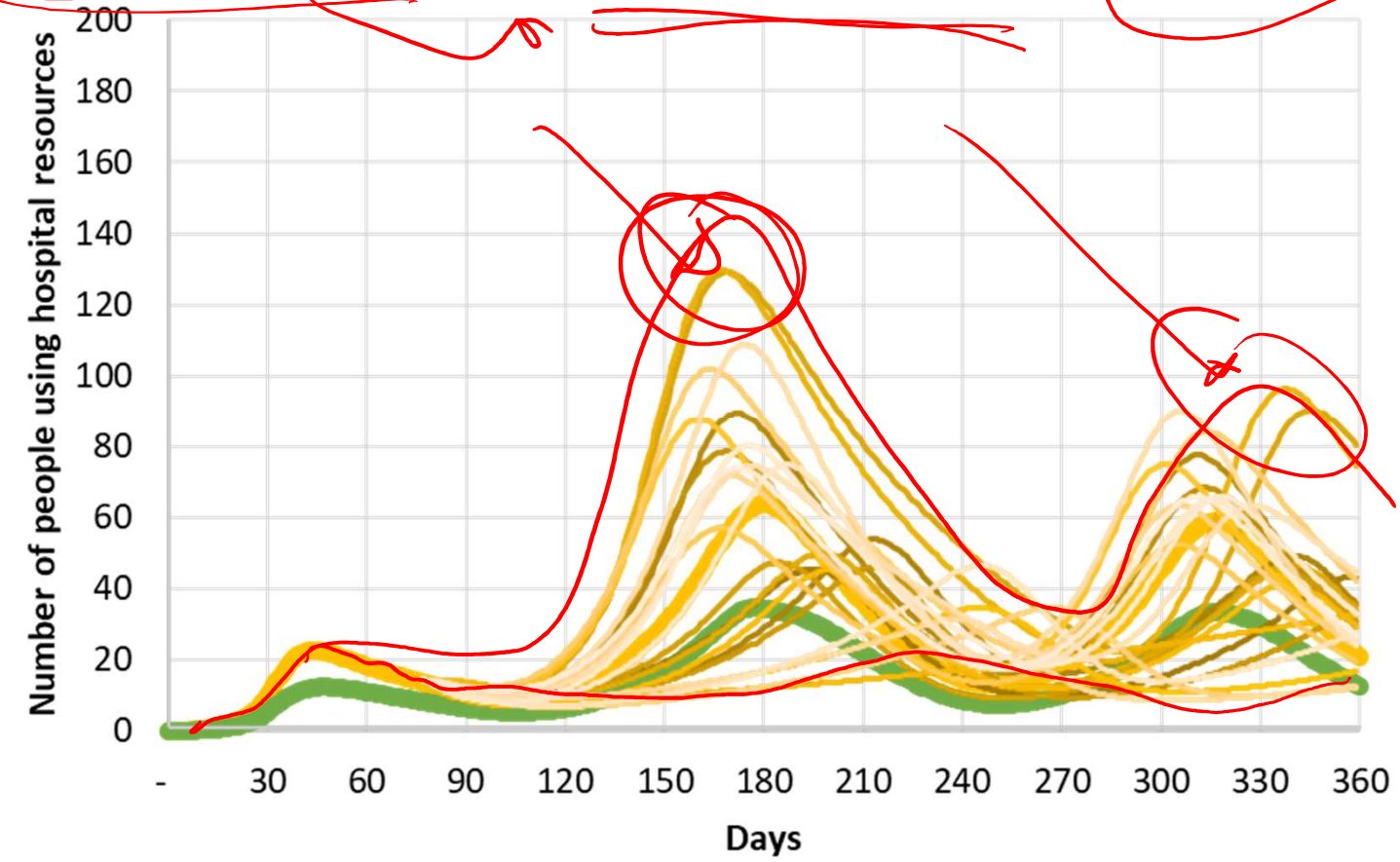
Preparing for Uncertainty
Just in Time vs Just in Case



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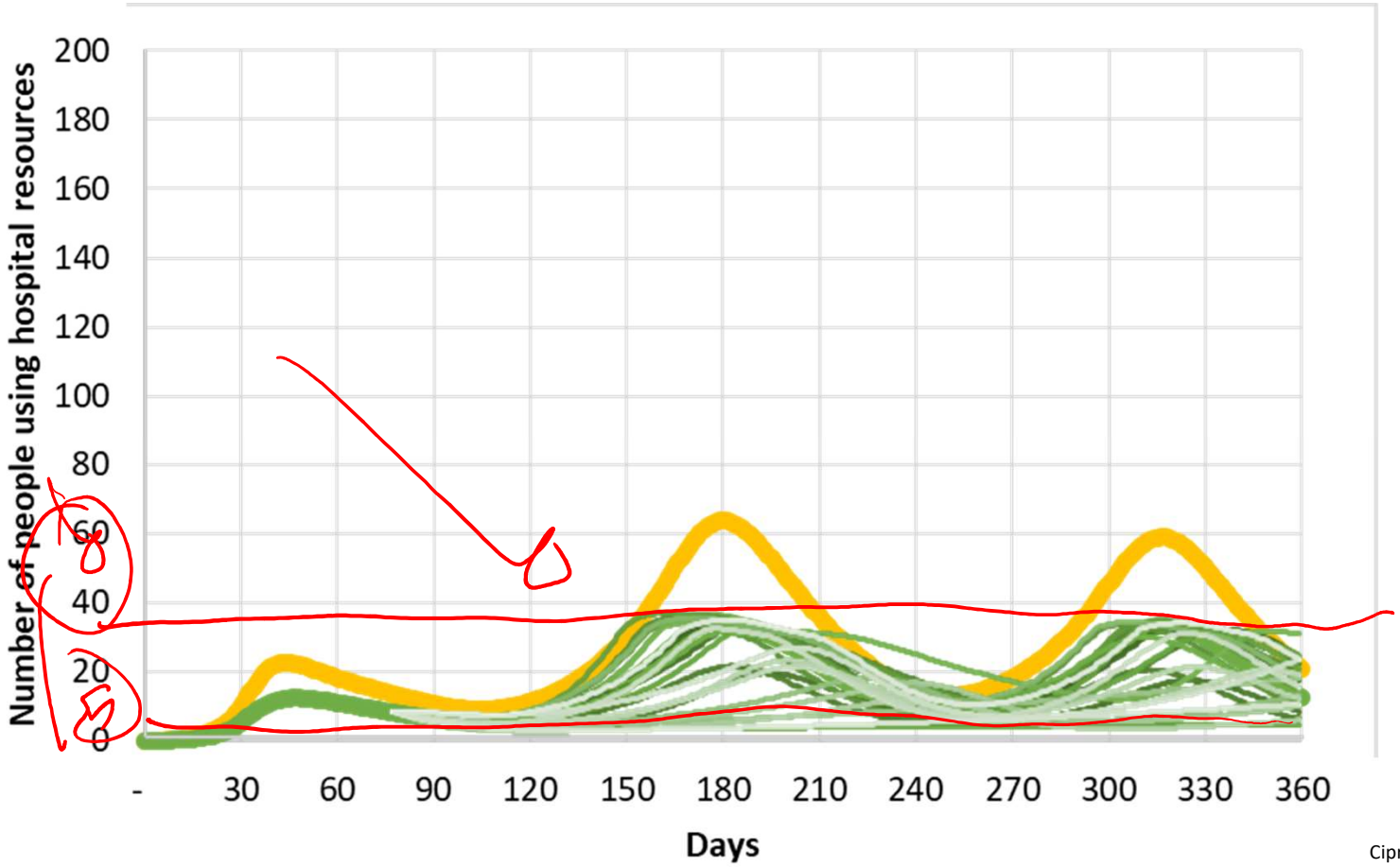

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Questions?

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