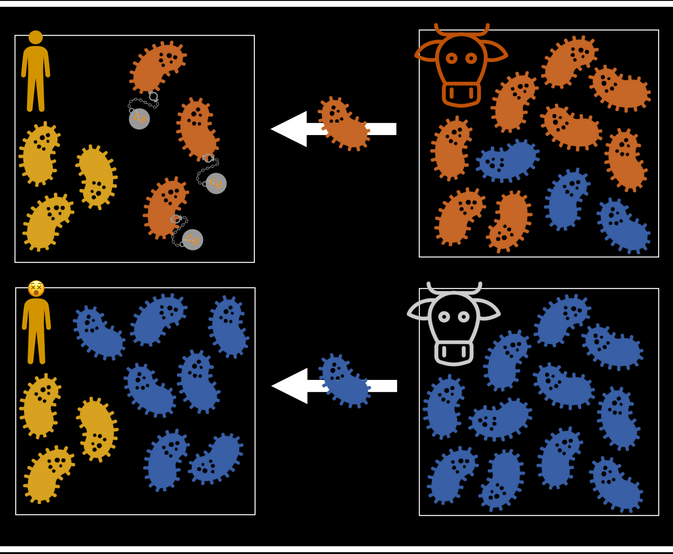
Using evolutionary theory to devise drug management strategies

Should we actually reduce antibiotic usage in agricultural settings?

Camille Simonet, Luke McNally

It is often suggested that reducing the volume of antibiotics consumed in food animals & agriculture could have public health benefits. It is actually not that straightforward.

Here, we explore four scenarios differing by (i) the intensity of drug usage and (ii) the similarity of drug usage practice in humans vs. animals (type and amount of drug used). We show that reducing antibiotic usage in animals can actually even be detrimental for public health in many situations.



OBJECTIVE

This is a highly simplified epidemiological model aiming at illustrating that public health benefits will only be achieved with a carefully devised strategy coordinating interventions in both human and animal compartments.

Ultimately, we aim at developing a fully comprehensive and parametrised model to help devising such strategy.

All those plots summarised in 4 sentences

Drugs usage in animals determines which strain flows into the human population

The resistance acquired in animals can be handicapping once circulating in humans

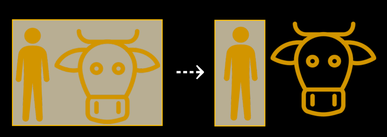
Cost of 'useless resistance'

This occurs when the pattern of drug usage (type and/or amount) differ between the two compartments

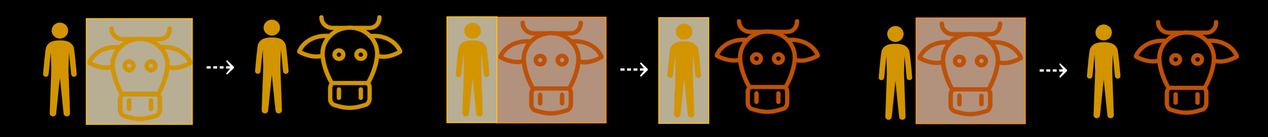
All scenarios lead to a reduction of resistance prevalence… but this does not always mean an actual public health benefit

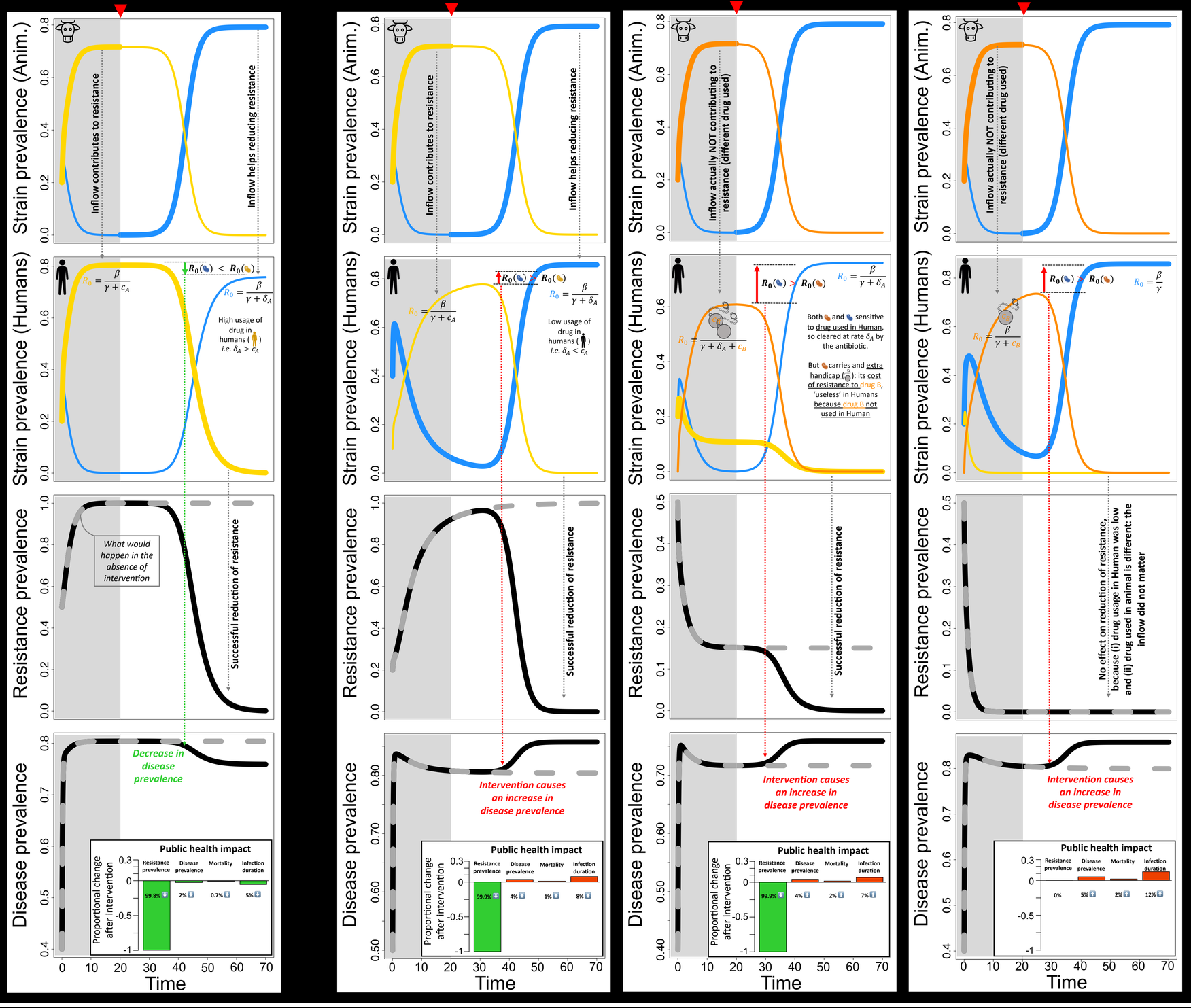
Because even for the same resistance profile, the transfer into the human population of strain fitter that the one before the intervention leads to an increase in the disease prevalence

The 'intuition'



Three scenarios with detrimental public health effects





Legend key

- **SCENARIOS**

Drug used: A A B

Drug usage rate (δ): High Low

▼ intervention reducing antibiotic usage in animals

- **STRAINS**

Sensitive strain

Resistant to drug A

Resistant to drug B

Thick line: selected strain by current drug usage practice in the focal compartment

- **"R naught:**

R_0 indicates how contagious an infectious disease is. It relates to the fitness of the pathogen.

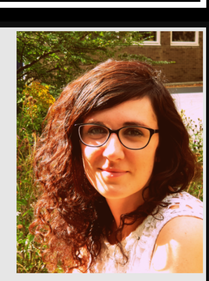
$$R_0 = \frac{Transmission}{Clearance}$$

γ	Immunity clearance
δ_A, δ_B	Antibiotic clearance by drug A or B
c_A, c_B	Cost of resistance to drug A or B

Take-home message & Future directions

- **Even if reducing antibiotic usage in animals reduces the prevalence of resistance in humans, it does not always translate into a public health benefit and can even be detrimental.**
- **This results from an interaction between the cost of drug resistance and differences in selective environments between animals and humans compartments.**
- **To determine where/if our current drug usage practises put us at risk of being in such scenario, we will:**
  - **Complexify the model (e.g. include MDR, feedback from humans to animals) to gain a more realistic picture**
  - **Parametrise the model using data on drugs usage to obtain precise quantitative results**

THE UNIVERSITY OF EDINBURGH
SynthSys
Centre for Synthetic and Systems Biology



camille.simonet@ed.ac.uk
@CamilleASimonet
lukemcnally.wordpress.com