Modeling Hepatitis A Transmission in the United States

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COMPANION TO THE SLIDES (COMMENTS)

SLIDE 4

The 6 age classes have been selected to reflect the variation of the per-susceptible rate of acquisition of infection (*force of infection*) by age, and the importance of HAV transmission in the youngest subjects.

SLIDE 5

The diagram on Slide number 5 is a visual representation of the compartmental model (only the 2 first age classes out of the 6 are shown for simplicity)

- The **"compartments"** represent the different infectivity stages, one per age class
- The **horizontal arrows** represent the flow of subjects between the different infectivity stages: from **susceptible (S)** to **infected not yet infectious (i)** ,to **infectious (I),** to **recovered, and immune (R).**
- The **vertical arrows** represent the flow between the different age classes with aging of the subjects.

Compartments for **vaccinated (V)** give the means to evaluate the impact of different immunization strategies. Subjects in the **vaccinated** compartments are completely absent from the infectivity process in the population.

SLIDE 6

Note that the force of infection pre-vaccination has been estimated in each of the 3 "ACIP 1999" regions for each of the 6 age classes

SLIDE 8

In this and all subsequent plots presented, the curves represent the yearly incidence rate per 100,000 subjects in the U.S., as predicted by the model.
The time window is 1995 to 2035.

The plot shows the predicted incidence rate **with the "ACIP 1999" regional immunization** strategy **with vaccination at 2 years of age**, whether one uses

- **a dynamic model** (bottom red curves): with the dynamic model, the force of infection changes over time with the number of infectives in the population,

or

- **a static model** (top green curve). With the static model, the force of infection is constant over time.

This plot shows that **we need a dynamic model because the static model under-estimates the true benefits of vaccination, not accounting for the herd protection effects.**
In other words, only with a dynamic model could we reach the low incidence rates that were reported in 2001.

In this plot and all subsequent plots presented, the different curves with the same color correspond to different model assumptions for the same immunization strategy, which is indicative of the robustness of the model.

SLIDE 9

Slide number 9 evaluates the herd protection effects of vaccination at either 2 or 12 years of age.

The plot shows the incidence **with the "ACIP 1999" regional strategy,** whether one vaccinates **at 2 or 12 years** of age, using either **a static** or **a dynamic model**.

With a static model, the predicted incidence rates are quite similar whether immunization takes place at 2 (top green curve) or 12 (top black curve), while the incidence rate predicted with the dynamic model is significantly lower with immunization at 2 (bottom red curves), compared to 12 years of age (blue middle curves).
The plot demonstrates that herd protection effects of vaccination are more important by vaccinating at 2 than at 12 years of age.

SLIDE 10

Slide number 10 shows the value of Nationwide routine immunization

The plot shows the incidence with either

- **the “ACIP 1999” regional vaccination strategy**: middle red curves
- **Nationwide routine vaccination:** purple bottom curves
- **Stopping vaccination in 2005:** orange top curves

The plot shows that

- **Nationwide routine vaccination is beneficial in terms of incidence compared to the “ACIP 1999” regional strategy.**

Note that the model predicts a slow re-increase in incidence with the regional strategy, most likely explained by the increasing pool of susceptible adults in the region without vaccination, and continued importation of HAV.

- **Stopping vaccination in the U.S. would lead to an immediate rebound of incidence and would lead to rates similar to those observed pre-vaccination within 2 decades.**

SLIDE 11

Slide number 11 shows the value of immunizing at 2 years of age with Nationwide routine immunization.

The plot shows **Nationwide routine immunization** with either
vaccination at 2 years of age: bottom purple curves
vaccination at 12 years of age: top grey curves

The plot shows that

- **vaccination at 2 years of age is significantly more beneficial than at 12 years of age in terms of incidence**
- **switching to vaccination at 12 would even lead to a rebound in incidence.**

The middle dashed red curves show the predicted incidence with **the regional strategy at age 2**.

It shows that in fact, switching to Nationwide vaccination at 12 years of age would be worse than the “ACIP 1999” regional strategy at 2 years of age.

SLIDE 12

The table on slide number 12 displays the number of cases predicted by the model with the “ACIP 1999” regional strategy, the nationwide routine immunization at 2, and the nationwide routine immunization at 12, with differences compared to the regional strategy.

Nationwide routine immunization can avert **40% of additional cases before 2030, compared to the regional strategy with immunization at 2.**
Note that the number of predicted cases does not account for under-reporting, hence the number of averted cases might be 5 to 10 times higher (the percentage averted remaining the same).

Switching to a nationwide strategy of immunizing at 12 years of age is predicted to result **in an increase of 19**% over the “ACIP 1999” regional strategy at 2 years of age (416,000 cases instead of 351,000 by 2030).