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A Dynamic Transmission Model for Predicting Trends in *Helicobacter pylori* and Associated Diseases in the United States

Marcia F.T. Rupnow,* Ross D. Shachter,* Douglas K. Owens,*† and Julie Parsonnet*

*Stanford University, Stanford, California, USA; †Department of Veterans Affairs Health Care System, Palo Alto, California, USA

Appendix

The mathematical equations underlying our compartmental model of *Helicobacter pylori* are a system of partial differential equations:

$$\frac{\partial I}{\partial t}+\frac{\partial I}{\partial a}=-\mu(a)\cdot I(a,t)$$
$$\frac{\partial S}{\partial t}+\frac{\partial S}{\partial a}=-[\lambda_1(a,t)+\lambda_2(a,t)+\mu(a)]\cdot S(a,t)$$
$$\frac{\partial AG}{\partial t}+\frac{\partial AG}{\partial a}=\lambda_1(a,t)\cdot S(a,t)-[\delta_1(a)+\delta_2(a)+\mu(a)]\cdot AG(a,t)$$
$$\frac{\partial CG}{\partial t}+\frac{\partial CG}{\partial a}=\lambda_2(a,t)\cdot S(a,t)-[\delta_4(a)+\mu(a)]\cdot CG(a,t)$$
$$\frac{\partial DU}{\partial t}+\frac{\partial DU}{\partial a}=\delta_2(a)\cdot AG(a,t)-[\delta_3(a)+\mu_{DU}+\mu(a)]\cdot DU(a,t)$$
$$\frac{\partial CAG}{\partial t}+\frac{\partial CAG}{\partial a}=\delta_3(a)\cdot DU(a,t)+\delta_4(a)\cdot CG(a,t)-[\delta_5(a)+\mu_{GU}+\mu(a)]\cdot CAG(a,t)$$
$$\frac{\partial GC}{\partial t}+\frac{\partial GC}{\partial a}=\delta_5(a)\cdot CAG(a,t)-[\mu_{GC}+\mu(a)]\cdot GC(a,t)$$

The mathematical equations underlying our compartmental model of *H. pylori* is a system of partial differential equations:

$$\lambda_1(a,t)=p(a)\cdot\int_0^\infty \beta(a',a)\cdot[AG(a',t)+CG(a',t)+DU(a',t)+\alpha\cdot CAG(a',t)+GC(a',t)]da'$$

$$\lambda_2(a,t)=(1-p(a))\cdot\int_0^\infty \beta(a',a)\cdot[AG(a',t)+CG(a',t)+DU(a',t)+\alpha\cdot CAG(a',t)+GC(a',t)]da'$$

where:

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$$I(0,t) = p_I \cdot \Pi$$
$$S(0,t) = (1 - p_I) \cdot \Pi$$
$$AG(0,t) = CG(0,t) = DU(0,t) = CAG(0,t) = GC(0,t) = 0$$

Notation:

a, a'	age index
t	time index
Π	birth rate per unit time
$I(a,t)$	number of isolated (not-susceptible) individuals of age *a*, at time *t*
$S(a,t)$	number of susceptible individuals of age *a*, at time *t*
$AG(a,t)$	number of infected individuals of age *a* with antrum-predominant gastritis, at time *t*
$CG(a,t)$	number of infected individuals of age *a* with corpus-predominant gastritis, at time *t*
$DU(a,t)$	number of individuals of age *a* with duodenal ulcer, at time *t*
$CAG(a,t)$	number of individuals of age *a* with chronic atrophic gastritis, at time *t*
$GC(a,t)$	number of individuals of age *a* with gastric cancer, at time *t*
p_I	proportion of population that is not-susceptible at birth
$\lambda_1(a,t)$	rate at which one susceptible of age *a* acquire infection and develop antrum-predominant gastritis
$\lambda_2(a,t)$	rate at which one susceptible of age *a* acquire infection and develop corpus-predominant gastritis
$\beta(a',a)$	transmission parameter; probability that an infective of age *a'* will infect a susceptible of age *a*
$p(a)$	proportion of newly infected individuals of age *a* developing antrum (vs. corpus) predominant gastritis
$\delta_1(a)$	transition rate from antrum- to corpus-predominant gastritis in age group *a*
$\delta_2(a)$	progression rate from antrum-predominant gastritis to duodenal ulcer in age group *a*
$\delta_3(a)$	transition rate from duodenal ulcer to chronic atrophic gastritis in age group *a*
$\delta_4(a)$□	progression rate from corpus-predominant gastritis to chronic atrophic gastritis in age group *a*
$\delta_5(a)$	progression rate from chronic atrophic gastritis to gastric cancer in age group *a*
$\mu(a)$	age-specific background mortality rate due to all cases
μ_{DU}□	mortality rate due to duodenal ulcer
μ_{GU}	mortality rate due to gastric ulcer
μ_{GC}	mortality rate due to gastric cancer

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