Unravelling the dynamics of hepatitis-E infections in displaced populations: implications for reactive vaccination campaigns

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Public-health context

Hepatitis E virus has been responsible for massive protracted epidemics in Africa and Asia with case fatality in pregnant women up to 25%. With no effective treatment and little evidence that emergency water and sanitation improvements slow epidemics, public health practitioners have been paralysed in epidemic response. Recent development of an efficacious vaccine1 has raised hopes for reactive vaccination in outbreaks. However, with the three-dose immunization schedule, the poorly quantified natural history and complex epidemiology, the impact of reactive strategies remains unclear. Here we investigate these issues by using a unique set of epidemiological, serological and environmental data from outbreaks that occurred in two camps of internally displaced populations.

Epidemiological, serological & precipitation data

Despite similar symptomatic attack-rates, the epidemic dynamics were very different in the two camps, starting either during the dry (Dogdoré) or rainy (Mornay) seasons.

Mechanistic modelling & Bayesian inference

Using a Bayesian framework2, we fit a stochastic SEIR model, accounting for asymptomatic infections and time-varying transmission rates, to epidemic curves and seroprevalence data3:

- Transmission rate is modelled by a diffusion: \( d\log(p_i) = a \beta_i \)
- Observed weekly incidence is modelled by: \( \lambda(t) = \text{Poisson} (\mu(t) \cdot \pi(t)) \)
- Observed number of asymptomatic infections is modelled by: \( A(t) \sim \text{Binom} (N(t) \cdot \lambda(t) \cdot \pi(t)) \)

Parameter Description | Mornay | Dogdoré
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\( E(0) \) | Initial number incubating | \( \mu(0,1000) \) | \( \mu(0,2000) \)
\( I(0) \) | Initial number infected | \( N(20000,30000) \) | \( \mu(0,15000) \)
\( D_{inc} \) | Incubation period (days) | \( N(34,7) \) | \( N(21,14) \)
\( D_{inf} \) | Infectious period (days) | \( N(21,14) \) | \( N(30,6) \)
\( \alpha \) | Proportion of symptomatic infections | \( \mu(0,1) \) | \( N(0.057,0.008) \)
\( R_0 \) | Basic reproduction number | \( \mu(0,100) \) | \( \mu(0,500) \)
\( \sigma \) | Volatility of transmission rate | \( \mu(0,1) \) | \( \mu(0,1) \)
\( \rho \) | Reporting rate | \( \mu(0,1) \) | \( \mu(0,1) \)

While significant cases and deaths were averted in all simulations, the impact of vaccination varied across strategies and settings. In Mornay, the impact of vaccination campaigns was low compared to Dogdoré due to the large number of exposed and incubating individuals early in the outbreak. The vaccine has a larger impact if it provides protection during the incubation period and if one and two-doses prove to be efficacious. Hepatitis E vaccines can play an important role in outbreak response, although the impact may be shaped by the modes of vaccination and uncertain aspects of vaccine-protection.