The Potential Public Health Impact of Varicella Vaccination in Hungary

Background

- Varicella (chickenpox):
  - Caused by the varicella zoster virus (VZV).
  - Highest incidence observed in <1 years of age in Europe (8/100,000 cases).
- Clinical symptoms include fever, generalized itchy rash, headache, malaise.
- Complications can occur among the previously healthy as well as in those who are immunosuppressed or considered to be at high risk and include scarring, bacterial infection, encephalitis, and pneumonia.
- Creates substantial burden:
  - On health care systems (hospitalizations; emergency department visits)
  - On society (school absenteeism; work time loss).

Objective:

- Estimate the current burden of varicella in Hungary.
- Project the potential public health impact of universal childhood varicella vaccination (UCVV).

Methods

- Adaptation of deterministic, compartment-based, age-structured dynamic transmission models.\(^{12,13}\)
- The model uses a Maternal/passive immunity – Susceptible – Exposed – Infectious (ESI) structure to model the natural history of VZV.
- Consists of a system of 126 ordinary differential equations, which are numerically integrated and used to determine model results.
- Model parameters related to natural history of the disease are taken from the literature.\(^ {14,15}\)
- The results indicate that the public health benefits extend beyond vaccinates, with a 98.6% reduction in disease in infants too young to be vaccinated.

Figure 1: Variella dynamic transmission model structure

\[\text{High immunity} \rightarrow \text{Susceptible} \rightarrow \text{Exposed} \rightarrow \text{Infectious} \rightarrow \text{Natural varicella} \rightarrow \text{Breakthrough varicella} \rightarrow \text{A2 after varicella vaccination}\]

Figure 2: Model calibration

- Prevalence of varicella immunity is obtained from a single seropositivity study in adults and children, respectively.

Figure 3: Impact of vaccination on wild-type and breakthrough varicella incidence and the age distribution of cases

\[\text{Incidence per 100,000 Population}\]

Table 1. Cumulative impact of one-dose varicella vaccination in Hungary over 25 years

<table>
<thead>
<tr>
<th>Years after start of vaccination program</th>
<th>1 year</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases of natural varicella</td>
<td>30,470</td>
<td>141,005</td>
<td>190,326</td>
<td>149,490</td>
</tr>
<tr>
<td>Number of cases of breakthrough varicella</td>
<td>271</td>
<td>199</td>
<td>191</td>
<td>664</td>
</tr>
<tr>
<td>Number of all varicella cases prevented</td>
<td>31,504</td>
<td>153,192</td>
<td>200,742</td>
<td>156,134</td>
</tr>
<tr>
<td>Number of varicella deaths prevented</td>
<td>0.5</td>
<td>0.77</td>
<td>0.95</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Results

- A rapid reduction of the burden of varicella will occur with both cases and deaths reduced by 99% within 10 years.
- Public health benefits extend beyond vaccinates, with a 98.6% reduction in disease in infants too young to be vaccinated.
- The impact of any on herpes zoster is not captured in the results.

Conclusions

- The results from this model predict a rapid and sustained decrease of varicella in Hungary, achieving near-elimination status within ten years.
- Notably, rapid disease reduction is seen even in age groups not vaccinated.
- The results indicate that the herd immunity threshold in Hungary is probably towards the lower end of previous results estimated in Europe\(^ {16}\) to range between 69.8% (Italy) and 91.9% (Netherlands), likely due to a combination of factors including a low birth rate.
- Further work to explore the cost-effectiveness of a national varicella vaccination program is warranted, given the demonstration shown of public health impact.

References


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References