Forecasting Typhoid Conjugate Vaccine Introduction and Demand in Typhoid-Endemic LMICs

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INTRODUCTION

FORECASTING: TCV ADOPTION YEAR

FORECASTING: TCV DEMAND

Q & A
INTRODUCTION

Background

- Part of IVI’s Policy & Economic Research of Typhoid Vaccine Investment Case Exercise
- Built on four factors that drive new vaccine introduction
- Address four areas of curiosity for typhoid endemic countries

Our Curiosity

- What are the TCV candidates, developers & manufacturers?
- Expected introduction of TCV: Which country & when?
- How will the global demand for TCV look like?
TCV INTRODUCTION FORECASTING
## TYPHOID CONJUGATE VACCINE PIPELINE

### Vaccine Development & Technology Transfer Institutions

<table>
<thead>
<tr>
<th>Institution</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVI, S. Korea</td>
<td>Vi-DT (Vi conjugated with Diphtheria Toxoid)</td>
</tr>
<tr>
<td>NIH, U.S.A.</td>
<td>Vi-rEPA (Vi recombinant exoprotein antigen)</td>
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<tr>
<td>NVGH, Italy</td>
<td>Vi-CRM (Vi conjugated with cross reacting material 197)</td>
</tr>
<tr>
<td>Own R&amp;D</td>
<td>Davac – Vi-DT; Bharat &amp; Bio-Med – Vi-TT*; Eubiologics – Vi-CRM; Walvax – Vi-TT; Finlay - Unknown</td>
</tr>
</tbody>
</table>

### Manufacturers

- **PCL**
- **Phase 1**
- **Phase 2**
- **Phase 3**
- **Formulation**
- **NRA**
- **WHO-PQ**

- Incepta, Bangladesh
- PT BioFarma, Indonesia
- Finlay Institute, Cuba
- SK Chemicals, S. Korea
- Eubiologics, S. Korea
- Bharat Biotech, India
- Bio-Med Pvt. Ltd., India
- Biological E., India
- Lanzhou Inst. (CNBG). China
- Walvax, China
- Davac, Vietnam

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Estimated through four indicators

- **Typhoid fever disease burden**
  - Utilized data from Mogasale et al. 2014, Lancet Global Health

- **Past vaccine adoption history**
  - **Hib, Hep B, pneumo CV, rota:**
    - Data for 92 countries from JHSPH IVAC-VIMS Database, March 2014 update
  - **Pentavalent Vaccine Introduction:**
    - Data for Indian 35 States from Gavi (personal Communication with Melissa Ko)

- **Immunization System Capacity**
  - **DTP3 coverage rate:**
    - Data for 92 countries from WHO 2014. Immunization System Indicator

- **Experience in typhoid fever research**
  - **Typhoid surveillance, clinical trial, RCT, demonstration trial:**
    - Data from 22 studies on typhoid surveillance experience in 92 countries
    - Data from 3 studies on Indian States typhoid surveillance experience
For each of the vaccines, a score ranging from 0 to 5 was allotted to signify speed of adoption.

METHOD OF FORECASTING

*Base Assumption Year (BAY) is the year in which Gavi supported typhoid conjugate vaccine introduction is expected.
FORECASTED TCV ADOPTION YEARS

Number of Countries/States

Rapid

Slow

Endemic Countries

Indian States

1 = base assumption year is the year in which Gavi supported typhoid conjugate vaccine introduction is expected

Rapid introduction proxy: Rota vaccine according to Brooks et al. (2012)

Slow introduction proxy:
What is needed

- Vaccination strategy: Age and risk group targeting

Assumptions

- For each country we assume TCV coverage at:
  - 9 month to be same (100%) as MCV1 coverage for that country
  - 15 – 18 months to be 75% as MCV1 coverage for that country
  - Catch-up dose: MCV1 coverage to be 75%
- Wastage factor: Routine=1.33 and Campaign=1.11
TCV VACCINATION STRATEGY

**High-Risk Population**
- One dose (9 mts)
- Two Doses (9 & 15 mts)
- Catch-up (1-14.9yrs)

**General Population**
- One dose (9 mts)
- Two Doses (9 & 15 mts)
- Catch-up (1-14.9yrs)
FORECASTED TCV DEMAND

1 = base assumption year is the year in which Gavi supported typhoid conjugate vaccine introduction is expected

Target Population by Year of Introduction

<table>
<thead>
<tr>
<th>Year</th>
<th>High Risk Population</th>
<th>General Population</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>18</td>
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<tr>
<td>19</td>
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</tbody>
</table>
LIMITATIONS

- Gavi funding shift
- Other potential interventions
- Rapid economic growth
- TCV competition with other health interventions incl. new vaccines
- Political instability and/or natural disasters
TAKE HOME MESSAGE

- Effective and improved TCV WHO-PQ around the corner
- Increased interest from donors, procurers & policy makers
- Mutual partnership for humanity: Producers & Manufacturers
- TCV demand ranging from 40 – 160 million doses/year

Global Policy Maker-Donor
Collaboration is Needed in Developing
Policy Framework for TCV Introduction
to Meet Projected Demand
Forecasting typhoid conjugate vaccine introduction and demand in typhoid endemic low and middle countries

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Typhoid conjugate vaccine, demand forecast, vaccine introduction
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- Policy and Economic Research Dept.
- VIVA Investment Case Advisory Committee

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Bill & Melinda Gates Foundation

Gavi
The Vaccine Alliance

WHO
ASANTE !
THANK YOU !
BACK-UP SLIDES
<table>
<thead>
<tr>
<th>Year</th>
<th>Gavi</th>
<th>Indian States</th>
<th>Graduating</th>
<th>Non-eligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Nepal Bangladesh(^3)</td>
<td>Delhi</td>
<td>Cuba(^3)</td>
<td>Angola(^4)</td>
</tr>
<tr>
<td>2021</td>
<td>Pakistan</td>
<td>Puducherry Tamil Nadu</td>
<td>Indonesia(^3)</td>
<td>Bhutan(^4)</td>
</tr>
<tr>
<td>2022</td>
<td>Malawi Burundi Kenya</td>
<td>Jammu &amp; Kashmir West Bengal</td>
<td>Vietnam(^1)</td>
<td>Philippines</td>
</tr>
<tr>
<td>2023</td>
<td>Eritrea</td>
<td>A&amp;N(^**) Island Arunachal Pradesh D&amp;N_Haveli Daman&amp;Diu Himachal Pradesh</td>
<td>India(^2) *</td>
<td>Ecuador El Salvador Maldives</td>
</tr>
<tr>
<td>2024</td>
<td>Burkina Faso</td>
<td>Andhra Pradesh Assam Goa Karnataka Kerala Punjab</td>
<td>Guyana Nicaragua(^1) Congo, Rep. Cameroon(^2) STP (^^) Zambia(^2)</td>
<td>Fiji</td>
</tr>
<tr>
<td>2025</td>
<td>Gambia Kyrgyzstan Uganda Cambodia</td>
<td>Chhattisgarh Chandigarh Haryana Uttarakhand Orissa</td>
<td>Ghana(^1) Sri Lanka</td>
<td>Iran Morocco Paraguay Turkmenistan Guatemala</td>
</tr>
<tr>
<td>2026</td>
<td>Tajikistan Senegal Tanzania</td>
<td>Gujurut Jharkhand Meghalaya Maharashtra</td>
<td>Honduras Uzbekistan(^1) Cote d’Ivoire(^2) Djibouti(^2)</td>
<td>Jordan Micronesia Swaziland Belize Cape Verde</td>
</tr>
<tr>
<td>2027</td>
<td>Comoros Mozambique Sudan Zimbabwe Afghanistan Congo, DR Ethiopia</td>
<td>Mizoram Nagaland Sikkim</td>
<td>Mongolia Armenia Lao PDR(^2) Lesotho(^2)</td>
<td>Egypt</td>
</tr>
<tr>
<td>2028</td>
<td>Mali Sierra Leone Yemen Benin</td>
<td>Lakshadweep Madhya Pradesh Manipur Tripura</td>
<td>Kiribati Timor-Leste Bolivia Georgia</td>
<td>Marshall Islands</td>
</tr>
<tr>
<td>2030</td>
<td>Liberia Mauritania Niger Togo CAR#</td>
<td></td>
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</tr>
</tbody>
</table>

\(^1\) Gavi eligible in 2014 but forecasted by Gavi to graduate by 2015
\(^2\) Gavi eligible in 2014 but will graduate by 2020
\(^3\) Qualitatively forecasted to introduce earlier as forecast based on communication with experts from IVI and BMGF
\(^4\) Will be 100% self-financing beginning 2020 [Communication with Melissa Ko]

**Note:** Forecasted years are subject to change based on base adoption year (WHO PQ)
## Doses per Year

<table>
<thead>
<tr>
<th>Population</th>
<th>One Dose (9 months)</th>
<th>Two Doses (9 – 12 months)</th>
<th>One Dose Catch-Up (1-14.9 yrs.)</th>
<th>Two Doses Catch-Up (1-14.9 yrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk</td>
<td>40 million</td>
<td>65 million</td>
<td>40 million (Peaks at 110, stabilizes at 40)</td>
<td>65 million (Peaks at 120, stabilizes at 65)</td>
</tr>
<tr>
<td>General</td>
<td>100 million</td>
<td>166 million</td>
<td>100 million (Peaks at 206, stabilizes at 100)</td>
<td>166 million (Peaks at 243, stabilizes at 166)</td>
</tr>
</tbody>
</table>
THREE TYPES OF TYPHOID VACCINES

- Ty21a
- Injectable Vi polysaccharide Vaccine
- New Generation Injectable TCV