Modeling the Public Health Impact of Enteric and Respiratory Vaccines

Session 1b: Welcome and Overview

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Objectives

1. To explore the **key aspects of the epidemiology of vaccine-preventable enteric and respiratory infections**, including rotavirus, RSV, and tuberculosis.
2. To examine how **epidemiological and natural history of these pathogens are applied in mathematical models**.
3. To gain foundational skills in using **compartmental models for vaccine-preventable enteric and respiratory infections**.
4. To understand the role of **human behavior** (e.g., social mixing data) and incorporate social contact data **in infectious disease modeling**.

Sessions

1. Epi concepts and fundamentals of modeling
2. Natural history of enteric and respiratory infections
3. Modeling vaccination
4. Adding demography and contact patterns
5. Applications of modeling

Format

Methods lectures – Emory

Subject matter experts – NDMC and others

Hands on sessions – Use your own laptop. Coding in R

Why focus on enteric and respiratory pathogens and vaccines

Complex natural history

- Imperfect immunity
- Affect the whole age range

Transmission

- Close contact
- Fomite

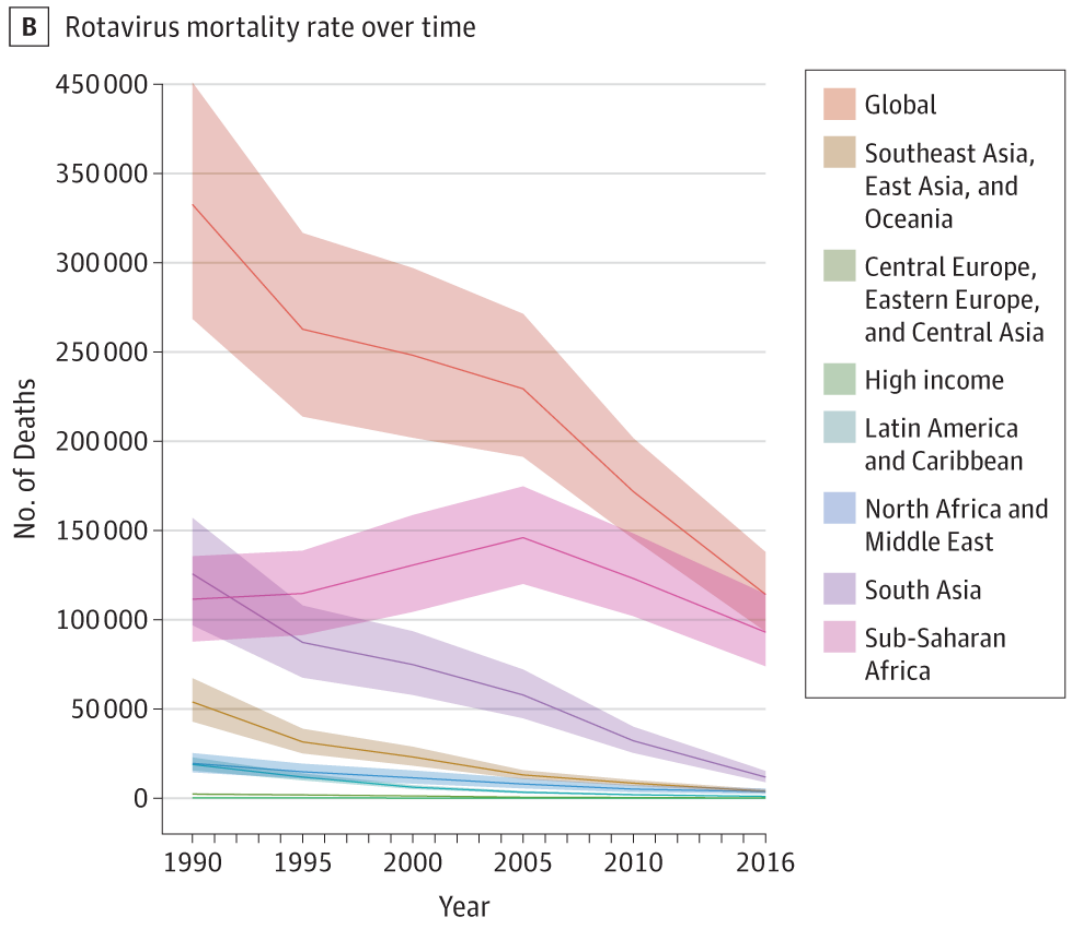
Many vaccines

- Multiple mechanisms of action
- Multiple vaccination strategies

Rotavirus

Global rotavirus burden

- Affects nearly every child by 5 years of age
- Most common cause of severe diarrheal disease
- Among children younger than 5 years (2016)
  - 129 thousand (95% UI: 104-156) deaths
  - 95% of deaths in LICs in Africa and Asia
    - 10,000 in India
  - 258 million (95% UI: 193 to 341) episodes

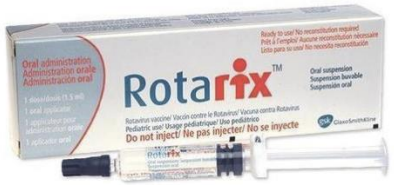


Troeger et al, GBD, JAMA 2018

WHO-prequalified Rotavirus vaccines

Rotarix® (RV1)

- GlaxoSmithKline Biologicals
- Monovalent G1P8
- 2 doses
  - 6 & 10 weeks



RotaTeq® (RV5)

- Merck & Co. Inc.
- G1, G2, G3, G4, and G9 reassortant
- 3 doses
  - 6, 10 and 14 weeks

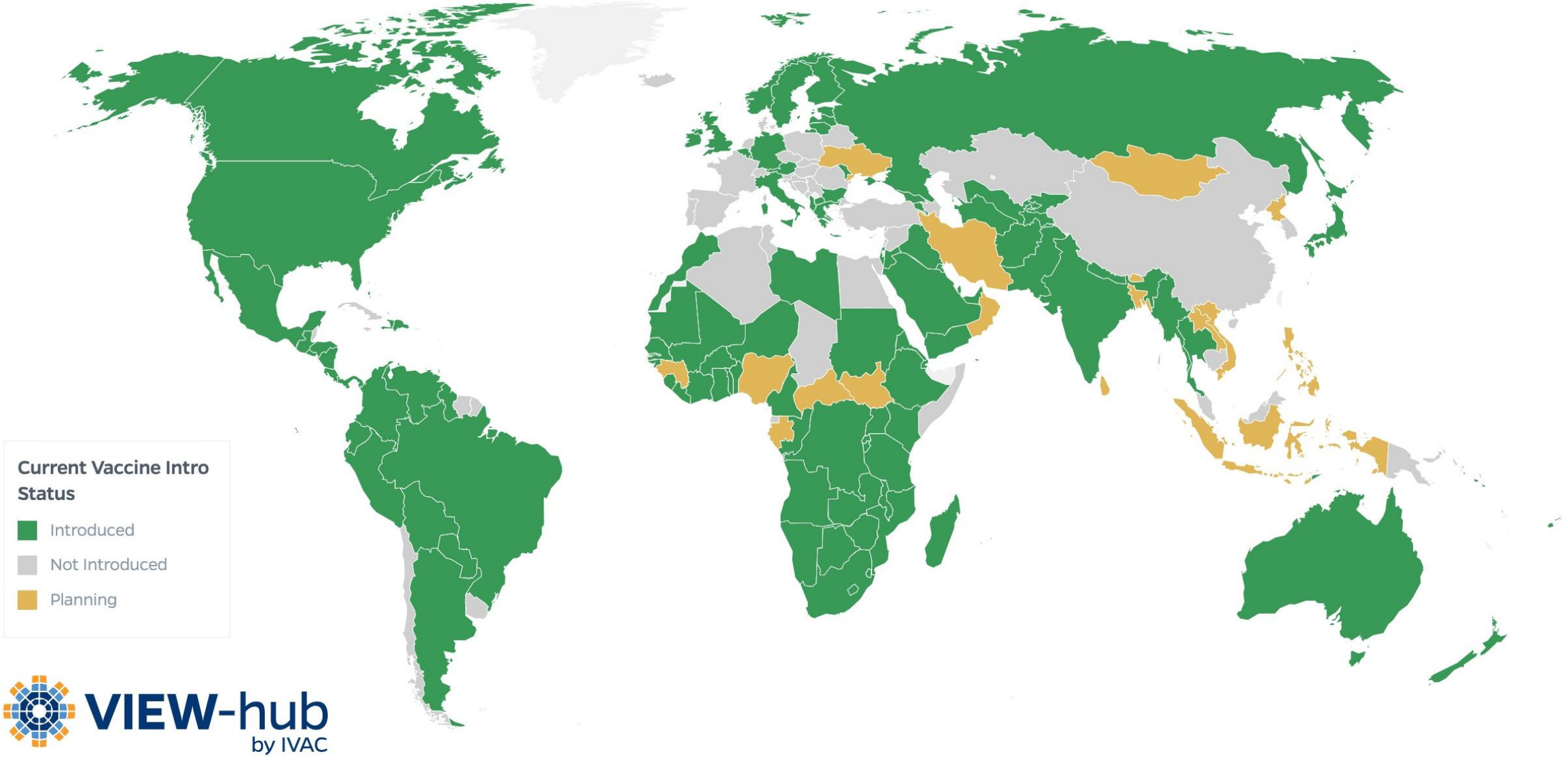
Rotavac

- Bharat Biotech International Limited
- Natural reassortant neonatal G9P[11]
- 3 doses
  - 6, 10 and 14 weeks

Rotasil

- Serum Institute of India
- G1, G2, G3, G4, and G9 reassortant
- 3 doses
  - 6, 10 and 14 weeks

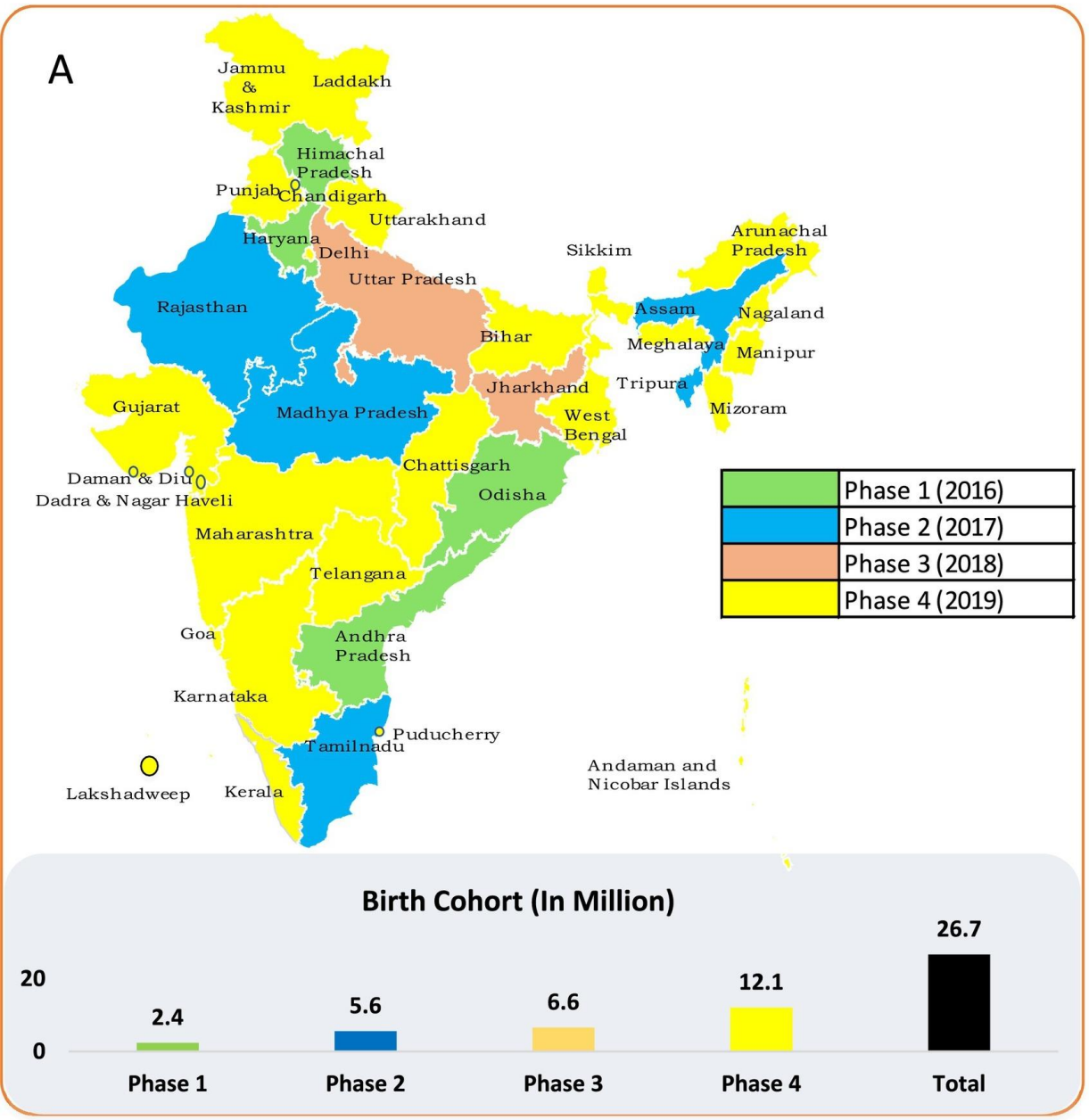
Rotavirus vaccines introduced in over 100 countries

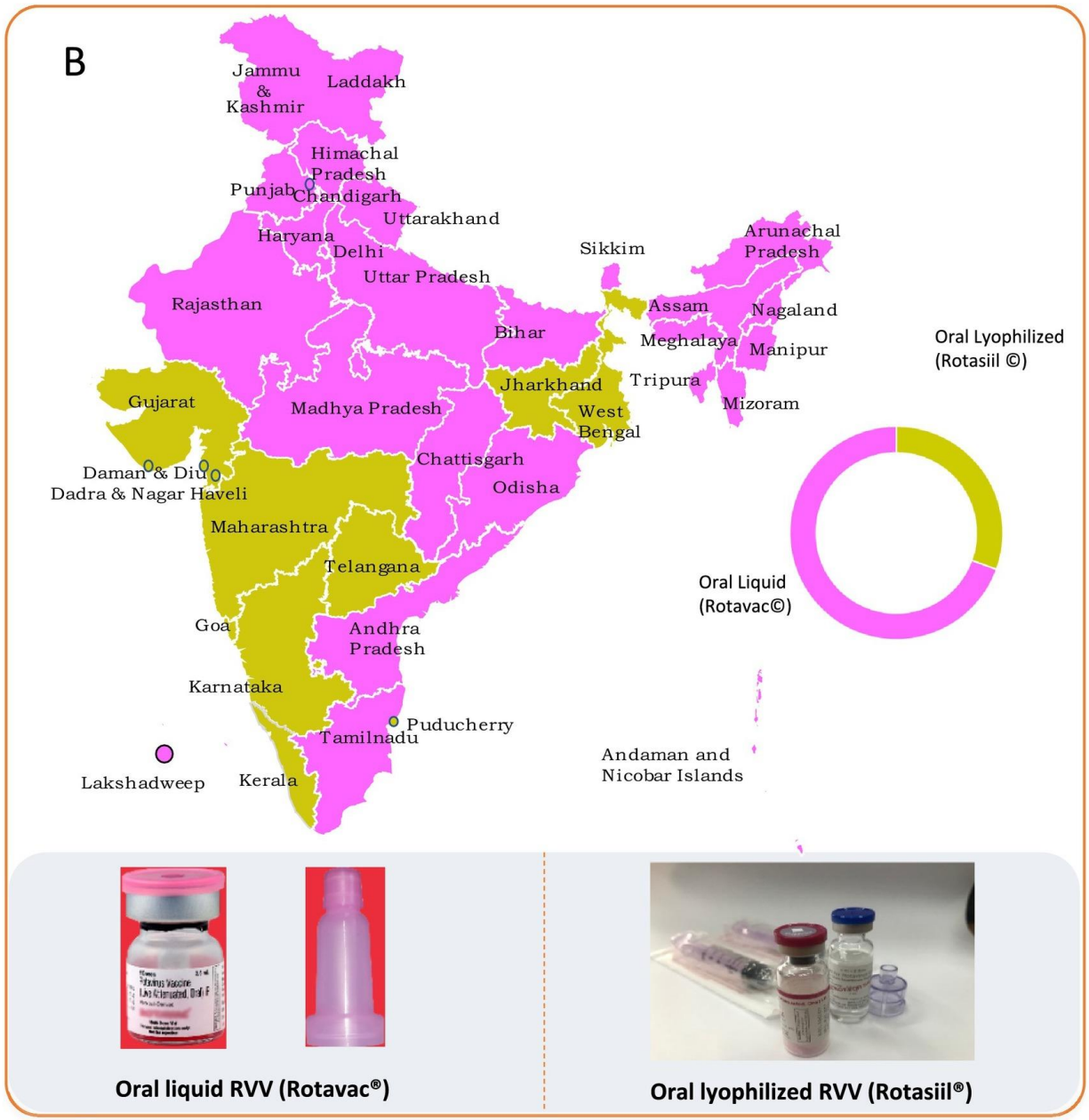


VIEW-hub by IVAC

April 25, 2022 © The International Vaccine Access Center (IVAC)

Figure 1. Phased introduction of rotavirus vaccine in India.[6]





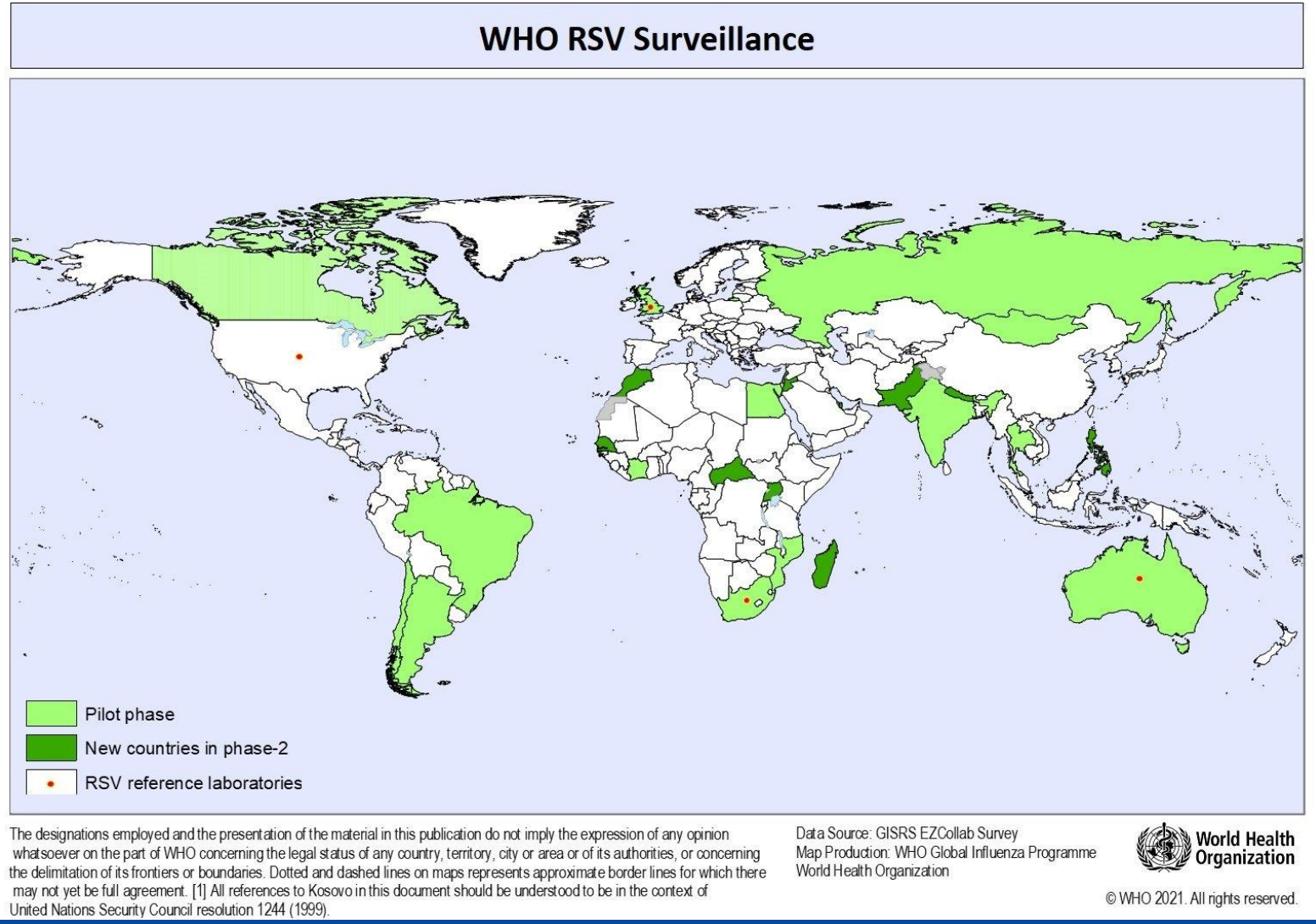
Panel A: Phased introduction of rotavirus vaccination and vaccinated birth cohort size by region; Panel B: Product distribution of rotavirus vaccine by region.

Respiratory Syncytial Virus

Global RSV burden

- Respiratory Syncytial Virus (RSV) is a major cause of acute respiratory tract infections in both children and adults.
- In children < 5, RSV is responsible for **33 million acute lower respiratory infection episodes** (UR: 25–45 million) and **101,400 deaths** (84,500–12,200).
- In India, the rates of RSV detection in various **hospital- and community-based studies** mostly done in children vary from **5% to 54% and from 8% to 15%**, respectively.
- Among older adults in industrialized countries, incidence rates are estimated to be 601 cases per 100,000 person-years and hospitalization rates are 157 hospitalizations per 100,000 PY.

Global RSV Surveillance Program as of 2021



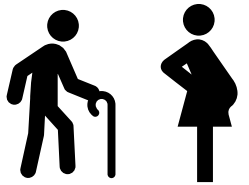
70% of RSV hospitalisations in children < 5 captured

10% of RSV hospitalisations in adults 50+ captured

RSV Vaccines

1. **Arexvy**: inactivated protein
   - US, EU, UK, Canada, Australia, Japan, Hong Kong, Taiwan, Singapore, etc.

2. **Abrysvo**: non-adjuvanted bivalent vaccine
   - US, EU, UK, Canada, Australia, Japan, Hong Kong, Singapore, etc.



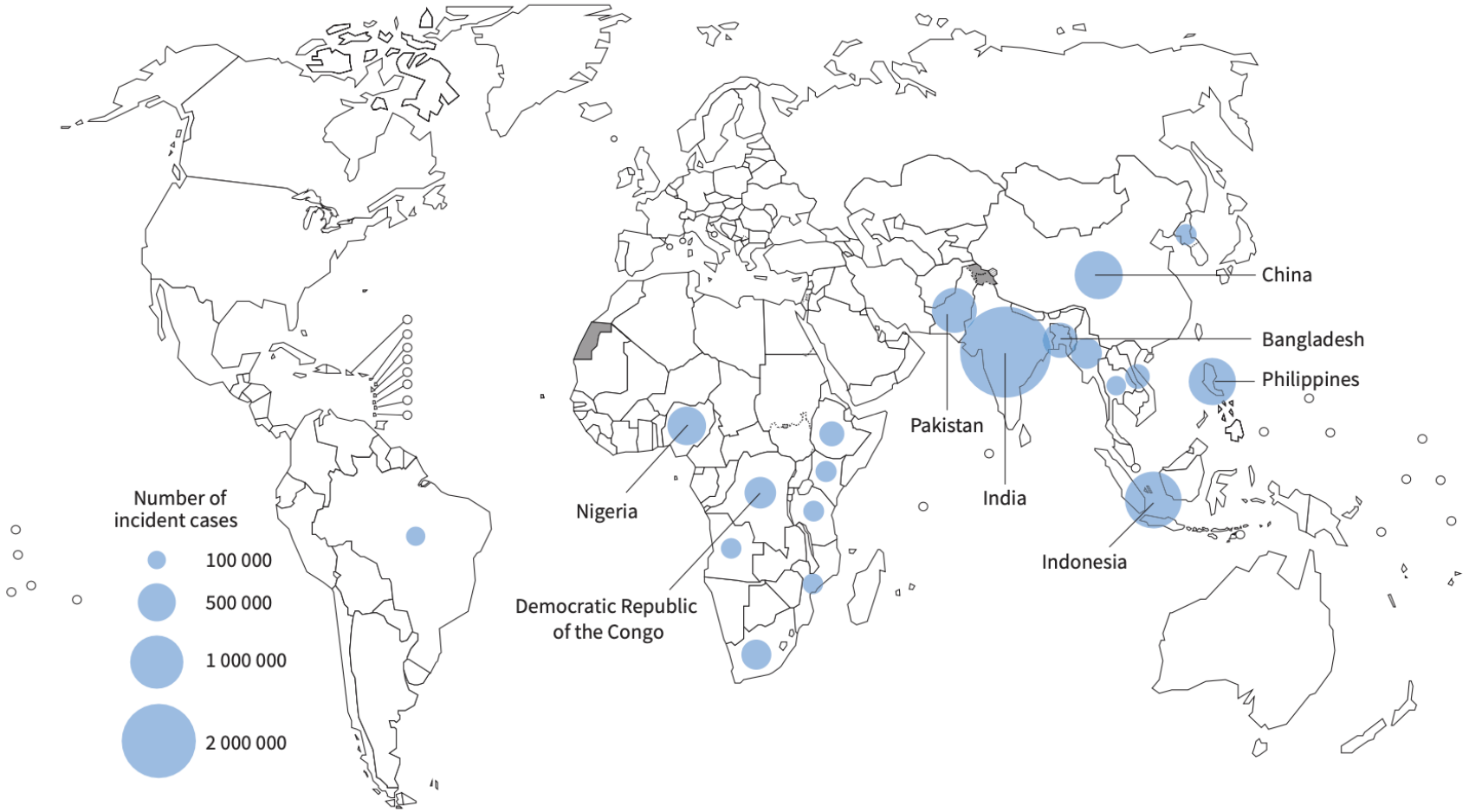
3. **Nirsevimab**: injectable long-acting monoclonal antibody
   - US, EU, UK, Canada, Japan, China, Saudi Arabia, Qatar

4. **mRESVIA**: mRNA
   - US, EU, Canada

Tuberculosis

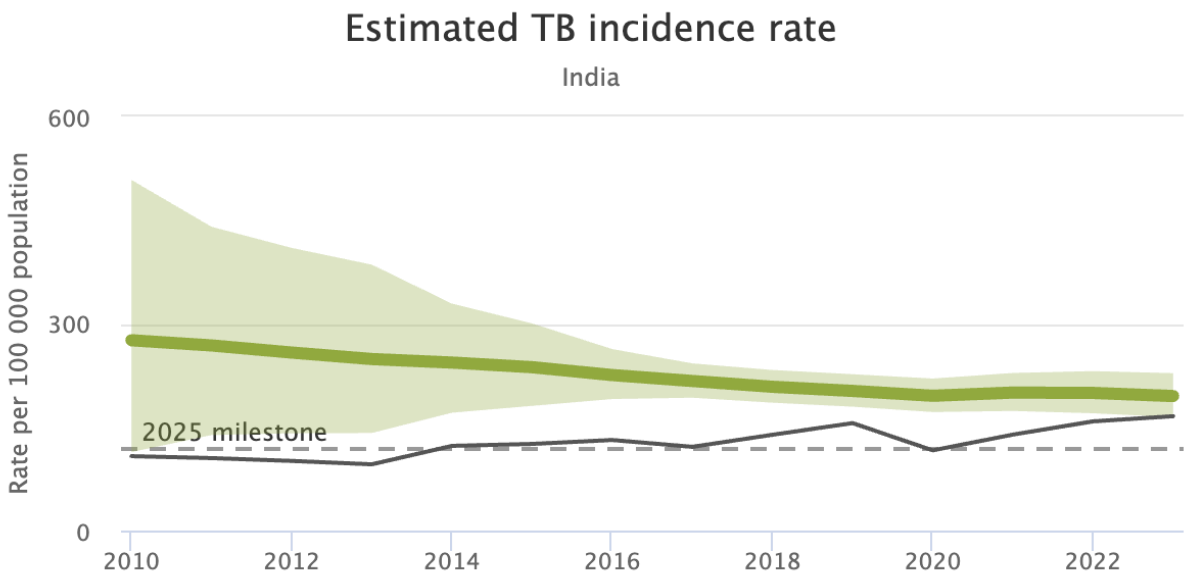
Leading infectious cause of death globally

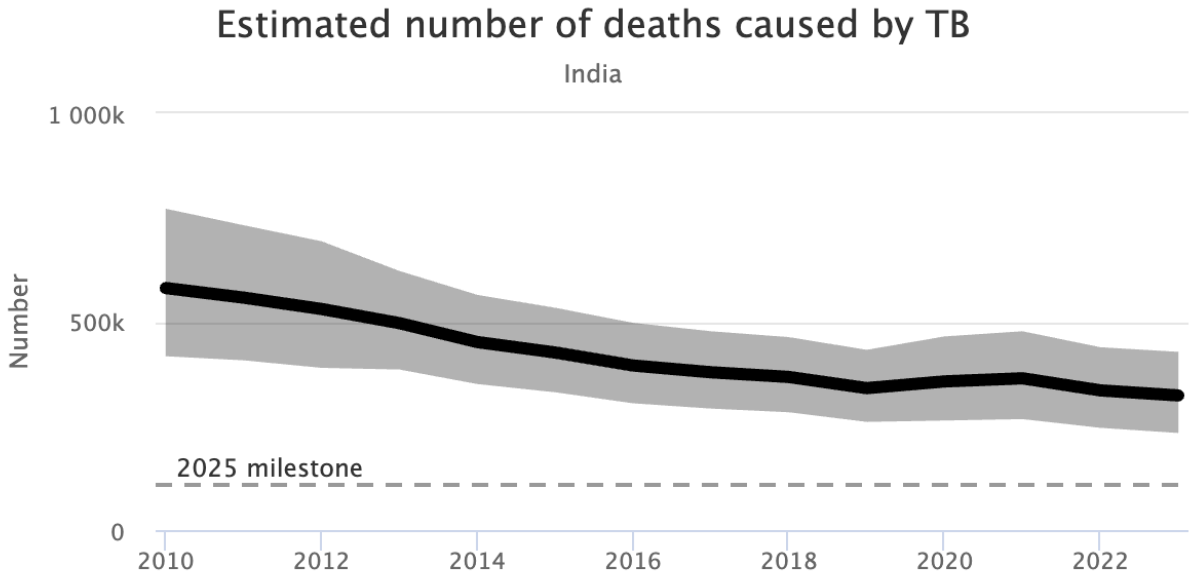
Estimated number of incident TB cases in 2023, for countries with at least 100 000 incident cases[a]



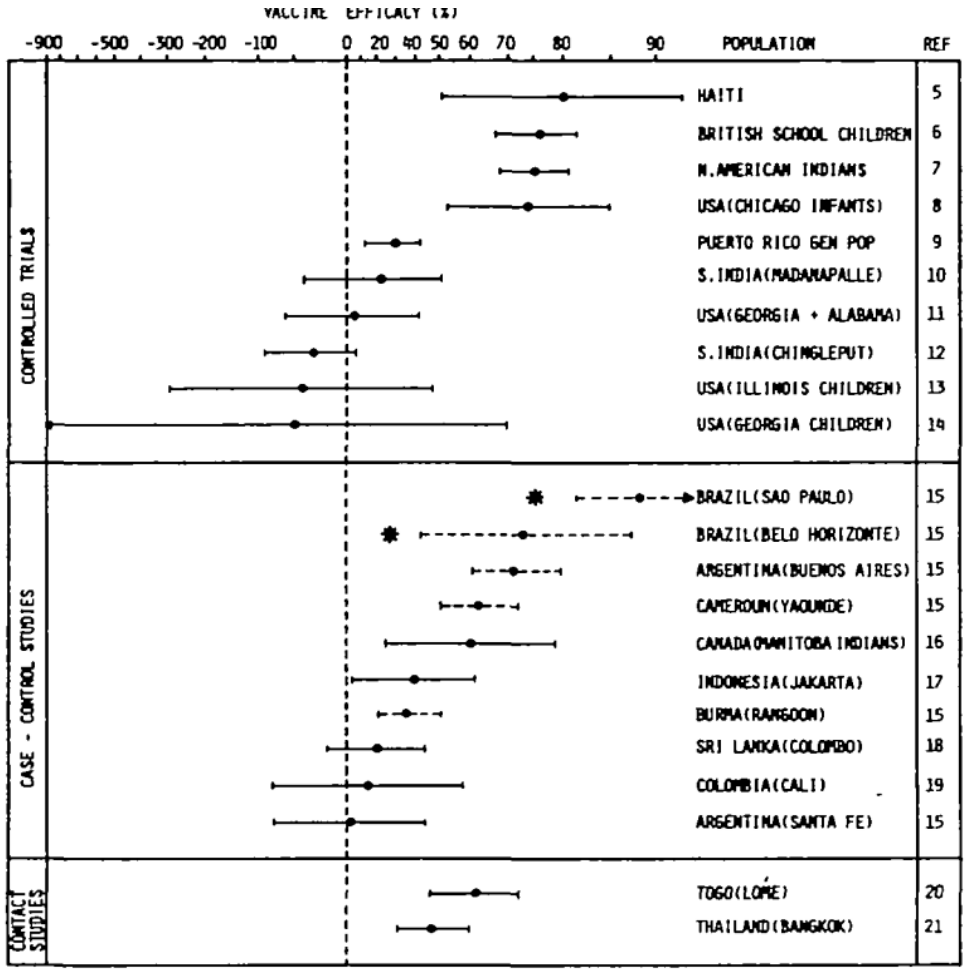
[a] The labels show the eight countries that accounted for about two thirds of the global number of people estimated to have developed TB in 2023.

Tuberculosis in India





The bacille Calmette-Guérin (BCG) vaccine



- Introduced in **1924**
- > 80% efficacy at preventing disseminated TB <u>in infants</u>
  - Efficacy against pulmonary TB in some cases
- **Wide variation** in efficacy
- 'Off-target' effects increase public health benefit to children globally

Fine PEM, British Med Bull 1988