



# Typhoid Fever Overview

December 12, 2008

**W. James Jackson, Ph.D.**  
Senior Vice President; Chief Scientific Officer

**EBS**  
**LISTED**  
**NYSE**

emergent

# Corporate Overview

## Company Mission and Vision

### Corporate Mission

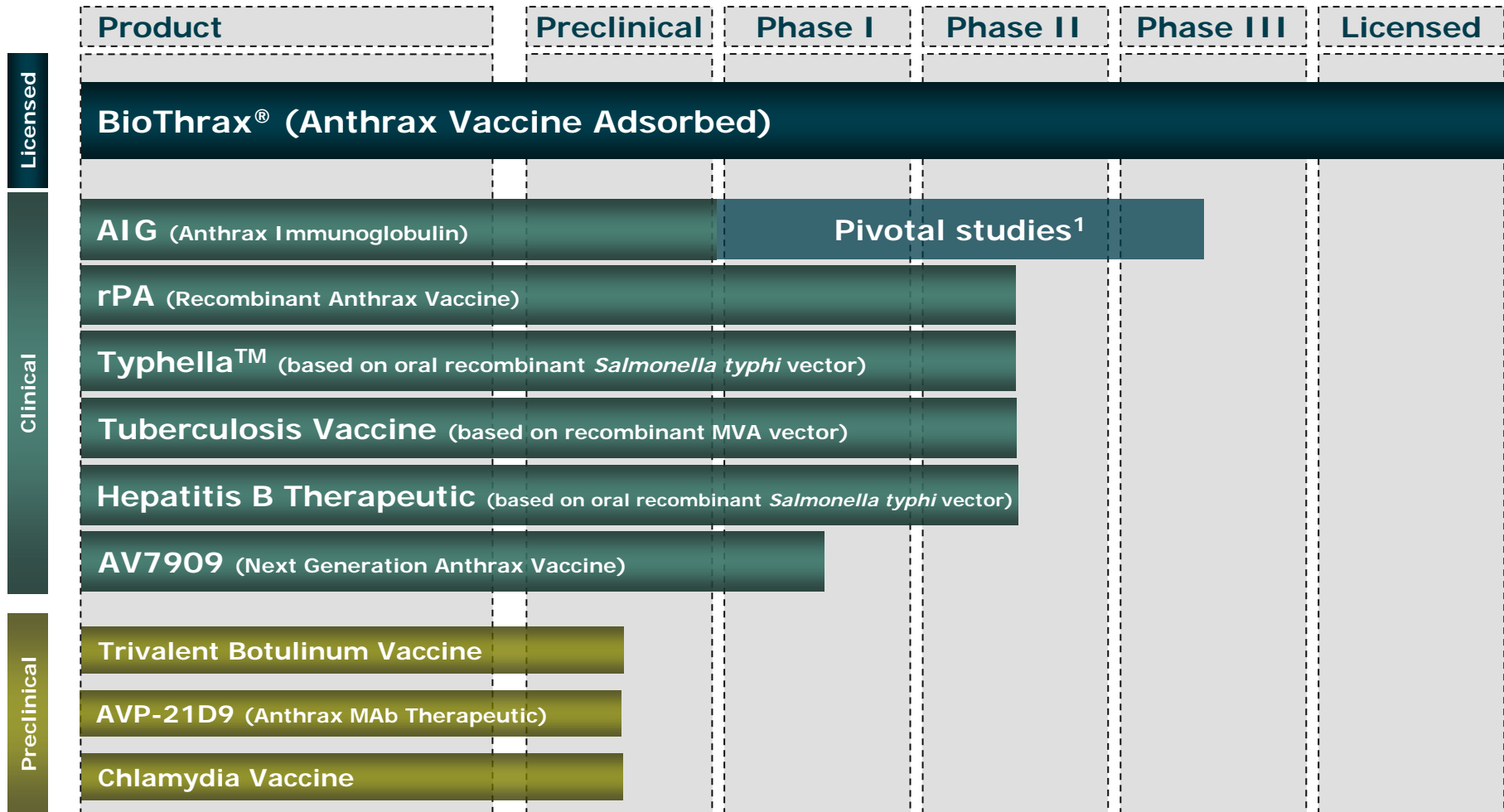
To protect life.

### Strategic Vision

To become a leading, fully integrated biopharmaceutical company focused on **immune-related** vaccines and therapeutics.

# Corporate Overview

## Product Pipeline Overview



<sup>1</sup> Pivotal studies in animals and humans expected to proceed in parallel under the FDA animal rule.

# Disease Overview

## Disease Pathogen and Transmission\*

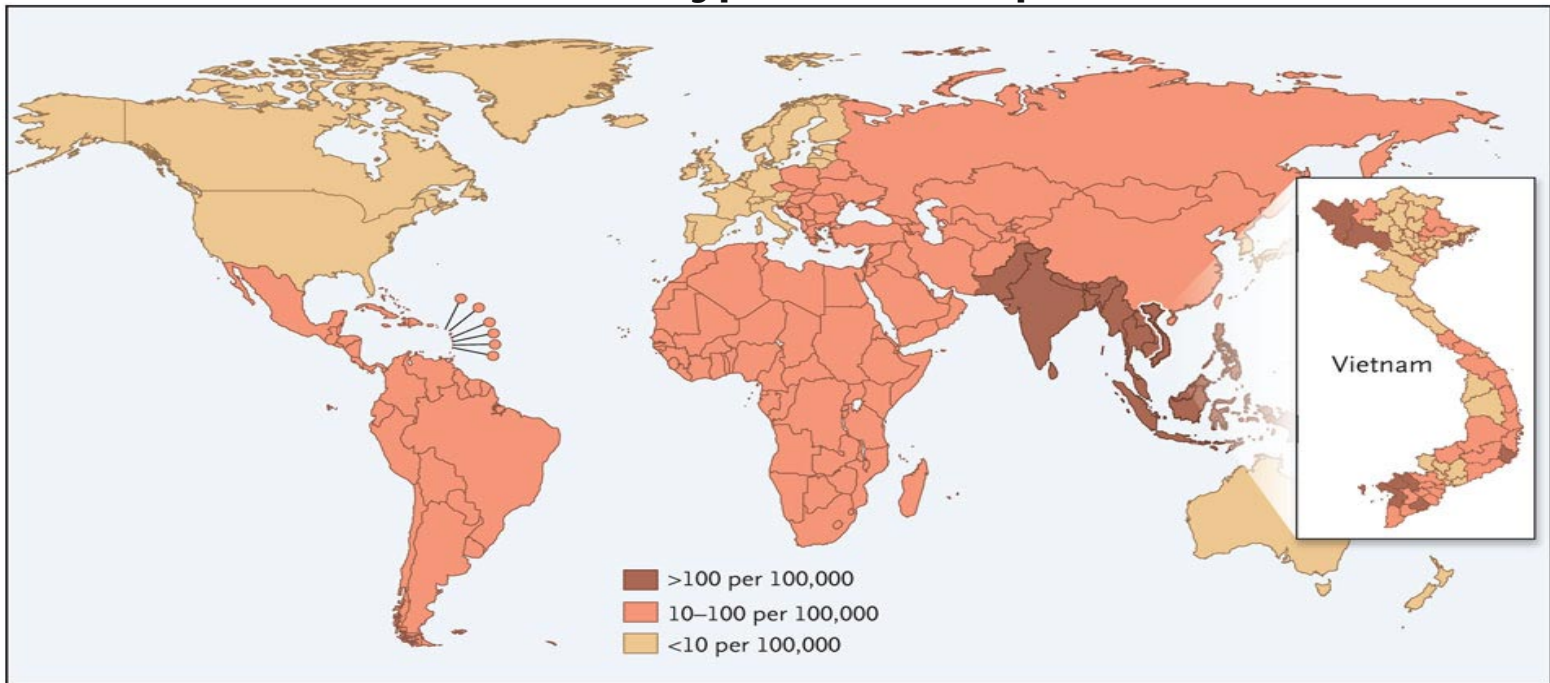
- Typhoid fever is caused by *Salmonella enterica* serovar Typhi (*S. typhi*) a highly virulent and invasive enteric bacterium
- Typhoid fever is both a water-borne and food-borne gastrointestinal infection
  - Incidence approaches 1% of the population annually in endemic regions
  - Transmission is through fecal-oral route
- Typhoid fever continues to be a public health concern in many developing countries in Asia, Africa and Latin America
  - Southeast Asia has seen an increasing incidence of multi-drug resistant typhoid fever
  - Southeast Asia has seen an emergence of Vi-negative *S. typhi* strains; currently available vaccines may not prove effective against these strains

\*Source: Background Paper on Vaccination Against Typhoid Fever Using New-Generation Vaccines, SAGE Nov 2007 Meeting

# Disease Overview

## Disease Prevalence

### Mean Annual Incidence of Typhoid Fever per 100,000 Persons



Source: DeRoeck D et al. N Engl J Med 2007;357:1069-1071

# Disease Overview

## Disease Impact

- Total Morbidity\*
  - Approximately 21 million typhoid fever cases occur annually worldwide
- Total Mortality\*
  - Estimated 216,000 deaths from typhoid fever occur annually worldwide; other estimates are as high as 600,000 typhoid related deaths annually
  - Deaths predominantly effect school-age children or younger
  - Estimated that 90% of deaths occur in Asia
- Developed World
  - Considered to be a travelers vaccine in developed world; CDC recommends individuals traveling to areas of high disease incidence be vaccinated against typhoid fever
  - According to the CDC, in the US, approximately 400 cases of typhoid fever occur annually

\*Source: Background Paper on Vaccination Against Typhoid Fever Using New-Generation Vaccines, SAGE Nov 2007 Meeting

# Disease Overview

## Disease Characteristics\*

- Disease Sequelae
  - Characterized by sudden onset of sustained fever, severe headache, nausea, loss of appetite, constipation (in older children and adults), diarrhea (in younger children) and abdominal pain
  - Untreated, typhoid fever can cause complications such as intestinal perforation, peritonitis and shock
  - Case fatality rates are as high as 10%

\*Source: Background Paper on Vaccination Against Typhoid Fever Using New-Generation Vaccines, SAGE Nov 2007 Meeting

# Disease Overview

## Inequities

- Inequity of Poor
  - Highest rates of typhoid fever are seen in developing countries in Southeast Asia
  - Urban slums in Asia and Southeast Asia have shown to be hyperendemic due to lack of sanitation and access to clean water is low
- Inequity of Young
  - Overall, highest incidence rates are found in children 5-15 years of age followed by 2-4 year olds
  - Recent prospective studies have shown that children 2-4 years of age living in hyperendemic slums have the highest disease incidence



Un-Met Needs

# Typhoid Fever Considered to be Public Health Crisis in Developing Countries

- Global public health organizations have identified typhoid fever as a public health concern and have initiated programs to attempt to reduce the burden of disease

## World Health Organization

Recommended vaccination of all school-age or pre-school age children living in high-risk areas

## Diseases of the Most Impoverished

Programs in place to disseminate information on the need for new vaccines against typhoid and ensure pipeline of newer-generation vaccines

## International Vaccine Institute

Developing next-generation vaccines, conducting studies to determine disease burden in endemic regions & funding of mass vaccination campaigns

## GAVI Alliance

Developing strategies to identify additional supplies of vaccine

# Response to High Rate of Disease

## Local Response to High Rates of Disease

- State and local governments in Asia have initiated typhoid immunization programs to address the high disease rates in urban areas\*

Feature	Country/Region			
	Thailand	Guangxi Province, China	Vietnam	Delhi State, India
Scope of Program	National	High-risk areas	High-risk districts	Statewide
Targeted Population	7-12 year olds	School aged (all-ages), food workers, residents in outbreak areas	3-10 year olds	2-5 year olds
Vaccine Used (vaccine acquisition price)	Locally produced Vi polysaccharide (\$0.50 USD/dose)	Locally produced Vi polysaccharide (Unknown)	Locally produced Vi polysaccharide (\$0.52 USD/dose)	Locally produced Vi polysaccharide (\$0.53 USD/dose)
Entity that Initiated and Managed Program	Ministry of Health	Guangxi Bureau of Health; city government	Ministry of Health	State government
Source of Funding	National government	User fees from students and workers (\$1.00)	National government	State government

\*Source: DeRoeck D et al. Typhoid Vaccination: The Asian Experience. *Expert Rev. Vaccines* 7(5), 547-560 (2008).

Un-Met Needs

# Currently Available Typhoid Fever Vaccines Are Lacking

Key Product Attributes	Typhim Vi (Sanofi-Pasteur)	Vivotif (Berna/Crucell)
Product Presentation	Single IM injection	4 doses taken on days 1, 3, 5, and 7; available in oral enteric coated tablets or lyophilized sachets
Key Market Availability	Over 90 countries worldwide (including India, China and Southeast Asia)	Over 50 countries worldwide <b><i>(not available in India, China and Southeast Asia)</i></b>
Safety	Low side effects	Low side effects
Efficacy	55-70% protective efficacy	55-90% depending on formulation
Approved Population	2 years of age and above	6 years of age and above
Duration of Protection	Re-administration (boost) required every 2 years	Re-administration (boost) required every 5 years
Onset of Protection	Dose to be administered 2 weeks prior to exposure	Full regimen to be completed 1 week prior to exposure

## Lack of Commercial Market

### Lack of Significant Market Available in Developed World

- In the US, approximately 400 cases of typhoid fever occur annually; most of which are travelers to endemic regions
- Incidence of typhoid fever in travelers is estimated to be 3-30/100,000 travelers to endemic regions
- Global revenue from travel vaccines is limited
  - Crucell 2007 global sales of all travel vaccines was \$60 million USD; included sales of 3 travel vaccines (hepatitis A, typhoid, cholera/ETEC)
  - Sanofi-Pasteur 2007 global sales of travel vaccines was \$415 million USD; included sales of 5 vaccines (typhoid, rabies, yellow fever, Japanese encephalitis, measles/mumps/rubella)

## Summary

## Conclusion

- Typhoid fever is a disease that primarily effects impoverished children living in developing countries
- The market in developed countries is focused on the need of travelers
- Lack of developed market inhibits development of new/better vaccines