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Research Article

A Literature study about Epidemiology of Typhoidal Salmonellosis

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Abstract
Typhoidal salmonellosis, caused by Salmonella enterica serovars Typhi and Paratyphi, remains a significant global health concern, particularly in low- and middle-income countries. This literature review explores the epidemiological patterns of typhoid and paratyphoid fever, highlighting regional disease burden, transmission pathways, risk factors, and emerging challenges. The highest incidence rates are found in South Asia, sub-Saharan Africa, and Southeast Asia, driven largely by poor sanitation, contaminated water supplies, and inadequate healthcare infrastructure. Children and adolescents are disproportionately affected. Surveillance data are often limited due to diagnostic constraints, although blood culture remains the diagnostic gold standard. Alarmingly, antimicrobial resistance, including multidrug-resistant and extensively drug-resistant strains, has complicated treatment strategies in several regions. Vaccination, particularly with typhoid conjugate vaccines, alongside improvements in water quality and hygiene, are key preventive measures. Continued epidemiological monitoring and investment in public health infrastructure are essential to controlling the spread of typhoidal salmonellosis and reducing its associated morbidity and mortality.

Keywords: *Epidemiology, Typhoidal Salmonellosis, Typhoid Fever, Enteric Fever, Non-Typhoidal Salmonellosis, Mode of Transmission.*

Introduction

Epidemiology of Typhoidal Salmonellosis

It is estimated that > 26.9 million typhoid fever cases occur annually, of which 1% result in death. The vast majority of this disease burden is witnessed in Asia. Additionally, an estimated 5.4 million cases caused by paratyphoid occur each year. In 2010, 13.5 million cases of typhoid fever were recorded, and both typhoid and paratyphoid fevers together accounted for > 12 million disability adjusted life-years.

In most developed countries, the incidence of typhoid fever is <15 cases per 1,00,000 population, with most cases occurring in travelers. In contrast, the incidence may vary considerably in the developing world, with estimated rates ranging from 100-1,000 cases per 100,000 population.

Typhoid fever is notable for the emergence of drug resistance. Following sporadic outbreaks of chloramphenicol-resistant S. Typhi infections, many strains of S. Typhi have developed plasmid-mediated multidrug resistance to all 3 of the primary antimicrobials: ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole.

Epidemiology of Typhoid Fever is stated by Figure 1 and Figure 3 Typhoid fever in Figure 2, Salmonella in Figure 4,

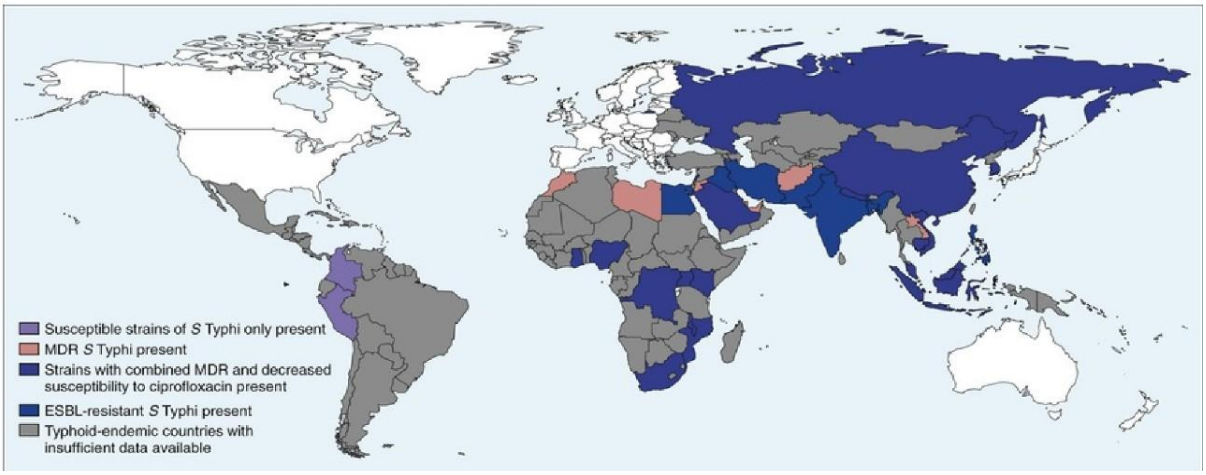

Figure 1: Epidemiology of Typhoid Fever

There is also a considerable increase in nalidixic acid– resistant and even ceftriaxone-resistant isolates of S. Typhi, as well as the emergence of fluoroquinolone-resistant isolates. Nalidixic acid–resistant isolates first emerged in Southeast Asia and India and now account for the majority of travel-associated cases of typhoid fever in the United States.

The discovery of the large number of pseudogenes in S. Typhi suggests that the genome of this pathogen has undergone degeneration to facilitate a specialized association with the human host.

Thus, direct or indirect contact with an infected person (sick or chronic carrier) is a prerequisite for infection. Ingestion of foods or water contaminated with S. Typhi from human feces is the most common mode of transmission, although water-borne outbreaks as a consequence of poor sanitation or contamination have been described in developing countries.

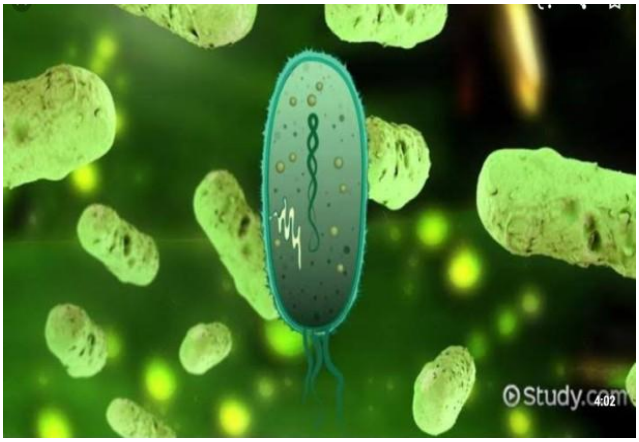

Figure 2: Typhoid fever.

Typhoid fever was on the decline in the last decade and the estimated incidence was less than 1/1000 population. However, in the 90s it has gone up by 15 to 20 times. This is due to variety of adverse factors including laxity in immunization against typhoid and emergence of multidrug resistance. Older children and young adults are most commonly infected though 10 percent cases occur below five years of age and 1 to 2 percent even below two years.

- The CDC estimates that 22 million typhoid cases occur each year in the world, with an annual incidence varying from less than 10 to more than 1000 cases per 100,000 population.
- The global mortality estimates from typhoid also have been revised downward from 600,000 to 200,000, on the basis of regional extrapolations. Globally the major non diarrheal causes of foodborne deaths were due to Salmonella Ser. Typhi

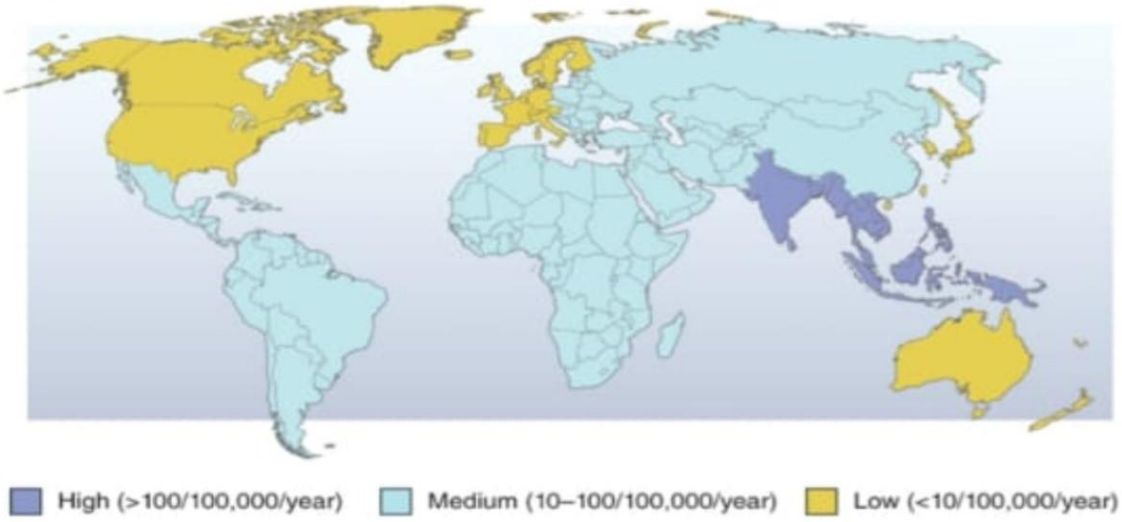

Figure 3: Epidemiology of Typhoid Fever

Typhi is the most common Salmonella isolate in many developing countries. Although the overall ratio of disease caused by S. ser. Typhi to disease caused by S. ser. Paratyphi is about 10: 1, the proportion of S. paratyphi infections is increasing in some parts of the world, sometimes paralleling S. ser. Typhi isolations.

62% to 81% of infections are related to foreign travel, especially to Mexico, India, the Philippines, Pakistan, El Salvador, and Haiti. Of these areas, the Indian subcontinent has the highest incidence of typhoid among travelers.

Method, Material, Findings and Discussion:

Epidemiology of Non-Typhoidal Salmonellosis

Worldwide,NTS causes 93million enteric infections and 155,000 deaths. The incidence of NTS is highest during warmer months in temperate climate. Rate of morbidity and mortality associated with NTS are highest among elderly, infants, and immunocompromised individuals.

Unlike s typhi and s paratyphi, whose reservoir is humans, NTS, can be acquired from multiple animals. Transmission is most commonly through food products of animal origin. Fresh produce contaminated with animal waste. And contact with animals or their environments.

S enteritidis infection associated with chicken eggs emerged as a major cause of food borne disease during the 1980s and 1990s S. Enteritidis infection associated with shell eggs continue to occur. In 2010, a national outbreak of S. Enteritidis infection resulted in more than 1900 reported illnesses and the recall of 500 million eggs. Transmission via contaminated eggs can be prevented by cooking eggs until the yolk is solidified and pasteurizing egg products.

Public Health Issues

In most of the world, the prevalence of Salmonella varies according to the water supply, waste disposal, food preparation practices, and climate. The incidence of NTS is 31 to 211 million gastroenteritis cases worldwide each year, causing 36,000 to 89,000 deaths globally and leading to the loss of 2 to 6 million of life-years. Most of the deaths occurred in the African region.

Globally NTS is the worst foodborne hazard 2.5 to 6.3 million disabilityadjusted-life-years.

A more than sixfold increase in reported NTS infection in the United States has occurred during the past 40 years,391 with an estimated 1.2 million illnesses, 23,000 hospitalizations, and 450 deaths annually during 2000 to 2008.69,341 This increase reflects industrial-scale food production and distribution,66 misuse of antimicrobial agents (in humans and animals) that alter the competing gastrointestinal flora and induce multidrug-resistant strains of Salmonella,381 and probably an increasing number of immunocompromised individuals in the population.

Mode of Transmission

ANIMAL RESERVOIR AND OTHER FOOD: Sources in contrast to Shigella spp., which infect only primates, nontyphoidal Salmonella spp. infect a variety of animals (including poultry, livestock, and pet reptiles and rodents.

Salmonella has been isolated from flies, mites, and other arthropods taken from animal farms; it is able to multiply inside some insects and is transmitted within insects and to birds, rodents, and livestock. These arthropods, birds, and rodents could contribute to Salmonella transmission to wildlife.

Animals and animal products (including meat and dairy products), water, and infected humans can be the source of infection.

Salmonella is the leading cause of foodborne illness in the United States and the second most common cause of death from foodborne pathogens. Spread of resistant organisms from food animals to humans has been shown. Salmonella spp. have been isolated from 50% of

poultry, 16% of pork, 5% of beef, and 40% of frozen egg products in retail stores. Slicing food with contaminated tools and surfaces transfers.

Salmonella in progressively decreasing amounts per slice, resulting in higher bacterial contamination for the first sliced portions. Undercooked eggs (e.g., in Caesar salad, egg-dipped bread, and homemade eggnog) may be contaminated by organisms on the shell surface or transovarially directly through the egg yolk. Grade A shell eggs have been implicated in more than 40% of more recent outbreaks.

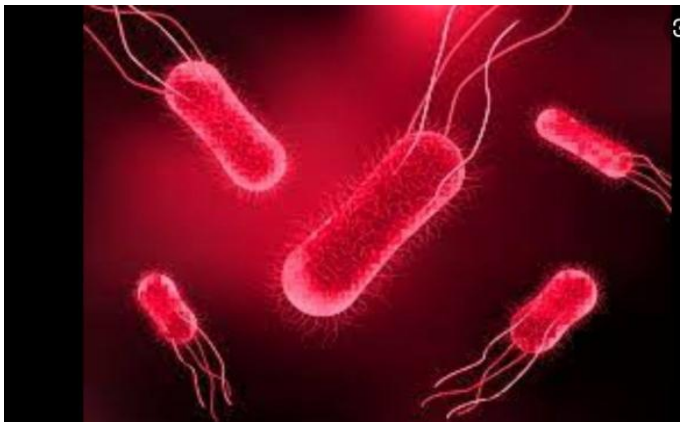

Figure 4: Salmonella.

From 2010 to 2014, the CDC's Foodborne Disease Outbreak Surveillance System reported 120 multistate foodborne disease outbreaks in the United States; Salmonella was the leading pathogen, responsible for 63 of these outbreaks. Of the 10 most frequent Salmonella serovars causing disease in humans, eight are included within the 10 serovars most frequently identified in at least one of the major food-animal species.

HUMANS AS A RESERVOIR: 1) Humans are the reservoir for S. ser. Typhi; infection implies direct or indirect contact with an infected person. Animal products transmit S. ser. Typhi if they are contaminated by infected humans during processing. The most common mode of transmission is food or water contaminated by human feces.

Water borne typhoid fever epidemics are especially important. Congenital transmission can occur from a bacteremia mother to her fetus trans placentally or at the time of delivery.

After infection occurs, NTS are excreted in feces for a median of 5 weeks. Children younger than 5 years may excrete the organisms for 20 weeks after having an illness, but older children and adults usually excrete Salmonella for less than 8 weeks. Up to 5% of children younger than 5 years have been found to excrete NTS for 1 year after disease.

2.2% to 2.7% of children in endemic settings have been found to excrete NTS. S. ser. Typhi may be excreted chronically, particularly in the presence of gallbladder disease and sustained by biofilms for decades.

Food handlers who are excreting Salmonella spp. represent an important risk group. NTS infection index cases have been mapped to isolation of the same clones in 65% of children and adults living in the same household versus less than 2% of home rural environment samples.

Conclusion:

BACTERIAL CHARACTERISTICS FAVOURING SURVIVAL: Salmonella spp. survive refrigeration and sometimes heating; they may remain viable at ambient or reduced temperatures for weeks, even in low-moisture foods. They may remain viable in foods after cooking for less than 12 minutes at less than 65°C (140°F). Salmonella spp. are killed by heating to 54.4°C (130°F) for 1 hour or 60°C (140°F) for 15 minutes**. Table 1 states the "Relationship of Age to Risk of Disease."**

Salmonellae survive for hours on the hands of slaughterhouse workers and in flour for nearly 1 year.

Nosocomial infections have been related to contaminated medical equipment (e.g., endoscopes) and diagnostic or pharmacologic preparations, particularly those of animal origin (e.g., bile salts, pancreatic extracts, pepsin, and vitamins.

Patient Group at Risk	Mechanism
Newborn	Achlorhydria, rapid gastric emptying Poorly developed cell-mediated immunity Complement deficiency Immunoglobulin deficiency in premature infants
Sickle-cell anemia	Reticuloendothelial system overload owing to hemolysis Functional asplenia Tissue infarcts Defective opsonization
Neutropenia (congenital or acquired)	Polymorphonuclear neutrophils needed for killing
Chronic granulomatous disease	Defective killing by polymorphonuclear neutrophils
Defects of immune system IL-12/interferon-γ axis	Defective signaling resulting in failure to activate macrophages and recurrent/ persistent infection by nontyphoid *Salmonella*
Acquired immunodeficiency syndrome	Low CD4 Effects of malnutrition on cell-mediated immunity Survival of organisms in macrophages (owing to *Salmonella* genes *PhoP/PhoQ, spvA-D, R*)
Organ transplantation, immunosuppression	Defective cell-mediated immunity
Gastrectomy	Loss of stomach acid barrier
Malaria	Reticuloendothelial overload during hemolysis Abnormal complement levels Abnormal macrophage function
Bartonellosis (verruga peruana)	Reticuloendothelial overload during hemolysis
Schistosomiasis	*Salmonella* sequestered in schistosomes protected from host defenses and antibiotics

Table 1: Relationship of Age to Risk of Disease

The highest incidence rates occur in children younger than 5 years (69.5 infections per 100,000 children), especially infants younger than 1 year, and in individuals older than 70 years.

- Low-birth-weight infants seem to be at higher risk than full-term infants for acquiring Salmonella infection. The source of infection occasionally is contaminated food, but more often it is fomites (e.g., delivery room resuscitators, rectal thermometers, suction devices, water baths for heating formula, soap dispensers, air-conditioning filters.
- Such outbreaks sometimes are caused by multi-resistant Salmonella Multidrug-resistant Salmonella has been isolated from cockroaches found in a neonatal intensive care unit in Africa.
- SEASONALITY: Salmonella infection occurs throughout the year with a predilection for warm months, especially for some serotypes as Norwich, Javiana, Mississippi, and Newport, whereas serotypes Senftenberg, Mbandaka, Anatum, and Derbyare are distributed throughout the seasons.
- INOCULUM SIZE REQUIRED TO CAUSE DISEASE: The estimated inoculum size required to cause symptomatic disease in healthy adult volunteers is 105 to 1010 organisms, but the number of organisms required to cause symptoms in infants and children probably is much lower.
- The incubation period usually is 6 to 72 hours but depends on inoculum size, bacterial virulence, and host immunocompetence.
- Infants especially may be susceptible to acquiring Salmonella infection directly or indirectly from ill family members. Infants also may acquire infection via exposure to raw meat while riding in a grocery cart or while having contact with infected pets.

References:

1. Antillón, M., Warren, J. L., Crawford, F. W., Weinberger, D. M., Kürüm, E., Pak, G. D., ... & Pitzer, V. E. (2017). The burden of typhoid fever in low- and middle-income countries: A meta-regression approach. PLoS Neglected Tropical Diseases, 11(2), e0005376. https://doi.org/10.1371/journal.pntd.0005376
2. Britto, C. D., Wong, V. K., Dougan, G., & Pollard, A. J. (2019). A systematic review of antimicrobial resistance in Salmonella enterica serovar Typhi, the etiological agent of typhoid. Clinical Infectious Diseases, 68(Suppl 2), S105–S110. https://doi.org/10.1093/cid/ciy1121
3. GBD 2019 Typhoid and Paratyphoid Collaborators. (2022). The global burden of typhoid and paratyphoid fevers: A systematic analysis for the Global Burden of Disease Study 2019. The Lancet Infectious Diseases, 22(4), 537–548. https://doi.org/10.1016/S1473-3099(21)00407-7
4. Saha, S., Islam, M. S., Sajib, M. S. I., Saha, S. K., & Clemens, J. D. (2021). Typhoid conjugate vaccine: An urgent tool to combat typhoid and antimicrobial resistance. The Lancet Global Health, 9(8), e1158–e1168. https://doi.org/10.1016/S2214-109X(21)00217-6
5. Stanaway, J. D., Reiner, R. C., Blacker, B. F., Goldberg, E. M., Khalil, I. A., Troeger, C. E., ... & Mokdad, A. H. (2019). The global burden of typhoid and paratyphoid fevers: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet Global Health, 7(3), e310–e320. https://doi.org/10.1016/S2214-109X(18)30475-6
6. World Health Organization (WHO). (2018). Typhoid vaccines: WHO position paper – March 2018. Weekly Epidemiological Record, 93(13), 153–172. https://www.who.int/publications/i/item/who-wer9313
7. Andrews, J. R., Qamar, F. N., Charles, R. C., & Ryan, E. T. (2018). Extensively drug-resistant typhoid — Are conjugate vaccines arriving just in time? New England Journal of Medicine, 379(16), 1493–1495. https://doi.org/10.1056/NEJMp1803926
8. Wain, J., Hendriksen, R. S., Mikoleit, M. L., Keddy, K. H., & Ochiai, R. L. (2015). Typhoid fever. The Lancet, 385(9973), 1136–1145. https://doi.org/10.1016/S0140-6736(13)62708-7
9. Marks, F., von Kalckreuth, V., Aaby, P., Adu-Sarkodie, Y., El Tayeb, M. A., Ali, M., ... & Gessner, B. D. (2017). Incidence of invasive salmonella disease in sub-Saharan Africa: A multicentre population-based surveillance study. The Lancet Global Health, 5(3), e310–e323. https://doi.org/10.1016/S2214-109X(17)30022-0
10. Qamar, F. N., Yousafzai, M. T., Sultana, S., Baig, A., Shakoor, S., Hirani, F., ... & Zaidi, A. K. M. (2018). A retrospective study of laboratory-based enteric fever surveillance in Pakistan, 2012–2014. The Journal of Infectious Diseases, 218(Suppl 4), S201–S205. https://doi.org/10.1093/infdis/jiy518
11. Saha, S., Tanmoy, A. M., Andrews, J. R., Sajib, M. S. I., Yu, A. T., Baker, S., ... & Saha, S. K. (2018). Evaluating PCR-based detection of Salmonella Typhi and Paratyphi A in the environment as an enteric fever surveillance tool. American Journal of Tropical Medicine and Hygiene, 99(4_Suppl), 43–50. https://doi.org/10.4269/ajtmh.18-0044
12. Darton, T. C., Blohmke, C. J., Pollard, A. J., Khanam, F., Shakya, M., Voysey, M., ... & Basnyat, B. (2017). Using a human challenge model of typhoid infection to investigate the impact of vaccination and mechanisms of disease. Clinical Infectious Diseases, 64(2), 161–167. https://doi.org/10.1093/cid/ciw708
13. Neuzil, K. M., Pollard, A. J., & Marfin, A. A. (2019). Introduction of typhoid conjugate vaccines in Africa and Asia. Clinical Infectious Diseases, 68(Suppl 2), S27–S28. https://doi.org/10.1093/cid/ciy879
14. Wong, V. K., Baker, S., & Pickard, D. J. (2015). Phylogeographical analysis of the dominant multidrug-resistant H58 clade of Salmonella Typhi identifies inter- and intracontinental transmission events. Nature Genetics, 47(6), 632–639. https://doi.org/10.1038/ng.3281
15. Crump, J. A., & Mintz, E. D. (2010). Global trends in typhoid and paratyphoid fever. Clinical Infectious Diseases, 50(2), 241–246. https://doi.org/10.1086/649541
16. Mogasale, V., Ramani, E., Mogasale, V. V., & Park, J. Y. (2016). What proportion of Salmonella Typhi cases are detected by blood culture? A systematic literature review. Annals of Clinical Microbiology and Antimicrobials, 15, 32. https://doi.org/10.1186/s12941-016-0147-z
17. Im, J., Khanam, F., Ahmmed, F., Kim, D. R., Kang, S., Tadesse, B. T., ... & Saha, S. (2022). Burden of typhoid and paratyphoid fever in low-income and middle-income countries: A systematic, model-based analysis. The Lancet Global Health, 10(4), e570–e580. https://doi.org/10.1016/S2214-109X(22)00010-9
18. Saha, S. K., Baqui, A. H., Hanif, M., Darmstadt, G. L., Ruhulamin, M., Nagatake, T., & Santosham, M. (2001). Typhoid fever in Bangladesh: Implications for vaccination policy. Pediatric Infectious Disease Journal, 20(5), 521–524. https://doi.org/10.1097/00006454-200105000-00014
19. Levine, M. M., Ferreccio, C., Black, R. E., Lagos, R., San Martin, O., & Blackwelder, W. C. (2007). Typhoid fever: a massive, single-point source, multidrug-resistant outbreak in South America. Journal of Infectious Diseases, 196(11), 1707–1714. https://doi.org/10.1086/522178
20. Bhan, M. K., Bahl, R., & Bhatnagar, S. (2005). Typhoid and paratyphoid fever. The Lancet, 366(9487), 749–762. https://doi.org/10.1016/S0140-6736(05)67181-4
21. Shakya, M., Colin-Jones, R., Theiss-Nyland, K., Voysey, M., Pant, D., Smith, N., ... & Pollard, A. J. (2019). Phase 3 efficacy analysis of a typhoid conjugate vaccine trial in Nepal. New England Journal of Medicine, 381(1), 23–34. https://doi.org/10.1056/NEJMoa1805683

22. Watson, C. H., Edmunds, W. J., & Garske, T. (2021). The impact of typhoid conjugate vaccine introduction in Gavi-supported countries: A modelling study. The Lancet Infectious Diseases, 21(8), 1157–1165. https://doi.org/10.1016/S1473-3099(20)30803-6

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