Economic evaluation of enteric vaccines

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2 Rotavirus vaccination: questions and evidence
3 Typhoid vaccination: questions and evidence
4 Other cost considerations
5 Conclusion

Background

- Gastroenteric pathogens result in:
    - approximately 600,000 deaths in children under 5 annually.*
    - millions of cases, facility visits, and hospitalizations each year.
    - strained health care resources and facility overcrowding.
- Vaccines and other measures can help avert the health and economic costs associated with disease caused by gastroenteric pathogens .
- Economic evaluation can help inform vaccine decision-making.

*WHO-MCEE; IHME

Objective

- Review the economic evidence regarding two important enteric vaccines: **rotavirus** and **typhoid**.

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Major rotavirus economic questions

- Should rotavirus vaccine be introduced into the national program?
  - Is rotavirus vaccination cost-effective?
  - Is rotavirus vaccination affordable?

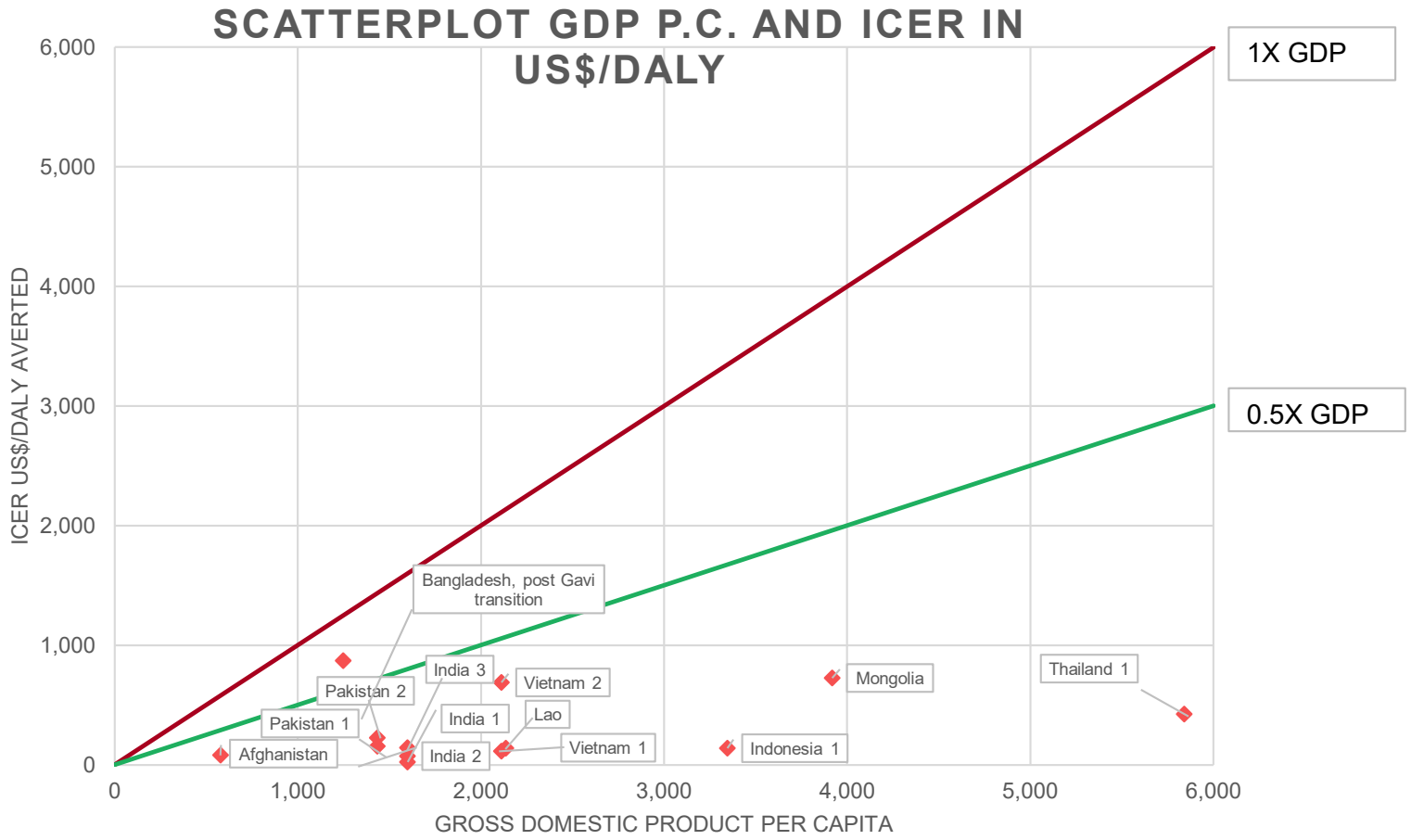
- Which rotavirus vaccine product would be economically preferred in my country?

Context on cost-effectiveness interpretation

- Historically, GDP per capita thresholds were used to determine cost-effectiveness at the country level:
  - < 1 X GDP per capita was *highly cost-effective*
  - < 3 X GDP per capita was *cost-effective*
  - > 3 X GDP per capita was *not cost-effective*
- However, these historical thresholds are no longer recommended by WHO.
- Country-specific thresholds are recommended, but often do not exist in practice.
- In the absence of a country specific threshold, new (interim?) norms seem to be evolving ~ 0.5 - 1 X GDP per capita.
  - E.g., an incremental cost-effectiveness ratio (ICER) of 0.5 X GDP per capita would likely be viewed by many as cost-effective.

Is rotavirus vaccination cost-effective?

Cost effectiveness studies in low- and middle-income countries in Asia reporting DALYs.



Excludes one study on China to preserve readability of figure.

Is rotavirus vaccination affordable?

- Great question, and difficult to answer outside of a single country context!
- The answer depends on available budget, delivery costs, and vaccine costs.
- Major cost drivers of rotavirus vaccination are incremental delivery costs (e.g. cold chain, vaccine administration) and vaccine costs.

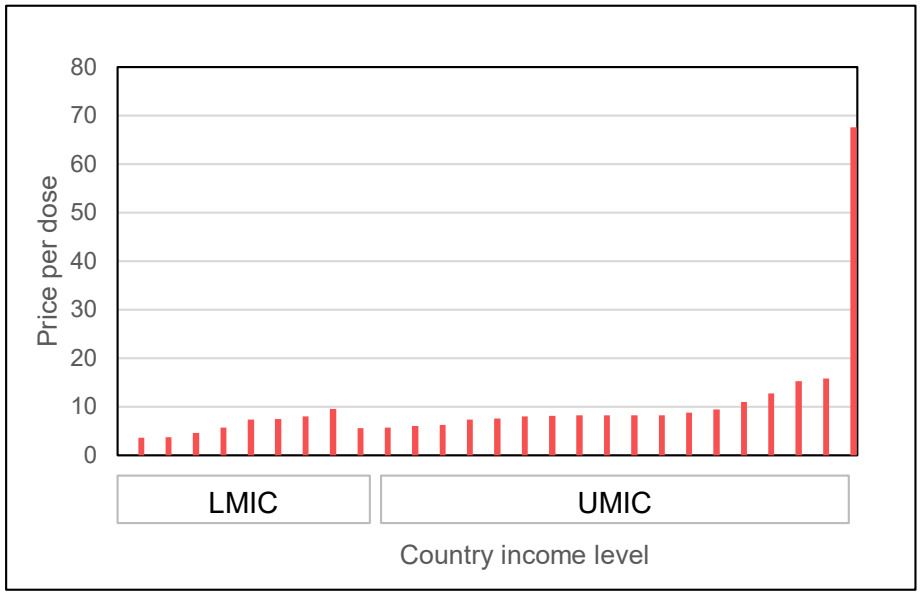
- Incremental delivery costs vary by country, region, income level, and vaccine.
  - Median incremental delivery costs per dose across vaccines were $0.86 (range: $0.16-$2.54) in a recent systematic review.*

*Vaughan et al. The costs of delivering vaccines in low- and middle-income countries: Findings from a systematic review. *Vaccine*. 2019.

Is rotavirus vaccination affordable? (cont.)

- Median price per dose in non-Gavi, middle-income countries outside PAHO, 2013-2017:

  $7.95 (range: $3.57-$67.63)*



- In 2018, two new rotavirus vaccines (ROTAVAC and ROTASIIL) were WHO-prequalified.
- Additional products are under development.
- New vaccines are expected to put downward pressure on rotavirus vaccine prices.
- Lower prices may significantly benefit non-Gavi countries and enhance affordability.

*WHO MI4A; https://www.who.int/immunization/programmes_systems/procurement/v3p/platform/module1/en/, accessed 8 Aug 2019.

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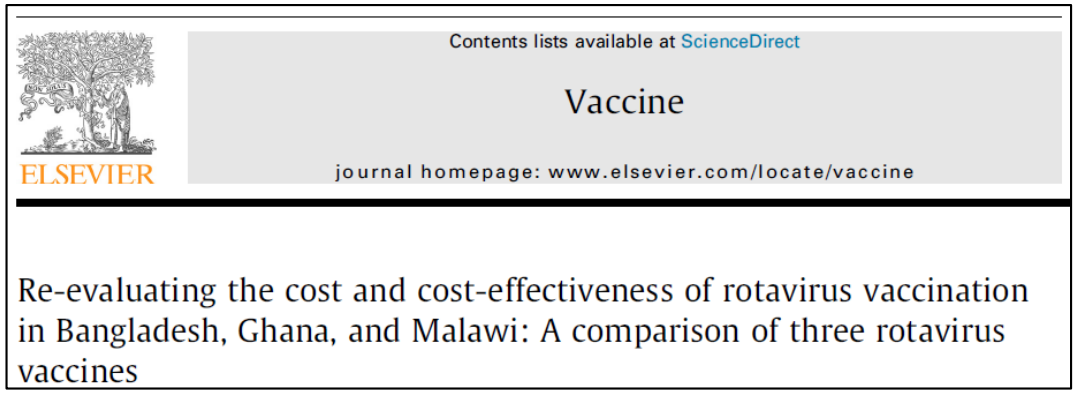
Which rotavirus vaccine would be economically preferred in my country?

We conducted a comparative cost and cost-effectiveness analysis examining three rotavirus products across 3 Gavi countries:



<u>Findings</u>

- All rotavirus vaccine products were cost-effective!
- The least costly (most cost-effective) product is sensitive to vaccine price and vaccine delivery costs.
- The most economical product is likely to differ by country.
- Country-specific analysis can help inform economic implications of product choice.

Review of major rotavirus economics questions

- Should rotavirus vaccination be introduced into the national program?

  Rotavirus vaccination is impactful, cost-effective, and affordable in many countries.

  - Is rotavirus vaccination cost effective?

    Rotavirus vaccination is likely cost-effective in most countries.

  - Is rotavirus vaccination affordable?

    This depends on available budgets, vaccine, and delivery costs. New vaccine products may enhance affordability through competition.

- Which rotavirus vaccine product would be economically preferred in my country?

  This depends on vaccine prices in each country and delivery costs.

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Major typhoid economics questions

- Should typhoid conjugate vaccine be introduced into the national program?
  - Is typhoid conjugate vaccination cost-effective?
  - Is typhoid conjugate vaccination affordable?

- What is the optimal delivery strategy for typhoid conjugate vaccine?

Is typhoid conjugate vaccination cost-effective?

- A recent literature review found 6 published typhoid cost-effectiveness studies.*
  - Most studies focused on Asia and generally found vaccination to be cost-effective.

- A recent cost-effectiveness study in Gavi-eligible countries found typhoid conjugate vaccination to be cost-effective in most countries.**
  - Vaccination was likely to be cost-effective in countries with >300 typhoid cases per 100,000 person years.
  - When vaccination is optimal, routine immunization with a campaign is preferred to routine immunization alone.

*Luthra et al. Economics of typhoid fever and typhoid vaccines. *CID*. 2019.
**Bilcke et al. Cost effectiveness of routine and campaign use of TCVs in Gavi-eligible countries: a modelling study. *The Lancet*. 2019.

Is typhoid conjugate vaccination affordable?

- As with rotavirus vaccination, this is difficult to answer in general.
- Affordability is enhanced in Gavi-eligible countries due to Gavi co-financing for vaccines and support for campaigns.
  - Vaccine price per dose is $1.50 for Gavi countries.*
- Numerous Gavi-eligible countries have expressed interest in typhoid conjugate vaccines, suggesting affordability in this market.
- Little evidence is currently available to assess the affordability of typhoid conjugate vaccination non-Gavi countries.

*https://www.gavi.org/about/market-shaping/detailed-product-profiles/

Review of major typhoid economics questions

- Should typhoid conjugate vaccine be introduced into the national program?
  - Is typhoid conjugate vaccination cost-effective?

    Typhoid conjugate vaccination is impactful and likely cost effective in high-incidence countries.
  - Is typhoid conjugate vaccination affordable?

    Typhoid conjugate vaccination is likely affordable in Gavi-eligible countries. There is little evidence to assess affordability elsewhere.

- What is the optimal delivery strategy for typhoid conjugate vaccine?

  Routine immunization with a campaign is generally preferred to routine immunization alone.

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Other cost considerations

- Rotavirus and typhoid vaccination also avert illness costs for the health system and households.

Illness costs per episode in low- and middle-income countries		
Rotavirus (25 studies)*	Outpatient	$4.30 - $145.40
	Inpatient	$41.10 - $538.30
Typhoid (5 studies)**	Outpatient	$16 - $74
	Inpatient	$159 - $636

*Baral et al. Under review.
**Luthra et al. Economics of typhoid fever and typhoid vaccines. *CID*. 2019.

Other cost considerations (cont.)

- Vaccination also frees hospital bed space for other childhood illness and reduces overcrowding.***
  - Rotavirus vaccination in Bangladesh will release 629 hospital beds in the country's largest pediatric hospital in a one-year period.

***Saha et al. Rotavirus vaccine will improve child survival by more than just preventing diarrhea: Evidence from Bangladesh. *AJTMH*. 2018.

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Conclusion

- The rotavirus health economics literature is well developed to answer critical questions.
- Rotavirus vaccination is impactful, cost-effective, and affordable in many countries.

- The typhoid health economics literature is still developing but can inform decision-making.
- Typhoid conjugate vaccination is impactful and likely cost-effective in high-incidence countries.

- Both rotavirus and typhoid vaccination programs can be affordable, but this question is best addressed on a country-by-country basis.
- Health economics is a useful tool to help inform vaccine introduction decisions.


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Backup slides

Is rotavirus vaccination cost-effective?

- At least 22 rotavirus cost-effectiveness studies have been conducted between 2005 and the present in Asian LMICs:

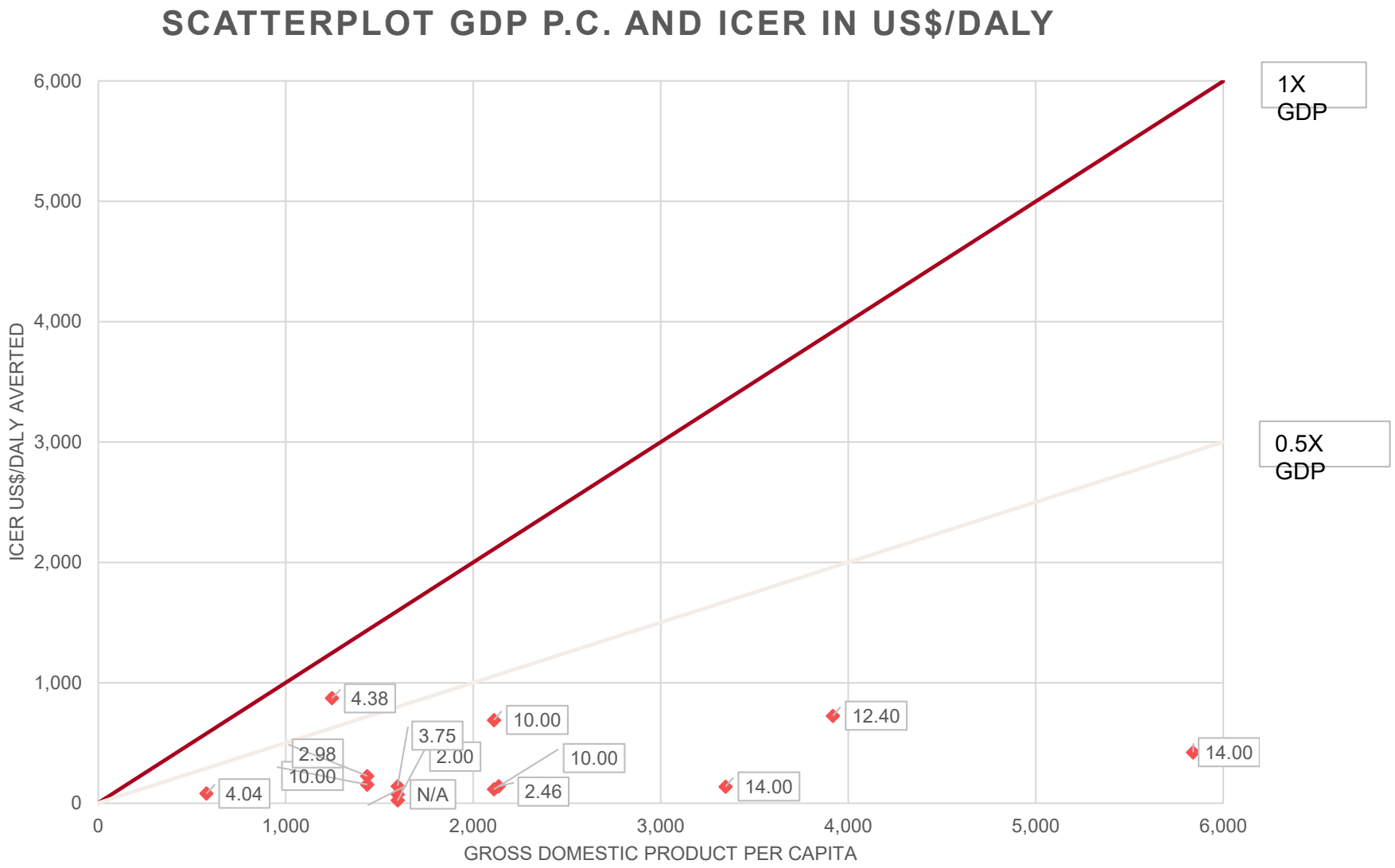
Country	WB Revenue group	n
China	Upper Middle Income	3
Thailand	Upper Middle Income	2
Bangladesh	Lower Middle Income	1
India	Lower Middle Income	5
Indonesia	Lower Middle Income	3
Lao DR	Lower Middle Income	1
Mongolia	Lower Middle Income	1
Pakistan	Lower Middle Income	2
Vietnam	Lower Middle Income	3
Afghanistan	Low Income	1
Total		**22**

Additional sources

Rotavirus vaccine cost-effectiveness:

- Rheingans et al. Systematic review of the economic value of diarrheal vaccines. *HV & I*. 2014.
- Pecenka et al. Impact and cost-effectiveness of rotavirus vaccination in Bangladesh. *Vaccine*. 2017.
- Rheingans et al. Effects of geographic and economic heterogeneity on the burden of rotavirus diarrhea and the impact and cost-effectiveness of vaccination in Pakistan. *Vaccine*. 2018.
- Rheingans et al. Effects of geographic and economic heterogeneity on rotavirus diarrhea burden and vaccination impact and cost-effectiveness in the Lao People's Democratic Republic. *Vaccine*. 2018.
- Anwari et al. Potential impact and cost-effectiveness of rotavirus vaccination in Afghanistan. *Vaccine*. 2018.
- Luvsan et al. Projected impact, cost-effectiveness, and budget implications of rotavirus vaccination in Mongolia. *Vaccine*. 2019.

Is rotavirus vaccination cost-effective at different vaccine prices per course?



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