Impact and cost-effectiveness of rotavirus vaccination in Palestine: examining a change from ROTARIX to ROTAVAC vaccines

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Health Economist
PATH’s Center for Vaccine Innovation and Access
<table>
<thead>
<tr>
<th></th>
<th>Context</th>
<th>Objective</th>
<th>Model</th>
<th>Inputs and assumptions</th>
<th>Results</th>
<th>Conclusion</th>
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Context

- 14 out of 22 countries in the WHO Eastern Mediterranean Region (EMRO) have introduced rotavirus vaccine.
- Palestine is the first country to use ROTAVAC in routine immunization outside of India:
  
  **2016** Start of the program with support from RVF, introduced ROTARIX
  **2017** 97% coverage after a year of implementation
  **2018** Switch to ROTAVAC
  **2019** Transfer of procurement's financial responsibility

- Switch provides an opportunity for empiric assessment of different rotavirus vaccine programmatic characteristics.
Product characteristics

**ROTARIX**

2 doses
1-dose plastic tube
Shelf-life 24 months at 2 to 8°C

Dose quantity 1.5 ml
Cold chain volume 17.1 cm³ per dose or 34.2 cm³ per FIC

**ROTAVAC**

3 doses
5-dose vial and dropper
Shelf-life 60 months at -20°C / 6 months at 2 to 8°C post thaw

Dose quantity 0.5 ml
Cold chain volume 4.2 cm³ per dose or 12.6 cm³ per FIC
1 Context
2 Objective
3 Model
4 Inputs and assumptions
5 Results
6 Conclusion
Objective of the analysis

To assess impact and cost-effectiveness of rotavirus vaccination in Palestine, specifically evaluating the economic implications of the change from ROTARIX to ROTAVAC.
Analysis overview

Study population: children < 5 years of age
10 cohorts, from 2016 to 2025
Health system and societal perspectives
Results reported in 2018 US$
Discount rate 3%
3 scenarios evaluated

Scenarios

1. ROTARIX vs no vaccine
2. ROTAVAC vs no vaccine
3. Switch from ROTARIX to ROTAVAC

Model Outputs
Health impact (averted cases, visits, hospitalizations, deaths and DALYs)
Averted healthcare costs
Costs of vaccination program
Incremental cost-effectiveness ratio
1 Context
2 Objective
3 Model
4 Inputs and assumptions
5 Results
6 Conclusion
UNIVAC model

UNIVAC is a single, universal vaccine impact and cost-effectiveness decision support model developed in a standardized, accessible Excel-based interface.

Developed as a follow-on to PAHO’s TRIVAC model, which has been used in many studies worldwide.

Allows economic evaluation of:
• Rotavirus vaccine
• PCV vaccine
• Hib vaccine
• HPV vaccine
• Men ACYW vaccine
• Others
1 Context
2 Objective
3 Model
4 Inputs and assumptions
5 Results
6 Conclusion
Data inputs

- Treatment costs
- Cost-effectiveness of rotavirus vaccination
- Introduction costs
- Vaccinespecific assumptions
- Incremental supply chain and service delivery costs
- Burden of disease
Vaccine assumptions

Dosing schedule based on Pentavalent vaccine

Price per dose: $4
Wastage: 0.3%
International delivery charges: $0.026 per dose
In-country delivery charges from airport to the Central Store: $0.029 per dose

Price per dose: $1 ($0.85 - $1.5)
Wastage: 4.7%
International delivery charges: $0.025 per dose
In-country delivery charges from airport to the Central Store: $0.017 per dose
Vaccine program costs

**Introduction costs** were collected for both vaccines but initial intro costs with ROTARIX were applied to both vaccines in the analysis to allow for a fair comparison.

Total economic intro costs were close to $300,000

**Supply chain and service delivery cost** data were collected in 20 health facilities, 6 districts and at the central store

Overall the supply chain and service delivery costs per dose are $0.33 cheaper with ROTAVAC
1. Context
2. Objective
3. Model
4. Inputs and assumptions
5. Results
6. Conclusion
Estimated health outcomes
(10 cohorts vaccinated over 2016 – 2025)

<table>
<thead>
<tr>
<th></th>
<th>Without vaccine</th>
<th>With vaccine</th>
<th>Averted</th>
</tr>
</thead>
<tbody>
<tr>
<td>RVGE Cases</td>
<td>782,660</td>
<td>213,380</td>
<td>569,280</td>
</tr>
<tr>
<td>RVGE Outpatient visits</td>
<td>414,027</td>
<td>112,879</td>
<td>301,148</td>
</tr>
<tr>
<td>RVGE Hospital admissions</td>
<td>111,209</td>
<td>30,320</td>
<td>80,889</td>
</tr>
<tr>
<td>RVGE Deaths</td>
<td>140</td>
<td>38</td>
<td>102</td>
</tr>
<tr>
<td>DALYs (discounted)</td>
<td>5,380</td>
<td>1,459</td>
<td>3,921</td>
</tr>
</tbody>
</table>

DALY = Disability Adjusted Life Years (sum of years of life lost to deaths and of years of life lost to disability)
# Estimated costs

(10 cohorts vaccinated over 2016-2025)

<table>
<thead>
<tr>
<th></th>
<th>Without vaccine</th>
<th>With vaccine</th>
<th>Averted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RVGE Treatment costs</strong>&lt;br&gt;(Health system perspective)</td>
<td>$19.4M</td>
<td>$5.3M</td>
<td>$14.1M</td>
</tr>
<tr>
<td><strong>RVGE Households costs</strong></td>
<td>$11M</td>
<td>$3M</td>
<td>$8M</td>
</tr>
<tr>
<td><strong>RVGE Total costs</strong>&lt;br&gt;(Societal perspective)</td>
<td>$30.4M</td>
<td>$8.2M</td>
<td>$22.2M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vaccine program costs</th>
<th>With ROTARIX $4/dose</th>
<th>With ROTAVAC $0.85/dose</th>
<th>With ROTAVAC $1/dose (base case)</th>
<th>With ROTAVAC $1.5/dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$19M</td>
<td>$14.8M</td>
<td>$15.5M</td>
<td>$17.8M</td>
</tr>
</tbody>
</table>

All figures are discounted and expressed in million US$
Incremental cost-effectiveness ratio (ICER)

<table>
<thead>
<tr>
<th></th>
<th>Health system perspective</th>
<th>Societal perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTARIX vs. no vaccination</td>
<td>$1,254</td>
<td>Cost-saving</td>
</tr>
<tr>
<td>ROTAVAC* vs. no vaccination</td>
<td>$353</td>
<td>Cost-saving</td>
</tr>
<tr>
<td>ROTAVAC* vs. ROTARIX</td>
<td>Cost-saving</td>
<td>Cost-saving</td>
</tr>
</tbody>
</table>

* At $1 per dose

- ICERs are usually compared to a specific willingness-to-pay (WTP) threshold.
- In Palestine, the practice has been to use 1 times GDP per capita as a WTP threshold.
- Palestine’s GDP per capita was $3,095 in 2017 US$ (World Bank).
- Both vaccines are likely cost-effective interventions under these criteria, with an economic advantage for ROTAVAC.
Scenario analysis

- Scenario analysis focused on disease burden, vaccine efficacy, health system costs, healthcare costs, and price for ROTAVAC.

- Most scenarios yield an ICER below the threshold.

- With ROTAVAC, results are above threshold only for the low-disease burden, health system perspective scenario.
Probabilistic sensitivity analysis

- 1,000 runs, ROTAVAC only
- ROTAVAC has 80% chance to be cost-effective at a WTP threshold of $1,100.
- ROTAVAC has 90% chance to be cost-effective at a WTP threshold of $1,500.
1. Context
2. Objective
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Rotavirus vaccination is a cost-effective intervention in Palestine, averting a share of the rotavirus burden and generating savings on healthcare costs, for the health system and for households.

ROTAVAC presents an economic advantage over ROTARIX. Shifting from ROTARIX to ROTAVAC was a cost-saving option because of:

- Lower vaccine price per dose.
- Smaller cold chain volume and, hence, lower supply chain costs.

Lower supply chain costs are driven by cold chain costs at the health facility level as well as in-country transportation costs.

The assumed similar efficacy of both vaccines may be confirmed by the ongoing epidemiological surveillance.

Countries should systematically assess the different products available and their characteristics as part of their decision-making process.
Study collaborators and funding source

Mercy Mvundura - PATH
Samer Jaber - Palestinian Ministry of Health
Yaser Bouzya - Palestinian Ministry of Health
Jehad Sabbah - United Nations Relief and Works Agency for Palestine Refugees in the Middle East
Mustafa Barham - Rostropovich-Vishnevskaya Foundation
Fakhr Abu-Awwad - Rostropovich-Vishnevskaya Foundation
Diaa Hjaija - Palestinian Ministry of Health
Assad Ramlawi - Palestinian Ministry of Health
Andy Clark - LSHTM
Clint Pecenka – PATH

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Thank you!
Process overview

- Stakeholder engagement
- Scope of the analysis
- Approach to modelling
- UNIVAC orientation

July 8-12, 2018
- Scoping visit

Scoping visit:
- Available local data
- Identification of data sources
- Development of questionnaires
- Secondary data collection

Data collection prep.:
- Field testing and adaptation
- Training on questionnaires and data collection
- Modelling of treatment costs

Field testing of questionnaires and training:
- Supply chain and service delivery data collection in HF, HD, and CS
- Secondary data collection (introduction costs and vaccine procurement)
- Surveillance data

Primary and secondary data collection:
- Discussion on disease burden modelling
- Supply chain and service delivery cost data analysis
- Conducting cost effectiveness analysis
- Scenario analysis

Data analysis and modelling:
- Presentation and discussion of results with the MoH (PMD, PHC, EPI)
- Deputy Ministry of Health
- UNRWA
- Local WHO
- RVF

Preliminary results dissemination:

HF = Health Facilities, HD = Health Directorate, CS = Central Store
Burden of disease

### Annual incidence per 100,000 among U5 before vaccine introduction

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall RVGE incidence¹</td>
<td>10,000</td>
<td>7,000</td>
<td>14,000</td>
</tr>
<tr>
<td>RVGE non severe cases²</td>
<td>8,224</td>
<td>6,160</td>
<td>11,373</td>
</tr>
<tr>
<td>RVGE non severe visits³</td>
<td>4,350</td>
<td>3,259</td>
<td>6,016</td>
</tr>
<tr>
<td>RVGE severe cases²</td>
<td>1,776</td>
<td>839</td>
<td>2,627</td>
</tr>
<tr>
<td>RVGE severe visits³</td>
<td>939.5</td>
<td>444</td>
<td>1,390</td>
</tr>
<tr>
<td>RVGE severe hospitalizations⁴</td>
<td>1,421</td>
<td>555</td>
<td>2,102</td>
</tr>
<tr>
<td>Severe RVGE deaths⁵</td>
<td>2.03</td>
<td>0.84</td>
<td>4.88</td>
</tr>
</tbody>
</table>

1. Global RVGE incidence as reported by Bilcke et al in their systematic review and meta-analysis including 21 studies worldwide. Commonly use for RV disease burden modelling.

2. Non-severe and severe RVGE cases are differentiated using another systematic review and meta-analysis by Fisher Walker et al. which gives proportion of RV in severe diarrhea episodes per WHO region (using EMRO here)

3. Using the Palestine MICS 2014: treatment seeking rate in case of diarrhea 52.9%

4. Assuming a larger proportion of severe cases would seek treatment or be referred to hospitals: 80%

5. Median value of 3 sources of data estimating RV related death per country (MCEE, IHME and WHO CDC)
Vaccine efficacy and waning

- Vaccine efficacy and waning based on data from 8 published randomized controlled trials in medium U5 mortality settings
  - 91% vaccine efficacy after 2 doses
  - 58% vaccine efficacy after 1 dose
  - Waning

- Assuming similar efficacy of ROTARIX and ROTAVAC

- With ROTAVAC, model assumes full protection after 2\textsuperscript{nd} dose but 3\textsuperscript{rd} dose is required
Introduction costs

ROTARIX introduction costs applied to both vaccines

<table>
<thead>
<tr>
<th></th>
<th>West Bank and Gaza</th>
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<tbody>
<tr>
<td><strong>Financial costs</strong></td>
<td>$61,398</td>
</tr>
<tr>
<td>Training</td>
<td>$27,511</td>
</tr>
<tr>
<td>Communication materials</td>
<td>$33,887</td>
</tr>
<tr>
<td><strong>Economic costs</strong></td>
<td>$296,263</td>
</tr>
<tr>
<td>Training</td>
<td>$262,376</td>
</tr>
<tr>
<td>Communication materials</td>
<td>$33,887</td>
</tr>
</tbody>
</table>
Treatment costs

- Direct medical costs were modelled using a study estimating unit costs of public hospitals and primary healthcare centers in Palestine¹ and local protocol and costs for laboratory tests and drugs.
- Non-medical (household) costs include meals, transportation for child and caregiver.
- Indirect cost corresponds to loss of productivity for caregiver.

<table>
<thead>
<tr>
<th></th>
<th>Health system perspective</th>
<th>Direct non-medical cost</th>
<th>Indirect cost</th>
<th>Societal perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment cost for RVGE inpatient care</td>
<td>$173.85</td>
<td>$28.04</td>
<td>$35.59</td>
<td>$237.48</td>
</tr>
<tr>
<td>Treatment cost for RVGE outpatient care</td>
<td>$7.63</td>
<td>$9.35</td>
<td>$4.45</td>
<td>$21.43</td>
</tr>
</tbody>
</table>

Supply chain and service delivery costing

- Estimated the cost per dose for supply chain and service delivery for all vaccines used in the EPI program.
- Then used these data to estimate the incremental economic costs of adding rotavirus vaccine into the immunization schedule in Palestine.
- Costing data collection was done using structured costing questionnaires
- Data were collected from:
  - 10 health facilities in West Bank and 10 in Gaza
  - 5 directorates in West Bank and 1 in Gaza
  - The Central Store in Nablus
### Incremental supply chain and service delivery economic cost estimates

<table>
<thead>
<tr>
<th>Cost category</th>
<th>ROTARIX</th>
<th>ROTAVAC – 5 dose vials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated incremental economic costs per dose at the health facility level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold chain</td>
<td>$0.28</td>
<td>$0.07</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>$0.04</td>
<td>$0.01</td>
</tr>
<tr>
<td>Human resource</td>
<td>$2.01</td>
<td>$1.95</td>
</tr>
<tr>
<td>Total</td>
<td>$2.32</td>
<td>$2.02</td>
</tr>
<tr>
<td>Estimated incremental economic costs per dose at the directorate level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold chain</td>
<td>$0.03</td>
<td>$0.024</td>
</tr>
<tr>
<td>Transport</td>
<td>$0.022</td>
<td>$0.005</td>
</tr>
<tr>
<td>Human resource</td>
<td>$0.30</td>
<td>$0.30</td>
</tr>
<tr>
<td>Total</td>
<td>$0.35</td>
<td>$0.33</td>
</tr>
<tr>
<td>Estimated incremental economic costs per dose at the central Store</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold chain</td>
<td>$0.0114</td>
<td>$0.012</td>
</tr>
<tr>
<td>Transport</td>
<td>$0.003</td>
<td>$0.003</td>
</tr>
<tr>
<td>Human resource</td>
<td>$0.01</td>
<td>$0.001</td>
</tr>
<tr>
<td>Total</td>
<td>$0.03</td>
<td>$0.016</td>
</tr>
<tr>
<td>Total incremental economic costs per dose costs at all levels of the supply chain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$2.695</td>
<td>$2.362</td>
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Limitations

• Unable to use local data for disease burden modelling...
  – Incomplete set of data from HMIS for hospitals (year 2015)
  – Follow up of different age groups in Gaza between MoH (U3) and UNRWA (U5)
  – PHC visits for diarrhea in West bank were reported for all the population, except for 1 district
• …addressed through scenario analysis accounting for uncertainty around the data used
• Assumption around similar efficacy of ROTARIX and ROTAVAC may be confirmed or informed by the epidemiological study.
• Difficult to capture differences between West Bank and Gaza outside of supply chain and service delivery cost.
• Assumption that services are provided through the 10-year period without changes