Distributional Effects of Rotavirus Vaccination in Low-income Countries

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Global vaccination disparities: Opportunities and challenges

- New vaccines provide an opportunity to substantially reduce child mortality
- Impact and cost-effectiveness are dependent upon the ability of immunization programs to reach children with the greatest risks

Purpose
- Examine whether immunization programs in low-income countries reach vulnerable and high-risk children, based on economic status, geography and vulnerability
- Identify opportunities to substantially improve impact and cost-effectiveness through improved targeting or delivery strategy
**Distributional Impacts of RV Vaccination in GAVI-eligible Countries**

- Based on an existing model of rotavirus impact and cost-effectiveness (Atherly et al, 2012)
- Demographic and Health Surveys (DHS) for 25 low-income countries

- Estimate RV mortality risk across wealth quintiles based on proxies (post-neonatal infant mortality and low weight for age)
- Estimate benefits and costs based on DPT1 and DPT2 coverage by quintile

- Estimate by quintile
  - Impact per 1000 children
  - Cost effectiveness ($/DALY)
  - Impact with current and equitable vaccination

Vaccination and RV Mortality Risks

- Greater risks and lower coverage for the poorest
- Pattern varies among countries

Estimated under 5 rotavirus deaths / 1000 births

Estimated vaccine coverage based on DPT2 coverage

Quintile
- Richest
- 4th
- Middle
- 2nd
- Poorest

Countries: Bangladesh, DR Congo, Ethiopia, India, Kenya, Niger, Nigeria, Uganda, Vietnam
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Countries:
- Bangladesh
- India
- DR Congo
- Ethiopia
- Nigeria
- Uganda
- Kenya
- Niger
- Nigeria
- Uganda
- Kenya
- Bangladesh

[Graph showing estimated vaccine coverage and rotavirus deaths across different quintiles and countries]
Vaccination and RV Mortality Risks

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Vaccination and Mortality Risks

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- Pattern varies among countries
Impact and Cost-effectiveness

- Most cost effective among the poor
- Greatest benefits for the poor in countries with equitable coverage
- Lower benefits poorest in countries with inequitable access
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Health Cost of Disparities

• What if all quintiles had the same protection as the richest?

• Little difference in countries with equal coverage

• In India, equal coverage would increase benefits among poor by 80% and 35% overall

• In Nigeria, equal coverage would increase benefits among poor 400% and 80% overall
A Closer Look: India

• Use the same approach to estimate impact and cost effectiveness by state
Within Country Differences
Difference in cost-effectiveness and impact

- 3 fold difference in impact
- 4 fold difference in cost-effectiveness
- Only accounts for disparities among states, not within
Effect of disparities on rotavirus vaccine impact and cost-effectiveness

• RV vaccination is cost-effective at a national level, but great variability within countries
• Vaccinating highest risk children is significantly more cost-effective
• With current vaccine delivery vaccine disproportionately benefits higher wealth and lower risk children
  – Less impactful
  – Less cost-effective
A Closer Look: Nigeria
Methods: Estimating Risk Distribution

• Individual data from Niger DHS 2008-9
• Overall RV mortality burden based on national estimates from WHO CHERG (Tate et al, 2011)
• Distribution of burden is based on individual risk factors
  – Weight for Age
  – Likelihood of receiving rehydration treatment
• Combine individual child risk factors and published meta-analysis estimates of relative risk to estimate each child’s risk
Vaccine Effectiveness Estimation

- Uses data on child 12-23 months old
- Assumes 2 dose vaccine introduced with DPT1 and 2
- Uses pooled estimates of vaccination efficacy (50%) and assumed efficacy of one dose (one third less)
- Considers age distribution of rotavirus illness and estimated timing of vaccination
Distribution of Burden

- Under nutrition and lack of ORS treatment are concentrated among poorest
- Estimated RV mortality risk is 3 times higher
- 20% of riskiest children with 60% of risk
Disparities in Vaccination and Timing

- Lower coverage of routine vaccination and greater delays for poorest

Nigeria DPT1 by Wealth Quintile by Wealth: DHS 2008

Cumulative Percentage of Coverage

Age at DPT1 Vaccination (Months)
Disparities in Effectiveness: By Economic Status

- Lower estimated vaccination effectiveness for poorest
- Due to differences in coverage and timing
• Majority of benefits go to richer children
Health Cost of Disparity

- Raising coverage increases benefit
- 600% for poorest
- 100% nationally
Can Indirect Protection Overcome Disparities?

- Some evidence of potential indirect protection from RV vaccines
- Requires vulnerable children to mix with well-vaccinated and protected children
- Used cluster data to estimate level of protection for ‘neighboring’ children

- Are vulnerable children around well-vaccinated children?
Protection from Communities?

- Highest risk children are predominantly in communities with unvaccinated children
- Low risk children in highly vaccinated communities
Key Findings - Nigeria

• RV risk factors are concentrated among the poorest children (up to 60% among the riskiest 20%)
• Substantially lower coverage and effectiveness among poor (80% lower)
• Risk and benefits are also concentrated geographically
• Ignoring disparities overestimates benefits (50%)
Conclusions: Delivery and Policy Implications

• **Need to redouble efforts and invest in getting vaccines to the most vulnerable**

• **Geographic targeting**
  – Introducing in high-impact, highly cost-effective areas first

• **Socio-economic targeting**
  – Increasing coverage among the low income (e.g., conditional cash transfers)

• **Vulnerability targeting**
  – Increasing coverage among highly vulnerable
  – Areas with poor coverage of ORS, children in feeding programs