Health Benefits of Rotavirus Vaccination in the United States

Umesh D. Parashar
For the Viral Gastroenteritis Team
Centers for Disease Control and Prevention
Atlanta, GA
New Vaccine Surveillance Network

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Centers for Disease Control and Prevention
Atlanta, GA       June 1, 2011
Rotavirus Vaccine Implementation in US

• Feb 2006 -- RotaTeq recommended

• June 2008 -- Rotarix recommended
Percentage of US children receiving full course of rotavirus vaccines, 2009-2013

Centers for Disease Control and Prevention, MMWR 2014
Vaccine Effectiveness

• To compare with *efficacy* in trials

• Measured using *case-control* study
  – *Cases* of laboratory-confirmed rotavirus diarrhea
  – *Controls*
    • Rotavirus-negative diarrhea
    • Healthy community controls

• Compare *vaccination rates in cases vs. controls* to calculate vaccine effectiveness
High Effectiveness of RotaTeq against Severe Rotavirus Disease

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
<th>Study 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 doses</td>
<td>89% (70, 96)</td>
<td>87% (71, 94)</td>
<td>90% (84, 94)</td>
<td>84% (78, 98)</td>
<td>92% (75, 97)</td>
</tr>
<tr>
<td>2 doses</td>
<td>82% (15, 96)</td>
<td>88% (66, 96)</td>
<td>90% (75, 96)</td>
<td>78% (65, 86)</td>
<td>84% (1, 99)</td>
</tr>
<tr>
<td>1 dose</td>
<td>65% (-11, 89)</td>
<td>74% (37, 90)</td>
<td>66% (16, 86)</td>
<td>70% (50, 82)</td>
<td>NA</td>
</tr>
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</table>
Sustained RotaTeq Effectiveness Over 4 Years of Life

## Comparable and High Effectiveness of Rotarix against Severe Rotavirus Disease

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<tr>
<td>2 doses</td>
<td>70% (39, 86)</td>
<td>91% (80, 95)</td>
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<tr>
<td>1 dose</td>
<td>57% (-45, 87)</td>
<td>53% (-41, 84)</td>
</tr>
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</table>
National Laboratory-Based Rotavirus Surveillance

- Network of 67 laboratories reporting since 2000
- Weekly reporting:
  - # stool specimens tested for rotavirus by EIA
  - # positive tests

Tate et al. Pediatrics 2009, PIDJ 2012, and unpublished CDC data
Total no. of rotavirus tests and positive results* from 23 continuous reporting laboratories — National Respiratory and Enteric Virus Surveillance System, United States, July 2000–June 2013

Vaccine introduction

*3 week moving average
Percent of rotavirus tests with a positive result, by week and rotavirus season, NREVSS laboratories, United States, 2000-2013
Active Rotavirus Surveillance

• Enrollment of inpatients, emergency room patients, and outpatients with AGE

• Fecal specimens obtained and tested for rotavirus
New Vaccine Surveillance Network (NVSN)

SEATTLE Children’s Hospital

ROCHESTER University Medical Center

OAKLAND Children’s Hospital Research Center

KANSAS CITY Children’s Hospital Medical Center

CINCINNATI Children’s Hospital Medical Center

NASHVILLE Vanderbilt University Medical Center

HOUSTON Texas Children’s Hospital
All Cause Acute Gastroenteritis (AGE) and Rotavirus AGE Hospitalizations, NVSN 2006-2013

Proportion of AGE hospitalizations positive for rotavirus by EIA by year, NVSN, 2006-2013

Why such a big decline?

Age-Specific Rotavirus Hospitalization Rate Reduction and Vaccine Coverage, NVSN, 2008

<table>
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<tr>
<th>Age</th>
<th>Rotavirus vaccine coverage in 2008 (≥1 dose)</th>
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<tr>
<td>&lt; 1 year</td>
<td>56%</td>
</tr>
<tr>
<td>1 to &lt; 2 years</td>
<td>44%</td>
</tr>
<tr>
<td>2 to &lt; 3 years</td>
<td>&lt;1%</td>
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Payne et al. *CID 2011*. 
### Age-Specific Rotavirus Hospitalization Rate Reduction and Vaccine Coverage, NVSN, 2008

<table>
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<th>Age</th>
<th>Rotavirus vaccine coverage in 2008 (≥1 dose)</th>
<th>Decline in rotavirus hospitalization rate (2008 vs. 2006)</th>
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<tr>
<td>&lt; 1 year</td>
<td>56%</td>
<td>66%</td>
</tr>
<tr>
<td>1 to &lt; 2 years</td>
<td>44%</td>
<td>95%</td>
</tr>
<tr>
<td>2 to &lt; 3 years</td>
<td>&lt;1%</td>
<td>85%</td>
</tr>
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*Herd immunity?*

Payne et al. *CID 2011.*
Reduction in Gastroenteritis Hospitalizations in Older Children and Young Adults

Estimated Rotavirus Hospitalizations 2008 vs. 2000–2006 (median and range)

Age 0-4 years: ~56,000 hospitalizations averted ($162 million)

Age 5-24 years: ~10,000 hospitalizations averted ($42 million)

Lopman et al. JID 2011
Gastanaduy et al JAMA 2013
Strain Surveillance
US Rotavirus Strain Surveillance Network

= NVSN site
= NRSSS site
Longitudinal Variation of Rotavirus G Types in the United States, 1996-2011

RotaTeq Effectiveness Against Severe Rotavirus Gastroenteritis, by Strain, NVSN, 2006-2009

Vaccine Effectiveness (%)

- G1: 88%
- G2: 77%
- G3: 87%
- G9: 84%
- G12: 86%

Staat et al Pediatrics 2011
Detection of Rotavirus Vaccine Strains in Children with Gastroenteritis

<table>
<thead>
<tr>
<th>Season</th>
<th>RotaTeq</th>
<th>Rotarix</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-08</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2008-09</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>2009-10</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2010-11</td>
<td>6</td>
<td>0</td>
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</table>

Reassortment in vivo Between RotaTeq Vaccine Strains

Reassortant strain: G1P[8] human

9 genes of WC3 parent

Slide courtesy Jon Gentsch
Summary

✓ Marked declines in rotavirus disease
  ▪ Appearance of a bi-annual pattern
  ▪ Herd immunity
  ▪ Changes in seasonal patterns

✓ High vaccine effectiveness
  ▪ Against a range of circulating strains

✓ Strain changes after vaccine implementation
  ▪ Could simply represent natural variation