Effectiveness of vaccination programmes
Insights from human vaccination programmes

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EUFMD 2012
"Appliance of Science in The Progressive Control of FMD"
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A HUGE literature !
5th edition
76 chapters
1725 pages
3.6 kilograms
1000s of refs

A few definitions

"Vaccine potency"
Lab measure of vaccine contents - eg PD50 type measures

"Vaccine efficacy"
Reduction in risk (of disease) in vaccinated individuals compared to non-vaccinated (under trial conditions)

"Vaccine effectiveness"
Vaccine efficacy under field conditions

"Vaccine programme effectiveness = impact"
Reduction in disease (morbidity, mortality) attributable to a vaccination programme

So, if the risk of disease in a trial is 10% in non vaccinated,
3% in (equally exposed) vaccinated,
the "vaccine efficacy" is 70% 

ie (10 - 3) / 10 = 0.7

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Open Session of the EuFMD: 2012, Jerez de la Frontera, Spain
Effectiveness of a vaccine

Depends upon:

• "Quality" of the vaccine (inc. "match")
• Cold chain
• Quality of administration
• Number of doses
• Age at vaccination
• Time since last vaccination
• Level of exposure
• Environmental factors

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Effectiveness of a vaccination programme

Depends upon:

- **Effectiveness of the vaccine**
- **"Coverage"**
  - Proportion of host population vaccinated
  - by age
  - by risk group,
  - geographic...
- Other sources of infection etc.

The basic global "vaccination" programme (for humans):
(Started by WHO in 1974)

**"EPI"**

("Expanded Programme On Immunization")

### Basic EPI schedule (from 1970s)
**Purposefully simple**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth (or &quot;first contact&quot;)</th>
<th>6 weeks</th>
<th>10 weeks</th>
<th>14 weeks</th>
<th>9 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DTP</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Polio (OPV)</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Measles</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

4-week spacing, to optimise boosting

To avoid maternal antibody

### Example of a current schedule (England and Wales, 2012)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth (&quot;first contact&quot;)</th>
<th>2 months</th>
<th>3 months</th>
<th>4 months</th>
<th>12-13 months</th>
<th>3-4 years</th>
<th>12-13 years</th>
<th>13-18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td></td>
<td>✔</td>
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<tr>
<td>DTaP</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
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</tr>
<tr>
<td>IPV</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
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<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>PCV</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MenC</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
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<tr>
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<td></td>
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<td>✔</td>
<td>✔</td>
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<td></td>
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</tr>
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<tr>
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<td></td>
<td>✔</td>
<td>✔</td>
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- BCG = bacillus Calmette-Guérin
- DTaP = diphtheria, tetanus, acellular pertussis
- IPV = Inactivated (killed) polio (trivalent)
- Hib = Haemophilus influenza B
- PCV = Pneumococcal conjugate
- MenC = Meningococcus type C
- MMR = measles, mumps, rubella
- HPV = Human papilloma virus
- Td = Tetanus and diphtheria toxoids
Examples of coverage and impact monitoring

Vaccine coverage

When EPI started, in 1974, only 15% of the world's children were receiving routine vaccines.

Impact of UNICEF's "UCI 90" (90% by 1990) target

These data are provided to WHO by most countries of the world, and are freely available.

Impact: eg at national level

Measles, UK

Pertussis, UK

Impact: eg at national level

Polio in:

- Cuba
- Brasil

Campaigns in all children under 5
Programme evaluation

“Herd immunity” thresholds have NOT proved useful for programme evaluation

They are, in general, “optimistic”

Examples of vaccine effectiveness monitoring

.....and responses

Something is happening, now, with pertussis (whooping cough), in several countries ...

England and Wales
lab-confirmed cases, by quarter, 2007 - 2012

inc 10 infant deaths in 2012

California, USA
September 13 2012

UK policy change ...
From The Guardian, Friday 28 September 2012

- to increase maternal immunity... and thus protect very young infants

Polio

Global eradication initiative, since 1988
(350,000 cases in 1988)
**Excludes viruses detected from environmental surveillance and vaccine derived polioviruses.**

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**10 Oct 2011**

Data in WHO HQ as of 05 Feb 2008

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**Last 12 months**

*From AFP (acute flaccid paralysis) surveillance - all virologically confirmed*

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**5 years ago**

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**Wild Poliovirus*, 06 Feb 2007 - 05 Feb 2008**

**Wild Poliovirus*, 06 Feb 2007 - 05 Feb 2008**

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**Wild Poliovirus*, 06 Feb 2007 - 05 Feb 2008**

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**Wild Poliovirus*, 10 Oct 2011 - 09 Oct 2012**

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**Endemic country**

**Country with WPV case in previous 6 months**

**Country with WPV case 6-12 months ago**

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**Total number of cases or outbreak following importation (6 months)**

**Total number of cases or outbreak following importation (0-6 months)**

**Total number of cases or outbreak following importation (0-12 months)**

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**War and breakdown of society**

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**Very low vaccine effectiveness (only 10% per dose)**

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**Appendix**

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"Conclusion"

Optimising effectiveness of a vaccination programme requires rigorous surveillance and analysis of:

- disease trends,
- vaccine “coverage”,
- vaccine performance,

and appropriate response

(Endemic country)

Last 12 months

Zero wild polio from India since January 2011

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