Overview

- The tremendous success of vaccination
- Success of vaccination, especially for the most vulnerable, is dependent on high communal uptake - being threatened by increasing skepticism and hesitance
- Review the current main concerns for vaccine hesitancy and evidence basis for their safety
Increasingly, parents are skeptical of the safety and necessity of vaccines and are opting out of immunizing their children.

**What Do Parents Think?**
Summary of U.S. Parent/Guardian Survey - 2009

- Vaccinators with no concerns: 43%
- Vaccinators with minor concerns: 36%
- Minor refusers: 6%
- Vaccinators with major concerns: 5%
- Significant refusers: 10%

N = 1,278

ASTHO Survey, 2009

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**Vaccination Rates and Parental Exemption Rates For Children Entering Kindergarten or 1st Grade**

<table>
<thead>
<tr>
<th>Immunization Rate</th>
<th>Exemption Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DTaP</td>
</tr>
<tr>
<td>86%</td>
<td>0.00%</td>
</tr>
<tr>
<td>87%</td>
<td>0.50%</td>
</tr>
<tr>
<td>88%</td>
<td>1.00%</td>
</tr>
<tr>
<td>89%</td>
<td>1.50%</td>
</tr>
<tr>
<td>90%</td>
<td>2.00%</td>
</tr>
<tr>
<td>91%</td>
<td>2.50%</td>
</tr>
<tr>
<td>92%</td>
<td>3.00%</td>
</tr>
</tbody>
</table>

Target for Optimal Herd Immunity: 95%

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**Herd Protection**

Herd Immunity Threshold (1 - 1/R0)

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**Stop Forced Vaccinations**
Prevent autism? Don’t vaccinate!

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**USA TODAY**

Measles cases in U.S. rise; most unvaccinated, CDC says

The Centers for Disease Control and Prevention is warning about a rise in the number of measles cases in the USA.

Earn Your M.P.H. Online and Work Remotely
Specific Parental Concerns

- Risk of autism from the MMR vaccine
- Believe child receives too many shots too soon
- Risks from "toxins" in the vaccines, (mercury-thimerosol, aluminum, formaldehyde)
- Dangers from the disease are minimal, vaccine not necessary (influenza, chickenpox, neonatal hepatitis B)
- Long-term effects of vaccine and possible links to chronic auto-immune disease
- Ethical and safety concerns about vaccines grown in cell lines derived from an aborted fetus

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What is the Science of Causality?

“He was vaccinated and something changed. My son is my science”

Our Brains are Hardwired to Make Associations

Some Associations Help Us and Some Don’t

Observation: People who sleep in their shoes frequently wake up with headaches

Conclusion: Going to bed with shoes on causes headaches
Expected Morbidity and Mortality in Childhood

For Every 1000 born infants

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death in 1st yr</td>
<td>6.6</td>
</tr>
<tr>
<td>Seizure disorder by age 10</td>
<td>10.2</td>
</tr>
<tr>
<td>Autism by age 5</td>
<td>15</td>
</tr>
<tr>
<td>Birth Defects 1st yr</td>
<td>30</td>
</tr>
<tr>
<td>Other Developmental Disability by age 17</td>
<td>122</td>
</tr>
</tbody>
</table>

Hierarchy of Epidemiologic Study Design

1. Generate Hypotheses
2. Establish Causality

- Case reports
- Case series
- Ecologic studies
- Cross-sectional studies
- Case-control studies
- Cohort studies
- Randomized controlled trials

Modern Anti-Vaccine Origins

- British physician and researcher, gastroenterologist
- Study published in Lancet 1998
- Study of 12 children with a history of autism or developmental disorder referred to gastroenterology clinic.
- Findings:
  - Onset of behavioral symptoms, per parents, started after MMR immunization in 8 of the children
  - Bowel abnormalities in all of the children on endoscopy
- Conclusions: speculated a connection between bowel pathology after MMR immunization that allowed "toxins" to circulate to brain causing brain damage and autism

Measles Immunization and Cases in U.K.

Source:

Wakefield Paper Published
Americans Beliefs About Autism and Vaccines

- Online Harris poll of 1756 adults for the National Consumer League in 2013
- Only 39% of parents described themselves as being extremely or very knowledgeable about how vaccines work. Yet…….
- 33% of parents of children under 18, and 29% of adults agree with the statement, ‘vaccinations can cause autism’.
Autism Signs Present Before Vaccination

- Focal patches of abnormal brain development in prefrontal and temporal brains of ASD children suggesting abnormal prenatal development¹
- Fetal US shows abnormal head and abdominal circumference around 20 wks gestation²
- Experts reviewing 1 y.o. birthday videos could correctly identify autistic vs non-autistic children 10/11 times in 2 separate groups³

2. Salter L. International Congress of the Royal College of Psychiatrists, 2014

Rising Rates of Autism Correspond with Reclassification from Other Diagnoses of Intellectual Disability

Cohort Studies Comparing Risk of Autism/ASD with Exposure to MMR, Mercury, or Thimerosal

Paternal Age as a Risk for Autism and Other Mental Health Disorders

- Total number of children studied in these 5 Cohort Studies
  \[ N = 1,256,407 \]
- Avg length of follow up – 8.6 yrs
- Conclusions – No association
Cochrane Review of Autism/MMR Link

- Respected independent collaboration that undertakes exhaustive reviews of the medical literature
- Feb 2012 released their review of 27 cohort studies, 17 case-control studies, 5 time-series trials, 1 case cross-over trial, 2 ecological studies, 6 self-controlled case series
- All told – involved 14,700,000 children assessing safety and efficacy of MMR vaccine
- Conclusions: Vaccine was not associated with autism, asthma, leukemia, hay fever, diabetes, gait disturbance, Crohn’s disease, or demyelinating disease

Brian Deer - Investigative Reporter

Deer’s Findings:
- No IRB approval
- Anti-vaccine group did recruiting
- All medical histories misreported or altered
- 8 mos prior - files patent for a new measles vaccine.
- Paid ~ $675,000 by a trial lawyer group building a case to sue vaccine makers
- No conflicts of interest disclosed to the Lancet
- Lab colleague later confessed non-supporting lab data was suppressed
- 5 patients found to have had problems BEFORE ever receiving the vaccine, 3 never had autism.
- His paper was retracted in 2011, co-authors removed their name from the paper, and an expose’ on the fraud appeared the BMJ.
- England’s General Medical Council removed his medical license for his “callous disregard” for putting children through clinically unnecessary invasive medical procedures.

Do Too Many Vaccines “Overwhelm” the Immune System?

- Antigens are what activate the immune system, not numbers of vaccines or shots.
- Need to count antigens!

More Childhood Vaccines—But Fewer Antigens

- Thanks to advances in technology, vaccines today contain fewer antigens. Even with more vaccines, the total immunologic load is much less.1,2

<table>
<thead>
<tr>
<th>Year</th>
<th>1940</th>
<th>1960</th>
<th>1980</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallpox</td>
<td>~200</td>
<td>~200</td>
<td>~200</td>
<td>~200</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>~200</td>
<td>~200</td>
<td>~200</td>
<td>~200</td>
</tr>
<tr>
<td>Tetanus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pertussis</td>
<td>~3000</td>
<td>~3000</td>
<td>~3000</td>
<td>~3000</td>
</tr>
<tr>
<td>Acellular pertussis</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>~3217</td>
<td>~3217</td>
<td>~3217</td>
<td>~3217</td>
</tr>
<tr>
<td>Mumps</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Rubella</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Hib</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Varicella</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>123-126</td>
<td>123-126</td>
<td>123-126</td>
<td>123-126</td>
</tr>
</tbody>
</table>

- Infants have tremendous capacity to generate immune responses except to antigens that are T-cell independent (like polysaccharides). Excellent responses to T-cell dependent antigens
  - Estimated cellular capacity: Could easily handle up the immune load of up to 10,000 vaccines at any one time
  - Can predict that 11 vaccines given to an infant at one time “makes use of” only ~ 0.1% of their immune capacity
  - Can easily demonstrate the robust immune response children display after given multiple vaccines (not a “weakened” or “overwhelmed” response)
Too Many Too Soon?

- B and T cells are present by 14 weeks gestation
- Within hours, prior sterile GI tract is heavily colonized with bacteria
- Start making secretory IgA against potentially harmful gut bacteria immediately
- Childhood antigen exposure – 2,000-6,000 per day
- Vaccine antigen exposure ~ 416 per lifetime

“I Prefer to Spread Out the Vaccines”

- Multiple neuropsychological tests performed on 1047 children age 7-10. Outcomes compared between those receiving varying amounts of antigens at 7, 12, and 24 mos.
- Increase in the amount of antigens (per 1000) not associated with any NP outcomes
- Antigen counts above the 10th percentile compared to lower counts → no adverse outcomes
- Only association: Children with higher antigen counts at 24 mos performed better on attention and executive function tests (OR 1.96)

“I Prefer to Spread Out the Vaccines”

<table>
<thead>
<tr>
<th>Measure</th>
<th>Untimely (N = 556)</th>
<th>Timely (N = 491)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal IQ</td>
<td>106</td>
<td>108.9</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>103.0</td>
<td>107.3</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>105.3</td>
<td>109.2</td>
</tr>
</tbody>
</table>

Smith MJ. Pediatrics 2010

When put to the test, the only evidence out there would suggest that vaccines may make your kid smarter!

Common Flaws in Anti-Vaccine Literature

- Incorrect compound cited for "toxic" effects and limit
- Inaccurate level of exposure reported
- Inaccurate claims of "toxin" presence in all vaccines
- Failure to report "toxin" purpose
- Failure to differentiate acute vs. chronic exposure
- Inaccurate mode of entry referenced
- No understanding of general chemistry and overall fear of "unnatural chemicals"
Dangerous Chemicals - Would You Put This in Your Body?

- 3-methyl-butyraldehyde
- Ethyl ethanoate
- Tocopherol
- Alpha-terpanine
- Terpinyl-acetate
- Proline
- Octene
- Hexanal
- Benzaldehyde

Components of Vaccines

<table>
<thead>
<tr>
<th>Type of Ingredient</th>
<th>Purpose</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjuvants</td>
<td>Improve the body’s immune response to antigens</td>
<td>Aluminum salts</td>
</tr>
<tr>
<td>Preservatives</td>
<td>Prevent contamination</td>
<td>Thimerosal</td>
</tr>
<tr>
<td>Stabilizers</td>
<td>Maintain vaccine potency during transportation and storage</td>
<td>Sorbitol, gelatin</td>
</tr>
<tr>
<td>Residual antibiotics</td>
<td>Prevent contamination by bacteria during manufacturing process</td>
<td>Neomycin</td>
</tr>
<tr>
<td>Residual inactivating ingredients</td>
<td>Kill virus or inactivate toxins during the manufacturing process</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Residual cell material</td>
<td>To grow enough of the virus or bacteria to make the vaccine</td>
<td>Egg protein</td>
</tr>
</tbody>
</table>

Which Vaccines Have Adjuvants?

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Adjuvant</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMR</td>
<td>None</td>
</tr>
<tr>
<td>Varicella</td>
<td>None</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>None</td>
</tr>
<tr>
<td>Polio</td>
<td>None</td>
</tr>
<tr>
<td>Seasonal Influenza</td>
<td>None</td>
</tr>
<tr>
<td>Hepatitis A and B</td>
<td>Aluminum</td>
</tr>
<tr>
<td>DTaP, Tdap</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Hib, Pneumococcus</td>
<td>Aluminum</td>
</tr>
<tr>
<td>HPV</td>
<td>Aluminum, (lipid A for Cervarix)</td>
</tr>
</tbody>
</table>

Paracelsus, “Father of Toxicology”

“The dose makes the poison!”

Thimerosal in Vaccines

- Very effective preservative that prevents bacterial and fungal contamination of vaccines
- Multiple studies have shown it to be safe with no long-term effects
- Removed from all childhood vaccines in 2001. MMR, varicella, and IPV never contained thimerosal
- Still present in multi-dose vials of influenza vaccine (not in individual dose vaccine)
Formaldehyde in Vaccines
- Used to kill the viruses that are used in producing inactivated viral virus vaccines
- Naturally occurs in many foods and is made by the human body
- Can be toxic when inhaled in large quantities over prolonged periods of time
- The EPA oral reference dose considered safe for long-term exposure is ingesting less than 200 mcg / kg body-weight per day (70 kg man could ingest 14,000 mcg daily for prolonged periods)

Formaldehyde in Vaccines
- Circulating normally in the bloodstream: 1100 mcg/mL

Vaccine Safety

**Why the Provider Can be Very Confident**

FDA Process for Vaccine Licensure
- Rigorous process to assure safety and efficacy before vaccine is licensed
- Multiple stages
  - File IND – outlines method of manufacture, quality control tests, animal safety and efficacy data, and proposed human clinical trials
  - Pre-licensure trials
    - Phase I – safety and immunogenicity in small number of subjects
    - Phase II – dose ranging studies in hundreds of subjects
    - Phase III – efficacy and safety data collected on thousands of subjects
- Process can take up to 10 yrs before vaccine is licensed
### Additional Measures Beyond Usual FDA Process

- Government passed the **National Childhood Vaccine Injury Act** in 1986
  - Requires health providers to provide a Vaccine Information Statement (VIS)
  - Providers are required to report certain adverse events to the Vaccine Adverse Events Reporting System (VAERS)
  - Formed the National Vaccine Injury Compensation Program (NVICP)
    - Tasked the Institute of Medicine to review all science on vaccine safety
- Established the Vaccine Safety Datalink (VSD) collaboration in 1990
- Clinical Immunization Safety Assessment (CISA) Network

### Institute of Medicine - Immunization Review Committee

- Immunization Safety Review Committee
- Tasked with addressing current and emerging vaccine-safety concerns and reviewing all the literature and evidence - exhaustive
- Go to great lengths to provide independent, non-biased advice to the public, practitioners, and vaccine-policy makers
  - Painstaking effort to avoid any COIs
- Usually includes chance for public commentary and input

### Institute of Medicine Reports

- Immunization Safety Review: MMR Vaccine and Autism - 2001
- Immunization Safety Review: Thimerosal-containing Vaccines and N-D disorders - 2001
- Immunization Safety Review: Multiple-immunization and immune dysfunction - 2002
- Immunization Safety Review: Hepatitis B Vaccine and demyelinating disorders - 2002
- Immunization Safety Review: SV-40 Contamination of Polio Vaccine and Cancer - 2002
- Immunization Safety Review: Vaccinations and SIDS - 2003
- Immunization Safety Review: Influenza vaccine and neurological complications - 2004
- Immunization Safety Review: Vaccines and Autism - 2004

### Adverse Events Associated with Vaccination

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Event</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arz</td>
<td>Anaphylaxis</td>
<td>1:1,000,000</td>
</tr>
<tr>
<td>MMR</td>
<td>ITP</td>
<td>1:40,000</td>
</tr>
<tr>
<td>MMRV</td>
<td>Febrile Seizures</td>
<td>1:2,500,000</td>
</tr>
<tr>
<td></td>
<td>12-47 mos old</td>
<td>1:1,250</td>
</tr>
<tr>
<td>RRV-TV</td>
<td>Intussusception</td>
<td>1:11,000</td>
</tr>
<tr>
<td>RV1 and RV5</td>
<td>Intussusception</td>
<td>1:20-100,000</td>
</tr>
</tbody>
</table>
No drug, device, process, or procedure in healthcare is as heavily scrutinized and monitored for safety and efficacy as are vaccines!

Vaccinate With Confidence!

Resources

- AAP: [http://www2.aap.org/immunization/families/safety.html](http://www2.aap.org/immunization/families/safety.html)
- Shot of Prevention: [http://shotofprevention.com/](http://shotofprevention.com/)
- Children’s Hospital of Philadelphia Vaccine Education Center – [http://vec.chop.edu/service/vaccine-education-center/home.html](http://vec.chop.edu/service/vaccine-education-center/home.html)
- Pertussis videos: [http://www.youtube.com/watch?v=Rmlo2to0ogs](http://www.youtube.com/watch?v=Rmlo2to0ogs), [https://www.youtube.com/watch?v=S3oZrMGDMMw](https://www.youtube.com/watch?v=S3oZrMGDMMw)