INFECTIOUS DISEASES IN CHILDREN

Acknowledgement:
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University of California, San Francisco
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I HAVE NOTHING TO DISCLOSE.
**Updates and Current Recommendations**

<table>
<thead>
<tr>
<th>FEVER</th>
<th>COUGH</th>
<th>SCREENING/PREVENTION</th>
<th>RASHES</th>
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<tbody>
<tr>
<td>Fever without a source (SBI)</td>
<td>Pertussis</td>
<td>TB</td>
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<td>Urinary Tract Infections</td>
<td>Community Acquired PNA</td>
<td>Vaccinations</td>
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<td>Acute Otitis Media</td>
<td>Bronchiolitis</td>
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<td>Influenza</td>
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- TB
- Vaccinations
Case Presentation: Infant with Fever

- Serrano is 2 week old girl with a fever
- No symptoms to suggest a source on exam/history
- VS: T 38.5, P 150, R 40’s, o/w WNL
- Exam: well-appearing, no focal findings to suggest source for fever
The most likely cause of Serrano’s fever is:

A. Viral infection
B. Urinary tract infection
C. Serious bacterial infection (bacteremia/meningitis)
D. HSV infection
THE FEBRILE INFANT
Everything you need to know about SBI in febrile infants - on ONE SLIDE

E.Coli > GBS > S. aureus > enterococcus, S pneumo

E.Coli/GBS ➔ S. pneumo

Greenhow, 2014

Fever without a source (FWS): Infants <30 days

- Appearance and lab criteria do not reliably rule out UTI/SBI in this age group
- Urine, blood, CSF, empiric abx recommended
  - Amp/cefotaxime or amp/gentamicin
UTI still the most common bacterial source, other SBI less likely

Viral source more reliable
- Named viral syndromes or + rapid viral test (flu, RSV) → SBI unlikely
- Consider testing for UTI

Inflammatory markers (CBC/CRP/PCT) helpful in select infants
- Well appearing infants with neg UA AND no viral source
Approach to FWS in Infants:

- **Infant well-appearing?**
  - yes
  - no → **Infant > 30 days?**
  - no → Stabilize, obtain cultures, start antibiotics

- **Infant > 30 days?**
  - yes
  - no

Markers WNL
- WBC > 15 or < 5
- CRP > 20mg/L
- PCT > 0.5ng/mL
Since Serrano is less than 30 days, and has no source for her fever, you obtain a UA/urine cx and blood cultures and perform an LP.

Her UA is positive for LE and nitrites.

Now what do you do?
URINARY TRACT INFECTIONS
Who is at risk for UTI/pyelonephritis?

- All infants with FWS < 3 mo of age
- Girls > 3 mo of age
  - FWS (>39) and < 24 months
- Boys > 3 mo of age
  - Circumcised: FWS (>39) and < 6 mo
  - Uncircumcised: FWS (>39) and < 12 mo
- Additional Risk Factors:
  - Race (non-black)
  - Length of fever (> 2 days)
2011 AAP Guidelines: Diagnosis

Roberts 2011; Pediatrics 128(3):595–610

- Collect urine for UA and cx by catheter for:
  - Infants < 3 mo of age (high risk)
  - Ill-appearing infants or those requiring empiric antibiotics for another reason

- Consider bag collection for:
  - Low-risk infant (eg: circ boy > 3 mo)
  - If UA +, consider cath for culture
Empiric treatment: Based on local E. Coli resistance
- PO and IV routes are equally efficacious
  - IV if <2 mo, toxic or not tolerating PO
- Total course: 7-14 days

Imaging after UTI (highest yield in youngest infants)
- U/S recommended (although prob not necessary)
  - ~15% abnormal, 1-2% actionable, 2-3% false positives
- Voiding Cystourethrogram (VCUG) if:
  - High grade VUR/obstruction on U/S (yes)
  - > 1 episode of febrile UTI (?)
Serrano’s 2 yo brother Aleppo has also had a runny nose and cough for 3-4 days, and Tmax of 38.5

Last night he started pointing at his ear saying “owie”, and mom is concerned that he has an ear infection

What would you do next?
ACUTE OTITIS MEDIA
Diagnosis requires

- Moderate to severe bulging OR new otorrhea
- Mild bulging AND
  - Recent onset ear pain OR
  - Intense erythema of the Tympanic Membrane
AAP Guidelines: Treatment

- Treatment guided by age and severity

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<thead>
<tr>
<th>Age</th>
<th>Non-severe</th>
<th>Severe*</th>
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<tbody>
<tr>
<td>6-23 months</td>
<td>Unilateral: observe or treat</td>
<td>Treat</td>
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<td></td>
<td>Bilateral: treat</td>
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<tr>
<td>2-12 yrs</td>
<td>Observe or treat</td>
<td>Treat</td>
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- Severe symptoms include:
  - Temperature >39
  - Moderate-severe otalgia
  - Otalgia > 48 hours
AAP Guidelines: Antibiotics
Lieberthal; Pediatrics 2013

- **First Line: Amoxicillin** (80-90 mg/kg/day)
  - Amoxicillin-Clavulanate (90m/k/d amox + 6.4 m/k/d clav)
    - If Amoxicillin in previous 30 days, + conjunctivitis
  - Cephalosporins: Cefdinir, cefuroxime, cefpodoxime
    - May have slightly lower efficacy against S. pneumoniae

- **Treatment failure = persistent sx for >48-72h**
  - Amoxicillin-Clavulanate or IM Ceftriaxone
  - Consider drainage, culture, specialist

- **Tubes: > 3 infections/6mo OR 4 in last year**
You decide to treat Aleppo’s OM supportively, but since he is febrile with cough, you are also concerned about flu.

He is well-appearing, with normal vital signs, and no resp distress.

He used an inhaler at 6 mo with a viral infection, no other PMH, has not yet received flu shot.

Should you test him for influenza?
INFLUENZA
Influenza-Associated Pediatric Deaths

Number of Influenza-Associated Pediatric Deaths by Week of Death: 2012-2013 season to present

2012-2013
Number of Deaths Reported = 171

2013-2014
Number of Deaths Reported = 111

2014-2015
Number of Deaths Reported = 148

2015-2016
Number of Deaths Reported = 13

Week of Death

Deaths Reported Previous Week

Deaths Reported Current Week

CDC, 2016
Current season...

Percentage of Visits for Influenza-like Illness (ILI) Reported by the U.S. Outpatient Influenza-like Illness Surveillance Network (ILINet), Weekly National Summary, 2015-2016 and Selected Previous Seasons

CDC, 2016
Who to Test/Treat \( (RVT = 60\% \text{ sens} / 98\% \text{ spec}) \)

- **Treat WITHOUT testing:** clinical suspicion AND
  - Moderate/severe illness
  - High risk for severe disease (<2yrs, chronic disease, immunosuppressed, chronic ASA therapy)

- **Test and treat only if +**
  - When you will do something with the result
  - Otherwise healthy AND <48 hrs of illness

- **Regimens**
  - Oseltamivir (Tamiflu) weight based dosing BID x 5 d
  - Zanamivir (Relenza) disk inhaler for children > 7 yo

- Our patient=unlikely to benefit
Influenza: Prevention

- **Who to immunize:** everyone > 6 mo
  - If < 8, give 2 doses for the FIRST season only
- **IM (Inactivated – IIV) vs nasal (Live – LAIV)**
  - Recent studies show equal efficacy
  - IIV ONLY if < 2, immunosuppressed
- **Contraindications:** LIFE-THREATENING egg allergy or previous reaction to vaccine

ACIP recs for 2015/16 season:
http://www.cdc.gov/flu/professionals/acip/index.htm
Case Presentation: 3 yo with cough

- Sorrel is a 3 yo who presents with 2 weeks of cough, keeps her awake, and occasional post-tussive vomiting
- She has a PMH of bronchiolitis (6 mo) and is up to date for age on vaccinations
- VS: T 38.2, P 130, RR 42, O2 sat 95%
- Her mother wants to know if this could be “the whooping cough”
Pertussis Epidemiology

Reported pertussis incidence by age group: 1990-2014

Incidence rate (per 100,000)

Year

SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System
# Phases of Pertussis

<table>
<thead>
<tr>
<th>PHASE</th>
<th>TIME COURSE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Catarrhal</td>
<td>1-2 weeks</td>
<td>Mild fever, cough, rhinorrhea</td>
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<tr>
<td>Paroxysmal</td>
<td>1-6 weeks</td>
<td>Older infants/children: Paroxysms, whoop, post-tussive emesis; Young infants: apnea, cyanosis, bradycardia, poor feeding</td>
</tr>
<tr>
<td>Convalescent</td>
<td>Weeks-Months</td>
<td>Improvement in severity and frequency of coughing episodes</td>
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Slide courtesy of Ellen Laves, MD
Pertussis: Clinical Diagnosis

- Cough lasting >2 weeks + 1 of the following:
  - Apnea*  [Neonates/young Infants]
  - Paroxysms of coughing
  - Inspiratory “whoop”  [Older children]
  - Post-tussive vomiting (least specific)

*May occur without cough
Pertussis: Laboratory Confirmation

- Lab confirmation ONLY in those with signs/symptoms consistent with pertussis
- Posterior NP specimen (not pharynx/ant NP)
- PCR for pertussis
  - False positives may occur
- Culture + for B. Pertussis
  - Most SPECIFIC test
- Most sensitive in first 3 weeks

cdc.gov/pertussis
**Pertussis: Treatment**

- **Major benefits:**
  - Prevent severe disease* in those at risk
  - Prevent spread to high risk (HR) patient

- **Empiric treatment:** high suspicion and/or HR
  - Infants <1 year (< 3mo, preemie at highest risk)
  - Pregnant women near term
  - Unimmunized or underimmunized

- **Test and treat if +:**
  - HR but low clinical suspicion
  - Patient LR but has HR contacts

*Only treatment BEFORE paroxysms may shorten course*
Sorrel’s vaccination status and non-specific clinical symptoms make pertussis less likely.

However, her RR (42) and O2 sat (95%) make you concerned for pneumonia.

- Well-appearing, in minimal resp distress aside from tachypnea
- Decreased breath sounds with crackles over the LLL
What is the RECOMMENDED next step?

A. Obtain a PA and lateral CXR
B. Obtain a blood culture and CBC
C. Obtain a sputum culture
D. Start PO amoxicillin and discharge with close follow up
E. Start IV cefuroxime and admit
COMMUNITY ACQUIRED PNEUMONIA
Community Acquired Pneumonia: Diagnosis


- Clinical
  - Symptoms of acute illness (ie: fever) + resp distress (tachypnea*, retractions, hypoxia) AND
  - Focal lung findings on exam OR on CXR

- Imaging
  - Chest x-ray NOT recommended routinely in outpatients
  - Does not distinguish between pathogens (viral, atypical, etc)

*MOST SENSITIVE sign
Community Acquired Pneumonia: Laboratory Diagnosis

- Routine lab testing NOT recommended
- Blood cultures:
  - Clinically worsening or hosp with mod/severe disease
- Viral testing (flu, RSV)
  - IF no evidence of bacterial co-infection
- CBC/CRP
  - Not recommended
- Testing for *Mycoplasma pneumoniae, S. pneumo*
  - If available, may guide antibiotic selection
Community Acquired Pneumonia: Treatment

- Based on age, severity, local resistance

**2 MO TO 5 YRS:**

- Viral is most common
- < 2 yrs: *S. pneumoniae*, *C. Trachomatis*
- 2-5 yrs *S. pneumoniae*, *M. pneumoniae*, *H influenzae*, *C. pneumoniae*

**OVER 5 YEARS:**

- *M. pneumoniae*, *C. pneumoniae*
- *S. pneumoniae*

Community Acquired Pneumonia: Treatment

- Inpatient or Outpatient 1\textsuperscript{st} line treatment:
  - Amoxicillin/ampicillin in infants and young children
  - Macrolide (azithro) in kids > 5

- Ill patent or high-level PCN resistance:
  - 3\textsuperscript{rd} generation cephalosporin if suspect S. pneumo
  - Vancomycin if suspicion for MRSA
  - +Macrolides if suspicion high for M. pneumoniae and C. pneumoniae

What is the RECOMMENDED next step?

A. Obtain a PA and lateral CXR
B. Obtain a blood culture and CBC
C. Obtain a sputum culture
D. **Start PO amoxicillin and discharge with close follow up**
E. Start IV cefuroxime and admit
Case Continued

- As you are explaining Sorrel’s discharge plan to her mother, she asks you to check on baby brother Sumac who also has a “cold”
- The 9 month old is alert and well-appearing
  - RR of 55, T of 38.5, O2 sat of 91%
  - Moderate retractions, coarse wheezes and rhonchi throughout on exam
You are concerned about bronchiolitis: what is the next step in diagnosis?

A. RSV test
B. Chest Xray
C. Response to albuterol
D. Response to hypertonic saline
E. Nothing, you have already made the diagnosis
BRONCHIOLITIS
Bronchiolitis

- Virally-mediated inflammation, edema, and epithelial necrosis in small airways
  - 50-75% caused by RSV
    - rhinovirus > influenza > Human metapneumovirus > coronavirus
  - Etiology correlates poorly with severity
- Most common reason for admission in children
Clinical Diagnosis

- Upper respiratory prodrome followed by increased WOB, wheezing, hypoxia, classic lung exam
- Radiographs and lab studies are not routinely recommended
You are concerned about bronchiolitis: what is the next step in diagnosis?

A. RSV test
B. Chest Xray
C. Response to albuterol
D. Response to hypertonic saline
E. Nothing, you have already made the diagnosis

What should you do for Sorrel?
Bronchiolitis: 2014 AAP Guidelines
Ralston, SL et al Pediatrics. 2014

- **Treatment:**
  - Albuterol trial: *only if dx uncertain*
  - Corticosteroids, racemic epi: *not routinely recommended*
  - Hypertonic saline: studies mixed, some evidence for shortened inpatient stay *when given with bronchodilators*

- **Monitoring**
  - Continuous pulse ox not required
  - Supplemental O2 only for persistent < 90%
Febrile infants > 30 days
- Do not need additional workup
- Consider UA/cx

Prophylaxis: palivizumab (Synagis)
- Preterm infants: gestational age <29 wks
- CHD/CLD: < 12 months old (<24mo if getting medical therapy)
- 5 monthly doses/season
Case Continued

- As you are wrapping up the visit, mom asks if big brother Chervil needs his “TB shot” for first grade

- You ask a few clarifying questions:
  - Last PPD when starting kindergarten was negative
  - No travel, no active TB contacts, no chronic medical conditions
TB SCREENING
Tuberculosis Screening

- Universal Screening NOT recommended
- Those at high risk of disease OR progression
  - Symptoms of disease, TB+ close contact
  - HIV disease, immunosuppressed
  - Travel to/immigration from/living with immigrant from an endemic country, stay in jail/homeless shelter
TB screening in Kids

- PPD recommended for first line screening
  - BCG NOT a contraindication
  - Can use Interferon-gamma release assay (e.g. Quantiferon) for confirmation if PPD+ with h/o BCG

- Threshold for positive PPD
  - **5 mm if high risk** (HIV +, abn CXR, contact w/ case)
  - **10 mm if mod risk** (<4, endemic area, medical conditions (diabetes, renal failure), IV drugs, contact with high-risk adult)
  - **15 mm all others**
Latent TB Treatment

Regimen options:

- INH 10-15mg/kg/day x 9 months
- Consider INH + rifapentine/rifampin x 3 months if unlikely to complete primary regimen

Screening labs (i.e. LFTs) are not needed in normal healthy children taking INH unless symptomatic
VACCINES

“An ounce of prevention is worth a pound of cure.” - Benjamin Franklin
# Standard Schedule

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth</th>
<th>1 mo</th>
<th>2 mos</th>
<th>4 mos</th>
<th>6 mos</th>
<th>9 mos</th>
<th>12 mos</th>
<th>15 mos</th>
<th>18 mos</th>
<th>19-23 mos</th>
<th>2-3 yrs</th>
<th>4-6 yrs</th>
<th>7-10 yrs</th>
<th>11-12 yrs</th>
<th>13-15 yrs</th>
<th>16-18 yrs</th>
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<tbody>
<tr>
<td>Hepatitis B' (HepB)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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<tr>
<td>Rotavirus' (RV) RV1 (2-dose series); RV5 (3-dose series)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>See footnote 2</td>
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<td>Diphtheria, tetanus, &amp; acellular pertussis' (DTaP; &lt;7 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Haemophilus influenzae type b' (Hib)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>See footnote 4</td>
<td>3rd or 4th dose, See footnote 4</td>
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<td>Pneumococcal conjugate' (PCV13)</td>
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<td>Inactivated poliovirus' (IPV; &lt;18 yrs)</td>
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<td>Influenza' (IIV; LAIV)</td>
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<td>Annual vaccination (IIV only) 1 or 2 doses</td>
<td>Annual vaccination (LAIV or IIV) 1 or 2 doses</td>
<td>Annual vaccination (LAIV or IIV) 1 dose only</td>
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<tr>
<td>Measles, mumps, rubella' (MMR)</td>
<td>See footnote 8</td>
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<td>2nd dose</td>
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<td>Varicella' (VAR)</td>
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<td>Hepatitis A' (HepA)</td>
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<td>Meningococcal' (Hib-MenCY ≥ 6 weeks; MenACWY-D ≥9 mos; MenACWY-CRM ≥ 2 mos)</td>
<td>See footnote 11</td>
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<td>Tetanus, diphtheria, &amp; acellular pertussis' (Tdap; ≥7 yrs)</td>
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<td>Human papillomavirus' (2v+HPV; females only; 4v+HPV, 9v+HPV; males and females)</td>
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<td>Meningococcal B'</td>
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<td>Pneumococcal polysaccharide' (PPSV23)</td>
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- **Range of recommended ages for all children**
- **Range of recommended ages for catch-up immunization**
- **Range of recommended ages for certain high-risk groups**
- **Range of recommended ages for non-high-risk groups that may receive vaccine, subject to individual clinical decision making**
- **No recommendation**
### Primary Series

- **Min age 6 weeks**
- **Min 4 wks between doses**
Primary Series: Rotavirus

- Start at < 15 weeks
- Last dose before 8 mo
**Primary Series: Hepatitis B**

- **1<sup>st</sup> and 3<sup>rd</sup> dose must be 6 months apart**

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- **Range of recommended ages for all children**
- **Range of recommended ages for catch-up immunization**
- **Range of recommended ages for certain high-risk groups**
- **Range of recommended ages for non-high-risk groups that may receive vaccine, subject to individual clinical decision making**
- **No recommendation**
### Primary Series: Boosters

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth</th>
<th>1 mo</th>
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<th>4 mos</th>
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- **DTaP/PCV/HiB:** 4th dose > 12mo
- **IPV/DTap:** final dose > 4yo
**Live Attenuated Vaccines**

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<th>Vaccine</th>
<th>Birth</th>
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- **After 1st birthday**
- **GIVE TOGETHER OR SPACE 4WKS from each other or PPD**
- **Booster 6 mo (Hep A)/3 yrs later**
### Influenza

#### Immunization Schedule

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth</th>
<th>1 mo</th>
<th>2 mos</th>
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<td>Pneumococcal conjugate (PCV13)</td>
<td>1st</td>
<td>2nd</td>
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<tr>
<td>Inactivated poliovirus IPV; &lt;18 yrs</td>
<td>1st</td>
<td>2nd</td>
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<td>Influenza (IV; LAIV)</td>
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<td>Measles, mumps, rubella (MMR)</td>
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**Min age 6 months**

**2 doses 4 weeks apart in first season (<8 yrs)**

**Inactivated IM form (IIV):**
- 0.25ml (6 mo-3yo)
- 0.5ml (> 3 yo)

**Nasal Live attenuated (LAIv): >2yo**
# Teen Vaccines

- **MCV4 at 11 and 16yo**
- **TdaP at 11yo: required for 7th grade in CA**
- **HPV (2,4,9 valent): 3 doses**
  - Min age 9; 6 mo between 1st and 3rd
Vaccine Contraindications

- **Serious** reaction to previous dose
  - Anaphylaxis, encephalopathy w/in 7 days (DTaP)

- **Life-threatening** allergy (anaphylaxis) to component
  - Neomycin (IPV, MMR, VZV)
  - Gelatin (MMR, VZV)
  - Egg (Influenza - both IIV and LAIV)
  - Yeast (Hep B, HPV)

- **Specific to Live Vaccines (RV5, MMR, VZV, LAIV)**
  - Severe immunodeficiency: SCID, AIDS
  - Pregnancy
  - LAIV only: chronic illness (active asthma, CKD, heart disease)
Vaccination Precautions

- Weigh risk, benefits, alternatives with family
  - History of Guillain-Barre within 6 weeks of previous vaccine (flu)
  - Progressive Arthus-type reaction after previous dose of tetanus or diptheria containing vaccine
  - Unstable neurological condition (pertussis)
  - Recent receipt of blood product (MMR, VZV)
  - History of thrombocytopenia (MMR)
  - DTaP: fever >105 or hypotonic hyporesponsive episode or crying >3 hrs within 48 hours of previous dose
VISUAL DIAGNOSIS
Toddler with fever, refusing po’s
drooling...

Hand- foot-mouth disease
(coxsackie virus)
Examples of “atypical coxsackie”
5 yo comes back from camp with fever, cough and runny nose, then develops rash proceeding head to toe
Measles

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<tr>
<th>PHASE</th>
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<th>DESCRIPTION</th>
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<td>3 - 5 days</td>
<td>Erythematous macules proceed cranial &gt; caudal. May become confluent.</td>
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Measles in the US

http://www.cdc.gov/measles/cases-outbreaks.html
Measles Fast Facts

- Droplet/airborne spread, ~90%
- 2 doses of vaccine = 97% effective
- Dx by serology (IgM or rise in IgG) or PCR
- High risk for severe illness = <5yo or >20yo, pregnant, immunocompromised
- Severe/fatal complications:
  - Encephalitis: 1/1000
  - Resp/neurologic complication: 1-2/1000
  - Subacute sclerosing panencephalitis (SSPE): rare, 7-10 years after infection
- No specific treatment (vit A for severe illness)
High fever for 3 days, defervesced then developed rash on chest ➔ head

Roseola infantum
Typically caused by Human Herpes Virus (HHV) 6 or 7
6 yo recently visiting grandparents in Boston, itchy rash:

Erythema migrans: early localized stage of Lyme Disease
7 yo with fever, sore throat now with dry, diffuse rash most pronounced on trunk and face.

Group A Streptococcal “Scarlet Fever”
Spices of the World...

- Serrano
- Aleppo
- Sorrel
- Chervil
- Sumac
References


Community acquired pneumonia guideline team, Cincinnati Children’s Hospital Medical Center. Evidence-based care guidelines for medical management of community acquired pneumonia in children 60 days to 17 years of age. Guideline 14.


Lieberthal, A et al “The Diagnosis and Management of Acute Otitis Media.” Pediatrics 2012-3488


Miller, EK et al. “Viral Etiologies of Infant Bronchiolitis, Croup and Upper Respiratory Illness during 4 Consecutive Years.” Pediatric Infectious Disease 2013; 32 (9) 950-955.

