Common childhood infections including vaccine-preventable diseases

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Infections in childhood

• Understanding & managing infections/infectious diseases in an individual child but also in the family and wider community
  – Neonates to adolescents
  – May be a ‘normal’ part of childhood
  – Infections have enormous impact on overall morbidity / mortality
  – Infectious diseases involve transmission from/to adults & other children

• Provides insight into functioning of health care system
  – Impacts all levels of care (primary / secondary / tertiary)
  – Intersects with public health / epidemiology / laboratory
  – Prevention (vaccination / prophylaxis / infection control interventions)
  – Antimicrobial therapy is one of most commonly prescribed treatments in medicine (antimicrobial stewardship)
• 5.9 million children <5yrs of age died in 2015 (16 000 each day)
• Approximately 50% of deaths <5yrs of age are due to infectious diseases
How to approach this topic?

- Infections by organ system e.g. CNS: meningitis, Renal: UTI etc
- Infectious (communicable) versus non-infectious infections
- Vaccine-preventable diseases
- Common versus less common/rare
- Serious/invasive versus less serious infections
- Bacterial, viral, fungal, protozoal...
Reading-1

  – Chapter 16 (page 128-139): Immunisation
  – Chapter 43 (page 369-382): Vaccine-preventable diseases
  – Chapters 40 (HIV infection), 41 (Acute respiratory infections), 42 (Diarrhoeal disease), 46 (Malaria), 47 (Tuberculosis), 50 (Parasitic infections of the gut)

• **Coovadia’s Paediatrics and Child Health - a manual for health professionals in developing countries, 7th edition (2014)**
  – Chapters 14-19, 22

• **Handbook of Paediatrics, 7th edition (2010)**
  – Chapter 9: Immunization and infections
  – Chapter 10: HIV infection
  – Other sections relevant to ID (newborn, CNS, immunodeficiency)

• The two websites listed below include up-to-date disease fact sheets and vaccine information for vaccine-preventable diseases and other infectious diseases of childhood. Suggested minimum topics to cover include: all diseases on SA national immunisation programme as well as rubella, chickenpox, influenza, rabies, typhoid, cholera, schistosomiasis, malaria & selected parasites.
Reading-2

• Articles
  – Common Childhood Infectious Diseases_MIMS Handbook 2014
  – Secondary & tertiary prevention of selected communicable diseases_MIMS Handbook 2014
  – Immunisation: new vaccines, schedules, catch-up, contraindications_MIMS Handbook 2014
Outline of seminar

• Focus on “common” infectious diseases occurring during childhood
  – Viral exanthems
  – Non-viral exanthems
  – Other infections targeted by vaccination programme

• Immunisation
  – Vaccines included in SA vaccination schedule
  – Other vaccines
  – Children with specific vaccination needs
  – Adverse events, contra-indications, barriers

• Clinical approach to infections/infectious diseases
Selected common infections in childhood

- **Viral exanthems**
  - Measles
  - Rubella
  - Roseola infantum (Human Herpes Virus 6)
  - Erythema infectiosum (Parvovirus B19)
  - Enteroviral infections
  - Hand-foot-mouth disease (Coxsackie)
  - Infectious mononucleosis (Epstein Barr Virus)
  - Cytomegalovirus
  - Herpes simplex infections
  - Varicella zoster (chickenpox / shingles)

- **Non-viral exanthems**
  - Scarlet fever (Grp A Strep)
  - Meningococcal disease
  - Tick bite fever
  - Staphylococcal infections
  - Kawasaki syndrome (uncertain aetiology)

- **Other infections targeted by immunisation programme**
  - Polio
  - Diphtheria
  - Pertussis
  - Tetanus
  - *Haemophilus influenzae* type b
  - *Streptococcus pneumoniae*
  - Hepatitis B
Measles

- Measles virus
- Highly infectious pathogen, airborne transmission
- Generally occurs in outbreaks / epidemics when vaccination coverage drops (<90%) resulting in a susceptible population
- Constant surveillance & mass measles catch-up immunisation campaigns required
- Young infants (<9mths of age) at particularly high risk

- Incubation period: 7-14 days
- Prodrome: fever, cough, coryza may last from 3-7 days. Koplik spots may be present from 2 days before until days after onset of rash
- Clinical features: fever, generalised erythematous maculopapular rash starts on face/neck, progresses down body, conjunctivitis
Measles natural history
“clinical timetable”
Measles

- Diagnosis: clinical case definition, serology (measles IgM), PCR testing on blood or urine

- Treatment: Symptomatic, Vitamin A, manage complications

- Complications: pneumonia, otitis media, laryngotraacheobronchitis, gastroenteritis, eye involvement, encephalitis, malnutrition

- Period of communicability: from 4 days before rash appears until 4 days after onset of rash (if immunocompromised may be longer)

- Prevention: vaccination, isolation (airborne precautions) if available
Koplik’s spots
Rubella (German measles)

• Rubella virus
• Clinically milder disease than measles
  – Rash less prominent, no conjunctivitis

• Complications: arthritis, encephalitis, thrombocytopenia

• Congenital rubella syndrome: congenital cataracts or glaucoma, congenital heart disease, hearing impairment, purpura, hepatosplenomegaly, jaundice, microcephaly, developmental delay, meningo-encephalitis, radiolucent bone disease
Erythema infectiosum
Parvovirus B19 ("slapped cheek syndrome")

• Incubation period 4-21 days
• Prodrome: fever, malaise, myalgia for 7-10 days
• Clinical: “slapped-cheek” appearance to face, fine rash on trunk & limbs
• Diagnosis: clinical, serology, PCR

• Complications: hydrops fetalis (intrauterine infection), aplastic crisis (haemoglobinopathies, HIV), polyarthritis

• Treatment: symptomatic, blood transfusions, intravenous immunoglobulin
Infectious mononucleosis
Ebstein Barr virus / “glandular fever”

- Incubation period: 30-50 days
- Prodrome: fever, sore throat
- Clinical: asymptomatic, fatigue, fever, pharyngitis, lymphadenopathy, generalised rash (exacerbation with ampicillin or amoxicillin), splenomegaly. Symptoms may last wks-mths.

- Diagnosis: serology, PCR
- Treatment: symptomatic & supportive

- Complications: hepatitis, haemolytic anaemia, thrombocytopenia, meningo-encephalitis, transplant patients (post-transplant lymphoproliferative disorder, EBV-associated malignancies)
Cytomegalovirus

• Cytomegalovirus (Human Herpes Virus 5)
• Clinical:
  – asymptomatic or EBV-like illness,
  – intrauterine infection may result in severe multisystem involvement, neurodevelopmental problems, sensorineural hearing loss
  – immunocompromised patients (opportunistic infection): pneumonitis, retinitis, colitis, disseminated infection

• Diagnosis: PCR
• Treatment: antiviral therapy not usually required in immunocompetent patients, ganciclovir in immunocompromised / severe disease
Herpes simplex infection

• Herpes simplex virus (1 & 2)
• Prodrome: fever, irritability
• Clinical:
  – Primary infection: gingivostomatitis (painful oral ulcers), genital ulcers in sexually active, eczema herpeticum (vesicular lesions in eczematous skin)
  – Reactivation disease: herpes labialis (“fever blisters”)
  – Disseminated disease including encephalitis, hepatitis (mostly infants)

• Diagnosis: clinical, PCR
• Treatment: symptomatic, acyclovir,
• Complications: recurrent disease, disseminated disease
Varicella zoster infection

• Varicella zoster virus
• Incubation period: 14-21 days
• Prodrome 0-2 days

• Clinical:
  – Primary infection (chickenpox): fever, vesicular rash (lesions at different stages of evolution) on trunk then limbs
  – Reactivation disease (herpes zoster/shingles): vesicular rash in sensory nerve distribution (dermatome), pain/pruritis
Varicella zoster infection

- Diagnosis: clinical, PCR
- Treatment: acyclovir for severe/immunocompromised cases, analgesia

- Complications: Primary infection: secondary bacterial skin infection, pneumonia, encephalitis; Reactivation disease: recurrences, disseminated infection (immunocompromised), post-herpetic neuralgia

- Period of communicability: Chickenpox: 1-2 days before onset of rash until all lesions are crusted (usually 5-7 days after onset of rash)
- Prevention: vaccination (not currently in SA EPI schedule), isolation with airborne transmission precautions in hospital
Herpes viruses

- Human herpes viruses 1-8
  - Herpes simplex virus 1 (HSV-1)
  - Herpes simplex virus 2 (HSV-2)
  - Varicella zoster virus (VZV)
  - Cytomegalovirus (CMV)
  - Epstein-Barr virus (EBV)
  - Human herpes virus 6 (HHV-6)
  - Human herpes virus 7
  - Human herpes virus 8 (KS)
Non-viral exanthems
Scarlet fever
Group A streptococcal infection

- Incubation period: hours-days
- Prodrome: fever, sore throat
- Clinical: intense, erythematous rash on face & trunk, circumoral pallor, strawberry tongue

- Diagnosis: clinical, evidence of streptococcal infection (ASOT/anti-DNAse B), throat swab culture
- Treatment: penicillin

- Complications: acute rheumatic fever, myocarditis, acute glomerulonephritis, arthritis
- Prevention: appropriate antibiotic treatment of pharyngitis
Meningococcal disease

- *Neisseria meningitidis*
- Clinical: fever, petechial or purpuric rash (may be preceded by maculopapular rash), septic shock
- Diagnosis: clinical, blood culture
- Treatment: intravenous antibiotics (cephalosporin) and fluids, may need inotropic support
- Infection control: isolation/droplet transmission precautions for 1st 48 hrs of antibiotic treatment, telephonic notification & post-exposure prophylaxis to close contacts
- Prevention: vaccination (not currently on SA EPI schedule)
Tick bite fever

- Mainly due to African tick bite fever (*Rickettsia africae*)
- Zoonosis (infection passed between animals & humans)
- Vertebrate hosts: wild animals, cattle, dogs, rodents
- Main tick vector: *Amblyomma* spp.
- At risk individuals: farm workers, ecotourists

- Incubation period: 5-7 days
- Prodrome: fever, headache, myalgia, malaise
- Clinical: rash (50%), maculopapular, or vesicular, inoculation eschar, lymphadenopathy
- Complications: not common, haemorrhagic illness with multi-organ involvement

- Treatment: antibiotics (doxycycline, fluoroquinolones in children <8 yrs)
- Prevention: protective clothing, tick repellents
Inoculation eschar of Tick Bite Fever
Staphylococcal infection

- *Staphylococcus aureus*
- Clinical: wide spectrum of conditions – skin infections (impetigo, abscesses, scalded skin syndrome), invasive infections (toxic shock syndrome, bacteraemia, pneumonia, osteitis, endocarditis)

- Diagnosis: clinical, culture
- Treatment: antibiotics directed at S aureus, supportive treatment

- Complications: invasive disease, multi-organ failure, antibiotic resistance
Impetigo
Kawasaki syndrome

- Acute, febrile, self-limiting, exanthematous, multi-system disease
- Unknown aetiology
- 80% of cases under 5 years of age
- 20% of untreated cases develop coronary artery aneurysms

- Clinical diagnosis, no confirmatory diagnostic test
- Fever persisting for at least 5 days + at least 4 of following 5 features:
  - Changes in peripheries (erythema and/or oedema of palms and soles; later desquamation) or perineum
  - Polymorphous exanthem
  - Bilateral conjunctival injection
  - Changes on lips & oral cavity (red fissured lips, strawberry tongue, injection of oral/pharyngeal mucosa)
  - Cervical lymphadenopathy

- In the presence of coronary artery involvement and fever, fewer than 4 of the remaining 5 criteria are sufficient

- Treatment: Intravenous immunoglobulin (IVIG) (2g/kg infused over 10-12 hrs) during first 10 days of illness reduces risk of aneurysms to <5%. 
Poliomyelitis

- Majority of infected cases are asymptomatic or have flu-like illness
- May have biphasic illness: meningism followed by paralysis or “bulbar” form of illness affecting circulation & respiration

- SA has been declared polio-free by WHO
  - Last cases in 1991
  - Monitoring: acute flaccid paralysis (AFP) surveillance
  - Risk of importing wild-type virus from neighbouring countries
    - Recent outbreak in Namibia

- Vaccination
  - Oral polio vaccine at birth & 6 wks, inactivated polio vaccine at 6/10/14 wks & 18 mths
  - Mass polio immunisation campaigns

- Eradication is technically feasible
  - No non-human reservoir, effective vaccine incl. campaigns, AFP surveillance
Diphtheria

- *Corynebacterium diphtheria*
- Clinical:
  - Severe upper airway obstruction due to pseudomembrane in oropharynx ("bull-neck")
  - Myocarditis in 1\(^{st}\) or 2\(^{nd}\) week of disease
  - Peripheral neuropathy / paralysis

- Effective vaccine: routinely at 6/10/14 wks, 18 mths, 6 & 12 yrs
- Disease surveillance & high vaccination coverage essential
  - Recent outbreak in KZN (2015)

- Treatment:
  - Antibiotics, diphtheria anti-toxin, bed-rest, supportive care, contact & droplet transmission precautions, post-exposure prophylaxis for contacts
Pertussis (whooping cough)

- *Bordetella pertussis*

- Clinical: cough paroxysms, apnoea (infants), seizures/encephalopathy, “100-day cough”
  - Re-emergence of cases in adolescents/adults

- Difficulties in accurate diagnosis
  - Clinical case definition
  - Microbiological confirmation (PCR)

- Most deaths in infancy

- Transmission via respiratory droplets within 4 weeks of disease onset

- Vaccination:
  - Acellular vaccine safer than whole-cell vaccine,
  - Routine schedule 6/10/14 wks, 18 mths
  - Adolescents/adults?
Tetanus

• *Clostridium tetani*
• Neonatal tetanus
  – Contamination of umbilical stump
  – Exotoxin released by organism (tetanospasmin)

• Clinical: severe convulsions, recurrent muscle spasms, respiratory complications frequent cause of death
• Treatment: debridement, antitoxin, antibiotics, supportive care (ICU), rehabilitation for survivors

• Maternal immunisation is key to prevention
• Neonatal tetanus elimination targets reached in SA in 2002
• Risk of breakthrough cases & tetanus in older child after injury
Neonatal tetanus
Haemophilus influenzae type b

- Severe respiratory infections, meningitis, epiglottitis, cellulitis, bone & joint infections
- Treatment: ampicillin, supportive care

- High case fatality rate (30%) & high incidence of neurological sequelae

- Routine vaccination introduced in SA in 1999
  - Conjugated vaccine, effective in infants

- Hib disease now very uncommon

- Role of other serotypes & non-typeable H. influenzae
Streptococcus pneumoniae

• 150 million global cases of pneumococcal disease annually, 1.6 million deaths
• Very young & elderly, HIV-infected most at risk

• Clinical: meningitis, pneumonia, bacteraemia, otitis media
• Treatment: penicillin (resistance occurs and requires treatment with cephalosporins)

• Prevention: vaccination (& prevention of HIV infection)
  – Polysaccharide vaccine not effective <2 yrs of age
  – Conjugate vaccine (PCV 13) effective at all ages, includes serotypes associated with penicillin resistance
  – 6 & 14 wks, and 9 mths
  – Vaccine efficacy less in HIV-infected children
Hepatitis B

- Children acquire Hep B via vertical transmission from mother (antenatally or intrapartum) or via horizontal transmission during early childhood (mechanisms may include scarification, ear-piercing, intra-familial spread, mosquito bites)
  - Vertical transmission associated with higher chronic carrier rate

- Mostly asymptomatic during childhood
  - Some children develop acute hepatitis which usually resolves without chronic carriage
  - Asymptomatic carrier rates are around 2.5% <6 yrs of age, around 14% at 6-8 yrs of age

- Chronic carriage associated with development of cirrhosis and hepatocellular carcinoma during adulthood (1 million global deaths annually)

- Prevention:
  - routine vaccination introduced in SA in 1995 for infants (6/10/14 wks),
  - birth vaccination?
  - Immunoglobulin to infant at birth in high risk pregnant women
  - occupational risk includes healthcare workers
Immunisation

- “The two public health interventions that have had the greatest impact on the world’s health are clean water and vaccines.” World Health Organisation

- “The time has come to close the book on infectious diseases. We have basically wiped out infection in the United States.” William Stewart, Surgeon General, USA, 1967
Some basic principles of vaccination

• Vaccines induce protection against a disease by stimulating active immunity
  – Passive immunity may be provided by administration of immunoglobulin

• Comprise
  – sub-unit components or toxin of target pathogens,
  – inactivated whole pathogens, or
  – live attenuated organisms

• Polysaccharide antigen may be conjugated with proteins to increase the immunogenicity (efficacy) of the vaccine particularly in infants
### Live attenuated & inactivated vaccines

<table>
<thead>
<tr>
<th>Classification</th>
<th>Sub-class</th>
<th>EPI Vaccine</th>
<th>Other Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Live attenuated</strong></td>
<td>Live attenuated virus vaccines</td>
<td>Measles, oral polio vaccine, Rotavirus vaccine</td>
<td>Mumps, rubella, yellow fever, varicella</td>
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<td>Live bacterial vaccines</td>
<td>BCG</td>
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<td>Live recombinant bacterial vaccine</td>
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<td>Oral typhoid</td>
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<td><strong>Inactivated</strong></td>
<td>Inactivated whole viruses</td>
<td>Injectable polio vaccine</td>
<td>Hepatitis A, influenza and rabies</td>
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<td>Inactivated whole bacteria</td>
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<td>Pertussis (whole cell) Cholera, typhoid and plague</td>
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<td>Fractional vaccines</td>
<td>Sub-units such as Hepatitis B and Pertussis (acellular)</td>
<td>Sub-units such as influenza and acellular pertussis</td>
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<td>Toxoid</td>
<td>Diphtheria, tetanus</td>
<td>Botulinum</td>
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<td>Polysaccharides</td>
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<td>Meningococcal</td>
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<td>Polysaccharide conjugates</td>
<td>Haemophilus Influenza type b (Hib), Pnemococcal vaccines</td>
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Vaccines included in SA schedule
Extended Programme on Immunisation (EPI), WHO

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Description</th>
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<tbody>
<tr>
<td>OPV</td>
<td>Oral Polio Vaccine</td>
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<td>RV</td>
<td>Rotavirus Vaccine</td>
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<tr>
<td>DTaP-IPV//Hib (Pentavalent)</td>
<td>Diphtheria, Tetanus, acellular Pertussis, Inactivated Polio Vaccine, Haemophilus influenzae type b</td>
</tr>
<tr>
<td>DTaP-IPV-HB-Hib (Hexavalent)</td>
<td>Diphtheria, Tetanus, acellular Pertussis, Inactivated Polio Vaccine, Haemophilus influenzae type b and Hepatitis B.</td>
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<tr>
<td>Hep. B</td>
<td>Hepatitis B Vaccine</td>
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<td>HPV Vaccine</td>
<td>Human Papillomavirus Vaccine</td>
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<tr>
<td>BCG</td>
<td>Bacillus Calmette Guerin (Anti-tuberculosis Vaccine)</td>
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<tr>
<td>PCV</td>
<td>Pneumococcal Conjugated Vaccine</td>
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<tr>
<td>Td</td>
<td>Tetanus &amp; reduced strength Diphtheria Vaccine</td>
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</tbody>
</table>
South African schedule (2015)
Extended Programme on Immunisation (EPI), WHO

<table>
<thead>
<tr>
<th>Age</th>
<th>Vaccine</th>
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<tbody>
<tr>
<td>Birth</td>
<td>OPV (0), BCG</td>
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<tr>
<td>6 weeks</td>
<td>OPV (1), RV (1), Hexavalent (1) {DTaP-IPV//Hib (1) plus Hep. B (1)}*, (1), PCV (1)</td>
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<tr>
<td>10 weeks</td>
<td>Hexavalent (2) {DTaP-IPV//Hib (2) plus Hep. B (2)}*</td>
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<td>14 weeks</td>
<td>RV (2), Hexavalent (3) {DTaP-IPV//Hib (3), plus Hep. B (3)}* , PCV (2)</td>
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<tr>
<td>9 months</td>
<td>Measles (1), PCV (3)</td>
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<tr>
<td>18 months</td>
<td>Hexavalent (4), {DTaP-IPV//Hib (4)}* , Measles (2)</td>
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<td>6 years (school entry)</td>
<td>Td</td>
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<tr>
<td>9 years (Grade 4)</td>
<td>HPV Vaccine</td>
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<td>12 years (Grade 7)</td>
<td>Td</td>
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</tbody>
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* \{DTaP-IPV//Hib (pentavalent) plus Hep. B \} given during the switch over from pentaxim to hexaxim at: 6, 10 and 14 weeks.
SA routine immunisation schedule by vaccine & age

<table>
<thead>
<tr>
<th>Age → Vaccine ↓</th>
<th>Birth</th>
<th>6 weeks</th>
<th>10 weeks</th>
<th>14 weeks</th>
<th>9 months</th>
<th>18 moths</th>
<th>6 years</th>
<th>9 years</th>
<th>12 years</th>
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<td>Hep B*</td>
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* Hep B at 6, 10 and 14 weeks should only be given with pentaxim. Do not give Hep. B if DTaP-IPV-HB-Hib (hexavalent) is used.
Vaccine coverage

- Critical to maintain high levels of vaccine coverage for target diseases in order to achieve protection in a community
  - Infectiousness of pathogen (e.g. measles >90% coverage required)
  - Variable efficacy & timing for different vaccines
  - Higher coverage obtained with vaccines given at earlier age (6/10/14 wks) than with vaccines given at 9 & 18 months (measles)
  - Coverage figures vary depending on reporting agency
  - Herd immunity
Elimination & Eradication

• Elimination (regional)
  – Measles elimination defined as the absence of continuous disease transmission for 12 mths or more in a specific geographic area e.g. measles is no longer endemic in USA
  
  – Highly effective vaccine, strong vaccination programme with high vaccine coverage, well defined clinical presentation, no chronic carrier state, strong public health system for detecting & responding to measles cases & outbreaks, no reservoir (outside humans)
    • Imported cases
    • Pockets of unvaccinated individuals

• Eradication (global)
  – Smallpox
  – Polio?
Barriers to achieving high vaccination coverage

- Limited integration of vaccination programme into all aspects of child health care delivery (separate vertical programme)
- Unavailability of vaccines (e.g. hospitals, stock-outs)
- Anti-vaccination lobby

- False contraindications (parents & health care workers)
  - Family history of adverse reactions after immunisation or convulsions
  - Previous measles, mumps, rubella or pertussis-like illness
  - Preterm birth
  - Jaundice after birth
  - Stable neurological condition (e.g. cerebral palsy, Trisomy 21)
  - Contact with an infectious disease or antibiotic treatment
  - Underweight
  - Minor illnesses e.g. upper respiratory tract infection
  - Breastfeeding
  - Prematurity (use chronological age)
  - Non-specific allergies
  - Local reaction after previous DPT
  - Treatment with low-dose inhaled or topical corticosteroids
Vaccines not currently included in SA EPI schedule

• Rubella
  – Live attenuated virus
  – Measles mumps rubella (MMR) vaccine at 15 mths & 4-6 yrs + catch-up dose for girls prior to reproductive age
  – Aim is to reduce/eliminate congenital rubella syndrome (sensorineural hearing loss, congenital heart disease, cataracts/retinopathy, developmental problems)

• Influenza
  – Annual recommendations from WHO on strains included in vaccine
  – Inactivated virus
  – Recommended from 6-59 mths of age & in pregnancy
  – High risk groups (including health care workers)
  – Not shown to be effective in HIV-infected children
Vaccines not currently included in SA EPI schedule

• Hepatitis A
  – 2 doses 6 months apart
  – Long lasting protection (>10yrs)
  – Children & at-risk individuals (incl. health care workers)

• Varicella
  – Live attenuated vaccine
  – Single dose from around 12 months of age
  – 2 doses more effective (in adolescents & older individuals)
  – Contraindications (pregnancy, immunosuppression)
  – Relatively low burden of severe illness in low resource countries so not regarded as high priority vaccine (WHO)
  – Institutional outbreaks
Vaccines not currently included in SA EPI schedule

• Meningococcal vaccines
  – Capsular & non-capsular vaccines
  – Capsular polysaccharide & polysaccharide-protein conjugate vaccines
  – In SA, a capsular polysaccharide-protein conjugate vaccine (Menactra) is registered for use from 9 mths-55 yrs of age for prevention of disease caused by A, C, Y, W serogroups of Neisseria meningitidis
Children with special vaccination requirements

• HIV-infected children
  – Protective antibody responses to Hib conjugate, Hep B, & pneumococcal vaccines are reduced but large burden of disease may still be prevented

  – Measles vaccine from 6 mths of age if admitted to hospital (followed by 9 & 18 mths)
    • New measles vaccine will be given at 6 & 12 months to all children

  – BCG is still given at birth despite risk of disseminated BCG disease in HIV-infected infants
Children with special vaccination requirements

- Preterm babies
  - Should receive vaccinations according to chronological age (not corrected gestational age) if well and no contraindications

- Children at special risk of infection
  - E.g. chronic lung, cardiac, renal, liver disease should receive annual influenza vaccine & be considered for certain other vaccines e.g. Hep A, varicella

- Immunodeficiency (disease or treatment-related)
  - Live vaccines usually contraindicated, post-exposure prophylaxis with immunoglobulins may be required

- Delayed or unknown immunisation status
  - ‘Catch-up’ schedules
Adverse events following immunisation

• Common minor adverse events

• Significant adverse events
  – Notifiable to local health authority

• Local
  – Severe local reaction (swelling >5cm/>3 days), lymphadenitis, injection site abscess

• Systemic
  – Hospitalisation
  – Encephalopathy with 7 days
  – Collapse or shock-like state within 48 hrs
  – Fever >40.5°C within 48 hrs
  – Seizure within 3 days
  – Deaths (thought to be related to immunisation)
Contra-indications to vaccination

• Very few true contra-indications, many ‘false’ contra-indications
  – Severe allergic reaction (anaphylaxis) to a vaccine component or following a prior to dose of a vaccine
  – Encephalopathy occurring within 7 days of pertussis vaccination
  – Severe systemic adverse reaction to previous vaccination
  – Egg allergy: avoid influenza & yellow fever vaccines, may receive measles vaccine
  – Avoid live vaccines in severe immunosuppression & pregnancy
Clinical approach to a child who may have an infection/infectious disease

- History
- Examination
- Assessment
- Differential diagnosis

- Investigation plan
  - According to differential diagnosis & severity of illness

- Treatment
  - Empirical if required
  - Directed

- Reassessments
  - Clinical
  - Laboratory
History

- Age of child
- Nutritional state
- Immunisation history
- Contact with other infected individuals
- Travel (prophylaxis)

Symptoms
- Prodromal symptoms
  - Fever, lethargy, myalgia, upper respiratory tract
- Rash
- Other localising symptoms

Previous / current treatment
Infectious Diseases &
The Road To Health Book

• Pregnancy & perinatal history
  – Exposure to vertically transmitted infections
    • E.g. syphilis, HIV, TB, others

• Vaccinations

• Exposure to horizontally transmitted infections
  – E.g. TB & prophylaxis provided

• Feeding & growth

• Communication between levels of health care system
  – E.g. TB treatment, antiretroviral therapy
Examination

• General examination
  – Nutritional state
  – Fever
  – Cardinal signs including lymphadenopathy
  – Rash
  – Haemodynamic instability & shock

• Systems examination

• Pattern recognition / characteristic features

• Specific complications
Rashes in paediatric infectious diseases

- ‘Skin’ includes:
  - Body, hands & feet (exanthem)
  - Nails
  - Scalp & hair
  - Mucous membranes
  - Mouth/nose/throat (enanthem)
  - Eyes
  - Genital/perineal/perianal

- Descriptive terms include:
  - Erythematous maculopapular
  - Papular
  - Nodular
  - Vesicular
  - Ulcers
  - Petechiae
  - Vasculitic (skin infarcts)
Pattern recognition & clinical case definitions

• Pattern recognition
  – Constellations of symptoms & signs e.g.
    • headache / fever / vomiting: meningitis, UTI
    • purpuric rash /shock: meningococcal disease

• “Alarm bells”

• Clinical case definitions e.g.
  – Measles
    • Fever + rash + at least 1 of the 3 ‘C’s
      – Cough or coryza (runny nose) or conjunctivitis
    • Useful in outbreaks for purpose of diagnosis, treatment (Vit A), surveillance
  – Kawasaki syndrome
Assessment & differential diagnosis

• Assessment: identification and statement of clinical diagnosis (based on history & examination)
  – e.g. lower respiratory tract infection ± specific complications (e.g. pleural effusion/empyema)

• Differential diagnosis & aetiology
  – Viral (e.g. respiratory syncytial virus)
  – Bacterial (e.g. *Streptococcus pneumoniae*)
  – Mycobacterial (e.g. *Mycobacterium tuberculosis*)
  – Fungal (e.g. *Pneumocystis jirovecii*)
  – Parasitic (e.g. *Plasmodium falciparum*)
  – Combinations
Investigation plan

• According to priority of differential diagnosis
  – Consider severity of conditions & urgency of diagnosis regarding treatment (e.g. meningitis)

• Options are:
  – Clinical diagnosis, no/minimal investigations, no empirical antimicrobial treatment required (non-severe, self-limiting infection, symptomatic treatment only)
  – Investigations to screen for presence & site of infection, no empirical antimicrobial treatment (stable patient)
  – Investigations to screen for presence & site of infection & start empirical antimicrobial treatment (unstable patient, potentially severe infection)

• Diagnostic tests: will confirm/exclude diagnosis & determine aetiology (e.g. lumbar puncture & cerebrospinal fluid evaluation, measles serology)

• Non-specific tests for infection: including inflammatory markers (e.g. white cell count, C-reactive protein), imaging studies (e.g. CXR) & tests that assist in monitoring and managing the patient (e.g. urea & electrolytes)
Infectious/communicable diseases
A theoretical framework

**Exposure**
- Route of transmission: contact, droplet, airborne, vector
- Risk factors for developing infection include duration & intensity of exposure, infectiousness of organism, susceptibility of host

Infection

No infection

**Incubation period (disease-specific)**
- Clinical: prodromal / “seroconversion” illness or asymptomatic/latent infection
- Laboratory: specific immunological response (±isolation of organism)

Disease

Infection only / no disease

- Clinical diagnosis: pattern recognition / clinical case definition
- Laboratory diagnosis: specific immunological response, isolation of organism/genetic material (sensitivity & specificity of tests)
### Incubation period & prodromal period

<table>
<thead>
<tr>
<th>Incubation period</th>
<th>Disease</th>
<th>Prodromal period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short (1-7 days)</strong></td>
<td>Cholera</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Diphtheria</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Influenza</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Meningococcal disease</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Scarlet fever</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>Intermediate (7-14 days)</strong></td>
<td>Measles</td>
<td>3-7 days</td>
</tr>
<tr>
<td></td>
<td>Pertussis</td>
<td>Usually 5-7 days (up to 21 days)</td>
</tr>
<tr>
<td></td>
<td>Polio</td>
<td>3-36 days</td>
</tr>
<tr>
<td></td>
<td>Tetanus</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>Typhoid</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>Long (14-21 days)</strong></td>
<td>Chickenpox</td>
<td>0-2 days</td>
</tr>
<tr>
<td></td>
<td>Mumps</td>
<td>0-1 day</td>
</tr>
<tr>
<td></td>
<td>Rubella</td>
<td>0-2 days</td>
</tr>
<tr>
<td><strong>15-40 days</strong></td>
<td>Hepatitis A</td>
<td>2-5 days</td>
</tr>
<tr>
<td><strong>60-180 days</strong></td>
<td>Hepatitis B</td>
<td>2-5 days</td>
</tr>
</tbody>
</table>
Treatment principles

• Always try to obtain appropriate good-quality samples for microbiological investigations prior to starting antimicrobial treatment in order to facilitate microbiological confirmation of a clinical diagnosis
  
  – Helps to reduce prolonged courses of broad-spectrum antimicrobials for unconfirmed diagnoses
  
  – Allows one to obtain culture and drug sensitivity results to guide optimal drug choices
  
  – Exceptions include lack of access to relevant laboratory tests, contraindication or inability to obtain appropriate samples (e.g. lumbar puncture) and urgency of initiating treatment prior to obtaining samples (e.g. meningococcal septicaemia)
Treatment principles

• Empirical antimicrobial treatment
  – Based on clinical diagnoses & severity of condition
  – Broad-spectrum agents (antibiotics, antivirals...)

• Directed antimicrobial treatment
  – Confirmed diagnosis (or strongly suspected microbiologically)
  – Narrow-spectrum agents directed at specific organism/s

• Consider
  – Dosing & route of administration
  – Duration / adherence to treatment

• Infection prevention & control
  – Notification
  – Post-exposure prophylaxis for contacts
  – Transmission-based precautions in health care facility
<table>
<thead>
<tr>
<th>Notifiable Medical Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute flaccid paralysis</strong></td>
</tr>
<tr>
<td><strong>Acute Rheumatic fever</strong></td>
</tr>
<tr>
<td><strong>Anthrax</strong></td>
</tr>
<tr>
<td><strong>Brucellosis</strong></td>
</tr>
<tr>
<td><strong>Cholera</strong></td>
</tr>
<tr>
<td><strong>Congenital syphilis</strong></td>
</tr>
<tr>
<td><strong>Diphtheria</strong></td>
</tr>
<tr>
<td><strong>Food poisoning (outbreak of &gt;4 persons)</strong></td>
</tr>
<tr>
<td><strong>Haemophilus influenza type B</strong></td>
</tr>
<tr>
<td><strong>Haemorrhagic fever of Africa (Congo, Dengue, Lassa, Marburg &amp; Rift Valley fever)</strong></td>
</tr>
<tr>
<td><strong>Lead poisoning</strong></td>
</tr>
<tr>
<td><strong>Legionellosis</strong></td>
</tr>
<tr>
<td><strong>Leprosy</strong></td>
</tr>
<tr>
<td><strong>Malaria</strong></td>
</tr>
<tr>
<td><strong>Measles</strong></td>
</tr>
<tr>
<td><strong>Meningococcal infections</strong></td>
</tr>
<tr>
<td><strong>Paratyphoid fever</strong></td>
</tr>
<tr>
<td><strong>Plague</strong></td>
</tr>
<tr>
<td><strong>Poisoning from any agricultural or stock remedy (e.g. pesticides/fertilizers)</strong></td>
</tr>
<tr>
<td><strong>Poliomyelitis</strong></td>
</tr>
<tr>
<td><strong>Rabies (specify whether human cases or human contact)</strong></td>
</tr>
<tr>
<td><strong>Tetanus</strong></td>
</tr>
<tr>
<td><strong>Tetanus neonatorum</strong></td>
</tr>
<tr>
<td><strong>Trachoma</strong></td>
</tr>
<tr>
<td><strong>Tuberculosis</strong></td>
</tr>
<tr>
<td><strong>Typhoid fever</strong></td>
</tr>
<tr>
<td><strong>Typhus fever (louse-borne)</strong></td>
</tr>
<tr>
<td><strong>Typhus fever (ratflea-borne)</strong></td>
</tr>
<tr>
<td><strong>Viral hepatitis (A, B, non-A non-B, undifferentiated)</strong></td>
</tr>
<tr>
<td><strong>Whooping cough</strong></td>
</tr>
<tr>
<td><strong>Yellow fever</strong></td>
</tr>
<tr>
<td>Disease</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td><strong>Chickenpox</strong></td>
</tr>
<tr>
<td><strong>Meningococcal disease</strong></td>
</tr>
<tr>
<td><strong>Measles</strong></td>
</tr>
<tr>
<td><strong>Hepatitis A</strong></td>
</tr>
<tr>
<td><strong>Pertussis</strong></td>
</tr>
<tr>
<td>Disease</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Measles</td>
</tr>
<tr>
<td>Rubella</td>
</tr>
<tr>
<td>Erythema infectiosum</td>
</tr>
<tr>
<td>Varicella zoster virus</td>
</tr>
<tr>
<td>Meningococcal disease</td>
</tr>
<tr>
<td>Scarlet fever</td>
</tr>
<tr>
<td>Viral gastroenteritis</td>
</tr>
<tr>
<td>Hepatitis A</td>
</tr>
<tr>
<td>Influenza</td>
</tr>
<tr>
<td>Pertussis</td>
</tr>
<tr>
<td>Mumps</td>
</tr>
</tbody>
</table>
Recommendations on when children with selected infectious diseases are no longer regarded as infectious and may return to school or other teaching institution:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Isolation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>5 days from start of rash</td>
</tr>
<tr>
<td>Rubella</td>
<td>7 days from start of rash</td>
</tr>
<tr>
<td>Chickenpox</td>
<td>Until all skin lesions have crusted, usually 5-7 days after start of rash</td>
</tr>
<tr>
<td>Meningococcal disease</td>
<td>2 days after start of antibiotic treatment</td>
</tr>
<tr>
<td>Scarlet fever</td>
<td>Until rash fades and desquamation starts</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>7 days from onset of jaundice</td>
</tr>
<tr>
<td>Pertussis</td>
<td>5 days from starting effective antibiotic therapy or 3 weeks after onset of paroxysmal cough</td>
</tr>
<tr>
<td>Influenza</td>
<td>Until apyrexial and feeling better or until 5-7 days after onset of symptoms</td>
</tr>
</tbody>
</table>
Infection Control Precautions for Health Care settings

• Standard precautions ("universal precautions")
  – Hand disinfection
  – Gloves & mask when working with blood/body fluids
  – Safe disposal of sharps
  – Safe disposal of contaminated linen/other waste

• Transmission-based precautions
  – Contact
  – Droplet
  – Airborne
My 5 Moments for Hand Hygiene (WHO)

• Defines the key moments when health care workers should perform hand hygiene
• Evidence-based, field-tested, user-centred approach
Routes of transmission

• Contact
  – Direct (e.g. STI)
  – Indirect (e.g. faecal-oral)

• Droplet (e.g. influenza, streptococcus, pertussis, diphtheria)
  – Large droplets, contact with mucous membranes

• Airborne (e.g. TB, measles, varicella)
  – Small droplets, inhaled

• Vehicle / Vector
  – Biological (e.g. mosquito in malaria)
  – Mechanical
Contact precautions

- **Organisms**
  - Resistant bacteria
    - Methicillin-resistant staphylococcus aureus (MRSA)
    - Extended spectrum B lactamase (ESBL)-producing Gram negatives
    - Carbapenem-resistant organisms e.g. Acinetobacter
  - *Clostridium difficile*
  - Respiratory syncytial virus
  - Adenovirus
  - Enteric illnesses (Hepatitis A, *Salmonella*, *Shigella*)

- Private room / cohort if possible
- Limit movement around hospital
- Use dedicated equipment (e.g. stethoscopes)
CONTACT PRECAUTIONS

WEAR GLOVES
- whenever making contact with patient, equipment or contaminated surfaces

WEAR PLASTIC APRON
- if in contact with patient or linen

WASH HANDS
- before and after patient care
- after touching body fluids
- after removing gloves
- before caring for another patient

REMEMBER STANDARD PRECAUTIONS AT ALL TIMES
Droplet precautions

• Organisms
  – Meningococcus
  – *Haemophilus influenzae* B
  – Diphtheria
  – Pertussis
  – Adenovirus
  – Mumps
  – Influenza

• Separate cubicle if possible, or cohort, or ≥1 metre separation of beds
DROPLET PRECAUTIONS

**BEDSPACE**
- single room if possible
- if not available, space beds at least one metre apart

**WEAR A MASK**
- staff and visitors in close contact with the patient
- the patient, when leaving the area

**WASH HANDS**
- before and after patient care
- after touching body fluids
- after removing gloves
- before caring for another patient

REMEMBER STANDARD PRECAUTIONS AT ALL TIMES
Airborne precautions

• Organisms
  – Tuberculosis
  – Varicella
  – Measles

• Private room with negative pressure ventilation
  – 6 air changes per hour

• Gloves, gown & particulate filter mask
AIRBORNE PRECAUTIONS

CLOSED DOOR
- a single room with a closed door is required

WEAR MASK
- all staff and visitors to wear a mask when entering the room
- patient requires a mask when leaving the room

WASH HANDS
- before and after patient care
- after touching body fluids
- after removing gloves
- before caring for another patient

REMEMBER STANDARD PRECAUTIONS AT ALL TIMES
Antimicrobial Stewardship

• A multi-disciplinary, systematic approach to optimising the appropriate use of antibiotics to improve patient outcome and limit the emergence of resistant pathogens whilst ensuring patient safety

• Other antimicrobials
Table 1. Principles and Strategies for AS Programs

<table>
<thead>
<tr>
<th>Principles</th>
<th>Examples of Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely antibiotic therapy management</td>
<td>Ensuring prompt initiation of antibiotic therapy when indicated</td>
</tr>
<tr>
<td></td>
<td>Critical illness such as sepsis</td>
</tr>
<tr>
<td></td>
<td>High-risk patients with serious bacterial infections</td>
</tr>
<tr>
<td></td>
<td>Avoiding use of antibiotics when not indicated</td>
</tr>
<tr>
<td></td>
<td>Viral upper or lower respiratory tract infections</td>
</tr>
<tr>
<td></td>
<td>Asthma exacerbations</td>
</tr>
<tr>
<td></td>
<td>Viral pharyngitis</td>
</tr>
<tr>
<td></td>
<td>Use of clinical guidelines and algorithms that facilitate provider recognition of clinical syndromes that do and do not require antibiotics</td>
</tr>
<tr>
<td>Appropriate selection of antibiotics</td>
<td>Ensuring that proper antibiotic regimens are selected for specific clinical syndromes and infections</td>
</tr>
<tr>
<td></td>
<td>Minimizing redundant antibiotic regimens for gram-negative or anaerobic bacterial infections</td>
</tr>
<tr>
<td></td>
<td>Use of antibiograms and clinical guidelines to optimize antibiotic selections</td>
</tr>
<tr>
<td>Appropriate administration and de-escalation of antibiotic therapy</td>
<td>Ensuring proper dosing of antibiotics</td>
</tr>
<tr>
<td></td>
<td>Peer review of antibiotic use at 48-72 h after initiation to determine if therapy should be continued, changed, or discontinued</td>
</tr>
<tr>
<td></td>
<td>Monitoring for serum therapeutic levels of antibiotics</td>
</tr>
<tr>
<td></td>
<td>Proper administration of antibiotics for surgical prophylaxis</td>
</tr>
<tr>
<td>Use of expertise and resources at point of care</td>
<td>Formation of multidisciplinary AS committees</td>
</tr>
<tr>
<td></td>
<td>Obtaining administrative and leadership support</td>
</tr>
<tr>
<td>Continuous and transparent monitoring of antibiotic use</td>
<td>Auditing antibiotic use to identify opportunities for stewardship and education</td>
</tr>
<tr>
<td></td>
<td>Prospective monitoring to assess efficacy of AS program</td>
</tr>
</tbody>
</table>

Abbreviation: AS, antimicrobial stewardship.
Figure. The Antimicrobial Stewardship Team

**Physicians**
- Local champions of clinical areas
- Supervisor of clinical decisions

**Infection Preventionists**
- Surveillance
- Prevent emergence and cross-transmission of MDROs
- Hand hygiene

**Clinical Pharmacist**
- Monitoring of antibiotic use
- Appropriate administration

**Hospital Administrators**
- Program funding
- Institutional policy

**Microbiologist**
- Timely and accurate reporting
- New biotechnology

**Patient**
- Antibiogram
- Promptly identify patients who require antibiotics

**Education**
- Director or codirector
- Timely and appropriate antibiotic management
- Prospective audit with intervention and feedback
- Streamlining/de-escalation
- Guidelines and clinical pathways
Table 2. Potential Strategies to Promote AS Programs in Community-Based Settings

<table>
<thead>
<tr>
<th>Key Elements</th>
<th>Outpatient Settings</th>
<th>Community Inpatient Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish need for AS program</td>
<td>Provide evidence-based data to implement AS program to leadership, management, and peers</td>
<td>Provide evidence-based data to implement AS program to leadership, management, and peers</td>
</tr>
<tr>
<td>Establish team and resources</td>
<td>Identify local physician champion (e.g., general pediatrician)</td>
<td>Identify local physician champion (e.g., hospitalist or general pediatrician)</td>
</tr>
<tr>
<td></td>
<td>Identify potential resources (e.g., pharmacy records, microbiology results, relevant information technology)</td>
<td>Solicit representation from key admitting practices</td>
</tr>
<tr>
<td></td>
<td>Establish dissemination and education strategies for peers, patients, and families</td>
<td>Identify potential resources (e.g., pharmacy records, infection-control practitioners, pharmacist, microbiologist, microbiology results, information technology)</td>
</tr>
<tr>
<td>Prioritize AS program activities to generate data</td>
<td>Develop treatment guidelines for common infections (antibiotic indications and regimens for pharyngitis, otitis)</td>
<td>Establish restrictive formulary</td>
</tr>
<tr>
<td></td>
<td>Develop treatment guidelines to avoid unnecessary antibiotics (e.g., for RSV, asthma)</td>
<td>Develop pediatric antibiograms</td>
</tr>
<tr>
<td></td>
<td>Examine susceptibility profiles of common pathogens (e.g., Staphylococcus aureus and Escherichia coli)</td>
<td>Develop treatment guidelines (empirical regimens for pneumonia and cellulitis; no antibiotics for RSV)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Review of select antibiotics (e.g., linezolid, carbapenems)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitate conversion of intravenous to oral antibiotic therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identification of “drug-bug” mismatch (resistant pathogens treated with ineffective antibiotics)</td>
</tr>
<tr>
<td>Set AS program goals for agreed-on process measures</td>
<td>Adherence to guidelines (e.g., avoid antibiotic use for viral infections)</td>
<td>Changes in antibiotic use</td>
</tr>
<tr>
<td></td>
<td>Changes in antibiotic selection and use (e.g., increased use of narrow-spectrum agents or decreased days of therapy per patient)</td>
<td>Formation of AS team with resources allocated as promised</td>
</tr>
<tr>
<td></td>
<td>Antimicrobial costs</td>
<td>Timely administration and appropriate duration of antibiotics</td>
</tr>
<tr>
<td></td>
<td>Appropriate cultures obtained before antibiotic therapy initiation</td>
<td>Appropriate cultures obtained before antibiotic therapy initiation</td>
</tr>
<tr>
<td></td>
<td>Provider acceptance of recommendations</td>
<td>Provider acceptance of recommendations</td>
</tr>
<tr>
<td>Set AS program goals for agreed-on outcome measures</td>
<td>Reduction in adverse events</td>
<td>Reduction in adverse events</td>
</tr>
<tr>
<td></td>
<td>Rate of hospitalization</td>
<td>Antibiotic resistance trends</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction in C difficile rates</td>
</tr>
</tbody>
</table>

Abbreviations: AS, antimicrobial stewardship; RSV, respiratory syncytial virus.
<table>
<thead>
<tr>
<th>Category</th>
<th>Barriers</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Lack of awareness</td>
<td>No knowledge of AS guidelines</td>
</tr>
<tr>
<td></td>
<td>Lack of familiarity</td>
<td>Unfamiliar with guidelines in general or with specific guideline(s)</td>
</tr>
<tr>
<td>Attitude</td>
<td>Lack of agreement</td>
<td>Disagreement with specific guidelines</td>
</tr>
<tr>
<td></td>
<td>Lack of self-efficacy</td>
<td>Perceived lack of confidence or preparation to implement guidelines</td>
</tr>
<tr>
<td></td>
<td>Lack of outcome expectancy</td>
<td>Lack of belief that guideline will lead to an important health outcome</td>
</tr>
<tr>
<td>Practice</td>
<td>External factors</td>
<td>Lack of time, staff, administrative support, reimbursement, supplies,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>educational materials to support stewardship program</td>
</tr>
</tbody>
</table>

Abbreviation: AS, antimicrobial stewardship.
Table 4. Minimum Requirements for AS Program Outlined by SHEA, IDSA, and PIDS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creation of a multidisciplinary Interprofessional AS team</td>
<td>Physician directed or supervised At least 1 member with training in AS</td>
</tr>
<tr>
<td></td>
<td>Team should include physician, pharmacist, clinical microbiologist, and infection preventionist</td>
</tr>
<tr>
<td>Formulary restriction</td>
<td>Limit duplicative antibiotics</td>
</tr>
<tr>
<td>Develop Institutional clinical guidelines</td>
<td>Management of common Infection syndromes</td>
</tr>
<tr>
<td>Stewardship Interventions to detect and eliminate unnecessary or Inappropriate antibiotic use</td>
<td>Multidrug redundant antibiotic use Antibiotic use in nonbacterial infections or bacterial colonizations Empirical antibiotic regimens that are inadequate or too broad Antibiotic selections that do not adequately treat culture-confirmed pathogens</td>
</tr>
<tr>
<td>Process to measure and monitor antimicrobial use</td>
<td>Internal benchmarking</td>
</tr>
<tr>
<td>Periodic distribution of facility-specific antibiogram</td>
<td>Provides rates of relevant antibiotic susceptibilities to key pathogens</td>
</tr>
</tbody>
</table>

Abbreviations: AS, antimicrobial stewardship; IDSA, Infectious Diseases Society of America; PIDS, Pediatric Infectious Diseases Society; SHEA, Society for Healthcare Epidemiology of America,