Zoonoses of Nonhuman Primates
Salmonellosis

Etiology
Salmonella spp.
Enterobacteriaceae
Aerobic (Facultative anaerobic)
Gram negative
Nonencapsulated
Nonspor-forming
Motile bacilli
S. choleraesuis, S. typhi, S.enteritidis
> 2,300 recognized serotypes!

Transmission
Fecal-oral; ingestion of contaminated food or water
Many species of wild and domestic animals are natural reservoirs.
Infectious dose – large (>100,000 cells)
lower dose may induce subclinical carriers
Organisms may remain viable and may persist in environment for long periods.
Zoonoses of Nonhuman Primates
Salmonellosis

Disease
- Incubation period: 6 - 72 hours
- Acute onset of fever, anorexia, depression, profuse watery diarrhea
- Enterocolitis – inflammation of intestinal mucosa in small bowel and colon.
- Disease usually self-limiting.
- Marked variation in virulence among serotypes

Salmonellosis in NHP
- *S. enteritidis var. typhimurium* most common isolate from NHP
- More common in New World monkeys
- More common in zoos
Zoonoses of Nonhuman Primates
Salmonellosis

Treatment
Antibiotic treatment shortens period of shedding (may also prolong shedding).
Correction of electrolyte imbalances and dehydration most important
Elimination of organism occurs in 3-5 days
R-plasmid mediated multiple drug resistance is well documented.

Zoonoses of Nonhuman Primates
Salmonellosis

Prevention
High standards of hygiene
Insect and rodent control
Protective clothing and gloves
Handwashing
Zoonoses of Nonhuman Primates
Salmonellosis

Pathogenesis
Multiplication in small intestine and colon following ingestion
Inflammatory response primarily PMN infiltrate.
Invasion of mucosa leads to net loss of fluids throughout GI tract -- diarrhea
Mesenteric lymph node enlargement

Zoonoses of Nonhuman Primates
Salmonellosis

Extra-intestinal Salmonellosis in NHP
Osteomyelitis
Septic abortion
Pyelonephritis
Septic arthritis
Zoonoses of Nonhuman Primates

Shigellosis

Etiology
Shigella spp.
Short, nonmotile, nonspore-forming, nonencapsulated, gram-negative rods

Worldwide distribution
Common and important infection of NHP
Endemic in many populations of NHP
Human and NHP are only reservoirs

Zoonoses of Nonhuman Primates

Shigellosis

Shigellosis in NHP
All primates are susceptible
Humans and NHP are only reservoirs
Infection more common in Old World monkeys and apes
Zoonoses of Nonhuman Primates
Shigellosis

Four Major Groups (~50 serotypes)

Group A: *S. dysenteriae*: most severe disease in humans; very rare in NHP

Group B: *S. flexneri*: most common in NHP; less disease in humans

Group C: *S. boydii*: common in tropics; rare in NHP (<1%)

Group D: *S. sonnei*: most common in humans in USA; uncommon in NHP

Zoonoses of Nonhuman Primates
Shigellosis

Transmission

Direct fecal-oral; contaminated food or water

Inapparent carriers – important in epidemiology in captive NHP.

*Shigella spp.* are sensitive to drying but can remain viable for long periods (>6 months) in water, mud, moist environments.

Infectious dose – low (10-100 organisms)
Zoonoses of Nonhuman Primates
Shigellosis

Disease
“Isozoonosis” – similar disease in humans and NHP
Incubation period: 1-4 days
Early signs: Fever, abdominal pain, watery diarrhea
Late signs: Dysentery (blood and mucous), anorexia, dehydration
Subclinical carriers common

Zoonoses of Nonhuman Primates
Shigellosis

Pathogenesis
Colon and cecum – major affected sites
Invasion of enterocytes - inflammation and necrosis of colonic mucosa.

Toxin production (Shiga toxin) increases loss of fluids and electrolytes
Case-fatality – 12-15% in untreated or severe cases.
Zoonoses of Nonhuman Primates
Shigellosis

Potential Sequelae
Reiter’s syndrome
Reactive arthritis
Hemolytic uremic syndrome

Extra-intestinal Shigellosis
“Shigella gingivitis” – erythematous, gingival hyperplasia
### Zoonotic Shigellosis from NHP

<table>
<thead>
<tr>
<th>Type</th>
<th>Source</th>
<th>Year</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. flexneri</em></td>
<td><em>Cercopithecus spp.</em></td>
<td>1930</td>
<td>Pets; 17 cases; 3 deaths</td>
</tr>
<tr>
<td><em>S. flexneri</em></td>
<td><em>Cercopithecus mona</em></td>
<td>1965</td>
<td>Pet; 8 cases</td>
</tr>
<tr>
<td><em>S. flexneri 1</em></td>
<td>Chimpanzee</td>
<td>1970</td>
<td>Clin Lab exposure</td>
</tr>
<tr>
<td><em>S. flexneri 2</em></td>
<td>Spider monkey</td>
<td>1970</td>
<td>Pet; 1 fatal case</td>
</tr>
<tr>
<td><em>S. flexneri</em></td>
<td>Macaques</td>
<td>1971</td>
<td>Research colony; 2 cases</td>
</tr>
<tr>
<td><em>S. sonnei</em></td>
<td>Wooly monkey</td>
<td>1972</td>
<td>Pet; 2 cases</td>
</tr>
<tr>
<td><em>S. flexneri 1</em></td>
<td><em>Macaca fascicularis</em></td>
<td>1993</td>
<td>3 cases; occupational</td>
</tr>
</tbody>
</table>

### Zoonoses of NHP

**Shigellosis**

**Treatment and Control**

- **Antibiotics** – Enrofloxacin, Trimethoprim-sulfamethoxizol

**Resistance**

Eradication through mass treatment

**Good hygiene practices**

Protective clothing and gloves

Handwashing
Zoonoses of Nonhuman Primates
Enteropathogenic *E. coli*

Enteropathogenic *E. coli* (EPEC)
- Infantile diarrhea and mortality in humans
- Under studied pathogen in NHP
- No toxin production
- Diarrhea - secondary to pathogen-host cell membrane interaction
- Typical human EPEC – no animal reservoir
  - Atypical EPEC – in many species

---

Zoonoses of Nonhuman Primates
Enteropathogenic *E. coli*

EPEC in Marmosets – similar to human isolates
- Isolates from healthy and diseased animals
  - Prevalence of EPEC in marmosets
    - Healthy 10/39 (27%)
    - Diarrhea 8/17 (47%)

*From Carvalho et al. J. Clin. Micro; 2003*
Zoonoses of Nonhuman Primates
Enteropathogenic *E. coli*

A. Pathogen adherence to colonic mucosal cell membranes
B. Crypt size reduction and inflammatory infiltrate

*From Carvalho et al., J. Clin. Micro.; 2003*