Zoonoses of Nonhuman Primates

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Diseases transmitted between humans and their closest relatives

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“Nonhuman primates . . . are the most dangerous of all animal groups with regard to the potential for disease transmission to humans”
Richard Fiennes
Zoonoses of Primates (1967)

“It is probable that at least the anthropoid apes among the nonhuman primates are susceptible to most or all human infections”
Calvin Schwabe
Veterinary Medicine and Human Health (1984)
Zoonoses of Nonhuman Primates
Contemporary Public Health Issues

Primate Zoonoses?
AIDS?
Hepatitis?
Cancer?
Unknown agents?

Zoonoses of Nonhuman Primates
Some General Categories

“Shared pathogens” – pathogens equally infectious to both human and NHP acquired from environmental source of from non-primate reservoir species (e.g. Monkey pox, Shistosomiasis)

Pathogens for which humans are natural or reservoir hosts;
NHP are aberrant host species (e.g. Measles virus, Tuberculosis)

Pathogens for which NHP are the natural hosts; humans the aberrant host (e.g. Yellow fever, B virus)
Human/NHP Interactions
Opportunities for Cross-species Transmission

“Ecological”
Humans and NHP share the same ecosystem

“Occupational”
Humans working with NHP is zoos or research facilities

“Recreational”
NHP kept as pets; Ecotourism

“Medical”
Xenotransplantation; Vaccines or biologics produced in NHP cell culture

Ways of Thinking about Primate Zoonoses

Zoonoses resulting from direct human/NHP contact
(e.g. B virus encephalomyelitis)

Zoonoses resulting from transfer of NHP disease
from remote habitat to high density human populations (e.g. Urban yellow fever)

“Species Jumping” – initial transmission from NHP to human population, with subsequent human to human transmission (e.g. HIV/AIDS)
Zoonoses of Nonhuman Primates
Some Terminology

“Zoonosis” – disease transmissible between animals and humans

“Isozoonosis” – a disease showing similar clinical signs and pathology in human and animal hosts

“Remote zoonosis” – strictly human disease resulting from an ancient cross-species transmission event

Zoonoses Classification
(Direction of Transmission)

“Anthropozoonosis” – disease transmitted from animals to humans

“Zooanthroponosis” – disease transmitted from humans to animals

“Amphizoonosis” – transmission can occur in either direction
WHO Classification of Zoonoses
(Maintenance Cycle in Nature)

“Direct zoonosis” – maintenance in single vertebrae species

“Cyclozoonosis” – maintenance requires more than one vertebrae species

“Metazoonosis” – cycle requires both vertebrae and invertebrate species

“Saprozoonosis” – cycle requires inanimate reservoirs or development sites as well as vertebrae species

Recently Recognized Infectious Agents of NHP: Potential Zoonoses

Viruses
- Simian T-lymphotropic virus 1982
- Simian Immunodeficiency virus 1984
- Ebola Reston 1989
- Baboon polyomavirus type 2 1989
- Ebola Cote d’Ivoire 1994
- Simian Parvovirus 1994
- Baboon reovirus 1994
- Simian rhadinovirus (HHV8-like) 1997
- Simian Hepatitis G virus 1998
- Callitrichid lymphocryptovirus 2001
- Marmoset rabies virus 2001
Recently Recognized Infectious Agents of NHP: Potential Zoonoses

Bacteria

- *Helicobacter pylori* 1994
- *Ehrlichia chaffeensis* 2002

Protozoa

- *Cyclospora spp.* 1996

Human Infectious Diseases with NHP Origins: “Remote Zoonoses”

- Malaria (*e.g. Plasmodium vivax*)
- HIV/AIDS
- Hepatitis B
- Dengue fever
- HTLV/T-cell leukemia/lymphoma
Ways of Thinking about Primate Zoonoses

Humans and NHP – “Parallel Universes”
Many (most?) “human pathogens” have
genetically and antigenically closely
related counter-parts in one or more
species of NHP

Introduction (continued)
Geographic Distribution of NHP

From: R. Fiennes, Zoonoses of Primates; 1967

Taxonomy of Nonhuman Primates
A Very Brief Introduction

Order Primates
11-13 Families
66 Genera
Approx. 280 Species

Vary in size by several orders of magnitude from mouse lemurs weighing 30 grams to mountain gorillas weighing up to 200 kilograms
Taxonomy of Nonhuman Primates
A Very Brief Introduction

Prosimians (Suborder Prosimii)
Means “before apes” or “before monkeys”
Occur only in Old World Tropics
Tapetum lucidum (night vision)
Moist rhinarium (enhances smell)
Large and mobile ears

Prosimians (cont.)
Muzzle and brows with whiskers
Eyes face slightly lateral
36 teeth with “toothcomb”
Flat nails all digits except 2nd digit of foot
(“toilet claw”)
Specialized scent glands
Prosimians

- Slender Loris
- Mouse Lemur
- Ringtailed Lemur
- Bush Baby (Galago)

Taxonomy of NHP
Tarsioidea

Tarsiers
- Share characteristics of both prosimians and anthropoids
- Large eyes, mobile ears
- Lack naked rhinarium and dental comb

*Tarsius* spp.
- 34 teeth
- Arboreal
- Large hands/feet for clinging
- Diet of insects, small vertebrates
**Anthropoidea**

**Monkeys and Apes**

- Short faces, dry noses, lack of prominent whiskers
- Ears are small and virtually immobile
- Eyes-face forward (adapted for diurnal vision)
  - Stereoscopic color vision (no tapetum)
- Lack grooming claws, toothcomb
- Dental formula varies from 32-36
- Flat nails on all digits

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**Anthropoidea**

**New World Monkeys**

**New World Monkeys (Platyrrhines)**

- Broad flat noses, nostrils wide apart and face laterally
- Prehensile tail present in some species (not all)
- Platyrrhine nose

**2 Families of NW Monkeys**

- *Callitrichidae* – marmosets and tamarins
- *Cebidae* – capuchins, squirrel monkeys, owl monkeys, howler monkeys, spider monkeys
New World Monkeys

Squirrel monkey  Owl monkey  Capuchin  Spider monkey

Common marmoset  Golden Lion tamarin  Howler monkey

Anthropoidea

Old World Monkeys

Old World Monkeys (Catarrhines)
Distinct from platyrhines by dentition
Narrow nose, nostrils face down
Ischial callosities present (some species)
Cheek pouches present (some species)

Family Cercopithecidae
Subfamily: Cercopithecinae
Macaques, Mangabeys, Baboons,
Guenons, Talapoins, Patas
Subfamily: Colobinae
Colobus, Langurs

Catarrhine Nose
Old World Monkeys

Long-tailed macaque
Colobus
Patas monkey
African Green monkey
Talapoin
Olive Baboon
Red-capped mangabeys

Anthropoidea
Apes

Family Pongidae
Chimpanzee
Orangutan

Family Hylobatidae
Gibbons and Siamangs
Gorilla
Major Differences Between Old and New World Primates

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<th>Feature</th>
<th>NW</th>
<th>OW</th>
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<td>Direction of nares</td>
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<td>Nasal septum</td>
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<td>Ischial callosities</td>
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<td>Cheek pouches</td>
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<td>+/-</td>
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<td>Colonic sigmoid flexure</td>
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<td>present</td>
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<td>present</td>
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<td>Premolars/molars</td>
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<td>2/3</td>
</tr>
<tr>
<td>Prehensile tail</td>
<td>+/-</td>
<td>-</td>
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Evolutionary Relationships of Modern NHP

[Diagram showing evolutionary relationships of modern non-human primates, with timelines and branches indicating splits and speciations.]
Major Health Problems of Nonhuman Primates in Captivity

Infectious disease accounts for roughly two-thirds of disease problems in captive primates.

G.I. disease accounts for the largest proportion of morbidity.

Major Health Problems of NHP Gastrointestinal Disease

Common Pathogens and Parasites

- *Campylobacter* spp.
- *Shigella* spp.
- *Cryptosporidium parvum*
- *Giardia lamblia*
- *Yersinia enterocolitica*
- *Entamoeba histolytica*
- *Balantidium coli*
- *Trichuris* spp.
Major Health Problems of NHP
Gastrointestinal Disease

Less Common Pathogens and Parasites

*Salmonella spp.*

*Strongyloides spp.*

Enteropathogenic *Escherichia coli*

Rotavirus

Major Health Problems in NHP
GI Disease – Magnitude of the Problem

Survey of 18 Primate Facilities

> 13,000 NHP of various species

Diarrheal disease

Overall Incidence = 10.6\% (range 2.1-18.8\%)

Diarrhea-specific mortality = 1.2\%

Diarrhea Case-fatality rate = 11.1\%

Incidence and mortality highest in infants

*Adapted from Hird et al. Lab. Anim. Sci. 34:465-470; 1984*
Major Health Problems of NHP
Respiratory Disease

Agents of Bacterial Pneumonia
- *Streptococcus pneumoniae*
- *Staphylococcus aureus*
- *Hemophilus influenzae*
- *Klebsiella pneumoniae*
- *Bordetella bronchisepticum*
- *Mycobacterium tuberculosis*

Respiratory Viruses
- Parainfluenza type 3
- Respiratory syncytial virus
  *Respiratory virus infections underdiagnosed*

Cross-species Transmission Among NHP
Increased Virulence in Unnatural Host

Simian Hemorrhagic Fever Virus
- African NHP → Asian macaques

*Herpesvirus saimiri*
- Squirrel monkey → Other NW monkeys

Simian Immunodeficiency Virus
- African NHP → Asian macaques

B Virus
- Asian macaques → Other OW and NW NHP