JOHNS HOPKINS UNIVERSITY
CWH
Center for Water and Health

Cryptosporidium Public Health Risks

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- SIGNIFICANT CONTRIBUTION TO THE MORTALITY OF IMMUNOSUPRESSED PEOPLE
- LACK OF EFFECTIVE PROPHYLACTIC OR THERAPEUTIC MEDICATIONS
- ID_{50} FOR IMMUNOCOMPETENT PEOPLE: 10-1000 OOCYSTS IOWA; 100 oocysts UCP; 1,000 oocysts TAMU; 10 oocysts MD; 300 oocysts
- CALF DAILY, 10^9 OOCYSTS; HUMAN DIARHOETIC FECES, 10^6 OOCYSTS/ML
- LONG LASTING INFECTIVITY IN THE ENVIRONMENT

Volunteer Study; Infectivity (ID_{50}), Immunity

136 Healthy adult volunteers 18-50-yr-old; Ab-negative individuals; challenged with geographically diverse isolates of *C. parvum* Genotype 2

Chappell et al., 2001

ID_{50}

IOWA; 100 oocysts (1,800 oocysts)

UCP; 1,000 oocysts

TAMU; 10 oocysts (140 oocysts)

MD; 300 oocysts

- Asymptomatic infections can occur; Symptoms can range and vary with isolate; Illness attack rate is independent of ID_{50}

Pre-existing anti-*Cryptosporidium* IgG

ID_{50}'s increase 20 fold; Protection from infection and illness (at low oocyst dosages); Illness at high oocyst dosage

GROUPS OF RISK

Young children < 5 years-old (immunological immaturity, unhygienic behavior. Predisposition: malnutrition, viral infections such as measles and chicken pox)

Patients undergoing immunosuppressive drug therapy (leukemia, lymphoma, organ or tissue transplants)

Patients with acquired or congenital immunodeficiencies (HIV-positive patients who have developed AIDS, hypo- or a-gammaglobulinaemia)

CLINICAL MANIFESTATION

Profuse, watery diarrhoea containing mucus (bowel motions copious and frequent)

Cramp abdominal pain, low grade fever, nausea, and vomiting

Nonspecific: malaise, weakness/fatigue, headache, flu-like symptoms, and anorexia

THE DURATION AND SEVERITY DEPENDS ON THE IMMUNE STATUS OF THE INDIVIDUAL

Fecal-oral route of infection
Zoonotic parasite

- Microscopic size
- Low sedimentation velocity
- Resistance to environmental stressors
- Long lasting infectivity
- Resistance to standard water disinfection
- Low ID_{50}

EPIDEMIOLOGY

Human-to-human transmission (household and family members, sexual partners both heterosexual and homosexual, hospital patients and staff, children in day-care)

Zoonotic transmission (farm animals, especially ruminants, pets, veterinary students, research workers)

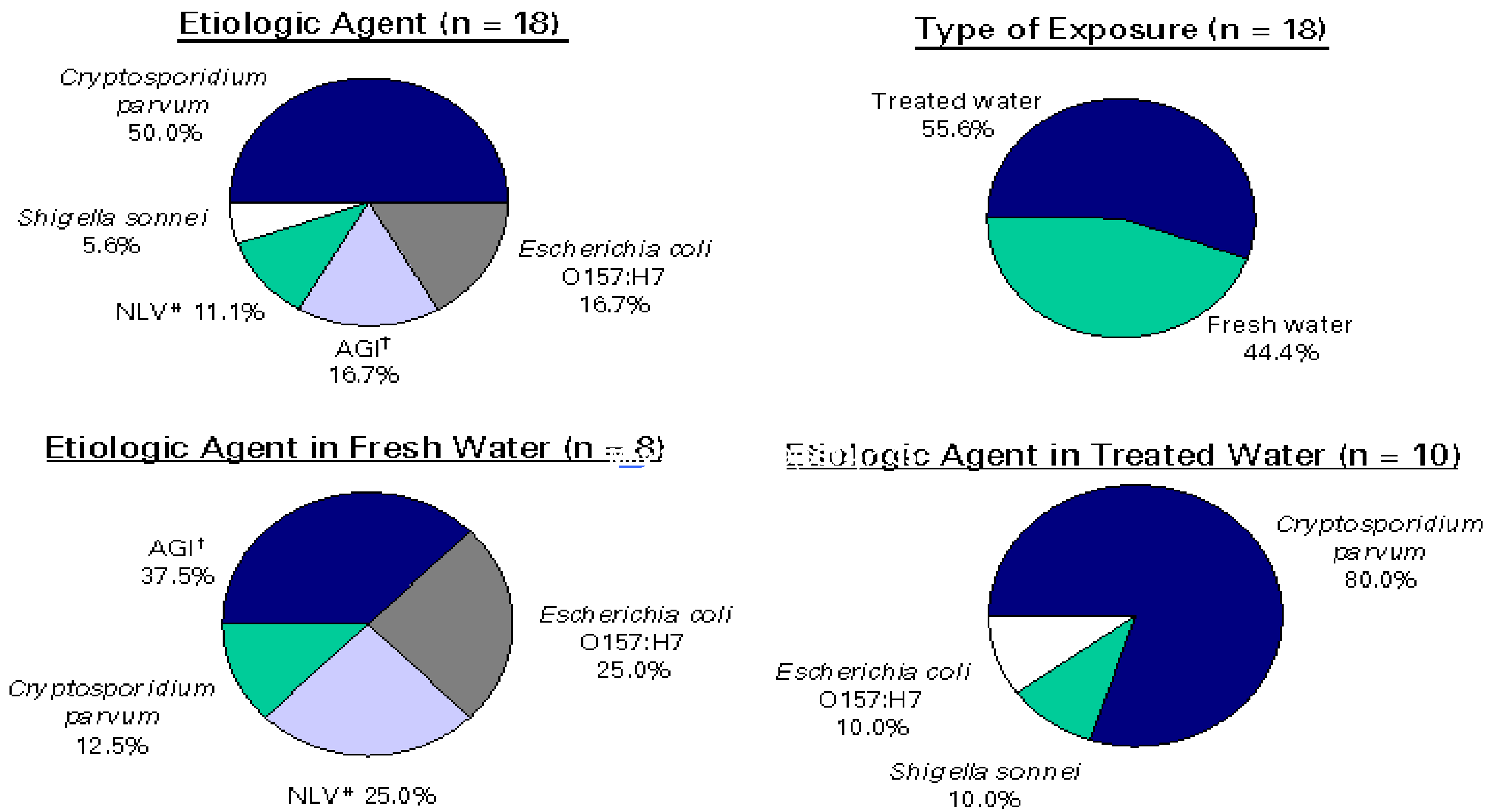
Contaminated water and food (travellers)

Contaminated food (milk, sausages, mineral water, apple cider)

Waterborne outbreaks in recreational waters (swimming pools, fecal accidents, cross-connection to sewage system)

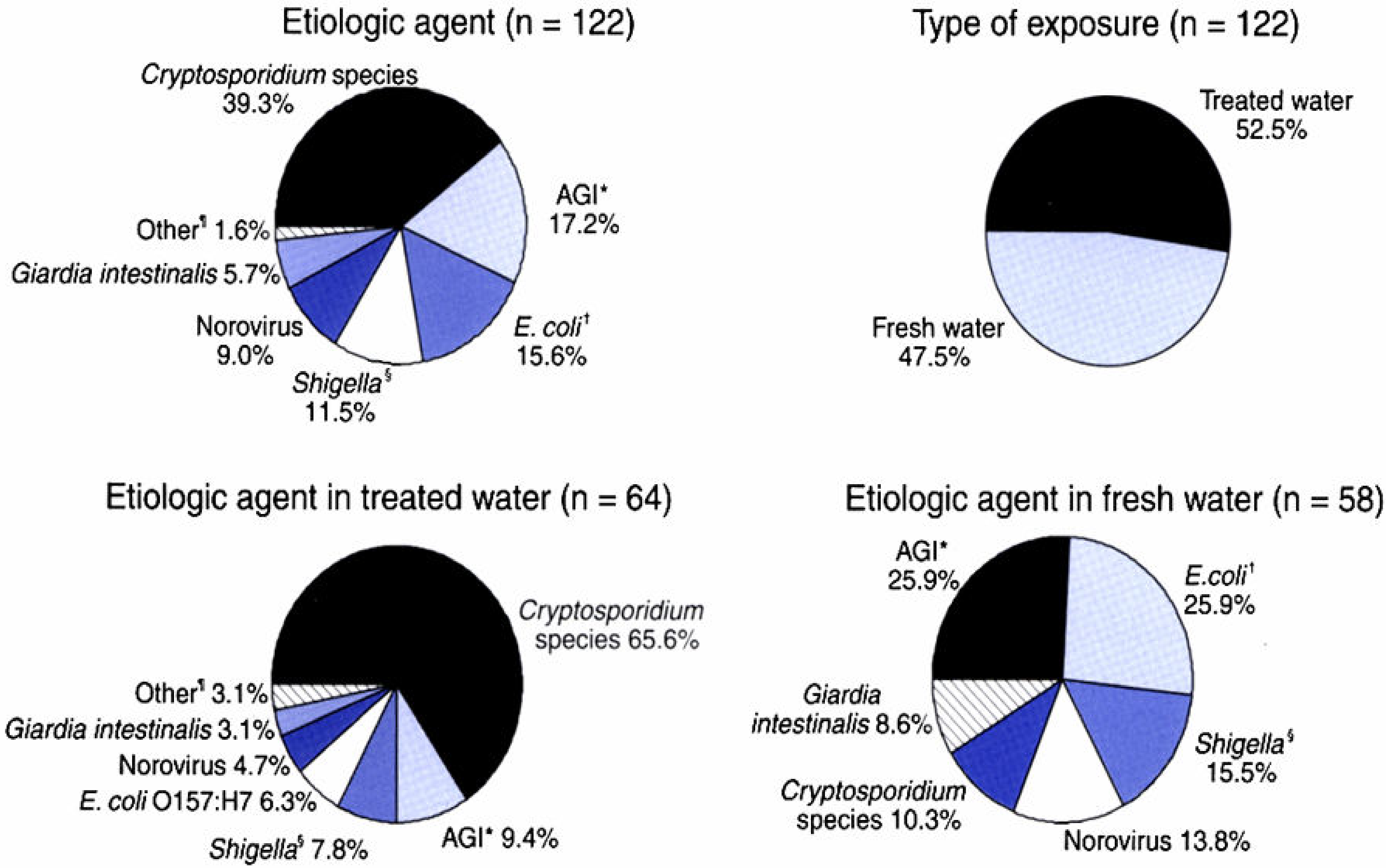
Waterborne outbreaks in drinking water (municipal water, well water, contamination of source water, suboptimal treatment at water treatment facility)

FIGURE 4. Waterborne-disease outbreaks of gastroenteritis associated with recreational water, by etiologic agent and type of exposure — United States, 1997–1998



*Norwalk-like virus.
†Acute gastrointestinal illness of unknown etiology.

FIGURE 7. Waterborne-disease outbreaks of gastroenteritis associated with recreational water, by etiologic agent and type of exposure — United States, 1993–2002



Cryptosporidium Risk Assessment; Drinking Water

$$P = 1 - \exp(-rN);$$

P **- probability of infection (= attack rate); *r* – fraction of infectious organisms (r = 0.00467) ; *N* – the daily exposure (2 liters)**

Milwaukee, WI.

1.6, 0.16, and 0.54 oocysts/liter for $P = 0.14$

79, 7.9, and 2.6 oocysts/liter for $P = 0.52$

Water testing: 0.6 – 1.3 oocysts/liter

Annual Safety Goal: $P < 10^{-4}$

Translated to 1 viable oocysts per 340 liters of water for not longer than 10 days

Current Monitoring Techniques Do Not Permit Such An Evaluation!!!

Mechanical Transmission of *Cryptosporidium* in the Environment

❖ Waterborne Transmission

1) Drinking / Recreational waters
2) Aquatic birds: Gulls (Smith et al. 1993)
Canada geese (Graczyk et al. 1998)

❖ Foodborne Transmission

Molluscan Shellfish; Oysters (Graczyk et al. 2004)
Insects: Feral Filth Flies (Graczyk et al. 1999; 2000; 2001; 2003; 2004)

67 - 686 *Cryptosporidium parvum* oocysts per gram of fecal droppings (Graczyk et al. 1998)

Host Specificity of *Cryptosporidium*

Cryptosporidium parvum (zoonotic; humans)
C. *hominis* (humans)
C. muris (rodents)
C. andersoni (cattle)
C. felis (cats; humans)
C. wrairi (guine pigs)
C. canis (dogs; humans)

C. meleagridis (birds-turkeys)
C. baileyi (birds)

C. serpentis (snakes)
C. saurophilum (lizards)

C. nasorum (fish)

Molecular studies indicate that this genus is complex and may contain many additional species

(Xiao, Ryan, Graczyk et al. 2004. *Appl Environ Microbiol* 70: 891-899)

Chalmers et al., 2001

Human cryptosporidiosis associated with recreational and drinking waters in U.K.

1% of 3,100 human clinical isolates are not ***C. parvum/C. hominis***

McLauchlin et al., 1999; 2001

Data from over 2,000 cases of human cryptosporidiosis in the U.K.

97% C. parvum/C. hominis

1% C. meleagridis

0.2% C. felis

0.1% C. canis

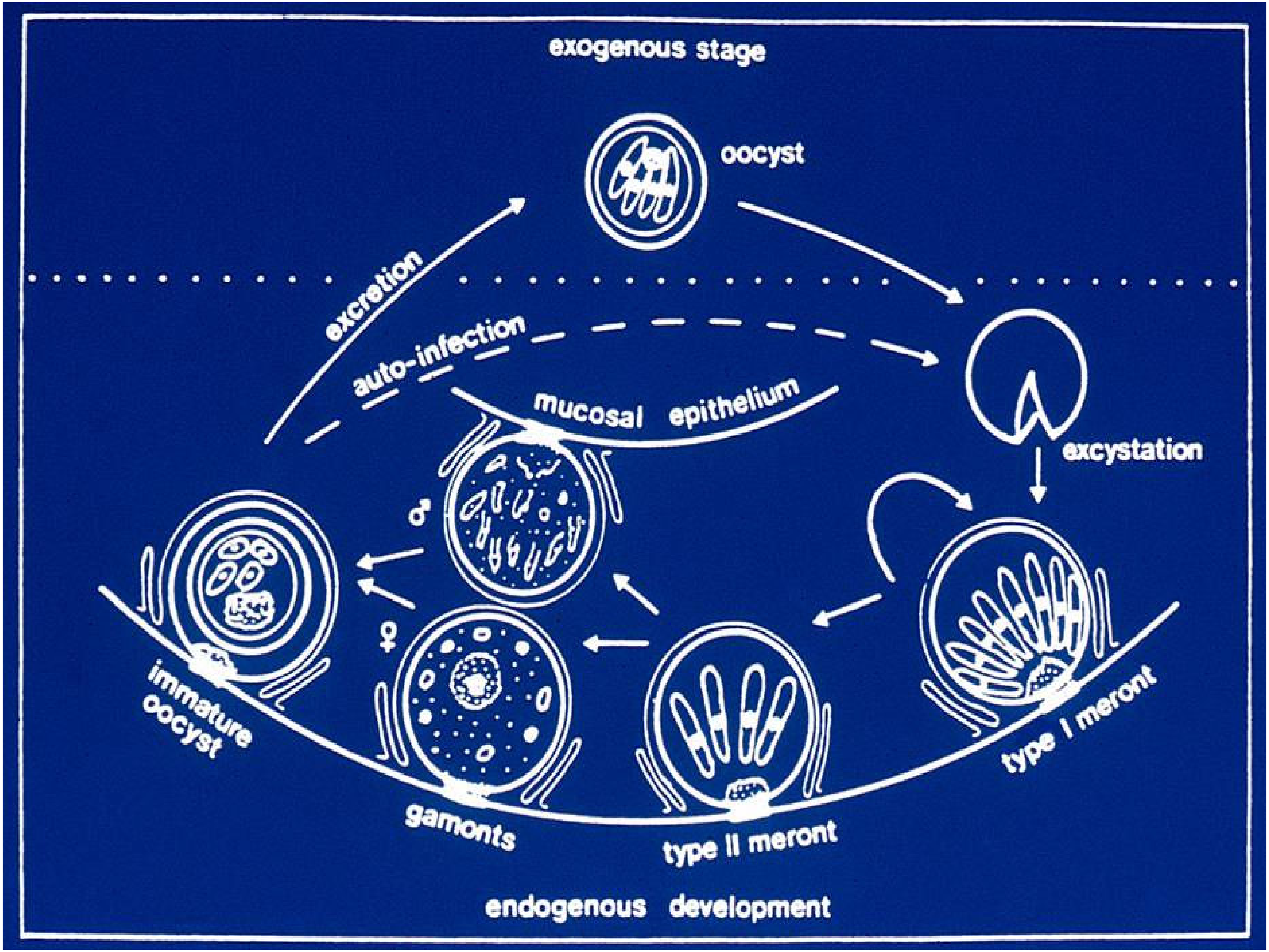
- **In immunocompromised individuals this distribution varies with a greater proportion of non-*C. parvum* and *C. hominis* species**
- **No specific risk factors associated with non-*C. parvum/C. hominis* infections**

Morgan et al., 2000; HIV-infected individuals

***C. parvum/C. hominis*; 64%**

***C. felis*; 27%**

***C. meleagridis*; 9%**


exogenous stage
oocyst
excretion
auto-infection
mucosal epithelium
excystation
♂
♀
immature oocyst
gamonts
type II meront
type I meront
endogenous development

THE JOHNS HOPKINS SCHOOL OF HYGIENE AND PUBLIC HEALTH
PER SCIENTIAM AD SALUTEM PUBLICAM
1916

MDE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Sea Grant
Mid-Atlantic

MORRIS ANIMAL FOUNDATION
Est. 1948