

MANURE MICROBIOLOGY AND ZOOONOSIS



BASICS

OVERVIEW

- Intensive farming has increased the microbial load in the environment; manure is an important source of non-zoonotic and zoonotic pathogenic organisms.
- Manure is a potential source of direct (bio-aerosol, fecal-oral transmission), or indirect (food, water sources) infection with pathogenic bacteria, viruses, protozoa, fungi and helminths.
- Contamination of water sources with zoonotic pathogens is a major cause of human morbidity.
- Manure is also a source of antibiotics, antibiotic resistant bacteria/genes, and hormones. Incorporation of antibiotics in the plant tissue is of concern.
- Manure increases phosphorus and nitrogen levels in the environment, which may cause nutrient pollution if managed improperly. Nutrient pollution results in serious environmental and human health issues, also impacting the economy.

GENETICS

Manure is a source of antimicrobial resistance genes. Intensive farming accelerates bacteria antimicrobial resistance evolution, and increases the probability of resistance acquisition in any exposed bacteria.

GEOGRAPHIC DISTRIBUTION

Worldwide. Geographical areas with intensive animal farming/industrial livestock production are more likely affected.

SIGNALMENT

Species

All ruminant species

ZOOONOTIC PATHOGENS ASSOCIATED WITH RUMINANT MANURE

Bacteria

Salmonella

- *Salmonella* (non-typhoidal) is the most important foodborne zoonotic pathogen.
- Manure is an important source of environmental contamination with *Salmonella*.
- *Salmonella* survival is up to 184 and 332 days in manure and manure-amended non-sterilized soil, respectively.

E. coli

- Serotype O157:H7 is associated with most VTEC infections.
- EHEC subgroup can also cause a severe foodborne disease with multiple organ failure due to verotoxins or Shiga-like toxins production.
- Contaminated water sources are the most common/important source of *E. coli* O157:H7 infection.
- *E. coli* O157:H7 can survive up to 21 months in a manure pile.

Listeria

- Most human cases are attributed to *L. monocytogenes*. *Listeria monocytogenes* is ubiquitously prevalent in natural environments and is transmitted via the food chain to animals and humans.
- *L. monocytogenes* is resistant to freezing, drying and heat (up to 42°C/107.6°F).
- *L. monocytogenes* can persist for several weeks in manure-amended soil, and several months in manure, especially during colder parts of the season.

Campylobacter

- 90% of human infections are caused by *C. jejuni*. *Campylobacter coli* is less often associated with animal or human infection.
- Chicken and cattle are the principal sources of *C. jejuni* pathogenic to humans.
- Campylobacteria persist in bovine manure and subsequently in compost for at least 10 months.

Brucella melitensis

- *Brucella melitensis* is considered a re-emerging pathogen, especially in the Middle East.
- Most infections in humans are the result of occupational exposure to infected manure of small ruminants. It is only occasionally reported in cattle.
- *Brucella melitensis* can survive up to 75 days in a (moist) manure pile.

***Mycobacterium avium* subspecies *paratuberculosis* (MAP)**

- MAP has been consistently identified in humans with Crohn's disease and ulcerative colitis.
- Manure is the source of infection through fecal-oral transmission. Infection via contaminated water is also of concern.
- MAP survival in manure at low levels can be longer than one year. Some studies were able to detect MAP by culture of fecal material after 117 weeks of composting. The relevance of this persistence at low levels to new cases of infection is not known.

Other bacteria known to be human pathogens isolated from ruminant manure

- *Clostridium difficile*, *C. perfringens* and *C. tetani* can be spread to humans by manure. Most spore forming bacteria survive manure composting.
- *Streptococcus* spp. infection can have a source in manure.
- Sheep manure can be the source of *Helicobacter pylori* infection. Cattle manure has not been yet implicated as a source of *Helicobacter pylori*.
- *Leptospira* can be isolated from manure. However; the source of infection in humans is usually through contact with the urine of an infected animal.

Protozoa

***Cryptosporidium* spp.**

- Cattle are the reservoir of *C. parvum* (oocysts). Sheep and goats can also shed infection through manure.
- *Cryptosporidium* oocysts are the infective agent.
- Infections in humans are mostly through food and water contaminated with infected manure.
- Oocyst can survive in manure up to one year. Their viability in manure is not affected over a wide temperature range.

Giardia lamblia

- Also known as *Giardia intestinalis* or *Giardia duodenalis*
- Ruminant feces can be the source of infection. Livestock is not considered to be a significant public health risk.
- Transmission occurs through fecal-oral route, or through contaminated food and/or water.
- The infection is acquired by ingesting *Giardia lamblia* cysts.
- *Giardia lamblia* cysts can survive in manure up to 130 days. Survival of cysts is highly temperature dependent.

Toxoplasma gondii

- Although infection with *T. gondii* is widespread in human and animals, livestock is not considered a significant source of infection.

Cryptosporidium parvum, *Giardia lamblia*, *Escherichia coli* O157:H7, *Salmonella*, and *Campylobacter* are classified as priority one waterborne zoonotic pathogens by WHO (2012 World Health Organization).

Viruses

Human Noroviruses

- Noroviruses may have a zoonotic route of transmission to humans.
- Human Norovirus Genogroup GII, which causes foodborne gastroenteritis in humans, was isolated from bovine manure.

Rotaviruses

- Phylogenetic analyses showed that human rotavirus strains cluster with rotaviruses of bovine and caprine origin, which suggests zoonotic transmission events.

Survival of viruses in manure is highly dependent on temperature and the degree of adsorption. Enteroviruses can survive around 180 days in amended soil at 4°C (39.2°F). The survival is reduced to 12 days at 37°C (98.6°F).

Prions

- Fecal-oral route is a likely natural mechanism for the transmission of chronic wasting disease among deer.
- Similar transmission is possible for other prion diseases: Scrapie, transmissible spongiform encephalopathies, and the variant Creutzfeldt-Jakob disease in humans.
- Composting reduces the infectivity of prions, and prolonged composting may render them non-infective. Specific timelines are not yet determined.

Antimicrobial resistance

- The increasing prevalence of antibiotic-resistant bacteria is one of the most serious threats to public health.
- Resistance genes enter the food system through amendment of soils with manure from antibiotic-treated animals.
- Horizontal transmission of antibiotic resistance genes in manure and/or manure amended soil to resident soil microorganisms, including pathogens, is of concern.
- Even manure from dairy cows never treated with antibiotics enhances the proliferation of resident antibiotic-resistant bacteria and genes encoding β -lactamases in soil.
- Plants intended for human consumption uptake antibiotics from manure amended soil and incorporate it in the plant tissue.

PATHOGEN REDUCTION BY MANURE TREATMENT REGIMES

Physical treatment

- Heat/Thermal Processes (Mesophilic, Thermophilic)
- Freezing
- Drying
- Screening and filtering
- Settling
- Centrifuging
- Incineration
- Gamma irradiation
- Ozone
- UV light

Chemical treatment

- High pH (>11)
- Low pH (<2 to <5)
- Ammonia
- Formalin
- Chlorine

Biological treatments

- Aerobic, mesophilic
- Aerobic, thermophilic (Composting)
- Anaerobic, mesophilic
- Anaerobic, thermophilic



MISCELLANEOUS

ZOONOTIC POTENTIAL

Zoonotic pathogens from manure can contaminate water, soil, crop, and fomites. Fecal-oral contamination and inhalation via aerosol are possible.

PREGNANCY

Several of these pathogens are abortifacients.

BIOSECURITY

Farm manure antibiotic residues, wastewater hormone levels, phosphorus and nitrogen levels (nutrient loading), and potential zoonotic pathogens are of concern for animal and human health.

PRODUCTION MANAGEMENT

Three different management techniques are capable of lowering the risk of infecting animals and humans with agents from the slurry spray:

- Adequate storage time/settling of the manure slurry or other infection-reducing treatment
- Spreading slurry under calm meteorological conditions (i.e., during the morning hours)
- Use of spreading methods that minimize the creation of aerosols (i.e., injection)

SEE ALSO

- Manure Management and Environmental Planning (www.fiveminutevet.com/ruminant)

ABBREVIATIONS

- EHEC: Enterohemorrhagic *E. coli*
- MAP: *Mycobacterium avium* subspecies *paratuberculosis*
- VTEC: Verotoxin-producing *E. coli*

Suggested Reading

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