

# Protozoal Pathogens

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## Environmental Concerns

- *Giardia* and *Cryptosporidium parvum*, parasitic pathogens found in animal manure, are the organisms of most concern for water quality and human health. *Giardia* is resistant to most disinfectants except quaternary ammonia compounds but can be killed with higher levels of chlorine. *Cryptosporidium parvum* is resistant to common disinfectants, including chlorine. Because standard water treatment processes do not control these organisms, filtration is required to remove their infective stage from water for human use.
- *Giardia* and *Cryptosporidium parvum* are transmitted from one animal to another when the infective stage of the organism is shed into manure or the environment and then ingested by another animal. Current research indicates that these parasites are more prevalent in young calves than in mature animals.
- *Giardia* cysts and *Cryptosporidium parvum* oocysts can remain viable in the environment outside a host animal for variable amounts of time. They can survive for many months under conditions of moderate moisture and temperature.
- *Giardia* and *Cryptosporidium parvum* may cause gastrointestinal ailments. Humans may be carriers of both parasites without showing symptoms.
  - No approved drugs are currently available to treat infection caused by *Cryptosporidium* (cryptosporidiosis). Although people with healthy immune systems can usually recover from cryptosporidiosis in several days, it may be severe or fatal in older people or those who have weak immune systems.
  - Infection by *Giardia* often does not require medical attention, but it may cause sudden, severe diarrhea in humans. Reinfection is common.
  - Poor hygiene practices after handling infected individuals (animals or humans) provide a direct pathway for infecting other animals or humans. Humans infected with these parasites can potentially infect animals through fecal contact or through contamination of animal watering sources by septic runoff or overflow.

– Many communities with filtration capabilities rely on unfiltered water sources as their backup water supply. Poorly managed filtration operations can result in outbreaks of parasitic illness.

- Bacterial pathogens, including *E. coli*, are found in animals of any age. These pathogens are killed by chlorination and are usually controlled in public water systems. Private or community wells may not be chlorinated. Unchlorinated wells should be tested regularly for coliform to avoid health risks.

## Potential Economic Benefits

- Effective biosecurity controls reduce animal health problems and death.
- Healthy calves have high resistance to diseases and low mortality.
- Healthy calves and cows require less veterinary treatment and thus lower veterinary costs.
- Drinking water sources for humans are protected against pathogen contamination, potentially resulting in reduced water treatment expenses and safer water quality.

## Summary of Pollution Prevention Practices

### Prevent Pathogens from Coming onto the Farm

Prevent or reduce the entry of pathogens onto the farm by restricting transport of manure from other animal production facilities.

- Require all farm visitors and workers to clean their boots or wear plastic ones before entering animal facilities.
- Restrict movement of milk trucks, livestock hauling trucks, or other vehicles around livestock facilities. Avoid contact between animals and manure or runoff from manure brought onto the farm by vehicles.
- Protect feed and water sources from fecal contamination by livestock, rodents, pets, or human sewage.

## Reduce Cross-Contamination among Animals

*Cryptosporidium parvum* and *Giardia* can remain infective in the environment for months under moderate temperature and moisture conditions. These organisms, most common in calves less than six months old, are transferred from one animal to another through fecal-oral contact. To reduce cross-contamination among animals on the farm

- prevent contact between calves and clothing or hands during feeding or handling.
- clean and dry feeding and watering equipment thoroughly between uses.
- clean and sun dry housing facilities thoroughly between calves.
- reduce the potential for runoff water to carry contaminated manure into areas used to house young animals.
- restrict access by calves to fields that have received manure applications within the last year.

## Restrict Movement of Contaminated Feces into Watercourses

To reduce the risk of surface and groundwater contamination by protozoal pathogens associated with manure

- prevent runoff from calf housing, exercise lots, and manure storage areas.
- store manure from animals six months and younger separately from the rest of the herd.
- apply manure from young calves to areas that are not hydrologically sensitive.
- compost calf manure to temperatures above 140° F. If the entire manure pile is heated above these temperatures, *Cryptosporidium parvum* oocysts and *Giardia* cysts will be killed.
- incorporate manure into soil so that it is exposed to freeze-thaw cycles. This practice can significantly reduce the viability of *Cryptosporidium parvum* oocysts and *Giardia* cysts in manure.

## Use Natural Resources Conservation Service–Approved Best Management Practices

Best Management Practices are designed to minimize protozoal pathogen contamination associated with animal manures. Practices to manage manure should be implemented as a component of a complete Comprehensive Nutrient Management Plan (CNMP) following Natural Resources Conservation Service (NRCS) Standard NY312. Large animal feeding operations currently need to address this standard to meet NYS Department of Environmental Conservation (NYSDEC) regulations for concentrated animal feeding operations (CAFOs). All animal feeding operations may need to address this standard in the future. See NRCS Standards NY312—*Waste Management Plan*, 313—*Waste Storage Facility*, NY633—*Waste Utilization*, 590—*Nutrient Management*, NY393A—*Filter Area*, 634—*Manure Transfer*, and 317—*Composting Facility* for more information.

## Summary of Regulations

*The CAFO permit*, issued through the NYSDEC, requires CAFO-sized livestock farms to provide storage or treatment of all process-generated wastes and polluted runoff from the confinement area for a 25-year, 24-hour storm event. In addition, a CNMP addressing at a minimum feed management, manure handling and storage, land application of manure, nutrient management, land management, and record keeping will be developed and used. CAFO-sized farms have more than 1,000 animal units or more than 300 animal units if wastes could be potentially discharged to state waters.

Participation in the Agricultural Environmental Management Program and implementation of NRCS-approved Best Management Practices are consistent with NYSDEC permit requirements for CAFOs.

*The U.S. Environmental Protection Agency*, through the Surface Water Treatment Act, has given provisional filtration waivers to the New York City Watershed and the Skaneateles Lake Watershed, which provide drinking water to the residents of New York City and Syracuse, respectively. These waivers permit the use of surface water without filtration to remove *Giardia* cysts. To ensure that water remains clean and free of pathogens, water

quality programs in these watersheds provide farmers, homeowners, and municipal treatment facilities with technical and financial assistance. If people do not voluntarily implement changes to address pathogen concerns by specified deadlines, regulations will mandate implementation. The Surface Water Treatment Act requires water systems to remove 99.9 percent of *Giardia* cysts during treatment processes.

Most other municipal water treatment systems use filtration to remove these pathogens. Backup water systems for municipalities may not be filtered.

## Background Information for Worksheet Questions

(Note: In this section, NYSDEC, EPA, or other state or local rules and regulations are indicated with the words “must” or “are required.”)

### What human pathogens found in livestock waste are of concern to drinking water quality?

The protozoa *Cryptosporidium parvum* and *Giardia* are the only species of concern for potential contamination of most public drinking water sources. These protozoa are not killed by standard chlorination. Both parasites may cause diarrhea and abdominal discomfort in humans. Cryptosporidiosis may be severe or fatal for people who have weak immune systems. *Cryptosporidium parvum* is found primarily in animals less than 30 days old. *Giardia* is found in livestock of all ages but is most prevalent in animals less than six months of age.

Bacterial pathogens, including *E. coli*, may be a health concern in private or community wells that are not chlorinated. Unchlorinated wells should be tested regularly for coliform and either not used or chlorinated if coliform levels exceed public health standards. Dry conditions that deplete the aquifer or extremely wet conditions that favor pathogen transport can result in rapid contamination of wells.

### How can pathogens from livestock waste contaminate ground or surface water?

When manure is allowed to run off from barnyards or is applied to land, pathogens associated with animal feces can be transported into ground or surface water. High-risk conditions for movement of

pathogens into surface water include application of manure

- near lakes or streams or within the floodplains of these surface water bodies.
- on wet ground near seeps or on ground that has a high or perched water table.
- on sloping land near a lake or a stream.

High-risk conditions for movement of pathogens into groundwater include application of manure

- to sandy soils.
- to soils that have preferential flow paths or vertical cracks in the profile caused by shrinking of clay materials in the soil or by activities of worms, insects, or other soil animals.
- to soils that have karst geology or fractured bedrock.

### Do you keep calves clean and free of caked manure?

Keep calf housing facilities and bedding clean to prevent calves from lying in or getting coated with manure.

- A calf trying to clean its coat or its neighbor’s through licking may ingest parasites and become infected through fecal-oral contact.
- Infected calves exposed to their own manure may become reinfected.
- Calves exposed to infected manure from other calves may become infected.
- Wetness associated with buildup of manure may lower calf resistance to diseases and promote survival of protozoa in the environment.

### How do you manage calf bedding?

Clean bedding helps to keep calves clean and dry.

- Remove old bedding, wash the floor, and put down new bedding between calves. If possible, allow thorough drying before adding new bedding and calves. This reduces the risk of spreading pathogens from older to younger calves.
- While calves are in the calf pen, clean, remove, or add bedding constantly. This will maintain clean and dry conditions in the pen and reduce risks of infection or reinfection.
- Keep bedding conditions clean enough to pass the “knee test”: If you kneel on the bedding, the knees of your jeans will remain clean rather than becoming wet or stained with manure.

Some farms use a crushed stone bedding surface for calves housed in outdoor hutches. The crushed stone allows manure to leach into a filter bed or a drainage system leading to a collection structure or a filter area. Care must be taken when using a stone bedding surface to maintain good drainage away from the calf housing area. If high water conditions exist, parasites may be forced from the subsurface filter bed into the stone bedding area, resulting in a high risk of infection.

### **How do you manage calf housing?**

To reduce the risk of spreading protozoal pathogens from older to younger calves, clean and disinfect all calf housing facilities between animals.

- Use disinfectants at higher than normal concentrations to eliminate risk of recontamination by *Cryptosporidium parvum*.
- Invert calf hutches, scrape manure off the bottom, and clean them thoroughly with soap and water. Steam cleaning, using the hose from the milk house, will decrease pathogen numbers.
- Expose calf pens to sunlight for 10 to 14 days to reduce the number of viable oocysts.
- If you use outdoor calf hutches, rotate their location between calves to allow the ground to dry out and be exposed to sunlight for 10 to 14 days. Rotation of pens and calf hutches will necessitate 20 to 25 percent additional pens as well as additional area for rotated hutches.
- If the bedding surface is crushed stone, remove the gravel and apply a new surface before new calves are put into the hutches.

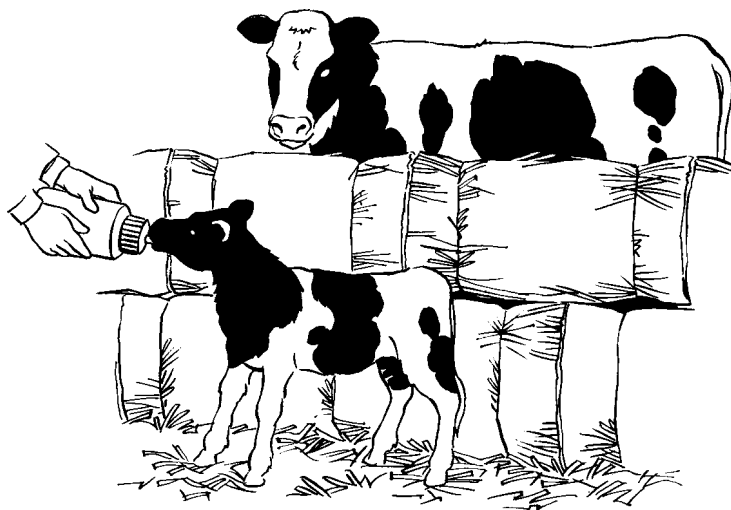
Wash and clean calf hutches on land that is not hydrologically sensitive and does not exhibit high nutrient loading. Alternatively, clean them on a paved surface where materials can be collected and applied to land that has low hydrological sensitivity. Do not house or graze animals on this land within the same year that the land was used for the application of potentially pathogen-infected manure.

### **Do you clean feeding and watering utensils between feedings?**

Thoroughly clean any feeding or watering implement with hot water and soap between animals, between feedings, and following any exposure to manure. Ideally, each calf must have its own feeding bucket to prevent cross contamination among animals.

- If calves cannot have their own feeding utensils, feed the youngest calves first. Older calves may be more likely to be infected than younger animals or may have developed immunity to parasitic pathogens.
- Minimize use of shovels, skidsteers, or other tools used for handling both manure and feed. If this is impossible, thoroughly clean these implements before using for feeding or watering animals.
- Do not allow feed to mix with manure within the feed bucket on the floor. Reducing the potential for fecal-oral contact decreases the risk of transfer of manure-borne pathogens.

Currently, no available disinfectant that can be used around animals will kill *Cryptosporidium parvum* oocysts. Only a few disinfectants, including Roccal D, are effective against *Giardia* cysts.



### **Are calves handled only by people familiar with biosecurity precautions?**

Pathogens can be inadvertently carried onto the farm on the shoes, clothing, or hands of people (friends, salespeople, technicians) who have visited other farms or on the tires or beds of vehicles.

- Require everyone who comes onto the farm to clean their boots thoroughly or put on disposable plastic ones before entering animal housing facilities.
- Do not permit calves to suck on the hands or clothing of visitors.

Pathogens can be transferred from older animals to younger ones through manure. All personnel working with calves should follow strict sanitary procedures to prevent this from happening.

### **Do calves have contact with clothing that is spotted or contaminated with manure?**

Calves like to suck on clothing. Clothing that is spotted with manure can be a source of pathogen infection if calves are allowed to suck on it. To minimize the risk of pathogen spread among calves

- wear hoseable overalls that can be cleaned before working with calves and between groups of calves.
- if hoseable overalls are not available, do not allow calves to suck on the clothing.
- work with younger calves first. Younger calves are most susceptible to infection and least likely to be carriers of parasitic pathogens.

### **Do you allow surface water runoff to enter calf housing facilities?**

Surface water entering the calf housing facility will dampen bedding, causing stress to animals and increasing susceptibility to disease. If runoff water is contaminated with manure before entering the facilities, it may cause calves to become infected with pathogens. Water moving through calf housing facilities can become contaminated with calf manure, making it likely that these protozoal pathogens will be transported to surface water bodies. Take the following steps to prevent surface water from entering facilities:

- Install diversions up slope from the facility to prevent water from entering the facility and mixing with manure and other contaminants.
- Contain runoff from calf housing facilities within a barnyard or other settling area. Store the runoff until it can be applied to land that has low hydrological sensitivity.
- Place well-managed filter areas down slope from the calf housing facility to collect manure and filter nutrients, chemicals, and pathogens carried in any runoff water.
- Install buffer strips along the banks of water bodies to protect these water sources by collecting some contaminants before they reach streams or lakes.

### **Do you treat calf manure to reduce pathogen viability before applying it to land?**

Calf manure can be treated to kill pathogens or applied to land areas least susceptible to leaching or runoff. The following methods will kill *Cryptosporidium parvum* oocysts:

- **Composting.** Research has shown that 99.99 percent of *Cryptosporidium parvum* oocysts are killed after two days at 148° F (50° C). Mix compost piles to allow the materials originally on the outside of the pile to be incorporated into the pile and heated to the necessary temperature to kill the oocysts. The high temperatures of compost piles will also kill other parasites, bacteria, and viruses. To ensure that most material has been heated and the compost pile is properly aerated, mix the pile at least three times. Depending on weather conditions and management of the compost pile, calf manure should be composted for at least three months.
- **Stacking manure in a pile.** Most manure piles reach temperatures of only 90° F. Research shows that 90 percent of the *Cryptosporidium parvum* oocysts were no longer viable in manure piles after 150 days.
- **Exposing manure to freeze-thaw cycles.** Manure incorporated into the soil in winter can be exposed to freeze-thaw cycles resulting in decreased viability of *Cryptosporidium parvum* oocysts and *Giardia* cysts. Do **not** surface apply calf manure in the winter because oocysts and cysts on the soil or snow surface will not be subjected to the same freeze-thaw cycles and may be susceptible to runoff while still viable.

### **How do you spread and store calf manure?**

To reduce risks of surface water contamination by *Cryptosporidium parvum* oocysts and *Giardia* cysts, manage manure from calves up to six months of age separately from that of older animals.

- Store calf manure in a location protected from rainfall, runoff, and leaching. Improperly stored calf manure could act as a point source of pathogens.
- Install diversions and curbs to minimize contamination of runoff water. Impermeable flooring must control leaching, and filter areas should be present to treat any contaminated water that runs off from the storage system.
- Do not spread calf manure near watercourses or on hydrologically sensitive areas where the probability of runoff or subsurface flows is high. Hydrologically sensitive areas include coarse soils that allow for rapid leaching, sloping land, saturated land, or land subject to flooding.

### **Are household and barnyard wells sealed to prevent contamination of groundwater?**

Unsealed wells can serve as a pathway for contaminants to reach groundwater. Cap and seal all wells, including abandoned ones, to minimize the potential for pathogens and other contaminants to travel through the shaft to groundwater.

### **Is calf production seasonal or continuous?**

Research has shown that the prevalence of *Cryptosporidium parvum* and *Giardia* is very low on farms with seasonal calf-raising practices.

- Noncontinuous calf raising helps to break the calf to calf infection cycle because these parasites are most effectively carried and multiplied in the guts of calves younger than six months of age. A small percentage of adult cattle shed *Giardia* cysts, so exposure to adult manure must also be controlled.
- Biosecurity practices, rodent control, and careful calf manure separation and spreading practices are more critical on farms that raise calves continuously because the potential for environmental contamination and buildup is greater.

### **Are pets, rodents, birds, and flies under control on your farm?**

Rodents and household or barnyard pets may become infected with pathogens, including *Cryptosporidium parvum* and *Giardia*. To prevent fecal contamination by pests or pets, store feeds and feeding utensils and do not allow pets to interact with young calves or to have contact with calf or cow manure. Control of pests and vermin may also reduce the exposure of animals to infection from various pathogens.

### **Do you allow young animals to graze on land to which manure has been applied within the past year?**

Calves less than six months old are susceptible to infection by *Giardia*. The cysts of this parasite can remain viable in the environment for an extended period of time. Calves can become infected with *Giardia* if they are allowed to graze on pastures to which calf manure has been applied within the past year.

### **Do calves and heifers have access to streams and other surface water sources?**

Do not allow these young animals to have access to streams or holding areas with direct access to streams. Locate calf housing facilities sufficiently away from streams or drainage ways to prevent direct movement of water from the facilities into watercourses. Ensure that vegetative buffers between calf housing facilities and water bodies are wide enough and have enough ground cover to minimize flows of contaminated runoff from the facilities into streams and lakes.

Older animals are not a risk for water quality contamination by *Cryptosporidium parvum*. They present a risk for contamination of streams with nutrients from manure and for the degradation of the stream banks by trampling, resulting in siltation and loss of aquatic habitat. Install fences, provide bridges or other walkways over streams, and create riparian buffer areas to keep all animals out of streams.

## **Resources**

### **Video**

“Waterborne Pathogens: Research and Resource Management.” 1997. Deborah Grantham, producer. 23 minutes. Cornell University Department of Soil and Crop Sciences, Ithaca, N.Y.

### **Fact Sheets**

Avery, B. K., and A. Lemley. 1996.

“*Cryptosporidium*: A Waterborne Pathogen.” Cornell Cooperative Extension, Ithaca, N.Y.

Staehr, A. E. 1995. “Pathogen Management for Livestock Farms.” Skaneateles Lake Watershed Agricultural Program, Lafayette, N.Y.

### **Technical Articles**

Conrad, N. 1996. Manure Impacts on Aquatic Systems. In “Animal Agriculture and the Environment: Nutrients, Pathogens, and Community Relations.” NRAES-96. Proceedings of the Animal Agriculture and the Environment North American Conference, December 11–13, 1996. Northeast Regional

Agricultural Engineering Service, Cornell University, Ithaca, N.Y.

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**Diagnosis of Disease Incidence on Farms****Cornell University Diagnostic Laboratory**

Fee-based analysis of animal disease and infectious contamination of animal wastes

[diaglab.vet.cornell.edu/dl\\_home.html](http://diaglab.vet.cornell.edu/dl_home.html)

607-253-3900 or -3333

Local farm veterinarian telephone: \_\_\_\_\_

**NYS Animal Industry Veterinarians**

518-457-3502 for referral to specific region

local number: \_\_\_\_\_

**NYS Cattle Health Assurance Program (NYSCHAP)**

Risk assessment of animal health concerns

[nyschap.vet.cornell.edu/](http://nyschap.vet.cornell.edu/)

Cornell: 607-255-8202

NYS Dept. of Ag. and Markets: 518-457-3502

Local number: \_\_\_\_\_

**Emergency Spills**

Local fire department telephone: \_\_\_\_\_

Police department telephone: \_\_\_\_\_

NYSDEC 24-Hour Spills hotline: 800-457-7362

**Financial Assistance****County Soil and Water Conservation District**

State and federal conservation programs including cost-share programs funded through the NYS Agricultural Nonpoint Source Abatement and Control Program

518-457-3738/local number: \_\_\_\_\_

**Natural Resources Conservation Service**

Federal conservation programs including EQIP, CRP, and WRP

[www.ny.nrcs.usda.gov/](http://www.ny.nrcs.usda.gov/)

315-477-6504/local number: \_\_\_\_\_

**Private sector organizations**

May provide assistance for barnyard management or other farm environmental conservation practices in some watersheds

Local number: \_\_\_\_\_

**U.S. Department of the Interior Fish and Wildlife Service**

Stream bank fencing and pasture management to protect fish, wildlife, and birds

607-753-9334/local number: \_\_\_\_\_

**Regulatory Guidelines****NYS Department of Environmental Conservation**

Information about and enforcement of state regulations

[www.dec.state.ny.us/index.html](http://www.dec.state.ny.us/index.html)

Local number: \_\_\_\_\_

**Municipal and county offices**

Information about and enforcement of local ordinances

Local numbers: \_\_\_\_\_

**Research and Educational Programs at Cornell University****Cornell Cooperative Extension**

County offices provide educational information on animal management, animal health, and biosecurity control.

[www.cce.cornell.edu/associations.html](http://www.cce.cornell.edu/associations.html)

Local number: \_\_\_\_\_

**Department of Agricultural and Biological Engineering**

Manure storage and treatment methods, barnyard management, animal housing facilities, and pesticide spray equipment

[www.cals.cornell.edu/dept/aben/](http://www.cals.cornell.edu/dept/aben/) 607-255-2465

**Department of Animal Science**

Feeds, forages, animal health, and biosecurity

[www.ansci.cornell.edu](http://www.ansci.cornell.edu) 607-255-5497

**Department of Crop and Soil Sciences**

Nutrient and crop management, crop production

[www.scas.cornell.edu](http://www.scas.cornell.edu) 607-255-5459

**Department of Natural Resources**

Wetland, stream bank, and floodplain management

[www.dnr.cornell.edu](http://www.dnr.cornell.edu) 607-255-7654

**Land and Water Management Program**

Video productions on pathogen management and water quality protection

[www.scas.cornell.edu/hmv1/s&wman/swman.html](http://www.scas.cornell.edu/hmv1/s&wman/swman.html)

607-255-4931

**Natural Resource, Agriculture, and Engineering Service**

Conferences and publications on agricultural production and environmental management technologies

[www.nraes.org](http://www.nraes.org)

607-255-7654

**NYS Home\*A\*Syst program (College of Human Ecology)**

Water well protection and testing

[www.human.cornell.edu/txa/extension/wq/homesyst.html](http://www.human.cornell.edu/txa/extension/wq/homesyst.html)

607-255-1943

**PRO-DAIRY Program**

Training courses on nutrient management, feeds and feeding, animal housing, biosecurity, and farm business management

[www.ansci.cornell.edu/prodairy/index.html](http://www.ansci.cornell.edu/prodairy/index.html)

607-255-4802

**Waste Management Institute**

Composting techniques, solid waste management, use of biosolids and septage

[www.cfe.cornell.edu/wmi/general.html](http://www.cfe.cornell.edu/wmi/general.html)

607-255-1187

**Technical Assistance****County Soil and Water Conservation District**

State conservation programs; list of CAFO planners

518-457-3738/local number: \_\_\_\_\_

**Natural Resources Conservation Service**

Federal conservation programs including EQIP, CRP, and WRP

[www.ny.nrcs.usda.gov/](http://www.ny.nrcs.usda.gov/)

315-477-6504/local number: \_\_\_\_\_

**NYS Animal Industry Veterinarians**

518-457-3502 for referral to specific region

Local number: \_\_\_\_\_

**Private consultants**

Certified CAFO planners can provide farmers with fee-based, NYSDEC-approved comprehensive nutrient management plans (CNMP). For a list of consultants in your area, contact the NYS AgriBusiness Association: 716-652-2191

Local number: \_\_\_\_\_

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