

# Ricin

**Last Updated:** January 2004



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Food Security  
& Public Health

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## Etiology

Ricin is a powerful protein toxin found in the castor plant, *Ricinus communis*. Ricin is present in all parts of the plant but is particularly concentrated in the seeds. The toxin could be used as a biological weapon. Purified toxin can be found in a crystalline form, as a dry lyophilized powder, or dissolved in liquid. Ricin acts by inhibiting protein synthesis.

## Transmission

Ricin is very toxic by several routes of exposure, including inhalation, ingestion and injection. Most natural exposures occur by ingestion. In mice, this is the least toxic route, as all of the toxin is not absorbed from the intestinal tract. Intact seeds have a hard coat and generally pass through the intestine without releasing toxic quantities of ricin; the toxin is released if the seeds are chewed or the seed coat is damaged.

## Inactivation/ Decontamination

Ricin can be inactivated by heat; it should be heated to 80°C for 10 minutes or to 50°C for approximately one hour at pH 7.8. A 0.1% sodium hypochlorite solution is also said to be effective, although some authorities recommend 0.5% sodium hypochlorite.

## Infections in Humans

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### Incubation Period

After ingestion, the incubation period is a few hours to a few days. After inhalation, the incubation period appears to be less than 8 hours; humans who were accidentally exposed to sublethal doses developed symptoms in 4 to 8 hours.

### Clinical Signs

#### *Clinical signs after ingestion*

Natural infections generally occur by ingestion. The ingested toxin usually causes severe gastrointestinal signs. The symptoms may include abdominal pain, diarrhea, fever, nausea, vomiting, incoordination, drowsiness and hematuria. The fluid loss can lead to dehydration, particularly in children. Vascular collapse and death can occur quickly, but most patients who survive for 3 to 5 days recover.

#### *Clinical signs after aerosol exposure*

The symptoms of toxicity appear acutely after aerosol exposure; the clinical signs may include fever, tightness of the chest, cough, dyspnea, nausea and arthralgia. In sublethal cases, profuse sweating occurred several hours later, followed by recovery. Lethal human exposures by aerosol have not been reported. Based on studies in laboratory animals, airway necrosis and pulmonary edema would probably develop within 24 hours. Severe respiratory distress and death from respiratory complications and circulatory collapse would be expected to occur within 36 to 72 hours. The symptoms would most likely include dyspnea, cyanosis and hypotension.

### Communicability

Toxins are not generally transmitted between people or animals. Ricin is not volatile and secondary aerosols are not expected to be dangerous.

### Diagnostic Tests

The diagnosis is usually based on clinical signs. Ricin can sometimes be detected in serum or respiratory secretions by enzyme-linked immunosorbent assays (ELISAs), and in tissues by immunohistochemistry. Polymerase chain reaction (PCR) assays can often find castor bean DNA in ricin preparations.

Ricin is very immunogenic and serology can be useful for a retrospective diagnosis. ELISA and chemiluminescence (ECL) tests are available.

## Treatment and Vaccination

Treatment is supportive. Depending on the route of exposure, it may include respiratory support and treatment for pulmonary edema, or gastric lavage and cathartics to remove the toxin from the digestive system.

Vaccines and antisera are not currently available, but have been promising for aerosol exposures in experimentally infected animals. A protective mask is currently the best form of protection from aerosol exposure; the eyes should also be protected whenever possible.

## Morbidity and Mortality

More than 750 cases of accidental or deliberate poisoning have been described in humans. The symptoms and outcome depend on the dose and route of exposure. By ingestion, two and a half to 20 seeds is a lethal dose, with children more susceptible than adults to small quantities of seeds.

## Infections in Animals

### Species Affected

Ricin can affect all domestic animals, including cattle, dogs, goats, horses, poultry, rabbits, sheep and swine but the susceptibility varies in different species. Horses are considered to be the most susceptible species; 0.01% of its body weight in seeds is toxic to a horse. Chickens, ducks and frogs are relatively insensitive to the effects of ricin.

### Incubation Period

After ingestion, the incubation period is usually a few hours to several days; 12 to 48 hours is most common. The incubation period varies with the amount of toxin consumed. In animal models, aerosols produce histological signs of toxicity after 8 hours.

### Clinical Signs

#### *Clinical signs after ingestion*

Most cases of ricin toxicity have occurred after ingestion of the seeds. In domestic animals, typical clinical signs include violent purgation, bloody diarrhea, tenesmus, anorexia, weakness, dehydration, thirst, salivation, trembling and incoordination. Muscle twitching, dyspnea, convulsions, opisthotonos and coma may be seen. Some affected animals may recover.

In horses, the symptoms of natural poisonings have included depression, trembling, sweating or shivering, an elevated temperature, cold extremities, dyspnea, incoordination, abdominal pain, constipation or diarrhea, and convulsions. A rocking gait, weak or rapid pulse and muscle spasms have also been seen. The initial symptoms may resemble respiratory infections.

In cattle, severe diarrhea with blood and mucus, weakness, shortness of breath, a feeble pulse, decreased

temperature, and swollen joints have been seen. Pregnant animals may abort and milk production may be severely decreased. In sheep and pigs, convulsions, incoordination, vomiting, weakness and death have occurred. Pigs may vomit frequently.

Poultry may have diarrhea, depression, emaciation and ruffled feathers. In one natural outbreak, poultry had ruffled feathers, impacted crops, drooping wings and grayish combs and wattles. Egg production stopped and the birds began to molt prematurely. In ducks, the symptoms may resemble botulism and can include ascending paralysis.

#### *Clinical signs after aerosol exposure*

Based on studies in laboratory animals, pulmonary edema and respiratory distress would be expected after aerosol exposure. In laboratory animals, inhaled toxin usually causes death from respiratory failure 36 to 72 hours after exposure. Severe respiratory signs are not usually seen after ingestion.

#### *Clinical signs after injection*

In experimentally infected animals, injected ricin caused disseminated intravascular coagulation, microcirculatory failure and multiple organ failure.

### Communicability

Toxins are not generally transmitted between animals or people. Ricin is not volatile and secondary aerosols are not expected to be dangerous.

### Diagnostic Tests

The diagnosis is usually based on clinical signs. In animal poisonings, red blood cell agglutination and precipitin tests are sometimes used for diagnosis. In humans, ricin can be detected in serum or respiratory secretions by enzyme-linked immunosorbent assays (ELISAs), and in tissues by immunohistochemistry. Polymerase chain reaction (PCR) assays can often find castor bean DNA in ricin preparations. Ricin is very immunogenic and serology can be useful for a retrospective diagnosis.

### Treatment and Vaccination

Treatment is supportive and typically includes intestinal detoxification and intestinal protectants. Sedatives, fluids, cathartics and ascorbic acid have been given. Antitoxins and vaccines have also been promising in experimentally infected animals but are not yet available.

### Morbidity and Mortality

Castor beans are grown commercially throughout the world and are planted as an ornamental in gardens. Accidental poisonings usually occur when animals chew the seeds or the seeds are mixed into their feed. The symptoms and outcome depend on the dose of toxin. Seeds equivalent to 0.2% of its body weight are toxic to a cow and 0.01% of its body weight in seeds can poison a horse. The

lethal dose by ingestion is 0.1 g/kg in horses, 1 to 2 g/kg in cattle, sheep, swine, rabbits and foals, and 5.5 g/kg in goats. Four to seven seeds will kill a rabbit, sheep, cow, horse or pig. Chickens and ducks are more resistant; approximately 80 seeds is a lethal dose.

## Post Mortem Lesions

After ingestion, the characteristic lesion is severe inflammation of the stomach and intestine. In cattle, hemorrhages in the heart, severe inflammation and erosions in the intestines, and necrosis of the kidneys and liver have been reported. Rodents exposed to aerosols develop severe lesions in the respiratory tract, including tracheitis, bronchitis, bronchiolitis, and interstitial pneumonia with perivascular and alveolar edema.

## Internet Resources

- Canadian Poisonous Plants Information System  
[http://sis.agr.gc.ca/pls/pp/poison?p\\_x=px](http://sis.agr.gc.ca/pls/pp/poison?p_x=px)
- Centers for Disease Control and Prevention (CDC)  
<http://www.cdc.gov/>
- Cornell University Poisonous Plants Informational Database  
<http://www.ansci.cornell.edu/plants/index.html>
- Plants Toxic to Animals. University of Illinois at Urbana–Champaign  
<http://www.library.uiuc.edu/vex/toxic/scilist.htm>
- The Merck Veterinary Manual  
<http://www.merckvetmanual.com/mvm/index.jsp>
- Toxic Plants of the Southeast. The University of Georgia  
<http://go-live.vet.uga.edu/vph/toxic/poison.htm#p18>
- USAMRIID’s Medical Management of Biological Casualties Handbook  
<http://www.vnh.org/BIOCASU/toc.html>
- U.S. Food & Drug Administration Poisonous Plant Database  
<http://vm.cfsan.fda.gov/~djw/readme.html>

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