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Ricin




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Toxin

- Castor plant - *Ricinus communis*
 - From processing waste
 - Castor beans for oil
 - Very stable
 - In several forms
 - Powder, mist, pellet, dissolved in water or weak acid
 - Irreversibly blocks protein synthesis
 - Potential medical uses



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Ricin toxin is found in the beans of the castor plant, *Ricinus communis*. It is one of the most lethal and easily produced plant toxins. The toxin is present in the entire plant but is concentrated in its seeds. Ricin can be in the form of a powder, mist, or pellet, or dissolved in water or weak acid. It is a very stable substance and is not affected by extremes in temperature. Castor beans are processed throughout the world to make castor oil. Ricin is part of the waste “mash” produced when castor oil is made. Ricin irreversibly blocks protein synthesis. Ricin has some potential medical uses, such as bone marrow transplants and cancer treatment (to kill cancer cells).
<http://www.clunet.edu/wf/chap/flowers/fwr-1005.htm> photo of castor plant and seeds.

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History



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History

- World War I
 - Considered for use as weapon by US
- 1978: London
 - Assassination of Bulgarian exile, Georgi Markov
- 1991: Minnesota
 - Patriot's Council plot to kill US Marshal

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Because of its relatively high toxicity and extreme ease of production, ricin was considered for weaponization by the U.S. during its biological weapons research program. In 1978 it was used for the assassination of the Bulgarian defector Georgi Markov. It is said that a ricin pellet was injected into Markov by a specially engineered weapon disguised as an umbrella. Markov died three days after the incident. This assassination was carried out by the communist Bulgarian government, and the technology to commit the crime was supplied by the former Soviet Union. In Minnesota, four members of the Patriots Council, an antigovernment extremist group, were arrested in 1991 for plotting to kill a U.S. Marshal with ricin. The group planned to mix the homemade ricin with DMSO and then smear it on the door handles of the Marshal's car. The plan was discovered and all four men were arrested. Some reports have indicated that ricin may have been used in the Iran-Iraq war during the 1980s and that quantities of ricin were found in Al Qaeda caves in Afghanistan. In January of 2003, castor oil beans, the equipment and containers for crushing them, and traces of the ricin toxin were found in a London apartment.

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History

- Iran-Iraq war
 - Reports of ricin use
 - Found in Al Qaeda caves in Afghanistan
- 2003
 - Ricin found in London apartment
- 2004
 - Toxin found in Senator's office
 - Found in letter; source unknown

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Transmission

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Transmission

- Three routes
 - Inhalation
 - Ingestion
 - Injection
- Person-to-person transmission does not occur

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Three routes of exposure are known to exist for humans and animals: inhalation, natural infection by ingestion, and injection. Depending on the route of exposure (such as injection), as little as 500 micrograms of ricin could be enough to kill an adult. A 500-microgram dose of ricin would be about the size of the head of a pin. A much greater amount would be required to kill a human being by either the inhalation or ingestion routes. Toxins are not usually transmitted person-to-person or animal-to-animal. Secondary aerosolization is not thought to be of concern.

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Human Disease

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Signs and Symptoms

- Inhalation
 - Incubation less than 8 hours
- Ingestion
 - Incubation few hours to few days
- Injection
 - Incubation immediate to hours

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The incubation period for ricin is dependent on the route of transmission. If the toxin is inhaled, the incubation is about eight hours. The incubation period for ingestion is a few hours to days. If ricin is injected under the skin, the incubation period could be immediate to several hours, depending on the location of injection and the dose of toxin injected.

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Clinical Symptoms

- Inhalation
 - Cough, weakness, fever, nausea, muscle aches, chest pain and cyanosis
 - Pulmonary edema, 18-24 hours after inhalation
 - Severe respiratory distress
 - Death from hypoxemia, 36-72 hours

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The initial symptoms associated with inhalation of ricin toxin are cough, weakness, fever, nausea, muscle aches, chest pain and cyanosis. Pulmonary edema occurs about 18-24 hours after inhalation, and severe respiratory distress and death from hypoxemia ensues at 36-72 hours.

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Clinical Symptoms

- Ingestion
 - Least toxic form
 - Less toxic if castor beans swallowed whole
 - Severe GI symptoms, 1-2 hours
 - Rapid heartbeat
 - Internal bleeding
 - Vascular collapse
 - Death occurs in 3 days or more



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The least toxic form of poisoning is by ingestion. Symptoms are also less severe if the seeds are swallowed whole as they have a thick coat which limits absorption of the toxin. Less than a few hours after ingestion, severe gastrointestinal signs occur, including nausea, vomiting, intestinal cramps and headache. These signs are followed by diarrhea and hemorrhage from the anus and dilation of the pupils. This generally leads to vascular collapse and death in three days or more. Image: Castor beans from <http://museum.gov.ns.ca/poison/castor1.htm>. The seeds of the castor bean are very attractive, which is why they are popular in certain costume jewelry. Unfortunately, they also look good enough to eat, which is why small children are the most common victims of castor poisoning.

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Clinical Symptoms

- Injection
 - Local pain and necrosis at site of injection
 - Systemic signs similar to those of ingestion

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There are no specific data on injection of ricin into humans, and likely human symptoms are based on those of animal models. Initially it would be expected that a person would experience local pain and necrosis at the site of injection, followed by systemic signs. Death would likely ensue at three or more days after exposure.

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Diagnosis

- Based on clinical symptoms
- ELISA
 - Serum or respiratory secretions
- Immunohistochemistry
 - Tissues
- Serology for retrospective diagnosis
 - Ricin is very immunogenic

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The diagnosis of ricin toxicosis is often based on clinical symptoms. Detection of the toxin in serum or respiratory secretions can be done by ELISA and immunohistochemistry on infected tissues. Ricin is very immunogenic, thus the toxin can be detected via serology.

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Treatment

- No treatment, vaccine or antisera currently available
- Supportive care
 - Dependent on route of exposure
 - Ventilator
 - Gastric lavage or cathartics

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There is no treatment or vaccine currently available for ricin poisoning. Supportive care is recommended based on the route of exposure, and includes respiratory support for inhalational exposure, gastric lavage and cathartics to remove the toxin from the GI tract if ingestion has occurred.

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Animals and Ricin

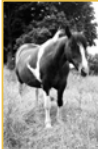
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Animals Affected

- Affects all domestic animals
- Horses most susceptible
 - Lethal dose 0.01% of body weight in seeds
- Chickens, ducks and frogs somewhat insensitive to toxin



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Ricin can affect all domestic animals. Horses seem to be the most susceptible to the effects of ricin, as they require the lowest dose of toxin. The most common form of natural animal infection is by ingestion; if the seeds are ingested whole the animal may show no signs. Chickens, ducks and frogs have shown to be somewhat resistant to the toxin.

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Clinical Signs

- Inhalation
 - Pulmonary edema
 - Respiratory distress
 - Death 36-72 hours



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Clinical signs were observed in experimental studies in laboratory animals. Inhalation of ricin would likely cause pulmonary edema, respiratory distress and death within 36-72 hours. The photo is an example of the lungs from a monkey exposed to ricin by aerosol. The lungs are edematous, with accompanying hemorrhage and necrosis. Courtesy of CL Wilhelmsen, DVM, PhD, Lieutenant Colonel, Veterinary Corps, U.S. Army; Division of Pathology, US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD. http://www.vnh.org/MedAspChemBioWar/chapters/chapter_32.htm#Diagnosis

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Clinical Signs

- Ingestion
 - Most common route
- Initial clinical signs
 - Frequent and violent vomiting, diarrhea, depression, weakness and shortness of breath
 - Salivation, trembling and incoordination
- Some affected animals may recover
 - With or without treatment

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Ingestion of ricin is the most common form of naturally occurring infection. If the seeds are eaten whole the severity of signs is decreased and seeds may pass with no ill consequences occurring. Severe vomiting and diarrhea are often seen with depression, weakness and shortness of breath. Trembling and incoordination accompanied by sweating or shivering can be seen. Death ensues in many animals but some animals do recover after ingestion of ricin.

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Diagnosis and Treatment

- Diagnosis and treatment in animals similar to humans
- Experimental vaccines and antitoxins promising but not yet available

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The diagnosis and treatment of animals infected with ricin are similar to that of humans with ricin toxicosis, which is based on the clinical signs. Research is being conducted on vaccines which are immunogenic and can offer protection against aerosolized ricin.

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Control and Protection

- Research on vaccines and antisera
- Decontaminate exposed skin
 - Soap and water and/or
 - 0.1% sodium hypochlorite (bleach)
- Protective mask
 - Effective against aerosol exposure
- Standard precautions
 - Should be used by healthcare workers

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Promising research is being conducted in animals for ricin antisera and vaccination. If exposure is suspected, decontamination of the area or exposed skin should be done with soap and water or with a 0.1% sodium hypochlorite bleach solution. A protective mask is effective against aerosol exposure. Standard safety precautions should be followed by all health care workers if exposure is suspected.

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Ricin as a Biological Weapon

- Extreme ease of production
- Widely available
- Relatively high toxicity
- Currently no treatment
 - Supportive care only

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Because of ricin's extreme ease of production, wide availability and the fact that it is one of the most potent plant toxins known, it is considered to be a potential agent that could be used for bioterrorism.

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Acknowledgments

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