

APPENDIX B. Biological Agents

This section provides basic information on six biological agents that may potentially be used by terrorists as weapons:

- › Anthrax
- › Botulism
- › Plague
- › Smallpox
- › Tularemia
- › Viral Hemorrhagic Fevers

These agents are classified as Category A (highest concern) by the Centers for Disease Control and Prevention (CDC) because they have the potential for major public impact and are known to have been studied by some countries for use in biological warfare.

Information on other possible biological agents can be found in the reference guide at <http://www.hhs.gov/emergency> or at <http://www.bt.cdc.gov>.

Please note that the descriptions of signs and symptoms in this section are not meant to be used to self-diagnose illness—they are for informational purposes only. Contact a health care provider if you suspect that you have been exposed to one of these agents or if you feel sick.

BASIC FACTS FOR BIOLOGICAL AGENTS

INFECTIOUS DISEASES

Infectious diseases are caused by the invasion of the body by harmful microorganisms. These microorganisms multiply and make the person sick by attacking organs or cells in the body. They include viruses and bacteria, as well as certain other microscopic organisms, and are sometimes called pathogens. All of the diseases discussed in this section are considered infectious diseases.

CONTAGIOUS DISEASES

A **contagious disease** is an infectious disease that can be “caught” by a person who comes into contact with someone who is infected. Not all infectious diseases are contagious. Exposure to a contagious disease usually happens through contact with the infected person’s bodily fluids or secretions, such as a sneeze.

TOXINS

Toxins are the poisonous, usually protein-based substances produced by microorganisms (bacteria, mold, virus) in certain infectious diseases. Microorganisms use these toxins as the specific weapons for attacking organs or cells in the body. Although toxins are usually classified as being biologically produced, common language often refers to the poisons created by nonliving chemical agents as chemical toxins.

BACTERIA AND VIRUSES

Bacteria


- › One-celled microorganisms that contain several components within the single cell.
- › Some bacteria can also exist as spores that help them survive harsh conditions. Spores can germinate to become full-fledged bacteria; this is the case with anthrax.
- › Antibiotics can be used to kill bacteria.

Viruses

- › Bits of deoxyribonucleic acid (DNA) or ribonucleic acid (RNA).
- › Viruses need to infect living cells to survive and multiply.
- › Antibiotics do not affect viruses; some antiviral medications exist.

DELIVERY OF BIOLOGICAL AGENTS

- › The ability to successfully deliver a biological attack depends on:
 - The type of agent or organism
 - The method of dissemination
 - The weather (e.g., wind speed, humidity, time of day, precipitation, temperature)
- › Biological agents can enter the body through absorption, inhalation, ingestion, and injection.
- › Biological weapons can be delivered by:
 - Wet or dry aerosol sprayers
 - Explosive devices
 - Transmission through insects, animals, or humans
 - Introduction into food, water, or even medications
 - In or on objects, in some cases (e.g., anthrax in envelopes)

 **BIOLOGICAL AGENTS QUICK REFERENCE CHART**

AGENT	DESCRIPTION	FIRST SIGNS AND SYMPTOMS	FIRST ACTIONS	MEDICAL RESPONSE
Anthrax	Skin, intestinal, or inhalational infection that is caused by bacteria. Signs and symptoms begin within 7 days. Not contagious.	Skin: blisters with black center. Intestinal: nausea, loss of appetite, like stomach flu. Inhalational: flu-like signs and symptoms that progress to severe breathing problems.	Contact your health provider.	Antibiotics should be started as soon as possible.
Botulism	Muscle-paralyzing disease caused by exposure to a bacterial toxin. Could be released in air, water, or food. Not contagious.	Blurred/double vision, slurred speech, drooping eyelids. Can lead to paralysis.	Immediately seek medical care.	Antitoxin and/or supportive care and/or ventilator.
Pneumonic Plague	Lung infection caused by bacteria. Could be released into the air. Signs and symptoms generally begin within 2–4 days of exposure. Contagious through coughing.	Rapidly developing pneumonia with fever, cough, and chills.	Immediately seek medical care.	Antibiotics must be started within 24 hours of signs and symptoms. Isolation for infected persons.
Smallpox	Severe illness with rash caused by a virus. Officially eradicated worldwide in 1980, but has resurfaced as a potential bioterrorist agent. Signs and symptoms begin within 7–17 days of exposure. Contagious.	High fever and aches followed by a severe rash of round lesions.	Contact your health provider.	Vaccines should generally be given within 3 days of exposure to prevent infection or lessen illness. Isolation for infected persons.
Tularemia	Disease caused by bacteria, which could be released in air, food, or water. Signs and symptoms generally begin within 3–5 days of exposure. Not contagious.	Sudden fever, chills, coughing, aches.	Contact your health provider.	Antibiotics.
Viral Hemorrhagic Fevers	Diseases contracted from viruses such as Ebola. Could be transmitted via bodily fluids of infected animals or humans. Contagious.	Fever, vomiting, diarrhea, heavy bleeding.	Immediately seek medical care.	Isolation for infected persons. Supportive care.

BIOLOGICAL TESTING

Quick diagnosis and treatment of a patient exposed to a biological agent are key to saving that patient's life. A biological attack may go unnoticed until large groups of people begin exhibiting signs and symptoms. But currently there is no single test that can diagnose whether a person has been exposed to biological agents. It is likely that a combination of tests will be used. In the absence of immediate results, physicians who suspect bioterrorism may begin a preliminary course of treatment until the lab results are in. There is no single answer to the question of how long testing will take. The testing of biological agents is complicated by several factors, which can affect timing. These factors include:

- › Identifying the Agent: Actual incidents of bioterrorism have been rare, leaving today's physicians with limited experience in identifying these agents in the lab or treating affected patients. The first patients who become sick may be mistaken for having other illnesses, thus causing a delay in the effort to test for biological agents.
- › Presumptive vs. Confirmatory Diagnoses: Not all tests are conclusive. Some tests can give a presumptive diagnosis that an agent is present, but followup tests are needed. In general, presumptive diagnosis of an agent can usually be made in about a day. Confirmatory diagnosis can take 2–3 days.
- › Viral, Bacterial, or Toxin Load: The “load” refers to how much of the agent is present in a patient. If relatively large amounts of an agent are present in a patient, cultures designed to grow the bacteria or virus could take as little as a few hours. If smaller amounts of the agent are present in a patient, these same culture tests could take up to 2 or 3 days.
- › Lab Capabilities: Can the needed tests be done in local labs, near a suspected attack, or do the samples need to be shipped out to more advanced labs, thus affecting the overall timeline? Shipping samples to more advanced labs can tack on an extra day or two to the wait time. CDC's Laboratory Response Network (<http://www.bt.cdc.gov/lrn>) helps facilitate this process.
- › The Kind of Test That Is Used: Numerous tests are employed to detect the presence of bioterror agents. Blood cultures can take up to 3 days, in some cases for example, but Gram stains can be ready within an hour. However, some of these quicker tests will only give preliminary information, which must be confirmed with more comprehensive tests.

More information on testing can be found in the media reference guide at <http://www.hhs.gov/emergency>.

You may notice that specific guidance on food and water safety after a terrorist attack is not included in this guide. The effect of an attack or other public health emergency on food and water supplies is very situation specific. As a result, public health officials will provide specific information on food and water safety as needed.

ANTHRAX

BASIC FACTS

- › Rod-shaped bacteria (not a virus) that can be treated with antibiotics if diagnosed early.
- › Anthrax is the disease that develops after exposure to spores produced by these bacteria.
- › The spores can remain dormant for long periods but are still capable of causing infection when someone comes in contact with them by touching or breathing them in.
- › The anthrax illness is not contagious.
- › A new vaccine is currently being produced for the Strategic National Stockpile (SNS) in case of an attack. An older anthrax vaccine exists but is not in widespread use.

ANTHRAX ILLNESSES

- › Anthrax spores can cause three types of illness, depending on how a person is exposed:
 - Inhalational (respiratory)—most lethal
 - Cutaneous (skin)
 - Gastrointestinal (digestive)

Inhalational Anthrax

Exposure

- › Victims breathe in spores floating through the air; the spores then lodge in their lungs.
- › Certain cells take the spores to the lymph nodes surrounding the lungs. Once the spores enter the lymph nodes, they germinate into bacteria and cause inflammation and enlargement of these lymph nodes.

- › Anthrax bacteria then spread from the lymph nodes to sites throughout the body and produce a toxin that can be destructive to organs and is difficult to treat.

Signs and Symptoms

Signs and symptoms can occur within 7 days of infection or can take up to 42 days to appear. These signs and symptoms include:

- › Fever (>100°F)
- › Flu-like signs and symptoms
- › Cough, chest discomfort, shortness of breath, fatigue, or muscle aches
- › Sore throat, followed by difficulty swallowing; enlarged lymph nodes; headache; nausea; loss of appetite; abdominal distress; vomiting; or diarrhea

Recovery/Mortality Rate

The survival rate for inhalational anthrax victims depends on quick diagnosis and treatment with antibiotics. The mortality rate is approximately 75 percent even with antibiotics, while untreated inhalational anthrax has a 90 percent mortality rate.

Cutaneous Anthrax

Exposure

Anthrax spores or bacteria enter the body through an open wound or cut or microscopic breakdowns of the skin.

Signs and Symptoms

- › Signs and symptoms appear within 1–7 days after exposure.
- › A small sore quickly develops into a blister, which becomes a skin ulcer and ultimately develops a black scab in the center.
- › The sore, blister, and ulcer do not hurt and initially look like a spider bite.

Recovery/Mortality Rate

The survival rate is 80 percent without treatment and more than 99 percent with treatment.

Gastrointestinal Anthrax

Exposure

Gastrointestinal anthrax occurs when anthrax is ingested, usually through meat from anthrax-infected animals.

Signs and Symptoms

- › First signs and symptoms of the infection appear within 2–5 days of exposure, including initial signs and symptoms of nausea and loss of appetite and later signs and symptoms of bloody diarrhea, fever, and severe stomach pain.
- › Signs and symptoms mirror those for stomach flu, food poisoning, and appendicitis.

Recovery/Mortality Rate

If untreated, at least 25 percent of gastrointestinal anthrax cases lead to death.

DIAGNOSIS

Early diagnosis is the key to successful treatment of anthrax. However, there is no single screening test to confirm anthrax illness.

- › Blood tests may be used, but can take up to 72 hours.
- › If inhalational anthrax is suspected, physicians typically obtain a chest X-ray and a CAT scan.
- › Nasal swabs can detect the presence of spores, but are not a diagnostic tool. A positive swab does not mean a person will develop an anthrax illness, and a negative swab does not mean a person will not develop an anthrax illness. A nasal swab is only an indicator of whether anthrax spores are present in an area.

TREATMENT

- › All three types of anthrax can be treated with antibiotics. Ciprofloxacin may be used, but doxycycline is now the preferred antibiotic. Antibiotics are prescribed for 60 days.
- › Treatment must begin as soon as possible after exposure to be successful, because the bacteria produce a toxin in the body that poisons the system quickly and sometimes irreversibly. Antibiotics kill the bacteria but cannot remove the toxin or lessen the effects of any toxin already in the body. There is no antitoxin for the anthrax toxin.

- › Those with inhalational anthrax may need hospitalization and a ventilator to help with breathing.

BOTULINUM TOXIN

BASIC FACTS

- › Botulism is a muscle-paralyzing disease that develops after a person is poisoned with botulinum toxin, which is produced by the bacterium *Clostridium botulinum* (not a virus).
- › The toxin is colorless, odorless, and tasteless and can be disseminated via air, water, or food.
- › Botulism is not contagious.
- › A rare form of botulism, wound botulism, will not be discussed here.

BOTULINUM TOXIN ILLNESSES

Foodborne Botulism

Exposure

- › This form of botulism is typically caused by eating improperly preserved or cooked food; it could also occur if food were contaminated deliberately with the toxin.
- › Contaminated food may be discolored or have a bad odor or taste.

Signs and Symptoms

- › Generally begin 18–36 hours after eating contaminated food but can occur as early as 6 hours or as late as 10 days afterwards.
- › Initial signs and symptoms include blurred or double vision, slurred speech, drooping eyelids, difficulty swallowing, dry mouth, and muscle weakness.
- › Botulism toxin spreads throughout the body and predominantly affects the nervous system.
- › Within hours, a facial paralysis begins and spreads to the rest of the body.
- › Botulism can result in respiratory failure.

Recovery/Mortality Rate

If treated, ingested botulism has a survival rate of over 90 percent.

Inhalational Botulism

Exposure

- › Does not occur naturally and only three cases (from a laboratory accident) have ever been reported
- › Would be caused if people inhaled refined botulinum toxin disseminated through the air

Signs and Symptoms

- › Similar to those of foodborne botulism.
- › Signs and symptoms may begin several hours to several days after an airborne attack.

Recovery/Mortality Rate

Because there are so few recorded cases, the fatality rate is unclear.

DIAGNOSIS

Botulism is a rare disease. Whether it is naturally occurring or the result of terrorism, a single case of the illness may be difficult for physicians to diagnose. However, if several or many cases appear together, it is likely that the diagnosis would be made quickly.

- › There is no single test to detect botulinum poisoning. Blood tests and stool sample tests may be useful.
- › Suspected foods may also be tested.
- › Special tests (e.g., brain scan) may be needed to exclude similar conditions from botulism.

TREATMENT

Prompt medical attention is the key to successful treatment for a botulism illness.

- › Treatment should begin as soon as botulism is suspected and may include use of an antitoxin.
- › This antitoxin reduces the spread of paralysis but will not reverse paralysis that has already set in.
- › With treatment, most paralysis will eventually go away, but in severe cases, patients may need long-term care, including a ventilator.

PLAGUE

BASIC FACTS

- › Plague is the disease that develops after infection with the bacterium *Yersinia pestis* (not a virus).
- › Humans contract plague by inhaling it or from the bite of an infected flea.
- › Plague infection takes three primary forms:
 - Bubonic
 - Pneumonic
 - Septicemic
- › Only pneumonic plague is contagious through respiratory droplets with direct close contact (within 6 feet).
- › Plague is highly lethal if untreated but can be treated with antibiotics if caught early.
- › Some plague infections occur naturally each year (usually bubonic).

PLAGUE ILLNESSES

There are three common forms of illness caused by the plague bacteria:

Bubonic

Exposure

- › Bubonic plague is caused when infected fleas bite humans or through a break in the skin.
- › This form of plague illness is not contagious.

Signs and Symptoms

- › Bubonic plague infects the lymphatic system and causes severe swelling.
- › The first signs and symptoms appear 2–6 days after infection and include weakness, high fever, and chills.
- › If bubonic plague is not treated, bacteria can spread through the bloodstream, causing septicemic plague or a secondary case of pneumonic plague.
- › Later signs and symptoms include muscular pain, swelling of lymph glands, and seizures.

Recovery/Mortality Rate

If untreated, bubonic plague is fatal in over 50 percent of cases.

Pneumonic

Exposure

- › This form of the disease infects the lungs. It is caused by breathing in aerosolized plague.
- › This illness can be transmitted from person to person through respiratory droplets with direct close contact (within 6 feet).

Signs and Symptoms

- › Signs and symptoms usually appear 2–4 days (range of 1–6 days) after exposure.
- › Initial signs and symptoms include high fever, cough, and chills similar to the flu.
- › Later signs and symptoms include pneumonia and bloody sputum (coughing up blood).

Recovery/Mortality Rate

Without early detection and treatment, the mortality rate from pneumonic plague is nearly 100 percent. If treated, the mortality rate from pneumonic plague is still 50 percent.

Septicemic

Exposure

- › Septicemic plague may be a secondary illness caused by complications from bubonic or pneumonic plague, or it can occur by itself.
- › Plague bacteria enter the bloodstream.
- › This form of the disease is not contagious.

Signs and Symptoms

- › Signs and symptoms appear 2–6 days after infection.
- › Initial signs and symptoms include nausea, vomiting, fever, and chills.
- › Later signs and symptoms include low blood pressure, abdominal pain, shock, and, finally, internal bleeding.

Recovery/Mortality Rate

Death occurs rapidly if this form of plague is untreated, but even with treatment, the recovery rate is only 50 percent.

DIAGNOSIS

Plague can be difficult to diagnose because its initial signs and symptoms are flu-like and the disease progresses so rapidly. A bioterror attack involving plague could go undetected until large groups of people begin exhibiting signs and symptoms.

- › If bubonic plague is suspected, physicians check for the presence of a painful, swollen lymph node called a bubo, which occurs no more than 24 hours after initial signs and symptoms.
- › Blood cultures, a sputum sample, or examination of a lymph node sample can confirm plague.
- › Physicians will ask for a travel history from the patient to see if he or she has traveled to a known outbreak area.

TREATMENT

- › Antibiotic treatment for pneumonic plague must begin within 24 hours after the first signs and symptoms to be successful.
- › Antibiotics, such as streptomycin, gentamicin, the tetracyclines, and chloramphenicol, are all effective against plague and may be provided to those exposed or with a suspected diagnosis.
- › Patients with pneumonic plague should be isolated to prevent disease spread.

SMALLPOX**BASIC FACTS**

- › The smallpox virus (*Variola Major*) is moderately contagious; direct, face-to-face contact is usually required to spread the disease.
- › Characterized by skin lesions and high fever, smallpox historically has killed approximately 30 percent of those infected.
- › Officially eradicated in nature in 1980, smallpox has more recently been of concern as a potential bioterrorism threat.
- › Routine vaccinations in the United States ended in 1972. At present, a large portion of the population is considered vulnerable to infection should a bioterrorism incident occur.

SMALLPOX ILLNESS**Exposure**

- › The incubation period is typically 7–17 days following exposure.
- › Typically, people with smallpox are not contagious until lesions start appearing and they are obviously ill.
- › The virus is usually spread by droplets, however, having it spread by aerosol or contaminated objects (e.g., bedding) is also possible.
- › Smallpox is not known to be transmitted by insects or animals.

Signs and Symptoms

- › Initial signs and symptoms of smallpox may include high fever, fatigue, headache, and backache.
- › *Two to three days* after the onset of signs and symptoms: A rash of round lesions develops on the face, arms, and legs. At the same time, lesions in the mouth are also present and release large amounts of the virus into the saliva.
- › *Seven days* after the onset of signs and symptoms: The lesions become small blisters and, by the seventh day, are filled with pus.
- › *Twelve days* after the onset of signs and symptoms: Lesions begin to crust over. Severe abdominal pain and delirium can occur in the later stages of the disease.
- › *Three to four weeks after the onset of signs and symptoms*: Scabs develop and fall off. A patient who survives is no longer contagious after the final scab falls off.

Recovery/Mortality Rate

Death is likely in 30 percent of all smallpox cases, usually during the first or second week of illness.

DIAGNOSIS

- › Smallpox is most commonly identified by the distinctive rash it causes, although the rash can sometimes be confused initially with chicken pox.
- › The smallpox lesions are painful (as opposed to chicken pox lesions) and the distribution of lesions on the body is different than chicken pox.

- › Patients with smallpox are typically much sicker than those with chicken pox.
- › Testing of the fluid from the lesions can confirm smallpox.

TREATMENT

- › There is no way to fight the virus once patients become sick. Antibiotics are not effective.
- › Patients with smallpox are isolated to prevent disease spread.
- › Patients with smallpox may require supportive care, such as intravenous (IV) fluids and medication to control fever or pain.

VACCINE

There is now enough vaccine available in the SNS for every American in case of an attack.

- › The vaccine contains a live virus (vaccinia) which is related to the smallpox virus but entirely different from it; it cannot give someone smallpox.
- › The vaccine provides a high level of immunity from infection for 3–5 years after vaccination and decreasing immunity thereafter. It is unclear how long the vaccine provides some protection against the disease. If a person is vaccinated again later, immunity lasts even longer. However, if a person actually has had smallpox and survives, he or she then has lifelong immunity.
- › The vaccine prevents disease in 95 percent of those vaccinated.
- › Given within 3 days after exposure to the smallpox virus, the vaccine will prevent or significantly modify smallpox in the majority of persons. Vaccination 4–7 days after exposure likely offers some protection from disease or may modify the severity of the disease.
- › The smallpox vaccine is currently not administered to the general public because the likelihood of an attack is not known, and vaccination can result in complications for some people.
- › The vaccine is effective after one dose, so it could easily be given to many people if a smallpox event or outbreak takes place.
- › Vaccination of only those people who might have been exposed to the smallpox virus and their contacts (ring vaccination) was used successfully in the past to eradicate smallpox.

However, mass vaccination might be necessary in the aftermath of a terrorist attack.

- › More information on smallpox vaccination can be found in the media reference guide at <http://www.hhs.gov/emergency>.

TULAREMIA

BASIC FACTS

- › Tularemia is the disease caused by the bacterium *Francisella tularensis* (not a virus); it is also known as Rabbit Fever or Deer Fly Fever.
- › Tularemia can spread to humans from infected animal tissue, contaminated food and water or the air.
- › Tularemia is not contagious.
- › There are three types of tularemia:
 - Ulceroglandular
 - Inhalational
 - Typhoidal

TULAREMIA ILLNESSES

The tularemia infection takes several forms, depending on the strength of the bacteria and how they enter the body.

Ulceroglandular

Exposure

People can contract this disease from the bite of an infected tick or fly or when an open wound comes in contact with infected meat.

Signs and Symptoms

- › Signs and symptoms typically appear between 3 and 5 days, but sometimes as late as 14 days after exposure.
- › Skin ulcers appear at the infection site. Lymph nodes in the area become swollen.

Recovery/Mortality Rate

The disease is treatable with antibiotics and, with treatment, fewer than 2 percent of victims die from this form of tularemia.

Inhalational

Exposure

The disease is contracted by inhaling the bacteria.

Signs and Symptoms

- › Signs and symptoms typically appear within 3–5 days, but sometimes as late as 14 days after exposure.
- › Early signs and symptoms include sudden fever, chills, coughing, joint pain, weakness, and headaches, similar to the flu.
- › Later signs and symptoms include inflamed eyes, oral ulcers, severe pneumonia, chest pain, and respiratory failure.

Recovery/Mortality Rate

This form of the disease is treatable by antibiotics, but inhalational tularemia has a 60 percent mortality rate if untreated.

Typhoidal

Exposure

This is a secondary form of tularemia that develops after a victim has contracted inhalational tularemia.

Signs and Symptoms

- › This form of tularemia attacks the circulatory system as well as the respiratory system.
- › Signs and symptoms include fever, extreme exhaustion, and weight loss.

Recovery/Mortality Rate

This form of tularemia is treatable with antibiotics. The recovery rate is similar to that for inhalational tularemia.

DIAGNOSIS

All forms of tularemia are difficult to diagnose because early signs and symptoms resemble those of the cold and flu.

A rapid diagnostic test for tularemia does not exist. Chest X-ray and/or blood tests may be used.

TREATMENT

All forms of tularemia can be successfully treated with antibiotics, including streptomycin, gentamicin, or doxycycline.

VIRAL HEMORRHAGIC FEVERS

BASIC FACTS

- › Viral hemorrhagic fevers (VHFs) are a class of diseases, contracted from viruses, that include:
 - Ebola
 - Marburg virus
 - Other illnesses (e.g., Lassa, Machupo)

The following are general characteristics of VHFs:

- › They are naturally occurring in mosquitoes, ticks, rodents, and other animals.
- › They cause massive internal and external bleeding.
- › The fatality rate can be as high as 90 percent.
- › With the exception of yellow fever and Argentine hemorrhagic fever, no vaccines exist.
- › No drugs are available to combat the viruses that cause VHFs.

VIRAL HEMORRHAGIC FEVER ILLNESSES

Ebola

Of all the VHFs, Ebola is probably the best known due to outbreaks in Africa.

Exposure

- › Ebola can be passed to humans through infected animals.
- › Once a person becomes ill, the virus can be transmitted to others through exposure to blood or bodily fluids, including airborne droplets from coughing.

Signs and Symptoms

- › Patients usually become sick 4–6 days after exposure.
- › The disease attacks blood vessels and organs, particularly the liver, spleen, and kidneys, causing heavy bleeding.

- › Signs and symptoms include fever, vomiting, diarrhea, and heavy bleeding from multiple sites.

Recovery/Mortality Rate

The fatality rates range from 50–90 percent within 1–2 weeks of illness onset.

DIAGNOSIS

- › Specific laboratory tests exist to detect the virus in a blood sample, but the handling of the virus is a biohazard, so tests need to be performed in a biosafety level 4 laboratory.
- › Diagnosis is usually made by monitoring signs and symptoms and by tracking a patient's exposure to the virus.

TREATMENT

- › Physicians treat the patient with fluids to prevent dehydration and try to control bleeding.
- › Patients and people who have had close physical contact with patients will need to be isolated and closely monitored.
- › Hospital workers and caregivers must wear gowns, gloves, and masks and practice extreme caution while treating patients.

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