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FOODBORNE ILLNESS

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The foodborne illnesses comprise a wide variety of toxemias and infections. Their common denominator is the transmission of a causative agent via food. This assortment of maladies can best be subdivided into three major categories.

The first category includes the traditional forms of food poisoning caused by preformed toxins that may contaminate different dietary constituents. These toxins may be of biologic origin (microbial, plant, or animal toxins) or they may be inorganic or synthesized organic substances.

The second category includes the many forms of acute gastroenteritis caused by pathogenic microorganisms. For inclusion in this category, localized gastrointestinal manifestations must predominate. The symptoms caused by some gastrointestinal pathogens are due to an actual invasion of the gut mucosa, while other organisms cause illness by releasing toxins into the gut lumen.

The last category includes the microorganisms that cause generalized nonintestinal infectious illness, with the gut serving primarily as the portal of entry into the body. Individual members of this large group include viruses such as those causing poliomyelitis or hepatitis A, bacteria such as those causing tuberculosis,

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brucellosis, or even streptococcal pharyngitis, rickettsia causing Q fever, or parasites causing toxoplasmosis or trichinellosis. Therapy for these diverse generalized infections is covered in other chapters of the Infectious Diseases section.

DIAGNOSTIC REQUIREMENTS

Several hundred outbreaks of foodborne illness are reported to the Centers for Disease Control each year. Many other small episodes go unreported, since most of the foodborne illnesses are relatively innocuous and of short duration. A comprehensive approach to diagnosis includes the following steps:

1. Characterize the illness according to symptoms, physical findings, and degree of severity.

2. Obtain an epidemiologic history to determine if similar illness has occurred concomitantly in companions or family members. Seek to identify the contaminated food in terms of when, what, and where it was eaten. In large outbreaks after a common meal, attack rates for each food can be calculated to identify the offending item. The local Health Department can be contacted to aid in conducting an epidemiologic investigation and in processing key diagnostic specimens.

3. Obtain specimens for diagnostic laboratory analysis. Food from recent meals should be saved along with vomitus, urine, stool, and sterilely collected samples of both unclotted blood and serum for toxicologic screening or specific cultures. An immediate examination of diarrheic stool may reveal fecal leukocytes that suggest an invasive enteritis, or the presence of parasites or their cysts. A rapid diagnosis of viral diarrheas in infants can be obtained with the electron microscope using direct negative contrast stains, if the facilities are available.

Routine complete blood count (CBC) and urinalysis are generally of little value in establishing a diagnosis. However, for tests involving patient management, serum electrolyte measurements are important if body fluids are depleted as are blood gas measurements in patients with progressive neurologic signs or overt respiratory difficulty.

FOOD POISONING

Foodstuffs may contain or be contaminated by a wide variety of toxins. Management of poisoning due to these toxins is ultimately dependent upon recognition of cause and the combined use of specific antidotes and general supportive measures. Certain types of food poisoning produce a true medical emergency and treatment must be initiated without delay. Acute gastrointestinal symptoms herald the onset of most, but not all, kinds of food poisoning. In other forms, neurotoxicity may be the principal manifestation, and respiratory failure the cause of death. Shock, hemolysis, or failure of vital organs can also occur.

General Concepts

PRINCIPLES OF MANAGEMENT. Principles in the overall management of food poisoning include the following points:

1. Monitor vital signs initially and on a continuing basis until the danger of shock or respiratory paralysis is over. Give these complications first priority in treatment.

2. Determine the source and type of food poisoning for planning specific therapy, for estimating prognosis and the need for hospitalization, and for anticipating complications.

3. Use specific therapy if indicated.

4. Replace fluid and electrolyte losses and maintain optimal homeostatic balances thereafter (see article on Parenteral Fluid Therapy for Infants and Children, Section 6).

5. Correct and control hypoglycemia, if present.

6. Eliminate unabsorbed toxins from the gut if severe vomiting has not already occurred. Gastric lavage, enemas, and a sodium sulfate purgative, 15 grams in 300 ml water instilled via the lavage tubing, can be of value if used promptly in adults. Ipecac syrup, 15 to 20 ml orally, or apomorphine hydrochloride, 6 mg subcutaneously, may serve as an emetic but should not be used if tracheal aspiration seems a likely possibility.

7. Hospitalize poisoned infants and children, since their therapy is often difficult to manage.

8. Provide general supportive care and symptomatic therapy depending upon need. Nausea and vomiting may be alleviated in adults by prochlorperazine (Compazine), 5 or 25 mg by rectal suppository or 10 mg intramuscularly. As an alternative in adults, trimethobenzamide hydrochloride (Tigan), 200 mg, may be used by either route. Drugs for treating diarrhea in adults include paregoric, 4 ml every 2 hours; kaolin with pectin (Kaopectate), 30 ml every hour; or diphenoxylate hydrochloride with atropine sulfate (Lomotil), 5 mg every 6 hours. Propantheline (Pro-Banthine), 15 mg, may be given orally or intramuscularly as an antispasmodic. Codeine, 60 mg, or meperidine (Demerol), 100 mg, is useful for pain and can be given intramuscularly. Most

pediatricians, however, advise against using such drugs for young children with acute vomiting or diarrheic illnesses.

DIFFERENTIAL DIAGNOSIS. Food poisoning must be differentiated from an acute surgical abdomen, acute infections of the intestinal tract, and the accidental contamination of food with heavy metals, chemicals, pesticides, or other poisonous industrial products. Toxin centers are currently available in many areas to provide rapid information. These should be contacted by phone. Also see the article on Acute Miscellaneous Poisoning (Section 16).

Preformed Toxins of Bacterial Origin

Staphylococcal Enterotoxemia

Protein toxins produced during the growth of *Staphylococcus aureus* in food cause the most common form of food poisoning. This intoxication may occur simultaneously in many people at picnics, camps, and the like, and thereby produce a mini–"mass casualty" situation. Symptoms begin 4 to 8 hours after ingestion of the toxin and include severe retching, vomiting, diarrhea, and cramping abdominal pain. Intoxication is self-limited and generally benign. Shock can occur, however, most often in patients at the extreme ages of life. A similar preformed enterotoxin is produced by *Bacillus cereus;* it is most often found in reheated rice. *Clostridium perfringens* food poisoning is also relatively common. The A- and C-type strains produce an enterotoxin like that of *Escherichia coli*, but the toxin is unique in that it is a component of the cell wall released only when the bacteria begin to sporulate. These toxins develop most commonly in meat dishes served a second time.

Therapy is nonspecific in patients poisoned by preformed enterotoxins in food (see above). Only those patients with severe symptoms and dehydration need be hospitalized. Most patients do not lose enough fluid to require intravenous infusions. Replacement of losses can generally be delayed until vomiting has ceased and then accomplished by the oral route. Antibiotic therapy is not required.

Botulism

Therapy of botulism is directed at the prevention or control of respiratory muscle paralysis. Sedatives should be avoided, since they may mask developing neurologic symptoms that often begin with diplopia, dryness of the mouth, or dysphagia. If present, respiratory failure takes first priority in management.

Because neuromuscular paralysis may progress with unpredictable speed, the affected patient should be hospitalized in anticipation of possible tracheostomy and the need for complete mechanical ventilatory support. Such therapy must be aggressive and accompanied by provisions for initiating meticulous, long-term respiratory management and intensive medical and nursing care (see article on Acute Respiratory Failure, Section 2).

Antitoxin therapy is of greatest value when given before the onset of paralytic manifestations. It should be employed as soon as possible in those patients showing a progressive development of paralysis and in those who require ventilatory assistance. A trivalent A, B, E antitoxin of equine origin is available from the National Centers for Disease Control along with diagnostic consultation, laboratory testing services, and support for epidemiologic studies. One may call the CDC, Atlanta, Georgia, 404-329-3753 by day or 404-329-3644 by night to obtain antitoxin and specific instructions for its administration. Only limited supplies of this product are currently available. A heptavalent (A B C D E F G) despeciated botulinum immunoglobulin of equine origin is currently under development. When approved for use in man, it will have the advantages of broad-spectrum, high-titer coverage combined with a far smaller propensity to cause serum sickness as a secondary complication.

Drugs have not as yet proved to be of much use in treating neurotoxicity. Guanidine was introduced more than a decade ago as an investigational drug to reduce neuromuscular blockade. Its effects on respiratory function are minimal and it may cause central nervous system (CNS) hyperirritability. Another drug, 4-aminopyridine, has been tried with questionable results in Britain. A similar investigational drug, 3,4-diaminopyridine, is less toxic and shows dramatic temporary effects on nerve transmission in animals. Aminopyridine-like drugs may ultimately prove useful in helping maintain a patient during transport to a center that provides respiratory support. The use of such drugs may also lessen the duration of intensive respiratory management required for patients with survivable botulism.

Poisons of Plant Origin

Mushroom Poisoning

A complex variety of toxins are produced by different species of poisonous mushrooms. Depending on the mushroom ingested, symptoms vary in time of onset as well as in the type of toxicity.

The earliest manifestations of toxicity result from the peripheral anticholinergic effects of muscarine. Symptoms begin 10 to 120 minutes after eating mushrooms that contain this toxin, and include sweating and salivation, lacrimation and visual disturbances, severe abdominal pain with retching, and vomiting, dizziness, and confusion. Cardiovascular collapse and death may follow. Atropine is the specific antidote for muscarine poisoning; 1.0 to 2.0 mg should be given without delay by intravenous or subcutaneous injection. Subsequent doses are then given at 2 to 6 hour intervals. With control of symptoms, the quantity and frequency of atropine doses should be reduced, to avoid drug toxicity.

Few patients exhibit muscarine effects as the sole manifestation of mushroom poisoning. Intestinal irritants and disulfiram-like compounds can also cause the rapid onset of nausea, vomiting, flushing, and tachycardia. Therapy is symptomatic. Substances such as indole derivatives and ibotinic acid may initiate central nervous system effects including mania, delirium, and even convulsions; these can best be treated with a rapidly acting intravenous barbiturate such as sodium thiopental (Pentothal), 0.1 to 0.2 gram.

In addition, one should also anticipate the onset of delayed additional symptoms that result from the slower action of cyclic peptide toxins such as phalloidine, amanitine, mycotrophine and helvallic acid. The delayed form of toxicity may also appear de novo 6 to 12 hours after mushrooms are eaten. Severe, acute abdominal pain, nausea, vomiting, and diarrhea are followed by the slowly progressive development of severe hepatic and renal failure, as well as by the onset of extensive capillary, myocardial, and central nervous system damage. No effective antitoxins are available; management must include the correction of dehydration, intensive care, and supportive and symptomatic therapy. Opiates can be used for control of pain. Attempts to remove toxins by gastric lavage or to absorb them with charcoal are relatively ineffective. Some of the low molecular weight toxins may be recovered by early hemodialysis. The use of a continuing intravenous infusion of 10 per cent dextrose may reduce hepatic toxicity, but the value of such infusions or of the use of exhange transfusions has not been established.

Other aspects of fluid and electrolyte balance must be carefully supervised. The output of urine should be monitored on an hourly basis and consideration given to the use of mannitol diuresis in an effort to prevent renal failure (see article on Acute Renal Failure, Section 8). If the patient survives for several days, the late complications are those of hepatorenal failure and infection by opportunistic microorganisms.

Favism

Some persons with an inherited deficiency of red cell glucose-6-phosphate dehydrogenase experience a hemolytic crisis of varying severity after ingesting "broad beans" (*Vicia fava*). Mild shock can develop, but severe constitutional disturbances and renal failure are infrequent. Transfusions of packed red blood cells should be considered if hemolysis is massive. Corticosteroids are of undetermined value but may be given for several days.

Lathyrism

Chronic inclusion of Lathyrus peas in the diet may give rise to symptoms of painful spasms, cramps and weakness in the legs, and eventually to degeneration of posterolateral tracts in the lower dorsolumbar regions of the spinal cord with accompanying muscle paralysis and incontinence. Muscle relaxants are without value. Subcutaneous neostigmine methylsulfate, (Prostigmin), 0.5 mg given daily, has proved beneficial, especially if used in patients with symptoms of short duration.

Solanine Poisoning

This toxin is present in potato eyes, sprouts, and skin; it is generally destroyed by boiling. Symptoms include abdominal pain, vomiting, and diarrhea, plus central nervous system manifestations, including confusion, hallucinations, and visual disturbances. Supportive care will be required for several days.

Oxalate Poisoning

Acute poisoning has been ascribed to the presence of oxalic acid in rhubarb leaves, beets, and spinach. Hypocalcemic tetany, if present, may be treated with intravenous calcium gluconate, 10 ml of a 10 per cent solution, repeated as required. The corrosive action of unabsorbed oxalic acid can be reduced by gastric lavage with an 0.15 per cent calcium hydroxide solution (lime water). Diuresis should be maintained by intravenous fluids to prevent deposition of calcium oxalate in renal tubules.

Poisons of Fungus Origin

Ergotism

Ergot alkaloids may be produced by *Claviceps purpurea*, a fungus that grows upon rye and other food grains. These alkaloids have multiple effects on adrenergic receptors of the smooth muscle of

the uterus, blood vessels, and vasomotor centers. Treatment of severe arterial vasoconstriction may require paravertebral nerve block or a slow intravenous infusion of papaverine, 60 mg every 4 to 6 hours, to achieve vasodilation. Calcium gluconate, 10 ml of a 10 per cent solution, may be used as an intravenous injection to relieve muscle pain.

Mycotoxin Poisoning

Moldy grains may become infected by a variety of fungi that secrete a large number of mycotoxins. Corn, peanuts, and grains in the warmer climates are frequently contaminated by one or more of the aflatoxins. These toxins can produce hepatic injury and intestinal bleeding if consumed in sufficient amounts, although this problem is generally seen in farm animals and fowl rather than in man. One potential long-term danger lies in the fact that aflatoxin B_1 is a potent hepatocarcinogen. Questions have been raised about a possible relationship of aflatoxin to liver cancer in Thailand.

Another major class of mycotoxins, the tricothecenes, are formed on grains in the colder climates. The consumption of flour produced from moldy grains by malnourished Russian villagers led in the 1940's to episodes of alimentary toxic aleukia, a protracted disease characterized by anemia, agranulocytosis, lymphopenia, vomiting, and bloody diarrhea. Tricothecene toxins are extremely stable and resistant to heating. They have complex actions on nucleic acid and protein synthesis comparable to those produced by ionizing radiation. Similar effects occur in animals that consume the moldy grains. The only known prophylactic or therapeutic measure for any of these agricultural toxins is the avoidance of mycotoxin-contaminated foodstuffs.

Poisons of Animal Origin

Shellfish Poisoning

Mussels and clams may accumulate a heat-stable small molecular weight neurotoxin, saxitoxin, in their tissues by feeding upon plankton blooms during a so-called "red tide." This toxin stops neural transmission by blocking sodium transport into the nerve fibers. Symptoms in man may appear within 10 to 120 minutes after poisonous shellfish are eaten. They consist of initial paresthesia, giddiness, and ataxia. If these are followed by the onset of paralysis and difficulty in breathing, full respiratory assistance must be provided aggressively without delay, for death can occur within minutes. The patient should be hospitalized for tracheostomy and artificial respiration. If life can be maintained for 24 hours, prognosis is good for survival without lasting effects. To diminish absorption of residual toxin, the stomach should be emptied by lavage and the gut purged. Supportive care includes maintenance of electrolyte, acid-base, and glucose homeostasis.

Fish Poisoning

Fish poisoning is caused by any one of a large group of toxins, many of which affect peripheral nerve transmission. Since little is known about these toxins, their treatment must be based upon symptomatic measures, and the patients followed closely for the possible onset of shock or respiratory muscle failure.

Certain organs of the puffer fish contain tetrodotoxin, a neurotoxin having a structure and a mechanism of action similar to those of saxitoxin. If improperly cleaned fish are eaten, paralysis of nerve transmission and respiration will follow, with time of onset and severity being dependent upon dose. Treatment consists of immediate respiratory support as described for shellfish poisoning.

Ciguatoxins have been recovered from a large variety of normally edible inshore fish throughout the Pacific and Caribbean. The toxins are thought to originate in algae and to be transmitted through the food chain. Certain of these toxins exhibit anticholinesterase activity. Although the toxins are not organophosphorus compounds, their symptoms may possibly be benefited by the use of a cholinesterase-reactivating drug such as pralidoxime chloride (Protopam). Such therapy may be considered for a trial if toxicity is life-threatening and if blood cholinesterase values are low. The oxime is given intravenously in a total adult dose of 1 to 2 grams at the rate of 500 mg per minute (investigational). The dose may be repeated after 20 minutes.

On the other hand, neostigmine, which itself is a cholinesterase inhibitor, has been used with success in treating toxicity from poisonous barracuda.

Massive urticaria may accompany scombroid fish poisoning (tuna, bonito, mackerel) and should be treated with antihistimine drugs.

Some commercial fish have been contaminated with mercury. This possibility should be considered in establishing the diagnosis of fish poisoning.

Other Food Poisons

The seasoning ingredient monosodium glutamate has been identified as the cause of the

"Chinese restaurant syndrome." Susceptible individuals may develop a brief, self-limited attack consisting of numbness, weakness, faintness and palpitation, sweating, lacrimation, and tightening of facial muscles. No specific therapy is indicated, but susceptibility should be recognized to prevent recurrence.

Toxic products from plants, such as white snakeroot or solanines from the jimson weed, when ingested by cattle, may reach man via milk. Treatment consists of gastric lavage and intravenous glucose infusions.

The wide use of organophosphate insecticides has increased the likelihood that they may contaminate foodstuffs. They act as powerful inhibitors of acetylcholinesterase, producing polyneuropathy, miosis, muscle fasciculations, manifestations of muscarine-like toxicity and a reduction in blood cholinesterase activity. Pralidoxime chloride (Protopam), 1 gram intravenously, and atropine, 0.4 mg every 6 hours, may be combined for therapy. Persistent convulsions may call for the addition of trimethadione (Tridione), 1.0 gram (25 ml) orally every 15 minutes to a maximum of 5 grams, or sodium thiopental (Pentothal) intravenously, giving 0.1 to 0.2 gram in a 2.5 per cent solution.

ACUTE GASTROENTERITIS

Acute infections of the intestinal tract can be produced by bacteria, viruses, and protozoa. Bacteria must be able to traverse the normally acid milieu of the stomach, attach to intestinal mucosal cells by means of specialized pili or cell receptors, and colonize in the face of competition from indigenous gut organisms. These infections are most common during travel, especially to areas where unsanitary conditions permit fecal contamination of food and water.

a. *Prophylactic measures* include the practice of "avoidance" by selecting packaged or protected foods, using fluids that are unlikely to have been contaminated, and eating meals known to be prepared, held, and served under good hygienic conditions.

b. *Drug prophylaxis* may also be used under special, relatively brief circumstances. Bismuth subsalicylate (Pepto-Bismol) has been shown to have some prophylactic effectiveness against enterotoxigenic *E. coli*, Shigella, and rotavirus infections, although the recommended dose of 60 ml four times a day constitutes a sizeable volume. Doxycycline (Vibramycin), 100 mg per day, may be protective against some enterotoxigenic *E. coli*, but many strains are resistant. Biweekly doses of 100 mg are only marginally effective. Since doxycycline is one of the tetracyclines, it may itself produce diarrhea or cause skin sensitization to sunshine in susceptible individuals. The drug combination of trimethoprim (80 mg) with sulfamethoxazole (400 mg) in tablets (Septra), given twice daily, has prophylactic value against both enterotoxigenic *E. coli* and Shigella diarrheas if given for short periods of time.

c. *Symptomatic therapy* alone will suffice for the viral forms of enteritis and many of the bacterial ones. Antiemetic drugs may provide welcome relief if nausea and vomiting are prominent. On the other hand, antiperistaltic medications are rarely, if ever, indicated. Antiperistaltic drugs are thought to retain toxins within the gut and to prevent their prompt evacuation. Bismuth subsalicylate may help in the milder forms of enterotoxigenic diarrhea. Specific antibiotics may be required in the enteroinvasive bacillary dysenteries, especially if fever is a prominent sign. Specific drugs should also be used for the acute parasitic diarrheas.

For further information on the treatment of bacterial gastroenteritis, viral diarrheas, and parasitic diseases, the reader is referred to the separate articles on Cholera, Salmonellosis, and Typhoid Fever (Section 1) and Acute Infectious Diarrhea and Intestinal Parasites (Section 5).