SALMONELLA INFECTIONS
All you wanted to know!

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LET’S GET THE NAME STRAIGHT!

Salmon (sam-mon) swim in the ocean and rivers

Salmonella (sal-mon-ella) swim around in your intestines!

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HISTORICAL

- The *Salmonella* were first described in 1880 and grown in the lab in 1884.
- They were named after Daniel E. Salmon, the pathologist who first isolated them from the intestines of pigs.
- Robert Koch isolated *Salmonella typhi* from patients with typhoid fever in 1883.

Colorized scanning electron micrograph of *Salmonella*
WHAT ARE THE SALMONELLA?

- The *Salmonella* are bacteria – *not* viruses or fungi

- They are part of a family of bacteria called the *Enterobacteriaceae* which means “enteric bacteria”

- They are reasonably easy to culture and identify in the laboratory

Gram stain of *Salmonella*
THE NAMING OF THE SALMONELLA

- The naming of the Salmonella is quite confusing to the layperson but really rather simple

- There are actually only three different species of Salmonella
  - *Salmonella enterica* – the one we are usually most concerned about
  - *Salmonella typhi* – the causative agent of typhoid fever in humans only
  - *Salmonella cholerae-suis* – causative agent of a cholera-like disease in swine
Naming- Continued

- With the exception of occasional cases of typhoid fever and human infections caused by *Salmonella cholerae-suis*, all the rest are caused by *Salmonella enterica*

- *Salmonella enterica* is then broken down into more than 2,700 serotypes (or serovars as they are now called) based on the antigens (O) found in their cell wall and on their flagellae (H) (hair-like appendages that propel them along)

- This serotyping is usually performed at the State Health Laboratory level
Naming - Continued

- The naming of the serotypes come from a variety of sources:
  - The place first found – *Salmonella* hartford, *Salmonella* newington
  - The animal first isolated from – *Salmonella typhimurium* (means rat typhoid)
  - The person who isolated it – *Salmonella* borman (Earl Borman was Director of the Conn. State Lab from 1945 to 1968)
WHAT IS THEIR NATURAL HABITAT?

- The *Salmonella* are found in virtually all animals including:
  - Humans
  - Wild animals
  - Domestic animals
  - Pets
  - Birds
  - Reptiles

- Animals represent the *major* reservoir of infection
Natural Habitation - Continued

- All of the different types of *Salmonella* (referred to as “serotypes” or “serovars”) are capable of causing disease in humans regardless of which animals they are associated with.

- The only *Salmonella* species that is uniquely found only in humans is *Salmonella typhi* – the causative agent of typhoid fever.

1909 magazine article featuring “Typhoid Mary” Mallon sprinkling little skulls into her food.
HOW ARE SALMONELLA TRANSMITTED?

- Most cases of Salmonella infections in humans (called “salmonellosis”) occur via the ingestion of contaminated food products (especially poultry, eggs, and dairy products)

- Occasionally, *Salmonella* can be transmitted via infected drinking water. This is usually the case with typhoid fever

- In the case of small children, direct oral-fecal transmission is often the culprit (especially when they handle pets and reptiles)
Transmission - Continued

- Direct contact with infected animals (which often aren’t sick) including:
  - Cows, swine, poultry
  - Pets (dogs, cats)
  - Reptiles (pet turtles, snakes)
  - Rodents (including hamsters and gerbils)

- Direct oral-fecal transmission in healthcare settings and institutions (such as prisons and schools for the mentally retarded)
Transmission - Continued

- Enzymatic drain cleaners
- Bone meal
- Plant fertilizers (especially organic ones)
- Aquarium food
- Dry pet foods
MODES OF TRANSMISSION SUMMARIZED

- Source
- Contaminated Water
- Contaminated Food
- Infected Person
- Infected Animal
- Susceptible Person

Routes of Transmission:
- Fecal contamination
- Oral-Fecal
- Close Contact
- Drinking
- Eating
EPIDEMIOLOGY

- There are approximately 40 to 50 thousand cases of salmonellosis reported annually in the U.S.
- The actual number may be 30 or more times greater!
- Many cases occur in an isolated situation - one person eats undercooked chicken, gets sick and doesn’t seek treatment - hence no reporting
- Children are the most likely to get salmonellosis
- Rate of diagnosed infections among children less than 5 years is about 5 times higher than the rate in all other persons
Epidemiology - continued

- Young children, the elderly and the immunocompromised are the most likely to have severe, even life-threatening infections.
- Approximately 400 persons die annually each year from acute salmonellosis.
- Most are small children, elderly and HIV-infected persons.
- In the last 25 years, there has been a gradual but definite increase in the number of *Salmonella* infections.
Epidemiology - Continued

- Increases are probably due to:
  - The way in which food animals are raised and slaughtered
  - Changes in food processing technology
  - Changes in the way food is stored and distributed (including the globalization of the food supply)
  - Changes in the way food is cooked
  - Changes in consumer behavior ("fast food junkies")
Isolation Rate for Salmonella Enteritidis By Region, United States, 1974-1994

Rate per 100,000 population

Year


New England
Pacific
Mid Atlantic
Total
Other

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WHAT ABOUT ALL THESE SALMONELLA OUTBREAKS?

- We have always had *Salmonella* outbreaks!
- As long as our food sources are contaminated with *Salmonella* and we fail to protect ourselves, they will continue.
- What has changed is extent of the outbreaks.
- They have gone from being local and regional to being national.
- This is a function of the way our food sources are handled today.
Outbreaks - Continued

- Over the years, they have changed from being mostly home/community-associated to being regional and national.

- Other factors:
  - Media coverage is much more extensive (even if not always accurate).
  - Corporate greed!
DISEASES CAUSED BY SALMONELLA

Gastroenteritis

- This is the *most common* manifestation of salmonellosis by far
- Symptoms usually appear 12 to 48 hours after consumption or exposure
- May take up to 72 hours in the elderly
- Incubation period partially related to the “inoculum” size

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Gastroenteritis, continued

- Symptoms usually last 12 to 48 hours but may last longer in some patients (up to several weeks) depending on the age and general condition of the patient.

- Symptoms include:
  - Diarrhea (often profuse and violent) with abdominal cramping
  - Usually non-bloody
  - Vomiting
  - Nausea
  - Muscle aches and headaches
  - Fever (occasionally)
Septicemia (Blood Infections)

- Most cases occur in children, the elderly and in patients with AIDS
- Often lead to the formation of localized abscesses, osteomyelitis (bone infection), endocarditis (infection of the heart valves) and arthritis

Urinary Tract Infections

- Usually seen in patients who are carriers
- Most cases are in the elderly who have many more UTIs
- Not very common
Enteric Fever

- Most cases of enteric fever are associated with just one species, namely *Salmonella typhi*, and the disease is called “typhoid fever”
- In theory, all the serotypes of *Salmonella* are capable of causing an enteric fever
- Onset usually occurs 10 to 14 days after ingestion of contaminated food or water
- Characterized by fever, malaise, anorexia, headache and muscle ache
- Symptoms usually persist for at least a week – often considerably longer
“SYMPATHETIC DISEASE”
AN INTERESTING PHENOMENON!

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DIAGNOSIS

- Bacterial cultures are absolutely necessary in order to identify *Salmonella* as the culprit since there are any number of other organisms that cause almost identical symptoms.

- The physician usually gives the patient a special collection container with a preservative to transport the stool specimen to the lab.
This is *Salmonella typhimurium* growing on Hektoen Agar. The organism produces hydrogen sulfide which reacts with the bismuth in the agar to produce these black-centered colonies.
TREATMENT

- Most cases of gastroenteritis caused by *Salmonella* resolve themselves in a few days *without* the need for antibiotic therapy.

- In fact, treatment with an antibiotic is usually *not* desirable since persons treated with them have a significantly increased risk of becoming permanent carriers!

- Treatment consists mainly of hydration measures. In the case of young children and the frail elderly, intravenous therapy may be necessary.
Bear in Mind!

- *Most* cases of salmonellosis occur as the result of ingestion of food products that are contaminated with *Salmonella* and *not* properly cooked *before* consumption

OR

- By ingestion of foods considered relatively “safe” but contaminated by poor preparation techniques (like the peanut butter)
ACTIONS TO REDUCE TRANSMISSION

- Avoid eating improperly cooked or undercooked food that may be contaminated with *Salmonella* – especially “high risk” foods such as eggs and poultry

- In recent years, there has been a steady *increase* in salmonellosis associated with eggs that were infected

- This is especially *true* in the *Northeast*

- Internal temperature of foods should reach 165ºF as evidenced by a meat thermometer
U.S. Department of Agriculture
Guidelines for Cooking Eggs

- Scrambled eggs should be cooked at least one minute at 250°F. After cooking, the temperature of the eggs should be maintained at 165°F or higher.

- Poached eggs should be cooked for at least 5 minutes in boiling water.

- Sunnyside eggs should be cooked in a frying pan (250°F) for at least 7 minutes.
USDA Guidelines - Continued

- Eggs fried “over easy” should be cooked at least three minutes on one side and then at least 2 minutes on the other side
- Eggs boiled in the shell (i.e. hard-boiled) should be cooked while completely submerged in boiling water for at least 7 minutes

As a point of interest, because of the *Salmonella* outbreaks that occurred in the 1960s and 1970s in nursing homes, many states (including Connecticut) do **not** allow poached and soft-boiled eggs to be served in nursing homes!
Reducing Transmission - Continued

- Wash all knives, cooking utensils, cutting boards, plates and other utensils after contact with potentially infected products such as poultry and meat.
- Generally felt that ceramic cutting boards are more acceptable than wooden ones since they are less porous.
- A good way to disinfect cutting boards is to soak them in a fresh solution of bleach (½ cup of household bleach to 10 cups of water). Cover board and let set for at least 10 minutes.
Reducing Transmission - Continued

- Refrigerate *all* leftover foods *immediately*. Cool such foods in shallow pans rather than deep pots in order to cool them quickly. Place in refrigerator as soon as possible.

- Meats and poultry *must* be thawed at refrigerator temperatures – *never* at room temperature.

- Place foods in a pan deep enough to catch all blood and juices and place in bottom shelf of the refrigerator in order to prevent other foods from becoming contaminated.
Growth of *Salmonella* in Raw Poultry at Room Temperature

By six hours, the count is up to 1 million organisms per gram.

At this point, the count reaches 1000 organisms and just one gram can cause infection!

Starting with 100 organisms.
Reducing Transmission - Continued

- Wash your hands thoroughly:
  - before and after food handling
  - After using the toilet

- Use an effective antibacterial soap if available

- If you have diarrhea, do not handle food!

- Why? In addition to Salmonella, there are numerous other bacteria and viruses that could be on your hands
The Steps to Effective Handwashing

- Wet hands
- Hands should be washed using soap and warm, running water working up a good lather
- Hands should be rubbed vigorously during washing for at least 20 seconds with special attention paid to the back of the hands, wrists, forearms and between the fingers and under fingernails
Effective Handwashing - Continued

- Rinse hands well with running water
- With the water running, hands should be dried with a single-use towel
- Turn off faucet with a paper towel, covering washed hands to prevent re-contamination
A Word about Alcohol-based Hand Sanitizers

- These are *not* the greatest gift to mankind in the last thousand years!
- There are a number of bacteria and viruses that can cause some very serious infections that are *not* killed by these sanitizers
- *Never* a substitute for good handwashing!
A Word about the Antibacterial Soaps
You buy in The Supermarket

- They contain a substance called “Trovan” or one of its derivatives
- Trovan is so “mildly antibacterial” as to be essentially worthless!
- To top it off, these compounds do not break down and are starting to accumulate in septic systems and sewage treatment plants
- If you need an antibacterial soap (like when there is an immunocompromised patient in the home) use one containing chlorhexidine. Examples are Hibiclens and Luroscrub – both available over the counter in pharmacies
Reducing Transmission - Continued

- **Avoid** contact with potentially infected animals and reptiles (farm, domestic or wild) or wash hands very thoroughly *after* handling.

- Even a cat, dog or pet bird can often be a ready source of infection.

- Wash hands thoroughly after contact with organic fertilizers, bone meal, plant foods, aquarium foods, etc. Often these products are derived from raw animal products.
Bon Appetit!