Introduction to Foodborne Infections and Intoxications:

An African Perspective

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Title: Introduction to Foodborne Infections and Intoxications Subtitle: An African Perspective

Foodborne infections and intoxications pose a significant global health threat, especially in Africa and other low-income regions. The goal of this book is to explore the intricate web of factors that influence foodborne infections in Africa. It delves into specific aspects of food safety, providing insights into the unique challenges and opportunities that Africa presents. By integrating disciplines such as microbiology, epidemiology, veterinary medicine, public health, and food science, the textbook advocates for a multidisciplinary approach to develop effective preventive measures, surveillance systems, and interventions.

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Dedication

This book is dedicated to the diverse communities of Africa, all who have devoted earnest efforts to ensuring food safety and the well-being of their communities, those who have dedicated their lives to understanding and combating foodborne infections in Africa, individuals and families who have suffered from the devastating effects of foodborne infections, as well as to the future generations of Africa — the young minds who will carry the torch forward, pioneering new research, and driving transformative change in infectious diseases.

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Preface and Acknowledgments

Foodborne infections and intoxications pose a significant global health threat, especially in Africa and other low-income regions. This textbook, "An Introduction to Foodborne Infections and Intoxications: An African Perspective," sheds light on the complex dynamics of food safety in Africa. It is the result of extensive research, collaboration, and practical experience gathered from experts in various fields.

The goal of this textbook is to explore the intricate web of factors that influence foodborne infections in Africa. It delves into specific aspects of food safety, providing insights into the unique challenges and opportunities that Africa presents. By integrating disciplines such as microbiology, epidemiology, veterinary medicine, public health, and food science, the textbook advocates for a multidisciplinary approach to develop effective preventive measures, surveillance systems, and interventions.

We recognize that the book is one step towards addressing the complex issue of foodborne infections in Africa. We hope it reinforces interest for further research, stimulates discussions, and provide a foundation for policy development and implementation.

We use this opportunity to thank Alex Odoom, Abdul-Halim Osman, Raphael Kwadwo Yeboah, Onyansaniba Kweku Ntim, and Wilfred Ofosu (national service personnel of the Department of Medical Microbiology, University of Ghana Medical School), and all others who, in diverse ways, assisted in compiling this textbook.

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Foreword

Food safety is a critical global concern, making insights on its complexities essential to safeguarding public health. In recent years, there has been an increasing recognition of the unique challenges and perspectives that Africa brings to this field. The textbook before you, "Foodborne Infections And Intoxications: An African Perspective," represents a significant milestone in bridging the knowledge gap and shining a spotlight on the African context.

Africa is a vast continent, with rich culture, agricultural practices, and culinary heritage. It is also confronted with distinct socio-economic, environmental, and infrastructural challenges that impact food safety. By exploring these diverse approaches to food production and consumption, this textbook offers valuable insights into the interconnectedness between culture, foodborne pathogens, and public health outcomes.

The textbook not only elucidates the challenges, but also highlights the innovative approaches and solutions emerging from the continent. From community-driven initiatives to policy advancements and collaborations, the textbook showcases the resilience, adaptability, and commitment of African researchers, healthcare professionals, and policymakers in addressing the complex issue of food safety. Thus, besides being a valuable resource, this textbook is a call to action. It emphasizes the urgent need for collaboration, knowledge sharing, and capacity building to strengthen Africa's capacity to prevent, detect, and respond to foodborne infections effectively.

The authors are experts in the field, having accumulated deep knowledge and experience through extensive research and practical engagement with food safety issues in Africa. Their collective expertise spans several disciplines, such as microbiology, epidemiology, public health, and food science, and reflect in their comprehensive and multidimensional exploration of foodborne infections in Africa. I applaud them for their dedication, passion, and meticulous work in bringing this textbook to fruition. Their commitment to advancing food safety in Africa is evident in the wealth of information, case studies, and practical recommendations presented.

As you embark on this enlightening journey through this textbook, I invite you to embrace the knowledge and insights offered. Let this book be a catalyst for dialogue, innovation, and meaningful change as we work jointly to ensure safer and healthier food systems for all.

PROFESSOR PATIENCE MENSAH
FORMER REGIONAL ADVISOR ON FOOD SAFETY,
WORLD HEALTH ORGANIZATION – AFRICA REGIONAL OFFICE

Introduction

Introduction

Despite the efforts of governments, international organizations, and researchers to mitigate the burden of foodborne infections and intoxications, the menace continues to affect millions of people in Africa each year. From contaminated water sources to unsanitary food handling practices, Africa is plagued by several factors that contribute to the spread of foodborne illness. This textbook brings to bare, specific challenges and complexities of foodborne infections in Africa. We explore the causes and consequences of these illnesses, as well as the strategies and interventions that are being employed to combat them. Our goal is to provide, from a microbiological perspective, a comprehensive and insightful outlook on foodborne infections, which is one of Africa's most pressing health issues.

The textbook mainly focuses on foodborne infections and intoxications that commonly occur in Africa, including those caused by *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella* species, *Shigella* species, *Vibrio cholerae*, *Escherichia coli* O157:H7, *Clostridium* species, Human norovirus, Rotavirus, Hepatitis A virus, Entamoeba histolytica, *Giardia lamblia*, and *Cryptosporidium parvum*.

We believe this textbook will be a valuable resource for public health professionals, researchers, and anyone interested in matters regarding foodborne illnesses. It will provide an understanding of the problem, the efforts being made to address it, and the current progress. Overall, this textbook supports the ongoing efforts to combat foodborne infections in Africa, for improved health and wellness of its people.

Chapter 1: Staphylococcus aureus

Objectives

The objectives of the chapter are to provide background information on *Staphylococcus aureus* (*S. aureus*), including its virulence determinants and the infections it is implicated in. The chapter also accentuates the public health concerns associated with *S. aureus*, including antibiotic resistance and methicillin-resistant *S. aureus* (MRSA) spread. Furthermore, it discusses the pathogenesis of *S. aureus* in the context of staphylococcal food poisoning (SFP) and sheds light on foods that can transmit the bacterium. In addition, it provides a discourse on the laboratory diagnosis, treatment, prevention, and control of staphylococcal food poisoning, as well as snapshots of some cases of SFP on the African continent. Finally, it summarizes key points discussed in the chapter.

Background information on *S. aureus*

The bacterium *Staphylococcus aureus* (*S. aureus*) is Gram-positive, belonging to the genus *Staphylococcus*. It is spherical-shaped, often occurring in irregular clusters, with a diameter of approximately 0.5 to 1.5 µm. Its colonies appear fairly large yellow or white on agar media, and typically exhibit beta-hemolysis zones on blood agar plates typically owing to hemolysin production. It is also a facultative anaerobe, meaning it can grow whether or not oxygen is present, although it prefers environments with low oxygen tension. It is commonly found in the nasal passages of humans and is a part of the normal skin and mucous membranes flora. Besides being a commensal, *S. aureus* is able to cause several infections, including skin infections, pneumonia, bloodstream infections, toxic shock syndrome, and a foodborne infection known as staphylococcal food poisoning [SFP].

The virulence of *S. aureus* is largely due to its production of a wide range of virulence factors, such as toxins, enzymes, and cell-surface components. Some of the most well-known virulence factors produced by the pathogen include coagulase (which also aids in the organism's identification), the toxic shock syndrome toxin-1 (TSST-1), the alpha-toxin, and Panton-Valentine leukocidin (PVL). In addition to these, the bacterium is capable of producing several types of food poisoning toxins, including enterotoxins and heat-stable toxins; these make *S. aureus* a common cause of foodborne illness and are responsible for the symptoms associated with SFP. As a composite, though, these virulence factors contribute to the ability of *S. aureus* to cause infections and evade the host's immune response.

A major public health issue concerning *S. aureus* is its propensity for developing antibiotic resistance. A case in point is methicillin-resistant *S. aureus* (MRSA), a strain of *S. aureus* that is resistant to many commonly used antibiotics, including beta-lactams. As is the case with other *S. aureus* strains, the spread of MRSA infections can occur directly via contact with persons who are infected or indirectly via contact with contaminated objects or surfaces, or through respiratory droplets in the air, particularly in healthcare settings. On the whole, MRSA evolution and spread have revolutionized the virulence of *S. aureus*, and especially complicated the management of *S. aureus* infections, even those originating from the consumption of contaminated food (staphylococcal food poisoning).

Foods associated with *S. aureus*

A wide range of foods is capable of transmitting *S. aureus* and potentially causing staphylococcal food poisoning (Figure 1.1). Those more commonly associated with the pathogen include:

- **Meat products:** Meats such as ham, poultry, beef, and seafood can be contaminated with *S. aureus* if not handled or cooked properly.
- **Dairy products:** Foods like milk, cheese, and cream can also harbor *S. aureus* if they are not kept at the right temperature or if they are made from contaminated milk.
- **Salad items:** Foods such as potato salad, pasta salad, and coleslaw can be "breeding grounds" for *S. aureus* if they are not stored at the appropriate temperature or if they are not properly washed.
- **Sandwiches:** Sandwiches made with deli meats, cheese, or mayonnaise can also be associated with *S. aureus* food poisoning.
- **Pastries:** *S. aureus* can survive in high-sugar environments, making baked goods like cakes, cookies, and pastries susceptible to contamination.

Figure 1.1: Some potential sources of staphylococcal food poisoning

Pathogenesis of staphylococcal food poisoning

Staphylococcal food poisoning results from preformed enterotoxins of *S. aureus*. To cause staphylococcal food poisoning, the food or one of its components must be tainted by a staphylococcal enterotoxin (SE)-producing *S. aureus* strain and exposed to temperatures that support *S. aureus* growth, often due to inadequate refrigeration or the need for a growth-permissive temperature during processing, such as in cheese-making. *S. aureus* synthesizes the enterotoxins in the course of the logarithmic growth phase or as it transits to the stationary phase via the exponential phase.

SEs, potent exotoxins that act on the gastrointestinal tract (even in high nanogram to low microgram quantities), are categorized into nine major serological types (A—J); they are recognized members of the pyrogenic toxin superantigen family and cause immunosuppression and non-specific T-cell proliferation. Generally, the mechanisms via which SEs cause food poisoning remain unclear. That notwithstanding, the prevailing belief is that SEs stimulate the emetic center by directly affecting the intestinal epithelium and vagus nerve, causing emesis. SEs have a high stability index and are able to withstand proteolytic enzyme activity, drying, freezing, heat, low pH, and other harsh environmental conditions that typically kill *S. aureus*. Hence, they can remain active in the digestive tract after ingestion.

SFP symptoms – abdominal cramps (sometimes accompanied by diarrhoea), nausea, and vomiting – could occur within up to eight hours of ingestion of the contaminated food. Generally, these symptoms self-resolve within two days following their onset. However, in severe cases, symptoms may also include fever, headache, and muscle aches, and may even require hospitalization.

Diagnosis and management of staphylococcal food poisoning

Diagnosis of staphylococcal food poisoning is based on the characteristic symptoms and a history of ingesting contaminated food. Laboratory tests may be performed to confirm the presence of *S. aureus* in food samples or to detect the presence of SEs in the stool or vomit of the affected individual.

Management of SFP is mainly supportive and includes rehydration and correction of electrolyte imbalances resulting from vomiting and diarrhoea. Antibiotics are not routinely used to treat SFP, as they do not shorten the course of the illness and may increase the risk of complications. In SFP caused by MRSA, however, prompt oral vancomycin administration is warranted. In severe SFP cases, hospitalization may be necessary for intravenous hydration and electrolyte replacement.

In outbreaks of SFP, public health officials may investigate the source of contamination and implement measures to prevent further spread, including the recall of contaminated food products and the closure of food establishments that fail to meet proper hygiene and storage practices.

Prevention of staphylococcal food poisoning

Prevention of SFP is crucial and relies on proper food handling and storage practices. These include avoiding the contamination of food with *S. aureus*, proper refrigeration, and heating food to adequate temperatures to kill any *S. aureus* present. Good personal hygiene and hand washing practices, and thorough washing of fruits and vegetables, are also essential to prevent the spread of *S. aureus*.

Cases of *S. aureus* foodborne disease outbreaks in Africa

Case 1: Zimbabwe (2014)

In August 2014, an outbreak of diarrhoea occurred among employees who had attended a workshop held in Bulawayo City, Zimbabwe, a day earlier. A retrospective cohort study was conducted to investigate the outbreak, involving 74 council employees. The study found the attack rate to be 71.6% overall, with abdominal cramps and watery diarrhoea being the predominant symptoms. Eating the stewed chicken served during the workshop increased the odds of SFP occurrence, while drinking purified bottled water reduced the odds. The investigations further revealed that the hands and nails of the food handlers harboured *S. aureus*, indicating a possible source of contamination during food handling and preparation. The outbreak was thus attributed to food poisoning caused by *S. aureus* toxins. The study recommended that the food handlers are taken through basic microbial food safety training.

Case 2: Ghana – 2015

In September 2014, a foodborne disease outbreak occurred in Ghana's Eastern Region, affecting patrons of a community eatery. Investigations revealed that "waakye", a local delicacy prepared from beans and rice and eaten with "shitor", a peppery sauce, were the probable contaminated food items responsible for the outbreak. Laboratory diagnostic capacity was weak, highlighting the need for strengthening local response capacity. The study emphasizes the importance of effective surveillance systems and laboratory capacity in preventing and controlling foodborne disease outbreaks.

Case 3: South Africa – 2015

In May 2015, an outbreak of gastroenteritis occurred in Pretoria, South Africa, affecting 51 individuals who had eaten food at a local hotel. The Tshwane Outbreak-Response-Unit (ORU) conducted an investigation to determine the cause of the outbreak and gathered epidemiological data from three affected hospitals. Of the 50 individuals who could have been exposed, 37 were found to be cases, displaying symptoms such as fever, cramping in the abdomen, nausea, vomiting, and diarrhoea. The mean age of those impacted by the outbreak, who were predominantly males, was 23 years. The investigations further revealed that *S. aureus* enterotoxin A present in the chicken component of the meal was responsible for the outbreak; this was facilitated by poor hand hygiene on the part of the food handlers.

Case 4: Zambia – 2015

A college in Lusaka, Zambia, recorded an outbreak of an unidentified source in March 2017. An investigation was conducted to confirm the outbreak, identify exposures, and implement preventative measures. Thirty case-patients and seventy-one controls were interviewed, and laboratory analyses were carried out on swabs of kitchen surfaces and the hands of the food handlers, as well as food samples. The findings suggested that the outbreak was most likely brought on by tainted food served at College A's supper on March 18. *S. aureus* and other bacteria were found on the hands of all food handlers and in the food samples. The predominant exposures were drinking water provided at the college, eating beans at the dinner, and eating in the college cafeteria, and these increased the odds of foodborne disease outbreak by 8.8, 21.6, and 5.8 times, respectively. To stop further outbreaks, the investigators advised educating food handlers and instituting better food handling and handwashing procedures.

Summary of the Chapter

In this chapter, we have provided information on the public health significance of *S. aureus* via the lens of staphylococcal food poisoning (SFP). Key takeaway points from the chapter are as follows:

- *S. aureus* is a major food pathogen and causes staphylococcal food poisoning (SFP).

- Its significance as a food pathogen has been enhanced by several virulence factors, including staphylococcal enterotoxins (which are capable of withstanding several harsh environmental conditions), as well as its capacity for antibiotic resistance, mainly, methicillin resistance.

- A wide range of foods is capable of transmitting *S. aureus* and potentially causing SFP, the major ones being meat products, dairy products, salad items, sandwiches, and pastries.

- Once a SE-producing *S. aureus* strain is ingested, symptoms (abdominal cramps, nausea, and vomiting) could occur within eight days, and may usually self-resolve within two days or occasionally become serious, requiring hospitalization.

- Diagnosis of SFP is based on the characteristic symptoms and a history of ingesting contaminated food, which may be confirmed by laboratory testing of food, stool, or vomitus samples.

- SFP management is mainly supportive, but antimicrobial chemotherapy involving vancomycin may be required in cases involving MRSA, and its prevention relies on proper food handling and storage practices.

End of chapter questions on *S. aureus*

Multiple Choice Questions

1. Which toxin produced by *Staphylococcus aureus* is responsible for causing foodborne illness?
A. Shiga toxin
B. Botulinum toxin
C. Enterotoxin
D. Cholera toxin

2. Which of these food items is most commonly associated with *Staphylococcus aureus* foodborne infections?
A. Raw seafood
B. Cooked poultry
C. Unpasteurized milk
D. Deli meats and prepared salads

3. What is the typical incubation period for *Staphylococcus aureus* foodborne infection?
A. 6-48 hours
B. 1-6 hours
C. 12-72 hours
D. 2-5 days

4. Which of the following is NOT a common symptom of *Staphylococcus aureus* foodborne infection?
A. Nausea
B. Diarrhoea
C. Fever
D. Vomiting

5. Which of the following preventive measures is most effective in reducing the risk of *Staphylococcus aureus* foodborne infections?
A. Thoroughly cooking raw meat
B. Washing fruits and vegetables before consumption
C. Proper handwashing and sanitation in food handling
D. Storing food at temperatures below 40°F (4°C)

Essay Type Question:
Discuss the various factors contributing to the growth and toxin production of *Staphylococcus aureus* in food and explain the measures that can be taken to prevent foodborne illnesses caused by this bacterium.

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Chapter 2: *Listeria monocytogenes*

Objectives

The objectives of the chapter are to provide background information on *Listeria*, including details about its different species and their importance in food safety. The chapter also discusses the impact of *Listeria monocytogenes* (*L. monocytogenes*) on human health, including the symptoms and consequences of listeriosis. Moreover, it explores the factors that contribute to *Listeria* contamination in food products and describes prevention and control measures against the spread of the bacterium. It additionally highlights the importance of education and awareness for reducing the risk of *Listeria* infections and protecting public health. Moreover, it summarizes key takeaways from the chapter and emphasizes the need for continued efforts in preventing and controlling *Listeria* contamination.

Background information on *Listeria monocytogenes*

Listeria monocytogenes is the most well-known and medically significant bacterium of the *Listeria* genus, which also hosts species such as *Listeria newyorkensis*, *Listeria booriae*, *Listeria grandensis*, *Listeria riparia*, *Listeria cornellensis*, *Listeria aquatica*, *Listeria floridensis*, *Listeria fleischmannii*, *Listeria weihenstephanensis*, *Listeria rocourtiae*, *Listeria marthii*, *Listeria grayi*, *Listeria welshimeri*, *Listeria innocua*, *Listeria seeligeri*, and *Listeria ivanovii*. It is a foodborne pathogen that can cause a severe and sometimes life-threatening infection known as listeriosis in humans. It is widely distributed in the environment and can be found in soil, water, and a variety of animal and plant products, including ready-to-eat foods, raw meats, dairy products, and smoked salmon.

L. monocytogenes is rod-shaped, Gram-positive, and facultatively intracellular. It is also oxidase-negative, catalase-positive, and facultatively anaerobic. Even though it is able to survive at 0 to 45 °C temperatures, it grows best at 30–37 °C. It can adhere to a variety of surfaces, withstand disinfectants and other harsh environmental conditions, and even proliferate at refrigerated temperatures. It is motile at 20–25°C, but not at 37 °C, as it produces flagella at room temperature.

Based on somatic (O) and flagellar (H) antigens, at least, 13 serotypes of *L. monocytogenes* have been identified, including 1/2a, 1/2b, 1/2c, 3a, 3b, 3c, 4a, 4ab, 4b, 4c, 4d, 4e, and 7. Multiplex PCR targeting four marker genes has, however, heterogeneously placed the majority of these under four distinct serogroups – IIa (which comprises the 1/2a, 1/2c, 3a, and 3c serovars), IIb (which comprises the 1/2b, 3b, 4b,4d, and 4e serovars), IIc (which comprises the 1/2c and 3c serovars), and the IVb (which comprises the 4b, 4d, and 4e serovars). The 1/2a, 1/2b, 1/2c, and 4b serotypes commonly contaminate food or food processing plants; owing to their biofilm-forming capacity, they can remain viable under adverse conditions for extended periods in these plants, and cause listeriosis following their ingestion in food.

Listeriosis is particularly concerning because it has a higher mortality rate compared to other foodborne illnesses, and can also result in severe complications such as stillbirths, miscarriage, and neonatal infections in pregnant women. The elderly, infants, and individuals in immunocompromised states (such as cancer patients) are at a higher risk of developing severe symptoms and complications from a *Listeria* infection. Thus, such individuals need to be wary not only of food potentially contaminated with *Listeria* but also of other routes of exposure to listeriosis, including inhalation or direct contact with infected animals or animal products.

Foods associated with *L. monocytogenes*

Some of the foods that are commonly associated with *Listeria* contamination (Figure 2.1) include:

- Ready-to-eat foods, such as Deli meats, hot dogs, and smoked salmon
- Dairy products, such as raw milk, soft cheese, ice cream, and cottage cheese
- Raw meat products, including poultry, beef, and pork
- Produce items, such as leafy greens and sprouts, through exposure to contaminated water or soil.
- Processed foods, such as pre-packaged salads, fruits, and frozen foods

It is important to note that while these foods are commonly associated with *Listeria* contamination, any food product can become contaminated with the bacterium if proper safety measures are not followed. Consumers can reduce their risk of *Listeria* infection by properly storing and handling food, especially ready-to-eat products, and thoroughly cooking raw animal products.

Figure 2.1: Potential vehicles for listeriosis transmission

Pathogenesis of *L. monocytogenes* foodborne infections

The pathogenesis of *Listeria* infections involves several stages, including the ingestion of contaminated food, the colonization of the intestinal tract, and the spread of the bacterium to other parts of the body.

- **Ingestion of contaminated food:** The ingestion of contaminated food products is the most common route of exposure for listeria infections. *L. monocytogenes* can persist and grow in a variety of environments, including refrigerated temperatures, making it a significant concern in food safety.

- **Colonization of the intestinal tract:** Once the bacterium is ingested, it is able to colonize the intestinal tract and penetrate the gut wall, allowing it to spread to other parts of the body. This stage of the infection is facilitated by the ability of Listeria to produce virulence factors, such as internalins, that enable it to evade the host's immune response.

- **Spread to other parts of the body:** Once *Listeria* has colonized the intestinal tract, it can spread to other parts of the body, including the bloodstream, the central nervous system, and the placenta in pregnant women. The bacterium is able to spread through the bloodstream due to its ability to resist phagocytosis or the engulfment and destruction of pathogens by white blood cells.

- **Invasion of host cells:** *Listeria* can invade host cells and replicate within these cells, leading to the formation of intracellular infections. This stage of the infection is facilitated by the bacterium's ability to produce actin polymerization-promoting factors, which enable it to spread within host cells.

The severity of *Listeria* infections varies depending on the individual's immune status and the amount of bacterium ingested. In healthy individuals, listeriosis may result in mild symptoms such as fever, headache, and gastrointestinal symptoms. However, in individuals with weakened immune systems, the infection can lead to severe symptoms and complications, including meningitis, sepsis, and brain and spinal cord infections.

In pregnant women, *Listeria* infections can lead to stillbirths, miscarriages, and neonatal infections. Importantly, individuals need to take steps to reduce their risk of listeria infection, such as thoroughly cooking raw animal products and properly storing and handling food, especially ready-to-eat products.

Diagnosis and management of *Listeria* foodborne infections

Listeria foodborne infections can be diagnosed through laboratory testing of a patient's blood or other bodily fluids, such as cerebrospinal fluid or placental tissue in pregnant women. To diagnose listeriosis, a healthcare provider will collect a sample of the patient's bodily fluids and send it to a laboratory for testing.

- **Laboratory testing:** The laboratory will test the sample for the presence of Listeria monocytogenes and identify the strain of the bacterium. This information is used to determine the appropriate course of treatment and to track outbreaks of listeriosis.

- **Antibiotic treatment:** Listeria foodborne infections are treated with antibiotics, such as ampicillin, penicillin, or erythromycin. The choice of antibiotic depends on the severity of the infection and the patient's immune status. Antibiotic treatment is typically administered for a minimum of two weeks and may be extended depending on the severity of the infection.

- **Supportive care:** In addition to antibiotic treatment, patients with listeriosis may require supportive care, such as hospitalization, to manage symptoms and prevent complications. This may include fluid and electrolyte replacement, as well as measures to prevent secondary infections, such as prophylactic antibiotics.

Prevention of *Listeria* foodborne infections

Listeria foodborne infections can be prevented by following good food safety practices and taking precautions, especially for individuals who are at higher risk for infection, such as pregnant women and individuals with weakened immune systems. The following are some steps that can help decrease the risk of *Listeria* infection:

- **Thoroughly cooking raw animal products:** Raw animal products, such as meat, poultry, and seafood, should be thoroughly cooked to kill any bacteria that may be present. This includes fully cooking steaks and roasts to an internal temperature of 145 °F (63 °C) and fully cooking poultry to an internal temperature of 165 °F (74 °C).

- **Proper storage and handling of food:** Food should be stored at the appropriate temperature to prevent the growth of bacteria, such as Listeria monocytogenes. Raw animal products should be stored separately from ready-to-eat foods to prevent cross-contamination. Food should also be handled properly, including washing hands before and after handling food, to prevent the spread of bacteria.

- **Avoiding high-risk ready-to-eat foods:** Certain ready-to-eat foods, such as deli meats, soft cheeses, and smoked seafood, have been associated with outbreaks of listeria and should be avoided, especially by pregnant women and individuals with weakened immune systems.

- **Properly cleaning and sanitizing kitchen surfaces:** Kitchen surfaces, such as cutting boards and countertops, should be properly cleaned and sanitized to prevent the spread of bacteria.

- **Monitoring food recalls:** It is important to stay informed about food recalls and to properly dispose of any food products that have been recalled due to potential contamination with *Listeria monocytogenes*.

Cases of *Listeria* foodborne outbreaks in Africa

Case 1: South Africa – 2017 to 2018

Between January 2017 and January 2018, South Africa recorded the biggest outbreak of listeriosis that affected over 1000 people and resulted in over 200 deaths. In the public and private healthcare sectors, samples of cerebral spinal fluid (CSF) (23%) and blood (71%) were taken; 34% of diagnoses came from the private healthcare sector and 66% from the public healthcare system. The highest number of cases increased across Kwa Zulu-Natal (7%), Western Cape (13%), and Gauteng Province (59%). The majority (96%) of the patients were neonates (and the affected ages ranged from birth to 93 years) and of the female gender (55%). The source was traced to processed meat products, which were found to be contaminated with a highly virulent strain of *Listeria monocytogenes* – Sequence Type 6. The outbreak led to widespread panic, with many South Africans avoiding processed meat products, and this caused significant economic losses for the food industry.

Case 2: Nigeria

Generally, surveillance systems for, and documented reports on, listeriosis are scanty in Nigeria, as is the case with most African countries. Insights on listeriosis outbreaks in the country have been limited to a few reports on isolation of *L. monocytogenes* from food (mainly fish), the environment (mainly soil and water), animals (mainly ruminants), and people (mainly neonates and expectant mothers).

Summary of the chapter

In this chapter, we have discussed the objectives, background information, foods associated with *Listeria*, the pathogenesis of *Listeria* foodborne infections, diagnosis and management of *Listeria* foodborne infections, and prevention of *Listeria* foodborne infections. We have also provided Cases of listeria foodborne outbreaks in Africa to highlight the importance of food safety and the ongoing efforts to prevent the spread of the bacterium.

- *Listeria* is a foodborne pathogen that can cause serious infections, especially in individuals with weakened immune systems, such as pregnant women. It can be found in a variety of foods, including raw animal products, ready-to-eat foods, and dairy products. Listeria foodborne infections can be diagnosed through laboratory testing and treated with antibiotics.

- To prevent *Listeria* foodborne infections, it is important to follow good food safety practices, such as thoroughly cooking raw animal products, properly storing and handling food, avoiding high-risk ready-to-eat foods, properly cleaning and sanitizing kitchen surfaces, and monitoring food recalls.

- In conclusion, *Listeria* foodborne infections are a serious public health concern that requires ongoing efforts to prevent the spread of the bacterium and protect public health. This includes implementing and enforcing food safety regulations, promoting food safety awareness, and investing in the development of safe and nutritious food products.

End of chapter questions on *Listeria* / listeriosis

1. Which of the following is NOT a common symptom of *Listeria* foodborne infections?
   A. Diarrhoea
   B. Fever
   C. Muscle aches
   D. Confusion
   E. Nausea

2. Which group of individuals is most susceptible to severe listeria foodborne infections?
   A. Healthy adults
   B. Children
   C. Older adults
   D. Pregnant women
   E. Athletes

3. Which of the following is NOT a way to prevent listeria foodborne infections?
   A. Thoroughly cooking raw animal products
   B. Properly storing and handling food
   C. Eating raw animal products
   D. Properly cleaning and sanitizing kitchen surfaces
   E. Monitoring food recalls

4. Which of the following is NOT a common food source of Listeria monocytogenes? A. Raw animal products
   B. Ready-to-eat foods
   C. Fresh fruits and vegetables
   D. Dairy products
   E. Seafood

5. Which of the following is the most effective way to diagnose listeria foodborne infections?
   A. Blood test
   B. Stool test
   C. Urine test
   D. Throat swab
   E. Food sample testing

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Chapter 3: *Salmonella*

Objectives

The objectives of the chapter are to provide background information on *Salmonella* species, including its virulence determinants and the infections it is implicated. The chapter also accentuates the public health concerns associated with salmonellosis. Furthermore, the chapter discusses the pathogenesis of salmonellosis and sheds light on foods that can transmit the bacterium. In addition, it provides a discourse on the laboratory diagnosis, treatment, prevention, and control of salmonellosis, as well as a summary of some cases of salmonellosis on the African continent.

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Introduction to Foodborne Infections and Intoxications:

An African Perspective

Foodborne infections and intoxications pose a significant global health threat, especially in Africa and other low-income regions. This textbook, "An Introduction to Foodborne Infections and Intoxications: An African Perspective," sheds light on the complex dynamics of food safety in Africa. It is the result of extensive research, collaboration, and practical experience gathered from experts in various fields.

The goal of this textbook is to explore the intricate web of factors that influence foodborne infections in Africa. It delves into specific aspects of food safety, providing insights into the unique challenges and opportunities that Africa presents. By integrating disciplines such as microbiology, epidemiology, veterinary medicine, public health, and food science, the textbook advocates for a multidisciplinary approach to develop effective preventive measures, surveillance systems, and interventions.

We recognize that the book is one step towards addressing the complex issue of foodborne infections in Africa. We hope it reinforces interest for further research, stimulates discussions, and provide a foundation for policy development and implementation.

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