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# PATHOGENICITY OF *CLOSTRIDIUM PERFRINGENS*: A SHORT REVIEW

Aroosa Akram[1], Imran Taj Hassani[1*], Muhammad Ali Khan[1], Muhammad Kamran Taj[1], Muhammad Tariq Hasni[3], Masroora Ali khan[1,2], Bilal Javed[1]

[1]**Center for Advanced Studies in Vaccinology and Biotechnology (CASVAB),** University of Balochistan, Quetta Pakistan

[2]**Department of Microbiology**, Sardar Bahadur Khan Women's University (SBKWU), Quetta, Pakistan

[3]**Department of Orthopedics,** Bolan Medical Collage, Quetta, Pakistan

***Corresponding Author:** Dr. Imran Taj Hassani E. mail: taj_Imran@yahoo.com

**Abstract**

*Clostridium perfringens has been linked to a number of illnesses in both people and animals. It causes various diseases, including gas gangrene, foodborne infections, antibiotic-associated diarrhea, and necrotic enteritis, by producing a variety of toxins. The bacterium, widespread in the environment, can contaminate food and cause food poisoning epidemics. The virulence factors and toxin classes revealed by C. perfringens are numerous, including alpha, beta, epsilon, iota, enterotoxin, and NetB. Growing concerns about antibiotic resistance in C. perfringens underline the necessity of careful antibiotic use. Distinct antibiotic resistance patterns have been found in many regions where C. perfringens is prevalent, including Pakistan, Iran, China, and India. Because of the contaminated water and vectors that result from floods, there is an increased risk of disease outbreaks, especially gastroenteritis. The health concerns connected with flooding must be reduced through proper sanitation, clean water access and hygiene practices. Recognizing the interdependence of humans, animals and nature in the spread of diseases, the "One Health" concept is crucial in nations like Pakistan. It is crucial to implement strict sanitation procedures and quality control techniques to ensure the safety of the meat. For efficient preventative and therapeutic methods, it is crucial to comprehend the prevalence, spread, factors affecting virulence, and antibiotic resistance of C. perfringens.*

**Keywords**: *Antibiotic resistance, Clostridium perfringens, Foodborne infections, Gastroenteritis, Necrotic enteritis, One Health, Prevalence, Toxins*

## INTRODUCTION

### *CLOSTRIDIUM PERFRINGENS* ENTERIC PATHOGEN

The latter part of the nineteenth century witnessed the discovery of *Clostridium perfringens,* which was once known as Bacillus aerogenes capsulatus and then Bacillus phlegmonis emphysematosae. Due to its capacity to break agar in deep agar medium by creating gas, it was dubbed *Bacillus perfringens*. *Bacillus welchii* was also given to it in honor of William H. Welch. The word "*Clostridium*" was proposed in 1920, and the Society for American Bacteriologists' report on bacterial taxonomy included *C. perfringens* and *C. welchii*. A bacteria called *Clostridium perfringens* can cause serious illnesses in individuals as well as animals (1). In addition to histotoxic, enteric and enterotoxemic disorders, it produces a variety of toxins. Seven toxin classes have recently been identified, including alpha, beta, epsilon, iota, enterotoxin (CPE), and netB. The five sorts of *C. perfringens* (A to E) are connected with the synthesis of alpha toxin, including serotype A and several others (2). A plasmid-borne gene called cpa, which encodes the alpha toxin, is present in all living things. Phospholipase C, a zinc-dependent enzyme that enzymatically changes the membranes of cells, is one of the essential enzymes made by *C. perfringens*. Phosphatidylcholine and sphingomyelin, two crucial elements of eukaryotic cell membranes, are the substances that it particularly addresses (3).

## TYPE "A" TOXINOTYPE

The spread of food-borne illnesses and antibiotic-related diarrhea are both caused by *C. perfringens* type A strains that produce the CPE toxin. In contrast to non-foodborne strains, which have the CPE gene on plasmids, foodborne strains often have the CPE gene on the chromosome. Gas gangrene, a severe infection brought on by *C. perfringens* type A, is defined by tissue destruction and necrosis. The beta-toxin in *C. perfringens* type C is thought to be responsible for the necro-hemorrhagic enteritis it causes in young animals like sheep, pigs, goats and cattle. Pig-bel is a foodborne illness that affects Papua New Guineans during "pig feasts" and is linked to strains of *C. perfringens* type C (4).

## TYPE "B" TOXINOTYPE

Dysentery and intestinal toxaemia are the consequences of type B and type D outbreaks in lambs and ruminants, each of which has the ETX toxin as a prominent virulence component. Epsilon-toxin, which is produced by *C. perfringens* type B and D strains, damages various organs, but the kidneys in particular. The wide range of illnesses that *C. perfringens* can cause and its effects on both human and animal health are highlighted. The bacterium *Clostridium perfringens* exhibits a wide variety of toxins and virulence factors linked to numerous health conditions in both humans and animals (5).

## TYPE "E" TOXINOTYPE

Iota-toxin, which is made up of the chemical protein Ia and the binding protein Ib and has fatal and cytotoxic properties, is produced by type E strains. Rabbits with antibiotic-associated enterotoxaemia are found, whereas calves and lambs with acute intestinal inflammation and fatal outcomes are observed. However, the exact role of iota-toxin in these disorders and the identification of diseases linked to *C. perfringens* type E remain unknown. It is well recognized that this toxinotype causes enteritis in a variety of animal species, especially livestock and poultry. Iota-toxin works by interfering with cellular processes, which causes cell rounding and death. A recent study has also revealed its potential impact on human health, even though it has typically been researched in the context of veterinary disorders. Even though the precise mechanisms and implications of human infections are still being researched, it is proposed that iota-toxin may be relevant to human gastrointestinal problems. A more thorough grasp of the "Type E toxinotype" and its iota-toxin's potential effects on both animal and human health is being formed as research advances (6).

## CPE ENTEROTOXIN

Diarrhea and cramping in the abdomen are the most common symptoms of CPE-related food poisoning, which usually go away in a few days. However, prolonged CPE can be lethal in some circumstances, especially in conditions like constipation. In many animal species, CPE has also been associated with diarrhea and sudden infant death syndrome (SIDS). The enterocyte-damaging protein NetB, which has been linked to avian necrotic enteritis, is produced by *C. perfringens* type G strains. Although the precise causes of cell death in avian necrotic enteritis are not entirely known, the breakdown of tissue layers and the creation of NetB pores are thought to play a part (7).

## EPIDEMICS, RISK FACTORS AND OCCURRENCES OF *C. PERFRINGENS*

Thousands of children die each year from acute diarrhea, which is a serious worldwide health concern. Children under the age of five in Korea have a 0.3% death rate. A spore-forming bacteria called *Clostridium perfringens* is a major contributor to food-borne diarrhea and is usually discovered in mixed protozoal infections, especially in those over the age of 50. Compared to other pathogens like *Staphylococcus aureus* and *Bacillus cereus*, *C. perfringens* is more frequently associated with documented outbreaks of gastrointestinal illnesses in the United States of America (8). Males are more frequently infected than females, and those over 20 are the main demographic affected by the outbreaks. Necrotizing colitis and fatalities have been linked to *C. perfringens* type A infections, and it has been linked to outbreaks that were first assigned to other viruses, like norovirus. People with Crohn's disease and other inflammatory bowel disorders have been found to have *C. perfringens* in Poland. Furthermore, in Egypt, *C. perfringens* has been found in both individuals and camels (9). These results demonstrate the importance of *C. perfringens* as a cause of diarrhea and its effects on the health of society. Worldwide outbreaks are linked to the widespread foodborne illness-causing bacteria *Clostridium perfringens*. Infections that cause diarrhea, food poisoning and antibiotic-associated diarrhea (AAD) have all been related to it. Studies carried out in numerous nations have emphasized its significance in foodborne outbreaks, with *C. perfringens* having been a substantial contributor to outbreaks in Ghana, Australia, Germany, South Korea, the UK, and South Australia. Numerous investigations from various geographical areas have documented the presence of *C. perfringens* in food samples, including ground beef and lamb meat (10). The presence of *C. perfringens* in faeces specimens also suggests that it has a role in digestive disorders, especially in cases of food poisoning and antibiotic use. Clinical assessment is complicated since *C. perfringens* is infrequently seen in blood cultures. Appropriate prevention and control measures require a thorough understanding of the incidence, spread and related diseases brought on by *C. perfringens*. Numerous studies carried out in various parts of Pakistan, including Balochistan, have emphasized the presence of *Clostridium perfringens* in various contexts. A high positive rate for *C. perfringens* was found in commercial poultry farms in Balochistan, with broilers having a higher rate than layers. Small ruminants were also shown to be impacted by *C. perfringens*, with sheep significantly more susceptible than goats (11). The frequently consumed meat items in Pakistan have been linked to outbreaks of food poisoning, and a high proportion of beef samples tested positive for *C. perfringens*. Dairy items and milk specimens from Quetta City both contained *C. perfringens* infections. Furthermore, investigations carried out in Thailand and Egypt indicated diverse *C. perfringens* resistance patterns to various antibiotics, highlighting the significance of antibiotic stewardship (12). These results emphasize the need for improved food safety precautions, such as adequate transportation and storage procedures, to lower the frequency and dangers of *C. perfringens* infection in a variety of food sources and animal habitats. The frequency and susceptibility to antibiotics of *Clostridium perfringens* have been studied in several geographical locations. Antibiotic resistance patterns in Clostridium perfringens have displayed regional variability. In certain regions, such as North America and Europe, some strains have exhibited resistance to commonly used antibiotics like clindamycin and ciprofloxacin. On the other hand, in parts of Asia, strains have shown resistance to erythromycin and tetracycline. These distinct resistance patterns emphasize the need for region-specific monitoring and tailored antibiotic strategies to effectively combat infections caused by *C. perfringens*. In an Iranian investigation, it was discovered that *C. perfringens* strains from raw meat specimens had numerous antibiotic resistance patterns, including ampicillin, tetracycline, amoxicillin, ciprofloxacin, and chloramphenicol (13). Isolates from pigs and chickens in China demonstrated tolerance to some drugs while displaying resistance to others. The development of antimicrobial resistance in *C. perfringens* globally, which poses a possible threat to the health of people, has been facilitated by the overuse and improper use of antimicrobial drugs in food-producing animals. Sulphonamide and tetracycline resistance were found at considerable levels in *C. perfringens* isolates from India. The antimicrobial susceptibility profile of *C. perfringens* isolates differed in certain parts of Punjab Province, with some drugs demonstrating good tolerance while others displayed resistance. The susceptibility and resistance profiles of *C. perfringens* isolates from industrial poultry operations were examined in a study conducted in Balochistan. The dissemination of antibiotic-resistant *C. perfringens* strains can be slowed down and public health can be preserved by careful antibiotic usage and surveillance, according to these findings. In Quetta, *C. perfringens* in milk products demonstrated sensitivity to chloramphenicol, ciprofloxacin, amoxicillin, gentamycin, vancomycin, streptomycin, penicillin G, kanamycin and amikacin, while illustrating high resistance to the antibiotics lincomycin, colistin sulphate, tetracycline, erythromycin, metronidazole, neomycin sulphate, and polymyxin trimethoprim (14, 15). Studies have shown that *C. perfringens* is resistant to penicillin as well as substitute medications like metronidazole and clindamycin, which suggests that the use of antibiotics in the livestock industry has led to the evolution of antimicrobial resistance in this organism. Because of contaminated water and vector contamination during floods, there is a considerable danger of infectious outbreaks. To emphasise the importance of sanitation and quality control in meat safety, specific practical measures are necessary, such as rigorous facility cleaning, temperature monitoring, Hazard Analysis and Critical Control Points (HACCP) implementation, microbial testing, and consumer education. Diarrheal illnesses are transmitted as a result of the surrounding overpopulation and gastric pathogen transmission. The "One Health" concept must be included, especially in nations like Pakistan where the interdependence of people, animals, and the environment has a major impact on disease transmission. To fully address the problems posed by *C. perfringens* and lessen its effects on public health cooperative efforts across the human and animal health sectors, environmental monitoring, and food safety legislation are essential. Healthcare providers play an important role in ensuring meat protection and imposing quality assurance regulations. Strict sanitation practices and protocols are required in meat production to guarantee the health and purity of meat, including organic and export-oriented products (16).

# CONCLUSION AND FUTURE PSRESPECTIVES

The health of both humans and animals is seriously endangered by the pathogenic bacterium *Clostridium perfringens*. It has been linked to a wide variety of problems, including necrotic enteritis, gas gangrene and disorders that are food- or antibiotic-related. The infectious nature of the bacteria is aided by the production of several toxins and virulence factors, including the alpha toxin, CPE toxin, beta toxin, epsilon toxin, iota toxin, and NetB toxin. *C. perfringens* has a widespread distribution and has been connected to epidemics of food poisoning and diarrheal illnesses in several nations. The prevalence of *C. perfringens* and its resistance to antibiotics emphasize the need for improved food safety measures and responsible antibiotic usage. Furthermore, floods might worsen the spread of *C. perfringens* and other gastrointestinal diseases, highlighting the significance of good sanitation and hygiene practices. Adopting precautions and comprehending the variety of *C. perfringens* are essential for safeguarding the health of the general population. Future studies on *Clostridium perfringens* may focus on understanding the genetic diversity and evolution of strains from different sources through revolutionary genomic analyses, dissecting intricate host-pathogen interactions to pinpoint critical virulence factors and defence mechanisms, examining the role of environmental reservoirs in transmission dynamics, and researching novel strategies to combat antibiotic resistance and the spread of resistance genes.

## Conflict of Interest:

The authors report no conflict of interest.

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