

The Isolation of Antibiotic-Resistant Salmonella from Retail Ground Meats

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FROM INCLUDED ABSTRACT

Background

Salmonella is a leading cause of food-borne illness. The emergence of antimicrobial-resistant salmonella is associated with the use of antibiotics in animals raised for food; resistant bacteria can be transmitted to humans through foods, particularly those of animal origin. We identified and characterized strains of salmonella isolated from ground meats purchased in the Washington, D.C., area.

Methods

Salmonella was isolated from samples of ground chicken, beef, turkey, and pork purchased at three supermarkets. The isolates were characterized by serotyping, antimicrobial-susceptibility testing, phage typing, and pulsed-field gel electrophoresis. The polymerase chain reaction and DNA sequencing were used to identify resistance integrons and extended spectrum beta-lactamase genes.

Results

Of 200 meat samples, 41 (20 percent) contained salmonella, with a total of 13 serotypes.

Eighty-four percent of the isolates were resistant to at least one antibiotic, and 53 percent were resistant to at least three antibiotics.

Sixteen percent of the isolates were resistant to ceftriaxone, the drug of choice for treating salmonellosis in children.

Bacteriophage typing identified four isolates of *Salmonella enterica* serotype typhimurium definitive type 104 (DT104), one of DT104b, and two of DT208.

Five isolates of *S. enterica* serotype agona had resistance to 9 antibiotics, and the two isolates of serotype typhimurium DT208 were resistant to 12 antibiotics.

Electrophoretic patterns of DNA that were indistinguishable from one another were repeatedly found in isolates from different meat samples and different stores. Eighteen isolates, representing four serotypes, had integrons with genes conferring resistance to aminoglycosides, sulfonamides, trimethoprim, and beta-lactams.

Conclusions

Resistant strains of salmonella are common in retail ground meats. These findings provide support for the adoption of guidelines for the prudent use of antibiotics in food animals and for a reduction in the number of pathogens present on farms and in slaughterhouses. National surveillance for antimicrobial-resistant salmonella should be extended to include retail meats.

THESE AUTHORS ALSO NOTE:

Salmonella food-borne diseases represent an important public health problem worldwide.

"Nearly 1.4 million cases of salmonellosis occur each year in the United States."

"Most salmonella infections in humans result from the ingestion of contaminated poultry, beef, pork, eggs, and milk."

Intestinal salmonellosis that does not resolve in five to seven days may result in bacteremia (3% to 10% of cases), and antimicrobial therapy can be life-saving.

"The use of antimicrobial agents in any environment creates selection pressures that favor the survival of antibiotic-resistant pathogens."

In 2000, the World Health Organization noted that antibiotic-resistant pathogens have become increasingly prevalent worldwide.

"The routine practice of giving antimicrobial agents to domestic livestock as a means of preventing and treating diseases, as well as promoting growth, is an important factor in the emergence of antibiotic-resistant bacteria that are subsequently transferred to humans through the food chain."

"Most infections with antimicrobial-resistant salmonella are acquired by eating contaminated foods of animal origin."

There is now widespread dissemination of multi-drug resistant Salmonella.

METHODS

Two hundred samples of ground meat (51 samples of chicken, 50 of beef, 50 of turkey, and 49 of pork) were purchased at three supermarket chains in the greater Washington, D.C., area.

RESULTS

"Salmonella isolates were recovered from 41 of 200 samples of ground meat (20 percent)."

"Salmonella was isolated more frequently from poultry (35 percent of chicken samples and 24 percent of turkey samples) than from pork (16 percent of samples) or beef (6 percent of samples)."

ANTIMICROMIAL RESISTANCE

"Eighty-four percent of isolates (38 of 45) displayed resistance to at least one antibiotic, and 53 percent (24 of 45) displayed resistance to at least three antibiotics."

Five Salmonella isolates showed resistance to nine antibiotics (including ceftriaxone).

Seven of the Salmonella isolates displayed resistance to at least five antibiotics.

"The isolates were most likely to be resistant to tetracycline (80 percent of isolates), streptomycin (73 percent), sulfamethoxazole (60 percent), and to a lesser extent, ampicillin (27 percent)."

DISCUSSION

"In this study, 20 percent of ground meat samples from supermarkets in the greater Washington, D.C., area were contaminated with 13 serotypes of salmonella."

Foodborne transmission of multidrug-resistant isolates serotypes has been well documented, and outbreaks have involved the consumption of contaminated meat and dairy products or contact with cattle.

This study "identified five such isolates that were resistant to nine antibiotics, including ceftriaxone and ceftiofur."

"Ceftiofur is the only expanded-spectrum cephalosporin approved for use in food animals in the United States."

Ceftriaxone is commonly used to treat children with invasive salmonella infections.

The use of ceftiofur in livestock has accelerated the rate of the development of resistance to ceftriaxone in salmonella.

"The ability of bacteria to acquire antibiotic-resistance genes and subsequently spread them to many different bacterial species is well known."

One such method of transfer of antibiotic resistance is through "integrons." Integrons play an important part in the transfer of resistance.

These findings demonstrate that multi-drug resistant strains of salmonella are frequently present in retail ground meats in the greater Washington, D.C., area.

"The high prevalence of multi-drug resistant salmonella in retail ground meats reflects a reservoir of resistance in animals that can be transmitted to humans."

"Efforts are needed to reduce the prevalence of resistant salmonella in food, including the adoption of guidelines for the prudent use of antimicrobial agents in animals used for food."

THIS ARTICLE GENERATED THE FOLLOWING EDITORIAL by Sherwood L. Gorbach:

**Antimicrobial Use in Animal Feed -- Time to Stop.
N Engl J Med 345: 1202-1203 October 18, 2001**

"Antimicrobials have been used in food animals in North America and Europe for nearly half a century."

The most commonly used antimicrobial drugs are either identical to or related to those administered to humans.

"These antimicrobial agents are given to food animals as therapy for an infection or, in the absence of disease, for sub-therapeutic purposes with the goals of growth promotion."

It is estimated that 50 percent of all antimicrobials produced in the United States are administered to animals, and mostly for sub-therapeutic uses.

“The Union of Concerned Scientists recently estimated that, each year, 24.6 million lbs (11.2 million kg) of antimicrobials are given to animals for non-therapeutic purposes and 2 million lbs (900,000 kg) are given for therapy; in contrast, 3 million lbs (1.3 million kg) are given to humans.”

Substantial amounts of antimicrobials are administered to food animals for growth promotion in the absence of known disease.

The three reports in this issue of the Journal add weight to the rising movement to ban sub-therapeutic uses of antimicrobials in animals.

(1) White DG, Zhao S, Sudler R, et al. The isolation of antibiotic-resistant salmonella from retail ground meats. *N Engl J Med* 2001;345:1147-1154.

(2) McDonald LC, Rossiter S, Mackinson C, et al. Quinupristin-dalfopristin-resistant *Enterococcus faecium* on chicken and in human stool specimens. *N Engl J Med* 2001;345:1155-1160.

(3) Sørensen TL, Blom M, Monnet DL, Frimodt-Møller N, Poulsen RL, Espersen F. Transient intestinal carriage after ingestion of antibiotic-resistant *Enterococcus faecium* from chicken and pork. *N Engl J Med* 2001;345:1161-1166.

White et al. found that 20 percent of samples of ground meat obtained in supermarkets were contaminated with salmonella and that 84 percent of the isolates were resistant to at least one antimicrobial.

The study by McDonald et al. found that at least 17 percent of chickens obtained in supermarkets in four states had strains of *Enterococcus faecium* that were resistant to quinupristin-dalfopristin.

The study by Sørensen et al. found glycopeptide-resistant and streptogramin-resistant strains of *Ent. faecium*, isolated from chicken parts obtained at a grocery store and pigs after slaughter.

Over 80 percent of infections with salmonella and campylobacter in humans are acquired from food animals.

A 1999 study estimated that there were 1.4 million cases of illness due to salmonella and 2.4 million cases of illness due to campylobacter infection in the United States, and that 26% of salmonella isolates and 54% of campylobacter isolates were resistant to at least one antimicrobial.

“The use of antimicrobials in food animals selects for resistant strains and enhances their persistence in the environment.”

“Another concern is the horizontal spread of the resistance genes from bacteria in food animals to commensal strains in the intestinal microflora of humans.”

Resistance genes can be transferred to other members of the colon microflora or to pathogenic bacteria.

“Not all antimicrobial resistance in human pathogens can be ascribed to the use of these drugs in food animals, however. The use of antimicrobials in humans, much of which is inappropriate, is responsible for rising levels of resistance in organisms such as *Streptococcus pneumoniae*, *Staphylococcus aureus*, and *Neisseria gonorrhoeae*, as well as in many bacteria acquired in hospitals.”

Vancomycin-resistant enterococci accounts for 25% of nosocomial enterococcal infections in the United States. Vancomycin-resistant enterococci are widespread in many hospitals in the United States.

“The most widely proposed argument in favor of the use of antimicrobials for growth promotion and feed efficiency in animals is the economic savings.”

“In my view, the findings of White et al., McDonald et al., and Sørensen et al., along with the abundant supporting evidence provided by previous studies, represent the proverbial ‘smoking gun.’”

The author makes these recommendations:

- (1) Antimicrobials should be used only when indicated in individual infected animals for a targeted pathogen and prescribed by a veterinarian.
- (2) The use of certain drugs that have important uses in humans, such as fluoroquinolones and third-generation cephalosporins, should be prohibited in animals.
- (3) Subtherapeutic use of these agents to promote growth should be banned

KEY POINTS FROM DAN MURPHY

- (1) Antibiotic resistant strains of salmonella are common in retail ground meats, and most are resistance to more than one antibiotic.
- (2) Salmonella food-borne diseases are a significant worldwide public health problem.
- (3) The use of antibiotics in any environment creates selection pressures that favor the survival of antibiotic-resistant pathogens.
- (4) Antibiotic-resistant pathogens have become increasingly prevalent worldwide.
- (5) The routine practice of giving antibiotics to domestic livestock to promote their growth is an important factor in the emergence of antibiotic-resistant bacteria that are then transferred to humans through the food chain.
- (6) Each year in the USA:
 - 24.6 million lbs of antibiotics are given to animals for non-therapeutic purposes;
 - 2 million lbs of antibiotics are given to animals therapeutically;
 - 3 million lbs of antibiotics are given to humans.Consequently, eight times more antibiotics are released into the environment through animals than through humans (27 million lbs v. 3 million).
- (7) The most commonly used animal antibiotics are either identical to or related to those administered to humans.
- (8) Most human infections with antibiotic-resistant salmonella are acquired by eating contaminated animals and animal products.
- (9) There is global widespread dissemination of multi-drug resistant Salmonella.