Prevalence and Distribution of Antimicrobial Resistance

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Introduction

Concerns about antimicrobial resistance have grown in recent years, becoming a truly global issue today. In addition, the antimicrobial issue is not limited to either the agricultural or human health care arenas. The World Health Organization has seated several consultancy groups to discuss the implications of antimicrobial use and resistance development. The National Academy of Sciences also has taken up the issue of antimicrobial use and resistance. Numerous other groups have held public and private meetings to discuss various aspects of antimicrobial resistance. Though there is little consensus regarding the roles of various antimicrobial use practices in the development of resistance that can impact public health, there is widespread recognition that the issue merits further study. There is a sense of urgency in our need for more data and information.

To track emerging resistance, the National Antimicrobial Resistance Monitoring System - Enteric Bacteria (NARMS-EB) was established for both human and veterinary pathogens in 1996. *Salmonella* was chosen as the sentinel organism to describe levels of resistance and monitor trends. *Campylobacter* (starting in 1998 for veterinary isolates) and *E. coli* 0157 (when available) also are tested. Testing for the veterinary NARMS-EB *Salmonella* isolates is conducted using a semi-automated system (Sensititre™, Trek Diagnostics) at the United States Department of Agriculture, Agricultural Research Service, Richard Russell Research Center (USDA-ARS-RRC) facility in Athens, GA. Plates are custom made with 17 antimicrobials in a minimum inhibitory concentration (MIC) format. This system is also used for the *E. coli* O157 isolates. *Campylobacter* susceptibility testing to 8 antimicrobial drugs is done using the E-test (AB BIODISK). Testing for the human NARMS-EB isolates is conducted at the Centers for Disease Control (CDC) in Atlanta using the same testing methodologies and antimicrobials as those used for the veterinary isolates.

The goals and objectives of the monitoring program are to 1) provide descriptive data on the extent and temporal trends of antimicrobial susceptibility in *Salmonella* and other enteric organisms from the human and animal populations; 2) facilitate the identification of resistance in humans and animals as it arises; 3) provide timely information to veterinarians, physicians and others; 4) prolong the life span of approved drugs to promote prudent and judicious use of antimicrobials; and 5) identify areas for more detailed investigation. Information resulting from the monitoring program and follow-up outbreak investigations will be distributed to veterinarians, physicians, and food animal producer groups. The information will be targeted to redirecting drug use so as to diminish the development and spread of resistance over the short term. Directives involving long-term use will be developed in collaboration with professional practitioner groups. Outbreak investigations and field studies will be initiated in response to major shifts or changes in resistance patterns in either animal or human isolates.

In 1998, *Salmonella* isolates of veterinary origin numbering 3,318 were tested. These isolates represented a broad range of species and came from diagnostic laboratories, healthy farm animals, and raw product collected in slaughter or processing plants. Isolates were classified as susceptible, intermediate, or resistant based on National Committee for Clinical Laboratory Standards (NCCLS) established break points used in human medicine. Comparable veterinary break points are unavailable. All isolates were susceptible to amikacin and ciprofloxacin. Resistance was most common to tetracycline (38.1% of isolates), sulfamethoxazole (31.9%), streptomycin (34.7%), ampicillin (17.9%), ticarcillin (17.0%), kanamycin (14.7%), and gentamicin (11.0%). Resistance to the remaining antimicrobials was less than 10% each (chloramphenicol (7.4%), cephalothin (4.8%), amoxicillin/clavulanic acid (3.1%), trimethoprim/sulfamethoxazole (3.1%), ceftiofur (2.8%), apramycin (1.3%), ceftriaxone (1.2%), and nalidixic acid (0.9%)).

Also in 1998, *Campylobacter* isolates numbering 215 were tested for resistance against 8 antimicrobials. These isolates originated from a Food Safety Inspection Service (FSIS) survey of *Campylobacter* from raw chilled broiler carcasses during studies to improve culture methods and collection protocols. All isolates were susceptible to chloramphenicol. Resistance was most common to tetracycline (59.1%), ciprofloxacin (13.5%), azithromycin (12.6%), and clindamycin and erythromycin (11.6% each). Resistance to gentamicin was 1.4%.

Resistance to multiple antimicrobials is a concern. As organisms become resistant to more antimicrobials, the problem of therapy is compounded. In 1998, 51.9% of all isolates were susceptible to all antimicrobials tested and 8.1% were resistant to only 1, most commonly tetracycline (n=217). The remaining 40% of the isolates were resistant to 2 or more antimicrobials. Of these, 17.9% were resistant to 5 or more. The most common multiple (2 or more antimicrobials) resistance pattern was streptomycin/sulfamethoxazole/tetracycline (n=155; 4.7% of isolates) followed by ampicillin/kanamycin/streptomycin/sulfamethoxazole/tetracycline/ticarcillin, which was observed in 4.0% (n=133) of the isolates.

The emergence of a multi-drug-resistant strain of *Salmonella typhimurium* DT104 has caused a great deal of concern in the U.S. and abroad. One hallmark of this organism is a resistance pattern that includes ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline (ACSSuT). In this study of 3318 *Salmonella* isolates, 557 (16.8%) were *S. typhimurium*. The ACSSuT resistance pattern was exhibited by 163 (163/557; 29.3% of *S. typhimurium*). Definitive classification of these isolates as DT104 or some *S. typhimurium* by phage typing are pending.

This program will help identify antimicrobial resistance in humans and animals as it arises and provide data on the extent and temporal trends of antimicrobial susceptibility in *Salmonella* and *Campylobacter* from human and animal populations. Timely information will be available to veterinarians and physicians. By promoting the prudent and judicious use of antimicrobials, the life span of approved drugs could be prolonged. The program also will identify areas for more detailed investigation.

References

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