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Factors Affecting the Emergence of Antimicrobial Resistance in Bacteria of Animal Origin

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The emergence of resistance to antimicrobial agents has compromised control of many bacterial pathogens. Recently, resistance has been observed in bacteria of significant public health interest such as *Yersinia pestis*, which is known to cause plague, as well as *Staphylococcus aureus*, a common pathogen of wound and blood infections. Additionally, multiple resistance has also emerged among many bacterial strains including *Salmonella* species. A penta-resistant strain *(Salmonella typhimurium* DT104) in which the resistance genes have been chromosomally integrated is particularly problematic [9,10,12,13,14].

The development of antimicrobial resistance is recognized as a global problem. Expert scientific groups such as the Institute of Medicine [6], the American Society for Microbiology [1] and the World Health Organization have expressed concern about the global increase in antimicrobial resistance and the complex issues surrounding the increase in the community and institutional settings (IOM, 1992; ASM, 1995; www.who.org). The development of resistant human pathogenic bacteria can result from direct use of antimicrobial agents in humans or indirectly through acquisition of resistant organisms or resistance factors from animal and environmental bacteria [5]. Resistant organisms may be transferred through a variety of mechanisms. Recovery of antimicrobial resistant bacteria occurs more often in urban than rural settings implicating contaminated food products as the likely vehicle rather exposure to the individual animal [3]. Although food borne illness transmitted through foods contaminated by infected human food handlers must be considered along with animal sources [7] this mode of transmission has historically been of less importance. Person-to-person spread of food borne pathogens is also possible [7], although food borne illness outbreaks are generally limited with few or no secondary cases except in institutions. Person-to-person spread of food borne pathogens is more common with organisms such as *E. coli* and *Shigella*. However, factors other than exposure appear to be involved in resistance development since, interestingly, the resistance patterns of intestinal flora from meat eaters does not differ when compared to vegetarians[4].

It has been demonstrated that the intestinal flora of animals that have been treated or prophylaxed with antimicrobial agents can serve as a reservoir of resistance factors [8]. Use of antimicrobials in animals can result in a human health hazard in a number of ways. If antimicrobial-resistant bacteria that are pathogenic to humans are selected and food is contaminated during slaughter or food preparation, the bacteria may cause an infection that requires treatment and therapy may be compromised. Also, if antimicrobial resistant bacteria

pathogenic to humans are selected in the animal and food is contaminated, the bacteria may transfer the resistance to the other bacteria in the human gut. Additionally, if antimicrobials remain as residues in animal products, the residues may allow the selection of antimicrobial-resistant bacteria in the human gut [8].

Surveillance Needs

Antimicrobial susceptibility testing of bacterial isolates has been used for clinical purposes in humans and animals to determine appropriate antimicrobial drug therapy. Susceptibility testing of bacterial isolates not only allows for evaluation of individual isolates, but may also be used for assessment of trends in the development of resistance in a population. Susceptibility testing methods include disk diffusion, broth dilution, E-test (AB Biodisk), and broth microdilution assays. Determination of minimal inhibitory concentrations (MICs) is particularly useful in evaluating incremental changes in the development of resistance over time.

Recognizing the potential utility of antimicrobial susceptibility testing for monitoring trends in antimicrobial resistance development and because of the public health concerns associated with the use of antimicrobials in food-producing animals, the FDA, USDA, and CDC initiated the National Antimicrobial Resistance Monitoring System-Enteric Bacteria (NARMS) to prospectively monitor changes in antimicrobial susceptibilities of zoonotic pathogens from human and animal diagnostic specimens, from healthy farm animals, and from raw product collected from federally inspected slaughter and processing plants [2,11]. Non-typhoid *Salmonella* was selected as the sentinel organism and the program has also expanded to included testing of isolates from retail meat. Program information is available to the public and may be accessed at www.fda.gov/cvm/index/narms/narms_pg.htm. Additional information on results from the animal isolate testing can be found at www.arru.saa.ars.usda.gov. As the information generated from any monitoring system is descriptive, outbreak investigations, field studies, and research will be initiated as a result of major shifts or changes in resistance patterns in either animal or human isolates to fill known information gaps and to clarify observational discrepancies.

Abstract

The emergence of resistance to antimicrobial agents has compromised control of many bacterial pathogens and is recognized as a global problem. Resistance can result from use of antimicrobials or indirectly through acquisition of resistance factors. Antimicrobial susceptibility testing of bacterial isolates is critical for the evaluation of individual isolates and assessment of trends in the development of resistance in a population. Susceptibility testing in the United States is being conducted through the National Antimicrobial Resistance Monitoring System-Enteric Bacteria (NARMS) which prospectively monitors changes in antimicrobial susceptibilities of zoonotic pathogens from human and animal diagnostic specimens, from healthy farm animals, and from raw product collected from federally inspected slaughter and processing plants.

Résumé

L’émergence de souches bactériennes résistantes compromet le contrôle de plusieurs infections causées par des agents pathogènes bactériens et constitue un problème global en santé publique

et animale. La résistance observée chez une souche peut résulter de l'exposition des bactéries aux agents antimicrobiens ou de l'acquisition de gènes de bactéries déjà résistantes. L'utilisation de tests de susceptibilité aux antibiotiques est à la fois très utile pour établir le profil de susceptibilité d'une souche et obtenir des données sur le développement des résistances aux antibiotiques dans les populations. Le système mis en place aux États Unis d'Amérique (National Antimicrobial Resistance Monitoring System-Enteric Bacteria ou NARMS) fait en sorte que l'on peut suivre l'évolution des changements des profils de résistance des agents pathogènes zoonotiques isolés d'échantillons de processus pathologiques chez les humains et les animaux, d'échantillons prélevés chez des animaux sains et ceux provenant d'établissements de transformation des viandes.

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