Editorial Commentary

Resistant Escherichia coli—We Are What We Eat

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(See the article by Johnson et al. on pages 195–201)

Escherichia coli is a frequent cause of life-threatening bloodstream infections [1] and other common infections, such as urinary tract infections. Antibiotic resistance rates in E. coli are rapidly rising, especially with regard to fluoroquinolones and third- and fourth-generation cephalosporins. Surprisingly, most of these multidrug-resistant strains are acquired in the community rather than in healthcare settings [2, 3].

Drug-resistant E. coli are readily acquired via the diet (food and water), and there is a major turnover of drug-resistant E. coli each day [4]. When people eat sterile food, there is a rapid and substantial fall in the numbers of drug-resistant E. coli that these people carry [4].

What remains unclear is where the drug-resistant E. coli in our food are coming from. Are they mainly human strains that contaminate our food (and water), or are these strains mainly derived from food animals?

The study by Johnson et al [5] in this issue helps to answer this important question. They analyzed 287 E. coli isolates recovered from meats for a large number of virulence factors and resistance markers. They showed that drug-resistant isolates had characteristics very similar to those of susceptible isolates recovered from the same types of meat but quite different from those of isolates found in other types of meat. Put another way, the drug-resistant isolates found on retail poultry products are very similar to susceptible isolates found on retail poultry products, compared with drug-resistant or susceptible isolates of E. coli recovered from pork or beef. Thus, it is very likely that most drug-resistant isolates found on poultry meat, for example, are the result of antibiotic use in poultry (rather than the result of the introduction of strains from people or other animals into poultry flocks or the cross-contamination of poultry meat after slaughter). Although this fact may seem obvious, it has not been readily accepted by many people associated with the agriculture and pharmaceutical sectors.

There are limitations in this study. The authors only looked at resistance to a few antibiotics and relatively small numbers of isolates (especially for some food). Grocery stores in only 4 United States geographical sites were sampled. However, it is hard to see how an expansion of their study to many more sites and an increased sample size would have altered their highly convincing and statistically significant findings. The applicability of these findings to the E. coli found on food from regions or countries where human fecal material may frequently contaminate food or water will, however, need further study.

Some people argue that antibiotic-resistant strains that develop in food animals are largely irrelevant to human health because E. coli strains are relatively species-specific and so will not cause disease in people. This current study [5] shows that argument is flawed. A large proportion of isolates in these meats possessed virulence factors associated with causing disease in people. Even if some E. coli animal strains are relatively species-specific, the antibiotic resistance genes carried in animal strains are likely to be much less host-specific and thus transferrable to bacteria carried more frequently by people. We carry large numbers of E. coli in the bowel (more than 1 × 10^9 organisms per gram of feces) [4]. Johnson et al [6] have shown elsewhere that the majority of drug-resistant E. coli carried by people are likely derived from food animals (especially poultry). Indeed, susceptible strains carried by people are very different in characteristics to the drug-resistant E. coli strains they carry. Indeed, the latter are much more similar to susceptible poultry strains than to susceptible human strains.

What does this mean? It is very likely that a large proportion of the drug-resistant strains of E. coli carried by people are acquired via food and especially food animals. We know that highly drug-resistant strains of E. coli (resistant to fluoroquinolones, to extended-spectrum β-lactams, etc) are spreading into the community.
The food chain appears to be the most likely explanation for this spread. There is widespread use of antibiotics in food animals (often for inappropriate practices such as growth promotion or ongoing mass prophylactic medication). In many countries, there is widespread use of third- and fourth-generation cephalosporins (ceftiofur and ceftiofur sodium) and fluoroquinolones (enrofloxacin) in food animals. Although many countries, especially some developing countries, use more of these critically important antibiotics than the United States does, we know that large numbers of meat chickens produced in the United States and Canada are exposed to third-generation cephalosporins [7,8]. Recently, when the US Food and Drug Administration tried to limit the use of ceftiofur [7], especially for mass medication and off-label use in poultry, lobbying by agriculture and pharmaceutical interests resulted in this decision being deferred (although, one hopes, not reversed).

There are arguments that sections of agriculture can’t survive without the use of these types of broad-spectrum antibiotics. However, this argument appears fallacious. Fluoroquinolones have been withdrawn from poultry use in the United States without major production problems. In Australia, fluoroquinolone use in food animals was never approved, yet there remain viable export meat industries and expanding meat production. There are almost no fluoroquinolone-resistant *E. coli* isolates in food animals or locally produced retail meats in Australia [9, 10]. More importantly, very little fluoroquinolone resistance (<5%) is found in Australia in *E. coli* isolates recovered from people, even from people who are hospitalized [1, 11], despite fluoroquinolone use in people and pets for >20 years. Thus, it is very likely that the low level of fluoroquinolone resistance in *E. coli* isolates recovered from people in Australia is related in major part to the lack of use of fluoroquinolones in food animals. This relationship has implications on what to do to decrease the antibiotic resistance burden elsewhere.

Although we worry about the rapidly increasing number of extended-spectrum β-lactamase–producing and fluoroquinolone-resistant *E. coli* in developed countries, the problem is much worse in developing countries [1,2], where resources, controls, and surveillance are often lacking. Huge numbers of people who live in developing countries are infected with multidrug-resistant *E. coli* that may be effectively untreatable. This is also an issue for travelers. Travel is a major risk factor for acquisition of extended-spectrum β-lactamase–producing *E. coli* and other antibiotic-resistant strains of *E. coli* [2]. This is also an issue for food imported from many countries, because these can frequently have extended-spectrum β-lactamase–producing and fluoroquinolone-resistant strains of *E. coli* present [12]. The drug-resistant strains that people in the community carry will have an effect on the types and numbers of drug-resistant bacteria seen in healthcare facilities. The drug resistance seen in bacteria recovered from patients in healthcare settings is normally attributed to the often poor infection control and antibiotic practices of the hospital. However, when drug-resistant strains are carried widely in the community and these people are exposed to antibiotics (eg, to treat pneumonia or to provide surgical prophylaxis), then any drug-resistant strains they carry have the opportunity to proliferate and spread in healthcare settings.

We need to stop using fluoroquinolones and third- or fourth-generation cephalosporins in food animals. This seems to be most important in poultry [6], where there is often mass medication by adding antibiotics to feed or water and by using automated injections into the eggs of meat chickens just before they hatch. At the very least, as an immediate measure worldwide, we need significant decreases in the usage of these types of antibiotics, and we can achieve these decreases by banning all off-label use in food animals (eg, as proposed by the US Food and Drug Administration for ceftiofur).

Antibiotic resistance in *E. coli* strains carried and acquired in the community is rapidly rising, especially resistance to critically important antibiotics. We need to do all we can to stop these strains from developing and spreading further. We need to stop using antibiotics such as third-generation cephalosporins and fluoroquinolones in food animals.

**Acknowledgments**

**Potential conflicts of interest.** P.C.: no conflicts.

**References**


