2

Use of Critically Important Antimicrobials in Food Production

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BACKGROUND

Most genes encoding resistance are complex—they are usually not just newly developed mutations in bacteria, occurring when people or animals receive antibiotic therapy. Resistance is mostly encoded by resistant genes that are already carried by bacteria in the environment, humans or animals, with the genes then acquired by other bacteria (Davies and Davies, 2010; D'Costa *et al.*, 2011; Aminov, 2009; Finley *et al.*, 2013). Most resistance genes have been in the environment for very long periods, well before antibiotics were developed for medical purposes, some potentially for billions of years (Davies and Davies, 2010; D'Costa *et al.*, 2011; Aminov, 2009; Finley *et al.*, 2013). Wild animals that have never been exposed to antibiotics carry resistant bacteria (but at low levels), as do people who died in the preantibiotic era and those currently living in very remote regions, such as the Amazon (Shirley *et al.*, 2000; Clemente *et al.*, 2015).

The One Health concept is important for efforts to better understand, manage, and control antibiotic resistance. All sectors (agriculture, the human health sector, and the environment) are part of One Health. Bacteria, fungi, viruses, and resistance genes readily spread among sectors. What we do in one sector that increases the numbers of resistant microorganisms, or helps their spread, will almost certainly have effects in other sectors (Edo *et al.*, 2015; ECDC, 2012; Collignon, 2013a). Water is frequently contaminated with large numbers of resistant bacteria and their resistance genes, by fecal contamination from both people (poor sanitation) and animal manure. This contaminated water then recirculates to people and food animals given antibiotics, which then allows even more resistance to develop and spread (Collignon, 2013b; Walsh *et al.*, 2011; Larson, 2015; Xi *et al.*, 2009; Graham *et al.*, 2014).

Over the last decades, as economic development and per capita incomes have increased in most developing countries, there have also been major increases in livestock and meat production and consumption (FAOSTAT, 2015; Van Boeckel *et al.*, 2015). This is likely to continue, especially for poultry and pork. China alone produces and consumes roughly half the earth's pigs, about 500 million annually (FAOSTAT, 2015; Van Boeckel *et al.*, 2015; Collignon and Voss, 2015; Krishnasamy *et al.*, 2015; Zhang *et al.*, 2015). An unfortunate consequence of this increased meat production has been the increased use of antibiotics in food animals and the adoption of potentially poor intensive farming practices. Recent modeling suggests that between 2010 and 2030, the global consumption of antimicrobials in agriculture will increase by 67%, from 63,000 tons to 105,000 tons per year. For Brazil, Russia, India, China and South Africa, the estimated increase in antimicrobial consumption is 99%. This is up to seven times higher than the projected human population growth in these countries (Van Boeckel *et al.*, 2015).

ANTIBIOTIC USAGE IN MEAT PRODUCTION AND ITS IMPACT ON HUMAN HEALTH

Antimicrobials are used for at least three main reasons in food animals (JETACAR, 1999; Mevius and Heederik, 2014; Aarestrup *et al.*, 2008):

Therapeutic use: administration is to individual animals or groups of animals for treatment when there is evidence or suspicion of an infection.

Prophylaxis: administration is to healthy animals that are believed to be at risk of developing an infection but when