Can we stop the unstoppable?

Addressing the relationship between intensive animal farming and antimicrobial resistance

Introduction

Due to the increased consumption of animal products, intensive farming has extensively spread, especially in industrialised countries (Fraser *et al.*, 2001). It is based on maintaining vast numbers of animals in restricted spaces and is usually associated with inadequate welfare conditions that expose animals to health risks (McEwen and Fedorka-Cray, 2002). Many diseases are commonly treated or prevented with antimicrobials, i.e. natural, semi-synthetic, or synthetic substances that kill or inhibit the growth of microorganisms like bacteria (OIE, 2019). Nevertheless, their indiscriminate use has enhanced the phenomenon of antimicrobial resistance (AMR), i.e. 'the ability of micro-organisms... to become increasingly resistant to an antimicrobial to which they were previously susceptible' (European Commission, 2018, p.2), with negative consequences on animal and human health.

This essay will focus on the main animal welfare issues related to the use of antimicrobials and will analyse the strategies adopted to mitigate AMR providing recommendations for their further development.

Intensive animal farming and antimicrobials

In intensive farming systems animals typically live in over-crowded environments with poor hygienic conditions and have reduced opportunities to move and to express species-specific behaviours (Ferguson, 2014). Therefore, they are exposed to stressful stimuli that can impair their biological functions and immune system, favouring the development and spread of diseases (McEwen and Fedorka-Cray, 2002). Moreover, aggressive and abnormal behaviours, such as bar biting (Figure 1), which are namely induced by overcrowding and unsuitable environments, can lead to additional injuries and pathologies (Mason and Burn, 2011).

Figure 1. A pig biting a bar (World Animal Protection, 2018).

What are the main health issues treated with antimicrobials? Focusing on the major farmed species, pigs, beef and dairy cattle are, for example, vulnerable to bacterial diarrhoea, dysentery and pneumonia (McEwen and Fedorka-Cray, 2002). Infectious lameness, udder and uterus inflammation are also frequently reported in dairy cows and sows, as a result of greater crowding and increased productivity, which is obtained by breeding higher numbers of offspring and reducing the pregnancy interval (FAWC, 2009; FAWC, 2011). Parasitic infections, necrotic enteritis and *E. coli* infections are spread among broiler chickens and laying hens (McEwen and Fedorka-Cray, 2002), that can also develop skin lesions and breast and foot dermatitis (Figure 2) due to the huge amount of time they are forced to spend on the ground (Bessei, 2006; FAWC, 2010). High stocking densities and poor water quality represent instead the main sources of health-related issues for fish in aquaculture (Håstein *et al.*, 2005). Sharing the same confined environment with thousands of conspecifics, competing for shelters and resources, can indeed cause skin and fin damage that are often associated to infectious diseases (Ashley, 2007).

Figure 2. Foot dermatitis in broiler chickens (Clarke, 2015).

<u>Antimicrobial treatments and antimicrobial resistance</u>

Antimicrobials should be administered as therapeutic treatment to cure animals which are affected by a specific pathology (Bengtsson and Greko, 2014). However, they are primary used as a prophylaxis to prevent diseases, or as a metaphylaxis, i.e. as a treatment targeted to a whole group of animals instead of some individuals (McEwen and Fedorka-Cray, 2002). Consequently, a tremendous amount of antimicrobial drugs are put on sale worldwide. For instance, only in 2017, five thousand tonnes of antimicrobials, mostly marketed for food animals, were sold in the United States (FDA, 2017), and almost seven thousand tonnes in the EU countries (EMA and ESVAC, 2019), as shown in Figure 3.

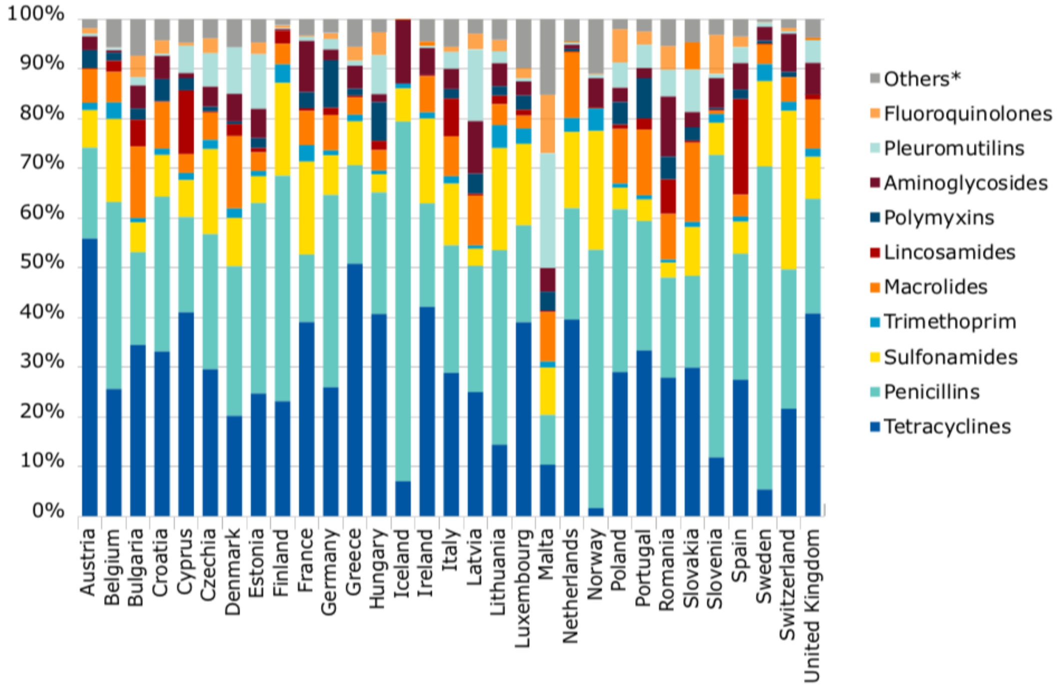

Figure 3. Proportion of the 2017 total sales of antimicrobial classes, in mg/PCU, in 31 European countries. * Amphenicols, cephalosporins, other quinolones and other antibacterials (EMA and ESVAC, 2019, p.26).

AMR is a natural process which is created by random mutations that modify the genetic code of bacteria (Woodford and Ellington, 2007). Nonetheless, the use of antimicrobials has increased its occurrence, negatively affecting both animal and human health. AMR can indeed reduce the effectiveness of treatments in farm animals (Vaarten, 2012), and resistant bacteria can be passed to humans through the food chain (Hernando-Amado *et al.*, 2019), and even through soil and groundwater sources due to the faecal waste used as a fertilizer (Bengtsson and Greko, 2014). Consequently, only in the EU countries, AMR determines an annual expenditure of over 1.5 billion euros in terms of productivity losses and healthcare costs (European Commission, 2018).

Strategies to reduce antimicrobial resistance

AMR is currently addressed using two complimentary holistic concepts, One Health and Global Health, that refer to the interconnection among animals, human-beings, and ecosystems (Hernando-Amado *et al.*, 2019). The One Health approach takes into account geographically close ecosystems and deals with the implementation of integrated actions at local level. Instead, the Global Health approach focuses on the worldwide dissemination of AMR and the socio-economic and political interventions that can be undertaken at a global level (Figure 4).

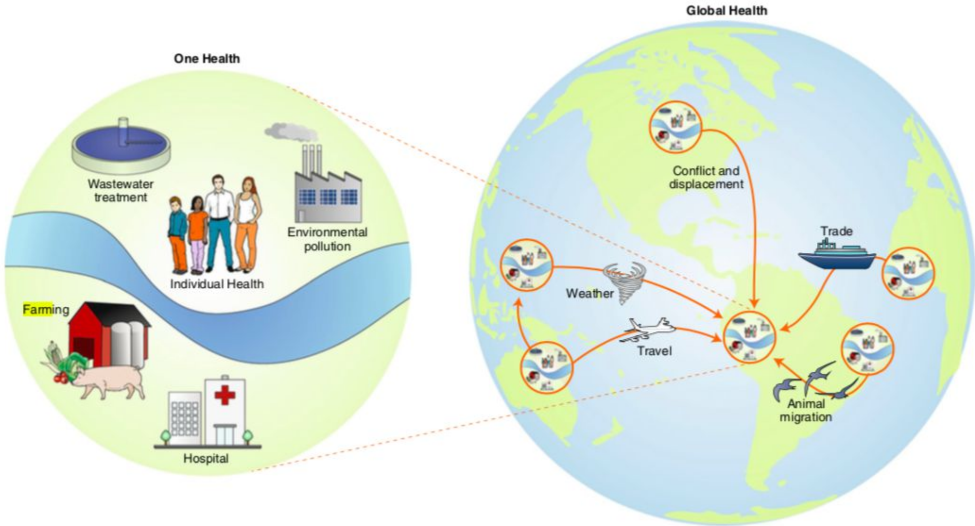

Figure 4. Transmission of AMR in One Health and Global Health views (Hernando-Amado *et al.*, 2019, p.1433).

The integration of these two approaches has led to a growing number of global political initiatives, such as the creation of international partnerships and task forces (WHO, 2015). Regionally, it has contributed for example to the issue of the Regulation (EU) 2019/6 on veterinary medicinal products and the Regulation (EU) 2019/4 on medicated feed in Europe (European Commission, 2019a and European Commission, 2019b). These documents define rules and measures to tackle AMR and highlight the fundamental role played by disease prevention in the reduction of antimicrobial use.

What are the main preventive actions which can be undertaken? The occurrence of pathologies can be mainly minimised improving animal housing conditions and management, as well as biosecurity (i.e. measures designed to reduce the transmission of pathogens) and disease control programmes (McEwen and Fedorka-Cray, 2002). As suggested by Ferguson (2008), enrichments, exposure to novel stimuli, and positive human interaction, must be also implemented to enhance the animals' adaptability to confined systems. Moreover, selective breeding, aimed to increase immunocompetence and disease resistance, must be recommended (Mallard et al., 2015).

Antimicrobials must be also used only as targeted treatment and their selection must be based on a clinical diagnosis (European Commission, 2015). Integrated surveillance systems and international databases are also required to monitor AMR and research on new treatments (e.g. antibacterial vaccines) must be incentivised (Kahn *et al.*, 2018). Finally, awareness campaigns concerning the welfare of farm animals must be implemented to drive the market demand towards products with animal welfare and antimicrobial-free certification labels, such as the EU organic labelling system.

Conclusions

Intensive farming systems are associated with a massive use of antimicrobials due to inappropriate housing and husbandry practices that reduce the animals' immunocompetence (McEwen and Fedorka-Cray, 2002). As a consequence, antimicrobial resistance (AMR) has emerged as a global phenomenon, negatively impacting animal and human health (European Commission, 2018). To effectively reduce AMR, the welfare of farm animals must be urgently improved (European Commission, 2015). Furthermore, *ad-hoc* interventions and research projects on alternative treatments need to be encouraged and communication campaigns must be extensively carried out to increase the market demand for antimicrobial-free certified products (Kahn *et al.*, 2018).

In conclusion, only holistic actions can have the power to break the tight connection between animal farming and AMR, resulting in a significant improvement of animal and human welfare.

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