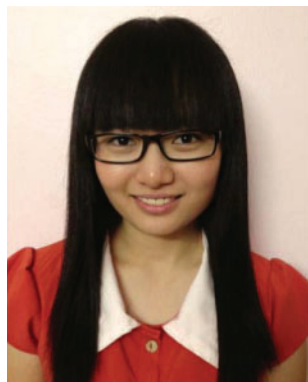
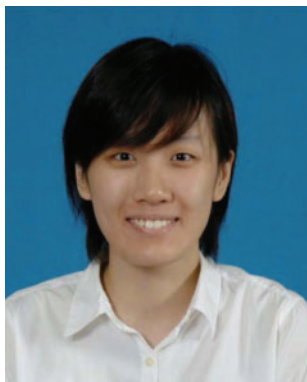


Antimicrobial resistance in food associated *Salmonella*



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***Salmonella enterica* is one of the leading causes of food-borne disease worldwide. Infection with *Salmonella* results in symptoms ranging from mild gastroenteritis through to severe complications such as septicemia and even death. These infections place a significant financial and health burden on the economies of both developed and developing countries. The emergence of antibiotic resistance in bacteria is of current international concern and has added an extra dimension to the issue of foodborne salmonellosis. Understanding and controlling the spread of antibiotic resistance among foodborne *Salmonella* is a goal that requires a global approach but one that needs to be tailored to local scenarios.**

Food associated *Salmonella* strains which are resistant to multiple antibiotics are widely distributed and their prevalence has been increasing¹. Of particular concern is the emergence of resistant strains which are also particularly virulent and appear to persist well throughout the food supply chain. The *S. Typhimurium* DT104 strain is one such strain of concern and which was first isolated in the 1990's. This strain is characterised by chromosomally encoded resistance to ampicillin, chloramphenicol, sulphonamides, streptomycin and tetracycline. Many of these antibiotics are used therapeutically to treat salmonellosis and the resistance of this strain may enhance its morbidity and mortality. In addition many other infections are also treated with these antibiotics and it is feared that this strain may act as a reservoir for the transfer of antibiotic resistance

genes to other bacteria. This strain is also reportedly more virulent than many other strains, although this claim is contentious¹. The *S. Typhimurium* DT104 strain is widely spread and has been isolated from the food supply chain in countries across the globe. Human infections with this strain have been associated with the consumption of a range of foods including chicken, beef, pork and unpasteurised cheese². Understanding how strains such as these emerge, and preventing this from happening, is an important public health goal.

The presence of antibiotic resistant strains in the food supply chain is widely suggested to be due to the selective pressure imposed on bacteria by the frequent use of antibiotics as therapeutics, prophylactics or for growth promotion in farm animals. An association with the use of antibiotics in human medicine is also likely to play a role in resistance among foodborne bacteria³. Different countries have different approaches to the regulation and enforcement of the use of antibiotics in animals and humans. These differing approaches lead to a variety of local scenarios that may influence the prevalence of antibiotic resistant foodborne pathogens, such as *Salmonella*, on food. With an increasingly globalised food supply, however, the presence of high levels of antibiotic resistant bacteria on food in one region is likely to be felt in another. In developing countries the issue of antibiotic resistant bacteria in food is often complicated by a lack of general hygienic practice throughout the food supply chain. In particular high levels of contamination of food with bacteria from various sources (including wild animals and humans) confound

attempts to establish a link between on-farm practice and antibiotic resistant bacteria in food.

Surveys of the prevalence of antibiotic resistant *Salmonella* in foods of animal origin in developed and developing countries illustrate this issue. Retail surveys indicate that the prevalence of *Salmonella* in developed countries range from 0–10% on red meat^{4–7} and from 12–20% on poultry^{2,8}. In these same surveys *Salmonella* strains resistant to two or more antibiotics made up between 0.6–48% of the isolates from red meat and 50–100% of the isolates from poultry. By contrast, retail surveys of the prevalence of *Salmonella* in developing countries range from 17–64% on red meat^{9–11} and 54–57% in poultry^{8–11}. In these same surveys *Salmonella* strains resistant to two or more antibiotics made up between 6–70% of the isolates from red meat and 57–70% of the isolates from poultry. A similar scenario for *Salmonella* from foods of plant origin is likely although there is a lack of data in this area, particularly from developing countries. These data effectively demonstrate the key differences between developed and developing countries with respect to *Salmonella*. In developing countries at retail there is an overall higher prevalence of *Salmonella* on muscle-based foods but this prevalence is not necessarily correlated with a higher prevalence of resistance to multiple antibiotics than in developed countries. In order to understand the scenario in developing countries an approach which entails identifying as many sources of *Salmonella* as possible which result in contamination of food is required. This will aid in establishing the potential contribution of these sources to both the prevalence of antibiotic resistant strains and the diversity of antibiotics to which they are resistant. This would include assessing contributions both from direct sources, such as farm animals and humans, as well as from other potential sources, such as cross-contamination and vectors including insects and wild animals. In developed countries the lower *Salmonella* prevalence and better levels of hygiene and traceability mean that a more direct approach is possible.

In summary, reducing antibiotic resistance in food associated *Salmonella* is an important global public health goal. Approaches to understanding and controlling the prevalence of antibiotic resistant strains in developed and developing countries must necessarily be different. In particular, in developing countries a focus on promoting general food hygiene and establishing the relative contribution of all sources of antibiotic resistant bacteria, rather than making

assumptions based on the situation in developed countries, is required.

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