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EDITORIAL

Food Safety: Pathogen Transmission Routes, Hygiene Practices and Prevention

Improvements in food safety require initiatives that address risks identified along the 'farm-to-fork continuum'. Two papers in this issue of the Journal look at opposite ends of this continuum; an article by Akoachere *et al*. examines a common foodborne pathogen (*Salmonella* Typhimurium) in livestock (1) and Takanashi *et al*. assess the impact of food hygiene in the home on diarrhoea (2).

Foodborne disease is defined as illness resulting from consumption of contaminated food; food can be contaminated with microbial pathogens or a toxic substance (3). Many common foodborne pathogens are zoonotic (4). To attribute diarrhoeal disease to zoonotic transmission or other transmission routes, data collected for specific pathogens through investigations of outbreaks, analytical studies, and laboratory-based studies can provide insights. Transmission from animals to humans can occur through direct contact (5), consumption or handling of meat (6), consumption of unpasteurized milk (7), untreated water (8,9) or consumption of contaminated fresh produce (10).

In the article by Akoachere *et al*., microbial subtyping was used as a means to link *Salmonella* Typhimurium-related disease in humans with animal reservoirs (1). In investigations of outbreaks, the linkage between humans and animals is clear as there is laboratory evidence, along with information for a specific exposure window (11,12). In analytical studies, epidemiological evidence suggests a link by detecting an elevated risk of being an *S.* Typhimurium case among those exposed to meats (13) or animal contact (14). These data, however, lack accompanying microbiological evidence. In the article by Akoachere *et al.* (1), microbiological evidence is proposed, in the absence of an epidemiological link. There are limitations to this approach to attributing food-animal exposure to human disease and so the findings should be interpreted with caution. The authors conclude that their findings are circumstantial. Using microbial subtyping data to attribute human disease to a source can be useful for prioritizing intervention strategies. Recent advances in the use of *Salmonella* subtyping data to attribute human infections to animal reservoirs have been described (15). This may be further assisted by the wider use of multiple-locus variable-number tandem repeat analysis (MLVA) developed for several *Salmonella* serovars (16-18). The method has the advantages of being rapid, cheap, and reproducible, offering advantages over traditional *Salmonella* serotyping and phage typing. MLVA has initially been used in outbreak situations and is now being applied as a routine method in some settings (19).

The study described by Akoachere *et al*. also reports antimicrobial resistance of the *S.* Typhimurium isolates (1). There has been considerable debate on antimicrobial resistance among foodborne pathogens and the role of clinical usage versus antimicrobial use during food-animal rearing. The source of resistance remains controversial and has been the subject of many analytical studies that include human and/or animal isolates and data on antimicrobial agent consumption for humans and animals (20-23).

In addition to identifying areas for improvement at the food production and food processing level, collecting evidence of food safety at the point of consumption is warranted. Epidemiological data suggest that poor food-hygiene practices are responsible for a substantial proportion of foodborne disease (24).

In this issue, an article by Takanashi *et al.* examines the role of food-hygiene practices on diarrhoeal disease among children (2). They found limited association between food-hygiene or general hygiene behaviours and diarrhoea. This is consistent with the findings from a systematic review of the effect of domestic kitchen-hygiene practices on diarrhoeal disease in developed countries (25). There is, however, evidence of a role of poor hygiene

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practices in diarrhoeal disease from investigation of outbreaks and environmental studies (26,27). Collecting accurate information on hygiene practices is challenging. Self-reported food-handling and hygiene practices at home are unreliable compared to observed behaviours (24); this was acknowledged by the authors. For example, they found no association between diarrhoea and handwashing practices, a finding at odds with studies that have demonstrated the effectiveness of handwashing interventions on diarrhoea (28). The study reported in this issue focused on practices important for foodborne transmission, which include handwashing; this can have an impact on person-to-person transmission. Among the age-group of study children, diarrhoea may be due to pathogens acquired by the person-to-person and fomite transmission routes, in addition to the foodborne transmission route.

From a disease-prevention perspective, hygiene efforts at both farm and fork-end of the continuum are worth pursuing. Strong evidence of the impact of these initiatives will be required to satisfy the food industry and policy-makers that changes are needed. In addition to addressing animal and human hygiene, continued research to attribute disease to pathways and vehicles to target those of the greatest impact and/or with viable practical solutions is required.

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