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A mathematical model to investigate the transmission of CTX-M genes between *E. coli* in the bovine gut

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Commensal *Escherichia coli* are bacteria commonly found in both livestock and people and they can also be involved in disease in both. As infection is generally asymptomatic, the bacteria can enter the food chain undetected and infect people. Extended spectrum beta lactamases are enzymes that break down 3rd and 4th generation cephalosporin antibiotics, which are commonly used as front line treatments in hospitals. CTX-M genes encoding for these enzymes are usually carried on plasmids and studying the molecular epidemiology of these genes is key to understanding their origin and spread and hence for designing control measures. We propose a model specifically designed to model the resultant transmission of CTX-M genes between donor and recipient bacteria in the bovine gut, via conjugation and transduction, due to invasion of 'foreign' donor bacteria. We parameterise the model based on the bacteria being strains of *E. coli* and use it to investigate the effect of cephalosporin use in cattle, which kill off and inhibit the growth of recipient bacteria. Based on comparing the model results with those of an experimental study, we extend the deterministic model to stochastically simulate the variability in the duration of infection and concentration of bacteria during the latter stages of infection, when levels shed in faeces are generally below the limit of detection (102 cfu/g), but sporadic 'spikes' in concentration of up to 104 cfu/g are observed. The model results suggest an association between antibiotic usage and high CTX-M levels. In the baseline model, initial concentrations of up to 107 cfu/g of CTX-M *E. coli* will decay exponentially, generally reducing to below 102 cfu/g within 10 days. However, when cephalosporins are used the bacteria persist for longer in higher concentrations. This could have consequences for farm level transmission, with high levels of bacteria being shed in the environment by infected animals for longer periods of time.