A Transport & Lairage model for Salmonella transmission between pigs, applicable to EU member states

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Introduction

Transport and lairage (T&L) are thought to be important stages for salmonella transmission in the pig production chain. It has been reported that there are significant increases in the prevalence of pigs infected with salmonella between the farm and the slaughterhouse and that pigs can become infected when exposed for less time than the duration of T&L (Berends et al. 1996). There has been little development of the T&L stages in previous pig salmonella QMRAs, mostly relying on simple equations to model a proportional change in infection levels between the farm and slaughterhouse. Here we present a detailed stochastic model for salmonella in pigs during T&L, designed to be able to simulate the effect of interventions. This model is part of a full farm-to-consumption risk assessment for salmonella in pigs, which was requested by the European Food Safety Authority (EFSA) in response to a European Commission mandate. The full model provides an estimate for the risk of human illness from consumption of pork cuts, minced meat and fermented sausages (EFSA, 2010).

Methods

The T&L model simulates the transmission of salmonella infection within batches of pigs, during transport to the slaughterhouse and subsequent lairage. It uses as an input, a database detailing the number of infected slaughter-age pigs in batches leaving the farm module. The environmental contamination of the trucks and the lairage environment is also simulated, in order to model cross contamination. Each iteration of the model represents one day's worth of pigs going to one slaughterhouse. The model was parameterised using data obtained from MSs, published literature and, where necessary, expert opinion. The computational steps of the model are outlined in the Figure 1.

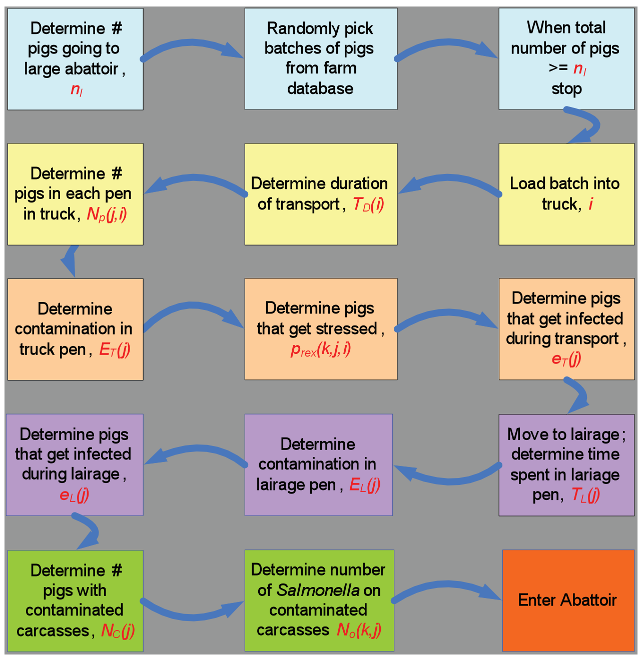

Figure 1: Model overview

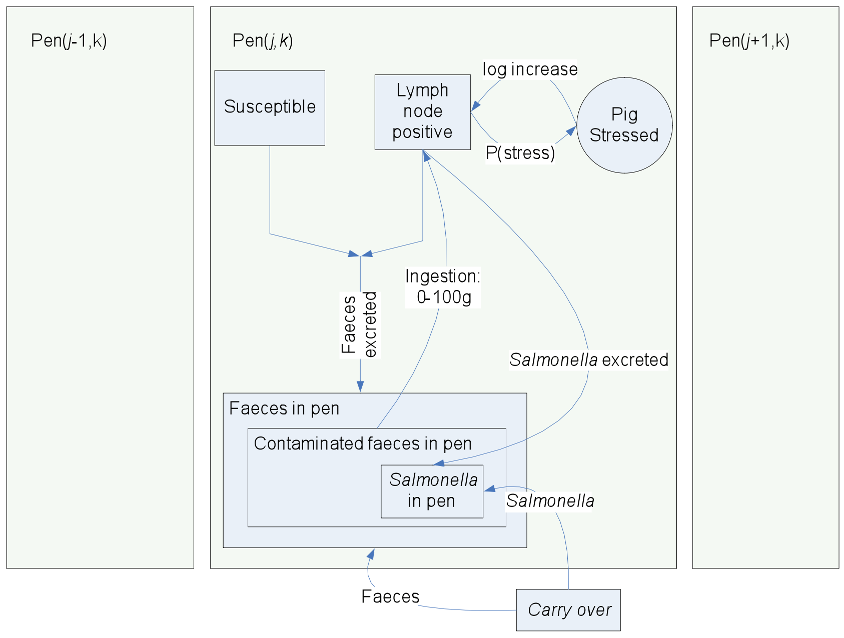

Figure 2: Transmission framework

Results

Table 1 details the lymph node positive prevalence in batches of pigs at different stages of the T&L model for two case study MSs. Figure 2 shows the distributions of the nonzero increases in lymph node positive batch prevalence during T&L for two case study MSs. Most batches have a small increase (<5%), but a few batches show more than a 70% increase in lymph node positive prevalence. Large changes are more frequent in MS2 than MS1. Figure 3 shows that the change in prevalence during transport for MS2 is inversely proportional to the number of infected pigs at the start of transport. However large increases (>50%) can still be observed with up to 60 initially infected pigs.

Table 1: Prevalence of infection

	Mean (5th, 95th percentiles) of prevalence (%)		
Member state	**Before transport**	**After transport**	**After lairage**
MS1	0.43 (0.08, 1.03)	0.62 (0.12, 1.38)	1 (0.2, 2.7)
MS2	16.5 (3.1, 29)	17.6 (4.1, 30.2)	20 (4.9, 35.4)

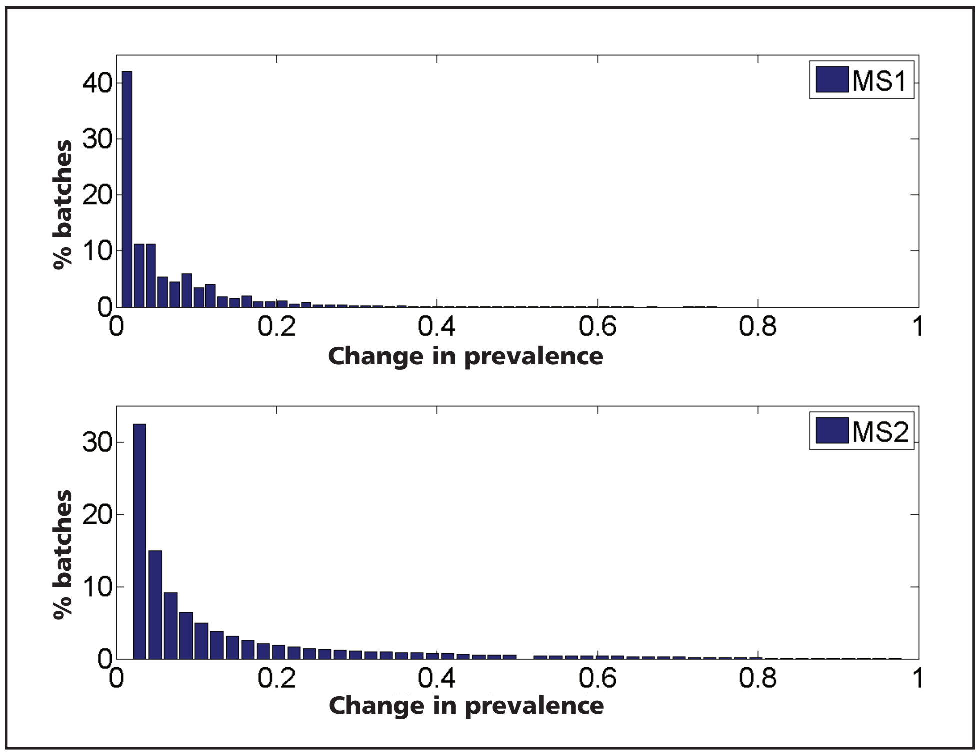

Figure 2: Change in within-batch prevalence during T&L

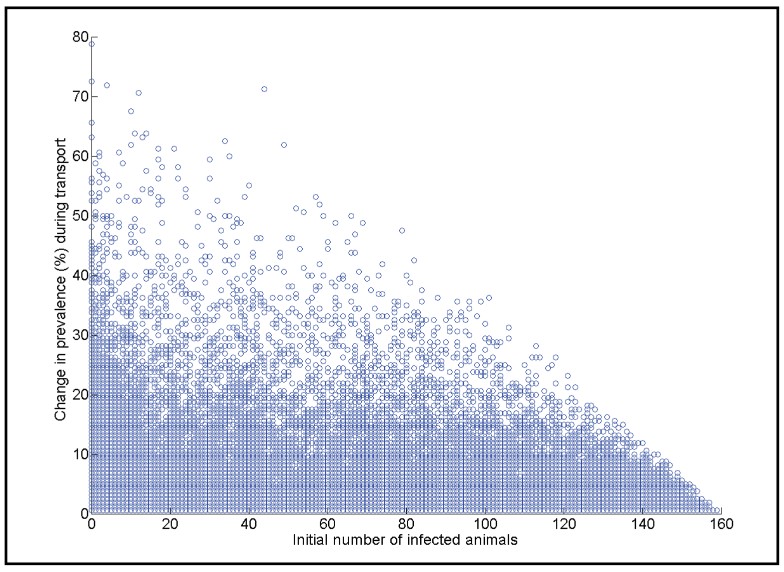

Figure 3: Correlation between change in prevalence and initial number of infected pigs for MS2

Summary

The T&L model shows that transmission of salmonella can occur during both Transport and Lairage. The estimated increase in batch prevalence between farm and entry to the slaughterhouse, brings the average member state lymph-node prevalence at slaughter in line with the EFSA baseline study results (EFSA, 2008). The change in prevalence is also consistent with Berends et al. (1996) where trials suggest a 0-20% increase in prevalence.

Sensitivity analysis suggests that stress during transport is the most important factor in the model. The main data gap was in estimating carcass contamination, which may have impacted on human health.

Analysis of the full QMRA (EFSA, 2010) suggests that, while T&L interventions show some effect on the prevalence at the start of slaughter, they have little effect on the number of human cases.

Acknowledgements

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References

Berends et al. (2006). International Journal of Food Microbiology 30: 37-53. EFSA (2010), EFSA QMRA, http://www.efsa.europa.eu/en/scdocs/scdoc/46e.htm. EFSA (2008), EFSA baseline survey of Salmonella in slaughter pigs, in the EU, 2006-2007. http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178713190037.htm