Risk factors for hide contamination of Scottish cattle at slaughter with *Escherichia coli* O157

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Abstract

In 2002 – 2004, a large scale study took place Scotland examining potential risk factors for *Escherichia coli* O157 contamination of cattle carcasses. During this study, an unexpectedly high prevalence of hide contamination was observed. To investigate possible related risk factors, logistic regression analyses were applied to aspects of individual animal characteristics, farm management practices and slaughterhouse features. Two models were fitted to the data, the first including slaughterhouse modelled as a fixed effect. In this model, an animal had higher odds of having a contaminated hide if adjacent animals on the processing line also had contaminated hides. Transportation to the slaughterhouse by haulier, as opposed to transport by the farmer, and the use of a crush in the lairage, were also found significantly to increase the odds of hide contamination with VTEC O157. If animals were held in lairage, receiving hay as feed appeared to have a protective effect on hide contamination. The second model included slaughterhouse as a random effect, which resulted in none of the examined factors being associated with hide contamination. This suggests that the most appropriate approach to reduce VTEC O157 hide contamination is individual slaughterhouse risk assessment and tailored intervention strategies.

Introduction

Verocytotoxigenic *Escherichia coli* O157 (VTEC O157) is a food-borne pathogen with the capacity to cause serious gastrointestinal illness in humans, as well as severe sequelae in other body systems. A major source of VTEC O157 carcase contamination in the harvest of beef animals are contaminated hides, as pathogenic bacteria can be transferred from the hide to the carcase during the hide removal process (Reid *et al*. 2002). Determining the risk factors for hide contamination can provide the knowledge base required to formulate effective strategies aimed at reducing the prevalence of VTEC O157 in slaughterhouses.

The data used in this analysis were part of a larger study conducted under the Wellcome Trust International Partnership Research Award in Veterinary Epidemiology (IPRAVE), one part of which examined peri- and post-harvest risk factors for VTEC O157 carcase contamination in twelve Scottish slaughterhouses. The results of this investigation demonstrated that, while the prevalence of carcase contamination was very low (1%), the prevalence of hide contamination was relatively high (53%). This report examines potential risk factors and their association with animals being positive for VTEC O157 on their hide at slaughter.

Material and Methods

Farms that had participated in an earlier VTEC O157 prevalence study were recruited on a voluntary basis. Slaughterhouses included in the study were those that received animals from the participating

farms. Farm and slaughterhouse visits were conducted over a period of 22 months, April 2002 to February 2004.

Aspects of individual animal's characteristics that were examined in this analysis included breed (beef/dairy/beef-dairy cross), age (months), and the VTEC O157 status of individual animal rectal faecal samples (positive/negative). Farm management practices that were examined included belly hide clipping (yes/no) to remove contamination before transport to slaughter, previous isolation of VTEC O157 on the farm (yes/no), number of animals sent in the batch to the slaughterhouse, how animals were transported to the slaughterhouse (farmer/haulier), and whether animals were mixed during transport with animals from other farms (yes/no). Once at the slaughterhouse, the factors examined were the time from farm departure to slaughter (hours), average daily number of animals killed at the slaughterhouse, operating capacity of the slaughterhouse on the day of the visit (number of animals killed that day / average number of animals killed), use of a crush to read eartags and verify animal identity (yes/no), whether held in lairage (yes/no), whether animals received feed in lairage (hay/no feed), mechanics of the processing line (manual/automated), hygienic management of the landing area from the stunning box between animals (wiped down/nothing), position number on the processing line, and VTEC O157 hide contamination status of the animal immediately before and immediately after each study animal (both/one/neither animal positive).

Two multivariable logistic regression models were fitted to these data, using the statistical software R (version 2.0.1) (RCDT 2004). The hide sample test result for VTEC O157, negative or positive, was the dichotomous outcome. Records in which there were missing values were removed from the data set. Categorical variables with more than two levels were coded as dummy variables. The first model was a generalised linear model (glm), in which Slaughterhouse was included as a fixed effect. The second model was a generalised linear mixed effect model, implemented using Penalised Quasi-Likelihood (glmmPQL), with Slaughterhouse included as a random effect.

Results

Once records with missing values were excluded, 222 animals remained in the data set, with 33 groups from 29 farms going to 10 slaughterhouses. The results of the logistic regression analysis are presented in Table 1.

Table 1 Logistic regression analysis of factors associated with VTEC O157 hide contamination at slaughter, with slaughterhouse identity specified as a fixed effect (Model 1) and with slaughterhouse identity modelled as a random effect (Model 2).

	Factor	Coefficient	S.E.	OR	95% CI	P
Model 1	(Intercept)	-4.19	0.89	0.02	(0.002, 0.08)	
	Adjacent					
	One animal positive	1.27	0.50	3.57	(1.36, 9.87)	
	Both animals positive	2.45	0.51	11.55	(4.40, 32.51)	< 0.001
	Feed (hay)	-5.82	4.49	0.003	(NA, 0.16)*	0.001
	Transport (haulier)	1.69	0.50	5.43	(2.10, 15.36)	0.05
	Crush (crush used)	2.07	0.61	7.92	(2.54, 28.52)	<0.001
Model 2	(Intercept)	-0.01	0.67	--	--	0.98

* Due to data sparsity issues, the lower limit for the 95% CI for *Feed* could not converge

Discussion

In the model in which clustering at the slaughterhouse level was not taken into account, three factors were found to be positively associated with hide contamination, and one was found to be protective. The presence of hide contamination on the processing line (*Adjacent*) was associated with a 3.6-fold (one adjacent hide contaminated) or an 11.6-fold (both adjacent hides contaminated) increase in the odds of the study animal having a contaminated hide. This clustering of positive samples on the processing line has been previously reported by Fegan *et al.* (2005). Transport to the slaughterhouse by haulier (as opposed to transport by the farmer) was associated with a 5.4 times increase in the odds of a contaminated hide. This may indicate that trailers were not thoroughly cleaned and disinfected between transports. However, in this study all cattle that mixed with animals from other farms during transport traveled by haulier and therefore the increase in hide contamination may be due to the introduction of contamination from animals from other farms. The use of a crush increased the odds of animals testing positive for VTEC O157 on the hide by approximately 8-fold. If a crush is used, every animal slaughtered comes in contact with its surfaces, facilitating the spread of contamination.

Providing animals with hay in lairage appeared to have a protective effect on hide contamination. However, the brief length of time that animals spent in lairage (maximum 22 hours, data not shown) makes it unlikely that hay consumption would have an appreciable effect upon intestinal *E. coli* populations. According to UK legislation, only animals held in lairage for >12 hours must be provided feed. This may suggest that a 'resting' period in lairage may be beneficial in terms of reducing hide contamination.

From the results of the second model including slaughterhouse as a random effect, it is clear that the differences between slaughterhouses account for most of the variation observed in the data. This suggests that there is no universal solution to reduce VTEC O157 hide contamination in slaughterhouses. Instead, more detailed slaughterhouse-specific studies, perhaps with purposeful selection of those with distinct and identified practices, would be required.

References

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