Estimating the impact on the food chain of removal of bovine tonsils from specified risk material in Great Britain assuming negligible risk status for bovine spongiform encephalopathy

V. Horigan[a], M. Arnold[a], L. Patea[b], A. Adkin[a],*

[a] Department of Epidemiological Sciences, Animal and Plant Health Agency, Woodham Lane, New Haw, Surrey, KT15 3NB, UK
[b] Food Standards Scotland, 4th Floor, Pilgrim House, Old Ford Road, Aberdeen, AB11 5RL, UK

ABSTRACT

The earliest estimate for Great Britain (GB) as a whole to achieve negligible risk (NR) status for bovine spongiform encephalopathy (BSE) is 2021. This status allows certain tissues, such as bovine tonsils, to no longer be designated as Specified Risk Materials (SRM). The BSE control model was used to estimate what effect any additional lingual tonsillar material from harvested tongues inadvertently entering the human food chain would have on the amount of infectivity being consumed. Using the baseline model, with tonsils classed as SRM, a mean of 0.08 Bovine Oral (BO) ID_{50} was estimated to enter the food chain over one year for GB. Under NR status this mean was estimated to increase to 0.83 BO ID_{50}. Whilst this equates to a 10 fold increase in BO ID_{50} the amount is still small due to the very low likelihood of infected animals being present in the 2017 healthy slaughter population. There are a number of assumptions made within the model, namely, the amount of lingual tonsil inadvertently entering the food chain, and the infectivity titre within this particular tonsillar material.

1. Introduction

Bovine spongiform encephalopathy (BSE), primarily a disease of domestic cattle, was first identified in Great Britain (GB) in 1986. To protect human and animal health, control measures such as the removal and incineration of Specified Risk Materials (SRM) from animals at slaughter were implemented to prevent potentially infected materials recycling into food and feed chains. Specified risk material refers to those parts of cattle (and sheep and goats) that are most likely to pose a risk of infectivity if the animal from which it comes from was infected with a transmissible spongiform encephalopathy (TSE) disease (FSA 2017). In 2017 the World Organisation for Animal Health (OIE) recommended the BSE risk status of Northern Ireland and Scotland be upgraded from Controlled Risk (CR) to Negligible Risk (NR). In brief, a NR country is defined as a country or region that has demonstrated that appropriate measures have been taken to manage identified risks and that has demonstrated that there are sufficient surveillance and controls in place to meet a legislative "points target". The country or region must undertake awareness campaigns, notification and investigation and sampling. Neither meat and bone meal, nor greaves must have been fed to ruminants during the previous eight years and if indigenous BSE cases have occurred, they must have occurred in an animal born at least

11 years ago, and they, and all contact cattle, must be destroyed on slaughter or death. Controlled Risk countries or regions are those that have demonstrated that appropriate measures are being taken to manage identified risks but that a longer period is required for their application, and that have demonstrated that the surveillance and controls are in place to meet a legislative "points target". In these countries sampling will have only been ongoing for less than 7 years, and/or the country or region must be able to demonstrate that ruminants do not eat meat-and-bone meal or greaves although bans on this practice will have not yet been demonstrably ongoing for 8 years.

In a country with NR for BSE some tissues, including the tonsils, are no longer defined as SRM. Consequently, although bovine tonsils must be hygienically removed after post-mortem inspection (EC 853/2004) and their use is specifically not permitted for use in the production of mincemeat, meat preparation and mechanically separated meat, additional lingual tonsillar material could inadvertently enter the food chain attached to the tongue, if food business operators choose to harvest more tongue material than is currently permitted. EC Regulation 999/2001 currently specifies that for animals from countries with CR status the tongue should be harvested so as to avoid food contamination by lingual tonsils. Despite this, tonsils have still been found on tongues prepared for consumption using this method (Casteleyn, Breugelmans,

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Muylle, Van den Broeck, & Simoens, 2007; Kato & Sawada, 2008; Kühne, Klein, & Gasse, 2005; Rebmann, Kühne, Gasse, & Klein, 2010; Wells, Spiropoulos, Hawkins, & Ryder, 2005). The most likely destination for palatine and pharyngeal tonsils from animals from countries with NR status (NR cattle) would be Category 1 attached to the head.

Experimental studies have detected BSE infectivity by bioassay or the highly sensitive technique of protein-misfolding cyclic amplification (PMCA) (Saborio, Permanne, & Soto, 2001) in bovine palatine tonsils and tongues (Balkema-Buschmann et al., 2011; Murayama et al., 2010; Wells et al., 2005; Epinosa et al., 2007). Detection of infection, however, appears to be sporadic and it is hypothesised that the inconsistency in findings could be as a result of transient infectivity in the tonsils after oral challenge or that infection may only occur in highly restricted regions of the tonsils, and in small amounts.

Due to the long time taken in eradicating BSE and the low sensitivity of the tests used to detect disease, NR countries may still have disease at low levels. This was evidenced by France who achieved NR status for BSE for less than a year before the status was suspended in 2016 with another case of Classical BSE. The BSE Control Model (Adkin, Webster, Arnold, Wells, & Matthews, 2010) was specifically designed to estimate the impact of variations in surveillance controls and SRM removal and the total amount of infectivity entering the food chain and waste material streams. The model was used here to estimate what effect any additional lingual tonsillar material from NR cattle inadvertently entering the human food chain could have on the amount of infectivity being consumed.

2. Materials and methods

The BSE Control Model is a risk assessment which estimates by use of stochastic simulation the impact of testing of cattle at slaughter and the removal of Specified Risk Materials (SRM) on potential BSE infectivity entering the food chain. Parameters comprising surveillance, abattoir and infectivity are used to estimate the amount of infectivity per infected animal that has by-passed testing. These results are then used to estimate the annual amount of infectivity entering the food chain. There are a number of key parameters dependent on the age of the animal including: the probability of BSE infection; likelihood of slaughter and whether or not that animal is tested. The stage of incubation at which an infected animal is slaughtered can influence the exit category at death (i.e. healthy slaughter, emergency slaughter, fallen stock and clinical suspect). The stage of incubation will also determine the titre of infectivity in key tissues at the time of slaughter.

An infected animal, if tested, may not test positive, for example, BSE tests are dependent on the number of months prior to clinical onset of the animal, with the test only detecting disease in the last few months of the incubation period. The estimated average number of cattle that are infected but are classified as "negative" by testing and enter the food chain or fallen stock surveillance stream annually since 2008 and predicted to 2020 is shown in Table 1.

This application of the model is based on surveillance data i.e. GB cattle slaughter data and BSE cases recorded up to December 2017 and includes estimates, where available, of parameter uncertainty (Table 2).

The BSE control model already accounts for residual tonsillar material remaining on the tongue and entering the food chain from CR animals and estimates that the maximum value of tonsil would be a mean of ~1 g. How much additional tonsil inadvertently enters the food chain from NR cattle is difficult to determine as the lingual tissue is dispersed within the root of the tongue. The weight of bovine tonsils has been reported as 200 g (MAFF, 1997) and between 70 g and 170 g (Vařechová, 2015), however, it is uncertain whether this is total tonsillar weight or just palatine/pharyngeal. EFSA assumed a lingual tissue weight of 50 g (EFSA, 2008), a likely maximum estimate given the relative volumes of the tonsil types (Casteleyn, Breugelmans, Simoens, & Van den Broeck, 2011). To account for variability the model assumes that between 1 and 20 g of lingual tonsils per NR animal could remain

Table 1
Estimated number of infected animals in GB by-passing controls and entering the food chain (healthy slaughter and emergency slaughter) and fallen stock per year, with 5th and 95th percentiles.

Number of infected animals per year in Great Britain		
Year	Healthy and emergency slaughter	Fallen stock
	Mean (5th, 95th percentiles)	Mean (5th, 95th percentiles)
2008	545 (246, 987)	216 (98, 391)
2009	487 (172, 1001)	190 (67, 391)
2010	261 (124, 477)	152 (72, 278)
2011	161 (92, 262)	132 (76, 215)
2012	96 (56, 151)	97 (57, 153)
2013	59 (33, 95)	72 (40, 116)
2014	43 (22, 72)	54 (28, 90)
2015	30 (14, 53)	40 (19, 71)
2016	23 (10, 42)	32 (14, 58)
2017	16 (6, 30)	23 (9, 44)
2018	11 (4, 21)	17 (6, 33)
2019	8 (2, 15)	12 (4, 25)
2020	5 (1, 11)	9 (3, 18)

attached to the tongue post harvesting and enter the food chain.

The model assumes that tonsils of naturally infected cattle have a minimum probability of 0 and maximum probability of 1 of being infected. The titre of infectivity in tonsils was previously estimated using a uniform distribution between 1 and 10 bovine intracerebral (i.c.) $ID_{50}g^{-1}$. One ID_{50} represents the infective dose of material that causes infection in 50% of the exposed population. Using infectivity loads of $\leq 10^{2.5}$ Mouse i.c. TgBov XV $ID_{50}g^{-1}$ estimated for the tongue (Balkema-Buschmann et al., 2011), as a proxy for lingual material, and the conversion factors of Adkin, Simons, and Arnold (2014), a most likely estimate of 0.44 Bovine i.c. $ID_{50}g^{-1}$ was assumed but is skewed due to the uncertainty associated with the conversion factors to yield a mean of 7.6 Bovine i.c. $ID_{50}g^{-1}$ (5th 0.25, 95th 31).

Cattle eligible to be classed as NR animals have to be born, continuously reared and slaughtered in an NR country. The total number of cattle born and slaughtered in Scotland in 2017 was 416, 682 (Rural Payments Agency data 2017) but it's unknown whether these cattle were also continuously reared there. The total throughput for abattoirs authorized to process BSE NR cattle in the financial year 2017–2018 was ~ 245,000 (Food Standards Scotland 2018). Due to uncertainty in the throughput numbers and as the current estimate to request NR status for England and Wales is 2021, the model was used here to assess GB assuming NR status throughout.

3. Results and discussion

Assuming tonsils are classified as SRM under current conditions, using the baseline model (Fig. 1), a mean value of 4% tonsillar infectivity enters the food chain through contamination with 96% entering Category 1 materials with no further use permitted. Over one year for GB as a whole, this represents a mean of 0.08 Bovine Oral (BO) ID_{50} entering the food chain. It should be noted that this makes up only 0.02% of the total contribution of infectivity entering the food chain through all tissue types. If tonsils are no longer classed as SRM under NR status it is assumed that harvesting of the tongue will be cut further back on the tongue so more tonsillar tissue will remain and inadvertently enter the food chain. The assumption is that all tongues harvested will have some tonsillar tissue remaining with a minimum of 5 g and a maximum value of 20 g. This new estimate gives a mean value of 38% of tonsillar infectivity assumed to be harvested, however, more material may be removed when the skin is stripped from the tongue during processing. Over one year, if GB as a whole had NR status, this represents a mean of 0.83 BO ID_{50} entering the food chain from additional tonsillar material. Whilst this equates to a 10 fold increase in BO