Economic efficiency of preventive measures against transmission of *E.coli* O157:H7; A preliminary study

Vosough Ahmadi, B.[1], Velthuis, A.G.J.[1], Hogeveen, H. & Nauta, M. J.[2]

[1] Farm Management Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, the Netherlands
[2] Microbiological Laboratory for Health Protection, National Institute of Public Health and Environment (RIVM), PO Box 1, 3720 BA, Bilthoven, the Netherlands
Contact author: Bouda Vosough Ahmadi, Tel: +31 317 484057,
Email: Bouda.Vosough-Ahmadi@wur.nl

1. Introduction

E.coli O157:H7 (VTEC) is a very harmful bacteria for humans, causing haemolyitic uremic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP) in children and elder victims respectively. Beef is regarded as the main transmission vehicle of VTEC from cattle to human. In order to reduce the risk of human infections due to beef consumption, several intervention strategies can be applied along the beef supply chain. However it's not known in which part of the chain application of preventive measures is the most cost-effective. Recently a large research project started, aiming at more insight in the economic efficiency of known preventive measures against the spread of VTEC throughout the beef chain. The goal of this paper is to describe the modelling approach in this project. The seize of the paper is too small to be complete, so examples of the modelling process are given.

2. Materials and Methods

A detailed quantitative risk assessment model on transmission of VTEC from steak tartar in the Netherlands is available (Nauta, 2001). This is used as the basis for the current research. The mentioned model is in the process of being extended for the total beef production in the Netherlands. Economical parameters and more detail to certain parts of the model (e.g., slaughterhouse) are also incorporated in the model. The modelling is based upon available literature information. Initial modelling is carried out using the @Risk software (version 4,5, Palisade Corporation).

3. Results

- Beef supply chain

The beef supply chain in the Netherlands consists five main levels: farm, slaughterhouse, processing, retailer and consumer (Figure 1). Any contact between contaminated materials, such as skin, manure and equipment with non-contaminated muscles during the slaughtering process can lead to contamination of meat. One of the important aspects in the Dutch beef chain, are the import /export streams. Fore instance in 2001 only 36 percent of the total number of slaughtered animals in the Netherlands went to domestic consumption. The remaining part was exported. At the same time 75 percent of domestic beef consumption of the country was imported.

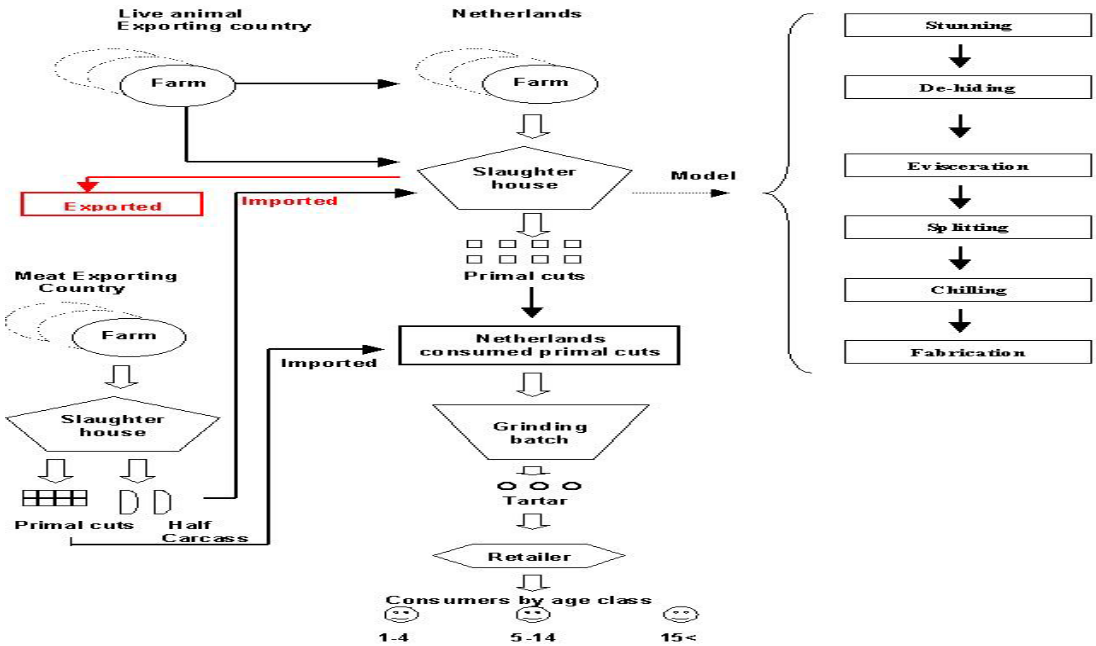

Figure 1. The Dutch beef supply chain and a schematic view of the risk assessment model

- Slaughterhouse model

First work on the Dutch beef supply chain model has been carried out on prevention of *E.coli* VTEC in contamination in the slaughterhouse. In a routine industial slaughterhouse in EU countries, follwing risky stages for transmission of VTEC can be recognized (Figure 1):

1- Stunning box	2- De-hiding	3- Evisceration
4- Splitting	5- Chilling	6- Fabrication

In each simulation of the model ten randomly selected animals from Dutch farms, either VTEC positive or negative (in both their digestive tract and skin) enter into the slaughtering process. To estimate the number of infected animals, both, herd and animal prevalence of *E.coli* VTEC were taken in to account. The surface area of the animals' skin was divided to the eight different parts, corresponding with eight primal cuts at the end of the slaughtering process. The number of bacteria in each cm^2 of these regions and in total area was calculated, using the following cumulative distribution (0,6, (2,3,4,5), 90.469, 0.531, 0.875, 0969)) [log g/cm^2] (Nauta, 2001). Certain parts of the carcasses have a higher probability of transferring the bacteria from skin during de-hiding process. These parts are the opening sites of the skin. For example approximately 7 % of the available VTEC on the skin of the *Sirloin* area can be transmitted to the *sirloin* surface (Bell, 1996). Contamination of the next carcasses by contaminated equipment (e.g., splitter and knives), after the passing of a heavily contaminated carcass was modeled as well (Gill, 1999). Increase or decrease in the number of bacteria on the carcasses, during chilling stage was modeled using following formula, adopted from (Nauta, 2001):

Cfu after chilling = cfu before chilling * 2 ^ (RiskTriangular (-2.32, -0.3,1.25)).

Prevalence of the contaminated primal cuts between domestic slaughtered animals at the end of this stage, is the first out put of the model. The prevalence of contamination among exported beef and between whole Dutch consumed beef are two other outputs of the model.

- Interventions and next steps

More than 25 different lterature-derived intervention measures (measures to reduce bacterial contamination) are under consideration. All the measures are assumed to be independent from each other. Some of them consists of only one activity (e.g., knife trimming) and some are the final result of more activities (e.g., lactic acid spray after hot water washing). The next stage in this project is the calculation of economical factors of mentioned measures. Once costs and benefits of each intervention are obtained, the next step will be determining their cost-effectiveness and make a comparison between them.

4. Discussion and conclusions

Studies on prevention of VTEC throughout the beef supply chain are mostly directed on epidemiological efficiency to prevent transmission of pathogens. However, in order to advice decision-makers correctly, insight in the economic efficiency of prevention is also important. In order to accomplish this, an economic model will be integrated into the described risk assessment model. This would also illustrate the distribution of intervention costs along the supply chain. Not only the slaughterhouse is important in this respect, also the farm level is important. The described model, which is under development, will be integrated with a farm level model. This farm level model describes the VTEC transmission between and within the farms (Turner, 2003). Appropriate adjustment of this model to the Dutch situation will be performed in order to make it compatible to the Dutch farming system. When both models are combined, different possible intervention measures at the farm level will be studied and can be compared with prevention measures at the slaughterhouse level. Since a large proportion of the Dutch domestic beef production is exported to other countries and a large proportion of domestic consumed beef is imported, one should be careful about interpretation of any change in outputs of the model due to interventions for the Dutch public health. Application of any intervention strategy at slaughterhouse level will mostly increase the level of the exported beef safety. The epidemiological-economical model, which is under development for VTEC contamination in the Dutch beef supply chain, seems to be a promising approach to deal with VTEC.

5. References

Bell, R. G (1996) Distribution and sources of microbial contamination on beef carcasses. Meat Industry Institute of New Zealand, Hamilton, New Zealand 5738/04/96.

Gill, C.O., Badoni, M., McGinnis, J.C (1999) Assessment of the adequacy of cleaning of equipment used for breaking beef carcasses. *International Journal of Food Microbiology*, 46.

Nauta, M.J., Evers, E.G., Takumi, K & Havelaar, A.H (2001) Risk assessment of Shiga-toxin producing *Escherichia coli* O157:H7 in steak tartar. *RIVM report 257851003/2001.*

Turner, J., Begon, M., Bowers, R.G., French N.P (2003) A model appropriate to the transmission of a human food-borne pathogen in a multigroup managed herd. *Preventive Veterinary Medicine*, 57. P.175-198.