**Appendix 25**

# Risk assessment on Foot-and-Mouth Disease (FMD) in pork from vaccinated animals

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**Abstract**

Foot-and-Mouth Disease (FMD) is a problem of great economic importance in livestock producing countries. Time and again, it has been experienced in a number of outbreaks worldwide. The Type O strain, for example, has been noticeable in recent outbreaks in most of Asia, Europe, and South America affecting susceptible pigs, sheep and cattle in these regions. Spread of the FMD virus is mostly by direct or indirect contact with infected animals and by airborne transmission. The inadvertent feeding of infected, inadequately processed or untreated meat and meat products also make the livestock population vulnerable to FMD (Alexandersen and others 2003).

The disease causes much astir in international trade, particularly in Europe, where borderless economies can be greatly affected. Free, unrestricted trade in the European Union (EU) as well as the close proximities and accessibilities of member states open avenues for the unhampered spread of the disease. The 2001 FMD epidemic in Great Britain, for example, quickly gave rise to subsequent epidemics in France, Ireland and The Netherlands (Bouma and others 2003).

In the case of the FMD epidemic in The Netherlands, immediate culling of affected animals, emergency vaccination, slaughter and destruction of vaccinated animals was done to control the disease in addition to culling of all susceptible animals in affected farms. Pre-emptive culling in nearby farms within a one kilometer radius of these farms (EEC Council Directive 85/511/EEC) was carried out. Emergency vaccination followed as a further control measure, that is, suppressive vaccination was performed from a radius of two kilometers around an affected farm going inwards (EEC Commission Decision 2001/246/EC). But suppressive vaccination also meant that all vaccinated animals were to be destroyed (Pluimers and others 2002). With the subsequent slaughter of many vaccinates, comes the problem of disposing their carcasses. The volume of meat from these carcasses is more than what local domestic consumption can handle. Considering putting into good use the surplus of meat from vaccinated animals, marketing this commodity can be an option. But what are the risks that have to be dealt with to safely trade this commodity within the EU?

Work had been done on the risks of FMD in various commodities in international trade (Callis 1996, Metcalf and others 1996, Gallagher 2002, Sutmoller and Casas Olascoaga 2003). Risk analyses and assessments on the importation beef (Astudillo and others 1997, Yu and others 1997, Sutmoller 2001) and milk and dairy products (Heng and Wilson 1993, Donaldson 1997) from countries infected with FMD were carried out. However, no studies have been done yet on the risks posed by FMD virus in pork or its meat products, particularly not from vaccinated pigs.

This paper assesses the risks associated with FMD virus in pork from vaccinated animals in FMD-affected areas already declared free from the disease. Possible risks of FMD virus contamination from pork of vaccinates are identified (farm to abattoir) and their probabilities are determined in a semi-quantitative risk assessment. This paper also makes a qualitative risk

assessment of the processed meat and its meat products to further evaluate the potential risks of exporting pork to FMD-free countries within the EU.

## SEMI-QUANTITATIVE RISK ASSESSMENT

### Scenario tree

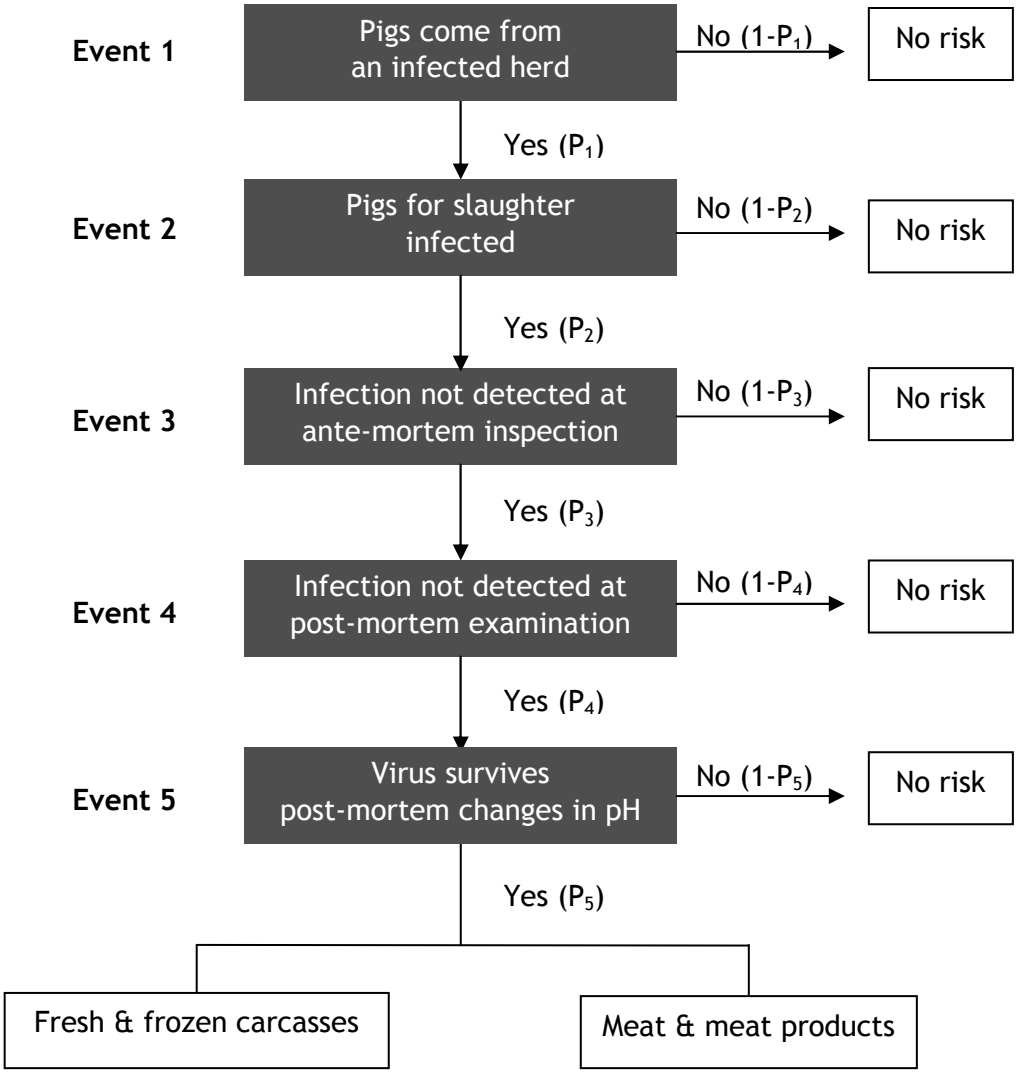
Fig 1 shows the scenario pathway for the possible risks of contaminating pork with FMD virus. It is assumed that the sources of animals are vaccinated pigs coming from an area which has regained freedom from FMD.

In the articles of a new EU directive (EEC Council Directive 2003/85/EC), three phases of a waiting period are described till an affected area is declared FMD-free (Fig 2). Phase 1 is, at least, a 30 day elapsed period after the completion of emergency vaccination. Phase 2 follows this period where a survey and a classification of holdings are completed. Phase 3 is the time after the completion of the survey and the classification of holdings until the foot-and-mouth disease and infection status is recovered. In this paper, the risk assessment is carried out for Phase 3 only, because it seems unrealistic to restart trade in Phase 1 and 2.

A semi-quantitative risk assessment from Events 1 to 5 is made using the software program "@Risk" version 4.5 (©2002, Palisade Corporation) to determine the probability distributions for the events in the scenario tree and sensitivity analysis. The combined risk of having contaminated meat is computed by multiplying all the estimated probabilities of the five events.

After the last event, a qualitative risk assessment is made as regards the possible risks of the FMD virus still surviving in fresh, frozen carcasses and meat and meat products for export.

**FIG 1: Scenario pathway for the risk of contaminating pork with FMD virus**




**Probability of Contaminated Meat (Pcontam) = $P_1 \times P_2 \times P_3 \times P_4 \times P_5$**

The events where these risks can be evaluated are identified as follows:

- **Event 1** - the source of the vaccinated pigs come from an undetected, infected herd or farm
- **Event 2** - the selected vaccinated pigs are infected at the time of slaughter
- **Event 3** - apparent infection in the live, vaccinated pigs is not detected during ante-mortem inspection
- **Event 4** - meat inspection fails to detect infection during post-mortem examination
- **Event 5** - the FMD virus survives post-mortem changes in pH in meat

FIG 2: Schematic Diagram of the Phases of the Waiting Period for FMD

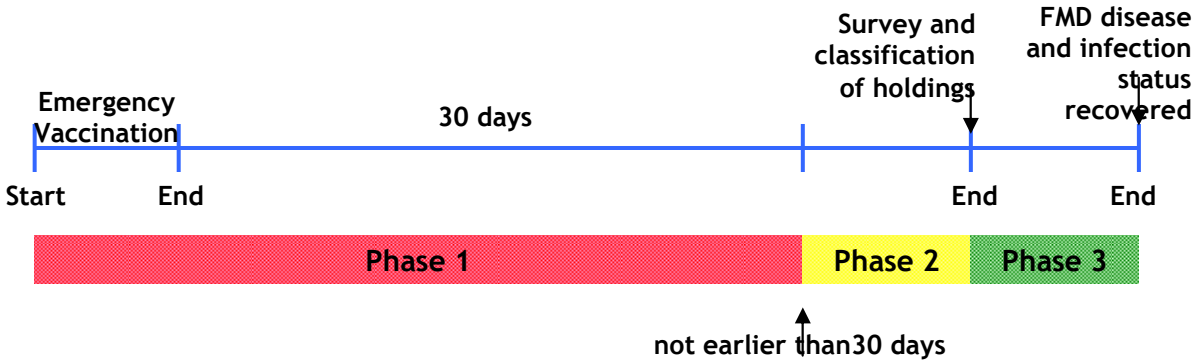



TABLE 1: Estimated phases of the outbreaks in the 1997 FMD epidemic in Taiwan

| Dates | Cumulative no. of days | No. of newly-infected herds | Herd Prevalence | Remarks | Phase in waiting period |
|---|---|---|---|---|---|
| March 14-20 | 6 | 28 | 0.110% | | |
| March 21-27 | 12 | 689 | 2.713% | | |
| March 28-April 3 | 18 | 850 | 3.346% | Started mass Vaccination (March 29) | Phase 1 |
| April 4-10 | 24 | 1,087 | 4.280% | | |
| April 11-17 | 30 | 1,113 | 4.382% | | |
| April 18-24 | 36 | 772 | 3.039% | | |
| April 25 - May 1 | 42 | 625 | 2.461% | | |
| May 2-8 | 48 | 677 | 2.665% | Started blanket Vaccination (May 3) | |
| May 9-15 | 54 | 240 | 0.945% | | Phase 2 |
| May 16-22 | 60 | 42 | 0.165% | | |
| May 23-29 | 66 | 15 | 0.059% | | |
| May 30 - June 5 | 72 | 5 | 0.020% | | |
| June 6-12 | 78 | 0 | 0.000% | | |
| June 13-19 | 84 | 1 | **0.004%** | | Phase 3 |
| June 20-26 | 90 | 0 | **0.000%** | | |
| June 27 - July 3 | 96 | 0 | **0.000%** | | |
| July 4-10 | 102 | 2 | **0.008%** | | |
| July 11-15 | 108 | 1 | **0.004%** | | |
| July 16-23 | 114 | 0 | **0.000%** | | |

**TABLE 2: Summary of probabilities for each event in the scenario tree**

| | Event | | Probability | Reference for values |
|---|---|---|---|---|
| 1 | Pigs come from an infected herd | $P_1$ | 0.0016% | Yang and others 1999 |
| 2 | Pigs for slaughter infected | $P_2$ | 0.47% | Chung and others 2003 |
| 3 | Infection not detected at ante-mortem inspection | $P_3$ | 79.7% | Metcalf and others 1996 |
| 4 | Infection not detected at post-mortem examination | $P_4$ | 79.7% | Metcalf and others 1996 |
| 5 | Virus survives post-mortem changes in pH | $P_5$ | 1.1% | Metcalf and others 1996 |

**TABLE 3: Calculated volume of exports based on the risk of exporting a contaminated product by the Netherlands (2003 figures)**

| | Export Volume | Quantity | |
|---|---|---|---|
| Commodity | metric tons | metric tons | kilos |
| Pork | 343,657 | 0.00044 | 0.43925 |
| Bacon | 129,568 | 0.00017 | 0.16561 |
| Sausages | 34,033 | 0.00004 | 0.04350 |
| Meat Preparations | 20,995 | 0.00003 | 0.02684 |

**Discussion**

There is little data available on surveillance and monitoring programs for vaccinated pigs after an FMD outbreak. More studies should be made on the FMD antibody titers using ELISA-based tests detecting NSPs to differentiate infection from vaccination.

In a global sense, the prevalence rates used in the semi-quantitative risk assessment here may not be representative of the true picture of the disease in a vaccinated animal population. Disease situations differ from region to region. In Europe, outbreaks in pigs are smaller, containment is better therefore the risks are much lower. Nevertheless, this study would necessitate for more scientific literature depicting different scenarios of FMD disease prevalence in other countries.

Regardless of the present prevalence of FMD, residual virus survivability and infectivity in pork depends mainly on the chemical changes that take place at post-mortem. The sufficient lowering of pH in muscle tissues of carcasses is a crucial factor in the inactivation of the virus. It is important, therefore, that meat manufacturing or processing systems observe required chilling times after slaughter to hamper further survivability of the virus.

Where there are organ systems which are unaffected by these pH changes, the FMD virus is most likely to survive. Fresh and frozen carcasses pose potential risks in FMD virus

introduction since these can harbour the virus in remaining lymph nodes, residual blood, bone marrow and the skin. In the case of meat and meat products, the risks are much lower, especially those which do not contain bone. Various meat processing methods like cooking with required heat treatments, long curing periods and specific processing methods (e.g., grinding), can contribute to the eventual inactivation the virus.

Information on infectious virus survival in the skin, lymph nodes, bone marrow and blood of already vaccinated animals are lacking. More studies in the pathogenesis of the virus in these particular organ systems in a vaccinated population especially after an outbreak is therefore warranted.