Risk Assessment for Supply Chain Meat Inspection of Danish Finisher Pigs

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Abstract
The food safety value of routine incision into the major mandibular lymph nodes and the heart was assessed in finisher pigs from integrated production systems in Denmark. A risk assessment was conducted following international guidelines as a joint effort between university, industry and veterinary services. It was concluded that omission of routine incisions into the mandibular lymph nodes and the heart was not associated with a significant increase in the risk for human health. The main reason is that Denmark is officially free from bovine tuberculosis since 29 years, and the pathogens causing granulomatous lymphadenitis and endocarditis are not likely to be food-borne. The new way of conducting meat inspection is called supply chain meat inspection – the Danish way. The system will gradually be implemented on all slaughterhouses in Denmark during 2009.

Introduction
Recent changes in EU legislation enable the introduction of modifications to the traditional meat inspection of finisher pigs, which originate from integrated production systems and are housed under controlled conditions. In Denmark, two issues were of interest with regards to such pigs: 1) what is the food safety value of routine incision into the major mandibular lymph nodes? And 2) what is the food safety value of routine incision in the heart? To assess this, a risk assessment was conducted following international guidelines. The work was conducted as a joint effort between university, industry and veterinary services.

Materials and methods
This risk assessment is primarily qualitative and based on the general approach described by OIE. This approach differs only in the order of the elements from the guidelines described by Codex Alimentarius. Hence, the following elements were included:

1. Hazard identification
2. Release assessment
3. Exposure assessment
4. Consequence assessment
5. Risk estimation

In the hazard identification we judged which agents could be associated with a risk for humans and if so how (occupational hazard or food safety hazard). This was based on information from the literature. In the release assessment, the probability of the hazards (identified in step 1) in/on the live animals or the carcass was assessed both based on our two studies as well in-house statistics, the literature, report from official laboratories and expert opinion. In the exposure assessment we estimated the prevalence of the exposure of consumers to the relevant hazards. In the consequence assessment the consequences related to the unwanted outcome were evaluated, based on data from the literature. The unwanted outcome was first seen as a person becoming ill due to exposure to the hazards. Furthermore, the number of people
becoming ill was assessed. Then, we compared the two ways of conducting meat inspection (traditional versus Supply Chain Meat Inspection). Data from slaughterhouses, laboratory statistics, information from the literature, and expert opinions were included. In particularly, we used data from a large scale side-by-side study conducted in Denmark in 1993 (Moussing et al., 1997). In that study, 183,383 pigs underwent both traditional and visual inspection. Moreover, we collected up-to-date in-country data. More specifically, we made a microbiological and pathological examination of lymph nodes with gross morphological changes and hearts with endocarditis. The risk assessment went through external review, and comments from the reviewers were incorporated in a transparent way and can, hence, be seen in the report (Alban et al., 2008).

Results
The mandibular lymph nodes
Omission of routine incisions into the mandibular lymph nodes was not associated with a significant increased risk for human health. The main reason is that Denmark is officially free from bovine tuberculosis since 29 years and a surveillance programme is in place. Moreover, the pathogens causing granulomatous lymphadenitis are not likely to be food-borne.

Table 1
Distribution of different organisms found in a study on 43 mandibular lymph nodes with granulomatous lesions and/or caseous necrosis in finisher pigs, Denmark 2008

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number of samples (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative* for Mycobacterium spp.</td>
<td>43 (100)</td>
</tr>
<tr>
<td>Rhodococcus equi</td>
<td>27 (63)</td>
</tr>
<tr>
<td>Nocardia farcinica</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Culture-negative</td>
<td>15 (35)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43 (100%)</strong></td>
</tr>
</tbody>
</table>

* Acid-fast negative by Ziehl-Neelsen stain

We collected 43 mandibular lymph nodes with granulomatous lesions. All were negative for Mycobacterium spp. in Ziehl-Neelsen stain. Rhodococcus equi was found in 63% of the samples (Table 1). This bacterium is not known for being zoonotic. Even though none of the 43 lymph nodes were positive for Mycobacterium spp. we cannot rule out avian tuberculosis, which is known to occur at a very low level in Denmark. Occasionally wild birds, zoo birds or pigs are found infected. Pigs are mainly infected through contact to infected birds or by use of sphagnum or soil-contaminated wood shavings. The infection in pigs usually results in granulomatous lesions and/or caseous necrosis in the mandibular or mesenterial lymph nodes. This will result in local condemnation of the affected organs. If TB-like lesions are found outside these two groups of lymph nodes, the veterinarian will send the material to further laboratory investigation to the Danish Veterinary Institute. If Mycobacterium avium is found, the entire carcass is condemned. The mandibular lymph node is used for production of animal feed after sufficient heat treatment. This limits the probability that humans will be exposed to M. avium. Humans might occasionally get infected with M. avium, although this primarily was a problem for immuno-compromised patients like HIV/AIDS patient in the 1980s and 1990s. Today, adequate treatment exists limiting the problem largely. It is unknown whether infected pork can cause disease in humans. The prevailing opinion in the literature is that this is not the case. Mycobacterium avium is a bacterium linked to the environment and can be found in water, cigarettes, and cheese. Hence, people can be exposed in many ways.

The heart
Omission of the routine incisions into the heart was not associated with a significant increased risk for human health. The main reason is that the pathogens causing endocarditis are not likely to be food-borne. According to the literature and in line with our study on 88 hearts with endocarditis - the most common bacteria associated with endocarditis are Streptococcus suis and Erysipelothrix rhodopethiae. They were found in 46% and 32% of the hearts with endocarditis, respectively (Table 2). These bacteria are not
known for being food-borne; however, they might result in infection through contact. Hereby, veterinarians and slaughterhouse personnel are at higher risk of infection than consumers in general. But this risk will not be increased if hearts are not opened routinely. However, if lesions are observed in other organs or on the carcass indicating that the pig is affected by a generalised disease (generalised septicaemia or pyaemia) the carcass should be subjected to extended meat inspection following traditional rules. To reduce the exposure of the consumers to these pathogens, it was recommended that hearts should be opened prior to sales but not as a part of the meat inspection. Any finding of endocarditis should result in the heart being condemned.

Table 2
Distribution of organisms found in a study of 88 pig hearts with endocarditis found at the slaughter line, Denmark 2008

<table>
<thead>
<tr>
<th>Organism found in heart</th>
<th>Number of hearts with endocarditis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Streptococcus suis</em> like</td>
<td>40 (45.5)</td>
</tr>
<tr>
<td><em>Erysipelothrix rhusiopathiae</em></td>
<td>28 (31.8)</td>
</tr>
<tr>
<td>Beta-hemolytic <em>Streptococci</em></td>
<td>5 (5.7)</td>
</tr>
<tr>
<td><em>Lactobacillus garvieae</em></td>
<td>4 (4.5)</td>
</tr>
<tr>
<td><em>Arcanobacterium pyogenes</em></td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Isolates awaiting identification</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Culture-negative</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Total</td>
<td>88 (100.0)</td>
</tr>
</tbody>
</table>

*: Awaiting final laboratory identification.

Discussion
The meat inspection rules should be evaluated form time to another to ensure that we are constantly managing the hazards in the most effective manner. If the pathogens present in pigs and pork are changing, then we need to evaluate whether we are dealing with the agents that constitute the highest risk for humans (Fig. 1).

![Diagram](attachment:probability.png)

Fig. 1. Risk of getting ill (combination of release, exposure and consequences) from consumption of Danish pork, irrespective of type of meat inspection, Denmark 2008
- = High certainty linked to estimate of probability
%= Some uncertainty linked to estimate
Today, *Salmonella* spp. and *Yersinia* are causing a high number of human cases whereas we only see a few persons with wounds secondarily infected with *Erysipelothrix rhusiopathiae*. Moreover, during a 3-year study of human meningitis in Denmark, only one case of *S. suis* was found – and that was in a farmer.
indicating that infection was caused by contact. Bovine tuberculosis has been eradicated. Should it re-emerge it is hardly in an indoor-living finisher pig. Moreover, a surveillance programme is in place. Finally, the role of pork in the spreading of avian tuberculosis is unclear; the prevailing opinion in the literature is that pork is not of importance.

According to the risk assessment, the risk associated with omission of the routine incision into the mandibular lymph nodes and the heart is associated with a negligible risk. Risk assessment seemed to be an effective way of evaluating the questions raised. The collaboration between university, veterinary services and the industry ensured that most aspects were covered during the work. And the peer-review process with subsequent incorporation of the reviewers’ comments ensured that the remaining aspects were acceptably covered. It might be difficult for slaughterhouse personnel as well as the official meat inspectors to understand why meat inspection rules should be changed. To assist in this process, the results of the risk assessment were communicated to the slaughterhouse personnel as well as the official meat inspectors during several meetings as well as through publishing popular and scientific papers in Danish veterinary journals.

Conclusion

It was concluded that omission of routine incisions into the mandibular lymph nodes and the heart was not associated with a significant increased risk for human health. The main reason is that Denmark is officially free from bovine tuberculosis since 29 years, and the pathogens causing granulomatous lymphadenitis and endocarditis are not likely to be food-borne. This conclusion relates to otherwise healthy finishers from integrated production systems, reared indoor since weaning under controlled housing conditions. We call this way of conducting meat inspection “Supply Chain Meat Inspection – The Danish” way to emphasize that focus is on the entire production chain from stable to table (Alban et al., 2008).

Epilogue

The assessment and a description of “Supply Chain Meat Inspection – The Danish Way” were presented to the US Food Safety and Inspection Services in December 2008 – and acceptance of equivalence was granted on December 24, 2008. The new way of meat inspection for finisher pigs in Denmark will be implemented during 2009. Initially it will be implemented on two slaughterhouses to gain experience, and thereafter gradually on all slaughterhouses. The work also resulted in a new risk assessment being undertaken dealing with the effect of palpating the mesenterial lymph nodes.

References
