Modernisation of meat inspection of pigs by use of risk assessments
- An evidence-based approach

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Meat inspection - historically

Aims of inspection
• To ensure food safety and wholesomeness of meat
  • Later: also to ensure animal health and welfare

Rules known since antiquity
• Often connected to religious rites

Germany: leading country in the past centuries
• *Trichinella* epidemics and identification of *Trichinella* =>
  • Renewed interest for meat inspection – requirement for trichinoscopy
• Dr. Robert von Ostertag's meat inspection act of year 1900
  • Led to a reduced incidence of bovine tuberculosis in humans

100 years later, time for an update
Introduced the concept of
1. Risk-based approach
2. Stable-to-Table line of thinking
3. Food Business Operator’s responsibility

These three elements are basic principles for the General Food Law in EU
1. EU Regulation 178/2001

The concept was addressed in the EU Meat Inspection Regulation 854/2004
1. Which opened up for use of risk assessments, when considering to change meat inspection
   - From traditional to a more visual inspection
   - For young calves and finishing pigs, raised under controlled housing conditions
Risk assessments undertaken in Denmark

To illustrate what the effect would be of changing inspection
- Cut-by-cut, palpation-by-palpation
- OIE approach to risk assessment

Up-to-date-in-country data used
- Danish meat inspection database
- Own collection of samples taken during inspection/slaughter
- Worldwide published literature
- Expert opinion, when needed

Collaboration
- Academia-Authority-Industry

Diagram:
- Hazard identification
- Release assessment
- Exposure assessment
- Consequence assessment
- Estimation of risk
Example: The heart

What is the risk associated with abandoning routing incision allowing inspection of the inner side of the heart?

Endocarditis may be overlooked
• Prevalence of 0.01% in Danish finishing pigs

Hazard identification
• *Streptococcus suis* and *Erysipelothrix rhusiopathiae*
  • Considered occupational hazards that are not foodborne

Release/exposure/consequences
• Years’ of focus on work safety → Not considered a problem among abattoir employees’ union
• Statens Serum Institute’s 3-year study on human meningitis:
  • 1 case (a farmer) caused by *S. suis*
Example: The heart, continued

Conclusion
• Presence of endocarditis *per se* does not render the meat unsafe for human consumption

If other lesions are found during inspection, indicative of systemic infection
• Such as abscesses that could be part of a septicaemia complex
• Then carcass should go to rework area and be subjected to traditional inspection

Handling of heart
• Danish solution: heart is opened by an abattoir employee
  • Condemned, if lesions are found
  • To reduce exposure of consumers to *S. suis* and *Erysipelothrix rhusiopathiae*
Process 2004-2009 – Danish risk assessments about swine inspection

EU Regulation 854/2004

- Opened up for use of risk assessments in indoor finishing pigs

Risk assessment for heart and mandibular lymph nodes, 2008

- **Concern:** Risk of overlooking tuberculosis and endocarditis

Risk assessment for intestinal lymph nodes, 2009

- **Concern:** Risk of overlooking disease only in intestines or their lymph nodes
Process 2013-2019 – Danish risk assessments about swine inspection

1. **Risk assessment for lungs and liver, 2013**
   - **Concern:** Risk of overlooking embolic pneumonia caused by septicaemia, and liver abscesses

2. **Microbiological burden of pigs with septicaemia, 2013**
   - **Concern:** Meat from pigs with septicaemia have high microbiological burden

3. **De-boning of cases with lesions indicating prior septicaemia, 2014-19**
   - **Concern:** Osteomyelitis could be overlooked, if carcass is not de-boned
Low quantitative number of *S. aureus* in pigs with lesions indicative of septicaemia

Table 2
Quantitative presence of *S. aureus* in various sites in each of 19 finisher pigs identified with embolic pneumonia during traditional meat inspection, carcasses (final judgement of the carcass and presence of ulcer).

<table>
<thead>
<tr>
<th>Pig no.</th>
<th>Final judgement</th>
<th>Lung</th>
<th>Muscle</th>
<th>Heart</th>
<th>Liver</th>
<th>Kidney</th>
<th>Spleen</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>De-boning</td>
<td>&gt;200</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>28</td>
<td>0</td>
<td>0</td>
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<td>2</td>
<td>Condemnation</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Condemnation</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>4</td>
<td>De-boning</td>
<td>&gt;200</td>
<td>0</td>
<td>-150</td>
<td>87</td>
<td>44</td>
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<td>0</td>
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<tr>
<td>5</td>
<td>De-boning</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>115</td>
<td>N/a</td>
<td>0</td>
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<tr>
<td>6</td>
<td>De-boning</td>
<td>&gt;200</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td>-50</td>
<td>-100</td>
</tr>
<tr>
<td>7</td>
<td>De-boning</td>
<td>&gt;200</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>De-boning</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>De-boning</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>N/a</td>
</tr>
<tr>
<td>11</td>
<td>De-boning</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>De-boning</td>
<td>&gt;200</td>
<td>0</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>14</td>
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<td>0</td>
<td>15</td>
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<td>0</td>
</tr>
<tr>
<td>15</td>
<td>De-boning</td>
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<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Condemnation</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>17</td>
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<td>0</td>
<td>15</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>18</td>
<td>De-boning</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>N/a</td>
<td>N/a</td>
</tr>
<tr>
<td>19</td>
<td>De-boning</td>
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<td>3</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
</tbody>
</table>

N/a: Data not available.

*a* Per sample represents a swap sample from lung, heart and joint and a tissue sample of approx. 1 g from muscle, liver, kidney and spleen. See **S** section for explanation.

Suspicion of septicaemia

Presence of lesions indicative of septicaemia needs careful evaluation
  • In Denmark, so-called “pyaemia” investigation undertaken in the rework area
    Acute cases → Total condemnation
    Chronic cases → De-boning

Lesions probably caused by a tail bite, which occurred months earlier
  • In many case, lesions are in healing
  • Deboning will ensure that osteomyelitis cases will be detected
    • Hereby abscesses are removed
Study of septicaemia in finishing pigs, 2013-14

Study at Tican Abattoir during 2 weeks in 2013
• Table shows location of abscesses in 102 carcasses
• Detected during pyaemia investigation

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic cavity</td>
<td>50</td>
<td>42.0</td>
</tr>
<tr>
<td>Lumbal spine</td>
<td>21</td>
<td>17.6</td>
</tr>
<tr>
<td>Thoracic spine</td>
<td>17</td>
<td>14.3</td>
</tr>
<tr>
<td>Foreleg</td>
<td>14</td>
<td>11.8</td>
</tr>
<tr>
<td>Hindleg</td>
<td>10</td>
<td>8.4</td>
</tr>
<tr>
<td>Other¹</td>
<td>5</td>
<td>4.2</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Main part of abscesses found in the thoracic cavity

¹ Tail bone, pelvis, jaw, neck, lungs.

Bækbo et al., 2015. Food Control
Study of septicaemia in finishing pigs, 2013-14

The 102 finisher pigs sent for de-boning - All accepted afterwards

One abscess found during de-boning (not related to septicaemia complex)
- Most (83%) muscle samples sterile, but abscesses only 6% sterile
- Positive samples: mostly known pig pathogens and environmental bacteria
  - *Streptococcus* sp., *Pasteurella* sp., *Trueperella pyogenes*, *Aeromonas* spp.,
    *Ralstonia Pickettii* (judged as contaminant)

*S. aureus* judged as only potential human patogen (toxin production)
- No association between presence of bacteria in muscle and abscess (P = 0.86),
  neither for the specific findings of *S. aureus* (P = 1)

Subsequent data from 6 other abattoirs evaluated
- Less efficient in finding all abscesses during the pyaemia investigation
  - Some abscesses overlooked
Prior septicaemia in sows

Sows are destined for de-boning
• If lesions are found, indicating septicaemia
  • As for finishing pigs

Data from 14 months from Skærbæk Sow Abattoir
• Very few abscesses escape detection during the pyaemia investigation
• Only 5 cases out of 322,972 condemned due to septicaemia
• According to Pedersen et al., Fleischwirtschaft International (2017)
Locations of 127 abscesses in 105 sows/boars

- The tenderloin is the most common location in sows/boars.
- Not the same in finishing pigs, where the thoracic cavity is the most common location.

Pedersen et al., 2017. Fleischwirtschaft International
Difference between conventional and alternative raised sows

Research question:
• Does prevalence of de–boning and total condemnation of sows differ according to production system?
• Abattoir data (Jan. 2014–Mar. 2015)
• Divided into sows raised in:
  • Conventional or alternative system

Result:
• Conventional sows with septicaemia are less likely to be totally condemned than similar sows from alternative production
• Could be related to low AM-use in alternative production

Pedersen et al. 2017 Fleischwirtschaft International
Process in Denmark – collaboration across parties

Review process in place
- Risk assessments are developed by the livestock and meat industry in collaboration with University of Copenhagen with Master or Ph.D. students on board
  - Assessments are presented to the veterinary authorities
- The veterinary authorities send the assessment to the Danish Technical University (DTU)
  - For objective, external review
  - Any concern raised by DTU will then be addressed

Case: Changing handling of de-boning of carcasses with lesions indicative of prior septicaemia
- Risk assessments accepted, but implementation study was judged as required
Studies of implementation of alternative handling of prior septicaemia cases, 2017-19

Study objective: find alternatives to de-boning of chronic cases
- Studies done separately in sows and finishers
- Showed that some abscesses were overlooked in specific areas

- Pyaemia investigation updated + targeted cutting described for own control
- Own control used by abattoirs => will result in lower costs because 1) no need for de-boning, 3) higher value of meat, and 3) no category 2 animal by-products
Results of risk assessments – in general

Finishing pig have few lesions of importance to food safety
• Seriously ill pigs are euthanised and are hence not delivered to the abattoir
• The body is clearing itself after an infection
• Very low count of bacteria in muscles – bacteria also found in healthy controls

In most cases, lesions are macroscopically observable
• Except from endocarditis and small abscesses in lymph nodes
• Embolia in lungs may be overlooked, if few and only located deep in the tissue

Bacteria involved are usually not foodborne, but considered occupational hazards
• May cause infections in existing wounds in humans
• Lungs not considered edible tissue in Denmark
Experienced gained - gradually

The approach led to a gradual implementation of visual-only inspection

For indoor finishing pigs, routine incisions/palpation was abandoned
1. Mandibular lymph nodes
2. Heart
3. Intestinal lymph nodes
4. Lungs

Experience gained regarding how to modify the slaughter line
• Enabling inspection of plucks hanging over intestines
• Mirrors and lights to ensure documentation

Moreover, studies of septicaemia cases provided evidence regarding microbiological burden and more cost-effective ways of handling, depending upon stage of infection
Risk communication

Judged as very important to communicate
• Risk assessments written in English
• Scientific papers published in various journals
  • Placed on website of Danish Agric. & Food Council
  • http://lf.dk/aktuelt/publikationer/svinekod

Presentations given, and discussions taken
• At scientific meetings and arrangements for people involved in meat inspection

Dialogue with important trade partners
• To obtain acceptance of equivalence
• Very important for a country, which is exporting a high proportion of its pig meat
Discussion – EFSA Opinion from 2011

Identified the hazards, which should be covered by meat inspection of swine
• Salmonella, Yersinia, Trichinella and Toxoplasma
• EFSA concluded that traditional meat inspection in swine could safely be replaced by visual-only inspection
  • Without jeopardizing food safety, animal health or animal welfare

Hazard identification should be updated regularly
• Hepatitis E virus? - Relevant hazard?
• Residues of antimicrobials in meat – Relevant hazard?

Septicaemia was not covered in the EFSA Opinion
• Therefore, we did the work ourselves 😊
• Similar studies are currently undertaken in Portugal
Discussion – New EU Regulation not fully complied with

In June 2014, new EU Meat Inspection Regulation came into force
• Stipulating that meat inspection of all swine should be visual-only
  • Irrespective of age or production system
• Unless food chain information (FCI) or info from AM or PM indicate otherwise
  • Hence, FCI system is a requirement for visual-only inspection

However, countries outside the EU did not allow this
• Creating a difficult situation for pig meat exporting Member States
• This has delayed the implementation in some countries
• In Denmark, outdoor raised pigs as well as sows and boars slaughtered at the export-oriented abattoirs are still inspected in the traditional way
Development of national risk assessments in parallel with EFSA

- May be seen as complimentary work addressing specific needs in Member State
- EFSA Opinion 2011 not considered as sufficiently detailed for trade partners
  - When negotiating acceptance of equivalence
  - Here, in-country-up-to-date risk assessments may be needed

Next question in Denmark is to look at same issues in bovines

- Beginning with update of microbiological testing methodology
  - Used when certain lesions involving prior septicaemia are found
  - Will involve detailed study of microbiological burden of animals/carcasses
Discussion - continued

EFSA recommended development of meat safety assurance systems
• With focus on the hazards that make humans and animals fall ill

Private standards in place
• Listing different requirements - among others for meat safety

RIBMINS Cost Action network 2019-2024
• Will bring together academia, authorities and stakeholders
• To look further into development of feasible meat safety assurance systems

Challenge: Food Chain Information
• Usefulness: how, where and when?
• For- and backward feeding of information
Conclusion

Risk assessment
• An effective tool and a constructive process, involving evidence and people
• Publishing in English is necessary
• Dialogue with different stakeholders is needed
• External review system: safe structure, but patience required

Approach made it possible to implement changes gradually
• As acceptance of equivalence was obtained from importing trade countries
• People involved in meat inspection became accustomed to visual-only inspection
• System modified step-by-step to ensure continued detection of important lesions
  • For food safety, animal health, and animal welfare

→ Confidence in the Danish inspection system has been maintained
For your interest:
RIBMINS Cost Action Network 2019-2024

Open inaugural workshop about risk-based meat inspection and integrated meat safety assurance
• Monday 26 August 2019 in Berlin
• Held in relation to the Safepork Conference
• Find more information on: www.safepork-conference.com
Thank you for your attention

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