Trial of visual inspection of fattening pigs from non-controlled housing conditions

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EXECUTIVE SUMMARY

FINAL REPORT FOR PROJECT FS145003

The purpose of meat inspection is to contribute to the production of safe food for human consumption. Derogations from European Union (EU) regulations enable carcases of fattening pigs to be inspected by visual-only methods, provided that certain requirements are met, and the pigs have been reared under controlled housing conditions, in integrated production systems, from weaning to slaughter. Such visual-only methods reduce the handling of the carcases or incisions into parts of it by officials. This may reduce the risk of cross carcass contamination. Uptake of visual-only inspection by the United Kingdom (UK) pig industry has been low because slaughterhouses accept a mixture of indoor and outdoor reared pigs throughout the day and the latter still need to be inspected by traditional means.

In Project FS145003 – “Trial of visual inspection of fattening pigs from non-controlled housing conditions” – the carcases we looked at were from pigs reared in outdoor management systems entirely from weaning to submission to slaughter. As far as we are aware, all such pigs in the UK are also born in outdoor management systems. We use the terms ‘outdoor’ pigs, pigs from non-controlled housing conditions and ‘free-range’ pigs interchangeably to refer to the pigs we looked at, unless clearly stated otherwise.

The project consisted of a field study and a risk assessment. In the field study, we investigated the frequency and types of conditions that could be identified by the two different meat inspection methods when fattening pigs from outdoor housing conditions were slaughtered in an abattoir in the UK. The two different meat inspection methods used were the ‘traditional’ method and a ‘visual-only’ method. The traditional method involved visual inspection with additional handling and incisions to investigate parts of the carcass and offal (the internal organs and entrails) that cannot be easily observed from the outside. With the visual-only method no handling of the carcass and offal was allowed. We compared the conditions that could be found by each inspection method. We also took samples, after each inspection method, from a subset of the carcases to see if we could grow particular bacteria. These bacteria are either indicators for the hygiene of the slaughter process (total aerobic and Enterobacteriaceae counts), or can cause food-borne disease in humans (Salmonella spp. and Yersinia spp.). We compared whether they were present or absent and how many could be found on the carcases after each inspection method.

We used the results from the field study along with previous work, scientific literature and publically available information to do a formal, mostly qualitative, risk assessment (RA), based on guidelines described by the Codex Alimentarius Commission (CAC). We looked at the risks to human (public) health, animal health and animal welfare and whether these risks would change if visual-only inspection for fattening pigs from non-controlled housing conditions was to be introduced. In addition, we looked separately at what obstacles there might be to the implementation of visual-only inspection for fattening pigs in UK abattoirs.

In order to establish an idea of what the baseline might be in our study abattoir, for our findings of frequencies and types of conditions by traditional meat inspection, we looked at historic records. Meat inspection data, from all batches of pigs slaughtered at the study abattoir, were made available directly from the Food Standards Agency (FSA). Over a period of one year, data were available from the ante-mortem and post-mortem carcass inspection
and post-mortem offal inspection of more than 1.2 million pigs from approximately 7,400 batches (the groups that they are submitted to the abattoir in). These pigs came from both indoor and outdoor rearing and fattening systems. The frequency (prevalence) of each condition in each batch and the proportion of the batches affected with a condition were calculated. The latter was compared between the two management systems (indoor v. outdoor). Batch size and seasonality were considered, in case they were related to the frequency of the diseases, or circumstances, that caused the conditions, but they had no influence on the associations found. The mean (average) prevalence in batches with each condition was also compared between the two management systems. The prevalence of conditions detected on inspection of pigs submitted to slaughter from different fattening systems were quite similar. Most of the differences found were predictable from knowledge of the housing and fattening systems being used and the relationship with the diseases, or circumstances from which the conditions arise.

Our field study involved five separate weeks of work in one abattoir in the East of England during the period from the November 2011 until April 2012. More than 11,000 carcases of fattening pigs from non-controlled housing conditions from 62 batches and 12 farms were inspected. Every carcase was inspected using both post-mortem inspection method (traditional and visual-only inspection). The number of carcases affected by each condition was recorded at a batch level for each inspection method. The baseline of type, frequency and distribution of conditions detected by both post-mortem inspection methods was established and then compared. The pairing of the observations was accounted for in the analyses. Similar to the historic analysis, the effect of season and farm of origin were considered. No such effects were found.

There were statistically significant differences in the frequencies found by the two inspection methods for six of the categories of conditions. However, the biological differences (i.e. what the numbers mean in terms of actual carcases or conditions missed/found) are very small. The frequencies were higher with the visual method of detection for hair contamination. This outcome can be explained by the early position of the visual-only inspection on the line. The frequencies were higher with the traditional method of inspection for milk spot, renal pathology, enteritis, pluck pathology and faecal contamination.

Samples for microbiological investigation were taken after visual-only inspection and after traditional inspection. For total aerobic plate count, Enterobacteriaceae count and Salmonella spp. isolation, 800 swabs were taken (400 after the traditional inspection point and 400 after the visual-only inspection point) during the four weeks of the trial from January 2012 to April 2012. For the Yersinia spp. isolation a slightly different subset of carcases was sampled. In the whole study 759 swabs were tested for Yersinia: 379 after traditional inspection and 380 after visual-only inspection.

No Salmonella spp. were isolated from any sample in the study. Also no statistical difference was found in the proportion of carcases contaminated with Yersinia spp. after the two inspection methods. Although there was no evidence for a difference in the general bacterial contamination of carcases after the two inspection methods, when we looked at carcases where Enterobacteriaceae were present there was some evidence that the level of contamination of carcases was lower after visual-only inspection compared to traditional inspection. We concluded that there was some evidence for a reduction in the cross contamination of carcases by changing the post-mortem inspection method to a visual-only
system where handling of carcases by FSA personnel was minimised. In addition, because this result has been observed in a particularly clean abattoir, a similar outcome would be expected to be observed in any abattoir with level of contamination as low as and higher than the study premises.

In the risk assessment we assessed the potential for a change in risk to human (public) health via a food-borne route, animal health and animal welfare if the meat inspection method was changed from the traditional method to a visual-only method, for fattening pigs from non-controlled housing management systems in the UK. We did not consider the component of public health risk that is due to occupational exposure. We took a cautious approach and considered a worst case scenario.

Of the five public health hazards that we assessed (endocarditis, granulomatous lesions, *Salmonella* spp., *Yersinia* spp., and the hygiene process indicators - total aerobic plate count and *Enterobacteriaceae* count), only two have a revised risk on a change in inspection method; the risk associated with endocarditis (inflammation of the internal lining of the heart), changed from negligible to non-negligible i.e. very low; and, it is possible that the risk of microbial cross-contamination between carcases is reduced. Only two animal health hazards were identified and assessed (endocarditis and granulomatous lesions). Again, endocarditis has a revised risk on a change in inspection method from negligible to non-negligible i.e. very low.

Despite the revised risk classification for public and animal health attributable to endocarditis for visual ‘hands-off’ inspection compared to traditional inspection for outdoor pigs, the fact still remains (from previous work) that outdoor pigs from non-controlled housing conditions present at least the same, if not less of a risk than indoor pigs from controlled housing conditions. Visual inspection is acceptable for indoor pigs from controlled housing conditions; therefore, we find that there is no reason relevant to the public health risk presented to exclude fattening pigs from outdoor, non-controlled housing conditions purely on grounds of the management system from which they originate.

There is also no reason for the exclusion of such pigs from a visual inspection system due to the revised risk to animal health. This is because action by producers is unlikely to be taken on the basis of information received about endocarditis lesions from post-mortem data feedback. Action would be taken in response to clinical signs in live pigs with associated production losses and their economic impact for the causal agents associated with endocarditis lesions (*Streptococcus* spp, including *S. suis* & *E. rhusiopathiae*). It is possible that a change in the inspection method from traditional to visual would lead to reduced microbial contamination of carcases in any abattoir with a level of contamination as low as or higher than the study premises. If the level of contamination of carcases is reduced by a change in inspection method, then it could be hypothesised that the potential for cross-contamination would be also be reduced; however, we cannot draw that as a conclusion from our study.

We conclude that the major obstacles to implementation of a visual-only system of inspection that encompassed pigs from non-controlled housing conditions (‘outdoor’) in the UK would be the same as those that are expected if visual-only inspection were to be implemented for fattening pigs from controlled housing conditions.
ACKNOWLEDGEMENTS
This Project FS145003 was funded by the Food Standards Agency (FSA).

This project could have not been performed without the help of all the participants in the within-abattoir field trial including the study premise owners, the plant staff and especially the official inspection team (the Lead Veterinarian, the Official Veterinarian, Meat Hygiene Inspectors and their Senior Meat Hygiene Inspector). We thank them for their time, effort and support; their diligence, thoughts and comments were much appreciated – without them there would have been no project.

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In addition we thank: the staff in SRU’s Contracts Office for their help and support throughout the project lifetime; SAC Consulting Veterinary Services staff at Inverness for their technical assistance with the laboratory work, especially Lynette Shaw and Euan Rafferty; Manuel Sanchez Vazquez (formerly of SAC), who initiated and developed the original project proposal; Dr Roger Humphry (SRUC) and colleagues from BioSS (Biomathematics and Statistics Scotland) for their statistical advice; the FSA Project Officer, Carles Orri, and Javier Dominguez.

THE PROJECT TEAM
The project team was led and managed by Dr Sue C. Tongue, Epidemiology Research Unit (ERU), SRUC. She had overall responsibility for the project including the budget, reporting, finalising all reports and FSA liaison. In addition, she was responsible for the risk assessment (Annex 4).

Ruth Oliva Abascal (ERU, SRUC) contributed to the design of the field study and managed it. She was the primary contact between the FSA personnel and SAC (as was) regarding practicalities and logistics. In addition, she was responsible for training all field study personnel, their supervision, sample collection and data entry and management. She was responsible for noting any obstacles to implementation and for writing the original report for Annex 5. She also wrote the initial reports for Annex 2 and Annex 3 and commented on other work.

Ian McCrone, University of Cambridge, assisted Ruth with the requirements of the field study including training of field study personnel, their supervision and sample collection. He was
responsible for the data analysis and original report writing for Annex 1 and commented on other reports.

Judith Evans (ERU, SRUC) assisted with the development of the microbiological aspects of the project proposal; led and co-ordinated the laboratory team; tested microbiological samples; managed the laboratory data and contributed the microbiological methods to the original reports for Annex 3.

Catriona Webster (ERU, SRUC) provided substantial technical support in the laboratory, while Carla Gomes (ERU, SRUC) did the statistical analysis, contributed the statistical methods to the original reports for Annexes 2 and 3 and commented on other work.

All project team members contributed to the Final Report.

**Version Control**

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Additional attachments

There are five separate Annexes to this Final report. These annexes provide the scientific detail of the work completed for this project, which has been summarised and simplified for the main body of the final report.
BACKGROUND

The problem

The focus of traditional methods of meat inspection is on the detection of gross lesions or flaws in the carcass that make a carcass ‘unfit for human consumption’. Such methods of meat inspection are not always suitable for detecting some of the important food-borne pathogens encountered today, such as Salmonella spp. and Yersinia spp. Provisions in the EU regulations allow carcases of fattening pigs, reared under controlled housing conditions in integrated production systems from the age of weaning onwards, to undergo visual-only inspection (EC Regulation 854/2004), provided that certain requirements are met. This visual-only inspection does not involve palpation, or incisions, and may reduce the risk of transfer of microbes from one carcass to another i.e. cross carcass contamination.

In the United Kingdom (UK) only pigs reared in indoor management systems qualify for such visual-only inspection. Slaughterhouses in the UK accept a mixture of pigs reared in different management systems throughout the day and any carcases of pigs from other housing conditions and systems still have to be inspected by traditional methods. For this reason the visual-only inspection method has not been introduced in slaughterhouses in the UK pig industry.

The introduction of visual-only inspection may lead to a reduction in the detection of some conditions in the carcases and there is concern that this reduction will lead to increased risk to human (public) health, animal health and/or animal welfare. It is perceived that the disease status of pigs raised in indoor, controlled, integrated systems will be more readily quantified and more uniform than those from outdoor, non-controlled, non-integrated systems; hence the risk from the latter may vary more. A qualitative risk assessment (Hill et al., 2011) of the comparative risks to public and animal health from visual inspection of indoor and outdoor pigs concluded that the risk was negligible for all pigs. However, there were insufficient data to assess if there would be a reduction in food-borne risk due to reduced microbial carcass contamination.

Microbiological hazards, such as Salmonella spp. and Yersinia spp. may be present in the animals prior to slaughter. The carcase can become contaminated and/or other carcases next in the line can be cross-contaminated during dressing and evisceration of the carcases. These risks are believed to increase during human manipulation of carcases and offal in abattoirs, such as the official post-mortem inspection by an Official Veterinarian (OV) or a Meat Hygiene Inspector (MHI). Visual-only post-mortem inspection of carcases eliminates the palpation and/or incision of parts of the carcases and offal during the inspection. This technique is believed to help to reduce the microbial cross-contamination of carcases/offal during the official inspection but there is no conclusive evidence either way. The reduction of microbial contamination of carcases in abattoirs is a priority to reduce the impact of food-borne disease in human population.

1 Meat Hygiene Inspector is the UK term for Official Auxiliary
THE PROJECT
The aim of the project was to investigate the implications of changing the inspection method, from the traditional method to a visual-only method, for fattening pigs from non-controlled housing conditions in the UK.

Definitions
The following definitions apply to this study.

**Fattening pigs**: these are pigs raised specifically for slaughter.

**Non-controlled housing conditions or ‘outdoor’**: these are fattening pigs raised entirely outdoors from weaning to slaughter.

At the abattoir these pigs are often referred as ‘free-range’ or ‘organic’ pigs. Within this study and report, the terms ‘outdoor’ and ‘free range’ are used interchangeably and are used to refer to pigs that have been raised as defined above. As far as the authors are aware, all such commercial fattening pigs in Great Britain (GB) are also born in non-controlled housing conditions. They need to be distinguished from outdoor pigs that are raised outdoors and enter controlled housing conditions at some point to be finished before they are sent to the abattoir. It was assumed, in the design of the study, that fattening pigs raised entirely outdoors, from weaning to slaughter, would be more likely to be different to pigs raised totally indoors, than fattening pigs raised partially outdoors and partially indoors; therefore they would potentially present the greatest risk, if inspection systems were to be changed.

**Visual-only inspection**: this is an inspection of the carcass without any palpation or incision of any part of the carcass. It is an inspection modified from the requirements of the European Hygiene Regulation (EC) 854/2004 (Anon., 2004b), in which the carcases are not handled, palpated or incised, they are only examined visually (See Table 2).

**Traditional inspection**: this is an inspection of the carcass where different parts of the carcass are visualised, palpated and/or incised (See Table 2). This is derived from the requirements of the European Hygiene Regulation (EC) 854/2004 (Anon., 2004b).

Project structure
The project took place during the period from 1st November 2011 to 21st December 2012 (Table 1).

The project consisted of two parts and eight interrelated objectives (Figure 1).

The eight objectives were:

Objective 1: to establish a baseline of the frequency and the types of pathological conditions that can be expected to be identified when using visual-only inspection in fattening pigs from non-controlled housing conditions.
Objective 2: to establish a baseline of the frequency and the types of conditions that can be expected to be identified using traditional meat inspection of fattening pigs from non-controlled housing conditions.

Objective 3: to compare the baseline values of the frequency and type of conditions found using visual-only inspection and traditional inspection procedures in fattening pigs from non-controlled housing conditions.

Objective 4: to establish and compare a baseline of the frequency and the types of conditions that can be expected to be identified in the study abattoirs in those fattening pigs from non-controlled housing conditions and those from controlled conditions.

Objective 5: to identify any possible obstacles that may hamper the implementation of a risk based visual-only inspection system and suggest appropriate adaptations to overcome those obstacles.

Objective 6: to identify differences in the risk of cross-contamination in carcasses visually inspected compared with those traditionally inspected through microbiological sampling for total aerobic plate counts, Enterobacteriaceae and Salmonella.

Objective 7: to review of existing protocols for culturing Yersina and to identify differences in the risk of cross-contamination due to Yersina in carcasses visually inspected compared with those traditionally inspected through microbiological sampling.

Objective 8: to undertake a formal, mostly qualitative, risk assessment, based on guidelines described by the Codex Alimentarius Commission (CAC), on the impact of the implementation of visual-only inspection for fattening pigs from non-controlled housing conditions and the impacts that this could have in terms of public health, animal health, animal welfare and the allocation of resources.

The project included a field trial of visual versus traditional meat inspection of fattening pigs from non-controlled housing conditions. There was one study abattoir in the east of England. Batches of pigs (termed ‘outdoor’ or ‘free-range’) were inspected by both visual and traditional methods. The conditions found by each inspection method were recorded and compared (Objectives 1, 2 & 3). Samples were taken from a subset of carcases on the slaughter line after each of the inspection points to see if we could grow specific bacteria, as follows: these bacteria are either indicators for the hygiene of the slaughter process (total aerobic plate count and Enterobacteriaceae count), or can be a cause of food-borne disease in humans (Salmonella spp. and Yersinia spp.). We compared whether they were present or absent and how many could be found by each inspection method (Objectives 6 & 7). In addition, historic data, from a full calendar year of traditional meat inspection in the abattoir, were analysed to establish a baseline for the frequency of conditions recorded by this method for pigs from the two different management systems (Objective 4). The results from all these investigations were then used to inform a risk assessment (Objective 8). Obstacles to the implementation of a risk-based visual-only inspection system were also investigated (Objective 5). Detailed scientific reports for the studies and analyses that were completed to meet the objectives are available in the Annexes to this report (Annex 1-5).
Table 1: Project FS145003 timeline

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<td>Week 1 Pilot of conditions reporting, logistics and microbiological sampling methods</td>
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<td>Initial historic data acquisition attempts</td>
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<td>Revision of research schedule Monthly progress report</td>
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Figure 1: FS145003 project structure and relationships

Objective 4 – historical data analysis

Objective 1, 2 & 3 – 'conditions found' data analysis

Objective 6 & 7 – microbiological investigations data analysis

Objective 8 – risk assessment

Objective 5 - obstacles to implementation

FS = Field study
W = week

FSW1, W2, W3, W4, W5
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<td>Pericardium</td>
<td>visual</td>
<td>visual</td>
</tr>
<tr>
<td>Heart</td>
<td>visual, incision</td>
<td>visual</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>visual</td>
<td>visual</td>
</tr>
<tr>
<td>Liver</td>
<td>visual, palpate</td>
<td>visual</td>
</tr>
<tr>
<td>Hepatic and pancreatic lymph nodes</td>
<td>visual, palpate</td>
<td>visual</td>
</tr>
<tr>
<td>GIT and mesenteric</td>
<td>visual</td>
<td>visual</td>
</tr>
<tr>
<td>Gastric and mesenteric lymph nodes</td>
<td>visual, palpate, incision²</td>
<td>visual</td>
</tr>
<tr>
<td>Spleen</td>
<td>visual, palpate²</td>
<td>visual</td>
</tr>
<tr>
<td>Kidneys</td>
<td>visual, incision²</td>
<td>visual</td>
</tr>
<tr>
<td>Renal lymph nodes</td>
<td>incision²</td>
<td>visual</td>
</tr>
<tr>
<td>Pleura and peritoneum</td>
<td>visual</td>
<td>visual</td>
</tr>
<tr>
<td>Genital organs</td>
<td>visual³</td>
<td>visual</td>
</tr>
<tr>
<td>Udder</td>
<td>visual</td>
<td>visual</td>
</tr>
<tr>
<td>Supramammary lymph nodes</td>
<td>visual, incision² ³⁴</td>
<td>visual</td>
</tr>
<tr>
<td>Umbilical region (young)</td>
<td>visual, palpate, incision²</td>
<td>visual</td>
</tr>
<tr>
<td>Joints (young)</td>
<td>visual, palpate, incision²</td>
<td>visual</td>
</tr>
</tbody>
</table>

Based on the legal requirements contained in Regulation (EC) 854/2004.

¹When for human consumption
²When necessary
³Unless penis discarded
⁴Sows
**Historical data analysis – Objective 4**

We established a baseline of the conditions found by traditional inspection, within the study abattoir, for indoor and free range pigs.

A preliminary analysis, of meat inspection data from batches of pigs slaughtered at the one study abattoir, provided a proof of principle for the later analysis. These data were part of the food chain information (FCI) and collection and communication of inspection results CCIR data. They were kindly supplied by the British Pig Executive (BPEX) from the newly implemented BPEX eAML2 system, which extracts data from inspection recording systems. As these data were incomplete and information regarding the provenance of the batches of pigs was not available to allow a comparison of the frequency of conditions in free range and indoor finished pigs, these analyses are not reported further here.

Meat inspection data, from all batches of pigs slaughtered at the study abattoir, were then made available directly from the Food Standards Agency (FSA). These data form the basis of the analyses reported here.

The period covered by the data was January 2010 to December 2011.

Data were available from the *ante-mortem* and *post-mortem* carcass inspection and *post-mortem* offal inspection of 1,220,340 pigs from 7,410 batches of pigs from the different rearing and fattening systems.

The mean number of pigs in each batch was 164 and 166 pigs for indoor and free range fattening systems, respectively. There is only slight variation in the different batch size categories for the different fattening systems.

The proportion of the batches that were from free range systems was fairly consistent, accounting for approximately a quarter (range 19.5-26.3%) of the batches of pigs slaughtered.

The prevalence of each condition in each batch and the proportion of the batches affected with a condition were calculated. The latter was compared between the two management systems. Batch size and seasonality were considered as possible confounders but had no influence on the associations found. The mean prevalence in batches with each condition were also compared between the two management systems. The analyses were corrected for multiple significance testing. For further details of the analyses see Annex 1.

The prevalence of conditions detected on traditional inspection of pigs submitted to slaughter from the two different fattening systems were quite similar. Most of the differences found can be explained with knowledge of the housing and fattening systems being used and the influence that has on the occurrence of disease.

The statistically significant findings were as follows (Table 3):

- A higher percentage of indoor batches were recorded as affected with ‘tail bite’ and ‘lameness’ during *ante-mortem* inspection; and as affected with ‘oedema’ during *post-mortem* carcass inspection, than free range batches.
- A higher percentage of free range batches were recorded as affected with ‘hair contamination’ during *post-mortem* carcass inspection, than indoor batches.
- A higher percentage of free range batches were recorded as affected with 'milk spot' during *post-mortem* offal inspection, than indoor batches, and the mean prevalence was higher in the batches in which the condition was present.
- A higher percentage of indoor batches were recorded as affected with 'pericarditis' during *post-mortem* offal inspection, than free range batches.
- The mean prevalence of 'kidney pathology', in the batches in which the condition was present, was slightly higher for indoor pigs than for free range pigs; whereas for 'hepatitis',' peritonitis', 'pneumonia' and 'other pathology', the reverse was the case.

**Table 3:** The frequency (percentage %) and 95% confidence intervals (C.I.) for the 11 conditions that had a *statistically significant* difference between the inspection systems, and which are found either at *ante-mortem* inspection, or *post-mortem* inspection, of carcases or offal from slaughter pigs from indoor and free range fattening systems.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage of the batches affected with the condition (95% C.I.)</th>
<th>Mean prevalence (%) in batches in which the condition was present (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tail bite</td>
<td>Indoor: 26.4* (24.9-27.9) Free Range: 5.9* (3.5-8.3)</td>
<td>Indoor: 1.4 (1.2-1.6) Free Range: 0.8 (0.6-1.0)</td>
</tr>
<tr>
<td>Lame</td>
<td>Indoor: 46.5* (44.8-48.2) Free Range: 24.7* (20.3-29.1)</td>
<td>Indoor: 1.2 (1.0-1.3) Free Range: 0.7 (0.6-0.8)</td>
</tr>
<tr>
<td>Oedema</td>
<td>Indoor: 25.7 (24.1-27.4) Free Range: 8.1* (5.8-10.3)</td>
<td>Indoor: 1.1 (1.0-1.2) Free Range: 1.1 (0.5-1.6)</td>
</tr>
<tr>
<td>Hair Contamination</td>
<td>Indoor: 3.9* (3.4-4.4) Free Range: 5.9* (4.8-7.1)</td>
<td>Indoor: 0.8 (0.7-1.0) Free Range: 1.0 (0.8-1.1)</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>Indoor: 35.8 (34.6-37.1) Free Range: 34.1 (31.8-36.3)</td>
<td>Indoor: 2.2* (2.1-2.4) Free Range: 3.1* (2.5-3.6)</td>
</tr>
<tr>
<td>Kidney Pathology</td>
<td>Indoor: 95.2 (94.7-95.8) Free Range: 93.8 (92.6-94.9)</td>
<td>Indoor: 7.2* (7.1-7.4) Free Range: 6.7* (6.4-6.9)</td>
</tr>
<tr>
<td>Milk Spot</td>
<td>Indoor: 23.4* (22.3-24.5) Free Range: 54.8* (52.4-57.2)</td>
<td>Indoor: 5.9* (5.2-6.6) Free Range: 21.1* (19.5-22.7)</td>
</tr>
<tr>
<td>Pericarditis</td>
<td>Indoor: 60.6* (59.4-61.9) Free Range: 53.5* (51.1-55.9)</td>
<td>Indoor: 2.0 (1.9-2.1) Free Range: 2.4* (1.9-2.2)</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>Indoor: 57.7 (56.4-58.9) Free Range: 58.6 (56.3-61.0)</td>
<td>Indoor: 1.8* (1.7-1.8) Free Range: 2.4* (2.1-2.6)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Indoor: 86.6 (85.8-87.5) Free Range: 88.9 (87.4-90.5)</td>
<td>Indoor: 8.6* (8.4-8.9) Free Range: 10.8* (10.2-11.4)</td>
</tr>
<tr>
<td>Other Pathology</td>
<td>Indoor: 78.2 (77.1-79.3) Free Range: 76.2 (74.2-78.3)</td>
<td>Indoor: 4.9* (4.8-5.1) Free Range: 6.0* (5.6-6.4)</td>
</tr>
</tbody>
</table>

*xx.x* (yy.y-zz.z) – statistically significant values are shown in bold text
The data obtained were of good quality with very little missing data (99.9% was used). The classification of the batches of pigs to the type of fattening system was likely to be accurate as the slaughterhouse had good records of the provenance of pigs.

The study only involved the inspection data from one abattoir. This means that the results of the analysis cannot be generalised to pigs slaughtered in other regions, although most of the outdoor fattened pigs are produced in the east of England.

The field study

The field study consisted of five separate weeks of work in one abattoir in the east of England, during the period from the end of November 2011 until the middle of March 2012.

Carcasses of fattening pigs from non-controlled housing conditions were inspected using both post-mortem inspection methods (traditional and visual-only inspection).

Study premises:
There was only one study premise. It was in the East of England. This was due to difficulties in identifying abattoirs that had a sufficient throughput of fattening pigs that met the definition of being from non-controlled (outdoor) housing conditions and had space to safely set up the two inspection points.

The trial consisted of five separate weeks of data and sample collection within the period 28th November 2011 to 16th March 2012. The trial was carried out from Monday to Friday where it was logistically possible. Wednesday 30/11/2011 was not included in the trial due to a Civil Service industrial action that was expected to affect the availability of FSA personnel. It was anticipated that there might be a lack of personnel to perform the extra inspection.

The abattoir slaughters an average of 400 free-range pigs first thing in the morning. Sometimes they might slaughter some more later in the day, usually after the lunch break. Only batches slaughtered in the morning were included in the trial, for logistical reasons. The whole process of inspecting 400 carcases usually took no more than two hours.

Inspection methods:
The batches were available for inspection as presented according to the abattoir’s killing schedule on the trial days. There were no additional inclusion or exclusion criteria for selection of batches and/or farms.

All carcases were inspected by FSA qualified personnel. Two additional Meat Hygiene Inspectors (MHIs) were provided by the FSA and placed along the line to carry out the visual-only inspection: one at the whole carcass point and one at the offal point. These were located at different positions in this particular abattoir. The visual-only inspectors were positioned in the line before the traditional inspectors (see Figure 2 & 3).

Traditional inspection was carried out as detailed under the legislation (Regulation (EC) 854/2004 (Table 2)).

MHIs carrying out the visual-only inspection were not allowed to palpate or incise any of the carcases/offal for the purpose of the inspection (Table 2). They were instructed on the visual-only inspection procedures by the FSA managers, prior to the start of the trial, again
by the project team personnel on the first day of the trial and, for any new MHI included in the trial, during the weeks it took place.

Different inspectors were used on each day at each point to control for potential confounding. All carcasses and offal inspected on any one day were inspected by the same two people at the visual-only inspection points, i.e. one person at the whole carcase inspection point and one person at the offal inspection point. It was not possible to change visual-only inspection personnel during the day due to the speed of the line. MHIs at the traditional inspection point were rotated every 20 minutes. This was normal practice at the study abattoir.

**Figure 2**: Schematic diagram of the position of the two different inspection points on the abattoir line.
**Figure 3:** Bird’s-eye schematic of the layout of inspection, detection and recording for both inspection methods at the study abattoir

**Data collection and management:**
Conditions detected by traditional inspection were recorded as required by the current FSA procedures. The daily results for the batches included in the study, identified by slap mark and batch number, were made available to the project personnel.

Conditions detected by visual-only inspection were recorded and managed by the same project personnel, in a spreadsheet mirroring the FSA system.

The frequency of a condition was recorded as the number seen per batch. The number of pigs in each batch was also provided.

When traditional inspection only is implemented at the study abattoir, contamination on carcases (e.g. hair) is identified and labelled by the first MHI then corrected by plant staff along the line, before a second MHI does the final inspection. It is at this final inspection point that conditions are recorded and entered into the FSA condition touch-screen system.

For the trial the visual-only inspection point was placed at the point of the first traditional MHI. The conditions found by visual-only inspection were recorded at this point and therefore before both any rectification by the plant personnel and the point of traditional inspection and recording. This may mean that there will be a higher frequency of recording of certain conditions, such as hair contamination, by visual-only inspection compared to traditional inspection. It might appear, therefore, that visual-only inspection is able to detect a greater number of these conditions, but this would be an incorrect assumption; usually those conditions were detected, rectified, but never recorded.
The member of the plant personnel positioned between the two points of inspections had a role prior to the start of the trial in the study abattoir. This operator removes only any aesthetic conditions (mainly removal of hair left on the carcases) to improve the presentation of the carcase. These personnel do not remove any conditions that affect the fitness of the carcases for human consumption, so the final FSA MHI carrying out the traditional inspection is presented with all conditions affecting the safety of the meat.

**Microbiological investigations:**
The study population was the carcases from the pigs from non-controlled housing systems included for the conditions found at post-mortem inspection study above.

**Sample collection**
Sponge swabs were collected from carcases in the study premises after the traditional inspection and visual-only inspection points (Figure 4).

The sampling methodology followed that described in Regulation 2073/2005. This is outlined in the FSA protocol at [http://www.ukmeat.org/RedMeatCarcasses.htm](http://www.ukmeat.org/RedMeatCarcasses.htm)

Samples were not intentionally taken from the same carcase after both inspection methods (visual-only and traditional). Measures were in place to avoid sampling the same area of the carcase, if the same carcase was sampled at both inspection points by chance.

Swabs had to be collected and sent to the diagnostic laboratory (Epidemiology Research Unit [ERU], Inverness) before 11 am on every day during the trial. Batches included in the study population, for collection of conditions found at traditional inspection and at visual-only inspection, that were expected to be slaughtered after 10 am that day were therefore not included in the sampling frame, in order to avoid any delay with the transport of samples to the laboratory.

![Figure 4](image-url)

**Figure 4:** A pictorial representation of the microbiological swabbing points on the abattoir line.
**Sampling plan**

Samples were taken during the five separate weeks of the trial between 28th November 2011 and 16th March 2012 (weeks 1-5).

The aim was to collect approximately 200 swabs weekly; 40 swabs daily (20 swabs after traditional inspection and 20 swabs after visual-only inspection), where it was logistically possible, using a systematic random sampling strategy (see Annex 3 for further details). Samples were only collected on three days during the first pilot week (week 1) of the trial, due to industrial action and issues with the courier. Swabs were collected every day from Monday to Friday during weeks 2 to 5.

In week 2, samples after traditional inspection were taken according to a slightly different pattern because of logistical issues. This was not expected to affect the analysis and the 200 weekly samples were reached by the end of the week.

For total aerobic plate (TAP) count, *Enterobacteriaceae* count and *Salmonella* spp. isolation, the swabs used were those collected during the four separate weeks, within the period 16th January 2012 to 16th March 2012 (Weeks 2-4)

For the isolation of *Yersinia* spp., all the swabs collected in week 1, 4 & 5 were used. However, during weeks 2 and 3 only, one in every two swabs was selected on each day, when the samples arrived at the laboratory, using a systematic random sampling approach (see Annex 3 for further details).

**Sample processing**

Samples were processed in the laboratory 24 hours after collection in the abattoir. Counts and isolation were carried out by two of the project team.

Total aerobic plate count, *Enterobacteriaceae* count, and *Salmonella* spp. isolation were carried out using the following methods (see Annex 3 for further details):

1. Total aerobic plate count was carried out according to the BS EN ISO 4833:2003 (British Standard Institution, 2003a)
2. *Enterobacteriaceae* count was carried out according to the BS EN ISO 21528-2:2004 (British Standard Institution, 2004)
3. *Salmonella*: Isolation of *Salmonella* was carried out using the BS EN ISO 6579:2002 (British Standard Institution, 2002 and Health Protection Agency, 2011b)

*Yersinia* spp. isolation was carried out using the following methods (see ANNEX 3 for further details):

Analysis of conditions found at post-mortem inspection during the field study (Objectives 1, 2 & 3)

We established a baseline of the frequency and types of pathological conditions that can be expected to be identified in the study abattoir when using visual-only post-mortem inspection in fattening pigs from non-controlled housing conditions; did the same for traditional inspection; and, compared the baseline values of the frequency and type of conditions found using the two inspection methods.

The records of conditions found at post-mortem inspection, by the two methods, came from the inspection of a total of 11,086 carcases, from 62 batches and 12 farms.

The effect of season and farm of origin, as potential confounders, were investigated in the statistical analyses, as was the effect of farm of origin as a cluster. No such effects were found. The analyses were corrected for multiple significance testing. For further detail of the analyses see Annex 2.

There were statistical differences in the frequencies found by the two inspection methods for six of the categories of conditions (Tables 4, 5 & 6). However, the biological significance of these differences is very small, in terms of the additional, or reduced, number of carcases found with a condition.
Table 4: Descriptive analysis of the frequency (number [N], percentage [%] and 95% confidence interval [C.I.]) of the nine conditions, found in pigs from non-controlled housing conditions at post-mortem meat inspection, that had a statistically significant difference between the two inspection methods.

<table>
<thead>
<tr>
<th>Conditions in whole carcasses and offal</th>
<th>FSA coding of conditions</th>
<th>Visual-only inspection</th>
<th>Traditional inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95% C.I.</td>
<td>95% C.I.</td>
</tr>
<tr>
<td>Generalised Conditions</td>
<td>Suspect pyaemia, Suspect fever/septicaemia, Oedema/Emaciation, Anaemia</td>
<td>12</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.02 – 0.20</td>
<td>0.16 – 0.83</td>
</tr>
<tr>
<td>Hepatic Pathology</td>
<td>Hepatopathy, Hepatitis/Cirrhosis, Jaundice</td>
<td>27</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.92 – 0.40</td>
<td>0.39 – 1.20</td>
</tr>
<tr>
<td>Milk Spot</td>
<td>Milk Spot</td>
<td>263</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.33 – 3.41</td>
<td>3.52 – 7.32</td>
</tr>
<tr>
<td>Renal Pathology</td>
<td>Kidney lesions, kidney pathology, suspect uraemia</td>
<td>448</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.28 – 4.80</td>
<td>5.87 – 8.52</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>Endocarditis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.05 – 0.33</td>
</tr>
<tr>
<td>Enteritis</td>
<td>Enteritis, colitis, Pathology in the guts</td>
<td>22</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.97 – 0.33</td>
<td>0.75 – 1.47</td>
</tr>
<tr>
<td>Pluck Pathology</td>
<td>Pathology in the pluck</td>
<td>181</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.82 – 2.44</td>
<td>3.47 – 5.98</td>
</tr>
<tr>
<td>Faecal Contamination</td>
<td>Faecal contamination in any part of carcass/offal</td>
<td>353</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.16 – 4.21</td>
<td>3.53 – 6.30</td>
</tr>
<tr>
<td>Hair Contamination</td>
<td>Hair contamination in any part of carcass/offal</td>
<td>1362</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.83 – 14.75</td>
<td>1.20 – 6.36</td>
</tr>
</tbody>
</table>
Table 5: Summary of the mean of the differences and their 95% confidence interval (C.I.) for the mean of the difference between the percentage of detection of conditions/contaminations between traditional and visual inspection methods for the six normally distributed conditions that had a statistically significant difference.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean of the difference (traditional – visual) %</th>
<th>95% C.I. for mean difference %</th>
<th>Lower Level</th>
<th>Upper Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk spots</td>
<td>3.21</td>
<td>1.51</td>
<td>4.91</td>
<td></td>
</tr>
<tr>
<td>Renal Pathology</td>
<td>3.09</td>
<td>1.82</td>
<td>4.37</td>
<td></td>
</tr>
<tr>
<td>Enteritis</td>
<td>0.99</td>
<td>0.61</td>
<td>1.37</td>
<td></td>
</tr>
<tr>
<td>Pluck pathology</td>
<td>3.02</td>
<td>1.88</td>
<td>4.15</td>
<td></td>
</tr>
<tr>
<td>Faecal contamination</td>
<td>1.62</td>
<td>0.80</td>
<td>2.44</td>
<td></td>
</tr>
<tr>
<td>Hair contamination</td>
<td>-8.21</td>
<td>-10.79</td>
<td>-5.63</td>
<td></td>
</tr>
</tbody>
</table>

There were some conditions with a very low prevalence (generalised conditions, hepatic pathology, endocarditis, and ‘other processing faults’). These had to be analysed with a different test. There was a statistically significant difference between the two inspection methods for two of the four conditions where a non-normal distribution was observed (Table 6).

Table 6: MacNemar results for the two absence/presence categorised conditions that had a statistically significant difference between the numbers found by each inspection method.

<table>
<thead>
<tr>
<th>Condition</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generalised conditions</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>0.002</td>
</tr>
</tbody>
</table>

The trial has been carried out in one study abattoir. Conditions in pigs might be different depending on the locations of the farms of origin. However, due to the large number of outdoor pigs processed in the study abattoir we expect to have covered different areas of production in the UK.

It will be unlikely that we can generalise the finding to the whole of the UK unless we do further research into the coverage of the study population achieved.

Some conditions, such as hair contamination, or pleurisy, are found at a higher frequency by visual-only inspection compared to traditional inspection. This is considered to be due to the plant staff procedures, which involved correcting these conditions along the line (see earlier Data collection and management).

Granulomatous or caseous lesions in mandibular lymph nodes have been considered by some (Alban et al. 2008) as a potential proxy measure indicative of tuberculosis (TB) in pigs. In the study abattoir, TB-like lesions are recorded separately to abscess. None were recorded during the study period.
The majority of conditions where traditional inspection exceeded visual-only inspection are conditions that are found in offal. Access to the whole offal was substantially reduced by the visual-only method. Improving accessibility to all parts will increase the ability to find these conditions. The same could be said for conditions located in the back of the carcass and any contamination affecting the rear of carcass that was not accessible for visual-only inspection.

**Analysis of outcomes from the microbiological sampling during the field study (Objectives 6 & 7)**

We established the frequency, counts and distribution of microbiological carcass contamination after each method of inspection, and compared the two. To do this we used total aerobic plate count, *Enterobacteriaceae* counts and *Salmonella* and *Yersinia* spp. isolation.

For total aerobic plate count, *Enterobacteriaceae* counts and *Salmonella* spp. isolation, during the four weeks of the trial between 16th January 2012 and 16th March 2012, ten farms, 44 batches and 7,931 carcases from outdoor pigs were included in the sampling frame. Only five batches were not included due to their late arrival at the abattoir. A total of 800 samples were collected and processed for total aerobic plate and *Enterobacteriaceae* counts and *Salmonella* spp. isolation.

For *Yersinia* spp. isolation, 12 farms, 54 batches and 9,633 carcases from outdoor pigs were included in the sampling frame. The original plan had been to process half the number of samples; however, in the whole study 759 swabs were tested for *Yersinia* spp.: 379 after traditional inspection and 380 after visual-only inspection.

The data used for this study were individual observations, sampled by systematic random strategy from the same study population. Potential sources of bias and confounders, such as season (week), farm of origin (date of sampling) and position on the line, were considered during the sampling design, or accounted and adjusted for during the statistical analysis. The analyses were corrected for multiple significance testing. For further detail of the analyses see Annex 3.

No *Salmonella* spp. were isolated from any sample in the study.

There was no statistical difference in the mean of the log^{10} of total aerobic plate count from carcases after the two inspection methods (Table 7).

**Table 7: Results of student t-test for the log^{10} of total aerobic plate count**

<table>
<thead>
<tr>
<th>Inspection method</th>
<th>Mean</th>
<th>Difference between the mean (95%CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>1.497</td>
<td>0.08 (-0.06, 0.21)</td>
<td>0.2772</td>
</tr>
<tr>
<td>Visual</td>
<td>1.421</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The variable *Enterobacteriaceae* count had a high number of samples with zero counts. After categorisation of this variable as absence/presence of *Enterobacteriaceae*, there was no association between the categorized *Enterobacteriaceae* variable and the inspection method (p=0.76).
However, the level of contamination of carcases with Enterobacteriaceae was lower after visual-only inspection compared to traditional inspection; i.e. there was a statistically significant difference in the mean of the log$^{10}$ of the Enterobacteriaceae count when present (i.e. count >0, n=235); (Table 8).

**Table 8**: Student t-test for the comparison between the two inspection methods for Enterobacteriaceae counts where Enterobacteriaceae = presence.

<table>
<thead>
<tr>
<th>Inspection method</th>
<th>Mean</th>
<th>Difference between the mean (95%CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>-1.14</td>
<td>0.43 (0.22, 0.63)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Visual</td>
<td>-1.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the pilot study (week 1 – the first week in November 2011) 160 carcass swabs were tested for Yersinia. Seven Yersinia enterocolitica, one Yersinia pseudotuberculosis, and one Yersinia fredericksenii were isolated from the carcass swabs received in that week. For the rest of the trial (four weeks between 16th January 2012 and 16th March 2012) 599 carcass swabs were tested for Yersinia; a total of three Yersinia enterocolitica were isolated.

For Yersinia spp. isolation, the outcome variable was categorised as presence or absence, regardless of the type of Yersinia. There was no statistical difference in the proportion of Yersinia contamination of carcases found after the two inspection methods.

The EU Regulation No 1441/2007 (Anonymous, 2007a) imposes microbiological criteria for foodstuffs. Chapter 2 of this Regulation defines the hygiene status of the process by the level of microbial contamination. If we apply these microbiological criteria to the results of the samples in the study, then this abattoir is considered a ‘satisfactory’ abattoir, as far as hygiene is concerned when measured by microbiological checks of carcases after inspection.

The study abattoir was visually clean. There was a very good protocol of hygiene measures and this was implemented by both the plant personnel and the FSA personnel. Plant personnel and FSA personnel had a very good routine of washing and disinfecting hands and knives on the line. This was the norm and was not just due to the occurrence of the trial. This emphasis on good hygiene practice would result in a low level of cross contamination between carcases under normal circumstances. The microbial outcomes of the study (TAP and Enterobacteriaceae counts) were not, therefore, unexpected.

Given that a statistical difference in Enterobacteriaceae counts, when present, has been observed between traditional and visual-only inspection methods in a particularly clean abattoir, then we would expect similar results in any abattoir with a level of contamination as low as, and higher than, the study premises. However, no difference was identified, through microbiological sampling, in the risk of cross-contamination due to Yersinia spp.
**RISK ASSESSMENT**

We have used a qualitative modified Codex Alimentarius Committee (CAC) risk assessment approach (Annex 4) to assess the potential change in risks to public health via a food-borne route, animal health and animal welfare of a change in the meat inspection method, from the traditional method currently employed to a visual-only methodology, for fattening pigs from non-controlled housing management systems. We have not considered the component of public health risk that is due to occupational exposure. We have used data from previous work, scientific literature, publically available information and our own field study to inform the risk assessment. Based on this information we have taken a cautious approach and considered a worse case scenario.

The assumption for the risk assessment for this project is that fattening pigs from non-controlled housing conditions inspected by traditional methods pose an acceptable risk to public health and animal health and welfare. Thus, if the same type of pigs pose the same or less of a risk (in respect of specified hazards) when inspected by visual-only methods, then these risks must also be acceptable.

The risk pathway and therefore the risks on farm, during transport, *ante-mortem* and during the slaughter process up until the carcass is presented for inspection were assumed to remain constant for all outdoor pigs, regardless of the inspection method used.

In addition, the risk pathway and the processes for the final (chilled) pork carcass in the rest of the food chain are assumed to remain constant. We, therefore, considered only the portion of the risk pathway from slaughter to the relative risk of the final (chilled) pork carcass.

Previous work by Hill *et al.*, (2011) and Alban *et al.*, (2008) identified two conditions found in fattening pig carcases that may be sources of hazards to public health if the inspection system changes from traditional to visual-only. These conditions are endocarditis and granulomatous lesions to include porcine tuberculosis lesions. The associated hazards are *Streptococcus* spp. & *Erysipelothrix rhusiopathiae* and *Rhodoccus equi* & *Mycobacterium* spp, respectively.

Our field study provided evidence about the frequency of endocarditis lesions in outdoor fattening pigs inspected by the two methods to use in our risk assessment. It did not provide any additional evidence about granulomatous lesions to include porcine tuberculosis lesions.

No additional animal health hazards or animal welfare hazards were identified.

A recent EFSA opinion on the public health hazards to be covered by the inspection of meat (swine) looks at the European Union (EU) situation as a whole (EFSA 2010b). Two microbial hazards were identified - *Salmonella* spp. and *Yersinia enterocolitica* of biotype/serotype combinations that have their main reservoirs in pigs and are enteropathogenic to humans.

Our field study provided evidence about the frequency of isolation of *Salmonella* spp. and *Yersinia* spp. from carcases of outdoor fattening pigs inspected by the two methods to use in our risk assessment.

Our field study also provided evidence about total aerobic plate count and *Enterobacteriaceae* counts from carcases of outdoor fattening pigs inspected by the two
methods to use in our assessment of contamination and therefore the risk of cross-
contamination of carcases.

Of the five public health hazards we have assessed (endocarditis, granulomatous lesions, 
Salmonella spp., Yersinia spp., and the hygiene process indicators - total aerobic plate count 
and Enterobacteriaceae counts), only two have a revised risk on a change in inspection 
method (Table 9).

The risk for hazards arising from endocarditis lesions, changes from negligible to non-
negligible i.e. very low, while from the results of the Enterobacteriaceae count, it is possible 
that the risk of cross-contamination between carcases may be reduced i.e. when present the 
Enterobacteriaceae count was lower on carcases that had been visually inspected than 
traditionally inspected, implying less contamination.

Only two animal health hazards were identified and assessed (endocarditis and 
granulomatous lesions). Again, hazards associated with endocarditis have a revised risk on 
a change in inspection method from negligible to non-negligible i.e. very low (Table 10).

Despite the revised risk classification for public and animal health attributable to the reduced 
detection of endocarditis lesions for visual-only inspection compared to traditional inspection 
for outdoor pigs, the fact still remains (from previous work by Hill et al., 2011 and Annex 1 
Table A1.5) that outdoor pigs from non-controlled housing conditions present at least the 
same, if not less of a risk, than indoor pigs from controlled housing conditions. Visual 
inspection is acceptable for pigs from indoor, controlled, integrated management systems 
(Anon., 2004b); therefore there is no apparent reason relevant to the public health risk 
presented to exclude outdoor pigs purely on grounds of the management system from which 
they originate.

This is also the case for the risk to animal health. Action by producers is unlikely to be taken 
on the basis of information received about endocarditis lesions from post-mortem data 
feedback. Action would be taken in response to clinical signs in live pigs with associated 
production losses and their economic impact, for the causal agents associated with 
endocarditis lesions (Streptococcus spp, including S. suis & E. rhusiopathiae).

One of the arguments for a move from a traditional palpation and incision inspection system 
to a visual-only based one is that it could reduce cross contamination of carcases that would 
occur via the hands and knives of meat inspectors.

In our field study, no difference was found in the isolation of Yersinia spp. or 
Salmonella spp. total aerobic plate count or the presence/absence of Enterobacteriaceae; 
however, when present the Enterobacteriaceae count was lower on carcases that had been 
visually inspected than traditionally inspected, implying less contamination.

The abattoir used for the field study had a particularly good hygiene process. It is possible 
that a change in the inspection method from traditional to visual would lead to a similar result 
in any abattoir with a level of contamination as low as or higher than the study premises. If 
the level of contamination of carcases is reduced by a change in inspection method, then it 
could be hypothesised that the potential for cross-contamination would also be reduced; 
however, we cannot draw that as a conclusion directly from our study.
The primary benefit of a visual-only system of inspection that encompassed pigs from non-controlled housing conditions would be, in the United Kingdom (UK), the ability to implement such an inspection system for all pigs. At present, although it is theoretically possible to do so for pigs from controlled housing conditions, in terms of the regulatory process, such systems have not been implemented because slaughterhouses process fattening pigs from different management systems in the same day.

**Risk assessment conclusions**

1) Five hazards that are related to public health and that might be affected by the inspection method were identified - endocarditis, granulomatous lesions, *Salmonella* spp. and *Yersinia* spp. and the hygiene process indicators - total aerobic plate count and *Enterobacteriaceae* count.

2) The risk to public health associated with one of these hazards, endocarditis, alters with a change in inspection method.

3) The risk to public health from endocarditis in outdoor pigs from non-controlled housing conditions inspected by a visual-only method is slightly higher (very low) relative to the same pigs inspected by the traditional method (negligible). The absolute risk to public health from endocarditis in outdoor pigs from non-controlled housing conditions inspected by a visual-only method is negligible.

4) There is some evidence from the hygiene process indicator *Enterobacteriaceae* count that the visual-only method results in a lower level of contamination of carcases than inspection by the traditional method.

5) Two hazards that are related to animal health and subsequently their welfare that might be affected by the inspection method were identified – endocarditis and granulomatous lesions.

6) The risk to animal health and welfare associated with neither of the two hazards identified in 5) alters appreciably with a change in inspection method. The risk does change to non-negligible (i.e. very low) for endocarditis but this is highly unlikely to have any subsequent effects on animal health and welfare.

From this risk assessment, based on current evidence, there is a potential for a change in the risk to public health. However, we do not consider that there is any appreciable additional risk to public health, animal health or animal welfare from visual-only inspection of fattening pigs from non-controlled housing conditions in the UK, over and above that which currently exists with traditional inspection (see Annex 4 for further details).
### Table 9: Summary of the Risk Characterisation for Public Health for the five hazards for which detection could be or was affected by the inspection method

<table>
<thead>
<tr>
<th>Identified Hazard</th>
<th>Hazard Characterisation [Occurrence – Severity – Fatality - Treatment]</th>
<th>Exposure Assessment Amount attributable</th>
<th>Risk characterisation (Baseline – current – traditional inspection)</th>
<th>Change in risk profile if inspection method changed to visual</th>
<th>Revised risk (for visual-only inspection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>Human cases</td>
<td>Public health</td>
<td>Change</td>
<td>Relevance</td>
<td></td>
</tr>
<tr>
<td>Endocarditis</td>
<td>Extremely Rare – Severe - Extremely rare – Possible</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Yes</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Streptococcus spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocarditis</td>
<td>Rare (occupational) – Generally mild – Extremely rare – Possible</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Yes</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Erysipelothrix rhusiopathiae.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granulomatous</td>
<td>Extremely rare (opportunistic) – Severe – Likely – a challenge</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Possible</td>
<td>Highly unlikely</td>
</tr>
<tr>
<td>lesions - Rhodococcus equi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granulomatous</td>
<td>Extremely rare (opportunistic) – Severe – Likely – Possible, can be a challenge</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Possible</td>
<td>Highly unlikely</td>
</tr>
<tr>
<td>lesions - Mycobacterium spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>Not uncommon - Mild to moderate – Unusual – Possible</td>
<td>LOW</td>
<td>VERY LOW</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Y.enterocolitica</td>
<td>Uncommon – Mild to Moderate – Highly Unlikely – Self-limiting/possible</td>
<td>MEDIUM</td>
<td>LOW</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Total aerobic plate and Enterobacteriaceae counts</td>
<td>Indicator of hygiene process rather than direct clinical relevance</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>Possible</td>
</tr>
</tbody>
</table>

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Table 10: Summary of the Risk Characterisation for Animal Health (AH) for the two major hazards for which detection could be or was affected by the inspection method

<table>
<thead>
<tr>
<th>Identified Hazard</th>
<th>Hazard Characterisation [Occurrence – Severity – Fatality - Treatment]</th>
<th>Exposure Assessment Amount attributable</th>
<th>Risk characterisation (Baseline – current – traditional inspection)</th>
<th>Change in risk profile if inspection method changed to visual</th>
<th>Revised risk (for visual-only inspection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs</td>
<td>Animal cases</td>
<td>Animal health</td>
<td>Change</td>
<td>Relevance</td>
<td>AH</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>Mostly asymptomatic carriage – Varies – Possible – Possible</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Yes</td>
<td>Highly unlikely</td>
</tr>
<tr>
<td><em>Streptococcus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Erysipelothrix</em></td>
<td>Mostly asymptomatic carriage – Mild to severe – Can be high - Possible</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Yes</td>
<td>Highly unlikely</td>
</tr>
<tr>
<td><em>rhusiopathiae</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granulomatous</td>
<td>Asymptomatic – N/A</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Possible</td>
<td>Extremely unlikely</td>
</tr>
<tr>
<td>lesions - <em>Rhodococcus equi</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granulomatous</td>
<td>Asymptomatic – N/A</td>
<td>NEGLIGIBLE</td>
<td>NEGLIGIBLE</td>
<td>Possible</td>
<td>Extremely unlikely</td>
</tr>
<tr>
<td>lesions - <em>Mycobacterium</em> spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk mitigation measures

From this risk assessment, based on current evidence, we do not consider that there is any appreciable additional risk to public health, animal health or animal welfare from visual-only inspection of fattening pigs from non-controlled housing conditions in the UK, over and above that which currently exists with traditional inspection. However, we have considered potential mitigation measures that could be considered, if it is perceived that further additional measures are necessary to manage any residual risk.

If endocarditis lesions are perceived to represent a residual risk then arrangements could be made to open hearts for inspection, where it is thought to be necessary.

If granulomatous lesions are perceived to represent a residual risk then arrangements could also be made to incise relevant lymph nodes for inspection, where it is thought to be necessary.

It is unlikely that a total hands-off visual-only inspection, even in the usual inspection position on the line, will allow all surfaces of the carcases and offal to be visible. Measures such as strategically placed mirrors or systems that rotate carcases would be needed to facilitate this. In addition, different ways of presenting the offal could be considered to attempt to maximise the frequency of detection by visual inspection.

Harmonised epidemiological indicators have been identified and have been proposed for use for food-borne hazards to public health related to pigs and pork such as Salmonella and Y. enterocolitica (EFSA 2011c). These should form the basis for any further risk mitigation measures, if it is deemed necessary for these micro-organisms.

Obstacles to implementation

We were asked to consider, in the course of our field study, what obstacles to the implementation of visual-only inspection for fattening pigs from non-controlled housing conditions might occur and to recommend ways to address them i.e. use the findings from our studies to identify any possible obstacles that may hamper the implementation of a risk based visual-only system.

The obstacles that we identified are the same as those that are expected if a risk based visual-only inspection were to be implemented for fattening pigs from controlled housing conditions (Annex 5).

We have identified ten main areas where potential obstacles to implementation of a risk-based visual meat inspection system for fattening pigs may arise. These include:

- the development of (and agreement on) how to classify batches of pigs according to risk;
- how to ensure that appropriate arrangements are in place to process batches of pigs according to their risk classification;
- the resource implications in terms of alterations to plant layout, staff available and amendments to plant operating procedures to ensure meat quality;
- maximising the visibility of the carcass and offal while minimising microbial contamination;
- the potential loss of data for animal health and surveillance purposes;
- and issues associated with change in the job, methods and responsibilities for FSA staff.

There are adaptations that could be made to overcome most of these obstacles (Annex 5); some however, will require further work and some will need to involve change management and behavioural change; areas that are outwith the scope of this project.

If it is perceived that there is unacceptable, unmanaged residual risk with visual-only inspection, and arrangements for additional incision and inspection are deemed to be necessary, then the first obstacle would be the need to work out how to determine and agree when this is required i.e. what criteria would be used, or set, on which to make such a decision. Subsequent obstacles would arise from aspects of implementation of such a system. The implementation of such measures would have an impact (Annex 4). The resource implications could become perceived, proposed, or actual obstacles (Annex 5). These might include capital expenditure within the abattoirs to install mirrors, or rotating systems; changes to slaughter house procedures, such as logistics, ordering of submissions, staff deployment and/or numbers, if carcases are required to be presented to the MHIs in a different way; for example, if hearts are required to be opened by a member of staff and then presented to the MHI for a visual inspection of the opened heart. Any such resource implications may have economic implications for individual premises. The resource implications will need to be carefully considered by risk managers with respect to whether they are deemed proportionate to the apparent risk.

It is difficult to make clear recommendations when the precise concepts and basis for a future risk based system are still so abstract. This is an area in which further work is required. In order to make evidence-based recommendations, the questions must be clearly defined first. The major obstacles to implementation are likely to be due to people, business and economic considerations, and politics: resistance to change; differing perceptions of the need (or not) for change; differing understanding, perceptions, and thresholds for the acceptance of risk and resource allocation. It is outwith the scope of project to make recommendations on approaches to change management and behavioural change.
SUMMARY OF OUTCOMES

From the studies that have been completed in this project we have achieved several outcomes:

We have provided field evidence, of a quantitative nature, for conditions found in fattening pigs from indoor and outdoor/free-range rearing systems by traditional inspection methods, albeit from one abattoir over a two year period (Annex 1).

We have provided field evidence, of a quantitative nature, for the frequency of conditions found in fattening pigs from outdoor rearing systems by both traditional and visual-only inspection methods, albeit from one abattoir over a single season in the UK (Annex 2). As previously stated, further work would be required to assess whether this is a representative sample. If it was, then it would allow the results to be generalised to all outdoor reared fattening pigs in the UK. However, data is not currently, or readily, available to enable us to do this.

We have explored the differences between the two inspection systems and have confirmed the finding from previous work (Hill et al., 2011, Alban et al., 2008); that hazards associated with endocarditis lesions in the hearts of fattening pigs should be included in risk assessments that look at the implications of change from a traditional to visual-only inspection system for fattening pigs. In addition, we did not identify any new hazards to public health, animal health and/or animal welfare (Annexes 1, 2, 3 & 4).

We have determined that the good hygiene practices, in place in this abattoir, are reflected in the results from the microbial investigations (Annex 3). These results could be used as a baseline measure for this abattoir for what they currently achieve in fattening pig carcases, from outdoor management systems, in the winter season. We have established that there is some evidence for reduced carcass contamination with Enterobacteriaceae, on carcases where it was present, after visual inspection compared to after traditional inspection (Annex 3). We can hypothesise that this lower level of contamination should result in reduced levels of cross-contamination. Mousing et al., (1997) concluded that the main benefit of a visual-only inspection system for pigs would “...probably, be a reduced level of cross-contamination with hazardous bacteria.” This is still a debatable point.

Mousing et al., (1997) also concluded that an indirect benefit would be a reduction in labour, which could be a resource that could be utilised elsewhere. It is not clear on what evidence this conclusion was based. It is not apparent from observations made during our field study that a significant reduction in labour (in terms of person-hours on the line) would occur (Annex 5). However, this was not explicitly studied.

We have used the findings from our studies to enhance and inform a qualitative risk assessment (Annex 4). From this risk assessment, based on current evidence, there is a potential for a change in the risk to public health and, possibly, animal health from the hazards associated with endocarditis lesions, if the inspection method were to be changed to a visual-only method. However, we do not consider that there is any appreciable additional risk to public health, animal health, or animal welfare from visual-only inspection of fattening pigs from non-controlled housing conditions in the UK, over and above that which currently exists with traditional inspection (Annex 4).
An important consideration is that the actual risk would still not be greater than that presented by fattening pigs from controlled housing conditions and integrated systems, which has been deemed ‘acceptable’ (Hill et al., 2011 and Anon., 2007b).

We have identified a number of possible obstacles to implementation of a visual meat inspection system and, where possible, identified potential solutions and areas for further investigation.

**CONCLUSION**

We do not consider that there is any appreciable additional risk to public health, animal health or animal welfare from visual-only inspection of fattening pigs from non-controlled housing conditions in the UK over and above that which currently exists with traditional inspection. This is, however, a matter for the risk managers.

If a visual-only inspection system could be implemented for all fattening pigs in the UK, then the benefit would be the initiation of a methodology that could change the emphasis of inspection and form the basis of a system that maximises aspects related to consumer safety, in addition to providing reassurance of the use of sound hygiene processes in production and, ultimately, food safety.
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