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Animal Health and Disease Monitoring in the Abattoir

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Abstract.

All slaughter animals are examined before and after slaughter by an Official Veterinarian. Findings of diseases and conditions that could affect public health or animal health have to be reported to the management of the abattoir and the private veterinarian as well as the farmer of the farm of origin. The abattoir provides a vast amount of information on zoonotic and notifiable diseases, as well as diseases relevant for animal husbandry or on-farm animal health. Notifiable diseases can be identified through clinical signs (e.g. foot-and-mouth disease), but in specific cases samples are taken for serological surveillance (e.g. Aujeszky's disease). Surveillance and monitoring schemes are generally based on the Terrestrial Animal Health Code of the World Organisation for Animal Health. Bovine tuberculosis is another example of a disease for which monitoring and surveillance is often entirely based on abattoir detection. For transmissible spongiform encephalopathies (TSE's) abattoir sampling constitutes an important proportion of all samples taken. Monitoring of public health threats, including diseases such as trichinellosis and cysticercosis, remains an important element of the inspection practices in the abattoir. Monitoring of trichinellosis can be risk-based: only pigs expected to be at a higher risk of infection are included in the testing regime. Abattoir sampling is also used for assessment of compliance with legislation on residues of antimicrobial drugs in meat. The number of samples is small, but the sampling itself has a preventive effect. An important category of diseases are those relevant for the performance on farm. Some examples are lung and heart lesions, as well as several parasitic diseases such as liver fluke. Indicators for welfare problems on-farm may also appear at slaughter. Foot lesions in poultry and tail biting in pigs are some examples. Abattoir information is easy and cheap to come by and is underutilised at the moment, particularly to feed into animal health management on farm. It would be advisable to design a feedback system in which post mortem findings are described with the interest of the farmer and her/his vet in mind.

Key points

- Abattoirs provide an opportunity to collect relevant animal health information in an easy and cost effective manner.
- Use of abattoir samples for disease status assessment and management is a convenient method.
- Abattoir information for use in on-farm health management is currently underutilised.
- Convenient ways for farmers and their vets to access abattoir data about the animals under their care are necessary.
- Classification/information transfer of post-mortem findings needs to be done with the farmer in mind.

Key words

Abattoir, monitoring, surveillance, notifiable disease, eradication, disease-free status, herd health.

Animal Health and Disease Monitoring in the Abattoir

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Introduction.

In the United Kingdom, a total of 28 million head of cattle, sheep and pigs (Defra, 2015a), and 960 million poultry (Defra, 2015b) were slaughtered in 2014. On the basis of European and national legislation, these animals are all examined before and after slaughter by an Official Veterinarian or an Official Auxiliary (European Parliament and Council, 2004, Defra, 2001). Official Veterinarians in this context are veterinary surgeons who have followed the required course to enable them to work in the meat industry on safeguarding food safety, animal and public health and animal welfare. Official Auxiliaries work under the supervision of the Official Veterinarian assisting in carrying out several of these duties. Regulation 854/2004/EC, the European legislation that covers the official controls of products of animal origin, specifically states in its considerations that the official controls should cover all aspects relevant for public health, animal health and animal welfare (European Parliament and Council, 2004). The same legislation also states that the Official Veterinarian, who must be authorised by the Competent Authority (i.e. the central Government) to carry out these duties, has to report findings of diseases and conditions that could affect public health or animal health to the management of the abattoir. If the problem has arisen at the farm of origin, the private veterinarian attending that farm as well as the farmer should be informed (European Parliament and Council, 2004).

The European Food Safety Authority (EFSA) identified three main purposes for inspection: protection of public health, of animal health and welfare, and of meat quality (EFSA, 2011). Because of the intensity with which all these animals are inspected, both ante mortem and post mortem, the abattoir provides a vast amount of information on animal health as well as public health threats. Among the diseases that are considered relevant in this context, several zoonotic diseases as well as epidemic, often notifiable, diseases can be mentioned (EFSA 2011, EFSA 2012, EFSA 2013a, EFSA 2013b). Apart from that, there are a number of diseases that are neither epidemic nor zoonotic, but highly relevant for animal husbandry or on-farm health and welfare (MacGillivray et al, 2013, Ezatpour et al., 2014).

In this paper an overview is given of the use of abattoir data for the monitoring and surveillance of notifiable disease, zoonotic disease, welfare issues and economically relevant farm associated health problems.

Notifiable disease.

Upon arrival to the abattoir, animals are inspected by the Official Veterinarian for signs of notifiable disease (European Parliament and Council, 2004). Monitoring and surveillance is based on European legislation (European Parliament and Council, 2001), which, in its turn, is based on the Terrestrial Animal Health Code (OIE, 2014). Interestingly, the foot-and-mouth disease epidemic of 2001 in the UK was first identified at an abattoir in Essex, even though the index case occurred on a pig farm in Northumberland (Davies, 2002, Bourn, 2002, Mansley et al, 2003).

The foot-and-mouth disease outbreak was first identified on the basis of clinical signs, but frequently samples taken from the abattoir are also used for surveillance purposes. Boklund et al (2013) report on the use of blood samples taken from export and slaughter pigs for Aujeszky's disease and classical swine fever in Denmark. Denmark is officially free of both diseases and samples 3.5 % of sows and boars exported and slaughtered, a total of around 70.000 samples per year. Martin et al (2007) describe the risk based sampling strategy for classical swine fever surveillance through abattoir sampling in Denmark. In the UK, the surveillance to substantiate the official disease-free status for Aujeszky's disease also relies on taking samples at slaughter, in particular cull-boars (Defra, 2014.)

In most cases the surveillance and monitoring schemes for notifiable diseases are designed on the basis of the Terrestrial Animal Health Code of the World Organisation for Animal Health (OIE, 2014a). It is of utmost importance to follow the standards described in the Code, particularly when maintaining or pursuing national disease-free status. Disease-free status is significant in international trade of animals and animal products (WTO, 2015)

In European legislation, particularly the so-called trade directives (e.g. those for cattle and swine, and for sheep and goats, European Council, 1964 and European Council, 1991 respectively) requirements are laid down for control of certain (notifiable) diseases and how to prove disease freedom, based on the same standards. The control and eradication of bovine tuberculosis (bTB) and brucellosis are also based on these directives. In many cases testing of samples taken from abattoirs serves as the method to provide year on year proof of freedom from disease. For bTB, surveillance in countries that have the disease-free status depends predominantly on abattoir surveillance and to a lesser extent on reporting of clinical cases (Hadorn and Stärk, 2008, Bessell et al., 2013). Bessell et al. (2013) have modelled abattoir-only surveillance versus two levels of herd testing (yearly and 4-yearly) along with abattoir surveillance, at the same time including several levels of risk encountered by farms (e.g. farms that imported with regularity from England and Ireland). They concluded that their more risk based approaches to bTB testing had broadly similar efficacy in detecting infection, and targeting higher risk farms for testing as well as pre- and post-movement testing provided the best results. In all cases abattoir surveillance was indispensable.

Sampling at the abattoir also plays a role in monitoring and surveillance of transmissible spongiform encephalopathies (TSEs). The aim of the monitoring of the TSEs is to detect an upward trend in the prevalence of scrapie and prevalence of bovine spongiform encephalopathy. Part of the samples for the monitoring of these diseases are taken from healthy slaughter animals (Wall et al., 2015); 33 % of the total of 20 000 samples from sheep are taken at the abattoir. Wall et al. (2015) modelled changes in the current monitoring practices to evaluate whether decreasing the sample size would have serious consequences for the intended detection of the trend. It appears that the period until detection of an upward trend is prolonged slightly, but even at the baseline level it takes about 11 years to detect an upward trend of, for example, the scrapie prevalence if the prevalence increases with 10 % per year. In this model of the baseline a sample size of 20 000 samples per year are sampled, and the prevalence will have increased from 0.000453 in year one of the simulation to 0.0013 in the year of detection.

Wall et al. (2015) stress that the protection of the consumer is based on the removal of specified risk material (material that can transmit the causative agent to humans), (European Parliament and Council, 2001) and that therefore a slight increase in detection time will not endanger public health. The same applies for animal health: the feed ban preventing feeding ruminants with animal-derived protein, based on the same legislation, should prevent infection of cattle, sheep and goats.

Zoonotic disease.

Meat inspection was originally developed to prevent infected meat from reaching the consumer (Ostertag et al., 1904), and monitoring of public health threats remains an important element in the inspection practices in the abattoir. Bovine tuberculosis as earlier mentioned, is an example of this, as is the monitoring for trichinellosis (European Commission, 2005, Zimmer et al., 2008) and cysticercosis (Calvo-Artavia et al., 2013, European Parliament and Council, 2004).

The monitoring of trichinellosis in particular is entirely based on taking samples of striated muscle from pigs and horses in the slaughter line (Alban et al., 2011, Boireau et al., 2000). In most European countries, trichinellosis has become a rare disease and its prevalence in

domestic animals is low, with several countries being considered free of the disease (EFSA 2006a, EFSA 2006b). Because of this, the monitoring of trichinellosis in slaughter animals has changed in recent years (Alban et al., 2008, Alban et al., 2011). Where the risk of pigs getting infected with *Trichinella spiralis* is low to negligible, the monitoring of trichinellosis can be risk-based. This means that only those pigs expected to be at a higher risk of infection will be included in the testing regime (European Commission, 2005). The European Regulation 2075/2005 uses the term “controlled housing”: in cases where pigs are kept under controlled housing, testing will no longer be required if the country acquires a derogation, which means it is exempted from this particular requirement (European Commission, 2005). Horses and hunted game, in particular wild boar, are to be sampled whenever they are submitted for human consumption (European Commission, 2005, Zimmer et al., 2008, Pozio and Murrell, 2006).

Cysticercus bovis is one of the parasites that typically can be detected through post mortem inspection in the abattoir (Calvo-Artavia et al., 2013). Now rare in the UK and many western countries (Dupuy et al., 2014a, Dupuy et al., 2014b), it can be found abundantly in many third world countries (Abunna et al., 2008, Tolosa et al., 2009). Abunna et al. (2008) found a prevalence of 26.25 % among cattle slaughtered, corresponding with a 64.2 % prevalence of *Taenia saginata* in people from the town where the abattoir was based. *Cysticercus cellulosae* is similarly rare in the western world, but still causes serious disease in people in developing countries (Prakash et al., 2007, Phiri et al., 2003). Monitoring for these diseases is entirely based on identification of cases in the abattoir, which, in the case of *C. bovis*, does result in a positive case now and then. Table 1, showing results of post mortem inspection in a cattle abattoir in the United Kingdom over a 2 year period, shows a prevalence of 0.03 %.

The Official Veterinarian in the abattoir also samples for monitoring of the presence of antimicrobials in animals sent for slaughter (Veterinary Residues Committee, 2014). Samples from several types of materials and tissues (kidneys, liver, serum, urine, muscle) of all slaughter species are taken according to a pre-arranged sampling schedule. The number of samples taken is, considering the total number of animals slaughtered on an annual basis, comparatively low (25226 samples taken in red meat abattoirs, 8488 in poultry abattoirs in 2014 (Veterinary Medicines Directorate, 2014)), but the sampling itself should have a preventive effect on application of antimicrobials to slaughter animals shortly before slaughter. The residue monitoring schemes are based on European legislation (European Council, 1996) and international standards (OIE, 2014b).

Endemic disease and diseases of economic or welfare relevance.

An important category of diseases for the farming community are those that are relevant for the performance of the farm. As all animals going to slaughter are inspected, ante- and post mortem, this is a potentially huge source of information about animal health on farm.

In slaughter pigs, lung lesions are a relatively common find (Meyns et al., 2011, Merialdi et al., 2012). Meyns et al. (2011) found a prevalence of 20.76 % visible lesions of pleuritis, and 23.85 % of visible lesions of pneumonia in a study in which over 6000 slaughter pigs were examined. Merialdi et al. (2012) found enzootic pneumonia-like lesions in 46.4 % of lungs. Fablet et al. (2012) studied the association between lesions and micro-organisms in lungs of 3731 pigs from 125 herds, and found that *Mycoplasma hyopneumoniae* and *Pasteurella multocida* were most often associated with lesions (with 69.3 % and 36.9 % of affected lungs respectively). *Actinobacillus pleuropneumoniae* was present in 20.7 % of the lungs, and *Haemophilus parasuis* and *Streptococcus suis* in 6.4 % and 0.99 % respectively.

Another increasingly problematic health issue on farms is infection with liver fluke (*Fasciola hepatica*, McCann et al., 2010, Pritchard et al., 2005, Mazeri et al., 2014). Condemnation of livers is largely due to liver fluke; MacGillivray et al. (2013) carried out a survey in autumn 2010 in three abattoirs in the UK and Ireland, where condemned livers were assessed for

the number of *Fasciola hepatica* present. They found 85.7 % of condemned livers containing flukes. 97 % of the flukes at this time of year appeared to be adult or late immature flukes. Khoramian et al. (2014) found a prevalence of 3.28 % in central Iran and calculated a considerable economic loss. Ezatpour et al. (2014) studied the prevalence of liver fluke in the abattoirs of Lorestan in Iran. They found a prevalence of 7.1 % overall in sheep and goats, with seasonal variation, whereby most condemnations were found in spring and autumn. Mazeri et al. (2014) studied the value of slaughterhouse data for the study of the epidemiology of the disease and the identification of sustainable control measures in the light of changing circumstances influencing the spread and severity of the disease. The study was mainly aimed at evaluating the reliability of the abattoir information. Ansari-Lari and Moazzeni (2006) investigated the prevalence and long-term trend of liver fluke in sheep, cattle and goats in southern Iran and found a decreasing trend between 1999–2000 and 2003–2004 respectively. Apart from a period of drought, raised awareness among farmers was a contributing factor. In table 1. it is shown that liver fluke is the most common pathology found with a prevalence of 2.18 % in the abattoir where the data were collected, which reflects the trend in British abattoirs.

Cardiac pathology is specifically investigated during meat inspection (Nielsen et al., 2015, Raji et al., 2010). Both publications particularly discuss pericarditis. Nielsen et al. (2015) conclude that there is not a strong correlation between the post mortem findings and the prevalence assessed on the basis of systematic health monitoring in fattening pigs in Denmark. Raji et al. (2010) found a relatively high prevalence (17.06 %) in cattle in an abattoir in Nigeria.

Welfare aspects are part of the assessment as well: in the poultry industry, foot lesions are considered to be an indicator of certain aspects of on farm animal welfare (De Jong et al., 2012), and the rate of occurrence is assessed at slaughter. Kyvsgaard et al. (2013) studied time trends and predisposing factors on the flock lesion scores for foot pad dermatitis in broilers in Denmark. The programme on broiler welfare in Denmark is based on abattoir scoring of foot pad lesions: if the problem reaches specific score levels, as measured in the abattoir, farmers are penalised. Kyvsgaard et al. (2013) found poor litter quality, winter season as opposed to summer, low daily weight gain, straw as bedding and increased age at slaughter to be risk factors.

Harley et al. (2012) reviewed literature on the use of meat inspection to measure animal welfare on pig farms. They proposed that the presence of disease and injury can be used to assess animal welfare on farm. Many lesions (e.g. fractures, skin wounds, abscesses) may be directly related to suboptimal production systems. Farm level measures can decrease the incidence of pulmonary lesions and tail-biting outbreaks, as well as disease conditions which occur during transport and slaughter.

Discussion.

A few examples have been presented of the wide range of health issues that can potentially be monitored using abattoir information from ante and post mortem inspection. Where possible, abattoir information provides a cost effective and easily accessible source of valuable information about health and welfare of animals and threats to human health. This may be particularly relevant for on-farm health problems. Yet, these resources are underutilised (Harley et al., 2012).

For notifiable disease monitoring, particularly for the category of the acute diseases such as foot-and-mouth disease and classical swine fever, the normal obligation for any veterinary surgeon applies that suspected cases have to be reported. As the outbreak of foot-and-mouth disease in the UK in 2001 has shown, ante mortem inspection in the abattoir can play an essential role in the identification of notifiable diseases. On the whole, Official Veterinarians are generally not likely to be confronted with- the situation that a notifiable

disease is found at an abattoir such a situation, at least in much of the Western world. Even so, it remains extremely important for Official Veterinarians to stay vigilant in the abattoir for the occurrence of notifiable diseases, as they would have to be in areas where these diseases are still present.

Bovine TB monitoring in some countries relies entirely on abattoir findings, with positive cases being followed up to identify the source and detect in-contact animals. Particularly in countries that have the Official bTB Free status, granted by the OIE and the EU, this system is applied. In practice this means that if an animal is found with lesions, it is often found that some spread has in fact taken place.

Sampling healthy slaughter animals for spongiform encephalopathies rarely provides cases. The prevalence of scrapie has always been low, and the prevalence of bovine spongiform encephalopathy is equally low nowadays. In 2014, in the entire United Kingdom, only one case of BSE was detected, down from three in 2013 and two in 2012 (OIE, 2015). The sample size, both in cattle and sheep, is in actual fact far too small to assess prevalence in these populations. The purpose of the monitoring here is therefore identification of (upward) trends in prevalence (Wall et al., 2015). Even for that purpose however the sample size seems to be small.

Detection of zoonotic diseases such as cysticercosis and trichinellosis has always leaned on post mortem inspection and will continue to do so. Most of these diseases are rare in western countries but still present in many developing countries. *Cysticercus cellulosae* in particular causes serious disease. There does not seem to be any reason to reduce attention for these diseases, as through increased mobility of people reintroduction can and does occasionally occur. Where possible, risk based approaches are implemented for some of them, trichinellosis in particular (Alban et al., 2008, Alban et al., 2011). Van Knapen (2000) argued for the relative importance of abattoir based monitoring and on farm serological monitoring for *Trichinella*, both having a place in detection of the parasite, depending on the presence of an infection in the country. He also argued the necessity to concentrate on animals that are at the greatest risk of acquiring an infection and on wildlife. At present this transition is being made (Alban et al., 2011). In the European Union pigs do not have to be sampled for *Trichinella* if they come from controlled housing.

European legislation on meat inspection now prescribes that information, wherever collected, has to be transferred up and down the food chain, as laid down in Regulation 854/2004 (European Parliament and Council, 2004). The regulation states that the Official Veterinarian must record and evaluate the results of the inspection, and if a public or animal health problem arose during primary production, the private veterinarian of the holding of origin has to be informed as well as the farmer. In practice, this does not happen often enough. There are some issues with this: it is not always straight forward to approach the private veterinarian and the farmer of the holding of origin, especially when animals have been travelling over long distances and have changed hands on markets several times before ending up at the abattoir. There are countries where centralised systems are in place that vets and farmers can subscribe to and that subsequently give them access to the results of meat inspection of the farm (Wanda et al., 2013). This however is not yet fully developed in all member states. Wanda et al. (2013) describe how tablets are used by Official Meat Inspectors to enter lesions found during inspection in the system.

In a report by MLCSL consulting (Meat and Livestock Commercial Services Limited) for the Food Standards Agency in 2013, the current Food Chain Information (FCI) system and the Collection and Communication of Inspection Results (CCIR) system are evaluated (MLCSL, 2013). From this evaluation it appeared that, in the cattle and sheep sectors specifically, feedback to farmers and their vets is only given in a few cases, and then mostly related to rejections, not to pathology found that does not lead to rejection. In the pig and poultry

sectors, feedback to farmers and their vets is much more common. In Northern Ireland the Animal and Public Health Information System (APHIS online) contains all ante- and post mortem results for animals, and farmers can sign up to the service and access the information for their own animals. In Britain the Food Standards Agency operates the *Innova* system, which seemingly is much less accessible for farmers and vets.

For some pathological findings the abattoir can play a significant role in supporting the health management on farm. This is undoubtedly true for lung problems in pigs, as has been illustrated, and for liver fluke and a variety of other parasitic diseases. For some syndromes it may be useful to develop a classification or description system that is more informative for the farmer and her/his vet, and make sure that farmers and vets are well aware of its existence. Pericarditis is an example of that. It is important for the farmer to know that pericarditis is there, but in many cases it will be an incidental finding. If however, the pericarditis is traumatic in origin and happens more often in the same herd of cattle, it is all the more relevant that the farmer knows about it. It would be advisable to design a feedback system in which post mortem findings are described with the interest of the farmer and her/his vet in mind. Dupuy et al. (2013) describe a typology of syndromes for cattle that intends to do precisely that. [Having a well described typology is an important element in developing a feedback system for farmers, having access to the data is also relevant.](#) Particularly access to the *Innova* system, with use of relevant codes, is helpful. It could be considered to develop an app that allows farmers to access the data for their animals.

Conclusion.

Ante- and post-mortem inspection in abattoirs can play an important role in monitoring and surveillance of a number of disease categories. More importantly, the data collected in the abattoir provide a wealth of information on health aspects of livestock. These data are grossly underutilised at the moment. At the very least, it should be possible for farmers to have access to the information about their own animals enabling them to discuss these results with their vet. To that end it would probably be necessary to give a broader interpretation to the requirement for feedback to the farm of origin of any abnormalities if a public or animal health problem arose during primary production.

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Table 1. Overview of post mortem results from a British beef abattoir over a two year period. During that period 64,434 animals were slaughtered and 6,686 conditions were recorded affecting 5,754 animals (unpublished data from a MSc. thesis, Z. Jasper, 2010).

Condition	% of animals affected
Liver Fluke	2.18
Abscess	1.43
Pleurisy/Pneumonia	0.78
Tuberculosis	0.49
Cirrhosis	0.35
Peritonitis	0.26
Trauma	0.22
Actinobacillosis	0.20
Pericarditis	0.13
Telangiectasis	0.11
Lung Worm	0.09
Arthritis	0.09
Pyaemia	0.05
Emphysema	0.04
Emaciation/Oedema	0.04
Hydatidosis	0.04
Melanosis	0.04
<i>Cysticercus bovis</i>	0.03
Xanthosis	0.02
Actinomycosis	0.02
Fibrosis	0.02
Nephritis/Nephrosis	0.01
Tumours	0.01
Enteritis	<0.01
Anaemia	<0.01
Mastitis	<0.01
Endocarditis	<0.01
Uraemia	<0.01