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Health and welfare management of pigs based on slaughter line records

Abstract

Health and welfare management of pigs are relevant issues to optimise productivity. Diseases and injuries are important elements when monitoring health and welfare. On farm, disease is assessed by observing symptoms and behavioural signs. Evaluation of injuries includes inspection of skin lesions and tail and ear wounds due to aggression or biting, respectively. However, these measures are taken in large groups, dirty animals or when insufficient light is available. These constraints may compromise sometimes reliability and feasibility. At slaughter, carcass and viscera examination allow the evaluation of skin lesions, and tail and ear wounds, as well as the identification of diseases. As a result of infections, affected lymphatic nodes become swollen and abnormal in colour. Conditions such as pneumonia or porcine atrophic rhinitis have characteristic lesions. Validity and reliability are high. However, to be a feasible and valid method, carcass identification should be kept throughout the process. Determination of acute plasma proteins (APPs) in blood after sticking gives valuable information on clinical and even subclinical disease on farms. Furthermore, several reports have suggested that APPs could be good indicators of animal welfare. At the slaughterline, animals from several farms can be sampled on the same day, reducing the risk of disease transmission. However, to use the Slaughter line records to improve health and welfare, a feedback system to the farm should exist.

Keywords: pigs, welfare, health, management, slaughter records

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Introduction

Society is increasingly concerned about health and welfare of farm animals. The origin of that concern seems to be a lack of transparency and reliable information about the way in which animal-based food products are actually produced. In order to include these aspects in animal production and achieve safe market products for human health resulting from welfare friendly systems,[1] producers need to consider animal health and welfare management.[2]

On farm management may be assessed according to correct husbandry procedures and competent stockmanship, but also according to good records, written evidence of sanitary and welfare status of the animals.[3] To be a valuable tool, the recording system needs to monitor health and welfare in a valid, reliable and feasible way.[4] The records need to collect information about the health and welfare of the animals in real time and be able to follow the evolution with continuous recording. Therefore, registrations should be carried out over several visits to the herd to show development over time and seasonal changes in animal health and welfare.

Welfare

Raising animals intensively favours the occurrence of some welfare problems such as aggression and ear or tail biting. Aggression is a normal pattern of the pig social behaviour; however, if prolonged in time it impairs animal welfare due to two main reasons. First, aggressions may result in injuries, pain and in extreme cases, death of the animal. Second, aggressions lead to physiological stress, immunosupression and reduction of food intake.[5] Potential sources of aggression are mixing of unacquainted animals, crowding or limited available space and access to a limited resource (e.g. feed).

Tail and ear biting are also considered a major welfare problem in pig production. It indicates pain and suffering of the bitten animal due to the biting itself and to possible secondary infections. Tail biting may also be stressful to the group and may indicate frustration of the biting animal.[6]

Record of agonistic encounters either during feeding or in the pen, or tail and ear biting behaviours allows a valid evaluation of the welfare problems.[7,8] If the observers are correctly trained, the inter observer reliability may be high. However, as it requires extensive and detailed observations and a large amount of time and work, its feasibility is low.

Clinical observations of wounds are valid indicators of these welfare problems.[9] Several protocols have been developed to assess skin, ear and tail lesions. Wounds may be assessed according to number, location (head/neck, flank/back and hindquarters), nature (scratch or crust, opened wound, abrasion, blotch or haematomas), size and state of healing. Marks due to biting during fighting are scratches or cuts, 5-10cm long, of comma shape and normally numerous and concentrated in a specific area.[10] Lesions on the head and shoulder area are caused by fights connected with social ranking.[11–13] Lesions on the rear part of the body may be caused by competition for food[9] or by rough handling.

The incidence of injuries seems to be more reliable and feasible than behavioural observations, and therefore preferred. This is especially true when attention is focussed on the more severe wounds. However, when measures are taken in large groups, when insufficient light is available to inspect the pigs, dirty animals, when animals are lying, or if the lesion is underneath the animal (e.g. at udder) its reliability and feasibility may be compromised.

Among the main issues involved in the concept of welfare are the concepts of 'suffering' and 'need,' as well as the 'five freedoms' which are more related to animal husbandry and management by man.[14] This five freedoms, defined in the Brambell Report of 1965[15] as first time and revised later by the Farm Animal Welfare Council in 1993[16] defines animal welfare as freedom from thirst, hunger and malnutrition; freedom from discomfort; freedom from pain, injury and disease; freedom to express normal behavior and freedom from fear and distress. This has been the basis for animal welfare for decades, although other definitions based in lists of needs for the animals have appear.[17] With the intention to produce a tool for assessing animal welfare by means of aggregation of different measures in a multicriterion approach and based on the existing definitions, the European Project Welfare Quality® defined animal welfare by means of 12 criteria: absence of prolonged hunger, absence of prolonged thirst, comfort around resting, thermal comfort, ease of movement, absence of injuries, absence of disease, absence of pain induced by management procedures, expression of social behavior, expression of other behavior, good human-animal relationship and positive emotional state. These criteria were then aggregated in four principles of animal welfare: good feeding, good housing, good health and appropriate behavior.[17] Therefore, as in the case of the five freedoms, this approach includes health as a basic part of the welfare of animals.

Health

Disease is an important welfare indicator by itself and because it is associated with pain, discomfort or distress. Furthermore, diseased animals have very often difficulty in coping with their environment.[2] Traditional health control consists in clinical examination, detecting behavioural changes or other clinical symptoms, and treating the affected animals.[18] Behavioural changes, such as abnormal lying (location, posture or duration) or loss of appetite, are in many cases the first evidence of the disease.[19] For example, depression and disorientation are features of Aujeszky's disease and encephalomyelitis. Other clinical symptoms include body condition, skin, ear, tail, legs or feet lesions, lameness, laboured breathing, excessive salivation, vaginal discharge, frequent coughing, swollen joints, scouring and presence of external parasites.[20]

The early detection of the affected animals is crucial for the success of the management measures. To obtain valid and reliable records, the pigs must be inspected routinely at least daily, and the observer should be able to recognize the behavioural changes and clinical symptoms. Some signs of diseases, such as severe diarrhoea may be easy to appreciate, but other signs that are not easy to observe, may be overlooked by the observer. In most of the cases, the examination of clinical symptoms needs the handling of the animals, or the animal to be forced to move. Pigs are not easy to handle and some detailed physical examination need to be deferred until the animal can be removed and inspected alone, delaying the inspection of the animal. For these reasons, clinical examination may be too time consuming, decreasing its feasibility.

The current intensively pig production favours the occurrences of subclinical diseases. Environmental factors such as feeding, housing, husbandry and hygiene, play the most important role in the impact of the subclinical disease on the population.[21] Subclinical diseases compromise seriously productivity and profitability of farm animal production and impair meat safety. Pneumonia, atrophic rhinitis, arthritis, gastric ulcers, abscesses and zoonotic agents such as *Salmonella, Campylobacter* spp., *Clostridium perfringens*, and pathogenic serotypes of *Escherichia coli*, for example *E. coli* O157:H7 have greatly increased in the pig population and are often present as subclinical diseases in apparently healthy pigs at slaughter.[22] Animals that are symptomless carriers of pathogens may not be detected by the classical clinical examination. When these animals arrive to the abattoir, they shed bacteria or virus that can infect other animals and cause cross contamination.

Logbook can also be used to record farm health and welfare. Attention should be paid on how the data can be verified. The reliability of registrations, both reproducibility (between observer variations) and repeatability (within observer variation) has to be considered very carefully. Furthermore, veterinary treatment records do not give a precise measure of diseases, and general data on growth and piglet production are not usually presented in a way which facilitates the identification of individuals with health problems. Therefore, animal health data are rarely easy to use.[23]

Slaughter line records

At slaughter, carcass and viscera examination allow the evaluation of skin, tail and ear wounds, and the identification of diseases. Originally, post-mortem inspection was designed to improve meat safety by detecting and removing cut or entire carcasses potentially hazardous to human health due to e.g. tuberculosis or cysticercosis.[21] Currently, post-mortem inspection has gradually paid increasing attention to other areas that have no direct relevance for human health. This includes detection and eradication of certain diseases of livestock, assessment of animal welfare, and evaluation of productivity and meat and carcass quality.[24–27] Post-mortem inspection involves visual examination, as well as palpation and incision of the carcass, viscera and certain lymph nodes following standardised methods. Codex Alimentarius in its Code of Hygienic Practice for Meat (CAC/RCP 58-2005) describes *ante-mortem* inspection as "*any procedure or test conducted by a competent person on live animals for the purpose of judgement of safety and suitability and disposition*" and *post-mortem* inspection as "*any procedure or test conducted by a competent person on all relevant parts of slaughtered/killed animals for the purpose of judgement of safety and suitability and disposition"*.[28]

Lesions

Skin damage and ear and tail wounds are assessed by visual inspection at the slaughterline. The assessment can be conducted as a whole or separately in different parts of the carcass, such as head/neck, flank/back and hindquarters. If the carcass is to be evaluated as a whole, the most common photographic scales used are the five point scale (from one=none to five=severe) provided by the Meat and Livestock Commission[29] in the United Kingdom and the four point scale (from one=none to four=extreme) set up by the EU working group.[13] The latter can also be used to score the incidence of blemishes in different parts of the carcass. Assessment of skin lesions at the Slaughter line not only helps to determine number of marks on the carcass, but also may recognize the source (fighting, rough handling, overcrowding or poor facilities design) according to the anatomical location and damage type. Old wounds may be recognised as scars, and may be indicative of some animal welfare problem on the farm. Fresh wounds may indicate damage due to fighting during transport and lairage. However, the methodology to determine the time when the bruise occurred needs standardisation. If determination of the time can be achieved, the recording of skin lesions on the carcass may solve the difficulty of scoring skin lesions on farm (overcrowded pens,

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dirty animals, if the lesions are underneath the animal, if the animal is resting, poor light etc.) and increase its reliability and feasibility. A system to assess skin lesions as part of an animal welfare assessment schema in the slaughterhouse is presented in the Welfare Quality® protocols[30] and some results discussed in Dalmau et al.[31] Tail biting is not assessed in the slaughterhouse by these protocols, but other authors have developed studies in tail bitten slaughter pigs in relation to performance, meat quality and animal welfare traits.[32–34]

Catarrhal and fibrinous pneumonia, pleuritis, atrophic rhinitis, abscesses, ulceration, pericarditis and white spots in the liver are pathological findings that can be identified by postmortem inspection.[22–35] These lesions are often present in asymptomatic carriers of pathogens. Therefore, post-mortem inspection is needed to permit the identification of some subclinical diseases, which are impossible to assess with on farm clinical examination. However, this procedure will not reveal the presence of zoonotic agents such as *Salmonella* spp., *Yersinia enterocolitica*, *Campylobacter*, *Trichinella spiralis* or *Toxoplasma gondii*, as these infections may often be present without overt signs of illness and with no apparent macroscopic lesions. Therefore, in addition to carcass inspection, muscle, faecal samples, skin scrapings and blood samples taken during sticking could be useful tools to look for infections, parasites and viral diseases.[22]

As post-mortem inspection procedure includes palpation and incision of lymph nodes and infected tissues, it can give rise to cross contamination. To avoid these problems, research has aimed at reducing the spread of any meat borne pathogens by minimizing carcass handling and number of incisions made during traditional meat inspection.[36] Following the same objectives, only visual inspection procedure, without any cutting or palpation of the carcass or organs, has been proposed by several authors as a replacement for traditional inspection.[36–38] They consider that with visual inspection alone, lesions can be detected with equal facility and, apparently, with no compromise (or lower compromise) for public health. It also reduces inspection cost. However, visual meat inspection will satisfactorily address some conditions but not all. Some lesions, such as those in the lymph nodes, may remain undetected following a change from traditional post-mortem inspection to a visual system.

Acute plasma proteins

Blood or meat juice samples can also be used for the determination of acute plasma protein (APPs) that are produced in the liver and show a change in their plasma concentration after infection or inflammatory lesions.[39–42] For instance, they have been associated with tail biting in finishing pigs.[32] Haptoglobin is the most widely APPs used in pigs, mainly due to the availability of methods for its quantification.[43] The level of haptoglobin in serum has been recognised to be a valuable marker of clinical and even subclinical disease in farm animals.[44] Petersen et al.[40] were able to distinguish healthy, sub clinically diseased and clinically diseased pigs by measuring levels of plasma haptoglobin. Lame pigs or pigs with tail or ear bite in Danish herds also showed elevated haptoglobin levels.[45]

The level of haptoglobin may act also as an integrative indicator for animal welfare related to tissue damage, indicating pain, fear, health or discomfort.[43] APP has been used also to study the effects of transport and pre-slaughter handling on welfare.[46] The concentration of haptoglobin increases after stress induced by extreme temperatures or high stocking densities.[43] Haptoglobin sampling in the Slaughter line will be in the near future a relevant tool for integrative health and welfare assessment of slaughter pigs at individual level and for longitudinal monitoring at farm level.

Information regarding subclinical diseases and injuries can be more reliably and feasibly obtained from Slaughter line records than on farm. If data are collected at the slaughterline, the visit to farms can be reduced, minimizing the risks of disease transmission. Furthermore, at the abattoir, pigs from several farms can be sampled on the same day, reducing travelling costs. However, to be a feasible method, the carcass should be identified throughout the process.

Discussion

Systematic recording of several measures at slaughter can be regarded as an important complementary tool for the management of health and welfare.[47–49] Data collection at the abattoir combined with information gathered on the farms (clinical signs, production and welfare indices) and at the laboratory, allow the development of a comprehensive database for health and welfare management. Such integrated systems have been proposed by several authors.[50–55] However, to be a valid, reliable and feasible tool, the Slaughter line records should be taken at regular intervals, and a feedback system of information between the abattoirs and the farmers or their advisers should be in operation. Existing data from pig health and welfare abattoir system records are currently being greatly under utilised. To provide value, abattoir surveillance data must be utilised through analysis to support future direction in the decision-making process.[28]

Effective health and welfare management depends on knowledge and information exchange between the various links of the production chain. The control of pathogenic microorganisms on meat must start on the farm. Abattoirs must have information about management and environmental factors of the farm of origin, for example disease history and medical treatments that might have an effect on its welfare and health status. This information would allow differentiating, previous to inspection, animals that are unlikely to have any lesions and those that may, which will allow the meat inspector to give more time and effort to the examination of carcasses in which problematic conditions are suspected.[21] In the current EC regulations, the owners of animals do not have to provide meat inspection authorities with any information that may be important for meat inspection, and they are not inclined to do so, because the disclosure may led to a more specific examination and the possibility that their animals may be condemned.[56]

On the other hand, each farmer should receive feedback information, which means reports of the records with the prevalence of injuries and subclinical lesions, a hazard analysis and, ideally, recommendations about how to solve the problems. Any effects of the transport such as the presence of Pale Soft Exudative (PSE) or Dark Firm Dry (DFD) meat or other defects such as fatigue or stress should be added to the previous information. Key factors that may adversely affect animal welfare include animal fitness, fasting, vehicle design, driving style, stocking density, weather condition or ventilation.[28] Nowadays, data from the abattoirs are frequently not available to the farmers, or if available, are not in a form that allows their interpretation and use.

The success of the feedback system between the abattoirs and the farmers or their advisers, depends on the ability to trace foods of animal origin back to the production farm. The identification of live animals, either individually or at the farm level is becoming an increasingly important component of the health and welfare management.

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Edwards et al.[21] and von Borrel[2] proposed the assessment of pig welfare and health according to the 'hazard analysis and critical control' (HACCP) concept, as a basis for hazard analysis and quality-improvement programmes. Noordhuizen and Welpelo[57] addressed also the principles of the HACCP concept in relation to animal health management strategy. According to these authors, the process control (expressed in terms of controlling both general and specific disease risk factors) and product control (expressed in terms of testing animals or animal products for specific disease agents) could be the basis for improving animal health. This involves the identification of risks during the whole production (on farm and at the slaughterline) so that they may be avoided, reduced or managed. If the whole production is continuously monitored, the control measures can be introduced promptly and effectively in response to either new hazards or altered risks, so that their impact can be eliminated or minimised before product safety and welfare are compromised.

The objective of sampling in abattoirs is primarily to estimate the prevalence of a problem, and therefore a representative sampling of the slaughter population is required. The most common sampling strategy to be used in a abattoir is systematic sampling, but stratified multi-stage sampling strategies can also be used. Systematic sampling involves selection of individuals at regular intervals froman ordered population. When the population of interest is the live or slaughter population for a region or theentire country, multiple abattoirs participate in the study and a stratified design must be used. Stratification by abattoir, with sample size proportional to the number of animals slaughtered, stratification by month within a year, with an equal sample size per month, etc..[58] HACCP provides wide opportunity for preventive health action and risk management at a relatively low cost in terms of labour, finance and documentation expenditure, at both the farm and sector level. However, HACCP systems are not in general use on farms and other sites of primary production, although there is no reason why they should not be introduced to control the spread of pathogens and welfare problems. Farm-level pig health information has been used in several countries for meat inspection purposes. Based on available literature, its value has been limited.[58]

Conclusion

There are several health and welfare problems in pigs that can be assessed by means of Slaughter line records (Table 1). The advantage of the Slaughter line is that animals from different farms can be sampled on the same day, reducing the risk of disease transmission. However, to use the Slaughter line records to improve health and welfare, a good feedback system to the farm is necessary.

Table 1 Measures that can be used in the slaughterline as indicators of health and welfare in pigs

Measures	Possible health and welfare causes associated
Skin lesions	Agonistic behaviour, rough handling, overcrowding
Ear wounds	Ear bitting, virical infections
Tail wounds	Tail bitting
Pneumonia/pleurisy	Respiratory diseases

Table Continued..

Measures	Possible health and welfare causes associated
Twisted snouts	Atrophic rhinitis
Abscesses	Local infections
Gastric ulcerations	Stress, prolonged hunger
Pericarditis	Infections and sometimes perforations
White spots on the liver	Ascariasis
Acute Phase Proteins	Inflammatory processes

Conflict of interest

The authors of this article have no financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

References

1. Main DCJ, Webster AJF, Green LE. Animal welfare assessment in farm assurance schemes. *Acta Agriculturae Scandinavica, Section A-Animal Science Supplement*. 2001;51(30):108–113.
2. Von Borell E. Assessment of pig housing based on the HACCP concept-critical control points for welfare, health and management. In: Harry J, editor. *Improving health and welfare in animals production: Proceedings of sessions of the EAAP commission on Animals Management and Health*. Hague, Netherlands: EAAP publication No 102; 2000;21–21.
3. Scott EM, Nolan AM, Fitzpatrick JL. Conceptual and methodological issues related to welfare assessment: A Framework for measurement. *Acta Agriculturae Scandinavica, Section A-Animal Science*. 2001;51(Suppl 030):5–10.
4. Wemelsfelder F, Lawrence AB. Qualitative assessment of animal behaviour as an on-farm welfare-monitoring tool. *Acta Agricultural Scandinavica, Section A - Animal Science*. 2001;51(Suppl 30):21–25.
5. Fraser D, Rushen J. Aggressive Behavior. *Vet Clin North Am Food Anim Pract*. 1987;3(2):285–305.
6. Schroder-Petersen DL, Simonsen HB. Tail biting in pigs. *Vet J*. 2001;162(3):196–210.
7. Ewbank R, Bryant MJ. Aggressive behaviour amongst groups of domesticated pigs kept at various stocking rates. *Animal Behaviour*. 1972;20(1):21–28.
8. Kelley KW, Mcglone JJ, Gaskin CT. Porcine aggression: measurement and effects of crowding and fasting. *J Anim Sci*. 1980;50(2):336–341.
9. Leeb B, Leeb CH, Troxler J, et al. Skin lesions and callosities of group housed pregnant Sows-animal related welfare indicators. *Acta Agriculturae Scandinavica, Section A-Animal Science*. 2001;51(Suppl 30):82–87.
10. Scientific Veterinary Committee. The welfare of intensively kept pigs. Report to the Directorate General XXIV of the European Commission. Adopted 30. September 1997. Doc. XXIV/ScVc/0005/97, Scientific Veterinary Committee, Animal Welfare Section, Brussels; 1997.
11. Jensen P, Wood-Gush DGM. Social interactions in a group of free ranging sows. *Applied Animal Behaviour Science*. 1984;12(4):327–337.
12. Luescher UA, Friendship RM, Mckeown DB. Evaluation of methods to reduce fighting among regrouped gilts. *Canadian Journal of Animal Science*. 1990;70(2):363–370.

Citation: Dalmau A, Fabrega E, Manteca X, et al. Health and welfare management of pigs based on slaughter line records. *J Dairy Vet Anim Res*. 2014;1(3):73–78. DOI: 10.15406/jdvar.2014.01.00016

13. Barton Gade PA, Warriss PD, Brown SN, et al. Methods of improving welfare and meat quality by reducing stress and discomfort before slaughter - methods of assessing meat quality. *Proceedings EU-seminar: New information on welfare and meat quality of pigs as related to handling, transport and lairage conditions.* Denmark: Landbauforschung Volkenrode, Sonderheft; 1996. p. 97–106.

14. Carenzi C, Verga M. Animal welfare: a review of the scientific concept and definition. *Italian Journal of Animal Science.* 2009;8(Suppl 1):21–30.

15. *Brambell Report. Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. London:* Her Majesty's Stationery Office; 1965.

16. FAWC. *Second Report on Priorities for Research and Development in Farm Animal welfare*. Tolworth, London: MAFF Publications; 1993.

17. Botreau R1, Bracke MB, Perny P, et al. Aggregation of measures to produce an overall assessment of animal welfare. Part 2: analysis of constraints. *Animal*. 2007;1(8):1188–1197.

18. Rousing T, Bonde M, Sorensen JT. Aggregating welfare indicators into an operational welfare assessment system: a bottom up approach. *Acta Agriculturae Scandinavica, Section A-Animal Science*. 2001;51(Suppl 30):53–57.

19. Fraser AF, Broom DM. Welfare and behaviour in relation to disease. *In: Farm Animal Behaviour and Welfare.* 3rd ed. Wallingford: CAB International. 1997. p. 294–304.

20. Fraser AF. The behaviour of suffering in animals. *Applied Animal Behaviour Science*. 1984;13(1984/85):1–6.

21. Edwards DS, Johnston AM, Mead GC. Meat inspection in the UK: an overview of the present practices and future trends. *Vet J* 1997;(154):135–147.

22. Visser IJ, Odink J, Smeets JF, et al. Relationship between pathological findings and values of haematological and blood-chemistry variables in apparently health finishing pigs at slaughter. *Zentralbl Veterinarmed B.* 1992;39(2):123–131.

23. Sorensen JT, Sandoe P, Halberg N. Animal welfare as one among several values to be considered at farm level: The idea of an ethical account for livestock farming. *Acta Agriculturae Scandinavica, Section A-Animal Science.* 2001;51(Suppl 30):11–16.

24. Van Logtestijn JG. Integrated Quality. Meat Safety: a new approach. *Meat focus International*. 1993;2:123–128.

25. Eckhardt P, Fucks K, Kornberger B, et al. Indicators of health in the slaughter. *Wiener Tierarztliche Monatsschrift*. 2009;96:145–153.

26. Prevedello P, Brscic M, Schiavon E, et al. Effects of the provision of large amounts of solid feeds to veal calves on growth and slaughter performance and intravitam and postmortem welfare indicators. *J Anim Sci.* 2012;90(10):3538–3546.

27. Vanderhasselt RF, Buijs S, Sprenger M, et al. Dehydration indicators for broiler chickens at slaughter. *Poult Sci.* 2013;92(3):612–619.

28. EFSA. Scientific opinion on the public health hazards to be covered by inspection of meat (swine). *EFSA Journal.* 2011;9(10):2351.

29. Meat and Livestock Commission. Rindside Damage Scale. Reference 2031M 8/85. Milton Keynes, Bletchley; 1985.

30. Welfare Quality®. Welfare Quality® assessment protocol for pigs (sows and piglets, growing and finishing pigs). Lelystad, Netherlands: Welfare Quality® Consortium. 2009.

31. Dalmau A, Temple D, Rodriguez P, et al. Application of the Welfare Quality® protocol at pig slaughterhouses. *Animal welfare.* 2009;18(4):497–505.

32. Heinonen M1, Orro T, Kokkonen T, et al. Tail biting induces a strong acute phase response and tail-end inflammation in finishing pigs. *Vet J*. 2010;184(3):303–307.

33. Harley S1, More SJ, O'Connell NE, et al. Evaluating the prevalence of tail biting and carcass condemnations in slaughter pigs in the Republic and Northern Ireland, and the potential of abattoir meat inspection as a welfare surveillance tool. *Vet Rec*. 2012;171(24):621–626.

34. Valros A, Munsterhjelm C, Puolanne E, et al. Physiological indicators of stress and meat and carcass characteristics in tail bitten slaughter pigs. *Acta Veterinaria Scandinavica*. 2013;55:75–83.

35. Straw BE. A look at the factors that contribute to the development of swine pneumonia. *Vet Med*. 1986;81:747–756.

36. Harbers THM, Smeets JFM, Faber JAJ, et al. A comparative study into procedures for postmortem inspection of finishing pigs. *Journal of Food Protection*. 1992;55(8):620–626.

37. Willenberg P, Gardner I, Zhou H, et al. On the determination of non-detection rates at meat inspection. *Preventive Veterinary Medicine*. 1994;21(2):191–199.

38. Steinmann T, Blaha T. Meemken D. A simplified evaluation system of surface-related lung lesions of pigs for official meat inspection under industrial slaughter conditions in Germany. *BMC Vet Res*. 2014;10:98–106.

39. Eckersall PD. Acute phase proteins as markers of infection and inflammation: monitoring animal health, animal welfare and food safety. *Irish Vet J*. 2000;53(6):307–311.

40. Petersen B, Lipperheide C, Knura-Deszczka S, et al. Mit Haptoglobin dranke Tiere erkennen. Ein Screeningparameter in der flsishzeugende Dette. *Fleischwirtschaft*. 2001;3:21–23.

41. Geers R, Petersen B, Huysmans K, et al. On-farm monitoring of pig welfare by assessment of housing, management, health records and plasma haptoglobin. *Animal Welfare*. 2003;12(4):643–647.

42. Pomorska-Mál M, Kwit K, Markowska-Daniel I. Major acute proteins in pig serum from birth to slaughter. *Bulletin of the Veterinary Institute in Pulawy*. 2012;56(4):553–557.

43. Piñeiro M, Alava M, Lampreave F. Acute phase proteins in different species: a review. *Proceedings of the Fourth European Colloquium on Acute Phase Proteins*. In: Animal Welfare and acute phase proteins. Segovia, Spain; 2003. p. 77–82.

44. Knura-Deszczka S. *Evaluation of haptoglobin as parameter of assessment of health status of fattening pigs*. Hannover, Germany: Dissertation in Medicine Veterinary. 2000.

45. Petersen B, Knura-Deszczka S, Ponsgen-Scmidt E, et al. Computerised food safety monitoring in animal production. *Livestock Production Science*. 2002;76(3):207–213.

46. Manteca X. Assessment of stress during handling, transport and slaughter. Acute phase proteins in different species: a review. *Proceedings of the Fourth European Colloquium on Acute Phase Proteins*. In: Animal Welfare and acute phase proteins. Segovia, Spain; 2003. p. 39–43.

47. Christensen NH, Cullinane LC. Monitoring the health of pigs in New-Zealand abattoirs. *N Z Vet J.* 1990;38(4):136–141.

48. Elbers ARW. *The use of abattoir information in monitoring systems for herd health control in pigs*. Netherlands: Thesis University of Utrecht. 1991.

49. Almond GW, Richards RG. Evaluating porcine reproductive failure by the use of slaughter checks. *Compendium on Continuing Education*. 1992;(14):542–544.

Citation: Dalmau A, Fabrega E, Manteca X, et al. Health and welfare management of pigs based on slaughter line records. *J Dairy Vet Anim Res.* 2014;1(3):73–78. DOI: 10.15406/jdvar.2014.01.00016

50. Willeberg P, Gerbola MA, Kirkegaard-Petersen B, et al. The Danish pig health scheme: nation-wide computer based abattoir surveillance and follow-up at the herd level. *Preventive Veterinary Medicine*. 1984;3(1):79–91.

51. Petersen B, Kunneken J, Norpoth A. BIPS: an information and preventive system for pig breeding farms. *Pig News and Information*. 1989;10(4):473–476.

52. Ekesbo I. Monitoring systems using clinical, subclinical and behavioural records for improving health and welfare. In: Moss R, editor. *Livestock Health and Welfare*. Longman Veterinary Health Series. 1992:20–50p.

53. Blocks GH, Vernooy JC, Verheijden JH. Integrated quality control project: Relationships between pathological findings detected at the abattoir and information gathered in a veterinary health scheme at pig farms. *Vet Q*. 1994;16(2):123–127.

54. Brandt P, Rousing T, Herskin MS, et al. Identification of post-mortem indicators of welfare of finishing pigs on the day of slaughter. *Livestock science*. 2013;157(2–3):535–544.

55. Depoorter P, Van Huffel X, Diricks H, et al. Measuring general animal health status: development of an animal health barometer. *Preventive veterinary medicine*. 2015;118(4):341–350.

56. Snijders JMA, Smeets JFM, Harbers THM, et al. The evolution of meat inspection of slaughter pigs. *Fleischwirtschaft*. 1989;69(9):1422–1424.

57. Noordhuizen JP, Welpelo HJ. Sustainable improvement of animal health care by systematic quality risk management according to the HACCP concepts. *Vet Q*. 1996;18(4):121–126.

58. EFSA. Technical specifications on harmonised epidemiological indicators for public health hazards to be covered by meat inspection of swine. *EFSA Journal*. 2011;9(10):2371.

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