2nd Boehringer Ingelheim Expert Forum on

Farm Animal Well-being

May 29th 2009, Alcalá de Henares (Spain)

Boehringer Ingelheim

The enclosed abstracts are the property of the individual authors. The comments and opinions expressed therein are those of the authors and not necessarily reflect the position or beliefs of Boehringer Ingelheim or its employees.
No abstract should be reproduced, transmitted or used for 3rd party purposes without the express written consent of the author.

2nd Boehringer Ingelheim Expert Forum on

Farm Animal well-being

May 29th 2009, Alcalá de Henares (Spain)

Boehringer Ingelheim

2ND BOEHRINGER INGELHEIM EXPERT FORUM ON

FARM ANIMAL WELL-BEING

CONTENT

Prof. Dan Weary and Prof. Marina von Keyserlingk

Daniel M. Weary (B.Sc., M.Sc., D. Phil., Professor) and Marina A.G. von Keyserlingk (B.Sc., M.Sc. Ph.D., Associate Professor) are NSERC Industrial Research Chair holders at The University of British Columbia and are recognized internationally for their research on care and housing for dairy cows and calves.

Dan is originally from the Province of Quebec, and did his B.Sc. and M.Sc. degrees in Biology at McGill University before moving to the UK to do his doctoral studies in animal behavior at Oxford University. Dan worked as a research scientist for Agriculture and Agri-Food Canada before moving to UBC in 1997 to co-found the University's Animal Welfare Program.

Marina's love of animals began while growing up on a beef cattle ranch in British Columbia. She completed her undergraduate in Agricultural Sciences at UBC, her M.Sc. at the University of Alberta and Ph.D. in Animal Sciences at the University of British Columbia. Marina worked as a research scientist in the animal feed industry for 6 years before joining UBC's Animal Welfare Program in 2002.

Dan and Marina direct an active group working on research problems in dairy cattle welfare and they are frequent speakers for professional audiences on this topic. Dan and Marina have extensive publication records and co-authored the recent book entitled "Welfare of cattle" (Springer, 2008).

The scientific assessment of animal welfare in dairy cattle

Prof. Dan Weary and Prof. Marina von Keyserlingk
University of British Columbia, Canada

Introduction

Concern about the welfare of dairy cattle is nothing new; producers and veterinarians have always been concerned about the condition of animals in their care and have tried to ensure that they are healthy and well nourished. In the tradition of good animal husbandry, good welfare can be seen largely as maintaining production and the absence illness or injury. However, more recent interest in farm animal welfare stems more from concerns about pain or distress that the animals might experience, and concerns that animals are kept under “unnatural” conditions, with limited space and often a limited ability to engage in social interactions and other natural behaviors. Our first objective is to describe a conceptual framework for these different types of animal welfare concern (reviewed in more detail by Fraser, 2008), using examples from dairy production systems. Over the past decade we have seen a tremendous increase in scientific research on the welfare of cattle. Although research alone cannot tell us which types of concerns are most important, it can and has provided solutions to a number of issues. Our second objective is to provide examples of how science can help provide solutions to welfare concerns (these and other examples are reviewed in Rushen et al., 2008).

Animal welfare: a conceptual overview

Animal welfare includes three types of concerns: 1) is the animal functioning well (biological functioning), 2) is the animal feeling well (affective state), and 3) is the animal able to live a reasonably natural life (natural living; Fraser et al., 1997). Farm animal care givers are naturally concerned about the first category; addressing issues such as disease, injury, poor growth rates and reproductive problems, issues that are good for the animal and ultimately also vital in terms of the economic viability of the farm enterprise. However, people are also concerned with the affective state of the animal, and focus upon whether the animals are suffering from unpleasant feelings such as pain, fear or hunger. For some people (including many producers and consumers of organic products), a key concern is whether the animal is able to live a relatively natural life (Fraser and Weary, 2004). For example, is the calf kept with the cow and do cows have access to pasture?

These different types of concern about animal welfare can and do overlap. A lactating dairy cow unable to seek shade on a hot day (natural living), will likely feel uncomfortably hot (affective state), and may show signs of hyperthermia and ultimately reduced milk production (biological functioning). In such cases, research directed at any or all the levels can help address the welfare problem. In other cases, overlap may be less obvious or the different concerns may even be in conflict. For example, group housing of dairy calves allows them to engage in natural social interactions, but when poorly managed can lead to increased incidence of certain diseases or aggressive interactions. Different people can thus reach opposite conclusions about the relative advantages of different housing systems by favoring different welfare indicators (see Fraser, 2003 for case study).

Clearly the best solutions will be those that address all three concerns, for example, by creating group-housing systems for calves that avoid competition, allow for social contact and maintains healthy calves. In this way, the three types of concerns can be considered as a checklist with researchers working to identify and solve the various welfare issues. Below we review a few examples of recent work showing how science can be used to address dairy cattle welfare issues from the perspective of biological functioning, natural living and affective states.

Biological functioning

Problems in biological functioning, such as disease and injury, are clearly a welfare concern. For example, lameness is now widely regarded as a major welfare problem for dairy cows and in recent years has received considerable attention in the scientific literature. Compounding the problem is that producers find it difficult to identify animals at the early stages of lameness, likely because dairy cows remain stoic unless injuries are relatively severe. (Whay et al., 2003). Current research is developing improved gait scoring system that can be used to identify cows that are becoming lame. Better scoring systems will require improved knowledge of cows' gait, and this can be derived from computer-assisted kinematic techniques that obtain precise measures of gait and how this changes with different types of hoof injuries (Flower et al. 2005).

Our group uses a gait scoring system based on several specific gait features (e.g. asymmetric steps, tracking up etc.), and these scores have proven sensitive in identifying cows with sole ulcers (Flower and Weary, 2006), pain reduction following use of local anesthetic (Rushen et al.,

2007) or non-steroidal anti-inflammatory drug (Flower et al. 2008), and the advantages of softer walking surfaces for lame cows (Flower et al., 2007). Improved training in lameness detection, can serve to recognize which cows will benefit from treatment, and perhaps more importantly identify management and environmental factors to reduce the risk of cows becoming lame.

Affective state

Measures of biological functioning, like disease and growth, can normally be characterized scientifically with little disagreement. The same cannot always be said for measures of how animals feel. Developing validated measures of animal affect remains one of the most interesting and challenging problems in animal welfare science. Painful procedures remain part of the everyday business of dairy farming, but new scientific studies are showing ways that this pain can be reduced or avoided. For example, dehorning calves is so widely recognized to be painful. Considerable research has shown that all methods of dehorning and disbudding cause pain to calves (reviewed by Stafford and Mellor, 2005). It is now also becoming clear that use of local anesthetic alone does not fully mitigate this pain. For example, local anesthetic does not provide adequate post-operative pain relief. Lidocaine is effective for 2 to 3 h after administration and treated calves actually experience higher plasma cortisol levels than untreated animals after the local anesthetic loses its effectiveness (Stafford and Mellor, 2005). However, the use of non-steroidal anti-inflammatory drugs, in addition to a local anesthetic, can keep plasma cortisol and behavioral responses close to baseline levels in the hours that follow disbudding and dehorning. A second consideration is that animals respond to both the pain of the procedure and to the physical restraint. Calves dehorned using a local anesthetic still require restraint, and calves must also be restrained while the local anesthetic is administered. The use of a sedative (such as xylazine) can essentially eliminate calf responses to the administration of the local anesthetic and the need for physical restraint during the administration of the local anesthetic and during dehorning (Grøndahl-Nielsen et al., 1999). Thus a combination of sedative, local anesthetic and a non-steroidal anti-inflammatory drug reduces the response to pain during dehorning and in the hours that follow. Unfortunately, such a combination of treatments may not be practical for farmers and may itself have drawbacks for the animal. For example, an effective local block requires repeated injections and additional restraint.

One common alternative to hot-iron dehorning is using caustic paste to cause a chemical burn. This method of dehorning is still painful for the calves (Morisse et al., 1995), but the pain appears easier to control. Calves treated only with the sedative xylazine showed no immediate response to application of the paste, and little response in the hours that followed (Vickers et al., 2005). Moreover, caustic paste dehorning combined with a sedative actually resulted in less pain to calves than dehorning with a hot iron combined with both a sedative and a local anesthetic. This example shows how methods of pain treatment can be developed that are effective and practical for use on farm.

In this section we have focused on pain, in part because the science is clear but also because there is considerable social consensus regarding the ethics of intentionally causing (or failing to prevent) pain to animals. However, we urge readers not to focus only on pain; other affective states may be equally or more important to many cattle, including negative states like fear associated with poor handling practices and facilities and perhaps also positive affect associated by cows suckling their calf or grazing on pasture. The ability to perform these types of natural behavior are also considered important in their own right, as we turn to in the next section.

Natural living

For some, the natural living criteria may seem clear – simply allowing animals to live as naturally as possible. We see this approach as naïve; some natural conditions such as exposure to climatic extremes, disease, parasite infections and predator attacks cannot be seen as good for the animals. Thus the welfare benefits of providing more natural living must be assessed through the lens of the first two criteria.

We use the example of more natural feeding systems for calves to illustrate how research can be used to determine if access to more natural environments also provides benefits to the animals in terms of biological functioning and affective state.

Traditionally calves are fed milk twice daily at 10% body weight, but calves often fail to gain weight during the first weeks of life (Hammon et al. 2002). When provided the opportunity, calves consume considerably more than 10% of their body weight (de Passillé and Rushen, 2006). Calves grow much more rapidly when allowed to suckle from the dam (Flower and Weary, 2003), but this biological functioning benefit does not require keeping the cow and calf together. Simply feeding more milk allows for much higher weight gains, better feed conversion, and reduced age at first breeding (Jasper and Weary 2002; Diaz et al. 2001; Shamay et al., 2005). A better understanding of the calf's natural behavior and preferences, and how allowing this behavior this can benefit calf growth, is helping to revolutionized calf feeding practices.

The milk feeding practices also affect calf hunger. Calves vocalize when hungry and this vocal response, even in the first days after separation from the cow, can be much reduced or eliminated by providing more milk or colostrum (Thomas et al., 2001). Calves that are fed restricted amounts of milk from an automated calf feeder typically visit the feeder more than 20 times a day even when they only receive milk on 2 of these visits. Increasing the milk ration much reduces the frequency of these 'non-nutritive' visits (Jensen 2006; Vieira et al. 2008). This reduction benefits the other calves using the feeder by reducing feeder occupancy and competition for feeder access. Thus allowing more natural feeding behavior reduces hunger and in this case also improves the efficiency of the feeding system facilitating group housing of calves.

The benefits in terms of improved growth and reduced hunger can be achieved by proving the calves more milk. Nipple feeding is clearly more natural but does this provide other benefits for the calf or the producer? Calves allowed to suck on a teat during or after a meal show higher concentrations of cholecystokinin and insulin (de Passillé et al., 1993) and a greater degree of relaxation after the meal (Veissier et


al., 2002). Group-housed milk-fed calves will sometimes suck each other (i.e. cross sucking), but this cross-sucking can be much reduced or eliminated if calves consume their milk ration via free access to a teat (de Passillé, 2001), likely because the sucking behavior per se, rather than the ingestion of milk, is responsible for reducing sucking motivation (de Passillé, 2001). Thus nipple feeding also facilitates group housing, saving labor for producers (Kung et al., 2001) and perhaps providing other benefits to the calves.

Conclusions

Many in the dairy industry may have assumed that animal welfare concerns can be met by working to ensure good health and productivity for the cows and calves in their care. We have argued above that good biological functioning is a necessary component of welfare, but this focus alone is not sufficient; affective states like pain or hunger, and concerns about naturalness are also important. Animal welfare science addresses all three types of concern by identifying problems in production systems and developing solutions to these problems. The best solutions are win-win, improving the lives of cattle and the people that work with them.

Acknowledgements

We thank our colleagues, especially David Fraser, Jeff Rushen and Anne Marie de Passillé and the many students in the Animal Welfare Program that helped develop these ideas. The Program is funded by Canada's Natural Sciences and Engineering Research Council Industrial Research Chair Program with industry contributions from the Dairy Farmers of Canada, Westgen, Pfizer Animal Health, BC Cattle Industry Development Fund, the BC Milk Producers, BC Dairy Foundation, BC Dairy Education and Research Association, and Alberta Milk.

References

de Passillé, A. M. 2001. Sucking motivation and related problems in calves. Appl. Anim. Behav. Sci. 72: 175-187.

de Passillé, A.M.B., Christopherson, R. J., and Rushen, J. 1993. Nonnutritive sucking and the postprandial secretion of insulin, CCK and gastrin in the calf. Physiol. Behav. 54: 1069-1073.

de Passillé, A. M., and J. Rushen. 2006. Calves' behaviour during nursing is affected by feeding motivation and milk availability. Appl. Anim. Behav. Sci. 101: 264-275.

Diaz, M. C. M. E. Van Amburgh, J. M. Smith, J. M. Kelsey, and E. L. Hutten. 2001. Composition of growth of holstein calves fed milk replacer from birth to 105-kilogram body weight. J. Dairy Sci. 84:830-842.

Flower, F.C., M. Sedlbauer, E. Carter, M. A. G. von Keyserlingk, D. J. Sanderson, and D. M. Weary. 2008. Analgesics Improve the Gait of Lame Dairy Cattle. J Dairy Sci 2008 91: 3010-3014.

Flower, F. C., A. M. de Passillé, D. M. Weary, D. J., Sanderson, and J. Rushen. 2007. Softer, higher-friction flooring improves gait of cows with and without sole ulcers. J. Dairy Sci. 90: 1235-1242.

Flower, F. C. and D. M. Weary. 2006. Effect of hoof pathologies on subjective assessments of dairy cow gait. J. Dairy Sci. 89:139-146.

Flower, F.C., D. J. Sanderson, D.M. Weary. 2005. Hoof pathologies influence kinematic measures of dairy cow gait. J. Dairy Sci. 88:3166-3173.

Flower, F. C. and D. M. Weary. 2003. The effects of early seperation on the dairy cow and calf. Animal Welfare 12:339-348.

Fraser, D. 2008. Understanding Animal Welfare: The Science in its Cultural Context. Wiley-Blackwell, Oxford, UK .

Fraser D., D. M. Weary, E. A. Pajor, and B. N. Milligan. 1997. A scientific conception of animal welfare that reflects ethical concerns Anim. Welfare. 6:187-205.

Fraser, D. 2003. Assessing animal welfare at the farm and group level: the interplay of science and values. Anim. Welfare 12:433-443.

Fraser, D., and D. M. Weary. 2004. Quality of life for farm animals: linking science and ethics. Pages 39-60 in The Well-Being of Farm Animals: Challenges and Solutions. G. J. Benson and B.E. Rollins, ed. Iowa State Press, Ames, IA.

Grøndahl-Nielsen, C., H. B. Simonsen, J. Damkjer Lund, and M. Hesselholt. 1999. Behavioural, endocrine and cardiac responses in young calves undergoing dehorning without and with use of sedation and analgesia. Vet. J. 158:14-20.

Hammon, H.M., G. Schiessler, A. Nussbaum, and J. W. Blum. 2002. Feed intake patterns, growth performance, and metabolic and endocrine traits in calves fed unlimited amounts of colostrum and milk by automate, starting in the neonatal period. J. Dairy Sci. 85:3352-3362.

Jasper, J., and D. M. Weary. 2002. Effects of ad libitum milk intake on dairy calves. J. Dairy Sci. 85:3054-3058.

Jensen, M.B. 2006. Computer-controlled milk feeding of group-housed calves: The effect of milk allowance and weaning type. J. Dairy Sci. 89:201–206.

Morisse, J. P., J. P. Cotte, and D. Huonnic. 1995. Effect of dehorning on behaviour and plasma cortisol responses in young calves. Appl. Anim. Behav. Sci. 43:239-247.

Rushen J., E. Pombourcq, and A. M. de Passillé. 2007. Validation of two measures of lameness in dairy cows. Appl. Anim. Behav. Sci. 106, 173-177.

Rushen, J., A.M. de Passillé, M.A.G. von Keyserlingk, D.M. Weary. 2008. The Welfare of Cattle. Springer, Dordrecht, The Netherlands.

Shamay, A., D. Werner, U., Moallem, H. Barash, and I. Bruckental. 2005. Effect of nursing management and skeletal size at weaning on puberty, skeletal growth rate and milk production during first lactation of dairy heifers. J. Dairy Sci. 88:1460-1469.

Stafford, K. J., and D. J. Mellor. 2005. Dehorning and disbudding distress and its alleviation in calves. Vet. J. 169:337-349.

Thomas, T.J., D.M. Weary and M.C. Appleby. 2001. Newborn and 5-week-old calves vocalize in response to milk deprivation. Appl. Anim. Behav. Sci. 74:165-173.

Vieira, A. D., V. Guesdon, A. M. de Passillé, M.A.G. von Keyserlingk and D. M. Weary. 2008. Behavioural indicators of hunger in dairy calves. Appl. Anim. Behav. Sci. 109: 180–189.

Veissier, I., A. M. de Passillé, G. Despres, J. Rushen, I. Charpentier, A. R. Ramirez de la Fe, and P. Pradel. 2002. Does nutritive and non-nutritive sucking reduce other oral behaviors and stimulate rest in calves? J. Anim. Sci. 80:2574-2587.

Vickers, K. J., L. Niel, L. M. Kiehlbauch, and D. M. Weary. 2005. Calf response to caustic paste and hot-iron dehorning using sedation with and without local anesthetic. J. Dairy Sci. 88:1454-1459.

Weary, D. M., L. Niel, F. C. Flower and D. Fraser. 2006. Identifying and preventing pain in animals. Appl. Anim. Behav. Sci. 100:64-76.

Wells, S. J., D. A. Dargatz, and S. L. Ott. 1996. Factors associated with mortality to 21 days of life in dairy heifers in the United States. Prev. Vet. Med. 29:9–19.

Whay, H. R., D. C. J. Main, L. E. Green, and A. J. F. Webster. 2003. Assessment of the welfare of dairy cattle using animal-based measurements: direct observations and investigation of farm records. Vet. Rec. 153:197-202.

Notes

Dr. Cathy Dwyer, BSc, PhD

Cathy was appointed Reader of Behavioural Development and Animal Welfare at Scottish Agricultural College in Edinburgh in 2007, and has been employed as a researcher at SAC from 1994. She manages a number of research projects concentrating on parturition, mother-offspring interactions and behavioural development in sheep, cattle and mice, and welfare in extensively managed species. She also teaches on the University of Edinburgh MSc course in Applied Animal Behaviour and Welfare, is currently supervising 4 PhD students and supervises MSc student dissertations.

Before moving north to Scotland, Cathy was awarded her PhD from the Royal Veterinary College in London in 1992 for studies of prenatal nutrition and maternal effects on foetal development in pigs. She worked as a postdoctoral research assistant at the Royal Veterinary College and at Massey University, New Zealand, investigating foetal development in guinea pigs and mice. Cathy has a degree in Physiology from the University of Bristol, UK.

Impact of a difficult birth process on maternal and neonatal health and development

Dr. Cathy Dwyer
Scottish Agricultural College, Edinburgh, UK

Birth is an intrinsically risky process for both mother and young: half of all preweaning mortalities in cattle and sheep, for example, occur within the first day or so life (Hansen et al., 2003; Sawalha et al., 2007), and maternal mortalities and health problems also peak around parturition. Prolonged or difficult deliveries are associated with increased offspring mortality in cattle, sheep and pigs (e.g. cattle: Erikksson et al., 2004; Johanson and Berger, 2003; Meyer et al., 2001; sheep: Haughey, 1993; pigs: Baxter et al., 2008; Alonso-Spilsbury et al., 2005). Thus, optimizing the parturition process can have important impacts on health, welfare and productivity in all farmed species.

Parturition and the mother

From the maternal perspective, parturition in any species is generally accepted to be a painful process. However, births associated with malpresentation and dystocia may cause unacceptably high levels of pain in the mother. For example, cows are often known to give a roaring vocalisation indicative of pain during assisted calving (Gregory, 2004). Use of analgesics during parturition may not be beneficial during uncomplicated deliveries, since some interventions may disrupt the physiological signals that underpin the onset of maternal behaviour, which is intimately related with the normal process of parturition. However, use of analgesics for assisted deliveries may have benefits to the mother in both the short and long term, and may be beneficial for maternal behaviour, which can be affected by pain during a prolonged delivery.

In addition to the short-term impact of a difficult delivery on maternal welfare, there is evidence of longer term effects on maternal health and welfare. In cattle, there is evidence that dystocia reduces milk yield, increases the risk of mastitis and increases the chances that a cow will be culled (Tenhagen et al., 1999; Rajala and Grohn, 1998). In addition, having a stillborn calf reduces milk yield and subsequent fertility (Dematawewa and Berger, 1997; Bott and Distl, 1994). Whether a stillbirth has a further psychological effect on the mother is unknown. However, the birth of a dead offspring may cause anxiety or frustration in the mother, when she does not receive appropriate feed-back in response to her maternal care.

Parturition and the neonate

Calving difficulty or dystocia is consistently found to be related to high calf mortality occurring within 24 hours of birth, with mortality increasing with the severity of the dystocia (Nix et al., 1998). Nearly half of all calf mortality in first parity heifers, and a quarter of all calf mortalities in cows, are associated with dystocia (Erikkson et al., 2004). Calculation of odds ratio (that is the ratio of stillbirths with dystocia over stillbirths without dystocia) suggests that calves are 3-15 times more likely to die if there has been calving difficulty (Johanson and Berger, 2003; Meyer et al., 2001; Chassagne et al., 1999). Singleton lambs, in particular, are also at risk of dying following a difficult delivery (Haughey, 1993), and piglets born late on in the birth order, or with a long cumulative farrowing period, are more likely to be stillborn (Baxter et al., 2008; 2009). The ability of the stillborn animal to have awareness in utero has recently been debated (Mellor and Gregory, 2003; Mellor and Dietsch, 2006). These authors suggested that the foetus and newborn, prior to the onset of pulmonary respiration, have low arterial oxygen pressure and are influenced by placental and environmental inhibitors which suppress arousal and awareness. The implication of these hypotheses is that the young animal is incapable of perceptual awareness before the onset of breathing (Mellor and Gregory, 2003), and thus the welfare of a stillborn calf, lamb or piglet may not be seriously challenged. Nevertheless, a farming system with a high degree of stillbirth and dystocia could not be considered as providing good welfare for either mother or young.

Why does dystocia cause neonatal mortality? Neonates may die during the birth process, as a consequence of asphyxia and/or damage and trauma suffered during delivery. Calf and lamb losses in the first two days after birth can also be related to injuries sustained during the birth process which prevent the newborn from adjusting completely to postnatal life. Birth injury is reported to be present in over 80% of lambs classified as parturient deaths (dying up to 3 h after birth) and up to 57% of lambs dying from starvation, mismothering or exposure (Haughey, 1993). Neonates can suffer a range of injuries, particularly involving haemorrhage around the brain and spinal cord, subcutaneous oedema or rupture of the liver. By extrapolating findings from studies of central nervous system haemorrhages carried out in humans (Moussouttas et al., 2006; Schwedt et al., 2006), neonatal calves or lambs with these injuries are likely to experience severe pain. In addition, studies have shown 35% calf mortality where calves were delivered by a mechanical calf puller, with 13% of calves showing evidence of traumatic lesions (Zaremba

et al., 1995), and 7% of calves having vertebral fractures (Agerholm et al., 1993).

In addition to physical damage, young animals experiencing birth difficulty frequently suffer periods of anoxia or hypoxia which can lead to brain damage. Birth-injured lambs and calves surviving the birth process have low vigour (Wittum et al., 1994; Haughey, 1980; Dwyer, 2003) and may also struggle to regulate their body temperature effectively. Calves experiencing severe dystocia (where a mechanical calf puller or two of more people were required to deliver the calf) have a lower rectal temperature than calves experiencing no birth difficulty, or where the calf was delivered by caesarean section (Bellows and Lammoglia, 2000), and physiological changes suggesting their ability to thermoregulate efficiently has been impaired. These hypoxic neonates show behavioural problems of low vigour and so will be slow to stand after birth and slow to find the udder and suck, or may not suck without assistance. Whether this low vigour occurs because of the pain and trauma that the animals may be experiencing as a consequence of their difficult delivery is unknown. However, our data suggests that neonatal lambs that have experienced an assisted delivery have elevated plasma cortisol, and high plasma cortisol in the first three days of life is associated with impaired vigour (Dwyer and Lawrence, 2002). Low vigour animals are particularly vulnerable to starvation and hypothermia immediately after birth, and may also fail to get sufficient transfer of passive immunity by ingesting only small amounts of colostrum, thus making them susceptible to infection. In a US study of beef calves, calves that have been born with assistance took more than twice as long to stand after birth than calves born from an unassisted delivery, and had lower plasma immunoglobulins. Similar findings have also been seen in lambs following assisted deliveries (Dwyer, 2003). Hypoxic neonates are thus more likely to suffer starvation, hypothermia (exacerbated by the physiological changes described above) and have lowered immunity. This poor neonatal behavioural competency can be compounded by the effects of a difficult birth on the onset and quality of maternal care expressed by the mother, particularly in inexperienced dams, which may also hinder the ability of the young to reach the udder. The compound effect of mothering problems and a weak calf can contribute to a quarter of calf deaths (Wittum et al., 1994) although this may partly be secondary to dystocia. Thus birth injury, and the potential pain associated with this, also leads to neonates that are vulnerable to other welfare challenges (such as hunger, hypothermia etc.).

Future perspectives and practical applications

As difficult deliveries can have such long term effects on the health and welfare of both mother and young, in addition to the need for labour inputs and the effect on staff morale of delivering dead neonates, measures to reduce and prevent dystocia will be very beneficial. Management to prevent dystocia, such as attention to maternal nutrition, provision of a quiet, stress-free birth environment and careful sire selection particularly for first-time mothers, are measures that should reduce birth difficulty in the short-term. Genetic selection to reduce birth problems is also underway in cattle and sheep which would provide a longer term solution to preventing difficult deliveries. Finally, the sympathetic management of any cases of dystocia that do arise, by taking care when using traction and providing additional support to the neonate to ensure a good mother-young bond and adequate intakes of colostrum, may reduce the impact of the difficult delivery for mother and young.

References

Agerholm, J.S., Basse, A., Arnbjerg, J. (1993). Vertebral fractures in newborn calves. Acta Veterinaria Scandanavica, 34, 379-384.

Alonso-Spilsbury, M., Mota-Rojas, D., Villanueva-Garcia, D., Martinez-Burnes, J., Orozco, H., Ramirez-Necoechea, R., Mayagoitia, A.L., Trujillo, M.E. (2006). Perinatal asphyxia pathophysiology in pig and human: A review. Animal Reproduction Science 90, 1-30

Baxter, E.M., Jarvis, S., D'Eath, R.B., Ross, D.W., Robson, S.K., Farish, M., Nevison, I., Edwards, S.A. (2008) Investigating the behavioural and physiological indicators of neonatal survival in pigs. Theriogenology 69, 773-783.

Baxter, E.M., Jarvis, S., Sherwood, L., Robson, S.K., Ormandy, E., Farish, M., Smurthwaite, K.M., Roehe, R., Lawrence, A.B., Edwards, S.A. (2009) Indicators of piglet survival in an outdoor farrowing system. Livestock Science (in press).

Bellows, R.A. & Lammoglia, M.A. (2000). Effects of severity of dystocia on cold tolerance and serum concentrations of glucose and cortisol in neonatal beef calves. Theriogenology, 53, 803-813.

Bott, K. & Distl, O. (1994). Commercial corss-breedings of German Brown with Blonde D'Aquitaine and German Simmental. 2. Influence of dystocia and sire breed on fertility, milk production and survival in the consecutive lactation. Zuchtungskunde, 66, 124-135.

Chassagne, M., Barnouin, J., Chacornac, J.P. (1999) Risk factors for stillbirth in Holstein heifers under field conditions in France: A prospective survey. Theriogenology, 51, 1477-1488.

Dematawewa, C.M.B. & Berger, P.J. (1997). Effect of dystocia on yield, fertility, and cow losses and an economic evaluation of dystocia scores for Holsteins. Journal of Dairy Science, 80, 754-761.

Dwyer, C.M. (2003). Behavioural development in the neonatal lamb: Effect of maternal and birth-related factors. Theriogenology 59, 1027-1050.

Dwyer, C.M., Lawrence, A.B. (2002) Involvement of the hypothalamic-pituitary-adrenal axis in early neonate development in the sheep. Proceedings of the 5th International Congress of Neuroendocrinology 31 Aug-4 Sept, Bristol, UK

Eriksson, S., Nasholm, A., Johansson, K., Philipsson, J. (2004). Genetic parameters for calving difficulty, stillbirth, and birth weight for Hereford and Charolais at first and later parities. Journal of Animal Science, 82, 375-383.

Gregory, N. (2004). Physiology and behaviour of animal suffering. UFAW, Blackwells, Oxford.

Hansen, M., Madsen, P., Jensen, J., Pedersen, J., Christensen, L.G. (2003). Genetic parameters of postnatal mortality in Danish Holstein calves. Journal of Dairy Science, 86, 1807-1817.

Haughey, K.G. (1980). The effect of birth injury to the foetal nervous system on the survival and feeding behaviour of lambs. Reviews of Rural Science 4, 109-111.

Haughey, K.G. (1993). Perinatal lamb mortality - Its investigation, causes and control. Irish Veterinary Journal 46, 9-28.

Johanson, J.M. & Berger, P.J. (2003). Birth weight as a predictor of calving ease and perinatal mortality in Holstein cattle. Journal of Dairy Science, 86, 3745-3755.

Mellor, D.J., Gregory, N.G. (2003). Responsiveness, behavioural arousal and awareness in fetal and newborn lambs: experimental, practical and therapeutic implications. New Zealand Veterinary Journal 51, 2-13.

Mellor, D.J., Diesch, T.J. (2006). Onset of sentience: the potential for suffering in fetal and newborn farm animals. Applied Animal Behaviour Science 100, 48-57.

Meyer, C.L., Berger, P.J., Thompson, J.R., Sattler, C.G. (2001). Genetic evaluation of Holstein sires and maternal grandsires in the United States for perinatal survival. Journal of Dairy Science, 84, 1246-1254.

Moussouttas, M., Abubakr, A., Grewal, R.P., Papamitsakis, N. (2006). Eclamptic subarachnoid haemorrhage without hypertension. Journal of Clinical Neuroscience 13, 474-476.

Nix, J.M., Spitzer, J.C., Grimes, L.W., Burns, G.L., Plyler, B.B. (1998). A retrospective analysis of factors contributing to calf mortality and dystocia in beef cattle. Theriogenology, 49, 1515-1523.

Rajala, P.J., Gröhn, Y.T. (1998). Effects of dystocia, retained placenta, and metritis on milk yield in dairy cows. Journal of Dairy Science 81, 3172-3181.

Sawalha, R.M., Conington, J., Brotherstone, S.,Villanueva, B. (2007). Analyses of lamb survival of Scottish Blackface sheep. Animal 1, 151-157.

Schwedt, T.J., Matharu, M.S., Dodick, D.W. (2006). Thunderclap headache. Lancet Neurology 5, 621-631.

Tenhagen, B.A., Edinger, D., Heuwieser, W. (1999). Impact of dystocia in primiparous cows on lactational performance and survival. Tierärztliche Umschau 54, 617-623.

Wittum, T.E., Salman, M.D., King, M.E., Mortimer, R.G., Odde, K.G., Morris, D.L. (1994). Individual animal and maternal risk factors for morbidity and mortality of neonatal beef calves in Colorado, USA. Preventative Veterinary Medicine, 19, 1-13.

Zaremba, W., Guterbock, W., Ahlers, D. (1995) The effects of extraction force during obstetrical intervention of calves in the perinatal period and postnatal period. Praktische Tierarzt, 76, 870.

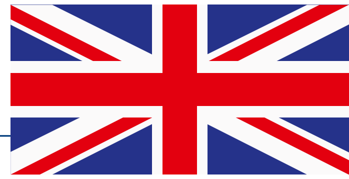
Notes

Hanna Miedema

Hanna Miedema has been a Research Associate at the University of Edinburgh since 2005, shortly after she graduated with first class Honours in Zoology from the same university. Her undergraduate project was on the foraging strategies of common gulls, which started her interest in studying animal behaviour.

After graduation, she completed an M.Sc. by Research (with distinction) on developing behavioural and physiological methods of identifying fatigue in sheep.

She is currently working on her PhD at the Royal (Dick) School of Veterinary Studies. Her research is on the calving behaviour of dairy cows and the use of behaviour to predict calving and identify early signs of problems. She is aiming to submit her thesis in July this year.



Calving difficulty in dairy cows and behavioural changes before parturition

Hanna Miedema
Royal (Dick) School of Veterinary Studies, University of Edinburgh, UK

Selective breeding, along with improved nutrition and management, have resulted in a steady rise in the milk yields of modern dairy cows. However, this increased milk production has also increased the risk of health problems (Mottram, 1997). This is especially true during the transition period, normally defined as the time from three weeks before until three weeks after parturition, when cows are vulnerable to a range of disorders such as milk fever, ketosis, metritis, mastitis and displaced abomasum (Drackley, 1999; Rushen et al., 2008).

In addition, dystocia is also an increasingly common problem, (reviewed by Mee, 2008). Due to the lack of a standard system for scoring calving difficulties, it is difficult to determine exactly how common this problem is, but in most countries the prevalence of dystocia is between 2 – 7%, but is as high as 13% in the US. Severe cases of dystocia can increase the incidence of cow and calf mortality (Noakes *et al.*, 2001), but even in less serious cases it can cause considerable pain and distress. In a survey of cattle practitioners in Ireland, dystocia (foeto-pelvic disproportion requiring traction alone) was ranked as one of the most painful conditions experienced by cattle (Huxley and Whay, 2006). More long-term consequences include reduced milk yields and reproductive performance. When both short-term and long-term effects are considered, calving problems are very expensive for farmers. A recent study in the UK showed that a slightly difficult calving costs £110, and a seriously difficult calving can cost £350 - £400, depending on the veterinary costs (McGuirk *et al.*, 2007). Some cases of dystocia can be prevented or minimised with careful management, such as sensible dam and sire selection and good husbandry and healthcare. However, there will always be some cases when cows have problems that require assistance.

All animals need to be individually monitored to identify any signs of calving difficulties or health problems as early as possible. Even if cows are checked regularly, it can be difficult to assess from visual observation alone exactly how close a cow is to calving, so it is easy for problems to go undetected for some time. As the number of cattle per farm is increasing in Europe, the number of cows that each stockperson is responsible for is also rising meaning less time is available for the management of each individual cow (Raussi, 2003). Improved monitoring during the transition period would help minimise losses and could improve the health and welfare of cattle.

Changes in behaviour before calving

Cows show obvious changes in their behaviour during the final day before calving, as well as physical changes such as slackening of the pelvic ligaments and enlargement of the udder. Experienced stockmen can recognise these physical and behavioural changes to estimate when cows may be about to calve, and offer assistance when required. Restlessness, characterised by frequent changes in posture, can be indicative of pain or discomfort and is often observed prior to parturition in dairy cows (Huzzey *et al.*, 2005), and sows (Wang *et al.*, 2005; Mainau *et al.*, 2007).

The behaviours observed prior to parturition during normal and dystocic calvings may also provide some early warning signs of problems. Wehrend *et al.*(2006) found that cows with dystocia were more likely to rub against walls, discharge urine, and scrape the floor than those which did not experience any difficulty during calving. Huzzey *et al.*(2007) showed that cows that developed metritis compared to healthy cows, had from two weeks before any clinical signs of illness were seen, shorter feeding times, lower dry matter intakes and fewer aggressive interactions at the feed bins.

If consistent changes in behaviour between cows were identified these could potentially be used to predict the time of calving. Miedema *et al.* (2008) analysed the behaviour of twenty cows from video recordings for 24 hours before their calf was fully expelled, and for a 24-hour control period during late pregnancy. The frequencies of lying and tail raising were the most useful indicators of calving, as they showed consistent changes in the final 6-hour period during calving. During this period, lying frequency (number of lying bouts/6-hour period) was significantly higher ($p<0.001$) at calving (median = 13, interquartile range = 9-17) than during late pregnancy (median = 4, IQR = 3-5), and all cows showed an increase of ≥2 bouts. The frequency of tail raising also increased significantly ($p<0.001$) during the final 6 hours before calving (median = 35, IQR = 27-55) compared to the control period (median = 5, IQR = 3-7). This shows that counting transitions between standing and lying, or tail raises, could potentially be useful for predicting calving.

Behavioural differences between cows and heifers, with and without calving difficulties

Heifers are more likely to experience problems during calving than cows which have calved previously (Lombard *et al.*, 2007) and there may be differences in their behaviour before calving because it is a novel experience and they may react more strongly to the pain or discomfort experienced. Differences in the behaviour of cows before difficult calvings, compared to normal calvings are also of interest because this information could be used to describe early warning signs that could be useful for predicting problems.

Miedema *et al.*(2009) investigated these differences by studying the behaviour of twelve Holstein-Friesian heifers and twelve cows. Half of each group had calved without assistance, and half had been assisted using a calving jack (for >1 minute). Their behaviour was analysed from video recordings for 12 hours prior to the calf being expelled and for a 12-hour control period. Compared with the control, both groups of heifers showed a significant increase in the duration of tail-raising from 4 hours before calving with an average increase of 31 min 51s ± 34 min SD (t = 3.11, df = 10, p=0.011). This was earlier than observed in cows which only showed a significant increase (of 47 min 42s ± 19 min 41s: t = 8.04, df = 10, p<0.001) in the final 2 hours. In unassisted groups, a significant increase in lying frequency compared with the control period started 6 hours before calving (heifers: p = 0.048, cows: p = 0.042) whereas in the assisted calving groups a significant change only occurred in the final 2 hours before calving.

These results show that there are differences between heifers and cows in their pre-calving behaviour which must be taken into account when predicting the time of calving from behaviour. For those assisted with a calving jack, no early-warning signs of a difficult calving were identified in the time frame studied.

Conclusions

Changes in the behaviour of dairy cows during late gestation could potentially be useful for predicting the onset parturition. An increase in the number of transitions between standing and lying, or number of tail raises is a consistent sign of imminent calving in multiparous cows. There are differences between the behaviour observed in heifers compared with multiparous cows, and between those which calved with and without assistance. However, early behavioural warning signs of calving problems have still to be identified.

Acknowledgements

The author would like to thank ITI Techmedia for funding the research she is involved with and Alastair Macrae, Cathy Dwyer and Michael Cockram for their supervision of her PhD. She would also like to give a special thanks to Wilson Lee and the other stockmen at Langhill Farm for their technical support.

References

Drackley, J.K. 1999. Biology of dairy cows during the transition period: The final frontier? Journal of Dairy Science, 82: 2259-2273.

Huxley, J.N. and Whay, H.R. 2006. Current attitudes of cattle practitioners to pain and the use of analgesics in cattle. Veterinary Record, 159: 662-668.

Huzzey,J.M., Velra,D.M., Weary,D.M. and von Keyserlingk,M.A.G. 2007. Prepartum behavior and Dry Matter Intake identify dairy cows at risk for metritis. Journal of Dairy Science, 90: 3220-3233.

Huzzey, J.M., von Keyserlingk, M.A.G. and Weary, D.M. 2005. Changes in feeding, drinking, and standing behavior of dairy cows during the transition period. Journal of Dairy Science, 88: 2454-2461.

Lombard,J.E., Garry,F.B., Tomlinson,S.M. & Garber,L.P. 2007. Impacts of dystocia on health and survival of dairy calves. Journal of Dairy Science, 90: 1751-1760.

Mainau, E., de la Torre, J.L.R, Dalmau, A and Manteca, X. 2007. A possible scale to measure ease of farrowing and pain caused by parturition. Proceedings of the 41st congress of the Internation Society of Applied Ethology, 34.

McGuirk, B.J., Forsyth, R. and Dobson, H. 2007. Economic cost of difficult calvings in the United Kingdom dairy herd. Veterinary Record, 161: 685-687.

Mee, J.F. 2008. Prevalence and risk factors for dystocia in dairy cattle: A review. Veterinary Journal, 176: 93-101.

Miedema, H.M., Macrae, A.I., Dwyer, C.M. and Cockram, M.S. 2008. Identifying changes in dairy cow behaviour to predict calving. Proceedings of the 42nd congress of the International Society of Applied Ethology , 19.

Miedema, H.M., Macrae, A.I., Dwyer, C.M. and Cockram, M.S. 2009. Differences in the pre-calving behaviour of dairy heifers and cows, with and without calving difficulties. Proceedings of the 43rd congress of the International Society of Applied Ethology (submitted).

Mottram,T. 1997. Automatic monitoring of the health and metabolic status of dairy cows. Livestock Production Science, 48: 209-217.

Noakes, D.E., Parkinson, T.J. and England, G.C.W. 2001. Arthur's Veterinary Reproduction and Obstetrics. 8th edition. London: Saunders.

Raussi, S. 2003. Human-cattle interactions in group housing. Applied Animal Behaviour Science, 80: 245-262.

Rushen,J., de Passille,A.M., von Keyserlingk,M.A.G. and Weary,D.M. 2008. The Welfare of Cattle. Springer.

Wang,J.S., Huang,Y.S., Wu,M.C., Lai,Y.Y., Chang,H.L. & Young,M.S. 2005. Quantification of pre-parturition restlessness in crated sows using ultrasonic measurement. Asian-Australasian Journal of Animal Sciences, 18: 780-786.

Wehrend,A., Hofmann,E., Failing,K. and Bostedt,H. 2006. Behaviour during the first stage of labour in cattle: Influence of parity and dystocia. Applied Animal Behaviour Science, 100: 164-170.

Notes

Prof. Xavier Manteca

Xavier Manteca Vilanova received his BVSc degree from the Autonomous University of Barcelona and a Master's degree in Applied Animal Behaviour and Animal Welfare from the University of Edinburgh. He has a PhD from the Autonomous University of Barcelona. Currently, he is associate professor at the Department of Animal Science, School of Veterinary Science in Barcelona, where he teaches animal behaviour and animal welfare. His main research interests are in the field of farm animal behaviour and welfare. He is member of the Managemnt Committee of the Welfare Quality project and has published many papers in national and international journals. He has been member of several working groups of the Panel on Animal Health and Animal Welfare of the European Food Safety Authority.

Behavioural modifications associated with calving in dairy cows and with farrowing in sows

Prof. Xavier Manteca[1], Eva Mainau[1], José Luis Ruiz de la Torre[1], Anna Cuevas[1] and Antoni Dalmau[2]
[1] School of Veterinary Science, Universitat Autònoma de Barcelona, Spain
[2] IRTA, Monells (Girona), Spain

Introduction

Pain caused by parturition is a welfare problem and may substantially modify the normal behaviour of sows and dairy cows during and after parturition. In sows, this may have a dramatic impact on production performance as some piglets can be crushed when the sow moves from standing to lying or sitting position. In both species, behavioural changes may be used as an indicator of parturition and to assess pain and discomfort.

The aim of this project was to study behavioural modifications associated with parturition in dairy cows and sows. The first step was to register female activity around parturition. In sows, an automatic system was developed and validated, whereas in dairy cows, an activity-meter (Westfalia Surge, Germany) was used. The second step was to develop a pain scale based on behavioural parameters as an indirect measure of pain caused by parturition. The third step was to study the effect of Metacam® (meloxicam) after parturition on behaviour, physiology and performance. Meloxicam is a non-steroidal anti-inflammatory drug (NSAID) used for the treatment of MMA in sows and locomotor disorders in pigs and for the treatment of neonatal diarrhea in calves and acute mastitis and respiratory infection in cattle. SAS software package was used for all the statistical analysis and significance level was established at $P<0.05$.

Validation of an automatic system to detect position changes in puerperal sows

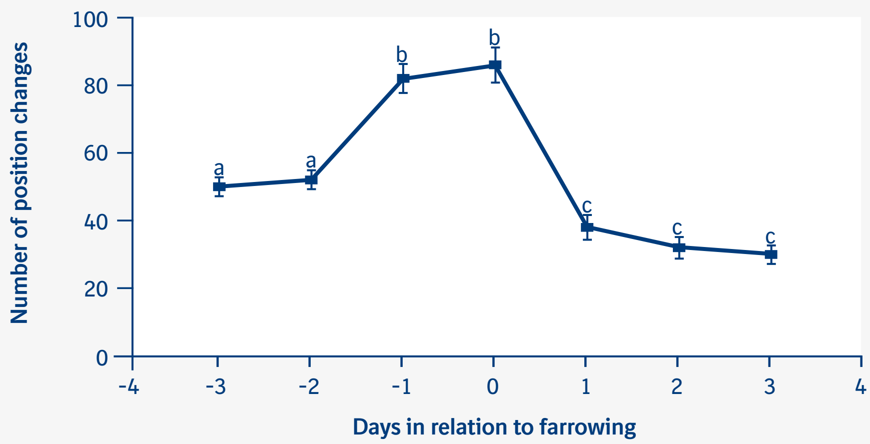
Forty hybrid (Large White x Landrace) sows from first to eighth parity housed in individual crates were used. Sow activity (defined as total time spent in each posture and frequency of position changes) was automatically recorded using Standing Lying Sensors (SLS), which consisted of a photoelectric cell located near the forelegs of each sow. Sow activity was registered continuously for 3 days before until 3 days after farrowing. To validate the SLS, data obtained through video recordings were compared with data obtained from SLS using Spearman correlations. When total time in each posture was considered, a 96.40% of coincidence was obtained. Using a 55 seconds filter that converted lying bouts of less than 55 seconds into standing behaviour and vice versa, a 91.82% of coincidence was obtained for the frequency of position changes. The sensitivity and specificity were 85.8% for both activity variables. SLS could not differentiate between standing and sitting position. However, according to video recordings, changes from sitting to standing accounted for 14.40% of the total activity and changes from standing to sitting –which are position changes potentially dangerous to the piglets- accounted for only 0.31% of the total activity. A complete description of the activity of sows was obtained using SLS recordings (Fig. 1). The frequency of position changes and the total time in each posture were not affected by parity.

Effect of Metacam® (meloxicam) on postfarrowing sow behaviour and piglet performance

A second experiment with forty eight hybrid (LW x Ld) sows (24 gilts and 24 sows) housed in individual crates was done with a total of 6 different replicas. In each replica, sows were randomly allocated into two homogeneous groups regarding parity and treated with either meloxicam (Metacam® 20 mg/ml inj. sol.; Boehringer Ingelheim), 0.4 mg/Kg BW or saline solution as placebo. Metacam® or saline were administered intramuscularly 1 ½ hours after the birth of the last piglet. Sow activity was registered continuously for 3 days before and 3 days after farrowing using SLS. Overall, 583 piglets were individually weighed at farrowing and at weaning. Data showed that multiparous sows spent less time lying during the 3 days

postfarrowing in the treatment group compared with the control. Differences were statistically significant on days 2 and 3 after farrowing. In litters from multiparous sows, piglets of low birth weight (defined as percentile 25: BW <1,200 g) had an average daily gain significantly higher in the treatment group than in the control (202.14 g/day and 173.7 g/day, respectively). Piglet mortality was not affected by treatment or sow activity.

Figure 1. Number of position changes (mean ± SE) of sows on the days around farrowing; 0 is the day of farrowing and values with different letters indicate significant differences (P<0.05) between them.



Preliminary results of a study in dairy cows during puerperal period: effect of parity on acute phase proteins (APP) and general activity as possible indicators of discomfort caused by calving.

Sixty Friesian dairy cows from first to sixth parity with eutocic calving were included. Haptoglobin (Hp, mg/mL) and serum amyloid A (SAA, µg/mL) were determined in serum samples taken immediately postcalving (d0) and on d2, d4 and d15 after calving. Information about the activity of the cows was obtained using activity meters (Westfalia Surge, Germany) from day 1 before until day 7 postcalving. Concentrations of Hp and SAA on d2 and d4 were significantly higher than those on d0 and d15 (P<0.0001). Heifers showed higher values than multiparous cows throughout the study period (Fig. 2). A significant correlation between Hp and SAA was found (r=0.79; P<0.001). General activity showed a day by parity interaction effect. Heifers showed higher general activity than cows from day 1 before until two days postcalving (P<0.01). In both heifers and cows, activity was highest around calving (from d-1 to d2) than from d3 to d7. Significant correlations were found between APP and total average activity (Hp, r=0.62; P<0.0001 and SAA, r=0.58; P<0.0001). These preliminary results suggest that inflammation associated with parturition, measured through the concentration of APP, may cause discomfort and increase the general activity in dairy cows after calving.

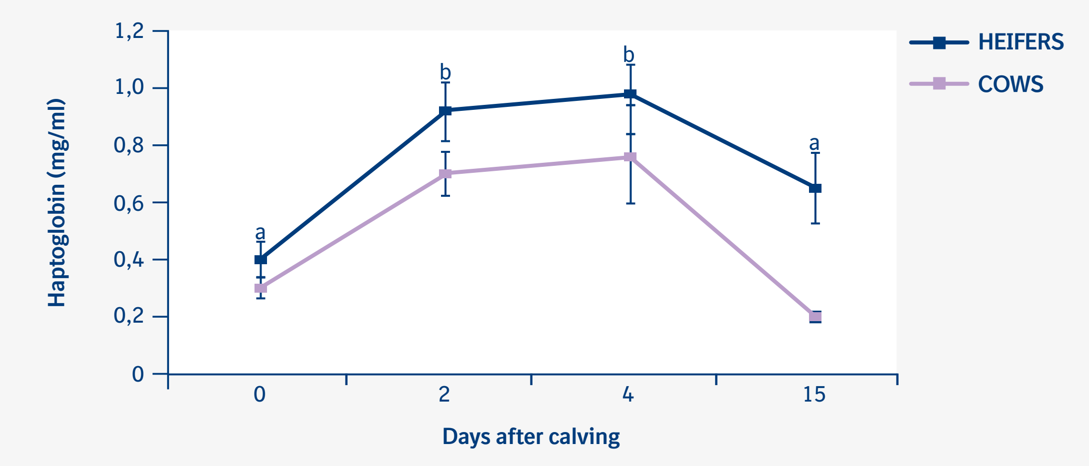


Figure 2. Concentrations of Hp (mg/mL) on the day of calving (d0) and on days 2, 4 and 15 after calving in heifers and cows.

References

Colburn, D.J., Deutscher, G.H., Nielsen, M.K., Adams, D.C., 2007. Effects of sire, dam traits, calf traits, and environment on dystocia and subsequent reproduction of two-year-old heifers. J. Anim. Sci, 75, 1452-1460.

Fraser, D. 1990. Behavioural perspectives on piglet survival. J. Reprod. Fertil. Suppl. 40, 355-370.

Hirsch, A.C., Philipp, H., Kleemann, R., 2003. Investigation on the efficacy of meloxicam in sows with mastitis-metritis-agalactia syndrome. J. Vet. Pharmacol. Therap., 26, 355-360.

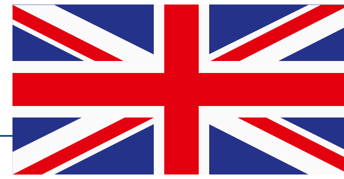
Todd, C., McKnight, D., Millman, S., Duffield, T. Leslie, K., 2007. An investigation of Meloxicam (Metacam®) for the relief of pain associated with diarrhea in dairy calves. OVMA Conference Proceedings.

Weary, D.M., Pajor, E.A., Fraser, D., Honkanen, A.M., 1996. Sow body movements that crush piglets: a comparison between two types of farrowing accommodation. Appl. Anim. Behav. Sci. 49, 149-158.

Dr. Emma Roe

B.Sc (Reading) Ph.D (Bristol) currently holds the position of Lecturer in Human Geography at the School of Geography at Southampton University.

Her interests are in the area of nonhuman geographies, to date within the arena of agro-food studies; specifically, embodied food consumption practices, animal welfare and commercialising the embodied food animal. Since, completing her thesis in 2002, she has lectured at Bristol University; held an ESRC postdoctoral fellowship at the Open University; and worked as a researcher and Principle Investigator on sub-projects within the EU funded WelfareQuality® research project at Cardiff University, and more recently at Southampton University.



The developing market for welfare-friendly food products across Europe and the opportunities/demands on farmers

Dr. Emma Roe
School of Geography, Southampton University, UK

Marketing Farm animal welfare

For a long time legislation has been the commonest way of protecting farm animal welfare but more recently growing consumer demand both for quality food products and more ethical food production has meant that farm animal welfare is emerging as an area of potential added value for producers, retailers and other food chain actors.

To support chain actors in their efforts, Welfare Quality® has been investigating the impact of these new consumer demands, and the current industry responses to them. Research carried out by Welfare Quality® in Norway, Sweden, the Netherlands, the UK, France and Italy looked at how animal welfare is mobilised from farm to supermarket shelf as a means of both achieving increased product value and broader ethical branding.

Animal Welfare and product differentiation

Two main groups are driving the segmentation of food products and product ranges on the basis of animal welfare:

- consumers, seeking to buy products from farms with higher standards of welfare, and
- food chain actors (retailers, processors, manufacturers, producer cooperatives) exercising and displaying their ethical responsibilities.

Welfare Quality® research shows this market segmentation operates in two, often related, ways:
a) through the use of specific welfare claims on products and, b) the inclusion of welfare conditions within supply chain assurance schemes.

Through a detailed inventory and assessment of food products with welfare claims available to consumers across Europe, Welfare Quality® research shows significant use of animal welfare as a component of product differentiation. Statements that are perceived to be linked to animal welfare such as ‘free range’, ‘grass fed’, ‘outdoor reared’, ‘absence of growth promoters’ and ‘slower growth’ are appearing on a large number of animal-based food products. In some countries, more than 100 such products were identified.

However, Welfare Quality® research also shows that specific welfare conditions are increasingly included as part of quality assurance schemes used by abattoirs, transporters and farmers. This new strategy shows that animal welfare is often important for market access and that more products conforming to additional welfare standards are entering the market than a census of only identifiable product labelling would suggest. This indicates that animal welfare is becoming a component of broader notions of quality. It also shows the ethical and quality commitment of food suppliers to their consumers.

Animal Welfare and product quality

Despite the growth in the use of welfare conditions revealed by our study, there are very few dedicated animal welfare labelling schemes. In general, improved animal welfare is communicated to consumers in three ways:

- the active use of animal welfare claims on product packaging;
- the use of independent labels that support a particular production system considered to offer better welfare to animals;
- and through the bundling of a range of desirable product qualities implicitly conveyed through a brand.

Welfare Quality® research shows that while many food producers and suppliers welcome the growth of welfare conditions as a component of product and brand differentiation, the use of dedicated stand-alone welfare labelling is not widely supported. Tighter standards of animal welfare are seen as contributing to the quality of the product – as well as the quality commitment of the producer and supplier. That is why animal welfare is usually bundled up with other product 'qualities' such as nature, tradition, environmental benefits, and organic production, thus appealing to a wide range of consumer interests and concerns. Across Europe, clear differences emerge with French and Italians often favouring gastronomic qualities while the northern countries more often link welfare with environmental concerns.

Animal Welfare and added value

Animal welfare is a component of added value. Not only can improved animal welfare conditions contribute to the generation of higher commodity prices, but lower welfare conditions are proving costly. That cost comes through harmful effects on the animals' health, productivity and product quality, and when producers are unable to access higher value markets or respond to consumer demand. In different European countries, Welfare Quality® research has shown how producer groups, manufacturers and retailers have responded to this potential in different ways, yet a number of common challenges remain.

Because of the nature of the premium market, only some cuts can be sold as premium quality products that benefit from value addition, so the opportunity remains to find a premium market for as many products as possible from animals produced to high welfare standards. Assessment procedures, critical to the validity of welfare claims, need to be flexible enough to support diverse brand demands and encourage welfare improvements throughout the food chain. The Welfare Quality® assessment will offer a flexible tool to compliment the market's diverse welfare commitments and, by introducing animal based parameters, will provide greater clarity to welfare claims. Through appropriate regulation and market mechanisms working together to raise the welfare quality of European farm animals, suppliers and consumers alike can benefit.

Notes

Mike Gooding

Mike graduated from Seale Hayne Agricultural College in the late 1980s and quickly established a career in agriculture, financial marketing, public relations and senior management. Building a reputation for dealing with some of the most challenging issues and with a strong sense of entrepreneurial spirit, he has taken on projects, causes and initiatives which have often been innovative, ground breaking and at the forefront of developing agriculture and food in the UK.

His experience includes heading marketing and customer services teams, public relations consultancy, financial and operational control, company set-up and flotation, food processing, and retail market development. He has particular knowledge of the meat industry and consumer market.

With a track record for bringing about change to businesses and delivering results, he has enjoyed a high profile in UK agriculture and has worked across all groups of parties interested in food and agriculture from negotiating with Ministers of Agriculture to cooking for primary school children.

He has joined the Board of Directors of FAI Farms Ltd and it's sister company Woodland, to help drive the business forward as it expands into new and exciting areas of development and opportunity. With his particular interests in food production, marketing and animal and environmental welfare, as well as ensuring the business achieves its aims and delivers on current core business and projects, he will be working to grow FAI and Woodland in their operations, strategic direction and commercial success.

Mike has two children and lives near Woodstock in North Oxfordshire.

Management practices improving animal well-being: role played by the retailers

Mike Gooding, Managing Director FAI Farms Ltd, UK

A brief introduction to the work of FAI

- Objectives of the business
- How we work
- The connection to the retail trade
- Project work
- International projects – Brazil and China
- Independent evidence based science

What drives retailers?

- Share holder value
- Management commitment
- The role of the customer

What drives the consumer?

- Media influence
- Empty stomachs
- The credit crunch

Bringing about change

- The 3e’s
- Push : Pull theory
- Turn-key projects

Project Examples

- Broiler chicken genetics
- Tails on pigs

The future

- Production challenges on farmed livestock
- Outcome measures
- What the retailers will do

Armelle Prunier

Armelle Prunier is a senior scientist in the research unit Livestock Production System, Animal and Human Nutrition of the INRA Institute at Saint-Gilles (France). She has obtained a Master in agriculture (INAPG, 75005 Paris, France) in 1980, a PhD in Biology (speciality in Reproduction, University of Paris VI, France) in 1984, a permanent researcher position at INRA in 1984.

Between 1981 and 2002 she has worked essentially on the control of pig reproduction: analyses of hormonal patterns and ovarian development around puberty, lactation and return-to-oestrus after weaning in relation to environmental factors, nutrition and reproductive performance. From 2000, her research is devoted to the assessment and improvement of pig welfare: evaluation of stress reactions (plasma and/or salivary concentrations cortisol, ACTH catecholamines, heart rate variability) in response to environmental challenges (e.g. inappropriate housing, social aggression) or to husbandry practises (e.g. castration, tooth resection, tail docking); integration of physiological, behavioural and sanitary measurements to assess usefulness of husbandry practises and compare ways of rearing and housing pigs.

In 2004, she belonged to the working group of EFSA that was in charge of writing a scientific report concerning the welfare aspects of castration in piglets. In 2007, she belonged to the EFSA group in charge of analysing the risks associated with tail biting in pigs and possible means to reduce the need for tail docking.

Welfare consequences of man-made painful husbandry procedures with special emphasis on surgical castration in piglets

Armelle Prunier
INRA, UMR 1079, Saint-Gilles, France

Introduction

Nearly 80% of the 125 millions of male piglets reared yearly in the EU are castrated by surgical means without pain prevention (Fredriksen *et al.*,2009) primarily to improve meat quality and secondly to facilitate management. Tooth resection and tail docking are routinely performed in numerous pig herds (tail docking: more than 90% of pigs in EU, EFSA report, 2007, tooth resection: probably much less frequent) in order to reduce the occurrence of injuries essentially on the mammary glands or vulva of the dam and on faces of littermates during lactation and to reduce the occurrence of tail biting after weaning. These husbandry practices are criticized since they are source of pain. Current EU legislation (Directive 2001/630/CE) authorizes pig producers to perform these husbandry procedures but with some limitation that theoretically leads to ban docking and tooth resection on a routine basis. After the 7th day of life, castration or docking should be performed under anaesthesia and prolonged analgesia by a veterinarian. EU legislation for organic pigs is stricter and tooth resection and tail docking are more clearly banned whereas anaesthesia at castration will become compulsory from 1st January 2012 regardless the age of pigs (CE No 889/2008). Some countries within EU (Denmark, Sweden, Finland and Lithuania) and close to EU (Norway, Switzerland) have specific legislation for standard pig production further limiting tail docking and tooth resection and/or imposing anaesthesia at castration regardless the age of the pigs (Norway, Switzerland). Finally, there are initiatives from the pig industry to undergo anaesthesia at castration regardless the age of the pigs in Netherlands, Belgium and Germany. In this review, we will describe the welfare consequences of tooth resection, tail docking and castration with more emphasis on this latter procedure

Welfare consequences of tooth resection and tail docking

Tooth resection of the superior and inferior canines and of corner incisors (8 teeth in total) is usually performed by the farmer or his employees within a few days after birth together with other routine practises such as iron injection, tail docking and sometimes also castration. It is carried out by clipping teeth with pliers or grinding them with a rotative grindstone. The proportion of tooth that is removed varies from about 1 to 31% according to the farmer and the tooth with longer teeth (e.g. corner incisor of the superior jaw) being proportionally more resected (Gallois *et al.*, 2005). During the intervention, pigs submitted to grinding demonstrate some defence behaviours (movements of the legs, Bataille *et al.,* 2002). As soon as resected pigs are back in their home pen, they have more chewing behaviours (clipping: Noonan *et al.,* 1994, clipping and grinding: Bataille *et al.,* 2002). However, time to first suckling and main time-budget (resting, suckling or standing) during the 12 hours following tooth clipping or grinding are similar in resected and control pigs (Bataille *et al.,* 2002). Acute pain is usually associated with an activation of the adrenal axis. However, Prunier *et al.*(2005) did not observe any clear changes in plasma profiles of cortisol and ACTH during the first 3 hours following tooth resection in one-day old piglets. Tooth resection allows reducing the number and gravity of injuries on other littermates but there is clear effect on maternal behaviour and mammary injuries of the dam (Prunier *et al.,* 2004, Gallois *et al.,* 2005). Histological analysis of teeth at various ages shows that both neonatal clipping and grinding induce numerous lesions (pulp cavity opening, fractures, haemorrhage, pulp inflammation, abscess or osteodentine formation) but most of them appear sooner and are of greater magnitude in the case of clipping (Hutter *et al.,* 1994, Hay *et al.,* 2002). Because most of the histological alterations observed are known to induce severe pain in humans, it is likely that tooth resection induces strong pain in piglets, even with grinding.

Tail docking is carried out with scalpels, scissors/wire cutters or by cautery with a hot iron. As a general rule, no anaesthesic nor analgesic treatments are performed to reduce the pain. The proportion of the tail that is removed by docking is variable: from only the tip of the tail to up to 3/4 of the tail, or more. Docking itself is likely to be a source of pain since the tail is innervated already in neonatal pigs: histological observations from Simonsen *et al.*(1991) have demonstrated the existence of peripheral nerves to the tip of tails in one-day old piglets. Behavioural data from Noonan *et al.*(1994) and Prunier *et al.*(2001) confirmed that tail docking probably induces pain. Indeed, animals “struggled” and screamed during docking; they wagged (flicking the tail from side to side or up and down) or jammed (clamping of the tail between the hind limbs) the tail in the first minutes following docking. However, time to first suckling and main time-budget during the 12 hours following docking were similar in docked (hot iron cautery) and control piglets (Prunier *et al.,* 2001). There are no clear changes in plasma profiles of cortisol and ACTH during the first 3 hours following docking

(hot iron cautery) in one-day old piglets (Prunier *et al.*, 2005). In addition to acute pain, docked pigs may suffer from long-term pain as described in humans after amputation. Indeed, Simonsen *et al.*(1991) and Done *et al.*(2003) observed the presence of neuromas (random proliferation of axons and glial support cells at the tip of docked tails) that are known to be very sensitive in other species and have been associated with stump pain in humans with amputated limbs. Therefore, the tail stump of docked pigs might be sensitive to touching. This hypothesis was tested by observing the behavioural reactions (trial to jerk the tail away or loud vocalization) of piglets when the tail was squeezed by calibrated pressure callipers (McIntyre, 2003). Data obtained failed to show any difference between control and docked (either 1/3 or 2/3 of the tail being removed) pigs from 2 to 10 weeks of age. Therefore, the question of long-term pain after docking in pigs is still open.

The tissue lesion due to ***tooth resection*** and ***tail docking*** may constitute a route for bacterial entry and hence favour local or systemic infection. Experimental evidence regarding this possible consequence is scarce. Data from Riising *et al.* (1976) have shown that tail docking and tooth clipping increase the incidence of fatal streptococcal infections. Strøm (1996) also suggested that tail docking, tooth clipping and castration increase the risk of arthritis in piglets.

Castration

The consequences of castration on welfare may be due to the surgical process itself as well as to deprivation of the testicular hormones. Indeed, testicular hormones may influence behaviour, health and hence welfare of male pigs. Moreover, catching and handling the animals for castration are likely to be stressful. However, comparison between non-handled animals and sham-castrated ones shows very few differences in profiles of stress hormones (Prunier *et al.*, 2005) and in behaviour (Hay *et al.*, 2003).

Existence of pain and stress

During castration, most piglets vocalise. High frequency calls (> 1000 Hz) are due, at least in part, to the surgery of the animals since they are more frequent, of higher intensity and longer duration in castrated than in sham-manipulated pigs (Weary *et al.*, 1998, Taylor & Weary 2000, Marx *et al.*, 2003). Marx *et al.*(2003) identified three types of calls during castration: grunts, squeals and screams. The number of screams per animal was almost doubled in piglets that were castrated without local anaesthesia compared with piglets castrated with anaesthesia. These calls were accompanied by physical resistance movements and an activation of the sympathetic nervous system, as demonstrated by an increase in heart rate (White *et al.*, 1995). Analysis of the calls suggests that extraction of the testes and severing the spermatic cords are the most painful parts during castration (Taylor & Weary 2000). This was further supported by the observation that local anaesthesia is most effective to reduce behavioural resistance when the cords are cut (Horn *et al.*, 1999). Characteristics of vocalisations (peak frequency, pureness and entropy of the sound) emitted by two-week-old piglets during the surgical period of castration and comparisons to those emitted during the pre- and post surgical handling periods have been analysed in detail by Puppe *et al.*(2005). They observed subtle alterations like lower entropy of high frequency calls. Such alterations are supposed to be under the control of brainstem centres that receive information from higher sensory and emotional brain areas (Manteuffel *et al.*, 2004).

Immediately after surgical castration, measurement of hormones in plasma clearly indicates an activation of the adrenal and sympathetic axes (Prunier *et al.*, 2005 & 2006, Caroll *et al.*, 2006). A 40-fold increase in plasma ACTH, peaking 5 minutes after surgery, is followed by a 3-fold increase in plasma cortisol, peaking 15 to 30 minutes after surgery. A very rapid and transient increase in plasma adrenaline is followed by a longer lasting increase in plasma noradrenaline (Prunier *et al.*, 2006). Adrenaline is probably of adrenal medullary origin and noradrenaline from peripheral sources. As a consequence of the catecholamine stimulation, glycogen is mobilized, leading to a transient increase in lactate from muscles (Prunier *et al.*, 2005). A major proportion of cortisol circulates in blood being bound to the cortico-binding globulin (CBG) that protects cortisol from being metabolized and avoids excessive action of cortisol on target tissues.

By measuring cortisol and CBG, Carroll *et al.*(2006) calculated the free cortisol index (FCI) and observed that it is increased at 0.5 and 1.5 hours after castration. Measurement of corticosteroids and catecholamines in urine suggests that the adrenal and sympathetic axes are no longer stimulated (Hay *et al.*, 2003). Similarly, data from Carroll *et al.*(2006) indicate also that plasma levels of cortisol and FCI are no more increased at 24 and 48 hours after castration.

The expression of the protein c-fos in neurons of the spinal cord, which are likely to transmit the nociceptive stimuli originating from the perineal region to the brain, has been studied in pigs submitted to surgical castration (Nyborg *et al.*, 2000). It was shown that the number of activated neurons was three times lower in pigs treated with local anaesthetic before castration than in pigs receiving an injection of saline.

In addition to these physiological reactions, behaviour is modified (review: Prunier *et al.*, 2005). During the first hours following castration, castrated pigs spend less time at the mammary glands, massaging and/or suckling, (McGlone & Hellman 1988, McGlone *et al.*, 1993, Hay *et al.*, 2003, Llamas Moya *et al.*, 2008a). They remain more inactive while awake, they show more pain related behaviours (prostration, stiffness, trembling, spasms, huddled-up and scratching the rump) and tail wagging. However, postures (ventral and lateral lying, sitting and standing) and location in the crate (at the sow's udder or sow's back, at heat lamp) are not altered. Finally, castrated pigs are frequently isolated and their behaviour is more often desynchronized than in their littermates (Hay *et al.*, 2003). Some alterations in behaviour were observable 3 to 5 days after castration: more isolation and desynchronization of the behavioural activity, less social interactions and dog-sitting, tail wagging, scratching the rump (Wemelsfelder & van Putten 1985, Hay *et al.*, 2003, Llamas Moya *et al.*, 2008a). In general, these behavioural alterations are of low or moderate amplitude but allow a reduction in the stimulation of the painful area by a direct effect (e.g. more huddling, less locomotion and dog-sitting) or by the avoidance of littermates (e.g. isolation and desynchronization). The increase of scratching the rump seems paradoxical but this behaviour may inhibit the activation of nociceptive receptors through the simultaneous activation of mechanoreceptors as suggested earlier (Hay *et al.*, 2003).

On the other hand, castration has long term positive effects on behaviour due to the lack of increase of sexual hormones at puberty: castration reduces undesirable behaviours such

as aggressive and mounting behaviours (EFSA report, 2004).

Growth and health of the piglets

Regarding growth during lactation, castration may have depressing effects when it is realized in very young animals (see below). In most studies evaluating the consequences of castration, mortality rate is rarely mentioned, suggesting that there is no obvious effect. However, data from commercial herds have suggested that poor hygiene at castration could promote the occurrence of arthritis which itself may result in death of the piglets (Strøm 1996). In addition, Lessard *et al.*(2002) observed a lower antibody response to an immune challenge realized during lactation in castrated piglets than in entire ones. This short-term immunosuppressive effect of castration is probably due to the stress reaction, especially ACTH and cortisol release. Comparing the response of castrated or intact pigs to an endotoxin challenge (LPS intra-peritoneal injection) realized on the day after weaning at 24 days after castration or handling, Moya *et al.*, (2008b) observed that the sickness behaviour (e.g. anorexia and lower general activity) was attenuated in the castrated group suggesting an inhibitory influence of castration on the inflammatory response that elicits this behaviour.

On a long term basis, there are some indications that surgical castration may impair health of pigs. For instance, higher prevalence of pneumonia and higher incidence of chronic inflammation (due to pericarditis, pleurisy, pneumonia, inflammation of the tail or of the feet) was observed in castrates than in gilts (Tielen 1974, de Kruijf & Welling 1988). It was also demonstrated that pneumonia, chronic pleurisy and chronic pericarditis were less frequent in entire males than in castrates, whereas no difference was detected between gilts and entire males (de Kruijf & Welling 1988). The causes for these effects of castration are not clear. The higher prevalence of tail inflammation in castrates than in gilts can be explained by differences in behaviour because, in pens of castrates and gilts, the tails of castrates are more often bitten than those of gilts (Penny & Hill 1974). The higher prevalence of chronic inflammatory diseases in castrated male could be explained by the lack of androgens as suggested by De Kruijf & Welling (1988). These hormones are known to suppress both T-cell and B-cell immune responses and hence to reduce disease expression.

Effect of the method of castration

Comparison between methods of restraining (piglets held on a flat bench vs. piglets suspended by the legs vs. piglets restrained in a v-trough) did not show any difference in the number and duration of "low" calls (frequency < 1000 Hz) nor in the number, duration and frequency of "high" calls (frequency > 1000 Hz) (Weary et al 1998). Comparing two methods of severing the cord (pulling and tearing vs. cutting) Taylor & Weary (2000) did not observe any difference in the calls recorded during castration. This suggests either that both methods are equally painful or that both methods evoke the piglets' maximal vocal response. The technique of pulling/tearing is believed to reduce bleeding due to the recoil of the testicular artery and consequent narrowing of its lumen, but also probably results in more ragged edges that disrupt platelets. Informal observations support the assertion that pulling/tearing induces less bleeding (Taylor & Weary 2000).

Effect of age

The influence of age on pain inflicted at castration has been investigated in a few studies with different approaches: behaviour, physiology and growth. Comparing the time spent suckling in intact and castrated piglets during the 6 hours following castration, McGlone *et al.*, (1993) observed a similar reduction when castration was realized at 1, 5, 10, 15 or 20 days of age. Taylor *et al.*(2001) compared the calls (numbers of low frequency, high frequency and total calls) produced during castration and sham-castration at 3, 10 and 17 days of age. Castration and age had significant effects but the interaction between age and castration was not significant: the increase with age that was seen for high-frequency calls (more calls at 10 and 17 days of age) in castrated pigs was also seen in sham-castrated ones. Similarly, Marx *et al.*(2003) observed age-related variations in the characteristics of piglets' calls. Therefore, it can be assumed that the influence of age on calls at castration is mainly due to an increase in vocal capacity with age. Analyzing the time of arrival at the sow's udder and the number of missed sucklings in the hours following castration, Taylor *et al.*(2001) did not observe any effect of age. When comparing piglets submitted to surgical castration at 3, 6, 9 or 12 days of age, Carroll *et al.*(2006) observed similar increases in plasma levels of cortisol and FCI.

Concerning growth rate of the piglets in the days following castration, a decrease was observed only when surgery was carried out shortly after birth (1 to 3 days, McGlone *et al.*, 1993; Kielly *et al.*, 1999). This decrease may be due to a more stressful and painful event when castration is performed early or may be the result of castrated piglets being disadvantaged when competing for teats. Indeed, the teat order is established in the first days following birth and any lack of suckling at that age may have deeper consequences than at an older age. This was further supported by the data from Carroll *et al.* (2006) showing that growth rate during the first two days after castration is similar in control and castrated pigs regardless the age at surgery (3, 6, 9 or 12 days of age).

Lessard *et al.*(2002) showed that castration had a more pronounced immunosuppressive effect when it was realized at 10 or 17 days of age than at 3 days of age. However, the immune response was similarly low in control pigs immunized in parallel to those castrated at 3 days. Finally, Heinritzi *et al.*(2006) demonstrated a better wound healing in piglets submitted to surgical castration at 4 days of age compared to 7, 10 and 28 days of age.

Conclusion

On the overall, data from the literature suggest that tooth resection induces pain without clear positive effects on the dam and littermates. Therefore, this practice should be more clearly banned. The situation regarding tail docking is not so clear since the level of pain due to docking should be compared to its positive effects on tail biting when animals are housed on slatted floor as it is done in most piggeries across EU (EFSA

report, 2007). Surgical castration is clearly a painful procedure. Several options exist to solve that problem: alleviating pain by anaesthesia and long-term analgesia, avoiding castration and perform immunocastration or even rise entire males. Each solution has pros and cons in terms of welfare, health and meat quality that should be balanced before any decision.

References

Bataille G, Rugraff Y, Meunier-Salaün MC et al, 2002. Journ. Rech. Porcine Fr. 34, 203-210.

Carroll JA, Berg EL, Strauch TA et al, 2006. J. Anim. Sci. 84, 1271-1278.

EFSA report, 2004. http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620775386.htm.

EFSA report, 2007. http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178672658201.htm.

de Kruijf JM, Welling AA, 1988. Tijdschrift voor Diergeneeskunde 113, 415-417.

Done SH, Guise J, Chennels D, 2003. The Pig Journal 51, 136-154.

Fredriksen B, Font i Furnol M, Lundström K et al, 2009 Practice on castration of piglets in Europe. Animal, in press.

Gallois M, Le Cozler Y, Prunier A, 2005. Prevent. Vet. Med. 69, 13-23.

Hay M, Rue J, Sansac C, Brunel G, Prunier A, 2002. Animal Welfare.

Hay M, Vulin A, Genin S, Sales P, Prunier A, 2003. Appl. Anim. Behav. Sci. 82, 201-218.

Heinritzi K, Ritzmann M, Otten W, 2006. Deutsche Tierärztliche Wochenschrift 113, 94-97.

Horn T, Marx G, von Borell E, 1999. Deutsche Tierarztliche Wochenschrift 106, 271-274.

Hutter S, Heinritzi K, Reich E, Ehret W, 1994. Revue de Médecine Vétérinaire 145, 205-213.

Kielly J, Dewey CE, Cochran M, 1999. Swine Health Production 7, 151-153.

Lessard M, Taylor A A, Braithwaite L, Weary DM, 2002. Can. J. Anim. Sci. 82, 519-526.

Llamas Moya S, Boyle LA, Lynch BP, Arkins S 2008a. Appl. Anim. Behav. Sci. 111, 133-145.

Llamas Moya S, Boyle LA, Brendan Lynch P, Arkins S 2008b. Appl. Anim. Behav. Sci., 112, 40-57.

Manteuffel G, Puppe B and Schön PC 2004. Appl. Anim. Behav. Sci. 88, 163-182.

Marx G, Horn T, Thielebein J, Knubel B, von Borell E, 2003. J. Sound Vibration 266, 687-698.

McGlone JJ, Hellman JM. 1988. J. Anim. Sci. 66, 3049-3058.

McGlone JJ, Nicholson RI, Hellman JM, Herzog DN, 1993. J. Anim. Sci. 71, 1441-1446.

McIntyre J, 2003. PhD, University of Newcastle, UK.

Noonan GJ, Rand JS, Priest J, Ainscow J, Blackshaw JK, 1994. Appl. Anim. Behav. Sci. 39, 203-213.

Nyborg PY, Sorig A, Lykkegaard K, Svendsen O, 2000. Dansk Veterinoertidsskrift 83, 16-17.

Penny RHC, Hill FWG, 1974. Veterinary Record 94, 174-180.

Prunier A, Bataille G, Meunier-Salaun MC et al, 2001. Journ. Rech. Porcine Fr. 33, 313-318.

Prunier A., Mounier A. M., Hay M., 2005. J. Anim. Sci. 83, 216-222.

Prunier A, Gallois M, Klouytten A, Le Cozler Y, 2004. Journ. Rech. Porcine Fr., 36, 379-388.

Prunier A, Bonneau M, von Borell EH et al, 2006. Animal Welfare 15, 277-289.

Puppe B, Schön PC, Tuchscherer A, Manteuffel G, 2005. Appl. Anim. Behav. Sci. 95, 67-78.

Riising HJ, Nielsen NC, Bille N. Svendsen J. 1976. Nordisk Veterinaermedicin 28: 65-79.

Simonsen HB, Klinken L, Bindseil E, 1991. Brit. Vet. J. 147, 407-412.

Strøm I, 1996. Dansk Veterinaertidsskrift 1996. 79, 13, 575-577.

Taylor AA, Weary DM, 2000. Appl. Anim. Behav. Sci. 70, 17-26.

Taylor AA, Weary DM, Lessard M, Braithwaite LA, 2001. Appl. Anim. Behav. Sci. 73, 35-45.

Tielen MJM, 1974. Proefschrift Landbouwhogeschool Wageningen.

Weary DM, Braithwaite LA, Fraser D, 1998. Appl. Anim. Behav. Sci. 56, 161-172.

Wemelsfelder F, van Putten G, 1985. B-260 Zeist: Instituut voor Veeteeltkundig Onderzoek 'Schoonoord'.

White RG, DeShazer JA, Tressler CJ et al 1995. J. Anim. Sci. 73, 381-386.

Dr. Susanne Zöls

Dr. Susanne Zöls is member of a research staff at the Clinic for Swine of the University of Munich since 2005. The main field of investigation is castration of piglets and the working group of Prof. K. Heinritzi is especially engaged in all sorts of alternatives to the current castration practice. Her doctoral thesis dealt with the effect of analgesics and local anesthesia on castration induced pain of piglets.

Reduction of pain associated with piglet castration using NSAIDs

Susanne Zöls[1], R. Langhoff[1], I.C. Mühlbauer[1], A. Zankl[1], C. Schulz[1], A.Palzer[1], S. Elicker[1], M. Ritzmann[2], K. Heinritzi[1]
[1] Clinic for Swine, LMU Munich, Germany
[2] Clinic for Swine, VU Vienna, Austria

In most European countries and even in many parts of the world, castration of piglets is a routine practice often performed by the farmer. Legislation from the European Union allows the castration of piglets without any pain reduction up until seven days after birth. Afterwards castration of piglets must be performed by a veterinarian under anaesthesia with subsequent analgesic treatment.

In Europe about 125 millions male pigs are slaughtered every year. Therefore about 80% of male piglets are normally castrated without any analgesic treatment. The rate of castration ranges extremely between countries from no castration in few countries like Great Britain or Ireland to castration of most piglets (up to 97%) in large pig producing countries such as Germany, France, Netherlands, Denmark, etc. Accordingly, 97 millions barrows are fattened and slaughtered in Europe per year compared to 25 millions boars (Pigcas, 2008).

Motivation for pig castration is the reduction of boar taint: a deviation in the smell of pork that develops during puberty in male piglets. Androstenone, the main component is a steroid that is formed in the testis similarly to testosterone. The awareness of animal welfare in farm animals is rising and additionally the scientific opinion that newborns have reduced pain perception has long since been revised. Hence, the current procedure is increasingly criticized not only by animal welfare organisations but also by public and academics, and pressure is growing for governments, marketer and trade.

Several alternative solutions are being discussed in course of abandoning piglet castration without any analgesic treatment. Therefore boar fattening as practised in Great Britain, Ireland and partly Spain is being openly discussed. As well as vaccination against boar taint as done in Australia or New Zealand for the export and Brasil and licensed in Switzerland is up for discussion. Inhalation anaesthetics such as isoflurane or CO_2 cause unconsciousness. Although pain perception is reduced during unconsciousness, there is no analgesic effect to minimize the pain: especially not the postoperative pain.
In Switzerland castration without any pain treatment will be forbidden from 2010. To implement this ban, isoflurane inhalation anaesthesia combined with preoperative analgesic treatment, boar fattening and vaccination against boar taint is being favoured in Switzerland. But in 2008 veterinarian organisations and SWISSMEDIC (Schweizerisches Heilmittelinstitut) decided not to endorse any responsibility regarding how anaesthesia is performed by farmers or related to

safety during the release of isoflurane. Nevertheless, Switzerland favours isoflurane anesthesia because vaccination against boar taint is only allowed by one specific retailer's label.

At the end of 2007, pig retailers in the Netherlands signed a voluntary declaration to discontinue castration without any pain treatment from 2009. Presently, castration should be performed by using CO_2-O_2 anaesthesia. However, previous publications and a present investigation by our working research team detected only a low influence on pain reduction but a high degree in stress and distress caused by CO_2 anesthesia (Muehlbauer 2009). Furthermore, all these methods cause unconsciousness during castration but they are unsuitable for reducing especially the long lasting pain which comes afterwards (Muehlbauer 2009, Schulz 2007a,b).

Since 2002 Norway allows castration of piglets only under "appropriate analgesia", that is realised through local anaesthesia exclusively performed by veterinarians. In addition several investigations allocate additional pain caused to intratesticular injection and no detectable positive effect on postoperative pain (Zankl 2007, Waldmann et al. 1994).

Our team was involved in some research works to investigate not only the pain expressed during castration and caused by mechanical destruction of the tissues and activation of the nociceptors but also the long lasting pain associated with tissue damages which is felt long after the surgery. Moreover, the influence of different analgesics especially on the postoperative castration pain was investigated. The pain following surgical intervention is caused by sensitisation of the nociceptors. Tissue damage and associated inflammation induce prostaglandins synthesis, thus sensitising nociceptors, reducing the pain threshold which in turn leads to long lasting pain by nonpainful stimuli. According to several studies, this pain lasts about 24 hours but there are also other investigations that recorded behavioural changes for up to four days (Hay et al. 2003, Prunier 2005, Thornton et al. 1999). Nonsteroidal anti-inflammatory drugs (NSAIDs) block the expression of cyclo-oxygenase (COX), an enzyme in the cell wall that metabolizes arachidonic acid into prostaglandins after tissue damage. This inhibition reduces prostaglandins synthesis in inflammed tissue, hence decreasing the sensitisation of the nociceptors and consequently the postoperative pain. This class

Table 1.
Treatment groups

group	procedure	agent	animals
Handling NaCl	fixation	natrium chloride 0.9% 0.3ml	35
Castration NaCl	castration	natrium chloride 0.9% 0.3ml	28
Castration Meloxicam	castration	Meloxicam 0.4mg/kg bw	25
Castration Flunixin	castration	flunixin-meglumin 2.2mg/kg bw	26
Castration Metamizol	castration	Metamizol 50mg/kg bw	25


of agents are not able to modulate the acute intraoperative pain induced by mechanical stimulation of the nociceptors (Kietzmann et al. 2001; Lang 2005; Schroer und Hohlfeld 2005).

Pain assessment plays a pivotal role in the investigation of pain. Pain is a subjective emotion that is variably perceived by individuals which makes it very difficult to assess pain objectively, especially in animals. Many studies followed the modification of cortisol concentrations in blood serum to identify a stressful stimuli.

Stress-stimuli such as fear or pain influence the cortisol level via the hypothalamic-pituitary-adrenal axis (Seyle 1977, Stafford et al. 2002, Thornton et al. 1999). Prunier et al. (2005) detected rising cortisol concentration from two up to 90 minutes after castration with a maximum level of 30 minutes after castration.

Similar variations of cortisol levels after castration were also observed in several research works by our team (Langhoff ,2008; Schulz, 2007a,b; Zankl, 2007 und Zoels, 2006). In order to detect side effects which may be caused by handling, blood sampling and administration of drugs, we included a control group of piglets that were handled but not castrated. The three treatment groups were castrated 15 minutes after application of Meloxicam, Flunixin or Metamizol[1] (Table 1). Blood samples were taken before and then 30 minutes, one hour, four hours and twenty-four hours after corresponding procedure.

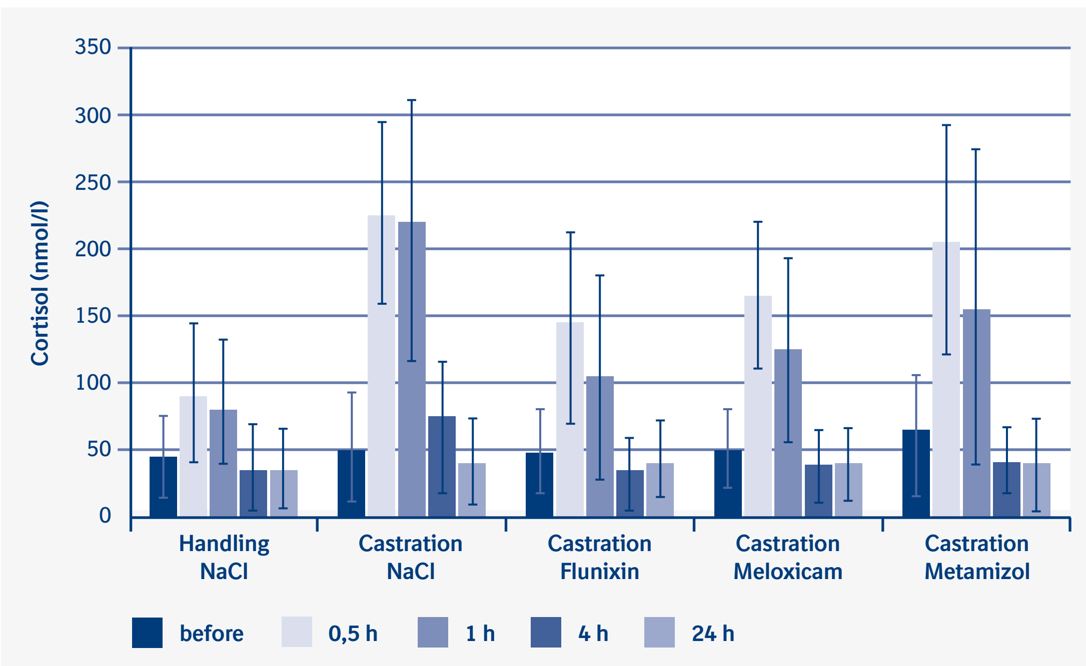


Figure 1. Mean cortisol level (nmol/l) and standard deviation before, 30 min, 1 hour, 4 hour and 24 hours after fixation or fixation and castration

[1] Metamizol is a non-narcotic, analgesic and anti-pyretic pyrazolone derivative which belongs to the non-steroidal anti-inflammatory class of drugs. This drug is used in Germany, Spain and Italy, and in many South American countries.

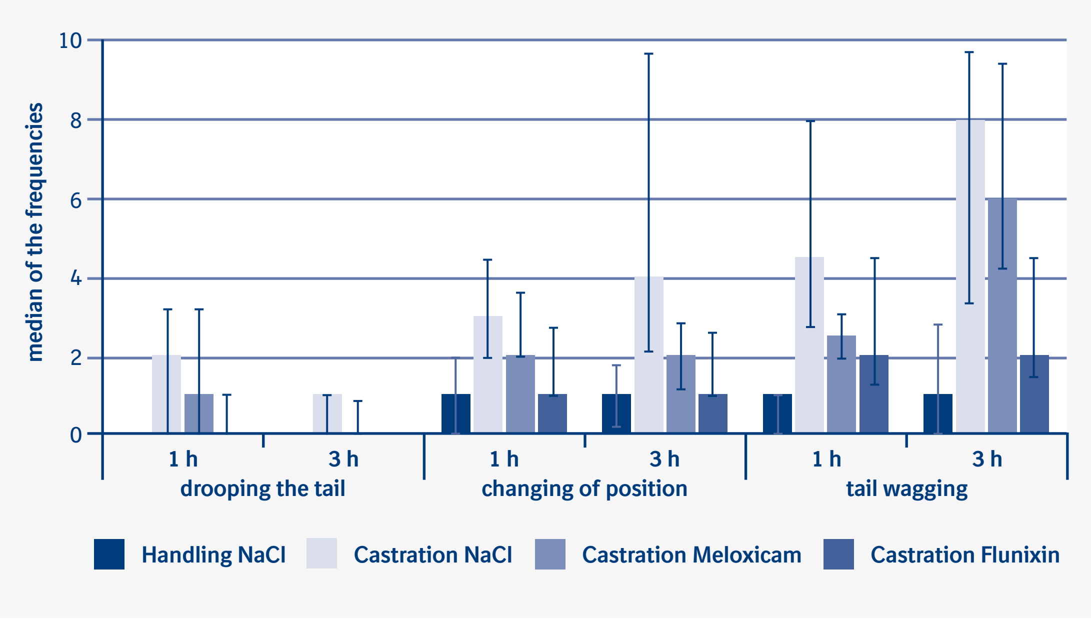
As seen in figure 1, significantly higher cortisol levels were detected from 30 minutes to up to four hours after castration without any analgesic treatment (Castration NaCl) as compared to the non-castrated group (Handling NaCl). There were also significantly lower cortisol levels at 30 minutes and one hour after castration in the groups having received either Flunixin (Castration Flunixin) or Meloxicam (Castration Meloxicam) before castration. Metamizol, Carprofen or Detomidin did not have this positive effect on castration pain (Langhoff, 2008; Zoels, 2006).

Behavioural parameters were assessed to confirm these results. A change in behaviour was considered as pain induced if a significant difference in the frequency of occurrence could be detected between non-castrated (Handling NaCl) and castrated animals (Castration NaCl).

Castration induced signs of pain were parameters such as "tail wagging", "tremor of the hind limbs" and "scratching of the scrotum", "drooping the tail" or "changing the position". These parameters were recorded by focal sampling in a similar experimental setup 5 minutes, 60 minutes and 3 hours following castration and compared to those obtained on handled but not castrated animals. The frequency of observation of these parameters was significantly reduced in animals that received either Flunixin or Meloxicam.
A summary of the behavioural assessment is illustrated in figure two.

The behavioural observations confirmed the findings of the above cortisol-investigations; preoperative analgesic treatment with Flunixin or Meloxicam considerably reduces postoperative castration pain.

Figure 2. Diagram of the median frequency of different behaviour parameters „focal sampling" under specification of upper and lower quantile 1h and 3h after fixation/castration



References

Kietzmann, M., R. Scherkl und R. Schulz (2001): Pharmakologie der Entzündung und der Allergie. In: H.-H. Frey und W. Löscher (Hrsg). Lehrbuch der Pharmakologie und Toxikologie für die Veterinärmedizin. Thieme Verlag, Stuttgart, 2. Auflage: 318-344

Hay, M., A. Vulin, S. Génin, P. Sales und A. Prunier (2003): Assessment of pain induced by castration in piglets: behavioral and physiological responses over the subsequent 5 days. Appl. Anim. Behav. Sci. 82 (3): 201-218

Lang, F. (2005): Hormone. In: S. Silbernagel und F. Lang (Hrsg). Taschenatlas der Pathophysiologie. Georg Thieme Verlag, Stuttgart, New York, 2. Auflage: 256-296

Langhoff, R. (2008): Untersuchungen über den Einsatz von Schmerzmitteln zur Reduktion kastrationsbedingter Schmerzen beim Saugferkel. Vet. Med. Diss., München

Marx, G., T. Horn, E. Von Borell und J. Thielebein (1999). Einschätzung der Belastung von Ferkeln mittels Lautanalyse am Beispiel der Kastration. Aktuelle Aspekte bei der Erzeugung von Schweinefleisch , Sonderheft 193: 181-185

Mcglone, J., R. Nicholson, J. Hellman und D. Herzog (1993): The development of pain in young pigs associated with castration and attempts to prevent castration-induced behavioral changes. J. Anim. Sci. 71 (6): 1441-1446

Mühlbauer, I. C., W. Otten, W. Lüpping, A. Palzer, S. Zöls, S. Elicker, M. Ritzmann, K. Heinritzi (2009): Untersuchung zur CO2-Narkose als eine Alternative zur betäubungslosen Kastration von Saugferkeln; Prakt. Tierarzt, in press

Pigcas, EU-Projekt (2008): An EU Specific Support Action; Attitudes, practices and state of the art regarding piglet castration in Europe: WP3: Evaluation of research and other information on castration in pigs. März 2008. http://www.rennes.inra.fr/pigcas/fichiers/deliverables/fichierspdf/D3.2%20first%20draft%2within%20topic%20reports.pdf (2008).

A. Prunier, M. Mounier und M. Hay (2005): Effects of castration, tooth resection, or tail docking on plasma metabolites and stress hormones in young pigs. J. Anim. Sci. 83 (1): 216-222.

Schulz, C., M. Ritzmann, A. Palzer, K. Heinritzi und S. Zöls (2007a): Auswirkungen einer Isofluran-Inhalationsnarkose auf den postoperativen Kastrationssschmerz von Ferkeln. Berl. Münch. Tierärztl. Wochenschr. 120(5/6): 177-182

Schulz, C., M. Ritzmann, A. Palzer, W. Otten und K. Heinritzi (2007b): Verlauf der Noradrenalin- und Adrenalinkonzentrationen vor und nach der Kastration von Saugferkeln mit und ohne Isofluran-Narkose. Dtsch. Tierärztl. Wschr. 114(12): 453-458

Selye, H. (1977): Gesamtheit und Streßkonzept. In: H. Selye (Hrsg). Bewertung von Risiken für die Gesundheit. Gustav Fischer Verlag, Jena, Stuttgart

Stafford, K.J., D.J. Mellor, S.E. Todd, R.A. Bruce und R.N. Ward (2002): Effects of local anaesthesia or local anaesthesia plus a non-steroidal anti-inflammatory drug on the acute cortisol response of calves to five different methods of castration. Res. Vet. Sci. 73 (1): 61-70

Thornton, P.D. und A.E. Waterman-Pearson (1999): Quantification of the pain and distress responses to castration in young lambs. Res. Vet. Sci. 66 (2): 107-118

Zankl A., M. Ritzmann, S. Zöls und K. Heinritzi (2007): Untersuchungen zur Wirksamkeit von Lokalanästhestika bei der Kastration von männlichen Saugferkeln. Dtsch. Tierärztl. Wschr. 114(11): 418-422

Schrör, K. und T. Hohlfeld (2005): Derivate des Arachidonsäurestoffwechsels. In: K. Aktories, U. Förstermann, F. Hofmann und W. Forth (Hrsg). Allgemeine und spezielle Pharmakologie und Toxikologie. Urban & Fischer Verlag, München, 9. Auflage: 349-361

Waldmann, K.H., K. Otto und W. Bollwahn (1994): Ferkelkastration - Schmerzempfindung und Schmerzausschaltung. Dtsch. tierärztl. Wschr. 101 (03): 105-109

Zöls, S. (2006): Möglichkeiten der Schmerzreduzierung bei der Kastration männlicher Saugferkel. Diss. med. vet. München.

Willem Maertens and Annelies Van Nuffel

Willem Maertens (M. Sc. Bioscience engineering – Katholic University Leuven, 2002) is working at the Agricultural and Fisheries Research Institute (ILVO) as a researcher involved in the development of an automated technique for cattle lameness detection.

Annelies Van Nuffel graduated in applied bio-engineering for animal production in Agriculture at University College Ghent (Belgium, 2002). Since then she has worked for the Agricultural and Fisheries Research Institute ILVO as a researcher on several animal welfare and housing subjects such as: prelaying behaviour of laying hens in enriched cages, fluctuating asymmetry as an animal welfare indicator; leg problems in poultry, pigs and cattle. Since 2007 she coördinates the projects concerning Agricultural Engeneering and provides the team with knowledge of animal welfare and behaviour.

Lameness:
Is it that easy to give a subjective score to a painful condition?

Willem Maertens and Annelies Van Nuffel,
Department of Food and Technology, Institute for Agriculture and Fisheries Research, Ghent, Belgium

Cattle lameness

Monitoring cattle health and behavior is a necessary but time consuming activity for the dairy farmer. The early detection of cattle diseases or problems has a beneficial influence on management and farmer income as well as on animal welfare. The farmer needs to know whether and when the cow is in heat, suffers from mastitis or another disease and whether she is lame or not. Atypical behavior may be an indicator for these situations. Noticing these problems by farmer observation requires a lot of effort, time and training. Acceptable detection level is often not within reach in normal practice, and very often monitoring technology is used as e.g. step counters to detect oestrus. Although commercial applications are becoming available, the automatic detection of lameness is in full development.

Lameness may be defined as an abnormal gait (e.g. reduced speed and ground contact force of the cow, a back arch curving and a lowering of the head) in an attempt to minimize pain (Scott, 1989). This pain is often a consequence of claw- and feet damage or inflammation. This abnormal gait, unfortunately, is very often only noticeable with acute illness or damage or when the inflammation is an advanced phase.

Causes of lameness are being studied widely and range from bad hoof care, calving, excess standing, freestall bedding, floor type, comfort and hygiene to heifer rearing and diet. Many factors contribute to the overall risk on trauma or infections of the claws and legs. A lot is still to be discovered and even the pathology and interactions of different kinds of infections is poorly understood.

Regarding to gait scoring, only a trained observer may notice the onset of lameness by multiple subtle gait aberrations (for a given cow). Other claw or feet diseases may even not result in an abnormal gait pattern at all. Finally, a healthy cows might be walking “funny” because of a full udder or some stiffness after laying down. Although several “indicators” for lameness have been described and applied in different gait score systems, many questions remain unanswered.

Gait scoring

Basically, subjective gait scoring requires that the observer is able to distinguish "normal" from "abnormal" walking behavior. Gait scoring is based on specific indicators (e.g. irregular foot fall, head bobs, arched back) described in the scoring system used, but often blends to a global impression of the cows movement and condition. Even within a clearly defined scoring system, visual lameness scoring, and human observation in general, remains inherently subjective and observers need to be trained profoundly and repeatedly. Nevertheless, gait scoring is widely used in herd health surveys or in the assessment of animal welfare.

Various scoring systems are available which differ in used scale (three or five point scale) and considered indicators like irregular gait, arches back or head bobs. Well-known lameness scoring systems are those of Manson and Leaver (1988), Winckler and Willen (2001), Sprecher et al (2002) and many others. Some features (e.g. "tracking up") are perceived as more important than others depending on the scoring system used and the human observer. Furthermore, it is not clear which classifiers described in the scoring systems are most easy to observe unambiguously (see also table 1).

Cow gait analysis (kinematics)

Only recently, techniques are being adopted in cow lameness research to measure spatial variables (Telezhenko & Bergsten 2005) and/or temporal variables (Flower et al 2005) of cow gait. Other efforts aim to add force of pressure related variables (Van der Tol et al 2005): Tasch and Rajkondawar (2004) developed a walk-over force plate detection system that records the ground reaction force of the hooves and Pastell et al (2006) uses the weight bearing between hind limbs in a milking robot. Maertens et al (2007) focus on the use of a pressure sensitive mat to provide spatial, temporal and force related variables (see figure 1).

Table 1
Observed lameness indicators mentioned by 39 observers watching 40 different movies of walking cows according to Van Nuffel et al., 2009 (submitted).

Lameness indicator	Relative use (%) of indicator by experienced (n=14) observers vs. observers (n = 25) unfamiliar with gait scoring (100%).
Tenderness	90 %
Arched back	149 % ***
Reduced speed	417 % *
Irregular gait (unspecified)	95 %
Irregular placement	62 % **
Irregular timing	147 % **
Irregular in space and time	46 % **
Reduced tracking up	- °
Increased abduction	1842 % ***
Head bobbing	102 %

Significance levels: p <0.5 (*); p<0.1 (**); p<0.001 (***).
No "reduced tracking up" was reported by the inexperienced observers (°).
It was also mentioned that the notion of "tracking up" and "abduction" could have been confusing to inexperienced observers.

Systems are being designed to support daily herd health management and a number of them monitor changes in activity, walking or stance behavior. As it is a significant task to judge lameness by human observation, it is an even greater challenge to choose and develop fully automated tools to warn for the onset of lameness. These tools should be able to measure the relevant gait or behavioral parameters frequently and in a cost-effective way.

Figure 1
Cow walking on a 6 m long instrumented walkway to measure the gait kinematics at ground contact level.

During the workshop, different systems and lameness indicators used to score cow gait will be discussed. Additionally, several video's from cows walking on a pressure sensitive mat will be scored and discussed.

References

Flower FC, Sanderson DJ & Weary D M 2005 Hoof pathologies influence kinematic measures of dairy cow gait. Journal of Dairy Science 88: 3166-3173

Maertens W, Baert J, Vangeyte J, Vranken E, Berckmans D & Sonck B 2007 Acquisition techniques for dairy cow gait analysis. Proceedings of the 3rd European Conference on Precision Livestock Farming, 3-6 June 2007, Skiathos (Greece), 7p

Manson F J & Leaver J D 1988. The influence of concentrate amount on locomotion and clinical lameness in dairy cattle. Animal Production 47: 185-190

Scott G B 1989 Changes in limb loading with lameness for a number of Friesian cattle. British Veterinary Journal 145: 28-38

Sprecher DJ, Hostetler DE & Kaneene JB 1997. A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. Theriogenology 47: 1179-1187

Tasch U & Rajkondawar PG 2004 The development of a SoftSeparator for a lameness diagnostic system. Computers and Electronics in Agriculture 44: 23-245

Telezhenko E & Bergsten C 2005 Influence of floor type on the locomotion of dairy cows. Applied Animal Behaviour Science 93: 183-197

Van der Tol PPJ, Metz JHM, Noordhuizen-Stassen EN, Back W, Braam CR & Weijs WA 2005Frictional forces for unrestrained locomotion in dairy cattle. American Dairy Science Association 88: 615-624

Winckler C & Willen S 2001 The reliability and repeatability of a lameness scoring system for use as an indicator of welfare in dairy cattle. Acta Agriculturae Scandinavica: Section A, Animal Science 30: 103-107

Notes

ANIMAL HEALTH

Boehringer Ingelheim Animal Health GmbH
Binger Straße 173
55216 Ingelheim am Rhein / Germany
Webmaster-AnimalHealth@ing.boehringer-ingelheim.com
www.boehringer-ingelheim.com

Contact
Dr. Laurent Goby
Corporate Marketing
Phone +49(0)61 32 77 - 9 04 96
Fax +49(0)61 32 77 - 89 48
Mail laurent.goby@boehringer-ingelheim.com

Issued by Boehringer Ingelheim Animal Health GmbH

© Boehringer Ingelheim Animal Health GmbH, 2009

All rights reserved.

42376399

Boehringer Ingelheim