3RD Boehringer Ingelheim Expert Forum on

Farm Animal Well-Being

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Boehringer Ingelheim

Welcome. We are very pleased you have been able to attend this 3rd Boehringer Ingelheim Expert Forum on Farm Animal Well Being.

The last few years have seen a rise in consumer concern about what they eat and how it has been produced. People are more and more concerned for animal well-being, both on ethical grounds and because it may affect product safety and quality. This demand put the issue of animal welfare firmly on the political agenda.

However, a single parameter or discipline has not been identified to assess and quantify the well-being of farm animals. Pathologic, physiologic, performance or production as well as behavioural parameters must be considered and measured; hence the assessment of animal welfare is a true multidisciplinary and holistic approach.

That is exactly what drove us at Boehringer Ingelheim to set up the first expert forum 3 years ago. We gathered experts with different backgrounds: veterinarians, animal scientists, sociologists or economists as well as represen-tatives of retailers, farmers and the food industry, who all play a key role in the progress of animal welfare research.

The success of the previous forums showed us that such a discussion platform is worthwhile and effective in facilitating communication and transfer of knowledge.
This year again, leading experts have been approached to ensure that the program will be relevant, attractive.....and challenging! Among the topics covered, the following questions will be addressed:

How may the well-being of dairy calves be ensured? Can play behaviour be used to assess calf welfare?

How do piglets react to pain? Can we modulate it? Can castration have an impact on teat hierarchy and suckling behaviour?

How easy is it to detect pain and discomfort in cows following parturition? Does a caesarean section affect cow's behaviour? Is there any difference between heifers and multiparous cows?

And eventually what is the cost of improved animal welfare? Should farmers only be those supporting it? Or may one expect some benefit or even profit from producing food under "animal-friendly" conditions?

We hope that you will both enjoy and benefit from the research compiled herein.

Dr. Laurent Goby
Boehringer Ingelheim Animal Health

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Content

Prof. Marina von Keyserlingk and Prof. Dan Weary

Marina A.G. von Keyserlingk (B.Sc., M.Sc. Ph.D., Associate Professor) and Daniel M. Weary (B.Sc., M.Sc., D. Phil., 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.

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

Opportunities and challenges in dairy calf housing and management for the next decade

Prof. Marina A. G. von Keyserlingk and Prof. Daniel M. Weary,
Animal Welfare Program, University of British Columbia, Vancouver, Canada

Introduction

Calf care is possibly the most challenging job on the dairy farm, in part because milk-fed calves are the animals most likely to become ill. New methods of calf rearing are becoming available that can benefit both producers and their calves, providing the potential for widespread improvements in calf care over the next decade. We predict that in the coming years producers will begin feeding dairy calves more milk than they are now commonly fed, increasingly using labour-saving milk delivery systems that facilitate more natural milk drinking behaviour. These improved feeding systems will ease the move towards group housing of calves before weaning, saving producers time and money. However, changes in feeding and housing systems pose new challenges for producers and their calves that require much innovation and research.
In this presentation we will describe how new milk feeding methods promote rapid growth and more natural calf behaviour. New feeding systems facilitate keeping calves in groups, but group housing can result in increased competition and increased risk of disease transmission. Therefore, we will also discuss the challenges involved in using new feeding methods, and how to reduce these problems.

Calf feeding

Methods of feeding calves in modern dairying differ markedly from those found in nature (von Keyserlingk and Weary, 2007), but knowing more about the natural behaviour of cow-calf pairs can help us develop better ways of feeding calves (von Keyserlingk et al., 2009). On many dairy farms, calves are separated from their mothers within 24 h of birth and then fed milk by bucket or bottle until 4 to 12 wks of age. Separating the cow and calf early is thought to allow for better supervision of colostrum, milk and solid food intake and help prevent transmission of disease. Early separation also reduced the distress response of both the cow and calf. For example, Flower and Weary (2001) examined some of the effects of the age of separation on cow and calf behaviour and found that cows and calves that were separated (14 days versus 1 day) had higher levels of activity and vocalized more often. However, the calves separated at 14 days gained 16.5 kg over this period, versus just 4.5 kg for those separated early, and the calves maintained this weight advantage even after separation from the dam. The higher growth of calves kept with the cow may have been due, at least in part, to higher milk intakes – the spread between the cow-fed and people-fed calves shows the opportunity we have for improved gains with improved feeding management of dairy calves.

In conventional management schemes, calves are normally provided milk at 10% of their body weight (~ 4 kg per day), are vulnerable to disease, often fail to gain adequate weight and can sometimes experience high levels of mortality. We have tested the effects of feeding calves ad libitum by teat (Appleby et al., 2001; Jasper and Weary, 2002). In each experiment we compared weight gain, milk intake, starter intake and number of days with diarrhoea for calves fed milk conventionally (i.e. twice daily by bucket at 10% of body weight per day) versus ad libitum from a teat. In our first experiment, we found that weight gains during the first 2 weeks after birth were less than 0.4 kg per day for the conventionally fed calves versus 0.85 kg per day for the teat-fed ones; during the next 2 weeks gains were 0.58 and 0.79 kg per day respectively (Appleby et al., 2001). In a second experiment we again found that the teat-fed calves gained weight more quickly (0.78 versus 0.48 kg per day from birth to weaning at 37 days of age) (Jasper and Weary, 2002). We also found that calves maintained their advantage in body weight after weaning. In both experiments the differences in weight gain were likely due to teat-fed calves drinking approximately twice as much milk as the calves fed conventionally. For example, the ad libitum fed calves consumed on average 8.8 litres of milk per day, compared to 4.9 litres per day for the conventionally fed calves (Jasper and Weary, 2002). Calves limit fed according to conventional practices also show behaviours indicative of chronic hunger (de Paula Vieira et al. 2008).

It is commonly thought that feeding less milk will encourage solid feed intake. Indeed, we have found that over the first 5 weeks of life, feeding calves less milk does increase starter consumption (0.17 versus 0.09 kg per day) but this practice also severely limits weight gains (Jasper and Weary, 2002). Moreover, we have found that the ad libitum milk-fed calves quickly caught up to the conventionally fed calves in their intake of starter after weaning; both groups consumed on average 1.9 kg per day during the two weeks after weaning.

Improving access to milk raises practical problems, such as maintaining milk quality throughout the day, especially during warm weather. An alternate approach to continuous access is to provide unlimited availability of milk but only for a few hours each day. Previous research has found that calves provided unlimited access to milk spend just 45 minutes per day drinking milk, and that the largest meals occur just after the delivery of fresh milk (Appleby et al., 2001). In another study, we tested the effects of limited access to milk (4 h per day) versus continuous (24 h per day) access on milk intake, weight gain and behaviour of dairy calves (von Keyserlingk et al., 2006). Calves consumed as much milk in the 4 h per day treatment as they did in the 24 h per day treatment. An added advantage of the 4 h per day treatment, for some facilities at least, is that the same equipment can also be used to supply water to calves.

Much research and on-farm innovation is required to maximize the benefits of these new calf-feeding methods. In particular, little is known about how best to wean rapidly growing calves fed high milk rations. Current recommendations for weaning age and method are specific to slow growing calves fed conventionally, but new work is showing that slowly reducing milk intakes in the days before weaning can be helpful (Khan et al., 2007). In one study with calves fed up to 12 L per day (Sweeney et al., 2010), we compared calves weaned abruptly with calves weaned gradually over 4, 10, or 22 days. Calves weaned over 22 days ate the most starter, but also had the lowest weight gains before weaning. The abruptly weaned calves ate the least amount of calf starter but had the best weight gains before weaning. After weaning, calves on the 22 and 10 day treatments ate more starter and had better weight gains than calves on the more abrupt treatments. These findings suggest that weaning over 10 days is optimal. This type of gradual weaning is easily accomplished using automated calf feeders.

Group housing

For the past decades, common wisdom among North American dairy experts was that calves should be housed individually, in separate pens or hutches (e.g. Quigley, 1997). This practice was considered to maximize performance and minimize the risk of disease. Individual housing also helps avoid behavioural problems such as competition and cross-sucking.

The new calf-feeding methods described above work well for individually housed calves, but also facilitate group housing. Group housing provides more space for calves and allows for social interactions. Research and practical experience show that group rearing of calves can result in considerable benefits through reduced labour requirements for cleaning pens and feeding. One study on a commercial farm in New York State showed that calves kept in groups required one third of the labour that went into caring for the individually housed and fed calves (de Passillé et al., 2004). Calves are social animals that need exercise and keeping dairy calves in groups may provide a number of advantages to both producers and their calves. Successful adoption of group housing will mean avoiding problems such as increased disease and competition. Recent research provides some insights into how these risks can be minimized.

We evaluated the behaviour and growth rates of calves housed in pairs versus individually (Chua et al., 2002); calves gained weight steadily regardless of treatments. Interestingly, during the week of weaning (approximately 5 weeks of age), pair-housed calves continued to gain weight normally but the individually housed calves experienced a slight growth check. There were no differences between groups in the amounts of milk, starter or hay consumed, or in the incidence of scouring or other diseases. Aggressive behaviour and cross-sucking were almost never observed (less than 0.2% of time).

In a more recent study, de Paula Vieira et al. (in press) found that calves housed in pairs vocalized less during weaning than did individually housed calves. The results of this study also illustrated some longer-term costs to housing calves individually. When all calves were eventually introduced to a group pen after weaning calves that had previously been single housed took on average 50 h to begin feeding, in comparison to just 9 h for the pair-reared calves. These results suggest that individual housing may result in at least temporary deficits in cognitive or social tasks.

Successful group rearing requires appropriate management, including feeding method and group size. Large epidemiological surveys of U.S. and Swedish dairy farms found increased mortality and disease on farms keeping calves in large groups (more than 7 or 8) (Losinger and Heinrichs, 1997; Svenson et al., 2000). Thus, small groups are likely a better alternative than large ones.

Calf immunity and the design and management of the housing systems, such as its cleanliness and ventilation, likely affect disease susceptibility more than group housing per se.
Our work shows that housing young dairy calves in small groups is viable in terms of calf health, performance and behaviour. New research is now required on management strategies that will help prevent disease. For now, we encourage producers to consider keeping a closed herd (i.e. no new animals entering the herd), keeping groups small and physically separated from one another (e.g. in super hutches), and managing group pens in an all-in-all-out basis.

Calves in groups sometimes compete with pen mates. In one experiment using a simple teat-feeding system, we found that group-housed calves can displace one another from the milk teat many times each day if there are not enough teats (von Keyserlingk et al., 2004). However, giving each calf access to its own teat greatly reduced these displacements. This improved access to teats resulted in longer feeding times and increased milk intakes.

Other research has focused on how computerized feeding stations can be managed to reduce competition between calves. Increasing the daily milk allowance for calves from 5 to 8 litres per day reduced by half the number of times calves visited the feeder, reducing occupancy time and displacements from the feeder, and improving the efficient use of this equipment (Jensen and Holm, 2003; de Paula Vieira et al. 2008). Our research shows that young calves can be introduced into a group with little disruption when they are trained to feed from the computerized feeding station prior to the introduction (O'Driscoll et al., 2006). Although the calves visited the feeder less frequently on the day of mixing, they were able to compensate by increasing both the duration and amount consumed per meal, and established their pre-mixing feeding pattern after just one day.

Conclusion

Current research on dairy calves is paving the way for new methods of managing and housing these animals that will facilitate calf care and improve living conditions for these young animals. Calf care is arguably the most difficult job on the dairy farm. For the good calf manager, the research that we will describe provides opportunities to further improve calf care and reduce labour. However, like any new method, these are best adopted first by the best and most innovative managers. New methods require new skills and a careful eye to ensure that these are implemented in the best ways possible.

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Notes

Notes

Margit Bak Jensen

Margit Bak Jensen is a Senior Scientist at the Department of Health and Bioscience, Faculty of Agricultural Sciences, University of Aarhus, Denmark. She received a candidate degree in Animal Science from The Royal Veterinary and Agricultural University of Denmark (RWAU), a MSc degree in Applied Animal Behaviour and Animal Welfare from The University of Edinburgh, Scotland, and a PhD degree in Ethology from the RWAU.

Her research includes the effects of housing and management on behaviour and welfare of cattle, as well as the development of methods to assess behavioural needs of farm animals. Another research area is improvement of milk feeding methods for group housed calves, and investigation of the relation between feeding behaviour and health.
She is presently investigating behavioural needs of dairy cows around calving, as well as the early social needs of dairy calves.

Play behaviour as an indicator of welfare in dairy calves

Margit Bak Jensen
Faculty of Agricultural Sciences, University of Aarhus, Denmark

Good animal welfare is about the absence of negative experiences and the presence of positive experiences. Juveniles are motivated to play when their primary needs are met and when they feel no serious threats or challenges. Moreover, the performance of play behaviour is believed to indicate positive emotions. Thus play behaviour relates to animal welfare in two ways; by indicating the absence of poor welfare and the existence of good welfare.

Play behaviour in calves

Play behaviour in calves may be seen among suckled-calves on pasture as they spontaneously start galloping around as a group. Housed in pens calves often buck as a response to provision of fresh straw bedding, or after release from their pens into a novel and large area. Calf play behaviour includes fast galloping, interrupted by sudden change of direction, bucking, hind leg kicking, and body rotations and twists. This locomotor play behaviour includes elements of defence and flight, but during play behaviour these elements are exaggerated, repeated, and more variable than during the corresponding functional behaviour.

Another characteristic of play behaviour is, that it lacks the end-point of its serious counterpart. Social play includes postures and interactions seen during aggressive interactions, but play does not result in flight or submission and social play is typically interspersed with locomotor play and rotations of the head directed towards the play partner.

The function of play behaviour

The function of animal play behaviour is not clear. Due to the obvious lack of immediate purpose it has been proposed to have later benefits in adulthood, but research has found little evidence of long-term effects, and current theories also focus on short-term benefits to the juvenile (Martin and Caro, 1985). Proposed functions of play behaviour are physical training and cognitive development (Byers and Walker, 1995), self-assessment of physical and social abilities (Thompson, 1998), and training of flexible locomotor and emotional responses to unexpected events (Spinka et al., 2001).

The motivation to perform play behaviour

In relation to animal welfare we are interested in the motivation to perform play behaviour. Juveniles play when their primary needs are met, while individuals that suffer from under-nourishment, thermal stress, illness, and injury do not play. Dairy calves are typically fed a limited amount of milk and although this is not normally viewed as under-nourishment, it is often too low to sustain their growth potential until rumen development allows a substantial intake of solid foods (Barlett et al., 2006), and limit fed calves may be under-nourished. Reducing the milk allowance immediately reduced play behaviour in deer (Müller-Schwarze et al., 1982), and dairy calves offered a low milk allowance played less than their ad libitum fed peers (Krachun et al., 2010). Furthermore, weaning off milk resulted in a sudden drop in play behaviour in calves on both milk allowances (Krachun et al., 2010) and a drop in play behaviour at weaning has also been reported in piglets (Donaldson et al., 2002). Evidence of the effect of thermal stress comes from domestic pigs that did not play during periods of cold weather in a semi-natural environment, (Newberry et al., 1988). The effect of illness on play behaviour in domestic animals has not been investigated systematically, but it has been reported that castration eliminated play behaviour in lambs (Thornton and Waterman-Pearson, 2003). The absence of play behaviour when these well-known threats to welfare are in effect suggests that absence, or reduction, of play behaviour indicates reduced welfare in juvenile animals.

Play behaviour as an indicator of welfare in juvenile farm animals

The relation between play behaviour and welfare is hypothesised to be the following. The absence of motivation to play indicates a state of poor welfare (e.g. due to poor nutrition, illness, or injury). The presence of motivation to play indicates a state of good welfare (as primary needs are met and there is no suffering). More importantly, however, is that the performance of play behaviour is associated with positive emotions, and that the performance of the behaviour is rewarding in its own right (Boissy et al., 2007). Evidence to support the hypothesis that the

performance of play behaviour is rewarding is, firstly, that animals actively seek out play partners and solicit play behaviour (Fagen, 1981), and secondly, that the opportunity to play may be used as a reward in place preference conditioning experiments with laboratory animals (e.g. Calcagnetti and Schechter, 1992). In summary, the presence of the motivation to play may indicate that the primary needs of the animals are met, but only the performance of play behaviour may be taken as indicative of a positive emotion.

The physical and social environment may restrict play behaviour

The physical environment may affect play behaviour in two ways. Firstly, juveniles that are motivated to play may be prevented from play behaviour due to environmental constraints e.g. lack of sufficient space, lack of play partners or lack of suitable objects to play with. Once the constraint is lifted a rebound may result. Secondly, juveniles that are motivated to play may be more or less stimulated to play by stimuli in the environment impinging on the animals.

Housing of calves in small individual pens does not allow full social contact and thus prevents the performance of social play. The performance of locomotor play behaviour is dependent on the available space, and the traditional small individual pen limits the performance of locomotor play to a minimum and literally prevents several of the characteristic locomotor play behaviour elements. At a given space allowance, moving from individual housing to group housing gives the calves more shared space and calves with 1.4 m2 per calf did play more if in groups of 4 compared to calves in individual pens. Furthermore, in the group pen the calves could perform all elements of locomotor play unlike in the individual pen (Jensen et al., 1998).

Group housing thus gives the calves a better opportunity for locomotor play at a given space allowance. However, also increasing the space allowance for group housed calves has been found to increase the occurrence of play behaviour. At a group size of 4 calves more locomotor play was observed at the larger space allowances (3- 4 m2 per calf) compared to the smaller space allowances (1.5- 2.2 m2 per calf) (Jensen and Kyhn, 2000). Furthermore, calves kept with little space showed a larger rebound of locomotor play indicating that these calves had build up a larger motivation during the period of confinement (Dellmier et al., 1985; Jensen and Kyhn, 2000).

Suggestions for the development of play behaviour as a welfare indicator

As outlined above play behaviour is a good candidate for an indicator of positive emotions. There is, however, some discussion of whether play behaviour in all instances is a good positive welfare indicator, or not. Play is by definition without the function of the original behaviour, but nevertheless in some reports social play in piglets ending in fight is included (e.g. Blackshaw et al., 1997). Thus some elements of play behaviour may be better indicators than others in piglets (Newberry et al., 1988). In cattle the tendency for social play to develop into real fights increases as the animals reach maturity (Reinhardt, 1980), and here it is important to realize at which stage the behaviour may develop into serious interactions. One way of developing the area further could be to identify and validate so called 'play markers' as sign of true play in the different farm animal species (Newberry et al., 1988). Such play markers may be play signals, which have the purpose to communicate a playful mood to potential play partners. Such play signals often have the advantage of being conspicuous and easy to distinguish.

In future it may become possible to record play behaviour automatically. De Passillé et al. (2010) showed that data from accelerometers attached to the leg of a calf could distinguish between walking, trotting and galloping, as well as count the number of steps taken in each category. Galloping is the most predominant element of locomotor play behaviour in dairy calves when housed in spacious group pens (Jensen et al., 1998), and automatic collection of this variable would make data collection of play behaviour on a large scale possible.

Perspectives

As outlined above there is support for the suggestion that play behaviour in juveniles indicates the presence of good welfare. Future research should focus on validation of play behaviour as indicative of positive emotions in calves, on identification of 'play markers', and on development of techniques to automatically record play behaviour. This would potentially enable us to relate play behaviour to various housing and management conditions, as well as to health status on commercial farms.

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Notes

Marion Kluivers

Marion Kluivers graduated at the Veterinary Faculty of Utrecht University in 1999. She worked at the Pig Health Unit of the Farm Animal Department at the same faculty for seven years as a teacher and veterinarian. In this period she was trained to become a specialist in porcine health and management, with an emphasis on reproduction and welfare.

In 2007 she started working at the Animal Sciences Group of Wageningen University and Research Centre (at present called Wageningen UR Livestock Research), in the section Welfare & Health. In the following two years she dedicated her time to research into the effects of the use of anaesthetics and analgetics in castration of piglets. Effects of the use of local anaesthesia with lidocaine, pain relief with meloxicam and general anaesthesia with carbon dioxide were investigated. In 2008 this resulted in the introduction of carbon dioxide anaesthesia in Dutch swine husbandry. In 2009 she started working on her PhD investigating new methods to measure pain during tail docking of piglets.

Evaluation of pain associated with routine procedures in piglets

Marion Kluivers
Wageningen UR Livestock Research, Lelystad, The Netherlands

During early life piglets are submitted to several routine husbandry procedures. Usually in their first week of life, a piglet's tail is docked, teeth clipped or grinded, ear notched or tagged and iron, vaccines and/or antibiotics injected. Besides these, male piglets are also castrated. These procedures were accepted, until recently, as common husbandry practice. However, concern is growing because of the integrity of animals and the (suspected) pain these procedures are accompanied with. Extensive research has confirmed the experienced pain of several of these procedures. It is, however, not easy to assess pain in animals.

Pain is considered a subjective experience and according to this, in humans, self scoring is a preferred method. People themselves indicate the amount of pain they experience: 'Pain is what a person says it is'. Understandably, this subjectivity is not easy to measure in animals. Since there is no golden standard to relate measurements to, measurements in animals that undergo a painful procedure (i.e. castration or tail docking) are compared to measurements in control (sham) animals.

It is assumed that measurements are linked to a noxious sensory input when:

1. A change is measured in treated but not in control animals

2. A change is prevented by administration of anaesthesia

3. A change is less pronounced after administration of anaesthesia

Assessment can either be focussed on the procedural pain (at the time of surgery) or the post procedural pain (afterwards). Husbandry procedures in piglets are extensively used in pain research for two main reasons; 1. to assess the pain caused by these procedures, 2. to develop new methods for measuring pain. The latter reason has the advantage that no unnecessary pain is inflicted on the animal, since the procedure will be carried out nonetheless. Although there are no specific parameters for pain, it is generally accepted that animals can react to painful stimuli in two major ways: physiologically and behaviourally (among which vocalization).

The physiological response to pain and stress consists of activation of the sympathico-adrenal system (SA) and the hypothalamus-pituitary-adrenal gland axis (HPA). Activation of the SA-system can result in changes in (nor)adrenaline levels, heart rate and blood pressure, diameter of pupils and peripheral blood flow. Activation of the HPA-system can result in changes in CRH, ACTH and cortisol levels. For measuring changes in these components several sampling methods are required that vary regarding the invasiveness to the animal. An invasive sampling method provides stress to the animal, which may in turn influence the measured changes. Generally, this is not a problem since treated animals are compared to control animals. It is, however, a problem when the variable of interest has a ceiling level that is (nearly) reached by the stress of measuring. A difference caused by the procedure will not be made visible under those circumstances. Another problem can be considerable within-group variability. This is often present when measuring cortisol and may lead to a diminished capacity to detect between-group differences. Measuring changes instead of absolute levels is a solution in this case.

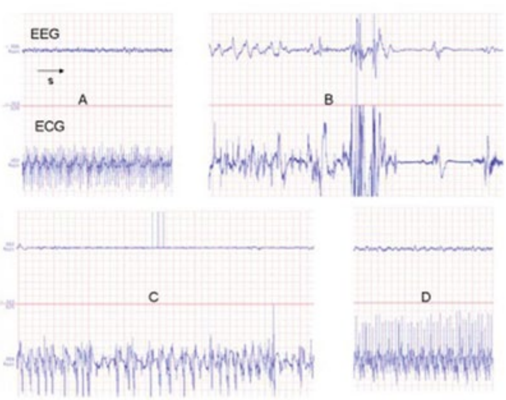
As a behavioural measurement, vocalizations in piglets are merely used to assess procedural pain. During castration, piglets squeal more often, more loudly and at a higher pitch than piglets that are only being held, or piglets being castrated with local anaesthesia (Weary et al., 1998; Taylor and Weary, 2000; Taylor et al., 2001). Detailed analysis of vocalizations provides insight into the effects of anaesthesia as well as analgesia during castration of piglets (Animal Sciences Group, 2007). When compared to control animals, local anaesthesia lead to a change in almost all components of vocalizations, while a NSAID also influenced several aspects. As is found in literature important aspects of vocalizations to assess procedural pain appeared to be entropy, duration and main frequency of high frequency calls.

In the days after a procedure changes may be seen in behaviour. Assessed behaviour can be divided in non-specific (normal) behaviours,

pain related behaviours and social cohesion. Pain can cause a change (increase or decrease) in non-specific behaviours like suckling or walking, or an increase in pain related behaviours like huddling, tail wagging and trembling (Taylor and Weary, 2000; Taylor et al., 2001; Hay et al., 2003). These changes are especially important within the first few hours following castration, but also over subsequent days. In one of our studies into the effects of anaesthesia and/or analgesia on pain (Animal Sciences Group, 2007) behavioural changes during four days after castration appeared to be limited. There was a tendency over the whole observation period that piglets castrated without anaesthesia and piglets castrated under anaesthesia with lidocaine showed more pain-related behaviour than piglets that underwent sham castration. Surprisingly, piglets treated with lidocaine showed significantly more tail-wagging (a pain-related behaviour) than the piglets in the other treatment groups. This effect of lidocaine was absent when meloxicam was also administered The effect on behaviour was greatest during the first afternoon after castration. In the following observation periods, other behaviours only sporadically showed a treatment effect or trend. Consistent effects over several periods were not found. The question raised is whether this is due to the method of registering behaviour (scan sampling), to a limited effect of pain on behaviour or maybe to the specific study design. In several studies into the painfulness of husbandry procedures, piglets have undergone certain procedures (i.e. tail docking, iron injection) before the experiment (Hay et al., 2003). Surgical injuries are known to induce hypersensitivity at the injury site, but also in adjacent tissues, called secondary hyperalgesia (Lavand'homme, 2006). Secondary hyperalgesia is considered a consequence of central sensitization and results from enhanced response of dorsal horn neurons in the spinal cord to peripheral inputs, with magnitude and duration related to the degree of tissue injury. Brennan et al. (1996) found that incision into the muscle of a rat's foot caused hyperalgesia for several days. Amputation of a part of the body often leads to persistent pain which can last for months to years, including stump and phantom pain (Weinstein, 1994). Therefore, docking piglets' tails could induce hyperalgesia in the hind area of the piglet including the scrotum. When piglets are subsequently castrated a couple of days after tail docking, this could lead to an increased pain sensation in the piglet, resulting in higher frequencies of pain related behaviour of castrated piglets. Therefore, study design is an important point of interest when comparing studies into pain and when designing a study.

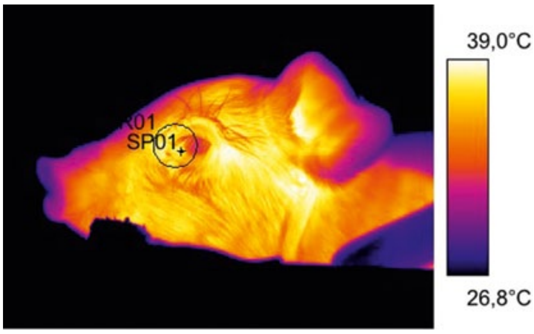
Weight is an indirect measurement of pain that is used in laboratory animals. Substantial weight loss after surgery is indicative of severe pain and reason to exclude an animal from the study. This weight loss can be caused by a decreased feed intake or an increased need. Piglets, however, are young and fast-growing and thus weight loss will only appear under the most severe of circumstances. A more appropriate measurement is decreased growth. In young piglets, weight is easier to assess than suckling behaviour, which is quite labour intensive. This would make growth an interesting measurement. However, growth after castration and tail docking proved an insensitive measurement in several of our studies with piglets of 3 to 6 days of age (Animal Sciences Group, 2007 and unpublished results), as it was also in a study of McGlone et al. (1993). Weighing piglets daily during a week after castration or tail docking showed no differences in weight gain between treatments. This may be due to the fact that teat order has been established at 3 days of age and piglets don't have to compete anymore during suckling.

Newer or less researched methods for measuring pain include electroencephalogram (EEG), infrared thermography (IRT) and heart rate variability (HRV). EEG is especially important in research where general anaesthesia is used. During unconsciousness brain activity is measured to evaluate the pain signal that is registered in the brain. In our research regarding carbon dioxide anaesthesia, piglets showed no change in brain activity when castration was performed, which lead to the conclusion that the pain of castration is not registered (Animal Sciences Group, 2007). Advantages of IRT and HRV are that they can be monitored in a non-invasive way and thus cause little additional stress to the animal. IRT is used in human medicine to measure localized changes in skin temperature due to underlying processes, for example breast cancer or inflammations.



Less researched is the use of skin temperature to monitor generalized reactions to stress and pain. Stewart et al. (2008) used eye temperature in calves to measure a reaction during dehorning. They found a significant decrease in eye temperature shortly after the procedure. In a recent study we assessed the possibility of using skin temperature to measure pain in piglets during tail docking and ear tagging. Both procedures caused a decrease in skin temperature. Further research should provide more insight into the possibilities and limitations, as well as the underlying mechanism.

Possibilities for pain relief during husbandry procedures in piglets are limited. In The Netherlands, no specific anaesthetics are registered for use during husbandry procedures in piglets, and only meloxicam (Metacam®, Boehringer Ingelheim) has a specific registration for postoperative pain. This makes the use of anaesthesia 'off label use' and not available for general use. When using anaesthesia in piglets, this must preferably be short-acting and able to substantially alleviate pain during the procedure. From a practical point of view, anaesthesia has the disadvantage of a substantial increase in costs, because anaesthesia can only be provided by veterinarians. The only husbandry procedure in which anaesthesia is sometimes used is castration. The most widely used anaesthetic method for castration is the injection of lidocaine into the testicles, as is commonly practised in Norway since 2002. After injection in the testicles, lidocaine disperses into the spermatic cord (Ranheim et al., 2003) and provides anaesthesia at the location where the cord is severed during castration. Various studies have shown that the intratesticular administration of lidocaine reduces the pain sensation at the moment of castration. There is, for example, less disruption to suckling behaviour after castration, and the animals struggle less, particularly when the spermatic cord is cut



(Horn et al., 1999). However, injection causes a certain amount of pain and the pain response during castration does not disappear completely. This may be explained by the limited time frame in which castration should be performed after administration of lidocaine, or by the fact that the cremaster muscle is not anaesthetised with this method.

General anaesthesia is an alternative that can provide an advantage regarding the level of pain relief, but can have disadvantages regarding safety of user as well as animals. A combination of azaperone and ketamine can be used for general anaesthesia by injection in piglets, but this method has many disadvantages. The level of reduced consciousness and analgesia is much less than with narcosis. During castration, the animals still struggle, albeit to a lesser extent (Lahrmann et al., 2004; Kmiec, 2005). The incidence of mortality and poor wound healing is higher than in unanaesthetised control groups (Kmiec, 2005; McGlone and Hellman, 1988). Coordination is impaired as the anaesthetic wears off, which means that piglets may become trapped under the sow and crushed. General anaesthesia through inhalation (inhalation anaesthesia) takes effect quickly and ensures good muscle relaxation and loss of consciousness. A disadvantage is that many gases (i.e. isoflurane) can be used only under strictly controlled conditions, in line with health and safety considerations. In addition, gases are generally expensive. Carbon dioxide is an exception, it is relatively cheap and not subject to strict regulation. CO_2 prevents struggling during castration, but struggling and squealing during the induction phase can be observed (Kohler et al., 1998). Safety margins are narrow, however, under controlled circumstances it can safely and effectively be used (Gerritzen et al., 2008). The administration of a Non-Steroidal Anti-Inflammatory Drug (NSAID) prior to castration reduces postoperative pain, and has a limited effect on intraoperative pain. An important advantage of a pre-operatively administered NSAID is that it protects the pain system against excessive activation and sensitisation to subsequent pain stimuli (Song and Carr, 1999; Sumihisa, 2005).

In piglets meloxicam can be used, which is registered for postoperative pain relief, available in an appropriate concentration for piglets and is effective for at least 24 hours. It can be discussed whether a NSAID should be administered more than just once after surgery.

Studying literature provides researchers with a great variety of pain measurements. However, pain (perception) varies according to the site, duration and intensity of the stimulus and can be modified by previous experience, emotional state and perhaps innate individual differences. This makes it hard to choose one parameter or a defined combination of parameters that can be used under all circumstances. It also emphasises the importance of study design when measuring pain and comparing results. In available research, there is no clear consensus regarding pain measurements to be used. Several studies are exclusively focussed on a single parameter, while others use a combination of physiological and/or behavioural parameters. In the latter situation problems with the interpretation of results can arise, when the measured parameters do not give a consistent result. Often, parameters are explained individually.

Developing an acceptable protocol for the use of anaesthesia or analgesia during husbandry procedures in piglets is an ongoing search. The challenge is to develop a protocol that significantly reduces the amount of pain the animal experiences, while safety, method of administration as well as costs are taken into account as important considerations.

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Notes

Prof. Eberhard von Borell

Institute of Agricultural and Nutritonal Sciences, Martin-Luther-University
Halle-Wittenberg, Department of Animal Husbandry and Ecology
Theodor-Lieser Str. 11, D-06120 Halle (Saale), Germany.
e-mail: eberhard.vonborell@landw.uni-halle.de

Eberhard (Ebby) von Borell has a degree in Agricultural Biology and a PhD in Life Sciences from the University of Hohenheim in Germany. After his PhD he spent in total 6 years in Canada (University of Guelph) and the United States where he held a faculty position in Animal Behaviour and Stress Physiology at Iowa State University. In 1994, he became a Professor in Animal Husbandry and Ecology at the Martin-Luther-University Halle-Wittenberg in Germany. His main expertise is in animal welfare, animal housing and management assessment and behavioural physiology.

Tatjana Schmidt

Tatjana Schmidt is currently working on her PhD on alternatives to non-anaesthetized piglet castration. She conducted her diploma thesis research at the Conservation & Research Center of the National Zoo, VA, USA, studying the parental behavior of maned wolves (Chrysocyon brachyurus) and reproductive physiology of corsac foxes (Vulpes corsac). She received her degree in biology (behavioral physiology) from the University Wuerzburg, Germany.

Impact of anaesthesia and analgesia on post–castration behaviour and teat order of piglets

Prof. Eberhard von Borell and Tatjana Schmidt
Department of Animal Husbandry and Ecology, Martin-Luther-University Halle-Wittenberg, Germany

Introduction

For animal welfare reasons, alternatives to anaesthesia-free piglet castration have been demanded in a few European countries. In the EU report by the panel of experts PIGCAS, additional research in the field of animal welfare pertaining to general anaesthesia and analgesia has been recommended (PIGCAS Report, 2009; von Borell et al. 2009). Studies by Lahrmann et al. (2006) and Kmiec (2005) show that neuroleptanalgesia (injection anaesthesia with ketamine and azaperone) can reduce the defensive movements during castration but cannot always prevent it. However, as an alternative to piglet castration without anaesthesia, they refer to this method as practical and as in conformity with animal welfare standards.

A disadvantage of this type of general anaesthesia is the long post-operative sleeping phase (approximately 3 hours) that makes it necessary to separate the piglets to prevent them from being crushed by the sow. Behavioural analyses by Wemelsfelder and van Putten (1985) noted lasting symptoms of pain as well as a decrease in the activity and play behaviour of castrated piglets. They therefore concluded that piglets experience pain for up to five days after the operation. The results obtained by Mcglone et al. (1993) and Hay et al. (2003) demonstrated that castrated animals spend less time suckling on the first day after castration than non-castrated animals. Zonderland and Verbraak (2007) did not note any difference in post-operative behaviour between castrated piglets with or without the administration of analgesic medication (meloxicam, Metacam®, Boehringer Ingelheim), and no difference was observed in uncastrated piglets either. Llamas Moya et al. (2008) found that castrated animals (without anaesthesia or analgesia) were less active (walking) directly after castration than non-castrated animals. Although behavioural changes alone do not allow definitive conclusions to be drawn, changes in the activity level and suckling behaviour of piglets appear to be indicators of pain or stress. The EFSA report (2004) recommends that anaesthesia should influence piglet behaviour as little as possible after surgery. Other studies also cite this as an important factor in choosing alternatives to castration without anaesthesia (Mcglone et al. 1993; Prunier et al. 2006).
The aim of our investigation was therefore to analyse the behaviour of piglets after castration that had received a combination of general anaesthesia (ketamine/azaperone [K/A]) and analgesia (meloxicam [M]), in order to evaluate the influence of medication and separation on post-operative behaviour.

Materials & Methods

The experiment included 82 piglets (5-7 days old, > 2 kg, Hermitage x Piétrain) from 29 litters that were subject to three types of treatment: Group 1 (combination, n=29) received a combination of anaesthesia (K/A) and analgesia (M); Group 2 (meloxicam, n=24) was only given analgesic medication (M); Group 3 (control, n=29) was the control group and was castrated without medication. The drugs (Ursotamin®, 25 mg/kg; Stresnil®, 2 mg/kg; Metacam®, 0.4 mg/kg) were administered 10 minutes before castration. After surgery, all of the piglets were separated from the sow by a board in their pen during the post-operative sleeping phase to protect them from being crushed. A second piglet nest with a piglet mat and heat lamp was set up behind the board to protect the animals from hypothermia. Their behaviour was observed for three hours on the day before castration and for three hours after castration (after reunion with the sow). A single observer who was "blinded" to the different treatments conducted focal animal observations from video tapes (the observer was unaware of the meaning of the markings on the backs). The length of time that the animals spent in active behaviour (walking/standing away from the suckling area) was compared with suckling duration (lying or standing with the snout at the teat).

Two criteria were used to evaluate the constancy of the suckling position:

1. During the observation period before castration, the suckling position (1-7, cranial to caudal) in which a piglet spent most of its time (preferred teat position [PTP]) was determined, and this was compared with the position after castration/separation (change in direction to anterior = higher in rank, posterior = lower in rank).
2. The number of teats used (at which a piglet spent more than two minutes over a three-hour period) was measured and compared.

Statistical analysis

The length of time that the piglets spent suckling and in active behaviour was analysed using a linear mixed model in SAS (9.1). The treatment (three levels) and time period (four levels) were considered fixed effects in the model. The individuals were clustered for each litter/sow (29 levels) and considered a random effect. Because the data were not normally distributed, data were ranked for analysis. A Wilcoxon matched pair test was used in a before/after comparison of the number of teats used. The change in PTP was evaluated using a logistical analysis of variance (ANOVA). In addition, a Spearman rank correlation coefficient was calculated for the teat positions. The weight gains were compared using unifactorial ANOVA.

Results

The group of anaesthetized animals contained the highest proportion of piglets that changed their preferred teat (PTP), but the difference was not significant (Group 1: 27.5%; Group 2: 16.0%; Group 3: 17.2%). In the Metacam group, no animal switched to a “lower-rank” teat position (anterior: high, posterior: low), whereas 10.3% of the anaesthetized animals and 13.8% of the control animals lost their preferred teat position after the three-hour separation (x2=5.3, p=0.07) (Fig. 1). The Spearman rank correlation coefficients of rs = 0.98, 0.88 and 0.90 revealed a high agreement for the teat positions used before and after castration in the control, Metacam® and combination treatment groups.

After castration and separation, all piglets used a greater number of teats than before castration. However, this increase was only significant for the anaesthetized piglets (p=0.004; Group 2: p=0.054; Group 3: p=0.068, Fig. 2).

With a difference of almost 200% (corresponding to 31 min/3 h), the anaesthetized animals (combination) exhibited a significantly higher increase in activity (comparison of before and after castration) than the other two treatments (control: 49%, Metacam: 52%, p<0.001), but revealed a decrease of 27% in the suckling time (Fig. 3). The piglets that underwent analgesic treatment (Metacam) spent 68% more time suckling (corresponding to 19 min/3 h) after separation, whereas the control animals scarcely revealed any difference from the period before castration (Fig. 3). All three treatments exhibited significant differences in suckling times (Group 1-2: p< 0.001; Group 2-3: p= 0.002, Group 1-3: p= 0.018).

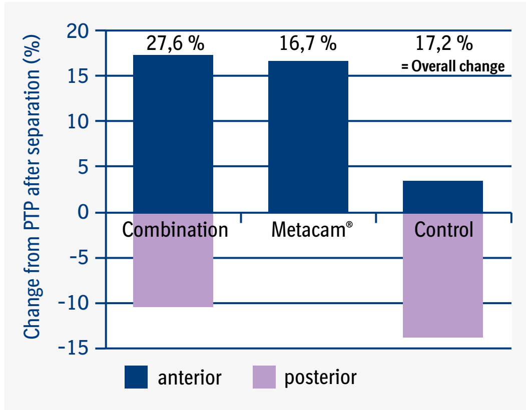

Figure 1. Proportion of piglets (%) changing from their preferred teat position (PTP) after castration/separation, to a lower (posterior) or higher (anterior) position.

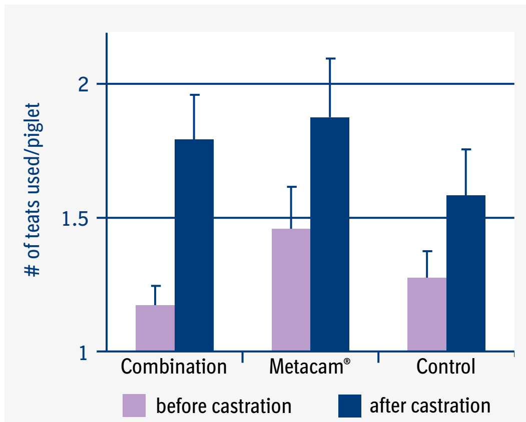

Figure 2. Average number (#) of teats used per piglet (longer than 2 min in 3 hours) before (light columns) and after (dark columns) castration (±SEM).

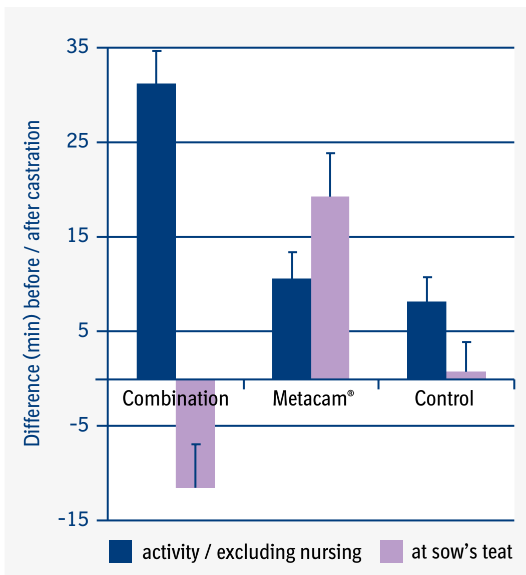

Figure 3. Difference of activity (away from the sow [dark columns]) as well as time at sow’s teat (min [light columns]) after separation compared to before castration (±SEM).

The weight gain (Fig. 4) was between 7 and 10% of body weight. From the day of castration to day 1 after castration, the piglets in the combination treatment experienced a slight decrease in weight (7.3%) compared with the previous day (before castration: 8.3%). However, this difference was not significant when compared with the other treatments (p=0.108) and was already compensated for by day 2 after castration.

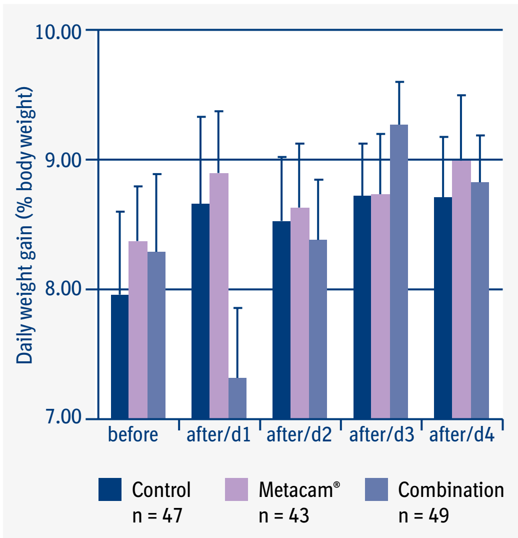

Figure 4.
Daily weight gain (in % body weight) of piglets from the day before castration to castration day, as well as from castration day to the following 4 days (±SEM).

Discussion

The high correlation of rank before and after castration shows that the suckling order was not substantially influenced by the three-hour separation of male animals. Nonetheless, although not significantly higher, nearly 30% of the anaesthetized piglets changed their PTP, which indicates a certain amount of disturbance after reunion. Accordingly, for every treatment, there was a rise in the number of teats used and hence an increased change in position after reunification. This disturbance arising from the re-establishment of the suckling order could have a negative effect on all members of the litter. Interestingly, it appeared easier for the piglets that had received Metacam® to be re-integrated into the group. These animals exhibited the lowest proportion of changes and were not displaced into lower ranking positions. The analgesic treatment may give them an advantage in recovering their PTP. Accordingly, they spent significantly more time suckling than the other treatment groups.

Mcglone et al. (1993) and Hay et al. (2003) demonstrated that castrated piglets spent less time nursing (massaging & suckling) and were less active than non-castrated animals. Langhoff (2008) confirmed a tendency towards a reduction in teat stimulation in the first hours after castration for piglets without analgesic treatment and the contrasting positive effect of Metacam® on suckling behaviour. In the present study, the animals that received analgesic treatment (Metacam®) spent much more time suckling after castration than before, whereas the control group scarcely exhibited any change (Fig. 3). This behaviour of the animals receiving analgesic treatment may help them recover their teat position (see above), and could be interpreted as an indicator of the efficacy of the analgesic.

The results obtained by Llamas Moya et al. (2008) demonstrated that piglets "in pain" (castrated) were less active after surgery than animals "without pain" (non-castrated). In our study, however, there was no difference in activity between animals with and without analgesic treatment (Metacam®), thus preventing the conclusion that the animals were "pain-free".

The strong increase in activity of the anaesthetized animals (combination) after castration probably arises from impaired coordination. They moved about within the pen apparently disoriented and restless, whereas piglets that

underwent the other treatments searched for a teat or rested more quickly after reunification. This impaired orientation could also have contributed to the decreased suckling time.

In earlier studies, K/A anaesthesia has been described as being "practical and in conformity with animal welfare" with reference to the reduction of pain during surgery (Kmiec, 2005; Lahrmann et al., 2006). Based on our results, it is however doubtful that the animal's post-operative well-being is improved by this method, because the additional handling, recovery from anaesthesia and long post-operative sleeping and hunger phase are also stressful for the animals and, furthermore, may lead to a significant loss of energy (such as from increased activity). Separating the piglets by a board in the pen is stressful for both piglets and sow, since they both hear each other's vocalizations but cannot reach each other for three hours. In practice, it would probably be impractical to separate the piglets by removing them from the pen due to reasons of space.

Neonatal animals are sensitive to hypothermia and their metabolic and excretory functions may still be too underdeveloped to completely process the drugs (Prunier et al. 2006). According to the EFSA report (2004), an animal's behaviour should be influenced as little as possible after surgery. However, our results show that anaesthetized piglets exhibit significant behavioural changes during an observation period of up to six hours after castration. In the first days after birth, in particular, separating and reuniting the male animals could be a stress factor for the entire litter since the suckling hierarchy is established during this period. Reducing the stability of the suckling order can trigger fights between the piglets. If the milk intake is also reduced as a consequence, this can be particularly critical for young piglets. According to Ewbank (1976), a stable suckling hierarchy is the basis for a calm, "satisfied" and productive group of piglets. The weight comparisons in this study, however, showed that separation for three hours and re-establishing the suckling order do not significantly affect the piglets' weight increases.

Another alternative is inhalation anaesthesia using isoflurane, halothane or CO_2 (carbon dioxide). Although these methods are associated with their own disadvantages (von Borell et al. 2009; PIGCAS Report, 2009), the short post-operative sleeping phase should be considered advantageous in comparison to K/A injection anaesthesia because it presumably has less of an effect on piglet behaviour.

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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, and companion animal behaviour. He has been member of several working groups of the Panel on Animal Health and Animal Welfare of the European Food Safety Authority and has published around 90 papers in international journals.

The effect of parity and time on pain and discomfort associated with normal calving in dairy cows

Prof. Xavier Manteca, Eva Mainau, Anna Cuevas, José Luis Ruiz de la Torre
School of Veterinary Science, Universitat Autònoma de Barcelona, Spain

Introduction

Pain caused by parturition is a welfare problem and may substantially modify the normal behaviour of dairy cows around calving. Meloxicam is a non-steroidal anti-inflammatory drug (NSAID) of the oxicam class that acts by inhibiting prostaglandin synthesis and inducible cyclo-oxygenase-2 (COX-2), thereby exerting anti-inflammatory, antiexudative, analgesic and antipyretic effects. The objective of this study was to investigate the effects of parity and time on pain and discomfort caused by calving in dairy cows using general indices, physiological and behavioural parameters. It is part of a larger project aiming to assess the effects of the NSAID meloxicam on pain associated with calving.

Material and methods

The study was carried out on a commercial dairy farm (Torre Santa Maria, Vallfogona de Balaguer, Lleida, Spain). A total of 60 Friesian cows: 30 heifers and 30 multiparous cows (from second to sixth parity) were studied. Only cows with a satisfactory body condition and without lameness or any other clinical signal of illness were included in the study. Only calving without assistance (score 0) and calving with some assistance with an easy manual pull (score 1) were included in the study. About ten days before the expected end of pregnancy, cows were housed in a cowshed with straw. The calves were kept with their dams for a minimum of 30 minutes and a maximum of 4h after calving. After calving, cows were allocated in groups in a new post-calving cowshed. Cows were milked twice a day (at 9:00am and at 7pm). The illumination was constant to allow 24 hours per day of video recording, and cows were identified individually. Cows were randomly allocated into two homogeneous groups regarding parity and treated with either meloxicam (Metacam® 20mg/mL inj. sol; Boehringer Ingelheim) SC, at a dose 0.5mg/Kg BW or excipient as placebo. Treatments were administered within a maximum of 12 hours after calving.

The timing of the following events was recorded: position of the calf at birth (head or back position), sex of the calf (male or female), calving difficulty (score 0 or score1) and the time interval between calving and treatment (in hours). Milk production was studied during 1 month after calving. Rectal temperature was measured every 12 hours, from the first day the animals enter in the pre-calving cowshed to 3 days after calving and everytime a blood sample was taken. The Acute Phase Protein (APP), Haptoglobin

(Hp, mg/mL) and serum amyloid A (SAA, µg/mL) were determined in blood serum samples taken postcalving (d0) and on d2, d4 and d15 after calving. Cow activity, calculated as the number of steps per hour, was obtained using activity meter (Westfalia®, Germany) from 1 day before to 7 days after calving. Behaviour was observed at 10 minutes interval using video recordings from 2 days before to 2 days after calving. Behaviours observed were: cow position in the pen (eating, drinking, peripheral or central area), cow posture of the cows (inactive posture that included lateral and semi-lateral recumbency or active posture that included standing, walking or position changes), head behaviours (rumination, eating or drinking), back behaviours (tail up or tail down) and body behaviours (arching, scratching, rubbing against the wall or contractions). Moreover, total of 7 behaviours were observed continuously during 15 seconds every 10 minutes from 2 days before to 2 days after calving. The behaviours studied were: looking and turning head, kicking, self-grooming, interaction grooming, exploratory behaviour and interaction behaviour (positive or negative interaction). Veterinary treatments and all kind of diseases and disorders diagnosed after calving were studied.

All the statistical analyses were carried out with the Statistical Analyses System (SAS V9.1; software SAS Institute Inc., Cary, NC; 1991-2001). The significant level was established at $P<0.05$.

Results

The study began with similar calving conditions in both treatments, but not in both parities. Heifers showed a higher percentage of calving with a score 1 than multiparous cows (64% versus 28.57%; $p=0.0060$). Milk production showed a parity effect ($p<0.0001$), where multiparous cows showed a higher milk production than heifers. Also, milk production showed a day effect ($p<0.0001$) because after calving the milk production increased every day. Rectal temperature showed a day by parity interaction effect ($p=0.0366$). Heifers had higher rectal temperatures than cows on all day except on d15 after calving. In both cows and heifers, the highest rectal temperature was found on the day of calving (39.12 ± 0.07 in heifers vs 38.81 ± 0.05 in cows). Heifers, but not cows, showed daily changes in rectal temperature from d1 to d4.

Concentrations of APP on d2 and d4 were significantly higher than those on d0 and d15 ($p<0.0001$). Heifers showed higher values than multiparous cows (Hp: 0.73 ± 0.07 vs 0.48 ± 0.06 and SAA: 132.04 ± 13.27 vs 85.86 ± 12.59) ($p=0.0039$ and $p=0.0031$ respectively). A significant positive correlation between Hp and SAA was found ($r=0.79$; $p<0.001$).

Activity showed a day by parity interaction effect. Heifers had higher general activity than cows from day 1 before until two days postcalving ($p<0.01$). In heifers and cows, activity was higher around calving (from d-1 to d2) than from d3 to d7. Activity also showed a parity per treatment interaction effect. Heifers that received meloxicam treatment showed a significant higher activity during days after calving than heifers that received placebo treatment ($p=0.014$). Although the degree of calving difficulty did not show any effect on activity ($p=0.1565$), the position of the calf at birth showed a simple effect because cows whose calf was born in a back position, showed more activity than those whose calf was born in a head position ($p=0.0444$).

A time effect was observed in the position of the cows in the precalving and postcalving pen. In the period of -12h precalving, cows stayed for a lower proportion of time in the drinking area (p=0.0042). From -18h precalving to +6h post-calving, cows spent less time in the eating area (p=0.0186). Moreover, in the postcalving pen, cows whose calf was born in a head position, spend more time in the drinking area pen than those that their calf was born in a back position (p=0.0402).

A time effect was also observed in the posture of the cows in the precalving and the postcalving pen. In general, cows were more active during the hours preceding calving than after calving. The period of -48h, -36h and -24h were the periods of time where the cows presented the highest percentage of active behaviour. In the period of +6 hours postcalving, cows were less active than the other periods of hours postcalving studied (p<0.0001).

Head behaviours showed a time effect (p=0.0006). Since 12 hours before calving, cows spend less time eating, drinking and ruminating in comparison to the other hours studied. After calving, cows increased the time spend eating, drinking and ruminating. For instance, the period of +6h presented a higher percentage of head behaviours than the other period of hours studied. Back behaviour showed a time effect (p<0.0001). About 12 hours before calving, cows started to do the tail-up behaviour. After calving, the period of +6h presented a higher percentage of tail-up behaviour than periods from +12h to +48h. Moreover, period of +12h showed a higher percentage of tail-up behaviour than periods from +18h to +48h (Figure 4). The body behaviours observed (arching, scratching, rubbing against the wall and contractions) did not show any significant fixed effect.

Some of the quantitative behaviours showed a time effect in the precalving pen. For example, during the -30h and -6h period, cows looked and turned head more frequently in comparison the other periods of time studied (p=0.017). Also, during the -12h and -6h period, cows showed a higher number of exploratory behaviour than the other periods of time studied (p=0.0003). Similarly, some of the quantitative behaviours showed a parity effect: heifers performed a higher kicking behaviour during days preceding calving than multiparous cows (0.38±0.050 versus 0.24±0.021 times/hour; p=0.004) and had a tendency to perform a higher number of self-grooming behaviour after calving than multiparous cows (0.21±0.019 versus 0.16±0.012 times/hour; p=0.08).

In the precalving pen, cows that received some manual assistance with an easy pull (score1), showed a higer frequency of turning head, kicking and self-grooming behaviour than cows that did not recive any assistance (score0) during calving (p=0,03, p=0.007 and p=0.01 respectively).

No cow was diagnosed with digestive or respiratory disorders during 15 days after calving. Only one multiparous cow from placebo treatment had left displaced abomasums and one multiparous cow from meloxicam treatment was affected by milk fever. During 15 days after calving, heifers showed a higher probability to have metritis and fever than multiparous cows (p=0.0035 and 0.0020 respectively).

These results will be discussed in the presentation as a means to assess pain and discomfort caused by calving, as well as in relation to the differences between heifers and multiparous cows.

Iris Kolkman

Iris Kolkman studied a Bachelor in Veterinary Medicine from 1998-2001 at the University of Antwerp (RUCA) in Belgium. She then prepared a Master in Veterinary Medicine at Ghent University (UGent). Her thesis was on Immunity against endoparasites in ruminants.

In 2004, she embarked on an Internship in the European College of Bovine Health Management with the Ambulatory Clinic, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine at Ghent University. From 2005-2008, she was resident at European College of Bovine Health Management in Ghent. Concomitantly, she was part-time employee of the Department of Agro- and Biotechnology at KaHo Sint Lieven, Sint Niklaas, Belgium where she monitored a project aiming at “Exploring the natural calving ability in the Belgian Blue (BB).

In 2009, she became a Diplomate of the European College of Bovine Health Management. She defended her PhD in Veterinary Medicine on the “Calving problems and calving abilities in the phenotypically double muscled Belgian Blue breed” in January 2010. She gave many presentations in internationals congresses and conferences and was involved in a number of peer reviewed publications.

Indicators of pain in double muscled Belgian Blue cows following caesarean section

I. Kolkman[1,2], S. Aerts[3], H. Vervaecke[1], J. Vicca[1], J. Vandelook[1], A. de Kruif[2], G. Opsomer[2], D. Lips[1,3]

[1] Department of Agro- and Biotechnology KaHo Sint-Lieven/Association University of Leuven, Ethology & Animal Welfare group, Sint Niklaas, Belgium,
[2] Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium,
[3] Centre for Science, Technology and Ethics, University of Leuven, Leuven, Belgium

The present paper describes a study of the behaviour of double muscled Belgian Blue cows during the peripartum period in order to assess the differences in pain perception in cows calving per vaginam versus cows delivering by caesarean section (CS). In one herd a total of 30 multiparous cows, of which 17 delivered by CS and 13 calved per vaginam, were closely observed at approximately 1 month before calving and at day 1, 3 and 14 after parturition. The main behavioural indicators of pain were alertness, transition in posture from standing to lying and vice versa, aggressive behaviour, vocalization, rumination quality, reaction on wound and vulva pressure, and the percentage of visible eye-white.

Results show that after a CS, animals had significantly ($p < 0.05$) less limb movements, and had more transitions in posture ($p < 0.001$) on the first day after calving in comparison to cows that calved per vaginam (Table 1). In the CS group, the rumination quality was lower and less time was spent eating ($p < 0.001$; Table 1). Results also demonstrated a difference in total resting and standing time ($p < 0.001$), the resting time being longer and the standing time shorter within the CS group. When lying down, CS animals laid more on their right site ($p < 0.001$; Table 1). Finally, cows of the CS group reacted significantly more when pressure was put on their left flank, whereas animals that calved naturally showed more reaction when the area around the vulva was touched ($p < 0.05$; Table 1).

All these above mentioned significant differences were only observed on the first day after calving. On the third day post partum there was only a significant difference in the time spent eating ($p < 0.05$) and the reaction of the animal to wound pressure ($p < 0.05$). Animals delivered by CS spent more time eating and reacted more upon pressure on the left flank. Fourteen days after calving the animals in the CS group did not only show a more sensitive reaction after pressure on the left flank, but also showed more interest in their neighbour by sniffing ($p < 0.05$). Vocalisation, both loud and soft, occurred more frequently in the naturally calving group ($p < 0.05$).

The differences in eating and rumination time can be explained by the farm management since the farmer did not feed the CS animals during the first day after surgery to prevent adhesions between rumen and peritoneum. On D3, when food was available, eating time was higher in CS cows than in naturally calving cows, possibly to compensate for the period of food deprivation.

*Table 1.
Comparison of general activity, pain indicators and activity budget between the naturally calving and CS group on the first day after calving (D1; 3 x 45 min observation)*

Observations	CS N = 17	Natural calving N = 13	Probability (Mixed Model or x^2)
General activity (#)			
overall activity	251 ± 134	388 ± 214	p = 0.052
limb movements	214 ± 126	349 ± 192	**p = 0.042***
ear flicking	2.9 ± 4.0	1.7 ± 2.2	p = 0.694
nose licking	9.4 ± 6.5	13.2 ± 16.5	p = 0.323
licking itself	4.5 ± 5.0	5.3 ± 4.9	p = 0.751
look at/sniff at neighbour	20.5 ± 15.4	18.2 ± 16.0	p = 0.807
Pain indicators (#)			
transition in posture	5.5 ± 2.0	3.7 ± 0.9	**p < 0.001****
aggressive behaviour	0.7 ± 1.7	0.9 ± 2.6	p = 0.814
vocalisation (loud and soft)	24.6 ± 31.3	49.2 ± 91.0	p = 0.335
vocalisation loud	3.2 ± 5.1	3.2 ± 5.1	p = 0.095
vocalisation soft	20.3 ± 28.6	15.7 ± 16.2	p = 0.716
lip curl	0.59 ± 1.50	0.38 ± 0.65	p = 0.738
rumination quality	47 ± 18	66 ± 13	**p < 0.001****
reaction to noise			
- reaction	29%	31%	p = 0.935
- no reaction	71%	69%	
wound pressure left			
- reaction	94%	31%	**p = 0.016***
- no reaction	6%	69%	
wound pressure right			
- reaction	6%	15%	p = 0.412
- no reaction	94%	85%	
vulva pressure			
- reaction	12%	62%	**p = 0.014***
- no reaction	88%	38%	
eye white			
- no eye white	12%	8%	
- eye white seen once or twice	41%	31%	p = 0.485
- eye white seen more than twice	47%	62%	
Activity budget (in sec)			
eating	595 ± 602	1998 ± 775	**p < 0.001****
rumination	1680 ± 1264	2471 ± 1578	p = 0.101
lying (left or right)	4802 ± 1948	2372 ± 2472	**p < 0.001****
lying left	1421 ± 1755	1174 ± 1993	p = 0.665
lying right	3382 ± 2209	1198 ± 1994	**p < 0.001****
standing	3292 ± 1945	5728 ± 2472	**p < 0.001****
leaning	107 ± 277	78 ± 154	p = 0.751

x ± s represents the mean ± 1 SD.
* p < 0.05
** p < 0.001

A higher frequency of transitions on D3 from standing to lying and vice versa could indicate an attempt to alleviate discomfort due to pain. Alternatively, this behaviour could have increased due to a higher drive to forage. The higher resting time and decreased standing time in CS cows on the first day post partum, can be interpreted as a probable pain indicator. On D1 the CS group laid down more on their right side ($P < 0.001$), but contradictorily, this was not observed during the subsequent days, and they did not lay down less on their left side (even at D1). This relative shift to the right side seems to indicate that the wound side is more painful. Cows of the CS group reacted significantly more when pressure was put on the left flank on D1, D3 and D14, whereas naturally calving animals only showed more reaction on D1 when the area around the vulva was pressed.

These results suggest that both parturition types provoke some pain and discomfort i.e. when the wound side for the CS group and the vulva area for the naturally calving group was squeezed. Pain after pressure apparently subsides faster in animals of the naturally calving group.

Based on the results of the present study, we can conclude that there are some significant short-term behavioural differences between Belgian Blue cows that calve naturally and those that deliver by CS, but in general, the differences are subtle and of short duration.

Notes

Notes

Prof. Todd Duffield

Todd graduated from the Ontario Veterinary College (OVC) in 1990 (DVM) and worked for 4 years in a large dairy practice in eastern Ontario, Canada. He returned to OVC in 1994 and completed a Doctor of Veterinary Science (DVSc) degree in 1997. He is currently a Professor in the Department of Population Medicine, OVC, University of Guelph. Todd's time is split approximately 50% for teaching and 50% for research. He teaches in all years of the undergraduate veterinary program and works 1 to 2 days per week in the OVC ruminant field service veterinary practice.

He is actively involved in dairy research, graduate supervision and teaching. He has authored or co-authored over 90 peer-reviewed articles on several aspects of dairy health management including transition cow metabolic disease, use of monensin in dairy cattle, Johne's disease, Neospora abortion, and more recently strategies for minimizing pain in cattle. He has spoken on many of these areas of dairy health management in several countries including Italy, Spain, Mexico, Argentina, Australia, and Japan. Todd was on sabbatic leave with Ian Lean at Strategic Bovine Services in Camden, Australia in 2007 working on learning meta-analysis methods.

Assessing indicators of pain and discomfort in the peripartal cow following dystocic calving in dairy cattle

Todd F. Duffield and Nathalie C. Newby
Department of Population and Medicine, University of Guelph, Guelph, ON, Canada

Introduction

Parturition is a necessary event for production that happens every day on dairy farms across the world. A dystocia is defined as a cow that requires assistance for calf delivery (Mee, 2004). Dystocia rates for dairy cows have been reported to be higher in North America (>10%) compared with other parts of the world (<5%) and regardless of country are much higher in primiparous animals (Mee, 2008). Dystocic calvings have been classified into two main levels, depending on the difficulty of calf delivery (Proudfoot et al., 2009). The first category is an easy pull and is defined as an assisted calving requiring only one person to extract the calf. The second category is a hard pull where either two people or the help of a calving jack are needed to assist the dam. A third level could be included where surgical intervention (fetotomy or c-section) is required to extract the calf but this latter category is infrequent and often is lumped into category two.

Impact of dystocia on dry matter intake (DMI) and milk production

Changes in dry matter intake in the periparturient cow have been used as a tool to identify cows at risk of postpartum complications (Drackley, 1999; Grummer et al., 2004). Proudfoot et al. (2009) have shown that the dry matter intake for cows that experienced dystocia was lower 24-48 hours prior to calf delivery and 48 hours after calf delivery compared to cows that were not assisted. Since feed intake and milk production are closely related, a decrease in feed intake will correspond to a decrease in milk production. There has been little research to examine the effects of dystocia levels on feed intake and milk production in dairy cattle.

Dystocia and Haptoglobin

Calving is an inflammatory event, and studies have shown an increase in acute phase inflammatory proteins, such as haptoglobin, following parturition (Koets et al., 1998; Humblet et al. 2006). Schonfelder et al. (2005) observed higher levels of haptoglobin concentration in animals with dystocia after uterine torsion compared to animals with natural parturition after 5 days postpartum. No studies in cattle have examined haptoglobin concentrations following different dystocia categories.

Behavioural changes associated with dystocia

The activity of the cow increases quite dramatically prior to calving. It has been suggested that this increased restlessness may be due to discomfort (von Keyserlingk and Weary, 2007). Houwing et al. (1990) reported a significant increase in the number of standing bouts within the three hours immediately prepartum. Huzzey et al. (2005) found that during the three days prior to calving, the number of standing bouts increased by 80% in dairy cows housed indoors. Lying time was shorter and lying bouts more frequent in cows requiring calving assistance (Misch et al, 2006). Cows that were treated with disinfectants to induce vaginal irritation (as might be created by tears or lacerations following birth) showed specific behavioural changes – tail lifting and pressing and occasionally groaning (Grussel and Busch, 1998). Thermal nociception testing has also been used successfully in cows to assess pain response (Machado et al, 1997).

Dystocia and analgesia

There is limited work published on the impact of analgesia at calving in dairy cows. Consumption of the amniotic fluid by the cow was shown to provide some analgesic effect (Machado et al, 1997). This effect of amniotic fluid has also been documented in rats (Kristal et al, 1990). Because of our management recommendations, many dairy cattle may not get the benefit of ingestion of amniotic fluid. It is much better for calf health if the calves are removed from their dams immediately after birth. Also, most dystocias result in rupture and dispelling of most of the amniotic fluid prior to the delivery of the calf. In addition, up to 10% of dairy calves may be stillborn and, the amniotic fluid from these dystocias may not provide the same degree of analgesia as a normal calving.

Treatment of dairy cows at calving with flunixin meglumine has been shown to have negative effects, including decreased DMI (Shwartz et al, 2009) and increased risk of retained placenta (Duffield et al, 2009). However, treatment with ketoprofen on the day of, and day following, calving tended to reduce the incidence of retained placenta (Richards et al, 2009).

Approximately 1 year ago, we embarked on a randomized clinical trial to assess the impact of meloxicam (Metacam®, Boehringer Ingelheim) in dystocic calvings in dairy cows administered 1 day following parturition. This research project is still ongoing. The following preliminary report is an evaluation of completed trial cows comparing dry matter intake, milk production and serum haptoglobin levels between two different levels of dystocia: easy versus hard pull during assistance to the dam. The hypothesis is that animals with easy pulls would have greater dry matter intake and milk production, and lower serum haptoglobin levels compared with animals that experienced hard pulls.

Impact of dystocia severity on DMI, milk production and serum haptoglobin

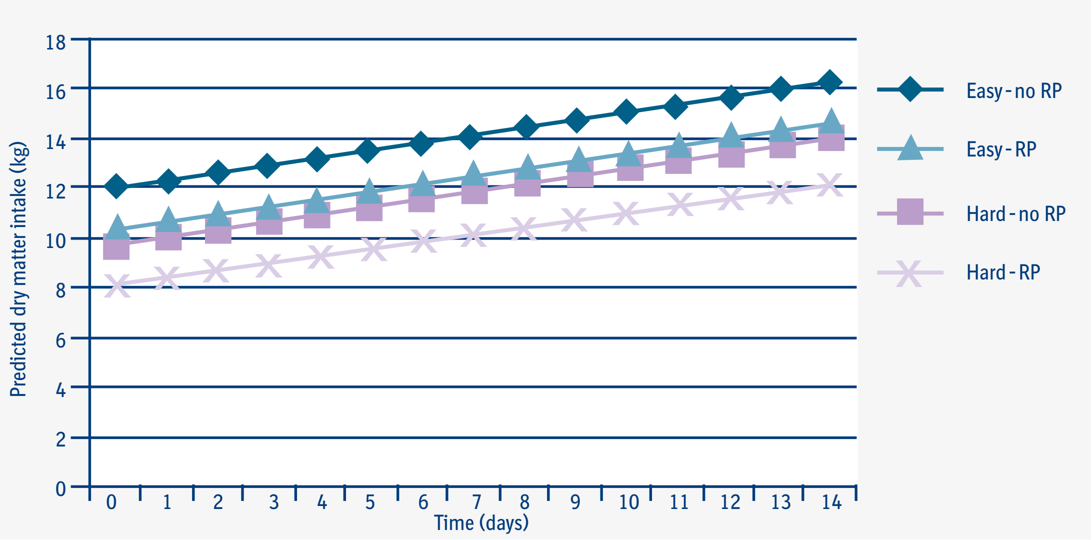
Material and Methods

For the purpose of this preliminary summary, forty-eight dairy cattle (31 heifers and 17 cows) with dystocia were used for the haptoglobin component of the results, and 35 of these animals (23 heifers and 12 cows) have complete milk and dry matter intake records. Calving dif-

ficulty scores were 1= easy pull (one person only) and 2= hard pull (two people with or without a calving jack). A retained placenta was a retained fetal membrane after 24 hours following calving (average time of retained placenta was 2.5 ± 0.6 days, with a maximum of 6 days). The animals were housed in individual maternity pens a few days prior to calving and up to 2 days following calving at the Elora Dairy Research Center, University of Guelph, Guelph, Ontario. The animals were then moved a tie-stall. Feed intake was recorded when the animals were in the maternity pens and up to 14 days postpartum. Feed samples were collected and dried to obtain moisture content in order to convert feed intake into dry matter intake. Milk weights were also recorded twice daily for 14 days postpartum. Blood samples were collected via coccygeal venipuncture following assisted calving and on days 3, 6, 9 and 12 postcalving. The blood was centrifuged and the serum was stored at -20°C until it was analyzed for haptoglobin by the Animal Health Laboratories, University of Guelph, Guelph, Ontario.

The data were analyzed in STATA (STATA 10.0, StataCorp, Texas, USA) using multilevel mixed-effects linear regression with repeated measures for dry matter intake, milk production and serum haptoglobin levels comparing dystocia levels easy and hard pulls. In all models, retained placenta was a confounder variable. For the haptoglobin models, time was a continuous variable with a quadratic term to compare dystocia levels in the first model, and time was also modeled as a categorical variable to investigate the effect of time on haptoglobin levels in general in the second model. For all models, predicted values for the dependent variables were generated and used for graphical representation of this preliminary data. The models were tested for normality and homoscedasticity. The statistical significance was set at $p<0.05$.

Figure 1. Predicted dry matter intake (kg) for the first 14 days postpartum using the preliminary data for heifers and cows with assisted calvings (Easy versus Hard) with a retained placenta (RP) or without a retained placenta (no RP). Hard versus Easy pull (p=0.098), the RP versus NO RP groups (p=0.049).



Results

Dry Matter Intake

The dry matter intake of animals postpartum increased over time for the first 14 days but was not significantly different between heifers and cows. The dry matter intake was not significantly different (p=0.098) between dystocia difficulty easy versus hard pull while controlling for retained placenta over the 14 day period postpartum.

However, the dry matter intake between cows with no retained placenta and with a retained placenta within each dystocia level was significantly different (p=0.049). Figure 1 represents the predicted dry matter intake values for each dystocia level with and without a retained placenta.

Milk Production

The milk production for all animals increased over time for the first 14 days, and was significantly greater in cows compared to heifers (p<0.001). However, there were no difference between difficulty, easy versus hard pull, while controlling for parity and retained placenta over the 14 day period postpartum (p=0.098).

Serum Haptoglobin Levels

Following analysis where time was a continuous variable, there were no differences between easy pull and hard pull serum haptoglobin levels (p=0.882), but there was a retained placenta effect which was an interaction term with time (p=0.002) and time squared (p=0.001). In other words, haptoglobin levels changed over time in a quadratic fashion (Figure 2). This was not different whether the animal was a heifer or a cow. When time was modeled as a categorical variable, haptoglobin levels at day 3 and day 6 were significantly greater than at day 0 (Figure 2).

Discussion

The dry matter intake for all animals increased in a linear fashion following parturition, and there were no significant difference between heifers and cows. There was a significant reduction in dry matter intake in both dystocia levels for animals with a retained placenta compared to animals with no retained placenta. Although

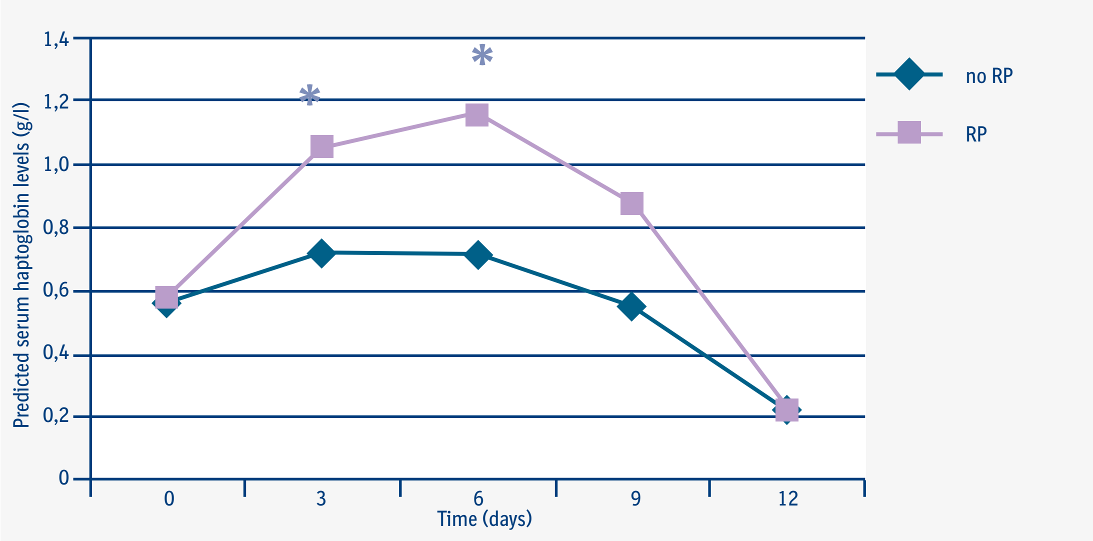


Figure 2.
Predicted serum haptoglobin levels (g/L) over sample period up to 12 days postpartum using the preliminary data for heifers and cows with assisted calvings with a retained placenta (RP) or without a retained placenta (no RP) for the first 12 days postpartum. The serum levels for days 3, 6, and 9 were different between the RP and no RP groups ($p<0.001$). Stars indicate a significant difference in serum haptoglobin for both the RP and no RP groups compared to day 0 ($p<0.001$ for day 3; $p<0.005$ for day 6).

there were no significant difference in dry matter intake between easy pulls and hard pulls, it is noteworthy that trends are emerging. Easy and hard pull animals with no retained placenta tend to eat more than easy and hard pull animals with a retained placenta respectively. Furthermore, easy pull animals with no retained placenta have the greatest intake, while hard pull animals with a retained placenta have the lowest intake. There is a definite need of further animal enrolment in order to increase statistical power.

As expected, heifers had a lower milk production than cows. Similar to the dry matter intake results, there were no differences between dystocia levels, but there were differences between animals with retained placenta and no retained placenta. In the literature, it has been demonstrated that retained placenta results in significant milk loss in dairy cattle (van Werven et al., 1992; Rajala and Grohn, 1998; Bareille et al., 2003).

Haptoglobin levels in the blood increased following parturition, peaked between days 3 and 6, and then decreased over time to be below parturition day sample at day 12. Although there were no differences between easy and hard pulls, animals with a retained placenta had significantly higher haptoglobin concentrations on days 3, 6, and 9, compared to animals that had no retained placenta. The time to peak of haptoglobin, around day 6 in this report, is similar to the time to peak found after 5 days in the study by Schonfelder et al. (2005). The serum levels found in this report are quite similar to those found in dystocia animals in the study by Chan et al. (2004).

In conclusion, animals with a retained placenta following assisted calving ate less, produced less milk, and had higher serum haptoglobin levels compared to animals with no retained placenta 24 hours following calving. Although no significant differences were found in the present report, emerging trends in the dry matter intake and milk production suggest that animals assisted with an easy pull have a better feed intake and milk production compared to animals assisted with a hard pull. Further research is needed to compare easy versus hard pull in animals experiencing dystocia, accounting for retained placenta in these animals.

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Notes

Henri de Thoré

Henri de Thoré is a graduate in agriculture and ecology from the "école nationale d'ingénieurs des techniques agicoles" of Dijon (1981), also gaining a masters degree in management (university of Rennes 1992). After one year carrying out research on salmon farming (IFREMER, Brest 1980), he began to manage his own cattle farm in Brittany and started pig farming (60 sows) one year later. There are now 700 sows and 6000 pigs on his farm (farmed under Label Rouge production until 2008).

He is a member of the board of FNP/FNSEA (the syndicate of French pig farmers) and of the co-operative AVELTIS (4 million pigs per year) and is a stakeholder representative in the French pig production organizations (syndicates, cooperatives and inter-professional organisations) for welfare issues and is also a member of the board of European Pig Producers (EPP).

He represents pig farmers in the Welfare Quality® Advisory Council.

How much animal welfare can farmers afford to deliver?

Henri de Thoré
Pig producer, Elevage de Menez-Kamp, Menez-Kamm, 29540 Spézet, France

It is clear to everybody that farmers can only afford to devote financial resources to animal welfare if the market is willing to pay sufficiently higher prices for meat products to cover these extra costs. I would therefore like to put forward the notion of overall costs in the realm of pig production, and its consequences on increased value of the meat, on overall consumption and competition, and the overall impact on pig production.

Welfare carries significant additional costs.
To take one example, group housing of sows (instead of individual pens) cost 1000 € per sow, which is the equivalent to one entire year's sale of piglets, and the annual cost of paying off of this investment in a farm of 200 sows is equivalent to the annual salary of the farmer.
To take another example, the change from fully slatted to partially slatted flooring cost 1000 €/pighousing, which is one year's margin generated by this same housing. Again, if a farmer opted for immunocastration of piglets, this would cost 10 % of the farm gross income margin each year.

But to answer 'how much welfare can farmers afford?', we need first of all to quantitatively assess additional animal welfare. It is useful to start by recalling the following points:

In the Europe of 2010, pig farmers pay considerable attention to the welfare of their animals, and already devote considerable resources towards it.

- This is confirmed by the results of the enquiry carried out by the WELFARE QUALITY PROJECT®, which established a group of indicators.

- EU regulations are already very strong as regards pig welfare. Granted, the recent PAULSEN report suggests that certain regulations are currently imperfectly applied. However, the DG SANCO (Directorate General for Health and Consumer Affairs) is currently looking into this subject, and will shed light on why this is the case. This will enable us to proceed further.

- Finally, those that cast a critical eye on farm animal welfare in Europe should direct the other eye towards the rest of the world, notably towards Africa, Latin America, and above all Asia, where more than half the pigs on the planet are to be found. This would have a salutary effect, and modify their opinions.

In Third World countries, the Food and Agriculture Organization (FAO) and the World

Organization for Animal Health (OIE) have barely begun to consider animal welfare, focussing mainly on transport and slaughter, and fail to consider issues of rearing. The World Trade Organization (WTO) refuses to consider this question in trade negotiations. There is an immense amount of work required to achieve a level playing field, and it is essential to take into account the cultural differences between the various countries.

This gap between production methods across the world has a considerable impact on competition. If we take a look at how this works, we will be better able to evaluate the actual consequences for farmers.

Economic impact and the consequences of additional costs: competition, vulnerability and mutual dependence

Characteristics of the pig market

- The pork industry is a global business with pork products circulating from one country to another on a daily basis. Large volumes circulate and the importation of cheaper products into a stable market is sufficient to lower prices across the entire market. Therefore a rise in prices to compensate for a rise in the cost of production is quickly neutralised by the importation of cheaper meat from abroad.

- The price sensitivity of pork is very strong. A 1 % increase in volume will result in a 7 % reduction in price. This contributes to accentuating the above phenomenon.
- The costs of production in Europe are pretty similar from one country to another, but widely spread within each country.
- In 2007 and 2008 the average recorded price of pork in Europe was less than the average cost of production. More than half the farmers are now in deficit. In 2009 the average price was equal to the cost of production. Half the farmers are weighed down by deficits already accrued by failing to pay off the debts of the 2 previous years.

The consequence of these characteristics is that a rise in costs in Europe, even minor, will put a considerable number of farms and farmers at great risk. Some farmers retain a good capacity for investment and adaptation, whereas a considerable number that recently have just been coping will pass into deficit.

The consequence is a reduction in production that in practice will not be compensated by expected efficiencies, such as consolidation of farm units and improved reproduction rates. This phenomenon is slow, because farmers will stretch themselves to their financial limits, and the majority of farms that disappear will be due to non-competitive farms failing to be passed on. The best illustration of this phenomenon can be seen in Europe. Great Britain lost 40.1 % of its production between 1995 and 2008, following the adoption of stricter welfare norms than those in the rest of Europe.

Is it possible to compensate for higher production costs by an increased market value placed on animal welfare?

The perceived market value placed on animal welfare varies from one country to another. Concern for animal welfare varies between Member States, and the geographical map of this concern often reflects the religious variations of the different production areas. Liberal concerns and animal rights issues are more marked in Protestant countries than largely Catholic countries. The animal rights concerns of Anglo-Saxon consumers allow an increased market value from stricter welfare regulation, but this is not feasible in all Member States.

For example, Freedom Food is a UK food labelling scheme that focuses solely on improving the welfare of farm animals reared for food. Freedom Food is very successful in Great Britain, as is a similar scheme, Neuland, in Germany, whereas the adoption of animal welfare standards in the regulation of 'Label Rouge' for ham in France has raised the price of this ham and reduced consummation by 44 %, and thus reduced the number of farms prepared to meet the requirements of the 'Label Rouge' production standards.

It is very much in order, therefore, to question the relevance and the consequences of strict rules that would be common to a group of countries where consumers have different cultures, concerns and expectations. The possibility of new EU animal rights standards, with the attendant added market value, risks provoking a concentration of production in Member States which are capable of responding to local demand, where the consumers are prepared to pay for the extra costs linked to animal welfare. This can be seen currently in Germany and Holland.

On the other hand, there is a risk that farms will reduce in numbers in countries such as France and Spain, where the consumer would not be prepared to pay extra for animal welfare if the farms were to be submitted to the same constraints and the same costs. In those countries, consumers will probably buy less pork meat or favour cheaper imported meat.

New welfare standards that would be strictly and evenly enforced in every Member State may therefore lead to an unfair distortion of competition. Should legislation prevent farmers from producing meat according to local cultural standards?

For a global approach to the questions of society regarding farming

Over and above the social aspects and rural activity that the risk of a reduction in farming suggests, the gamble for Europe is that of its independence and autonomy in food, and the potential lack of control in terms of food safety. Are we ready to follow the example of Great Britain, and allow other geographic zones, to produce our food supplies, following standards that would have become illegal across Europe?

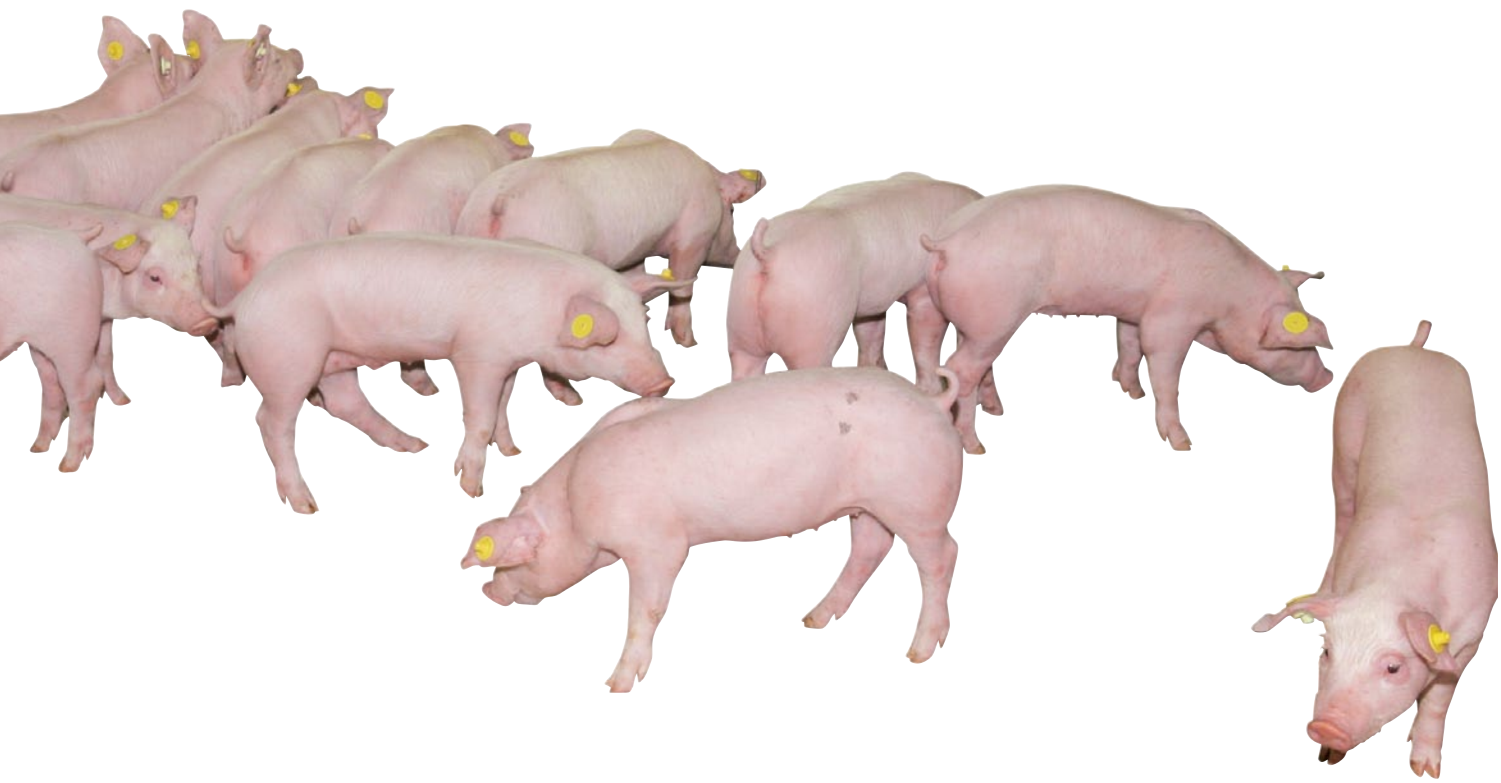
Furthermore, it is useful to analyse all the consequences of farming methods that might be promulgated in the future. One could cite, amongst other examples, the question of gas emissions linked to partially slatted flooring, or when rearing on straw, the question of gas emissions linked to transport, the greenhouse effect linked to composting the litter, or the disease and public health risks (Salmonella) linked to control of the quality of litter, etc. These issues can place farming up against the general public, which might in turn create new taxes to compensate for the 'environmental damage', which will in its turn render pig farming even more vulnerable.

Thus these issues are not simply something for the farming industry to sort out, but require political solutions. Adoption of animal welfare rules demands a global vision that takes account of the many social aspects impacted by any decisions. It requires, from the European Commission, wide-ranging and searching studies of their impact, covering economic, social and environmental problems. Today's data is currently too partial and insufficient, which plays into the hands of the animal rights sympathisers and certain non-governmental organizations (NGOs), who only see, or perhaps only choose to see, the animal welfare aspects.

So, will farmers have the tools to assure the welfare of their animals?

They will have the tools that society and governments allows them, for they will decide the hierarchy of priorities and make their choices. These choices will shape the markets of tomorrow. They will definitely help to improve the welfare of farm animals. However, legislators should be attentive to the actual consumers' needs and expectations, and allow regulation and the market to change at the same pace.

If these political choices favour increased animal welfare, then providing new animal welfare legislation is enacted with vision, and above all is evidence-based, farmers will be more than happy to deliver the goods.



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Prof. Alistair Lawrence

I was born into a farming family in Perthshire, Scotland and studied Zoology at St Andrews University. As a postgraduate I moved to the University of Edinburgh initially to take a one year diploma in animal science, and then to study for a PhD under Professor David Wood-Gush one of the pioneers of farm animal welfare research. Following this I was employed as Research Assistant to then The Principal of the School of Agriculture (Professor Peter Wilson), before becoming responsible for behaviour and welfare research at SAC.

I currently head the Animal Welfare Team at SAC and am also acting head for the Sustainable Livestock Systems Group. SAC's welfare research aims to improve targeted animal welfare problems, develop scientific approaches for assessing animal welfare and integrate the biology of animal welfare with economics. I also have an interest in developing wider public understanding of animal welfare particularly in young people. I currently hold a joint position with the University of Edinburgh Veterinary School where I help oversee delivery of welfare teaching to undergraduate veterinary and masters student. I recently finished a 9 year spell as a member of the UK Farm Animal Welfare Council.

Animal welfare and profitable farming: getting the best of both worlds

Alistair Lawrence and Alistair Stott
Scottish Agricultural College, Edinburgh, UK

Animal welfare is a high profile ethical concern for the physical and mental health of animals under our care. The idea that we (as citizens) should be concerned for animal welfare has been developing since the 18th century, but it was in the mid-1960s that Ruth Harrison's book 'Animal Machines'[1] matched concerns for animal welfare with the development of more 'intensive' livestock production systems[2]. This led inevitably to a polarisation of views, with animal welfare activists pointing to the adverse welfare impacts of intensive systems such as the battery cage. On the other hand the farming industry justified these same systems on the basis that they were a necessary development, being more efficient and also providing other benefits such as improved animal health. In this debate it was quite possible for the animals' 'voice' to be lost amongst headlines such as 'free range is better' or 'animals can only produce if their welfare is good'. Much of the application of science to animal welfare issues has been devoted to developing scientific approaches aimed at better characterising the animals' perspective of welfare issues.

More recently the debate in the UK and the EU between farm animal welfare advocates and the farming industry has moved onto less confrontational territory with more of a focus on finding acceptable solutions. There appear to be several reasons for this. Prior to 2000, legislation had been the main pillar of government policy to improve welfare (e.g. UK legislation phasing out the use of sow stalls in 1999). There are sound economic reasons for using legislation to impose minimum animal welfare standards, if animal welfare as an issue is likely to be subject to 'market failure' (i.e. where it is undervalued in the free market). However, UK government policy took a shift in 2004 with the publishing of the GB Animal Health & Welfare Strategy[3], which emphasised the wider roles and responsibilities of all stakeholders (including consumers) in improving animal welfare. In a similar vein the EU published its animal welfare action plan (2006-2010) which aimed to increase dissemination of best practice and information to consumers to allow them to make informed choices[4]. This shift coincided with the growth of farm assurance schemes which opened up the possibility that the food chain could help regulate and improve on-farm welfare through standards developed by industry based farm assurance schemes. A number of studies have demonstrated that the public are in principle 'willing to pay' for welfare improvements[5]. Yet the values generated in such willingness to pay studies are always greater than those seen in real life consumer behaviour. One reason put forward for this 'mismatch' is the relative invisibility of animal welfare attributes in products and hence the difficulty consumers' face in making informed choices about products varying in their welfare attributes. For this reason increasing emphasis is being placed on better integration of animal welfare into the food chain, for example through labelling linked to the use of scientifically robust methods for assessing welfare on farms[6]. At SAC we have developed an approach to assessing welfare on farms (qualitative behavioural assessment) which is showing considerable promise as a scientifically sound yet practical approach, which addresses public concerns and has at its basis stockmanship skills in observation of animal behaviour[7].

We believe that in improving on-farm welfare it is also important to consider the capacity for farmers to supply more welfare. In this context we are interested in the extent to which welfare and business interests can be matched-up, but also in estimating any potential losses incurred in improving welfare, as this information helps to pinpoint where consumers' 'willingness to pay', most needs to be directed . We believe there are some important issues that are brought into focus when we consider the supply of welfare; for example the relationship between farming 'intensity' and animal welfare. Scientific evidence from welfare studies suggests that we should be cautious about drawing simple conclusions, as the relationship between intensive production systems and animal welfare is usually complex, and that animals' day to day experiences are key to animal welfare; as far as the animal is concerned the 'devil is in the detail' not the headline[2].

Another important issue which underlies the supply of welfare is the extent to which welfare is really a cost. There are a number of examples of 'system components' where improvements to welfare and farmers' interests are matched including improving animal health and neonatal survival, and reducing impacts of animal temperament on welfare and production[2]. At a higher level of complexity we can consider how to optimise welfare within a production system. We have been working on this sort of problem using combinations of resource economics and animal science. Our work initially considered welfare in extensive sheep production, and has demonstrated the potential for individual sheep farms to choose management options to improve welfare at little or no additional cost[8]. We have extended the approach to the issue of the farrowing crate which has long been an unresolved area of welfare concern, given the dilemma between protecting piglets and humans versus allowing the farrowing sow greater behavioural freedom. Our most recent results indicate that a pen designed to accommodate the needs of the sow, piglets and farmer has potential to achieve higher levels of welfare, again at little cost or even with a financial benefit[9].

This work demonstrates the importance of understanding the relationships between inputs to systems intended to improve welfare and overall performance of the system (either in physical or financial terms). These relationships are important because they can account for hidden benefits or costs of improving welfare; the cost of supplying an input to improve welfare

may be offset (partially or wholly) by related benefits. For example in a recent analysis of the economic costs of improving dairy cow welfare in Denmark[10], it was concluded that improvements to cow housing might be better value for money, than requiring farmers to provide cows with compulsory grazing. However this cost: benefit analysis does not take account of the interaction of these 2 strategies with the incidence of cow lameness, an important welfare issue with well known financial costs[11]. The length of time cows spend on grass is well known to have beneficial effects in reducing cow lameness[12]; such 'hidden' benefits need to be accounted for in arriving at the net financial value of providing welfare improvements.

We can also use economic modelling to look beyond the farm-gate in order to understand how improvements to welfare will affect wider (industry level or even national) concerns. At SAC we have developed an economic approach known as partial equilibrium (PE) modelling, to explore how improvements to animal welfare could affect trade and environmental outputs including green house gas emissions. Using a relatively straightforward welfare issue as a case study (the use of high fibre diets fed to sows in pregnancy to improve piglet survival), the PE modelling found, associated with a reduction in piglet mortality, an improvement in trade volumes and an environmental benefit; in other words the analysis was able to quantify positive effects on multiple sustainability goals (a 'win-win-win' scenario) [13]. We are currently expanding this work to assess the wider impacts of more complex welfare improvements including the phasing out of battery cages for laying hens and a move from farrowing crates to designed farrowing pens.

In conclusion the debate over farm animal welfare is at a cross-road. In the past animal welfare concerns were somewhat disconnected from mainstream livestock farming, mainly concerned with pointing to the welfare problems of intensive farming rather than seeking widely acceptable solutions. Today animal welfare has moved to being one of a number of issues (externalities) that need to be accounted for and resolved when producing meat and other animal products. There are risks in this new situation not least because other externalities (e.g. climate change) may be seen as having a higher priority than animal welfare. There is however also an opportunity to ensure that welfare is more central in decisions made across the food chain with respect to livestock production. In this paper we have illustrated the application of a combination of economics and animal science to the supply of animal welfare and analysis of the cost and benefits of improving welfare. There are significant challenges in this approach, such as the estimation of the hidden benefits and costs of improving welfare and how we value welfare against other externalities.

However the approach does provide a rational basis for farmers, retailers and policy makers to better understand the choices they face in improving animal welfare in the real world.

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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

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